

CITY OF PORTLAND, MAINE
Standing Committee on Sustainability and Transportation
Councilor Andrew Zarro, District 4, Chair
Councilor Roberto Rodriguez, At-Large
Councilor Victoria Pelletier, District 2

Agenda
January 12, 2022
5:00 PM

Remote Meeting

Please click the link below to join the webinar:

<https://us02web.zoom.us/j/86393383109?pwd=SzRtVXROOFhhdXhZajlmUG4zKzhjdz09>

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1. Review and approve minutes from November 10, 2021
 - a. November 10, 2021 Minutes
2. Sustainability Program Updates
 - a. Sustainability Updates
3. One Climate Future Overview and 1st Year Progress
The One Climate Future plan can be viewed online at <https://www.oneclimatefuture.org>
 - a. Portland One Climate Future End of Year Report
 - b. One Climate Future
4. Community Resilience Self Assessment
Presentation by Troy Moon, Sustainability Director Public comment will be taken
 - a. Portland Resilience Self Assessment
 - b. Climate Vulnerability Assessment
5. Resolution to join the State of Maine's Community Resilience Partnership
Public comment will be taken
 - a. Resilience Self Assessment
6. Discuss work plan / Committee goals and objectives
No public comment

CITY OF PORTLAND, MAINE
Standing Committee on Sustainability and Transportation
Councilor Belinda Ray (D1), Chair
Councilor Andrew Zarro (D4)

Draft Minutes November 10, 2021

Members Present: Councilor Ray, Councilor Zarro

Staff Present: Troy Moon, Jeremiah Bartlett, John Peverada

Meeting called to order.

October Minutes

Councilor Zarro moves to approve the September meeting minutes. Councilor Ray seconds the motion. October minutes passed unanimously, 2-0.

Sustainability Update

Presented by Troy Moon

The Sustainability Office assisted the consulting team working on the State's strategy for deployment of distributed energy resources and discussed the role they should play in increasing capacity on the grid. We are adding another cart to the community composting drop site at Clark St Garden. The leaf collecting program will be donating leaves to a farmer in Bowdoinham. Over the past year, EV drivers used 23.5 mWh of electricity from our chargers. That is about 33,000 gallons of gasoline that were not burned by cars. Our chargers were used for 2,346 charging sessions. We are installing 4 DC fast chargers and 44 level 2 charging stations that will be announced shortly. The goal is to have Portland be an EV charging hub for the state.

New part-time Sustainability Associate, Erin Ferrell, started in late October. The next Coffee and Climate series is on Friday Nov 12th with the topic being recycling. December's Coffee and Climate will focus on an annual report on the progress made on One Climate Future program this year.

Committee Comment on Sustainability Update

Councilor Zarro is happy to see the 33,000 gallons of gasoline saved due to the city's EV chargers. Asks if there is a way to know how many distinct cars use the chargers. *Troy clarifies there are at least 100 different cars each month. The new chargers are to be installed in March or April 2022.*

Councilor Ray asks how often are we using the overtime fee? *Not often. We do not make much revenue from this, just about \$1,000. The charge occurs when the car stays past the amount of time it takes to charge.* Councilor Ray asks if there will be another Resilience Corps member this year. *We did not have the budget to request another Resilience Corps member. We would*

need to put up around \$3,500. Councilor Ray would like to follow up on requesting the funds to have another Resilience Corps member.

Bayside Parking

Presented by Jeremiah Bartlett

Bayside Parking Changes Requested by the Szanton Company Summary and Status

Furman Block: the Szanton Company. Project approved in July 2018 and consists of 51 age-restricted units. The project provides 18 on-site parking spaces and construction was completed in 2021. Szanton parking requests included adjusting a total of 89 on-street spaces around their site and mostly geared toward residents.

Parking changes to date include:

Marginal, South Side, Wixnet-Hanover went from 2-hour metered to unmetered parking.

Marginal, South Side, Enterprise to Chipotle went from unregulated to 2 hr metered parking.

Marginal, South Side, Forest to Enterprise went from no parking to 2 hr parking.

Kennebec, North Side by Chipotle markings were removed for clarity.

Kennebec, South Side, Forest and Brattle changes were not supported by DPW. This area is included in a smart corridor study. The shift of this street will be an outcome of that study.

Marginal, North side, West of Preble additional signage was placed to convey availability of unrestricted parking.

Parris St parking associated with 52 Hanover gained 7 additional on-street parking spaces.

Hanover st parking associated with 52 Hanover is no longer supported by the Portland Fire Department due to the width of the street

Hanover, West Side, by USPS: DPW/Emergency concerns with USPS operations- no spaces were added due to emergency services access and concerns from the USPS.

Brattle Street is generally too narrow for on-street parking. Plan to reassess potential for two on-street spaces on east side north of Forest ave.

Marginal, South Side, Chestnut East gained 15 2-hour spaces. A redevelopment project added 10 2-hour spaces in the same area near Dunkin Donuts.

Public Comment on Bayside Parking

Email from the public asked what the highest and best use for streets is? If we have space, are there opportunities? *Jeremiah agrees this is a good topic to discuss and they plan to touch on this.* Also asked what is the level of preferential parking provided for high school students?

John Peverada says we do provide preferential parking spaces for Portland high school students. Several areas were identified. There are likely 40 parking spaces labeled for Portland High School students. Councilor Ray points out that we do not provide the same preference for Baxter High School. This is something to possibly revisit. All students have a free metro bus pass.

Nathan Szanton speaking on the Furman block, the Kennebec st closest to Forest Ave, is parking near there part of the new redesign? *Kennebec st east of Forest ave, plan will come out next year. Would like to add spaces but the details are not available.* Marginal way near where

there were emergency concerns, what were the concerns? Is USPS able to veto adding additional spaces? *Hanover st and post office- post office would be difficult to persuade as well as emergency services.* Brattle street- seems to have a lot of space for additional parking spaces. Would recommend making it a one way street to allow for more parking. *Brattle st becoming one-way would be difficult with many studies recommending as many streets as possible be two-way. This could be something to discuss and would like to work with the post office starting next year. Would like to revisit how the one-way streets function in Bayside.*

Sarah Michniewicz from Bayside neighborhood association points out the need for a convenient parking garage in Bayside. The addition of the Marginal Way spaces is good but not where there are more people in the vicinity of 82 Hanover St. People are parking on the streets in the area of 52 Hanover but that is now not available. What is preventing the additional spaces from being considered? *The DPW concern on Hanover is for emergency services. This requires conversations with the post office and fire department. If those spaces were brought to life, they would require council action. The reason these have not been implemented yet is because emergency staff is not in favor.*

Jim Hall from Cedar St comments on the general need to plan around the development in the area. Approving only 18 spaces for many more residents being added is not enough. Spaces should be added in Bayside instead of around it.

George Rheault notes the Szanton project was to complete a study on parking 6 months into their project and it is not available. *Parking study for the Furman Block would be helpful information to know. The information is unknown at this time.* Walking around the area near the project there are cones there for an unknown reason. Is this part of the additional 18 spaces being added? There is a parking garage in Bayside that is closed on weekends. Can that garage be used to provide more parking spaces throughout the entire week? *John Peverada notes the developments that have come in, they provide a parking plan and had said they would provide enough parking. There is minimal business at the Elm st parking garage on weekends. Revisiting the Market place parking would be a possibility.*

Councilor Zarro agrees Bayside can be difficult to navigate. What is the parking deficit we are trying to make up for? *We do not have that information. Have noticed where there is more development, there is an uptick in parking demand. Also a question of demand by time. In the morning, afternoon, and night. Would need to do an in depth study but the Planning Department is not able to do it currently.* Councilor Zarro would be in favor of making this study more of a priority for Bayside and other neighborhoods as well. One way streets make drivers unlikely to stop and that does not make a pedestrian centered city. Notes exploring the vacant parking garage could be a possibility. Post office is a big footprint and it is important to have them be part of the conversation.

Fees for Solar Installations

Presented by Troy Moon

Have been looking at our solar fees and reducing them so they are not a barrier to installing solar. OCF encourages people to electrify everything and prioritize renewable energy. We would like to align our fees with our policy goals. Arrays more than 200kw in size \$10 per kilowatt which adds up quickly. Troy recommends bringing the fee down to \$1 from \$10. The inspection fee would then align with the state's policy.

Councilor Comment on Fees for Solar Installations

Councillor Zarro has no comment

Councilor Ray asks how high about 200 kwh do residential projects go? *They do not go that high. We are talking more for commercial installations. Larger big flat roofs such as the Jetport is 450kw. Parking garage rooftops would be between 300-400kw. Why are we charging over 200kwh? We are charging because there is more electrical work and more inspections.*

Councilor Ray is in favor of this.

Public comment on Fees for Solar Installations

No public comment.

Committee Vote on Fees for Solar Installations

Councilor Zarro motions for the Committee to endorse the Solar Installation Fee Changes.

Councilor Ray seconds the motion. Endorsement passes unanimously of all present, (2-0).

Update on Food Composting Program

Presented by Troy Moon

Portland Food Composting Drop Off sites launched on Earth Day 2021. The material collected to be composted and creates MOFGA certified organic compost. There are 5 locations at 4 community gardens and one at the Riverside Recycling Facility. Drop sites have been successful and would like to continue past the pilot program and look for more spots to start drop sites. There are two more community gardens that would be likely candidates - Brentwood St and Payson Park.

Data collected from the collection vendor says they collect about 10,000lbs of materials each month. There is positive feedback each week from residents. We will be working with Parks and Rec to make a plan for maintaining the carts in the winter months to continue the success of the program. Troy would like to thank the Parks Department for their work on this project and contribution to the project's success.

Councilor Comment on Update on Food Composting Program

Councilor Zarro is very excited about this program and happy about the public response. This is a first step to eventually having municipal composting. Would like to do whatever he can to assist and advocate for this project.

Councilor Ray asks when the pilot is over. *The pilot ends on Earth Day. There is no reason why this cannot continue. There has been little or no contamination. The program is not costing more*

than what is budgeted for trash. Curbside pickup would be much more expensive but we will look to other cities to explore other options. Whose budget is this in? It is in the DPW budget because they have the trash budget.

YEAR in Review

Presented by Troy Moon

It has been a busy year looking at many topics. Topics included: legislation supported, carbon fee & dividend resolution, tree canopy, Portland Transportation Center, Western Prom Master Plan, voluntary tolling, Libbytown Safety. Carry over items include Sustainability Fund/Green CIP, Building Energy Labeling, and REC Policy. Over the course of the next year, the committee will need to decide what to do with the RECs acquired through the city's solar projects.

Councilor Comment on Year in Review

Councilor Ray adds Food Trucks and Trash issues to be revisited in the next session. Councilor Ray encourages staying updated with the Portland Transportation center idea and project. The committee needs to be present in the discussion. *With the new infrastructure package, there will be funding coming to move forward with projects. Working with other departments and focusing on projects that address climate and equity will be important. The projects will need to solve more than one project at a time.*

Councilor Zarro would like to agree that this was a successful year and is looking forward to what the committee will work with next year. Councilor Zarro thanks Troy and Councilor Ray for making this committee work well. This committee is a place of optimism and hope. Councilor Zarro thanks Councilor Ray for providing the space to do this work.

Councilor Zarro moves to adjourn.



CITY OF PORTLAND

Sustainability Office

Troy Moon

Sustainability Director

Sustainability Updates

January, 2022

Energy:

We have been preparing to launch our Electrify Everything! initiative to help residents and small businesses electrify their homes. The program will provide Portland residents with a primary resource to learn about beneficial electrification and will help people move toward fully electrifying their property by packaging incentives, discounts, rebates, and financing toward air source heat pumps, heat pump water heaters, solar panels, or community solar. We're partnering with Efficiency Maine and other providers to ensure low and moderate income residents can take advantage of the program.

Waste Reduction

The composting program continues to see increasing use



Parks & Recreation and DPW collaborated to host Christmas tree drop off locations on Cutter St, at Payson Park, and at Riverside Golf Course. Trees dropped off at these locations will be chipped up to be used as mulch. Trees collected at the curb will be delivered to ecomaine and combusted for energy.

Electric Vehicles

We've installed four new EV charging stations in the parking lot at the corner of Spring Street and High Street but are waiting for CMP to connect electric service.

We are very close to announcing our strategic partnership to dramatically expand EV charging opportunities in the City to include multiple DC fast chargers and neighborhood charging hubs to facilitate charging by people in apartments.

Education and Outreach:

During the past month we have had conversations with communities around the State to share information about our work including the collaboration with South Portland on our joint climate action plan and our experience with the new energy code, IECC 2021.

We invite everyone to attend our monthly (virtual) Coffee and Climate on Friday, January 14. We will have Director of the Climate Center at GMRI, Dr. David Reidmiller and staff from Friends of Casco Bay to discuss how changes in the Gulf of Maine such as sea level rise, rising ocean temperatures, and ocean acidification affect Portland and South Portland.

Climate and Coffee events are community conversations that happen on the 2nd Friday of the month at 9 AM. We record sessions with guest speakers and post them on www.oneclimatefuture.org, along with other information about our work. You can also follow us on social media. Instagram @sustainableportlandme / Twitter @SustainPortME / FB @SustainablePortlandME

City of Portland

One Climate Future Annual Report

November 2020 – December 2021

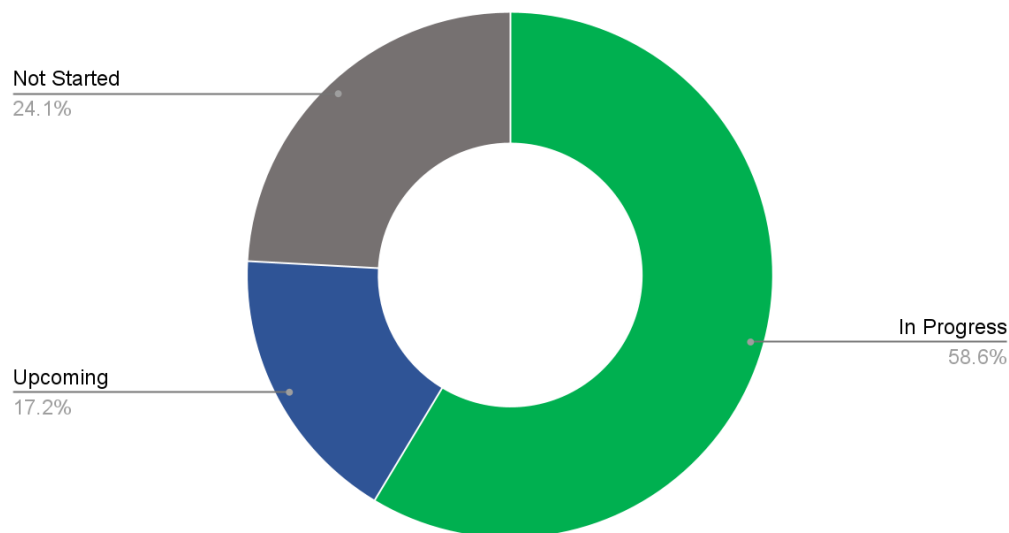
The City's joint climate action and adaptation plan with South Portland, One Climate Future, was adopted in November 2020. It contains 67 strategies with 186 action items for reducing greenhouse gas emissions 80% by 2050 and building the resilience of our neighborhoods, infrastructure, and ecosystems to the impacts of climate change.

58 (85%) of the strategies and 107 of the action items are near-term, to be completed by 2025.

One year in, we have made significant progress toward implementing our plan.

Of the 58 near-term strategies, the chart below illustrates the 34 in progress, 10 upcoming, and 14 not started.

58 Near-Term OCF Strategies



BE 1. MUNICIPAL BUILDINGS AND ENERGY SUPPLY

In Progress

- 1.1 Renewable Municipal Electricity – Have installed solar and signed offtake agreements with offsite projects that produce about 75% of the City’s annual electricity consumption.

Upcoming

- 1.1 Renewable Municipal Electricity cont’d - Install new solar projects on City property.
- 1.2 Net-Zero New City Buildings - exploring energy and resilience retrofits for some facilities.
- 1.3 Energy Efficiency Retrofits for City Buildings – see 1.2 (same)

Not started

- 1.4 Internal Carbon Pricing for Municipal Construction and Operations (mid-term strategy)

BE 2. NEW CONSTRUCTION ENERGY EFFICIENCY AND DECARBONIZATION

In Progress

- 2.1 Energy Stretch Code – adopted Maine Energy Stretch Code (IECC 2021) with zero energy appendix; learning and leading on building inspections.
- 2.2 Solar-Ready and EV-Ready Code Requirements – updated the technical design manual to require EV charging for all new parking with 10 or more spaces..
- 2.4 Leadership and Education – establishing a leaders program for the building and design community.

Upcoming

- 2.1 Energy Stretch Code cont’d - developing a training program for city staff and private builders..
- 2.2 Solar-Ready and EV-Ready Code Requirements cont’d - update the solar ordinance and update the Historic Preservation design standards.

Not started

- 2.3 Code Enforcement (mid-term strategy) - add capacity in Building and Inspections to review energy models for advanced energy codes

BE 3. EXISTING BUILDINGS ENERGY EFFICIENCY AND DECARBONIZATION

In Progress

- 3.1 Energy Benchmarking – launched a benchmarking program to improve compliance with the Benchmarking Ordinance for single occupant buildings over 20,000 square feet.
- 3.3 Energy Efficiency Spending – advocated for several state-level bills to increase funding for energy efficiency and renewable energy (C-PACE, Energy accelerator, etc.)
- 3.4 Renewable Heating and Cooling – developing an Electrify Everything! comprehensive program to decarbonize the residential sector
- 3.5 Bulk Buy Programs – included in Electrify Everything!
- 3.6 Solar Proliferation – included in Electrify Everything!

Upcoming

- 3.1 Energy Benchmarking cont'd - expand benchmarking program to include multi-tenant buildings and achieve a goal of 80% compliance rate.
- 3.3 Energy Efficiency Spending cont'd - continue to advocate at the state level. Access grant and infrastructure funding to support energy efficiency and decarbonization efforts.

Not started

- 3.2 Building Performance Standards (mid-term strategy)
- 3.7 Energy Efficient Rental Housing

BE 4. INDUSTRIAL ENERGY EFFICIENCY AND DECARBONIZATION

In Progress

Upcoming

- 4.1 Industrial Energy Efficiency Spending – meet with key industries, Efficiency Maine

Not started

- 4.2 Industrial Energy Efficiency and Decarbonization Study

BE 5. CLEAN AND RENEWABLE ENERGY INFRASTRUCTURE AND REGULATORY TRANSFORMATION

In Progress

- 5.1 Renewable Portfolio Standard and Community-Scale Purchasing – continues to be on track
- 5.2 Utility Data Access Reform – successfully advocated for legislation mandating that the PUC to issue an RFI for the development of a statewide aggregated data platform
- 5.3 Utility Regulatory Reform to Support Electrification – participating in statewide discussions about rate design, DER strategy, and innovation; advocating for legislation to support reforms
- 5.5 Electrical Transmission and Distribution – working with CMP and Efficiency Maine to develop a hosting capacity study, and CMP/PUC to increase capacity of the local grid; participating in NWA (non wires alternative) docket at PUC

Upcoming

Not started

- 5.4 Renewable District Energy Systems
- 5.6 Natural Gas Phase-Out
- 5.7 Carbon Pricing (long-term)

WR 1. RESIDENTIAL AND COMMERCIAL WASTE

In Progress

- 1.1 Pay-As-You-Throw – This is a South Portland-specific strategy
- 1.3 Food Waste Reduction and Organics Recycling – launched City’s first public food waste recycling program, a pilot drop-off program with 5 collection sites. Exploring options for citywide curbside food waste collection.
- 1.4 Single-Use Plastics - rolled out Phase II of the Straw Ban in April and created a retailer FAQ page with best practices.

Upcoming

- 1.2 Single-Stream Recycling – improve education and enforcement of existing multi-family recycling ordinance.
- 1.3 Food Waste Reduction and Organics Recycling cont’d - Recommend strategies to expand opportunities for residents to compost food waste.

1.4 Single-Use Plastics cont'd – Working with retailers to reduce single use plastics

Not started

1.5 Circular Sharing Economy

WR 2. CONSTRUCTION, INDUSTRIAL, AND MUNICIPAL WASTE

In Progress

Upcoming

2.4 Sustainable Purchasing Policy – adopt a sustainable purchasing policy for the City

Not started

2.1 Construction and Demolition Waste (mid-term strategy)

2.2 Industrial Waste (long-term strategy)

2.3 Wastewater Emissions (long-term strategy)

TLU 1. MODE SHIFT AND LAND USE

In Progress

1.1 Public Transit Networks - participating in PACTS's Transit Together and Rapid Transit Study Work

1.2 Inclusive Transit Oriented Development - identified land use policy opportunities around TOD through ReCode Phase II land use code evaluation 1.3 Bike Accessibility – released Bike Share Program RFP and chose Tandem Mobility as program vendor with program kickoff next summer; initiated concept design for Baxter-Bates-Veranda St. Bikeway/East Coast Greenway; Peninsula Circumferential Shared Use Pathway network (Bayside Trail Extension; initiated Union Branch Rail Line Shared Use Pathway from Forest Ave to Park Ave); leveraged private construction of West Commercial St Pathway; Neighborhood Byways- Transportation Center Byway Project designed and bid awarded, North Deering Neighborhood Byway trail upgraded by DPW facility; conducted analysis of potential higher quality bike lane locations

1.4 Complete Streets – enhanced project scoping of Libbytown Safety and Accessibility Project began; implementing Smart Corridor with preliminary design funded for Morrills Corner and Forest Ave, enhanced project scoping funded for Woodfords Corner to Exit 6; advanced the enhanced project scoping for Brighton Ave Multimodal Project; began construction of Somerset St Reconnection/Bayside Trail Extension, Elm st to Brattle st

- 1.5 Employer Transit Partnerships - contacted TDM coordinators for active TDM plans to update reporting requirements to standard spring reporting period, began buildout of TDM resources website for use by TDM coordinators
- 1.6 Parking - eliminated parking requirements for significant portions of the city through ReCode Phase I; added EV parking requirements to the city's Technical Manual
- 1.7 Land Use for a Smaller Carbon Footprint – streamlined Accessory Dwelling Units (ADU) Policy; initiated work on ReCode Phase II to incorporate OCF's land use goals as a foundational element

Upcoming

- 1.1 Public Transit Networks cont'd – advocate for increased state funding for multimodal projects
- 1.2 Inclusive Transit-Oriented Development cont'd – advocate for increased state funding for multimodal projects and adopt ReCode.
- 1.3 Bike Accessibility cont'd – install more bike infrastructure; public engagement and design/implementation of higher quality bike lane analysis

Not started

TLU 2. VEHICLE ELECTRIFICATION

In Progress

- 2.1 Electric Vehicle Charging Infrastructure – added 15 networked L2 EV chargers; finalizing contract with a private partner to install multiple DC fast chargers and many L2 chargers across the City.
- 2.2 Electric Vehicle Incentives – continued promoting EV rebates
- 2.4 Electric and Alternative-Fuel Municipal Fleets – leased four new EV Hyundai Konas at zero cost; initiated City Hall EV carshare program

Upcoming

- 2.1 Electric Vehicle Charging Infrastructure cont'd - Access federal and state infrastructure funding for more EV chargers and vehicles
- 2.4 Electric and Alternative-Fuel Municipal Fleets cont'd - adopt city fleet electrification policy

Not started

- 2.3 Electric Public Transit Bus Fleets
- 2.5 Electric Shared Vehicles and Vehicles for Hire
- 2.6 Autonomous Vehicles (mid-term strategy)

TLU 3. TRANSPORTATION INFRASTRUCTURE

In Progress

- 3.1 Idling Reductions – implemented smart traffic signals that reduce idling through RapidFlow technology
- 3.3 Ferry Service - Casco Bay Lines designed and approved hybrid ferry

Upcoming

- 3.1 Idling Reductions cont'd - explore potential for expansion of smart traffic signals

Not started

- 3.2 Freight Transit Partnerships (long-term strategy)
- 3.4 Shore Power (long-term strategy)
- 3.5 Jetport (mid-term strategy)

CR 1. RESILIENT BUILDINGS AND NEIGHBORHOODS

In Progress

- 1.1 Resilient New Development – working with U.S. Army Corps of Engineers, FEMA, NOAA, USDA, USGS, and Maine ACFD to complete dynamic coastal flood inundation modeling for Portland

Upcoming

- 1.2 Resilient Existing Buildings - working on historic preservation design standard amendments
- 1.3 Resilient Open Space Planning

Not started

CR 2. STRONG AND HEALTHY COMMUNITIES

In Progress

- 2.2 High Heat Mitigation – allocated \$250k to expand tree canopy in Bayside neighborhood

Upcoming

- 2.1 Housing Affordability and Resilience - work to ensure energy efficiency and renewable energy for affordable housing

Not started

- 2.3 Resilient Food Systems
- 2.4 Transportation Access (mid-term strategy)
- 2.5 Neighborhood Resources

CR 3. RESILIENT LOCAL ECONOMY

In Progress

- 3.1 Resilient Working Waterfronts - ongoing conversation with waterfront stakeholders to promote and develop marine uses
- 3.3 Climate-Ready Industries and Innovation – Economic Development supported small businesses through a COVID hardship grant; Covid related street closures made permanent to facilitate outdoor dining

Upcoming

- 3.1 Resilient Working Waterfronts cont'd - Waterfront Master Plan through Comp Plan Update
- 3.2 Workforce for a Resilient Economy - identify opportunities from infrastructure funding to promote clean energy jobs

Not started

CR 4. RESILIENT INFRASTRUCTURE SYSTEMS

In Progress

- 4.1 Stormwater Systems - improvement of mapping/data for sewer and storm system; improvement of SLR mapping to understand parcel level impacts

Upcoming

Not started

- 4.2 Green Infrastructure (long-term strategy)
- 4.3 Energy Systems (mid-term strategy)
- 4.4 Transportation Systems (mid-term strategy)

CR 5. ECOSYSTEM RESILIENCE

In Progress

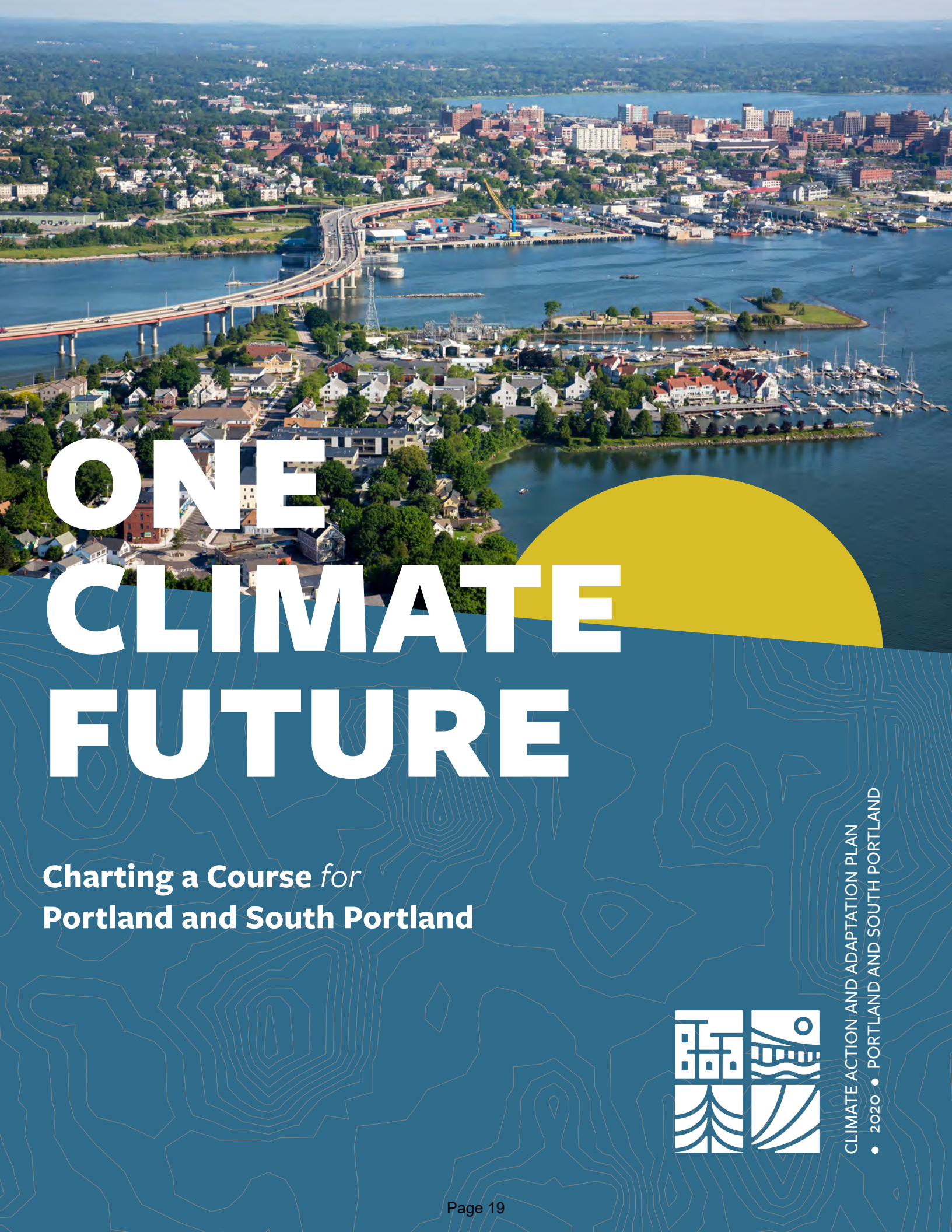
5.1 Ecosystem Adaptive Management – monitoring invasive pests

5.2 Soil Health – adopted soil standards for new development

Upcoming

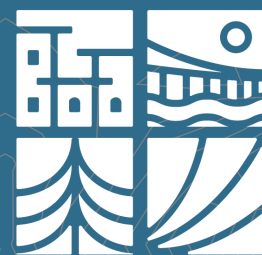
5.2 Soil Health cont'd - adopt a fertilizer ordinance

Not started



ONE CLIMATE FUTURE

**Charting a Course *for*
Portland and South Portland**



CLIMATE ACTION AND ADAPTATION PLAN
• 2020 • PORTLAND AND SOUTH PORTLAND

One Climate Future

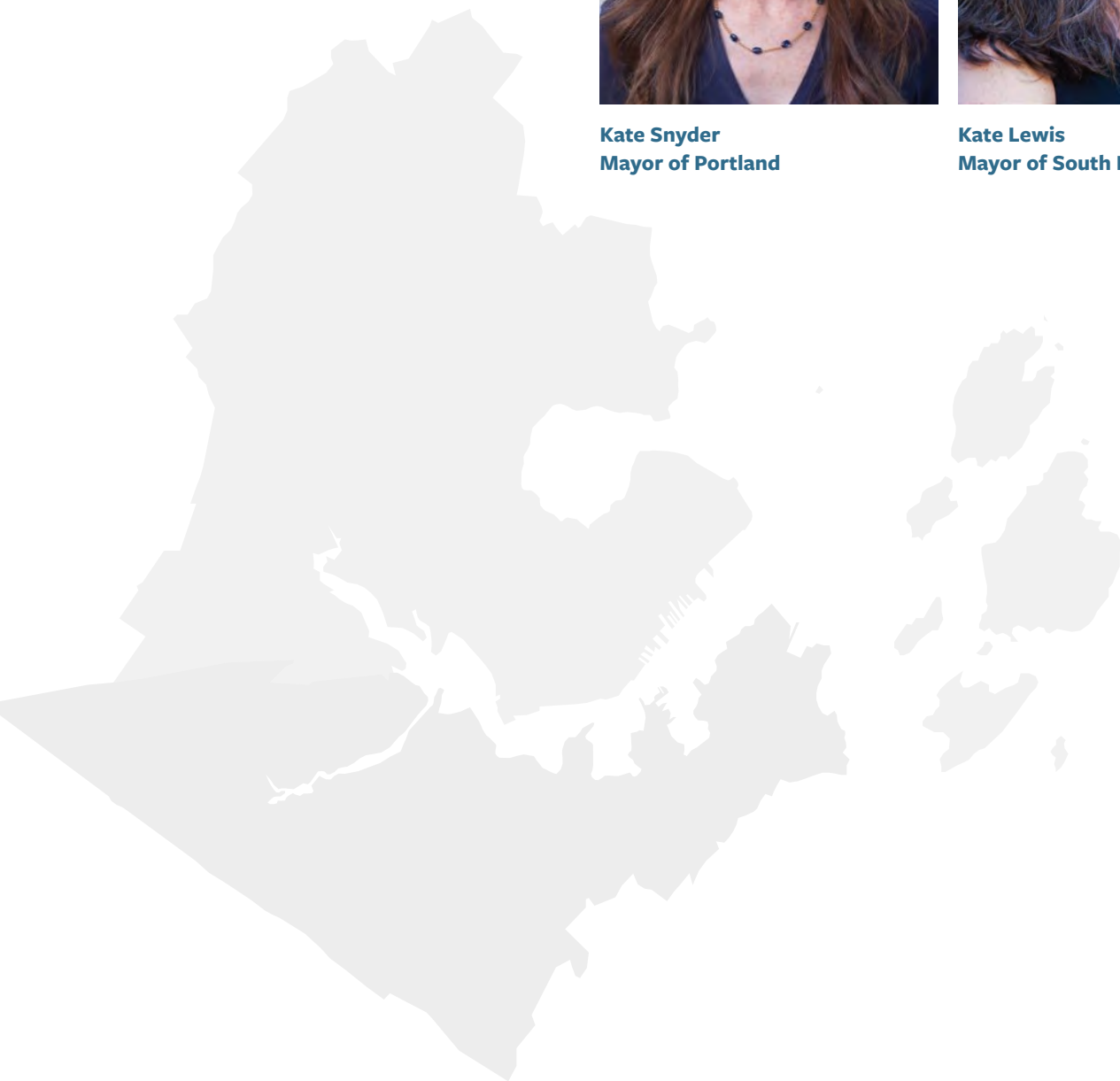
LETTER TO THE COMMUNITIES of Portland & South Portland



Kate Snyder
Mayor of Portland



Kate Lewis
Mayor of South Portland



Dear fellow residents:

On June 10, 2019 the Mayors of Portland and South Portland joined community members from both cities at the Gulf of Maine Research Institute to kick off One Climate Future, our groundbreaking effort to develop a joint climate action and adaptation plan for our two cities. During this event, speakers shared what makes Portland and South Portland great places to live, work, and play—the beauty of Casco Bay, a strong sense of community, opportunities for business, and a commitment to ensure that everyone can participate meaningfully in civic life. These friends and neighbors also spoke of the need for action to ensure that the people who live here in 2050 will still be able to experience this wonderful way of life in the face of higher seas, more intense storms, and other threats brought on by climate change. City staff and community members have worked hard during the past year and a half to create an ambitious but achievable plan designed to make sure our cities are vibrant, livable communities now and in the future.

This plan recognizes and builds on the strong geographic, economic, and social connections that join our two cities. It recognizes that our efforts to address climate change will have more impact if we coordinate our actions and speak in unison at the State and Federal levels for policies that we will need to make our work successful. It builds on our shared vision for regional climate action that began in 2017 with joint commitments to the Mayors National Climate Action Agenda and continued in 2018 with the adoption of aggressive climate goals to decarbonize and strengthen our communities. In 2019, we listened to the youth who filled the courtyard in front of Portland City Hall and declared a climate emergency, pledging to act quickly to ensure the wellbeing of future generations in the face of this climate crisis.

Adoption of this plan signals our resolve to act, despite the many challenges we face now and will continue to face in the coming decades. In June of 2019, we didn't hesitate to welcome asylum seekers to our Cities, providing immediate assistance while also searching for long-term shelter. In the spring of 2020, our businesses demonstrated ingenuity in the face of a global pandemic to reimagine daily operations while ensuring the health of our community. At the same time, we began a process of looking inwards to address systemic racism and attend to deep inequities. Through it all, we elevated the voices of those in need and came together around our shared wellbeing. Our approach to the climate crisis is and will be no different.

We are immensely proud to launch One Climate Future together. Over the next 30 years Portland and South Portland will chart a collaborative course to a carbon-neutral future. One Climate Future is about more than climate action and clean energy. It is also about improving public health, building a diverse economy, and ensuring the vitality of our coastal ecosystems. This will be a transformative undertaking. With your input and support we can build inclusive, thriving, and resilient communities.

Sincerely,



Kate Snyder
Mayor of Portland



Kate Lewis
Mayor of South Portland

One Climate Future ACKNOWLEDGMENTS

One Climate Future would not be possible without the significant contributions in time and thought of many. Thank you to the hundreds of Portland and South Portland residents and local and regional organizations who provided input in the development of this plan.

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CITY COUNCILS

Portland

Kate Snyder, Mayor
Belinda S. Ray, District 1
Spencer Thibodeau, District 2
Tae Y. Chong, District 3
Justin Costa, District 4
Kimberly Cook, District 5
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Jill C. Duson, At Large
Nicholas M. Mavodones, Jr., At Large

South Portland

Katherine W. Lewis, Mayor
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Misha C. Pride, District 3
April L. Caricchio, District 4
Deqa A. Dhalac, District 5
Katelyn S. Bruzgo, At Large
Susan Henderson, At Large

PROJECT TEAM

Ashley Krulik, Portland Sustainability Office
Troy Moon, Portland Sustainability Office
Lucy Perkins, South Portland Sustainability Office
Julie Rosenbach, South Portland Sustainability Office

CLIMATE PLANNING PROCESS COMMITTEE

Kristina Egan, Greater Portland Council of Governments
Tyler Kidder, The Onion Foundation
Dave Low, Portland 2030 District
Tim Schneider, Tilson Technology
Cheryl Sessions, Portland Housing Authority
Martha Sheils, New England Environmental Finance Center
Anna Siegel, Maine Youth Climate Strikes
Peter Slovinsky, Maine Geological Survey
Addy Smith-Reiman, Portland Society of Architecture
Barry Woods, ReVision Energy

* Municipal staff with asterisks next to their names also served on the Climate Planning Process Committee.

MUNICIPAL STAFF

Portland City Manager's Office - Lena Geraghty
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One Climate Future

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01

One Climate Future **IN SUMMARY**

**PORTLAND AND SOUTH PORTLAND
ARE WORKING TOGETHER TO
CREATE A PROSPEROUS AND
INCLUSIVE LOW-CARBON FUTURE.**

CASCO BAY BRIDGE, PORTLAND AND SOUTH PORTLAND • Photo by City of South Portland



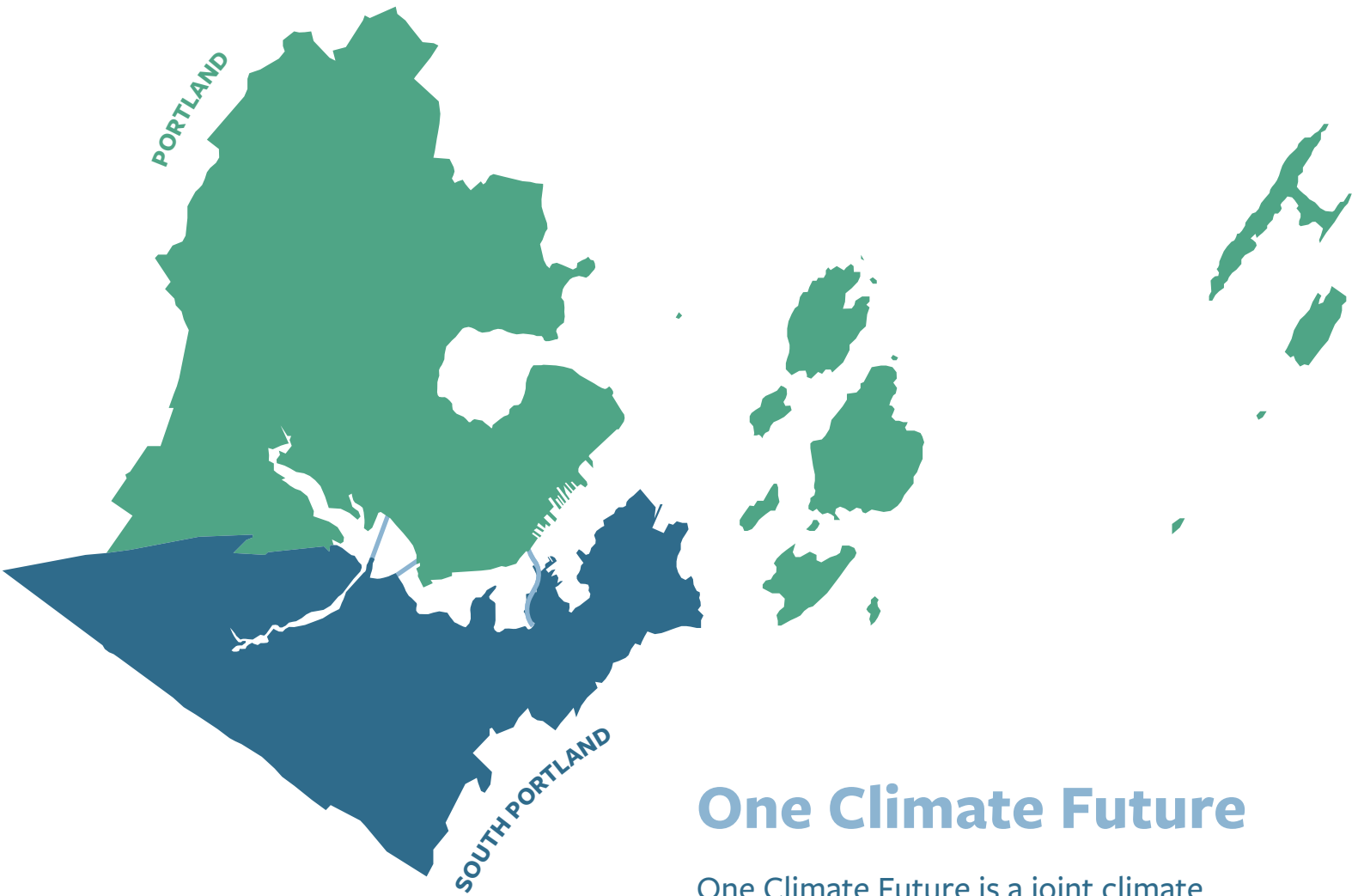


The communities of Portland and South Portland have set our sights on a livable future. This future is powered by clean, renewable energy. It opens doors to economic opportunity. In this future we continuously innovate, working in partnership with natural systems, replenishing resources, and creating new potential from waste. Clean air, clean water, and healthy food are a given.

In this livable future, we create buildings and neighborhoods that maximize our health and happiness and minimize our carbon footprint. We create stronger connections—on the sidewalks, in the parks, on the bus, on the ferry—linking people to people, places, and opportunity.

We invest in people and communities. In this future, we equip our communities with the resources to adapt to change and to create the quality of life we each envision. We partner, seeking the insight of people with direct experience and diverse knowledges. Together, we create a prosperous future for everyone, now and for generations to come.

This is One Climate Future.



One Climate Future

One Climate Future is a joint climate action and adaptation plan for the Cities of Portland and South Portland. We are working together to be thriving, vibrant, and inclusive communities now and in the future.

SUMNER PARK OVERLOOK • Photo by Ian Johnson



A joint plan for climate action.

Portland and South Portland residents, businesses, organizations, and city leaders are seeing, feeling, and anticipating the growing effects of climate change—and calling for accelerated action. Along our coast, we are observing rising sea levels and the warming of the Gulf of Maine at increasing rates. We can also track how our current use of fossil fuels will continue to alter the climate, with further harm to ecosystems, our economy, and neighborhoods. Most importantly, we can envision a future for our cities that is both low-carbon and prosperous, and we know that we have the tools, solutions, and will within our cities to create this future.

Together, the communities of Portland and South Portland have created One Climate Future, a climate action and adaptation plan that charts a course towards a low-carbon, thriving, and inclusive future. This plan builds on the momentum of past and ongoing efforts to improve the sustainability and resilience of our cities, and lays out next steps for meeting aggressive carbon reduction goals, growing a circular economy, building community resilience, and creating more just and equitable cities.

PORTLAND AND SOUTH PORTLAND'S CLIMATE GOALS

Leading up to the launch of One Climate Future, the Cities of Portland and South Portland committed to a set of climate goals to reduce greenhouse gas emissions and to prepare our cities for the effects of climate change. One Climate Future charts a course to meeting these goals.

● **80% x 2050** **COMMUNITY-WIDE**

Portland and South Portland will reduce community-wide greenhouse gas emissions 80% from 2017 baseline levels by 2050.

● **100% x 2040** **MUNICIPAL**

Portland and South Portland will run all municipal operations on 100% clean renewable energy by 2040.

● **CLIMATE RESILIENCE**

Portland and South Portland will build the resilience of our neighborhoods, infrastructure, and ecosystems to prepare for the impacts of climate change.

CLIMATE EMERGENCY

Driven by youth climate leadership, Portland and South Portland declared a climate emergency in November 2019. Through this declaration, we reaffirmed our commitment to a rapid and equitable transition to clean renewable energy, and to **accelerating greenhouse gas emissions reductions between now and 2030.**



LIBERTY SHIP MEMORIAL • Photo by Paul VanDerWerf

► One Climate Future is a partnership.

Portland and South Portland have committed to tackling climate change together. Our cities share invaluable resources—stretches of forests, nesting grounds along the Fore River, and the abundance of Casco Bay. We share communities, exchanging people through a daily ebb and flow as our residents commute to work in each other's cities. Likewise, climate change is not confined to jurisdictional boundaries; our cities share risks created by climate hazards and we share many of the same challenges in reducing greenhouse gas emissions. Importantly, our cities' leadership also share a commitment to addressing these challenges head-on.

It was only natural that we also share solutions. One Climate Future was crafted by the combined knowledge, ideas, and experience of city staff, organizations, businesses, and residents across our two communities. We developed joint approaches, with opportunities to take advantage of economies of scale and to use resources wisely. By continuing to work together in

implementation, we can magnify our impact, creating a more regional response to climate change.

At the same time, One Climate Future is much more than a partnership between two municipalities. Nearly every action in the plan calls on partnerships—with our community organizations, development sector, property owners and renters, food growers and producers, and working waterfronts, for example—to identify the best ways to implement each action. The strategies likewise call on regional partnerships to build out a robust and integrated public transportation system, develop more efficient freight transit, and link regional bike networks. Finally, the strategies depend on statewide coordination: meeting our renewable energy targets statewide will be integral to achieving our Cities' climate goals. We will continue to advocate for and support state policy across energy, buildings, transportation, and waste sectors that will enable emissions reductions for our cities, as well as statewide.

► One Climate Future is a transformation.

Portland and South Portland have committed to transitioning all municipal operations to clean energy sources by 2040, and to reducing community-wide greenhouse gas emissions 80% below 2017 levels by 2050. Driven by the leadership of the youth in our cities and globally, we have committed to accelerate this transition, aiming to achieve as much greenhouse gas emissions savings as possible within a 2030 timeframe.

These goals require bold changes: we know we must transform how we power our cities, rethink the way we design buildings, re-envision how we travel, and transition to a more circular economy. As a starting point, powering homes, offices, cars, buses, ferries (and so much more) with renewable electricity requires that we work with regional and state partners to reform how utilities currently operate, build out renewable energy sources at a much larger scale, and significantly expand the capacity of the grid—radically transforming our current energy systems and infrastructure.

One Climate Future likewise sets bold goals in other sectors—aiming for “zero waste” through smarter production, consumption, and material reuse, and committing to improving the safety of our streets and traffic patterns until we have zero pedestrian and bicyclist fatalities. With a vision for more walkable, transit-oriented neighborhoods, we aim for a seven-fold increase in the size of our bus fleets to create a more robust and integrated public transit system. By meeting our 2050 goals, 40% of all trips will be taken by walking, biking, and public transit—over three times the number of trips taken by these modes today.

But perhaps just as importantly, we will also transform many of our processes. We will use climate data to inform changes to our city zoning, and resilience metrics to monitor and adapt how we manage our stormwater, transportation, energy, and open space networks. We will focus on job training, skill building, and knowledge sharing to improve how we build buildings and expand regenerative industries. We will also continue to focus on how processes play a role in advancing equity in our cities, ensuring that decisions are informed by the people who will be most affected, and focusing on community ownership of projects to create more just and equitable cities.



STATE-LEVEL ACTIONS

Several recent state-level actions are particularly significant to the work in our cities to address climate change.

● MAINE RPS

In June 2019, Maine passed a new renewable portfolio standard (RPS). Electricity in the state will come from **80% renewable sources by 2030, and 100% by 2050.**

● **80% x 2050** STATE-WIDE

At the same time, the State committed to reducing greenhouse gas emissions 80% from 1990 levels by 2050.

● MAINE CLIMATE COUNCIL

Maine also launched the Maine Climate Council to develop a state climate action plan. City staff from Portland and South Portland participate in the working groups.



BAYSIDE PLAYGROUND • Photo by Corey Templeton

► One Climate Future is achievable.

While One Climate Future is ambitious, it is also achievable. The actions in this plan identify steps that can be implemented today, based on current technology, policy, and funding streams. They draw on successful models in other cities, while catering to our strengths, resources, and context here in Portland and South Portland, and in Maine. For actions that require new state policies, coordination with regional partnerships, or longer-term research and implementation, One Climate Future identifies the initial incremental steps that will advance those bigger efforts.

For such an ambitious shared vision to come to fruition, the approach must be practical. The transition to a cleaner, more resilient future cannot be funded entirely by local property tax payers. Such a method would be both unsustainable and inequitable. Implementing One Climate Future will require innovative financing mechanisms and strategic investments by the public and private sectors—creative approaches that the Cities of Portland and South Portland have already begun to use for sustainability investments. We have used power purchase agreements for renewable energy, lease-purchase contracts for lighting infrastructure, and a public-private partnership to access federal money for a large-scale dredging

project in Portland Harbor. The State of Maine is currently considering legislation to help businesses and municipalities access private capital (C-PACE) as well as a green bank that could help finance infrastructure projects. Efficiency Maine already provides significant funding to support energy efficiency, and One Climate Future recommends new state policies that could generate additional sources of revenue to support their programs.

Furthermore, we have a head start on many of the actions in this plan. Portland and South Portland have adopted municipal climate action plans, enacted benchmarking ordinances to increase building energy efficiency, and implemented aggressive waste reduction and recycling programs. We have built large-scale solar arrays (with more solar procurement in the works!), and have deployed electric vehicles and charging infrastructure. We have run workshops and planning processes on adapting to sea level rise. These initiatives build on the significant efforts of our youth, residents, businesses, and organizations who are leading campaigns for school rooftop solar, building energy efficient buildings, and finding innovative ways to produce less waste. All of these initiatives provide the groundwork for the steps ahead.

Implications of the COVID-19 pandemic



Thirteen months into the One Climate Future planning process, the novel coronavirus (COVID-19) pandemic hit the United States. The ramifications have been severe: businesses closed for extended periods of time to curb the spread of the virus, and workers across nearly all sectors have been furloughed or laid off. Even as Maine has progressively reopened, the dearth of tourism and the precautions around face-to-face interaction have kept a rebound in the economy at bay.

The pandemic has therefore become a potent test for our community resilience—challenging us to think on our feet and employ a lot of Maine ingenuity. Our cities' hospitals and health centers have worked overtime, ramping up protocols to serve COVID-19 patients and keep staff and other patients safe. Businesses have shifted to new online service models; restaurants that had been purely dine-in establishments have started offering takeout. Portland closed down certain streets to cars to allow for outdoor eating and social distancing. Community centers, restaurants, shelters, and schools across both cities have stepped up in new ways to offer free meals.

At the same time, COVID-19 has both highlighted and exacerbated the cracks in our systems. The number of hungry families has escalated, while we have seen an enormous amount of food loss regionally as procurement chains have been put on hold. Schools shifted quickly to online learning, a process that has amplified the sharp disparities between families who have internet access at home and those who don't. COVID-19 has thus further exposed vulnerabilities that hinder the capacity of communities to respond, adapt, and thrive—regardless of whether we are facing a pandemic or climate change.

The direct experiences of Portland and South Portland residents during the pandemic will therefore be one of the most important sources of insight as we collectively build community resilience through the implementation of One Climate Future. These insights will be core to shaping how we support business resilience (see action CR 3.3); build back the strength of our workforce (see action CR 3.2); and enhance the resilience of our food systems (see action CR 2.3). They will also be foundational in how we identify

There will be a continuous need to accommodate change and remain flexible with implementation. And yet, this uncertain context makes the work of One Climate Future all the more meaningful, critical, and timely.

ways to support the existing solutions in our communities, and particularly those that have emerged in response to elevated need (see action CR 2.5).

While we first and foremost seek to restore our economic and public health, there may also be lessons drawn from the drastic shift in status quo that could carry forward. Bringing restaurant tables into the streets to limit the transference of the virus has created a pilot for activating the streetscape, an approach to encourage walking over vehicle use. Companies and organizations proved the possibility of teleworking, which if sustained, could significantly cut greenhouse gas emissions from commuting (see action TLU 1.5). Given the option to work remotely, we may see growth in our cities' populations as employees from other states move to Portland and South Portland. We want to use these changes in our favor.

Lastly, we recognize that One Climate Future will be launched into the world at a very uncertain time for our cities—for employment, for financial resources, and for the lives of our residents. There will be a continuous need to accommodate change and remain flexible as we move forward with implementation. And yet, this uncertain context makes the work of One Climate Future all the more meaningful, critical, and timely. Now more than ever we will want to use One Climate Future to build our community resilience, to bolster the solutions in our communities that are investing in our people and their health, and to be proactive about improving the ways that we deal with uncertainty to build the safe, healthy, and vibrant future we want.

One Climate Future is for everyone.

Hundreds of people provided input in the development of this plan, and that was essential: the implications of climate change are diverse and widespread, affecting our infrastructure, economies, ecosystems, and community health. We also currently use fossil fuels in nearly all areas of our daily lives. To address these integrated challenges we needed strategies that create systems-level change—and we needed insight across sectors, city departments, and communities to collectively develop those solutions.

For the same reason, implementing One Climate Future will involve everyone. The actions we will take are not housed within one city department, but rather integrate resilience and sustainability thinking across city planning and operations. The strategies for advancing building performance apply to building owners, homeowners, renters, and property managers, across all building types. Businesses across sectors play a role in new approaches to employee commuting, alternatives to single-use plastics, and improving business resilience. And even more broadly, the actions touch nearly everyone's daily lives, shaping housing and transportation affordability, influencing our access to healthy food, and improving the cleanness of the air we breathe.

The key to the success of One Climate Future will therefore come from making climate action increasingly affordable, accessible, and collaborative. The partnerships, funding mechanisms, and participatory processes for further shaping the development and implementation of strategies are some of the most important attributes of the One Climate Future plan. We will achieve the greatest collective success as we involve more people and benefit more people. It is with the combined will, experience, and vision of our communities that we can create vibrant, thriving, and inclusive low-carbon cities.



Photo credits (left to right, top to bottom):
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WHAT IS OUR PLAN for reaching our One Climate Future goals?

IT INCLUDES SIX BIG MOVES.

Portland and South Portland's **SIX BIG MOVES**

One Climate Future includes 68 strategies across four focus areas for how our two cities will address climate change. These “six big moves” encapsulate the plan, summarizing how we—the communities of Portland and South Portland—will create thriving, inclusive, low-carbon cities over the next thirty years.

1.

Build better buildings.

With the help of new policies, we will improve the way we design, build, and retrofit our buildings—creating spaces to live and work that are more energy efficient, comfortable, healthier, resilient to extreme weather, and powered by renewable energy. The goal is to build smarter, not more expensively, and to ensure everyone can benefit from climate-ready homes. We will work to expand financial incentives to make retrofits more affordable, encourage upgrades to rental properties to lower renters’ utility bills, and continue to expand our cities’ low-carbon and resilient affordable housing.

Key milestone: All new buildings to be net-zero energy starting in 2032.

Looking to read more?

Check out these strategies, in particular:

- BE 2.1** Energy Stretch Code
- BE 3.1** Energy Benchmarking
- BE 3.2** Building Performance Standards
- BE 3.3** Energy Efficiency Spending
- BE 3.7** Energy Efficient Rental Housing
- CR 1.1** Resilient New Development
- CR 1.2** Resilient Existing Buildings
- CR 2.1** Housing Affordability and Resilience



2.

Connect people to places, to opportunity.

We will create connected neighborhoods—where it is easy to push a stroller to the park, roll a wheelchair to the grocery store, ride your bike to school, and take the bus to a new job opportunity. To reach this goal, we will implement safer street designs, build out our network of bikeways, and radically expand our public transit system, while making travel on transit more accessible and seamless. Supported by land use policy, we will cluster a mix of housing and businesses near transit, and increase housing in the cities to bring people closer to jobs. And we will ensure that the people who most rely on public transit systems, due to income, disability, or otherwise, are part of the decision-making teams connecting our homes, businesses, open spaces, and community resources.

Key milestones: **a** By 2035, 26% of trips in the cities will use public transit or active transportation (up from 12% today).
b Housing stock meets workforce demand within the cities by 2035.

Looking to read more?

Check out these strategies, in particular:

- TLU 1.1** Public Transit Networks
- TLU 1.2** Inclusive Transit-Oriented Development
- TLU 1.3** Bike Accessibility
- TLU 1.4** Complete Streets
- TLU 1.5** Employer Transit Partnerships
- TLU 1.7** Land Use for a Smaller Carbon Footprint
- CR 2.4** Transportation Access

3.

Power everything* with clean renewable electricity.

We will power everything possible with electricity—including cars, buses, ferries, as well as building heating systems. Rebates, tax incentives, and federal funding will help us reach this goal. The proportion of electricity that comes from renewable sources in Maine will ramp up to 100% by 2050, driven by the new renewable portfolio standard (RPS). The RPS is vital to transforming Maine's energy sector and to reaching our cities' carbon reduction goals. We will continue to advocate for the timely implementation of the state RPS and lead by example: we will meet all municipal electricity demand with renewable energy by 2032, and we will launch a solar proliferation strategy with a focus on community solar to expand access to the benefits of clean energy.

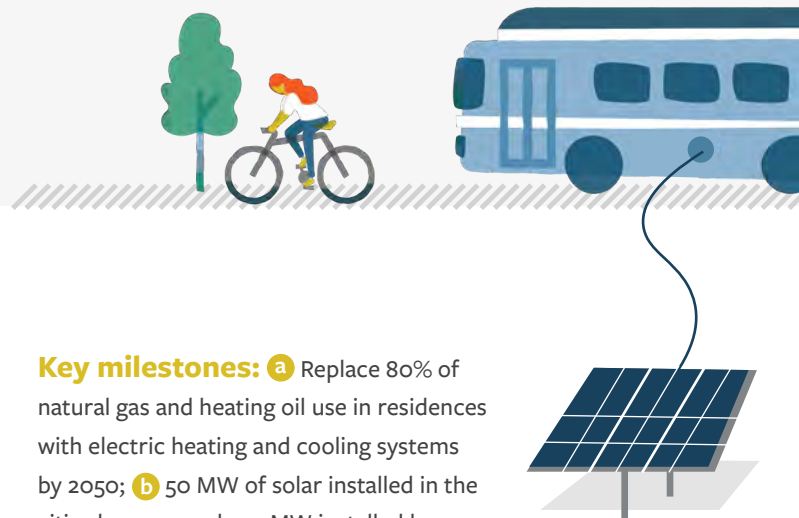
Key milestones: **a** Replace 80% of natural gas and heating oil use in residences with electric heating and cooling systems by 2050; **b** 50 MW of solar installed in the cities by 2030 and 245 MW installed by 2050;
c All-electric Greater Portland METRO and South Portland Bus Service fleets by 2040.

Looking to read more?

Check out these strategies, in particular:

- BE 1.1** Renewable Municipal Electricity
- BE 3.4** Renewable Heating and Cooling
- BE 3.6** Solar Proliferation
- BE 5.1** Renewable Portfolio Standard & Community-Scale Purchasing
- BE 5.3** Utility Regulatory Reform to Support Electrification
- TLU 2.1 - 2.7** (full section) Vehicle Electrification
- TLU 3.4** Shore Power

* Ok, almost everything. Some operations—such as certain industrial processes or heavy-duty vehicles—are currently difficult to power by electricity. Switching to biofuels is another low-carbon alternative that will have increasing viability between now and 2050.



4.

Grow a circular economy.

The old unsustainable model for economic growth was “take resources, make products, and discard waste.” We will innovate: we will extend the useful lifespan of materials and products, encouraging alternatives to single-use plastics and growing the sharing economy. We will find new value in waste, using organic waste to improve soil health, expanding the reuse marketplace for building materials, and taking advantage of “by-product synergies” where one industrial waste stream serves as the source material to another. We will further invest in the people and skillsets to lead growth in clean energy and other regenerative industries. Through a circular economy, we will build and replenish not only our economic capital, but our natural and community capital, too.

Key milestones: **a** Reduce organics in waste stream 70% by 2030. **b** Achieve “zero waste” (90% waste diverted from waste stream) by 2050.

Looking to read more?

Check out these strategies, in particular:

- WR 1.2** Single Stream Recycling
- WR 1.3** Food Waste Reduction & Organics Recycling
- WR 1.4** Single-Use Plastics
- WR 1.5** Circular Sharing Economy
- WR 2.1** Construction and Demolition Waste
- WR 2.2** Industrial Waste
- WR 2.4** Sustainable Purchasing Policy
- CR 3.2** Workforce for a Resilient Economy
- CR 3.3** Climate-Ready Industries and Innovation

5.

Nourish ecosystems, which nourish us.

Our natural resources, on land and at sea, are our biggest assets in facing climate change. We will continue to protect open spaces and coastal waters to ensure our ecosystems can adapt and thrive despite new pests, invasive species, and climate conditions. In the process, we will increase the capacity of our soils, forests, and wetlands to sequester and store carbon, and we will expand tidal wetlands and living shorelines to buffer our neighborhoods against storm surge. We will capture and store more stormwater in green infrastructure systems, in turn reducing the effects of coastal acidification to support marine industries. A more robust tree canopy will mitigate extreme heat, protected open spaces will foster community, and healthy soils and marine ecosystems will cultivate more resilient food systems. In other words, we will protect and nourish ecosystem health, economic health, and community health in tandem.

Key milestones: **a** Convert 15% of the cities’ impervious surfaces to green infrastructure by 2050. **b** Ensure that all residents live within ½ mile of a park or open space by 2035.

Looking to read more?

Check out these strategies, in particular:

- CR 1.3** Resilient Open Space Planning
- CR 2.2** High Heat Mitigation
- CR 2.3** Resilient Food Systems
- CR 4.2** Green Infrastructure
- CR 5.1** Ecosystem Adaptive Management
- CR 5.2** Soil Health



6.

Build collaborative capacity to create this future.

We will create new systems for working together, locally, regionally, and statewide. We will share data—improving access to data, crowdsourcing data, and generating new data—to make decisions about flood risk, track progress on energy efficiency, and improve upon our approaches to transportation demand management, for example. By sharing processes, we will create more integrated transit systems, take advantage of economies of scale in electricity procurement, and magnify the impact of our efforts. And we will share resources, equipping the people in our communities who are rich with experiential knowledge and low on resources to lead these solutions.

Key milestones: **a** Create partnerships and design processes that cultivate collaboration and foster community ownership starting today. **b** Award resilience grants to expand the capacity of local organizations, neighborhood associations, and community groups by 2025.

Looking to read more?

Check out these strategies, in particular:

BE 2.5 Leadership and Education

BE 5.2 Utility Data Access Reform

TLU 1.2 Public Transit Networks

TLU 1.4 Complete Streets

TLU 1.5 Employer Transit Partnerships

TLU 3.2 Freight Transit Partnerships

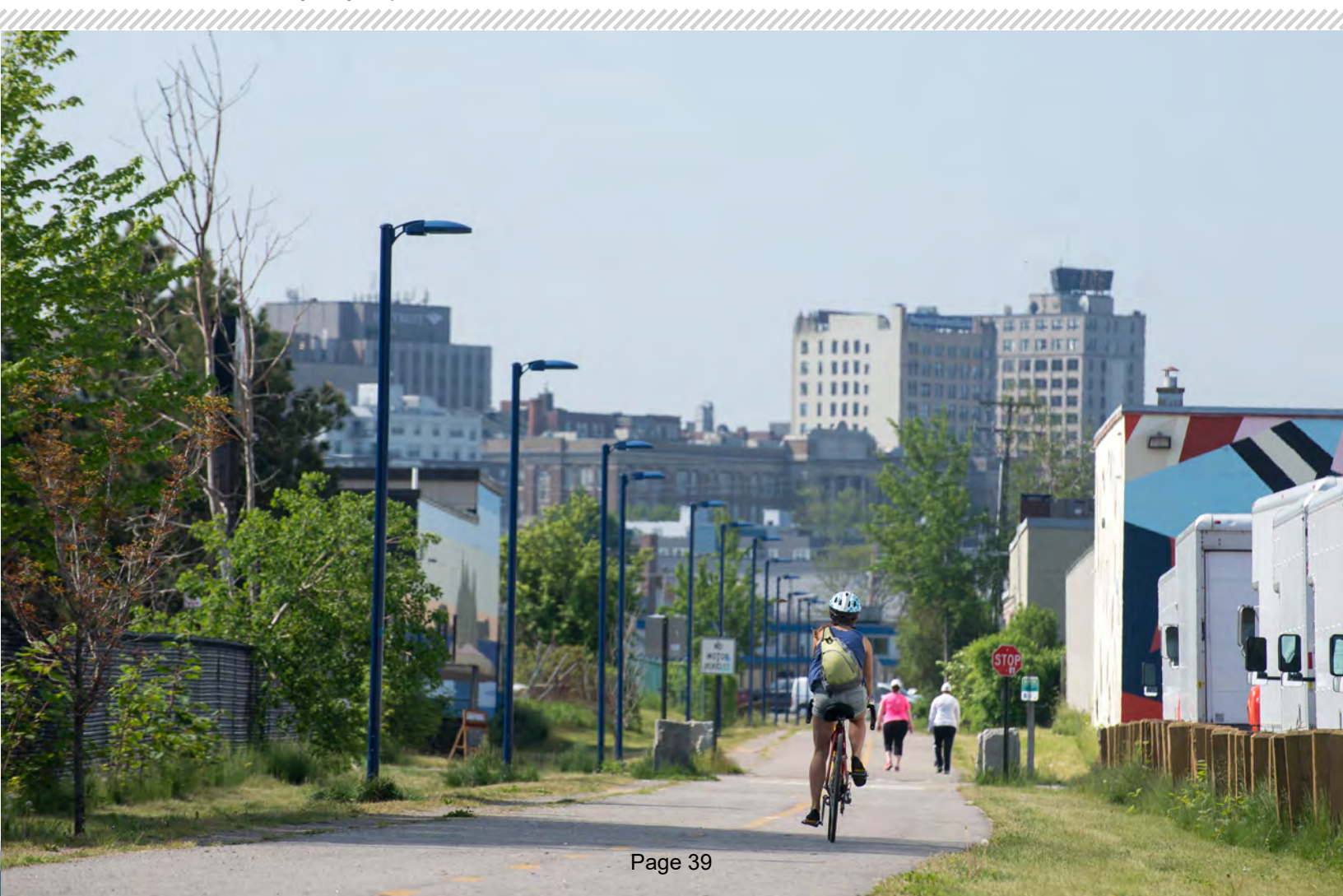
CR 2.2 High Heat Mitigation

CR 2.3 Resilient Food Systems

CR 2.4 Transportation Access

CR 2.5 Neighborhood Resources

BAYSIDE TRAIL • Photo by Corey Templeton



02

One Climate Future **THE CONTEXT**

**THE GREENHOUSE GASES WE ARE
ADDING TO THE ATMOSPHERE TODAY
WILL CONTINUE TO DRIVE CHANGES TO
OUR CLIMATE DECADES FROM NOW.**



GREENHOUSE GASES

Greenhouse gases in the atmosphere trap heat radiating from the earth back into space. This trapped heat increases global temperatures, driving climate change.

BURNING FOSSIL FUELS

Burning fossil fuels adds large quantities of greenhouse gases into the atmosphere. Gasoline, diesel, heating oils, and natural gas are fossil fuels we use daily that produce greenhouse gas emissions.

CLIMATE CHANGE IMPACTS

Rising sea levels, higher temperatures, and more extreme storms are some of the many effects of climate change that can severely impact our ecosystems, economies, and health.

The challenges we are tackling with the One Climate Future plan

One Climate Future addresses the causes of climate change, the effects of climate change, and many underlying patterns that work against our vision of being thriving, inclusive, and sustainable cities now and in the future.

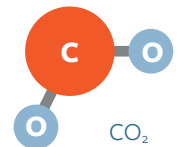
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Rapidly rising greenhouse gas concentrations

For three million years, the concentration of carbon dioxide in the atmosphere never surpassed 300 parts per million (ppm). Yet as recently as the mid-1900s, burning fossil fuels to heat our homes, drive our vehicles, and to power industries has caused carbon dioxide levels to rise at an alarming and accelerating rate—passing 400 ppm in 2016, and reaching 415 ppm less than 5 years later. Carbon dioxide and other greenhouse gases trap energy from the sun and are warming the earth: average global temperatures have increased over 1.0 degree Celsius since pre-industrial times. Without a rapid shift to carbon-free energy sources, we can expect carbon dioxide concentrations of 500 ppm within 50 years, and a temperature increase over 3.0 degrees Celsius.

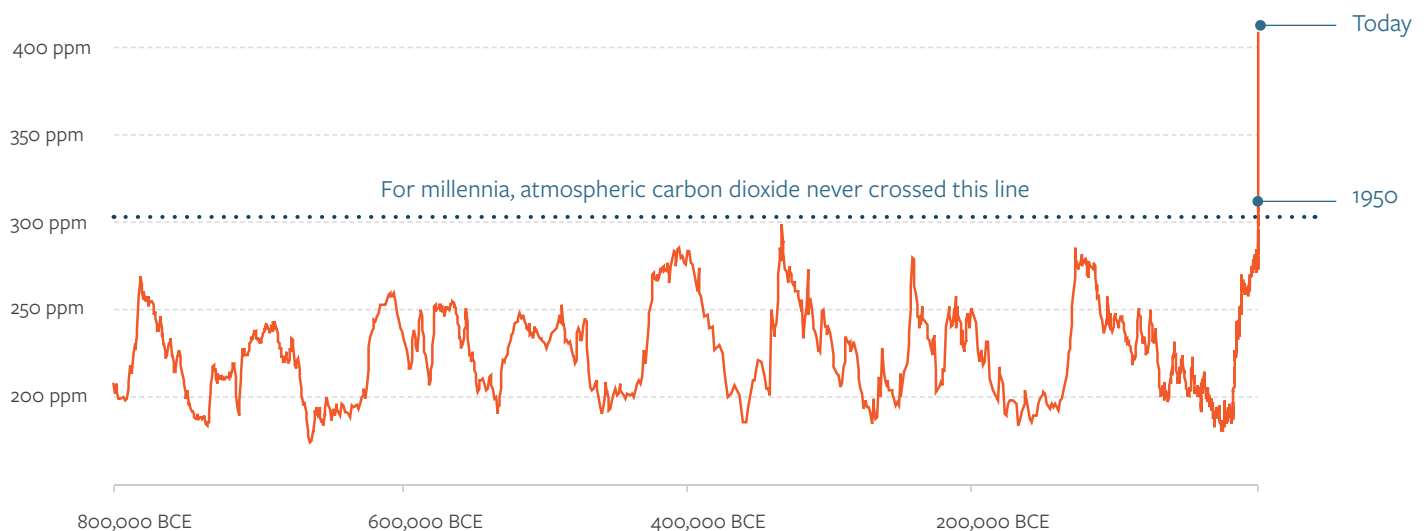
GREENHOUSE GASES

There are dozens of types of greenhouse gases in the atmosphere. We primarily focus on carbon dioxide (CO₂) emissions, because they are the primary driver of climate change. The One Climate Future plan also looks at methane (CH₄) emissions.



Global carbon dioxide in the atmosphere

Average long-term atmospheric carbon dioxide (CO₂) measured in parts per million (ppm). Source: EPICA Dome C CO₂ record (2015) & NOAA (2018).



2 Cascading hazards from a changing climate

While a 1.0 degree increase in global temperature sounds minimal, it is enough to create significant repercussions: globally, we are seeing melting ice sheets in the Arctic, reduced snow pack in the mountains, rising sea levels, droughts, wildfires, and record-breaking storms. In Maine, sea levels have been rising 0.07 inches per year since 1912; the duration of winter snow pack has decreased by two weeks over the past century; and the Gulf of Maine is warming faster than 99% of the world's oceans. With these changes we know we will increasingly experience new sources of vulnerability, including threats to our health and safety, strain on our economy, stress on our food systems, degradation of our native ecosystems, and higher risk of infrastructure failure.

3 Even bigger systems at play

The climate challenges we face are ultimately indicators of bigger systems that continue to work against a vibrant, inclusive, and sustainable future. Our use of fossil fuels is only one part of a model of economic growth that uses resources inefficiently and unsustainably, and that fails to fully capture the value of healthy communities and ecosystems. Climate change disproportionately burdens communities that have faced a long history of oppression and marginalization; therefore, climate change increases social inequity, and existing social inequity magnifies the harm created by climate change. Addressing these bigger challenges thus becomes integral to how we create a carbon-neutral and resilient future.

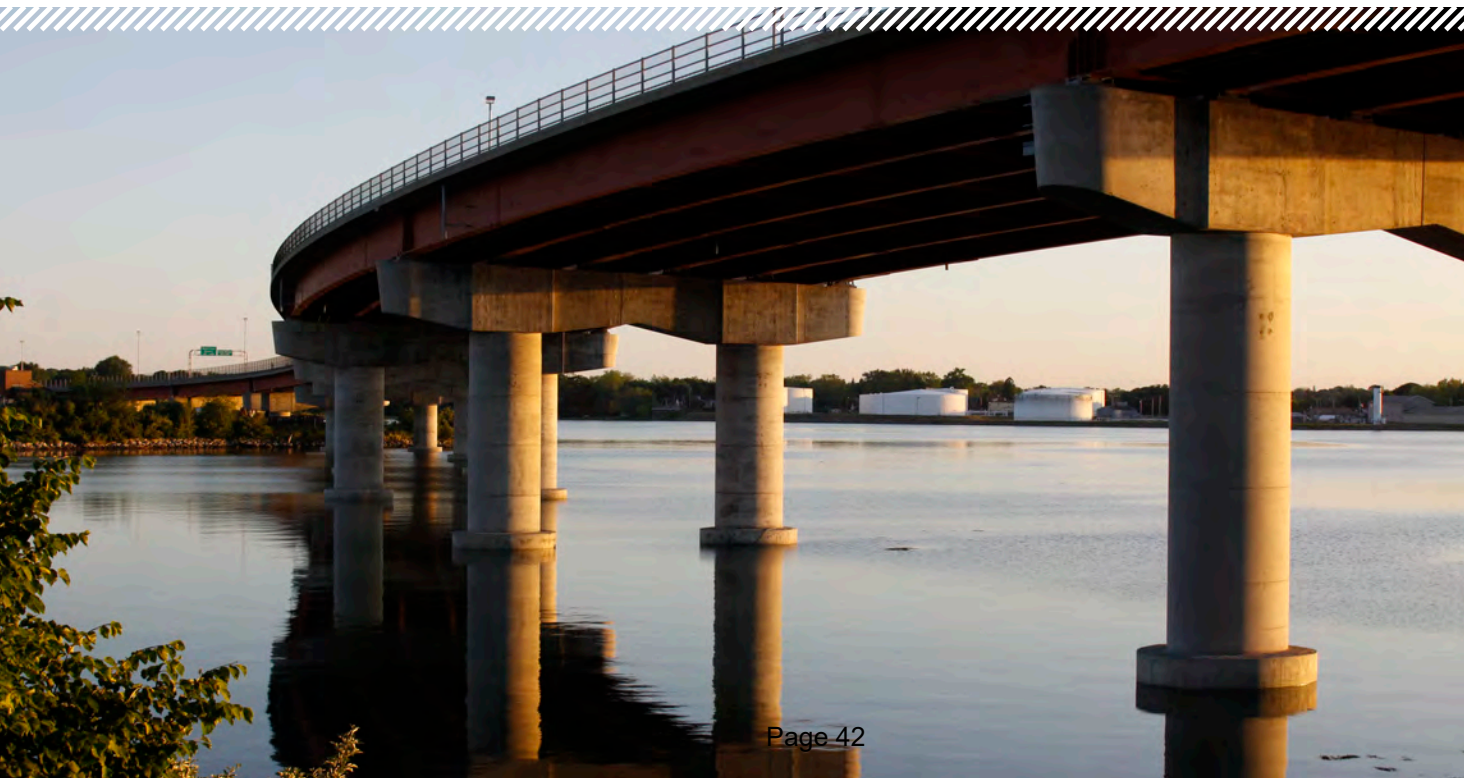
Where we are today

Part of addressing these challenges involves understanding where we are starting from. Community-wide greenhouse gas inventories were conducted for each of our cities to identify large sources of emissions and the magnitude of emissions reductions we must achieve (see pages 26-29). The One Climate Future Vulnerability Assessment summarizes changes in the local climate to date, and the range of changes we expect to see over the next century, depending on the pace of global greenhouse gas emissions reductions. The Vulnerability Assessment also identifies vulnerabilities across our communities, economy, infrastructure, and ecosystems (see pages 30-33).

Defining the change we envision

The assessments of where we are today help to define the change we hope to see, including the quantity of greenhouse gas emissions reductions, areas to increase the resilience of our cities, and the opportunity for creating just and sustainable cities (see pages 34-35). This context sets the foundation for the One Climate Future strategies, through which Portland and South Portland will play our part in minimizing the worst effects of climate change, while simultaneously investing in our local businesses, our health, and our communities.

UNDER THE CASCO BAY BRIDGE • Photo by Denise Michaud



Sustainability defined

The One Climate Future plan expresses the vision of Portland and South Portland to be thriving, vibrant, and sustainable communities now and in the future. As we work toward that goal, it's important to define what we mean. Too often, people imagine that sustainability simply means protecting the environment. While that is important, it isn't enough. A popular analogy illustrates sustainability as a series of interlocking rings. To be truly sustainable, a community must reach the sweet spot where the rings equally overlap. Our cities will work with our residents, businesses, community organizations, and other stakeholders to achieve this alignment. Here's how we characterize each ring:



Social Sustainability

In order to be truly sustainable, a community must strive to meet the needs of all its members regardless of factors such as race, ability, gender identity, education, place of birth, or income. One Climate Future imagines a future where all residents of Portland and South Portland are able to fully participate in the civic, economic, and social life of the community, where everyone has access to safe, affordable housing, healthy food, and where people can move about safely and conveniently on foot, by bicycle, or by transit.

efficiently, adopting a conservation mindset, and considering how the Cities' financial decisions impact property taxes and other fees. Maintaining a high bond rating allows our cities to access capital markets to support investments to prepare vital municipal infrastructure for future storms and sea level rise. Such investments make good financial sense because, according to the World Economic Forum, "An average of 3% additional upfront capital investment is required to build resilience into infrastructure, yet every dollar invested in resilience generates four dollars of economic value."

Economic Sustainability

Portland and South Portland can become more sustainable by investing in and incentivizing business activity that aligns with our One Climate Future goals. This means working to attract diverse businesses to locations where they can anchor neighborhoods built near transit corridors, allowing people to shop or seek entertainment within walking distance of their home. It means supporting locally-owned businesses that invest in the community, create local jobs, and circulate money throughout the economy by using goods and services provided by other local businesses. It means encouraging entrepreneurship and business development for everyone including New Mainers looking for an opportunity to participate in the economy.

Economic sustainability also means being good stewards of the public's financial resources by providing services

Environmental Sustainability

To be environmentally sustainable, Portland and South Portland work to achieve a circular economy so that we don't deplete natural resources or cause long lasting damage to the planet. We must continue our efforts to clean our stormwater, increase the health of our soils, and protect the quality of the air we breathe to ensure community members can thrive now and in the future. We must meet our goal to eliminate carbon emissions to avert the worst impacts of climate change that could devastate marine- and land-based ecosystems. We must also work to mitigate the disproportionate burden of industrial processes and pollution on neighborhoods with vulnerable populations.

These three interlocking rings define the full picture of what it means to be a sustainable city.

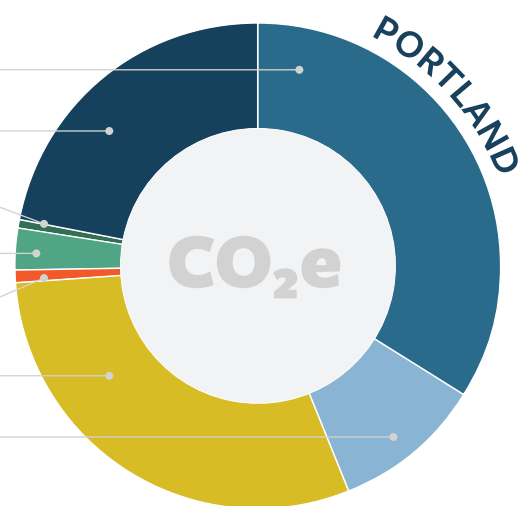
Portland and South Portland’s greenhouse gas emissions

In 2017, Portland and South Portland collectively emitted 1,192,665 MTCO₂e. This threshold will serve as our baseline for measuring emissions reductions moving forward.

EMISSIONS BY SECTOR

- 34% COMMERCIAL BUILDINGS
- 22% RESIDENTIAL BUILDINGS
- 0.3% WASTEWATER
- 3% SOLID WASTE
- 0.8% WATERBORNE TRANSPORTATION
- 30% ON-ROAD TRANSPORTATION
- 10% INDUSTRIAL BUILDINGS

840,419 MTCO₂e
OF GREENHOUSE GASES EMITTED IN 2017



Portland’s greenhouse gas emissions

In 2017, Portland emitted 840,419 MTCO₂e of greenhouse gas emissions community-wide. The use of electricity, natural gas, and fuel oil in buildings is the main driver of Portland’s greenhouse gas footprint—commercial and residential buildings emit over half (56%) of our city’s greenhouse gas emissions. Another 10% of emissions comes from industry, including industrial buildings and process loads. Transportation within the city is responsible for roughly one third (31%) of Portland’s emissions, with just under 1% of those emissions attributed to waterborne transportation, including Casco Bay Lines and cruise ships while in port. The remaining 3% of Portland’s emissions are produced from the incineration of solid waste and processing of wastewater.

South Portland’s greenhouse gas emissions

In 2017, South Portland emitted 352,246 MTCO₂e of greenhouse gas emissions community-wide. As in Portland, the use of electricity, natural gas, and fuel oil in buildings is a primary driver of South Portland’s greenhouse gas footprint—commercial and residential buildings emit 42% of our city’s greenhouse gas emissions. In South Portland, however, a much larger proportion (24%) of emissions comes from our industrial sector, including industrial buildings and process loads. Transportation within the city is responsible for roughly one third (32%) of our emissions, and the incineration of solid waste and processing of wastewater is responsible for the remaining 3%.

What is MTCO₂e?

MTCO₂e is an abbreviation for “metric tons of carbon dioxide equivalents.” Each greenhouse gas has a different capacity to trap heat, or “global warming potential.” By expressing quantities of greenhouse gases in MTCO₂e, we are converting one metric ton of a greenhouse gas into the equivalent number of metric tons of carbon dioxide, based on their global warming potential, in order to compare and sum the emissions from various greenhouse gases.

EMISSIONS BY SECTOR

23% COMMERCIAL BUILDINGS

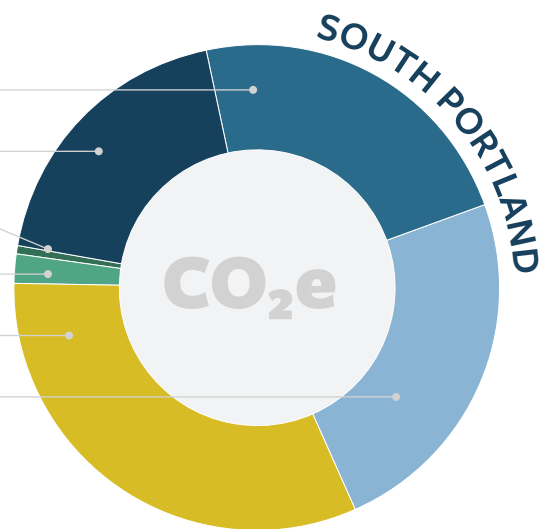
19% RESIDENTIAL BUILDINGS

0.4% WASTEWATER

3% SOLID WASTE

32% ON-ROAD TRANSPORTATION

24% INDUSTRIAL BUILDINGS



352,246 MTCO₂e

OF GREENHOUSE GASES EMITTED IN 2017

CASCO BAY LINES FERRIES • PHOTO BY ANNA ACKERMAN

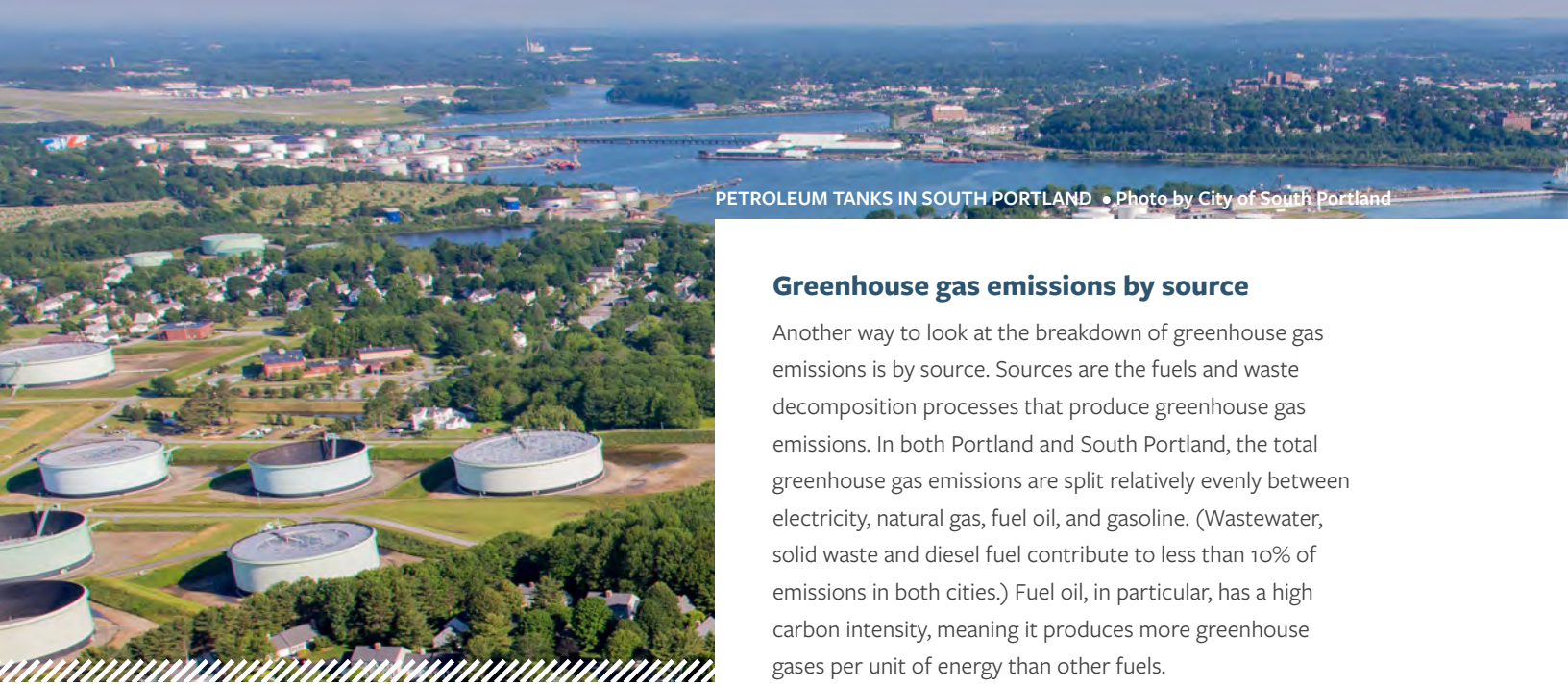
WHAT'S INCLUDED IN THE INVENTORIES?

Greenhouse gas inventories are generally divided into three scopes:

- Scope 1:** All emissions within the city.
- Scope 2:** Emissions occurring as a result of grid-supplied electricity used within the city.
- Scope 3:** Other emissions occurring outside the boundaries of the city as a result of activities taking place within the city.

The inventories follow the BASIC approach to the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC). BASIC includes all scope 1 and 2 emissions, as well as scope 3 out-of-boundary waste and wastewater emissions. It excludes other scope 3 emissions sources, such as emissions from natural gas leakages, electric transmissions losses, or out-of-boundary aircraft or ships. Using the BASIC methodology aligns the inventories better with the elements the cities can control.





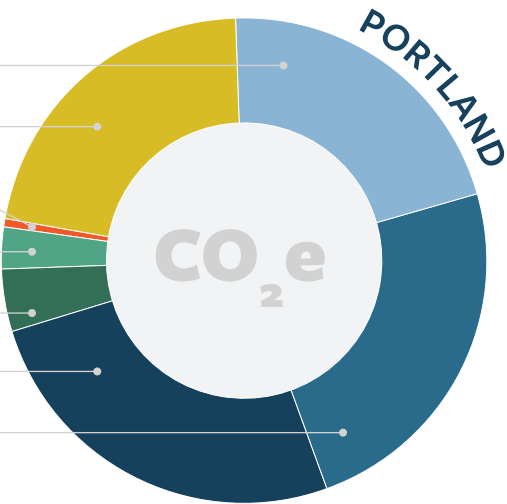
PETROLEUM TANKS IN SOUTH PORTLAND • Photo by City of South Portland

Greenhouse gas emissions by source

Another way to look at the breakdown of greenhouse gas emissions is by source. Sources are the fuels and waste decomposition processes that produce greenhouse gas emissions. In both Portland and South Portland, the total greenhouse gas emissions are split relatively evenly between electricity, natural gas, fuel oil, and gasoline. (Wastewater, solid waste and diesel fuel contribute to less than 10% of emissions in both cities.) Fuel oil, in particular, has a high carbon intensity, meaning it produces more greenhouse gases per unit of energy than other fuels.

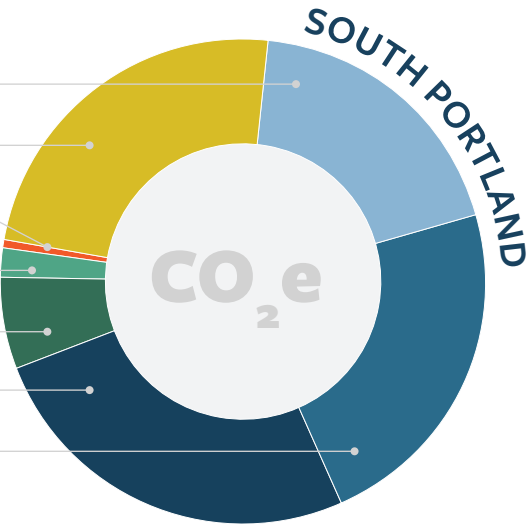
EMISSIONS BY FUEL SOURCE

- 21% NATURAL GAS
- 22% ELECTRICITY
- 0.3% WASTEWATER
- 3% SOLID WASTE
- 4% DIESEL
- 26% GASOLINE
- 24% FUEL OIL



EMISSIONS BY FUEL SOURCE

- 19% NATURAL GAS
- 24% ELECTRICITY
- 0.4% WASTEWATER
- 2% SOLID WASTE
- 6% DIESEL
- 26% GASOLINE
- 23% FUEL OIL

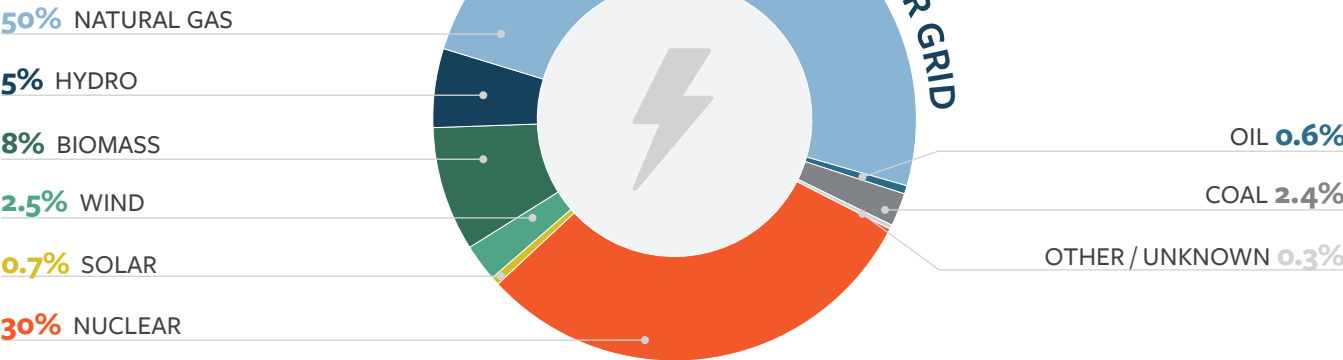


The role of electricity

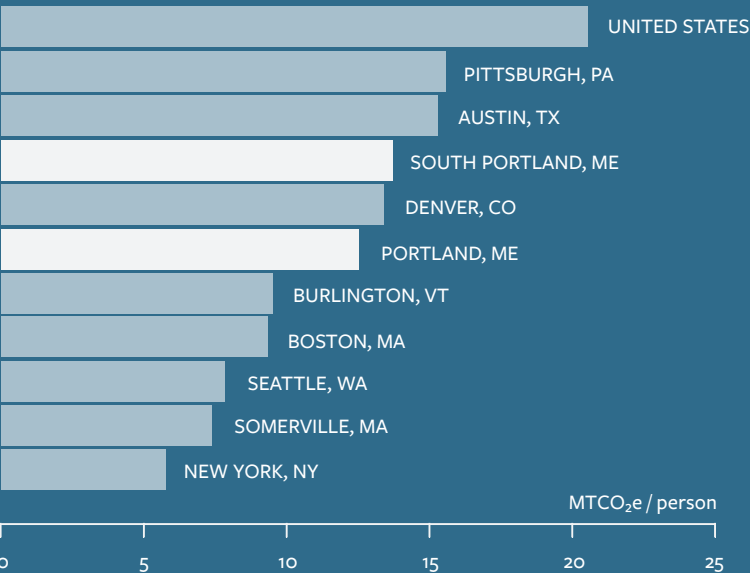
Just under a quarter of all greenhouse gas emissions in both cities come from electricity, due to the mix of fuel sources that are currently used to produce electricity. As we continue to expand the amount of renewable energy on the electrical grid, such as solar and wind power, the greenhouse gas emissions from electricity (the yellow wedges in the “Emissions by Fuel Source” charts) will shrink. If Maine continues to hit its renewable portfolio standard targets, we will reach zero emissions from electricity by 2050.

Therefore, the primary way that we can reduce greenhouse gas emissions involves three steps: 1) Ensuring our systems run as efficiently as possible, 2) Expanding the amount of electricity that comes from renewable sources, and 3) Switching as many systems that are currently powered by fossil fuels to electricity, such as transportation and building heating and cooling. In some cases we can switch to biofuels, particularly for processes (such as industrial processes) that are difficult to run on electricity.

ELECTRICITY SOURCES



EMISSIONS PER CAPITA



How do we stack up?

On a per capita basis, South Portland emits 13.8 MTCO₂e per resident and Portland emits 12.6 MTCO₂e per resident. These numbers are well below the U.S. national average of 20.7 MTCO₂e per resident, but are more emissions-intensive than a number of other Northeast cities. In general, these differences reflect the greater use of fuel oil for heating, lower density development and less robust public transit systems, higher reliance on private vehicles, and a greater proportion of industrial energy use.

Note: Emissions per capita are shown for rough comparison; Inventory methodologies may differ.



Climate change in Portland and South Portland

Portland and South Portland are already feeling the local effects of global climate change—including rising sea levels, more intense storms, warmer air and water temperatures, and ocean acidification. The changes that we detect today are only indicators for the more significant changes that are projected to come.

• See the One Climate Future Vulnerability Assessment at oneclimatefuture.org for more. •

Changes in sea level, storm surge, and tidal flooding

Sea levels in the Greater Portland area have been rising at a rate of 0.07 inches per year since 1912. According to the 2018 National Climate Assessment, sea levels will continue to rise and the pace will likely accelerate. Under an intermediate sea level rise scenario, we can expect to see 1.5 feet of sea level rise by 2050 and nearly 4 feet by 2100. Under the most extreme scenarios, we could see over 3 feet as early as 2050, and upwards of 8.8 - 10.8 feet by 2100. Portland and South Portland are likely to experience more intense and frequent flooding from sea level rise and storm surge, and certain areas that flood now during heavy storm events will likely experience daily flooding at high tide by the end of the century.

See pages 10-19 of the One Climate Future Vulnerability Assessment for more information.

Changes in precipitation and storm patterns

As the climate changes, warming ocean surface temperatures lead to higher levels of evaporation and greater moisture in the air—contributing to more precipitation and extreme weather events. The average amount of precipitation that Maine sees in a year has already increased six inches (13%) since 1895. Precipitation in the Greater Portland area is projected to increase by another 4–5% from current totals by 2050. We expect most of this yearly increase to come in the fall and winter, and for precipitation to fall increasingly as rain rather than snow. With increasing storm intensity, more precipitation will fall in shorter periods of time, causing strain on stormwater systems and increasing the risk from flooding.

See pages 20-24 of the One Climate Future Vulnerability Assessment for more information.



SEA LEVEL RISE PROJECTIONS ALONG THE FORE RIVER FOR 2100 UNDER 6 SCENARIOS • Geospatial data from Maine Geological Survey
HAT = Highest Astronomical Tide. See the One Climate Future Vulnerability Assessment for maps of other parts of Portland and South Portland.

Changes in air temperatures

Average annual temperatures across Maine have increased 3°F since 1895. Along the coast, temperatures are expected to continue to increase another 3.5–4°F by 2050. In addition to warmer average temperatures, Portland and South Portland are expected to experience more days of extreme heat and fewer days below freezing. The Portland area has historically experienced four high-heat days a year where the heat index reaches over 95°F. The number of high-heat days per year is expected to reach 13.5 by 2050. Extreme heat is a significant public health risk, while fewer days below freezing are leading to increases in rates of pest outbreaks and vector-borne diseases, like Lyme disease.

See pages 25–28 of the One Climate Future Vulnerability Assessment for more information.

Changes in water temperature and acidification

Between 2004 and 2013, the Gulf of Maine warmed 0.41°F per year, a rate faster than 99% of the world's oceans. In Casco Bay, specifically, water temperatures have increased roughly 2.5°F between 1993 and 2018. At the same time, oceans globally are becoming more acidic as they absorb carbon dioxide from the atmosphere, and as stormwater runoff reduces their buffering capacity. The Gulf of Maine is particularly susceptible to acidification due to its relatively low pH, cold water, and freshwater inputs off the coast. Ocean warming and acidification are affecting species health, species distributions, and creating shifts in marine ecosystems and food webs.

See pages 29–31 of the One Climate Future Vulnerability Assessment for more information.

Vulnerabilities enhanced by climate hazards

Climate hazards, such as sea level rise and more extreme storms, will exacerbate vulnerability in our cities and put strain on our infrastructure, ecosystems, and community health. Below are ten of our top concerns for Portland and South Portland.

● See the One Climate Future Vulnerability Assessment at oneclimatefuture.org for more. ●



BUILDING AND PROPERTY DAMAGE
Sea level rise and more extreme storms will damage buildings and decrease property values if we don't increase the resilience of existing buildings and new development.



MORE POWER OUTAGES
Extreme storms increase the likelihood of power outages, which can disrupt transportation, communication, and water systems, and create short- and long-term economic losses for businesses.



TRANSPORTATION CLOSURES
Sea level rise and storm surge are expected to increasingly flood roads, including portions of I-295. A Category 2 hurricane could cut off access to bridges between the two cities.



STORMWATER AND SEWER SYSTEM RISKS
Portions of the cities' sewer and stormwater systems along the coast are vulnerable to storms and sea level rise that may lead to pipe damage, saltwater infiltration, and failure of electrical pumping equipment.



ECOSYSTEM IMPACTS
Climate change will affect freshwater, marine, and land ecosystems by allowing new invasive species and pests to thrive. Sea level rise and more stormwater runoff can further degrade sensitive tidal ecosystems.



EXPOSURE TO HAZARDOUS WASTE
Without proactive preparedness, sea level rise and more extreme storms could increase our exposure to toxins from hazardous waste sites along the coast, posing a risk to human and environmental health.



PUBLIC HEALTH CHALLENGES

Heat-related illnesses, diseases carried by ticks, poor air quality, and emotional stress are some of the public health challenges our region will increasingly face as our climate changes.



FOOD SYSTEM VULNERABILITY

International droughts, floods, and new pests will impact global food systems and potentially increase food prices here in Maine. Climate hazards locally will likely compromise food distribution and food access.



STRAIN ON SOCIAL SERVICES

Climate hazards will increase the need for social services. At the same time, climate hazards can make essential services inaccessible to vulnerable populations during weather-related emergencies.



GREATER SOCIAL INEQUITY

Residents facing poverty, a disability, or other forms of marginalization will experience disproportionate harm from climate change. Climate adaptation planning and implementation must address these inequities to ensure that benefits are shared equitably among our communities.

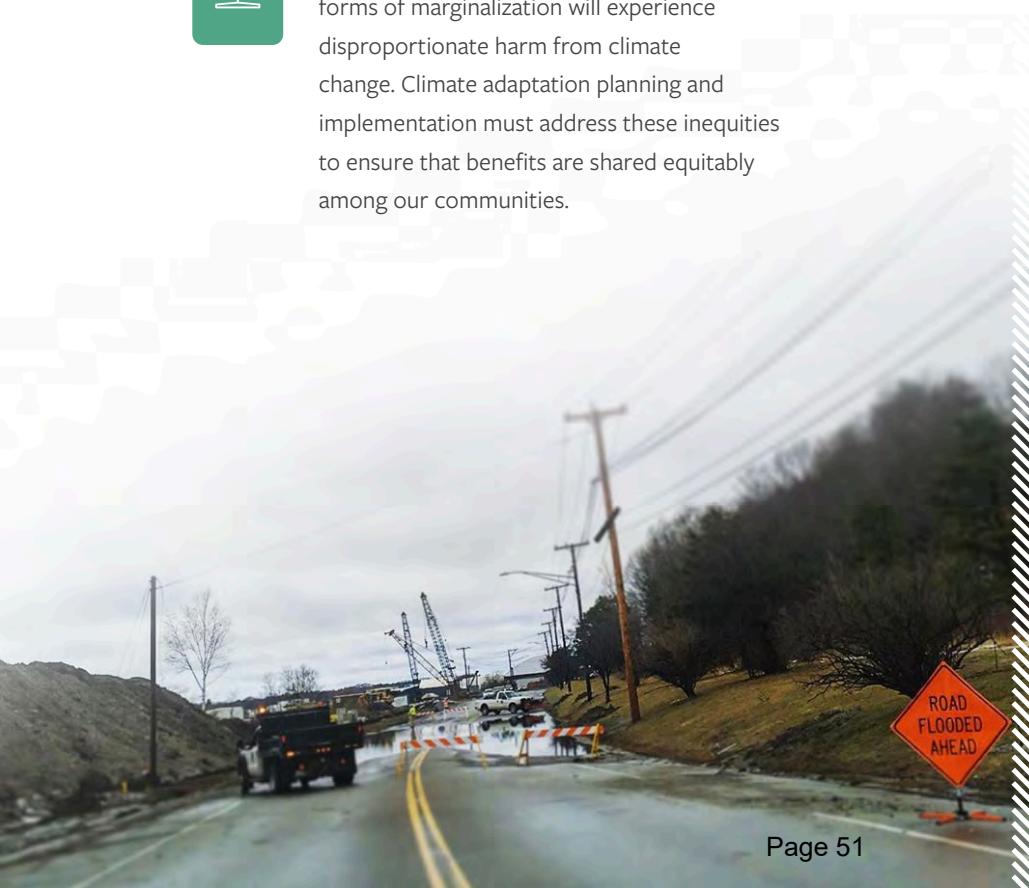


Parallels with the COVID-19 pandemic

As of fall 2020, the COVID-19 pandemic has created severe financial uncertainty for businesses, organizations, and residents in Portland and South Portland, as well as nationwide. Although not directly related to climate change, the pandemic has similarly tested the resilience of our economy, our social services, and our healthcare systems, and has exposed many of the same vulnerabilities that we will likely see with future climate hazards.

There are also significant parallels in how the COVID-19 health emergency and the climate crisis disproportionately affect residents with existing health conditions, communities of color, and low income communities. These frontline communities face greater exposure to both hazards, and have more limited financial safety nets, more limited access to healthcare, and fewer resources to respond. In other words, both crises magnify the stark systemic inequities in the country. For this reason, becoming more resilient cities and more equitable cities are intertwined.

See page 15 for further discussion on how the experiences and lessons drawn from the COVID-19 health emergency will shape the implementation of One Climate Future. See page 34 for a discussion on becoming just, resilient, and sustainable cities.



Creating just, resilient, sustainable cities

Climate change will not affect us all equally and will instead magnify existing inequities. We have the opportunity to create more equitable cities as we work towards a carbon-neutral future.

.....

Just climate action

Frontline communities are those that will be impacted “first and worst” by the effects of climate change. These communities include Indigenous, Black, and communities of color, low-income communities, workers, and other groups that face greater exposure to pollution and climate hazards with more limited resources to respond. These patterns are created by systems that have marginalized and oppressed these communities for hundreds of years, and continue to do so today. We see these patterns across the United States and world, as well as here in Maine.

Taking *just climate action* refers to the enormous opportunity to not only run our economies on clean and renewable energy, but to transition to a regenerative economy—and to make that transition in a just and equitable way. A regenerative economy is one where our work and livelihoods continuously restore and build (as opposed to exploit and diminish) the long-term health and wellbeing of our natural systems, people, and communities. We collectively stop processes that threaten our quality of life, including polluting water and air. We create pathways for workers to transition to clean industries. By doing so, we work to reverse the disproportionate burden on frontline communities and create ways to equitably distribute the benefits of a growing clean economy.

For just climate action, processes and decisions must center the direct experiences of frontline communities. The Cities are able to develop better and more equitable solutions through more inclusive processes when community members are partners in problem solving and capacity building, and when those who are most impacted have the greatest say in the approach and outcomes. We become more sustainable cities when we can create a great quality of life without living better at the expense of others, including our future generations. And ultimately, this creates greater outcomes for everyone. This promise is fundamental to the vision of One Climate Future.



- “We live in an interconnected world, in an interconnected time, and we need holistic solutions. We have a crisis of inequality, and we need climate solutions to solve that crisis.” ●
- Naomi Klein

BAYSIDE ANCHOR, PORTLAND • Photo by Kaplan Thompson Architects



03

One Climate Future **CHARTING A COURSE**

OVER 18 MONTHS, THOUSANDS OF
COMMUNITY MEMBERS HELPED TO
SHAPE A BOLD CLIMATE PLAN FOR
OUR CITIES.

KING MIDDLE SCHOOL
students discuss the
opportunities for solar!



How this plan was developed

In collaboration

One Climate Future is a people-based plan that would not have been possible without the engagement of so many Portland and South Portland residents, organizations, and neighborhood groups. Over the course of 18 months, thousands of community members helped to shape a bold climate action plan for our cities. By answering surveys, attending book discussions, participating in community workshops, joining Lunch and Learns, and gathering around neighborhood tables, your voices elevated One Climate Future to take on the climate crisis in equitable, smart, ambitious, and creative ways. Thank you for your participation in this endeavor, and for your shared commitment to ensuring that Portland and South Portland are places of opportunity for all residents and businesses to thrive in a changing climate.

KING MIDDLE SCHOOL • Photo by Troy Moon



At the beginning of the process, the Cities set a series of goals to guide the development and implementation of a robust community engagement campaign. Our goals for engagement were threefold:

1 Deliver an Equitable Process that gives residents from all neighborhoods and backgrounds in Portland and South Portland a voice in the process. Our cities will not be sustainable unless they are also equitable. It is important that the planning and implementation of One Climate Future be shaped by the insight, input, and direction of populations and members of our frontline communities that have been underrepresented or historically excluded from planning processes, and who will be most disproportionately impacted by climate change.

Driven by this imperative, the plan's process reached a large number of residents and community groups in a variety of ways. And yet we know there is more we can do to ensure that One Climate Future advances a just and equitable future as we implement the plan. We must ensure that every community member has access to the resources they need to be resilient in the face of climate change, and can equitably benefit from the opportunities created by climate action. Portland and South Portland are committed to these outcomes, and to partnering with frontline communities that are already leading this work to create healthier and more resilient cities.

2 Build Local Capacity by equipping partner organizations, community leaders, and other residents with the tools, resources, and knowledge to discuss climate change and its impacts, and to take an active role in making our cities stronger tomorrow than we are today. We came together, leveraging existing strengths and networks across both cities and regionally. An enthusiastic group of volunteers, community partners, and street team members stepped up to lead climate conversations and host events after participating in trainings on messaging, surveying, and presenting project materials. This leadership and the partnerships through this process set us on a course for climate action that enhances existing solutions and builds towards bold new initiatives.

3 Spark an Ongoing Climate Conversation by building on the momentum of this process to ensure One Climate Future is only the start of our climate change dialogue. Residents with diverse backgrounds and stories joined the conversation—as youth, New Mainers, islanders, parents, seniors, college students, people of color, residents with low incomes, and residents representing local businesses, the building and affordable housing sector, food justice and urban agriculture, the fishing and waterfront community, and many other sectors. Each shared the ways in which they are already feeling the local effects of climate change and their goals for climate action. Both Cities are harnessing this opportunity to keep the conversation going, and to turn talk into measurable change.

Over 50 volunteers, 100 events and 1,500 completed surveys in 4 languages later, Portland and South Portland are excited for the next phase of this plan. We extend deep gratitude to each and every one of you that participated in the planning process, grounded One Climate Future in the local community context, and launched Portland and South Portland in an ambitious direction of climate leadership.

MANY OF THE HIGHLIGHTS

ARE RECAPPED IN THE FOLLOWING PAGES

1,625
COMPLETED
SURVEYS
TAKEN IN 4 LANGUAGES

91
EVENTS HOSTED
OR ATTENDED
TO DISCUSS ONE CLIMATE FUTURE

57
VOLUNTEERS
TRAINED
VIA THE VOLUNTEER TRAINING

6
STREET TEAM
MEMBERS
PAID TO LEAD CLIMATE CONVERSATIONS

MEETING IN A BOX

The “Meeting in a Box” built local capacity by equipping community partners and volunteers with tools and content to host their own presentations and events. Discussion questions, handouts, surveys, trivia questions, and other materials fostered robust conversations at neighborhood meetings and community gatherings across the two cities.



KEEP IN TOUCH!

oneclimatefuture.org
Check for updates on the One Climate Future website at oneclimatefuture.org where you can also download a copy of the vulnerability assessment and One Climate Future plan.

Community Newsletter
Sign up for the One Climate Future Community Newsletter via the sign-up form on the home page of the One Climate Future website at oneclimatefuture.org.

Follow One Climate Future:

 @sustainableportlandme
@soposustainability
 City of Portland
Sustainability Office
City of South Portland
Sustainability Office
 @SustainPortME

Engaged Volunteer Training

Volunteers played a critical role in shaping One Climate Future and promoting engagement with the planning process. At an evening training, over 50 community members refined approaches to engaging people in effective climate conversations by delivering public presentations, talking to friends and family, and effectively leveraging social media.



Official Launch Event

On June 10th, community leaders and representatives took the stage at the Gulf of Maine Research Institute for the official launch of One Climate Future. The event attracted over 100 people and set the tone for the Cities' continued collaboration on climate action.

Did you miss the launch? Watch the press conference with the featuring remarks from community members at the following link!
<https://www.youtube.com/watch?v=G6oe3gyhz4g&feature=youtu.be>



Equity Partner Training & Workshop

The Cities connected with community organizations that are run by and/or directly support communities in the cities that will be most affected by climate change. Through a training in climate change communication, this group became advocates and spokespeople for how climate change intersects with their existing work to build stronger communities. Later in the process, these community organizations joined us again to identify ways that the plan can advance equity and elevate existing community priorities.

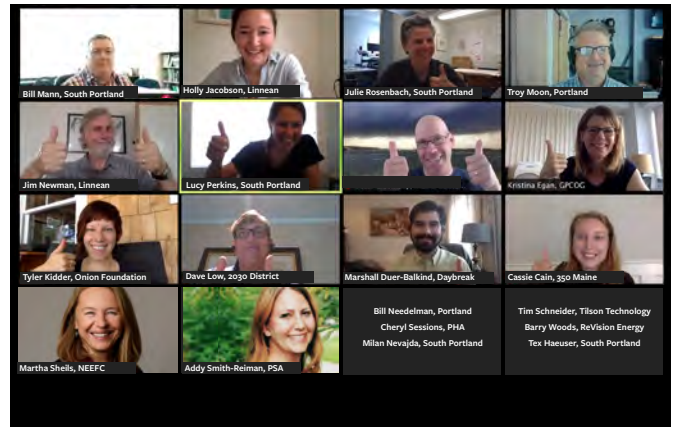
Street Team

The Street Team, made up of six paid community members, attended events to communicate the goals of One Climate Future to the public and to gather feedback through surveys. The team collectively attended over 25 events throughout the summer, spreading enthusiasm and interest in the plan and creating a great way for our young residents to drive conversations on climate change.



Climate Planning Process Committee (CPPC)

The Climate Planning Process Committee, appointed by the City Councils, served as a sounding board to the plan's development. The Committee provided input on the plan's potential for impact, climate vulnerabilities, the largest levers for reducing greenhouse gas emissions, and the plan's big picture narrative in four workshops—in addition to participating in strategy development calls and providing feedback to written drafts.



Topic Area Engagement Posters

Community members provided informal, creative ideas on posters strategically located throughout the Cities, including in cafes, libraries, and events.

Climate Change Book Discussions

We hosted a series of gatherings to discuss Joseph Romm's *Climate Change: What Everyone Needs to Know*. By sharing what surprised us and where we had questions, the book helped us, as a community, to get on the same page about climate science.

Lunch & Learns ... and Online Workshops

Over 85 community members joined us for a series of lunchtime workshops to learn about and discuss Portland and South Portland's greenhouse gas emissions, climate vulnerabilities, ways we can reduce emissions and build resilience, and how we can advance equity in the process. In the spring of 2020, the COVID-19 pandemic prohibited in-person events. Remaining adaptive, we went virtual with a series of online workshops. More than 75 attendees tuned in to help us refine the strategies within the context of the lived experiences of our residents and community members.

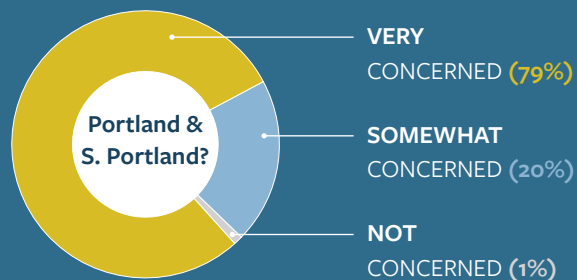
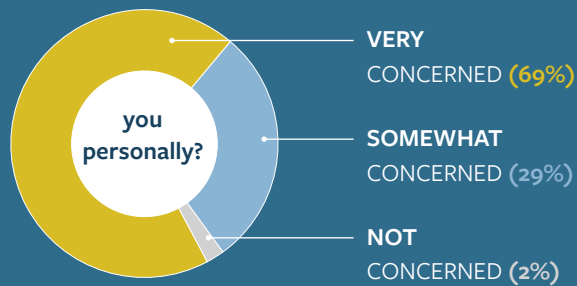


Presentations with Community Partners

Local businesses and organizations hosted community presentations about One Climate Future. Open discussions after each presentation created opportunities for community members to share feedback and find ways to continue their involvement in climate action in the cities.



How concerned are you that climate change will affect...



Surveys

Through three surveys over the course of the plan's development, community members collectively completed over 1,600 surveys, grounding the plan in the needs and ideas of our residents and businesses. The first survey captured climate concerns and established a benchmark of existing community actions. The second survey identified barriers to taking further climate action. The final survey gathered community input on the proposed strategies for the plan.

A snapshot of what we heard:

“ I want those who work in the cities to be able to live in the cities. ”

“ Yes to Stretch Code! Yes to Net-Zero for any city incentives. ”

“ We need financial support, rebates, and affordable options for renewable energy conversion for local residents. ”

“ Micro-grid creation for neighborhood sustainability! ”

“ We need to protect the ecosystems in order to have a sustainable marine culture. ”

“ I think the Old Port should be car-free in the summer. ”

“ More affordable housing ”

“ The [bus] systems just aren't coordinated very well. If they were, I wouldn't have to try to figure out where one system's buses connect with another's by navigating two different websites to come up with travel plans. I get off one bus and then have to wait an hour for a connection to the other system. I'm never going to choose the bus over a car if that's the case. ”

“ Support regional agriculture! ”

Engagement Timeline

- = Presentation/Discussion
- = Training
- = Tabling
- = Workshops

2019

FEB

- Equity Partner Training
- Engaged Volunteer Training

MAR

- Friends of Casco Bay: Ocean Acidification, Climate Change, and You
- CPPC Kick-off Meeting

APR

- Allagash Brewery
- Green Neighborhood Family Fest
- Knitting Nook Lunch & Learn
- CPPC Vulnerability Workshop



MAY

- Green New Deal Presentation at Portland Resilience Hub
- Parks Commission, Green Space Gathering
- Sierra Club Statewide Conference
- Portland High School
- Neighborhood Connection Night
- South Portland Farmers Market
- "Paris to Pittsburgh" Movie Discussion



AUG

- National Night Out at Redbank Community Center
- Climate Change: What Everyone Needs to Know at Congregation Bet Ha'am
- St. Luke's Episcopal Cathedral & First Parish Portland Unitarian Universalist Church
- Allen Avenue UU Church
- Maine Mall
- Hinckley Park
- Deering Oaks Park Farmers Market
- South Portland Farmers Market
- South Portland Library



JULY

- St. Luke's Episcopal Cathedral
- Gateway to Opportunity High Schooler Discussion
- Stars and Stripes Spectacular
- Bug Light Movies
- Revision Energy event
- "Paris to Pittsburgh" Movie Discussion in the West End
- Hinckley Park
- University of Southern Maine
- Climate Change: What Everyone Needs to Know at the South Portland Library
- Council on International and Educational Exchange (CIEE) Lunch and Learn
- Third Thursday at Trinity Park
- WillardFest
- Bug Light Movies
- Monument Square Farmers Market
- Cia Cafe
- Climate Change: What Everyone Needs to Know at the Knitting Nook
- OCF Open City Night



JUNE

- E-waste Drop Off: City staff passed out surveys at the annual drop off event
- Deering Oaks Park Farmers Market
- Monument Square Farmers Market
- St. Luke's Episcopal Cathedral Coffee Hour
- Old Port Festival
- Launch Event
- Portland Housing Authority
- Republican City Committee
- CPPC Mitigation Workshop
- Monthly Meeting at St. Luke's Episcopal Cathedral
- Maine Medical Center
- West End Neighborhood Association Meeting
- South Portland Community Dinner
- South Portland Farmers Market
- Redbank Community Dinner
- Startup Maine

NOV

- EcoMaine Presentation
- Global Warming Prayer
- Resilient Food Systems strategy discussion
- Sustainability Programs and Initiatives Lunch and Learn
- Gulf of Maine Symposium
- IDEXX Environmental Stewardship Committee

OCT

- Greenhouse Gas Emissions Lunch and Learn
- Redbank Community Center Climate Discussions
- PassivhausMAINE Fall Forum
- “Paris to Pittsburg” Movie Discussion
- Home Energy Fair
- Conversation about Climate Change at Tandem Coffee
- The Impacts of Climate Change in East Bayside and Surrounding Communities
- Maine Public Health Conference
- Portland West End Neighborhood Association



SEPT

- Portland GreenFest
- St Luke’s Start Up Sunday
- Opportunity Alliance
- Portland Green Fest
- We are Portland Walk & Dance
- Portland Electric Vehicle Ride & Drive
- Vajra Vidya Portland Climate Change Art Discussion
- Portland King Middle School Solar Discussion
- RiverPlace Apartments
- Portland Parking Day
- WGAN Radio Show



DEC

- Vulnerability Assessment Lunch and Learn
- Portland Public Library Sustainability Series
- Portland Rotary Club



2020

JAN

- Equity in Sustainability Lunch and Learn

FEB

- South Portland Planning Board
- Resilient Affordable Housing strategy discussion
- University of Southern Maine Lunch and Learn
- Green & Healthy Maine- Home + Energy Show



MAR

- South Portland Polling Locations

APR

- Online Workshop Series
- Stormwater and Green Infrastructure strategy discussion
- Resilient Ecosystems strategy discussion
- Waterfront Alliance
- IDEXX Environmental Stewardship Committee

MAY

- Maine Conservation Voters Lunch & Learn Series
- Transportation and Land Use strategy discussion
- Regional Public Transportation strategy discussion

JUL

- CPPC “Six Big Moves” Workshop

04

One Climate Future

THE COURSE WE TAKE

.....

PORTLAND AND SOUTH PORTLAND
WILL ADVANCE 68 STRATEGIES
ACROSS FOUR FOCUS AREAS TO
CREATE MORE REGENERATIVE,
RESILIENT, AND EQUITABLE CITIES.



Our plan for creating a thriving future

The communities of Portland and South Portland have developed **68 strategies** across **4 focus areas** that set us on a course to be thriving, inclusive, low-carbon cities. Three key components:

Meeting our greenhouse gas emissions goals

Through energy and emissions modeling, we evaluated the effects of a suite of policies on greenhouse gas emissions reductions, and identified implementation timelines and targets for meeting our climate goals.

[SEE PAGE 46](#)

Focusing on the potential for transformation

We looked beyond greenhouse gas emissions reductions, working to craft strategies that would help us become increasingly equitable, regenerative, and resilient cities.

[SEE PAGE 52](#)

Setting an achievable course for implementation

We outlined timelines, milestones, city stewards, and financing mechanisms to create a feasible course for implementation in the near-term and over the next thirty years.

[SEE PAGE 256](#)

STRATEGIES ACROSS 4 FOCUS AREAS



Buildings and Energy

[SEE PAGE 56](#)



Waste Reduction

[SEE PAGE 118](#)



Transportation and Land Use

[SEE PAGE 140](#)



Climate Resilience

[SEE PAGE 202](#)

The strategies are summarized in a **matrix** at the end of this chapter.

[SEE PAGE 262](#)



OCEAN AVE SOLAR, PORTLAND • Photo by Troy Moon

Achieving our greenhouse gas emissions reductions goals

Portland and South Portland have committed to the following goals for greenhouse gas emissions reductions:

- 1 Reduce community-wide greenhouse gas emissions **80% by 2050**, from 2017 levels.
- 2 Run all municipal operations on **100% clean renewable energy by 2040**.

In 2019, we declared a climate emergency, committing to **accelerate emissions reductions by 2030**.

► How will particular policy actions help us to achieve those goals?

Modeling energy and emissions reductions

As part of the One Climate Future planning process, we modeled greenhouse gas emissions that will be generated by activity in our cities over the next thirty years—both if we were to take no action to reduce emissions and if we were to take immediate and aggressive action to meet our goals. For each policy action, the magnitude of emissions reductions depends on the pace and the extent of implementation or adoption. The model bases these assumptions on trends in other U.S. jurisdictions, as well as assessments of what is both ambitious and achievable for Portland and South Portland, given our current housing stock, transportation systems, industries, location within Maine, and other factors.

The model looks at fifteen sets of policies, all of which are components of the One Climate Future strategies. Not all of the plan's strategies are included in the model, and in some cases the model looks at the combined effect of several strategies, based on where emissions savings can be readily quantified with available data or appropriate proxies. For this reason, the modeled policies do not match the One Climate Future strategies one-for-one. Actions such as promoting leadership and education in high performance buildings (action BE 2.4) are more difficult to directly quantify, yet will still play an important role in reaching our climate goals. The emissions savings attributed to each of the One Climate Future strategies or sets of strategies, where applicable, are included in the implementation matrix on pages 262 - 285.

A pathway to reaching our climate goals

The combined effects of the modeled policies show one pathway for Portland and South Portland to reach our climate goals—specifically how we can reduce community-wide greenhouse gas emissions over 81% by 2050, relative to 2017 emissions totals. As modeled, all municipal operations are run on 100% clean energy by 2040 based on initiatives to decarbonize municipal buildings, procure renewable electricity, and transition to electric vehicle fleets. Many of the assumptions in the model are conservative, and greater savings may well be possible with additional state and federal support.

MODELED POLICIES



Municipal Renewable Energy

Renewable energy procurement to cover municipal energy use



Municipal Building Policies

Energy efficiency upgrades and net-zero energy new municipal buildings starting in 2026



New Construction Policies

New energy stretch code with net-zero energy requirement starting in 2030



Existing Building Efficiency

Expansion of energy benchmarking, energy efficiency retrofits, and gut-rehabs



Existing Building Decarbonization

Switching to electric heating, cooling, and cooking systems, such as air-source heat pumps



Industrial Decarbonization

Efficiency improvements, and conversions to combined heat and power, biofuels, and natural gas



Local Solar

Solar installations within the cities; Emissions savings from local solar are also attributable to the RPS



Renewable Portfolio Standard (RPS)

Statewide policy to generate 80% of electricity from renewable sources by 2030, and 100% by 2050



Mode Shift and Land Use Policies

Targeted reductions in vehicle miles traveled based on the expansion of public transit and development policies



Bus Electrification

Transition to all-electric bus fleets by Greater Portland METRO and South Portland Bus Service by 2040



Fuel Economy Standards

Retaining California Corporate Average Fuel Economy (CAFE) Standards for vehicle efficiency



Electric Vehicle Adoption

Growth in electric vehicle adoption, representing 60% of new vehicle purchases by 2040, and 100% by 2050



Ferry and Ship Electrification

Transition to all-electric Casco Bay Lines ferry fleet by 2045, and shore power for cruise ships by 2040



Solid Waste Reduction

Waste reduction by source reduction, recycling, and composting to achieve “zero waste” (90% diversion)



Wastewater Efficiency

Efficiency upgrades to treatment plants and through anaerobic digester

See the modeling memorandum in Appendix B for further details.

Based on the energy and emissions modeling, the One Climate Future actions can reduce our cities' emissions by over 81% by 2050, relative to 2017.

Accelerating emissions reductions

Recognizing the scale of the global climate crisis and the need to take aggressive action, many actions have been front-loaded. The plan's implementation timeline considers municipal staff and funding capacities, and prioritizes the early and aggressive implementation of strategies that will have the most significant emissions savings. Almost half of the plan's actions are fully implemented in the next decade. As such, Portland and South Portland are projected to achieve a 33% reduction in greenhouse gas emissions by 2030, and a 50% reduction by 2036, relative to 2017.

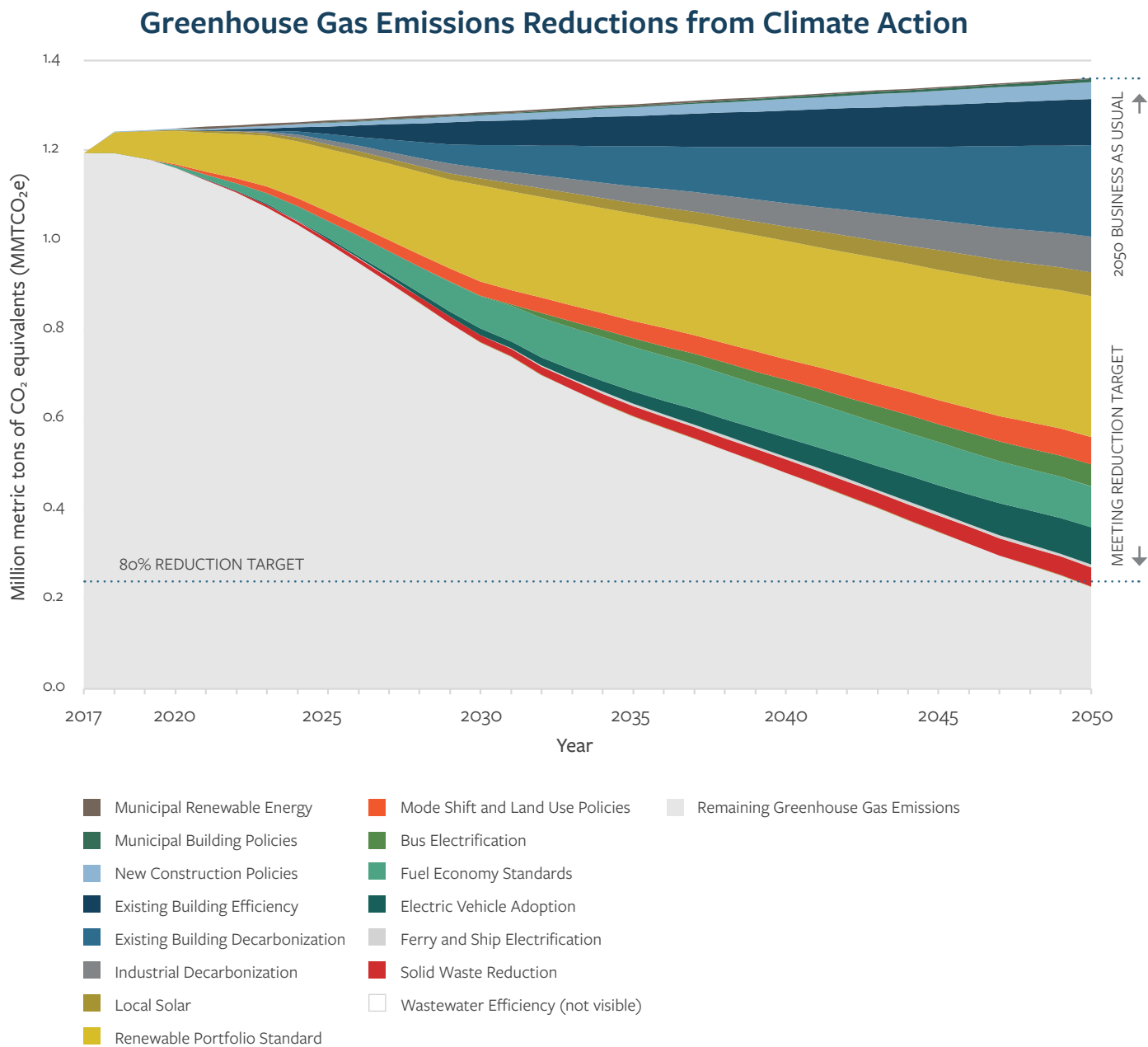


Table 1. Greenhouse gas emissions reductions in 2030, 2040, and 2050 compared to the 2017 baseline, driven by climate action policies.

Climate action “wedge”	GHG reductions in year 2030		GHG reductions in year 2040		GHG reductions in year 2050	
	MTCO ₂ e	% of 2030 reductions	MTCO ₂ e	% of 2040 reductions	MTCO ₂ e	% of 2050 reductions
Municipal Renewable Energy	3,567	0.7%	3,542	0.4%	1,930	0.2%
Municipal Building Policies	1,429	0.3%	4,299	0.5%	7,170	0.6%
New Construction Policies	11,797	2.4%	24,477	2.9%	38,116	3.3%
Existing Building Efficiency	41,122	8.4%	79,137	9.5%	100,336	8.8%
Existing Building Decarbonization	51,019	10.4%	125,181	15.0%	204,056	17.9%
Industrial Decarbonization	5,413	1.1%	35,779	4.3%	66,144	5.8%
Local Solar	16,598	3.4%	34,497	4.1%	56,474	4.9%
Renewable Portfolio Standard	227,605	46.2%	276,951	33.2%	333,004	29.2%
Mode Shift & Land Use Policies	30,744	6.2%	46,681	5.6%	61,089	5.4%
Bus Electrification	2,093	0.4%	29,837	3.6%	48,866	4.3%
Fuel Economy Standards	71,726	14.6%	98,559	11.8%	91,746	8.0%
Electric Vehicle Adoption	13,959	2.8%	42,853	5.1%	82,396	7.2%
Ferry & Ship Electrification	0	0.0%	1,578	0.2%	6,852	0.6%
Solid Waste Reduction	15,292	3.1%	29,292	3.5%	42,272	3.7%
Wastewater Efficiency	0	0.0%	917	0.1%	1,024	0.1%

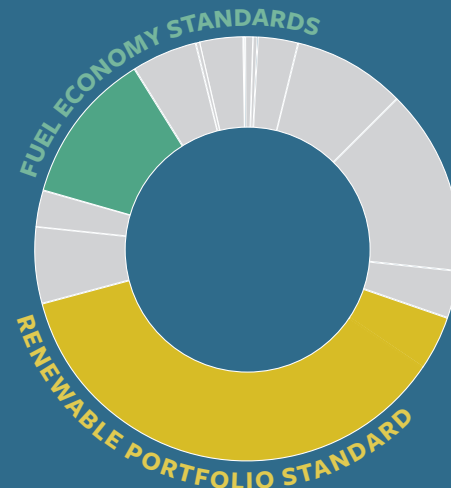
Scenario	2030	2040	2050
Business as usual (BAU) greenhouse gas (GHG) emissions (MTCO ₂ e)	1,283,823	1,321,596	1,360,362
GHG emissions after One Climate Future actions (MTCO ₂ e)	791,459	488,017	218,887
Percent change from baseline (Baseline = 1,192,784 MTCO ₂ e)	-33%	-59%	-81%
Percent change from BAU	-38%	-63%	-84%

Table 2. Cumulative greenhouse gas emissions savings between now and 2050.

Climate action “wedge”	Corresponding One Climate Future actions	Cumulative greenhouse gas savings 2020-2050	
		MTCO ₂ e	% of total savings
Municipal Renewable Energy	BE 1.1	110,421	0.6%
Municipal Building Policies	BE 1.2, 1.3	93,748	0.5%
New Construction Policies	BE 2.1, 2.3	578,672	2.9%
Existing Building Efficiency	BE 3.1, 3.2, 3.3	1,744,458	8.7%
Existing Building Decarbonization	BE 3.4, 3.5, 5.4, 5.6	2,800,102	14.0%
Industrial Decarbonization	BE 4.1, 4.2	753,726	3.8%
Local Solar	BE 2.2, 3.5, 3.6, 5.1	828,246	4.1%
Renewable Portfolio Standard	BE 5.1	7,247,418	36.3%
Mode Shift & Land Use Policies	TLU 1 (all)	1,151,719	5.8%
Bus Electrification	TLU 2.3	604,305	3.0%
Fuel Economy Standards	N/A	2,320,100	11.6%
Electric Vehicle Adoption	TLU 2.1, 2.2, 2.4, 2.5	982,046	4.9%
Ferry & Ship Electrification	TLU 3.3, 3.4	64,965	0.3%
Solid Waste Reduction	WR 1 (all)	685,655	3.4%
Wastewater Efficiency	WR 2.3	13,998	0.1%

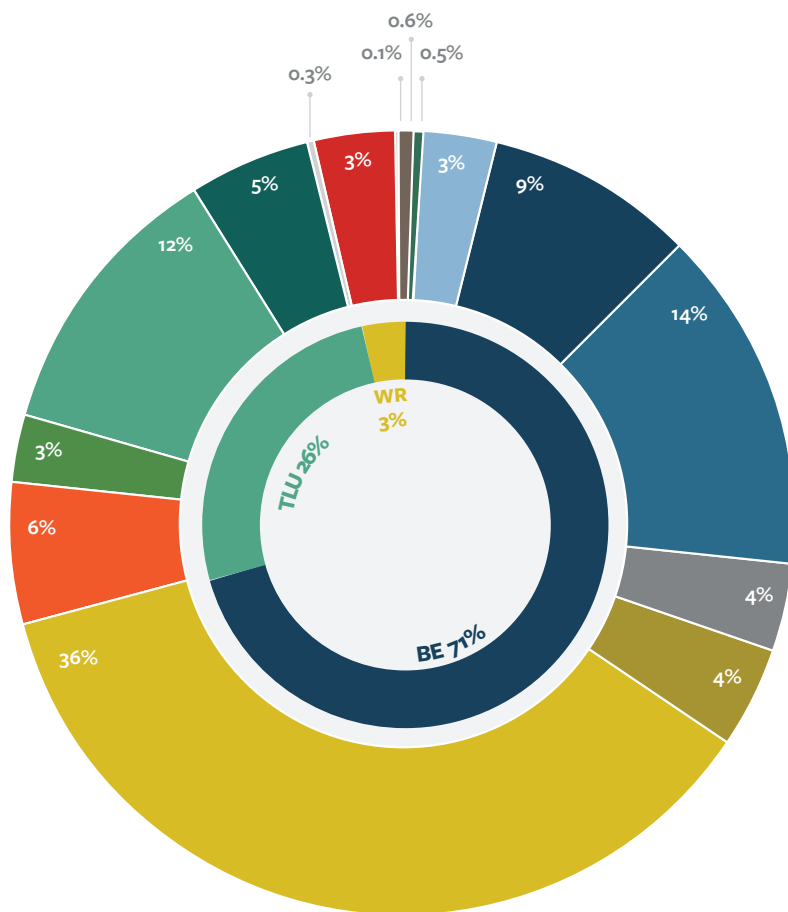
State and federal action included in the model

Maine has committed to a new renewable portfolio standard (RPS), which will ensure electricity in Maine comes from 100% renewable sources by 2050. Maine has also remained committed to the California Corporate Average Fuel Economy (CAFE) Standards, which are aligned with vehicle fuel efficiency standards set under President Obama. These two policies will play a significant role in reducing greenhouse gas emissions in our cities, accounting for over 50% of cumulative emissions savings by 2050. We have chosen to show these actions as part of our pathway (rather than assume they will proceed in the business as usual case) to emphasize the importance of these policies being implemented as planned for reaching our climate goals—as well as their impact on the rest of Maine. While we broke out local solar to show its specific contribution, locally generated solar counts towards the renewable portfolio standard (RPS). The donut chart to the right includes local solar within the RPS to show the full effect of the RPS.



Cumulative greenhouse gas emissions savings from 2020 - 2050

The **outer ring** shows the proportion of cumulative emissions savings achieved between 2020 and 2050 that can be attributed to each set of climate policies. The **inner ring** shows the proportion of cumulative emissions savings that can be attributed to the following three sections of the One Climate Future plan: Buildings & Energy (BE), Transportation and Land Use (TLU), and Waste Reduction (WR).



BE Buildings & Energy

- Municipal Renewable Energy
- Municipal Building Policies
- New Construction Policies
- Existing Building Efficiency
- Existing Building Decarbonization
- Industrial Decarbonization
- Local Solar
- Renewable Portfolio Standard

TLU Transportation & Land Use

- Mode Shift and Land Use Policies
- Bus Electrification
- Fuel Economy Standards
- Electric Vehicle Adoption
- Ferry and Ship Electrification

WR Waste Reduction

- Solid Waste Reduction
- Wastewater Efficiency

Areas for largest emissions savings

The five most significant areas for cumulative greenhouse gas emissions savings between now and 2050 include:

- 1 Renewable energy**
The renewable portfolio standard and policies to support local solar contribute to 40% of all cumulative savings.*
- 2 Existing building retrofits**
Existing building efficiency improvements and decarbonization contribute to 23% of all cumulative savings.
- 3 Clean vehicles**
Electric vehicle adoption in conjunction with maintaining current federal fuel economy standards contribute to 17% of all cumulative savings.
- 4 Mode shift**
Land use and transportation policies that encourage travel in ways other than a private vehicle contribute to 6% of all cumulative savings.
- 5 Industrial Decarbonization**
Policies to support energy efficiency savings and switching to renewable energy sources (e.g., biofuels) in the industrial sector contribute to 4% of all cumulative savings.

* Note: While we've highlighted the potential impact from local solar, in almost all circumstances, local solar will count towards the RPS. Thus the RPS and Local Solar wedges actually represent the full effect of the RPS.

But reducing greenhouse gas emissions isn't enough.

Our goal is to reduce emissions in a way that creates abundance—through quality jobs in sustainable industries; through a circular economy that creates potential instead of waste; through protecting and strengthening the health of our ecosystems and communities; and through ensuring that everyone, regardless of where they are starting from, has access to this future.

.....

The One Climate Future strategies work to collectively chart a course towards a future that is...

... equitable.

An equitable community is one where deliberate policies and practices ensure that all people—regardless of race or ethnicity, income, gender identity, sexuality, age, citizenship, or ability—have the opportunity, tools, and support to achieve their potential and to lead healthy and fulfilling lives.

... regenerative.

A regenerative community is one where our daily activity continuously restores and nourishes (as opposed to exploits and diminishes) the long-term health and vitality of our natural systems, people, and communities.

... resilient.

A resilient community is one that has the capacity to respond, recover, and bounce forward in response to stresses and new challenges.





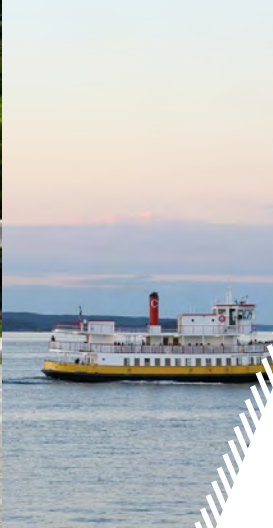


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Pg. 53: Holly Jacobson, Ashley Krulik, Ian Johnson, Emily Scully, Holly Jacobson, Bill Mann, Corey Templeton, Holly Jacobson, Holly Jacobson, Ian Johnson, Paul VanDerWerf, City of South Portland, Denise Michaud
Pg. 54: Corey Templeton, Daderot, Corey Templeton, unknown, Denise Michaud, Denise Michaud, Denise Michaud, Denise Michaud, Denise Michaud, Denise Michaud

In what ways does each strategy support a transformation towards a more equitable, regenerative, and resilient future? For each strategy it's different, but measured based on the following parameters:

.....

equitable.

- a** **Addresses injustice:** Reduces disproportionate burden from climate change; mitigates social disparities
- b** **Expands access:** Ensures benefits of climate action flow equitably; improves access and affordability specifically for communities disproportionately affected by climate change
- c** **Creates inclusive processes:** Supports inclusive and participatory decision-making, inclusive of people from underrepresented groups
- d** **Builds community ownership:** Creates opportunities for community ownership and leadership of projects, planning, investments

regenerative.

- a** **Draws down carbon:** Reduces our carbon footprint and our reliance on fossil fuels
- b** **Restores ecosystems:** Builds and protects the health and vitality of marine, freshwater, and land ecosystems
- c** **Supports a circular economy:** Develops closed-loop systems that eliminate waste and reuse, renew, and recycle materials and products
- d** **Builds shared wealth:** Distributes (as opposed to consolidates) wealth, access, and opportunity; supports a sharing economy; supports quality sustainable jobs

resilient.

- a** **Reduces vulnerability:** Reduces exposure, vulnerability, or level of impact from climate change hazards or pollution
 - b** **Strengthens communities:** Provides households or neighborhoods with tools and resources to adapt and thrive in response to stresses and challenges
 - c** **Adapts processes:** Develops processes to monitor, learn, and change our approach over time (i.e., through feedback loops)
 - d** **Builds partnerships:** Fosters relationships locally and/or regionally to jointly solve challenges
-

Each strategy is marked with the above indicators, based on how it advances an equitable, regenerative, and resilient future.

One Climate Future Strategies

BE BUILDINGS & ENERGY



Buildings and Energy

The Buildings and Energy strategies focus on transitioning to renewable sources of electricity, increasing the energy efficiency of new and existing buildings, and transitioning building systems to electric heating and cooling. Collectively, the actions in this section account for 71% of our cumulative greenhouse gas emissions savings between now and 2050.

.....

BE 1 PAGE 58

Municipal Buildings and Energy Supply

Includes municipal renewable electricity procurement, and reducing emissions in municipal buildings and operations.

BE 2 PAGE 66

New Construction Energy Efficiency and Decarbonization

Includes new building standards, and promoting education and leadership in the building sector.

BE 3 PAGE 80

Existing Buildings Energy Efficiency and Decarbonization

Includes increasing energy efficiency of existing buildings, and switching to electric heating and cooling systems.

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BE 4 PAGE 96

Industrial Energy Efficiency and Decarbonization

Includes increasing funding for industrial energy efficiency and a study on industrial efficiency and decarbonization.

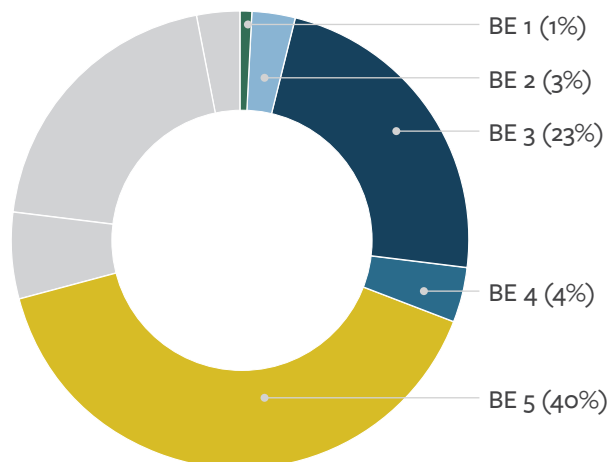
BE 5 PAGE 101

Clean and Renewable Energy Infrastructure and Regulatory Transformation

Includes infrastructural and regulatory changes to expand distributed energy resources, support electrification, and transition away from natural gas.

Cumulative greenhouse gas emissions savings attributed to each section

The renewable portfolio standard is the single most influential policy for reaching our climate goals, followed by decarbonizing and improving the energy efficiency of our existing building stock.



BE 1

Municipal Buildings and Energy Supply



DANIEL F. MAHONEY MIDDLE SCHOOL • Photo by Denise Michaud

BE 1.1 Renewable Municipal Electricity

ACTION: Pursue power purchase agreements (PPAs) to reach 100% renewable energy for city facilities ahead of the state renewable portfolio standard (RPS) schedule.

Where we are today

A renewable portfolio standard (RPS) requires that electricity must be increasingly produced using renewable energy sources over time. In 2019, the State of Maine adopted legislation (LD 1494), which raised the renewable portfolio standard for the state to 80% renewable electricity by 2030 and 100% by 2050. This ambitious step towards carbon neutrality will be transformational for Maine's electricity sector, and in our greenhouse gas (GHG) emissions projections, represents the single largest contribution to achieving One Climate Future goals. Nevertheless, the Cities have an opportunity and obligation to lead by example, and to move towards 100% renewable electricity faster than the state as a whole.

Around the country, local governments are entering into power purchase agreements (PPAs) for regional solar and wind power to reach near-100% renewable electricity. Power purchase agreements are contracts between electricity generators (i.e., sellers) and consumers (i.e., buyers) in which a buyer provides the payment stream necessary for a seller to generate the electricity. The contracts ensure that electricity generation can help finance the development of projects in instances where it might otherwise be unfeasible. Generally, these PPAs are based on projected future electricity demand after efficiency improvements, and usually come slightly shy of 100%, so the city is not on the hook to buy more power than it needs. The

remaining electricity is covered with renewable energy credit (REC) purchases.

The Cities have an opportunity and obligation to lead by example, and to move towards 100% renewable electricity faster than the state as a whole.

The action we will take

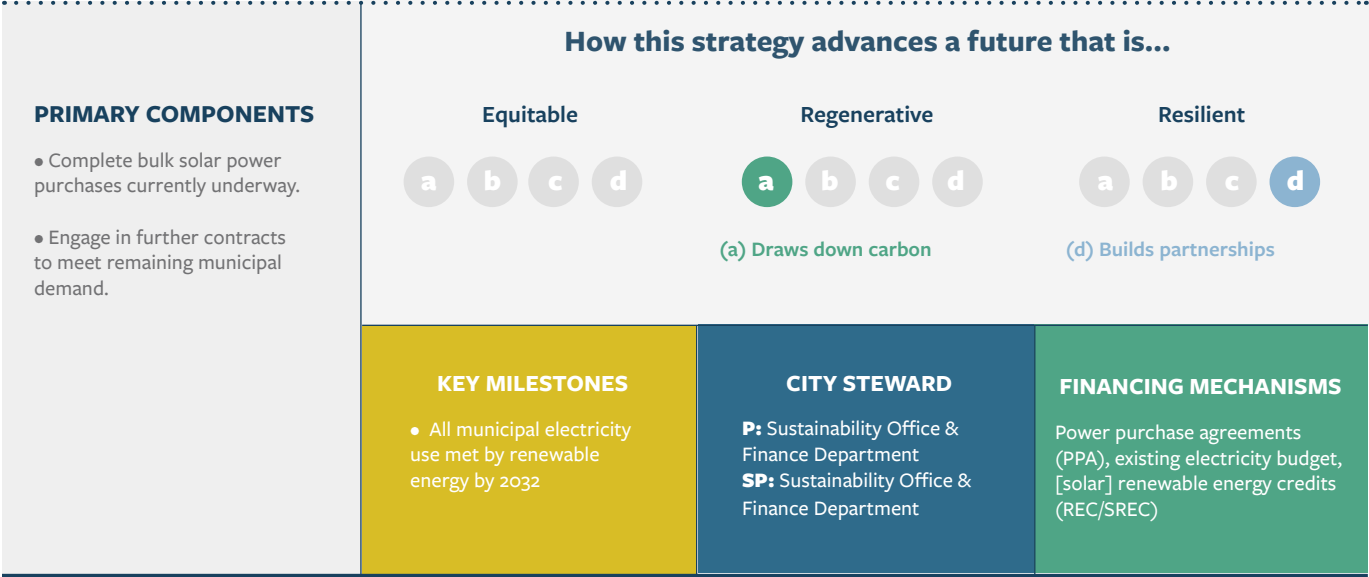
Through power purchase agreements, the Cities will meet 100% of the electricity demand for municipal facilities with renewable sources by 2032. Both Cities are currently in the process of securing large bulk solar deals that will supply a significant percentage of the current electricity demand for municipal operations with in-state, utility-scale solar. Portland has entered a renewable energy consortium through which it will procure 20 million kilowatt-hours per year—66% of the municipal load—from new solar farms within the state. South Portland is expanding its solar capacity within the city by 4.7 million kilowatt-hours per year through solar developments

on the City’s capped landfill and on the roof of the Community Center, at which point, 65% of South Portland’s electricity load will be supplied by solar. South Portland is further pursuing a 1.3 million kilowatt-hour off-site solar project in the coming year to meet 80% of the City’s electricity load in total. The remainder of the load could be met with a subsequent power purchase agreement, potentially for onshore or offshore wind. The Cities will evaluate additional renewable energy needs, incorporating forecasts for energy efficiency improvements, and will engage in subsequent contracts by 2028 to meet the remainder of future demand.

Our next steps

- Complete development of on-site renewable projects at the City’s landfill and Community Center (South Portland).
- Evaluate additional renewable energy needs, after forecasting efficiency improvements, and by 2028 develop additional projects or agreements to meet the remainder of future municipal demand.

BE 1.1 Summary - Renewable Municipal Electricity



BE 1.2 Net-Zero Energy New City Buildings

ACTION: Pursue net-zero energy (NZE) buildings for new city government buildings through performance-based procurement.

Where we are today

A net-zero energy (NZE) building is a highly energy-efficient building where 100% of the site energy use is met with renewable energy in net over the course of a year, either completely from on-site or a combination of on-site and off-site renewable energy. Most NZE buildings are all-electric (though some supplement with renewable thermal resources), as most NZE certifications do not allow any fuel combustion on site. Designers of NZE buildings should maximize the energy efficiency potential and on-site solar generation potential of the building before supplementing with off-site renewable energy. Studies have found that net-zero energy buildings can be delivered in a cost-effective manner, with first cost premiums for commercial NZE buildings ranging from 0% to 7%, but generally with positive net present values. High-profile real-world examples of “what is possible” help rapidly advance sector-wide change. The current Green Building Code in Portland requires new municipal buildings to be built to LEED Silver standards; no similar requirements exist in South Portland. Encouraging the development of NZE new municipal buildings through procurement will both support the decarbonization of city buildings and serve as a precedent to other building projects in Portland and South Portland.

The action we will take

To promote cost-effective net-zero energy and other progressive performance targets, the Cities will use a performance-based procurement (PBP) methodology for new

Performance-based procurement has shown success in allowing governments to achieve the highest level of feasible building performance without increasing costs.

city buildings or substantial retrofits. The PBP methodology has shown success in allowing governments to achieve the highest level of feasible building performance without increasing costs. A summary of the approach follows; for more, see the U.S. Department of Energy’s “How-To Guide for Energy-Performance-Based Procurement.”²²

In a performance-based procurement approach, the city issues a request for proposals (RFP) stating the maximum budget and specific environmental performance goals for the project. Bidders’ responses detail what level of environmental performance their team can achieve within the stated budget. While performance-based procurement allows a city to set minimum environmental performance targets for projects, there is also the opportunity to encourage incrementally higher performance by articulating tiers of performance in the RFP.

Tier 1: “Mission Critical” outlines performance targets that are required in all basic responses to the RFP.

Tier 2: “Highly Desirable” outlines performance targets that represent a more ambitious level of performance overall;

This level would be for achieving energy performance levels substantially above code, or net-zero-energy-ready.

Tier 3: “If Possible” outlines performance targets that are considered “best in class” and that could be pursued when project parameters and budget allow; this tier would be for net-zero energy.

The benefits of this approach include that the process:

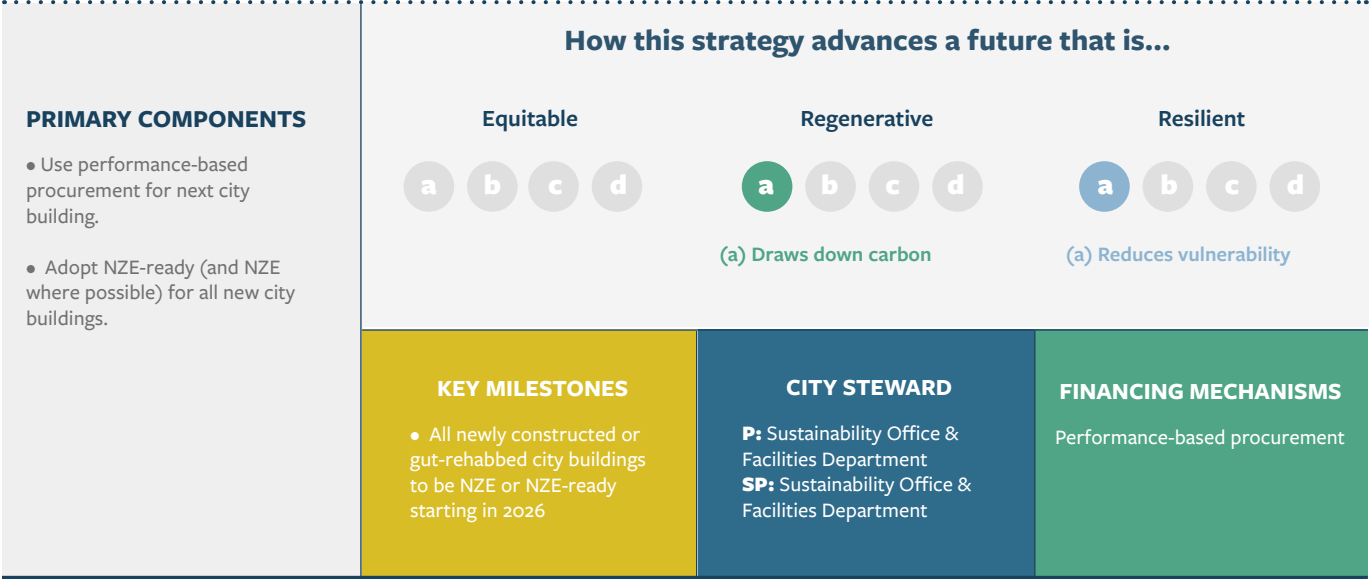
- Guarantees a minimum standard environmental performance;
- Lowers the city’s risk by bestowing the contractual responsibility for performance on the design team;
- Encourages innovation and creativity;
- Reduces design and construction costs; and
- Results in higher-performance buildings than a conventional procurement process.

One deficiency of this method is that it may be more challenging to adapt to community feedback, especially for the first such projects. Therefore, the approach may be best piloted in a new development area where there is community support for the required flexibility. The Cities may choose to also include sector-specific standards, such as Collaborative for High Performance Schools (CHPS) standards for K-12 educational facilities.

Our next steps

- ☐ Use performance-based procurement, targeting NZE, for the next appropriate city-owned building.
- ☐ By 2026, aim for new city buildings to be built NZE-ready.

BE 1.2 Summary - Net-Zero Energy New City Buildings



BE 1.3 Energy Efficiency Retrofits for City Buildings

ACTION: Develop a strategic energy management plan (SEMP) for all city facilities and lead by example by pursuing deep energy retrofits and electrification for large existing city buildings.

Where we are today

The Cities of Portland and South Portland track the energy consumption of government buildings and disclose this data as part of the Cities’ benchmarking laws (discussed more in action BE 3.1). This data can be used to identify buildings most in need of energy retrofits. Because cities have large, diverse portfolios, with buildings changing uses, the process of tracking energy usage will require a regular quality control review. A dashboard of public building energy usage data can also help increase transparency and help building owners in the private sector see the value of energy data. However, while benchmarking helps to identify the worst-performing buildings and to target retrofits, it does not tell us what needs to be done to improve those buildings. For an individual building, the next step is often conducting an energy audit that meets a common standard, such as an ASHRAE Level II audit. However, these audits can be expensive, and their findings cease to be relevant if not acted upon within a few years. Therefore, for large portfolio owners like cities, conducting audits of every building can not only be expensive but can produce more data than the portfolio owner is capable of acting on within a timely period. Rather, what is needed is a strategic energy management plan (SEMP) for each city’s building portfolio, along with targeted audits.

Strategic energy management (SEM) is a focused, long-term approach to reducing energy use through efficiency and conservation. SEM can also involve complementary steps to reduce costs and greenhouse gas emissions, with a focus on continuous improvement and ongoing re-evaluation to ensure

retrofit projects are performing as designed. As outlined by the U.S. Department of Energy, “A successful strategic energy management plan builds long-term relationships with energy users and targets persistent energy savings. The benefit of effective planning ensures continuous improvement of energy efficiency and increases the property value of buildings. For public buildings, strategic energy management reduces costs across many end uses, institutionalizes practices to sustain long-term savings, and can serve as a model for the private sector.”³ These programs originally focused on industrial customers, but are now increasingly targeting commercial and institutional facilities.

A strategic energy management plan (SEMP) also helps to establish the level of investment needed to allow public buildings to lead by example. SEMP’s should target deep energy retrofits over shallower measures wherever possible. A deep energy retrofit is a building-specific, whole-building analysis designed to identify points in the building lifecycle where investments in energy efficiency can achieve the highest return. They involve bigger measures, such as replacing all windows to reduce heating and cooling loads—which in turn can allow a switch to building equipment that requires less energy. A deep energy retrofit may occur over a few years, and will require a more significant financial commitment than conventional energy retrofits. The energy savings created with a deep energy retrofit can be greater than 40%.

The action we will take

The Cities will build on their benchmarking program by contracting for the development of a SEMP for municipal facilities, built on the ISO 50001 standard for continuous energy improvement. Each city’s SEMP will establish an ongoing approach to persistently identifying, assessing, prioritizing, and implementing energy and greenhouse gas reduction measures. It will specify guiding policies, clarify roles and responsibilities, codify the methods used to evaluate potential opportunities, and identify and begin to resolve any organizational barriers. Most importantly, the SEMP will lay out a path to pursue deep energy retrofits of city buildings, as well as a comprehensive plan for transitioning all non-industrial municipal and school buildings to air-source or ground-source heat pumps or other zero-carbon or low-carbon heating technologies.

In the next few years, we will target buildings for whole-building retrofits that aim to reduce building site energy use by an average of 30% or more. Retrofits will also focus on beneficial electrification through air-source and ground-source heat pumps, which will reduce the municipal carbon footprint and enable our procurement of renewable power to serve ever larger portions of our total energy needs.

As the Cities gain experience in operating net-zero energy (NZE) new buildings, we will begin to target NZE retrofits of existing buildings—with the goal that all retrofits undertaken by 2030 and thereafter be NZE retrofits. By 2050, all government office buildings, city schools, and public libraries will have been retrofitted to be NZE buildings, and all other municipal buildings will have been retrofitted to the highest levels of efficiency appropriate for their use. Portland and South Portland will also complete the transition of all streetlights and traffic lights to LEDs.

Our next steps

- ☐ Set up an energy management platform, and institute an annual quality control review of all energy, water, and space use data for public buildings being benchmarked in Portfolio Manager.
- ☐ By 2025, both Portland and South Portland will commission strategic energy management plans for all municipal facilities, including public schools as appropriate.
- ☐ By 2026, begin deep energy retrofits of municipal buildings, with a focus on beneficial electrification.

BE 1.3 Summary - Energy Efficiency Retrofits for City Buildings



BE 1.4 Internal Carbon Pricing for Municipal Construction and Operations

ACTION: Create either a shadow carbon price for evaluating all city decisions, and/or an internal carbon charge paid to a central climate emergency fund.

Where we are today

Incorporating the true environmental costs of carbon emissions into decisions is an essential part of combating climate change. In lieu of a carbon tax, municipalities, institutions, and organizations have two main methods they can use to internalize this cost into their own operations:

The first option is a “shadow carbon price” policy that adds an additional charge for carbon emissions into any financial cost-benefit analysis. No actual money is collected or paid, but the institution thus makes decisions as if it had to pay that carbon charge. This can change the calculus on investments and construction projects, and increase the modeled benefit of zero-carbon or low-carbon technologies. A shadow carbon price is most effective when applied consistently.

The second option is a “carbon charge,” which is a fee charged internally to all organizational departments based on their energy use and carbon emissions. This is a model being experimented with in numerous institutions, and thus there are various approaches to implementing a carbon charge. The fee may be based on the emissions intensity of the buildings, based on the year-over-year change in emissions, or based on each building or organizational unit’s performance relative to an appropriate benchmark. The carbon charge also may or may not be revenue-neutral by design. In a revenue-neutral model, the charge is rebated back in proportion to the degree to which the building/department reduced its emissions relative to the institution as a whole, or it may be rebated in full with a requirement it be spent on energy efficiency. In other

models, the revenues collected by the charge can be used to fund energy or sustainability programs and staff, or put into a revolving fund for energy efficiency investments.

In 2016, the U.S. Environmental Protection Agency (EPA) calculated the social cost of carbon at between \$46 to \$138 per ton, depending on assumptions for climate impacts and the discounting of future costs.⁴ Several leading colleges and universities in New England and the mid-Atlantic are currently using carbon charges and shadow carbon prices of \$100 or more per ton.⁵

The action we will take

Portland and South Portland will evaluate the appropriate level for an internal carbon charge and/or shadow carbon price. A shadow carbon price will help guide investments, and will be implemented as soon as feasible. An internal carbon charge would also be beneficial, but needs further evaluation to determine its organizational, financial, and legal feasibilities. In setting an internal price on carbon, the Cities will consider the following:

- a. The best estimates of the social and environmental damages associated with one metric ton of CO₂e (carbon dioxide equivalent) emissions;
- b. The best estimates for the price that would be necessary to align the global economy with a 1.5-degree or 2-degree global warming scenario;

- c. The carbon prices that are used by other cities and institutions;
- d. The cost that would be necessary to help the Cities meet their 2040 municipal carbon neutrality commitment;
- e. A consistent methodology for allocating the charge across departments or buildings;
- f. A consistent and effective methodology for internal assessment for collecting the charge; and
- g. Whether the charge should be rebated back to incentivize savings, or whether the revenues should be used directly to fund efficiency improvements and emissions reductions.

The Cities also recognize the value in implementing a statewide carbon price to more fully account for the social and environmental costs associated with carbon emissions. We will work with the Maine Climate Council to support the development of a statewide carbon price, as discussed in action BE 5.7.



PORTLAND CITY HALL • Photo by Alexius Horatius

Our next steps

- ☐ Determine appropriate levels for a carbon charge and/or shadow carbon price.
- ☐ Implement shadow carbon price and/or carbon charge for municipal operations by 2026.

BE 1.4 Summary - Internal Carbon Pricing

How this strategy advances a future that is...			
Equitable	Regenerative	Resilient	
a b c d (a) Addresses injustice — if implement internal carbon charge	a b c d (a) Draws down carbon (c) Supports a circular economy	a b c d (a) Reduces vulnerability (c) Adapts processes	
PRIMARY COMPONENTS • Conduct carbon price feasibility assessment to set appropriate price. • Implement shadow carbon price or internal carbon charge.	KEY MILESTONES • Municipal shadow carbon price or carbon charge implemented by 2026	CITY STEWARD P: Sustainability Office & Finance Department SP: Sustainability Office & Finance Department	FINANCING MECHANISMS N/A

BE 2

New Construction Energy Efficiency and Decarbonization

VIEW FROM FORT SUMNER PARK • Photo by Ian Johnson

BE 2.1 Energy Stretch Code

ACTION: Advocate for an advanced energy stretch code with an optional net-zero energy compliance path, and adopt the stretch code once finalized. Advocate for the stretch code to require net-zero energy buildings by 2030.

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Where we are today

Building codes are the single most powerful tool that states and cities have at their disposal to require higher levels of performance from new buildings. In general, codes tend to increase in stringency using small percentage improvements that occur at regular intervals. For example, many cities and states across the country have adopted ASHRAE Standard 90.1 building standard as a basis for their energy codes, and ASHRAE also created ASHRAE Standard 189.1-2014, which supplements 90.1 with a higher performance green building standard. Provisions in this code offer an excellent resource for more aggressive energy improvements. Most energy codes offer both a prescriptive path, where certain specific measures

are required, and a performance path, where an energy model is used to demonstrate that the building can achieve a certain required level of performance. Good code enforcement and strong performance requirements are essential to ensuring the intentions of the code are met.

Energy codes are usually mandated by state code boards. In some states, the state allows local governments to develop and adopt their own codes, or the state develops a second, more stringent energy code, and allows local governments the option to use and enforce either the base state code or this alternate code. This latter approach is called a “stretch code,” and has

found great success in Massachusetts over the past decade. As of November 14, 2019, 278 Massachusetts municipalities, comprising over 85% of the state's population, have adopted the stretch code.

Since 2010, Maine has continued to use the 2009 International Energy Conservation Code (IECC 2009) and ASHRAE 90.1-2007. In 2019, the state legislature adopted LD 1543 requiring the state to update the Maine Uniform Building and Energy Code (MUBEC) to the latest 90.1 and IECC energy codes, and to develop a stretch code.

Recent developments demonstrate that efficiency and affordability are not at odds. High performance and more efficient building designs demonstrably reduce energy usage and operating costs. In 2016, Avesta Housing completed the development of Bayside Anchor. This 45-unit property designed to Passive House standards is approximately 61% more efficient and costs 39% less to operate than a code compliant development created by Avesta Housing the same year.⁶ These savings more than offset the initial capital investment. Such projects, now becoming more common in Maine, demonstrate that a stretch code with strong performance requirements can have significant implications for the long-term resilience and affordability of our built infrastructure.

The action we will take

Portland and South Portland will adopt Maine's Energy Stretch Code when it is released. The Cities have been active in supporting the stretch code legislation with the state legislature and in supporting the development of the stretch code. We will continue our advocacy to ensure that the code creates a pathway to net-zero energy (NZE) buildings.

While energy codes have achieved significant reductions in building energy use over the past 30 years, the stepwise improvements of a few percentage points each cycle will not be enough to achieve our One Climate Future goals. To achieve those goals, the code must move aggressively to higher performance, and eventually to NZE performance. While it is premature to require NZE levels of performance today, the State and Cities can build a foundation for net-zero performance within the next decade.

We will continue our advocacy to ensure that the stretch code creates a pathway to net-zero energy (NZE) buildings.

Leading jurisdictions have begun to put NZE requirements into codes as an optional path. For example, the District of Columbia's new 2020 energy code includes an "Appendix Z," the first voluntary, performance-based code compliance pathway for buildings in North America. The Appendix establishes minimum building performance requirements for overall energy use intensity, thermal energy performance, and airtightness. To achieve NZE performance, a building must be made as energy efficient as possible before specifying the renewable energy equipment that would supply the building's energy. The Appendix also outlines requirements concerning the appropriate type of renewable energy generation, as well as specific stipulations for energy metering and building commissioning. Including this optional path in the stretch code moves NZE from generalities to code-specific language, and provides contractors a line in the sand for targeting future performance. It is also important that the next stretch code, and future stretch codes, begin to incrementally move buildings towards NZE. The stretch code should be updated every three years. The Cities will advocate for the following recommendations in future code cycles.

For commercial buildings, the next stretch code should:

- Adopt ASHRAE Standard 90.1-2019 and chapter seven of ASHRAE 189.1;
- Adopt a commercial air leakage performance testing requirement;
- Include sub-metering of major systems, including plug loads (pending feasibility and value analysis).

For residential buildings, the next stretch code should:

- Adopt a requirement for the use of cold-climate heat pumps as the primary heating source in any residential buildings using electric heating above 2 kW of installed capacity;
- Offer alternative compliance paths for third-party standard pathways, such as the U.S. Green Building Council LEED for Homes certification, Enterprise Community Partners Green Communities certification, Passive House Institute U.S.



Community Spotlight

Bayside Anchor

In 2015 the Portland Housing Authority (PHA) completed its Strategic Vision Plan for all of its 1,000 units of public housing. As a part of this plan, PHA identified various sites in Portland with under-utilized land and parking lots that could serve as creative solutions to meeting the need for more affordable housing in southern Maine. On one of these parking lots, a unique partnership between Avesta Housing and PHA led to the creation of Bayside Anchor. Bayside Anchor now stands as a catalyst for future redevelopment through the re-imagining of hundreds of units of public housing in East Bayside.

Bayside Anchor is now a service hub for low-income residents in East Bayside, giving the project its name as a stabilizing “anchor” for the community. PHA’s local property management offices were relocated to the first floor, along with a Headstart pre-school, and the East Bayside Community Policing Office. Bayside Anchor successfully increased the availability of affordable housing while fostering community connections in an innovative, multi-use building.

In addition to providing resilience benefits, Bayside Anchor was built to Passive House standards and received PHIUS+ certification. Combining the very low cost target with the ambitious goal of Passive House certification drove the development team to conduct a rigorous management process that dove deep into building design and engineering details. Through this process, the development team achieved a very low construction cost of \$149 per square foot, achieving the maximum affordability points under the State of Maine scoring system. The success of Bayside Anchor demonstrates that we don’t have to pay a premium to construct safe, energy efficient buildings. The project sets a gold standard for the future growth of Portland and South Portland that is both affordable and high-performing.

INSIDE BAYSIDE ANCHOR • Photo by Jeff Stevenson

(PHIUS) Passive House certification, and the International Living Future Institute (ILFI) Living Building Challenge; and,

- Mandate air performance sealing and strong envelope requirements.

Specific prescriptive minimums for the commercial code could include:

- Strong insulation: R-value = R-40 for walls, R-60 for roof
- Minimum windows: U-factor = 0.22
- Minimum air leakage rate: 1.0 air changes per hour (ACH) at 50 pascals
- Ventilation: Rate and locations per ASHRAE using heat recovery and dedicated outdoor air systems, solar electric pre-heat
- Lighting density: 0.3 watts per square foot
- A minimum level of daylighting for all occupied spaces
- Occupant and operator energy monitoring system and reduction strategy
- Minimum appliance standard: Best in class ENERGY STAR®

The stretch code should also mandate solar and electric vehicle readiness; these are discussed in action BE 2.2.

Where existing land development ordinances prescribe strict performance standards, bulk/massing standards, and design guidelines that may impair the ability of a development project to meet energy performance goals, the Cities will

provide flexibility through a Green Development Flexibility Ordinance. Allowances or concessions will be made based on demonstrated achievement of energy use reduction and high performance building improvements. The Cities may explore establishing a voluntary offset fund and/or carbon impact fee as alternative approaches to meeting energy performance goals.

A Green Development Flexibility Ordinance will apply to all development undergoing site plan review, requesting conditional uses or special use permits, or participating in tax increment financing (TIF). Affordable housing projects will be exempt if the applicants can demonstrate that the energy performance requirements undermine the ability of the project to provide the affordable housing, but affordable housing projects will be incentivized to comply with the standard by offering concessions and waivers to development standards that may allow for cost offsets for the green building requirements. New development not subject to site plan review may also opt-in to the Green Development Flexibility Policy.

Additionally, the prevalence of mass timber construction is growing across the United States and Canada. Mass timber is the use of solid and engineered wood for structural support (as opposed to stick-frame construction). Solid and engineered woods can provide structural support in buildings similar to concrete. However, while concrete is extremely carbon-intensive, mass timber actually sequesters carbon. It is also beautiful, and because of its heavy mass, fire-resistant. Given

the importance of the forestry industry in Maine, Maine could become a leader in mass timber, which would not only help sequester carbon, but support the local economy. The Maine Mass Timber Commercialization Center at the University of Maine Orono is one of multiple entities working to advance mass timber manufacturing in Maine. Support for mass timber is growing, and tall wood buildings using mass timber will be allowed in the 2021 International Building Code. The Cities will advocate for the adoption of IBC 2021 for the state building code once finalized, with particular focus on the permitting of mass timber construction.

Our next steps

- ☐ Advocate for best-in-class prescriptive requirements and an NZE code path in the next feasible code cycle.
- ☐ Convene representatives from the development community, affordable housing community, and other relevant stakeholders to develop Green Development Flexibility Ordinance.
- ☐ Adopt the energy stretch code, when finalized, and the Green Development Flexibility Ordinance.
- ☐ Conduct a review of zoning codes to identify and address any conflicts with the energy code, such as solar setback requirements.
- ☐ Advocate for the adoption of the IBC 2021 for the state building code once finalized, with particular focus in the permitting of mass timber construction.

BE 2.1 Summary - Energy Stretch Code



BE 2

BE 2.2 Solar-Ready and EV-Ready Code Requirements

ACTION: Adopt or advocate for solar-ready and EV-ready requirements for new construction, followed by renewable energy generation building code requirements.

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Where we are today

In 2019, the Maine State Legislature adopted legislation requiring the state to update the building energy code to ASHRAE Standard 90.1-2016 / IECC 2016, and to develop a stretch code (see action BE 2.1 for further details). This stretch code would allow cities to adopt a more stringent energy code for new construction, and could also be expanded to include renewable energy or “renewable energy-ready” requirements. A renewable energy-ready building is one that is designed to accommodate a renewable energy installation (such as solar) at some point in the future. Not all buildings can accommodate renewable energy due to siting and sizing of mission-critical needs. The National Renewable Energy Laboratory has produced guidelines on what solar readiness means in practice.⁷

Renewable energy-ready buildings offer greater opportunity and flexibility in achieving One Climate Future targets, and would also support grid resilience objectives. A requirement to install renewable energy systems on new buildings and existing buildings undergoing deep energy retrofits will also directly support ongoing efforts to study and realize neighborhood-scale energy systems (e.g. microgrids) and net-zero or net-positive buildings. For context, the State of California has already instituted requirements for new single-family homes to have solar power. However, given the costs of solar, solar-ready requirements will be an easier first step. In the commercial sector, building owners tend to purchase solar as a power purchase agreement (PPA) instead of directly owning

the panels, and therefore solar-ready requirements will likely remain appropriate until the stretch code is a net-zero energy code.

The action we will take

Portland and South Portland will advocate for the new stretch code, either in this code cycle or the next, to include requirements for buildings to be solar-ready and electric-vehicle-ready (EV-ready). Putting these requirements in the code, instead of in separate legislation, simplifies both implementation and compliance. An EV-ready building is a building with electrical conduits laid in all parking spaces to support charging stations in the future, as well as Level 2 chargers in a certain percentage (e.g. 10% or 20%) of the spaces (see action TLU 2.1 for further details).

When it comes to moving from a solar-ready requirement to a solar requirement, it may not be feasible to set a specific, universal percentage of energy that must come from on-site solar. Most large office and multifamily buildings can typically only generate a couple percentage points of their total energy use from on-site solar, absent deep energy retrofits. Conversely, a one-story warehouse might easily be able to get 25% or 50% of its energy from on-site solar, and a net-zero energy single family home should be able to get most of its energy from on-site solar. While emphasizing solar deployment, it is also essential to recognize the potential limitations of a building-

by-building approach. The most well-intentioned owner, combined with the most progressive building code, will still fail to realize a new building’s potential for solar if the new power supply cannot be integrated with the local distribution system. We recognize that solving this problem requires action beyond the scale of the building—either at a neighborhood-scale (see action BE 3.5) or grid scale (see actions BE 5.3 and BE 5.4).

Our next steps

- ☐ Advocate for solar-ready and EV-ready requirements in the next energy stretch code, and future base energy codes thereafter.
- ☐ In the cycle thereafter, transition new single-family homes to having an on-site solar requirement.
- ☐ Conduct a review of existing city codes to ensure there are no conflicts (see BE 2.1).



ELECTRIC VEHICLE CHARGING WITH SOLAR POWER • Photo by ReVision Energy

BE 2.2 Summary - Solar-Ready and EV-Ready Code Requirements

How this strategy advances a future that is...			
PRIMARY COMPONENTS	Equitable	Regenerative	Resilient
	a b c d	a b c d (a) Draws down carbon (d) Builds shared wealth	a b c d
	KEY MILESTONES - EV-ready / solar-ready requirements to be implemented by 2028 - On-site solar requirements to be implemented by 2032	CITY STEWARD P: Sustainability Office & Planning Department SP: Sustainability Office & Planning Department	FINANCING MECHANISMS Solar-readiness can be implemented with no added cost; EV-readiness can be supported with Efficiency Maine incentives / VW settlement funds; <i>Future: federal funding</i>

BE 2.3 Code Enforcement

ACTION: Ensure code compliance in all buildings through increased investment in robust code enforcement.

Where we are today

Even though states and cities across the nation are adopting increasingly stringent energy and green codes, overall code compliance rates remain low. This is often the result of a combination of factors such as insufficient financial investment in the energy code enforcement program, lack of trained staff dedicated solely to energy and green code enforcement, lack of political support for tough enforcement, and a local building industry that has not yet caught up to speed or been well-educated on the new, more complex codes. In Maine, while the building codes and energy codes are set by the state, enforcement remains a local government responsibility.

The action we will take

Portland and South Portland will invest additional resources in code enforcement. Enforcement of energy codes by dedicated and resourced staff is associated not only with improved compliance, but also energy-related cost savings. As the code advances, it becomes increasingly important that staff have the technical knowledge and tools to provide sufficient oversight of compliance, correctly evaluate a project's energy performance, and advise applicants on operational elements of efficient design. Buildings following the performance path must submit an energy model, but in cities without sufficient staff capability, these models can often go unreviewed. Each City would benefit from having at least one full-time staff member with expertise in reviewing energy models for effective quality control.⁸

ASHRAE Building Energy Modeling Professional (BEMP) and AEE's Building Energy Simulation Analyst (BESA) professional certification are two credentials that recognize individuals with expertise and experience in building energy simulation software.

Additionally, the Cities will explore third party code enforcement as a complimentary approach. In this model, a private sector company verifies compliance with building codes on behalf of the government regulatory agency. Third party code enforcement is a particularly good fit for large commercial projects, and has been critical to bringing compliance rates up in other jurisdictions. For example, in the District of Columbia, the third-party code enforcement program helped achieve a weighted commercial code compliance rate of 99%. The Institute for Market Transformation (IMT), in their report "Third Party Building Code Enforcement," reports that a third-party program would be more cost-effective for small or medium-size jurisdictions with populations under 100,000,⁹ suggesting that Portland and South Portland would be good fits for a third-party program.

Funding for either a code enforcement officer or for third-party verification can be generated through a surcharge on development fees. The Cities will also advocate for state or Efficiency Maine funding, as energy code compliance will be critical for the State to also reach its climate goals.

Our next steps

- ☐ By 2026, identify funding to hire at least one staff member or third-party consultant in each City with the qualifications to critically review energy models, and to purchase appropriate software licenses.
- ☐ Investigate launching a third-party code enforcement program for commercial projects.



OVERLOOKING SPRING STREET • Photo by Corey Templeton

BE 2.3 Summary - Code Enforcement



BE 2.4 Leadership and Education

ACTION: Partner with organizations in the building sector to develop and promote platforms for education and leadership in high-performance buildings.

Where we are today

In other jurisdictions that have seen success in the proliferation of high-performance building design, a strategy for education and leadership promotion has been an essential element. The transformation that is needed in the built environment cannot be forced solely by regulation or driven by incentives—there must be private sector demand as well. While the exact set of strategies vary by city, the following are a selection of methods that have proven successful in building a “virtuous cycle” for continued improvement in the built environment.

The action we will take

Portland and South Portland will partner with organizations in the building sector to develop and/or promote platforms for education and leadership in high performance buildings, including net-zero energy and passive house buildings; building materials and practices that reduce embodied carbon; and land use planning. Options that will be explored include:

- **Educational series.** An educational series can cover a set of different topics related to high performance buildings for different audiences. As cost can be a barrier to entry for such courses, we will explore options to underwrite the course and/or ensure basic provider costs are met to improve attendance and popularity. The goal of these educational series will be largely to support a transition from conventional building techniques and usher in a larger market transformation towards sustainable design principles. Potential topics could include energy benchmarking, improved building operations,

basics of net-zero energy buildings, net-zero energy case studies, mass timber buildings, life cycle assessments and embodied carbon, next generation technologies, and maximizing passive and active energy opportunities.

- **Annual conference.** An annual conference for southern Maine on energy efficiency, renewable energy, and net-zero energy building can serve to unite the industry, spread knowledge, build excitement, and facilitate new connections. We will seek to partner with, encourage, or support a local/regional organization with interest and capacity to launch a regular conference that has experience in developing educational materials on building energy management and operations.

- **High-performance building media, outreach, and communications strategy.** We will explore ways to create a “narrative of success” in addressing climate change and fossil fuel independence in the building sector as a core element of our media and outreach on the topic. Demand for high-performance buildings can increase as the principles and benefits become well known and better understood. Individual homeowners and office tenants will seek higher levels of efficiency in their homes and workplaces. The narrative would combine down-to-earth stories of what living/working in such a building is like, positive success stories of high-performance energy homes and offices, and information about available energy incentives and opportunities.



PRESENTATION BY PSA AT MECHANICS' HALL • Photo by Ashley Krulik

- **Energy leadership groups.** We will partner with leading firms and organizations in the building sector to launch energy leadership groups made up of prominent and forward-thinking design and construction industry members. Pulling local leaders together, recognizing their contributions, and uniting them around a common understanding and strategy could greatly accelerate forward movement on energy efficiency and renewable energy. This group will also help educate peers, and support the development and implementation of the energy stretch code.

- **Mayor's One Climate Future Awards for Climate Leadership.** These awards would recognize individuals, companies, organizations, and buildings that are contributing to achieving One Climate Future goals and a zero-carbon future across One Climate Future's four focus areas. At least one award each year would go to a high-performance new or existing building. Energy benchmarking data can be used to identify and highlight best-in-class energy performers.

- **Contractor training and realignment.** The Cities will identify ways to partner with HVAC and envelope/siding subcontracting unions and trade associations to prepare for a

Community Spotlight

Portland Society for Architecture

Portland Society for Architecture (PSA) is a non-profit organization that encourages innovation and vision in the built environment of Greater Portland through education, advocacy, and engagement with community members, design professionals, and civic leaders.

PSA works with many stakeholders. Their diverse programming brings people together to talk about how place is shaped—whether through the signature *Complete City: Imagined* community charrettes and design competitions, the *Mechanics of the Built Environment* series that brings together practitioners and policy makers, a high school curriculum linking math and architectural and urban design, construction site tours, or PSA's annual Beaux Arts Ball.

PSA helps empower people to advocate on issues related to the built environment: zoning, streets and transportation, urban in-fill, neighborhoods, and climate change. One Climate Future has provided concrete data to help them re-imagine what our built environment should look like in the future—from energy consumption to protective measures against sea-level rise. PSA will continue to use this data—whether with policy makers, designers and contractors, students, or the public—and will continue to produce programming that embodies sustainable, responsible, and creative growth.

transition to heat-pump-based systems and high-performance envelopes. To do so, we will partner with educational and career development organizations to support the creation of a job skills program focused on next generation building technologies. These efforts can connect to the existing economic initiatives in creating stronger workforce pipelines to connect residents with the skills they need for well-paying, sustainable jobs that help our cities address climate change (see action CR 3.2 for further details).

- Community charrettes.** Design charrettes bring together community members, stakeholders, and decision-makers to co-develop solutions for the build environment. By embedding community members into the design process, charrettes create a non-traditional format for collaborative planning and policy work. The Cities will partner with a facilitator to hold design charrettes that engage the public in site design and land use planning initiatives focused on decarbonization of the built environment and energy systems.

Our next steps:

- ☐ Identify organizations and groups in the building sector who may champion one or more of these platforms; develop partnerships and funding streams to support one or more of these initiatives.
- ☐ Establish the Mayor’s One Climate Future Awards for Climate Leadership.

BE 2.4 Summary - Leadership and Education





BE 3

Existing Buildings Energy Efficiency and Decarbonization

SOLAR ON THE FORE STREET GARAGE • Photo by ReVision Energy

BE 3.1 Energy Benchmarking

ACTION: Expand Portland and South Portland’s energy benchmarking programs, and couple with outreach programs to turn energy savings opportunities into action.

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Where we are today

Energy benchmarking is a procedure where buildings measure their energy use in order to see whether they use more or less energy than peer buildings of a similar size, occupancy, and climate. Energy use is measured in energy use intensity (EUI) or the amount of energy used per square foot. Portland and South Portland both have benchmarking laws that require large buildings to annually measure their energy performance in ENERGY STAR Portfolio Manager and report it to the Cities for public disclosure. ENERGY STAR Portfolio Manager is a free, online software tool provided by the U.S. Environmental Protection Agency (EPA) that allows building

owners to calculate an ENERGY STAR score to “benchmark” their building’s energy use against its peers and its own past performance. The ENERGY STAR score is a 1-100 score that allows fair evaluation of a building’s performance, accounting for weather and use factors.

In November 2016, the Portland City Council adopted Order 67 16/17. The Order requires municipal buildings greater than 5,000 square feet, non-residential buildings greater than 20,000 square feet, and multifamily properties with at least 50 residential units to participate in a benchmarking



MILL CREEK • Photo by City of South Portland

and transparency program. Municipal buildings are already benchmarking, and implementation will expand to owners of buildings with at least 20,000 square feet of single-tenant floor space in 2020. Implementation for multi-tenant commercial and multifamily buildings is currently on hold, awaiting cooperation from the utility companies to provide whole building data. Whole building aggregated data access is an important prerequisite to the implementation, and is discussed further in action BE 5.2.

In January 2017, South Portland adopted its Energy and Water Use Performance Benchmarking ordinance, which introduced benchmarking to sections of South Portland. South

We will expand the reach and effectiveness of our benchmarking programs through overcoming limitations in data access, expanding the scope of the programs, and coupling the benchmarking ordinances with outreach programs to turn energy savings opportunities into action.

Portland's ordinance only applies to municipal, commercial, and multifamily buildings in the Mill Creek area of South Portland (including the Village Extension, Broadway Corridor, and Mill Creek Core zoning districts). Non-residential buildings over 5,000 square feet and residential buildings with over 10 units have to comply. Because of the limited geographic scope of the law, South Portland has been able to collect data, but is also limited in the ability to require whole-building data from multi-tenant buildings.

Over twenty cities in the United States have adopted similar laws requiring benchmarking using Portfolio Manager. Coupled with effective outreach to turn the identification of savings opportunities into action, benchmarking laws can yield actual savings; findings around the country range from 7% to 14% over a 5-year period.

The action we will take

Portland and South Portland will expand the reach and effectiveness of our benchmarking programs through overcoming limitations in data access, expanding the program citywide (South Portland) and to smaller buildings (Portland), and coupling the benchmarking ordinances with outreach programs to turn energy savings opportunities into action. The first step to successful use of the benchmarking laws will be full implementation of the laws currently on the books. This requires that the utility companies provide building owners with aggregated whole-building data for multi-tenant buildings, provided via direct upload to ENERGY STAR Portfolio Manager. This is discussed further in action BE 5.2.

Once the current laws are successfully implemented with compliance rates above 80%, the Cities will look to expand the laws. For Portland, the law will be expanded to apply to residential buildings with 20 or more units (this is the level of coverage of several other successful benchmarking laws, and is the lower limit for the ENERGY STAR score for multifamily buildings). South Portland will first adjust the size and scope of buildings covered in the pilot program, and then expand the current law to cover buildings across the whole city.

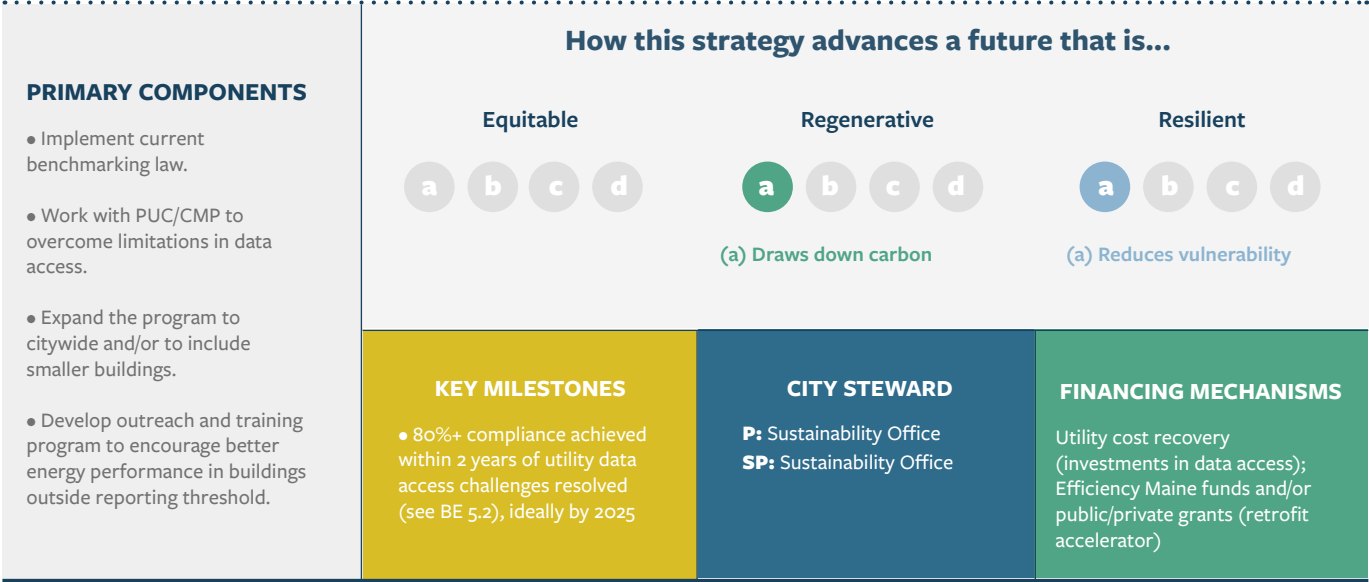
To ensure the benchmarking data is being put to good use, the Cities will build out an outreach and training program to turn the energy savings opportunities identified by benchmarking into action. New York City’s Retrofit Accelerator program serves as an example of this approach. It offers building owners and operators free, independent, and building-specific technical assistance and advice on energy and water efficiency. The program targets buildings with high savings potential, via a combination of public and non-public datasets collected under Local Law 84 (for energy and water benchmarking) and Local Law 87 (for energy audits and retrocommissioning).

The Cities would staff or contract for a retrofit accelerator program that pairs Portfolio Manager and energy efficiency training with targeted energy efficiency consulting at the “walkthrough” level. Efficiency Maine may be able to support the accelerator and/or support building owners with forgivable loans for energy audits. The Cities will also explore foundation funding to support the initiative.

Our next steps

- ☐ Work with the Maine Public Utilities Commission and utility companies to improve building energy data access.
- ☐ Update the existing benchmarking ordinance to be more in line with other cities with a 20,000 square foot reporting threshold (South Portland).
- ☐ Work to achieve 80% compliance in the pilot area, and then expand the geographic scope of the ordinance to apply citywide (South Portland).
- ☐ Work to achieve 80% compliance with existing covered properties, and then expand the building size scope of the ordinance to include smaller buildings (Portland).
- ☐ Develop a program to support buildings below the reporting threshold to achieve higher energy performance.

BE 3.1 Summary - Energy Benchmarking



BE 3

BE 3.2 Building Performance Standards

ACTION: Incorporate tune-up or performance standards into the Cities’ benchmarking programs for large buildings to achieve carbon savings, and strengthen coordinated job-training programs to support building retrofits.

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Where we are today

Cities around the country are finding that energy benchmarking is an important first step for encouraging energy efficiency retrofits in large existing buildings (see action BE 3.1), but that benchmarking alone does not incite the deep energy efficiency improvements that are needed to reach greenhouse gas emissions reductions goals for existing buildings. To reach an 80% reduction in citywide emissions, and eventually carbon neutrality, more proactive performance policies are needed. Several different levels of “building performance standards” have been adopted around the country:

- **Austin, TX:** Requires energy efficiency rating and improvements for single family homes at point of sale;
- **Boston, MA:** Requires large buildings to undertake an energy audit, or achieve 15% savings every five years;
- **Los Angeles, CA:** Requires large buildings to either be ENERGY STAR Certified, reduce energy use by 15% every five years, or undertake an audit and retrocommissioning/ retrofit every five years;
- **Seattle, WA:** Requires building “tune-ups” for commercial buildings every five years. Building tune-ups involve assessment and implementation of operational and maintenance improvements to achieve energy and water efficiency, and can be thought of as a simpler form of retrocommissioning;
- **New York, NY:** Requires large buildings to meet greenhouse gas intensity requirements by 2030 and 2050. The 2030 targets will drive both energy efficiency improvements and phasing out of fuel oil use; the 2050

targets will likely require deep energy efficiency and electrification.

- **Washington, DC:** Requires buildings 10,000 square feet or larger to perform at or better than the median energy efficiency (ENERGY STAR score) for their building type, with the bar adjusted every five years. Buildings must meet the threshold, drop energy use by 20%, or undertake prescriptive measures comparable to a 20% reduction.

Coupling performance standards with the Cities’ benchmarking programs will encourage property owners to invest in retrofits that can both result in energy cost savings for building owners and accelerate decarbonization of existing buildings throughout our cities.

The action we will take

Portland and South Portland will assess options for adding a performance mandate to the Cities’ energy benchmarking programs within 3-5 years, after buildings have had several years to track their energy use. To support electrification and thermal decarbonization, these policies will be most effective if they are based on greenhouse gas emissions intensities instead of energy use. The standards will apply to all buildings covered under the building benchmarking programs, phased in over two to three years—starting with the largest buildings first. It is premature to identify specific greenhouse gas emissions reductions targets at this time, but the targets will be optimized to drive thermal decarbonization and cost-effective energy efficiency retrofits.

Building owners will be offered the opportunity to apply for an exemption under certain conditions or contribute to an offset fund explored under the Green Development Flexibility Ordinance (see action BE 2.1 for further details). These conditions may include buildings that are already achieving sufficient performance levels, buildings that hold certain certifications, or buildings that have recently undergone equivalent action to improve energy performance. (Under Seattle’s Building Tune-Up Program, exemplary performance options include the U.S. Green Building Council’s LEED Gold or Platinum O+M certifications and the International Living Future Institute’s Living Building, Petal, or Zero Energy certifications, among others, while equivalent action options include Active Monitoring and Continuous Commissioning, ASHRAE Level II Audit recommendations, and Substantial Alteration or New Construction, among others). The affordable housing sector will also be afforded additional flexibility.

Adopting performance targets will increase demand for building retrofits and a skilled workforce in construction trades. The Cities will work with partners—including colleges, technical schools, high schools, labor groups, career development organizations, and other partners—to advise and recommend opportunities for strengthening employment pipelines and job training programs in building trades to help meet this need

(see action BE 2.4 and CR 3.2 for further details). Programs could work with HVAC and envelope/siding subcontracting unions and trade associations to prepare for a transition to heat-pump-based systems, high-performance envelopes, and next-generation building technologies. A technical series on select technologies and approaches, including heat pumps, high-performance detailing, and air sealing performance testing led by a career development program could help build workforce capacity. Likewise, modern, energy-efficient commercial buildings require specialized knowledge to operate, and poor energy management can negate all the gains of high efficiency building systems. The Cities will work with schools, universities, labor groups, and other career training partners to advise and recommend opportunities to expand program options for building operator training. A good example is the City University of New York Building Performance Lab, which offers building operator certification.

Our next steps:

- ☐ Conduct a quantitative study and stakeholder process to identify appropriate greenhouse gas emissions standards, and adopt performance requirements for large existing buildings.

BE 3.2 Summary - Building Performance Standards



BE 3.3 Energy Efficiency Spending

ACTION: Expand statewide and local energy efficiency spending; advocate for changes in Efficiency Maine spending that remove barriers for fuel switching.

Where we are today

Maine currently spends \$33 million per year on energy efficiency—equivalent to 2.13% of retail sales. Energy savings in 2018 were equivalent to 0.87% of electric sales and 0.7% of residential gas sales. These levels are competitive nationally—in the top 10 for spending, and the 60th percentile for savings—but will likely need to be better in order to achieve energy and climate goals statewide, and to support electrification. Neighboring jurisdictions including Massachusetts and Vermont spend upwards of 5% of utility revenues on efficiency, and see energy savings in excess of 2-3% per year.

Efficiency Maine Trust is the primary administrator for statewide programs to improve energy use efficiency and reduce greenhouse gas emissions in homes and businesses throughout Maine. As currently structured, Efficiency Maine achieves these goals primarily through offering residents and businesses financial incentives to reduce the costs of high-efficiency building systems and appliances that help customers save electricity, natural gas, and other fuels.

The action we will take

Portland and South Portland will advocate for increases in Efficiency Maine funding, an expansion of eligible programs, and adjustments in how Efficiency Maine funding is earmarked. In particular, we will advocate for all Efficiency Maine Trust revenue from electric and natural gas conservation charges to be targeted towards beneficial electrification and energy efficiency, behind-the meter, and storage programs

independent of fuel source to reduce overall electrical demand. It is important that the measures of tracking Efficiency Maine performance and evaluating savings be transitioned to fuel-neutral metrics. Separate efficiency targets for gas and electricity force investments in renewing gas infrastructure. Switching to a fuel neutral target, such as site energy consumption or greenhouse gas emissions would allow Efficiency Maine to count the savings associated with removing gas systems. Often utilities are disincentivized from fuel switching because it creates “negative savings” in electricity use. To counteract this, the state should explore allowing increased electricity use from electrification projects to not count against the energy savings, so long as the electric technology is best-in-class (such as an air-source heat pump with a coefficient of performance of 3).

The Cities will also advocate for increased Efficiency Maine funding, which could occur in several ways:

- **Increasing conservation charges.** Conservation charges (also known as “system benefits charges”) are surcharges on residential and commercial bills that support conservation programs. These rates currently sit at 0.12 cents per kilowatt-hour, which is substantially below many other Northeast states. While the simplest method, this method also places the cost burden most directly on ratepayers. It is important that low income ratepayers be exempted from any system benefits charge increase.

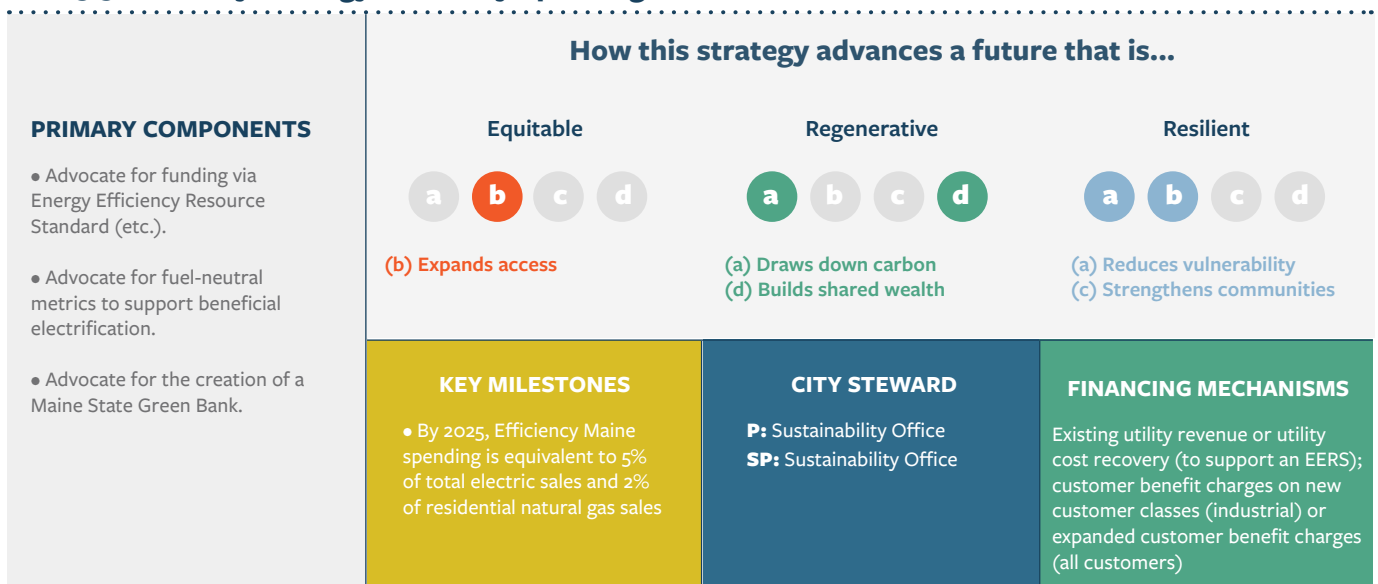
It's important that fuel-neutral metrics are used to track Efficiency Maine's performance in order to better incentivize beneficial electrification.

- **Direct re-capitalization by the State.** Currently Efficiency Maine is seeking up to \$5 million to re-capitalize their revolving loan fund to support low-to-moderate income Mainers with efficiency projects. Governor Mills has proposed a state bond to re-capitalize the fund.
- **Energy Efficiency Resource Standard (EERS).** An EERS is a law requiring electricity and/or natural gas utilities to achieve specified levels of customer energy savings, either through direct investment in energy efficiency, or payments to a third-party that is subject to performance requirements and incentives. In Oregon, efficiency programs are administered by the Energy Trust of Oregon, a similar entity to Efficiency Maine.

The Energy Trust of Oregon receives a portion of its funding from a system benefits charge, but much of its funding comes directly from the utility companies, who provide funding to the trust based on a negotiated agreement as to the funding needed to achieve the EERS. Except for New Hampshire, all other New England states have an EERS. In drafting an EERS, it is important that it does not authorize the utilities to run their own efficiency programs, but instead directs funding to Efficiency Maine.

- **Elimination of the “opt-out” for industrial and large users.** Currently, large industrial customers are able to opt out of supporting Efficiency Maine, with no strict requirements for any comparable self-investment in efficiency. Elimination of this opt-out clause would increase funds, particularly for industrial energy efficiency programs. Alternatively, the State could allow industrial users to choose to opt-out on a case-by-case basis, instead of automatically, on the condition they operate their own self-directed efficiency program subject to oversight and guidance from Efficiency Maine or another state entity.¹⁰ See action BE 3.1 for more discussion on this issue and options for addressing it.

BE 3.3 Summary - Energy Efficiency Spending



• **Creation of a green bank.** To meet the long-term energy infrastructure needs, the State would benefit from the creation of a green bank or infrastructure bank. Green banks are typically public or quasi-public entities that leverage private sector capital to increase the overall level of investment in renewable, low-carbon energy. A green bank could supply a range of financial products, including credit enhancements, warehousing and securitization services, direct lending, underwriting support, and other technical expertise. This initiative could expand, enhance and supplement existing financing programs currently offered by Efficiency Maine, the Finance Authority of Maine, Coastal Enterprises Inc., and the Maine Technology Institute. For example, a green bank could offer forgivable loans for energy audits; the loan would pay the costs of the energy audit, and would convert to a grant if all the cost-effective measures recommended in the audit were installed.

Throughout the One Climate Future plan, there are multiple actions that will strongly benefit from, or require, support from Efficiency Maine, including:

- Offering a pay-for-performance (P4P) program to support complex whole-building programs that include operational improvements;
- Design assistance and financial incentives for net-zero energy new buildings (see BE 2.1 and BE 2.3);

- Establishing a retrofit accelerator or similar outreach program that is targeted at encouraging buildings submitting benchmarking data or other performance data to undertake simple retrofits (see BE 3.1);
- Supporting the uptake of cold-climate air-source heat pumps (see BE 3.4);
- Supporting a bulk buy program for heat pumps, solar photovoltaics, and/or electric vehicles (see BE 3.5);
- Focusing more deeply on industrial energy efficiency (see BE 4.1);
- Ensuring that the custom industrial programs include heat recovery applications (BE 4.2); and
- Custom incentives for district-scale energy solutions (see BE 5.4).

Our next steps:

- ☐ Advocate for an increase in system benefits charges or the creation of an EERS that supports an expansion in revenue to Efficiency Maine Trust.
- ☐ Advocate for the creation of fuel-neutral metrics for Efficiency Maine performance (and EERS, if applicable) that incentivize beneficial electrification.
- ☐ Continue to advocate for the creation of a green bank.

BE 3

BE 3.4 Renewable Heating and Cooling

ACTION: Launch a program to shift single family homes and larger multifamily and commercial buildings from fuel oil directly to all-electric heating and cooling.

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Where we are today

Fuel oil remains a major source of heating in Maine at large and in both Portland and South Portland. Analysis conducted for this plan shows that the majority of single-family homes and many commercial buildings in Portland and South Portland still use fuel oil for heating, and fuel oil makes up almost a quarter of citywide energy use and greenhouse gas emissions for both cities (23% of site energy and 24% of emissions in Portland; 22% of site energy and 23% of emissions in South Portland). This rate of use is dramatically higher than much of the country—in the Mid-Atlantic, fuel oil typically makes up less than 5% of energy use and emissions. However, there is an ongoing transition to natural gas use in both cities. Natural gas use in Portland in 2018 was higher than in 2017, and dramatically higher than the values reported in Portland’s 2010 greenhouse gas inventory. While these conversions have the short-term benefit of reducing fuel costs and emissions, they lock homeowners and businesses into a fossil fuel combustion technology for the next 15-30 years.

To reduce greenhouse gas emissions, cities are increasingly looking to modern heat pumps, paired with renewable sources of electricity, to provide renewable heating and cooling. People may have the impression that electric heat pumps cannot handle the cold Maine winter. However, modern cold-climate air-source heat pumps are far superior to older models that people may be familiar with. Research by the Rocky Mountain Institute (RMI) notes that cold-climate heat pumps can heat homes even when outdoor temperatures dip to -12 degrees Fahrenheit and found that supplemental electric resistance heating was needed just 3% of the time in Bozeman (a similar



HOMES ON THE EAST END • Photo by Paul VanDerWerf

climate zone to Portland) and 10% of the time in Duluth (a colder climate than Portland).¹¹

The State of Maine has made electrifying heating with air-source heat pumps a policy priority. State legislation LD 1766 sets the goal to install 100,000 new heat pumps throughout the state within five years—a goal that will have benefits for both reducing greenhouse gas emissions and improving comfort. Most homes in Maine do not have cooling/air conditioning. However, as summers get warmer, more people will install air conditioning, which will drive up electricity use. Air-source and ground-source heat pumps can provide renewable heating as well as energy-efficient cooling. In other markets in the region, studies have found it to be cost-

Air-source and ground-source heat pumps can provide renewable electric heating and energy efficient cooling—an important option as summers in Maine continue to get warmer. Studies have found it to be cost-effective to switch directly from heating with fuel oil to heat pumps.

competitive to switch directly from heating with fuel oil to heat pumps—however, once a building has switched to natural gas, switching to electric heat pumps rarely provides cost savings.

The action we will take

The Cities will begin operating a program to shift single family homes and larger multifamily and commercial buildings from fuel oil directly to all-electric heating and cooling via air-source heat pumps and ground-source heat pumps, aligning with

the LD 1766 goal of installing 100,000 new heat pumps in the state within 5 years, and in an effort to get ahead of ongoing gas conversion. The Cities worked with Meister Consultants Group (now part of Cadmus) in 2018 to analyze the potential for heat pumps. The study identified which single family and multifamily homes were the best fit for ductless or ducted air-source heat pumps, ground-source heat pumps, or wood pellet boilers. This data must be looked at with some caution since it did not involve home inspections, and natural gas service penetration has increased dramatically in just the last couple years. Nonetheless, it provides a good foundation for launching a targeted marketing and incentive program for heat pump conversions.

The program will initially target homes and businesses that use fuel oil. As stated above, fuel oil to electric conversions are cost-effective from the start, delivering utility savings and increased reliability. The marketing and incentive program will dovetail with existing state-led consumer outreach and education to grow demand for energy efficiency and heat pump technologies while maximizing energy savings. Where appropriate, electrification can be combined with on-site solar

BE 3.4 Summary - Renewable Heating and Cooling



and battery storage to improve resilience. However, the priority should be on electrification of thermal demand. Bulk buy programs will be one mechanism to help reduce the cost of heat pump technology (see action BE 3.5 for further details).

To further incentivize conversions, the Cities will consider adopting legislation requiring that any building owners with an active oil tank either update their tank to a code-compliant tank or decommission their tank by the end of 2028 (or otherwise specified date). Such legislation would address rusting, corrosion, and leakage from older oil tanks; help to protect soil and groundwater; as well as establish a date by which building owners must invest in a new system, encouraging transition to renewable electric systems at that point, if not sooner. It will be important that the Cities and State simultaneously indicate that natural gas will not be a long-term viable option (through statewide bans on new pipelines or restrictions on new hookups; see action BE 5.6) to prevent this policy from driving conversions to natural gas. A statewide carbon tax (see action BE 5.7) would further make electric heating systems a preferable option, discouraging updates to a code-compliant oil tank or natural gas system.

Our next steps

- ☐ Review Meister Consultants Group recommendations, and study best practices in beneficial electrification incentives in other New England states. Work with Efficiency Maine, key heat pump manufacturers, and the local HVAC contractor industry to design and launch a program to shift buildings to air-source heat pumps.
- ☐ Explore ways to address split economic incentives for renters versus property owners in multi-tenant buildings (see action BE 3.7).
- ☐ Aim to launch a new electrification marketing and incentive program by 2023 (see action BE 3.5).
- ☐ Adopt legislation by 2023 to require building owners with active oil tanks to update their tank to a code-compliant tank or decommission their tank by 2028, or another a specified date.

BE 3.5 Bulk Buy Programs

ACTION: Launch bulk buy programs for solar power and heat pumps, paired with electric vehicles as appropriate.

Where we are today

Bulk procurement programs are a way for cities to buy large quantities of products—such as solar panels, air-source heat pumps, or other energy efficiency technology—and offer them for purchase at a reduced price to residents and businesses. Making energy efficient and renewable energy technology more affordable will support the State’s policy priority to install 100,000 new heat pumps throughout the state within five years (see action BE 3.4), as well as advance both the State’s and Cities’ goals of decarbonizing building energy consumption.

Successful bulk purchase programs in other jurisdictions include Solarize and HeatSmart Massachusetts, and Benefits Boulder County. Solarize and Solar United Neighbors (SUN) programs work by encouraging groups of residents to jointly sign up for solar installations, and once a critical mass is met, a contractor comes and installs solar on all the homes at a reduced, bulk price. HeatSmart Mass is modeled on Solarize and applies the same model to the purchase and installation of air-source heat pumps (ASHP) and ground-source heat pumps (GSHP). Local governments sign up to participate in the statewide program, and in 2019, it led to the installation of 282 heat pumps. Benefits Boulder County is a combined solar, electric vehicle, and electric bike bulk buy, which over the past two years, facilitated the sale of 123 discounted residential solar systems, 289 discounted electric vehicles, and over 280 discounted electric bikes. The pairing of electric vehicles with solar was found to introduce additional complications and in Maine may work better as an optional add-on.

The action we will take

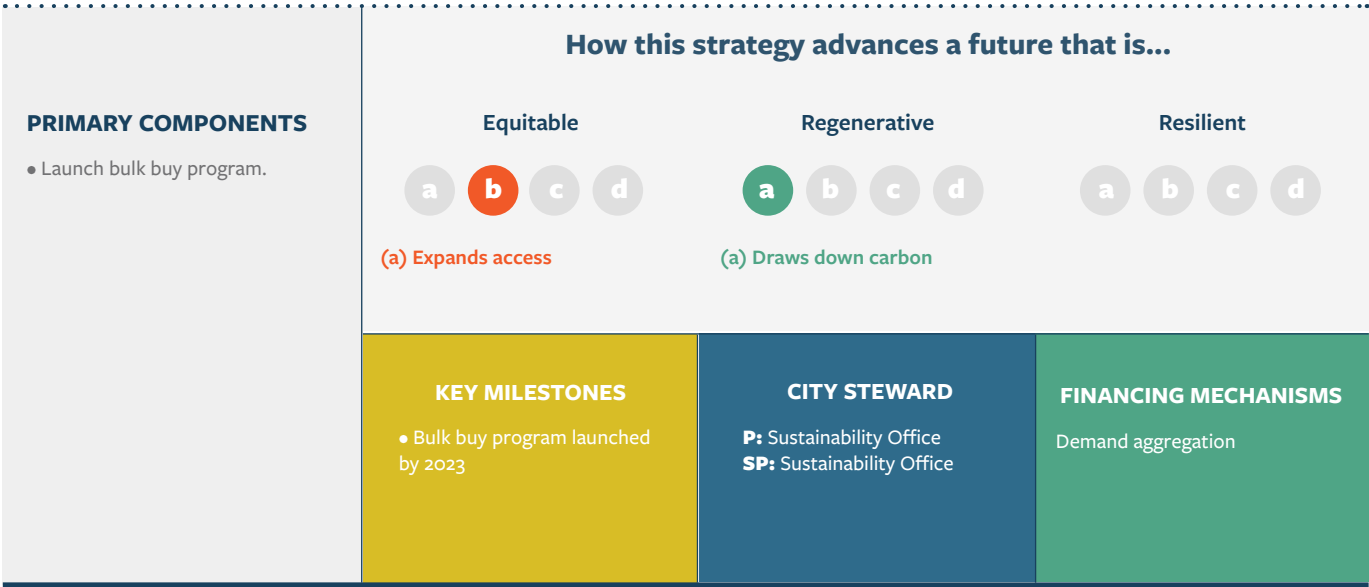
The Cities will launch a bulk purchase program for residential solar and cold-climate air-source heat pumps, either as a municipal program or as part of a regional or statewide initiative. A well-orchestrated bulk buy program will require no government funding (other than staff time), and will result in an increase in the number of installations. This program would be a part of the larger campaign to convert homes to heat pumps as discussed in action BE 3.4.

Our next steps

- ☐ Assign staff to connect with Massachusetts and Boulder, Colorado program staff to learn how these bulk buy programs were designed, implemented, and managed. Determine which staff may be best suited to lead the initiative, whether a minimum number of buyers would need to be procured, and the type of manufacturer and installer partnerships required.
- ☐ By 2023, launch the bulk buy program.

Launching a bulk buy program will support the State’s priority of installing 100,000 new heat pumps throughout the state within the next five years.

BE 3.5 Summary - Bulk Buy Programs



BE 3.6 Solar Proliferation

ACTION: Continue to enhance the attractiveness of solar through a solar proliferation strategy, as well as offering financial and/or structural incentives.

Where we are today

Rooftop solar panels are “contagious.” When a building owner installs rooftop panels, others often soon follow atop other nearby buildings.¹² Efforts to enhance the attractiveness of solar can help to increase the number of solar photovoltaic installations, while generating resident and business awareness and interest. It builds on ongoing work to modernize and increase the resilience of the grid, and acts as a catalyst to build local workforce capacity and economic development opportunities in the renewable energy sector.

In 2020, GridSolar completed an analysis of rooftops in the Greater Portland area to estimate the cities’ maximum capacity for rooftop solar generation, based on a set of physical and economic parameters for what constitutes a viable rooftop solar array. The study found that Portland and South Portland could collectively accommodate 375 MW of rooftop solar, or 599,492 MWh of annual generation—a capacity that could meet 29% of all electricity needed in both cities, even with electrification of buildings! In reality, however, it would be very difficult to meet this maximum build-out: not all building owners will install solar for a variety of technical, economical, or personal reasons. Nevertheless, the GridSolar study offers proof that a significant supply of solar can be locally sourced.

The action we will take

To grow solar generating capacity on private buildings in a short period of time, Portland and South Portland will launch

a continuously evolving solar proliferation strategy. This is a direct marketing and education campaign that targets buildings suitable for solar. Residents and businesses can self-identify as interested in the solar assessment. Program staff will provide additional information to support decision-making and implementation, and will connect property owners with solar installers and financing options. The proposed solar proliferation strategy involves four phases.

Phase 1: Identify local partners and organizations.

Successfully implementing this strategy will require support from local organizations and coordination with solar installers, financing providers, marketing and outreach companies, and tenant advocacy groups. Solar installers, financing providers, and marketing and outreach companies will be important to continuing to implement the solar proliferation strategy and translating the implementation of the strategy into new solar adoption. The Cities will issue a competitive request for proposals (RFP) for a marketing and outreach company to develop a marketing campaign to directly engage with owners of identified buildings.

Phase 2: Identify target buildings. Working with project partners, the Cities will identify a subset of building rooftops with the highest solar potential. This process will draw directly from the GridSolar solar assessment completed in 2020. Primary targets for rooftop installations will include multifamily buildings, condominium buildings, small businesses, nonprofit organizations, and opportunities for residential solar co-



SOLAR ON BAYSIDE BOWL • Photo by ReVision Energy

ops. The process will likewise seek opportunities to advance more equitable access to renewable energy by prioritizing installations that benefit people who typically have lower access to solar and its economic benefits, including low income households and communities of color,¹³ as well as opportunities to install larger solar systems (e.g., community-scale solar). Additional factors in determining the subset of buildings to target will include:

- Ease of rooftop accessibility (e.g., by an aerial work platform or cherry picker);
- Capability of the building to accommodate a solar system;
- Ability of the local grid to absorb new renewable energy generating capacity and the opportunity for new technology, including microgrids (see action BE 5.4), to mitigate grid issues;
- Ability of the building to accommodate energy storage infrastructure;
- Opportunities to coordinate with upcoming construction projects to reduce installation costs; and
- Expected future lifespan of buildings and roofs.

Renters who are interested in solar can be connected with community solar programs, when available, which would allow renters who are unable to install solar on a roof to receive the financial benefits of solar installations.

Phase 3: Design and implement a targeted marketing campaign. This campaign will clearly and simply communicate the benefits of solar systems, explain the program being offered, and summarize available incentives and support. The Cities and marketing and outreach consultant may implement a “Solar Coach” program which hires program staff to connect with residents from diverse demographics for whom solar has been traditionally inaccessible. Renters who are interested in solar can be connected with community solar programs, when available, which would allow renters who are unable to install solar on a roof to receive the financial benefits of

solar installations. Messaging as part of the solar proliferation strategy will be informed by an understanding of consumer perceptions of solar systems’ pricing, value and reliability, as well as the perceived complexity and duration of the purchase, installation, and rebate process.

Phase 4: Facilitate solar installations. Program staff will implement assessments for interested building owners, and provide supporting information on payback timeframes and financing options. For all building owners that choose to move forward with a solar installation, program staff will connect the building owners with the appropriate organizations for solar installation and financing. Program staff liaisons at the Cities will simultaneously identify mechanisms to help reduce costs of solar installations. Approaches may include offering structural incentives, such as expedited permitting and design support, or financial incentives, such as waiving permit fees. Major solar incentives, however, will likely have to come from state programs. Costs can also be reduced through a bulk buy program, as discussed in action BE 3.5.

Our next steps:

- ☐ Review existing zoning and regulation to ensure that solar installations can be maximized and streamlined.
- ☐ Begin implementation of the solar proliferation strategy by working with local stakeholders, and then drafting and issuing a request for proposals for a marketing and outreach team.

BE 3.6 Summary - Solar Proliferation

How this strategy advances a future that is...			
PRIMARY COMPONENTS	Equitable	Regenerative	Resilient
• Reduce permit times and fees for solar installations. • Launch solar proliferation strategy.	a b c d (a) Addresses injustice (b) Expands accesss (d) Builds community ownership	a b c d (a) Draws down carbon (d) Builds shared wealth	a b c d (a) Reduces vulnerability (b) Strengthens communities (d) Builds partnerships
	KEY MILESTONES	CITY STEWARD	FINANCING MECHANISMS
	• Solar proliferation strategy launched by 2023 • 50 MW of solar installed in the cities by 2030 and 245 MW of solar installed by 2050	P: Sustainability Office & Planning Department SP: Sustainability Office & Planning Department	General fund, special assessments, or utility-supported funding (for permitting improvements); savings on solar PPAs, SREC revenue, or grants (for proliferation strategy); SREC sales, federal tax credits, PPAs (for solar development)

BE 3.7 Energy Efficient Rental Housing

ACTION: Require minimum energy efficiency standards for residential rental properties to decrease energy use, increase thermal comfort, and reduce energy costs paid by renters.

Where we are today

Roughly 56% of Portland residents and 38% of South Portland residents are renters.¹⁴ Homeowners often have an incentive to invest in energy efficiency upgrades because the investments can lead to lower energy use and energy cost savings over a relatively short payback period. For most rental properties, however, renters pay for their energy use and have little influence over the energy efficiency of the building, heating and cooling systems, and appliances. Because rental property owners do not directly benefit from energy efficiency cost savings or improved thermal comfort, there tends to be a much smaller incentive for landlords to invest in energy efficiency upgrades. This “split incentive” has led to notable differences in the energy efficiency of rented versus owned homes: Across the United States, energy use per square foot tends to be 10% greater for rentals than owner-occupied homes for buildings built since 1980 and 35% greater for those built before 1940.¹⁵ Roughly 40% of all housing units in Portland and 32% of units in South Portland were built before 1940.¹⁶ Due to lower incomes on average, renters tend to pay a larger proportion of their income towards energy costs, and show greater incidences of energy insecurity than homeowners, factors that are compounded by lower energy efficiency of rental units on average.^{17, 18}

To address this challenge, Maine law (statute 6030-C) provides prospective tenants the right to request energy consumption and cost data for the past year for the given housing unit prior to renting. Landlords are also required to provide prospective tenants with an energy efficiency disclosure statement, stating

whether the rental unit meets suggested minimum energy efficiency guidelines for heating systems, insulation, windows and doors, and appliances. Disclosing this information provides greater transparency to potential renters, calls attention to ways landlords can meet minimum energy efficiency standards, and particularly in a “buyer’s market,” encourages landlords to improve the energy efficiency of the building as a competitive edge. To further improve energy efficiency in rental properties, a number of U.S. cities—such as Burlington, VT; Ann Arbor, MI; and Boulder, CO—have begun requiring (as opposed to suggesting) that rental properties meet the energy efficiency minimums. Boulder’s “SmartRegs” policy, which was adopted in 2010 and required compliance by 2018, reports that at full compliance, the city’s rental properties are expected to result in 8,300 metric tons of avoided carbon emissions and \$1,100,000 in energy bill savings, annually.

The action we will take

Portland and South Portland will expand the use and effectiveness of the State’s energy efficiency disclosure requirement for rentals in the cities, and assess the feasibility of instituting a required minimum energy efficiency standard for residential rentals. As a starting point, Portland will require submission of the State of Maine energy efficiency disclosure statement as part of its long-term residential rental unit registration. South Portland will establish a long-term rental licensing program in the city, and include the State’s disclosure statement as part of the application. Collecting



HOMES ON MAYO STREET • Photo by Holly Jacobson

this documentation will better ensure that the disclosure statements are being used in rental agreements throughout the cities—further encouraging voluntary efficiency upgrades—and will allow the Cities to collect data on the number of units that currently meet, exceed, or do not meet the State’s suggested minimum standards.

Portland and South Portland will collect data as part of the Cities’ long-term rental licensing for three years to fully institute the system and track any voluntary investments to meet minimum standards over that period. The Cities will then use this dataset to conduct an internal assessment of

the costs and benefits of implementing minimum energy efficiency standards for residential rentals, including assessing the number of rentals below the State’s minimum standards (or otherwise defined standards); the estimated energy and cost savings for renters; the total annual impact on greenhouse gas emissions; the potential cost to property owners accounting for available rebates, tax credits, or other financing mechanisms; and the approximate program costs for the Cities to implement.¹⁹

The Cities will be able to to work with property owners to set minimum efficiency standards, compliance timelines, and financing mechanisms that can ensure that costs to retrofit stay within the energy cost savings created by the efficiency project.

If the potential impact generated through the program proves cost-effective, the Cities will assess and model baseline and potential energy savings for a set of prototypical properties in order to establish energy targets and payback periods. As part of this process, the Cities will work with property owners in the cities to vet efficiency standards, as well as discuss financing options, training or resource needs, and potential logistical sticking points that can be overcome through the program design. It will be important to determine the degree to which costs incurred by property owners for efficiency investments will be passed to renters through higher rents, potentially affecting housing affordability. By understanding these cost thresholds, the Cities will be able to work with property owners to set minimum efficiency standards, compliance timelines, and financing mechanisms that can ensure that any increase in rent stays within the energy cost savings for renters created by the efficiency project. For example, to address this concern Burlington, VT instituted a cost cap, whereby housing units are considered compliant if the building meets minimum standards or if the property owner has invested in efficiency upgrades up to the cost cap.

The Cities will consider implementing both a prescriptive and performance-based compliance path. The City of Boulder, for example, implemented a prescriptive path using an internally-designed checklist and a performance-based path based on the Home Energy Rating System (HERS) index. It will be important for any compliance path to encourage renewable or electric heating and cooling systems in alignment with One Climate Future goals.

Our next steps:

- ☐ Require submission of the State of Maine energy efficiency disclosure statement as part of the City’s long-term residential rental unit registration (Portland).
- ☐ Establish a long-term rental licensing program in the city, and include the State’s disclosure statement as part of the application (South Portland).
- ☐ By 2026, assess the potential impact and cost effectiveness of adopting minimum energy efficiency standards for residential rental properties, using data from the State’s energy efficiency disclosure requirement.

BE 1.4 Summary - Energy Efficient Rental Housing

How this strategy advances a future that is...			
PRIMARY COMPONENTS	Equitable	Regenerative	Resilient
	a b c d (a) Addresses injustice (b) Expands access (c) Creates inclusive processes	a b c d (a) Draws down carbon (d) Builds shared wealth	a b c d (a) Reduces vulnerability (b) Strengthens communities
	KEY MILESTONES	CITY STEWARD	FINANCING MECHANISMS
	Determination of whether to proceed with a rental minimum energy efficiency program by 2026	P: Housing Office SP: Sustainability Office	General fund (for study of minimum efficiency standards)



BE 4

Industrial Energy Efficiency and Decarbonization

ALLAGASH PURSUES ENERGY SAVINGS THROUGH TEMPERATURE CONTROL SYSTEMS • Photo by Allagash Brewing Company

BE 4.1 Industrial Energy Efficiency Spending

ACTION: Advocate for expanded energy efficiency incentives for large industrial users.

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Where we are today

The industrial sector is a major source of greenhouse gas emissions in both Portland and South Portland. In 2017, industry accounted for 25% of site energy use and 24% of emissions in South Portland and 11% of site energy use and 10% of emissions in Portland. In short, it will be impossible to achieve the One Climate Future goal of reducing greenhouse gas emissions in both cities 80% by 2050 without substantial reductions coming from the industrial sector.

Fortunately, the industrial sector can often take advantage of large, highly cost-effective opportunities for increasing energy efficiency. Nationally, the industrial sector has shown to save more energy per program dollar than other customer

classes.²⁰ Consequently, the United States has seen significant and consistent reductions in industrial energy use intensity in recent decades, decreasing 45% from 1977 through 2016. (However, increased output counterbalanced these efficiency savings in many cases.) Efficiency Maine operates a suite of custom energy efficiency programs for industrial customers. Funding levels range from a minimum of \$10,000 to a maximum of \$1 million per customer, or up to 50% of the total project costs.²¹ These programs are largely funded with money from the Regional Greenhouse Gas Initiative (RGGI), as industrial customers in Maine are automatically “opted-out” of the system benefits charges and cost recovery mechanisms that support Efficiency Maine.

The action we will take

Portland and South Portland will support expanded statewide energy efficiency programing for industrial customers by advocating that the automatic opt-out provision for industrial customers be removed. These opt-out clauses are common to several states, and are justified by the idea that industrial firms will invest in energy efficiency on their own. However, there is substantial evidence that most industrial customers leave large energy efficiency opportunities on the table, and that these opt-out programs increase inequity and do not achieve their intended goals.²² By removing the opt-out provision, industrial users will by default pay into funding streams to support Efficiency Maine programs and then in turn receive greater investment and technical support for efficiency efforts. Programs in Oregon, Rhode Island, Ohio, Vermont, Colorado,

and Wisconsin show that a well-structured energy efficiency program can achieve large savings at costs of less than 3 cents per kilowatt-hour.

As an alternative approach to fully removing the opt-out provision, the State could allow industrial users to choose to opt-out on a case-by-case basis instead of automatically, on the condition that they operate their own self-directed efficiency program subject to oversight and guidance from Efficiency Maine or another state entity.²³ A well-structured self-direct option should follow best practice guidance from the American Council for an Energy Efficient Economy. Efficiency Vermont has found success with performance-based incentives and strategic energy management approaches, using ISO 50001 Standard for Energy Management Systems, which should be explored for adoption in Maine.

It will be impossible to achieve the One Climate Future goal of reducing greenhouse gas emissions 80% by 2050 without substantial reductions coming from the industrial sector.

Our next steps

- ☐ Advocate for increased energy efficiency investment in the industrial sector, funded by the removal of the automatic industrial opt-out provision. Specific industrial programs that should be explored include pay-for-performance and ISO 50001 Strategic Energy Management.

BE 4.1 Summary - Industrial Energy Efficiency Spending



BE 4.2 Industrial Efficiency and Decarbonization Study

ACTION: Advocate for a statewide study on energy efficiency and decarbonization opportunities in the industrial sector to better target industrial combined heat and power, heat recovery, and renewable fuel oil or biogas.

Where we are today

Combined heat and power (CHP) systems, industrial heat recovery, and the use of renewable fuel oil or biogas are three primary ways that industries can increase their energy efficiency and/or decarbonize the fuel used for industrial processes. CHP systems generate electricity using natural gas and capture the waste heat to provide useful thermal energy. By using waste heat and avoiding distribution losses, CHP systems can achieve efficiencies of over 80%, compared to efficiencies around 50% for typical electricity sourcing or stand-alone electricity generation and on-site boilers for thermal loads.²⁴ Because CHP systems increase natural gas use, this approach may seem counterproductive for a decarbonization strategy. However, in situations where natural gas is already being burned for thermal energy, taking advantage of the potential to also generate electricity on site increases resilience and reduces peak and total electrical demand. In the short and medium term, the increased gas use from CHP systems can help offset declines in residential and commercial gas consumption driven by the shift to renewable electric systems. In the long term, these CHP facilities would be potential targets for transitioning to biogas (discussed in further detail below).

Industrial heat recovery likewise takes advantage of waste heat and uses it as a resource. Through the installation of heat recovery chillers and heat exchangers, waste heat from industrial processes can be recaptured to provide space heating for a building, reducing overall energy demand. Moreover, industrial heat recovery presents an opportunity

for facilities to operate as an ecosystem rather than in silos: Industrial users with heat generation and demand profiles that differ in intensity or temporally can share, sell, or purchase each other's waste heat. These relationships generate value for what was once a rejected byproduct, and allow facilities to purchase energy at lower costs than gas or electricity.

Both CHP and heat recovery serve as ways to increase the energy efficiency of industrial processes. Full decarbonization for the industrial sector, however, is much more challenging. Many industrial processes require high temperatures that are only achievable through combustion. Moreover, the energy densities of fossil fuels are difficult to compete with for industrial uses, and some industrial processes use the byproducts of fossil fuel combustion.²⁵ In the longer term, decarbonization of industry will likely rely heavily on biogas (generated from anaerobic digestion of wastewater, organic waste, waste wood, and agricultural processes), biomass (such as wood pellets), renewable fuel oil (RFO, a liquid fuel generated from wood waste among other sources), and potentially carbon sequestration.

The action we will take

Portland and South Portland will advocate for Efficiency Maine to conduct or commission an in-depth study of the energy efficiency and decarbonization potential of Maine's industrial sectors. The study would quantify current loads, project future loads, and explore a range of efficiency opportunities such

as combined heat and power systems, waste heat recapture, and conversion to biogas, biomass, or renewable fuel oil. Data about the specific efficiency opportunities for industrial sectors is closely tied to proprietary business information. Efficiency Maine has access to proprietary energy use data, which makes Efficiency Maine a suitable entity to lead such a study in collaboration with industry partners. By assessing these areas for efficiency and decarbonization, the study would help to advance the following:

● **Combined heat and power (CHP) systems.** Assessing opportunities for combined heat and power would enable Efficiency Maine and the Cities to promote CHP systems in a targeted fashion. Per Efficiency Maine guidance, a cost-effective CHP system is one where there is “a continuous, 24-hour per day electric demand that exceeds the nameplate electric output rating of the CHP unit; serviceable thermal loads and/or thermal storage capacity that allows for utilization of nearly 100% of the thermal output available from the CHP installation on a continuous basis; and an overall seasonal operating efficiency of 60% or higher.”²⁶ In the industrial context, CHP is most often installed when a facility is already generating steam or hot water for thermal loads and purchasing grid electricity, and could instead generate that electricity on site to both save money and increase resilience. It is important to note that CHP is often promoted as an efficiency strategy for large commercial and institutional customers, especially in campus settings. However, buildings do not actually require the high temperatures generated by CHP plants, and are a better fit for lower-temperature hot water distribution supported by heat recovery chillers and geo-exchange systems. Efficiency Maine offers funding for CHP feasibility studies under the Commercial and Industrial (C&I) Custom Distributed Generation program.²⁷

● **Industrial heat recovery systems.** Assessing the generation of waste heat and the geographic distribution of industrial processes would allow Efficiency Maine and industrial facilities within Portland and South Portland (as well as elsewhere in the state) to explore opportunities for industrial energy users to recapture their own waste heat and

share thermal loads to support energy needs of neighbors. For heat recovery in a single plant, the Cities will encourage Efficiency Maine’s expanded industrial programs to focus on heat recovery applications. At the larger scale, we will work with Efficiency Maine and use the results of the study to identify sites within the cities where several industrial plants in an industrial district—or the future siting of new industrial facilities—may be able to share thermal loads for mutual benefit. This first stage of building an industrial ecosystem could also lead to ways to capture other industrial waste streams (see action WR 2.2).

● **Biogas, biomass, and renewable fuel oil.** We recommend that the study assess opportunities and costs for industrial plants in using biogas, biomass (wood pellets or other wood waste), or renewable fuel oil (RFO) in place of natural gas. A primary component of that assessment entails evaluating the biogas potential of southern Maine, and comparing it to industrial gas demand. Nationwide, preliminary estimates



OAKHURST USES BIOFUELS IN ITS MILK TRUCK FLEETS • Photo by John Phelan

of biogas supply put it at 10% to 20% of total national gas demand—equivalent to the demand of the industrial sector alone, for whom it is best suited due to high temperature requirements. However, biogas is highly localized in both production and distribution. If there is enough biogas potential regionally, the State could explore allowing biogas to be fed into the natural gas supply, or delivered directly to customers. This would require regulatory updates. Based on the study’s findings and the biogas potential in Maine, the Cities would promote the opportunity among targeted industrial or large commercial/institutional entities in the cities, seeking partners interested in championing the conversion to biomass, biogas, or RFO for thermal energy use as a cutting-edge demonstration for others in the local industrial sector.

Reducing emissions from the industrial sector will require co-investment and joint planning across industrial companies, government, grid operators, and other relevant stakeholders. Nonetheless, Portland and South Portland recognize the opportunity to support efficiency and decarbonization with combined heat and power (CHP) systems, industrial heat

recovery, and renewable fuel oil or biogas. Following an in-depth study of the energy efficiency and decarbonization potential, Portland and South Portland will evaluate and revise relevant zoning regulations and incentives to enable the build-out of low-carbon industrial solutions.

Our next steps

- ☐ Advocate for Efficiency Maine to lead or commission a study of industrial energy efficiency and decarbonization potential, working in collaboration with industrial partners.
- ☐ Building on the findings of the industrial energy efficiency potential study, promote CHP in a targeted fashion to industrial users. CHP will be discouraged for building and campus projects without substantial demand for high-temperature supply of water/steam.
- ☐ Work with Efficiency Maine to ensure that the custom industrial programs are working on heat recovery applications.

BE 4.2 Summary - Industrial Efficiency and Decarbonization Study





BE 5

Clean and Renewable Energy Infrastructure and Regulatory Transformation

SOLAR ARRAY ON THE SOUTH PORTLAND LANDFILL • Photo by ReVision Energy

BE 5.1 Renewable Portfolio Standard and Community-Scale Purchasing

ACTION: Continue to advocate for full, timely, and cost-effective implementation of Maine’s renewable portfolio standard; in case it becomes necessary, advocate for municipal authority to bulk procure renewable power on behalf of residents, businesses, and municipal users.

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Where we are today

A renewable portfolio standard (RPS) is a statewide policy that requires that the state’s electricity must be increasingly generated from renewable energy sources over time. As of April 2020, thirty states, the District of Columbia, and three territories in the United States had set renewable portfolio standards.²⁸ The State of Maine adopted legislation (LD 1494) in 2019, which raised the RPS for the state to 80% renewable electricity by 2030 and 100% by 2050. As mentioned in action BE 1.1, this ambitious step towards carbon neutrality will be transformational for Maine’s electricity sector and based on our greenhouse gas emissions projections, represents the

single biggest contribution to achieving One Climate Future goals. Compared to RPS laws in other states, the Maine RPS is particularly notable because it accelerates the timeline towards carbon neutrality by allocating much of the growth in renewable electricity within the first ten years. Adherence to that trajectory, however, depends on continued support for the RPS (to prevent the law from being repealed) and support for an energy market and policy that can continue to enable and incite the build-out of renewable energy projects statewide at a pace in line with the RPS targets.

In conjunction with RPS targets, some states have granted local municipalities the authority to bulk purchase renewable energy on behalf of residents, businesses, and organizations such that municipalities can transition to 100% renewable electricity ahead of the RPS targets. There are a number of types of power purchase aggregation or third-party purchase. Under traditional programs, customers must opt into the program, which tends to result in decently high uptake for commercial customers but extremely low residential uptake. Alternatively, under opt-out models—such as community choice aggregation (CCA)—residents and businesses are automatically enrolled, and are offered the option to opt out, returning to their original utility supplier or to another third party, if available. As of 2020, under Maine state law municipalities are not authorized to procure power on behalf of their constituents, via community choice aggregation or another method.

The action we will take

Portland and South Portland will continue to advocate for full, timely, and cost-effective implementation of the Maine renewable portfolio standard as envisioned under the state legislation LD 1494. Supporting the renewable portfolio standard will likewise include continuing to advocate for strong renewable energy policy in the legislature and at the Maine Public Utilities Commission to incentivize and enable the development of solar energy projects and distributed energy resources. Currently, such efforts are in line with the intent of LD 1711 (enacted in 2019), which revised size limits of solar projects, enabled community solar development, and instituted new crediting mechanisms to reduce barriers and create stronger incentives for solar development and other distributed energy resources.

To protect against policy changes or against a situation where renewable energy generation in the state fails to keep pace with the targets outlined by the renewable portfolio standard, Portland and South Portland will advocate for state legislation that would allow municipalities to bulk purchase power for all electricity users in the cities. Two policies in particular would support this goal: 1) authorizing a Maine Energy Generation Authority to syndicate the development of renewable generation for municipalities, or 2) enabling community choice

To protect against policy changes or against a situation where renewable energy generation in the state fails to keep pace with the targets outlined by the renewable portfolio standard, Portland and South Portland will advocate for state legislation that would allow municipalities to bulk purchase power for all electricity users in the cities.

aggregation. The Cities will support the advancement of either (or both) at the state level to safeguard the option of municipal purchasing to meet (or exceed, if deemed feasible and cost-effective) the pace outlined in the RPS.

The Cities will first pursue policy that would grant municipalities the ability to bulk procure electricity through establishing a Maine Energy Generation Authority (MEGA). The MEGA would be authorized to finance, develop, and own renewable energy generation plants in order to build out the state's renewable energy resources.²⁹ Under this purview, MEGA would syndicate the development of renewable generation on behalf of municipalities that wish to provide their constituents with renewable electricity, representing another avenue for aggregating the buying power of a community. Portland and South Portland will support legislation for the establishment of a Maine Energy Generation Authority, and if implemented, would work with MEGA to acquire shares of future renewable energy projects if necessary to meet or accelerate the Cities' renewable electricity goals independent of the state's RPS.

An alternative policy, community choice aggregation, grants local governments the authority to engage in the bulk purchase of renewable electricity. As the name "community choice" implies, communities can choose whether to implement community choice aggregation programs once the policy is enabled by the state. Portland and South Portland may advocate for state authorization of a CCA program if at any

point it becomes clear that the state RPS targets may not be met. The Cities can also use a CCA program to transition to renewable electricity faster than the RPS timeline. However, because implementing a CCA is very resource intensive—and would require an ongoing assessment of whether a CCA could viably offer cost-competitive energy rates—the Cities will initially prioritize other One Climate Future actions and reassess a CCA based on the ongoing progress of the RPS.

Our next steps

- ☐ Continue to advocate for full and timely implementation of Maine’s renewable portfolio standard as envisioned by LD 1494.
- ☐ Continue to advocate for strong renewable energy policy in the legislature and at the Maine PUC to support the intent of LD 1711.
- ☐ Advocate for the establishment of a Maine Energy Generation Authority to grant municipalities the authority to bulk purchase electricity for constituents if warranted.



SOLAR ARRAY ON THE PORTLAND LANDFILL • Photo by ReVision Energy

BE 5.1 Summary - Renewable Portfolio Standard and Community-Scale Purchasing

How this strategy advances a future that is...			
PRIMARY COMPONENTS	Equitable	Regenerative	Resilient
	a b c d (b) Expands access — to renewable energy, assuming no net increase in electricity costs	a b c d (a) Draws down carbon (b) Builds shared wealth	a b c d (a) Reduces vulnerability (d) Builds partnerships
	KEY MILESTONES Electricity to be 80% renewable by 2030 and 100% renewable by 2050	CITY STEWARD P: Sustainability Office SP: Sustainability Office	FINANCING MECHANISMS N/A (existing state law)

BE 5.2 Utility Data Access Reform

ACTION: Reform data access by pursuing legislation that would require utilities to disclose data with building owners and municipalities.

Where we are today

Access to utility data for building owners and municipalities is a necessity for implementing building performance policies, tracking greenhouse gas emissions reductions, and expanding distributed energy resources. Access to utility data has been a concrete stumbling block for Portland and South Portland's benchmarking ordinances, and for the One Climate Future project itself. Building owners need easy, online access to near-real-time consumption information to better manage their energy use; building owners with multiple separately metered tenants need access to aggregated data at a whole building level; and municipalities need to be able to access residential, commercial, and industrial consumption data aggregated to zip code or citywide level in order to track greenhouse gas emissions over time. Furthermore, better access to temporal and geographic distributions of electricity use is important for targeting and right-sizing distributed energy resources. Other jurisdictions, including the District of Columbia, California, and New York, have resolved these access challenges with legislation or Public Service Commission/Public Utilities Commission rulings.

The action we will take

Portland and South Portland will work with the Maine Legislature and the Maine Public Utilities Commission to expand access to utility data. In particular, we will advocate for the following requirements for data access:

- **Downloadable data that can integrate with building energy management systems.** Commercial customers must be able to access monthly and interval electricity and gas consumption information via utility websites as well as APIs (application programming interfaces) that integrate with building energy management systems. Where smart meters have been installed, this interval data is made available in as close to real-time as possible (such as next-day), using the GreenButton *ConnectMyData* standard. While customers can currently download their data as a spreadsheet, this format does not provide the integration needed for effective advanced energy management.

- **Aggregated, anonymized, monthly whole building data.** Building owners must be able to access aggregated, anonymized, monthly whole building data upon request. U.S. Department of Energy studies show that once at least five units are aggregated, with no one unit (other than the house meters) making up more than half the load, customer privacy is protected as it becomes impossible to deduce the energy use of an individual tenant. This level of data access has been provided by many utilities around the country, but is not yet provided in Maine. Aggregated and anonymized whole-building data should be made available as quickly as possible to support the benchmarking laws of Portland and South Portland. Within a year of making whole-building data available, utilities should implement systems to allow automatic monthly upload of this aggregated data to ENERGY STAR Portfolio Manager.

● **Municipality-wide energy consumption data.**

Municipalities in Maine must be able to access monthly municipality-wide energy consumption information within 30 days of a request. The data shall be broken out into residential, commercial, and industrial sectors, including both the number of customers and total consumption. If an electric vehicle electricity rate class is introduced, this consumption should also be provided. To the extent possible, the State Energy Office shall be charged with helping tabulate fuel oil sales and reporting fuel oil sales data to local governments.

● **Individual customer data in usable formats to be used by Efficiency Maine.** Most efficiency utilities, such as Efficiency Vermont (operated by Vermont Energy Investment Corporation), have signed non-disclosure agreements with utilities to get individual customer data for better program targeting, while protecting privacy. In jurisdictions where this has not been possible due to regulatory barriers, the ability of the efficiency utility to operate is severely hampered. We will work with the state to ensure that Efficiency Maine is able to access the energy consumption and customer account

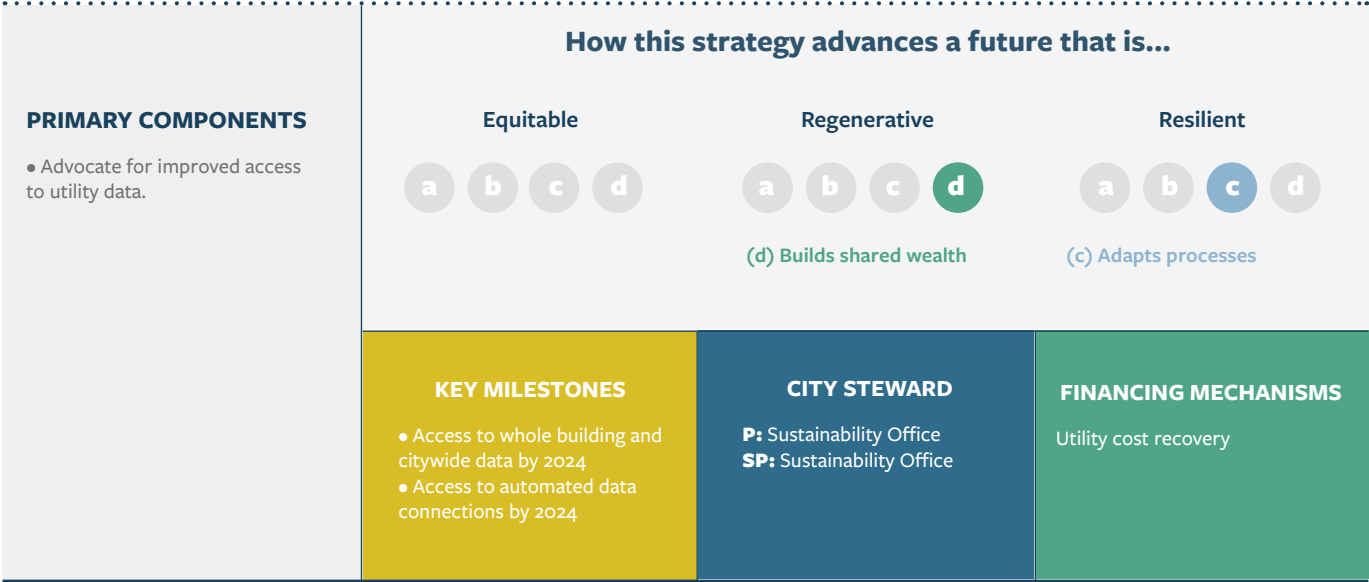
Access to quality utility data is critical for building owners and municipalities to improve building performance, track greenhouse gas emissions reductions, and expand distributed energy resources.

information needed to support its operations in formats that are usable and effective. It may be beneficial for Efficiency Maine to engage a third party under a non-disclosure agreement to provide the IT and data warehousing support.

Our next steps

- ☐ Advocate for the Maine Legislature and Public Utilities Commission to mandate that utilities provide whole building data access to property owners and Efficiency Maine with reasonable accommodations for data privacy.
- ☐ Advocate for utilities to provide citywide aggregated data annually, split out by sector and by month.

BE 5.2 Summary - Utility Data Access Reform



BE 5.3 Utility Regulatory Reform to Support Electrification

ACTION: Advocate for regulatory reforms to support state-wide electrification and the integration of distributed energy resources.

Where we are today

The past several years have seen the growing adoption of new energy technologies known as distributed energy resources (DER). The National Association of Regulatory Utility Commissioners defines DER as resources “sited close to customers that can provide all or some of their immediate electric and power needs and can also be used by the system to either reduce demand or provide supply to satisfy the energy, capacity, or ancillary service needs of the distribution grid.”³⁰ In other words, DER refer to the technologies themselves (such as solar panels and wind turbines) as well as the multiple aspects of the energy delivery system with which these technologies interact (such as smart metering). Solar, wind, fuel cells, battery storage, microgrids, demand response systems, electric vehicles, and energy efficiency at the level of the grid and consumers are all DER. Integrating DER technologies into the existing grid creates opportunities to both increase renewable energy generation and support more efficient and cost-effective management of the energy delivery system.

Because DER interact with the grid in more complex ways, integrating DER also presents new challenges. The existing grid infrastructure is based on a model of centralized, large-scale electricity generation (e.g., hydroelectric dams, natural gas-fired power plants) whereby electricity is transmitted through regional distribution networks to end-users. DER technology can be connected throughout the grid, which can impact grid performance and operation when significant DER capacity is added. For example, electricity generated at customers’ residences can affect the performance of both the distribution

network and the broader transmission network, as well as the way a centralized fleet of generators may be deployed to meet energy demand. Such interactions can lead to reliability problems—and challenge the existing utility models, regulatory structures, and decision-making processes around the design and operation of the grid. Reforming the regulatory structure that shapes the design, expansion, and operation of the grid can better enable DER integration and can modernize the way we generate and consume energy in Maine.

Providing better data to DER is also essential to help optimize the reduction of carbon emissions. Energy storage only reduces emissions if excess renewable power is stored and then discharged at peak times to displace dirtier power. However, there is no guarantee this will happen without data and regulation—sometimes the reverse might happen, leading to a net increase in emissions. In 2019, California required battery storage and discharge to use real-time greenhouse gas emissions data to optimize stored power for carbon reductions.

In addition, it is important that regulatory changes and actions help empower tenants. The energy used by tenants within their spaces can amount to up to 50% of the energy consumed in typical commercial office buildings. In many cases in Maine, residential and commercial tenants already have separate electricity bills. However, they may not have efficient access to their own consumption data in digital forms that support active energy management, as discussed in action BE 5.2. In

commercial, multi-tenant buildings with a single or master meter, tenants are typically charged on a per-square-foot basis, and have limited or no visibility on their actual energy consumption. In this latter scenario submetering these spaces and requiring building owners to inform tenants about their energy consumption gives tenants the information they need to track and reduce consumption. While submetering alone does not reduce energy consumption, it provides a window into a building's tenant- and system-level energy consumption, and allows market actors to make informed operational and capital-investment decisions. Research by commercial real estate practitioners indicates that submetering tenant spaces can contribute to reducing building energy costs by more than 20%. Residential submetering also allows residents to capture the benefits of more efficient behavior and appliances. Many jurisdictions have legalized submetering of electricity use, and a number are now requiring it for commercial properties.

The action we will take

Portland and South Portland will work in partnership with the Maine Climate Council and statewide partners to advocate for regulatory reforms to support state-wide electrification and the integration of distributed energy resources. Several regulatory structural reforms can better facilitate the integration of DER in Maine, including performance-based, incentive ratemaking; time-varying rates; and participatory distribution system planning and modification.

These new structures can often be incorporated within existing regulatory structures. However, there are also other options for transforming the governance and operation of energy systems that are being explored around the country. In the District of Columbia, for example, legislation has been introduced that would create a “Distributed Energy Resources Authority” (as discussed in action BE 5.2) to govern data sharing, system planning, and DER integration.

To better enable the integration of DER, Portland and South Portland will work with the Maine Climate Council and statewide partners to encourage the state to evaluate, and adopt as relevant, the following regulatory updates:



POWER LINES, CORNER OF MIDDLE AND EXCHANGE • Photo by Corey Templeton

- **Performance-based ratemaking.** Transition electric utility business models to performance-based ratemaking, which ties utility revenue to performance rather than capital investments. Performance would be evaluated based on specific metrics, including but not limited to greenhouse gas emissions reductions.

- **Prioritization of beneficial electrification.** Position beneficial electrification as a target priority in all utility rate decisions.

- **Time-of-use electricity pricing.** Adopt time-of-use electricity pricing, which varies electricity rates for customers based on electric demand and renewable supply. Rates are higher at times with peak demand to incentivize customers to manage loads and shift energy use to off-peak times. To be accessible to customers, successful time-of-use pricing does

not vary on an hour-by-hour, day-by-day basis, but rather establishes predictable periods of higher and lower charges. Time-of-use pricing should be piloted with commercial and industrial users first, and only later expanded to residential rate classes. The state may want to evaluate other time-of-use policies such as California’s recent reforms to battery storage discharge based on temporal greenhouse gas emissions data, so that batteries do not end up replacing clean energy with dirty energy.

- **Microgrids and district energy systems.** Reform regulations around energy infrastructure and public-rights-of-way to allow the construction of microgrids and district energy systems, as discussed further in action BE 5.4.
- **Distribution planning reform.** Improve distribution planning, similar to the Rhode Island Power Sector Transformation, which allows for better participation, transparency, and accountability to Integrated Resource Planning (IRP) and distribution planning.
- **Distributed Energy Resources Authority.** Consider establishing a Distributed Energy Resources Authority or Maine Energy Generation Authority (see action BE 5.1), authorized

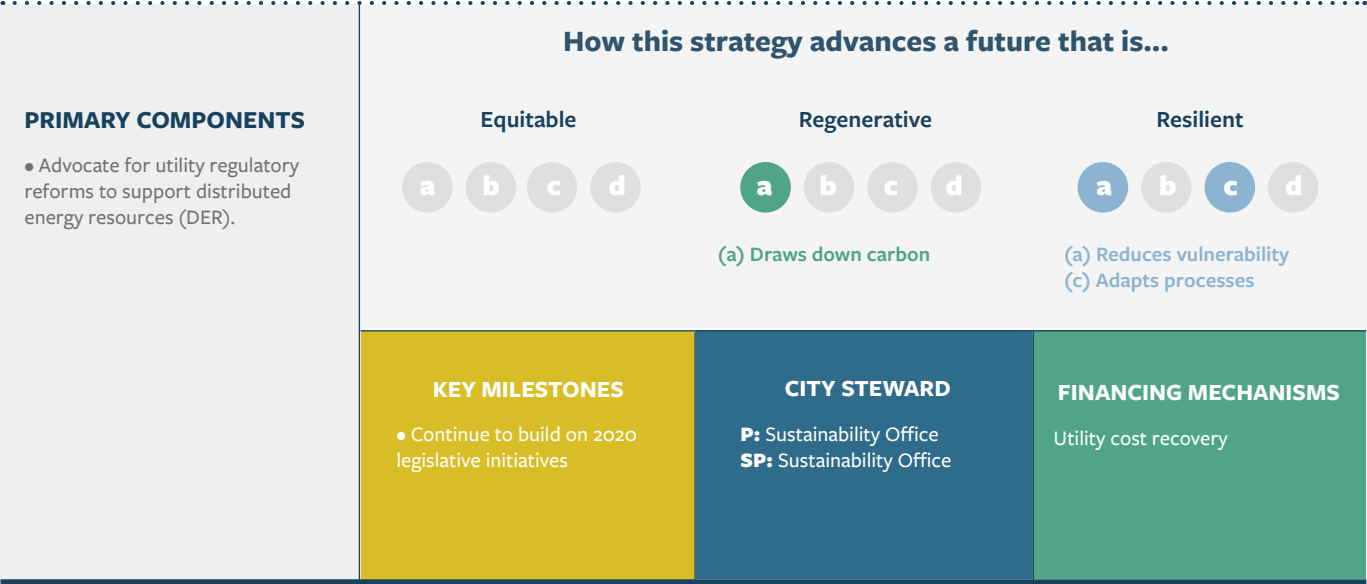
with the financing and development of renewable generation projects to advance beneficial electrification throughout the state.

- **Submetering.** Remove legal barriers where they exist to submetering for commercial and residential buildings. It should be noted that this action can be particularly sensitive—and important—for affordable housing. As buildings increase in their efficiency toward net-zero energy levels of performance, developers of affordable housing must be able to provide a reduced utility allowance and proportionally increase the rent. The State should ensure that the net level of affordability for the tenant remains the same. Once submetering becomes more common, the stretch energy code should be updated to require separate metering or submetering for electricity consumption in new construction and major renovation of commercial projects (see action BE 2.1).

Our next steps

- ☐ Building on 2020 legislative initiatives, advocate for state legislation and in Public Utility Commission rate cases for the above utility regulatory reforms.

BE 5.3 Summary - Utility Regulatory Reform to Support Electrification



BE 5.4 Renewable District Energy Systems

ACTION: Identify opportunities and encourage the development of fully electric low temperature thermal district energy systems for new and existing developments and campuses.

Where we are today

District energy systems can be a cost-effective way to reduce greenhouse gas emissions and energy costs, while improving energy system resilience. A neighborhood-scale energy strategy could ensure that Portland and South Portland can capitalize on cost-effective opportunities as one component of a larger shift to low-carbon and renewable energy. Neighborhood-scale energy also has the potential to improve resilience and efficiency by centralizing neighborhood-scale modular systems. These systems, particularly microgrids, low-temperature thermal systems, and/or non-wire alternatives for meeting load growth better manage load and peak demand, lower energy costs, and can cut greenhouse gas emissions by upwards of 90%.

Campus settings provide unique opportunities for low-carbon energy systems. Traditionally, large campuses such as universities were served by district energy systems that relied on oil or gas combustion at a central plant, and steam distribution to the campus for thermal needs. However, new thermal district energy technologies provide the opportunity for full decarbonization of campuses in a cost-effective manner. While campus conditions vary, the experience has found that low-temperature hot water (LTHW) or medium-temperature hot water (MTHW) distribution systems are more efficient, and can be supplied primarily with geo-exchange / ground-source heat pump (GHX/GSHP) systems. Sometimes, residual combustion is necessary for resilience or to meet peak winter demand, but even these features can be met with renewable sources such as biogas or renewable fuel oil (RFO)—the latter is being employed at Bates College.

The easiest opportunity for increasing energy efficiency is capturing waste heat from cooling equipment during periods with simultaneous heating and cooling demand. The next best opportunity for on-site low-grade thermal energy source and sink are geo-exchange systems (otherwise known as ground-source or geothermal). Geo-exchange systems consist of either “open loop” wells using groundwater in a non-consumptive manner as a heat source or sink, or a “closed loop” system typically constructed of a buried closed loop piping network. These systems are being deployed at the campus scale at some of the leading colleges and universities in the Northeast, and will provide 95%+ reductions in campus greenhouse gas emissions. Portland already has one large geo-exchange system at the Portland International Jetport.

At present, installing microgrids and other district energy systems in an urban context is largely limited by restrictions on utility connections crossing public rights-of-way. This regulatory hurdle is addressed in action BE 5.3; the following action assumes that issue has been resolved, or is not a barrier due to the district’s layout with respect to the rights-of-way.

The action we will take

Portland and South Portland will work with campuses to promote and explore opportunities for the replacement of older steam heating systems with modern geo-exchange systems. Because large district energy systems can last for 50 years or more, it is crucial to seize any opportunities to shift campuses to low-carbon alternatives.

Additionally, when new development districts are proposed and built out, we will use the development review process to encourage developers to explore the feasibility of district energy solutions. Three conditions help mixed-use district energy facilities cost-effectively reduce greenhouse gas emissions. First, a high load density is necessary to ensure enough heating and/or cooling demand is available in a small enough area to bring down the costs of installing piping and other infrastructure necessary for thermal distribution. Second, a high load diversity (users with energy demands at different times of the day) is valuable because it spreads the demand more evenly across the day, thereby increasing the overall efficiency of the energy supply system and improving its financial case. Finally, both the use of low carbon energy sources, and efficiency gains from shifting to neighborhood-scale energy, can significantly reduce greenhouse gas emissions. Once statewide regulatory barriers to the installation of microgrids and district energy systems are resolved, the Cities will require any project over 500,000 gross square feet with a zoning overlay district to evaluate district energy and microgrid opportunities in planning.

The action we will take

- ☐ Work with existing campuses to explore renewable district energy systems, especially if existing systems need replacement.
- ☐ Identify thermal energy and electricity demand opportunities based on new construction, anticipated growth, and current thermal energy demand compatible with neighborhood-scale energy.
- ☐ Add zoning guidance and amendments to the Cities’ zoning codes that encourage/incentivize developers to explore microgrids and renewable thermal energy systems.

BE 5.4 Summary - Renewable District Energy Systems

How this strategy advances a future that is...			
PRIMARY COMPONENTS	Equitable	Regenerative	Resilient
- Advocate for the removal of barriers to microgrids. - Work with existing campuses to explore microgrids / district energy. - Adjust zoning to encourage microgrids / renewable district energy.	a b c d	a b c d (a) Draws down carbon (c) Supports a circular economy	a b c d (a) Reduces vulnerability
	KEY MILESTONES All new development over 500,000 square feet to evaluate district energy/ microgrids starting within one year of microgrid enabling legislation	CITY STEWARD P: Sustainability Office & Planning Department SP: Sustainability Office & Planning Department	FINANCING MECHANISMS For developers, costs would be built into the existing project funding; for campuses, these systems pay for themselves in utility cost savings and deferred maintenance savings

ACTION: Improve the efficiency and capacity of transmission and distribution networks to improve electricity supply to Portland and South Portland.

Where we are today

As we shift to driving electric vehicles and heating and cooling our buildings with electric systems, we will dramatically increase our electricity demand, as well as amplify our peak demand. At the same time, meeting the new renewable portfolio standard (RPS) targets will require massive expansion in renewable energy generation throughout the state. Wind and solar power are largely intermittent and “non-dispatchable,” meaning they cannot be ramped up in response to market needs. Currently, the battery capacity needed to temper this variability remains cost-and-resource-prohibitive. Due to these factors, we will need significant statewide upgrades to the transmission and distribution (T&D) system. These upgrades also offer the opportunity to address system inefficiencies. Current T&D line losses, for example, tend to average 4-5%, but may be higher in local areas. Additionally, certain areas of the cities—most notably the Portland peninsula—are constrained in current electricity supply and will need new feeder lines to support increased demand.

While the impact of full electrification on the regional grid has been examined by GridSolar, it will be crucial to better understand the impact that efficiency can have on shaping the load curve, and reducing overall demand. Modern heat pump systems have site efficiencies of 250% to 300% or more, as compared to the 80-95% efficiency of a gas boiler or furnace. In addition, in larger buildings and campuses, heat recovery chillers can recover rejected heat during simultaneous heating and cooling to further increase efficiency, and efficiency improvements in homes will also increase heating efficiencies.

While full electrification will increase electricity loads and likely shift the overall electricity peak demand to winter months, the impact may be less severe than anticipated, and in a scenario where all efficiency is maximized, total electricity consumption can be held close to current levels.

Where we are today

Portland and South Portland will work with relevant state-level partners, including the Maine Climate Council, Central Maine Power, and the Public Utilities Commission, to assess the extent to which DER can be accommodated on specific portions of the distribution grid, and to identify new opportunities to expand electricity supply for the cities. Specifically, the Cities will work with partners to:

- **Undertake a hosting capacity study.** A hosting capacity study will determine the level of DER integration that can be accommodated on different parts of the distribution grid without impacting the current grid infrastructure’s ability to deliver high quality and reliable electricity.
- **Update study of full electrification to incorporate efficiency.** Current projections for total electricity loads under a fully electric scenario assume the one-for-one replacement of natural gas and fuel oil with electricity; however, efficiency improvements may make this demand substantially less than has been assumed. As the state implements a new stretch building code and expansion of heat pumps, the Cities should

work with the State to continue to evaluate the projected changes in electricity demand, and the requisite needs for T&D infrastructure. The study should break the buildings into appropriate typologies and geospatially examine the decarbonization and efficiency potential across the cities. For thermal loads that require high temperatures or that cannot be electrified for another reason, the study should examine the use of biogas from anaerobic digestion of wastewater, organic waste, waste wood, and agricultural processes. As discussed in action BE 4.2, heat recovery between buildings and processes should also be examined. Campus/district systems should also be a key focus, as discussed in action BE 5.4.

• **Consider land routes for electricity supply.** To meet growing electricity needs, the Cities will work with regional and state partners to understand the political and technical feasibility, and most effectively support, increased electricity supply to Portland and South Portland along land routes. This may include actively land-banking portions of the city and supporting new substations or other grid infrastructure that may be necessary to meet the grid capacity and redundancy requirements for beneficial electrification. Where undergrounding of wires is pursued, the City, utilities, and other

critical service providers will establish a system to coordinate infrastructure upgrades.

• **Consider underwater routes for electricity supply.** The Cities will continue ongoing conversations with regional and state partners, local marine partners, and research and development teams for offshore wind to explore the feasibility of direct underwater transmission connections between the cities and offshore wind resources,

Our next steps

- ☐ Launch a hosting capacity study with regional and state-level partners to identify opportunities and constraints for electricity supply options and inform decision-making around capital infrastructure needed to support beneficial electrification in Portland and South Portland.
- ☐ By 2025, scope out the full set of needs for the electrification and thermal decarbonization study, in coordination with stakeholders, the Public Utilities Commission, and the utility Integrated Resource Plans, and support continued revaluation of projected future electricity demand.

BE 5.5 Summary - Electrical Transmission and Distribution



BE 5.6 Natural Gas Phase-Out

ACTION: Advocate for a state-level ban on new intrastate natural gas pipelines and any state support for interstate gas pipelines, and advocate for allowing local jurisdictions to limit new and expanded natural gas connections.

Where we are today

While it is both cost-effective and prudent to start with converting buildings using fuel oil to air-source heat pumps, as discussed in action BE 3.5, the greenhouse gas modeling for this plan shows that to achieve One Climate Future goals, virtually all residential and commercial buildings—including those using natural gas—must be transitioned to renewable sources of heating and cooling by 2050. Therefore, it will be important to expand our efforts to tackle decarbonization of heating, irrespective of fuel source. As the State moves toward a 100% renewable electric grid and towards a carbon-neutral future, new natural gas infrastructure risks quickly becoming a stranded asset. In addition, natural gas hookups to new and existing buildings continue to support fossil fuel consumption, working directly against One Climate Future policy goals. Recognizing similar tensions, other jurisdictions in California and Massachusetts are banning new natural gas hookups for new construction projects.

The action we will take

Portland and South Portland will begin taking preliminary actions for phasing out natural gas in the cities over the next thirty years. This phase-out will initially entail advocating for statewide bans on the build-out of new pipelines, and discerning the Cities' legal authority to limit natural gas hookups at the city scale. Once determined (or made) legally feasible, Portland and South Portland will map out a phased approach for reducing natural gas use across the cities, starting with banning new natural gas hookups in new residential and commercial construction and substantial renovation.

To achieve One Climate Future goals, virtually all residential and commercial buildings—including those using natural gas—must be transitioned to renewable sources of heating and cooling by 2050.

Without proactive measures, transitioning fully to carbon-free heating sources and replacing fuel-based heating systems will likely incur significant costs for building owners. Simultaneously, without ensuring that a carbon-neutral future is accessible to all Portland and South Portland residents, we will not have reached our One Climate Future goals. Portland and South Portland are committed to working with state and local partners to ensure that the cost of technology and the process for transitioning to carbon-free building systems are not barriers for our residents and businesses. In the near-term the Cities will specifically advocate for the following policy changes and planning processes at the state level:

• A just plan for transitioning to clean heating resources.

Portland and South Portland will be working to eliminate barriers to accessing clean heating resources, ensuring that residents with lower incomes are not disproportionately burdened by the costs of switching and that all residents regardless of income, race, nationality, disability, or other factor are able to reap the benefits of cleaner and more efficient heating sources. As a starting point to support the



Community Spotlight

Maine Youth Climate Strikes

Young people around the world and in Maine are demonstrating for urgent climate action. On September 20th, 2019 thousands of youth participated in the Maine Youth Climate Strikes at Portland City Hall, demanding Portland and South Portland declare a Climate Emergency. This declaration called for bold policy goals, immediate financial resources, and just climate action.

Since the fall, youth-led groups and voices continue to hold municipal and state leadership accountable for aggressive and equitable climate policies. Maine Youth for Climate Justice and ME Strikes are working towards climate action, consistent with science and social justice. Maine Youth for Climate Justice is a statewide coalition, networking activists and their efforts from Bar Harbor to York, Bangor to Portland. The coalition ME Strikes is an organization campaigning for climate emergency declarations and other action steps through demands-based strikes. In recent months, ME Strikes shifted to solidarity work to support the Black Lives Matter and March 4 Black Lives movements.

Youth will play a central role in the transformational work ahead with the implementation of One Climate Future. The powerful and moving voices of young people in our cities represent our shared future and will continue to advocate for climate justice and collaborate with community leadership for fundamental change.

MAINE YOUTH CLIMATE STRIKES • Photo by Troy Moon

Cities' efforts—and recognizing that this is a challenge that spans our municipal jurisdictions—we will advocate for the Maine Public Utilities Commission to develop and implement a comprehensive and just plan for transitioning the state to clean heating resources, including a phased ban on gas hook-ups, infrastructure build-out, and capacity and supply contracting.

- **Ban on new intrastate and interstate gas lines.** The Cities will advocate for a state-level ban on new intrastate gas pipelines and any Maine entity contracting for the construction or expansion of interstate gas pipelines.

- **Restrictions on new natural gas hookups.** The Cities will explore the legal authority for municipalities in Maine to unilaterally limit natural gas hookups. If possible, Portland and South Portland will adopt legislation, and if not, the Cities will advocate for municipalities to be given this authority. New ordinances would prevent natural gas hookups for new construction and major renovations. Expanded use of natural gas will be reserved only for process heat for which no reasonable substitute exists (e.g. commercial kitchens and industrialized uses).

• **Re-purposing fossil fuel infrastructure.** The Cities will advocate for state support for re-purposing fossil fuel infrastructure such as pipelines and large-scale tanks. This support would be complimentary to the recent legislation to ensure proper closure of oil terminal facilities (LD2033).

As natural gas use declines in the region there will come a point where the need to maintain the safety of gas pipe infrastructure needs to be balanced against the need to not invest new money in stranded assets. We will continue to engage with the PUC to ensure these competing interests are properly weighed.

Our next steps

- ☐ Advocate for the Public Utilities Commission to launch a planning process that will outline a just strategy and pathways for transitioning to clean heating resources state-wide.
- ☐ Advocate for state legislation to restrict new intrastate and interstate gas lines.
- ☐ Determine the legal authority of Maine municipalities to unilaterally limit gas hookups.

BE 5.6 Summary - Natural Gas Phase Out

PRIMARY COMPONENTS	How this strategy advances a future that is...		
	Equitable	Regenerative	Resilient
	a b c d (a) Addresses injustice (b) Expands access — via just plan for transition	a b c d (a) Draws down carbon	a b c d
- Advocate for / support a just plan for transitioning to clean heating. - Advocate for a ban on new interstate / intrastate natural gas pipelines. - Investigate legal authority / institute ban on natural gas hookups in new construction.	KEY MILESTONES - A just plan for transitioning to clean heating developed by 2025 - Statewide restrictions on new interstate and intrastate gas pipelines in place by 2030, along with defined timeframes for phasing out natural gas	CITY STEWARD P: Sustainability Office & Corporation Counsel SP: Sustainability Office	FINANCING MECHANISMS Public Utilities Commission / state funds (for study)

BE 5

BE 5.7 Statewide Carbon Pricing

ACTION: Continue to advocate for carbon pricing at national, regional, and statewide scales.

Where we are today

Economy-wide carbon pricing will be essential to the transition to a low-carbon or carbon-neutral future. As discussed in action BE 1.4, jurisdictions and institutions with carbon prices can and often do find they change investment outcomes and operational practices. Both Portland and South Portland have signed on in support of the Citizens Climate Lobby Carbon Fee and Dividend Policy, which advocates for a nationwide, steadily rising price on carbon with all fees from the carbon price returned to households as a monthly energy dividend. This policy forms the basis of the Energy Innovation and Carbon Dividend Act, which was introduced in the House of Representatives in 2019. Other carbon pricing proposals conceive of spending the revenues on investments in energy efficiency, renewable energy, and support for a just transition for sectors of the economy dependent of fossil fuels.

Maine is also part of the Regional Greenhouse Gas Initiative (RGGI), which is a cooperative effort across ten northeast states to drive greenhouse gas emissions reductions through a regional cap and trade system. RGGI states set a cap for the amount of carbon pollution power plants can emit each year, and pollution permits are sold up to that limit. Power plants buy the permits at quarterly auctions and the revenue supports a range of economic development, renewable energy, and energy efficiency initiatives. The cap is slated to decrease 30% over the next decade between 2021 and 2030.

Regardless of any regional or national progress, a large number of states have also made efforts to adopt statewide carbon pricing. Maine's first bill to propose a price on carbon (LD 434) was voted down in the spring of 2019 over concerns in how the revenue would be spent and whether the bill would have a regressive effect on Maine residents. As of summer 2020, no state has approved a statewide carbon fee.

The action we will take

Portland and South Portland will continue to support national, regional, and statewide efforts to implement a price on carbon. Two of the most significant challenges with establishing a carbon fee include 1) identifying an effective price point that can both drive greenhouse gas emissions reductions while still receiving the necessary political support; and 2) identifying the best use for the revenue and ways the program can be structured to mitigate regressive outcomes. The Cities will work with statewide partners to support ongoing efforts to assess a range of models for potential carbon pricing in Maine.

The action we will take

- ☐ Work with the statewide partners to advance a statewide carbon fee.

Economy-wide carbon pricing will be essential to the transition to a low-carbon or carbon-neutral future. The Cities will work with statewide partners to support ongoing efforts to assess a range of models for potential carbon pricing in Maine.

BE 5.7 Summary - Statewide Carbon Pricing

PRIMARY COMPONENTS	How this strategy advances a future that is...		
	Equitable	Regenerative	Resilient
	a b c d (a) Addresses injustice — if funds are progressively redistributed	a b c d (a) Draws down carbon (c) Supports a circular economy	a b c d
	KEY MILESTONES Price on carbon as soon as feasible at national, regional, or statewide scale	CITY STEWARD P: Sustainability Office SP: Sustainability Office	FINANCING MECHANISMS N/A

One Climate Future Strategies

WR WASTE REDUCTION



Waste Reduction

The Waste Reduction strategies focus on improving single-stream recycling, diverting organic waste, re-using building materials, improving wastewater treatment efficiency, and enhancing a circular sharing economy. Collectively, the actions in this section account for 3% of our cumulative greenhouse gas emissions savings between now and 2050. Waste reduction strategies also play a significant role in reducing “upstream” emissions from processes that fall outside our city boundaries.

WR 1 PAGE 120

Residential and Commercial Waste

Includes single stream recycling, organics recycling, minimizing single-use plastics, and enhancing a circular sharing economy.

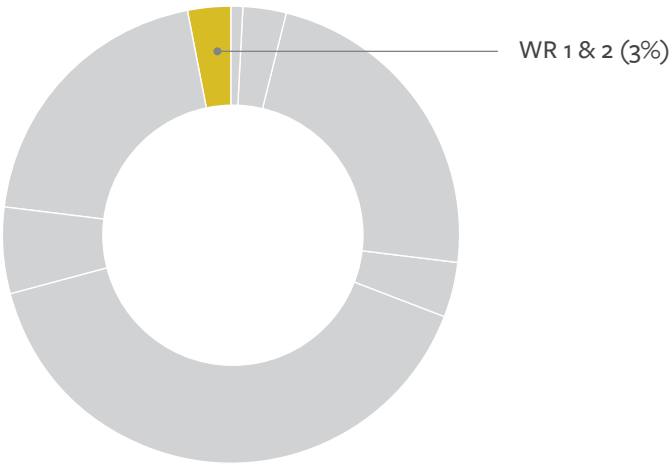
WR 2 PAGE 132

Construction, Industrial, and Municipal Waste

Includes deconstruction and reuse of building materials, facilitating industrial “by-product synergies,” reducing wastewater emissions, and adopting a municipal sustainable purchasing policy.

Cumulative greenhouse gas emissions savings attributed to each section

While waste reduction strategies play a relatively small role in reducing our cumulative emissions, it is important to note that the emissions and savings documented are based on what we track as part of the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) BASIC approach. Enhancing a circular economy where we minimize waste and use resources more efficiently can have significant upstream effects on reducing emissions outside the cities.





WR 1

Residential and Commercial Waste

COMPOST • Photo by Garbage to Garden

WR 1.1 Save-As-You-Throw

ACTION: Expand a save-as-you-throw system to South Portland.

Where we are today

Save-as-you-throw (SAYT) trash systems, also referred to as pay-as-you-throw (PAYT) or “unit-based pricing” charge households for trash service based on the amount of waste they generate, instead of using a flat fee. As a result, SAYT systems provide an economic incentive for residents to reduce trash and increase recycling, including recycling organic waste. According to a study by the Massachusetts Institute of Technology on food waste, SAYT/unit-based pricing is a powerful driver for waste reduction that can maximize the impact of curbside food waste and recycling collection programs.³¹ Studies done by Integral Group and Waste Zero for other jurisdictions show that achieving zero waste (generally considered to be 90%+ diversion of waste from landfills or

incineration) without a SAYT system to drive source reduction may not be feasible.

Portland adopted a SAYT system for waste collection in 1999 (referred to as “pay-as-you-throw” in Portland), which has had a measurable impact on reducing municipal solid waste production from residential homes. Residents buy purple bags at local retailers and trash is only collected if it is in those bags. South Portland does not yet have a SAYT program. According to a study by Waste Zero in 2018, among southern Maine jurisdictions participating in ecomaine, cities without SAYT programs generated on average 1.8 times as much trash per capita as jurisdictions with SAYT. In 2017, Portland generated

268 lbs. of residential trash per capita and South Portland generated 491 lbs. of residential trash per capita.³²

The action we will take

South Portland will implement a save-as-you-throw system for residential waste collection, modeled on what has worked for Portland and other local municipalities. If South Portland were to match Portland’s per-capita waste output, the city could reduce its residential waste emissions by 45%, and its overall waste sector emissions by 15%.

There are two potential approaches for implementing a SAYT system: variable rates and proportional rates. Portland uses a proportional rate system, wherein residents pay per each bag of trash they fill. This rate structure creates a more direct relationship between cost and the amount of trash, and also gives residents and businesses more control on how much money they save by reducing trash. Under this system, all trash must be thrown away in trash bags that are a specific color or branded as part of the SAYT system, which can be purchased at retailers throughout the city.³³ By purchasing the bags, residents and businesses “pre-pay” for trash collection. Using fewer bags means paying less for trash collection.

Alternatively, in a variable-rate system, or container-based system, which is common in California, residents are charged for garbage collection based on their subscription, which is usually associated with a particular size of trash barrel provided by the city. For any garbage that exceeds what fits in that barrel, residents pay an additional fee. While this creates a very consistent revenue stream for the city, the administrative costs in addition to providing barrels tends to make this a more expensive option for cities. The incentive to reduce trash volume is also weaker in many cases; once a household or business is below the threshold of a single barrel, there isn’t an incentive to reduce trash further. Additionally, this model does not work as well for renters, since the size of the subscription is determined by the landlord, and tenants have no financial incentive to produce less trash.

Our next steps

- ☐ Assess SAYT models that could work with the City’s existing cart program (South Portland).
- ☐ Conduct a community outreach and educational campaign on the value of SAYT programs (South Portland).
- ☐ By 2026, present proposal to South Portland City Council for a SAYT program (South Portland).

WR 1.1 Summary - Save-As-You Throw



WR 1

WR 1.2 Single-Stream Recycling

ACTION: Mandate recycling for commercial and multifamily buildings.

Where we are today

Solid waste collected from businesses, organizations, institutions and households in Portland and South Portland goes to the state-of-the-art ecomaine waste-to-energy plant, an incinerator which burns trash to produce electricity. The plant serves over 70 communities in southern Maine and conforms to high standards of environmental performance, including ISO 14001 certification, making it much less polluting than most incinerators in the United States. The waste-to-energy plant not only prevents waste from going to a landfill (where it would contribute to higher levels of greenhouse gas emissions), but it also generates enough steam to create over 100,000 megawatt-hours of electricity annually—enough to power 15,000 homes, in addition to ecomaine’s own facilities, each year.³⁴

Despite these significant benefits, recycling materials (as opposed to burning them) has an even greater impact on reducing greenhouse gas emissions globally. Recycling materials reduces the amount of natural resources we consume, and on average requires less energy to create new products. A study by the Sound Resource Management Group—conducted in 1996 and still widely cited today—found that even accounting for the shipping of recycled material, recycling materials from municipal solid waste saves three to five times more energy on average compared to burning those materials for electricity.³⁵ For this reason, ecomaine has made recycling its top priority: It runs the largest recycling facility in Maine (processing over 40,000 tons of single-sort material each year), and continues to advocate for higher recycling rates in our cities. In 2019,

Even accounting for the energy used to ship recycled materials, studies show that recycling materials from municipal solid waste saves three to five times more energy on average compared to burning those materials for electricity.

diversion rates for Portland and South Portland were 38% and 29%, respectively.

Both Portland and South Portland provide curbside single-stream recycling to residential homes, which has played a significant role in diverting paper, plastic, and metal waste from the cities’ waste streams. However, in most large multifamily or commercial buildings, there is no curbside trash or recycling pickup; the building owner or operator is required to arrange for a private hauler to collect and dispose of the building’s waste. Absent regulations, many building owners will opt to simply provide the basic required trash pickup, and not provide building occupants the option to recycle or compost their waste. The State requires all businesses with fifteen employees or more to recycle copy paper and corrugated cardboard. In 2014, Portland expanded curbside recycling collection to small multifamily buildings, and instituted requirements that owners of larger multifamily buildings must provide recycling to residents, and housing cooperatives and condominiums must likewise provide recycling to occupants. There are no

requirements for owners of multifamily housing to provide recycling infrastructure or service to tenants in South Portland. There are also no mandates in Portland or South Portland that owners of commercial buildings provide recycling to workers or tenants, other than the state requirement.

The action we will take

By the end of 2026, Portland and South Portland will introduce and adopt legislation requiring commercial businesses to recycle cardboard, paper, glass, plastic, and metal waste. South Portland will also introduce and adopt legislation, requiring multifamily housing owners and/or managers to provide recycling for residents. In both processes, the Cities will work with commercial entities and multifamily housing owners, respectively, to vet the legislation, identify constraints and pathways for reducing constraints, and establish timelines for implementation that allow commercial entities and multifamily housing time to prepare for and implement new systems.

Our next steps

- ☐ Draft legislation to require multifamily building owners/managers to provide recycling service and infrastructure to residents by end of 2025 (South Portland) and



OPPORTUNITY FOR BETTER RECYCLING, PORTLAND • Photo by City of Portland

- legislation to require recycling for commercial businesses by end of 2026 (Portland and South Portland).
- ☐ Work with commercial entities and multifamily housing owners and/or managers to vet and finalize the legislation.
- ☐ Increase education and outreach to residents and businesses about recycling and waste reduction in collaboration with ecomaine.

WR 1.2 Summary - Single-Stream Recycling

How this strategy advances a future that is...			
PRIMARY COMPONENTS	Equitable	Regenerative	Resilient
	a b c d	a b c d (a) Draws down carbon (c) Supports a circular economy	a b c d
	KEY MILESTONES Require recycling in commercial and multifamily residential buildings by 2026	CITY STEWARD P: Sustainability Office SP: Sustainability Office	FINANCING MECHANISMS User fees, savings from reduced waste hauling, revenue from selling recycling (contingent on market)

WR 1.3 Food Waste Reduction and Organics Recycling

ACTION: Expand programs to divert food waste and increase organics recycling rates to ensure that excess food is better used to nourish people, animals, industries, and soils.

Where we are today

Because the organic waste we put in our trash is incinerated, and because much of food production occurs outside our city boundaries, the full extent of the carbon emissions that are generated by producing (and wasting) food is not captured in Portland and South Portland’s greenhouse gas inventories.³⁶ Nevertheless, organic waste—and specifically food waste—has shown to be a significant contributor to greenhouse gas emissions globally. Project Drawdown ranks reducing food waste at the global scale as the third most impactful tactic for reducing greenhouse gas emissions,³⁷ and it has been estimated that disposing one ton of edible food results in 2.5 tons of full lifecycle carbon dioxide emissions.³⁸ Based on statistics from a 2017 report by the National Resources Defense Council (NRDC),³⁹ we can roughly estimate that Portland and South Portland dispose of over 8,000 tons of food waste per year, approximately 5,600 tons of which is edible.

Diverting food waste can take many forms—many of which not only reduce emissions, but also help to better feed our communities, create sustainable energy, fertilize our soils, and sequester carbon from the atmosphere. Maine has formally adopted the Food Recovery Hierarchy, which prioritizes actions to reduce food waste based on their community benefits. The hierarchy starts with reducing the volume of surplus food (in store inventories, at events, and purchased by households), followed by directing excess food to food-insecure people, feeding animals, composting food waste or converting it to fuel, and finally disposing of food waste as a last resort. A significant number of organizations in the Greater Portland area—including food banks, pantries, kitchens/meal programs, and gleaning initiatives—work to redirect thousands of pounds of surplus food every year to the over 38,000 people who are food insecure within Cumberland County.

What is organic waste?

Organic waste is anything that was once living. Food waste is the primary source of organic waste in cities. Other sources of organic waste include food-soiled paper, as well as yard waste such as grass clippings, landscape prunings, and non-hazardous wood waste.



South Portland and Portland have also been expanding ways to better use food waste for compost, sustainable energy, and other regenerative uses. A number of private food waste haulers provide curbside compost services in the Greater Portland area. South Portland also has an opt-in food waste recycling program for all city residents, which offers free food waste bins to residents. Residents can choose to bring their food waste to any one of the six drop-off sites in the city free of charge, or hire Garbage to Garden for curbside collection for a reduced fee. The food waste collected through this program is sent to the Exeter (Maine) Agri-Energy anaerobic digester to create sustainable electricity, farm fertilizer, and animal bedding.

for dairy cows at Stonyvale Farm. Agri-Cycle and We Compost It Food Waste both also operate subscription programs to collect food waste from commercial customers throughout the region, including the Portland Public Schools.

The action we will take

Portland and South Portland will work to reduce organic waste in our trash streams by 70% by 2030. This target will be achieved through combined efforts to reduce food surplus, direct excess food to families that need it, and expand organics recycling by households, businesses, and organizations throughout our cities. To address the first objective, the Cities will collaborate with food recovery agencies to identify major sources of food waste and support existing efforts to redirect surplus food where it is most needed. This action is part of the strategy for building a resilient food system; see action CR 2.4 for further details.

To increase organics recycling, Portland and South Portland will advocate for the state to adopt mandatory organics recycling to be phased in over a period of roughly five years. This aligns with efforts already underway across New England states and in states around the country. As of April 2019, six states and seven municipalities had implemented mandatory organics recycling laws, including New England states Massachusetts, Connecticut, Rhode Island, and Vermont.⁴⁰ Generally speaking, these laws cover commercial and large-scale institutional waste generators; Vermont, along with the City of Seattle and the City of San Francisco have extended their mandatory organics recycling laws to cover individual residences. Seattle and San Francisco couple food waste collection with a save-as-you-throw unit-based rate structure, similar to what already exists in Portland.⁴¹

Portland and South Portland will also work with ecomaine and member communities to expand the organization's capacity for organics collection and processing in an effort to advance a regional program. A regional organics program would improve accessibility to food waste recycling across southern



FOOD WASTE DROPOFF SITE, SOUTH PORTLAND • Photo by City of South Portland

Maine. With growing capacity at a regional level, and absent a mandatory state policy, the Cities will move to mandate organics recycling for commercial and institutional entities and establish curbside organics collection for residential households by 2030.

Curbside food waste collection will reduce waste tonnages and volume, and provide an opportunity to evaluate co-collection systems. Co-collection systems enable multiple waste streams to be collected on one route in the same truck, thus reducing truck miles and fossil fuel consumption. A 2013 organics feasibility study by Northern Tilth explored different types of collection scenarios, from split-bodied trucks, to “blue bag” organics collected with trash, to every-other-week source-separated collection.⁴² In the study, curbside organics collection coupled with SAYT unit-based pricing resulted in the most

efficient method and yielded a significantly greater volume of diverted organic material.

Studies on mandatory organics recycling programs also report significant social and economic benefits. A 2016 economic impact analysis of Massachusetts’ food waste ban, which was implemented in 2014, reported that the hauling, processing, and food rescue industry segments supported a 250% increase in related jobs compared to 2010 as well as \$5.4 million in tax revenue. While waste generators appear to bear the brunt of the costs, a recent study found that 99% of businesses in 17 countries (including the United States) saved money as a result of waste ban measures.⁴³ These cost savings were largely achieved through source reduction measures that result in lower purchasing and hauling costs, but savings were also achieved through tax incentives associated with food donation. In mature markets, the hauling costs for organics are often lower than for trash.

Our next steps

- ☐ Advocate for the state to adopt mandatory organic waste recycling to be phased in over a period of roughly five years.
- ☐ Continue to collaborate with ecomaine and regional partners to expand collection and processing capacity for organics.
- ☐ By 2026, if there has been no traction with statewide mandatory organic waste recycling, begin a process to institute citywide mandates for commercial and institutional recycling of food/organic waste. Provide a robust education, technical assistance, and enforcement campaign to reduce waste contamination.
- ☐ Move towards curbside collection of residential food waste in both Cities by 2030.

WR 1.3 Summary - Food Waste Reduction and Organics Recycling



WR 1

WR 1.4 Single-Use Plastics

ACTION: Ban select single-use plastics and identify partnerships to reduce plastic waste.

Where we are today

Single-use plastics include plastic straws, bags, cups, cutlery, bottles and other items that are meant to be used only once before they are thrown away or recycled. They are primarily made of petrochemicals (fossil-fuel-based chemicals), and because they are used for a very short time before disposal, single-use plastics also have a large carbon footprint. Although their usable lifespan is short, most single-use plastics take a long time to decompose—a plastic drink bottle that is used only once, for example, can take over 450 years to break down. Millions of tons of single-use plastics now leach chemicals, build up in rivers and oceans, and compromise the health of marine ecosystems. Because of these impacts, cities and states throughout the United States (and nations globally) are moving towards regulating or banning the use of certain single-use plastics. Another approach gaining traction is extended producer responsibility (EPR) laws that require manufacturers to be responsible for both reducing their packaging and waste, and taking back waste. EPR programs have been implemented for items like paint and electronic products—Maine has an existing Product Stewardship program for the takeback of electronic waste at transfer stations and electronics retailers, and a “PaintCare” program for paint recycling.

Portland and South Portland have had a 5-cent fee on plastic bags since 2015 and 2016, respectively. In 2019, the State of Maine adopted legislation to ban single-use plastic bags, Styrofoam (also known as polystyrene), as well as plastic drink stirrers, effective January 2021. The law will prohibit food establishments, including restaurants, caterers, coffee shops

The Cities will advocate in support of state legislation LD 2104, which will be the first state law to require extended producer responsibility for packaging.

and grocery stores from using these items, as they cannot be recycled in single stream recycling. In October 2019, Portland adopted an ordinance banning plastic straws. Under the ordinance, food providers may only supply a plastic beverage straw, stirrer, or splash stick on request after April 2020, and distribution of plastic beverage straws, stirrers, and splash sticks will be prohibited after January 2021.

The action we will take

Portland and South Portland will phase out single-use plastics to the greatest extent practicable by 2026. In almost all cases, implementing single-use plastic bans at the state level as opposed to the city scale will be most effective—to have a wider reach and to create consistent standards for businesses operating in neighboring jurisdictions. Portland and South Portland will support and advocate for increasing restrictions on the use of single-use plastics statewide in all cases where suitable alternatives exist and where such restrictions do not pose undue cost burdens for Portland and South Portland businesses and residents. This state advocacy effort will be coupled with ongoing assessments of options for eliminating



Community Spotlight

Taco Trio

Taco Trio serves up traditional Mexican food on the corner of Ocean Street in South Portland. Co-owners of the local restaurant made the commitment to incorporate sustainable principles into their business model from the very start. Through perseverance and experimentation, they found ways to reduce waste while also turning a profit at Taco Trio.

According to the Green Restaurant Association, the average U.S. restaurant produces 100,000 pounds of waste a year. Taco Trio was determined to buck this trend, but it took several different approaches before landing on one that worked. Reusable dishware and cutlery didn't make sense for their take-out business. Recyclables presented unique challenges in educating customers how to properly sort their waste; it was too hard to get it right. Compostable kitchenware proved to be a streamlined disposal process while also diverting solid waste. Now front-of-house waste goes into one compost bin, and customers don't have to sort their items. Behind the counter, they compost food scraps and send their used cooking oil to be converted to biofuel.

The local business continues to think outside the box to identify opportunities to reduce the environmental impact of their employees and patrons. Achieving a sustainable business model is an ongoing process, but Taco Trio is proud of their commitment and leadership in the local community.

MANUEL PENA AND EVELIN SANCHEZ OF TACO TRIO • Photo by The Forecaster (2017)

single-use plastics and barriers. If further restrictions on single-use plastics are not possible at the state level, we will examine ways the Cities can take municipal measures to meet our 2026 target. Plastic to-go containers, cutlery, plates/bowls, plastic cotton bud sticks, and sticks for balloons (in addition to straws and drink stirrers) have been identified as significant sources of single-use plastic waste for which affordable alternatives exist.

While bans are an effective method for change, they are not the only approach. We'll explore a number of other complementary approaches that collectively seek to change markets, behavior, and precedents. Approaches the Cities will pursue include:

- **Extended producer responsibility (EPR).** The Cities will advocate in support of state legislation LD 2104, which will be the first state law to require extended producer responsibility for packaging. The bill draws on a similar program in Quebec, Canada, calling for the creation of a product stewardship organization that packaging producers would pay into and would support local efforts to manage and recycle plastic waste.

● **Partnerships with retailers, events, and food establishments.**

The Cities will seek ways to partner with retailers and food service establishments on initiatives to reduce excessive packaging and transition to compostable or reusable products. Initiatives could include branding, marketing, or recognition for single-use plastic reduction efforts or technical assistance in identifying suppliers for compostable alternatives.

Our next steps

- ☐ Pass ordinances prohibiting the distribution of single-use plastics by 2026.
- ☐ Support LD 2104 or subsequent legislation on extended producer responsibility for packaging, and advocate for the inclusion of goals and requirements for reducing packaging, in addition to funding local recycling programs.

WR 1.4 Summary - Single-Use Plastics



WR 1.5 Circular Sharing Economy

ACTION: Foster a circular and sharing economy.

Where we are today

A “circular economy” refers to a system in which nothing is wasted. All materials are repurposed and kept in use, instead of being disposed. Through better design and consideration of a product lifecycle, and expanded repair and reuse, circular economies expand the lifespan of products, support the regeneration of natural systems, and eliminate the need for disposal. A “sharing economy” in many ways supports a circular economy by creating models for sharing resources, tools, or services between individuals and households—reducing consumption by eliminating the precedent that every individual or household must own their own items. Portland and South Portland have a large number of formal and informal organizations—including public libraries, the Maine Tool Library, South Portland Swap Shop, shared or community kitchens, thrift shops, makerspaces, community gardens, “Buy Nothing” groups, and hour exchanges, among many others—that both cultivate and continue to strengthen a circular, sharing economy locally.

The action we will take

Portland and South Portland will continue to support initiatives that foster a circular, sharing economy. Such initiatives support One Climate Future efforts to reduce greenhouse gas emissions and build the resilience of our cities by reducing both consumption and waste, saving residents and businesses money, while also creating stronger connections and support networks between community members. This action is broad

and multi-faceted, and ultimately aligns with many actions in this plan that contribute to a stronger circular economy. To support a circular, sharing economy, the Cities will seek ways to:

- **Foster community spaces for sharing resources.** The Cities will support the development of new and existing shared community spaces and spaces for sharing items, including community kitchens, community centers, community gardens, makerspaces, tool libraries, or other lending libraries. This effort goes hand-in-hand with cultivating neighborhood hubs for community resilience (see action CR 2.5). The Cities will work with community partners to strengthen existing spaces and potentially identify new spaces to serve as neighborhood hubs. A small grants program can be used to support the development of hubs as well as other circular, sharing economy initiatives that support community resilience (see action CR 2.5).

- **Support ways for re-use businesses to locate or stay within the cities.** The Cities will encourage growth of businesses that reuse or repair consumer goods by removing barriers for these types of businesses to locate and stay within the cities. This could include reducing financial barriers (e.g., through rent subsidies, waived license fees, or other small business economic development support), relaxing zoning restrictions, or fostering “reuse business clusters” located in a shared commercial space.

- **Sponsor or promote fairs and workshops for reuse, rental, and repair.** The Cities will support “repair fairs” by hosting them in public spaces or promoting them on City media platforms. We will also increase public awareness of and access to opportunities for reuse, product rentals, repair, and donation.

- **Cultivate community gardens and food forests.** The Cities will continue to seek ways to expand access to public open spaces for community gardens and food forests, and support gleaned and food recovery programs to redistribute food surplus (see action CR 2.3).

- **Procure recycled and remanufactured products through municipal purchasing.** Through municipal purchasing, the Cities will support and strengthen markets for remanufactured products and products with high recycled content that are produced locally (see action WR 2.4), and foster the growth of the building material reuse marketplace for deconstructing, reusing, and recycling building materials (see action WR 2.1).

- **Facilitate by-product synergies in the industrial sector.** The Cities will work with state and regional partners to establish a regional materials marketplace to cultivate “by-product synergies” among industries in the cities whereby industrial waste streams for one product are used as source materials for another product (see action WR 2.2).

- **Recognize organizations and businesses championing a circular sharing economy.** The Cities will develop a grant, recognition, or incentive program to celebrate and encourage local businesses, organizations, or leaders who promote or exemplify a circular, sharing economy. This program would align with the One Climate Future Awards (see action BE 2.4).

Our next steps

- ☐ Utilize the findings of the One Climate Future community surveys on the types of shared resources people would use if available, along with discussions with community groups and organizations, to identify opportunities for strengthening or expanding shared community resources. (To be conducted in alignment with action CR 2.5.)

WR 1.5 Summary - Circular Sharing Economy





WR 2

Construction, Industrial, and Municipal Waste

DEMOLITION WASTE • Photo by anonymous

WR 2.1 Construction and Demolition Waste

ACTION: Reduce construction and demolition waste through targeted re-use initiatives.

Where we are today

Construction and demolition (C&D) waste makes up an enormous proportion of the U.S. waste stream—548 million tons were generated in 2015 (the most recent year of data), over twice the weight of municipal solid waste.⁴⁴ The vast majority (90%) of that waste is generated during the demolition process. Deconstruction is an alternative to demolition that entails the systematic dismantling of structures—usually in reverse order from which they were built—to maximize the reuse and recyclability of materials. Deconstruction significantly reduces waste generation, reduces the environmental impacts of demolition, and reduces demand for virgin materials when items are recycled or reused. As of 2019, at least 13 states had adopted waste bans that address

materials associated with C&D waste and several cities and counties had passed ordinances that specifically regulate the deconstruction process or its outcomes. C&D waste is not tracked by either City, and so the full scope of waste and emissions from this sector is unknown.

The amount of potential material that could be recovered through deconstruction tends to be quite high, with up to 25% of materials being available for reuse, another 70% available for recycling, and only 5-15% needing to be disposed.⁴⁵ Deconstruction can be practiced along a spectrum from “soft stripping,” going after the easiest-to-capture materials for reuse and recycling, to full deconstruction, which entails piece-

by-piece dismantling of a structure. Among the more readily recovered materials are cabinetry, appliances, and architectural salvage, whereas lumber and flooring are among the harder to recover materials.⁴⁶ The Portland/South Portland area has a number of waste processors that are already sorting C&D waste for recycling and re-use, including wood waste, metal, asphalt shingles, and masonry and concrete debris. However, costs and lack of regulation keep many construction projects from taking advantage of these services. Other waste materials such as clean and demolition drywall are not getting processed, even though there are potential ready markets for clean gypsum material nearby.

The action we will take

Portland and South Portland will work to reduce construction and demolition waste generated in the cities through public-private partnerships at the local and state-levels. The combination of local policies, campaigns, and training with state-level initiatives will drive demand for a more robust regional market for C&D waste and material reuse. Actions the Cities will take include:

• **Conduct baseline assessment to drive C&D waste policy development.** The Cities will assess baseline practices for managing C&D waste; establish goals and interim targets for C&D waste minimization and reuse; and conduct an inventory of existing regional markets and facilities for material reuse and recycling. In conducting the assessment and developing a subsequent policy, Portland and South Portland will work with the construction sector in both Cities to discuss policy objectives, identify current market-based or logistical constraints to deconstruction and material reuse, and identify resources and incentives that would encourage new waste management practices to support the policy’s effectiveness.

• **Advocate for state-level initiatives.** The Cities will work with state-level partners and representatives from the building sector, the waste handling sector, and the environmental sector to develop statutes or rules that require building deconstruction or reuse. Portland and South Portland will also advocate for the State to assess opportunities for the expansion of reuse and recycling facilities, as the majority of materials currently directed to C&D recycling facilities in Maine continue on to a landfill.⁴⁷

BE 2.1 Summary - Construction and Demolition Waste



• **Support the further development of the reuse**

marketplace. Building deconstruction is most feasible when there is a robust market or “ecosystem” for material reuse and recycling, including suppliers (e.g., deconstruction contractors), sellers (e.g., reuse warehouses), and buyers (e.g., contractors, homeowners, artists). Fostering this marketplace will involve identifying and revising regulatory barriers that may restrict material reuse or recycling, as well as expanding material processing capabilities in the region for products such as gypsum. The Cities will also consider supporting markets for remanufactured materials produced locally by setting priorities in municipal purchasing (see action WR 2.4).

Our next steps

- ☐ Draft a report assessing baseline practices for C&D waste management; goals for waste reduction and reuse; and the marketplace and facilities to support material reuse and recycling to inform C&D waste ordinances.
- ☐ Engage the construction sector on steps needed to successfully implement C&D waste ordinances, and on providing continuous training and education for contractors.
- ☐ Advocate for the State to address regional needs for reuse and recycling facilities in conjunction with stronger policies for the management of C&D waste to maximize diversion from landfills.
- ☐ Introduce and adopt C&D waste ordinances in both cities.

WR 2

WR 2.2 Industrial Waste

ACTION: Work with state and regional partners to encourage “by-product synergy” with industrial waste streams.

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Where we are today

As with construction and demolition (C&D) waste, industrial waste is not tracked by the Cities or by ecomaine, so the full scope of waste and emissions from this sector is unknown. (This waste is likely mixed into the commercial waste stream, but a portion may also be going directly to landfills.) Nevertheless, “cradle-to-cradle” and industrial ecology approaches used in other contexts have shown opportunities for innovative waste reduction options in this sector. Cradle-to-cradle plays on the term “cradle-to-grave,” which refers to a linear lifecycle for products, transitioning from production, to use, to disposal. By contrast, cradle-to-cradle mimics “closed loop” natural processes whereby nutrients are constantly recycled. For cradle-to-cradle approaches in industry, products and processes are designed from the outset to reuse and recycle materials into new products or uses. “Industrial ecosystems” and “industrial symbiosis” are other terms for creating closed loop processes within the industrial sector where the industrial waste streams for one product can be recognized as source materials for another product. In other cities and states in the United States, so called “by-product synergy” organizations and platforms have been created by local governments and non-profits working together to organize beneficial material and waste-stream exchanges within limited regions. The Greater Portland area is an ideal scale for the implementation of such material and waste exchanges to be successful.

The action we will take

Portland and South Portland will work with state and regional partners to explore opportunities and platforms for launching

an online “materials marketplace” to facilitate by-product synergies within the industrial sector. The United States Building Council for Sustainable Development (US BCSD) Material Marketplace—with a number of regional marketplaces across the country—is one successful model.⁴⁸ Chicago’s Waste-to-Profit Network and Austin’s Material Marketplace are two of the city-based programs developed under the US BCSD platform. Ohio, Tennessee, Michigan, and Ontario have likewise launched statewide (or Province-wide) marketplaces.

Through a regional materials marketplace, industrial facilities, businesses, academic institutions, nonprofits, and entrepreneurs within the region can create a profile and share sought after or available materials to exchange. Under the US BCSD model, the marketplace is actively monitored and facilitated, and reuse partnerships are identified and recommended to companies as they emerge. The platform further serves as a learning community and information exchange for businesses and organizations seeking innovative solutions to repurposing and reusing waste, fostering a culture shift towards a circular economy.

Our next steps

- ☐ Work with state and regional partners to explore platforms for launching an online materials marketplace either statewide or regionally; obtain price quotes for various platforms that use a city- or state-sponsorship model for regional marketplaces.

WR 2.2 Summary - Industrial Waste

PRIMARY COMPONENTS	How this strategy advances a future that is...		
	Equitable	Regenerative	Resilient
	a b c d	a b c d (a) Draws down carbon (c) Supports a circular economy (d) Builds shared wealth	a b c d (d) Builds partnerships
	KEY MILESTONES • Regional materials marketplace launched by 2035	CITY STEWARD P: Sustainability Office & Economic Development SP: Sustainability Office & Economic Development	FINANCING MECHANISMS Grants, public-private partnerships (for marketplace sponsorship/start-up costs), user fees

WR 2.3 Summary - Wastewater Emissions

PRIMARY COMPONENTS	How this strategy advances a future that is...		
	Equitable	Regenerative	Resilient
	a b c d	a b c d (a) Draws down carbon (c) Supports a circular economy	a b c d (a) Reduces vulnerability
	KEY MILESTONES • Engineering feasibility study commissioned by 2032	CITY STEWARD P: Sustainability Office & Water Resources SP: Sustainability Office & Water Resources Protection	FINANCING MECHANISMS ESCOs, Efficiency Maine funding, revolving loan funds (e.g., Clean Water State Revolving Loans)

WR 2

WR 2.3 Wastewater Emissions

ACTION: Investigate options for reducing emissions of wastewater treatment with anaerobic digestion.

.....

Where we are today

Anaerobic digestion is the process of breaking down organic waste, which produces a compressed and drier waste stock, along with biogas. Traditionally, anaerobic digestion was used at wastewater plants solely to make the end product easier to transport to landfills. The gas generated was not of sufficient quality to use in boilers or electricity generation, and so was burned off (flared). However, modern thermal hydrolysis and anaerobic digestion systems efficiently turn wastewater into fuel-grade gas and dry solids. These systems allow wastewater plants to reduce their need to burn natural gas or fuel oil, replacing those fossil fuels with a carbon-neutral, renewable, locally-produced fuel. The Lewiston-Auburn Water Pollution Control Authority (LAWPCA) became the first municipal wastewater treatment operation in Maine to install anaerobic digesters in 2013. The two digesters generate electricity and heat through combined heat and power (CHP); reduce total solids produced by 50%; and decrease the facility's greenhouse gas emissions by 80%—with no increase in sewer rates.

There are two wastewater treatment plants in Portland: the East End facility and the Peaks Island facility, both of which are owned and operated by the Portland Water District. The South Portland Wastewater Treatment Plant is the one facility in South Portland, owned and operated by the City. Currently, there is no anaerobic digestion of waste at Portland and South Portland's wastewater treatment plants. A 2014 Treatment Facilities Plan for South Portland concluded that the site was not big enough to support investment in an anaerobic digester.

The action we will take

Treating the cities' wastewater with anaerobic digestion and using the resulting gas as fuel could reduce greenhouse gas and

process emissions from the plants by over 25%—representing 20% of city government greenhouse gas emissions savings. However, space constraints may limit the feasibility at the current wastewater treatment plants. As discussed in action WR 1.3, food waste collected in Portland and South Portland is currently hauled to an anaerobic digester in Exeter, Maine. The weight and moisture content of the wastewater plant output do not support this sort of extended transport.

South Portland, Portland and the Portland Water District will work to commission a joint engineering feasibility study to explore local and regional options for anaerobic digestion of wastewater. The study will assess the capacity and available area for anaerobic digesters at the current wastewater treatment plant sites; lifespan of current facilities and how anaerobic digestion could align with replacement timelines; options for hauling waste a shorter distance to an in-town but off-site digester; and the management of residual sludge. The selected consultant should be experienced with modern thermal hydrolysis and anaerobic digestion systems that are more common in Europe to ensure best-in-class space, performance, and fuel output. The biogas would be used to support industrial demand, as discussed in action BE 4.2.

Our next steps

- ☐ Commission an engineering study on the capacity for on-site anaerobic digestion of wastewater; options for transporting waste to an alternative site in the cities as part of a regional model; and how options are affected by timelines for plant replacement for each of the cities. Studies will be pursued and commissioned jointly to better take advantage of options for a regional facility.

WR 2

WR 2.4 Sustainable Purchasing Policy

ACTION: Adopt a sustainable purchasing policy for municipal procurement.

Where we are today

The decisions a city makes when purchasing goods or services have a significant impact on the carbon intensity of municipal operations. Carbon embedded in the manufacturing process, delivery to market, and end-of-life treatment of a product add up.⁴⁹ When municipalities start calculating these value chain emissions, many organizations find that the carbon impact from these indirect sources are more significant than the emissions they generate from burning fuel to operate vehicles or heat buildings.⁵⁰ This accounting approach provides a more complete picture of the greenhouse gas emissions associated with a municipality's operations.

A Sustainable Purchasing Policy (or “Environmentally Preferable Purchasing Policy”) can be used to guide procurement decisions to meet established environmental, health, or social responsibility commitments. Such a policy requires organizations to evaluate procurement decisions based on “greatest value” as opposed to lowest cost by considering the environmental, health, or social impacts of a product or service, not simply the purchase price. As a part of the largest procurement group in the nation, federal, state and local governments can use buying practices to direct manufacturers toward products with a lesser or reduced effect on human health and the environment that serve the same purpose.⁵¹

For municipalities increasingly focused on reducing operational emissions, a Sustainable Purchasing Policy can prioritize the procurement of products and services from sources with

lower overall carbon footprints. These products or services may come from a local business with a short supply chain or a vendor that conserves natural resources, energy, or water. Municipalities with such policies in place consider the consumption of raw materials in a product or service; the toxicity of chemicals used in manufacturing; the quantity of recycled material used in packaging; the distance the product is transported; the lifespan of the product; the energy saved through efficiency gains; and options for product reuse, recycling, or disposal. This approach to public procurement is gaining traction as municipalities and states recognize efficiency improvements and financial savings over time, in addition to environmental and social benefits.⁵² Maine adopted an Environmentally Preferable Purchasing Policy in 2004.

Certifications and eco-labels make it possible for jurisdictions to systematically evaluate products and vet sustainability claims. The Ecolabel Index is an independent searchable database that catalogs products and ecolabels; likewise, the U.S. Environmental Protection Agency (EPA) publishes recommendations for specifications, standards, and eco-labels for federal purchasing, which are likewise referred to by state and local Sustainable Purchasing Policies.⁵³ Through adopting Sustainable Purchasing Policies, local governments can not only reduce the environmental impact of city operations, but also drive demand and strengthen the market for material reuse and environmentally preferable products, particularly those with higher recycled content (see action WR 2.1).

The action we will take

Portland and South Portland will each adopt a Sustainable Purchasing Policy to set standards for municipal procurement, and produce an accompanying Sustainable Purchasing Policy Guide to provide supporting resources and guidance for making procurement decisions. The Guide will be an online resource, broken down by sector (e.g., construction; landscaping; office supplies, etc.) and further broken down by product (e.g., concrete, carpet, vehicles). For products, the Guide will define minimum standards, “what to look for,” “what to avoid,” “end-of-life best practices,” and relevant ecolabels to use based on the product. For municipal equipment that currently uses fossil fuels (e.g., heating and cooling systems and municipal fleet vehicles), the Sustainable Purchasing Policy will set dates by which all future purchases must be electric in alignment with actions BE 1.3 and TLU 2.4.

The Cities will draw from the National Association of State Procurement Officials (NASPO) Green Purchasing Guide, which outlines guidance for drafting, implementing, marketing, and evaluating a Sustainable Purchasing Policy.

As a part of the largest procurement group in the nation, federal, state and local governments can use buying practices to direct manufacturers toward products with a reduced effect on human health and the environment.

Our next steps

- ☐ Draft Sustainable Purchasing Policies to set standards and best practices for municipal procurement.
- ☐ Develop Sustainable Purchasing Policy Guides with resources and information to support procurement decisions.

WR 2.4 Summary - Sustainable Purchasing Policy

PRIMARY COMPONENTS	How this strategy advances a future that is...		
	Equitable	Regenerative	Resilient
	a b c d (a) Addresses injustice — with inclusion of social sustainability	a b c d (a) Draws down carbon (b) Restores ecosystems (c) Supports a circular economy (d) Builds shared wealth	a b c d
	KEY MILESTONES	CITY STEWARD	FINANCING MECHANISMS
	• Sustainable purchasing policy adopted by 2024	P: Sustainability Office & Finance Department SP: Sustainability Office & Finance Department	N/A

One Climate Future Strategies

TLU TRANSPORTATION & LAND USE



Transportation and Land Use

The Transportation and Land Use strategies focus on expanding our public transportation systems, making it easier to travel between destinations without a car, transitioning to electric vehicles, and expanding charging infrastructure—including shore power for ships and ferries. Collectively, the actions in this section account for 26% of our cumulative greenhouse gas emissions savings between now and 2050.

TLU 1 PAGE 142

Mode Shift

Includes strategies to decrease private vehicle use, such as transit-oriented development, public transportation, biking accessibility, complete streets, employer transit partnerships.

TLU 2 PAGE 172

Vehicle Electrification

Includes the expansions of electric vehicle charging infrastructure, transition of municipal and bus fleets to electric vehicles, and electric vehicle incentives.

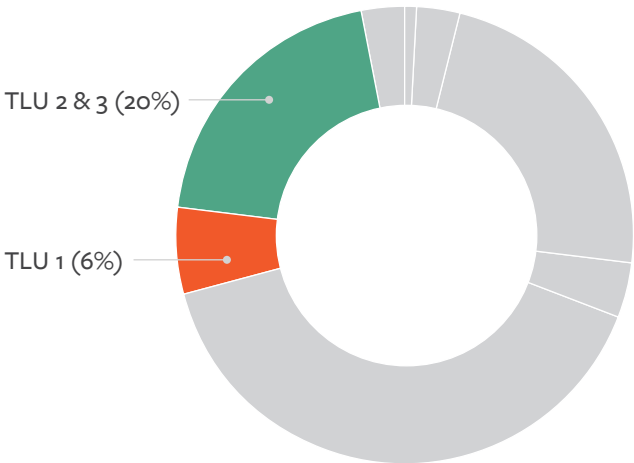
TLU 3 PAGE 188

Transportation Infrastructure

Includes strategies to reduce emissions from freight, ferries, ships, the Jetport, and through decreasing idling.

Cumulative greenhouse gas emissions savings attributed to each section

The combined effects of vehicle electrification and more efficient vehicles (driven by Corporate Average Fuel Economy Standards) are attributed to actions across both sections TLU 2 (Vehicle Electrification) and TLU 3 (Transportation Infrastructure). Collectively, they are the third biggest area for emissions reductions. Reducing vehicle miles traveled by a private vehicle through making trips by public transit, walking, biking and other modes easier contribute an additional 6% of emissions savings, and also bring important equity and resilience benefits.





WOMAN BIKING DOWN CONGRESS STREET • Photo by John Phelan

TLU 1.1 Public Transit Networks

ACTION: Support efforts to “Make Transit Easier,” “Expand Local Connections,” and “Introduce Rapid Transit” in alignment with the Transit Tomorrow vision for the PACTS region.

Where we are today

Seven public transit agencies serve the Portland Area Comprehensive Transportation System (PACTS) region, six of which provide service within Portland or South Portland. Greater Portland METRO (METRO), operated by the Greater Portland Transit District, runs nine bus routes in and around Portland and South Portland, in addition to the BREEZ, a route which runs from Portland to Brunswick—collectively giving rides to over 2 million people per year. The South Portland Bus Service (SPBS), operated by the City of South Portland, runs three bus routes primarily in South Portland with an annual ridership around 280,000. In addition to these

two primary fixed route services, the Biddeford-Saco-Old Orchard Beach (BSOOB) Transit Committee operates the Shuttlebus-Zoom (Sh-Zoom) between the “tri-cities” and South Portland and Portland, and the Regional Transportation Program (RTP) operates the Lake Region Explorer between Bridgeton and Portland as well as on-demand, door-to-door service in Cumberland County for non-ambulatory, low-income, and other qualifying riders. As the Metropolitan Planning Organization (MPO) for the region, PACTS currently divvies limited federal dollars across the seven agencies based on individual agency priorities. In addition to the region’s bus services, Casco Bay Lines (CBL), operated by the Casco Bay

What is bus rapid transit?

Bus rapid transit (BRT) systems are fixed bus routes that aim to provide service similar to a train, while taking advantage of the costs and flexibility of a bus and avoiding the installation of light or heavy rail systems. Common features of BRT systems include simplified and consistent routes; dedicated lanes so that the buses arrive at predictable times and without getting stuck in traffic; stations where people pay prior to boarding; elevated platforms so people can board without a step and through multiple doors; high frequency arrivals; and oftentimes a separate and prominent brand identity.



Island Transit District, ferries over one million passengers annually between downtown Portland and seven islands within Casco Bay, and the Amtrak Downeaster rail service, managed by Northern New England Passenger Rail Authority (NNEPRA), operates five daily trips between Portland and Boston, and three daily trips between Portland and Brunswick.

Collectively, these public transit networks cover a large territory—between neighborhoods, neighboring towns, islands, and states—and yet currently, only 3.2% of commuter trips across Portland and South Portland are completed using public transit. The One Climate Future modeling analysis targets that by 2050, 20% of all trips originating or terminating in the cities will use public transit to meet our One Climate Future goals. PACTS, in collaboration with regional partners, is currently developing a long-range transportation plan, Transit Tomorrow, that will chart a course for investments in the region's transportation system over the next thirty years. This work builds on investments that have led to increases in ridership over the past five years—including renovations to the Casco Bay Lines terminal in 2014; the automated vehicle location (AVL) systems installed by METRO, SPBS, and Casco Bay Lines in 2018 that allow riders to track buses and ferries

by a phone app; and the increases in METRO bus frequency, Sunday service, and new routes between 2014 and 2018. METRO, SPBS, and BSOOB are also in the process of rolling out a new uniform automated fare collection system that allows for quick, contact-less payment using a smart card or smart phone, universally used across the three bus systems.

Looking towards 2050, Transit Tomorrow sets an ambitious vision for increasing mobility, equity, and economic opportunity in the region while reducing carbon emissions. The plan has three focus areas that align with the intention of One Climate Future to design and connect our homes, businesses, and public spaces around an efficient transportation network:

- 1. “Make Transit Easier”** focuses on ways to increase the ease and convenience of transportation, such as through the new automated fare payment system;
- 2. “Expand Local Connections”** focuses on improving the reliability, frequency, available connections, and reach of bus routes; and
- 3. “Introduce Rapid Transit”** seeks to bring bus rapid transit to the Greater Portland region where feasible and effective. This focus area has the potential to greatly increase bus service reliability, decrease travel times, increase ridership, and decrease greenhouse gas emissions from personal automobile use.

Our vision for a connected, carbon-neutral transportation sector is nothing short of transformational. There is increasing recognition that expanding public transit in the region to meet the One Climate Future vision and pathways outlined by Transit Tomorrow requires strategic, streamlined, and highly coordinated efforts.

The action we will take

To achieve the One Climate Future goal that 20% of all trips will be taken by public transit by 2050, Portland and South Portland will coordinate with the public transit agencies in the PACTS region to make public transit easier and more reliable, to develop stronger and more connected local networks, and to advance bus rapid transit in the region.



ROUTE 21, SOUTH PORTLAND BUS SERVICE • Photo by City of South Portland

To meet this vision, the Cities will advocate for greater coordination and integration across transit agencies in the region. We see this as critical for two primary reasons. First, in order to “make transit easy” residents across the PACTS region must be able to plan a route and navigate fluidly between transit systems as if it were one coordinated system. Second, to meet these ambitious climate goals we must pursue and allocate external funding in the most tactical way possible. Under the current system, the transit agencies inadvertently compete for PACTS-administered federal funding. With greater coordination, METRO and the South Portland Bus Service could identify joint priorities that reduce competition for funding.

Greater Portland METRO and the South Portland Bus Service were one service until they split in 1983 due to concerns

about cost inequity. There are a number of pros and cons to reconsolidating the systems, many of which were discussed in early 2018 when the South Portland City Council opted to not further pursue a merger proposal initiated by METRO.

With or without administrative consolidation, the desired outcome is a highly streamlined and integrated experience for transit riders, made possible by coordinated and efficient planning, operations, and financing. The Cities see the following items as key opportunities for improving integration, some of which are already underway:

- **One payment system.** METRO, SPBS, and BSOOB are in the process of rolling out a new uniform automated fare collection system that allows for payment on any of the three bus systems using a smart card or smart phone.

Our vision for a connected, carbon neutral transportation sector is nothing short of transformational. There is increasing recognition that expanding public transit in the region to simultaneously meet our cities' transportation and climate goals requires strategic, streamlined, and highly coordinated efforts.

- **One centralized portal for information.** One portal would allow residents to see all route and fare information in one location to better assess options or map out routes on multiple services.

- **Coordinated routes and schedules.** Transit riders would be better able to switch between services if routes met at certain points and if schedules accommodated appropriate connection times.

- **Unified branding.** A unified branding would give consistent visual cues across all transit system, allowing riders to conceptually relate the systems as part of a unified network. Each system could still have its own logo, while creating better visual consistency across the systems.

- **A joint climate commitment.** METRO and South Portland Bus Service will commit to carbon neutrality by 2040—creating the potential for a region-wide commitment across public transit agencies to align around a single carbon mitigation goal.

- **Regionalized facilities.** There is the potential for operational and cost efficiencies by pursuing shared regional bus depots and maintenance facilities, particularly in the development of electric fleet charging infrastructure (see action TLU 2.3).

- **Transit mini-hubs.** Mini-hubs have more amenities than a bus stop, but are smaller than a transit station. Oftentimes they are best located at the convergence of multiple bus services (such as the Maine Mall), presenting opportunities for coordination in their development and maintenance.

Portland and South Portland will also continue to work with PACTS and regional transportation partners to provide the capital investments needed to support the three focus areas laid out in Transit Tomorrow. This work includes:

- **Continuing to upgrade transit stops so that they are safe and accessible.** PACTS Transit Stop Access Project will fund improvements at bus stops and mini-hubs for METRO, SPBS, and BSOOB in 2021-2022. To prioritize improvements, GPCOG and project consultants conducted an inventory of bus stops throughout the Greater Portland region, and catalogued needed improvements based on sidewalk quality, safety of road crossings, bus stop amenities, ADA accessibility, among other factors. The Cities will continue to collaborate with PACTS and the transit agencies to complete upgrades to make stops increasingly safe and accessible. (This step aligns with the Cities' efforts to create complete streets; see action TLU 1.3).

- **Supporting bus efficiency through roadway design.** The Cities will assess and pursue opportunities to give buses an advantage in traffic through road and infrastructure design, operations, and technology, which can make transit service more reliable, incentivize ridership, and reduce operating costs. These design advantages may include traffic signals with optimized or coordinated timing along a bus route (passive transit signal priority), traffic signals that can detect and respond to a bus approaching (active transit signal priority), dedicated transit lanes, or queue jump lanes which give buses a head-start in congested areas along significant transit corridors with traffic signals in close proximity.

- **Investing in transit-oriented nodes and corridors.** The Cities will promote transit-oriented development patterns through regulatory reform, incentives, and other measures (see TLU 1.2 for more detail).

● **Investigating a new ferry connection between Portland and South Portland.** Portland and South Portland will follow an ongoing study by PACTS to assess the economic viability and feasibility of a ferry connection between the Portland waterfront and South Portland near Bug Light Park and Southern Maine Community College. See action TLU 3.3 for further discussion.

● **Advocating for more state funding earmarked for public transportation investments.** MaineDOT is funded through the Highway Fund, and in Maine, public transportation is constitutionally and legislatively prohibited from using monies from this fund. The only source of state funding for public transportation is the Multimodal Transportation Fund (MTF), which receives funds from a portion of the sales and use tax on rental vehicles, the Aeronautical Fuel Tax, and the Railroad Company Tax. Currently this funding is very limited, which creates a challenge for securing federal funding; most federal transit money requires a 20% match or higher, which can be burdensome for local governments to cover entirely. As of June 2020, the State has charged a Joint Standing

Committee on Transportation to study reforms to the state’s transportation funding. The Cities will continue to advocate for funding reform to either increase the proportion of tax revenue from rental vehicles currently allocated to the MTF, or to identify new funding sources to capitalize the MTF, to increase local funding available for multimodal transit investments.

Our next steps

- ☐ Advocate for commitments by transit agencies to achieve carbon neutrality by 2040.
- ☐ Pursue funding to add transit signal priority capabilities at more bus system intersections (South Portland) and along priority bus routes (Portland).
- ☐ Continue participation in working meetings with PACTS and transit agencies to identify joint priorities for capital projects that would best support increases in ridership and strengthen TOD nodes and corridors (in alignment with action TLU 1.2).
- ☐ Implement upgrades to transit stops in alignment with recommendations from the Transit Stop Access Project.

TLU 1.1 Summary - Public Transit Networks

PRIMARY COMPONENTS ● Advocate for and implement coordinated measures between transit agencies. ● Advocate for increases in state funding for multimodal transportation. ● Improve safety and accessibility of transit stops. ● Invest in roadway design advantages for buses along transit routes.	How this strategy advances a future that is...		
	Equitable a b c d (a) Addresses injustice (b) Expands access	Regenerative a b c d (a) Draws down carbon (d) Builds shared wealth	Resilient a b c d (a) Reduces vulnerability (c) Strengthens communities (d) Builds partnerships
	KEY MILESTONES ● Roll-out of coordinated measures (portal, schedules, etc.) by 2025 ● All specified upgrades to transit stops implemented by 2028 ● METRO and SPBS achieve carbon neutrality by 2040	CITY STEWARD P: Planning Department & Public Works SP: Planning Department, Public Works, Bus Service	FINANCING MECHANISMS Bonds, TOD tax increment financing (TIF), federal/ PACTS funding, impact fees (Portland), general funds. <i>Future: infrastructure bank, expanded state funding for Multimodal Transportation Fund</i>

TLU 1.2 Complete Neighborhoods & Transit-Oriented Development

ACTION: Strengthen the cities’ transit-oriented development nodes to support travel by walking, biking, and public transportation.

Where we are today

Portland’s Plan 2030 describes complete neighborhoods as places where “all residents regardless of age, ability, or income have access to the basic necessities of daily life—high quality and affordable housing, schools and other civic functions, food, open space, other amenities and services—within a walkable, bikeable distance.” Creating these kinds of places is a cornerstone of the plan. This vision aligns with and complements the concept of transit-oriented development (TOD) that clusters these neighborhood features around public transit to improve accessibility between where people live, work, and recreate.

In TOD areas, compact development creates shorter distances between locations; pedestrian-oriented streets make walking more inviting; and connections to bus routes, rail lines, bike networks, and other mobility options make it easy to access other parts of a city. These key features help to decrease the dependence on cars, and lower the demand for parking, which in turn enable more compact development patterns. A higher density of people, jobs, and amenities helps to supply the ridership needed for a more robust transit service. In other words, the transit networks and compact development mutually support each other in a way that uses land and resources more efficiently, reduces greenhouse gas emissions, and creates vibrant and livable neighborhoods. In fact, land use policies (e.g., increasing density) and transportation policies (e.g., transit investments) when combined have shown to result in an 8.1% reduction in vehicle miles traveled over 20 years compared to a decrease of 1.1% and 0.9%, respectively, for each set of policies independently.⁵⁴

In complete neighborhoods oriented around transit, compact development creates shorter distances between locations; pedestrian-oriented streets make walking more inviting; and connections to bus routes, bike networks, and other mobility options make it easy to access other parts of the city.

GPCOG and PACTS have laid the groundwork to build on TOD opportunities throughout Greater Portland. Destination 2040, the long-range transportation plan for the PACTS region, establishes priority centers and corridors where TOD is viable, based on the original “Centers of Opportunity” identified through the Sustain Southern Maine planning initiative. Nine of these priority centers are in Portland: Downtown, West End, East End, Libbytown, USM/Bedford Street, Woodfords Corner, Rosemont, Morrill’s Corner, and North Deering. Six are in South Portland: Sunset Park, Thornton Heights, Maine Mall, Redbank, Knightville/Mill Creek, and Bug Light/SMCC.⁵⁵ Portland has further defined areas to cluster mixed-use development in *Portland’s Plan 2030* and made progress on nodal development work through ongoing transportation planning initiatives and investments. Portland has implemented two TOD tax increment financing (TIF) districts: Thompson’s Point and Downtown. In these TOD TIF districts, a portion of tax revenue generated in the districts is directed towards transit investments.

South Portland has likewise advanced planning initiatives to re-envision Mill Creek and the Maine Mall as more walkable, mixed-use, and transit-oriented centers in the *Mill Creek Masterplan* (2015) and the *Maine Mall Transit-Oriented Development Concept Plan* (2020). South Portland has also adopted a Transit TIF District throughout the community anchored at 15 transit points. The *Portland – South Portland Smart Corridor Plan* also identifies strategies to better support multimodal transit along the route from Morrill’s Corner in Portland to Southern Maine Community College in South Portland, linking a string of five priority centers across Portland and South Portland. These plans are expected to serve as the starting point for a more comprehensive TOD vision in Portland and South Portland.



DANFORTH AND CLARK STREETS, PORTLAND • Image by Corey Templeton

The action we will take

We will use a proactive approach to strengthening complete neighborhoods and transit-oriented development (TOD) in Portland and South Portland by focusing on a number of

“nodes” that have the potential to become more compact, mixed-use, pedestrian-oriented locations, connected to other parts of the city through multimodal transit. Over the next 5-10 years, we’ll work with residents, businesses, and the development community through a careful long-range planning effort to:

- Assess potential locations for TOD development, factoring in infrastructure capacity, development feasibility, environmental restrictions, transit functionality, capital improvement planning, and neighborhood input (South Portland);
- Conduct an assessment of barriers and available mechanisms to promote desired transit patterns and investments;
- Update comprehensive, land use, and capital improvement plans to implement TOD policies; and
- Examine needed capital investments and land use policy changes to facilitate TOD.

How will we identify the TOD nodes? We’ll build off the priority centers as a starting point, but we will look to other areas in the cities that could be best suited, based on their mix of activity, proximity to amenities or lack thereof, ability to expand affordable housing opportunity near quality transit, growth potential, and community input. Conventionally, TOD is centered around a high frequency rail line or bus station. Absent those features, we will prioritize areas where multiple modes of transportation or multiple bus routes converge. These could be opportune locations for transit mini-hubs, as envisioned in the Transit Stop Access Project.⁵⁶ In some cases, these nodes may serve as future anchors for the region’s bus rapid transit system (see action TLU 1.1). No nodes will be established in flood risk areas (see action CR 1.1), unless the development has the capacity to substantively reduce that risk.

Generally, the TOD nodes will cover a walkable area, with a quarter-mile radius from the transit service point serving as a general guideline because the average person is willing to walk 5-10 minutes—or roughly a quarter mile—to reach a transit stop. Concentrating people and jobs within that quarter mile radius is therefore more likely to generate ridership at the transit location. Likewise, establishing TOD



Community Spotlight

MAINE MALL TRANSIT-ORIENTED DEVELOPMENT

South Portland is one of Maine's fastest growing cities, expected to welcome up to 3,800 residents in the coming years. Recent sprawling development patterns distance home from job centers and services for many residents. This approach to growth has cascading effects on our quality of life and the environment.

A team of transit stakeholders, municipal staff, and the development community came together to counteract this trend. The team, led by the Greater Portland Council of Governments, sought to encourage growth in an area where jobs, housing, and services are within close proximity. As an existing transit hub with close proximity to major roadways and underutilized space, the Maine Mall area emerged as a priority center for growth.

With this priority center identified, stakeholders developed and presented a vision for the Maine Mall area in 10-20 years with compact, mixed-use development that supports and encourages transit use. This vision, known as the Maine Mall Transit-Oriented Development Concept Plan, sets a model for the region. The plan lays the groundwork for future efforts in Portland and South Portland to design and connect our homes, businesses, and public spaces around an efficient transportation network.

MAINE MALL TRANSIT-ORIENTED DEVELOPMENT • Image by GPCOG

nodes at intervals along a corridor (such as priority centers along the Smart Corridor) will further support ridership along the route because it creates destination opportunities and a network. Not all areas along a corridor have the same potential for development; there tends to be greater potential at intersections and sections with more cross-streets where there are more opportunities for buildings to have street frontage on more than one principle street.⁵⁷ By extending a TOD node several blocks around a transit point, rather than aligning it along a linear corridor, development can be clustered to create shorter walking routes between destinations, and additional opportunities may be created for public or civic spaces such as squares or plazas. In this way a TOD node becomes “a place” to encourage walking and congregating and not just a route to another destination.

To identify ways to strengthen TOD nodes, we will conduct an assessment of barriers and mechanisms to support desired transit patterns. In 2013, the Institute for Transportation and Development Policy (ITDP) developed the TOD Standard as a way to capture and measure the multitude of synergistic factors that play a role in creating an effective and inclusive TOD—including ways to evaluate the pedestrian realm, connection to bike networks, connectivity of streets, proximity to transit, mix of residential and non-residential uses, preservation of housing affordability, density of development,



MILL CREEK TRANSIT HUB • Image by Donna Tippet, Bus Service Director

connectedness to the rest of the city, and the minimization of space dedicated for passenger vehicles. The 2017 (3rd) edition offers a framework for evaluating the potential of a future project to achieve TOD goals, and a way of assessing the attributes of a place based on TOD parameters.⁵⁸ While not every metric will be applicable, it offers a consistent system for assessing gaps, a starting point for developing our own system of measurement, and a mechanism for strategically identifying ways to strengthen a location to meet TOD goals.

Residential density is one critical attribute to supporting transit systems; strengthening TOD opportunities requires reaching an effective density that can support transit ridership. National research has shown that densities around 7-8 homes per gross acre support reliable and efficient local bus service, but that ideally, TOD nodes should reach 10-20 residential units per acre.⁵⁹ For context, much of Portland's East End meets the 10-20 units per acre threshold, while densities in North Deering (Portland), Sunset Park (South Portland) and Thornton Heights (South Portland) are closer to 4-6 residential units per acre. The U.S. Green Building Council LEED for Neighborhood Development rating system gives a set of targeted density ranges for transit-oriented development, broken down by

residential and non-residential uses.⁶⁰ It's important to note that these thresholds assume that the development connects to high quality transit networks, and in many cases, higher density development may be contingent on more robust bus service.

While population density drives transit use, employment or job density near transit can have an even greater effect on stimulating transit ridership,⁶¹ and a mix of uses is important to increase walkability. To drive residential and job density with a mix of activity types, South Portland will follow the TOD gap assessment with a deeper market analysis to identify ways to relieve barriers or create incentives to spur the level of investment envisioned. Through Phase II of the ReCode process, Portland will be evaluating land use patterns for walkability, housing development, and density implications citywide. Land use barriers to TOD development typically include overly restrictive standards that limit the potential for compact, infill development such as excessive parking requirements, large setbacks, restrictions on height and building form that have the effect of limiting density, and low density limits. Both Cities, but South Portland in particular, will consider leading a land use planning process for potential TOD areas to identify regulatory barriers and explore modifications to standards to address them.

We will implement TOD nodes and related transportation planning initiatives through the Cities' comprehensive plans, land use ordinances, capital investment programs related to circulation infrastructure, and the menu of development incentives offered.⁶² TOD nodes would be key locations where One Climate Future policies converge: policies related to efficient built form, energy efficient construction and renovations, affordable housing, resilience, park and food accessibility, and transit improvements all contribute to an effective and sustainable TOD model. The Cities will focus on offering density bonuses and other incentives to induce desirable TOD projects in the TOD nodes. Model land use policies include considering appropriate use of density minimums, parking maximums, and mixed-use ratio requirements. TIF districts at TOD nodes and along connecting corridors should be explored to generate revenue to support

transit system expansion and infrastructure upgrades (see action TLU 1.1).

Our Next Steps

- Work with residents, businesses, transit providers, and the development community to identify a set of transit-oriented development nodes, and conduct an assessment of TOD barriers and opportunities with the TOD Standard and other national best-practices as a baseline measurement framework.
- Include a focus on identifying and creating policies that support TOD development within the Comprehensive Plan Update, anticipated for a 2024 adoption; this update shall include direction for zoning and other policy amendments that would reinforce and implement TOD goals (South Portland).
- Update the geographic area of existing transit-oriented development TIF districts to align with identified transit-oriented development nodes (South Portland).

- Work to implement complete neighborhoods in residential sections of Portland as described in *Portland’s Plan 2030*.
- Explore TOD tax increment financing (TIF) districts on Forest Ave, Brighton Ave, and Washington Ave (Portland).

TLU 2.2 Summary - Complete Neighborhoods and Transit-Oriented Development



TLU 1.3 Bike Accessibility

ACTION: Make biking easier through a complete network of bikeways and through building an inclusive biking culture.

Where we are today

On average, just under 2% of residents in Portland and South Portland commute to work by bike.⁶³ This small percentage is much bigger than the national average (0.6%), and yet also points to a large opportunity to expand biking as a carbon-free and affordable transportation option with a multitude of health and social benefits. Despite the weather, other cold and wintery cities have succeeded in growing biking as a transportation option. As of 2017, 5% of commuters in Minneapolis, for example, commuted by bike—an 18% increase since 2007 driven by new bike policy and infrastructure.⁶⁴ As a gold standard, over 60% of commutes within Copenhagen, Denmark are completed by bike. Cities across the nation (and globally) are dedicating investments towards separated bikeways, bike parking and storage, roadway safety features, road-sharing policies, bike-share programs, and other bike-supportive initiatives with the recognition that shifting to more active transportation modes necessitates that we invest in biking similarly to how we invest in vehicular transit.

Portland and South Portland work with GPCOG/PACTS, neighboring municipalities, Portland Trails, the Bicycle Coalition of Maine, the East Coast Greenway, and other local and regional partners to continue to make biking safer, easier, and more accessible. Over the past decade, both Cities have invested in multi-use trails and bike lanes to expand bike networks throughout the cities. Today, Portland and South Portland collectively have over 24.6 miles of bike lanes and 15.5 miles of shared use pathways, and continue to grow these numbers

annually.⁶⁵ Yet many trips within the cities start from or go to other towns. In 2018, PACTS published *Getting There from Here*, a long-range active transportation plan that sets a vision for an interconnected system of trails and bikeways for the PACTS region—including the Mountain Division Trail (Windham to Portland), the Saint Lawrence Atlantic Rail-with-Trail (Portland to Yarmouth), and the Eastern Bridge Trail (Scarborough to South Portland).

Yet, a complete network of bike lanes is only one piece of the puzzle in making biking safe, accessible, and easy. Access to bikes, increasing comfort and familiarity with bikes, and building a culture that invites everyone to bike are also integral. Organizations throughout the United States are working to expand the cycling culture—emphasizing that all races, incomes, body sizes, genders, and abilities can and do constitute the cyclists in our communities. While the Cities recognize that barriers to cycling prevent it from being an option for everyone, our goal is to relieve as many of those barriers as possible to make it a much more widespread, accessible, and inviting option for residents across the cities.

The action we will take

Portland and South Portland will continue to collaborate with partners to make biking easier by 1) building out bike-supportive infrastructure, including a complete network of bike lanes, paths, and byways, and 2) continuing to create a more prolific and inclusive biking culture. We define an inclusive biking culture as patterns and norms that make



WOMAN AND DOG BIKING ON THE BAYSIDE TRAIL • Photo by Jim Neuger

biking part of the status quo, and that are fostered by tools, resources, trainings, programs, and initiatives that make biking safer, more inviting, and more accessible to people across all demographics. This action will include the following components:

- **Develop a Bike Master Plan (South Portland).** We will evaluate the existing bike network and develop a Bike Master Plan that will outline how we will expand the bike network through designated bike lanes, paths, and byways. Two major components of the plan include: 1) Defining targets for bike network access using total mileage, connections to specific points, quality of bikeways, or other factors; and 2) Focusing on improvements in bike networks that will advance transportation equity in the city. Using this framework, we will set targets for a phased build out, establish data and methods for measuring progress towards these goals, and identify priority projects to meet the first phase based on potential impact and alignment with existing capital projects.

While we recognize that barriers to cycling prevent it from being an option for everyone, our goal is to relieve as many of those barriers as possible to make it a much more widespread, accessible, and inviting option for residents across the cities.

- **Continue to build out bike networks.** The Cities will continue to expand our bike networks, informed by municipal plans, such as Portland’s peninsula/circumferential pathway and South Portland’s anticipated Bike Master Plan. Bike network design will be based on the “green transportation hierarchy,” which establishes that pedestrians and bicyclists take priority on complete street roadways (followed by public transit, and then other vehicles). In alignment with the Complete Streets



BIKING ON THE BAYSIDE TRAIL • Photo by Corey Templeton

Design Manual (see Action 1.4), we will prioritize separated and protected bikeways whenever feasible, incorporate pavement markings to facilitate safe bike movements in intersections, and adapt streetlights where appropriate either to optimize signal timing for cyclists or integrate bike traffic signals. Through this work, the Cities will convene on a semi-regular basis to identify opportunities for alignment. Portland and South Portland will pursue joint projects—including, for example, coordinated investments in the Smart Corridor running between the two cities—which can score more highly for PACTS-administered federal funding. Portland will also coordinate with regional partners to plan for the completion of the Portland portion of the Mountain Division Trail.

• **Expand bike parking and storage facilities.** The Cities will collaborate with PACTS and public transit agencies to build out bike parking and storage facilities at train, ferry, and bus stations as well as future mini hubs, in line with goals outlined in

Getting There from Here and the Transit Stop Access Project. The Cities will also systematically increase the availability of bike parking in the cities by conducting surveys to identify areas with additional need. South Portland will develop an online resource to show the locations of bike racks and other public bike parking facilities, and will consider ways to integrate it with Portland's map, hosted by Downtown Portland.⁶⁶ Both Cities will also leverage the development review and approval process to mandate private sector investment in bike parking and storage.

• **Foster an inclusive biking culture through resources, trainings, and programs that make biking more accessible.** We will convene a broader community coalition, made up of youth and adult biking advocates as well as community advocates who can speak to diverse needs. The coalition will design an outreach plan for answering the question: *What would make biking your best mode of transit?* Through surveys and conversations, the coalition will assess barriers to biking and identify a set of potential initiatives for expanding resources, tools, messaging, and support systems for making biking more accessible. This project will be led in collaboration with efforts to advance transportation equity (see action CR 2.4)—and may be led by youth as part of a Gateway to Opportunity program through the Opportunity Alliance. The goal of the initiative will be to identify key needs, interested partners, and potential projects that could be pursued jointly with support from the Cities or grant funding.

• **Revisit efforts to launch a bikeshare program in the cities.** Bikeshare programs, which deploy bikes throughout a city for residents to rent, can expand access to bikes and have shown to greatly increase bike ridership in other cities. Some bikeshare programs offer electric-assist bikes (e-bikes), which increase the distance bikers can cover, improve bike speeds to make driving near traffic easier, and help people across a broader range of physical fitnesses and ages all take advantage of biking. Portland has extensively evaluated options for introducing a bikeshare in the city, and has discussed implementation with potential partners without finding a good fit. Within three years, Portland may reevaluate the opportunity

for a bikeshare program or both Cities, together, will explore a regional model through partnerships with PACTS and other neighboring municipalities. For any bikeshare program implemented, the Cities will seek ways to provide discounted access passes to qualifying individuals and cash-payment options for residents without credit, as well as seek ways to break down digital barriers. Philadelphia, PA; Austin, TX; Seattle, WA; and Arlington, VA are some of many cities that have begun tackling these equity barriers.

● Plan for effective maintenance and snow removal.

Bikeways are only effective if they are plowed and well-maintained; bike lanes also need regular re-painting to ensure they stay visible and safe. In conjunction with further planning for the expansion of bikeway networks, City staff will outline projected maintenance needs, and plans for covering maintenance costs in capital budgets. We will also outline any design considerations for maintenance as part of the complete streets manual (see action TLU 1.4).

Our next steps

- ☐ Develop and implement plans for complete bike networks, including identifying maintenance needs and plans for covering ongoing maintenance costs.
- ☐ Integrate the Bike Master Plan as a chapter or appendix in future updates of the City's comprehensive plan (South Portland).
- ☐ Convene a community coalition to assess barriers to biking and opportunities for expanding access, either as a Gateway to Opportunity project, or as a separate coalition of community advocates.

TLU 1.3 Summary - Bike Accessibility



TLU 1.4 Complete Streets

ACTION: Create safer and more accessible travel for people of all ages and abilities by all modes of transportation by adopting “Vision Zero” for the PACTS region and continuing to expand complete streets.

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Where we are today

Safety and accessibility play an important role in our transportation decisions: *Do I feel safe biking on that road? Can I cross this busy intersection to access that bus stop?* The safer and easier it is move about the cities without a car—whether by walking, biking, rollerblading, pushing a stroller, rolling in a wheelchair, or taking public transit—the easier it will be to choose those options. Portland, South Portland, the Portland Area Comprehensive Transportation System (PACTS), the region’s public transit agencies, and local partners including the Maine Bicycle Coalition and Portland Trails have made significant progress and continue to champion roadway design, educational initiatives, and policy to make our city streets safer for all people.

Vision Zero is a commitment and strategic approach—adopted by cities nationally and globally—to eliminate all fatalities and serious injuries from roadway collisions, while making mobility options safer, healthier, and more equitable for everyone.⁶⁷ Rather than treating traffic fatalities as inevitable, Vision Zero efforts treat them as preventable by anticipating, planning for, and designing for human error. Vision Zero builds upon an increasingly interdisciplinary approach to planning in our cities by including public health officials, advocacy groups, and community organizations in the implementation of engineering, policy, and behavioral solutions.

To date, Portland and South Portland have been focusing on the expansion “complete streets” as one method for improving

street safety. Complete streets refers to a policy and design approach for ensuring that roadways are designed, maintained, and improved using a holistic approach that addresses the needs of all users regardless of the mode of transportation. A complete streets approach considers where and to what extent sidewalks, bicycle facilities, transit stops, and crosswalks are needed to improve accessibility throughout the community. PACTS, the Cities, and transit partners are currently collaborating on the *Transit Stop Access Project*, which focuses on improving the safety and accessibility of transit stops in Greater Portland. Likewise, both Portland and South Portland have adopted complete streets policies, which call for the integration of complete street design principles whenever practicable during road construction or upgrades. Park Ave (Portland), Anderson Street (Portland), the Deering Center Neighborhood Byway project (Portland), Main Street (South Portland), and Westbrook Street (South Portland) are some of the many recent roadway redesigns.

Next generation complete streets policies (or “green streets”) further integrate green infrastructure and ecosystem services into street design and transportation corridors. For example, on Anderson Street in Portland, features such as trees, vegetation, and healthy soils bring climate mitigation and resilience benefits by capturing stormwater, sequestering carbon, and reducing ambient temperatures on hot days, but they also serve as tools for enhancing safety along the streets. Tree canopies and vegetated neighborhood circles,



BY FOOT, BY BIKE, AND BY MOPED • Photo by Denise Michaud

for example, help to calm traffic. The complete street projects both built and underway in Portland and South Portland thus create opportunities to drive numerous climate mitigation, community resilience, and health and safety benefits. Nevertheless, between 2014 and 2018, the PACTS region saw roughly 28 fatalities and serious injuries to bicyclists and pedestrians each year,⁶⁸ illustrating the work we still have ahead of us to make our streets increasingly safe for all users.

The action we will take

Portland and South Portland will continue to work with regional partners to ensure that people of all ages and abilities can safely and comfortably navigate the cities by walking, biking, transit, and other non-vehicular modes. As a primary step, we will work with PACTS and regional transportation partners to establish a Vision Zero commitment for the PACTS region to set safety goals and define concrete metrics for tracking progress towards safer roadways. Existing asset management

plans and comprehensive plans will leverage these metrics to further prioritize projects and investments to reach safety targets, improve accessibility, and ultimately help to transition Portland and South Portland into truly multimodal cities.

At the same time, we will continue to build out our networks of complete streets, strengthen our processes and policies for integrating complete streets into roadway development and upgrades, and reconsider new approaches for maintaining accessible streets. More specifically, Portland and South Portland will take the following steps:

• Develop a Complete Streets Planning and Design

Manual. We will build on initial efforts in Portland and South Portland to develop a Complete Streets Planning and Design Manual to aid in streamlining the planning, design, and construction of complete streets. The manual's content will draw from existing national and local resources including the PACTS Regional Bicycle and Pedestrian Facility

Design Guidelines (2013). In addition to detailing best and preferred practices for safe and fluid mobility, the manual will establish guidelines for maximizing ecosystem services along transit corridors, including stormwater infiltration, carbon sequestration, and heat mitigation through the integration of green infrastructure systems, specific tree and plant species, and maintenance standards.

• **Strengthen systems and policies for complete streets implementation.** The Cities will ensure that all infrastructure projects are incorporated into existing asset management plans to formally integrate transportation and stormwater projects for complete streets. This process will build upon existing in-house collaboration as well as annual alignment with local and state utilities. The Cities will track whether complete street projects are adequately funded and effectively implemented.



CLEARED SIDEWALK, PORTLAND • Photo by FEMA

We will update street design standards and road classifications to promote complete streets throughout the cities. On state roads, the Cities will adopt a local complete streets standard and proactively negotiate with MaineDOT to integrate local complete streets standards into state improvement projects, leveraging the MaineDOT's complete streets policy and commitments.

• **Complete [street] the Smart Corridor.** The Smart Corridor is the seven-mile route running from Morrill's Corner and the University of New England (UNE) in Portland to Bug Light Park and Southern Maine Community College (SMCC) in South Portland—by way of Forest Ave, High Street/State Street, the Casco Bay Bridge, and Broadway. It's a primary multimodal corridor, heavily used by vehicles, buses, pedestrians, and bicyclists. And yet, as documented by the *Smart Corridor Plan* (2018), the interaction of these uses creates significant challenges, including “roadway bottlenecks and congestion, safety issues and high crash rates, intimidating pedestrian access and crossings, gaps in the bicycle network, and an unappealing streetscape and urban design in many segments.”⁶⁹ As a critical route in need of complete streets—and one that links our two cities—we will prioritize the implementation of a complete multi-modal corridor in coordination with capital improvement plans, comprehensive planning initiatives, and negotiations with PACTS and state authorities.

• **Launch an Adopt-a-Sidewalk program for clearing sidewalks of snow and ice.** The Cities snowplow sidewalks on main thoroughfares and school walking streets; the City of Portland also plows its Downtown District, and coordinates volunteers to shovel bus shelters. All property owners not along these routes are responsible for clearing the sidewalks abutting their property. In Portland, this requirement is backed by city ordinance, and residents may be charged for snow removal if they fail to comply after a warning. Despite these measures, many sidewalks throughout the cities go uncleared, obstructing accessibility and safe walking routes. Reinforcing compliance with stricter fines enhances undue challenges: older adults, people with disabilities, and many other residents may not be able to shovel the walkway, and the fines can create excessive financial hardship for lower income residents. To try

another avenue, the Cities will launch an “Adopt-a-Sidewalk” program, which coordinates volunteers to shovel sidewalks. In Chicago, for example, the City worked with local programmers to create an online map, where during each storm, residents can flag that they need help with shoveling, claim a sidewalk to shovel, and mark that they’ve completed the shoveling.

Our next steps

- ☐ Collaborate with PACTS and regional partners to draft a Vision Zero policy statement and a set of concrete metrics for measuring the improvements over time.
- ☐ Develop a Complete Street Planning and Design Manual and align City ordinances and plans with references to the manual.
- ☐ Enhance asset management systems for complete streets with an accompanying process for reviewing and reporting on the rate at which complete streets are implemented.
- ☐ Implement an Adopt-a-Sidewalk program.

TLU 1.4 Summary - Complete Streets

How this strategy advances a future that is...			
PRIMARY COMPONENTS	Equitable	Regenerative	Resilient
• Draft “Vision Zero” policy statement and set metrics for measuring improvements over time. • Develop complete streets design manual and align city ordinances and plans. • Launch “adopt-a-sidewalk” program. • Complete the build-out of complete streets along the Smart Corridor.	a b c d (a) Addresses injustice (b) Expands access	a b c d (a) Draws down carbon (b) Restores ecosystems (d) Builds shared wealth	a b c d (a) Reduces vulnerability (b) Strengthens communities (c) Adapts processes (d) Builds partnerships
	KEY MILESTONES • Complete Streets Design Manual produced by 2025	CITY STEWARD P: Planning Department, Public Works SP: Planning Department, Water Resources Protection, Public Works	FINANCING MECHANISMS TOD tax increment financing (TIF), bonds, federal/PACTS funding, developer fees, general funds; <i>Future: infrastructure bank, expanded state funding for Multimodal Transportation Fund</i>

TLU 1.5 Employer Transit Partnerships

ACTION: Partner with PACTS, GO MAINE, and large public and private employers in the cities to continue to promote more efficient or zero-emissions commuting and to establish a Transportation Management Association (TMA) for the Greater Portland region.

Where we are today

Employers can play a big role in reducing greenhouse gas emissions from transportation by influencing how their employees commute to work—strategies that are collectively known as transportation demand management (TDM). Employer-offered TDM programs create incentives or make it easier for employees to take public transit, vanpool, carpool, ride a bike, or walk to work. Generally, TDM approaches fall into three overlapping categories: 1) Strategies that increase transportation options, such as through operating commuter shuttles, coordinating rideshare programs, or providing bike storage and shower facilities; 2) Strategies that create a stronger financial incentive not to drive, such as through subsidizing transit passes, offering pre-tax transit benefits, or implementing parking cash-out programs;⁷⁰ and 3) Supportive work policies, such as allowing employees to work a condensed workweek or telecommute. As a state-funded commuter connections program, GO MAINE supports TDM initiatives throughout Maine by connecting commuters to organized vanpools and carpools, and providing a rewards program for choosing to opt out of commuting alone by private vehicle.

To supplement voluntary programs, many U.S. cities require large new development projects and/or large employers to produce a TDM plan. Portland requires TDM plans for all commercial or institutional uses with 50,000 square feet or more of floor area, or that are designed to accommodate 100 or more employees or students. All major development in

What is transportation demand management?

“Transportation demand” refers to the number of people trying to travel in a given area at a given time. Transportation demand management (TDM) is the application of policies or strategies that reduce transportation demand in order to mitigate air pollution and street congestion generated by motor vehicles. In order to target solutions that reduce greenhouse gas emissions, we are focusing on TDM approaches that reduce drive-alone trips in a passenger vehicle.



the B7 zoning district (West Bayside) must also submit a plan. As part of the plan, the developer or owner must establish a parking and trip reduction target, periodically collect data on parking and trips through an employee or a customer survey, and outline a set of educational, infrastructural, or incentive-based efforts to work towards the established target. In line with this policy, Maine Medical Center offers a suite of TDM options through their *Commuter Choice* program, for example, and the University of Southern Maine helps to fund the METRO Husky bus line and provides transit passes for employees



BIKE COMMUTERS' BIKES AT MAINE MED • Photo by Maine Medical Center

and students. South Portland does not have a formal TDM policy; however, PACTS and the City developed a TDM plan for Southern Maine Community College (SMCC) in 2013 to mitigate traffic and to provide more transportation options for commuting students.

While individual employers can create very effective TDM programs, the coordination of TDM strategies across multiple employers in an area can oftentimes take advantage of economies of scale and amplify the benefits. A formal approach to this coordination can be through the formation of a transportation management association (TMA). A TMA is a non-profit, member-controlled organization that provides commuter benefits or transportation services in an area. They usually collaborate closely with public agencies, but as nonprofits, are able to take advantage of both private and government funding. The ability to pool resources and aggregate demand for transportation benefits can allow smaller employers to also participate. Employers often benefit from improved employee satisfaction and retention, as well as lower on-site parking demand. PACTS, the City of Portland, Greater Portland METRO, the Portland Regional Chamber of Commerce, and Portland Downtown launched a process in late 2019 to map out a strategy for developing a Greater Portland TMA.

Community Spotlight

Maine Medical Center

The Maine Medical Center (“Maine Med”) was one of the first companies in the state to develop a transportation demand management (TDM) program. The program was designed to reduce the number of single-occupancy vehicle trips to and from its main campus, where the majority of the hospital’s staff (approximately 4,400 individuals) are located. Known as *Commuter Choice*, the program supports alternative commuting options such as carpool, mass transit, bicycling, and walking.

Over the years, Maine Med has added elements to strengthen the program’s offerings. In 2015, for example, the hospital installed additional bicycle parking. In 2019, Maine Med’s parent company entered into agreements with METRO and the South Portland Bus Service, allowing all of their staff to ride buses in those transit systems for free (any day, anytime, unlimited travel) using their employee badge.

Total enrollment in *Commuter Choice* continues to increase year after year, and Maine Med was designated one of 2019’s Best Workplaces for Commuters in the nation, the first workplace in Maine with the honor. Maine Med leadership will hopefully inspire other local and regional organizations in Portland and South Portland to develop TDM programs that encourage efficient or zero-emissions commuting.

The action we will take

Portland and South Portland will continue to work with PACTS and local partners to pursue the development of a Greater Portland Transportation Management Association (TMA). A TMA can provide streamlined support for many of the TDM options that individual employers provide—for example, administrative and matching support for pre-tax transit benefits, commuter shuttles between high density neighborhoods and employment hubs, and transit pass subsidies. Beyond these services, a TMA can also act as a clearinghouse for information and ideas for area-wide demand management—for example, connecting neighboring employers who may be addressing complementary problems, piloting programs that can inform practices for a number of employers, as well as collecting and aggregating data that can inform city planning and the evolution of further TDM solutions.

Large employers responsible for producing a TDM plan will participate in the TMA as part of the TDM plan's requirements. The TMA will also target area-specific solutions for parts of the cities that have high employment densities and the opportunity to become increasingly transit-oriented, specifically the Portland Peninsula and the Maine Mall area. Reducing commuter trips in single-occupancy vehicles within these two areas will support Portland's goal of reducing parking demand on the Peninsula (see action TLU 1.6) in line with the *Peninsula Parking Study* (2017), and serve in support of the vision outlined in the *Maine Mall Transit-Oriented Development Concept Plan* (2020), which aims to reduce parking, reduce single-occupancy vehicle miles traveled, and increase transportation mode shift. Based on TMAs operating nationwide, funding for the TMA could be generated through a number of complementary structures, including a district assessment tax for specific participating districts, parking revenue, direct employer contributions, and potentially government grants for specific programs.

The TMA will be tasked with producing a TDM toolkit. The TDM toolkit will provide an inventory of TDM practices, organized in tiers (such as “baseline,” “advanced,” and

“champion”) based on their relative capacity to reduce miles traveled in a single-occupancy vehicle and encourage mode shift. A baseline strategy may include providing maps and public transit information; a champion strategy may include offering fully subsidized bus passes. Each strategy will have a “dashboard” that notes their applicability for different development sizes and types. The toolkit may also include information on pre-qualified local TDM planners, and a section that champions project teams that have taken innovative or exemplary approaches. The toolkit will be a recommended resource to any developer in the cities, a framework for assessing TDM practices in site plan review, and an educational and promotional tool for increasing familiarity with TDM approaches. The toolkit will also spell out any planned changes to the TDM ordinance that will come into effect in subsequent years to prepare developers for that transition.

As a complementary approach to the implementation of a TMA, the Cities will strengthen our policies and advocacy for TDM as part of the development review process. In the near-term, this process will include:

• **Revising (Portland) or adopting (South Portland) TDM plan requirements.** Portland will revise and expand its TDM plan requirement for new developments, and South Portland will explore creating a similar, aligned requirement. The revised/new ordinances will require the following, at a minimum. Portland's ordinance already requires a, c, d, and e.

- a. Identification of a mobility coordinator to interact with the City and GO MAINE (or TMA, as applicable);
- b. Membership and active participation in a TMA (if established) or Way 2 GO MAINE program;
- c. Commitment to a TDM target for mode shift, trip, and/or parking reductions, and an outlined pathway for achieving that target, drawing from methods provided in the toolkit;
- d. Annual survey of employees/users to document progress toward defined goals, transportation choices, and experience included with submission of an annual report;
- e. Active education of employees/users on non-single-occupancy-vehicle transportation options and incentives;

- f. Priority or discounted parking for low- or zero-emission vehicles, bicycles, carpools, and vanpools;
- g. Pre-tax transit benefits offered to employees (see call-out box).

The ordinance may also require the implementation of one or more “highly recommended” strategies as part of its pathway, which could include:

- a. Formal support for telecommuting or condensed work week schedules, both in terms of company policy and in meeting information technology (IT) needs. (Note: flexible work hours will have minimal to no effect on reducing greenhouse gas emissions and are not considered to be a recommended strategy);
- b. Subsidized public transportation passes or other equivalent public transit incentives;
- c. Guaranteed ride home programs;
- d. Incentives for purchase of zero emissions vehicles (including electric cars, bicycles, and e-bikes);
- e. Cash-out parking programs where employees may forgo an employer-provided parking spot for a one-time payment;
- f. Compensation fees wherein the development may contribute to a fund that supports transit system upgrades; or
- g. Bicycle facilities, including secure bicycle parking and employee shower facilities.

Within three years of the first phase, the Cities will further advance our policy by taking the following steps:

● **Establishing targets for mode shift.** All development responsible for completing a TDM plan will be required to plan and execute a TDM approach that meets pre-defined thresholds for mode shift. While the Cities seek overall reductions in VMT, the public and private sector will use mode shift as a proxy when monitoring TDM plan targets. The Cities may collaborate with PACTS for the development of region-wide targets, defined based on the type of land use and location (accounting for proximity to transit).⁷¹ The thresholds

may start modestly, but will increase at predefined timeframes in line with public transit improvements and the Cities’ goals for VMT reduction and mode shift, defined by the One Climate Future modeling. Effectively implementing these standards will require an increase in staff capacity to support, monitor, and ensure compliance.

What are pre-tax transit benefits?

Pre-tax transit benefits are a commuter benefit that has seen a large uptake in other urban areas. Under the U.S. Internal Revenue Code section 132(a), qualified transportation benefits are one of the eight types of statutory employee benefits that are excluded from gross income in calculating federal income tax. Employees can opt to put money from their paychecks towards a transit card and not pay tax on that portion. Employers receive savings—since employees are saving tax-free money in their paychecks, employers can see decreases in the payroll tax bill up to 7.5%.⁷² Employers can make using this benefit more attractive by giving a portion of that savings back to employees as a matching contribution so that the employees’ dollars go further.

In cities like Washington, D.C., Chicago, and New York, there are additional municipal laws increasing the allowable transit benefit, but this is not needed to start the program. In New York City, Washington, D.C., Seattle, and in the state of New Jersey, employers with over twenty employees are required to offer pre-tax benefits. In the San Francisco Bay Area (a region of nine counties), employers with over fifty employees are required to offer their employees commuter benefits, one option of which is pre-tax benefits.⁷³

● **Expanding TDM plan requirements to all site plan review processes for projects in TOD nodes or corridors.**

Effective transit-oriented nodes and corridors have less space dedicated to parking and are connected to robust transit networks (see action TLU 1.2). For these reasons, TDM strategies are both integral in these areas (to reduce parking demand) and more feasible in these areas (due to greater access to transit). Consequently, we will consider mandating that all projects requiring a site plan review in transit-oriented development nodes meet the Cities’ TDM plan requirements. This approach aligns with PACTS recommendations in *Destination 2040* for Priority Centers.

Finally, the Cities also commit to leading by example. In partnering with employers around TDM strategies, the Cities will assess ways to offer commuter benefits to municipal and school employees. In particular, the global COVID-19 pandemic has allowed us to pilot more extensive options for working from home. As municipalities are public facing, we will establish a policy that allows telecommuting if public access can be maintained at the same level, promote teleservices, and more

broadly encourage a reduction in single-occupancy vehicle trips to reduce emissions from employee commutes.

Our next steps

- ☐ Build upon informal conversations to establish a formal regional Working Group that will explore the development of a transportation management association for the Greater Portland region.
- ☐ Partner with the TMA to produce a TDM Toolkit that will serve as an educational and promotional tool for development.
- ☐ By 2026, adopt (South Portland) or revise (Portland) the TMD plan requirement in City zoning ordinances to meet recommended minimum standards.
- ☐ Reduce single-occupancy vehicle trips during employee commutes through a variety of mechanisms including but not limited to telecommuting and mode shift initiatives.

TLU 1.5 Summary - Employer Transit Partnerships



TLU 1.6 Parking

ACTION: Shift existing incentives that lead to more parking demand and supply to instead facilitate and strengthen multimodal transportation options.

Where we are today

Minimum parking requirements for new development aim to satisfy an estimated peak demand for off-street parking based on the type and size of the building. These requirements originated in the 1920s with the proliferation of the automobile, became fundamental to city planning by the 1950s, and are still ingrained in nearly all city codes today—driven by the notion that sufficient parking supply is necessary to meet mobility needs, real estate market demand, and to support local businesses. In the last decade, however, there has been growing recognition among researchers and policymakers that minimum parking requirements have both led to a net surplus of parking and continue to work against a wide number of city planning goals.⁷⁴ Minimum parking requirements create constraints for development and housing affordability, and on average have shown to contribute to an estimated 17% increase in rents nationwide.⁷⁵ Paved parking lots counter climate resilience goals by exacerbating stormwater pollution, flooding, and the urban heat island effect. By contributing to lower density development, large parking lots also make public transportation networks less effective and create streetscapes that deter walking and biking—thereby reinforcing car-dependency, increasing greenhouse gas emissions, and increasing demand for more parking. In effect, the oversupply of free parking creates a significant public subsidy for private vehicle travel that is only afforded to residents who can access and drive a vehicle, and that continues to limit the financial viability of public transportation. As cities across the United States set targets for reducing traffic, reducing housing costs,

increasing transit use, and achieving carbon neutrality, there is growing sentiment that the downsides to parking minimums outweigh their benefits.

Consequently, cities are reconsidering parking policies, primarily through three approaches. Most commonly, local governments are choosing to reduce parking minimums or create greater flexibility in how developers meet parking minimums. Portland has increased its flexibility by offering developers a number of options in lieu of meeting parking minimums, including paying an in-lieu fee into the City’s Sustainable Transportation Fund, demonstrating that the development will generate lower parking demand, building off-site parking, or investing in shared parking. As a second approach, many cities have eliminated parking minimums altogether, either for specific development types (such as multifamily housing), specific districts (such as downtown or in transit-oriented areas), or citywide. Since 2017, Hartford, CT; Buffalo, NY; San Francisco, CA; and Minneapolis, MN have eliminated minimum parking requirements citywide. As a third approach, a number of cities have begun adopting parking maximums, which can be implemented either at the site level or as a citywide or district cap. Many cities use these policies simultaneously: Burlington, MA and Portland, OR use both minimums and maximums, and Vancouver, Canada has applied site-level maximums as well as a total cap on the downtown area.

In 2017, Portland commissioned a parking study for downtown, the Old Port, and the Eastern Waterfront, which both addressed changing needs for parking, and recommended that the City pursue transportation demand management approaches to reduce parking demand in the study area by 700-750 vehicles within a 10-year period.⁷⁶ Currently, 22% of the area studied is used for parking. Parking pricing is a common tool for influencing travel behavior for areas with high parking demand, and cities are beginning to test demand-based pricing to further increase the efficiency of how parking is used. Portland currently has a sophisticated Parking Division that utilizes parking zones and cashless, touchless parking with apps on smartphones. South Portland has not yet needed to implement metered parking. Enabling travelers to internalize the true cost of driving can encourage use of less emissions-intensive travel modes, such as carpooling, transit, and active transportation.

The action we will take

Portland and South Portland will review and update the Cities' zoning ordinances so that our parking requirements support an ongoing shift towards more walkable, bikeable, and transit-oriented communities. These updates will be characterized by 1) loosening, or in some cases potentially eliminating, parking minimum requirements, as well as 2) considering parking maximums in specific transit-oriented areas. Approaches we will consider include:

- **Increasing flexibility in meeting parking minimums.**

South Portland will evaluate options for providing developers more flexibility in meeting parking minimums, including paying an in-lieu fee into a fund that would support public transit and complete streets investments, implementing transportation demand management approaches that reduce parking demand below the minimum, or investing in shared parking facilities—all three of which would encourage reductions in surplus parking. Portland already allows for this flexibility, but will reassess its effectiveness and consider adjusting the options as part of the ReCode process.

- **Eliminating parking minimums in commercial areas and along designated transit routes.**

Portland and South Portland will consider eliminating parking minimum requirements in commercial areas. This approach would still

require off-street parking, but it allows developers and/or property owners to determine the amount of parking needed for the given development based on the market and location—which is often driven by expectations from lenders, investors, and potential tenants. These expectations can be more dynamic than prescribed parking minimums, and can respond to land use changes and investments in public transit. This approach helps to reduce surplus parking driven by meeting minimums and allows for developers to also pursue shared parking facilities, transportation demand management, and other approaches to reduce costs towards parking.

- **Establishing parking maximums in transit-oriented development nodes or district-wide caps.**

Portland and South Portland will assess whether to establish parking maximums in specific transit-oriented development nodes (see action TLU 1.2) as a means to support more compact development and to encourage multimodal transit in these areas. Parking maximums could be paired with the elimination of parking minimums or more flexible parking minimums, especially for ADUs where on-street parking is an option. Portland will continue to evaluate recommendations made in the 2017 *Peninsula Parking Study* and its recommended targets for parking build out and for reducing parking demand in the study area.

It is important to note that our ability to reduce parking demand in the cities will be improved by investments and actions outlined in other strategies that provide for transportation alternatives—including increasing the frequency, reliability, and efficiency of public transit systems (see action TLU 1.1); expanding bikeway networks (see action TLU 1.3); and increasing transportation demand management through employer transit partnerships (see action TLU 1.5), in particular. Also, see action TLU 2.1 for the Cities' actions on incorporating electric vehicle charging infrastructure in parking lots and garages.

Portland will also continue to evaluate parking pricing as a means to better incentivize use of public transportation and employer-based transportation demand management strategies. Pricing parking has also shown to reduce vehicle miles traveled by drivers circling city streets while looking for parking—an activity that has shown to contribute to an estimated 8% of city traffic, and a significant source of

greenhouse gas emissions.⁷⁷ To assess parking pricing in the city, Portland will consider the following approaches:

- Piloting adjustments to pricing recommended in the 2017 Peninsula Parking Study.** Portland will conduct pilots to evaluate 1) higher prices for on-street parking in high demand areas on the Portland peninsula, 2) expanding metered parking areas surrounding high demand areas on the Peninsula, and 3) extending on-street meter hours to 8pm citywide. Higher on-street parking prices can both encourage other transportation modes and create a greater incentive to park in lots and garages as a first decision, rather than circling for parking. At the same time, higher rates may disproportionately affect low-wage workers—a challenge that will be weighed in any decision to raise rates, and that could be addressed through a customized TNC program that would connect qualifying individuals between a place of employment and a park and ride, as discussed in the 2017 *Peninsula Parking Study*. Increased revenue from parking fees would directly contribute to streetscape and transit amenities in those neighborhoods.

- Piloting demand-based pricing and parking app.** With demand-based pricing, cities use smart parking technology to increase the price of parking on streets that have 100% occupancy, which encourages people to park on other streets, lots, or garages with cheaper pricing. In 2017, the San Francisco

Municipal Transportation Authority (SFMTA) launched SFpark, a pilot for demand-based parking pricing, which they found to be so successful that its board moved to implement the pricing mechanism citywide. SFpark demonstrated that demand-based pricing resulted in decreases in time spent and vehicle miles traveled (VMT) by drivers searching for available parking, and therefore lowered greenhouse gas emissions, especially during peak congestion times. Portland will assess the potential for demand-based pricing in certain areas of the peninsula.

While the parking pricing strategies currently primarily apply to the Portland peninsula, Portland and South Portland will consider parking pricing mechanisms as other parts of the cities see higher demand for parking.

Our next steps

- ☐ Assess the Cities' parking requirements and the potential implications of adjusting existing parking minimums for specific zoning districts. Use outcomes of the assessment to revise zoning ordinances to allow for more flexibility in parking minimums, eliminate parking minimums in commercial areas, and/or adopt parking maximums in specific transit-oriented areas.
- ☐ Develop a pilot for adjustments in parking pricing on the Portland peninsula (Portland).

TLU 1.6 Summary - Parking



TLU 1.7 Land Use for a Smaller Carbon Footprint

ACTION: Plan for future growth in our cities by committing to land use principles for a smaller carbon footprint, codified in the Cities’ comprehensive plans, zoning, and subdivision ordinances.

Where we are today

Greater Portland will likely grow over the next twenty years: projections suggest that we’ll see a 23% increase in population and a 27% increase in jobs between 2015 and 2040 across the PACTS region.⁷⁸ While increases in population, activity, and development will contribute to more greenhouse gas emissions, new growth also creates great opportunities if we plan for growth well. Research shows that people who live in denser neighborhoods drive fewer miles (Table 3); compact neighborhoods with a diversity of housing, jobs, and services nearby make vehicle trips shorter, and walking and biking between destinations easier. At the same time, greater population and job densities within close proximity to transit routes can help support a more robust transit system (see action TLU 1.2).

As we plan for new growth, it’s critical that we consider that proximity of homes to jobs has shown to have the strongest effect on reducing vehicle miles traveled when a wide range of transportation and land use factors are compared.⁷⁹ Today over 44,000 and nearly 20,000 people commute from outside the cities to Portland and South Portland, respectively, for work.⁸⁰ As a significant employment hub for the region, we recognize that our statewide and city goals to reduce carbon emissions thus further increase the importance and urgency of expanding housing in the cities. Portland, as outlined in *Portland’s Plan 2030*, has set a policy goal that all people who work in Portland should have the option to live in the city—a goal that aims to increase the number of housing units by 2,557 units by 2030.

South Portland is in the process of setting a housing goal and plans to adopt a housing strategy either as a part of the City’s comprehensive plan update or as a standalone plan. Nonetheless, both cities have room to grow in ways that align with the character of our cities and continue to support a high quality of life.

Furthermore, effective land use patterns—“filling in” as opposed to “spreading out”—can ensure that even with this growth, we preserve forests, wetlands, and healthy soils that, among many other benefits, play a critical role in sequestering and storing carbon. Forests and wetlands in the northeast are estimated to store roughly 38 and 214 tons of carbon per acre, respectively, and on average can sequester an additional 0.2 and 0.1 tons of carbon per acre per year.⁸¹ While these rates of sequestration only minimally help to counter the greenhouse gas emissions produced within Portland and South Portland currently, they will play a proportionately more significant role as we work towards carbon neutrality. More importantly, the amount of carbon stored in forests and wetlands in our cities adds a clear incentive to avoid land conversion, which—although not tracked in the Cities’ greenhouse gas inventories—contributes an additional source of greenhouse gas emissions. Through our comprehensive plans and land use ordinances, we can lay the groundwork now to ensure that new population growth contributes to the lifestyle and climate mitigation goals envisioned in *One Climate Future*.

How does density relate to how much we drive?

Research has shown that people who live in denser areas drive fewer miles, on average, resulting in lower vehicle miles traveled (VMT) per capita in areas with higher densities (persons per square mile, or ppsm). For reference, much of Portland's East End reaches densities over 10,000 ppsm, while Ferry Village (South Portland), Thornton Heights (South Portland), and North Deering (Portland) fall in the 2,000 – 3,999 ppsm range.

Table 3. Vehicle miles traveled (VMT) forecasts by Census Tract Density

Persons per Square Mile (ppsm)	Approximate dwelling units per acre	2005 VMT	VMT Compared to < 500 ppsm	2035 VMT	VMT Compared to < 500 ppsm
0-499	< 0.6	11,422	0.0%	13,798	0.0%
500-1,999	0.6-2.5	10,083	-11.7%	12,196	-11.6%
2,000-3,999	2.5-5	9,345	-18.2%	11,345	-17.8%
4,000-9,999	5-12	7,986	-30.1%	9,792	-29.1%
10,000+	> 12	4,437	-61.2%	5,651	-59.0%

Table adapted from Cambridge Systematics. (2013).⁸² Dwelling units per acre conversions are gross densities estimated at roughly 50% residential land per tract.



The action we will take

Portland and South Portland will establish four land use commitments as part of our future comprehensive planning processes that support city growth in ways that reduce vehicle miles traveled and shrink our carbon footprint: 1) Increase housing availability and affordability near jobs; 2) Collocate transportation and density; 3) Create livable street networks; and 4) Preserve carbon sinks. These four principles will guide planning over the long term, and each includes a number of ways to act on those principles today through policy initiatives and changes to zoning and subdivision ordinances.

● **Increase housing availability and affordability near jobs.** We will continue to adopt policies that increase the housing stock in our cities and in turn, the share of employees with the option of living within Portland and South Portland. In the process, we will work to expand the supply of diverse housing options that cater to everyone—meeting the needs of households regardless of income, stage of life, household size, or type. To work towards this commitment, we'll pursue the following next steps, and will revise zoning ordinances accordingly:

- Assess options for removing barriers to accessory dwelling units (ADUs), such as allowing ADUs to be constructed “by right” (without review by the Planning Board) and removing requirements for off-street parking; this process is underway in Portland as part of the ReCode process.
- Adopt a housing strategy either as a part of the city's comprehensive plan update or as a standalone plan (South Portland).
- Conduct a residential zoning and housing study to assess options and affordability implications of permitting duplexes and triplexes in single-family housing districts or portions of districts.
- Reevaluate development standards to remove inadvertent disincentives for building housing units; for example, smaller units that generate less need for parking, sewer demand, lot area, etc. may warrant a reduced calculation to allow two studio apartments on a lot designated for one single-family dwelling unit.
- Pursue strategies to remove barriers and expand the development of energy efficient and resilient affordable housing, as outlined in action CR 2.1.



• **Collocate transportation and density.** We commit to integrating transportation and development-related decisions such that all future development serves to best support efficient and reliable transportation systems, and transportation systems continue to enable compact and walkable neighborhoods. As part of our Cities' transit-oriented development vision (see action TLU 1.2), we will focus on increasing housing and employment density along transit-oriented nodes and corridors. To work towards this commitment, we'll pursue the following next steps, and will revise zoning ordinances accordingly:

- a. Consider minimum density requirements and parking maximums for transit-oriented development nodes, in line with actions TLU 1.2 and TLU 1.6.
- b. Consider density bonuses for high-performance buildings (e.g., net-zero energy or passive house buildings) within transit-oriented development nodes and corridors.
- c. Establish "location-efficient criteria," such as proximity to a school, park, weekly amenities (e.g., groceries), transit, and job centers, when assessing revisions to zoning densities to collocate more compact residential development and amenities.

• **Create livable street networks.** We will create streetscapes that connect people to amenities and invite people to spend more time outside of a private vehicle—walking, biking, scootering, pushing a stroller, rolling in a wheelchair, browsing an art walk, or shopping at a farmers' market. Our goal is both to create public places for social gathering and to ensure that all residents can travel safely, efficiently, and comfortably regardless of the mode of transportation. In addition to efforts to expand bikeways (see action TLU 1.3) and complete streets (see action TLU 1.4), we'll pursue the following steps, and revise street standards accordingly:

- a. Review street design guidelines and standards to ensure development on urban neighborhood streets support a quality pedestrian environment, including requiring uniform build-to lines (Portland) and setback lines, requiring ground floor windows on street fronts, and requiring that parking be behind or adjacent to the building.
- b. Revise zoning to promote accessibility in neighborhoods by encouraging mixed uses within a walkable distance. Remove incentives promoting homogenous development that enable automobile travel, food deserts, and amenity

deserts. Implement Complete Neighborhoods as described in *Portland's Plan 2030* (Portland).

- c. Revise subdivision regulations to support travel by non-motorized transportation by requiring that streets contribute to an interconnected street network (e.g., a street grid), and limit cul-de-sacs and dead-end streets to the extent practicable (South Portland); these stipulations are already in Portland's code.
- d. Continue to revise subdivision regulations to further support travel by non-motorized transportation by limiting block minimums and maximums, requiring compliance with complete street standards, and requiring connection to a neighborhood bikeway to the extent practicable. Providing a paved and lighted pedestrian pathway that shortens the walking distance to adjacent destinations could be offered as a suitable alternative to above requirements.

● **Preserve carbon sinks.** We will protect and expand carbon sinks within the cities—including forests, wetlands, and healthy soils—by prioritizing infill development over greenfield development and by continuing to expand the acres of protected natural areas in line with our Open Space Plans. In addition to the actions in CR 1.3 (Resilient Open Space Planning) and CR 5.2 (Soil Health), which seek to expand the

carbon sequestration and storage capacity of the land in our cities, we will seek to preserve our cities' existing capacity by taking the following steps:

- a. Pursue legal protection for existing city open spaces and acquire new conservation land in line with the City's Open Space Plan (2020) (South Portland) and with recommendations from the Land Bank Commission (Portland).
- b. Identify and encourage sites suitable for transit-oriented infill development or redevelopment.
- c. Take stronger policy steps towards preventing loss of wetlands (see action CR 4.2 for detail).

Our next steps

- ☐ Conduct review and revisions to zoning ordinances, with accompanying studies as necessary; these steps will occur as part of the ReCode process currently underway in Portland, and as part of the upcoming comprehensive plan update in South Portland.

TLU 1.7 Summary - Land Use for a Smaller Carbon Footprint





EV RIDE AND DRIVE, BACK COVE • Photo by Ashley Krulik

TLU 2.1 Electric Vehicle Charging Infrastructure

ACTION: Expand electric vehicle (EV) charging infrastructure in public and private parking through public investments in chargers, updates to city land use codes, and EV-ready requirements in the state building code.

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Where we are today

Installing electric vehicle (EV) chargers at municipal facilities and public parking lots is one way that the Cities can lead by example. As of summer 2020, South Portland has installed three level 2 chargers for EVs at City Hall and the Community Center that are available for public use, in addition to a DC fast charger at the Community Center. The South Portland Municipal Services Department and the Planning Department also have chargers for municipal use. In Portland, the Elm Street and the Spring Street garages provide level 2 chargers, and Portland is currently installing public level 2 chargers at 5 other locations. A level 2 charger uses a higher-output power

source (e.g., 240-volts), and can charge an electric vehicle in roughly a quarter of the time that it takes a level 1 charger (at 120-volts). A DC fast charger, depending on the power source and car model, can charge a car in under an hour. Both the perceived and actual availability of chargers are critical for increasing consumer comfort with EVs. Providing high visibility public charging infrastructure on streets and in city parking lots helps to assure EV adopters that public charging is easily accessible when needed.

Nevertheless, while public charging infrastructure can support widespread adoption, more than 80% of EV charging

occurs at home or work. To achieve the level of EV adoption necessary to meet One Climate Future goals, property owners will need to provide parking spaces with charging stations. Other jurisdictions have found that it is significantly more cost-effective to install EV charging stations if the electrical infrastructure is already in place. The costs associated with modifying the electrical conduits, grid connections, and electrical rooms to accommodate charging at all parking spaces within a parking garage, for example, are much higher than pre-installing that capacity in the first place, and then adding chargers only as needed. As such, ensuring public and private building parking and electrical systems are designed to accommodate future EV charging stations will improve the overall cost-effectiveness of achieving the One Climate Future goals.

A number of cities have adopted building codes with EV requirements. Los Angeles requires that all residential buildings be equipped with either an EV charging outlet or the infrastructure necessary to install an outlet in the future. The code requires all one- and two-family residential buildings to provide at least one EV charger-ready space, while all other residential buildings and high-rise commercial buildings must ensure that 5% of parking stalls are EV charger-ready. Similarly, San Francisco's building code requires all new structures to be wired for EV charging stations, while Vancouver (Canada) requires a minimum of 20% of parking stalls in multi-family residential buildings to include a receptacle for EV charging, and that electrical rooms provide sufficient space to contain equipment needed for charging at all spaces. The Transportation and Climate Initiative (TCI) of Northeast and Mid-Atlantic States also produced a report that outlines approaches to implementing EV-ready codes for buildings.⁸³

For people to have certainty that charging infrastructure is widely available, a network of charging infrastructure that extends beyond the cities is also critical. TCI is coordinating a "Northeast Electric Vehicle Network" for aligned electric vehicle infrastructure planning. Through this network, Maine is collaborating with other states in the region to support widespread deployment of charging infrastructure at strategic locations to facilitate interstate travel, and working to remove barriers to charging infrastructure and EV adoption.⁸⁴ The Maine Clean Communities (MC2) coalition is a more local

coalition of governments and industries in southern Maine focused on supporting the transition to cleaner fuels and expanded charging. It is funded by the U.S. Department of Energy, the Portland Area Comprehensive Transportation System (PACTS), and the Greater Portland Council of Governments (GPCOG).⁸⁵

The action we will take

Portland and South Portland will expand access to electric vehicle charging infrastructure throughout the cities through strategically investing in publicly accessible chargers, as well as advocating for electric vehicle charging requirements in the state building code. To increase publicly accessible EV charging infrastructure, we will start by investing in chargers in municipal parking lots and garages—aiming to have chargers available in 10% of those spaces by 2025. To support this expansion of chargers, we will adjust city codes to ensure that chargers are incorporated in the development or redevelopment of city facilities. These changes will include:

- a. Requiring that any new municipal parking lots or garages install a minimum number of EV charging stations (such as 20%).
- b. Developing policies for who can use which chargers; some chargers should be prioritized for municipal vehicles, while others should be available to members of the public. We will consider prioritizing access to DC fast chargers to taxis, livery services, and delivery vehicles.
- c. Requiring that any new municipal garages include the electrical infrastructure (e.g., conduits, outlets) necessary for the installation of future charging stations at every parking spot.
- d. Requiring that all municipal parking spaces, including existing lots and garages, install a minimum percentage of EV-ready spots.
- e. Rewarding EV ownership and utilization by locating EV charging spots at higher-demand and more convenient locations within lots and garages.
- f. Supporting EV taxis, shuttles, and short-haul delivery vehicles by investing in DC fast chargers at key sites along routes frequented by taxi drivers and short-distance haulers (see actions TLU 2.5 and TLU 3.2 for further details).



EV CHARGING AT THE SOUTH PORTLAND DAYS INN • Photo by ReVision Energy

Additionally, the Cities will outline a strategy for supporting the build-out of publicly accessible EV chargers in commercial lots and garages over the next ten years. Based on global trends in EV adoption, along with the scale of EV adoption needed to meet the One Climate Future goals for greenhouse gas emissions reductions, we expect that by 2030 nearly a third of new car sales will be electric, and approximately 10% of all cars registered in the cities will be battery-electric or plug-in electric hybrid vehicles. To serve these vehicles, we have set a target that 5% of all parking spaces in garages and lots will have level 2 EV chargers by 2030. Priority locations for EV chargers will include convenient locations near services and areas with large parking lots, such as the Portland peninsula, Morrill's Corner, the Maine Mall area, and Mill Creek, as well as transportation centers, grocery stores, sports facilities, and other employment centers. The Cities will work with commercial entities to provide further information on technology options, costs, and incentives.

We will also update our land use and zoning codes to require the installation of EV charging infrastructure in new parking lots and garages. The level of infrastructure will vary by building use—a larger proportion of spaces with charging infrastructure is needed in lots where people park for most of a day or night, such as offices, multifamily housing, and dedicated lots that primarily serve commuters. A higher proportion of spaces with level 2 chargers is less important in lots that see mostly short-term parking, such as lots and garages that serve grocery stores, retail stores, or malls. However, in those cases, a smaller number of DC fast chargers is very desirable since customers could fully recharge their car while shopping. In addition, it is optimal for zoning codes to require that construction of a new garage make all spaces “EV-ready,” defined as running conduits to all spaces, and building a sufficiently large electrical room, so that charging pedestals, wires, and grid connections can be added/upgraded at a later date without disruptive and expensive site retrofits. Specifically, we will require that:

- a. New garages and surface parking lots, serving offices and other workplaces where most users park for much of the day, include level 2 chargers in 20% of spaces with the remaining 80% of spaces EV-ready.
- b. Multifamily garages and surface parking lots include level 2 chargers in 20% of spaces with the remaining 80% of spaces EV-ready.
- c. Retail and short-term customer parking include level 2 chargers in 20% of spaces, along with incentives for DC fast charging and capacity for expansion.

To expand charging to more buildings and support a broader charging network beyond Portland and South Portland, we will advocate for similar changes to the state building code. Building codes are established at the state level through the Maine Uniform Building and Energy Code (MUBEC). Portland and South Portland will advocate for electric vehicle charging requirements to be incorporated into either the next MUBEC, or the MUBEC voluntary stretch code (see action BE 2.1 for more information on the stretch code, and action BE 2.2 for more details on EV-ready requirements in the stretch code).

We will also continue to advocate for and collaborate with regional efforts to build a wider EV charging network in Maine

and beyond. The Transportation and Climate Initiative (TCI) and Maine Clean Communities are both working to support a regional charging network. As discussed above, these initiatives provide funding and support for EV charging stations, alignment of the user experience across stations, and technical support for reducing regulatory uncertainty. In particular, we will collaborate with these entities, as well as MaineDOT and the Federal Highway Administration, on the deployment of any charging infrastructure along the I-95 or I-295 corridors as they pass through Portland and South Portland.

Finally, as electric vehicles become more widespread, we will work with the Maine Public Utilities Commission (PUC) and other stakeholders to improve electricity rate structures. Currently, EV chargers, particularly DC fast chargers which require high input power levels, have high electric rate costs, hurting their business case. Additionally, in many parts of the country users “pay” for EV charging through a higher parking fee, or receive it as a benefit from their company; however, as EV penetration increases, this is unlikely to be a scalable strategy. We will work with the PUC, State, and utilities to create more EV-supportive electricity rate structures, and to ensure that building owners are able to meter and charge users for their vehicles’ electrical draw.

Our next steps

- ☐ Identify timeline and funding for installing new EV chargers in municipal garages or parking lots by 2025 and consider bulk purchasing to reduce costs. Increase staff resources to support advocacy and negotiations for chargers.
- ☐ Adopt new requirements in City land use codes that require minimum percentages of EV parking spaces in new parking lots and garages, preinstallation of electrical infrastructure to support chargers in all spots, and minimums for EV-ready parking spots in municipal lots.
- ☐ Advocate for requirements in the MUBEC Stretch Code for EV charging stations and EV-ready infrastructure in new and renovated buildings, aligned with the recommendations above and new requirements in the Cities’ land use codes.
- ☐ Work with the Maine PUC and other stakeholders on rate design reform that currently adds substantial cost to operations of chargers.

TLU 2.1 Summary - Electric Vehicle Charging Infrastructure

How this strategy advances a future that is...			
PRIMARY COMPONENTS	Equitable	Regenerative	Resilient
- Integrate EV charger requirements in land use and building codes. - Work with commercial entities to expand public chargers. - Collaborate on regional efforts to build out charging networks. - Work with PUC to reform electricity rate structures (see TLU 3.3).	a b c d (a) Addresses injustice — from localized roadway air pollution	a b c d (a) Draws down carbon	a b c d (a) Reduces vulnerability — from localized roadway air pollution (d) Builds partnerships
	KEY MILESTONES 20% of spaces in new garages required to have EV chargers (per land use code) by 2026 5% of parking spaces in all lots and garages in the cities have level 2 EV chargers by 2030	CITY STEWARD PS: Sustainability Office, Planning Department SP: Sustainability Office, Planning Department	FINANCING MECHANISMS Efficiency Maine incentives/ VVW settlement funds, demand aggregation via Climate Mayors Electric Vehicle Purchasing Collaborative, public-private partnerships

TLU 2

TLU 2.2 Electric Vehicle Incentives

ACTION: Offer excise tax exemptions for electric vehicles (EVs), and advocate for additional state EV incentives.

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Where we are today

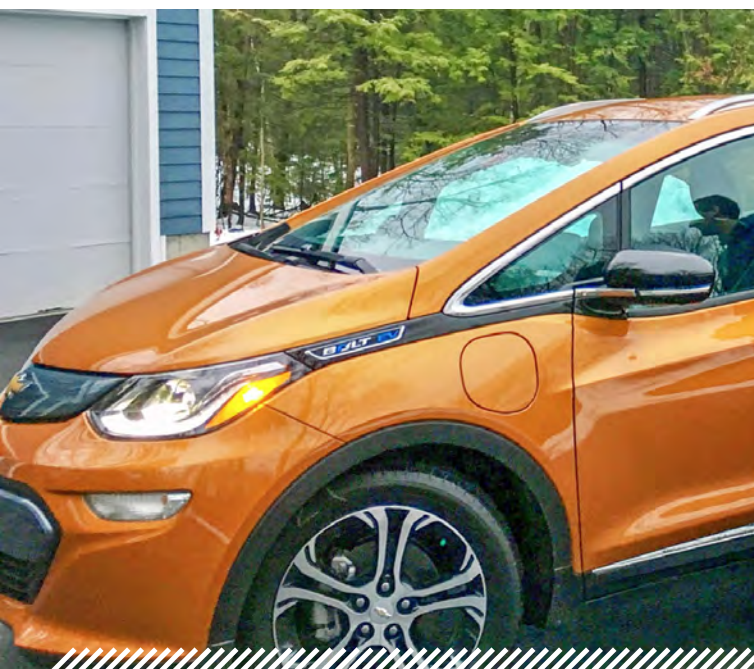
Purchase incentives that decrease the upfront cost of electric vehicles (EVs) are one of the most common tools used by states to generate EV sales. The effect of these incentives on vehicle sales varies between regions and incentive type. California has strong vehicle excise tax incentives for EVs (along with an extensive charging network) and the highest market share for EVs: 7.8% of new vehicle sales statewide and over 10% of new vehicle sales in the metro regions.⁸⁶ Massachusetts offers an EV rebate program, called MOR-EV (Massachusetts

Offers Rebates for Electric Vehicles), which has issued over \$32 million in rebates for approximately 16,000 vehicles since program implementation in 2014. Roughly 60% of the program's uptake has occurred since January 2018, which has supported an 87% increase in EV sales in the state, driving EV sales to 2.5% of new car sales.^{87, 88}

Under Maine law, local municipalities collect excise taxes at the time of vehicle registration and have broad authority to offer excise tax credits. In 2020, Efficiency Maine began offering instant rebates of \$2,000 for electric vehicles, as well as enhanced rebates (\$3,000 for eligible battery electric vehicles and \$1,500 for eligible plug-in hybrid vehicles) for qualifying low-income households.⁸⁹ Additionally, the federal government offers a tax credit of up to \$7,500 for an electric vehicle purchase.

The action we will take

Portland and South Portland will continue to encourage EV adoption both through greater promotion of existing state and federal programs, and through additional incentives to make EV purchases increasingly affordable. Specifically, the Cities will assess the financial feasibility of adopting an excise tax purchase incentive. This excise tax credit would be designed to prioritize vehicles that offer the largest greenhouse gas emissions reductions (e.g., full battery electric vehicles will receive a higher incentive than plug-in hybrid electric vehicles with a gasoline engine to back up the battery). The Cities will



CHEVY VOLT, ELIGIBLE FOR EFFICIENCY MAINE INCENTIVES • Photo by ReVision Energy

also continue to assess ways to scale incentives based on income to make electric vehicles increasingly affordable across a wider range of income levels.

In addition to assessing further incentives, Portland and South Portland will widely promote the rebates offered through Efficiency Maine and participating dealerships. The Cities will do this through online information, promotional campaigns, and other in-person events. This may include working with electric vehicle manufacturers to open an EV Showcase and Purchase Center. The Center would offer prospective EV drivers access to a wide variety of EV models from several automakers, allowing residents to consider the purchase of an EV over a longer timeframe, and increasing consumer awareness, comfort, and interest in EV technology.

Our next steps

- ☐ Work with Efficiency Maine to assess the uptake of EV purchases based on the new incentives; Review financial incentives in other jurisdictions, including incentives that vary based on income, and determine whether and how to tailor the level of financial incentive to achieve a high level of EV adoption.
- ☐ Assess the feasibility of adopting an excise tax discount for fully electric vehicles and plug-in hybrid vehicles, and work with the State to expand additional incentives for electric vehicles.
- ☐ Work with stakeholders to identify a good lead for developing and managing an EV Showcase and Purchase Center. As part of this project, determine the level of discounts that can be negotiated for new buyers.

TLU 2.2 Summary - Electric Vehicle Incentives



TLU 2.3 Electric Public Transit Bus Fleets

ACTION: Work with Greater Portland METRO and the South Portland Bus Service to transition all bus fleets to battery-electric vehicles (BEV) by 2040.

Where we are today

The two primary bus services with local circulator routes in Portland and South Portland include the Greater Portland METRO, a quasi-municipal regional transit organization with board membership from Portland, Westbrook, and Falmouth; and the South Portland Bus Service (SPBS), a South Portland city agency. As of spring 2020, METRO runs a fleet of 44 buses, with some running on compressed natural gas (CNG) and others on diesel. The South Portland Bus Service runs a fleet of seven diesel buses. Ultimately the public bus systems that serve Portland and South Portland must transition to full electric fleets before 2050 to meet our One Climate Future goals.

Both Greater Portland METRO and the South Portland Bus Service have adopted a goal of operating a zero-emissions bus fleet by 2040. METRO and the Biddeford-Saco-Old Orchard Beach Transit Committee (which runs the ZOOM Express line between Biddeford/Saco and Portland) jointly applied for and received a Federal Transit Administration grant to purchase four 40-foot battery-electric vehicle (BEV) buses, two for each system, along with depot-charging (for METRO) and on-route-charging (for BSOOB) infrastructure. The buses will be delivered in late 2021. In the meantime, METRO is in the process of replacing thirteen 2005 35-foot CNG buses with fourteen 40-foot diesel buses that are more fuel efficient in order to meet growing public transit demand. Since buses generally have a lifespan of 15 years, this is not yet in conflict with the 2040 zero emissions goal. South Portland Bus Service will be replacing three of its seven buses in 2022, for delivery in 2023, and has not yet decided if those buses will be battery-electric.

As of 2020, the cost for an average 40-foot, low-floor, all-electric bus is still roughly 66% higher than the comparable diesel bus, with the price of a typical diesel bus around \$450,000 and a modern battery-electric bus around \$750,000. Nevertheless, prices have dropped nearly 40% since initial commercialization and are expected to continue to drop.⁹⁰ Lower maintenance and fuel costs for battery-electric buses also allow for the excess costs to be recouped over a bus lifespan: an electric bus can save over \$400,000 in fuel costs and \$125,000 in averted maintenance costs over the life of the vehicle.⁹¹ In addition to lower operating costs and significant greenhouse gas emissions reductions, battery-electric buses offer other advantages—including faster acceleration, quieter operation, and zero local pollution. With improvements in battery technology, battery-electric buses are also now capable of operating all day on a single charge.

Supported by all of these benefits, the deployment of zero-emissions buses has increased significantly in the United States within recent years, rising from an estimated 360 buses in 2017 to 1,650 zero-emissions buses in 2019.⁹² As of 2019, 46 states had received federal funding for electric transit buses through the Low or No Emission (Low-No) Grant program, which has provided 72% of all public funding for electric transit buses since 2011.⁹³ The VW settlement funds represent the next largest source of public funding used for electric transit bus procurement; electric transit buses are not prioritized, however, in Maine's Beneficiary Mitigation Plan for allocation of funds.⁹⁴ As the Cities expand bus service in line with action TLU 1.1, it is important that the new buses be battery-electric, so that the Cities are not stranded with diesel or natural gas buses after 2040.

The action we will take

By 2022, Portland METRO and the South Portland Bus Service will develop electric vehicle capital transition programs for all public buses. In alignment with our One Climate Future goal of reaching 100% carbon neutral municipal operations by 2040 and METRO's goal of running a 100% zero-emissions fleet by 2040, our goal is to have all public transit buses in the cities be zero-emissions buses by 2040 or earlier. The Cities will also advocate for the Biddeford-Saco-Old Orchard Beach (BSOOB) Transit Committee and the Regional Transportation Program (RTP) to likewise commit to transitioning to all-electric fleets within the same timeframe, and will support these agencies in securing funding. (See action TLU 1.1 for discussion on aligning efforts between public transit agencies in the PACTS region.)

These capital transition programs will begin with building out initial charging infrastructure for a small pilot of EV transit buses within the next two years, evaluating the performance of those buses and the charging systems, and basing future procurement on the success of these pilots. Assuming a standard 15-year turnover, meeting the 2040 goal will mean that starting in 2025, all new buses and bus replacements must be battery-electric buses. We will also work to explore ways that the bus systems can further collaborate for electric bus

purchasing, such as through unified funding applications and procurement, and through exploring shared charging depots for buses.

Our next steps

- ☐ Proceed with the purchase, deployment, and evaluation of the two planned battery-electric buses (METRO).
- ☐ Evaluate feasibility for battery-electric bus purchases in upcoming 2022 bus procurement, and pursue partnerships for a joint multi-agency application for a federal Low-No Grant (South Portland/SPBS).
- ☐ By 2022, develop EV capital transition programs for public transit buses, with the goal of operating a zero-emissions bus fleet by 2040. Target the first EV buses to run on routes most affected by local air pollution and asthma.
- ☐ Initiate conversations with regional transit partners to advocate for a PACTS-region goal of zero-emissions bus fleets by 2040, and to establish ongoing plans for joint federal funding requests for the procurement of bus and charging infrastructure.
- ☐ Collaborate with the State on utilization of VW settlement funds to support this effort, and pursue additional state funding for vehicle electrification, including investigating vehicle-to-grid integration.

TLU 2.3 Summary - Electric Public Transit Bus Fleets



TLU 2.4 Electric and Alternative-Fuel Municipal Fleets

ACTION: Develop an electric and alternative-fuel vehicle capital transition program for municipal and school vehicles.

Where we are today

Portland and South Portland have substantial fleets of municipal vehicles to run city operations that include passenger vehicles, light-duty trucks, police vehicles, school buses, medium duty trucks, snowplows, fire trucks, refuse collection vehicles, and various specialized heavier duty vehicles. Collectively, the operations of these vehicles contribute to a notable number of vehicle miles traveled; the school buses alone for the two cities account for over 675,000 vehicle miles annually.

Municipal car fleets are an excellent and easy target for electrification, and Portland and South Portland will be able to leverage EV funding from Efficiency Maine and the second round of VW settlement funding to support this transition. Like public transit buses (see action TLU 2.3), battery-electric school buses are also becoming increasingly cost-effective, given decreasing price points, lower maintenance costs, and health and environmental benefits. Currently electric school buses cost around \$230,000, compared to \$110,000 for a diesel bus,⁹⁵ but are predicted to reach cost parity with diesel buses between 2025 and 2030 based on full lifespan costs.⁹⁶ In addition, because of their predictable schedules and the amount of time they sit idle, electric school buses show potential for vehicle-to-grid (V2G) initiatives, whereby buses can support electricity demand response by storing electricity and discharging it back to the grid.⁹⁷

While there are fewer cost-effective alternatives for light duty pickup trucks and medium- and heavy-duty municipal vehicles, electric vehicle technology for these vehicles is improving

rapidly, and will likely be ready for adoption within the next 10-15 years. Ecomaine and the City of Portland will replace diesel-powered waste haulers with electric trucks by the end of 2020. Some medium heavy-duty vehicles, such as snowplows, may be good targets for the use of alternative fuel / biofuel options, such as E85 (flex fuel), biodiesel, or renewable diesel. Given Maine's substantial timber industry, the use of biofuel options for medium and heavy-duty municipal vehicles may have regional economic development benefits in addition to reducing emissions.

Finally, decarbonization of mobile fossil fuel combustion also should include addressing small motor equipment—including gas-fired leaf blowers, lawn mowers, and other land care equipment used for municipal open space maintenance. In addition to generating greenhouse gas emissions, the two-stroke engines used by such equipment produce higher levels of criteria pollutants and particulate matter that represent a public health concern for both workers and residents, in addition to their high decibel noise levels. Other jurisdictions are moving quickly on this issue—it's estimated that over 100 U.S. cities and the District of Columbia have banned gas-powered leaf blowers.⁹⁸ California and Illinois are also considering statewide bans to phase out leaf blowers by 2022.

The action we will take

By 2022, Portland and South Portland will each create an electric vehicle capital transition program for municipal light-duty vehicle fleets and school buses. The rate of transition for each type of fleet vehicle will be largely driven by their lifespan.



SCHOOL BUSES AT THE BROWN SCHOOL • Photo by Denise Michaud

School buses have a lifespan of around 15 years, and so should be electrified on the same timetable as public buses (see action TLU 2.3), with no new diesel buses purchased after 2025. Light-duty vehicles in municipal fleets have a seven-year lifespan; all new or replacement light-duty vehicles purchased after 2032 would need to be battery-electric vehicles in order to achieve a zero-emissions fleet by 2040. The transition of each type of fleet vehicle will start with a pilot (the purchase of one or two vehicles) to test how they perform, followed by phased purchases to meet the timeline.

Heavy-duty vehicles also have long lifespans, but the replacements for those various vehicle types are either not mature or require further study. Over the next few years, we will continue to research the market landscape for battery-electric and/or alternative fuel medium- and heavy-duty electric vehicles (such as garbage trucks and snow management equipment), and local biofuel supply, and develop an electrification or alternative fuel plan for these vehicle types.

Pilot projects to test various vehicle solutions will be explored as we continue to monitor this market.

To support widespread EV use, charging depots will need to be installed at various schools and city lots, along with DC fast chargers at central locations. We will continue expanding the number of level 2 EV chargers in all city-owned parking garages (see action TLU 2.1). For school buses, we will also explore the various options for using the buses as mobile battery power banks for vehicle-to-grid initiatives to shave electricity demand peaks, which would provide additional income streams for the schools. However, the feasibility of this in practice may vary and the timing may not align, as peak grid demand is often late in the afternoon or early evening, right when buses are either on the road or just returned.

The capital plan for municipal vehicles will also address the electrification of land care equipment wherever feasible. Portland has already prioritized a transition to electric small

motor equipment; South Portland will pursue a similar transition. We will aim to eliminate all gas-powered leaf blowers by 2023 and prioritize the electrification of other small motor equipment based on when cost-effective electric alternatives come on the market.

Our next steps

- ☐ By 2022, develop EV capital transition programs for school buses and light duty vehicles.
- ☐ Continue building out networks of charging infrastructure needed for municipal electric fleets, including buses and light duty vehicles in alignment with the capital transition program.
- ☐ Explore additional pilots for medium- and heavy-duty electric or alternative fuel vehicles.
- ☐ Collaborate with the State on the utilization of VW settlement funds to support the transition to electric municipal fleets, and pursue additional federal or state funding for vehicle electrification, including investigating vehicle-to-grid integration.
- ☐ Support training for mechanics and technicians in electric bus and vehicle maintenance.

TLU 2.4 Summary - Electric and Alternative Fuel Municipal Fleets

PRIMARY COMPONENTS	How this strategy advances a future that is...		
	Equitable	Regenerative	Resilient
	a b c d (a) Addresses injustice — from localized roadway air pollution	a b c d (a) Draws down carbon	a b c d (a) Reduces vulnerability — from localized roadway air pollution
• Create capital transition program for light-duty vehicles and school buses. • Create parallel transition program for small motor equipment. • Pursue alternatives for medium/heavy-duty vehicles when viable.	KEY MILESTONES • All new school bus purchases are electric by 2025 • All new light-duty vehicle purchases are electric by 2032 • Zero-carbon municipal fleets by 2040	CITY STEWARD P: Public Works, Sustainability Office SP: Sustainability Office, Public Works	FINANCING MECHANISMS Efficiency Maine incentives/ VW settlement funds, lease-purchasing, demand aggregation via Climate Mayors Electric Vehicle Purchasing Collaborative, bonds

TLU 2.5 Electric Shared Vehicles and Vehicles for Hire

ACTION: Expand the use of shared electric vehicles, promote electric vehicle use by taxis and other vehicle-for-hire companies, and set a requirement that by 2030 all rideshare vehicles must be electric vehicles.

Where we are today

Car-sharing helps to decrease the use of private passenger vehicles, thereby reducing congestion, greenhouse gas emissions, and local air pollution. Vehicle share programs with electric vehicles (EVs) further decrease emissions, while also helping to increase awareness and familiarity with EVs as a passenger vehicle. Between 2014 and 2019, a large number of cities implemented EV-focused car share programs, including Montreal, San Diego, Los Angeles, Chicago, and Indianapolis. Unfortunately to date, a significant number of these programs have not been successful. These failures are as tied to the difficulty of shared vehicle programs as to the specific operational challenges of using EVs in these programs.⁹⁹

Unfortunately, to date, ridesharing has not shown the same benefits for emissions reductions as car-sharing. Research finds that rideshares tend to contribute to congestion, lead to higher vehicle miles traveled (VMT) to serve the same number of people, and displace other lower-carbon types of transportation, including walking, biking, or public transit—ultimately leading to more greenhouse gas emissions.¹⁰⁰ Nevertheless, encouraging rideshares to transition to electric vehicles can greatly reduce the carbon impact of these trips. Cities have seen success in encouraging taxi operators to transition to EVs through issuing new taxi licenses preferentially to operators with EVs. However, cities must support those taxi drivers with sufficient charging infrastructure (see action TLU 2.1) for this type of program to operate.

Vehicles operated by independent ride-hailing drivers and managed by transportation network companies (TNCs) represent a significant subgroup of private vehicles transitioning to EVs in the near future. A move to electric vehicles is starting to become a stated goal of some ridesharing companies—in June 2020, Lyft announced that by 2030, all Lyft rides will be in electric vehicles.¹⁰¹ TNCs have also signaled their intentions to transition their independent driver networks to driverless fleets as soon as possible, expressed through their autonomous vehicle (AV) research and development partnerships with vehicle manufacturers; AVs are discussed further in action TLU 2.6.

The action we will take

In the immediate term, to encourage taxi companies and other vehicle-for-hire companies to adopt electric vehicles, we will assess options for offering structural incentives in the permitting and licensing process, such as increased availability or reduced cost of licenses. We will support the success of this initiative with expanded charging infrastructure, and in particular DC fast chargers, as discussed in action TLU 2.1.

By 2030, we will require that any TNCs operating ridesharing services in Portland and South Portland use all-electric fleets of vehicles, regardless of vehicle ownership.

In the meantime, we will continue to monitor efforts in other jurisdictions and by private companies to offer electric vehicle car-share services. While this market has not shown viability yet, it still holds promise for the future. Partnering to offer a car-share fleet that is predominantly EVs will remain a long-term objective of Portland and South Portland.

Our next steps

- ☐
- Offer incentives for taxi drivers and shuttle services to operate EVs through increased availability or reduced cost of licenses, and support EV use with increased DC fast charging infrastructure.

TLU 2.5 Summary - Electric Shared Vehicles and Vehicles for Hire			
PRIMARY COMPONENTS ● Assess options for incentivizing EV use among taxis and hired vehicles. ● Reassess national market for feasibility of electric car sharing fleets by 2026. ● Mandate that all TNC rideshare vehicles must be EVs by 2030.	How this strategy advances a future that is...		
	Equitable	Regenerative	Resilient
	a b c d (a) Addresses injustice — from localized roadway air pollution	a b c d (a) Draws down carbon	a b c d (a) Reduces vulnerability — from localized roadway air pollution
	KEY MILESTONES ● All TNC rideshare vehicles are electric vehicles by 2030	CITY STEWARD - P: Sustainability Office - SP: Sustainability Office	FINANCING MECHANISMS N/A

TLU 2.6 Autonomous Vehicles

ACTION: Implement changes to curb and parking designs to incentivize shared autonomous vehicles, and advocate for state requirements that any autonomous vehicles must be electric and shared.

Where we are today

While autonomous vehicles (AVs) are unlikely to arrive en masse in the near term, they are very likely to arrive during the thirty-year timeframe of the One Climate Future plan. Unfortunately, studies of AV proliferation show that AVs will not necessarily reduce greenhouse gas emissions. If everyone uses their own AV—particularly if it drops you off, drives home, picks you up, and drives home again—it will contribute to significantly higher vehicle miles traveled, greenhouse gas emissions, and vehicle congestion.¹⁰² If AVs are electric and all electricity comes from renewable sources, then we can reduce the associated greenhouse gas emissions, but the grid impacts may be substantial. Private AVs would also continue to amplify congestion, increase parking demand, and work against our goals for more equitable transportation systems.

Thus, the two factors that will determine if AVs can effectively support our One Climate Future goals are whether they are battery-electric vehicles, and whether they are shared. If AVs are electric and shared, then they can reduce vehicle miles traveled, reduce emissions, reduce vehicle congestion, improve fluidity of traffic flow, and reduce land use for parking—contributing to more compact and transit-supportive land uses. Although rideshare services to date have been linked to higher greenhouse gas emissions, AV partnerships between TNCs and vehicle manufacturers have the potential to shift the private automobile market from an ownership model to a shared or subscription-based model.

The two factors that will determine if autonomous vehicles can effectively support our One Climate Future goals are whether they are battery-electric vehicles and whether they are shared.

Governments will play a large role in determining whether future AVs are shared and electric, even if inadvertently. This influence will come not only through direct vehicle regulations, but also through the incentives created by city land use, street planning, and parking policies. Therefore, long term climate planning must consider the multiplicity of influences on an AV future. And even if the promise of AVs never comes to fruition, the actions laid out here will also benefit the sharing of human-driven shared electric vehicles discussed in action TLU 2.5.

The action we will take

While the widespread use of autonomous vehicles may be five or ten years away at least, the steps taken now will lay the framework for a future with AVs. It is therefore important to establish, as soon as possible, expectations and requirements that AVs should be EVs, and use a shared ownership model to the greatest extent possible. At the state level, we will advocate



LIGHT TRAILS ON I-295 • Photo by Corey Templeton

for any permits for AVs to be limited to electric AVs. We will also work with the State to ensure that state and local laws pertaining to the operation of AVs necessitate that AVs adhere to laws and plans that protect people walking and bicycling in the public right-of-way—Portland has already begun to do this in pilot projects. In our cities, we will also plan for the adoption of AVs through the following approaches:

- Prioritizing space for safe and efficient drop-off and pick-up.** Road design that caters to safe and efficient passenger drop-off and pick-up is important for increasing the viability, safety, and efficiency of bus transit, rideshare services, as well as potential future AV use. Improved street and curb design that promotes drop-off and pick-up will help facilitate and incentivize a shared AV ownership model, where the AV at no point stays with the vehicle user. We will adjust the Cities' technical manuals, including the Complete Streets Planning

and Design Manual (see action TLU 1.4), to phase in allocations of more curb space for passenger loading, rather than parallel parking. On roads with bike lanes or transit service, we will amend loading zone design standards to reduce conflicts with active transportation and high-occupancy vehicles. We will also reflect these shifts in roadway design in our zoning ordinances, by increasingly prioritizing the provision of pick-up and drop-off zones for new construction. Once AVs are widely adopted, we will monitor curb space utilization by time and type of use to assess how it is currently used, and where it can be re-assigned, priced, or regulated to encourage higher occupancy motor vehicle travel, especially by AVs.

- Integrating projections for AV adoption in parking planning and policy.** The Cities will also continue to evaluate our parking policies, knowing that AVs are expected to dramatically impact both parking demand and how land

is prioritized and allocated for parking. AVs can park in much tighter spaces, leading to more efficient use of space and smaller parking lots. Furthermore, AVs would not need to park near the destination of their passengers, and shared AVs, in particular, would rarely park. These patterns would lead to large reductions in demand for surface parking lots and garages, particularly where land values are high.¹⁰³ Therefore, under a scenario with widespread AV adoption, the requirement of minimum car parking per individual property may become obsolete—a point that the Cities will keep in mind when considering parking demand management through adjustments to parking policy (see action TLU 1.6).

● **Exploring deployment of electric AV pilots as ground vehicles at the Jetport.** We will explore opportunities to deploy autonomous electric vehicle pilots at the Portland International Jetport (see action TLU 3.5) or other controlled sites with predictable routes in order to help test and increase public comfort with the new technologies.

Our next steps

- ☐ Advocate for any permits for AVs in the state be limited to electric AVs, and for policies to incentivize shared AV models.
- ☐ Advocate that the State ensures that laws for AVs protect people walking and bicycling in the right of way, and reduce conflicts with active transportation and high-occupancy vehicles.
- ☐ Adjust road design manuals and policies to phase in the repurposing of curb space for passenger loading, rather than parking, and incentivize or mandate passenger loading zones at new developments.

TLU 2.6 Summary - Autonomous Vehicles

How this strategy advances a future that is...			
PRIMARY COMPONENTS	Equitable	Regenerative	Resilient
- Continue to adapt curb and parking standards for safe and efficient drop-off, considering AVs. - Advocate at the state level for AV permits to be limited to electric AVs. - Work with state to ensure protections for pedestrian use of roadways.	a b c d (a) Addresses injustice — from localized roadway air pollution	a b c d (a) Draws down carbon (c) Supports a circular economy	a b c d (a) Reduces vulnerability — from localized roadway air pollution
	KEY MILESTONES State requirement that all AVs be electric in place by 2030	CITY STEWARD P: Sustainability Office SP: Sustainability Office	FINANCING MECHANISMS N/A

TLU 3

Transportation Infrastructure



CASCO BAY LINES FERRY TERMINAL • Photo by Corey Templeton

TLU 3.1 Idling Reductions

ACTION: Reduce vehicle idling through anti-idling policies, vehicle technology, and improved intersection design.

Where we are today

Gasoline-powered personal vehicles in the United States have shown to generate roughly 30 million tons of carbon dioxide annually merely by idling.¹⁰⁴ While this volume is relatively small at the scale of a single car, if all cars in the United States were to eliminate unnecessary idling, the impact would be similar to taking five million vehicles off the road. Turning off and on a vehicle can save emissions whenever the vehicle is idling for over ten seconds.¹⁰⁵

Portland and South Portland have anti-idling policies in place and have piloted anti-idling technologies in municipal vehicles. However, in both cities, the policies have not been uniformly

enforced and technologies have not led to reductions of idling in practice. In other cities, anti-idling policies, often with 3-to-5-minute limits, have become more common for private commercial vehicles. These are particularly important tools in areas where lines of private vehicles sit and wait, such as at schools, ports, other freight depots, and on the Casco Bay Bridge.

Advances in vehicle technology, including telematics, auxiliary power, vehicle calibration devices, and idle management systems, can dramatically support compliance with these policies. Increasingly, anti-idling technology has been installed

in light duty vehicles to help meet federal fuel economy standards—you may have noticed this in your own car. Municipalities have also begun adopting fleetwide policies and pilots to expand the use of anti-idling technology in older vehicles—with promising results. Washington, DC; Columbus, OH; and Santa Barbara County, CA, for example, have installed anti-idling software in their police fleets and found significant cost savings from reduced fuel consumption and returns on investment in under a year.¹⁰⁶ Clark Public Utilities in Vancouver, WA installed anti-idling technology across their fleet of man-lifts and cargo vans as an approach to additionally extend engine life and reliability. On-board electric heaters can heat vehicles like school buses more efficiently than by idling, eliminating the need for the 10-minute window in cold temperatures.

In addition to anti-idling policy and technology, roadway design and transportation infrastructure can play a role in creating more fluid transportation patterns, reducing time spent at traffic lights, stop signs, and stopped in traffic, thereby reducing vehicle idling time. Modern roundabouts—which are compact, one-way, circular intersections that direct traffic around a center island (and where all incoming traffic yields to traffic within the circle)—are now considered to be one of the safest and most efficient traffic control systems under many circumstances, and also effective at reducing vehicle idling time and fuel consumption. Neighborhood traffic calming circles, whereby vehicles are directed around a small island, are likewise an effective traffic calming technique that can reduce idling and fuel consumption compared to stop signs or speed bumps.

Adaptive signal control technology (ASCT) is an additional technology-based approach to improve the efficiency and flow of traffic. Coordinated traffic lights with ASCT can respond to traffic patterns to optimize vehicle flow in real time. Conventional traffic signals are programmed based on usual traffic patterns for the day and time. Adaptive traffic signals use cameras and sensors to gather data and can adjust signal length and timing to address real-time traffic demand. The software also communicates with coordinated traffic signals to sync lights within a corridor. Portland is currently piloting

ASCT in critical corridors—new adaptive signals were installed at Morrill’s Corner on Forest Avenue in 2018 and on Franklin Street in 2019. The Federal Highway Administration reports that ASCT generally improves travel time on average by over 10%, and at Morrill’s Corner in Portland, the signal technology has reduced travel time by 16% to 20%.¹⁰⁷ Traffic light optimization also can yield improved travel times for public buses, as discussed in action TLU 1.1. PACTS is also investing in the first phase of a Regional Traffic Management System. As of 2017, the project is in phase 3, working with Scarborough and Gorham, and funding has been allocated to evaluate 125 signals throughout the region.¹⁰⁸

While improving the flow of traffic can directly reduce emissions from vehicle idling, it is important to consider the macro effects on transportation patterns that influence net greenhouse gas emissions. As documented by researchers at Portland State University in Portland, OR, emissions saved from reduced idling and more fluid traffic patterns have shown to be offset by behavior change, particularly increased driving prompted by lower levels of congestion.¹⁰⁹ For this reason, changes in roadway design where relieving traffic is not the primary intention (such as implementing neighborhood circles as opposed to stop signs for traffic calming) will likely be most successful as a greenhouse gas mitigation tactic. From a greenhouse gas mitigation standpoint, modern roundabouts and ASCT technology may be best implemented only when there are also significant safety gains for pedestrians and bicyclists, or efficiencies in public transportation routes.

The action we will take:

Portland and South Portland will reduce vehicle idling in the cities through anti-idling policies and anti-idling vehicle technology. We will also consider the effects of idling and associated greenhouse gas emissions when updating roadway intersections. Specific elements will include:

- **Anti-idling technologies and policies for public vehicles.** Portland and South Portland will assess the feasibility of installing anti-idling technologies in city vehicle fleets, focusing on fleets that could benefit the greatest from such

technology, such as the Cities’ patrol cars. (Anti-idling systems can automatically turn off the engine after a set time, while still leaving all auxiliary equipment running—such as two-way radios and scanners.) Based on feasibility, the Cities will launch a pilot, integrating anti-idling systems into a set number of vehicles to assess the fuel and greenhouse gas emissions savings, cost-effectiveness, and equipment performance. Based on the pilot, the Cities will determine whether to integrate anti-idling technology across city fleets. We will also investigate supplemental heating for public buses and school buses to reduce the need for idling in colder weather. It should be noted that the Cities’ transition to electric buses as well as fully electric municipal fleets will make idling in municipal vehicles no longer a concern (see action TLU 2.3), but anti-idling technologies can serve as a cost-effective strategy in the mid-term until fleets are fully electric.

● **Anti-idling zones and policies for private vehicles.**

Portland and South Portland will continue to implement “no idling zones” at specific areas with substantial car idling, such as school drop zones and community facilities. Implementing these zones requires collaboration with facility owners and a public campaign for compliance. The Cities will adopt policy to restrict idling by heavy trucks at the Port and waterfronts.

If all cars in the United States were to eliminate unnecessary idling, the impact would be similar to taking five million vehicles off the road.

As with similar laws in California, terminal operators can implement appointment systems to reduce wait times and work with truckers to reduce lines and the need to idle, which in turn would reduce exposure to fines for idling.

● **Intersection design.** We will institute a policy of considering modern roundabouts and neighborhood traffic calming circles at any construction project to assess the potential implications for idling and greenhouse gas reductions, as well as pedestrian safety. Neighborhood traffic calming circles should be considered for any upgrades to low-volume neighborhood intersections, replacing four-way stops. In addition to slowing traffic, contributing to continuous traffic flow, and reducing emissions related to car idling, calming circles offer opportunities for vegetation and stormwater management. Larger roundabouts should be considered for any intersection with more than two roads meeting or standard two-road intersections with no more than two lanes in each direction.

TLU 3.1 Summary - Idling Reductions			
PRIMARY COMPONENTS	How this strategy advances a future that is...		
	Equitable	Regenerative	Resilient
	a b c d (a) Addresses injustice — from localized roadway air pollution	a b c d (a) Draws down carbon	a b c d (a) Reduces vulnerability — from localized roadway air pollution
	KEY MILESTONES Anti-idling policies to be updated (P) or adopted (SP) and enforced by 2025	CITY STEWARD P: Sustainability Office, Planning Department, & Public Works SP: Sustainability Office, Planning Department, & Public Works	FINANCING MECHANISMS Federal grants (for anti-idling technology)

Lastly, electric vehicles do not produce direct emissions and they consume little power when idling, so all actions in TLU 2 (Vehicle Electrification) will indirectly contribute to this action.

Our next steps

- ☐ Assess the feasibility and areas for greatest impact for implementing anti-idling technology in municipal fleets; Launch a pilot with a small set of vehicles to test cost-effectiveness, fuel and emissions savings, and equipment performance.
- ☐ Increase awareness and enforcement of current municipal anti-idling policies and adopt an ordinance to expand idling limits of 3 minutes (10 minutes when temperatures are below freezing) to all private commercial vehicles (Portland); Adopt an anti-idling ordinance that applies to both municipal and private vehicles (South Portland).
- ☐ Develop workshops with peer communities to educate and help officials and staff overcome ingrained practices around idling.
- ☐ Institute policy to ensure intersection construction or expansion considers greenhouse gas emissions reductions from idling and assesses modern roundabouts, neighborhood traffic calming circles, or improved adaptive street signals in the assessment.

TLU 3.2 Freight Transit Partnerships

ACTION: Partner with large stakeholders in the freight sector to encourage development of a Sustainable Freight Action Plan.

Where we are today

Freight plans need to be updated to meet the needs of the 21st century and promote sustainability. The Maine Department of Transportation (MaineDOT) adopted its latest statewide Integrated Freight Strategy in 2017,¹¹⁰ which does not substantively address sustainability or greenhouse gas emissions. The leading example of integrating climate change and environmental impacts mitigation into freight planning is California's Sustainable Freight Action Plan, which addresses how to reduce emissions and other environmental impacts from ocean-going vessels and trucks.¹¹¹ Regional support for working on freight efficiency is also available through the "Freight Efficiency" project at the Transportation and Climate Initiative (TCI). TCI studies have shown that over 80% of freight in the region is moved through heavy trucks, and thus moving more freight to trains, improving truck efficiency, and in the longer-term, electrifying on-road freight are critical solutions.¹¹²

Given the importance of both marine- and road-based freight shipping to both Portland and South Portland, there is an important role for us in partnering with large stakeholders to develop a Sustainable Freight Action Plan to advance efforts that reduce freight emissions. The electrification of trucking is a critical component to the long-term reduction in freight emissions. Shorter-haul medium duty trucks, such as delivery trucks with frequent stops, are particularly good targets for electrification. In 2019, Washington DC adopted a law requiring any entity with 50 or more vehicles in its fleet to map out an electrification plan and to electrify 50% of their fleets by 2030 and 100% of their fleets by 2045.¹¹³

The action we will take:

Sustainable freight planning is mostly done at the state level, but sometimes undertaken by municipalities or regional planning organizations. Portland and South Portland will advocate for and work with the State to develop a new statewide Sustainable Freight Action Plan. We will also work with GPCOG/PACTS to develop a Sustainable Freight Action Agenda for the region; this regional effort can move faster and set the example for the kinds of goals, targets, and actions needed in the state plan. As part of the Sustainable Freight Action Agenda, we will collaborate with regional transportation planning partners, the TCI Freight Efficiency Initiative, and a subset of commercial entities and freight service providers that have interest in leading the industry in sustainable freight systems.

We will also partner with delivery companies and other short-distance haulers within the cities to explore moving medium and light-duty delivery to electric vehicles, and work with the state and federal governments to seek incentives for this shift. We will support this transition by investing in DC fast charging stations for electric vehicles at key sites that would support delivery companies and other short-distance haulers (see action TLU 2.1). If there is sufficient commercial EV uptake, municipal fast charging can be reserved for commercial vehicles at certain times or locations. (Users will still pay for the electricity, though the efficiency of electric vehicles and the relative short-term predictability of electric rates means they will see lower and more predictable costs.) In the longer term, we will consider requirements for delivery companies to have

EV fleets by a date certain, such as 2040, to the extent allowed by law.

As part of the regional Sustainable Freight Action Agenda, we will also consider where higher polluting truck travel can be replaced with more efficient train travel. The International Marine Terminal (IMT) in Portland is served by rail, but most of the containers use trucks for land transport.

Our next steps

- ☐ Work with regional transportation planning and commercial freight partners to develop city and regional goals and targets for reducing emissions from freight travel as part of a Sustainable Freight Action Agenda.
- ☐ Put conditions on projects for commercial and industrial users that rely on freight, to require that service contracts include anti-idling, preferred routing, and other actions to reduce freight emissions.
- ☐ Advocate for and partner with the state to develop a Sustainable Freight Action Plan for Maine.



I-295 • Photo by John Phelan

TLU 3.2 Summary - Freight Transit Partnerships



TLU 3.3 Ferry Service

ACTION: Work with Casco Bay Lines to transition its fleet to hybrid-electric ferries, and to consider a ferry route connection between Portland and South Portland.

Where we are today

Casco Bay Island Transit District (CBITD), also known as Casco Bay Lines, operates year-round passenger, vehicle, and freight service between the Portland peninsula and the islands in Casco Bay. Ferry service operates 365 days a year, running routes to Peaks Island, Little Diamond Island, Great Diamond Island, Cliff Island, Long Island, and Chebeague Island, as well as Bailey Island in the summer—with a total annual ridership around 1.1 million.¹⁴ The Maine Public Utilities Commission currently allows Casco Bay Lines to have five vessels—all of which are scheduled for replacement within the timeframe of the plan.

Increasingly, ferry systems around the world are exploring hybrid-electric or fully electric ferries, to reduce pollution

and greenhouse gas emissions and to reduce fuel costs. For example, the Washington State Ferries, the second largest ferry system in the world, is planning to switch to fully electric ferries over the next decade.¹⁵ BC Ferries in Vancouver, Canada (the world's third largest ferry system), has purchased new hybrid-electric ferries that will be capable of running entirely on electricity once shore power connections are complete.¹⁶ The United Kingdom government has said all new ferries ordered from 2025 onwards will need to be equipped with zero-emission propulsion technology.¹⁷

For the imminent replacement of the Machigonne II, the Casco Bay Lines Board is currently investigating funding options for purchasing a hybrid diesel-electric ferry. A fully battery-electric

Table 4. Casco Bay Lines Fleet Summary

Vessel	Routes	Operating Hours (2017)	Passenger Capacity	Vehicle Capacity	Vessel Age (2020)	Engine Age (2020)	Scheduled Replacement
Machigonne II	Peaks Island	4,453	399	12	33	11	2020
Maquoit II	Down Bay / Freight	5,000	399	3	26	16	2024
Aucocisco III		3,500	399	0	15	15	2035
Wabanaki		2,150	398	0	7	7	2045
Bay Mist	Back-up/ Charters	345	297	0	35	35	2025

Table information provided by Casco Bay Lines.¹²¹



CASCO BAY LINES FERRY AND BUG LIGHT • Photo by Denise Michaud

vessel would require an 1800 kWh system; the recommended system would be 900 kWh and use battery power for 54% of the power needs.¹¹⁸ This new ferry is estimated to be able to reduce Casco Bay Lines' greenhouse gas emissions by 800 metric tons per year. The City of Portland has worked with PACTS, the State of Maine, and the Federal Transit Administration to help secure funding for the project.¹¹⁹

The action we will take

We will work with Casco Bay Lines (CBL) to transition all future ferry purchases to hybrid-electric ferries, including continuing to support CBL in securing funding for this transition. Beginning with the Maquoit II replacement in 2024, we will advocate for all ferries to be capable of running fully on electric power. We will also support efforts to add a shore power hookup at the terminal that is capable of supporting full electric charging. See action TLU 3.4 for further discussion on shore power. We will also work with Casco Bay Lines to

understand ideal charging times, and advocate with the Public Utilities Commission for utility rates that support electric vehicle charging (as also discussed in action BE 5.3 and TLU 2.1).

Secondly, we will continue to work with Casco Bay Lines, PACTS, Southern Maine Community College (SMCC), and other stakeholders to explore a ferry service between Portland and South Portland—an idea that has garnered interest within South Portland previously based on traffic along Broadway to SMCC. Because of the large number of people a ferry can transport in one trip, ferries on average have higher fuel efficiency per person than a passenger vehicle. A hybrid-electric or electric ferry would make this difference even more significant, unless all passenger vehicles had also transitioned to EVs. The envisioned ferry route would connect downtown Portland and Bug Light Park / SMCC and make it easier to go between the two cities without the use of a car. Currently, cars can take the Casco Bay Bridge and make the same trip in 15-20 minutes; a bike ride via the Greenbelt Pathway takes roughly 20

minutes, and a bus ride on South Portland Bus Service route 21 takes 30 minutes. The ferry trip between the two cities would be most viable if it took less than 30 minutes and was relatively cost-competitive with the bus service.

This route between the two cities could be served by adding a stop on one of the existing Casco Bay Lines routes, or via a new route with a new ferry. Adding a stop on an existing route would be the most cost-efficient strategy, but its feasibility would need to consider vessel size, available docking space, and the impact on existing schedules and passenger needs. Another option would be the acquisition of a new, smaller boat optimized for quick service between the two cities, and capable of using the smaller docks available at existing marinas. If Casco Bay Lines were to offer this service, they would need authorization to purchase a sixth vessel, as their fleet is currently capped at five vessels.

In 2021-2022, as a part of the Unified Planning Work Program (UPWP), PACTS will complete Mill Creek to Cushing’s Point Priority Corridor Study, a planning project for the South

Portland waterfront. This feasibility study seeks to address existing transportation deficiencies between the Casco Bay Bridge and Cushing’s Point and accommodate new development in the Cushing’s Point and Spring Point areas of South Portland. Once complete, this work will transcend previous efforts to evaluate the priority corridor by exploring increased transit service, improve traffic signal operations, and marine transportation to and from Portland.¹²⁰

Our next steps

- ☐ Advocate for all future Casco Bay Lines vessel purchases to be hybrid-electric and capable of operating solely on electricity, and support CBL in securing funding.
- ☐ Include shore power requirements for CBL in any study of shore power (see action TLU 3.4).
- ☐ When complete, the Cities alongside Casco Bay Lines, PACTS, and additional relevant stakeholders will review proposed land and marine improvements to the Mill Creek to Cushing’s Point Priority Corridor outlined in the PACTS UPWP.

TLU 3.3 Summary - Ferry Service

PRIMARY COMPONENTS	How this strategy advances a future that is...		
	Equitable	Regenerative	Resilient
- Support Casco Bay Lines in transitioning to electric ferries. - Assess feasibility of ferry service between Portland and South Portland.	a b c d	a b c d (a) Draws down carbon (b) Restores ecosystems	a b c d (a) Reduces vulnerability — from localized air pollution
	KEY MILESTONES 60% of ferries (three ferries, based on the current fleet of five) run on all electric power by 2035	CITY STEWARD P: Planning Department SP: Planning Department	FINANCING MECHANISMS Federal grants, PACTS funding, Maine Department of Transportation funding

TLU 3.4 Shore Power

ACTION: Commission an engineering study for shore power hookups to allow and eventually require docked ships to connect to electrical service.

Where we are today

We expect to see continuing increases in port activity in the coming years. The number of visiting cruise ships in the Port of Portland increased from 76 to 100 cruise ships between 2016 and 2019, and container shipping more than doubled in the five years between 2013 and 2018.¹²² In the longer term, as Arctic sea ice melts and the Northwest Passage becomes ice free in warmer months, the Port of Portland will become the closest U.S. east coast port to Asia. This proximity will likely lead to an additional increase in container shipping as some vessels that used to go through the Panama Canal to Florida or New York may instead come to the Port of Portland.

Port operations in both cities present a key opportunity for emissions reductions. Currently, ships in port idle their engines or run auxiliary engines for their power needs—producing higher levels of local air pollution (consisting of nitrogen oxides, sulfur oxides, particulate matter, as well as carbon dioxide) due to the nature of the bunker fuels used on board. Cruise ships docked at Portland generate over 4,000 tons of greenhouse gas emissions while docked in Portland, or 0.5% of Portland’s citywide emissions, and roughly equivalent to the emissions for all waste from South Portland. Data on the emissions of tankers docked in South Portland was not available. Under the methodology used for the greenhouse gas inventory, any emissions from ships while at sea beyond the borders of the cities was considered out of scope and not included.

Ports with shore power infrastructure allow marine vessels to plug into the electrical grid and turn off all auxiliary

engines while docked. Depending on the local grid’s mix of energy sources (i.e., how much of the electricity comes from renewables), shore power can reduce pollution emissions by up to 98%. A number of port cities in the United States, such as Seattle, Oakland, Los Angeles, and Brooklyn (as well as Halifax, Nova Scotia) have installed hookups to allow—or even require—docked ships to connect to onshore electrical power instead of idling their engines. In California, current requirements for docked vessels to use shore power apply to container ships, cruise ships, and refrigerated ships, and tankers will be required to connect to shore power between 2027–2029 (depending on the port). These changes have created noticeable shifts in port greenhouse gas emissions and local air quality.

The action we will take

Portland will commission an electrical engineering study of shore power requirements in order to assess the feasibility of providing shore power hookups for cruise ships, container ships, ferries, and other marine vessels. This study would assess power load requirements, including peak load impacts, as well as policy options for reducing peak load. Providing equipment to allow docked ships to hook up to electricity from the shore—and eventually requiring them to do so instead of running main or auxiliary engines—will cut Portland’s carbon emissions from docked cruise ships, in particular, by over 60%. When accounting for citywide emissions, shore power is not

a major source of emissions savings today but will become increasingly significant as we work towards carbon neutrality.

Cruise ships are only docked for a small portion of the year, but while docked, their energy draw is substantial. If two large cruise ships both connected to shore power at the same time, it is estimated that they could add up to 27 MW to the peak electrical load on the Portland peninsula. This peak load could be limited by staggering when the cruise ships connect. Nevertheless, it is highly likely that the electrical demand for all port activity would surpass the capacity of the one main electrical feeder line to the peninsula and necessitate a second feeder line. With full electrification of the building stock on the peninsula, however, (see actions BE 2.1, BE 3.4, and BE 5.6), one or more new feeders will likely be needed regardless.

As noted in action TLU 3.3, Casco Bay Lines is currently in the process of procuring its first hybrid diesel-electric ferry, and the One Climate Future plan further recommends that future additions to the fleet be capable of running solely on electricity

once sufficient charging infrastructure is in place. The Casco Bay Lines preliminary design review and battery optimization study found that to recharge the batteries during limited docking time would require a load draw of 1.2 MW. It can be assumed that not all four main ferries would need to charge at the same time, but if they did, this would result in 4.8 MW of additional demand.

The shore power feasibility assessment will assess both technical options for meeting shore power demand across waterfront uses, including required infrastructure investments to the electrical grid, as well as policy options for reducing peak load.

Our next steps

- ☐ Commission an electrical engineering study of shore power requirements for the Portland waterfront, including peak load impacts and policy options for demand management (Portland).

TLU 3.4 Summary - Shore Power

How this strategy advances a future that is...			
Equitable	Regenerative	Resilient	
a b c d	a b c d (a) Draws down carbon (b) Restores ecosystems	a b c d (a) Reduces vulnerability — from localized air pollution	
PRIMARY COMPONENTS	KEY MILESTONES	CITY STEWARD	FINANCING MECHANISMS
- Commission engineering study of shore power requirements (Portland). - Work with Casco Bay Lines to install shore power for ferries (Portland). - Work with PUC, Central Maine Power, and Port to install shore power for cruise ships (Portland).	- Shore power for full ferry fleet installed by 2040 - Shore power for cruise ships installed by 2040	P: Sustainability Office, Planning Department, Facilities SP: Sustainability Office, Planning Department	Utility cost recovery, port user fees, VW settlement funds, federal/state grants

ACTION: Reduce greenhouse gas emissions from the Portland International Jetport through benchmarking and tracking, and through decarbonizing ground vehicles.

Where we are today

The Portland International Jetport (PWM) is already a regional leader in sustainability and has invested substantially in energy efficiency and renewable energy as part of its recent expansion. The new \$75 million terminal for the Jetport and associated parking facility includes the state's largest geoexchange/ground-source heat pump (GHX) installation, and the largest solar array in the state of Maine. (See action BE 5.4 for more on GHX systems.) PWM was the first large airport in the United States to utilize GHX for heating and cooling. The system includes 120 500-foot wells, dug beneath a parking lot, and is designed to reduce the Jetport's consumption of oil by over 50,000 gallons per year. Based on these fuel savings, PWM expects to save more than \$160,000 in heating costs (in addition to further cost savings from reduced cooling loads), as well as reduce the Jetport's carbon dioxide emissions by 1,000 tons per year. Portland has also seen electrical load reductions from the solar array on top of the parking garage.

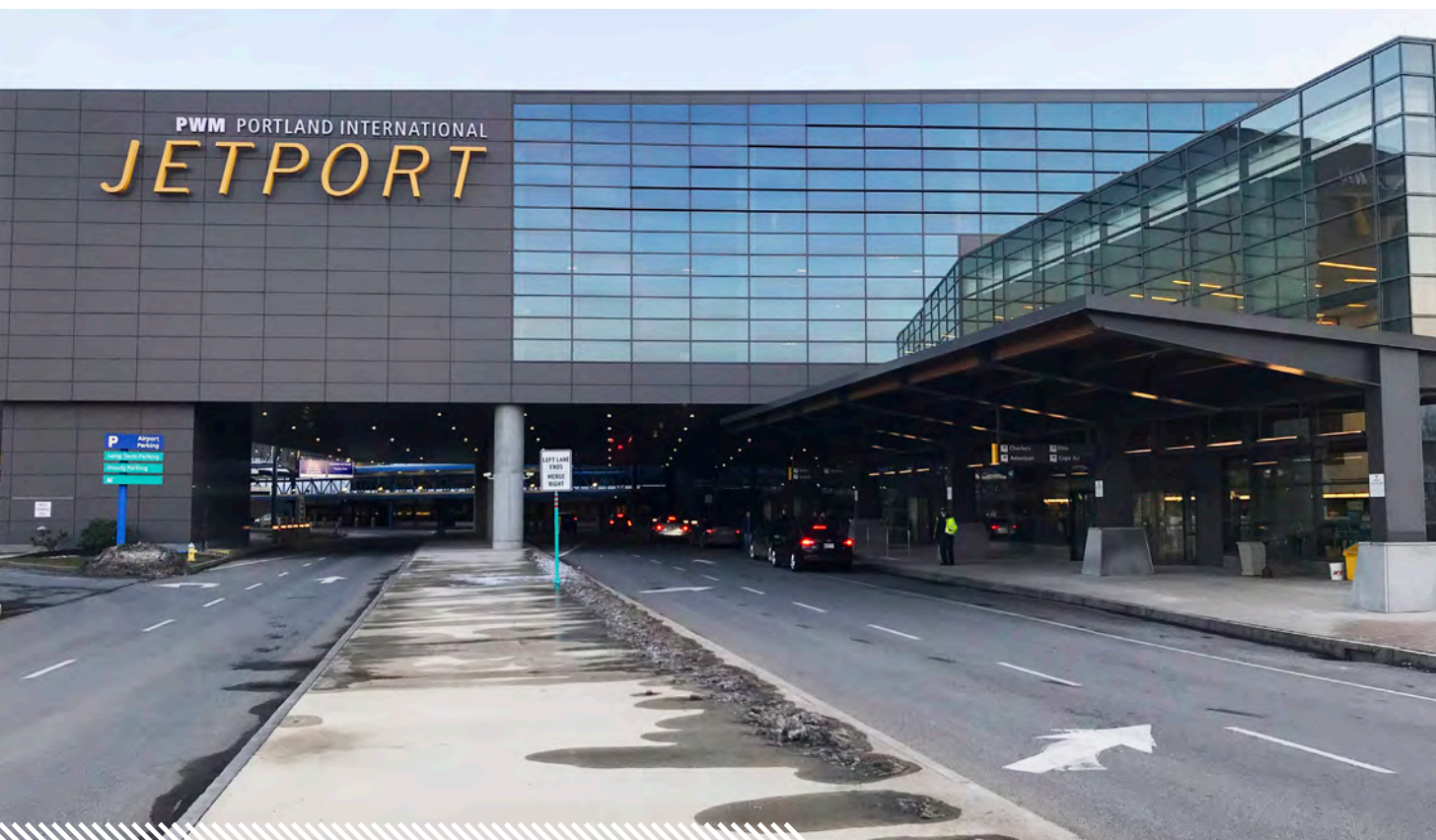
The PWM Sustainable Airport Master Plan reviews the suite of actions the Jetport has taken to reduce energy use, including not only the GHX and solar system, but also improving windows and insulation, installing LED lighting, and establishing better energy management practices.¹²³ Additionally, as of 2018, the airport is capturing and recycling deicing fluid, creating a closed-loop process that reduces effluent and water pollution—not only from PWM itself, but also by selling recycled deicing fluid to other airports. This is the first deicing fluid recycling operation at any U.S. airport.¹²⁴

As part of One Climate Future, Portland and South Portland completed updated greenhouse gas inventories in line with global standards under the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) BASIC framework. Under this framework, the transboundary emissions of aircraft in the air are not counted towards Portland and South Portland's emissions. To identify actions that will have a measurable impact toward the Cities' greenhouse gas reduction goals, Jetport actions focus on the decarbonization of building and ground transport energy use. These actions align with and build on many of the next steps highlighted in the PWM Sustainable Airport Master Plan.

The action we will take

The recommendations for this action represent steps the Jetport could take to build on past success, and further reduce emissions from buildings and ground transport, many of which are already identified in the Sustainable Airport Master Plan:

- **Purchasing renewable electricity in a municipal power purchase agreement (PPA).** The Jetport, which is owned by the City of Portland, is included in the City's electricity procurement, and thus will be included in any municipal bulk purchasing for renewable power (see action BE 1.1). The next bulk purchase agreement will therefore contribute to a decrease in the Jetport's greenhouse gas emissions from its electricity usage.



PORTLAND INTERNATIONAL JETPORT • Photo by AutoRentals

• **Improving the energy efficiency of the older portion of the terminal.**

The Sustainable Airport Master Plan calls for an evaluation of methods for improving the building envelope of the older portion of the terminal and converting the older portion's heating and cooling system to run on an expanded GHX system, as implemented in the new terminal building. The use of a GHX system could integrate with the existing radiant heat system, which currently heats nearly 50% of its space.¹²⁵ Renovating the heating and cooling for the old terminal is probably the most impactful action that can be taken at PWM, but also one of the most capital-intensive. In the short term, retrocommissioning existing systems at the old terminal is advisable.

• **Decarbonizing ground support vehicles.** Ground support vehicles and ground transportation can be decarbonized by transitioning to battery-electric or alternative biofuel sources. The PWM Sustainable Airport Master Plan aims to “encourage tenants to procure alternative fuel and/or fuel efficient ground support equipment” and notes that incentives such as

preferred facility locations or other financial discounts could be helpful.¹²⁶ We will aim to shift at least 50% of airport shuttles and ground support vehicles to alternative fuel vehicles by 2030, and all ground vehicles should be electric or use biofuels by 2040. As autonomous vehicles (AVs) become more feasible, they should be piloted for ground shuttles and other ground transportation—see action TLU 2.6 for more discussion on AVs.

• **Applying the “Airport Carbon Accreditation”**

framework. The Jetport will explore using the “Airport Carbon Accreditation” (ACA) framework to track, optimize, and reduce facility and transportation emissions. Under this framework, the airport will track all emissions within the airport's operational boundary, including third party operators such as ground support for individual airlines, and then set and achieve reduction targets. By 2030, the Jetport could aim for the “optimization” or “neutrality” certification level, which involves reducing ground transport emissions, and then offsetting any remaining emissions within the airport's control.¹²⁷

● **Increasing knowledge transfer within municipal staff.**

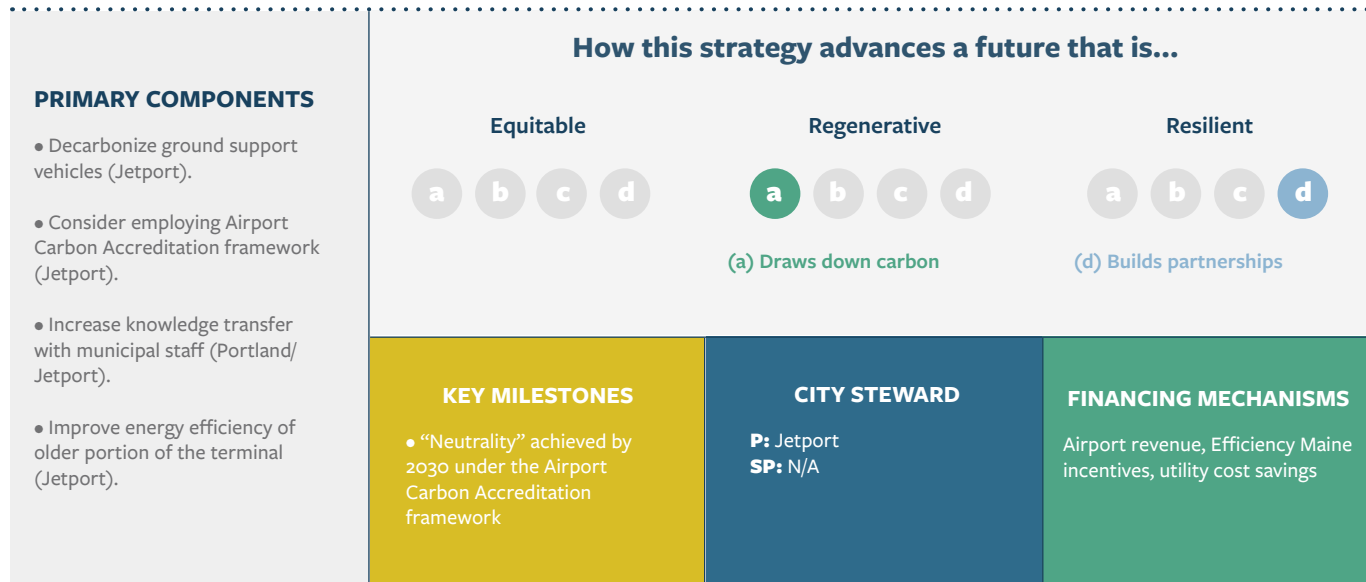
There is much that other City of Portland departments can learn from the work done at PWM. Increasing exchange of information between PWM and other City departments will help achieve the municipal goals set in action BE 1.3.

Our next steps

- ☐ As identified in the Sustainable Airport Master Plan, initiate retrocommissioning of existing HVAC equipment at the old terminal, and commission engineering analysis for converting the heating and cooling for the older portion of the terminal to use GHX, increasing the size of the GHX field, and improving the building envelope (Jetport).
- ☐ Utilize the Airport Carbon Accreditation framework to assess the full scope of airport greenhouse gas emissions and to target reductions, aiming for “optimized” or “carbon-neutral” emissions by 2030 (Jetport).

- ☐ Launch knowledge-sharing conversations around energy and sustainability between City of Portland department leadership and staff and the PWM leadership and facilities staff; ensure PWM is included as a stakeholder in the strategic energy master planning (see action BE 1.3) (Portland/Jetport).
- ☐ Introduce incentives to encourage tenants to procure electric or alternative fuel ground equipment (Jetport).

TLU 3.5 Summary - Jetport



One Climate Future Strategies

CR CLIMATE RESILIENCE



Climate Resilience

The Climate Resilience strategies focus on strengthening the ability of our communities, economies, infrastructure, and ecosystems to respond to climate hazards such as sea level rise, more extreme storms, and warming temperatures. They include approaches for incorporating climate data and resilience metrics into our planning processes, strengthening local food systems, and addressing issues such as housing affordability and transportation access to reduce vulnerability for communities in Portland and South Portland.

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CR 1 PAGE 204

Resilient Buildings and Neighborhoods

Includes resilience zoning and building standards, resources for resilient building retrofits, and the integration of resilience goals in open space planning.

CR 2 PAGE 214

Strong and Healthy Communities

Includes affordable housing, resilient food systems, transportation access, neighborhood resources, and mitigating the health impacts of high heat.

CR 3 PAGE 228

Resilient Local Economy

Includes strategies to enhance the resilience of the working waterfront, strengthen employment pipelines, and support “climate-ready” businesses and industries.

CR 4 PAGE 237

Resilient Infrastructure

Includes strategies to strengthen the resilience of transportation, stormwater/sewer, green infrastructure, and energy systems.

CR 5 PAGE 249

Ecosystem Resilience

Includes strategies to build the health of marine, freshwater, and land ecosystems, as well as soil health.

For further discussion on climate hazards and vulnerability in Portland and South Portland, see pages 30-33, as well as the One Climate Future vulnerability assessment at oneclimatefuture.org.

CR 1

Resilient Buildings and Neighborhoods



BACK COVE PARK • Photo by Corey Templeton

CR 1.1 Resilient New Development

ACTION: Integrate resilience standards and targets into Portland and South Portland’s land use code to minimize flood risk and promote resilient buildings and neighborhoods citywide.

Where we are today

Due to increasing precipitation and sea level rise, portions of Portland and South Portland are expected to increasingly flood over the next thirty years. If we choose to develop flood- and inundation-prone areas, our cities would likely face higher rates of property damage; greater risk to health and safety; higher costs to repair and maintain city infrastructure; and more strain on city resources. We have the opportunity now to guide future development to reduce that risk from coastal flooding.

To help manage flood risks, both Portland and South Portland currently participate in the Federal Emergency Management Agency’s (FEMA) National Flood Insurance Program (NFIP). Under the NFIP, municipalities must adopt and enforce

floodplain management ordinances that define building standards for new and existing development in zones with high flood risk (which in turn makes residents eligible to purchase NFIP flood insurance and to receive disaster assistance for flood-related damage). The Flood Insurance Rate Maps (FIRMs) for Cumberland County were updated in 2017, but adoption of the new FIRMs, and corresponding updates to the Cities’ ordinances, are still pending in both cities. While the FIRMs detail the areas that will likely be inundated in the current 1% and 0.2% annual chance floods, they do not project what those inundation areas might look like with sea level rise. Cities are legally allowed to establish their own floodplain management ordinances as long as they meet or exceed state and federal requirements.

What is zoning?

Zoning is the process of dividing land in a jurisdiction into areas with unique standards and regulations governing land use, development, investment, design, and other parameters cities use zoning to manage development, protect natural resources, promote desirable forms of community development, and create livable neighborhoods. Portland and South Portland have robust zoning ordinances that govern land use and activity throughout each city. Zoning is an essential regulatory tool for adaption to and mitigating the effects of climate change.

Cities throughout the country are also adopting resilient zoning overlays as a further zoning tool to address coastal flood risk posed by sea level rise and to guide more resilient urban development. Zoning overlays are special zoning districts that are applied on top of (i.e., in addition to) the city's existing base zoning, making it possible for cities to address certain conditions (such as flood vulnerability) across a specific area that does not necessarily align with the boundaries of the base zones. In the case of resilience zoning, overlays become a way for cities to set requirements or incentives in ways that align with the spatial extent of climate hazards. There's a tendency, however, to only focus on areas with the highest flood risk when designing resilience overlays, which misses an opportunity to use the rest of the city as part of an integrated system for increasing resilience. To collectively address coastal flooding, high heat, and storms, resilience zoning can be implemented through a set of resilience overlays, differentiated based on the relative exposure to climate hazards and respective adaptive responses required for different areas of the cities. Portland drafted an initial proposal for a Coastal Resilience Overlay in 2019, which will serve as the starting point for this strategy in Portland.

The action we will take

Portland and South Portland will update the Cities' zoning codes and development review process to ensure that all future development enhances the resilience of the cities. All new buildings and developed sites must help to minimize the collective impact of climate hazards in the cities from sea level rise, more intense storms, and higher temperatures, as well as help to protect and strengthen community and ecosystem assets that contribute to resilient cities. To meet those goals, revisions to the zoning ordinances and development review processes—as well as future updates to the Cities' comprehensive plans—will prioritize the following objectives:

- a. Incentivizing higher density construction in areas with no or low flood risk, while preventing development of hazardous, vulnerable, or incompatible uses in areas with high flood risk;
- b. Encouraging neighborhoods that cluster a diversity of housing types within walking distance to goods and services and in connection to public transportation;
- c. Preserving and expanding productive green space and green infrastructure systems on both public and private land to capture and retain stormwater and to mitigate heat;
- d. Preserving and increasing open space for food production, including community gardens, urban agriculture, food forests, and other forms; and
- e. Maintaining and enhancing stream and shore buffers and protection of critical ecosystems.

Portland and South Portland will adopt resilience zoning overlays as one mechanism to advance the above objectives. These resilience overlays would either require or incentivize all new development within the overlay to meet baseline resilience standards—to address coastal flooding, more intense storms, or higher temperatures—based on the potential climate risk exposure of the given site. At least one resilience overlay will identify areas of the cities with the highest flood risk from sea level rise and storm surge; ideally the boundary of this zone

will be defined by new modeling that looks at the combined effects of storms and sea level rise. (See Part 1 of Appendix C: “Memorandum: Resilience Zoning for Resilient Buildings and Land Use” for further details.) To allow for flexibility in how developers meet the resilience standards, the Cities will consider integrating a performance-based requirements into the development review process. Through this mechanism, new development would earn points for integrating resilience features, and projects would be required to meet certain point thresholds. New buildings in the resilience overlay with the highest flood risk would be required to specifically earn points by elevating the building, for example, while developments outside that overlay would have more flexibility in how they meet resilience targets. (See Part 2 of Appendix C: “Memorandum: Resilience Zoning for Resilient Buildings and Land Use” for further details.) The Cities will be evaluating a number of scenarios and approaches for resilience overlays. The two overlay tiers below represent one potential scenario that the Cities will evaluate:

● **Resilience Overlay Tier 1: Areas with the Highest Flood Risk.** Tier 1 would apply to areas of the cities with the highest flood risk from sea level rise and storm surge. Land use decisions within this resilience overlay would align with the following hierarchy:

Priority 1: Preserve existing open space areas as critical assets to buffer and absorb flood- and stormwater.

Priority 2: Seek opportunities to transition existing land uses to living shorelines or public parks with a primary focus on floodable open spaces in an effort to restore natural floodplains and expand coastal wetlands.

Priority 3: Encourage development of compatible land uses, as described further below.

Any new construction in these areas would be reserved for non-residential and “flood-tolerant uses” that do not fall into a list of incompatible, vulnerable, or hazardous uses, and that meet minimum resilient building design requirements. Such incompatible, vulnerable, or hazardous uses would include any building types that provide permanent or temporary shelter (e.g., houses, apartments, nursing homes, shelters, hotels,

All new buildings and developed sites must help to minimize the collective impact of climate hazards in the cities from sea level rise, more intense storms, and higher temperatures, as well as help to protect and strengthen community and ecosystem assets that contribute to resilient cities.

etc.) which amplify the need for evacuation and emergency response in a flood event; critical facilities (e.g., critical government buildings, emergency management services, hospitals, schools, etc.); and commercial and industrial uses that could create cascading repercussions if exposed to flood waters (e.g., those with hazardous chemical storage).

● **Resilience Overlay Tier 2: Areas with High to Moderate Flood Risk.** Tier 2 would apply to areas of the cities that fall outside Tier 1, but could see flooding from sea level rise and storm surge under more extreme storms and sea level rise scenarios by 2100. New construction in these zones would either be required or incentivized to demonstrate adaptation measures to future sea level rise and storm surge scenarios as part of reaching the baseline resilience point threshold.

Areas outside the first two overlays are not vulnerable to flooding from sea level rise and storm surge, but will still feel the effects of higher intensity rainstorms and higher temperatures, and can help the cities adapt to both these stresses. Requiring or incentivizing action in only the two overlay zones misses the opportunity to use the rest of the city as part of an integrated system for increasing resilience. Revised or expanded performance standards in the Cities’ zoning codes will require or incentivize development and redevelopment to meet specific point requirements for stormwater retention and cooling capacity, which in many instances can be addressed simultaneously through preserving open space or integrating green infrastructure. (See Part 2 of Appendix C: “Memorandum: Resilience Zoning for Resilient Buildings and Land Use” for further details.)

Our next steps

- ☐ Partner with local, state, and federal research partners to advance the Dynamic Coastal Flood Inundation Project to develop new flood modeling projections that account for the combined effects of storms and sea level rise.
- ☐ Evaluate climate scenarios, considering how each may likely affect future development within the city, housing affordability and security, vulnerability of city infrastructure, health and safety of residents, ecological resilience, and environmental justice.
- ☐ Develop and adopt a set of resilience overlays and updated performance standards, based on that evaluation.
- ☐ Conduct a review of the Cities' zoning codes to identify and revise current stipulations that tend to work against the resilience objectives outlined in this action.
- ☐ Become more versatile to all datums and standards NGVD29, NAD83, NAVD88, or the new modernized National Spatial Reference System (NSRS) across all levels of planning for the region and state (Portland).

CR 1.1 Summary - Resilient New Development



CR 1

CR 1.2 Resilient Existing Buildings

ACTION: Build knowledge, tools, and resources on climate risks and adaptation options for buildings and property.

Where we are today

While many Portland and South Portland residents are familiar with potential regional impacts from climate change, fewer residents feel they know the local risks for their neighborhood or property. Both Portland and South Portland are working to fill that gap. The One Climate Future Vulnerability Assessment (published in December 2019) includes citywide flood maps that show potential future inundation from sea level rise and storm surge, as well as inundation areas for hurricane categories one through four. In May 2019 as part of the Maine Silver Jackets High Water Marks initiative, Portland installed signs at four sites in the city that show the high water levels during the Blizzard of 1978—and how sea level rise by 2050 might impact those past flood levels—to raise awareness of flood risk and sea level rise. South Portland is now collaborating with the Maine Silver Jackets to install “High Water Marks” at Willard Beach, Bug Light, and along the Green Belt at Mill Creek.

Both Cities also utilize online tools to educate community members about climate hazards and facilitate flood preparedness initiatives. The City of Portland’s publicly available Hurricane Surge Inundation Dashboard supports the City’s hurricane emergency management and flood response activities. In January 2019, South Portland received a Coastal Communities Grant to create an online story map of sea level rise and storm projections for the city. This tool, aptly named “Preparing for Sea Level Rise in South Portland,” engages

Perceptions of local climate risks.

Based on a One Climate Future survey sent out in 2019, 36% of participants mentioned that they understood global climate change risks, but not climate risks at a local level. At the same time, 69% of participants voiced that they were “very concerned” that climate change would affect them personally.

the public in strengthening community resilience by building knowledge of local hazards and vulnerabilities.

The action we will take

Portland and South Portland will make it possible for every property owner in the cities to evaluate the flood risk of their property and to learn about potential short-term and long-term adaptation solutions. To do so, the Cities will continue to build knowledge, tools, and resources on flood risk, adaptation strategies, and financial resources for property owners and developers, both internally within city departments and externally with the community. Building out this capacity requires two types of action: A) Internal, proactive planning by the Cities for securing and administering emergency federal funding if and when it is needed for emergency relief, and B) Community-focused traditional and creative approaches for making information on neighborhood flood risk and adaptation solutions for buildings and properties more widely accessible. As part of this initiative, the Cities will:



HOMES ALONG WILLARD BEACH • Photo by Denise Michaud

• **Develop a suite of tools and resources for resilient building retrofits.** These resources will include online map-based tools (both existing and currently under development) for understanding flood risk at the neighborhood level. The Cities will also develop and compile information and guidelines for building and site retrofits that can be undertaken by homeowners, residential and commercial property owners, and developers to improve the resilience of their properties. The toolkit will be hosted on city websites, as well as promoted through social media, presentations, dashboards, pop-up booths, and other events.

• **Advocate for the State of Maine to adopt real estate flood risk disclosure requirements.** Unlike the majority of states in the United States (29 states as of January 2019), Maine has no statutory or regulatory requirements for sellers to disclose a property's flood risk or past flood damages to a potential buyer.¹²⁸ Disclosure requirements help to ensure that potential homebuyers are able to make smart decisions with respect to flood risk before purchase. Without flood risk disclosure, this information gap distorts market signals and fails to allow the price of the home to recalibrate with increasing

flood risk over time. Federally backed or regulated lenders require flood insurance for any properties in Special Flood Hazard Areas (areas in the 1% annual chance flood zone) as mapped by FEMA, and lenders must inform borrowers that their properties are in this area. This information, however, is often provided after buyers have put money down or otherwise committed to purchasing the property; it also does not adequately share information on past damages or the level of risk, and does not apply to properties outside Special Flood Hazard Areas.¹²⁹

• **Participate in FEMA's Community Rating System.**

The City of Portland is one of 17 municipalities in Maine that participates in FEMA's Community Rating System (CRS). The CRS is a voluntary program to mitigate flood risk that discounts flood insurance premiums when communities implement qualifying flood protection activities. These activities enhance public safety, limit floodplain development, reduce flood risk for existing development, preserve open space, and put in place preparedness systems. Through a series of completed public information and floodplain management activities, the City of Portland has already qualified for a 10% discount on

flood insurance premiums and for certain emergency financial assistance. In Portland’s recent *Portland’s Plan 2030*, the City reaffirmed a commitment to continue participation in CRS as a mechanism to develop climate resilience. The City of South Portland will explore participation in the CRS to prevent and reduce flood damage to insurable property and encourage a comprehensive approach to floodplain management.

● **Prepare for potential federal funding resources.**

Several federal grant programs can provide support for hazard mitigation, disaster relief, or home buyouts in order to ameliorate the financial burden from flooding on homeowners and cities. These programs include the HUD-administered Community Development Block Grant Disaster Recovery (CDBG-DR) funds, and the FEMA-administered Hazard Mitigation Grant Program (HMGP), Flood Mitigation Assistance (FMA) Program, and the Building Resilient Infrastructure and Communities (BRIC) program—the last of which is the newly established pre-disaster hazard mitigation program as of spring 2020, which replaces the former Pre-Disaster Mitigation (PDM) program.¹³⁰ These resources require proactive planning by the Cities and coordination with the State to identify suitable projects, secure funding, and prepare for its disbursement. The Cities will begin this coordination, to outline timelines,

prerequisites, and decisions that must be made in advance of any major climate event.

Our next steps

- ☐ Launch the “Preparing for Coastal Flooding in South Portland” map and expand the scope of the project to incorporate citizen science modules.
- ☐ Expand the scope of the Hurricane Surge Inundation Dashboard to support flood response activities, citizen engagement, and to further develop impact analyses in Portland.
- ☐ Develop a webpage and/or website with links to online mapping tools, the One Climate Future Vulnerability Assessment, and information on adaptation options and financial resources for adaptation for residential property owners, commercial property owners, and developers.
- ☐ Continue participation in the FEMA Community Rating System (Portland).
- ☐ Explore steps necessary for participation in the FEMA Community Rating System (South Portland).
- ☐ Work with the Maine Climate Council and statewide partners to advocate for the development of statewide real estate flood risk disclosure requirements.

CR 1.2 Summary - Resilient Existing Buildings



CR 1.3 Resilient Open Space Planning

ACTION: Establish open space climate resilience goals and protocols for monitoring progress towards those goals in Portland and South Portland’s open space planning.

Where we are today

Portland and South Portland have strong networks of conservation land, forests, public parks, and multi-use trails. These resources currently help to sequester carbon, encourage non-vehicular transit (such as walking and biking), absorb stormwater, keep air temperatures cooler during heat waves, and help support our health and happiness. In other words, these assets are helping Portland and South Portland to be thriving, low-carbon, and resilient communities. The Cities plan for, manage, and enhance many of these assets through open space planning: Portland completed its most recent update of its Portland Open Space Vision and Implementation Plan in 2016, and South Portland completed a new update to its Open Space Plan in 2019. By integrating climate change projections and resilience goals into open space acquisition, protection, renovation, and maintenance, open space planning can become an even stronger tool for increasing the potential of our open spaces to help us address climate change.

The action we will take

Between now and 2025, the Cities will identify a set of explicit open space goals for improving climate resilience across four focus areas (outlined below) and lay the groundwork for meeting those goals. This process will include establishing systems for monitoring open space resilience parameters; conducting necessary baseline studies to track change over time; continuing to expand, retrofit, or manage open spaces in ways that better help us address climate change; and adopting ongoing systems for monitoring and data collection to track

Portland and South Portland will set goals for our open space planning that will support more resilient cities. We will monitor and improve upon the capacity of our open spaces to infiltrate stormwater, sequester carbon, mitigate heat, and support healthy biodiversity.

and report on progress towards resilient open space goals in future iterations of the Cities’ open space plans. The resilient open space goals will also serve as guideposts for further directing the Cities’ land acquisition and conservation efforts, and for implementing programs and policies that will earn the Cities open space planning points through the Community Rating System. The Cities will adopt this process across the following four focus areas:

- **Stormwater and flood water infiltration.** We will assess public open spaces based on water storage, stormwater runoff, and infiltration potential. Across citywide networks of open space, where could soil health be most improved to increase stormwater infiltration? Where is there capacity to capture and retain stormwater on site through blue/green/gray infrastructure? Where do open space parcels exist in flood-prone areas? The Cities will set goals for increases in stormwater infiltration and retention in public open spaces



DEERING OAKS PARK • Photo by Corey Templeton

over established timeframes. Based on those goals, we will adjust land management practices to enhance infiltration potential, and incorporate stormwater retention systems in the redesign or expansion of parks and open space.

• **Carbon sequestration.** We will assess public open spaces based on carbon sequestration capacity and potential. Across citywide networks of open space, where could soil health be most improved to increase carbon sequestration? Where are there opportunities to expand forests and wetlands, and/or opportunities to better preserve forests and wetlands in perpetuity? The Cities will set goals for increases in carbon sequestration and storage capacity. Based on those goals, we will adjust land management practices to enhance carbon

sequestration and storage, and continue to protect, restore, and expand healthy forests and wetlands where possible.

• **Heat mitigation.** We will strengthen systems for quantifying the cities' tree canopies (both street trees and forest cover) and for tracking changes to the tree canopies over time. Where are there opportunities to expand the tree canopy? Are there areas that have lost tree canopy due to disease? The Cities will set goals for maintaining or increasing the tree canopy citywide and/or by block group, including parameters for planting species that can adapt to new climate conditions. Based on those goals, we will prioritize tree planting in block groups that could most greatly benefit from increases in impervious surfaces and tree shade for heat mitigation, as well as stormwater management.

● **Biodiversity and habitat connectivity.** We will evaluate and strengthen the biodiversity and habitat connectivity within city open spaces. Which areas are degraded by overgrowth of non-native invasive species? Where are there opportunities to connect patches of habitat to enable species migration and to restore healthy ecosystem functions? The Cities will set goals to enhance biodiversity and habitat connectivity to strengthen the resilience of our ecosystems to pest outbreaks, invasive species, and new climate patterns. Based on these goals, we will adjust open space plans, comprehensive plans, and relevant design guidelines (see action CR 5.1 for more detail).

Our next steps

- ☐ Expand Land Bank (Portland) and Open Space Plan (South Portland) prioritization of land parcels to consider the following ecosystem services: stormwater and flood water infiltration capacity, carbon sequestration, heat mitigation, and biodiversity.
- ☐ Identify gaps in baseline assessments across the four focus areas. Conduct in-house baseline assessments, where feasible, and commission assessments where additional technical capacity is required.



SAWYER MARSH • Photo by Denise Michaud

- ☐ Establish goals and metrics for tracking progress towards those goals in each of the four focus areas based on the results of the baseline studies.

CR 1.3 Summary - Resilient Open Space Planning

PRIMARY COMPONENTS	How this strategy advances a future that is...		
	Equitable	Regenerative	Resilient
● Expand Land Bank (Portland) and Open Space (South Portland) priorities to include resilient ecosystem services. ● Set goals and measure change for stormwater and floodwater infiltration. ● Set goals and measure change for carbon sequestration and storage. ● Set goals and measure change for heat mitigation. ● Set goals and measure change for biodiversity and habitat connectivity.	a b c d	a b c d (a) Draws down carbon (b) Restores ecosystems	a b c d (a) Reduces vulnerability (b) Strengthens communities (c) Adapts processes
	KEY MILESTONES ● Benchmark ecosystem and resilience metrics for open spaces and establish performance goals by 2028	CITY STEWARD P: Planning Department; Parks Division; Sustainability Office SP: Sustainability Office, Planning Department	FINANCING MECHANISMS Impact fees (Portland), Land Bank Fund (South Portland), revolving loan funds (e.g., Clean Water State Revolving Loans), federal/state grants (e.g., Project Canopy Assistance Grants, 319 Grants, Land and Water Conservation Fund)

CR 2

Strong and Healthy Communities



BASKETBALL AT REDBANK COMMUNITY CENTER • Photo by GPCOG

CR 2.1 Housing Affordability and Resilience

ACTION: Continue to expand access to resilient and energy efficient affordable housing, contributing to diverse and inclusive communities.

Where we are today

A resilient community is one where residents of all incomes can live securely, meet their basic needs, and contribute to and reap the benefits of a local regenerative and inclusive economy. Secure, healthy, and energy efficient affordable housing is a prerequisite for becoming resilient communities.

Portland Housing Authority, South Portland Housing Authority, and a number of public and private housing development partners provide safe and affordable housing for thousands of Portland and South Portland residents, and continue to seek ways to expand affordable housing in the cities. Despite these efforts, rising property values make it less affordable to live in Portland and South Portland. A higher cost of living creates

financial insecurity, reduces households' disposable income, and makes families more vulnerable to emergencies with unexpected costs. Rising home prices may increasingly lead to community displacement: residents with strong community ties to certain neighborhoods may no longer be able to afford to live in the cities, and more of Portland and South Portland's workforce must live further outside city borders and commute longer distances. While these factors degrade our community resilience, climate change will likely intensify this trend. More extreme storms and flooding may lead to property damage and loss, thereby compounding stresses related to housing security, affordability, and quality.

Both Cities are actively engaging in efforts with affordable housing partners, as well as initiatives internally to support an equitable and diverse housing supply. The City of South Portland is in the process of developing a long-term affordable housing strategy that will identify need, opportunities for housing, housing production goals, and incentives to promote affordable housing. In Portland, a series of tools, policies, and programs outlined in the City's seminal housing plan focus on best practices in workforce and affordable housing development. These larger plans assess needs and set a vision for improvements in housing affordability that are supported by daily and ongoing city programs, such as rental assistance, that are critical for the welfare of our residents.

The action we will take

Portland and South Portland will increase the quantity of affordable housing units while reducing barriers to and supporting the development of highly energy efficient, low-carbon, and resilient affordable housing. Meeting this goal calls for many complementary actions, including revisions to zoning codes to better enable affordable housing development; addressing cost caps and financial barriers to incorporating sustainability and resilience features in affordable housing; minimizing the exposure of our cities' housing to climate hazards; and prioritizing transit-oriented development to connect affordable housing to public transportation and pedestrian networks. To facilitate and support these efforts, Portland and South Portland will:

- **Identify priority growth areas.** Portland and South Portland will conduct housing studies to identify areas of the cities that can accommodate an increase, modification, or preservation of housing to meet the needs, preferences, and financial resources of all residents. This study will begin with an inventory of current housing types and a market assessment to identify gaps. We will focus on a range of multi-unit clustered housing types compatible in scale with single-family homes that help meet the growing demand for affordable, walkable urban living. Priority growth areas will be identified based on

the ability to cluster transportation and affordable housing, supported by zoning code updates and financing incentives. The study's findings will improve existing housing affordability data and will inform ongoing efforts in both cities to strengthen livable neighborhoods around public transportation, bike networks, and pedestrian-oriented streets (see action TLU 1.1).

- **Prioritize zoning decisions that support housing affordability in the cities.** Many existing zoning regulations, such as single-family zoning districts, parking requirements, and density restrictions, for example, can create constraints for affordable housing. Portland and South Portland will revise these city zoning codes to better enable higher density development; prioritize transit-oriented development to better connect housing to transportation, jobs, and services; and facilitate mixed-use development to cluster housing, shops, and services. The Cities will also reevaluate parking requirements to mitigate parking as a barrier to affordable housing development.

- **Integrate resilience and energy efficiency goals through repositioning housing assets.** Portland Housing Authority (PHA) is in the process of repositioning the city's public housing portfolio by converting units from their original sources of HUD financing to project-based Section 8 contracts. Through this repositioning, substantial funding is made available to retrofit these properties—an opportunity that PHA is using to prioritize energy efficiency and resilient building upgrades. South Portland Housing Authority (SPHA) is looking critically at repositioning its housing portfolio to take advantage of the same opportunity.

- **Revise development fee requirements to enable more resilient and sustainable affordable housing.** The Cities will assess the feasibility of waiving or reducing impact and building permit fees for affordable housing development in order to reallocate these costs towards resilience and sustainability features. These features may include passive house design, energy efficiency investments, distributed energy systems and energy storage, higher ground floor elevations,



ROOFTOP GARDEN AT 409 CUMBERLAND, AVESTA HOUSING • Photo by Ben Walter

space for local food production, on-site community centers with services to support social resilience, among other features.

• **Advocate for adjustments to state financing requirements to enable more resilient and sustainable affordable housing.**

MaineHousing, the designated housing credit agency for the State of Maine, sets statewide total development cost caps as part of the federally required Qualified Allocation Plan (QAP) for allocating and administering Low-Income Housing Tax Credits (LIHTC). Due to rising construction costs in southern Maine, the cost caps increasingly create constraints for affordable housing development in Portland and South Portland and often make sustainable and resilient building features cost-prohibitive, even if the attributes are economical over the long term. The Cities will work with MaineHousing on ways to eliminate these constraints. Approaches may include raising the cost cap to better align with rising construction costs; considering

variable cost caps for Greater Portland versus the rest of the state; or considering cost cap exemptions for sustainability and resilience features that bring substantial benefits despite upfront costs, such as solar installations, brownfield redevelopment, passive house design, incorporation of community centers, among other features.

• **Support financing of renewable energy sources for affordable housing.**

Affordable housing financing often precludes renewable energy systems such as solar panels due to the upfront costs, even if the payback for the systems can cover the costs over the long term. The Cities in conjunction with the public housing authorities and private affordable housing developers will explore options for building out distributed energy with affordable housing, which may include community solar projects, power purchase agreements, or establishing a revolving loan fund to provide third-party financing to affordable housing projects to implement clean energy systems.

• **Identify displacement prevention strategies.** The efforts listed above will help support the affordability of new housing built in the cities. At the same time, we recognize that many of the Cities' capital projects to address climate change—from mitigating flooding to creating a more robust tree canopy—can contribute to the already increasing property values for existing homes. The Cities will work with community partners to study how housing affordability has changed in the past decade, to project how affordability may continue to be affected by new growth and city investments, and to identify neighborhoods at risk for displacement.¹³¹ Drawing on the results, the Cities and community partners will assess a number of anti-displacement strategies to incorporate into long-term housing affordability plans that support the long-term diversity and inclusivity of our neighborhoods.

• **Promote the richness of diverse and inclusive neighborhoods.**

Throughout the United States, it is common for neighborhoods to be highly segregated based on race and income, driven by long patterns of prejudice, exclusionary zoning, and disinvestment. We recognize that prejudice has contributed to the stigmatization of affordable housing, which degrades our ability to create strong, diverse,

and inclusive communities. We will continue to seek ways to break that pattern both through housing development (i.e., neighborhoods and buildings with mixed levels of affordability), but also in the ways we build community. Working with the Cities' affordable housing partners, the Cities will support a storytelling initiative, designed to highlight people's stories, backgrounds, and experiences. The emphasis of the project will be to share the idea that "we are all Portland/South Portland" and we all bring rich and unique backgrounds to this community. The Cities will identify arts-based or other community partners to support the collection and sharing of stories.

Our next steps

- ☐ Advocate for changes to state financing requirements, administered by MaineHousing, to better enable more resilient and low-carbon affordable housing.
- ☐ Launch area-wide housing studies in both cities to identify existing gaps and opportunities for growth of a more equitable and diverse housing supply.

- ☐ Conduct a review of the Cities' zoning codes and reassess development fees to identify ways to relieve constraints on affordable housing and the integration of resilience and sustainability features.
- ☐ Begin working with community partners, including arts-based groups to lead a "We are Portland/South Portland" storytelling initiative.

CR 2.1 Summary - Housing Affordability and Resilience



CR 2

CR 2.2 High Heat Mitigation

ACTION: Expand the “cooling capacity” of Portland and South Portland.

.....

Where we are today

With climate change, Portland and South Portland are expected to see more unseasonably hot days and extended heat waves, both of which can have a significant impact on people whose bodies are less acclimated to warmer weather. Some residents, including children, older adults, people who work outside, people with limited financial means, people with certain disabilities, or people who take certain medications will face higher vulnerability to extreme heat. Because of Maine’s traditionally cold climate, air conditioning is also not as prevalent in homes, businesses, and public spaces. For all these reasons, higher temperatures in Portland and South Portland are predicted to be an increasing public health risk, and one that can exacerbate inequity. The One Climate Future Vulnerability Assessment discusses projections for increasing temperatures as well as the vulnerability and potential health concerns for Portland and South Portland in greater detail.

In addressing climate change, cities throughout the United States are considering how land use plays a role in decreasing or increasing ambient air temperatures. Urban areas tend to be warmer than neighboring rural areas, particularly at night—a phenomena called the “urban heat island effect.” Surfaces common in cities, including asphalt, steel, and brick absorb and retain more heat than natural and living surfaces such as grass and trees. Furthermore, trees help to keep air temperatures cooler on high heat days through transpiration (a tree’s version of sweating) and through providing shade. Retaining, expanding, and protecting the health of green space in the cities therefore becomes a very important component to mitigating the effects of higher temperatures.

The action we will take

Portland and South Portland will build out the cities’ “cooling capacity” to prepare for higher temperatures. This will entail protecting and expanding green spaces on public and private land, investing in public spaces where residents can cool off, and providing resources on building designs, retrofits, and other strategies to help keep indoor spaces cool. We will prioritize approaches that not only help us manage heat during periods with high temperatures, but that also have day-to-day benefits too—such as spaces for recreation, fostering community, supporting clean air and water, as well as increasing energy efficiency and energy cost savings. As part of this initiative, the Cities will:

- **Preserve and expand protected open space, public parks, and tree cover.** The Cities commit to protecting our existing natural resources, and expanding the tree canopy and public green space throughout our cities. In addition to continuing to invest in the maintenance and quality of our current open spaces, we will continue to expand the number and distribution of parks in the cities so that 100% of residents live within a ten-minute walk (half mile) from a public open space by 2035. We will also continue to expand our street tree canopies, prioritizing block groups that could most benefit from shade and impervious surfaces. See action CR 1.3 for how the Cities will track heat mitigation as part of our open space planning and land conservation efforts.
- **Protect and create greenspace through new development.** Using zoning updates and development ordinances, the Cities will set standards for the integration of

greenspace for new development (see action CR 1.1). Portland and South Portland will consider features such as tree canopy, shading structures, green roofs, vegetation, and paving with specified solar reflectance indices that contribute to cooling in the public realm. The Cities will weigh the contribution to cooling, co-benefits, and cost of each feature to determine appropriate standards that support high heat mitigation goals.

• **Increase access to (and awareness of) places to cool off.** The Cities will collaborate with neighborhood associations and residents to map areas in Portland and South Portland where residents can go during days of high heat, and to identify potential sites for expanding access to cooling amenities—including public beaches, swimming pools, splash pads, and public spaces with air conditioning that can serve as “cooling centers.” Access will consider both physical proximity, public transportation connections, handicap accessibility, and cost (e.g., entrance fees). New amenities will be incorporated into the Cities’ capital investment plans, and residents and City staff will promote existing and new resources in order to build awareness of these amenities.

• **Provide information on building retrofits to keep homes cooler.** The Cities will work with partners to provide and promote information on strategies for keeping homes cooler, which can range from improving insulation, to installing

air-source heat pumps, to shading south-facing windows. The Cities will likewise provide resources, information, and incentives for passive house design in new developments, which keeps building temperatures comfortable with very little energy use. In addition to keeping homes cooler, these retrofits can help reduce energy costs. These toolkits will be incorporated with the resources for resilient building retrofits (see action CR 1.2).

Our next steps

- ☐ Launch a process with neighborhood associations and residents to map current public places residents are able to go to cool off and identify potential locations for expanding access to cooling sites.
- ☐ Establish a baseline tree inventory (South Portland) and system for monitoring changes to the tree canopy over time. Set goals (both Portland and South Portland) for maintaining or increasing the tree canopy citywide and/or by block group (to be executed in alignment with action CR 1.3).
- ☐ Through land use and open space planning, maintain or reach goal of 100% of residents living within a half mile of a public open space.
- ☐ Work with partners to develop the content, design, and marketing strategy for resilient building retrofit toolkits (to be executed in alignment with action CR 1.2).

CR 2.2 Summary - High Heat Mitigation

PRIMARY COMPONENTS	How this strategy advances a future that is...		
	Equitable	Regenerative	Resilient
• Preserve and expand protected open space, public parks, and tree cover. • Increase access to and awareness of places to cool off. • Revise zoning codes to increase features that reduce heat island effect for new construction (see action CR 1.1). • Develop toolkit with partners that provides information on building retrofits to keep homes cooler.	a b c d (a) Addresses injustice (b) Expands access (c) Creates inclusive processes	a b c d (a) Draws down carbon (b) Restores ecosystems	a b c d (a) Reduces vulnerability (b) Strengthens communities (d) Builds partnerships
	KEY MILESTONES • All residents live within a half mile of a cooling center by 2035 • All residents live within a half mile of a park or open space by 2035	CITY STEWARD P: Parks, Recreation, and Facilities; Sustainability Office; Planning Department; Health & Human Services SP: Sustainability Office; Planning Department; Parks, Recreation, and Waterfront	FINANCING MECHANISMS Impact fees (Portland), Land Bank Fund (South Portland), federal/state grants (e.g., Project Canopy Assistance Grants, Land and Water Conservation Fund), Private grants

CR 2

CR 2.3 Resilient Food Systems

ACTION: Cultivate healthy, regenerative, and just food systems.

Where we are today

The Greater Portland area has become known as a culinary hub in the last half-decade. Nearly 55% of Portland and South Portland residents work at full-service restaurants (a rate higher than nearly everywhere else in the country), and together with local farms, fishermen, specialty food producers, and grocers, this culinary scene has driven and cultivated an emphasis on local and sustainable foods. And yet, 90% of food consumed by Mainers comes from outside the state, farmland acreage and the number of farms have decreased in Maine in the past decade, and roughly 13% of people in Cumberland County are food insecure. Each of these indicators helps to highlight both an outsized reliance on global and regional food distribution, and our distance from what could eventually become a more resilient, healthy, inclusive, and regenerative local food system.

The impacts of climate change on food production, distribution, access, and affordability both locally and globally make the realization of these rights even more tenuous. At a global scale, droughts, floods, and new pests introduced by climate change are expected to bring increasing uncertainty for global food systems, with the potential to create a net rise in food prices. In Maine, agriculture and fisheries will likely be challenged by shifts in growing seasons, pest outbreaks, warming oceans, and ocean acidification. Portland's and South Portland's food systems may be most acutely affected by interruptions in regional distribution and local food access, including closures of roads, public transit, and grocery stores

due to storms and flooding. These access challenges will likely exacerbate existing inequities and food insecurity.

The action we will take

Portland and South Portland will increase our food system resilience through strengthening our local capacity to grow, harvest, and produce food. Both food and the processes to grow, harvest, produce, transport, and access food can build value and health directly within our cities, simultaneously nourishing our communities, our soils, and our economies.

Therefore, we are thinking creatively and comprehensively about “local food”—both in supporting and cultivating resources in Maine and northern New England, as well as in our backyards. By growing and producing more of our food locally, our food systems are less vulnerable to interruptions in distribution due to storms, and create fewer greenhouse gas emissions in transit. Local food production can also create jobs and economic opportunity, reduce our vulnerability to price shocks from the global market, and contribute to healthier food options, greater food security, and stronger connections to the land and water. To build our food system resilience, the Cities will:

- **Expand public land access for food production in the cities.** Portland and South Portland will prioritize the creation and organization of new community gardens, with the goal of



COMMUNITY GARDEN AT THE EASTERN PROM • Photo by Anna Ackerman

making gardens available to all neighborhoods and meeting community demand. To build just and equitable access to healthy food, the Cities will advocate for allocations of garden or agricultural plots that prioritize community members with low or no incomes, people of color, and New Mainers.

• **Establish or improve policies that help farmers and fishermen efficiently access local consumers.** Through the COVID-19 pandemic, we have seen a re-orientation of consumption patterns towards local food. The Cities will leverage this momentum to further promote existing farmers' markets and explore the replication of this model for a fisherman's market on public properties.

• **Conduct a foodshed assessment.** The Cities, in collaboration with local and regional partners, will conduct or commission a regional foodshed assessment for Portland and South Portland that focuses on both land-based and

ocean-based food systems. The goals of the assessment will be to 1) assess the foodshed based on current capacity for food production, potential capacity, and limitations for expanded capacity across nested scales, including backyard, neighborhood, city, and regional levels and 2) develop recommendations to expand food production within the cities and regionally in line with estimated potential.

• **Partner with education and job training organizations to support education, job training, and reskilling in the food production sector.** Portland and South Portland will work with higher education programs, adult education programs, high schools, and nonprofits within the cities, as opportunities arise, to identify ways to support education, job-training, and reskilling initiatives in food production and practices such as soil-building techniques. Interpretation services and educators from immigrant communities will be prioritized in program design. This action aligns with action CR 3.2.



LOBSTER TRAPS AT CUSTOM HOUSE WHARF • Photo by Russell Stone

• **Fund a growing food system.** Together, both Cities will launch a small grants program to resource and elevate solutions in our communities that build resilience (see action CR 2.5). Projects eligible to receive funding will be intentionally broad and include initiatives that cultivate a healthy, regenerative, and just food system. Efforts to support, strengthen, or expand food gleaning initiatives are one such example. In addition to a small grants program, entrepreneurs will be encouraged to participate in ongoing small business development programs offered by the Cities.

Our next steps

- ☐ Expand community garden space in Portland and South Portland.
- ☐ Assess opportunities and barriers in existing land use policies to support and expand direct consumer connections for farmers and fishermen.
- ☐ Secure funding and launch or commission the foodshed assessment with local food systems partners.
- ☐ Launch the small grants program to resource local initiatives that affect peoples' abilities to grow, harvest, produce, transport, or access food.

CR 2.3 Summary - Food System Resilience

PRIMARY COMPONENTS

- Expand public land access for food production.
- Establish or improve policies that help farmers and fishermen efficiently access local consumers.
- Support resilience and innovation in the food sector through small grants and small business development programs.
- Conduct a foodshed assessment.
- Partner to support job training and reskilling in the food production sector.

How this strategy advances a future that is...

Equitable



- (a) Addresses injustice
- (b) Expands access
- (c) Creates inclusive processes
- (d) Builds community ownership

Regenerative



- (b) Restores ecosystems
- (c) Supports a circular economy
- (d) Builds shared wealth

Resilient



- (a) Reduces vulnerability
- (b) Strengthens communities
- (d) Builds partnerships

KEY MILESTONES

- Establish small grants for food system innovators by 2025
- Secure funding to commission foodshed assessment by 2028
- Expand access to community agriculture to all neighborhoods to meet demand

CITY STEWARD

P: Sustainability Office; Parks Division; Health & Human Services
SP: Sustainability Office; Economic Development Department; Parks, Recreation, & Waterfront

FINANCING MECHANISMS

Federal grants (e.g., USDA Federal Food System Partnerships grants), Private grants (e.g., New England Food System Resilience Fund, USDN Partners for Places grants), revolving loan funds (e.g., Portland Development Corporation)

CR 2

CR 2.4 Transportation Access

ACTION: Continue to prioritize decision-making processes and transit investments that advance equity in our cities.

Where we are today

The availability, cost, and efficiency of transportation options in Portland and South Portland affect our access to resources and services that support the health and wellbeing of residents—whether that’s access to jobs, school, healthcare, a park, or the grocery store. Access to such formal resources, as well as the informal social networks fostered in gathering spaces, prove crucial to supporting the resilience of any community.

Until recently, our infrastructure decisions have mostly prioritized private vehicle use, which tends to disproportionately benefit some residents and create greater burdens for others. Residents with lower incomes often must spend a greater proportion of income and time on transportation; residents who are unable to drive due to physical or mental disabilities face greater isolation; and transportation-related pollution tends to affect lower income households more than others. Continuing to strengthen public transportation systems therefore has the power to render a vast number of benefits related to our climate action and adaptation goals. Not only do transit systems decrease transportation-based greenhouse gas emissions, reduce congestion, and improve air quality if run on clean fuel, but efficient transit networks can increase community resilience through creating more affordable and equitable access to jobs, goods, and services.

The ability of a transit system to engender greater equity, however, is largely driven by how well it can break down barriers to accessing transit, consciously address inequities,

and ensure that residents who are affected most by transportation-related decisions—and yet who have been largely underrepresented in transportation planning—play a larger role in transportation decision-making.

In 2019, the Portland Area Comprehensive Transportation System (PACTS) under the Greater Portland Council of Governments (GPCOG) launched the Community Transportation Leaders Program. The program is part of a larger ongoing effort to create platforms and pathways for people from underrepresented communities—including residents with physical and cognitive disabilities, people of color, New Mainers, and older adults—to shape the region’s transportation planning. The program convened twenty-three leaders from underrepresented communities who, with the support of training and tools, identified challenges, developed solutions, and presented approaches to address key concerns to the PACTS Executive Committee. The ultimate goals of the program were both for these community leaders to weigh in on near-term transportation planning decisions, as well as to create peer-to-peer networks and pipelines for individuals who regularly ride transit and face added barriers to become members of the committees and leadership currently making transit-related decisions.

In the coming year, PACTS will be continuing the program through two follow-up initiatives: 1) A Travel Training program, whereby the transportation leaders will help to train members of the community on how to use the region’s public transit, and



Community Spotlight

COMMUNITY TRANSPORTATION LEADERS PROGRAM

The Community Transportation Leaders Program (CTLP) is part of a larger effort by the Greater Portland Council of Governments (GPCOG) to advance the inclusion of underrepresented communities in transportation planning. The training program was co-designed by a planning group that included GPCOG staff, consultants, municipal and organizations partners, and GPCOG's Mobility Liaisons. Mobility Liaisons are volunteers with lived experience of transportation challenges.

The program is based on four goals:

- Support community members to gain the knowledge and tools needed for meaningful participation in transportation planning and decision-making.
- Provide a peer-to-peer network to assist participants in acting on the goals they set.
- Enable decision-makers to hear directly from participants about the transportation needs and experiences of underrepresented communities.
- Act as a gateway for participation in transportation decision-making

Community Transportation Leaders know the issues facing their peers and are well-placed to inform decisions about the transportation projects that directly affect their lives. Once trained, Community Transportation Leaders are now weighing in on transportation studies and plans by participating in focus groups, promoting surveys, and collecting feedback. They work on projects that advance a regional Vision Zero Campaign, ensure sensitivity training for bus operators, and provide supports to new immigrants looking to access transit.

The CTLP is an integral and critical initiative that incorporates the voices of community members that rely on public transportation into planning efforts. One Climate Future will elevate and support the work of the program as we ensure public transit is accessible, equitable, and efficient.

COMMUNITY TRANSPORTATION LEADERS
DEREK O'BRIEN AND KAREN PERRY • Photo by GPCOG

2) A Ride-with-Me program, where transit system decision-makers ride public transportation with members of the community who face barriers in using public transportation, such as mobility challenges, to witness their experiences first-hand. All three initiatives will be instrumental to breaking down barriers to transit access and in expanding who shapes transit system decision-making in Greater Portland.

The action we will take

The Cities of Portland and South Portland endorse the Community Transportation Leadership Program and will support the program's subsequent phases. As we work towards transforming our transportation system networks

in the Greater Portland region towards increasingly robust, efficient, and carbon-neutral systems, it is both paramount and integral that the transformation also advances more equitable mobility options. In the upcoming year, the Cities will:

- Participate in the Ride-with-Me Program.** Members of the Portland and South Portland City Councils and/ or transportation planning staff will join the Ride-with-Me program to witness barriers faced by residents while accessing or riding public transit in the cities.

- Work with transit partners and Community Transportation Leaders to review and address proposed solutions.** The Community Transportation Leaders Program generated a booklet compiling the concerns, challenges, and proposed solutions identified by participants. Some of the proposed solutions relate directly to the bus systems, while others relate to items that the Cities could address, including expanding information on the transit systems or improving sidewalk conditions. The Cities will work with PACTS, the public transportation agencies, and Community Transportation Leaders to collectively review and prioritize ways to address highlighted concerns.

- Invite input from Community Transportation Leaders in ongoing transportation planning initiatives.** Through the implementation of One Climate Future, there will be many ongoing planning initiatives—to expand accessible transit systems, build out complete streets, develop bikeway networks, and adjust land use policy. The Cities will continue to invite the growing network of Community Transportation Leaders to participate in those decision-making processes, both to help shape the process for gathering community input and to inform the solutions.

Our next steps

- ☐ Identify City Council members and city staff to participate in the Ride-with-Me program.
- ☐ Review and address proposed solutions from the first round of the Community Transportation Leaders program.
- ☐ Collaborate with GPCOG to expand upon or launch a second phase of the Community Transportation Leaders Program.
- ☐ Invite Community Transportation Leaders to promote and participate in One Climate Future mode shift and land use planning initiatives.

CR 2.4 Summary - Transportation Access



CR 2

CR 2.5 Neighborhood Resources

ACTION: Support and strengthen our existing community resources.

Where we are today

Climate change is expected to amplify the challenges residents in Portland and South Portland already face—whether that’s financial, food, or housing insecurity, or strain on physical and mental health. Many solutions are already in our communities. We have people, organizations, and community groups that are helping to build an inclusive and regenerative economy; supporting safe, stable, and affordable homes; strengthening our physical and mental health; cultivating healthy foods, soils, and ecosystems; elevating voices and civic participation; and nourishing culture and creativity. In particular, these solutions exist in the communities that have been most marginalized in the current economic system. Elevating and resourcing the people, organizations, and community groups that are already

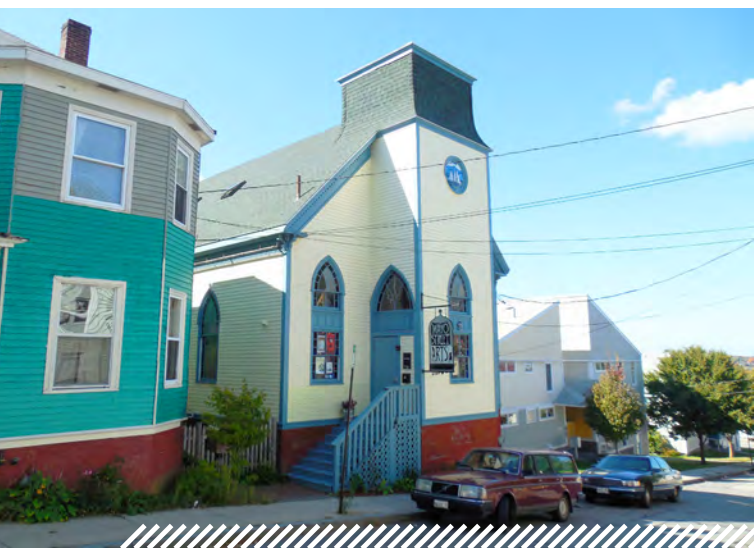
providing these solutions is necessary for a just and equitable transition to a more resilient and carbon-neutral future.

The action we will take

The Cities will partner with existing community groups and organizations to cultivate and strengthen neighborhood hubs, organize neighborhood-scale action, and expand services that will be increasingly needed as we continue to experience new stresses from climate change. This will entail working with organizations, community groups, and residents to understand gaps in access to resources or services, and to identify ways to best support and resource organizations to meet existing and growing needs. As part of this initiative, Portland and South Portland will:

- **Establish a small grants program for community organizations.** The small grants program will provide funding to community organizations, neighborhood associations, and community groups to support projects that build community strength, health, and resilience. The scope of eligible projects will be broad, with the intention of expanding capacity of existing organizations in ways that best support existing needs. Prioritization will go to projects led by and benefiting communities in Portland and South Portland that are likely to be disproportionately affected by climate change—including residents with low or no income, New Mainers, people of color, youth, older adults, and residents living with disabilities.

- **Launch a Sustainable Neighborhood Program.** The Sustainable Neighborhood Program will decentralize some of the Cities’ climate action efforts, and give residents the



MAYO STREET ARTS • Photo by John Phelan

opportunity to become active partners in building thriving, resilient, and low-carbon communities. The program will outline a set of neighborhood-scale initiatives for each of the four focus areas of the One Climate Future plan—such as home weatherization, zero waste campaigns, community solar projects, public transportation challenges, soil health revitalization projects, rain garden installations, or block parties designed to get to know your neighbors to increase social resilience. Neighborhoods may receive points for launching these initiatives, which accumulate towards Sustainable Neighborhood certification.

● **Cultivate neighborhood hubs.** Neighborhood hubs are spaces that bring people together to build community and to share resources. Resources may include community meeting space; shared kitchens; tool libraries; walk-in health services; or other community capital to help make neighborhoods stronger, healthier, happier, more connected, and more resilient. The Cities will explore ways to work with community partners to strengthen existing spaces and potentially identify new spaces to serve as neighborhood hubs. To inform that process, we will launch a community resource mapping project to discuss existing resources, opportunities, and needs: *What is a community resource for you? Where would you go to access that resource? What types of shared resources would you use if available?* Resourcing neighborhood hubs and developing

models for their ongoing operation could be supported through the small grants program specified above.

Our next steps

- ☐ Secure grant funding to launch the small grants program.
- ☐ Define goal areas and target initiatives for the Sustainable Neighborhoods Programs, and partner with community organizations to support participating neighborhoods.
- ☐ Launch the community resource mapping project to begin identifying locations and needs for neighborhood hubs.



NEIGHBORHOOD RESOURCES HUB • Photo by GPCOG

CR 2.5 Summary - Neighborhood Resources

How this strategy advances a future that is...			
PRIMARY COMPONENTS	Equitable	Regenerative	Resilient
	a b c d (a) Addresses injustice (b) Expands access (c) Creates inclusive processes (d) Builds community ownership	a b c d (d) Builds shared wealth	a b c d (a) Reduces vulnerability (b) Strengthens communities (d) Builds partnerships
	KEY MILESTONES	CITY STEWARD	FINANCING MECHANISMS
- Establish a small grants program to support projects or initiatives that build resilience. - Launch Sustainable Neighborhood programs. - Work with residents and community organizations to resource neighborhood hubs.	Award the first round of community organizations or neighborhood groups with resilience grants by 2025	P: Sustainability Office SP: Sustainability Office	Private grants, revolving loan funds (e.g., Portland Development Corporation)



DOWN AT WIDGERY WARF • Photo by Corey Templeton

CR 3

Resilient Local Economy

CR 3.1 Resilient Working Waterfronts

ACTION: Create an ongoing platform for collaborative planning to ensure that Portland and South Portland’s port and waterfronts can respond, adapt, and thrive with new climate stresses.

.....

Where we are today

Portland and South Portland have vital working waterfronts: commercial fishing boats unload their catches at the piers, marine terminals provision the state with energy resources, ferries shuttle people to and from the islands, products flow to global markets in shipping containers, students and researchers investigate marine life, tourists disembark cruise ships and fill restaurants, residents fly kites at Bug Light Park. The mix of commercial, industrial, cultural, and recreational activity enriches the cities directly and indirectly, through both economic and noneconomic value. As sea levels and storm surge increase with climate change, the waterfronts will be at

the forefront of increasing inundation, interrupted operations, and property damage—putting this value increasingly at risk. In particular, Portland’s East Bayside, Commercial Street, and piers, along with sections of South Portland’s waterfront (including portions of Front Street, Mill Creek, Turner Island, Bug Light Park, and Willard Beach) are expected to see more frequent and significant flooding, often brought by more intense storms. Studies now document how the benefits of proactive action far outweigh the economic costs of delayed or reactive action; responding to the aftermath of climate hazards has shown to be, on average, five times as costly

as the adaptation investments.¹³² While the waterfronts are comprised of a diverse and dynamic mix of activities, uses, and stakeholders, collective action across waterfront uses will be necessary for safeguarding the port activity and waterfronts as economic and cultural assets.

The action we will take

We will ensure the Port of Portland and our waterfronts can respond, adapt, and thrive with new climate stresses by A) Convening and collaborating with waterfront stakeholders to increase the resilience of current and future port and waterfront activity, and by B) Establishing land use policy that guides any future development towards more resilient waterfronts. To launch the first initiative, the Cities will collaboratively establish a platform for regular and ongoing resilience planning among waterfront stakeholders in both cities, in order to share information, identify opportunities for integration and coordination, and minimize duplicative efforts in resilience capital investments or planning processes. Ultimately, the goal will be for waterfront stakeholders in collaboration with city decision-makers to have a systematic

way to identify, address, and reassess a set of priorities to take advantage of cost-sharing and most strategically direct city, state, or federal funding. The Waterfront Alliance will serve as the initial convening and facilitating organization, with the option to develop into a separate federal, state, or grant-funded process moving forward. Primary topic areas for coordinated action may include:

- Vulnerability assessment of public and private infrastructure assets.** Marine operations rely on an interdependent network of infrastructure systems, owned by a mix of private and public entities. An engineering assessment, jointly commissioned across a set of waterfront entities, could serve as a cost-effective way for individual entities to assess risks to their own assets and operations within the context of broader infrastructure networks.
- Hazard mitigation tabletop exercises.** Tabletop scenario planning is a discussion-based exercise, usually executed by a team, to map out roles and responses during an emergency situation. Conducting a tabletop exercise following the vulnerability assessment of infrastructure assets is a way to

CR 3.1 Summary - Resilient Working Waterfronts



Community Spotlight

WATERFRONT ALLIANCE

The Waterfront Alliance was founded during the 1980s to protect and promote the Port of Portland and the working waterfronts of Portland and South Portland. Over the years, it has contributed to the revitalization of the Port by providing a valuable forum for its diverse membership—which includes marine associations, fishing and cruise industries, neighborhood organizations, terminal operators, environmental groups, pilots and tugboat operators, recreational boaters, marinas, and more—to discuss a variety of issues affecting the port.

Most recently, the Waterfront Alliance has served as a convener for climate action. The organization is currently working to engage waterfront property owners, both public and private, in assessing the physical vulnerabilities of the waterfront economy to rising seas and increasing storm intensity. With a data-driven understanding of these vulnerabilities, public and private entities can better coordinate resilience investments and actions that ensure our waterfront can adapt to and find opportunity in a changing climate.

The Waterfront Alliance's leadership in building resilience demonstrates a valuable and energizing model for collaborative planning. Regional solutions and collective action will be necessary to safeguard our shared natural resources, vibrant economies, and social fabric.



EIMSKIP SHIPPING • Photo by Justin Levesque

coordinate responses across entities to potential infrastructure failure. There may be further opportunities to align or share hazard mitigation protocols on preventing interruptions in transportation or operations, damage to property or equipment, hazardous material containment failures, or other health and safety hazards.

• **Coordinated resilience investments.** Resilience investments that address a suite of operations, infrastructure, and shoreline systems in the waterfronts (such as pier upgrades, in coordination with road and rail connections or living shoreline creation where compatible with marine access) may be able to capitalize on state or federal funding, particularly since the port functions in Casco Bay are so vital to the economy of the state and region. City funding structures such as tax increment financing could also help to support joint resilience investments. In all cases, building consensus around a set of strategic priorities will be advantageous in advocating for those funding streams.

In addition to coordinated resilience planning and investments across waterfront stakeholders, the Cities will use land use policy to guide future development, ensuring that the growth or evolution of the port and waterfronts continue to

strengthen our resilience. This will entail revising zoning codes and the development review process to better prioritize the following:

- a. Mandating no new development of hazardous, vulnerable, or incompatible uses in areas with the highest flood risk (see action CR 1.1);
- b. Evaluating and permitting the growth of compatible, “flood-tolerant” commercial and industrial uses that are built to resilience standards (see action CR 1.1), including new and diverse industries that can support the economic prosperity of the cities (see action CR 3.3);
- c. Assessing, identifying, acquiring, and conserving land parcels along the waterfronts that could accommodate marsh migration and living shorelines—as determined by factors including environmental suitability, physical feasibility, and land ownership (see action CR 5.1);
- d. Monitoring transmission and grid planning initiatives that could connect the cities with potential ocean derived energy and offshore wind resources (see action BE 5.5)

Our next steps

- ☐ Convene port-related industries, waterfront businesses, waterfront users, landowners, utilities, non-profits, and other interested parties to characterize vulnerabilities to rising seas and storms of waterfront infrastructure, businesses, supply chains, and critical services.
- ☐ Pursue public-private partnerships to leverage grant funds and other innovative financing approaches for collaborative waterfront resilience projects.



BUG LIGHT PARK AND GULF OIL TERMINAL • Photo by Dirk Ingo Franke

CR 3

CR 3.2 Workforce for a Resilient Economy

ACTION: Attract, mentor, and build the skills of our cities’ workers to partake in quality jobs that help build a diverse, resilient, and regenerative economy.

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Where we are today

In March of 2020, states and local governments throughout the United States started instituting temporary business closures and “stay-at-home” orders for all non-essential activity as a widespread effort to curb the spread of the global COVID-19 pandemic. In April 2020, Maine’s unemployment rate rose to nearly 11% (based on preliminary estimates) as the economic ramifications hit businesses throughout the state.¹³³ Leading up to the closures, Governor Mills set a number of emergency measures in motion to secure small businesses loans for Maine businesses, support Maine workers impacted by the virus, and

make unemployment insurance more quickly available during the health crisis.¹³⁴ Nevertheless, because such a large portion of the Maine economy relies on small businesses and face-to-face interaction—including hospitality, food and beverage, and other tourism-related industries—there are significant concerns that Maine’s economy will be hit particularly hard by the effects of COVID-19 and the ensuing economic recession.

Prior to the onset of the COVID-19 health crisis, Maine’s worker shortage had become one of the most pressing challenges for employers in the state. For nearly four years, unemployment in Maine had been below 4%, and under 3% in Cumberland County, driven in part by much of Maine’s population aging out of the workforce. While low unemployment is better than high unemployment, labor shortages can also suppress Maine’s economy: Studies as of 2019 had estimated that Maine needed to employ an additional 158,000 trained workers by 2025 to maintain economic growth.¹³⁵ Critically, Maine workers also need the skills for advancement to reach higher earning potentials and to adapt to changes in the global economy.¹³⁶ Maine is thus faced with the multi-pronged challenge of putting Mainers back to work and expanding the state’s skilled workforce in the coming years.

Why does this matter for a climate action and adaptation plan?

A robust, diverse, and talented workforce is the basis for a resilient economy—one that can withstand downturns caused by stresses such as climate hazards, one that can innovate and adapt to global industry trends, and one that can drive the necessary transformation towards a carbon-neutral and



PORTLAND ARTS AND TECHNOLOGY HIGH SCHOOL • Photo by Claude David



UNIVERSITY OF SOUTHERN MAINE • Photo by Corey Templeton

resilient future. As part of this statewide effort, Portland and South Portland must attract and retain young workers; connect our cities' youth, New Mainers, and underemployed persons to meaningful employment; and strengthen skill development opportunities for higher earning potential—to not only create a more diverse, inclusive, and regenerative economy, but to build the skills and industries that will help lead our transformation to low-carbon and more resilient cities.

The action we will take

Portland and South Portland will work with education and career training partners to strengthen employment pipelines for growing and emerging industries within the cities, and specifically for industries that will support the cities' carbon mitigation and resilience goals. Employment pipelines include a diverse suite of resources and programs designed to connect potential workers with an employment opportunity, in addition to equipping them with the skills to succeed. The Cities would measure the success of these employment pipelines based on their ability to: A) Foster a diverse and inclusive workforce,

including removing barriers to workforce participation; B) Enhance upward mobility, earning potential, and thereby retention in local industries; and C) Build a workforce that can support a carbon neutral and resilient economy.

The Cities will work with partners to launch this effort through two phases. In the first phase, Portland and South Portland will work with employers, economic researchers, and industry specialists to identify growing and emerging sectors that have notable gaps in skilled labor, and that directly advance climate mitigation and adaptation in the cities. Relevant fields may include advanced building trades; distributed energy resource installation and servicing; food system fields such as urban farming or aquaculture; waste diversion fields such as composting and material reuse supply chains; ecosystem adaptive management or green infrastructure installation and maintenance; among other fields. Surveys and outreach to business sectors will help identify where employers are having trouble finding qualified candidates.

In the second phase, the Cities will work with employers in the identified sectors in collaboration with high schools, higher education institutions, and job training or career mentorship agencies and nonprofits to design, develop, adapt, or strengthen programs that meet specific industry needs for recruitment, skill development, mentorship, or retention. The task force will inventory existing programs to further support, expand, or replicate successful models wherever possible. The task force will identify funding streams both through existing program funding and additional local, state, or federal workforce development grants to support program development and implementation.

Depending on the type of industry and field, programs could include high school immersion programs, apprenticeships, paid internships, employer-tailored training programs, certification or credentialing programs and advancement pathways, or career mentorship. In some cases, initiatives may include high school or

post-secondary curriculum development in target areas such as environmental and climate science, climate mitigation and adaptation, and environmental justice. Development of these education and job-training programs will prioritize interpretation services and educators from immigrant communities to better support New Mainers entering these trades. This initiative would build on Portland Professional Connections, a program in partnership with the City of Portland's Office of Economic Opportunity that connects foreign-trained professionals with people in their field to help build professional networks.

Our next steps

- ☐ Collaborate with state and local partners, employers, economic researchers, industry specialists, and labor groups in ongoing economic development efforts to identify gaps in skilled labor for growing and emerging climate-related sectors.

CR 3.2 Summary - Workforce for a Resilient Economy



*Depending on the nature of the program

CR 3.3 Climate-Ready Industries and Innovation

ACTION: Build the capacity of the businesses and industries in our cities to bounce back, adapt, and innovate.

Where we are today

Both Portland and South Portland have vibrant and diverse economies. The cities' historic industries, such as manufacturing, marine and railway shipping, fishing, and tourism, continue to evolve and flourish, with the addition of growing and thriving biotech, healthcare, finance and insurance, retail, arts and cultural, and local food sectors. Greater Portland contributes half the economic output in the state of Maine, and the impact of economic activity in the cities reaches far beyond our city boundaries—connecting to regional farms through craft food processing and farm-to-table markets as well as to global supply chains through the International Marine Terminal. A resilient economy is one that recovers quickly from shocks, evolves to accommodate new industries, and meets the needs of a diverse range of employees. Businesses within a resilient economy are able to weather storms (literally and figuratively), and able to shift their services, operations, or business models to contend with changing conditions. Furthermore, a resilient economy is one that is able to adapt to long-term changes as markets and sectors change. As Maine, the nation, and world seeks to decarbonize sectors and industries, we seek ways for Portland and South Portland's industries to not only respond to that shift, but to lead that transformation.

The action we will take

Portland and South Portland will build the capacity of the businesses and industries in our cities to bounce back, adapt, and innovate. Doing so will involve actions across a number of nested scales: 1) Ensuring that our businesses have the

resources to respond to shocks, 2) Supporting thriving and diverse sectors that can adapt to changing markets and business conditions, and 3) Ensuring that we cultivate businesses and industries that are leading our cities' adaptation and decarbonization. Primary approaches we will pursue include:

- Supporting business resilience through outreach, resources, and learning networks.** Through the Cities' business visitation programs, economic development staff in both Portland and South Portland regularly connect with businesses to learn about their needs, plans for growth, or other topics. In 2020, City staff have been working with businesses on marketing and other support programs in light of the extended business closures or modified hours and services due to the outbreak of the 2019 novel coronavirus. In the coming year, the Cities, in partnership with the Portland Regional Chamber of Commerce, Portland Downtown, Portland Buy Local, and other business associations, will continue this outreach to discuss business resilience, including key challenges, needed resources, or lessons learned—drawing on the direct experiences from the COVID-19 pandemic. For example, *what have been the most difficult challenges created by multi-week closures? How can businesses diversify services, or work online or remotely? What would most help in weathering downturns?* Based on the responses, the Cities and partners will identify a set of business resilience resources. These may include hosting a series of workshops on related topics; earmarking a portion of the Cities' respective small business revolving loan funds for emergency relief; launching

● **Embrace a blue economy.** Portland and South Portland are rich with marine resources, active working waterfronts, and a range of marine-based industries that make up our cities’ “blue economy.” Growing these sectors, and specifically sustainable fishing, aquaculture, and associated industries, offers an important and viable way to expand access to locally-sourced food (with smaller carbon footprints than many other proteins!) and contribute to food system resilience, while strengthening the local economy. The Cities will identify barriers and opportunities for the growth of the blue economy, as well as develop or revise land use policies to support traditional and emerging marine-related industries as guided by comprehensive and ongoing waterfront initiatives. Portland and South Portland will also continue to maintain the Portland

- **Cultivate diversified and vibrant industries.** Both Portland and South Portland will continue to cultivate diversified and vibrant industries. Through public-private partnerships and pilot projects, the Cities will focus on opportunities that build on the State’s effort to foster innovation and economic growth in industries that contribute to climate solutions such as renewable energy and biofuels, sustainable fishing and aquaculture, advanced building materials, and circular economy technologies.

- ☐ Continue outreach through the Cities' economic development business visitation programs, focusing on gathering insight on business resilience needs.
- ☐ Identify barriers and opportunities for the growth of blue economy and marine-related businesses, including seafood harvesting, landing, processing, and distribution.

- Support business resilience via economic development programs.
- Identify barriers and opportunities for the growth of a blue economy.
- Drive innovation and growth in climate-ready industries such as renewable energy, sustainable fishing, advanced building materials, and circular economy technologies through public private partnerships and pilot projects.

- (b) Strengthens communities
- (d) Builds partnerships

P: Economic Development,
Sustainability Office
SP: Sustainability Office,
Economic Development,
Planning Department

Revolving loan funds (e.g., Portland Development Corporation), public private partnerships, federal grants (e.g., EDA Build to Scale grants), tax increment financing

CLIMATE RESILIENCE

SECTION 3 - LOCAL ECONOMY



CR 4

Resilient Infrastructure Systems

THOMAS NIGHT PARK • Photo by Denise Michaud

CR 4.1 Stormwater Systems

ACTION: Use modeling and flood data to upgrade the Cities' stormwater and sewer systems to handle future climate scenarios.

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Where we are today

Portland and South Portland have invested in upgrades to the Cities' sewer and stormwater systems significantly over the past couple decades in order to better manage high volumes of stormwater, to separate combined sewer and stormwater systems, and to reduce overflows that carry pollutants into Casco Bay. South Portland recently completed an Asset Management Assessment to evaluate the likelihood of failure of all portions of the sewer (and roadway) systems, and Portland recently completed an Integrated Water Resources Management Plan to best prioritize spending with respect to wastewater and stormwater infrastructure and water quality protection. With climate change, Portland and South Portland

will likely see storms with more precipitation in shorter periods of time, which will continue to increase the strain on the Cities' stormwater systems. Sea level rise and storm surge will also add pressure to the systems in certain parts of the cities. The One Climate Future vulnerability assessment provides a preliminary geospatial analysis of the stormwater and sewer assets that fall within inundation areas from sea level rise and storm flooding. Modeling how coastal flooding and higher intensity and frequency of storms will impact the sewer and stormwater system will help the Cities target infrastructure upgrades both to manage future flooding and to reduce further detrimental impacts on the health of Casco Bay.

The action we will take

Portland and South Portland will commission the development of a citywide hydrologic/hydraulic drainage model with simulations for current and future design storm and sea level rise scenarios; expand data and reporting on the stormwater system and flood incidents; and develop a phased implementation plan for system upgrades based on this modeling and data. The hydrologic/hydraulic drainage study will evaluate whether existing storm drainage pipes have sufficient conveyance capacity, and identify areas with high flood risk due to drainage backups, capacity issues, and/or coastal and riverine flooding. In areas with high flood risk, the study will identify flood impacts to critical infrastructure and land uses (such as electrical substations, wastewater treatment facilities and pump stations, emergency services, schools, housing, commercial and industrial uses, among others) based on peak flood depths and flood duration.

In conjunction with the hydrologic/hydraulic drainage model, the Cities will improve geospatial data on stormwater system components and on the occurrence and extent of flood incidents. Specifically, this will include:

- **Filling gaps in geospatial data for the sewer and stormwater system.** For both Cities, completion of this modeling will involve collecting, compiling, and/or updating missing or outdated infrastructure attribute data, ideally in a central GIS repository. For Portland, filling these gaps will build on the *Infiltration and Inflow Study*, as well as recommendations from the *Bayside Adapts Phase 1 Stormwater and Sewer Gap Analysis*, to continually update and improve data quality.

- **Building out the protocol for consistently tracking flood incidences.** The Cities will each establish a protocol and continue to keep a geospatial record of flooding incidents, including flood extent, depth, and duration. These datasets will allow the Cities to track patterns, corroborate the drainage model, as well as identify operational deficiencies not captured by the model (such as clogging and root intrusion) that will affect stormwater system capacity. For South Portland, building out this protocol will formalize and operationalize the “Flood

Data Collection Protocol” developed in collaboration with the Southern Maine Planning and Development Commission.

- **Implementing a comprehensive asset management system.** Portland will leverage a systematic asset management framework and database for monitoring the performance of stormwater assets; South Portland will incorporate stormwater assets into an existing asset management system. Both Cities will use these systems to track maintenance and replacement needs and use predictive analytics for long-term capital planning. A goal of the databases will be to assess true costs of stormwater asset management across compliance programs over time and inform a stormwater utility or service charge. Tracking investments will also inform whether the Cities are seeing escalating maintenance costs in specific locations due to additional strain from climate change, as a comprehensive and adaptive approach to inventorying, planning, replacing, operating, and maintaining physical assets.

Using the drainage modeling, flood data, and framework for asset management, Portland and South Portland will develop a phased investment approach for capital improvement projects and maintenance, prioritizing investments based on the results of the hydrologic/hydraulic drainage model, ongoing flood incident records, and projects that have the greatest capacity to maximize health, safety, and environmental benefits. For Portland, this investment approach will be created in alignment with the priorities developed in the Integrated Water Resources Management Plan (2020). Based on information gained through the flood modeling, South Portland and the Portland Water District will establish protocols for the further long-term evaluation of flood risk to the Cities’ wastewater treatment plants and pump stations to ensure that upgrades, maintenance, or new facilities protect against flooding in line with the latest climate projections. Both Cities will continue to prioritize combined sewer separation and overflow mitigation, and will seek opportunities to use natural systems for stormwater infiltration and storage wherever possible (see action CR 4.2). For all components outlined above, the Cities will coordinate with the Portland Water District and the Maine Department of Transportation (MaineDOT), both of which manage certain portions of the Cities’ stormwater systems.

Our next steps

- ☐ Continue to work internally to fill gaps in geospatial data for the sewer and stormwater systems, and to build out a protocol for tracking flood incidents. Identify any components where additional consultant capacity is required.
- ☐ Secure funding and produce a request for proposals (RFP) to commission a hydrologic/hydraulic drainage model with simulations for current and future design storm and sea level rise scenarios.

CR 4.1 Summary - Stormwater Systems

How this strategy advances a future that is...			
PRIMARY COMPONENTS	Equitable	Regenerative	Resilient
	a b c d	a b c d	a b c d
			(a) Reduces vulnerability (c) Adapts processes
KEY MILESTONES		CITY STEWARD	FINANCING MECHANISMS
• Full geospatial data set completed for sewer and stormwater system by 2024 • Hydrologic / hydraulic drainage model completed by 2028		P: Water Resources SP: Water Resources Protection, Emergency Management	User fees (e.g., Portland stormwater service charge, South Portland Sewer User Fund), general fund

CR 4

CR 4.2 Green Infrastructure

ACTION: Expand the use of green infrastructure systems to capture and infiltrate the first inch of stormwater in any storm.

.....

Where we are today

Roughly 32% of Portland and South Portland respectively is covered with impervious surfaces, such as buildings, parking lots, streets, driveways, alleys, and sidewalks. When it rains, stormwater runs off these surfaces, sending large volumes of water into the stormwater system, contributing to localized flooding, and transporting pollution from those urban environments into rivers and Casco Bay. Reducing and/or disconnecting impervious surfaces and expanding green infrastructure can help manage stormwater, particularly with more intense storms brought by climate change. Decreasing the extent of impervious surfaces in the cities will also keep air temperatures cooler on days with high heat and will help support ecological resilience. Currently, both Portland and South Portland look for opportunities to upgrade stormwater systems using green infrastructure, and to expand use of green infrastructure through new development. These local efforts are also promoted by and led in partnership with regional programs, including the Long Creek Watershed Management District, Greener Neighborhoods Cleaner Streams, and Think Blue Maine—all of which work to protect clean water and the health of our water ecosystems through green infrastructure and the reduction of stormwater pollution.

The action we will take

Moving forward, Portland and South Portland will take a more proactive and aggressive approach to integrating green infrastructure in the cities by setting an explicit goal of “capturing the first inch” of rainwater citywide. In other

What is green infrastructure?

Green infrastructure is a method for managing stormwater at its source in an urban environment using plants and small-scale systems to treat water such as rain gardens, street trees, green roofs, gravel wetlands, and infiltration trenches. Green infrastructure supports healthier ecosystems and helps to restore the natural hydrology of a site by allowing water to soak into the ground.



words, Portland and South Portland will invest in nature-based systems across the cities until we can capture, infiltrate, retain, or evapotranspire the first inch of rainwater that falls on the cities in any storm event—with only the excess stormwater above one inch entering our piped stormwater system. Reaching this target will require that the Cities prioritize opportunities for green infrastructure installation in municipal capital projects; create stronger incentives or requirements for green infrastructure installation in (re)development; and encourage the conversion of impervious surfaces and the integration of green infrastructure on private land through educational tools, resources, programs, and incentives. As part of this goal, Portland and South Portland will work to “green” 15% of the current impervious area in the cities by 2050 through implementing green infrastructure systems in parking lots, public rights of way, and through green roofs.

Several studies and sets of spatial data mentioned in other One Climate Future actions will help the Cities prioritize locations for green infrastructure installation on public land, including geospatial data on the cities' tree canopy coverage (see action CR 1.3); a hydrologic/hydraulic drainage model that looks at future climate projections (see action CR 4.1); and an assessment of infiltration capacity of open spaces such as parks and athletic fields (see action CR 1.3). Updated performance standards will incentivize greater use of green infrastructure in new development to meet resilience goals (see action CR 1.1). Likewise, incorporating green infrastructure design guidelines into the Cities' complete streets design guidelines will support the integration of green infrastructure into the public right of way (see action TLU 1.4).

To encourage the expansion of green infrastructure and impervious surfaces on private land, the Cities will evaluate a number of scenarios for updating development requirements and revising (Portland) or adopting (South Portland) a stormwater service charge and credits program. Specifically, the Cities will evaluate the following options:

- **Requiring all new development to retain the first inch of rainwater on site.** Such a requirement would ensure that all new development contributes to the Cities' resilience goal of "capturing the first inch citywide." Portland and South Portland will evaluate a couple of options for this requirement, including whether the development standard would apply to all properties, or to new construction above a certain size threshold. This requirement would align with updated resilience performance standards for new development (see action CR 1.1).

- **Amending stormwater credits to better incentivize on-site stormwater management (Portland).** Portland levies a stormwater service charge and offers credit to property owners who install and maintain cisterns, dry wells, modified French drains, permeable pavers, and rain gardens. Portland will evaluate options for expanding the range of green infrastructure and low impact development (LID) strategies eligible to receive credit in order to strengthen the incentives

for on-site stormwater management. Additionally, Portland will conduct a broader marketing campaign under Think Blue Portland to raise awareness of the stormwater credits system and increase use of the model.

- **Adopting a stormwater service charge and credits program to better incentivize on-site stormwater management (South Portland).** South Portland will investigate the feasibility and effectiveness of implementing a stormwater service charge and credits program as a mechanism to further encourage on-site stormwater management on private property, and to institute a funding stream for additional public stormwater management improvements.

Portland and South Portland will further support the expansion of green infrastructure and pervious surfaces on privately owned land through educational resources, information, and incentives. Potential mechanisms that will be considered include:

- **Developing guidelines for green infrastructure design, operations, and maintenance.** Green infrastructure guidelines will allow the Cities to set standards for design, installation, operation, and maintenance to increase the effectiveness of public green infrastructure installations, and provide technical assistance to developers who otherwise would not consider green infrastructure. Pre-approving the designs and standards with relevant boards and committees (such as historic preservation) will simplify the development process for green infrastructure projects. Requiring maintenance plans as part of green infrastructure design development for city-owned projects will also help ensure effective maintenance. These green infrastructure design guidelines will be incorporated into city complete streets design guidelines (see action TLU 1.4).

- **Including stormwater infiltration initiatives in the Sustainable Neighborhoods Program.** The Sustainable Neighborhoods Program encourages residents within a neighborhood to work together to implement initiatives and

achieve Sustainable Neighborhood certification (see action CR 2.5). Climate Resilience will be one of the goal areas of the Sustainable Neighborhoods Program, with stormwater infiltration as a potential target category. In this case, residents would be able to receive points for projects that improve stormwater infiltration through rain-scaping installations such as rain gardens, downspout planters, and depaving projects.

• **Implementing a rain-scaping incentive program for residential properties.** Through a rain-scaping program, residents would be offered rebates for a range of stormwater management tools such as rain barrels, downspout planters, rain gardens, depaving projects, or permeable pavers. An online evaluation tool would help residents identify the stormwater tool that would work best for them. South Portland may also explore updating the wetlands compensation fund charter to explicitly allow for the use of funds to further incentivize green infrastructure installations on private land.

• **Supporting a public-private-partnership green infrastructure model.** Under such a model, the City would construct green infrastructure on private land at public cost. The landowner would be responsible for maintenance, based on a maintenance agreement.

• **Continuing to build education and awareness for green infrastructure with regional partnerships.** In alignment with messaging and outreach efforts through Blue Maine, Greener Neighborhoods Cleaner Streams, and the Long Creek Watershed Management District, we will continue to build out a suite of resources that share and promote information on the value of green infrastructure; methods and resources for homeowners to “rain-scape” or “bay-scape” their yard; and ways property-owners can receive stormwater credits (in Portland) through online tools and materials, tabling at events, and through social media. In Portland, these outreach efforts will continue to be expanded and collated under Blue Portland.

Our next steps

- ☐ Work with residents and the development community to update stormwater performance standards; this step will dovetail with the development of resilience point requirements (see action CR 1.1).
- ☐ Evaluate additional mechanisms to support the expansion of green infrastructure and pervious surfaces on private property.
- ☐ Explore leveraging stormwater service charge and/ or credits to better incentivize on-site stormwater management.

CR 4.2 Summary - Green Infrastructure

PRIMARY COMPONENTS	How this strategy advances a future that is...		
	Equitable	Regenerative	Resilient
• Evaluate and adjust ordinances to increase infiltration in new development. • Explore revising (P) or adopting (SP) stormwater service charges and credits to better incentivize on-site stormwater management. • Evaluate/implement initiatives and tools to support expansion of green infrastructure and pervious surfaces on private property. • Collaborate with regional partners to build education and awareness of green infrastructure.	a b c d	a b c d (a) Draws down carbon (b) Restores ecosystems	a b c d (a) Reduces vulnerability (b) Strengthens communities (d) Builds partnerships
	KEY MILESTONES • 5% of the cities’ impervious surfaces converted to green infrastructure by 2035; 10% by 2040; and 15% by 2050	CITY STEWARD P: Water Resources SP: Planning Department, Water Resources Protection	FINANCING MECHANISMS Revolving loan funds (e.g., Clean Water State Revolving Loans), bonds, federal/state grants (e.g., 319 Grants, Community Development Block Grant funding)

CR 4

CR 4.3 Energy Systems

ACTION: Build Portland and South Portland’s energy resilience.

Where we are today

Higher temperatures, flooding, and more intense storms may compromise power systems and contribute to more frequent or longer power outages. Traditionally, cities and organizations have relied on diesel generators to provide backup power to critical facilities, prevent cascading infrastructure failure, and protect acute health and safety needs. Because diesel generators are only called on in emergencies, they sit idle most of the time and bring no day-to-day benefits for their cost. They also contribute to air and noise pollution, depend on fossil fuels, and require reliable access to diesel fuel to operate over prolonged periods of time. The air pollution risks are of particular concern for health care facilities—by code, emergency and operating rooms must have diesel backup—but those generators can also pose acute health risks to vulnerable populations suffering from compromised respiratory function.

The reliance on this form of backup generation can be mitigated both through strengthening utility infrastructure to reduce the risk of disruptions, and expanding the use of solar generation, battery storage, and microgrids to support resilience and public health. A microgrid is a localized electricity network that is connected to the broader grid but also contains enough generation resources to be self-supporting and can be “islanded” and continue to operate autonomously with no loss in function. Microgrids can be contained and used within a building or campus with a single owner, or with regulatory support, can serve larger multi-owner networks. As discussed in action BE 5.3, such systems are not currently approved in Maine. However, they have been a critical part of resilience strategies in other jurisdictions.



POWER ON, ON FORE STREET • Photo by Corey Templeton

The action we will take

Portland and South Portland will expand renewable distributed energy sources in the cities to provide reliable back-up power for critical facilities while simultaneously supporting the Cities’ climate goals. Systems such as solar power and storage will help to lower the Cities’ carbon emissions, reduce electricity consumption during periods of peak demand, generate cost savings, and enhance the stability of the local grid—in addition to providing emergency power when the main grid is disrupted. We can also further advance environmental

justice goals by ensuring that the benefits of these distributed energy sources first and foremost benefit residents who will be disproportionately impacted by climate change. Specifically, the Cities will take the following multi-pronged approach to increasing our energy resilience:

- **Develop and implement a Resilient Power Plan.** Portland and South Portland will identify a list of critical facilities in the cities that could most benefit from backup power, assess critical power loads for those facilities, and commission an engineering assessment to identify cost and technology options to meet those power needs. This review will focus primarily on municipal facilities where the Cities have full control to implement improvements, but it will also look for opportunities to cluster multiple facilities, both public and private, in microgrid systems where possible. Projects will be prioritized based on their ability to safeguard health and safety, and based on their potential to protect or benefit residents who may be most significantly impacted by climate change—including older adults, residents with disabilities, residents with low or no incomes, youth, New Mainers, and communities of color. The work should be aligned with the Strategic Energy Management Plan (see action BE 1.3), as energy efficiency upgrades are important for cost-effectively optimizing the capacity requirements for energy generation and storage. The Cities will work with distributed energy system developers to implement systems through third-party ownership or leasing structures.

- **Incentivize distributed energy sources in private developments.** Distributed energy resources (DER) are a key component of a resilient energy system. At both the building and district scale, efficiency, renewable power generation, and energy storage can provide “non-wires alternatives” (NWA) to traditional energy infrastructure investments at lower cost and with far greater resilience. As discussed in actions BE 3.5 and BE 3.6, Portland and South Portland will be working to increase the penetration of solar generation and battery storage throughout commercial and residential buildings. We will work with Central Maine Power and solar installers to ensure that wherever possible, buildings with DER are able to disconnect from the grid and “island,” both automatically in the event of

a power outage and on demand in response to grid stress. As discussed in action BE 5.4, Portland and South Portland will use the zoning process and other structural or financial incentives to encourage developers of new private developments to explore and install district energy systems and microgrids to the greatest extent feasible under state utility regulations.

- **Consider resilience needs in decarbonization planning.** As Portland and South Portland move towards decarbonization and beneficial electrification, the risks to resilience must be considered. While natural gas and fuel oil boilers and furnaces contribute directly to climate change, they are also more resilient to power outages and other disruptions than electric heat pumps. These risks can be mitigated through ensuring enough on-site solar generation and storage capacity. However, these resources may not be able to cost-effectively heat and power some critical facilities for an extended period. In targeting buildings for electrification, Portland and South Portland will consider the critical facility needs of buildings, and may opt to delay full electrification of such buildings to a later date once the affordability of longer-term electricity storage improves.

- **Advocate for regulatory updates that support resilient energy systems.** As discussed in action BE 5.3, microgrids and other district energy systems are currently not allowed to cross public rights-of-way, which greatly limits their practicality in urban contexts. Enabling microgrids and district energy systems to cross public rights-of-way and, ideally, to provide and sell power to multiple users, will greatly expand the available energy resilience options in Maine. The Cities will advocate for state legislation to enable the use of microgrids in Maine.

- **Work with the State and utility companies to ensure climate risks to existing energy infrastructure are evaluated and addressed.** Electric substations, transformers, and overhead transmission and distribution lines are used to distribute power throughout the city and are vulnerable to extreme events. The Cities will advocate for Central Maine Power to conduct site-specific studies to evaluate and address the current and future risk to existing critical

utility infrastructure from flooding and extreme heat. As necessary, the Cities will advocate for the Maine Public Utilities Commission (PUC) to mandate a statewide study for utilities to evaluate and address these risks, and for local jurisdictions to be consulted in the study. To the extent practicable, the Cities will partner in the process to inform the study and recommendations based on local planning and resilience priorities.

- Ensure that climate risks are considered in utility rate cases for new investments.** The Cities will intervene in Maine Public Utilities Commission utility rate cases for investments in new and upgraded infrastructure to advocate for the review and mitigation of climate risks including flooding, extreme weather, and heat stress. Electric distribution equipment including but not limited to substations, switch gear, and transformers should be flood-proofed and/or elevated. Natural gas infrastructure including but not limited to pressure regulating stations, odorization equipment, tanks, controls, and electrical components should be flood proofed and/or elevated. Climate risks should also be addressed for any new

land and water routes for new electricity transmission lines, as discussed in action BE 5.5.

Our next steps

- ☐ Identify a list of critical facilities that could most benefit from backup power; assess critical power loads for those facilities; and commission an engineering assessment to identify cost and technology options to meet those power needs. Align this assessment with the Strategic Energy Management Plan (see action BE 1.3).
- ☐ Advocate with state legislature and Public Utilities Commission for revision or elimination of restrictions on microgrids and district energy systems (in alignment with action BE 3.5).
- ☐ Work with the Maine Public Utilities Commission and the electric and gas utilities to identify key energy infrastructure that is or will be vulnerable to climate impacts.

CR 4.3 Summary - Energy Systems

How this strategy advances a future that is...			
PRIMARY COMPONENTS	Equitable	Regenerative	Resilient
- Advocate for regulatory updates to enable use of microgrids. - Advocate for site-specific vulnerability assessments of critical utility infrastructure. - Advocate for climate risks to be evaluated in future infrastructure planning. - Develop and implement a Resilient Power Plan. - Incentivize distributed energy resources in private development.	a b c d (a) Addresses injustice (b) Expands access	a b c d (a) Draws down carbon	a b c d (a) Reduces vulnerability (b) Strengthens communities (c) Adapts processes (d) Builds partnerships
	KEY MILESTONES - Development of Resilient Power Plan by 2026 (align with BE 3.5) - All new development over 500,000 square feet to evaluate district energy/microgrids starting within one year of microgrid enabling legislation	CITY STEWARD P: Sustainability Office, Emergency Management, Public Works, Facilities SP: Sustainability Office, Planning Department	FINANCING MECHANISMS Federal/state grants (for Resilient Power Plan), utility cost recovery (for site-specific assessments), REC sales, federal tax credits, power purchase agreements (for DER development); see BE 5.4 regarding district energy; <i>Future: green/infrastructure bank</i>

CR 4

CR 4.4 Transportation Systems

ACTION: Adopt a risk-based transportation asset management approach.

Where we are today

The One Climate Future Vulnerability Assessment documents how the effects of climate change, including rising temperatures, more freeze-thaw cycles, more intense precipitation, and sea level rise-induced groundwater rise are expected to bring more wear and tear on roads, sidewalks, multi-use trails, and rail lines in Portland and South Portland. Likewise, sea level rise and storm surge may inundate portions of our road networks, rail lines, and marine terminals more frequently and consistently within the next thirty years and increasingly over the course of the century. Portland and South Portland prioritize regular infrastructure maintenance and upgrades in the Cities' capital improvement plans, and coordinate with federal, state, regional, and private transportation partners for projects involving state or federal assets. As a part of Smart City & Innovation Hub initiatives in Portland, the City has begun updating asset management systems and building out a robust geospatial dataset of transportation assets. Portland recently completed an inventory of the City's sidewalks, ramps, and roads to assess for ADA compliance, pavement conditions, and estimated costs for maintenance. South Portland recently completed an Asset Management Assessment to evaluate the likelihood of failure of all portions of the roadway systems.

The action we will take

Portland and South Portland will adopt a risk-based transportation asset management approach in order to develop more advanced protocols to protect, maintain,

and adapt transit infrastructure with climate change.

Transportation asset management (TAM) is a process for using financial and engineering data and modeling to optimize how a city systematically and strategically allocates resources for operating, maintaining, upgrading, and expanding transportation assets. Risk-based transportation asset management involves incorporating external factors—and specifically climate projections—into those calculations and investment decisions.¹³⁷ The Cities will incorporate the following components as part of a risk-based TAM approach:

- **Building out robust datasets to inform risk-based transportation asset management.** The Cities will continue to build out complete geospatial inventories for transportation assets throughout the cities, including attribute data that will support risk-based assessment. This will include, for example, elevation data for transportation segments to predict and corroborate flooding at specific elevations. The Cities will log flood events on specific transportation segments in order to validate risk and resilience modeling and its relationship to maintenance needs (see action CR 4.1 for further discussion on the Cities' flood tracking protocol)—in addition to tracking maintenance, repair, and upgrade costs attributed by segment, and whether maintenance costs can be primarily attributed to one storm or flood event. The goal of the maintenance costs database will be to track investments over extended periods of time in order to make strategic decisions about re-routing, raising, or decommissioning roads as we continue to see more effects from climate change. This work will enhance and align



HIGH TIDE FLOODING, MARGINAL WAY • Photo by Ian Johnson

with recommended actions presented to Maine’s Climate Council that increase the resilience of transportation infrastructure through the development of a maintenance database and resilient design standards.

• **Modeling wear and asset lifespan using consideration for climate hazards.** Adopting risk-based TAM will allow Portland and South Portland to incorporate exposure to hazards, vulnerability of the system, and the criticality of the asset or transportation segment as part of the calculation for preventative maintenance, repair, and/or upgrades. Exposure to hazards will include a ranking based on exposure to flooding from sea level rise and storm surge, and the likelihood of ponding due to lower elevations and drainage issues with higher intensity storms (to be based on the drainage study in action CR 4.1). Vulnerability of transportation segments would relate to the surface/material or design of the segment and its ability to handle higher intensity storms, flooding, or higher heat thresholds. Criticality will relate to the importance of that transportation

asset for maintaining critical municipal functions, particularly in emergency situations.

• **Establish climate-resilient design guidelines and performance parameters for asset upgrades.** The Cities will leverage robust asset datasets and flood risk modeling to establish design standards for the repair and replacement of transportation infrastructure that account for climate projections. To the extent practicable, all roads should be designed for a 20-year design life under the Intermediate sea level rise scenario, in addition to compounding effects from higher intensity storms and temperatures. Rail lines and bridges should consider a 50-year and 100-year design-life, respectively. Design guidelines will address pavement structure and materials, road elevation, and adjacent drainage capacity. As part of the design and performance parameters, the Cities will set cost and performance thresholds for preventative upgrades, as well as cost thresholds for considering road decommissioning or rerouting. Where applicable, culverts and bridges will be redesigned to support marshland migration (see action CR 5.1).

• **Develop a phased investment approach for capital investments.** Using the scenarios generated through risk-based asset management, the Cities will work across Public Works Departments and Planning Departments in coordination with Maine Department of Transportation (MaineDOT) and the Greater Portland Council of Governments (GPCOG)/Portland Area Comprehensive Transportation System (PACTS) to develop a phased approach for transportation capital investments that aligns timeframes for road upgrades with climate risk. The phased investment approach would identify immediate needs, and risk thresholds for making decisions about future investments. It would also be an opportunity to use the scenarios to support decisions around land use planning and city growth to minimize repeated damage to road infrastructure. The goal of this approach will be to plan in a proactive, coordinated way, and to pace investments in transportation infrastructure, knowing that flood risks from sea level rise will continue to intensify. This process will likewise involve collaborating with private transportation partners (rails and ferry terminals) to discuss climate projections and timelines for infrastructure upgrades in order to coordinate connecting infrastructure.

Our next steps

- ☐ Build out geospatial inventories; when complete, incorporate these inventories into flood-risk models and impact assessments for critical infrastructure focused on resilience, risk, and vulnerability.
- ☐ With asset management and geospatial systems in place, focus on vulnerability, criticality, and risk-based analyses of transportation assets.
- ☐ In collaboration with GPCOG/PACTS, establish a regular convening between regional transportation partners to discuss concerns and priorities for transportation system adaptation.

CR 4.4 Summary - Transportation Systems

PRIMARY COMPONENTS	How this strategy advances a future that is...		
	Equitable	Regenerative	Resilient
• Build out robust geospatial data to support modeling and predictions. • Model asset lifespans with consideration for climate hazards. • Establish resilience design guidelines and performance indicators. • Develop phased investment approach, influenced by climate risk.	a b c d	a b c d	a b c d (a) Reduces vulnerability (c) Adapts processes (d) Builds partnerships
	KEY MILESTONES • Climate hazards and resilience indicators applied to all asset management decision-making by 2028	CITY STEWARD P: Public Works SP: Finance Department, Public Works, Transportation Department	FINANCING MECHANISMS Impact fees, general fund

CR 5

Resilient

Ecosystems

MARSH, SAWYER ROAD • Photo by Denise Michaud

CR 5.1 Ecosystem Adaptive Management

ACTION: Strengthen ecosystem resilience through enhancing connectivity, biodiversity, and healthy habitat.

Where we are today

Environmental organizations and community groups, as well as Portland and South Portland’s respective parks and recreation departments, play a significant role in supporting ecosystem health in Portland and South Portland. Individually and in collaboration, these entities monitor environmental indicators; mitigate sources of pollution through policy, advocacy, and infrastructure upgrades; and protect biodiversity and habitat on land, in rivers and streams, and in Casco Bay. Through this work, we have already begun to assess the sources of ecosystem degradation that are intensifying with climate change: greater volumes of stormwater runoff are contributing to coastal acidification; sea level rise is contributing to loss of tidal wetlands; and changes in temperatures and precipitation

are allowing new invasive species and pests to thrive, while also causing native species to migrate northward to colder climates. To ensure that Portland and South Portland’s ecosystems can flourish in a changing climate, we will need to continue to restore and strengthen our ecological connectivity, biodiversity, and healthy habitats in ways that allow our ecosystems to evolve and adapt to new stresses over time.

And in turn, healthy ecosystems are vital assets in our ability to address climate change. Wetlands, for example, restore and regenerate ecosystem resilience by not only providing nesting grounds for birds and spawning habitat for fish, but by filtering stormwater pollution. They further protect our cities’ coastal

infrastructure by buffering wave action and reducing erosion, and they help to mitigate climate change by sequestering “blue carbon.” Blue carbon refers to the carbon captured in the ocean and coastal ecosystems, specifically. Although not as common in Portland and South Portland, sand dunes and beaches also play critical roles as natural buffers, protecting inland areas from coastal hazards while maintaining habitat and ecosystem function for species. Equivalent services and benefits can be attributed to the cities’ forests and freshwater wetlands, which also cycle nutrients, purify air and water, and sequester and store carbon. Thus, strengthening ecosystem resilience becomes integral to our efforts to both mitigate and adapt to climate change.

The action we will take

The Cities will continue to work with local environmental organizations to strengthen ecological connectivity, biodiversity, and healthy habitat in order to more aggressively buffer the cities’ ecological resources against climate change stresses. Strengthening these assets requires three types of action, implemented concertedly: 1) Reducing sources of pollution or degradation caused or intensified by climate change; 2) Strengthening ecosystems to withstand new stresses from climate change; and 3) Facilitating adaptation of ecosystems, including species compositions and distribution, to ensure that the cities’ natural systems can thrive under new climate conditions. As part of an adaptive management approach, Portland and South Portland will continue to monitor changes in ecosystem health over time and adjust the Cities’ land use and open space management practices accordingly. As part of this effort, Portland and South Portland will:

● **Facilitate tidal wetland migration to protect critical marine habitat, improve coastal resilience, and sequester blue carbon.** The Casco Bay Estuary Partnership has analyzed the distribution and extent of tidal wetlands in Portland and South Portland and noted areas in the cities where roads, railroads, and other structures alter the flow of water across tidal wetlands and degrade the resilience of marsh

ecosystems. Sea level rise is expected to further constrain and degrade these ecosystems. The Cities will use this information to inform future capital planning with the goal of increasing culvert sizes at these sites in conjunction with future road and infrastructure upgrades (to be completed in alignment with action CR 4.4). Likewise, the Cities will assess the areas along the coast where tidal marshes are expected to migrate inland to identify where it may be possible to acquire and conserve specific parcels of land as a living shoreline for inland marsh migration. As part of adopting resilience zoning overlays in the cities, we will consider implementing a hierarchy of land use for areas of the cities with the most extreme flood risk, which would prioritize the preservation of existing open space and acquisition of land for more natural floodplain over more development in these specific areas (see action CR 1.1).

● **Monitor intertidal and subtidal marine systems.** The Cities will partner with local institutions and organizations to assess the long-term stability and adaptive capacity of intertidal and subtidal zones through ecosystem level indicators of environmental change. Where landward migration of wetland systems is not possible due to geomorphology or human introduced restriction, Portland and South Portland will consider beneficial sediment management to encourage vertical migration in place of critical habitats such as beaches, mudflats, and eelgrass beds.

● **Develop biodiversity and connectivity goals and guidelines.** The Cities will collaborate with land trusts and conservation groups in the two cities to develop a set of goals and guidelines for expanding, managing, and cultivating ecosystem networks along multi-use trails and public rights of way, and across conservation land, parks, and other open spaces. The goals and guidelines will specify ways in which the Cities and organizations can collaboratively increase landscape connectivity to better facilitate species migration and dispersal; incorporate plant species that can best accommodate changes in the climate; and enhance biodiversity—all aspects that will strengthen the resilience of the cities’ ecosystems to pest outbreaks, invasive species, and new climate patterns. These goals and guidelines will further inform the Cities’ open space



BACK COVE LAND AND WATER ECOSYSTEMS • Photo by Corey Templeton

planning, comprehensive planning, technical manuals, green infrastructure guidelines, and upgrades to culverts and road design (see Actions CR 1.3, 4.2, and 4.4).

• **Monitor and manage pests and invasives.** In 2018, the South Portland Parks, Recreation, and Waterfront Department completed an *Invasive Plant Assessment and Management Plan*, documenting the prevalence of invasives throughout the city. The plan recommended management techniques, as well as first steps the City has taken to remove invasive species from trails and parks—a process supported by the help of South Portland Land Trust, community volunteers, and by using goats as a biological control. Drawing on successful approaches from this first phase, South Portland will outline concerted efforts to address invasives throughout the city’s forests and areas that risk losing much of their native vegetation, such as Hinkley Park. The Portland Parks, Recreation, and Facilities Department is at the beginning stages of mapping out a comprehensive strategy for invasives management, while testing approaches in targeted key problem areas. Portland will work towards developing a

comprehensive plan to prioritize and earmark resources as part of a long-term and ongoing strategy for invasives removal and management. Both Portland and South Portland will work with land trusts and community organizations focused on the stewardship of open spaces to develop a coordinated system for monitoring ecosystem vulnerability and adaptive management across green space in the cities. This may include assessing public open spaces for ecosystem health, removing invasive plant species, and monitoring for pest outbreaks.

• **Mitigate coastal acidification through reducing stormwater pollution.** The carbon dioxide released into the atmosphere from burning fossil fuels is increasing ocean acidity, and compromising the health of marine species. Freshwater runoff further exacerbates acidification along the coast as stormwater and streams bring excess nutrients—such as nitrogen from fertilizer, pet waste, and wastewater—into the ocean, contributing to large algal blooms that further increase acidic conditions. Portland and South Portland will continue to work with local partners, including Friends of Casco Bay, to

reduce excess nutrients and pollution carried by stormwater into Casco Bay. In particular, building on the recently adopted pesticide ordinances (see action CR 5.2), South Portland and Portland will continue processes that are underway to research, develop, and adopt fertilizer ordinances aimed at reducing fertilizer application to further protect the health of the bay. See action CR 4.1 and CR 4.2 for how the Cities will also reduce pollutant loads through continuing to improve stormwater management and green infrastructure.

• **Curtail coastal erosion with living shorelines.** Living shorelines are a green infrastructure technique that use plants and other natural materials to protect and stabilize the shoreline. This approach provides an alternative to traditional “hard” shoreline stabilization techniques that protect property but overtime can result in a loss of protected natural resources. Several communities in Maine are turning to living shorelines to curtail erosion while maintaining species habitat, and may be applicable to coastal wetland habitats in both cities. South

Portland and Portland will begin by using the Living Shorelines Decision Support Tool for Casco Bay, developed by the Maine Geological Survey, to evaluate the potential suitability of locations in both cities for natural approaches to shoreline stabilization.

Our next steps

- ☐ Finalize and adopt the drafted fertilizer ordinance (South Portland); Continue the work of the Portland Pesticide and Fertilizer Task Force to draft and adopt a fertilizer ordinance, drawing on South Portland’s model (Portland).
- ☐ Continue to implement the invasive species management plan (South Portland), and develop a comprehensive plan for long-term management (Portland), in coordination with land trusts and community environmental groups.
- ☐ Begin a study of coastal land uses to understand the feasibility of preserving or acquiring and transitioning parcels for marsh migration.

CR 5.1 Summary - Ecosystem Adaptive Management

How this strategy advances a future that is...			
PRIMARY COMPONENTS	Equitable	Regenerative	Resilient
• Monitor and manage pests and invasives. • Mitigate coastal acidification by reducing stormwater pollution. • Develop biodiversity and connectivity goals and guidelines (in alignment with CR 1.3). • Facilitate tidal wetland migration. • Curtail coastal erosion with living shorelines.	a b c d	a b c d (a) Draws down carbon (b) Restores ecosystems	a b c d (a) Reduces vulnerability (b) Strengthens communities (c) Adapts processes (d) Builds partnerships
	KEY MILESTONES	CITY STEWARD	FINANCING MECHANISMS
	• Fertilizer ordinance adopted by 2022 • No net coastal wetland loss by 2035 • Establish biodiversity and connectivity targets by 2028	P: Parks Division; Sustainability Office; Planning Department; Water Resources SP: Sustainability Office; Water Resources Protection; Parks, Recreation, & Waterfront; Planning Department	Impact fees (Portland), Land Bank Fund (South Portland), federal/ state grants (e.g., Maine Natural Resource Conservation Program funds, Maine Stream Crossing Upgrade Grant Program, Coastal Community Grants, 319 Grants)

CR 5

CR 5.2 Soil Health

ACTION: Build back the health of our soils for ecological vitality, water infiltration, and carbon sequestration.

Where we are today

Soils in the cities are critical for supporting ecosystems and for helping to buffer and purify pollutants. Healthy soils also have enormous potential to help cities address climate change by infiltrating stormwater, sequestering and storing carbon, and supporting plant growth. Portland and South Portland are already making efforts to increase soil health in the cities, including recently adopting pesticide ordinances to restrict the use of synthetic pesticides (which have been shown to kill beneficial soil microbes) for all lawns, gardens, and other outdoor landscapes. Nevertheless, centuries of industrial activity, infill, development, and other human activities that degrade soil cover have led to long-term loss of soil structure, contamination from the accumulation of heavy metals and organic pollutants (such as petroleum or pesticides), loss of soil depth, as well as the loss of soil enzymes and microbial activity needed to sustain ecological functions. Degraded soil stunts plant growth, weakens root structures, and has a lower capacity to infiltrate and store rainwater, creating more runoff and carrying higher pollutant loads into nearby water bodies. For all these reasons, improving the health of our soils, including increasing soil organic matter and microbial health, has the potential to increase the resilience of our cities and our ecosystems in ways that also increase quality of life for all residents.

The action we will take

Portland and South Portland will work with public and private partners in the cities to regularly and systematically measure

the health of the cities' soils based on microbial content, soil organic matter, soil structure, nutrient levels, and the presence of heavy metals and organic pollutants; set goals for improving the health of soils; and adopt landscape management practices to improve soil health on both public and private land. The Cities will initially pilot new land management practices on a number of public sites. After documenting a methodology with the best results, the Cities will expand these practices to open spaces throughout the cities, work with large institutional landowners to adopt new land management practices for improved soil health, and launch a campaign to encourage residents to improve the soil health of their gardens and lawns. The Cities will also move towards adopting post-construction soil standards to ensure future development and redevelopment continues to support our healthy soil goals.

Soil amendments, especially organic amendments including the application of compost, are a primary way to increase soil microbial content and soil organic matter—which are key to creating living, fertile ecosystems, improving soil structure, increasing the capacity of the soil to hold water, and for increasing soil carbon content. The Cities will work with researchers to develop high quality amendments focusing on compost. Key research targets will be compost composition targets for microbial content, nutrient balance, and other quality parameters to maximize the effectiveness of compost application on city-owned properties. Using these targets, Portland and South Portland will develop sources for compost, either by working with existing facilities to augment production



POPE PRESERVE • Photo by Maggie Burns

processes as needed, or through working with companies in the food service industry to provide fodder (such as spent grains from breweries) and producing the Cities’ own compost that meets the given targets. These compost-based amendments would initially be used on the pilot sites with the potential to expand as applications expand.

There are a number of ways in which this One Climate Future action dovetails with other actions. Systematically measuring and tracking improvements in carbon sequestration and stormwater infiltration potential on public land are two components of how the Cities will integrate resilience goals into our open space planning and prioritization (see action CR 1.3). Improving water infiltration through improved soil health will also advance the Cities’ goal of capturing and infiltrating the first inch of stormwater in any storm (see action CR 4.1). As part of the One Climate Future Waste Reduction actions, the

Cities are looking to expand programs for organics recycling (see action WR 1.3). This could be an additional source of feed stock for microbial-rich compost to support healthy soils.

The Cities will build on the pilot projects by expanding the healthy soils land management practices to public open spaces across the cities, and by working with landowners to adopt new practices on private land. The Cities will also consider adopting post-construction soil standards to ensure that soil health is increased as properties are developed or re-developed. Specifics of these methods may include:

- **Sharing the results of the pilot projects.** The Cities will include educational signs at the pilot sites to share the process and the progress of the soil’s health over time. The sites can also become hands-on learning spaces for schools, neighborhood associations, and other community groups.

● **Launching “100 Resilient Lawns.”** After building out a source for compost that meets the Cities’ targets, Portland and South Portland would launch an initiative to transform 100 lawns within the cities to sites with healthy soil. This would be done through workshops, community demonstration projects, and creative ways for residents to share that they are part of Portland’s and South Portland’s “100 resilient lawns” to create interest and momentum around soil health.

● **Including initiatives for improving soil health in the Sustainable Neighborhoods Program (Portland).** The Sustainable Neighborhoods Program encourages residents within a neighborhood to work together to implement initiatives and achieve Sustainable Neighborhood certification (see action CR 2.5). Residents will be able to receive points for improving soil health in yards and gardens throughout their neighborhood using a set of recommended techniques.

● **Adopting post-construction soil health standards through a new City ordinance or zoning amendments.** Soil requirements may include provisions for required soil depth as well as specific requirements for soil organic matter

(SOM) content to be between 5% and 10%, depending on expected cover. Other jurisdictions have seen success through this approach, including King County, Washington and Vermont. The King County Post-Construction Soil Standard requires all areas that have been cleared or graded to have a soil moisture holding capacity restored to that of the original undisturbed native soil, and that any areas that have been compromised must be amended with compost, imported topsoil, or other techniques.¹³⁸

Our next steps

- ☐ Work with local soil experts and environmental organizations to develop a protocol for measuring and tracking soil health at pilot sites.
- ☐ Gather baseline data on the soil health of the pilot sites.
- ☐ Develop partnerships for sourcing or producing compost that meets specific quality standards.
- ☐ Drawing from successful models in other jurisdictions, draft post-construction soil standards for inclusion in City ordinance or zoning amendment.

CR 5.2 Summary - Soil Health



Implementation

The implementation matrix on pages 262 - 285 summarizes the One Climate Future strategies, including the timeline for implementation, targeted milestones to track progress, financing mechanisms, and city stewards for coordinating implementation. The matrix also reports the greenhouse gas emissions savings attributed to each strategy, where applicable, as well as metrics that evaluate each strategy’s ability to support equitable, regenerative, and resilient cities.

All of these features contribute to the ongoing prioritization and successful implementation of the One Climate Future strategies.

► Key to reading the matrix

Timeline

-  **READY TO GO** - The action is ready to be implemented in the designated timeframe.
-  **READY TO GO, ONGOING IMPLEMENTATION** - Entails ongoing action to ensure the strategy is fully implemented in the designated timeframe.
-  **REQUIRES STATE ACTION** - Changes at the state level enable this action to proceed or move forward most effectively in the designated timeframe (e.g., policy must be passed at the state level).
-  **REQUIRES STATE ACTION, ONGOING IMPLEMENTATION** - Following enabling changes at the state level, the strategy entails ongoing action to ensure strategy is fully implemented over the designated timeframe.

Milestones

The milestones designate targets to hit by a specific date. When applicable to greenhouse gas emissions reductions, these milestones align with the energy and emissions modeling. It will be important to hit our milestones to meet our greenhouse gas reduction goals.

Greenhouse Gas Reductions

Greenhouse gas emissions reductions are reported cumulatively (total emissions saved over the course of 2020 - 2050), and specifically for the year 2050 for comparison with the baseline year (2017). Reductions are reported for actions that could be directly quantified; in some cases, the matrix reports the combined effect of several actions.

NIQ = Not independently quantified
NA = Not assessed

Financing

The ability to finance the implementation of the actions will be critical to the success of One Climate Future. Funding the transition to more resilient and low-carbon cities entirely by local property tax payers is not an option; such an approach would be both unsustainable and inequitable. Implementing the plan will require innovative financing mechanisms and strategic investments by the public and private sectors. Many such approaches have already been piloted by the Cities for sustainability investments.

The implementation matrix identifies potential financing mechanisms for each of the actions. Each of the four focus areas in One Climate Future present unique challenges and opportunities for funding, described in more detail below.

Buildings and Energy

Actions that improve energy efficiency and reduce greenhouse gas emissions generally have a co-benefit of reducing overall energy costs. This provides opportunities for property owners to harness energy savings to finance building envelope improvements, more efficient heating and cooling systems, and renewable energy deployments. Efficiency upgrades may also be eligible for rebates from Efficiency Maine that receive funding from the Regional Greenhouse Gas Initiative (RGGI) funds and benefit charges on utility bills. The One Climate Future plan includes advocacy for legislation that can open additional financial resources for municipalities, businesses, and property owners. These include Commercial Property Assessed Clean Energy (C-PACE) financing that allows property owners to partner with local governments to leverage municipal lien authority to secure private financing for energy projects. It also includes a statewide green bank that can support financing and revolving loan programs to fund sustainability related projects. Finally, purchasers of renewable energy may benefit from utility bill savings and the potential to sell renewable energy credits (RECs) for additional revenue that could support projects designed to meet our climate goals. The City of Portland's purchase of net energy bill credits following the passage of LD 1711 in 2019 exemplifies this approach. Once the associated projects come on line, the City will benefit from over \$500,000 of annual savings and the option to monetize RECs that could generate another \$500,000 of annual revenue.

How the strategy advances a future that...

This section evaluates the strategies based on their potential to advance a future that is equitable, regenerative, or resilient. Each quality is measured based on four metrics. See page 55 for a breakdown of the metrics.

City Steward

The City Steward is the city department responsible for the implementation of the action. In many cases, state, regional, or local partners will lead the work or serve as crucial partners; the City Steward will coordinate from the city-side.

Acronyms

See page 288 for a list of acronyms.

Waste Reduction

One Climate Future maps a path to a circular economy that will nearly eliminate waste in our cities by conserving resources, and reusing and repurposing products and materials. Such practices generate economic activity as local businesses take advantage of the opportunity to process, recycle, and add value to items that were formerly considered waste. Examples of this include resale and repair shops or businesses that recover building and construction materials to sell back to the market. One Climate Future further imagines extending programs such as Portland's purple bag trash collection program that charges residents based on the amount of waste they produce, which covers the costs of waste collection. This incentivizes people to reduce, reuse, and recycle while discouraging waste production—also saving the Cities money on tipping fees. Finally, the plan encourages efficiency and innovation in collection programs to reduce costs. For example, seeking ways to co-collect recyclables, waste, and organics to reduce the number of vehicles required to serve the public. This could ease the financial burden of these programs and reduce emissions by eliminating trucks from the collection routes.

Transportation and Land Use

Echoing Portland's Plan 2030, One Climate Future calls for the development of complete neighborhoods that contain opportunities for residents to live, work, and play close to home. Achieving this goal will require that we prioritize funding for transportation projects that will make such places accessible on foot, by bicycle, or by transit. This will require collaboration with neighboring PACTS communities and advocacy at the Federal, State, and regional level for increased funding for transit service and for an emphasis on transit-oriented development throughout the region. Fortunately, the seeds for this growth have been planted through ongoing work with the Greater Portland Council of Governments as demonstrated by the Transit Tomorrow plan and the ongoing implementation of the Portland and South Portland "smart corridor." The Cities also have the opportunity to ask private developers to assist in the creation of a cleaner, more active transportation system. Developers could be required to install bike storage, plant street trees, install EV charging infrastructure, or participate in traffic demand management programs in order to receive the necessary approvals from

each City. Impact fees could also offset municipal costs to improve the active transportation and transit systems. The Cities could also create tax increment financing (TIF) districts to create a funding stream to support the development of transit-oriented neighborhoods.

Climate Resilience

We know that Portland and South Portland will experience higher seas and more frequent storms that will damage public infrastructure and private property. Investing now in infrastructure upgrades and mitigation strategies makes good business sense. According to the National Institute of Building Sciences, every dollar spent to mitigate the impact of future disasters saves six dollars in the future by averting costly losses and rebuilding.¹³⁹ While that's a significant return, the problem of accessing the money needed to fund the initial investment remains. Many climate resilience strategies do not call for new capital projects, but instead will take advantage of existing upcoming projects such as road improvements and water system upgrades to integrate climate risk considerations into the project design. The incremental additional cost invested will extend the life of the project while minimizing the risk of future damage. The State and Federal governments will need to be partners in building local resilience through emergency preparedness grants and FEMA funding. Portland and South Portland will need to actively seek grant opportunities and advocate strongly for funding. The Cities also have opportunities to leverage impact fees so that developers can help bear the costs of improving public infrastructure. Finally, because private property owners stand to benefit from resilient infrastructure projects there are opportunities for collaborations between local governments, private property owners, and outside funders to develop and implement mutually beneficial projects. The planned Portland Harbor dredging project exemplifies this approach. It uses municipal contributions from Portland and South Portland and investments by private pier owners to leverage significant federal grant money to fund the project to ensure the viability of piers.

Descriptions of the financing mechanisms discussed above and included in the matrix are summarized on the following page.

Financing terms and definitions

Financing Terms	Description
Auction Revenue	Revenue from auctions of allowances on carbon markets like the Regional Greenhouse Gas Initiative (RGGI).
Battery Leasing	Battery leasing lowers the upfront costs of an electric transit bus by decoupling the cost of the battery from the cost of the electric transit bus. Through battery leasing, municipalities and transit agencies can purchase a battery-electric transit bus for roughly the same price as a conventional diesel- or natural gas-powered bus. Bus operators can then use funds earmarked for fuel costs to cover the battery lease.
Bonds	Municipalities can issue bonds to investors to raise capital for projects with the promise to repay with a level of certainty over a certain time period and with a certain return; bonds may require voter approval. Bond types vary and include Lease Revenue Bonds, Social Impact Bonds, and General Obligation Bonds.
Climate Mayors Electric Vehicle Purchasing Collaborative	The Climate Mayors is a peer-to-peer network of U.S. mayors working together to demonstrate leadership on combating climate change. The Climate Mayors Electric Vehicle Purchasing Collaborative is a procurement platform for electric municipal fleet vehicles that pools the purchasing power of cities to negotiate lower prices on EVs and charging infrastructure, and to offer municipal leasing programs.
Cost Recovery (by Utility)	Utilities can recover costs through rate increases with Public Utilities Commission approval.
Customer Benefit Charges / Public Benefit Funds	Customer benefit charges are additional surcharges added to utility bills, which go into a public benefit fund that can fund energy efficiency programs or other specialized programs.
Demand Aggregation	Group purchasing allows individuals, businesses, and municipalities to greatly reduce the cost of installing clean energy capacity through collective purchasing power.
Developer Impact Fees	Developer impact fees are assessments to developers to offset the impacts of development (e.g., externalities such as traffic congestion or lack of affordable housing). Establishing impact fees requires a study; the developer can only be charged the amount related to the proportional impact of the development.
Efficiency Maine	Efficiency Maine Trust (Efficiency Maine, or EMT) is the primary administrator for statewide programs to improve energy use efficiency and reduce greenhouse gas emissions in homes and businesses throughout Maine.
Energy Efficiency Incentives	Energy efficiency incentives refer to rebates and other incentives offered by a utility company or a state-designated entity for energy efficiency measures that result in quantifiable savings. In Maine these are provided through Efficiency Maine.
ESCO (Energy Service Company)	An energy service company (ESCO) is a commercial or non-profit business providing a broad range of energy solutions including design and implementation of energy savings projects, retrofitting, energy conservation, energy supply, and risk management. The client (such as the City) continues to pay the same amount of utility costs for a set period of time, but to the ESCO instead, and the ESCO implements measures that save energy, pays the now lower utility bills, and profits from the delta.

Fine Revenue	Fine revenue is money generated from penalty fees (fines) issued by the City. Fines are often for violation of local ordinances such as parking or building code violations.
Grants, Public (Federal and State)	Federal or state grants are non-repayable funds allocated through programs to support specific goals. Oftentimes federal funding is allocated through state agencies or a Municipal Planning Organization (MPO). The Portland Area Comprehensive Transportation System (PACTS) is the MPO for the Greater Portland region. Federal funding options are likely to change substantially if a new administration is elected in 2020.
Grants, Private	Private grants are non-repayable funds allocated by grant-making institutions such as community or family foundations.
General Fund	The general fund is a government's basic operating fund. Property taxes are a primary source of revenue for the general fund.
Green Bank / Infrastructure Bank	Infrastructure banks and green banks are public (or quasi-public) financial institutions, often established at the state level, that use public funds to leverage private investment to finance infrastructure projects (e.g., via direct loans at low-interest rates, bond issuances, and credit and loan guarantees). Green banks, in particular, provide low-cost financing to advance the widespread deployment and scaling up of clean energy technologies.
Municipal Lease Purchasing	Through a municipal lease-purchase program, local governments can use general funds rather than bonds to acquire vehicles through a lease-to-own program. Interest is tax-exempt, offering municipalities significant savings over a traditional lease. Municipal lease purchasing is usually facilitated through a municipal leasing company.
On-Bill Financing	On-bill financing allows for property owners to pay for clean energy upgrades through their utility. The utility incurs the cost of the clean energy upgrade, and the property owner repays the utility over time through their utility bill, offering a streamlined and simple way to pay for energy investments.
Power Purchase Agreement (PPA)	A power purchase agreement (PPA) is a contract between an energy developer or project owner and a buyer (such as the City) for the long-term purchase of electricity (typically 10-25 years). The project owner designs, permits, installs, owns, and maintains the project for the duration of the contract, and sells the electricity to the buyer at a competitive fixed rate.
PACTS (Portland Area Comprehensive Transportation System)	The Portland Area Comprehensive Transportation System (PACTS) is a federal metropolitan planning organization (MPO) that coordinates transportation planning and investment decisions for the Greater Portland area. PACTS works with the Maine Department of Transportation (MaineDOT) to allocate Federal Transit Administration and Federal Highway Administration funds in the PACTS Capital Management Area.
PACE (Property Assessed Clean Energy Financing)	Property Assessed Clean Energy (PACE) financing programs allow property owners to finance the upfront costs for sustainable energy investments and repay over time (usually 10-20 years) through property assessments, paid through their property tax bill. This financing method allows the clean energy loan to be attached to the property, and to transfer to the new owner when a property is sold. Commercial PACE (C-PACE) programs apply to commercial, industrial, and multi-family property owners; residential PACE (R-PACE) programs apply to all other residential properties.

Performance-Based Procurement	Performance-based procurement is a method for soliciting design and construction services for new City buildings or substantial retrofits that establishes a maximum budget, minimum performance targets, and ideal performance targets. This type of procurement process allows projects to achieve the highest feasible performance targets without increasing costs.
Public-Private Partnership	Public-private partnerships (PPPs) are agreements between the public and private sector for the delivery of services to the public. PPPs bring together the needs of the City with private market expertise and resources to achieve a common goal.
RGGI (Regional Greenhouse Gas Initiative)	The Regional Greenhouse Gas Initiative (RGGI) is a cooperative effort between ten northeast states, including Maine, to cap and reduce carbon dioxide emissions from the power sector. RGGI states set a regional “budget” (or cap) for greenhouse gas emissions, which gradually declines over time, and states sell allowances to emit greenhouse gases up to that cap. The proceeds from the auctions are invested in energy efficiency, renewable energy, and other consumer benefit programs.
REC (Renewable Energy Certificates) / SREC (Solar Renewable Energy Certificates)	Renewable energy certificates (RECs) are a financial instrument that captures the environmental value of a MWh of renewable electricity. RECs are used for accounting, tracking, and assigning ownership to the generation and use of renewable energy, and support the costs of installing those renewables. Solar renewable energy certificates (SRECs) are RECs specific to the generation of solar power, and are distinct and higher-value in some markets.
Revolving Loan	A revolving loan fund is a self-replenishing pool of money, utilizing interest and principal payments on old loans to issue new ones. It is a common gap financing measure used for development and expansion of businesses or initiatives within a particular focus area.
Settlement Funds	Settlement funds are a source of money from a legal settlement. The Volkswagen (VW) settlement, whereby VW agreed to pay \$14.7 billion to settle allegations of cheating vehicle emissions standards, are a major source of transportation funding allocated to states to support emissions-reducing transportation investments.
Special Assessments	Special assessments add (“assess”) an additional tax on property owners or businesses within a specific geographic area, or “Special Assessment District,” in order to finance public improvements within that district. Business Improvement Districts (BIDs) are a type of Special Assessment District.
Tax Credits	Tax credits are provided by federal, state, or local governments and allow residents or businesses to subtract a certain portion of tax owed in order to incentivize investments (such as the purchase of an electric vehicle).
Tax Increment Financing (TIF)	Tax increment financing (TIF) is a public financing method used to support redevelopment or public infrastructure investments, and often serves as a source of gap financing for projects. In a TIF district, municipalities use (divert) the expected future gains in property taxes spurred by a development or redevelopment project to finance the improvements that will create those increases in property value. Transit-oriented development (TOD) TIF districts use the future increases in value to fund transportation improvements and service in a specific area.
User Fees	User fees are payments to a local government (or other entity) for a service, such as waste collection.

One Climate Future IMPLEMENTATION MATRIX

The matrix summarizes key details for implementing the One Climate Future strategies, including timeline, funding mechanisms, and milestones for hitting our climate targets. • See **page 256** for a key for reading the implementation matrix. See **page 288** for a list of acronyms. •

BE Buildings & Energy

Action			Timeline			
#	Action Description	Action Subcomponents	By 2025	2026-2030	2031-2050	Milestones
BE 1 Municipal Buildings and Energy Supply						
BE 1.1	Renewable Municipal Electricity Pursue power purchase agreements (PPAs) to reach 100% renewable energy for city facilities ahead of state renewable portfolio standard (RPS) schedule.	a. Complete bulk solar power purchases currently underway.	●			● All municipal electricity use met by renewable energy by 2032
		b. Engage in further contracts to meet remaining municipal demand.		●		
BE 1.2	Net-Zero Energy New City Buildings Pursue net-zero energy (NZE) buildings for new city government buildings through performance-based procurement.	a. Use performance-based procurement for next city building.	●			● All newly constructed or gut-rehabbed city buildings to be NZE or NZE-ready starting in 2026
		b. Adopt NZE-ready (and NZE where possible) for all new city buildings.		●	●	
BE 1.3	Energy Efficiency Retrofits for City Buildings Develop a strategic energy management plan (SEMP) for all city facilities and lead by example by pursuing deep energy retrofits and electrification for large existing city buildings.	a. Benchmark and conduct annual quality control review of use data for buildings.	●	●	●	● SEMPs commissioned by 2025 ● Deep energy retrofits underway by 2026 ● All retrofits to be NZE by 2030
		b. Commission SEMPs for all city buildings.	●			
		c. Conduct deep energy retrofits for city buildings.		●	●	
BE 1.4	Internal Carbon Pricing for Municipal Construction and Operations Create either a shadow carbon price for evaluating all city decisions, and/or an internal carbon charge paid to a central climate emergency fund.	a. Conduct carbon price feasibility assessment to set appropriate price.	●			● Municipal shadow carbon price or carbon charge implemented by 2026
		b. Implement shadow carbon price or internal carbon charge.		●		

Greenhouse Gas (GHG) Reductions					How this strategy advances a future that is...			Implementation	
Cumulative GHG Reduction Potential 2020-2050 (MTCO ₂ e)			2050 GHG Reduction Potential (MTCO ₂ e)		Equitable	Regenerative	Resilient	Financing Strategies	City Steward
Section Total	Section %	Action Total	Section Total	Action Total					
BE 1 Municipal Buildings and Energy Supply									
204,169	1%	110,421	9,102	1,930	a b c d	a b c d (a) Draws down carbon	a b c d (d) Builds partnerships	Power purchase agreements (PPA), existing electricity budget, REC/SREC value	P: Sustainability; Finance SP: Sustainability; Finance
		20,707		2,143	a b c d	a b c d (a) Draws down carbon	a b c d (a) Reduces vulnerability	Performance-based procurement	P: Sustainability; Facilities SP: Sustainability; Facilities
		73,041 (includes TLU 3.5)		5,029 (includes TLU 3.5)	a b c d	a b c d (a) Draws down carbon	a b c d (a) Reduces vulnerability	ESCOs, bonds, general fund, Efficiency Maine incentives	P: Sustainability; Facilities SP: Sustainability; Facilities
		NIQ		NIQ	a b c d (a) Addresses injustice - if implement internal carbon charge	a b c d (a) Draws down carbon (c) Supports a circular economy	a b c d (a) Reduces vulnerability (c) Adapts processes	N/A	P: Sustainability; Finance SP: Sustainability; Finance

Buildings & Energy

Action			Timeline			
#	Action Description	Action Subcomponents	By 2025	2026-2030	2031-2050	Milestones
BE 2 New Construction Energy Efficiency and Decarbonization						
BE 2.1	Energy Stretch Code Advocate for an advanced energy stretch code with an optional net-zero energy compliance path, and adopt the stretch code once finalized.	a. Adopt the energy stretch code when finalized.				- Energy stretch code adopted immediately upon finalization - All new buildings to be net-zero energy starting in 2030
		b. Conduct city code review to identify conflicts with MUBEC/ stretch code.				
		c. Advocate for/adopt future stretch code with a pathway to NZE buildings.				
BE 2.2	Solar-Ready and EV-Ready Code Requirements Adopt or advocate for solar-ready and EV-ready requirements for new construction, followed by renewable energy generation building code requirements.	a. Adopt EV-ready and solar-ready requirements in land use code.				- EV-ready / solar-ready requirements to be implemented by 2028 - On-site solar requirements to be implemented by 2032
		b. Advocate for EV-ready and solar-ready requirements in MUBEC/stretch code.				
		c. Advocate for on-site solar requirements, or adopt via land use code.				
BE 2.3	Code Enforcement Ensure code compliance in all buildings through increased investment in robust code enforcement.	a. Hire (at least one) staff person or consultant to review energy models.				At least one staff person or consultant hired to review energy models by 2026
		b. Assess suitability / implement third-party code enforcement program.				
BE 2.4	Leadership and Education Partner with organizations in the building sector to develop and promote platforms for education and leadership in high-performance buildings.	a. Work with industry partners to develop /promote leadership/education platforms.				One or more platforms for high-performance building leadership and education launched by 2024
		b. Establish and award Mayor’s OCF recognition for climate leadership.				
BE 3 Existing Buildings Energy Efficiency and Decarbonization						
BE 3.1	Energy Benchmarking Expand Portland and South Portland’s energy benchmarking programs, and couple with outreach programs to turn energy savings opportunities into action.	a. Implement current benchmarking law.				80%+ compliance achieved within 2 years of utility data access challenges resolved (see BE 5.2), ideally by 2025
		b. Work with PUC/CMP to overcome limitations in data access.				
		c. Expand the program to citywide and/or to include smaller buildings.				
		d. Develop outreach and training program to further encourage retrofits.				
BE 3.2	Building Performance Standards Incorporate tune-up or performance standards into the Cities’ benchmarking programs for large buildings by 2025 to achieve carbon savings, and strengthen coordinated job-training programs to support building retrofits.	a. Conduct analysis and stakeholder process to identify GHG standards.				Performance standards identified within 2 years of fully implemented benchmarking (BE 3.1) with requirements adopted in following year
		b. Implement performance requirements for large existing buildings.				
		(+ actions to support job/skills training captured by other strategies - see text)				
BE 3.3	Energy Efficiency Spending Expand statewide and local energy efficiency spending; advocate for changes in Efficiency Maine spending that remove barriers for fuel switching.	a. Advocate for funding via Energy Efficiency Resource Standard (etc.).				By 2025, Efficiency Maine spending is equivalent to 5% of total electric sales and 2% of residential natural gas sales
		b. Advocate for fuel-neutral metrics to support beneficial electrification.				
		c. Advocate for the creation of a Maine State Green Bank.				
BE 3.4	Renewable Heating and Cooling Launch program to shift single family homes and larger multifamily and commercial buildings from fuel oil directly to all-electric heating and cooling.	a. Launch electrification incentive program, following review and research.				- Electrification incentive program launched by 2023 - Oil tanks to be code compliant or decommissioned by 2028
		b. Adopt legislation to require code compliant tanks (or decommissions).				

Greenhouse Gas (GHG) Reductions					How this strategy advances a future that is...			Implementation		
Cumulative GHG Reduction Potential 2020-2050 (MTCO ₂ e)			2050 GHG Reduction Potential (MTCO ₂ e)		Equitable	Regenerative	Resilient	Financing Strategies	City Steward	
Section Total	Section %	Action Total	Section Total	Action Total						
BE 2 New Construction Energy Efficiency and Decarbonization										
578,672	2.9%	578,672	38,116	38,116	a b c d	a b c d (a) Draws down carbon (d) Builds shared wealth	a b c d (a) Reduces vulnerability	Codes are generally designed to be cost effective; see code enforcement for city resources to support stretch code adoption	P: Sustainability; Planning; Code Enforcement SP: Sustainability; Planning; Code Enforcement	
		See BE 3.6			See BE 3.6	a b c d	a b c d (a) Draws down carbon (d) Builds shared wealth	a b c d	VW settlement funds/ Efficiency Maine funding (EV-ready); solar-ready can be implemented with no added cost. <i>Future: federal funding</i>	P: Sustainability; Planning SP: Sustainability; Planning
		NIQ			NIQ	a b c d (a) Addresses injustice - against substandard housing	a b c d (a) Draws down carbon	a b c d (a) Reduces vulnerability (c) Adapts processes	Impact fees, special assessments, fine revenue, utility funding (through Efficiency Maine or utility cost recovery with EERS)	P: Permitting & Inspections SP: Code Enforcement
		NIQ			NIQ	a b c d	a b c d (a) Draws down carbon (c) Supports a circular economy (d) Builds shared wealth	a b c d (b) Strengthens communities (c) Adapts processes (d) Builds partnerships	Private grants, state/ federal grants, public-private partnerships	P: Sustainability SP: Sustainability
BE 3 Existing Buildings Energy Efficiency and Decarbonization										
5,372,806	26.9%	518,541	360,866	76,026	a b c d	a b c d (a) Draws down carbon	a b c d (a) Reduces vulnerability	Utility cost recovery (investments in data access); Efficiency Maine funds and/or public/private grants (retrofit accelerator)	P: Sustainability SP: Sustainability	
		1,225,917			76,026	a b c d (b) Expands access	a b c d (a) Draws down carbon (d) Builds shared wealth	a b c d (a) Reduces vulnerability (c) Adapts processes	ESCOs, on-bill financing, revolving loan funds, Efficiency Maine incentives, Residential PACE <i>Future: green bank, C-PACE financing</i>	P: Sustainability SP: Sustainability
						a b c d (b) Expands access	a b c d (a) Draws down carbon (d) Builds shared wealth	a b c d (a) Reduces vulnerability (b) Strengthens communities	Existing utility revenue, utility cost recovery (EERS); expanded customer benefit charges	P: Sustainability SP: Sustainability
		2,800,102			204,056	a b c d	a b c d (a) Draws down carbon (b) Restores ecosystems	a b c d (a) Reduces vulnerability	State incentives, Efficiency Maine funding, Residential PACE loans <i>Future: federal funding</i>	P: Sustainability SP: Sustainability

Buildings & Energy

Action			Timeline			
#	Action Description	Action Subcomponents	By 2025	2026–2030	2031–2050	Milestones
BE 3.5	Bulk Buy Programs Launch bulk buy programs for solar power and heat pumps, paired with electric vehicles as appropriate.	a. Launch bulk buy program.				● Bulk buy program launched by 2023
BE 3.6	Solar Proliferation Strategy Continue to enhance the attractiveness of solar through a solar proliferation strategy, as well as offering financial and/or structural incentives.	a. Reduce permit times and fees for solar installations.				● Solar proliferation strategy launched by 2023 ● 50 MW of solar installed in the cities by 2030 and 245 MW of solar installed by 2050
		b. Launch solar proliferation strategy.				
BE 3.7	Energy Efficient Rental Housing Require minimum energy efficiency standards for residential rental properties to decrease energy use, increase thermal comfort, and reduce energy costs paid by renters.	a. Require Maine Energy Disclosure Statement in rental registration.				● Determination of whether to proceed with a minimum energy efficiency rental standards program by 2026
		b. Assess costs/benefits of minimum energy efficiency standards.				
		c. Implement minimum energy efficiency rental standards program.				
BE 4 Industrial Energy Efficiency and Decarbonization						
BE 4.1	Industrial Energy Efficiency Spending Advocate for expanded energy efficiency incentives for large industrial users.	a. Advocate for increased industry efficiency spending.				● Automatic industrial opt-out provision removed by 2028
BE 4.2	Industrial Efficiency and Decarbonization Study Advocate for a statewide study on energy efficiency and decarbonization opportunities in the industrial sector to better target industrial combined heat and power, heat recovery, and renewable fuel oil or biogas.	a. Advocate for industrial efficiency study, led by Efficiency Maine.				● Industrial efficiency and decarbonization study completed by 2025
		b. Use study findings for targeted promotion to industrial partners.				
		c. Ensure custom industrial programs are working on heat recovery applications.				
BE 5 Clean and Renewable Energy Infrastructure and Regulatory Transformation						
BE 5.1	Renewable Portfolio Standard and Community-Scale Purchasing Continue to advocate for full, timely, and cost-effective implementation of Maine’s renewable portfolio standard; in case it becomes necessary, advocate for municipal authority to bulk procure renewable power.	a. Advocate for full, timely, and cost-effective implementation of the RPS.				● Electricity to be 80% renewable by 2030 and 100% renewable by 2050
		b. Advocate for creation of a Maine Energy Generation Authority.				
BE 5.2	Utility Data Access Reform Reform data access by pursuing legislation that would require utilities to disclose data with building owners and municipalities.	a. Advocate for improved access to utility data.				● Access to whole building and citywide data by 2024 ● Access to automated data connections by 2024
BE 5.3	Utility Regulatory Reform to Support Electrification Advocate for regulatory reforms to support state-wide electrification and the integration of distributed energy resources (DER).	a. Advocate for utility regulatory reforms to support DER.				● Continue to build on 2020 legislative initiatives

Greenhouse Gas (GHG) Reductions					How this strategy advances a future that is...			Implementation	
Cumulative GHG Reduction Potential 2020-2050 (MTCO ₂ e)			2050 GHG Reduction Potential (MTCO ₂ e)		Equitable	Regenerative	Resilient	Financing Strategies	City Steward
Section Total	Section %	Action Total	Section Total	Action Total					
(see above value)	(see above value)	NIQ	(see above value)	NIQ	a b c d (b) Expands access	a b c d (a) Draws down carbon	a b c d	Demand aggregation	P: Sustainability SP: Sustainability
		828,246 (counted within BE 5 in wedge results)		56,474 (counted within BE 5 in wedge results)	a b c d (a) Addresses injustice (b) Expands access (d) Builds community ownership	a b c d (a) Draws down carbon (d) Builds shared wealth	a b c d (a) Reduces vulnerability (b) Strengthens communities (d) Builds partnerships	Special assessments, utility-supported funding (for permitting changes); PPAs, SREC revenue, or grants (for solar proliferation strategy)	P: Sustainability; Planning SP: Sustainability; Planning
		NIQ		NIQ	a b c d (a) Addresses injustice (b) Expands access (c) Creates inclusive processes	a b c d (a) Draws down carbon (d) Builds shared wealth	a b c d (a) Reduces vulnerability (b) Strengthens communities	General fund (for study of minimum efficiency standards)	P: Housing SP: Sustainability
BE 4 Industrial Energy Efficiency and Decarbonization									
753,726	3.8%	753,726	66,144	66,144	a b c d	a b c d (a) Draws down carbon (c) Supports a circular economy	a b c d	Customer benefit charges assessed to industrial users	P: Sustainability SP: Sustainability
		NA		NA	a b c d (a) Draws down carbon (c) Supports a circular economy	a b c d (a) Reduces vulnerability	Customer benefit charges assessed to industrial users, utility funds	P: Sustainability SP: Sustainability	
BE 5 Clean and Renewable Energy Infrastructure and Regulatory Transformation									
7,247,418	36.3%	7,247,418	333,004	333,004	a b c d (b) Expands access	a b c d (a) Draws down carbon (d) Builds shared wealth	a b c d (a) Reduces vulnerability (d) Builds partnerships	N/A (existing state law)	P: Sustainability SP: Sustainability
		NIQ		NIQ	a b c d (a) Draws down carbon	a b c d (c) Adapts processes	Utility cost recovery	P: Sustainability SP: Sustainability	
		See BE 3-4		See BE 3-4	a b c d (a) Draws down carbon	a b c d (a) Reduces vulnerability (c) Adapts processes	Utility cost recovery	P: Sustainability SP: Sustainability	

Buildings & Energy

Action			Timeline			
#	Action Description	Action Subcomponents	By 2025	2026-2030	2031-2050	Milestones
BE 5.4	Renewable District Energy Systems Identify opportunities and encourage the development of fully electric low temperature thermal district energy systems for new and existing developments and campuses.	a. Advocate for regulatory updates to enable use of microgrids.	●			● All new development over 500,000 square feet to evaluate district energy/microgrids starting within one year of microgrid enabling legislation
		b. Work with existing campuses to explore microgrids / district energy.		●	●	
		c. Adjust zoning to encourage microgrids / renewable district energy.		●		
BE 5.5	Electrical Transmission and Distribution Improve the efficiency and capacity of transmission and distribution networks to improve electricity supply to Portland and South Portland.	a. Undertake hosting capacity study with regional partners.	●			● Hosting capacity study launched by 2025
		b. Land bank and zone for expanded energy infrastructure.		●		
		c. Update full electrification study, accounting for efficiency.		●		
BE 5.6	Natural Gas Phase-Out Advocate for a state-level ban on new intrastate natural gas pipelines and any state support for interstate gas pipelines, and advocate for allowing local jurisdictions to limit new and expanded natural gas connections.	a. Advocate for / support a just plan for transitioning to clean heating.	●	●	●	● A just plan for clean heating developed by 2025 ● Statewide restrictions on new interstate and intrastate gas pipelines in place by 2030, along with defined timeframes for phasing out natural gas
		b. Advocate for ban on new interstate / intrastate natural gas pipelines.	●			
		c. Advocate for state support in repurposing fossil fuel infrastructure.		●		
		d. Investigate legal authority / ban natural gas hookups in new construction.		●		
BE 5.7	Carbon Pricing Continue to advocate for carbon pricing at national, regional, and statewide scales.	a. Work with state partners to advance statewide carbon fee.			●	● Price on carbon as soon as feasible at national, regional, or statewide scale

Greenhouse Gas (GHG) Reductions					How this strategy advances a future that is...			Implementation	
Cumulative GHG Reduction Potential 2020-2050 (MTCO ₂ e)			2050 GHG Reduction Potential (MTCO ₂ e)		Equitable	Regenerative	Resilient	Financing Strategies	City Steward
Section Total	Section %	Action Total	Section Total	Action Total					
(see above value)	(see above value)	NA	(see above value)	NA	a b c d	a b c d (a) Draws down carbon (c) Supports a circular economy	a b c d (a) Reduces vulnerability	For developers, costs built into the existing project funding; for campuses, systems pay for themselves in utility cost savings/maintenance savings.	P: Sustainability; Planning SP: Sustainability; Planning
		NIQ		NIQ	a b c d	a b c d (a) Draws down carbon	a b c d (a) Reduces vulnerability	Utility cost recovery	P: Sustainability; Planning SP: Sustainability; Planning
		See BE 3.4		See BE 3.4	a b c d (a) Addresses injustice (b) Expands access - via just plan for transition	a b c d (a) Draws down carbon	a b c d	Public Utilities Commission / state funds (for study)	P: Sustainability; Corporation Counsel SP: Sustainability
		NIQ		NIQ	a b c d (a) Addresses injustice - if funds are progressively redistributed	a b c d (a) Draws down carbon (c) Supports a circular economy	a b c d (c) Adapts processes	N/A	P: Sustainability SP: Sustainability

Action			Timeline			
#	Action Description	Action Subcomponents	By 2025	2026-2030	2031-2050	Milestones
WR 1 Residential and Commercial Waste						
WR 1.1	Save-As-You-Throw Expand a save-as-you-throw system to South Portland.	a. Conduct community educational campaign on SAYT (South Portland).				● Implement SAYT program in South Portland by 2026
		b. Implement SAYT model in South Portland (South Portland).				
WR 1.2	Single-Stream Recycling Mandate recycling for commercial and multifamily buildings.	a. Increase recycling outreach/education in collaboration with ecomaine.				● Require recycling in commercial and multifamily residential buildings by 2026
		b. Adopt ordinance requiring commercial and multifamily recycling.				
WR 1.3	Food Waste Reduction and Organics Recycling Expand programs to divert food waste and increase organics recycling rates to ensure that excess food is better used to nourish people, animals, industries, and soils.	a. Advocate for statewide mandatory organics recycling.				● Reduce food waste in trash streams 70% by 2040
		b. Implement mandatory commercial/institutional organics recycling citywide.				
		c. Move toward curbside collection of residential food waste.				
WR 1.4	Single-Use Plastics Ban select single-use plastics and identify partnerships to reduce plastic waste.	a. Advocate for statewide restrictions on single-use plastics.				● Eliminate single-use plastics in the cities to the fullest extent practicable by 2026
		b. Advocate for extended producer responsibility bill in the state.				
		c. Partner with retailers and food establishments to reduce plastic use.				
WR 1.5	Circular Sharing Economy Foster a circular sharing economy.	a. Strengthen or expand community spaces for resource sharing.				● Ongoing efforts to establish new spaces, programs, or initiatives in each city that support resource sharing, re-use, or repair
		b. Support re-use, rental, and repair businesses, fairs, and workshops.				
		(+ numerous actions captured by other strategies - see text)				
WR 2 Construction, Industrial, and Municipal Waste						
WR 2.1	Construction and Demolition Waste Reduce construction and demolition waste through targeted re-use initiatives.	a. Advocate for state policy and expansion of reuse/recycling facilities.				● Adopt C&D waste reduction targets and ordinance by 2035
		b. Draft report assessing baseline waste reduction/reuse practices and goals.				
		c. Engage construction sector on development of ordinance and training.				
		d. Adopt C&D waste ordinance.				
WR 2.2	Industrial Waste Work with state and regional partners to encourage “by-product synergy” with industrial waste streams.	a. Work with state partners to explore online materials marketplace.				● Regional materials marketplace launched by 2035

Greenhouse Gas (GHG) Reductions					How this strategy advances a future that is...			Implementation	
Cumulative GHG Reduction Potential 2020-2050 (MTCO ₂ e)			2050 GHG Reduction Potential (MTCO ₂ e)		Equitable	Regenerative	Resilient	Financing Strategies	City Steward
Section Total	Section %	Action Total	Section Total	Action Total					
WR 1 Residential and Commercial Waste									
686,045	3.4%	686,045	42,272		a b c d	a b c d (a) Draws down carbon (c) Supports a circular economy	a b c d	User fees	P: N/A SP: Sustainability; Public Works
					a b c d	a b c d (a) Draws down carbon (c) Supports a circular economy	a b c d	User fees, savings from reduced waste hauling, revenue from selling recycling (contingent on market)	P: Sustainability SP: Sustainability
					a b c d (b) Expands access - through excess food redistribution	a b c d (a) Draws down carbon (b) Restores ecosystems (c) Supports a circular economy (d) Builds shared wealth	a b c d (a) Reduces vulnerability (d) Builds partnerships	User fees, savings from reduced waste hauling, revenue from biogas sale	P: Sustainability; Public Works SP: Sustainability; Public Works
		NA	NA	a b c d	a b c d (a) Draws down carbon (b) Restores ecosystems (c) Supports a circular economy	a b c d (d) Builds partnerships	Grants or public-private partnerships (for partnerships with retailers and food establishments)	P: Sustainability SP: Sustainability	
		NA	NA	a b c d (b) Expands access (d) Builds community ownership	a b c d (a) Draws down carbon (c) Supports a circular economy (d) Builds shared wealth	a b c d (b) Strengthens communities (d) Builds partnerships	Grants, partnerships (see also CR 2.5)	P: Sustainability; Economic Development SP: Sustainability; Economic Development	
WR 2 Construction, Industrial, and Municipal Waste									
13,998	0.1%	NA	1,024	NA	a b c d	a b c d (a) Draws down carbon (c) Supports a circular economy	a b c d	User fees, general funds (for enforcement and contractor training), state funding (for statewide program investment, facilities)	P: Sustainability; Public Works SP: Sustainability; Public Works
		NA	NA	a b c d	a b c d (a) Draws down carbon (c) Supports a circular economy (d) Builds shared wealth	a b c d (d) Builds partnerships	Grants, public-private partnerships (for marketplace sponsorship/start-up costs), user fees	P: Sustainability; Economic Development SP: Sustainability; Economic Development	

Waste Reduction

Action			Timeline			
#	Action Description	Action Subcomponents	By 2025	2026-2030	2031-2050	Milestones
WR 2.3	Wastewater Emissions Investigate options for reducing emissions of wastewater treatment with anaerobic digestion.	a. Commission engineering feasibility study for anaerobic digestion w/partners.			●	● Engineering feasibility study commissioned by 2032
WR 2.4	Sustainable Purchasing Policy Adopt a sustainable purchasing policy for municipal procurement.	a. Adopt sustainable purchasing policy and guide for city procurement.	●			● Sustainable purchasing policy adopted by 2024

Greenhouse Gas (GHG) Reductions					How this strategy advances a future that is...			Implementation	
Cumulative GHG Reduction Potential 2020-2050 (MTCO ₂ e)			2050 GHG Reduction Potential (MTCO ₂ e)		Equitable	Regenerative	Resilient	Financing Strategies	City Steward
Section Total	Section %	Action Total	Section Total	Action Total					
(see above value)	(see above value)	13,998	(see above value)	1,024	a b c d (a) Draws down carbon (c) Supports a circular economy	a b c d (a) Draws down carbon (c) Supports a circular economy	a b c d (a) Reduces vulnerability	ESCOs, Efficiency Maine funding, revolving loan funds (e.g., Clean Water State Revolving Loans)	P: Sustainability; Water Resources SP: Sustainability; Water Resources Protection
		NA	(see above value)	NA	a b c d (a) Addresses injustice - with inclusion of social sustainability	a b c d (a) Draws down carbon (b) Restores ecosystems (c) Supports a circular economy (d) Builds shared wealth	a b c d	N/A	P: Sustainability; Finance SP: Sustainability; Finance

Action			Timeline			
#	Action Description	Action Subcomponents	By 2025	2026-2030	2031-2050	Milestones
TLU 1 Mode Shift and Land Use						
TLU 1.1	Public Transit Networks Support efforts to “Make Transit Easier,” “Expand Local Connections,” and “Introduce Rapid Transit” in alignment with the Transit Tomorrow vision for the PACTS region.	a. Advocate for/implement coordinated measures between transit agencies.	●	●		● Roll-out of coordinated measures (portal, schedules, etc.) by 2025 ● All specified upgrades to transit stops implemented by 2028 ● METRO and SPBS achieve carbon neutrality by 2040
		b. Advocate for increases in state funding for multimodal transportation.	●	●		
		c. Improve safety and accessibility of transit stops.		●		
		d. Invest in roadway design advantages for buses along transit routes.		●		
		(+ numerous actions captured by other strategies - see text)				
TLU 1.2	Inclusive Transit-Oriented Development Strengthen the cities’ transit-oriented development nodes to support travel by walking, biking, and public transportation.	a. Assess potential locations for TOD development (South Portland).	●			● Policy pathways for strengthening TOD nodes outlined in comprehensive plan by 2024 (South Portland) ● New/updated TOD TIF districts implemented by 2026
		b. Conduct assessment of barriers and mechanisms to promote desired transit.	●			
		c. Update comprehensive, land use, capital improvement plans w/ TOD policy.	●			
		d. Examine capital investments and land use policy changes to facilitate TOD.		●		
TLU 1.3	Bike Accessibility Make biking easier through a complete network of bikeways and through building an inclusive biking culture.	a. Develop and implement plans for complete bikeway networks.	●	●	●	● Bikeway network plan completed and implementation begun by 2026 ● 5% of all trips completed by bike by 2040
		b. Launch initiative for advancing an inclusive biking culture.	●			
		c. Expand bike parking and storage facilities.		●		
		d. Reevaluate potential for a bikeshare program.		●		
TLU 1.4	Complete Streets Create safer and more accessible travel for people of all ages and abilities by all modes of transportation by adopting “Vision Zero” for the PACTS region and continuing to expand complete streets.	a. Draft “Vision Zero” policy statement and set metrics for tracking progress.	●			● Complete streets design manual produced by 2025
		b. Develop complete streets design manual; align city ordinances and plans.	●			
		c. Launch “adopt-a-sidewalk” program.		●		
		d. Complete the build-out of complete streets along the Smart Corridor.			●	
TLU 1.5	Employer Transit Partnerships Partner with PACTS, GO MAINE, and large public and private employers in the cities to continue to promote more efficient or zero-emissions commuting and to establish a transportation management association (TMA) for the Greater Portland region.	a. Convene working group for development of a Greater Portland TMA.	●			● Working Group for TMA convened by 2024 ● TDM plans updated/ adopted by 2026
		b. Produce transportation demand management (TDM) toolkit.	●			
		c. Assess methods to reduce SOV trips made by municipal staff.	●			
		d. Update (Portland) or adopt (South Portland) TDM plan ordinance.		●		
TLU 1.6	Parking Shift existing incentives that continue to lead to more parking demand and supply to instead facilitate and strengthen multimodal transportation options.	a. Pilot adjustments to parking pricing and demand-based pricing.	●			● Zoning ordinances revised with new parking requirements by 2028
		b. Revise zoning to provide flexibility for parking minimums / explore maximums.		●		

Greenhouse Gas (GHG) Reductions					How this strategy advances a future that is...			Implementation	
Cumulative GHG Reduction Potential 2020-2050 (MTCO ₂ e)			2050 GHG Reduction Potential (MTCO ₂ e)		Equitable	Regenerative	Resilient	Financing Strategies	City Steward
Section Total	Section %	Action Total	Section Total	Action Total					
TLU 1 Mode Shift and Land Use									
1,151,719	5.8%	N/A	61,089	N/A	a b c d (a) Addresses injustice (b) Expands access	a b c d (a) Draws down carbon (d) Builds shared wealth	a b c d (a) Reduces vulnerability (b) Strengthens communities (d) Builds partnerships	Bonds, TOD tax increment financing (TIF), federal/PACTS funding, impact fees (Portland), general funds. <i>Future: infrastructure bank, expanded state funding for Multimodal Transportation Fund</i>	P: Planning; Public Works SP: Planning; Public Works; South Portland Bus Service
					a b c d (b) Expands access (c) Creates inclusive processes	a b c d (a) Draws down carbon (d) Builds shared wealth	a b c d (b) Strengthens communities (c) Adapts processes	TOD tax-increment financing (TIF); structural incentives (e.g., density bonuses, proactive redevelopment), federal/state grants (e.g., HUD SCRP Grants)	P: Planning; Public Works SP: Planning; Public Works
					a b c d (b) Expands access (c) Creates inclusive processes	a b c d (a) Draws down carbon (d) Builds shared wealth	a b c d (b) Strengthens communities (d) Builds partnerships	TOD tax increment financing (TIF), bonds, federal funding (e.g., Recreational Trails Program). <i>Future: infrastructure bank, Multimodal Transportation Fund</i>	P: Planning; Public Works SP: Planning; Public Works; Sustainability
					a b c d (a) Addresses injustice (b) Expands access	a b c d (a) Draws down carbon (b) Restores ecosystems (d) Builds shared wealth	a b c d (a) Reduces vulnerability (b) Strengthens communities (c) Adapts processes (d) Builds partnerships	TOD tax increment financing (TIF), bonds, federal/PACTS funding, impact fees. <i>Future: infrastructure bank, Multimodal Transportation Fund</i>	P: Planning; Public Works SP: Planning; Water Resources Protection; Public Works
					a b c d (b) Expands access	a b c d (a) Draws down carbon (d) Builds shared wealth	a b c d (c) Adapts processes (d) Builds partnerships	PACTS funding, membership user fees	P: Planning; Sustainability SP: Sustainability; Planning
					a b c d (b) Expands access - through supporting housing affordability, walkability, transit	a b c d (a) Draws down carbon (b) Restores ecosystems	a b c d (a) Reduces vulnerability - from flooding, heat island, stormwater runoff	Federal/state grants (for demand-based pricing start-up costs); fine revenue (ongoing operation of demand-based pricing)	P: Parking; Planning SP: Planning

Transportation & Land Use

Action			Timeline			
#	Action Description	Action Subcomponents	By 2025	2026-2030	2031-2050	Milestones
TLU 1.7	Land Use for a Smaller Carbon Footprint Plan for future growth in our cities by committing to land use principles for a smaller carbon footprint, codified in the Cities’ comprehensive plans, zoning, and subdivision ordinances.	a. Encourage infill through proactive redevelopment.				● Housing stock meets workforce demand within the cities by 2035: Anyone working in the cities can live within the cities by 2035
		b. Revise land use code to “amplify homes near jobs.”				
		c. Revise land use code to “collocate transportation and density.”				
		d. Revise land use code to “create livable street networks.”				
		(+ actions to protect open space captured by other strategies - see text)				
TLU 2 Vehicle Electrification						
TLU 2.1	Electric Vehicle Charging Infrastructure Expand electric vehicle (EV) charging infrastructure in public and private parking through public investments in chargers, updates to city land use codes, and EV-ready requirements in the state building code.	a. Integrate EV charger requirements in land use and building codes.				● 20% of spaces in new garages required to have EV chargers (per land use code) by 2026 ● 5% of parking spaces in all lots and garages in the cities have level 2 EV chargers by 2030
		b. Work with commercial entities to expand public chargers.				
		c. Collaborate on regional efforts to build out charging networks.				
		d. Work with PUC to reform electricity rate structures (see TLU 3.3).				
TLU 2.2	Electric Vehicle Incentives Offer excise tax exemptions for electric vehicles (EVs), and advocate for additional state EV incentives.	a. Widely promote existing rebates (e.g., through Efficiency Maine).				● 30% of new light duty vehicle sales are electric vehicles by 2030; 60% by 2040; 100% by 2050
		b. Collaborate with Efficiency Maine and dealerships to promote EV ownership.				
TLU 2.3	Electric Public Transit Bus Fleets Work with Greater Portland METRO and the South Portland Bus Service to transition all bus fleets to battery-electric vehicles (BEV) by 2040.	a. Pursue Low-No Grant funding for BEV in next bus purchase (SPBS).				● All new METRO and SPBS bus purchases are electric starting in 2025 ● All-electric METRO and SPBS fleets by 2040
		b. Work with transit providers on capital transition program for bus fleets.				
TLU 2.4	Electric and Alternative-Fuel Municipal Fleets Develop an electric and alternative-fuel vehicle capital transition program for municipal and school vehicles.	a. Create capital transition program for light-duty vehicles and school buses.				● All new school bus purchases are electric by 2025 ● All new light-duty vehicle purchases are electric by 2032 ● Zero-carbon municipal fleets by 2040
		b. Create parallel transition program for small motor equipment.				
		c. Pursue alternatives for medium/heavy-duty vehicles when viable.				
TLU 2.5	Electric Shared Vehicles and Vehicles for Hire Expand the use of shared electric vehicles, promote electric vehicle use by taxis and other vehicle-for-hire companies, and set a requirement that by 2030 all rideshare vehicles must be electric vehicles.	a. Assess options for incentivizing EV use among taxis and hired vehicles.				● All TNC rideshare vehicles are electric vehicles by 2030
		b. Reassess national market for feasibility of electric car sharing fleets by 2026.				
		c. Mandate that all TNC rideshare vehicles must be EVs by 2030.				
TLU 2.6	Autonomous Vehicles Implement changes to curb and parking designs to incentivize shared autonomous vehicles, and advocate for state requirements that any autonomous vehicles must be electric and shared.	a. Continue to adapt safe/efficient curb and parking standards, considering AVs.				● State requirement that all AVs be electric in place by 2030
		b. Advocate at the state level for AV permits to be limited to electric AVs.				
		c. Work with state to ensure protections for pedestrian use of roadways.				

Greenhouse Gas (GHG) Reductions					How this strategy advances a future that is...			Implementation	
Cumulative GHG Reduction Potential 2020-2050 (MTCO ₂ e)			2050 GHG Reduction Potential (MTCO ₂ e)		Equitable	Regenerative	Resilient	Financing Strategies	City Steward
Section Total	Section %	Action Total	Section Total	Action Total					
(see above value)	(see above value)	N/A	(see above value)	N/A	 (b) Expands access	 (a) Draws down carbon (b) Restores ecosystems (d) Builds shared wealth	 (a) Reduces vulnerability (b) Strengthens communities	General fund (for commissioned studies)	P: Planning SP: Planning
TLU 2 Vehicle Electrification									
3,905,203	19.6%	3,300,898 (combined effects of EV adoption and fuel economy standards)	223,008	174,142 (combined effects of EV adoption and fuel economy standards)	 (a) Addresses injustice - from localized roadway air pollution	 (a) Draws down carbon	 (a) Reduces vulnerability - from localized roadway air pollution (d) Builds partnerships	Efficiency Maine incentives/VW settlement funds, demand aggregation via Climate Mayors Electric Vehicle Purchasing Collaborative, public-private partnerships	P: Sustainability; Planning SP: Sustainability; Planning
		604,305 (assumes fleet growth with mode shift)		48,866 (assumes fleet growth with mode shift)	 (a) Addresses injustice - from localized roadway air pollution (b) Expands access	 (a) Draws down carbon	 (a) Reduces vulnerability - from localized roadway air pollution (d) Builds partnerships	Efficiency Maine incentives	P: Sustainability; Finance SP: Sustainability
		NIQ (light-duty fleet captured in TLU 2.1-2.2)		NIQ (light-duty fleet captured in TLU 2.1-2.2)	 (a) Addresses injustice - from localized roadway air pollution	 (a) Draws down carbon	 (a) Reduces vulnerability - from localized roadway air pollution	Efficiency Maine incentives/VW settlement funds, lease-purchasing, demand aggregation via Climate Mayors Electric Vehicle Purchasing Collaborative, bonds	P: Public Works; Sustainability SP: Sustainability; Public Works
		NIQ (included in TLU 2.1 - 2.2)		NIQ (included in TLU 2.1 - 2.2)	 (a) Addresses injustice - from localized roadway air pollution	 (a) Draws down carbon	 (a) Reduces vulnerability - from localized roadway air pollution	N/A	P: Sustainability SP: Sustainability
		NA		NA	 (a) Addresses injustice - from localized roadway air pollution	 (a) Draws down carbon	 (a) Reduces vulnerability - from localized roadway air pollution	N/A	P: Sustainability SP: Sustainability

Transportation & Land Use

Action			Timeline			
#	Action Description	Action Subcomponents	By 2025	2026-2030	2031-2050	Milestones
TLU 3 Transportation Infrastructure						
TLU 3.1	Idling Reductions Reduce vehicle idling through anti-idling policies, vehicle technology, and improved intersection design.	a. Adopt anti-idling technology and policies for public vehicles.	●			● Anti-idling policies to be updated (P) or adopted (SP) and enforced by 2025
		b. Adopt and enforce anti-idling zones and policies for private vehicles.	●	●	●	
		c. Consider anti-idling co-benefits in intersection design.	●	●	●	
TLU 3.2	Freight Transit Partnerships Partner with large stakeholders in the freight sector to encourage development of a Sustainable Freight Action Plan.	a. Work with PACTS to develop a Sustainable Freight Action Agenda.			●	● Regional Sustainable Freight Action Agenda drafted by 2032 ● Statewide Sustainable Freight Action Plan developed by 2035
		b. Advocate for development of a Maine Sustainable Freight Action Plan.			●	
TLU 3.3	Ferry Service Work with Casco Bay Lines to transition its fleet to hybrid-electric ferries, and to consider a ferry route connection between Portland and South Portland.	a. Support Casco Bay Lines in transitioning to electric ferries.	●	●	●	● 60% of ferries (three ferries, based on the current fleet of five) run on all electric power by 2035
		b. Assess feasibility of ferry service between Portland and South Portland.	●	●		
TLU 3.4	Shore Power Commission an engineering study for shore power hookups to allow and eventually require docked ships to connect to electrical service.	a. Commission engineering study of shore power requirements (Portland).			●	● Shore power for full ferry fleet installed by 2040 ● Shore power for cruise ships installed by 2040
		b. Work with Casco Bay Lines to install shore power for ferries (Portland).			●	
		c. Work with PUC, CMP, Port to install shore power for cruise ships (Portland).			●	
TLU 3.5	Jetport Reduce greenhouse gas emissions from the Portland International Jetport through benchmarking and tracking, and through decarbonizing ground vehicles.	a. Decarbonize ground support vehicles (Jetport).	●	●		● “Neutrality” achieved by 2030 under the Airport Carbon Accreditation framework
		b. Consider employing Airport Carbon Accreditation framework (Jetport).	●	●		
		c. Increase knowledge transfer with municipal staff (Portland/Jetport).	●	●		
		d. Improve energy efficiency of older portion of the terminal (Jetport).		●		

Greenhouse Gas (GHG) Reductions					How this strategy advances a future that is...			Implementation	
Cumulative GHG Reduction Potential 2020-2050 (MTCO ₂ e)			2050 GHG Reduction Potential (MTCO ₂ e)		Equitable	Regenerative	Resilient	Financing Strategies	City Steward
Section Total	Section %	Action Total	Section Total	Action Total					
TLU 3 Transportation Infrastructure									
64,965	0.3%	NA	6,852	NA	a b c d (a) Addresses injustice - from localized roadway air pollution	a b c d (a) Draws down carbon	a b c d (a) Reduces vulnerability - from localized roadway air pollution	Federal grants (for anti-idling technology)	P: Sustainability; Planning; Public Works SP: Sustainability; Planning; Public Works
		NA		a b c d (a) Addresses injustice - from localized roadway air pollution	a b c d (a) Draws down carbon	a b c d (a) Reduces vulnerability - from localized roadway air pollution (d) Builds partnerships	Maine Department of Transportation funding, PACTS funding, public-private partnerships	P: Sustainability SP: Sustainability	
		64,965		6,852	a b c d	a b c d (a) Draws down carbon (b) Restores ecosystems	a b c d (a) Reduces vulnerability - from localized air/water pollution	Federal grants (e.g., FTA grants), PACTS funding, Maine Department of Transportation funding	P: Planning SP: Planning
					a b c d	a b c d (a) Draws down carbon (b) Restores ecosystems	a b c d (a) Reduces vulnerability - from localized air/water pollution	Utility cost recovery, port user fees, VW settlement funds, federal/state grants	P: Sustainability; Planning; Facilities SP: Sustainability; Planning
		(Efficiency upgrades included in BE 1.3; other elements not quantified)		(Efficiency upgrades included in BE 1.3; other elements not quantified)	a b c d	a b c d (a) Draws down carbon	a b c d (a) Reduces vulnerability - from localized air pollution (d) Builds partnerships	Airport revenue, Efficiency Maine incentives, utility cost savings	P: Jetport SP: N/A

Action			Timeline			
#	Action Description	Action Subcomponents	By 2025	2026-2030	2031-2050	Milestones
CR 1 Resilient Buildings and Neighborhoods						
CR 1.1	Resilient New Development Integrate resilience standards and targets into Portland and South Portland’s land use code to minimize flood risk and promote resilient buildings and neighborhoods citywide.	a. Work with partners to model combined storm surge and SLR for overlays.	●			● No new incompatible, vulnerable, or hazardous uses built in areas of highest flood risk by 2026 (with adoption of resilience overlays)
		b. Review and update land use codes to reflect resilience objectives.	●			
		c. Develop and use resilience zoning overlay to guide new construction.		●	●	
CR 1.2	Resilient Existing Buildings Build knowledge, tools, and resources on climate risks and adaptation options for buildings and property.	a. Prepare for securing federal funding for mitigation and/or recovery.	●	●	●	● All city residents have access to tools to assess future flood risk to property by 2026 ● Maine real estate flood risk disclosure required by 2026
		b. Participate in FEMA Community Rating System.	●	●	●	
		c. Launch suite of tools for resilient building retrofits.		●		
		d. Advocate that the State adopt flood risk disclosure requirements.		●		
CR 1.3	Resilient Open Space Planning Establish open space climate resilience goals and protocols for monitoring progress towards those goals in Portland and South Portland’s open space planning.	a. Expand Land Bank (P) / Open Space (SP) priorities to include resilience goals.	●			● Benchmark ecosystem and resilience metrics for open spaces and establish performance goals by 2028
		b. Set goals and measure change for stormwater and floodwater infiltration.		●	●	
		c. Set goals and measure change for carbon sequestration and storage.		●	●	
		d. Set goals and measure change for heat mitigation.		●	●	
		e. Set goals and measure change for biodiversity and ecological connectivity.		●	●	
CR 2 Strong and Healthy Communities						
CR 2.1	Housing Affordability and Resilience Continue to expand access to resilient and energy efficient affordable housing, contributing to diverse and inclusive communities.	a. Launch area-wide housing supply studies in both cities.	●			● Portland to increase housing units affordable to lower and middle income households by 10% by 2025 (from 2019 baseline) ● South Portland to establish affordable housing goal through comprehensive plan or standalone process
		b. Review zoning codes and re-assess development fees to remove constraints.	●			
		c. Enable options for renewable energy financing for affordable housing.	●	●	●	
		d. Advocate for changes to state financing requirements.	●			
		e. Use repositioning to retrofit housing for resilience and energy efficiency.		●	●	
		f. Assess displacement risk and anti-displacement strategies.		●	●	
		g. Work with community partners to lead “We are P/SP” storytelling initiative.		●	●	
CR 2.2	High Heat Mitigation Expand the “cooling capacity” of Portland and South Portland.	a. Preserve and expand protected open space, public parks, and tree cover.	●	●	●	● All residents live within a half mile of a cooling center by 2035 ● All residents live within a half mile of a park or open space by 2035
		b. Increase access to and awareness of places to cool off.	●	●	●	
		c. Revise zoning to increase cooling features in new construction (see CR 1.1).		●		
		d. Develop toolkit w/partners on retrofits to keep homes cooler (see CR 1.2).		●		

How this strategy advances a future that is...			Implementation	
Equitable	Regenerative	Resilient	Financing Strategies	City Steward
CR 1 Resilient Buildings and Neighborhoods				
 (a) Addresses injustice (b) Expands access (c) Creates inclusive processes	 (b) Restores ecosystems	 (a) Reduces vulnerability (c) Adapts processes	Federal/local cost sharing (e.g., USACE Planning Assistance for States)(for sea level rise / storm surge modeling)	P: Planning; Sustainability SP: Sustainability; Planning
 (a) Addresses injustice (b) Expands access (c) Creates inclusive processes	 (a) Draws down carbon (b) Restores ecosystems	 (a) Reduces vulnerability (b) Strengthens communities (c) Adapts processes (d) Builds partnerships	Grant funding (e.g., Coastal Communities Grant, federal hazard mitigation and resilience grants)	P: Emergency Management; Sustainability SP: Sustainability; Planning; Emergency Management
 (a) Addresses injustice (b) Expands access (c) Creates inclusive processes	 (a) Draws down carbon (b) Restores ecosystems	 (a) Reduces vulnerability (b) Strengthens communities (c) Adapts processes	Impact fees (Portland), Land Bank Fund (South Portland), revolving loan funds (e.g., Clean Water State Revolving Loans), federal/state grants (e.g., Project Canopy Assistance Grants, 319 Grants, Land and Water Conservation Fund)	P: Planning; Parks; Sustainability SP: Sustainability; Parks; Planning
CR 2 Strong and Healthy Communities				
 (a) Addresses injustice (b) Expands access (c) Creates inclusive processes	 (a) Draws down carbon (d) Builds shared wealth	 (a) Reduces vulnerability (b) Strengthens communities (c) Adapts processes (d) Builds partnerships	Public housing repositioning, adjustments to QAP cost caps (for financing resilient/sustainable housing), revolving loan funds, power purchase agreements (for solar installations), private grants, community partnerships (for diverse and inclusive neighborhoods project)	P: Housing; Planning; Sustainability; Permitting & Inspections; Health & Human Services SP: Sustainability; Planning
 (a) Addresses injustice (b) Expands access (c) Creates inclusive processes	 (a) Draws down carbon (b) Restores ecosystems	 (a) Reduces vulnerability (b) Strengthens communities (c) Adapts processes (d) Builds partnerships	Impact fees (Portland), Land Bank Fund (South Portland), federal/state grants (e.g., Project Canopy Assistance Grants, Land and Water Conservation Fund), private grants	P: Parks; Sustainability; Planning; Health & Human Services SP: Sustainability; Planning; Parks

Climate Resilience

Action			Timeline			
#	Action Description	Action Subcomponents	By 2025	2026-2030	2031-2050	Milestones
CR 2.3	Resilient Food Systems Cultivate healthy, regenerative, and just food systems.	a. Expand public land access for food production.				• Small grants program for food system innovators established by 2025 • Funding to commission foodshed assessment secured by 2028 • Access to community agriculture expanded to all neighborhoods to meet demand
		b. Establish/improve policies to connect producers/harvesters and consumers.				
		c. Provide grants/business development for food system resilience/innovation.				
		d. Conduct a foodshed assessment.				
		e. Partner to support job training and reskilling in the food production sector.				
CR 2.4	Transportation Access Continue to prioritize decision-making processes and transit investments that advance equity in our cities.	a. Collaborate with GPCOG to launch next phase of CTLP program.				• Address first round of proposals made by Community Transportation Leaders by 2026
		b. Invite Community Leaders to participate in OCF planning initiatives.				
		c. Review and implement proposed solutions from CTLP first round.				
CR 2.5	Neighborhood Resources Support and strengthen our existing community resources.	a. Establish a small grants program to support initiatives that build resilience.				• Award the first round of community organizations or neighborhood groups with resilience grants by 2025
		b. Launch Sustainable Neighborhood programs.				
		c. Work with residents/community orgs. to resource neighborhood hubs.				
CR 3 Resilient Local Economy						
CR 3.1	Resilient Working Waterfronts Create an ongoing platform for collaborative planning to ensure that Portland and South Portland’s port and waterfronts can respond, adapt, and thrive with new climate stresses.	a. Develop PPP to access grant funding for waterfront resilience collaboration.				• Grant funding and partnerships secured for resilient working waterfronts project by 2026
		b. Convene port/waterfront industries for coordinated resilience planning.				
		(+ actions on revising land use code captured by other strategies - see text)				
CR 3.2	Workforce for a Resilient Economy Attract, mentor, and build the skills of our cities’ workers to partake in quality jobs that help build a diverse, resilient, and regenerative economy.	a. Work with partners to strengthen job training and employment pipelines.				• Targets set through collaboration for net increases in individuals trained in specific sustainability/resilience fields
CR 3.3	Climate-Ready Industries and Innovation Build the capacity of the businesses and industries in our cities to bounce back, adapt, and innovate.	a. Support business resilience via economic development programs.				• Revise land use policies to reduce barriers to traditional and emerging marine related industries by 2026
		b. Identify barriers and opportunities for the growth of a blue economy.				
		c. Drive innovation/growth in climate-ready industries via PPPs and pilots.				
CR 4 Resilient Infrastructure Systems						
CR 4.1	Stormwater Systems Use modeling and flood data to upgrade the cities’ stormwater and sewer systems to handle future climate scenarios.	a. Fill gaps in geospatial data for the sewer and stormwater system.				• Full geospatial data set completed for sewer and stormwater system by 2024 • Hydrologic / hydraulic drainage model completed by 2028
		b. Implement comprehensive asset management system.				
		c. Build out protocol for consistently tracking flood incidences.				
		d. Commission hydrologic/hydraulic drainage model.				

How this strategy advances a future that is...			Implementation	
Equitable	Regenerative	Resilient	Financing Strategies	City Steward
a b c d (a) Addresses injustice (b) Expands access (c) Creates inclusive processes (d) Builds community ownership	a b c d (b) Restores ecosystems (c) Supports a circular economy (d) Builds shared wealth	a b c d (a) Reduces vulnerability (b) Strengthens communities (d) Builds partnerships	Federal grants (e.g., USDA grants), private grants (e.g., New England Food System Resilience Fund, USDN Partners for Places grants), revolving loan funds (e.g., Portland Development Corporation)	P: Sustainability; Parks; Health & Human Services SP: Sustainability; Economic Development; Parks
a b c d (a) Addresses injustice (b) Expands access (c) Creates inclusive processes	a b c d (d) Builds shared wealth	a b c d (a) Reduces vulnerability (b) Strengthens communities (c) Adapts processes (d) Builds partnerships	PACTS funding, private grants	P: Planning; Public Works; Sustainability SP: Sustainability; South Portland Bus Service
a b c d (a) Addresses injustice (b) Expands access (c) Creates inclusive processes (d) Builds community ownership	a b c d (d) Builds shared wealth	a b c d (a) Reduces vulnerability (b) Strengthens communities (d) Builds partnerships	Private grants, revolving loan funds (e.g., Portland Development Corporation)	P: Sustainability SP: Sustainability
CR 3 Resilient Local Economy				
a b c d (d) Builds community ownership	a b c d (b) Restores ecosystems	a b c d (a) Reduces vulnerability (c) Adapts processes (d) Builds partnerships	Special assessments, bonds, federal/state grants (e.g., FEMA BRIC grants), private grants (e.g., NSF Civic Innovation Challenge)	P: Economic Development; Sustainability SP: Sustainability; Economic Development; Planning
a b c d (b) Expands access	a b c d (a) Draws down carbon * (b) Restores ecosystems* (c) Supports a circular economy * (d) Builds shared wealth	a b c d (a) Reduces vulnerability (b) Strengthens communities (d) Builds partnerships	Public private partnerships, public and private grants	P: Economic Development; Sustainability SP: Sustainability; Economic Development
a b c d	a b c d (a) Draws down carbon * (b) Restores ecosystems* (c) Supports a circular economy * (d) Builds shared wealth	a b c d (b) Strengthens communities (d) Builds partnerships	Tax increment financing (TIF), revolving loan funds (e.g., Portland Development Corporation), PPPs, federal grants	P: Economic Dev.; Planning; Sustainability SP: Sustainability; Economic Dev.; Planning
CR 4 Resilient Infrastructure Systems				
a b c d	a b c d	a b c d (a) Reduces vulnerability (c) Adapts processes	User fees (e.g., Portland stormwater service charge, South Portland Sewer User Fund), general fund	P: Water Resources SP: Water Resources Protection; Emergency Management

* Depending on the program

Climate Resilience

Action			Timeline			
#	Action Description	Action Subcomponents	By 2025	2026-2030	2031-2050	Milestones
CR 4.2	Green Infrastructure Expand the use of green infrastructure systems to capture and infiltrate the first inch of stormwater in any storm.	a. Evaluate/adjust ordinances to increase infiltration in new development.				● 5% of impervious surfaces in the cities converted to green infrastructure by 2035; 10% by 2040; and 15% by 2050
		b. Explore revising (P)/adopting (SP) stormwater service charges and credits.				
		c. Evaluate/implement initiatives and tools to expand GI on private property.				
		d. Collaborate with regional partners to build education/awareness of GI.				
CR 4.3	Energy Systems Build Portland and South Portland’s energy resilience.	a. Advocate for site-specific climate risk assessments of critical infrastructure.				● Development of Resilient Power Plan by 2026 ● All new development over 500,000 square feet to evaluate district energy/microgrids within one year of microgrid enabling legislation
		b. Advocate for evaluation of climate risks in future infrastructure planning.				
		c. Develop and implement a Resilient Power Plan.				
		(+ actions on energy resilience captured by other strategies - see text)				
CR 4.4	Transportation Systems Adopt a risk-based transportation asset management approach.	a. Build out robust geospatial data to support modeling and predictions.				● Climate hazards and resilience indicators applied to all asset management decision-making by 2028
		b. Model asset lifespans with consideration for climate hazards.				
		c. Establish resilience design guidelines and performance indicators.				
		d. Develop phased investment approach, influenced by climate risk.				
CR 5 Ecosystem Resilience						
CR 5.1	Ecosystem Adaptive Management Strengthen ecosystem resilience through enhancing connectivity, biodiversity, and healthy habitat.	a. Monitor and manage pests and invasives.				● Fertilizer ordinance adopted by 2022 ● No net coastal wetland loss by 2035 ● Establish biodiversity and connectivity targets by 2028
		b. Mitigate coastal acidification by reducing stormwater pollution.				
		c. Develop biodiversity and connectivity goals and guidelines (aligned with CR 1.3).				
		d. Facilitate tidal wetland migration.				
		e. Curtail coastal erosion with living shorelines.				
CR 5.2	Soil Health Build back the health of our soils for ecological vitality, water infiltration, and carbon sequestration.	a. Adopt post-construction soil health standards.				● Post-construction soil health standards adopted for new construction by 2025 ● “100 Resilient Lawns” achieved in each city by 2028
		b. Pilot and monitor healthy soil land management practices.				
		c. Share results and launch campaign to improve soil on private lawns.				

How this strategy advances a future that is...			Implementation	
Equitable	Regenerative	Resilient	Financing Strategies	City Steward
a b c d	a b c d (a) Draws down carbon (b) Restores ecosystems	a b c d (a) Reduces vulnerability (b) Strengthens communities (d) Builds partnerships	Revolving loan funds (e.g., Clean Water State Revolving Loans), bonds, federal/state grants (e.g., 319 Grants, CDBG funding)	P: Water Resources SP: Planning; Water Resources Protection
a b c d (a) Addresses injustice (b) Expands access	a b c d (a) Draws down carbon	a b c d (a) Reduces vulnerability (b) Strengthens communities (c) Adapts processes (d) Builds partnerships	Federal/state grants (e.g., FEMA BRIC (for Resilient Power Plan), REC sales, federal tax credits, PPAs (for DER), see BE 5-4 for district energy <i>Future: federal funding, green/infrastructure bank</i>	P: Sustainability; Emergency Management; Public Works; Facilities SP: Sustainability; Planning; Water Resources Protection
a b c d	a b c d	a b c d (a) Reduces vulnerability (c) Adapts processes (d) Builds partnerships	Impact fees, general fund	P: Public Works SP: Finance; Public Works; Transportation
CR 5 Ecosystem Resilience				
a b c d	a b c d (a) Draws down carbon (b) Restores ecosystems	a b c d (a) Reduces vulnerability (b) Strengthens communities (c) Adapts processes (d) Builds partnerships	Impact fees (Portland), Land Bank Fund (South Portland), federal/state grants (e.g., Maine Natural Resource Conservation Program funds, Maine Stream Crossing Upgrade Grant Program, 319 grants)	P: Parks; Sustainability; Planning; Water Resources SP: Sustainability; Water Resources Protection; Parks; Planning
a b c d	a b c d (a) Draws down carbon (b) Restores ecosystems (c) Supports a circular economy	a b c d (a) Reduces vulnerability (b) Strengthens communities (c) Adapts processes (d) Builds partnerships	Impact fees (Portland), Land Bank Fund (South Portland), private grants	P: Sustainability; Parks SP: Sustainability; Water Resources Protection; Parks; Planning

An aerial photograph of a city, likely Baltimore, showing a large body of water (the harbor) in the foreground. A large bridge (the Francis and Thomas Key Bridge) spans the water, curving from the right side towards the center. A large ship is docked at a pier on the left. The city is densely packed with buildings and greenery, with a forested area in the background.

One Climate Future

LAUNCHING THE PLAN

We live in a rapidly changing world. Innovative technologies disrupt long standing business models, people move around the country and around the world in search of opportunity, and unforeseen events—such as the COVID-19 pandemic—completely transform the way we live our lives. In a future of climate disruptions, we should anticipate that change will be the one thing we can count on.

We understand that the strategies and timelines laid out in this plan will need to adapt to future events and conditions to achieve our overarching climate and resilience goals. One Climate Future should be considered a living document and the pathways outlined should be dynamic and adaptable to future conditions. The Cities intend to return to and update One Climate Future periodically to reflect new technologies, financial resources, staff capacity, and community ownership.



THE CITIES LINKED BY THE FORE RIVER AND CASCO BAY BRIDGE • Photo by City of South Portland

Nonetheless, the strategies that Portland and South Portland put forward today reflect the magnitude and urgency of change. We will rely on the residents, businesses, community partners, and institutions within the cities to work together to achieve our goals. Success will depend on ongoing commitments of time, resources, and collective will. Both Cities will regularly report on this progress to hold ourselves accountable for bold action.

We are not starting from scratch, but rather building upon years of clean energy and climate initiatives. This momentum across city departments, community organizations, and our social fabric positions us well to launch into immediate action that will bring transformative change.

Acronyms

ACA	Airport Carbon Accreditation
ADA	Americans with Disabilities Act
ADU	Accessory Dwelling Unit
ASCT	Adaptive Signal Control Technology
ASHP	Air-Source Heat Pump
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
AV	Autonomous Vehicle
BAU	Business as Usual
BE	Buildings and Energy (One Climate Future Strategies)
BEV	Battery Electric Vehicle
BRIC	Building Resilient Infrastructure and Communities (FEMA Program)
BRT	Bus Rapid Transit
BSOOB	Biddeford-Saco-Old Orchard Beach (Transit Committee)
C&D	Construction and Demolition
C-PACE	Commercial Property-Assessed Financing
CAFE	Corporate Average Fuel Economy (Standards)
CBL	Casco Bay Lines
CCA	Community Choice Aggregation
CDBG	Community Development Block Grants (HUD funding)
CDBG-DR	Community Development Block Grant Disaster Recovery (HUD Funding)
CH₄	Methane
CHP	Combined Heat and Power
CHPS	Collaborative for High Performance Schools
CMP	Central Maine Power
CNG	Compressed Natural Gas
CO₂	Carbon Dioxide
COVID-19	Coronavirus Disease 2019
CPPC	Climate Planning Process Committee
CR	Climate Resilience (One Climate Future Strategies)
CRS	Community Rating System
CTLP	Community Transportation Leaders Program
DER	Distributed Energy Resources
EDA	U.S. Economic Development Administration
EERS	Energy Efficiency Resource Standard
EPA	U.S. Environmental Protection Agency
EPR	Extended Producer Responsibility
ESCO	Energy Service Company
EUI	Energy Use Intensity
EV	Electric Vehicle
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map

FMA	Flood Mitigation Assistance (FEMA Funding)
FTA	Federal Transit Administration
GHG	Greenhouse Gas
GHX	Ground Heat Exchanger
GPC	Global Protocol for Community-Scale Greenhouse Gas Emission Inventories
GPCOG	Greater Portland Council of Governments
GSHP	Ground-Source Heat Pumps
HERS	Home Energy Rating System
HMGP	Hazard Mitigation Grant Program (FEMA Funding)
HUD	U.S. Department of Housing and Urban Development
HVAC	Heating, Ventilation, and Air Conditioning
IBC	International Building Code
IECC	International Energy Conservation Code
ILFI	International Living Future Institute
IMT	Institute for Market Transformation
ISO	International Organization for Standardization
IT	Information Technology
ITDP	Institute for Transportation and Development Policy
kW / kWh	Kilowatt / Kilowatt Hour
LED	Light-Emitting Diode
LEED	Leadership in Energy and Environmental Design
LID	Low Impact Development
LIHTC	Low Income Housing Tax Credits
MaineDOT	Maine Department of Transportation
MC₂	Maine Clean Communities
MEGA	Maine Energy Generation Authority
METRO	Greater Portland METRO
MPO	Metropolitan Planning Organization
MTCO₂e	Metric Tons of Carbon Dioxide Equivalents
MTF	Multimodal Transportation Fund
MUBEC	Maine Uniform Building and Energy Code
MW / MWh	Megawatt / Megawatt Hour
NA	Not Assessed (One Climate Future Implementation Matrix)
NAVD88	North American Vertical Datum of 1988
NG	Natural Gas
NGVD29	National Geodetic Vertical Datum of 1929
NFIP	National Flood Insurance Program
NIQ	Not Independently Quantified (One Climate Future Implementation Matrix)
NOAA	National Oceanic and Atmospheric Administration
NSF	National Science Foundation
NSRS	National Spatial Reference System

NRDC	Natural Resources Defense Council
NWA	Non-Wires Alternatives
NZE	Net-Zero Energy
P	Portland (One Climate Future Implementation Matrix)
PACE	Property-Assessed Clean Energy
PACTS	Portland Area Comprehensive Transportation System
PBP	Performance-Based Procurement
PHA	Portland Housing Authority
PHIUS	Passive House Institute U.S.
PPA	Power Purchase Agreement
PPM	Parts Per Million
PPP	Public-Private Partnership
PPSM	People Per Square Mile
PSA	Portland Society for Architecture
PUC	Public Utilities Commission
PWM	Portland International Jetport
QAP	Qualified Allocation Plan
REC	Renewable Energy Certificate (or Renewable Energy Credit)
RFO	Renewable Fuel Oil
RFP	Renewable Portfolio Standard
RGGI	Regional Greenhouse Gas Initiative
RPS	Renewable Portfolio Standard
RTP	Regional Transportation Program
SAYT	Save-As-You-Throw
SCRIP	Sustainable Communities Regional Planning (HUD Funding)
SEM / SEMP	Strategic Energy Management / Strategic Energy Management Plan
SLR	Sea Level Rise
SMCC	Southern Maine Community College
SOM	Soil Organic Matter
SOV	Single-Occupancy Vehicle
SP	South Portland (One Climate Future Implementation Matrix)
SPBS	South Portland Bus Service
SPHA	South Portland Housing Authority
SREC	Solar Renewable Energy Certificate
T&D	Transmission and Distribution
TAM	Transportation Asset Management
TCI	Transportation and Climate Initiative
TDM	Transportation Demand Management
TIF	Tax Increment Financing
TLU	Transportation and Land Use (One Climate Future Strategies)
TMA	Transportation Management Association
TNC	Transportation Network Company

TOD	Transit-Oriented Development
UNE	University of New England
USACE	U.S. Army Corps of Engineers
US BCSD	U.S. Building Council for Sustainable Development
USDA	U.S. Department of Agriculture
USDN	Urban Sustainability Directors Network
USGBC	U.S. Green Building Council
USM	University of Southern Maine
VMT	Vehicle Miles Traveled
VW	Volkswagen
WR	Waste Reduction (One Climate Future Strategies)

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One Climate Future

APPENDIX

A

GREENHOUSE GAS INVENTORIES MEMORANDUM

Memorandum: Greenhouse Gas Emissions Inventories for Portland and South Portland

B

ENERGY AND EMISSIONS MODELING MEMORANDUM

Memorandum: Community Energy and Emissions Modeling Technical Methodology

C

RESILIENCE MEMORANDUM

Memorandum: Resilience Zoning for Resilient Buildings and Land Use



ONE CLIMATE FUTURE

Charting a Course *for*
Portland and South Portland

Community Resilience Partnership

Program Contact: Brian Ambrette
brian.ambrette@maine.gov

[Community Resilience Partnership | Office of Policy Innovation & Future \(maine.gov\)](#)

Community Resilience Self-Evaluation

Instructions: This tool is intended to help organize your community's approach to increasing resilience to natural hazards and climate change impacts. Answer the questions to the best of your knowledge and seek information from your colleagues in municipal and county government and organizations in your community. Provide any relevant information in the explanation field. If it is difficult to give a clear yes or no response to a question, use the explanation field to explain why. **There are no wrong answers and the responses here will not affect your community's eligibility to receive grants.** Where the response to a question is no, that may indicate an area of opportunity to address through a Community Action Grant.

Community name:	City of Portland
Self-Evaluation responses provided by: Please include contact info	Troy Moon thm@portlandmaine.gov 207-756-8362
Date:	1/15/2022
Was this evaluation discussed during a community workshop? Include the date of the workshop.	Sustainability and Transportation Committee meeting January 12, 2022

Once the questions on the following pages are complete, use these prompts to identify potential next steps for your community:

What are two things your community is doing well?	We have a City Council approved, comprehensive climate action and adaptation plan – One Climate Future -developed in collaboration with South Portland. Portland actively supports the seafood economy as a low carbon, local food system.
What are two areas that could be improved in the short-term?	Working with the community including private property owners to prepare for the impacts of sea level rise. Address resilience and threats from climate change in land use code / adopt resilience overlay zones.

What is important for your community to address in the long-term?	Ensure that the transition to a clean energy economy includes all members of the community and that everyone has equitable access to energy resources. Ensure access to wild harvest seafood and aquaculture resources in a future where species shifts and dynamic environmental conditions become the norm.
What specific 3 to 5 actions are priorities for your community?	Electrification of homes and business Electrification of transportation Revising the land use code to support goals established in One Climate Future and Plan 2030 (Comp plan) Implementing Climate Resilience Overlay Zones described in One Climate Future. Support the Portland Fish Exchange as the state's largest landing location for groundfish.

Minimizing Risk and Exposure to Hazards	
1) Has your community assessed the likelihood of various types of hazards or disruptive events?	X Yes ☐ No
Your local or county hazard mitigation plan is a good starting place to find this information. Hazards can include storms, floods, wind, fire, extreme temperatures, drought, etc. Likelihood could be indicated either numerically or qualitatively as low, medium, or high.	Explanation: The City conducted a comprehensive climate vulnerability assessment to inform the strategies in One Climate Future. It analyzes the City's risk for a wide range of impacts related to climate change including damage to vital infrastructure, discharges of hazardous materials, energy disruptions, heat, and disease outbreaks. It maps the location of individuals who may be at higher risk to climate impacts because of race, income, age, and other factors to help the City plan for equitable outcomes in climate action. City also participates in development of the County Hazard Mitigation Plan and has shared our Climate Vulnerability Assessment to help prepare responses to climate change at a regional scale.
2) Has your community assessed how the likelihood of each hazard has changed over time and may change in the future?	X Yes ☐ No
If your community has not tracked trends historically, you might infer past trends by determining if current priorities have shifted compared to past hazard mitigation plans. For example, drought or wildfire might be an emerging concern.	Explanation: The Climate Vulnerability Assessment documents how things like sea level rise, precipitation events, and heat have changed during the past century. It describes anticipated future conditions the City should prepare and establishes sea level rise projects to guide decision making regarding future development in vulnerable parts of the city.
3) Has your community assessed the impacts or consequences of each type of hazard for the community?	X Yes ☐ No
For example, flooding on Main Street impedes emergency services or affects local businesses.	Explanation: Yes – the Climate Vulnerability Assessment addresses the consequences of broad categories of threat and the broad impact they may have on the community.
4) Is your community taking steps to reduce exposure to multiple risk types?	X Yes ☐ No
Your local or county hazard mitigation plan probably contains this information.	Explanation: Yes – we participate closely with the County in the development and implementation of the regional emergency management plan. Our Climate Vulnerability Assessment identifies a broad spectrum of threats related to climate change that has informed local and regional emergency management plans. Our Emergency Management Coordinator uses risk assessment tools to gauge our preparedness for emergencies. Flooding response protocols are in place to mitigate flooding risk during high tides and storm surge events.

6) Is your community preparing for low-probability-but-high-consequence events?	X Yes ☐ No
These events could be, for example, a 1-in-100 year flood, or a prolonged electricity outage or heating fuel shortage. What events might the community need to consider?	Explanation: Yes – in addition to identifying hazards in the Climate Vulnerability Assessment, the City coordinates planning and preparation with the County and State emergency management agencies. The City has an Emergency Management Coordinator who helps prepare plans and contingencies, draws on local, State, and Federal resources, and coordinates with partners in government, the non-profit sector, and businesses to prepare for and respond to emergencies.
7) Has your community assessed the consequences of multiple events or different types of hazards occurring in geographic or temporal proximity?	X Yes ☐ No
Examples could include back-to-back flooding events or a power outage during a heat wave.	Explanation: Yes – our Climate Vulnerability Assessment describes the consequences of multiple hazards and how impacts from one hazard cause or compound additional hazards. For example, a flooding event on the waterfront could cause the discharge of hazardous waste from petroleum storage facilities or from businesses that store hazardous materials. Also, infrastructure damage could prevent delivery of vital goods and services to the public, exacerbating risks to vulnerable populations.
8) Is your community assessing emerging risks (e.g. drought, wildfire) and identifying blind spots?	X Yes ☐ No
In addition to natural hazards, consider public health threats that might be worsened by climate change, such as contamination of drinking water sources and vector-borne diseases from ticks and mosquitos.	Explanation: Yes – we commissioned the Climate Vulnerability Assessment to help us identify the full spectrum of impacts from climate change but we also employ our Emergency Management Coordinator to keep abreast of new threats to our community.

Understanding Sensitivity and Building Resilience	
9) Is your community tracking underlying societal characteristics and trends that increase vulnerability?	X Yes ☐ No
This information might be found in your community's comprehensive plan or economic development plan. Examples of characteristics and trends might include older or low-income populations, low housing availability, reliance on a single economic driver, aging infrastructure, environmental degradation, etc.	Explanation: As part of the Climate Vulnerability Assessment we used demographic information to map neighborhoods with populations that may face greater threat to climate change. Factors include race, immigration status, age, income level, and education, amongst others. More recently we have used a Tree Equity Score tool to identify neighborhoods that may be more vulnerable to urban heat island effect, flooding, and air pollution due to lack of tree canopy.

10) Is your community proactively addressing vulnerabilities associated with these underlying characteristics?	X Yes ☐ No
Look in your community's comprehensive plan or economic development plan for strategies that might address these trends.	Explanation: Yes – the City is aggressively seeking opportunities to adding housing for vulnerable populations. As noted above, our mapping exercises , identifying populations at risk from sea level rise, heat, and other impact of climate change. The City has begun exploring the creation of resilience overlay zones to ensure that new construction is prepared for the impacts of climate change including sea level rise. Our climate action plan calls for the creation of a neighborhood resilience program to enhance the adaptive capacity of existing neighborhoods by creating social bonds amongst community members through participation in projects that make their community more sustainable such as tree planting, neighborhood clean ups, and home weatherization.
10) Does your community have financial resources in reserve to cope with or absorb shocks?	☐ Yes X ☐ No
For example, a rainy-day fund.	Explanation: The City of Portland has a strong track record of good fiscal management and has operating reserves to address emergencies. However, extended periods without economic activity that require extraordinary expenditures present fiscal challenges. This was evident in the COVID-19 pandemic when the City was forced to reduce staffing and operations due to revenue reductions coupled with significant ongoing expenditures.
12) Is your community building flexible human capacity that can be drawn on in emergencies?	X Yes ☐ No
For example, community emergency response teams (CERT) or mutual aid agreements with neighboring communities.	Explanation: Yes – the City has formal agreements with neighboring communities for mutual aid. We have an EM Coordinator who coordinates with partners at the County, State, and Federal levels. We have a CERT team for our largest island community. We plan to implement a neighborhood sustainability program to increase adaptive capacity in neighborhoods around the city.

Improving Long-term Adaptive Capacity	
13) Does your community have plans or policies that anticipate future climate risks and community sensitivity trends?	X Yes ☐ No

Examples might include a comprehensive plan chapter that describes how the community is planning for climate change impacts, or a capital improvement plan that requires construction projects to consider future conditions like sea level rise, extreme rain, or drought.	Explanation: Yes – the City created and adopted a comprehensive climate action plan and commissioned a detailed vulnerability assessment to help us prepare for climate change. These established a planning threshold for sea level rise and call for the creation of resilience overlay zones to create standards for new construction to address threats from climate change. We have a local ordinance that requires new construction that benefits from City contributions to meet high performance standards for roofs, energy performance, and solar energy. The City adopted the voluntary energy code, IECC 2021, to ensure new construction is energy efficient.
14) Are there resources to sustain new capacity when needed?	X Yes ☐ No
This is different from Question 10 in that these resources would need to sustain a new long-term commitment rather than a one-time, short-term response. For example, if flooding emerges as an issue, a revenue source such as a stormwater utility fee could sustain a new community stormwater management program.	Explanation: The City of Portland established a stormwater utility funded by a stormwater utility fee that has been actively addressing stormwater issues including flooding. Having this discreet program allows the City to address future hazards proactively. We also have a stormwater impact fee that requires developers to contribute funds to address future stormwater issues. The City also has impact fees for transportation and parks. We contemplate the creation of a sustainability fund that could be used to fund climate mitigation and adaptation projects that advance One Climate Future.
15) Does the community have policies in place to build back smarter or recover with resilience after a disruptive event?	X Yes X No
Examples might include a flood ordinance that requires compliance with the current building codes after substantial damage, or a communitywide post-disaster recovery plan.	Explanation: While new construction after a disaster would be required to meet existing building codes, the City does not currently have an adequate policy framework to ensure that post disaster recovery reduces vulnerability to future events or disasters.
16) Does the community stress test to ensure plausible risks are manageable?	X Yes ☐ No
This might be a table-top exercise with emergency management and community stakeholders, or a financial health analysis.	Explanation: Emergency responders conduct regular training to respond to emergencies and also conduct table top exercises to prepare for things like mass casualty events, plane crashes, or fires on an island.
17) Does the community have a policy or process for managing uncertainty?	X Yes ☐ No
Does the community have a way of making important decisions when information is incomplete or unavailable?	Explanation: The City has a strong leadership team including the City Manager and department staff with varied expertise to address specific conditions whether it be a public health emergency, fire, or weather. Our Emergency Management Coordinator supports decision making with vital information about conditions and resources. Our City Council meets twice a month and

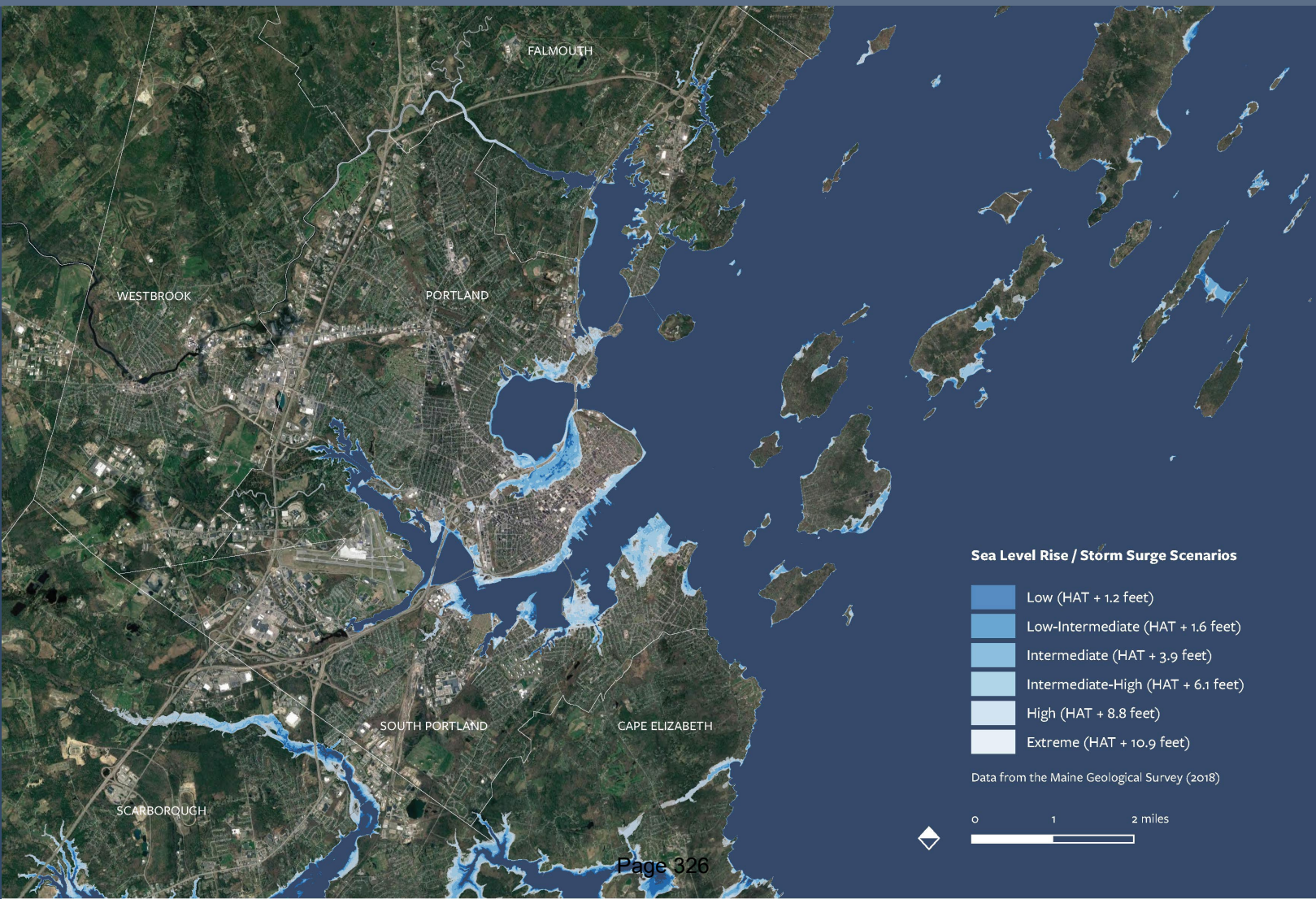
	holds emergency meetings as required to consider policies that may be required to address an emergency situation.
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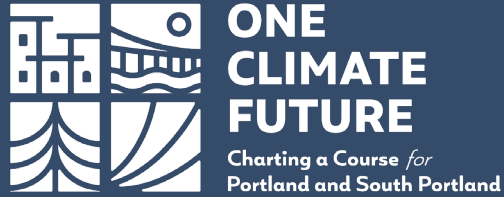


**ONE
CLIMATE
FUTURE**
Charting a Course *for*
Portland and South Portland

ONE CLIMATE FUTURE Climate Change Vulnerability Assessment

Cities of Portland and South Portland ■ 2019





The **One Climate Future** Vulnerability Assessment is a joint project between the Cities of Portland and South Portland, led by the Portland and South Portland **Sustainability Offices**.

We extend a large thank you to the city staff and members of the community who participated in workshops, shared research, and provided feedback in the production of this assessment.

This is the first phase of the One Climate Future planning process. The hazards and vulnerabilities documented in this assessment directly inform the One Climate Future Plan—which charts our ambitious and collaborative course to a thriving, inclusive, carbon-neutral, and resilient future.

The One Climate Future Vulnerability Assessment was produced by **Linnean Solutions** with contributions from Woodard & Curran.

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1. Executive Summary

Portland and South Portland are taking action together to address climate change.

THE GOAL

Through a joint climate action and adaptation plan, **One Climate Future**, our two cities are charting a course for reducing greenhouse gas emissions, while also increasing our ability to adapt to new climate hazards. In other words, we are working to be inclusive, vibrant communities that provide opportunities for residents and businesses to thrive in a changing climate.

This vulnerability assessment is one key step in that process. Its purpose is to identify the hazards that Portland and South Portland will likely face from climate change (such as sea level rise, higher temperatures, or more extreme storms), as well as the ways in which our infrastructure, ecosystems, economies, and communities may be most vulnerable to its impacts. Identifying those vulnerabilities will help us prioritize and invest in actions that can best build our community resilience.

HOW THIS ASSESSMENT WAS DEVELOPED

This assessment does not start from scratch—in fact, far from it. For nearly two decades, research institutions, advocacy groups, businesses, nonprofits, state and city governmental departments, and concerned residents across Portland and South Portland have been tracking environmental indicators, assessing flood vulnerability, and developing climate adaptation recommendations. This assessment starts by gathering and integrating that existing research, including information from local, regional, state, and national vulnerability assessments, as well as regional reports on topic areas ranging from food security, to watershed management, to public health concerns. (See the full bibliography at the end of this report.)

So much of this existing research takes a deep dive into specific areas of vulnerability; this report seeks to highlight those specifics, while creating a stronger understanding around how that vulnerability compounds across systems across the two cities. New map-based assessments provide further information about potential vulnerability. Likewise, the assessment integrates insight from city staff, representatives from businesses and organizations, and residents who participated in the One Climate Future Resilience Workshop in April 2019, as well as provided direct input into various areas of this assessment.

WHAT THE ASSESSMENT TELLS US

Portland and South Portland will continue to experience greater *shocks* and *stresses* related to climate change. “Shocks” refer to acute events that occur in a specific period of time, such as a powerful storm or a heat wave. These events can lead to business closures, transportation interruptions, and/or require enacting emergency management systems to keep residents safe. “Stresses” refer to chronic conditions—challenges that will affect us gradually on a daily basis, such as nuisance flooding, rising food prices, or worsening air quality. These conditions can strain household resources as well as our health and wellbeing. Both acute shocks and chronic stresses related to climate change will become more problematic when they overlap with other chronic stresses people face in their daily lives. These could include illnesses, financial insecurity, or poor-quality housing.

The assessment discusses the implications of these shocks, stresses, and sources of amplified vulnerability in the following sections of the report:

Section 2. Climate Hazards – Details the climate changes that we are already seeing in the Greater Portland area, as well as the changes we may see through 2100.

Survey Findings

IN SPRING OF 2019, residents across Portland and South Portland responded to a survey about climate change. Approximately 79% of 663 respondents indicated that they are “very concerned” that climate change will affect Portland and South Portland, and 69% of respondents reported being “very concerned” that climate change will affect them personally.

More specifically, 68% of 663 respondents reported sea level rise as one of their top three concerns, followed by intense storms (56%), ocean acidification (52%), extreme heat (39%), and flooding (38%).

What are the top three climate hazards you are most concerned about?

Answer Choices	Percent of People Who Ranked Answer in Top 3 Risks	Number of People Who Ranked Answer in Top 3 Risks
Drought	23%	151
Extreme Heat	39%	251
Flooding	38%	248
Intense Storms	56%	362
Ocean Acidification	53%	342
Sea Level Rise	68%	442
None of these	3%	21
Other	7%	41

Table 1.1. One Climate Future survey responses to the question: “Please indicate the top three climate hazards you are most concerned about,” as part of a survey disseminated to Portland and South Portland residents in spring 2019. Total number of answers (n) is 663. Percentages do not add up to 100 because respondents were asked to choose three responses.

Section 3. Infrastructural Risk, Exposure, and Vulnerability – Details how local climate changes may impact energy, transportation, water, and communication infrastructure systems, as well as affect hazardous waste sites.

Section 4. Environmental Risk, Exposure, and Vulnerability – Details how local climate changes may impact the health of terrestrial, tidal, and marine ecosystems, water quality, and coastal erosion.

Section 5. Socioeconomic Risk, Exposure, and Vulnerability – Details how local climate changes may impact local economic sectors, household financial security, housing markets, access to resources, food security, public health, and social equity.

Section 6. Social Vulnerability and Adaptability – Details how aspects of people’s current lives may increase their vulnerability and make it harder to adapt to climate change.

Across these sections, ten key areas rise to the surface. These areas show critical and cascading vulnerability with climate change, and also opportunity for resilience interventions that can have significant impact. Although all vulnerabilities in this assessment are relevant for businesses, organizations, residents, and city departments for planning and future investments, focusing on these ten key areas will help us take bigger steps towards becoming resilient cities. The top ten areas are listed below, not in any particular order.

1. RELEASE OF HAZARDOUS WASTE

Historic and present-day industrial uses have led to a concentration of contaminated sites and hazardous material storage facilities in the cities. There is significant risk that shoreline retreat due to sea level rise, changes in groundwater tables, as well as wind and wave action from severe storms could submerge or erode these sites, causing structural damage to above ground or subsurface hazardous waste containments (as well as releasing soil-bound contaminants). While a number of sites are vulnerable, this study concludes that the potential transport of the significant volumes of hazardous materials stored in containment systems along the Fore River shoreline in South Portland and, to a lesser extent, materials potentially stored by Resource Conservation and Recovery Act (RCRA) Generators in the Bayside Area of Portland, are of the highest concern. These containment sites are required to have written contingency plans, and yet the release of hazardous waste poses potentially one of the most significant risks for human and environmental health and safety. See section 3.5 for more details.

2. GRID SYSTEM RELIABILITY AND BUSINESS CONTINUITY

The electrical power system in New England is undergoing significant change, addressing how to continue to meet peak electricity demand in cold winters, while following a trajectory towards decarbonization.¹ Renewable energy sources, as well as natural gas-based generation, rely on “just-in-time” delivery of energy, which—without energy storage or fuel reserves—creates challenges for reliability. Recent studies by GridSolar suggest that as the cities move towards further electrification to reduce fossil fuel use, electricity load profiles in the Greater Portland area will experience significantly higher relative peak loads. These system transformations provide context for the intensified challenges brought by climate hazards that may reduce system function (i.e., from high heat) or compromise system components (i.e., from flooding or severe storms). Studies suggest that power outages are one of the top climate-related concerns for businesses in the northeast both because of their likelihood and the economic costs they create.² Likewise, power disruptions have shown to be the most frequent root cause of cascading system failures

across other infrastructural systems.³ Thus prioritizing vulnerabilities in power supplies, distribution systems, and the power-dependence of other infrastructure systems can help contain risk. See sections 3.1 and 5.1 for more details

3. IMPACT TO PROPERTY VALUES, COMMERCIAL AREAS, AND TAX BASE

Rising sea levels and storm surge are expected to not only create direct damage to buildings and property, but are predicted to create more lasting effects on property values, real estate markets, and the cities’ tax bases. Recent research in the southeast United States documents that homes within a quarter mile of a road that will flood completely within 15 years are already showing declines in value by \$3.71 per square foot annually—a pattern which can eventually leave residents with mortgages that exceed the value of their homes.⁴ Many of the most vulnerable areas in Portland and South Portland are also centers for commercial and industrial activity, including the waterfront, Back Bay, Knightville, Turner Island, and portions of Ferry Village, which would lead to loss of economic activity in addition to hurting the tax base. Expanding information on risk and identifying ways to retain value in these areas through zoning for alternative uses will be critical for mitigating economic repercussions. The cities’ access to additional capital (e.g., bonds) for resilience investments is also dependent on municipal credit ratings, which can become a “catch-22” if credit ratings are lowered based on flood risk.⁵ See section 5.1 for more details.

4. DISRUPTION TO CRITICAL TRANSPORTATION ROUTES

Sea level rise and storm surge are expected to increasingly inundate roads in Portland and South Portland, and most critically portions of I-295, a key corridor for travel in and out of the cities from the north and south. Sea level rise and storm surge inundation models suggest that I-295 directly south of exit 8 (before reaching Tukey’s Bridge from the south) will likely be the first bottleneck area due to flooding with a category 1 hurricane or sea level rise 6.1 feet above the highest astronomical tide. A category 2 hurricane could impact the same location on I-295, as well as cut off connections between the two cities by

affecting the I-295 bridge, Casco Bay Bridge, Veteran's Memorial Bridge, and the Congress Street (ME-22) bridge, all crossing the Fore River. Sea level rise could likely lead to regular flooding of I-295 exits 6A and 7 as early as 2050. Marine terminals, along with railroad corridors along Commercial Street and Turner Island will likely experience regular flooding by 3.9 feet of sea level rise. See section 3.3 for more details.

5. VULNERABILITY OF SEWER AND STORMWATER CRITICAL ASSETS

The sewer and stormwater systems in both cities show vulnerability to storms and sea level rise in areas along the waterfronts, including Back Cove and the Fore River. Most critically, the South Portland wastewater treatment facility shows vulnerability to storm surge under a category 2 hurricane or higher, as well as to sea level increases at 6.1 feet above the highest astronomical tide. Likewise, the Peaks Island wastewater treatment facility may see storm damage from a category 3 hurricane or higher. Sea level rise inundation models suggest that four pump station sites in Portland and five pump stations sites in South Portland are expected to experience regular flooding under 3.9 feet of sea level rise above the highest astronomical tide. See section 3.2 for more details. Note that it is possible that the city's drinking water infrastructure may be exposed to similar vulnerability; however, these assets were not included in this assessment for homeland security concerns.

6. DEGRADATION OF ECOSYSTEM HEALTH

The health of the cities' ecological resources will likely be affected by climate change. In particular, sea level rise may lead to habitat loss for sensitive tidal wetlands, which provide enormous benefit to aquatic species, and the surrounding built environment by serving as habitat and a protective barrier against storm surge. Without effective areas for marshes to migrate inland, the cities will lose significant wetland resources. Higher volumes of stormwater runoff from extreme precipitation events are likewise expected to lead to higher pollution levels in water systems, exacerbating coastal ecosystem degradation and coastal acidification. In both land and marine ecosystems, changes in temperature and precipitation patterns are also leading to the growth in invasive

species, which can outcompete and choke out native species. Changes in temperature are facilitating pest outbreaks that, in particular, can cause significant damage to the cities' tree canopies. Without new restoration and adaptive management efforts, these stressors can lead to significant losses in the cities' native ecosystems. See sections 4.1–4.5 for details.

7. PUBLIC HEALTH CHALLENGES, PARTICULARLY HIGH HEAT

Unseasonably hot days, extreme heat, as well as extended heat waves can have a significant physiological impact on people whose bodies are less acclimated to warmer weather, which both affects people in historically cooler climates and makes extreme temperatures in the spring more deadly than those later in the summer.⁶ Likewise, air conditioning is much less prevalent in homes, businesses, and public spaces in northern parts of the United States, including Portland and South Portland. Therefore, although Maine is not expected to see the same extreme temperatures as other parts of the country, cities in cooler climates tend to see more heat-related deaths and hospitalizations.⁷ Areas in western South Portland, particularly around the Maine Mall, are likely to feel the effects of extreme heat more acutely due to large areas of impervious surfaces (e.g., parking lots). Many types of disabilities and medications can also enhance vulnerability to heat. Likewise, children, elderly, and residents with limited financial means will also be disproportionately affected. See section 5.4 for more details. Climate change is also likely to exacerbate other public health challenges, including asthma from worsened air quality, higher rates of vector-borne disease, and strain on mental health.

8. GREATER NEED FOR SOCIAL SERVICES

Climate change is expected to amplify some of the burdens residents in Portland and South Portland already face—whether that's financial, food, or housing insecurity, or physical and mental health stress. Without proactive plans to support, fund, modify, coordinate, and/or expand social service systems in the cities, current programs risk becoming overstrained and under-resourced to adapt to changing needs. Service needs will likely spike during acute climate hazards such as severe storms or flooding—a time in

which social service locations may also be impacted. The Bayside area in Portland, which shows some of the highest vulnerability to sea level rise and storm surge flooding between now and 2050, may be most at risk for this scenario. The neighborhood has a higher proportion of residents with higher “social vulnerability” (based on a number of factors, such as income), as well as a significant proportion of the social network resources that residents in the area rely on (e.g., the Human Services Department building). Losing access to such resources can amplify hardship and prolong recovery from severe storms or flooding. Both the Portland and South Portland Housing Authority buildings are vulnerable to a category 2 hurricane or higher. See section 5.3 as well as 6.1–6.5 for more details.

9. VULNERABILITY OF FOOD SYSTEMS

International research increasingly suggests that droughts, floods, and new pests introduced by climate change will impact global food systems with a potential net rise in food prices; however, the nature and extent of the impact is both complex and uncertain. Locally, however, the most direct and apparent risk to the food system will likely come from compromised distribution chains and challenges to food access. Road closures due to flooding from severe storms, particularly on I-295 and local roads to supermarkets, could likely restrict food delivery. Sea level rise and storm surge models suggest that five of eleven large grocery stores across both cities may see significant inundation in a category 2 hurricane, or in a scenario where sea levels reach 3.9 feet above the highest astronomical tide. Four of those grocery stores may see flooding around their sites at 1.6 feet of sea level rise. Portland and South Portland residents that rely on public transportation and/or food assistance will likely face greater food insecurity driven by closures in public transportation, social services, or rising food prices. See section 5.3 for more details.

10. RISK OF INCREASING SOCIAL INEQUITY

There is a significant risk that climate change may contribute to greater social inequity. Portland and South Portland residents facing poverty, a disability, or other forms of social marginalization will have

more limited access to resources to respond in an emergency or proactively adapt to climate stresses. At the same time, climate change is expected to further impact livelihoods, housing security, food security, and health—thereby enhancing many of the vulnerabilities that make the impacts of climate change more acute for individuals and households. In other words, climate change creates a vicious cycle that increases social vulnerability, and with that, more susceptibility to climate hazards. Evidence from other cities have shown ways in which adaptation measures have also inadvertently enhanced inequity by continuing to invest in areas that have more resources. See section 5.5 for more details. Considering the equity implications of both processes and outcomes of climate adaptation efforts will be critical to ensuring that further sources of inequity do not become a byproduct of climate change response.

ACTION TO DATE AND NEXT STEPS

Climate change studies and instances of extreme weather prior to the release of this assessment have already prompted Portland and South Portland to begin integrating climate planning into city investments in a number of ways. Portland and South Portland City staff are currently participating on working groups for the Governor’s Climate Council in the areas of Transportation, Energy, and Coastal and Marine issues. The Cities have also participated in several studies exploring the impacts of climate change and sea level rise, such as the Maine Climate Change Adaptation Task Force in 2010, the Waterfront Vulnerability Assessment in 2013, and the Department of Homeland Security Regional Resiliency Assessment Program in 2014.

In 2007, the Portland City Council created a “green ribbon” task force that drafted the Sustainable Portland Report which identified sea level rise as the greatest threat to Portland since the Great Fire of 1866. In 2014 and 2015 Portland experienced significant rainfall events that dropped over six inches of rain in short periods of time. The 2015 storm coincided with

a high tide and resulted in widespread flooding in the Bayside neighborhood. Following this event, the City of Portland launched Bayside Adapts, a community scale resiliency planning process that sought to pave the way for more comprehensive planning by establishing a set of guiding principles and identifying key gaps in knowledge about civic infrastructure in the area.

Portland city projects have included resiliency elements as far back as the 2005 Ocean Gateway infrastructure upgrade. Ongoing resilience projects include improved stormwater management infrastructure designed to reduce impacts on the water treatment facility to reduce overflows of untreated water during significant rain events. City of Portland staff have also begun exploring ways to use incentives and mandates to encourage private developers to include resilience features in their buildings.

South Portland is not currently experiencing the increased levels and occurrences of flooding that Portland and many other communities are facing with climate change. This is due in part to the considerable steps the City has taken to improve its water management infrastructure.

Though planning for climate resilience is a relatively new concept, the City of South Portland's significant

investment in its sewer and stormwater infrastructure over the past few decades have effectively reduced flooding and increased sewer and stormwater capacity for new and redevelopment. Since the late 1980s, South Portland has invested more than \$42 million in collection system separations, pump station renovations, and upgrades to its wastewater treatment plant. These infrastructure upgrades, including the elimination of 24 out of 28 combined sewer overflows, have reduced flooding events and improved water quality.

While these investments have positioned the City of South Portland well for near-term impacts, we know that future projections for sea level rise and intensified storm surges reveal new vulnerabilities that South Portland will need to plan for and adapt to.

These interventions for both cities represent the very beginning of a more significant effort to prepare our communities for the anticipated impacts of climate change.

This vulnerability assessment identifies significant infrastructural, environmental, social, and economic impacts from sea level rise, changes in precipitation, more intense storms, as well as higher temperatures—all of which will provide the groundwork for action in the One Climate Future Plan.

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- 6 USGCRP, 2016: The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment. Crimmins, A., J. Balbus, J.L. Gamble, C.B. Beard, J.E. Bell, D. Dodgen, R.J. Eisen, N. Fann, M.D. Hawkins, S.C. Herring, L. Jantarasami, D.M. Mills, S. Saha, M.C. Sarofim, J. Trtanj, and L. Ziska, Eds. U.S. Global Change Research Program, Washington, DC, 312 pp.
- 7 USGCRP, 2016: The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment. Crimmins, A., J. Balbus, J.L. Gamble, C.B. Beard, J.E. Bell, D. Dodgen, R.J. Eisen, N. Fann, M.D. Hawkins, S.C. Herring, L. Jantarasami, D.M. Mills, S. Saha, M.C. Sarofim, J. Trtanj, and L. Ziska, Eds. U.S. Global Change Research Program, Washington, DC, 312 pp.

2. Climate Hazards

The Cities of Portland and South Portland are already feeling the local effects of global climate change.

Since 1985, average temperatures in Maine have increased 3°F and precipitation has increased by 13 percent. The Gulf of Maine is warming faster than 99 percent of the world's oceans, and sea levels locally have been rising by 0.07 inches per year since 1912. These climate hazards, including warmer air and water temperatures, bigger storms and more precipitation, as well as sea level rise and ocean acidification are all beginning to take a toll on our infrastructure, communities, health, livelihoods, and ecosystems. These hazards are indicators for how our climate is changing now, and for the impacts climate change will continue to bring.

CLIMATE SCENARIOS

While there is no doubt that Portland and South Portland will continue to see changes in the climate through the end of the century, there is a significant amount of uncertainty in how much change we will see.⁸ In addition to the complexities of climate modeling, it is difficult to predict future greenhouse gas emissions, which depend on whether and how quickly communities globally act to prevent climate change.

We thus use a scenario-based approach to look at the range of potential change. These scenarios, known as Representative Concentration Pathways (RCPs), represent possible futures with different levels of greenhouse gas concentrations in the atmosphere. The following three scenarios (RCPs) are used in the International Panel on Climate Change's Fifth Assessment Report⁹ and the Fourth National Climate Assessment.¹⁰

RCP 2.6: *We all act now and drastically reduce emissions.* This scenario represents significant immediate reductions in greenhouse gas emissions, resulting in “net-negative” emissions (more greenhouse gases being drawn from the atmosphere than released into the atmosphere) by 2100. This scenario results in an increase in global mean temperature of 1.9 to 2.3 degrees Celsius by the years 2081–2100 relative to temperatures in 1850–1900.

RCP 4.5: *We all act now, but reduce emissions at a slower pace.* This scenario represents moderate reductions in greenhouse gas emissions, resulting in the stabilization of global emissions by 2050 and a decrease in global emissions afterwards. This scenario results in an increase in global mean temperature of 2.0 to 3.6 degrees Celsius by the years 2081–2100 relative to temperatures in 1850–1900.

RCP 8.5: *We continue business-as-usual.* This scenario represents continued intensive use of fossil fuels and emission of greenhouse gases. This scenario results in an increase in global mean temperature of 3.2 to 5.4 degrees Celsius by the years 2081–2100 relative to temperatures in 1850–1900.

RCP 2.6 represents the pathway required to remain below an increase of 2 degrees Celsius, which has widely been used as a threshold for limiting more significant impacts from climate change. The Fourth National Climate Assessment, however, focuses on RCP 4.5 and RCP 8.5 as “low” and “high” emissions scenarios, respectively, in order to understand the likely potential range of impact due to climate change. Likewise, those two scenarios are primarily used in this Vulnerability Assessment to understand the potential range of climate impacts Portland and South Portland may face in the next thirty years and through the end of the century.

2.1 Changes in Sea Level, Storm Surge, and Tidal Flooding

SEA LEVEL RISE

Global average sea level has increased by roughly seven to eight inches (16 - 21 cm) since the early 1900s, with almost half of that rise occurring since 1993 as land-based ice has melted and oceans have warmed.¹¹ The National Ocean and Atmospheric Administration (NOAA) has three active tide stations for long-term sea level rise monitoring in Maine, one of which is located in Portland. According to data collected at the Portland tide gauge (Station 8418150), local sea levels have been rising at a rate of 0.07 inches (1.9 millimeters) per year since 1912 (**Figure 2.1**).

The 2018 National Climate Assessment suggests that sea levels will continue to rise, and that the pace will likely quicken.¹² In 2017, NOAA conducted a review of sea level rise literature and provided a range of global and regional

THE GIST

Portland and South Portland will experience more intense and frequent flooding due to sea level rise and storm surge. Certain areas that flood now during heavy storm events will likely experience daily flooding at high tide by the end of the century.

Note: Much of the data and projections in this section are drawn from the report *Bayside Adapts Phase 1: Stormwater and Sewer Gap Analysis*. Further details can be referenced in that report.

sea level rise projections based on the three emissions scenarios listed previously (RCP 2.6, 4.5, and 8.5).¹³ The six global mean sea level (GMSL) rise scenarios include an extreme upper-bound (highest potential sea level rise in 2100), a lower-bound (lowest potential sea level rise in 2100), and four intermediate conditions. **Table 2.1**

Relative Sea Level Rise (Measured at Portland, Maine Tide Gauge)

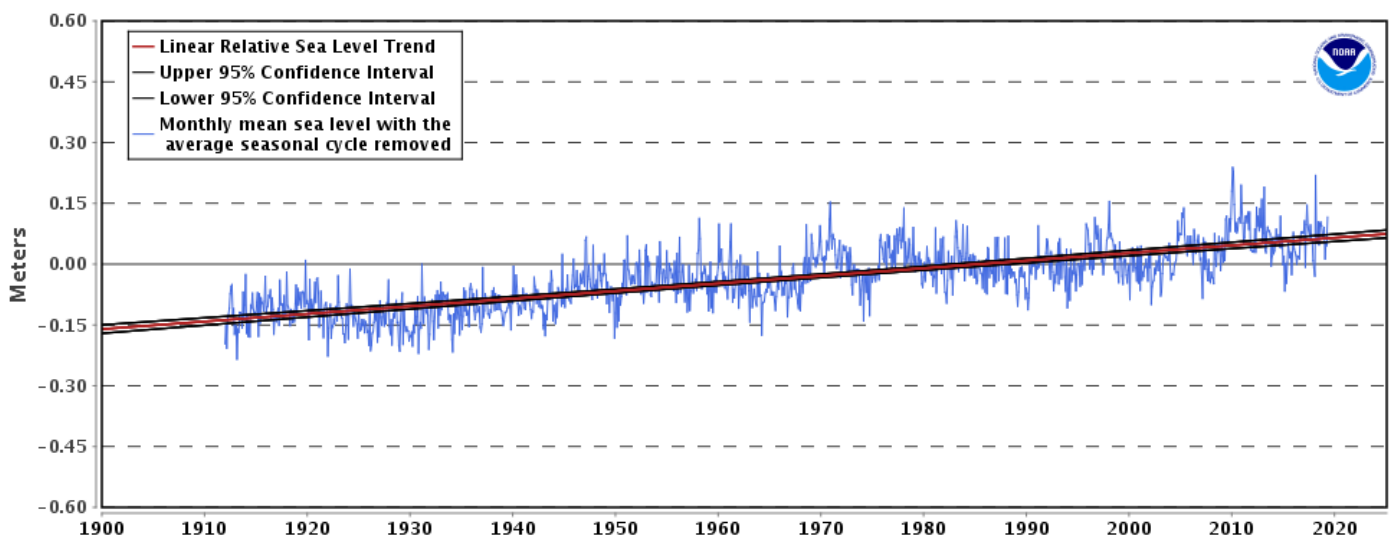


Figure 2.1. The plot shows monthly mean sea level with the regular seasonal fluctuations removed, as well as the long-term linear trend (red line) with its 95% confidence interval. The trend indicates a 1.88 mm per year increase in mean sea level with a 95% confidence interval of ± 0.14 mm per year based on data from 1912 to 2018. Figure source: National Ocean and Atmospheric Administration (NOAA) (2018).²¹

Global Mean Sea Level Rise Scenarios

Scenario	Global Mean Sea Level Rise	Probability of Exceedance
Low	0.3 meters (1 ft)	94 - 100%
Intermediate Low	0.5 meters (1.6 ft)	94 - 96%
Intermediate	1 meters (3.3 ft)	2 - 17%
Intermediate High	1.5 meters (4.9 ft)	0.4 - 1.3%
High	2 meters (6.6 ft)	0.1 - 0.3%
Extreme	2.5 meters (8.2 ft)	0.05 - 0.1%

Table 2.1. Global mean sea level rise scenarios for 2100 with the corresponding probability that sea level rise will exceed the given threshold. The probability is based on the RCP 2.6 to RCP 8.5 scenarios. Table adapted from Bayside Adapts Phase 1 report (2017).²²

summarizes the six global scenarios and, for each, gives the probability that sea levels will surpass that height, based on the three greenhouse gas emissions scenarios. Most notably, NOAA now suggests that a rise in sea level between 2.0 and 2.5 meters is not only plausible but also becoming more likely, based on new research on the instability of the Antarctic Ice Sheet.

Sea level rise will play out differently on a local scale based on a number of factors, including variations in the Earth's gravitational forces, ocean circulation patterns, ice sheet and glacial melt, and vertical movement in the land. To account for this variation, NOAA derived regional relative sea level rises from the global scenarios on a one-degree grid along the US coastline and at tide

gauges, including Portland Station 8418150.¹⁴ **Table 2.2** summarizes the regional relative sea level rise scenarios for 2050 and 2100 for the Greater Portland area, as well as the projections as mean sea level relative to NGVD29 (the cities' preferred vertical datum).¹⁵

With so many potential scenarios, which should we focus on? NOAA provides guidance on choosing planning thresholds based on the likelihood of the scenarios and the level of risk posed. Using this guidance, and referring to the data in **Tables 2.1** and **2.2**, Portland's *Bayside Adapts Phase 1: Stormwater and Sewer Gap Analysis* ("Bayside Adapts") defines "what is most likely to occur" as the intermediate scenario (2-17% probability of exceedance) and "how bad can things

Sea Level Rise Scenarios for Portland and South Portland

Scenario	2050		2100	
	Relative Sea Level Rise (feet)	Mean Sea Level (feet, relative to NGVD29)	Relative Sea Level Rise (feet)	Mean Sea Level (feet, relative to NGVD29)
Low	0.62	1.08	1.12	1.58
Intermediate Low	0.82	1.28	1.53	2.00
Intermediate	1.48	1.94	3.84	4.30
Intermediate High	2.16	2.63	6.00	6.46
High	2.95	3.41	8.72	9.19
Extreme	3.38	3.84	10.79	11.25

Table 2.2. Sea level rise scenarios for 2050 and 2100 in Portland and South Portland. Columns two and four report the regional relative sea level rise (i.e., the magnitude of change) in feet derived by NOAA²³ for Portland, Maine. Columns three and five report the relative sea level rise converted to mean sea level relative to NGVD29, the cities' preferred vertical datum. The conversion was completed as part of the Bayside Adapts Phase 1: Stormwater and Sewer Gap Analysis, based on the methodology presented by NOAA in Sweet et al. (2017).

Mean Sea Level for Portland and South Portland

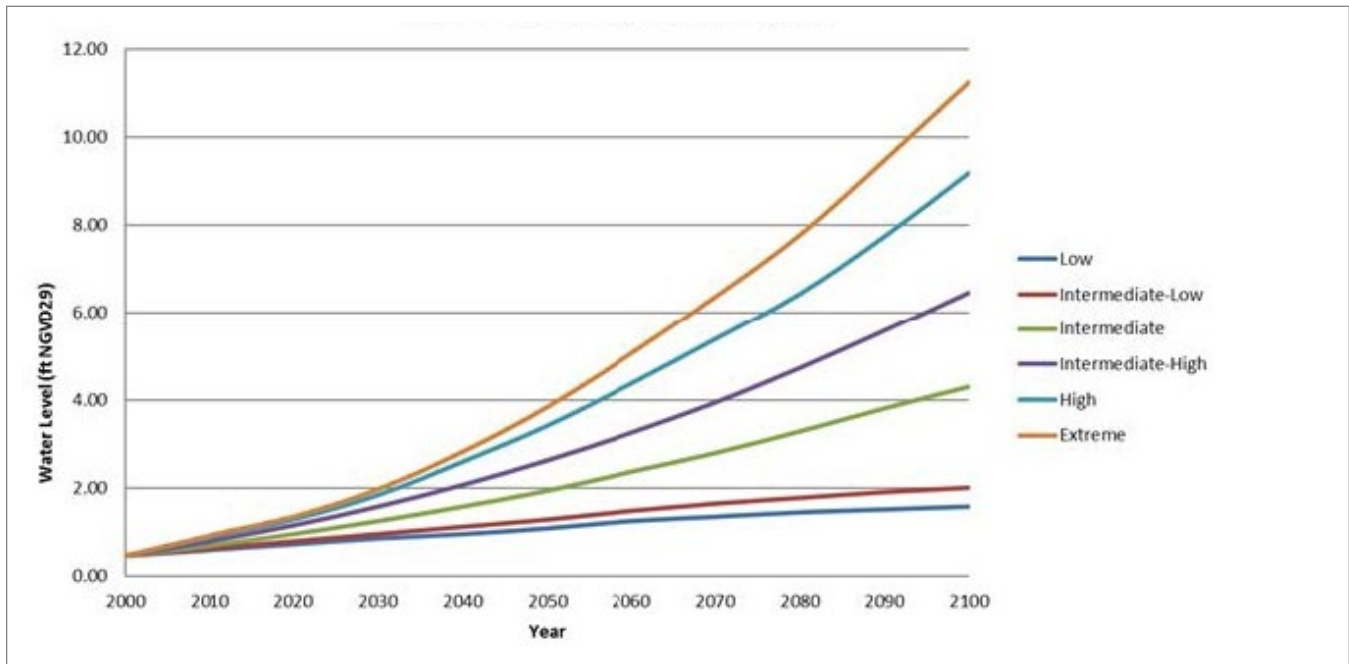


Figure 2.2. Mean sea level over the course of the century, based on Low to Extreme emissions scenarios for Portland and South Portland. Predicted water levels are in feet, relative to NGVD29. Figure source: Bayside Adapts Phase 1 report (2017).²⁴

get” as the extreme scenario (0.05 to 0.1% probability of exceedance, representing a low probability but high consequence event). These thresholds are based on the characteristics of the regional sea level rise scenarios, not characteristics specific to Portland. Therefore, the same planning thresholds also apply to South Portland. It is recommended that Portland and South Portland commit to managing the intermediate scenario (1.48 feet), but be prepared to manage the extreme scenario (3.38 feet) when considering a 2050 planning horizon (**Table 2.3**).

By 2100, the potential levels of sea level rise across the scenarios deviate from each other quite significantly. *Bayside Adapts* recommends committing to managing the intermediate scenario (3.84 feet) for a 2100 planning horizon, being prepared to manage the high scenario (8.72 feet), and being aware of and monitoring for the extreme scenario (10.79 feet). When planning for worst-case scenarios, it is important to consider these projected increases in sea level on top of the highest astronomical tide.

Sea Level Rise Planning Scenarios for Portland and South Portland

Scenario	Relative Sea Level Rise (feet)	
	2050	2100
Low	0.62	1.12
Intermediate Low	0.82	1.53
Intermediate	1.48 – “Commit to manage”	3.84 – “Commit to manage”
Intermediate High	2.16	6.00
High	2.95	8.72 – “Prepare to manage”
Extreme	3.38 – “Prepare to manage”	10.79 – “Be aware of”

Table 2.3. Sea level rise scenarios for 2050 and 2100 in Portland and South Portland, including recommendations for response in city planning. Table adapted from Bayside Adapts Phase 1 report (2017).

HIGH TIDE FLOODING

Due to sea level rise, Portland and South Portland will likely see more flooding on a more regular basis. Tidal flooding, also known as “sunny day flooding” or “nuisance flooding,” is the temporary inundation of low-lying areas during particularly high tides. Tidal flooding is usually not deep enough to cause significant threats to health, safety, or property, but it often causes road closures, disrupts daily activity, adds strain on sewer and stormwater systems, and can lead to minor property and infrastructure damage.¹⁶

NOAA’s National Weather Service (NWS) has defined a series of thresholds for minor, moderate, and major

flooding that are used for issuing flood advisories. The minor level refers to a likely inconvenience or some public threat, but no property damage; the moderate level refers to the likely inundation of roads and buildings, and the potential need for evacuation to higher elevations; and the major level refers to serious and extensive inundation of roads and property, and the need for significant evacuations to higher elevations.

At the Portland Tide Station (8418150), the minor, moderate, and major flooding thresholds are 7.5, 8.5, and 9.5 feet relative to NGVD29, respectively (or 12, 13, and 14 MLLW). These thresholds correspond to documented nuisance flooding in Portland in the Commercial Street

Historic Nuisance Flooding Inundation in Portland

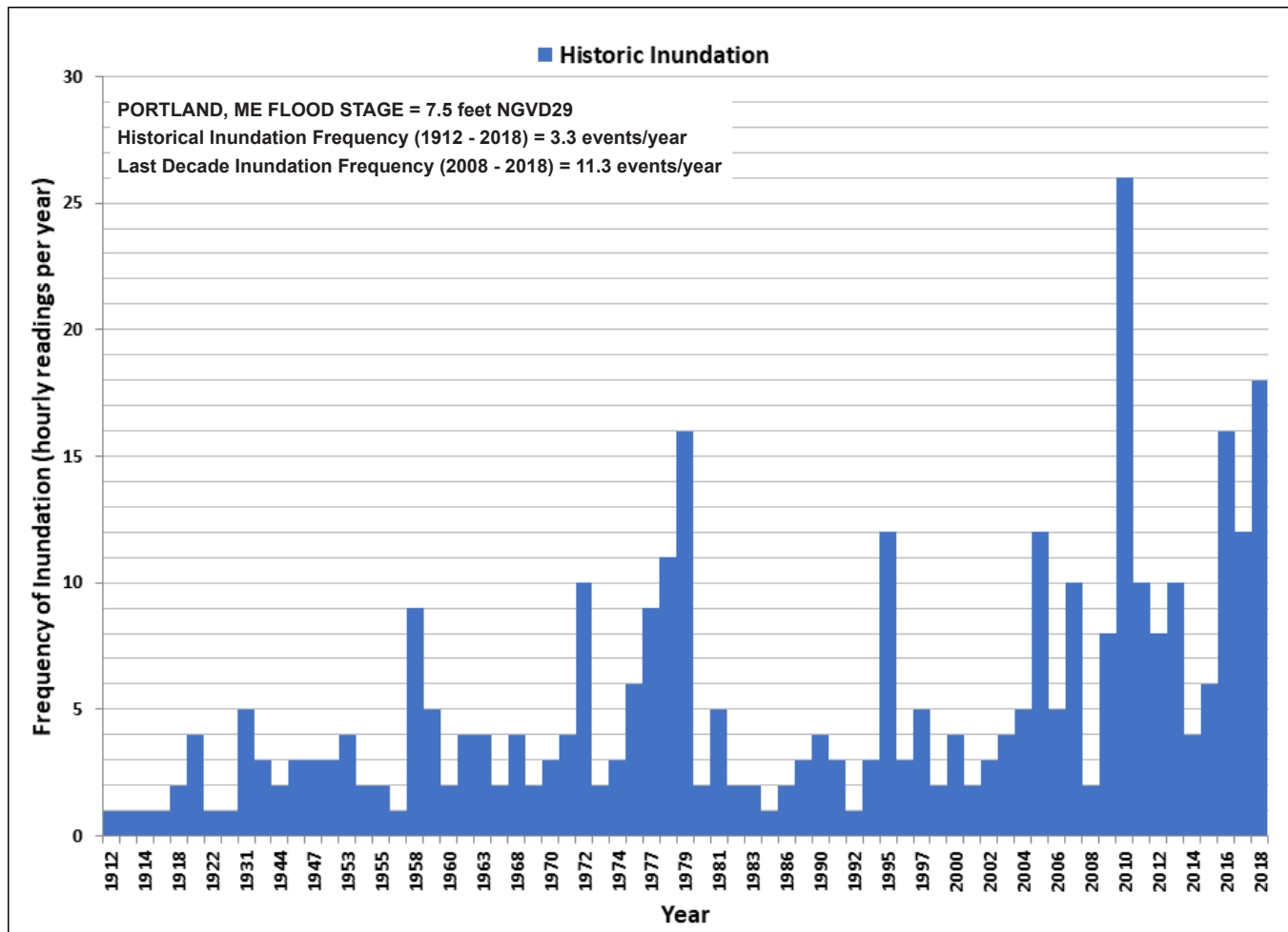


Figure 2.3. The frequency of inundation from nuisance flooding measured in hourly readings per year from 1912 to 2018, based on flood levels at the Portland tide gauge reaching 7.5 feet relative to NGVD29 (12 feet Mean Lower Low Water per NOAA AHPS). Graphic source: Peter Slovinsky, Maine Geological Survey (2019). Portland, ME flood stage from NOAA Advanced Hydrologic Prediction Service; Inundation data from NOAA-COOPS.

and Back Cove areas. To date, South Portland has had minimal coastal flooding, and so corresponding flood thresholds have not yet been defined.

Figure 2.3 shows the frequency of historic inundation from nuisance flooding from 1912 to 2018, based on flood levels at the Portland tide gauge reaching 7.5 feet relative to NGVD29 (the minor flood threshold for Portland). Since 1912, Portland has been flooding 3.3 times per year, on average. Within the last decade, that rate has increased to 11.7 times per year. **Figure 2.4** shows what that frequency of flooding would have looked like with one foot of sea level rise. With only a one-foot increase

in sea level, Portland would have seen nuisance flooding around 50 times per year, and over 130 times per year in the last decade.

Table 2.4 and **Figure 2.5** show what daily high water levels and the highest astronomical tide may look like in 2050 and 2100 under various sea level rise scenarios. Mean Higher High Water (MHHW) is the average height of the highest tide recorded each day during the recording period (the National Tidal Datum Epoch, NTDE) and thus denotes the high water level reached daily. The highest astronomical tide is the highest tide predicted to occur at the station within the NTDE.

Historic Nuisance Flooding Inundation and Inundation with 1 Foot of Sea Level Rise in Portland

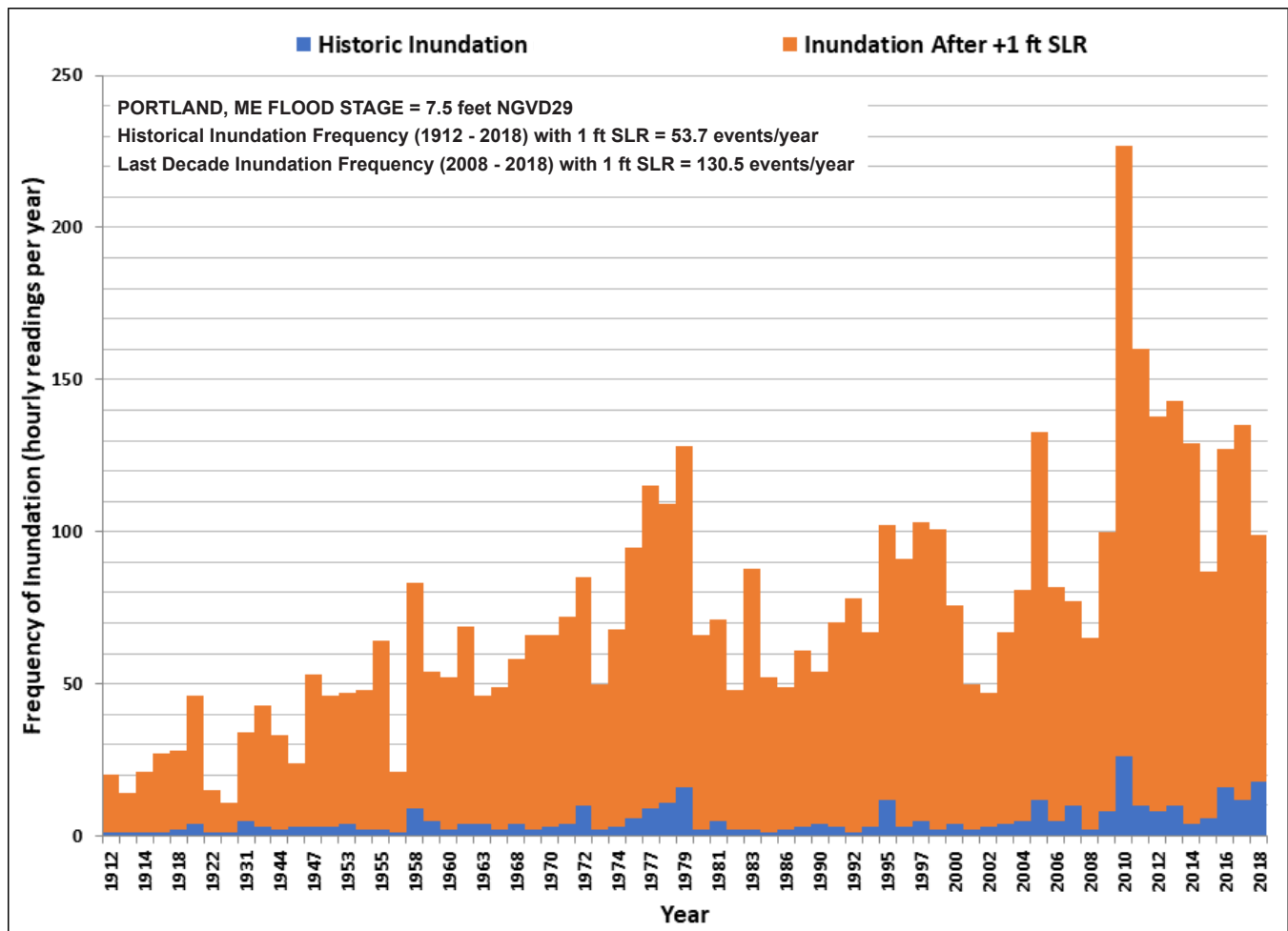


Figure 2.4. The frequency of inundation from nuisance flooding measured in hourly readings per year from 1912 to 2018, based on flood levels at the Portland tide gauge reaching 7.5 feet NGVD29 (12 feet Mean Lower Low Water per NOAA AHPS) (blue), as well as the frequency of historic inundation as it would have occurred over 1912 to 2018 with one foot of sea level rise (orange). Graphic source: Peter Slovinsky, Maine Geological Survey (2019). Portland, ME flood stage from NOAA Advanced Hydrologic Prediction Service; Inundation data from NOAA-COOPs.

Projected Daily High Water Levels and Highest Astronomical Tide

Scenario	2050		2100	
	MHHW (5.38 feet NGVD29)	HAT (7.42 feet NGVD29)	MHHW (5.38 feet NGVD29)	HAT (7.42 feet NGVD29)
Intermediate	6.93	8.97	9.29	11.35
Intermediate High	7.61	9.65	11.45	13.49
High	8.40	10.44	14.17	16.21
Extreme	8.83	10.87	16.24	18.28

YELLOW = Above NWS minor flood threshold (7.5 feet)

ORANGE = Above NWS moderate flood threshold (8.5 feet)

RED = Above NWS major flood threshold (9.5 feet)

Table 2.4. Daily high water (MHHW: Mean Higher High Water) and highest astronomical tide (HAT) projections for 2050 and 2100, based on measurements at the Portland tide gauge. Color designations indicate whether the water level surpasses National Weather Service flood threshold levels for Portland: red indicates major flooding, orange indicates moderate flooding, yellow indicates minor flooding. MHHW and HAT baselines and projections as well as flood threshold values are specified in feet relative to NGVD29. Table adapted from Bayside Adapts Phase 1 report (2017).

Flood Thresholds and Projected Mean Higher High Water

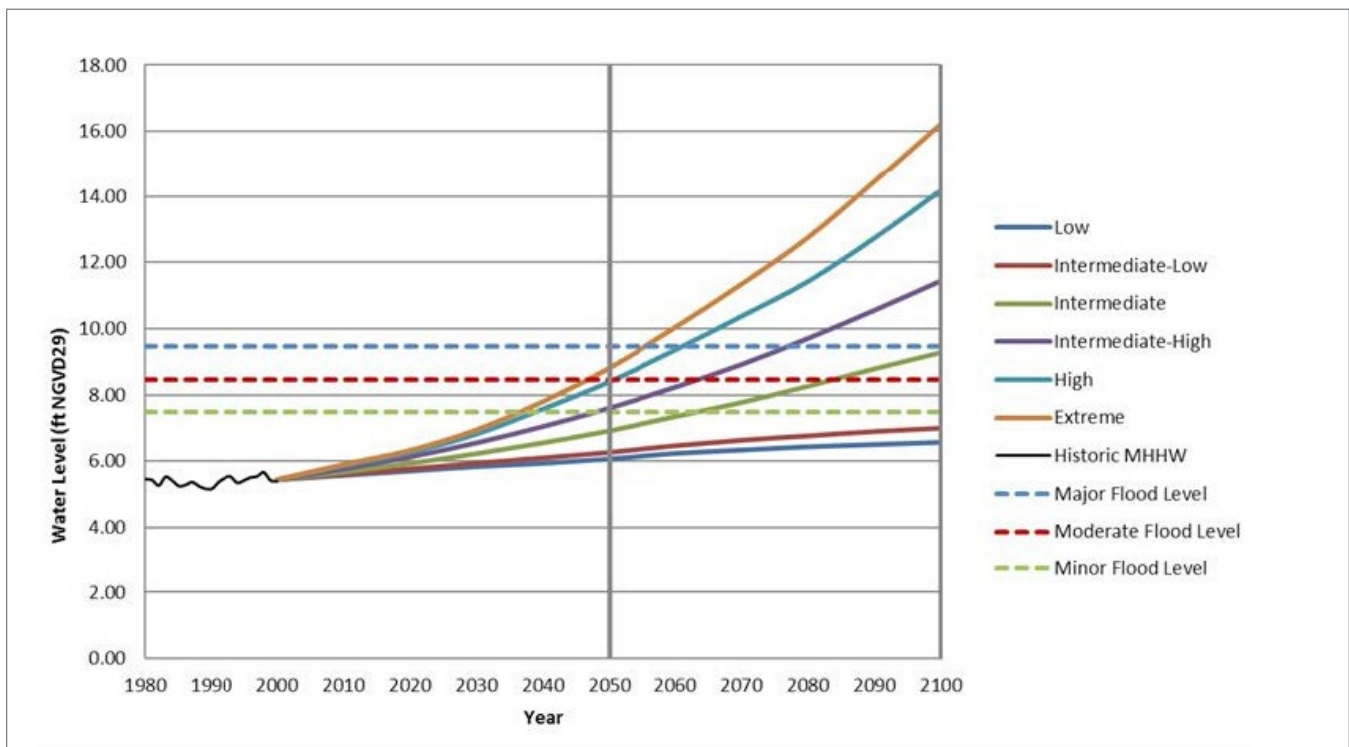


Figure 2.5. Predicted Mean Higher High Water (MHHW) levels from 2000 to 2100 in feet relative to NGVD29 for relative sea level (RSL) rise scenarios for Greater Portland. Dashed lines show major, moderate, and minor flood threshold designations by the NOAA National Weather Service (NWS) for Portland. Figure source: Bayside Adapts Phase 1 report (2017).

The following maps (**Figures 2.6, 2.7, and 2.8**) show potential flooding in Portland and South Portland for the six different scenarios due to sea level rise and/or storm surge on top of the astronomical high tide.¹⁷ All scenarios refer to the inundation we may see in Portland and South Portland by the year 2100.

To achieve the “low” or “low-intermediate” scenarios, we would need to achieve substantial global greenhouse gas emissions reductions (i.e., as aligned with Representative

Concentration Pathways 2.6 and 4.5, respectively).

The “intermediate” scenario represents a case where emissions continue to increase through the end of the century (i.e., as aligned with RCP 8.5). The “extreme” case represents the lowest probability, worst-case scenario (i.e., the upper bound of the model). In the near-term, it is likely that we will see the effects of the “low” scenario by 2030 and the “low-intermediate” scenario by 2050 if we continue on the “business as usual” trajectory.

Extent of Inundation from Projected Sea Level Rise in Portland and South Portland (2100)

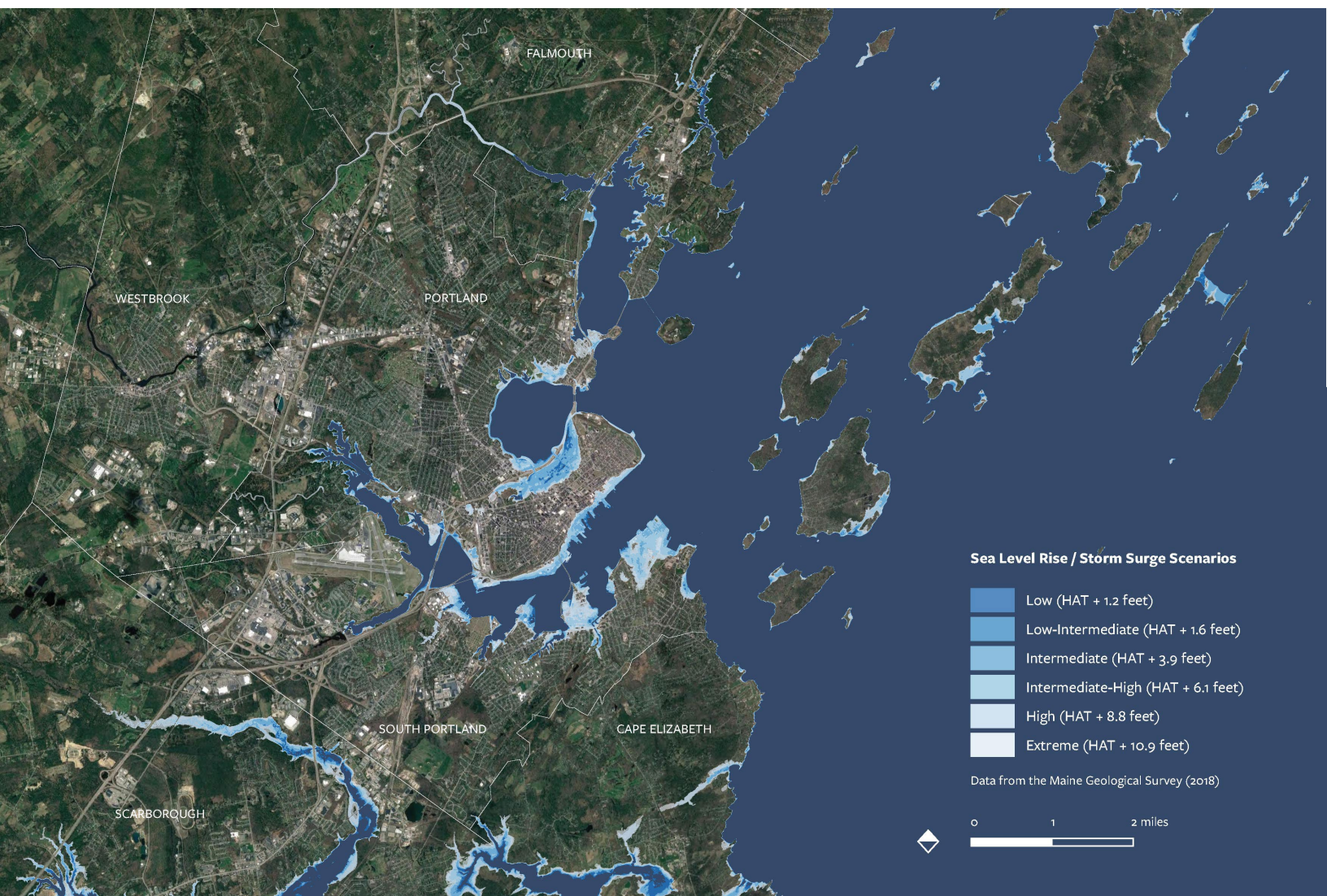


Figure 2.6. Extent of flooding due to sea level rise or storm surge on top of the highest astronomical tide in Portland and South Portland for six scenarios for the year 2100. Scenarios include low, low-intermediate, intermediate, intermediate-high, high, and extreme sea level rise at the 50% confidence interval. Data source: Maine Geological Survey Sea Level Rise/Storm Surge Data (2018).²⁵

Waterfront Inset: Sea Level Rise Scenarios (2100)

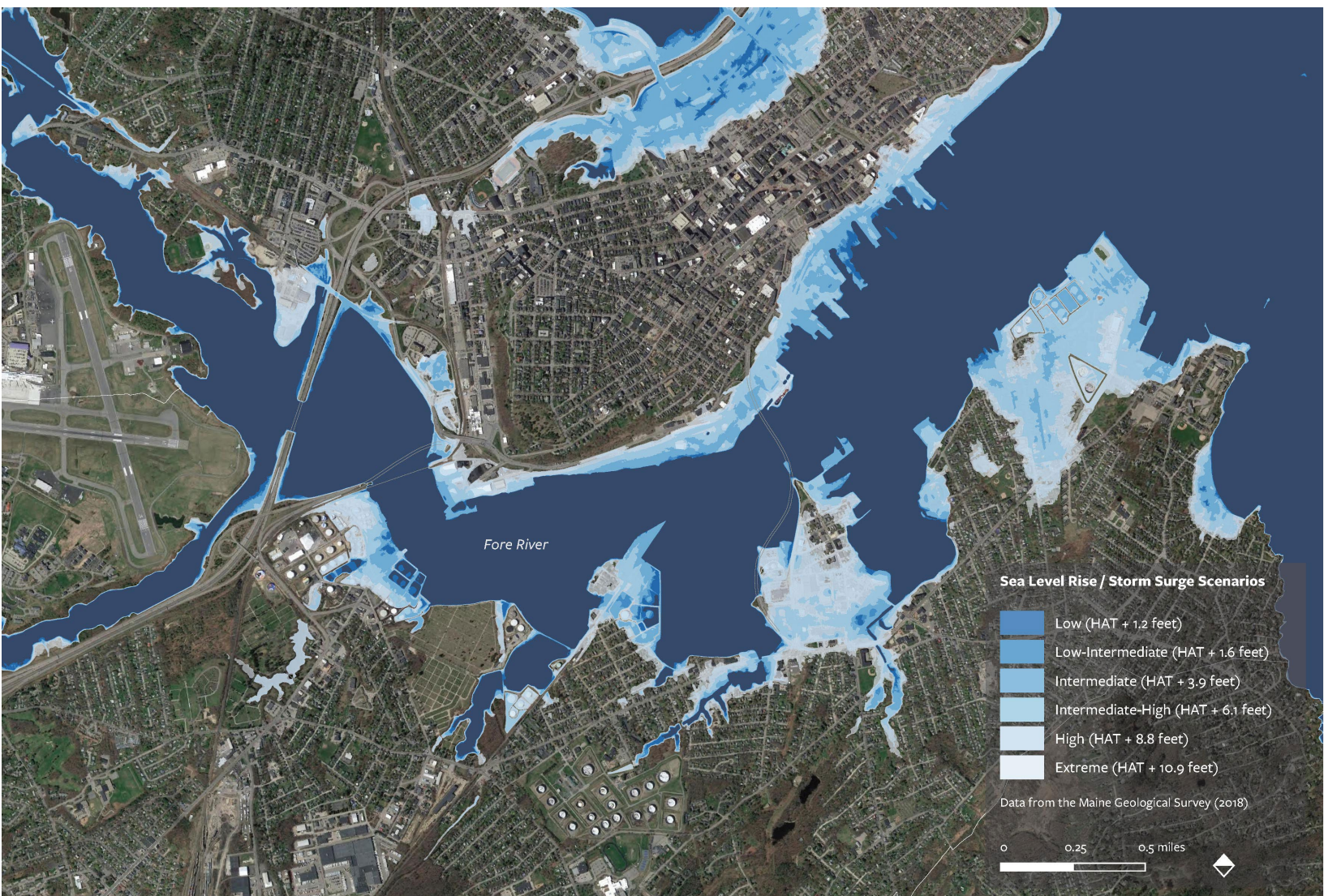


Figure 2.7. Extent of flooding along the Portland and South Portland waterfronts due to sea level rise or storm surge on top of the highest astronomical tide for six scenarios for the year 2100. Data source: Maine Geological Survey Sea Level Rise/Storm Surge Data (2018).

STORM SURGE

Storm surge is the temporary increase in water levels above predicted astronomical tides due to atmospheric pressure changes and strong winds from storms. The *storm tide* specifies the increase in water level from both storm surge and the astronomical tide. As climate change is projected to bring greater storm intensity, sea level rise and potentially greater storm surge compound to create even higher water levels and greater flood risk.

Through the 2015 North Atlantic Comprehensive Coast Study (NACCS), the U.S. Army Corps of Engineers

(USACE) characterized the impact of future storm hazards along the North Atlantic Coast by simulating winds, waves, and water levels based on 1,050 synthetic tropical storms and 100 historical extratropical storms, applied to 96 random tide phases. **Table 2.5** summarizes the 10-year, 20-year, 100-year, and 500-year return period storm tide levels at three of the NACCS stations based in Portland and South Portland and indicates how those are projected to change by 2050 under various sea level rise scenarios. **Table 2.6** summarizes the same information for 2100.

Waterfront Inset: Sea Level Rise Scenarios (2100)

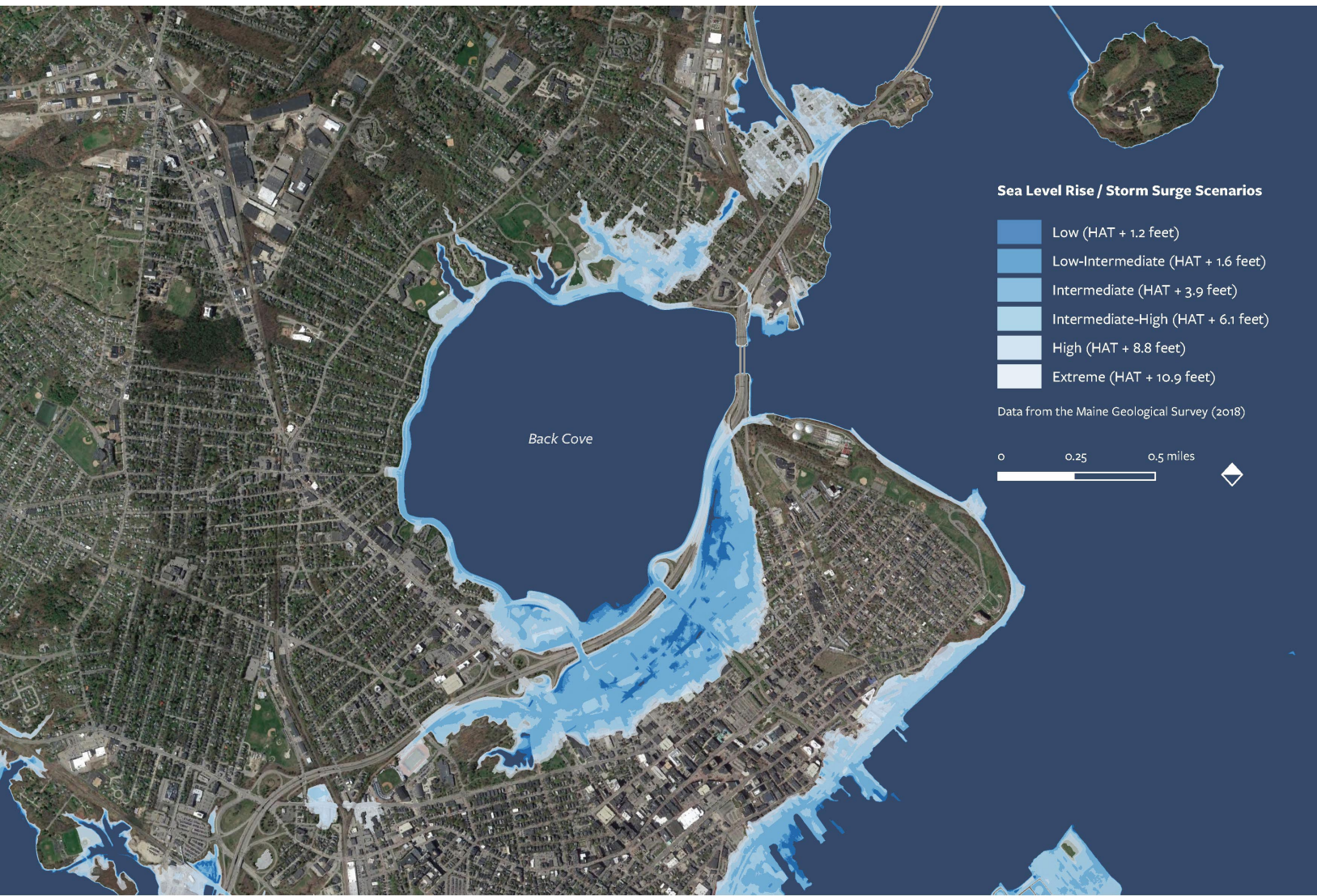


Figure 2.8. Extent of flooding in the Back Cove area of Portland due to sea level rise or storm surge on top of the highest astronomical tide for six scenarios for the year 2100. Data source: Maine Geological Survey Sea Level Rise/Storm Surge Data (2018).

For reference, the Blizzard of 1978 was representative of the 100-year water level for Greater Portland.¹⁸ During that storm, water levels reached 9.6 feet NGVD29, the highest values ever recorded at the Portland Tide Station by almost 0.9 feet. Under the Intermediate sea level rise scenario, similar water levels are projected to occur at a ten-year return period—in other words, ten times as frequently as they currently do today.

Although there is no scientific certainty as to whether climate change will impact the frequency of hurricanes, a number of studies point to the ways climate change will

increase their intensity.¹⁹ Warmer surface waters produce heat and water vapor, which fuel hurricane intensity, and warmer air temperatures can hold more of that available moisture, leading to higher levels of precipitation. These effects are combined with the impact of sea level rise, mentioned above, which amplifies the inland impacts of storm tides. According to NOAA, Maine has been hit by nine hurricanes, with five of those making landfall. All five have been either a category 1 or 2.²⁰

See **Appendix B** for maps of potential inundation from hurricane surge for hurricane categories 1-4.

Storm Surge Applied to Mean Sea Level Rise Scenarios for 2050

NACCS Station	Water Level Return Period	Storm Tide Water Level (Feet)	Storm Tide Water Level with Sea Level Rise (2050)			
			Intermediate Scenario 1.94 MSL, feet NGVD29	Intermediate-High Scenario 2.63 MSL, feet NGVD29	High Scenario 3.41 MSL, feet NGVD29	Extreme Scenario 3.84 MSL, feet NGVD29
Station 7047 (Maine State Pier)	10-year	7.81	9.75	10.43	11.22	11.65
	20-year	8.17	10.11	10.79	11.58	12.01
	100-year	8.89	10.83	11.52	12.30	12.73
	500-year	9.55	11.48	12.17	12.96	13.39
Station 7222 (Veteran's Memorial Bridge)	10-year	7.87	9.81	10.50	11.28	11.71
	20-year	8.27	10.21	10.90	11.68	12.11
	100-year	9.06	11.00	11.69	12.47	12.90
	500-year	9.84	11.78	12.47	13.25	13.68
Station 7221 (Back Cove)	10-year	8.04	9.97	10.66	11.45	11.88
	20-year	8.73	10.66	11.35	12.14	12.57
	100-year	10.73	12.67	13.35	14.14	14.57
	500-year	11.45	13.39	14.08	14.86	15.29

Storm Surge Applied to Mean Sea Level Rise Scenarios for 2100

NACCS Station	Water Level Return Period	Storm Tide Water Level (Feet)	Storm Tide Water Level with Sea Level Rise (2100)			
			Intermediate Scenario 4.3 MSL, feet NGVD29	Intermediate-High Scenario 6.46 MSL, feet NGVD29	High Scenario 9.19 MSL, feet NGVD29	Extreme Scenario 11.25 MSL, feet NGVD29
Station 7047 (Maine State Pier)	10-year	7.81	12.11	14.27	16.99	19.06
	20-year	8.17	12.47	14.63	17.35	19.42
	100-year	8.89	13.19	15.35	18.08	20.14
	500-year	9.55	13.85	16.01	18.73	20.80
Station 7222 (Veteran's Memorial Bridge)	10-year	7.87	12.17	14.33	17.06	19.12
	20-year	8.27	12.57	14.73	17.46	19.52
	100-year	9.06	13.36	15.52	18.25	20.31
	500-year	9.84	14.14	16.30	19.03	21.09
Station 7221 (Back Cove)	10-year	8.04	12.34	14.50	17.22	19.29
	20-year	8.73	13.03	15.19	17.91	19.98
	100-year	10.73	15.03	17.19	19.91	21.98
	500-year	11.45	15.75	17.91	20.64	22.70

Tables 2.5 (top) and 2.6 (bottom). Extreme water levels as derived from the NACCS Study for three stations in Portland and South Portland, combined with mean sea level scenarios for 2050 (top) and 2100 (bottom). Storm tides are relative to MSL. Note that storm tide water levels are highest at the Back Cove station, followed by the Veteran's Memorial Bridge station (located on the South Portland side of the bridge), followed by the Maine State Pier station. Storm tide water levels were also examined for NACCS stations located further out in Casco Bay east of Bug Light and Spring Point; water levels at these sites were lower and within an inch of those reported for the Maine State Pier station. Note that for simplicity these values assume that sea level rise and storm tides can be added; however, in some locations the actual effect on storm surge is non-linear due to local coastal geomorphology.²⁶

2.2 Changes in Precipitation and Storm Patterns

TOTAL PRECIPITATION

As the climate changes, warming ocean surface temperatures lead to higher levels of evaporation and greater moisture in the air—contributing to more precipitation and extreme weather events.²⁷ The average amount of precipitation that Maine sees in a year has increased six inches (13 percent) since 1895.²⁸ **Figure 2.9** illustrates the increase in precipitation specifically in the Greater Portland area over the past 40 years.

This trend is expected to continue, with precipitation in the Portland area projected to increase by 4–5 percent from current totals (defined by a time period from 1995–2014) by 2050.²⁹ **Figure 2.10** shows the total amount of precipitation expected for Portland and South Portland through 2100. Most of the increase is expected to come in the winter and spring, with precipitation in the summer and fall staying relatively constant.³⁰ See **Figure 2.11**

THE GIST

Portland and South Portland will experience more precipitation on a yearly basis, as well as greater storm intensity. In other words, more precipitation will fall in shorter periods of time, causing strain on stormwater systems and increasing the risk from flooding.

Note: Much of the data and projections in this section are drawn from the report *Bayside Adapts Phase 1: Stormwater and Sewer Gap Analysis*. Further details can be referenced in that report.

for projected change in winter precipitation. Graphs for all seasonal precipitation projections are included in **Appendix C**.

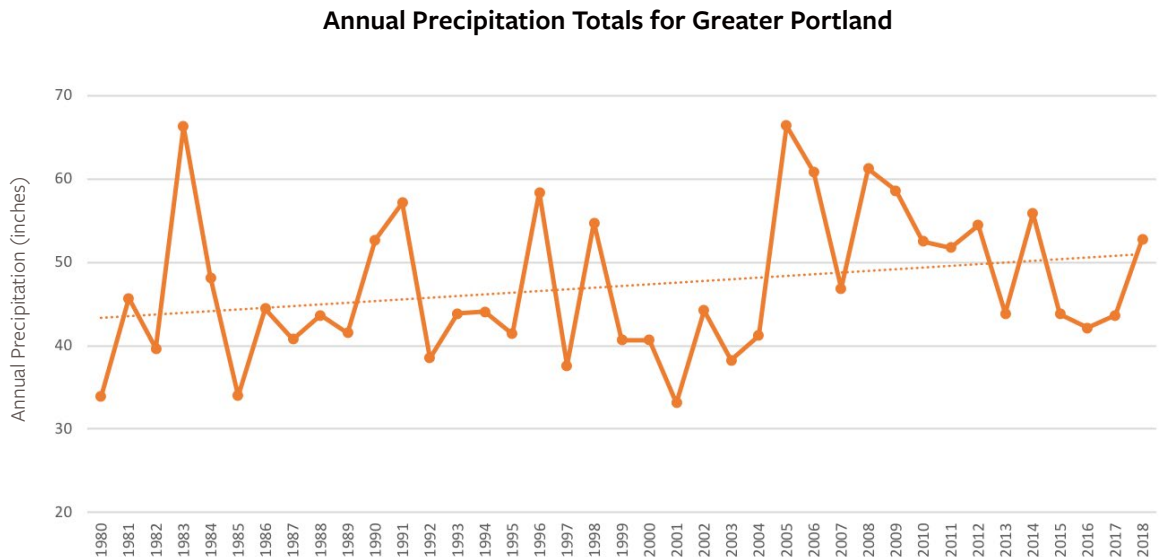


Figure 2.9. Annual precipitation totals from 1980 to 2018, as measured at the Portland International Jetport National Weather Service (NWS) weather station (the National Weather Service forecast area for both Portland and South Portland). The linear trend line fit to the data indicates an increase in total annual precipitation over the last forty years. Data source: NOAA Online Weather Data (NOWData).³⁴

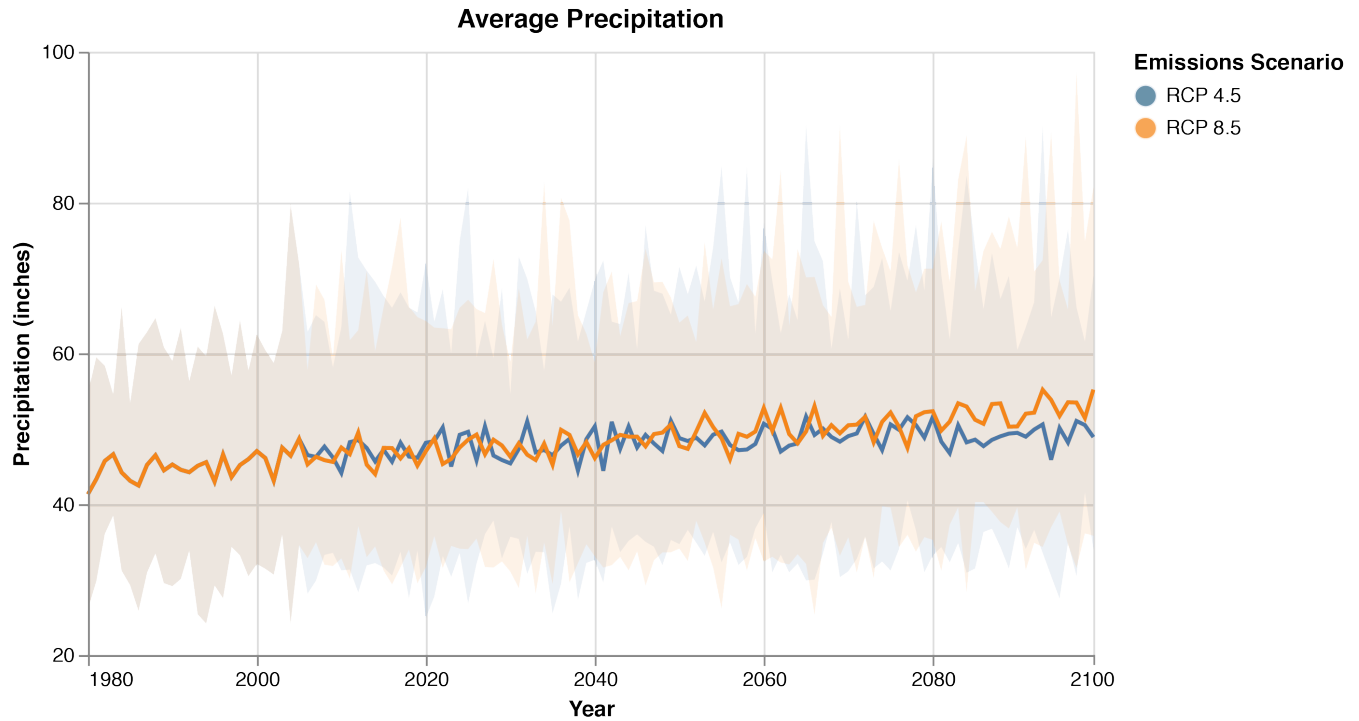


Figure 2.10. Historical simulations (1980–2005) and future projections (2006–2099) in annual averages of precipitation for Portland and South Portland. The orange line represents the business-as-usual high greenhouse gas emissions scenario (RCP 8.5), while the blue line represents a low emissions scenario (RCP 4.5). Average annual precipitation is expected to increase under both scenarios with relatively minimal difference between the scenarios through 2080. Data source: Earth System Research Center/EOS, University of New Hampshire (2019).³⁵

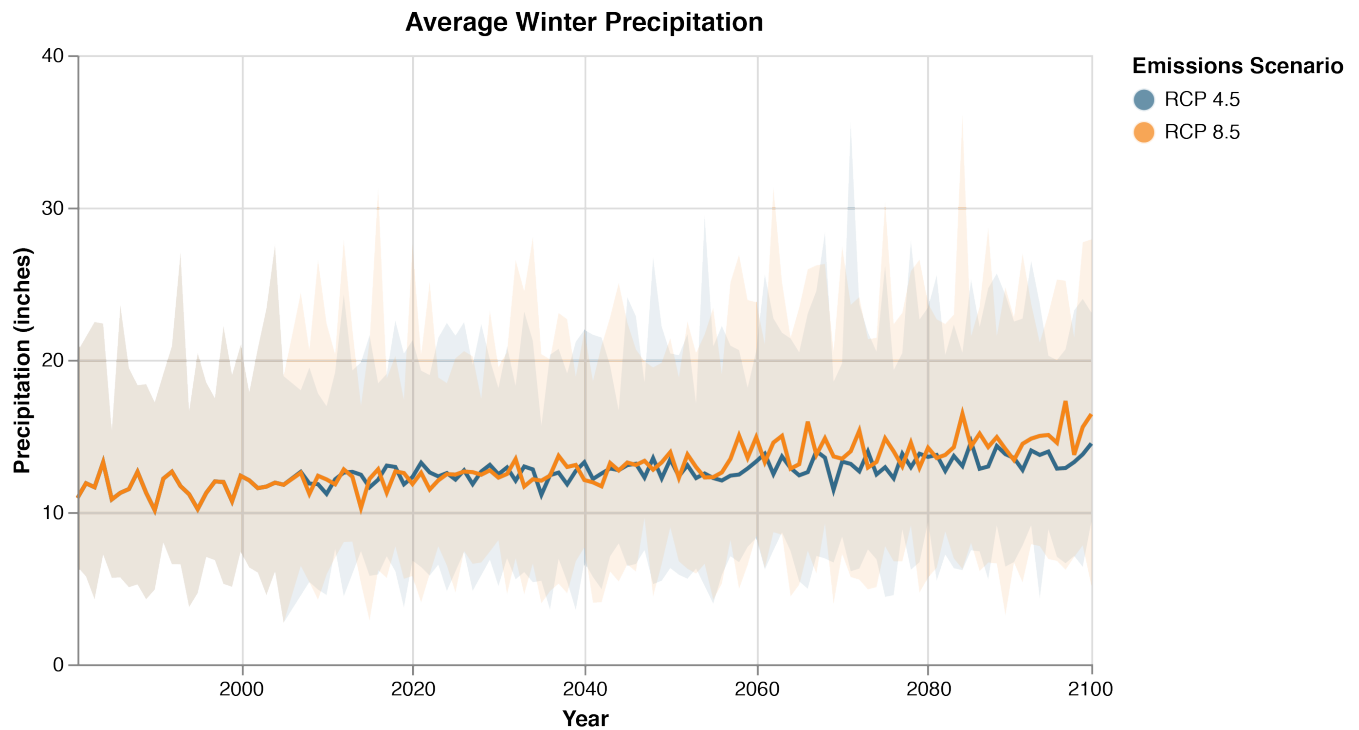


Figure 2.11. Historical simulations (1980–2005) and future projections (2006–2099) in annual averages of winter precipitation for Portland and South Portland. The orange line represents the business-as-usual high greenhouse gas emissions scenario (RCP 8.5), while the blue line represents a low emissions scenario (RCP 4.5). Although there is little difference between the two scenarios in the first half of the century, the two scenarios begin to deviate after 2050. Data source: Earth System Research Center/EOS, University of New Hampshire (2019).³⁶

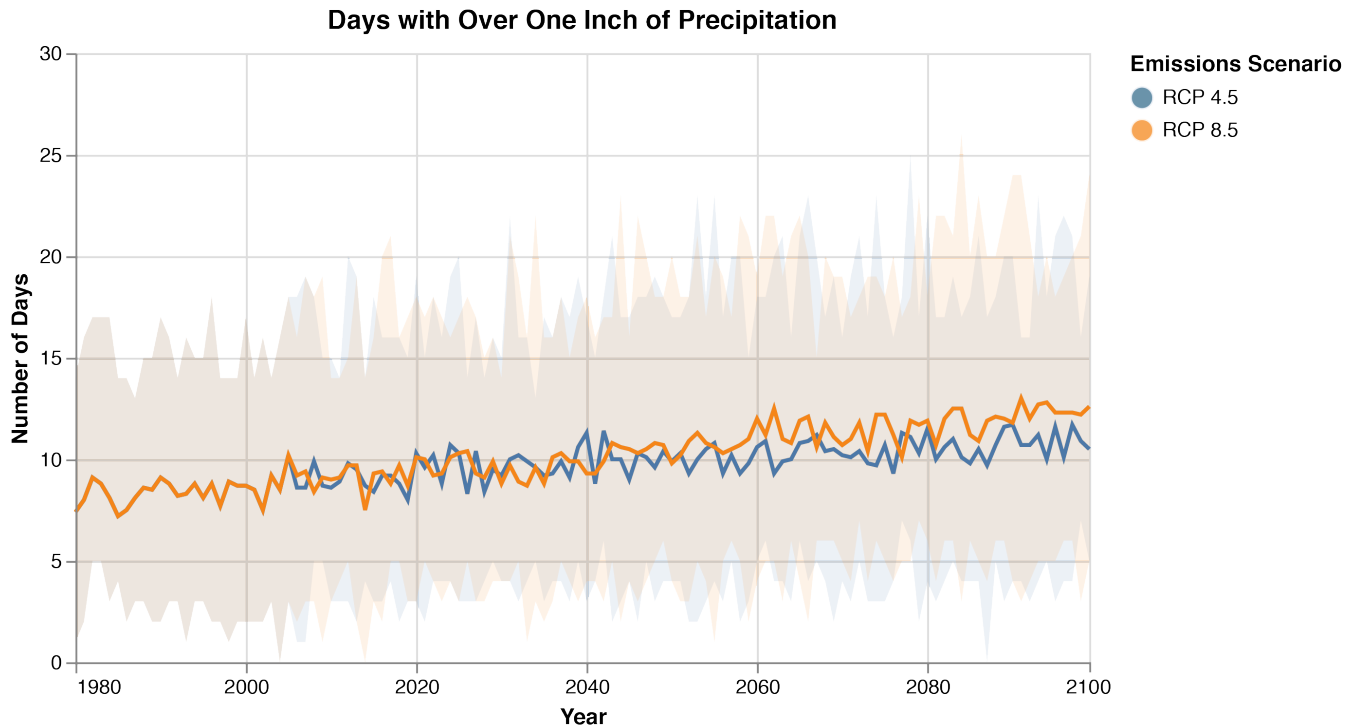


Figure 2.12. Historical simulations (1980–2005) and future projections (2006–2099) for the number of days per year with greater than one inch of precipitation in Greater Portland. The orange line represents the business-as-usual high greenhouse gas emissions scenario (RCP 8.5), while the blue line represents a low emissions scenario (RCP 4.5). Although there is little difference between the two scenarios in the first half of the century, the two scenarios begin to deviate after 2050. Data source: Earth System Research Center/EOS, University of New Hampshire (2019).³⁷

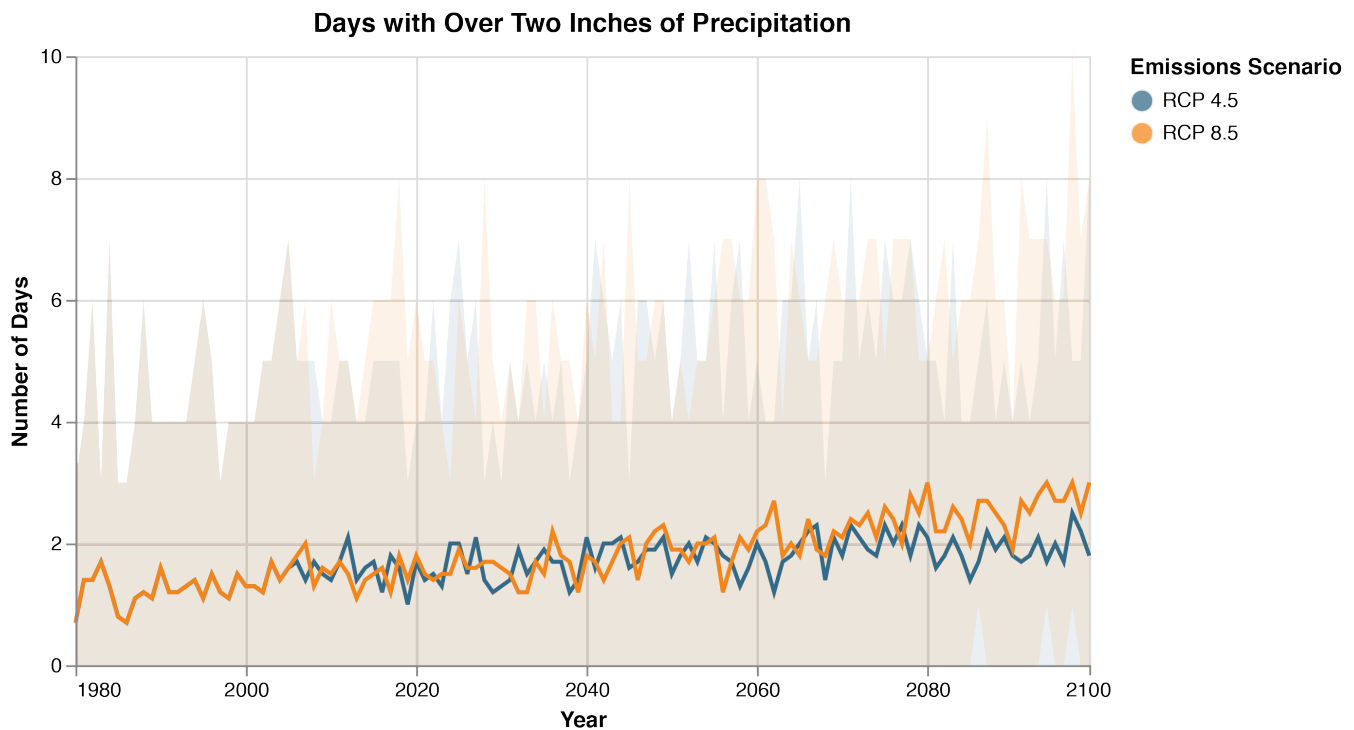


Figure 2.13. Historical simulations (1980–2005) and future projections (2006–2099) for the number of days per year with greater than two inches of precipitation in Greater Portland. The orange line represents the business-as-usual high greenhouse gas emissions scenario (RCP 8.5), while the blue line represents a low emissions scenario (RCP 4.5). Data source: Earth System Research Center/EOS, University of New Hampshire (2019).³⁸

STORM INTENSITY

Not only is the amount of precipitation increasing, but so is the intensity of precipitation events. Between 1958 and 2010, the northeastern United States has seen a 70 percent increase in the amount of precipitation occurring in very heavy rain events (defined as the heaviest 1 percent of all daily events).³¹ Communities in coastal Maine have seen larger increases in total precipitation and extreme precipitation events (greater than two inches of rain in 24 hours) than inland Maine due to the area's closer proximity to Atlantic storm tracks.³²

Figures 2.12 and 2.13 show the projected increase in the number of days per year that receive over one inch and over two inches of precipitation, respectively, for two different greenhouse gas emission scenarios for the Greater Portland area.

The historic and projected precipitation totals for a 24-hour storm for various recurrence intervals are summarized in **Table 2.7**.³³ A recurrence interval, also known as the return period, is the time between two storms of a particular magnitude, estimated through statistics. For example, a significant storm with five inches of precipitation within 24-hours has historically been likely to occur every ten years, as shown in **Table 2.7**. However, by 2100, a storm of that magnitude is roughly equivalent to the five-year storm. In other words, a storm of that size is likely to occur twice as frequently by 2100.

Figure 2.14 further illustrates how the historic 25-year 24-hour storm event is expected to be equivalent to the 16-year storm event in 2050 and to the 13-year in 2100. Likewise, the historic 100-year 24-hour storm is expected to be equivalent to the 52-year in 2050 and to the 42-year in 2100.

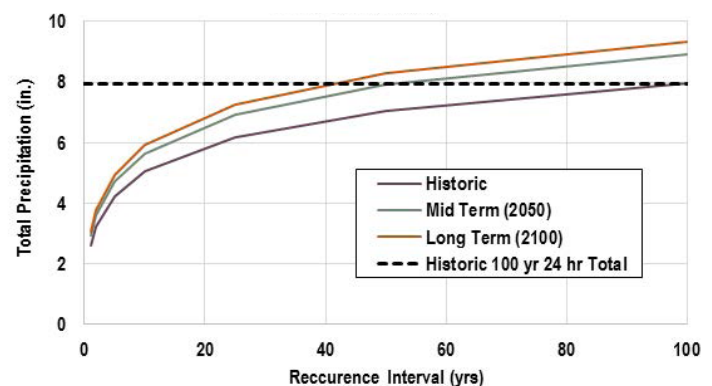
24-Hour Storm Event Precipitation Totals for Historic and Future Recurrence Intervals [Table]

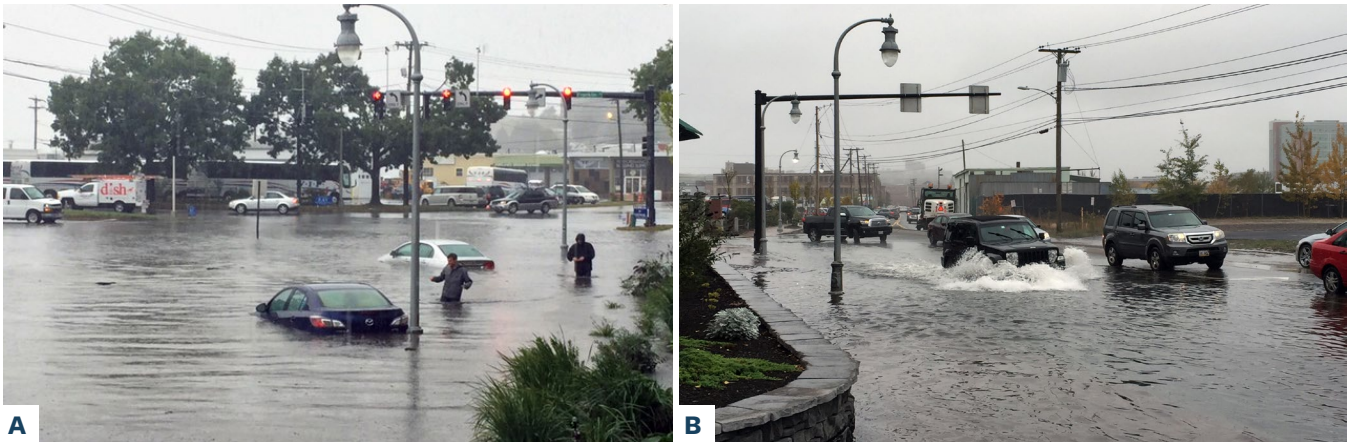
Average Recurrence Interval (ARI) (years)	24-Hour Precipitation Totals (inches)		
	Historic	Mid-Term (2050)	Long-Term (2100)
1	2.62	2.93	3.07
2	3.23	3.62	3.79
5	4.22	4.73	4.95
10	5.05	5.66	5.92
25	6.19	6.93	7.26
50	7.07	7.92	8.29
100	7.95	8.90	9.32

Table 2.7. Historic and projected precipitation totals for a 24-hour storm for various recurrence intervals. Table adapted from Bayside Adapts Phase 1 report (2017).

24-Hour Storm Event Precipitation Totals for Historic and Future Recurrence Intervals [Figure]

Figure 2.14. Precipitation totals for the 24-hr storm event for various recurrence intervals for historic (purple), mid-term (green), and long-term (red) timeframes. The precipitation total for the historic 100-year 24-hour storm (black dashed line) is marked to show how a storm of that magnitude will likely occur at increasing frequencies by 2050 and 2100. Figure source: Bayside Adapts Phase 1 report (2017).





A: Flooding at the intersection of Somerset and Franklin (Portland) during the September 30, 2015 rain event in which 4.8" of rain fell in six hours on top of an 11.6 foot tide and 0.5 feet of surge. Image from Cameron Adams, Maine Geological Survey. **B:** Flooding on Somerset Street (Portland) during the King Tide on October 19, 2016. Image by Abbie Sherwin, Maine Geological Survey / Maine Coastal Program. These images highlight some of the already recurring flooding in Portland, and what the future might hold when all factors combine. South Portland is not currently seeing this level of flooding, but will likely see increasing pressure on its stormwater system and areas along the coast as storm intensity and sea levels continue to rise.

TYPE OF PRECIPITATION

Due to rising temperatures, precipitation in Maine is increasingly falling as rain instead of snow. Since 1895, average annual snowfall in Maine has decreased by about one inch (6.6%) (**Figure 2.15**), and the snowpack duration has decreased by two weeks over the past century.³⁹

The state is expected to see further decreases in total snowfall accumulation, with coastal communities seeing the most significant decreases around 40 percent.⁴⁰ Likewise, the snowpack duration in the state is projected to decrease by another two weeks by 2050. Despite these trends, extreme snowfall events such as strong nor'easters are likely to increase in frequency.

DROUGHT

Although drought risk in Maine is much lower than nearly every other state in the United States, the risk increases with climate change. Despite projections suggesting that average annual precipitation will increase in the coming years, the increase is likely to be more consolidated in the winter and spring. Summer and fall, on the other hand, may have increasing seasonal drought risk. Summer drought threat considers the average monthly soil moisture projections for July, August, and September, and a widespread summer drought is when at least 30 percent of the state's soil is drier than usual. Projections suggest that Maine could see a 70 percent increase in threat from widespread summer drought by 2050.⁴¹

Total Annual Snowfall in Maine (1895-2014)

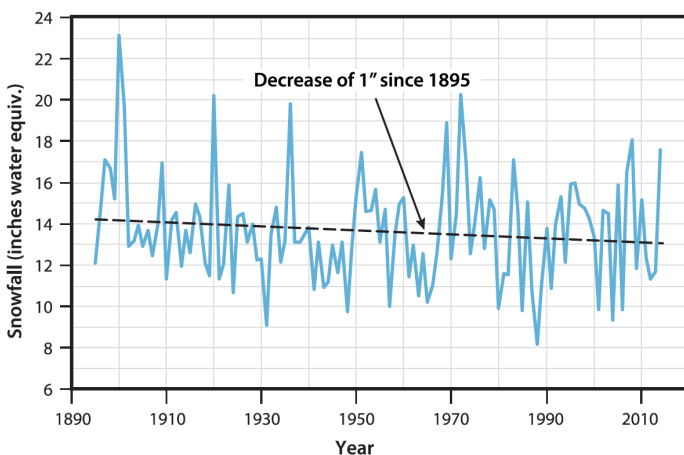


Figure 2.15. Total annual snowfall in Maine from 1895-2014. The linear trend (black dashed line) indicates that snowfall decreased approximately 1.0 inches (6.6%) during the recording period. Figure source: Maine's Climate Future: 2015 Update (2015).

2.3 Changes in Air Temperatures

AVERAGE TEMPERATURES

Average annual temperatures across Maine have increased 3°F since 1895 (**Figure 2.16**).⁴² Along the coast, temperatures are expected to continue to increase another 3.5–4°F by 2050.⁴³ **Figure 2.17** shows the projected increase in maximum annual temperature for a low greenhouse gas emissions scenario (blue) and high scenario (orange) for Greater Portland. Temperature projections remain relatively similar for the two scenarios through 2050, at which point they begin to diverge substantially through 2100.

With this increase in temperature, Maine's seasons are already shifting. Between the 1900s–2000s, Maine's "warm season" (when the average daily temperature is above freezing) increased by two weeks.⁴⁴ According to global climate models, the warm season will likely increase by two more weeks by 2050 (**Figure 2.18**).

To date, Maine's winters have been warming faster than summers. Downscaled climate models for the Portland area, however, indicate that the rate of change will increase for summers, particularly under a business-as-usual, high emissions scenario. See **Appendix C** for projected seasonal temperature changes for the Portland area.

Figure 2.19 illustrates how the annual number of days below freezing in the Portland area has been decreasing since the 1970s and is predicted to continue to decrease through the end of the century. Again, projections show a low greenhouse gas emissions scenario (blue) and high scenario (orange).

THE GIST

Portland and South Portland will experience warmer average temperatures over the course of the century, including more days of extreme heat and fewer days below freezing. Extreme heat can cause severe health complications, while fewer days below freezing are leading to increases in rates of pest outbreaks and vector-borne diseases, like Lyme disease.

Average Annual Temperature in Maine (1895 - 2014)

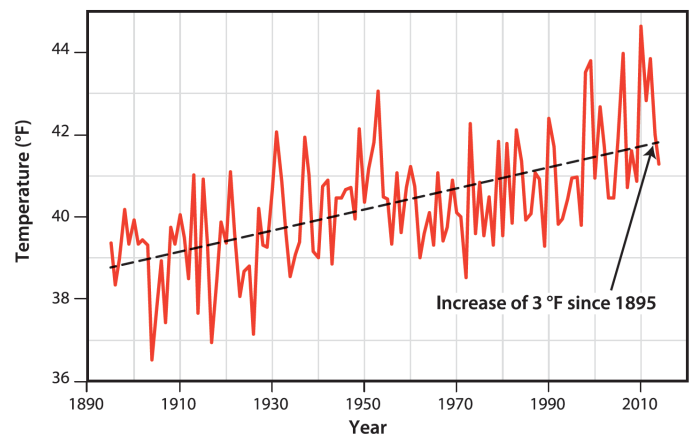


Figure 2.16. Average annual temperatures in Maine from 1895–2014. The linear trend (black dashed line) indicates that temperatures have increased approximately 3.0°F during the recording period. Figure source: Maine's Climate Future: 2015 Update (2015).

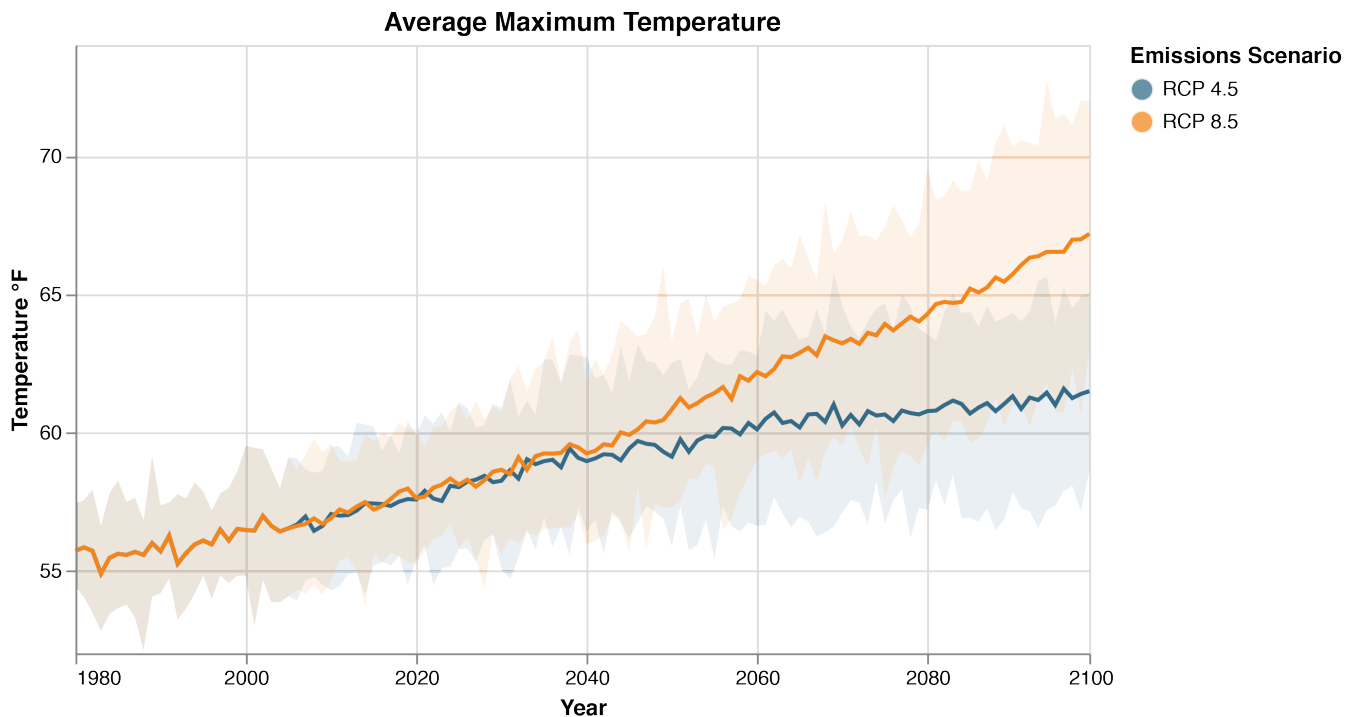


Figure 2.17. Historical simulations (1980–2005) and future projections (2006–2099) for average maximum temperature in Greater Portland. The orange line represents the business-as-usual high greenhouse gas emissions scenario (RCP 8.5), while the blue line represents a low emissions scenario (RCP 4.5). See the appendix for a similar graph of the change in average minimum temperature. Data source: Earth System Research Center/EOS, University of New Hampshire (2019).⁴⁶

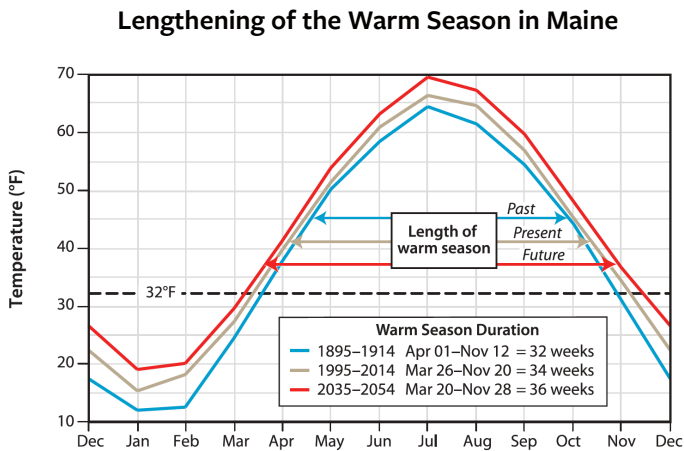


Figure 2.18. Mean monthly temperature for historical (1895–1914), recent (1995–2014), and future (2035–2054) time periods, averaged across Maine. The warm season (defined as when average daily temperature is above freezing) has increased two weeks since the historical period and is predicted to increase two more weeks by 2050. Figure source: Maine's Climate Future: 2015 Update (2015).⁴⁷

EXTREME TEMPERATURES

As temperatures warm, Maine is also seeing more days of extreme heat where temperatures exceed 90°F and 95°F. The combination of heat and high relative humidity can make a hot day feel even hotter. The heat index is therefore a measure that combines heat and relative humidity to give a sense of how hot a day feels. The Portland area has historically experienced four high-heat days a year where the heat index reaches over 95°F. The number of days is expected to reach 13.5 by 2050.⁴⁵

Figures 2.20 and 2.21 show the projected increase in the number of days above 90°F and 95°F, respectively, for a low greenhouse gas emissions scenario (blue) and high scenario (orange) for the Greater Portland area. Whereas the hottest day of the year for the Portland area has historically been around 95°F, the hottest day will likely reach temperatures closer to 100–108°F by 2100 (**Figure 2.22**).

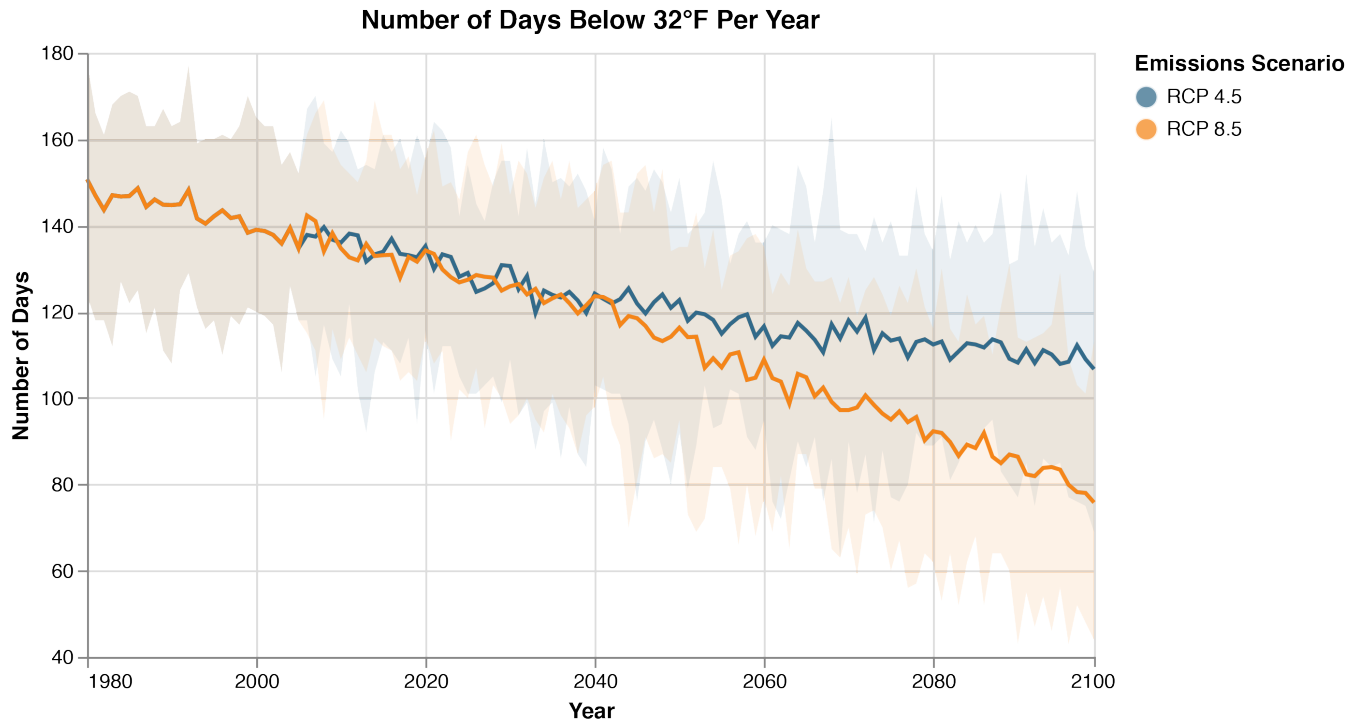


Figure 2.19. Historical simulations (1980–2005) and future projections (2006–2099) for the number of days below 32°F in Greater Portland. The orange line represents the business-as-usual high greenhouse gas emissions scenario (RCP 8.5), while the blue line represents a low emissions scenario (RCP 4.5). See the appendix for a similar graph of the change in the number of days below 0°F. Data source: Earth System Research Center/EOS, University of New Hampshire (2019).⁴⁸

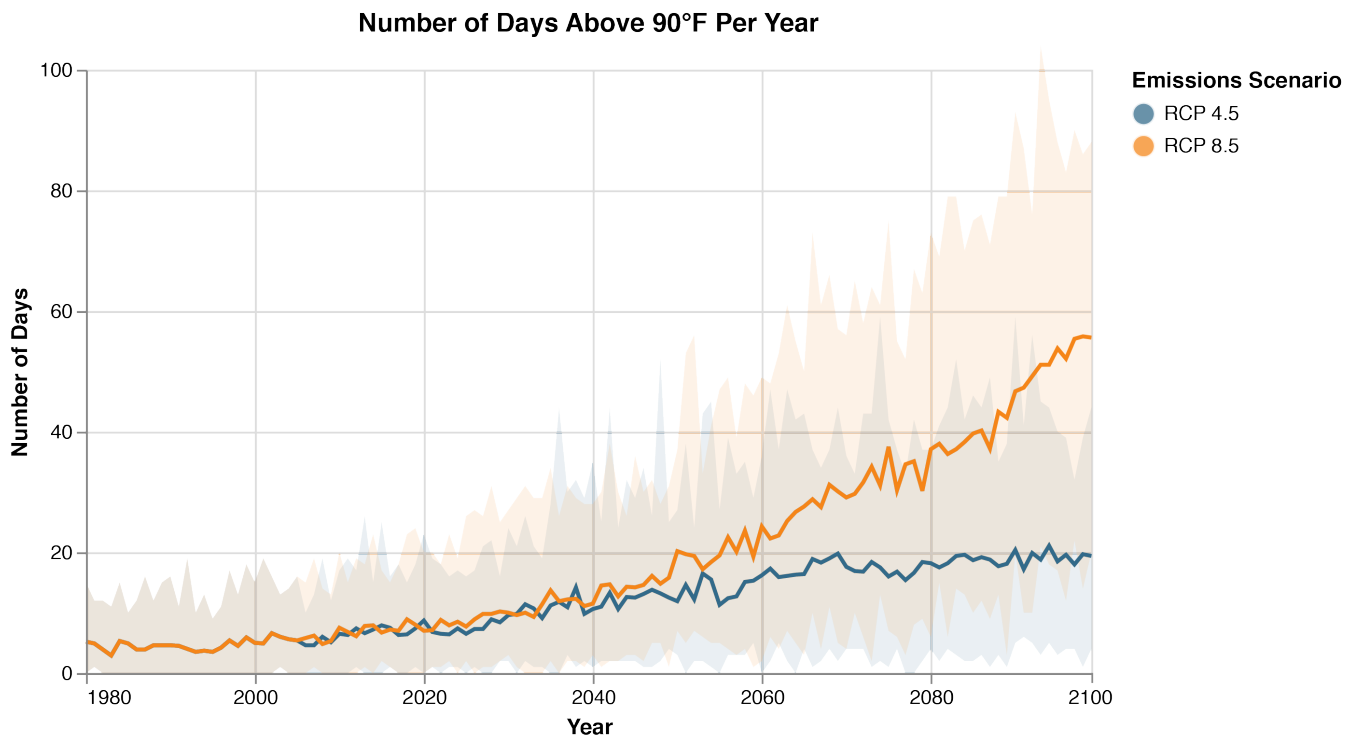


Figure 2.20. Historical simulations (1980–2005) and future projections (2006–2099) for the number of days above 90°F in Greater Portland. The orange line represents the business-as-usual high greenhouse gas emissions scenario (RCP 8.5), while the blue line represents a low emissions scenario (RCP 4.5). Data source: Earth System Research Center/EOS, University of New Hampshire (2019).⁴⁹

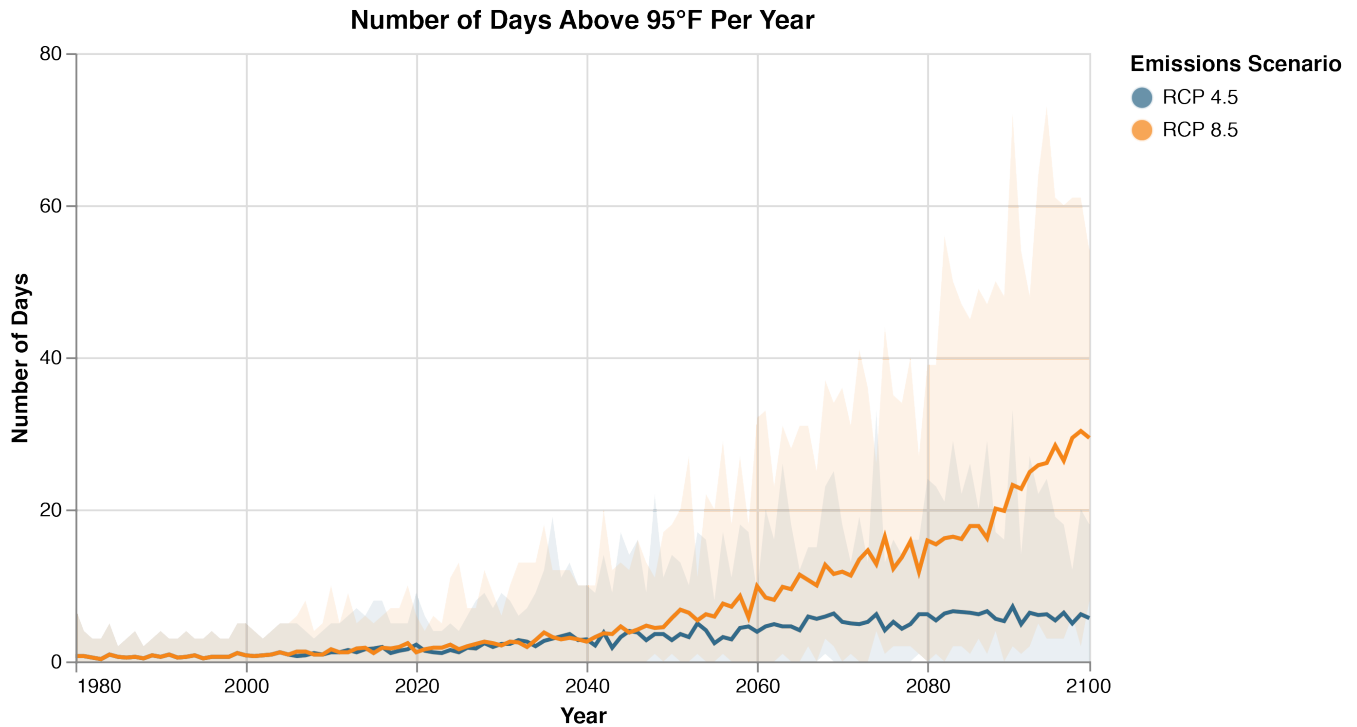


Figure 2.21. Historical simulations (1980–2005) and future projections (2006–2099) for the number of days above 95°F in Greater Portland. The orange line represents the business-as-usual high greenhouse gas emissions scenario (RCP 8.5), while the blue line represents a low emissions scenario (RCP 4.5). Data source: Earth System Research Center/EOS, University of New Hampshire (2019).⁵⁰

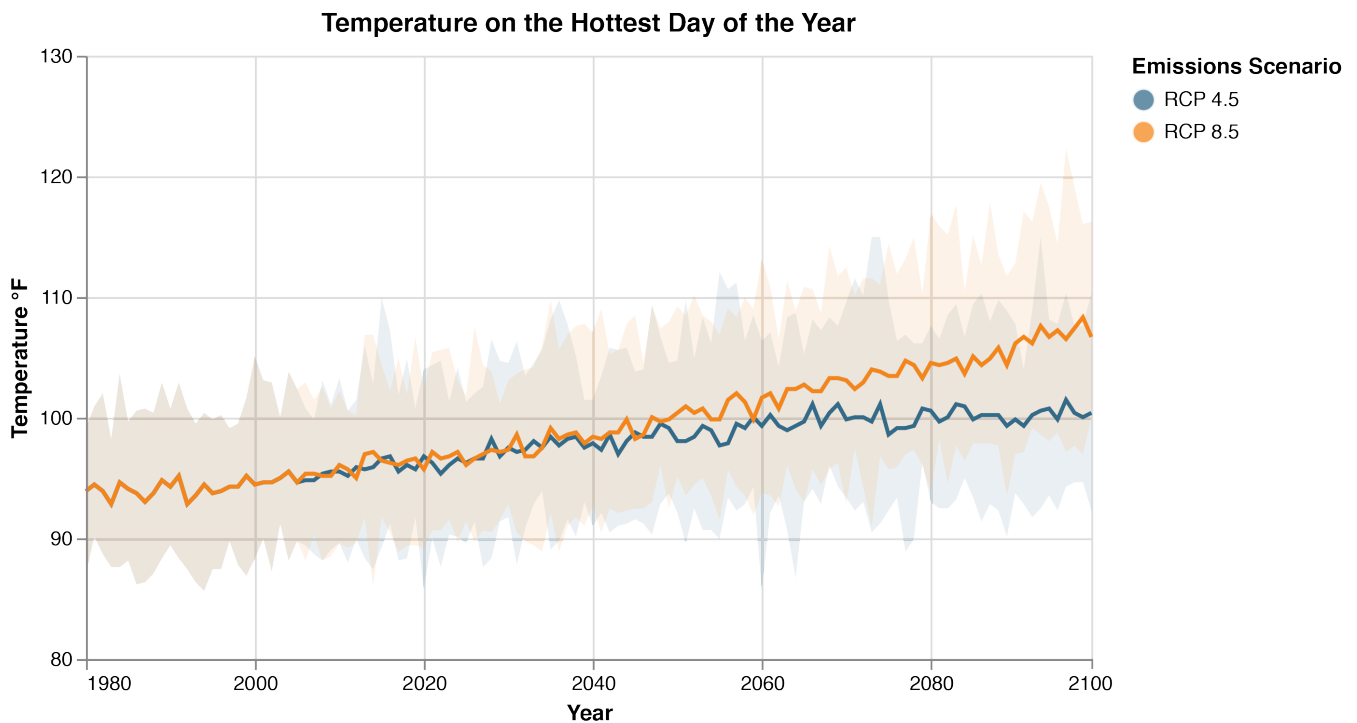


Figure 2.22. Historical simulations (1980–2005) and future projections (2006–2099) for the temperature on the hottest day of the year in Greater Portland. The orange line represents the business-as-usual high greenhouse gas emissions scenario (RCP 8.5), while the blue line represents a low emissions scenario (RCP 4.5). See the appendix for similar graphs for hottest night, coldest day, and coldest night of the year. Data source: Earth System Research Center/EOS, University of New Hampshire (2019).⁵¹

2.4 Changes in Water Temperatures and Acidification

OCEAN WARMING

Ocean temperatures in the Gulf of Maine have been rising, and at an accelerating rate. The Gulf of Maine has warmed three times as fast as the global average over the past three decades, and seven times as fast in just the last fifteen years.⁵² Between 2004 and 2013, the Gulf of Maine warmed 0.41°F (0.23°C) per year, a rate faster than 99 percent of the world's oceans.⁵³ In Casco Bay, specifically, water temperatures have increased about 2.5°F (1.4°C) between 1993 and 2018 (**Figure 2.24**).⁵⁴

While ocean temperatures have a natural cycle of variability, it is becoming increasingly clear that we are

THE GIST

The Gulf of Maine, including Casco Bay, is warming faster than 99 percent of the world's oceans. At the same time, the Gulf of Maine is particularly susceptible to ocean acidification and its acidity is expected to increase faster than average for oceans globally.

seeing an accelerating, long-term warming trend.⁵⁵ When warmer periods due to natural variability compound with the warming trend, we are likely to see more intense periods of extreme ocean temperatures. For example, the Northwest Atlantic from North Carolina to Iceland underwent an “ocean heat wave” in 2012,

Monthly Sea Surface Temperature Anomaly

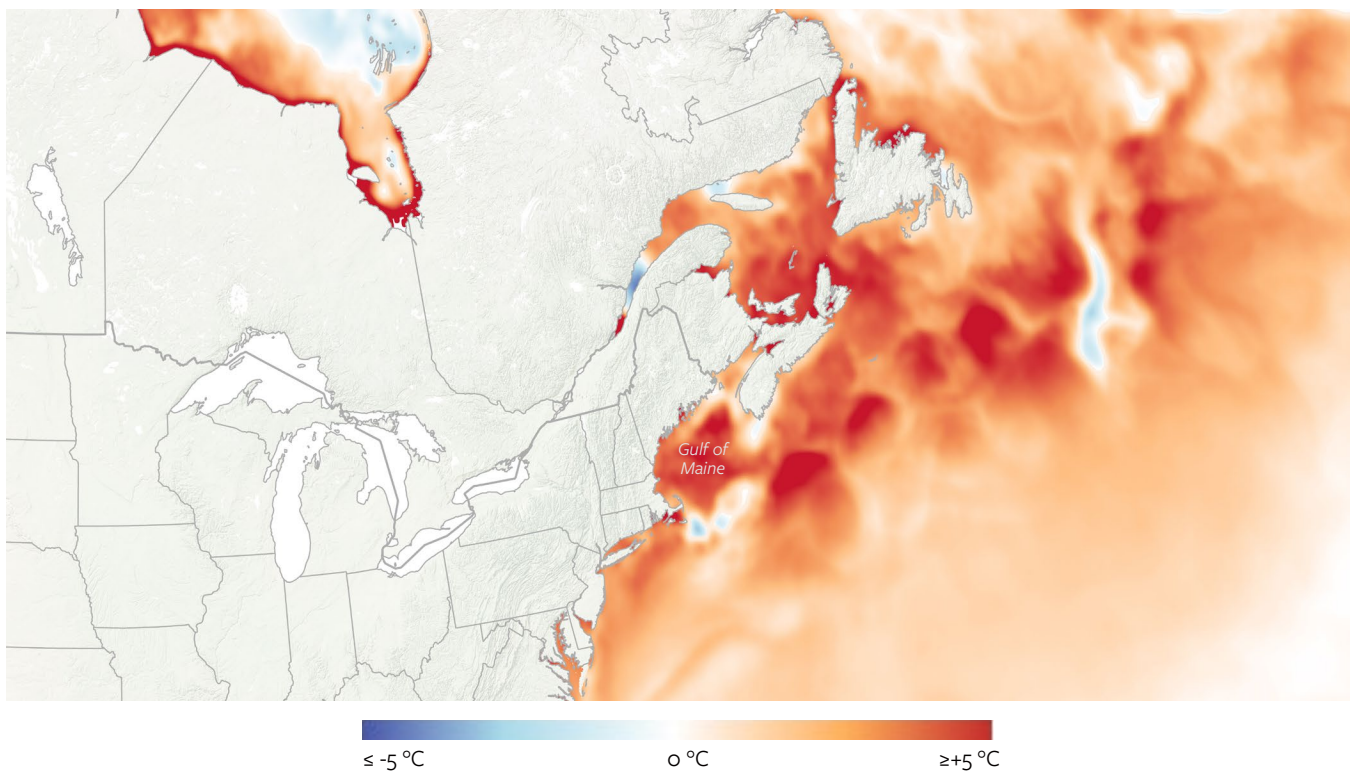


Figure 2.23. The difference in water temperature for the month of August 2018, as compared to average August water temperatures from 1985-2012. Shades of red and blue indicate how much the temperatures were above and below the long-term average, respectively. Figure source: NASA Earth Observatory with sea surface temperature data from Coral Reef Watch (2018).⁶¹

Warming Temperatures in Casco Bay (1993 – 2018)

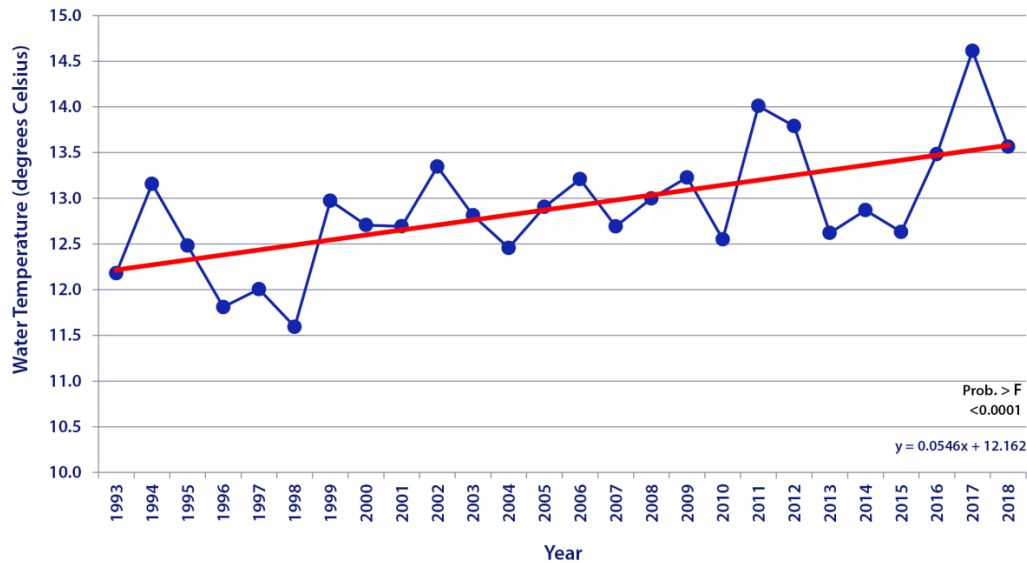


Figure 2.24. Rising water temperatures in Casco Bay, based on May through October annual averages of water sampling measured at the Sentinel Site by Friends of Casco Bay. Water temperatures have increased by 2.5°F (1.4°C) between 1993 and 2018. Graphic source: Friends of Casco Bay Baykeeper (2019).

which was considered the most intense heat wave in three decades—and was felt most acutely in the Gulf of Maine.⁵⁶ Using satellite data and sea-based sensors, scientists measured sea surface temperatures of 68.98 °F (20.55 °C), the warmest ever recorded temperatures for the Gulf of Maine.

The Gulf of Maine has experienced more heat waves since 2012. Oceanographers define marine heat waves as five consecutive days where water temperatures are above the 90th percentile of average temperatures. The Gulf of Maine had 180 days over the 90th percentile in 2018. **Figure 2.23** shows the difference in surface water temperatures for August 2018, compared to the long-term average. On August 8, 2018, the Gulf of Maine hit the second highest temperature ever recorded, just 0.05 °F (0.03 °C) below the record.

Warming ocean temperatures are causing populations of marine species to shift northward, creating repercussions for food webs and other ecosystem dynamics, as well as marine economies. See sections *4.4 Shifting Habitats: New Pests and Invasive Species* and *4.1 Local Economy and Livelihoods* for further details on the impacts to fisheries and marine ecosystems.

OCEAN AND COASTAL ACIDIFICATION

Simultaneously, oceans globally have become 30 percent more acidic (a 0.1 decrease in pH units) in the last 100 years.⁵⁷ This rate is faster than any period in the past million years and is driven by a number of factors. Oceans absorb roughly a quarter of the carbon dioxide added to the atmosphere from human activity (e.g., burning fossil fuels), contributing to global ocean acidification.⁵⁸ At the same time, pollutants from wastewater and stormwater runoff fuel greater net primary production in coastal waters, which leads to higher levels of respiration, increases in carbon dioxide, and thus further coastal acidification.

More annual precipitation and intense storms due to climate change will amplify the amount of pollutants entering marine waters through runoff. In particular, wastewater entering coastal waters from combined sewer overflows (CSOs) during heavy rain events can lead to higher acidities due to high nitrogen concentrations in wastewater. See sections *4.3 Compromised Natural Water Systems* and *4.5 Acidification Impacts on Species Health* for further details.

The Gulf of Maine, in particular, may have a higher susceptibility to ocean acidification because of its relatively low pH and colder waters, which more readily absorb carbon dioxide.⁵⁹ As a coastal area, the Gulf of Maine also has higher levels of freshwater input, which reduces the Gulf's buffering capacity, as well as higher levels of pollutants from stormwater runoff and river discharge. Researchers therefore predict that the acidity

of the Gulf of Maine will continue to increase rapidly in the coming decades and at a pace faster than the global average.⁶⁰ Acidification is expected to harm the health of marine species, particularly shellfish, which will have more difficulty in building shells and skeletons. See 4.5 *Acidification Impacts on Species Health* for further details.

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- 36 **NOTE:** Historical simulations (1980–2005) and future projections (2006–2099) in annual averages of precipitation from a 29-member, high resolution (4 km) statistically downscaled Coupled Model Intercomparison Project (CMIP5) ensemble mean lower (RCP 4.5 - blue line) and higher (RCP 8.5 - orange line) representative concentration pathway (RCP) emission scenarios. Orange and blue lines for the period 1980–2005 are identical. The light blue (light orange) shading represent the highest and lowest values from the 29 different model RCP 4.5 (RCP 8.5) simulations for each year. Graphs from Elizabeth Burakowski and Cameron Wake, Earth System Research Center/EOS, University of New Hampshire.
- 37 **NOTE:** Historical simulations (1980–2005) and future projections (2006–2099) in days with over one inch of precipitation from a 29-member, high resolution (4 km) statistically downscaled Coupled Model Intercomparison Project (CMIP5) ensemble mean lower (RCP 4.5 - blue line) and higher (RCP 8.5 - orange line) representative concentration pathway (RCP) emission scenarios. Orange and blue lines for the period 1980–2005 are identical. The light blue (light orange) shading represent the highest and lowest values from the 29 different model RCP 4.5 (RCP 8.5) simulations for each year. Graphs from Elizabeth Burakowski and Cameron Wake, Earth System Research Center/EOS, University of New Hampshire.
- 38 **NOTE:** Historical simulations (1980–2005) and future projections (2006–2099) in days with over two inches of precipitation from a 29-member, high resolution (4 km) statistically downscaled Coupled Model Intercomparison Project (CMIP5) ensemble mean lower (RCP 4.5 - blue line) and higher (RCP 8.5 - orange line) representative concentration pathway (RCP) emission scenarios. Orange and blue lines for the period 1980–2005 are identical. The light blue (light orange) shading represent the highest and lowest values from the 29 different model RCP 4.5 (RCP 8.5) simulations for each year. Graphs from Elizabeth Burakowski and Cameron Wake, Earth System Research Center/EOS, University of New Hampshire.
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- 50 **NOTE:** Historical simulations (1980–2005) and future projections (2006–2099) in number of days above 95°F per year from a 29-member, high resolution (4 km) statistically downscaled Coupled Model Intercomparison Project (CMIP5) ensemble mean lower (RCP 4.5 - blue line) and higher (RCP 8.5 - orange line) representative concentration pathway (RCP) emission scenarios. Orange and blue lines for the period 1980–2005 are identical. The light blue (light orange) shading represent the highest and lowest values from the 29 different model RCP 4.5 (RCP 8.5) simulations for each year. Graphs from Elizabeth Burakowski and Cameron Wake, Earth System Research Center/EOS, University of New Hampshire.
- 51 **NOTE:** Historical simulations (1980–2005) and future projections (2006–2099) in temperature on the hottest day of the year from a 29-member, high resolution (4 km) statistically downscaled Coupled Model Intercomparison Project (CMIP5) ensemble mean lower (RCP 4.5 - blue line) and higher (RCP 8.5 - orange line) representative concentration pathway (RCP) emission scenarios. Orange and blue lines for the period 1980–2005 are identical. The light blue (light orange) shading represent the highest and lowest values from the 29 different model RCP 4.5 (RCP 8.5) simulations for each year. Graphs from Elizabeth Burakowski and Cameron Wake, Earth System Research Center/EOS, University of New Hampshire.
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- 61 NASA Earth Observatory image by Lauren Dauphin, and sea surface temperature data from Coral Reef Watch.

3. Infrastructural Exposure, Risk, and Vulnerability

Climate change can create cascading impacts across Portland and South Portland's energy, transportation, water, and communication infrastructure.

CONTEXT FOR INFRASTRUCTURE VULNERABILITY

Portland and South Portland rely on a complex network of infrastructure to provide power, water and sewer, communication, and transportation capabilities to residents, businesses, and visitors. There are also unique components, like the working waterfront, that the two cities rely on to support the local, regional, and state economy. Climate hazards like heavy precipitation, sea level rise, storm surge, and extreme heat are causing damage to infrastructure including roads, buildings, and utilities (water, sewer, energy, communications). Much of the existing infrastructure currently in place was not built to handle the climate conditions that we are beginning to see and that we anticipate seeing by the end of the century. In addition to disruptions in these infrastructure systems, climate hazards increase the risk of exposure and transport of hazardous material currently stored in above and below ground containments and built up in soils. Identifying these vulnerabilities presents both challenges and opportunities for increasing the resiliency of these systems in Portland and South Portland.

THE INTERCONNECTEDNESS OF SYSTEMS

While each of these infrastructure systems are discussed individually in the sections below, it is critical to consider the significant interconnectedness and interdependencies of infrastructure systems in the two cities. This interdependence is both scalar (e.g., local distribution lines rely on regional high voltage transmission lines) and crosses systems (e.g., sewer/

stormwater pump stations rely on electrical power). Furthermore, infrastructure systems are often collocated, meaning telecommunications lines, water mains, and transportation infrastructure such as bridges are usually clustered alongside each other. This design strategy results in specific corridors that, if compromised, could lead to the failure of a number of systems simultaneously. The collocated telecommunications infrastructure on Pan Am rail bridges is one prime example.⁶²

Likewise, the interdependency of infrastructure systems can lead to “cascading failure,” whereby the failure of one system triggers secondary and tertiary (and often ongoing) system interruptions. During Hurricane Sandy, for example, widespread power outages compromised operations for oil terminals, pipelines, storage facilities, and filling stations. Only a few installations had access to backup power generation, and long-term recovery challenges led to gas shortages.⁶³ Limitations on gasoline distribution further hampered backup generation capacity across other sectors, as well as impacted transportation systems. Obstructed roadways further affected transportation systems, and collectively the gas shortages and blocked routes led to slower repair and recovery of the other systems. This case study points to the ways in which the resilience of one infrastructure system must rely on the resilience of multiple systems. Studies suggest that power disruptions are most frequently the root cause of cascading failures, and thus prioritizing vulnerabilities in power supplies, distribution systems, and the power-dependence of other infrastructures can help contain risk. Considering the power reliance of each of the infrastructure systems discussed below is one critical way to consider system interdependency.

A NOTE ON FLOOD VULNERABILITY ASSESSMENT

In several of the following sections, two sets of flood risk data were used to provide complementary assessments of flood risk. The first investigation looks at FEMA Flood Rate Insurance Maps (FIRMs), which depict areas that are vulnerable to inundation by the 1% annual chance flood, formerly referred to as the 100-year flood. In other words, areas designated on the map have a 1% chance of being flooded by a storm every year. FIRMs are based on existing shoreline characteristics and historic recurrence intervals for wave and storm dynamics, and do not project effects from climate change. Nevertheless, they offer an indication of flooding associated with a particular level of storm, and a relative probability of occurrence. It is important to note that by 2050 with climate change and sea level rise, we will likely see water heights equivalent to the 1% annual chance storm nearly ten times as frequently, or every ten years (based on an “Intermediate” emissions scenario).

Three types of FEMA flood zone designations are included on the maps in this assessment, which are summarized in **Table 3.1**. While there are differences between the zones, all three zones represent the 1% annual chance flood and are considered “high-risk areas.”

The second investigation uses geospatial data from the Maine Geological Survey, which shows relative levels

of inundation from sea level rise or storm surge for the Maine coast for the year 2100 under six scenarios. These sea level rise scenarios were constructed based on long-term sea level rise data from Portland, Bar Harbor, and Eastport tide gauges, the US Army Corps of Engineers Sea-Level Change Curve Calculator (v. 2017.55), and sea level rise scenarios established by NOAA et al. (2017), in alignment with the Fourth US National Climate Assessment. The scenarios selected for this analysis include 1.6, 3.9, 6.1 and 8.8 feet of sea level rise on top of the highest astronomical tide (HAT), which correspond to the Low-Intermediate, Intermediate, Intermediate-High and High scenarios for 2100, respectively. Under the Intermediate scenario, we would expect to see 1.48 feet of relative sea level rise by 2050 for the Greater Portland Area—or up to 3.38 feet under the Extreme scenario. For the sake of visualization, these 2050 thresholds roughly correspond with the lower two thresholds for 2100 (1.6 and 3.9-foot rise above HAT).

For reference, the Bayside Adapts report recommends “committing to manage” the Intermediate scenario for the Portland area, which corresponds to 1.48 feet of relative sea level rise (RSLR) by 2050, and 3.84 feet RSLR by 2100. It likewise recommends “preparing to manage” the Extreme scenario by 2050 (3.38 feet RSLR) and the Intermediate-High Scenario by 2100 (8.72 feet RSLR).

FEMA Flood Zone Descriptions

Zone	Description
AE	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. This is the base floodplain where base flood elevations are provided.
A	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. No depths or base flood elevations are shown within these zones, because detailed analyses have not been conducted for these zones.
VE	Coastal areas with a 1% or greater chance of flooding and an additional hazard associated with storm waves. These areas have a 26% chance of flooding over the life of a 30-year mortgage. No base flood elevations are shown within these zones.

Table 3.1. Descriptions for FEMA 1% annual chance flood zones A, AE, and VE. Table adapted from FEMA, “Definitions of FEMA Flood Zone Designations” (n.d.).⁷⁵

3.1 Energy Infrastructure

Energy systems across New England are increasingly vulnerable to climate change, with both direct and indirect impacts threatening the efficiency of the system and the reliability of supply. Extreme weather events, including high winds, heavy precipitation, storm surge, and flooding, may increasingly damage or disrupt electrical power plants, petroleum and natural gas storage, pumping facilities, and other energy production and distribution facilities. The projected temperature changes may change patterns in energy use, while also threatening system reliability and capacity. The energy systems that provide service and economic opportunities in Portland and South Portland are all interconnected in broader regional systems. Understanding local infrastructure connections in the context of both the regional systems and climate hazards is necessary to determine potential actions for risk mitigation.

The main energy infrastructure components evaluated in this section include: electric transmission and distribution, municipal solar arrays, petroleum, and natural gas. It is important to note that this assessment is looking at the vulnerability of *current* energy systems within the context of *future* climate projections out to the year 2100. As advanced through the One Climate Future planning process, both Portland and South Portland intend to transform their energy systems and move away from the use of fossil fuels within that time period. Therefore it will be important to re-evaluate vulnerability as these systems transition.

ELECTRIC TRANSMISSION AND DISTRIBUTION

Central Maine Power is the electric utility for Portland and South Portland as well as the majority of southern Maine. There are over 25,000 miles of transmission and distribution lines and 280 substations in the Casco Bay Region (**Figure 3.1**). Higher temperatures, increased

Regional Electrical Power Infrastructure

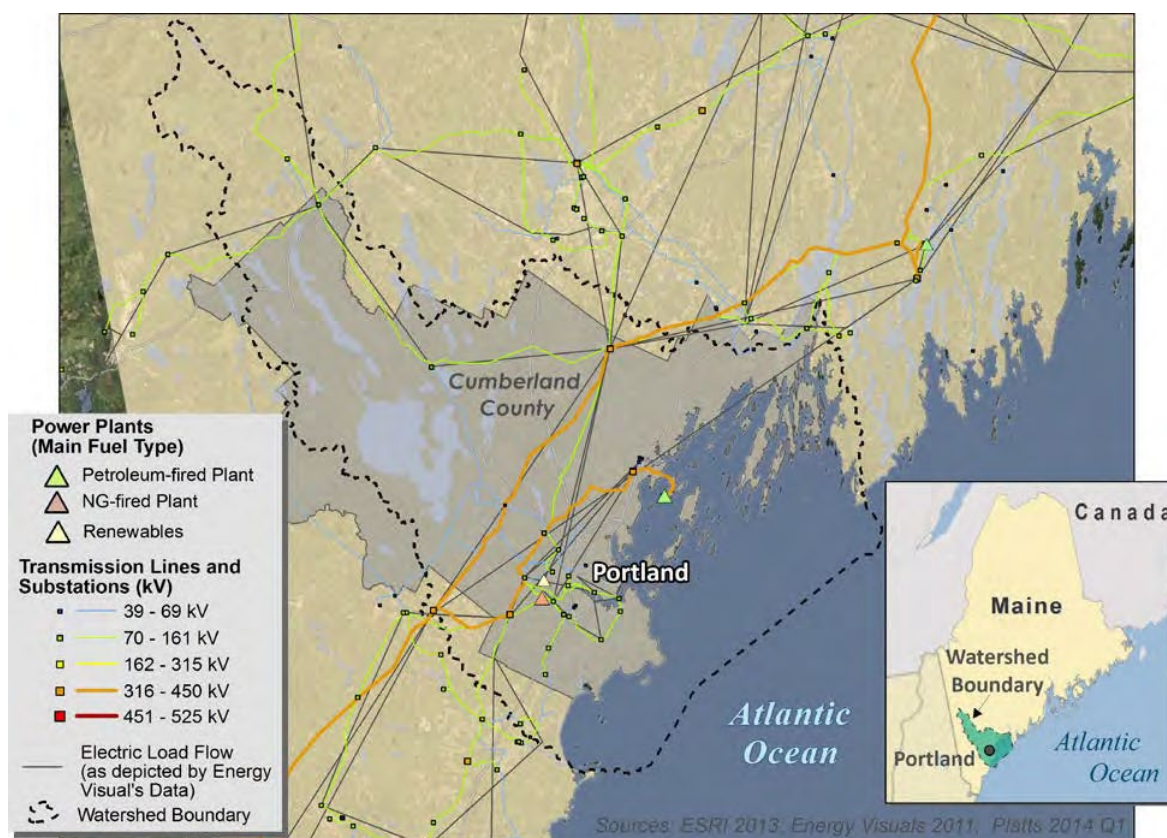


Figure 3.1. Regional electrical power infrastructure in the Cumberland County area. Figure source: U.S. Department of Homeland Security, (2016).⁷⁶

Climate Impacts to Electric Transmission and Distribution Infrastructure

Climate Hazard	Key Impacts
Increased Temperatures	• Lower generation efficiency • Decreased solar PV efficiency • Reduced carrying capacity and increased losses in lines and transformers • Increased demand for cooling
Increased Precipitation	• Damaged power lines from snow and ice • Flooding of underground infrastructure • Damaged towers due to erosion
Sea Level Rise	• Flood damage to coastal and/or low-lying infrastructure
Severe Storms	• Damaged infrastructure from wind and extreme weather • Disruption of supply chains at the local and regional level • Damage to facilities due to erosion

Table 3.2. Potential impacts to electric transmission and distribution infrastructure from climate hazards. Table adapted from Burillo, (2018).⁷⁷

precipitation, sea level rise, and storm surge due to climate change are all expected to hamper the function of the region's electric transmission and distribution system. **Table 3.2** summarizes some of the key issues for electric transmission and distribution systems.

In 2016, the U.S. Department of Homeland Security (DHS) conducted a study as part of the Regional Resiliency Assessment Program (RRAP) that looked at the effects of a category 2 hurricane along the coast of Maine. The study found that thirteen power plants (with a total generating capacity of 311 megawatts) and fifteen substations could be inundated by hurricane surge, reducing active electric generation in the state by 14 percent. This generation loss is unlikely to lead to power outages directly,⁶⁴ but localized power failures are probable during such a storm due to associated impacts on the distribution system.

The same study suggests that increases in average maximum temperature in Maine through 2050 could decrease overall plant generation output by 73 megawatts and decrease transmission line capacity by an average 8 percent. At the same time, electric power demand is expected to increase in the summers due to higher needs for cooling.⁶⁵

In the Northeast, there is a need for investment in the grid in order to continue to meet demand, reliability, resilience, and decarbonization goals. In 2018, AVANGRID Inc., the parent company of Central Maine Power, announced a plan to spend \$2.5 billion to improve the resiliency of the power grid that serves Maine, Connecticut, and New York to minimize the potential impacts of severe storms in the future. AVANGRID anticipates replacing aging infrastructure such as telephone poles, evaluating options and weighing costs

Portland and South Portland Municipal Solar Arrays

Facility	Community	Details
Riverside Golf Course	Portland	23 KW, Installed in 2018
Ocean Avenue Solar	Portland	1 MW, Installed in 2018
Portland International Jetport	Portland	450 KW, Installed in 2018
Landfill Solar (929 Highland Avenue)	South Portland	1 MW, Installed in 2017
Planning and Development Office	South Portland	18 KW, Installed 2012

Table 3.3. Municipal solar arrays in Portland and South Portland.

for hardening electrical infrastructure or installing microgrids, aggressively tree trimming, and targeting distribution system upgrades.

MUNICIPAL SOLAR ARRAYS

Portland and South Portland have developed solar projects on municipal properties to create locally generated renewable energy (Table 3.3). The existing solar arrays are not located in floodplains and are not currently projected to be impacted by sea level rise. Other climate hazards that may impact the arrays include heavy winds or precipitation, but major damage is unlikely.

PETROLEUM

Petroleum is a widely used resource in Maine, used both for heating and transportation fuel. As of 2016, petroleum supplied half of the energy consumed in the

state,⁶⁶ and 50 percent of the petroleum consumed in Maine entered through the Port of Portland.⁶⁷ The terminal infrastructure at the port, located in South Portland, plays a significant role in the state's petroleum supply chain, with seven terminals and a total storage capacity of 8.6 million barrels.⁶⁸ Refined products arriving at the port are transported within the state via the 124-mile Buckeye Pipeline, running from the port to the Buckeye Terminal in Bangor. There is also a pipeline from South Portland to Canada that has transported foreign crude oil since World War II, but which has largely been dormant since 2016 due to market competition from the Canadian tar sands.

The critical infrastructure associated with receiving and distributing petroleum is located in Portland Harbor at the mouth of the Fore River. Sea level rise and heavy storms projected with climate change may impact the

Petroleum Infrastructure Inundation Areas

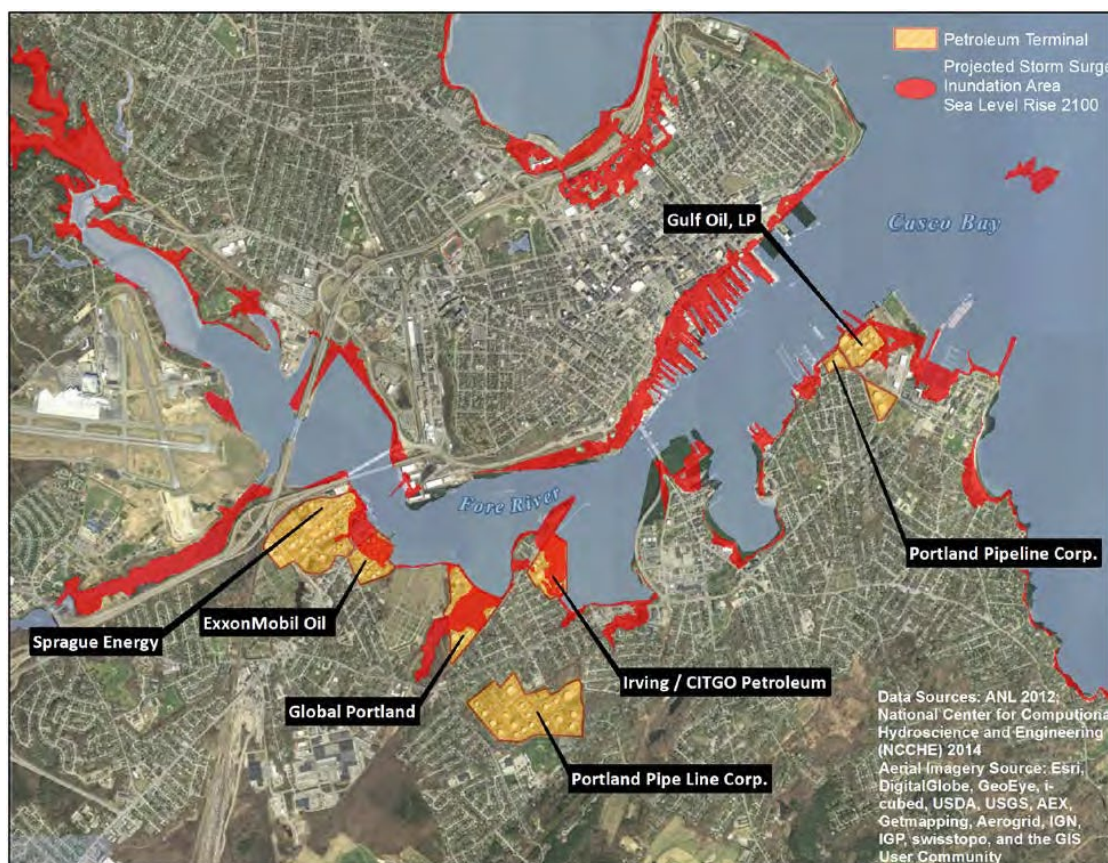


Figure 3.2. Petroleum terminals (2016) and areas projected to be inundated by sea level rise and storm surge based on a scenario of 38.6 inches of sea level rise by 2100. Figure source: Department of Homeland Security, (2016).⁷⁸

terminals and storage areas associated with petroleum operations, as well as the ability of oil tankers to utilize land-side infrastructure to distribute petroleum. An analysis completed by the US Department of Homeland Security (DHS) during the Regional Resiliency Assessment Program for Casco Bay shows significant inundation across the Portland and South Portland waterfront under a global sea rise scenario of 38.6 inches (3.2 feet) by 2100 (**Figure 3.2**). See section 3.5 *Impacts to Sites of Contaminated Soil and Hazardous Waste Storage* for a further assessment of the flood vulnerability of petroleum facilities along the Fore River.

Any disruption in the petroleum supply chain—including damage to terminals, transport interruptions, price spikes, and/or other obstructions—may have immediate implications for the state. The DHS Regional Resiliency Assessment for Casco Bay highlights the region’s limited

fuel reserves. As of 2016, a typical January-February inventory for stored distillate fuel oil can only meet two to four weeks of demand. Likewise, a typical January-February inventory is only able to meet an eight to twelve days of transportation-related fuel demand.⁶⁹ Furthermore, petroleum is distributed from terminals to retailers and homes primarily by truck in Maine, making the petroleum supply chain not only dependent on adequate driving conditions and unobstructed roads, but also on petroleum fuels for completing deliveries.

NATURAL GAS

In Maine, there are three interstate pipelines that provide natural gas for industrial, commercial, and residential use and electricity generation. The Maritime and Northeast Pipeline (M&NP) and the Portland Natural Gas Transmission System (PNGTS) import gas from Canada, with the former transporting natural gas southward to

Natural Gas Infrastructure in Greater Portland

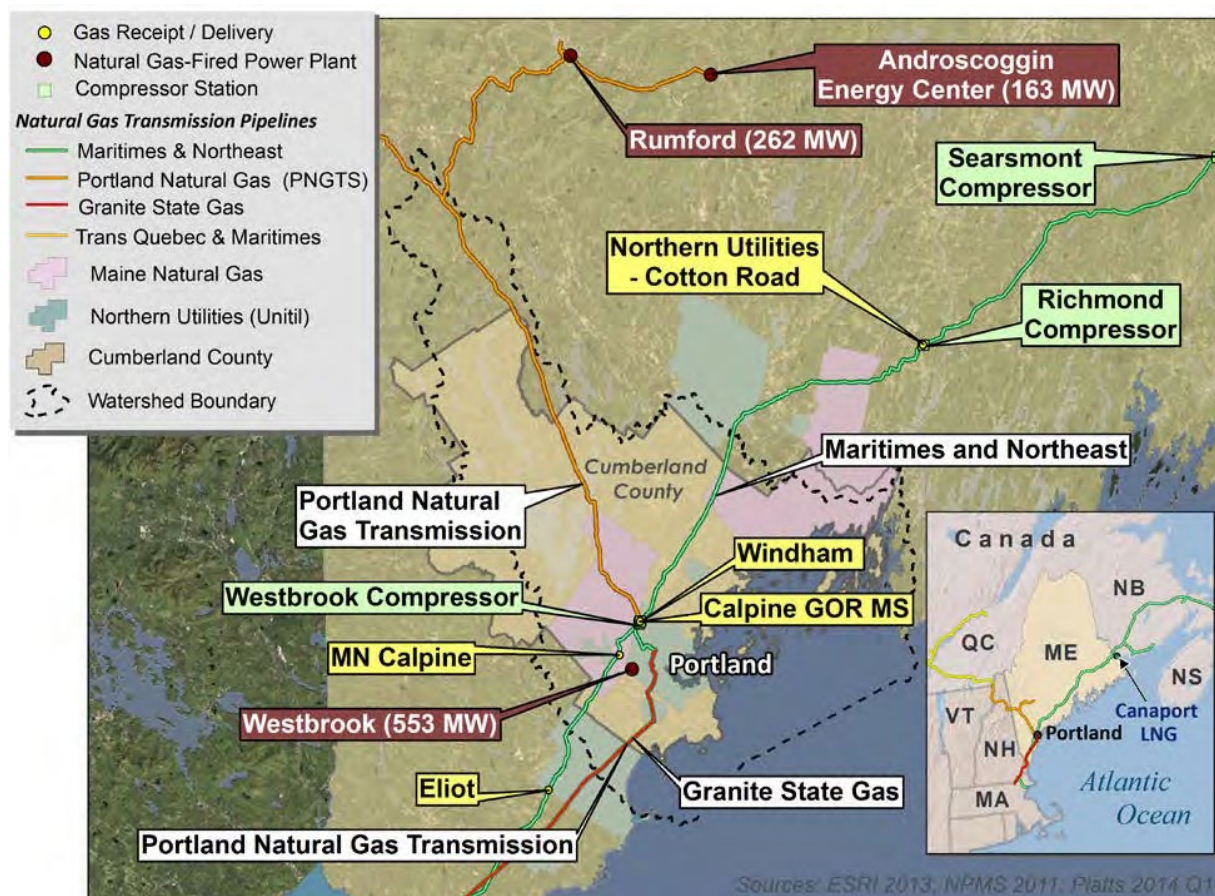


Figure 3.3. Natural gas transmission and power plant infrastructure (2016) in the Casco Bay region. Figure source: Department of Homeland Security (2016).⁷⁹

other US markets (**Figure 3.3**). Four local distribution companies further supply natural gas to Central and Southern Maine. Portland and South Portland are served by Northern Utilities (Unitil). Granite State Gas Transmission, which can be seen in **Figure 3.3**, is a subsidiary of Unitil.

Throughout the United States, natural gas is expected to provide the majority of electricity by 2050.⁷⁰ This is due to the increase in domestic supply, partially as a result of fracking drilling techniques and its increasing cost-competitiveness compared to other energy sources. The use of natural gas for residences, businesses, and electrical generation continues to grow, which places increased pressure to upgrade and expand the pipelines serving Maine. While considerations for changes or upgrades to natural gas systems need to consider climate resilience, any significant investment must also consider that improving natural gas infrastructure is a divergence in reaching carbon neutrality goals.

Because the region's primary natural gas infrastructure is located further inland, sea level rise and storm surge presents less of a risk for this system. Nevertheless, localized flooding caused by heavy precipitation or hurricanes remain a concern, particularly for the compressor stations that maintain the necessary pipeline pressure to move natural gas through the system. The DHS Regional Resiliency Assessment for Casco Bay further highlights the lack of redundancy in the region's natural gas system. Because M&NP and PNGTS each operate single pipelines, disruptions in these mainlines would cut off natural gas to the rest of the system. Maine, along with much of New England, has also seen recurring natural gas shortages and price spikes in association with extreme cold temperatures.

3.2 Water and Wastewater Infrastructure

Water and wastewater infrastructure in Portland and South Portland are critical assets. Protecting reliable drinking water, stormwater, and wastewater systems and services, as well as their associated public health, water quality, and economic benefits, has tremendous value locally, regionally, and statewide. Current and projected changes in the climate require altering how this infrastructure is being planned for, maintained, and upgraded.

DRINKING WATER

Portland and South Portland receive their drinking water from Sebago Lake. The Sebago Lake watershed is approximately 282,000 acres, extending from Standish to Bethel, Maine (**Figure 3.4**). Much of the watershed surrounding Sebago Lake is undeveloped forested land, which contributes to the superior quality of the drinking water. Sebago Lake is so clean that it requires no filtration before it is disinfected and distributed—

something that only 50 surface water suppliers out of 13,000 in the country can claim.⁷¹

Water Source — To date, the forestland in the Sebago Lake Watershed has maximized the removal of sediment and pollutants from water as it moves through the watershed to the lake. More recently, development pressure, deforestation, stormwater pollution and population growth have created concerns for maintaining this high water quality, and climate change exacerbates this risk. The Portland Water District, the region's water supplier, makes an intentional effort to invest in natural infrastructure to help support and prioritize clean water in Sebago Lake through land conservation and conservation easements.

For the Sebago Lake watershed, climate hazards will pose new challenges to maintaining water quality, particularly due to increases in nonpoint source pollution from heavy rain events and warmer waters which can encourage bacterial and algal growth. (See section 4.3 *Compromised Natural Water Systems* for further discussion of this

impact.) Beyond impacts on water quality, water quantity can be impacted by changes in seasonal, annual, or multi-year precipitation totals. For example, in 2016 much of Maine had lower than usual rainfall, and southern coastal Maine experienced severe drought conditions. Although Sebago Lake water levels were at a 10-year low, the Portland Water District affirmed that water supplies remained sufficient for all 54,000 customers.

Water Distribution — The Portland Water District maintains a water distribution network of 1,000 miles of water mains, pump stations, and reservoirs that bring water from Sebago Lake to its customers. Two large water mains run from the treatment facility to Westbrook and Portland, which allow for redundancy in the system.

Variations in water flow combined with the condition of the pipe network throughout the cities can cause early pipe failure. Climate hazards including extreme precipitation events, periods of drought, and sea level rise have the potential to exacerbate failure by increasing the likelihood of pipe breaks and distribution system damage for some of the following reasons:

- Frequent freeze and thaw cycles cause movement in the ground, resulting in strain on distribution system pipes;
- Increases in groundwater salinity in coastal areas due to sea level rise or coastal flooding can cause corrosion, which can weaken metal pipes, cause water mains to break, and result in saltwater intrusion into the water supply;
- Drought conditions may impact groundwater levels and cause movement in the ground as settling occurs; and
- Drought conditions can cause tree roots to grow into water lines as they seek a water source, eventually cracking the pipe or pipe joints.

All pipe failures and disruption to water service risk leading to loss of public trust, economic costs, and public health repercussions. The vulnerability of specific drinking water assets was not assessed in this study; Data related to such assets were not available for use due to homeland security concerns.

SEWER AND STORMWATER

The sewer and stormwater system plays a key role in treating and managing “used” water (wastewater) and rainwater that enters the cities, protecting the health of water systems, and mitigating flooding. The evaluation in this section assesses the vulnerability of wastewater and stormwater structures to sea level rise and storm surge in Portland and South Portland, including pump stations (PS), manholes (MH), sewer/stormwater pipe networks, and combined sewer overflows (CSOs). The potential sea level rise and storm surge impacts not only affect the structural integrity and design capacity of the infrastructure system, but also pose a threat to essential operation and maintenance (O&M) necessary of a combined sewer system as it begins to age.

Sebago Lake Watershed

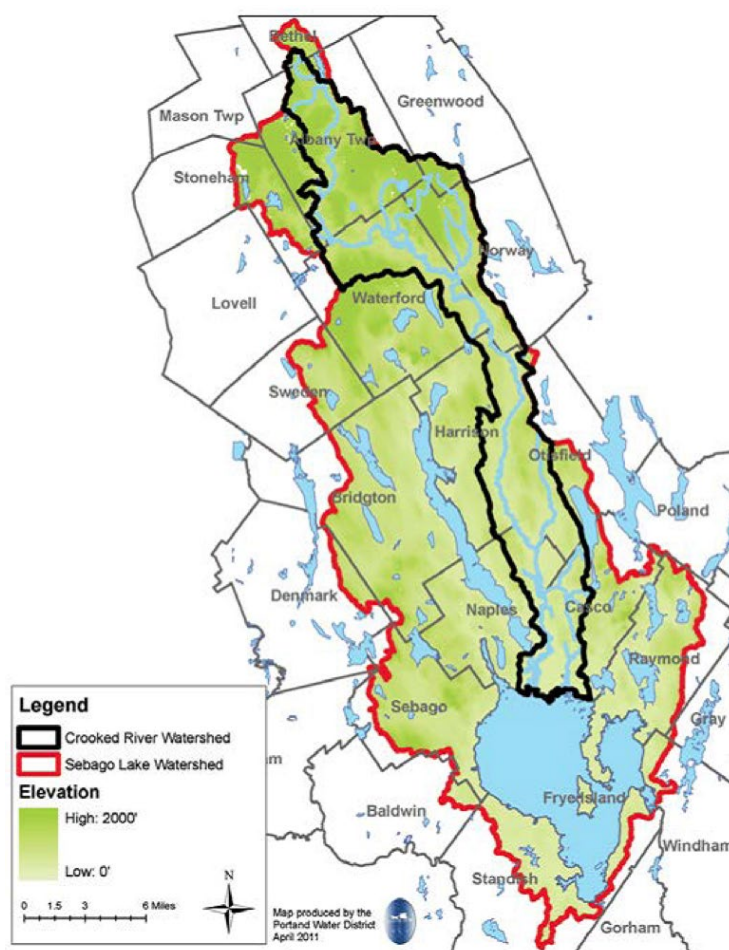


Figure 3.4. Sebago Lake Watershed. Figure source: Portland Water District (2011).⁸⁰

As outlined in the introduction of the Infrastructure section (page 34), two sets of flood risk data were used in this analysis, which provide complementary assessments of flood risk. The first investigation looks at FEMA Flood Rate Insurances Maps (FIRMs), which depict areas that are vulnerable to inundation by the 1% annual chance flood. (See page 35 for descriptions of the flood zone designations.)

The second investigation uses geospatial data from the Maine Geological Survey, which shows relative levels of inundation from sea level rise or storm surge for the Maine coast for the year 2100 under six scenarios. The specific scenarios selected for this analysis include 1.6, 3.9, 6.1 and 8.8 feet of sea level rise on top of the highest astronomical tide (HAT), which correspond to the Low-Intermediate, Intermediate, Intermediate-High and High scenarios for 2100, respectively. By 2050, we would expect to already see 1.48 feet of relative sea level rise under the Intermediate scenario, or 3.38 feet under the Extreme scenario specifically for the Greater Portland area. (See page 35 for further details.) The vulnerability of infrastructure assets within the cities was determined based on a visual assessment of asset locations, flood zones, and the sea level rise data under each of the four separate sea level rise scenarios to determine which assets fall within the projected boundaries of flood risk.

The data utilized for the following analysis were provided by the City of Portland, the City of South Portland, and the Portland Water District (PWD). The sewer and stormwater data for both cities were last updated between 2017 and June 2019. The observations about the sewer and stormwater systems in Portland and South Portland were based on the GIS data that were received from the cities and PWD, and may not directly coincide with results produced by other recent reports or analyses, depending on the version of the dataset used for those studies. In order to have consistency across our analysis, GIS sewer or stormwater structures identified in the data sources provided by the Cities in 2019 are the basis upon which results and conclusions were determined and presented in this section. Again, only sewer and stormwater assets (not drinking water assets) were included in this assessment.

Portland

System Overview

The City of Portland owns and maintains water, sewer, and stormwater infrastructure and is responsible for the cost of its maintenance, improvements, and expansion, as well as for the associated bonds and revenues. The City of Portland sewer system includes an estimated 270 miles of sanitary sewer and combined sanitary and storm sewers along with 24 pump stations, 15 of which are owned and operated by the Portland Water District. City of Portland pump stations are shown in **Figure 3.5**.

In addition to operating 15 pump stations, the Portland Water District owns and manages the treatment of the city's water and wastewater. The East End Wastewater Treatment Facility (WWTF) is located on a site adjacent to the Eastern Promenade and treats approximately 20 MGD of dry-weather flow, and is designed to treat 80 MGD during peak weather events. This facility is key to protecting the Casco Bay Watershed and has been upgraded and modified since it opened in 1979 to handle more wastewater.⁷² The Portland Water District also operates the Peaks Island WWTF, which serves 500 residents on the island, and treats 0.2 MGD of dry-weather flow and 0.61 MGD at peak flow.

The flood risk assessment also looks at Combined Sewer Overflows (CSOs), which occur when untreated wastewater is directed into streams, rivers, and oceans as a result of heavy rain events that cause the system's capacity to be exceeded. The City of Portland CSO Master Plan from 1993 identified 42 CSOs in the city. The current City GIS data includes 41 structures. Of the 41 structures, 30 are currently active CSOs according to the most recent Maine DEP Maine Pollutant Discharge Elimination System (MEPDES) Permit Renewal dated February 2019. These are currently being addressed through CSO separation efforts in the city. Some active CSOs are owned by the City and some are owned by Portland Water District. For the purpose of this analysis, all 41 structures in the City's GIS database have been analyzed for flooding and sea level rise impacts. Structures that were once active CSOs and are now closed should not discharge during rainfall events. However, unless the structure has been properly inspected, it is unknown if the structure is fully sealed when exposed to flooding and predicted sea level

rise. Although inactive structures may not be actively discharging during wet weather events, infiltration and inflow may still pose a threat to the sewer and stormwater network. Therefore all 41 structures within the City's GIS data were evaluated for impacts under the flooding conditions and the four sea level rise scenarios.

These structures are identified as CSOs for mapping purposes. It is recommended that the City of Portland inspect all inactive structures and active CSOs exposed to flood risk. Additionally, it is recommended that the City update the GIS inventory to match the DEP MEPDES Permit Renewal dated February 2019.

Portland City-Owned Pump Station Locations

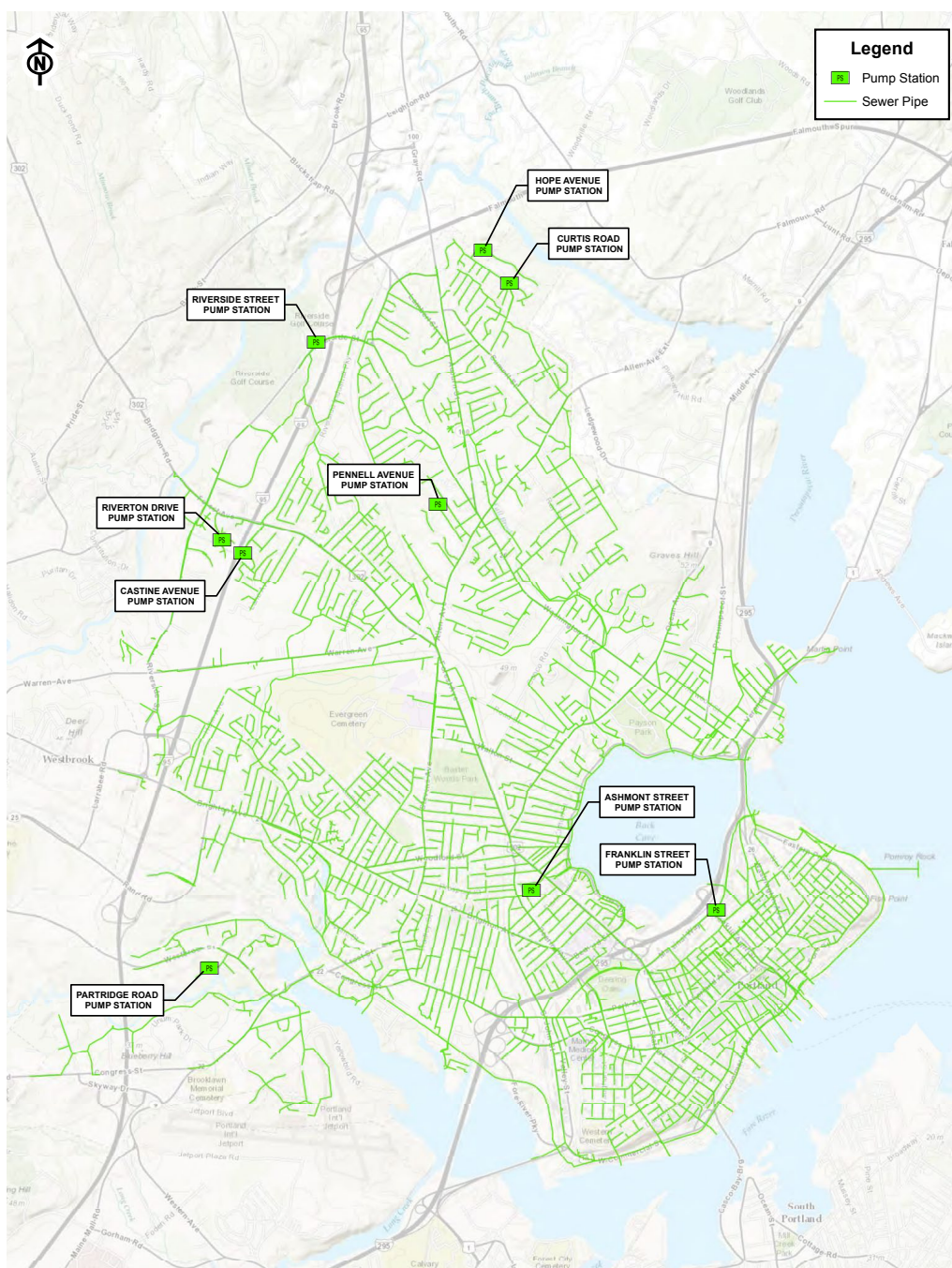


Figure 3.5. Locations of city-owned pump stations in Portland. Figure source: Woodard & Curran (2013).⁸¹

Vulnerable Assets

Table 3.4 summarizes the sewer and stormwater infrastructure in Portland that is vulnerable to flooding based on the 1% annual chance flood. Assets are tallied across three types of flood zones: VE zones are coastal, high velocity zones where flooding and wave action can be anticipated, AE zones are the base floodplain where base elevations have been provided, and A zones are areas where base flood elevations have not been determined. (See page 35 for these descriptions). All zones represent inundation areas associated with the 1% annual chance flood and are considered high risk areas.

Table 3.5 summarizes the sewer and stormwater infrastructure in Portland that are vulnerable to flooding based on four sea level rise scenarios. Based on both sets of flood risk data, sewer and stormwater infrastructure

in Back Cove, Bayside, and Commercial Street face the greatest vulnerability to flooding. Specific areas and vulnerable assets are discussed in more detail in the following sections.

A) Pump Stations — The East End Beach Pump Station is located in the FEMA VE flood zone; the Westbrook Pump Station, Riverside Street Pump Station, and Great Pond Pump Station are located in the AE flood zone; and the Blueberry Road Pump Station is located in the A flood zone (**Figure 3.6**). All five stations are vulnerable to the 1% annual chance flood, with the pump station in the VE zone being most vulnerable due to additional high velocity wave action. Any damage to the stations from flooding would disrupt the overall function of the wastewater collection system and lead to loss of service to customers.

Portland Sewer and Stormwater Structures in FEMA Flood Zones

Item	FEMA Flood Zones					
	VE Flood Zone		AE Flood Zone		A Flood Zone	
	Total	Percent	Total	Percent	Total	Percent
Pump stations (number)	1	4%	3	13%	1	4%
Manholes (number)	6	< 1%	270	3%	14	< 1%
CSOs (number)	2	5%	4	10%	0	0%
Pipe network (linear feet)	27,220	< 1%	152,930	3%	6,100	< 1%

Table 3.4. Sewer and stormwater structures in Portland that are located in VE, AE, and A FEMA preliminary flood zones (2018). Infrastructure in all flood zones is vulnerable to the 1% annual chance flood; infrastructure in the VE zone may also be exposed to wave action.

Portland Sewer and Stormwater Structures Vulnerable to Sea Level Rise

Item	Sea Level Rise Scenarios							
	HAT + 1.6 Feet		HAT + 3.9 Feet		HAT + 6.1 Feet		HAT + 8.8 Feet	
	Total	Percent	Total	Percent	Total	Percent	Total	Percent
Pump stations (number)	1	4%	4	17%	4	17%	11	46%
Manholes (number)	100	1%	403	4%	663	7%	835	9%
CSOs (number)	0	0%	0	0%	15	37%	18	44%
Pipe network (linear feet)	78,994	2%	169,606	4%	230,320	5%	281,190	6%

Table 3.5. Sewer and stormwater structures in Portland that are vulnerable to sea level rise based on four sea level rise scenarios for 2100. Inundation from each of the scenarios is based on sea level rise on top of the highest astronomical tide (HAT).

Portland Pump Stations Vulnerable to the 1% Annual Chance Flood

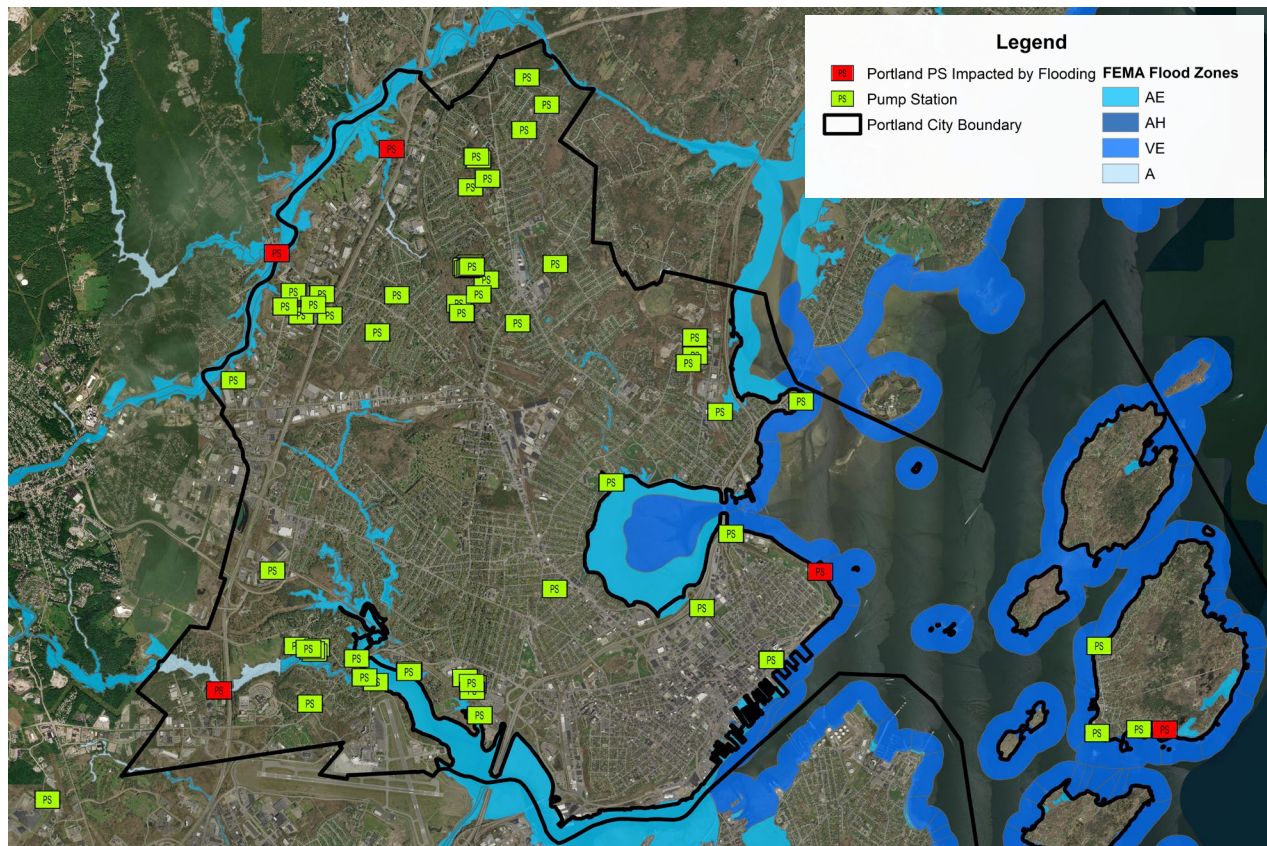


Figure 3.6. Pump stations in Portland that are vulnerable to the 1% annual chance flood. Included on this map are private pump stations which were in the GIS data provided by the City of Portland GIS Department. No private pump stations are predicted to be vulnerable to the 1% annual chance flood. Data from the City of Portland and Portland Water District and FEMA preliminary flood zones (2018).

Portland Pump Stations Vulnerable to Sea Level Rise

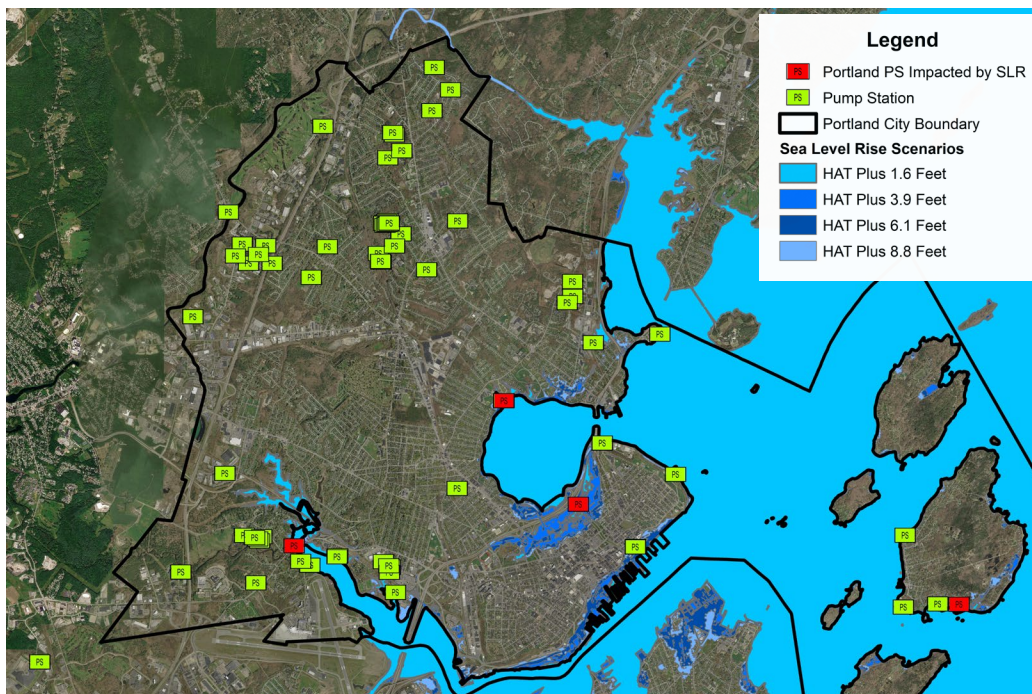


Figure 3.7. Pump stations in Portland that are vulnerable to flooding based on four sea level rise scenarios. Data from the City of Portland and Portland Water District and Maine Geological Survey Sea Level Rise/Storm Surge Scenarios.

Of the 24 pump stations operated by the City and the Portland Water District (PWD), 3.9 feet of sea level rise on top of the astronomical high tide will impact four pump stations: Baxter Street Pump Station, Commercial Street Pump Station, Franklin Street Pump Station, and Great Pond Pump Station (**Figure 3.7**). Franklin Street Pump Station is city-owned and operated and the remaining three are owned and operated by the Portland Water District.

B) Wastewater Treatment Facilities — The Portland wastewater treatment facility in the East End does not show significant vulnerability to the 1% annual chance flood, nor any of the four sea level rise scenarios. It is likely, however, that the city would lose access to the facility due to inroads being inundated both in the 1% annual chance storm and in a scenario where sea levels reach HAT + 6.1 feet or higher (**Figure 3.8**). The Peaks Island WWTF is not located in a FEMA Flood Zone and is not projected to be impacted by sea level rise. However, both facilities are still at risk of climate hazards concurrent to sea level rise, such as more frequent and more powerful storms. As they are situated on the shoreline, it is certainly possible that during a violent coastal storm, these WWTF could be at risk from water or storm damage.

C) Manholes — Six manholes in Portland are within the FEMA VE high risk coastal flood zone (less than 1 percent of all sewer and stormwater manholes in the city); 270 manholes are located in AE flood zones (approximately 3 percent of all manholes) and 14 manholes are located in A flood zones (less than 1 percent). Particularly vulnerable areas of concern include Back Cove, Commercial Street, and the Fore River area near Stroudwater (**Figure 3.9**). The implications of manholes that are located in an area at risk for flooding is that non-watertight manholes allow floodwaters to infiltrate the sewer system.

Approximately 1 percent of all sewer and stormwater manholes are predicted to be impacted by 1.6 feet of sea level rise above the astronomical high tide (a threshold that could likely be seen by 2050), which is an estimated 100 manholes out of 9,326 sewer and stormwater manholes included in the GIS data provided. Approximately 4 percent of all manholes (an estimated 403 manholes) are predicted to be impacted by 3.9 feet of sea level rise on top of the astronomical high tide. Although locations with affected manholes are widespread throughout the city, four primary areas of concern have been established: Back Cove, Bayside, Fore River, and Commercial Street.

Portland WWTF Flood Vulnerability

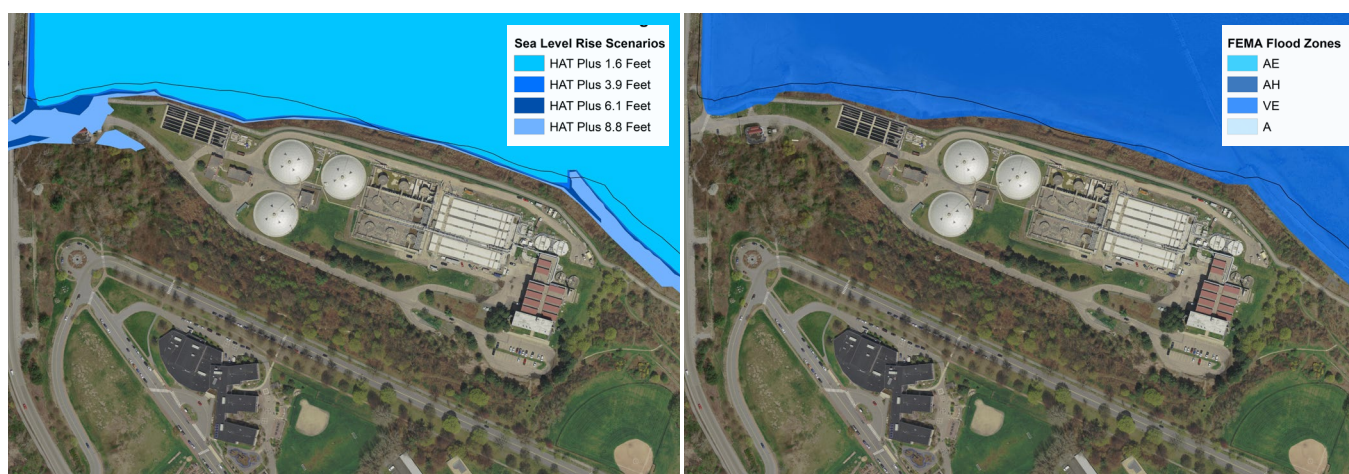


Figure 3.8. Extent of vulnerability of the East End wastewater treatment facility in Portland to flooding from four scenarios of sea level rise (left) and the 1% annual chance flood (right). Data from FEMA preliminary flood zones (2018), and Maine Geological Survey Sea Level Rise/Storm Surge Scenarios (2018).

Portland Manholes and Pipe Network Vulnerable to the 1% Annual Chance Storm

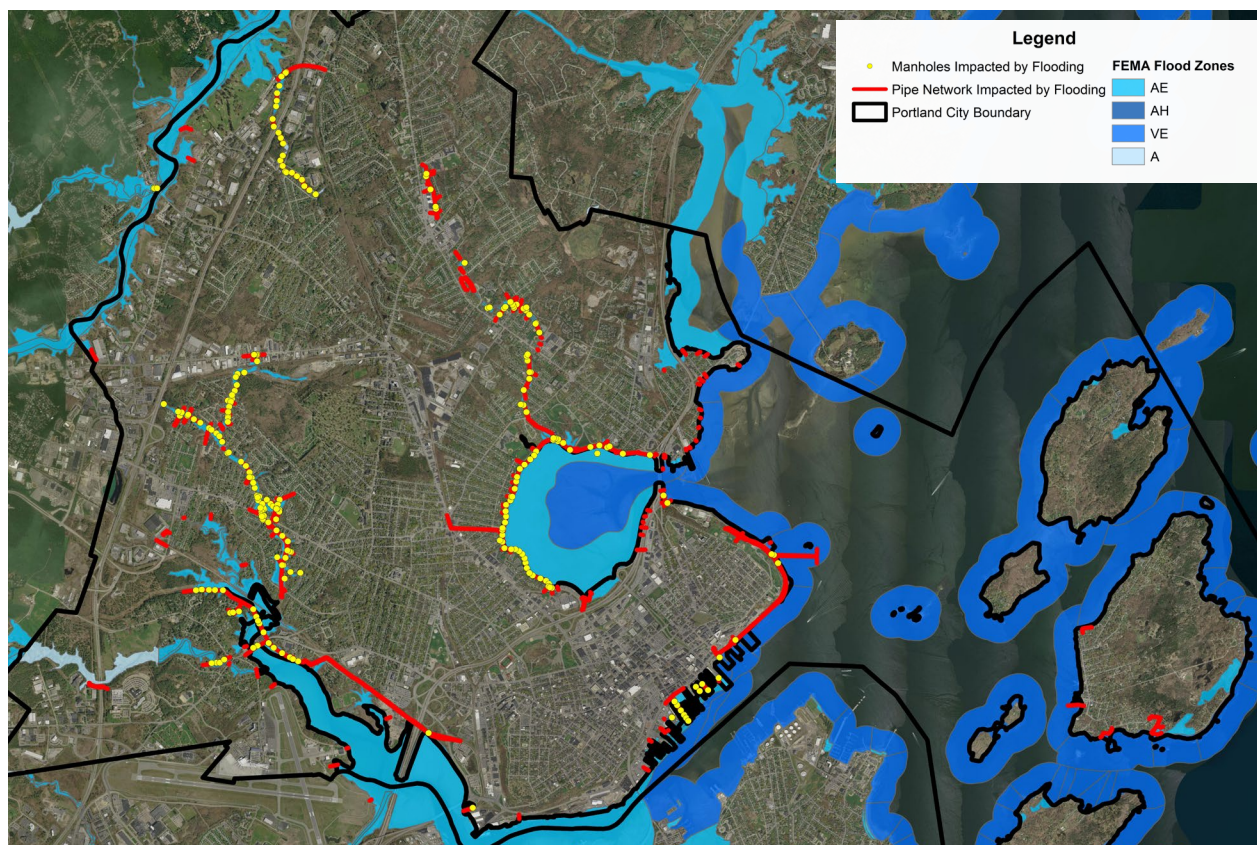


Figure 3.9. Manholes and pipe network segments in Portland that are vulnerable to the 1% annual chance flood. Data from the City of Portland and Portland Water District and FEMA preliminary flood zones (2018).

D) Pipe Network — The Portland pipe network that was evaluated for flood risk includes sewer gravity mains, sewer force mains, and stormwater mains. Less than 1 percent of the city's pipe network will be impacted by flooding within the VE FEMA flood zone, or approximately 27,220 linear feet of pipe, according to the data provided by the City of Portland GIS department and the Portland Water District. Approximately 152,930 linear feet (3 percent of the pipe network) is vulnerable to flooding in the AE flood zone and approximately 6,100 linear feet (less than 1 percent of the pipe network) is located in the A flood zone. The at-risk sewer and stormwater pipe network assets are primarily within the Back Cove, Commercial Street, and Fore River or Stroudwater Areas.

Based on the 3.9-ft sea level rise scenario, sea level rise will impact approximately 169,606 linear feet (4

percent) of the pipe network. High-risk areas include Back Cove, Bayside, and Commercial Street. Increases in groundwater salinity due to sea level rise or coastal flooding can lead to pipe corrosion, which weakens metal pipes and leads to pipe main breaks. Inundation of the sewer and stormwater pipe network also leads to higher volume and frequency of combined sewer overflows, discussed in the following section.

E) Combined Sewer Overflows — Portland's pipe network is subject to Combined Sewer Overflows (CSOs), which occur when heavy rain events overwhelm the capacity of the pipe network, and as a result, untreated wastewater is directed into streams, rivers, and oceans. CSOs pose a significant threat to the water quality along Portland's coast, creating health concerns for water recreation and impacting ecologically sensitive areas. Higher-intensity precipitation events are likely to

cause capacity issues and the potential for larger and more frequent CSOs for the system in its current state.

For the purpose of this analysis, all 41 structures (active and inactive CSOs) in the City's GIS database have been analyzed for flooding and sea level rise impacts, based on the reasoning described on page 42. Of these 41 structures, none are vulnerable to sea level rise based on the HAT + 1.6-ft or HAT + 3.9-ft sea level rise scenarios. Vulnerability significantly jumps when assessing sea level rise based on the HAT + 6.1-ft rise scenario, with 15 structures predicted to be impacted (approximately 37 percent). A total of 18 structures could be impacted under the HAT + 8.8-ft sea level rise scenario (the High scenario for 2100). Vulnerable areas include the north and south side of Back Cove and Commercial Street.

Six structures are vulnerable to the 1% annual chance storm, two of which (approximately 5 percent) are located in the VE flood zone, and four of which (approximately 10 percent) are located in the AE flood zone.

South Portland

Overview

The City of South Portland sewer system includes an estimated 170 miles of sanitary sewer and stormwater pipes in the network and over 6,000 stormwater and wastewater structures.⁷³ The South Portland wastewater treatment plant (WWTP) is located in Knightville just east of the Casco Bay Bridge with a design capacity of 9.3 MGD of dry-weather flow, and is designated to treat 22.9

South Portland City-Owned Wastewater Pump Stations

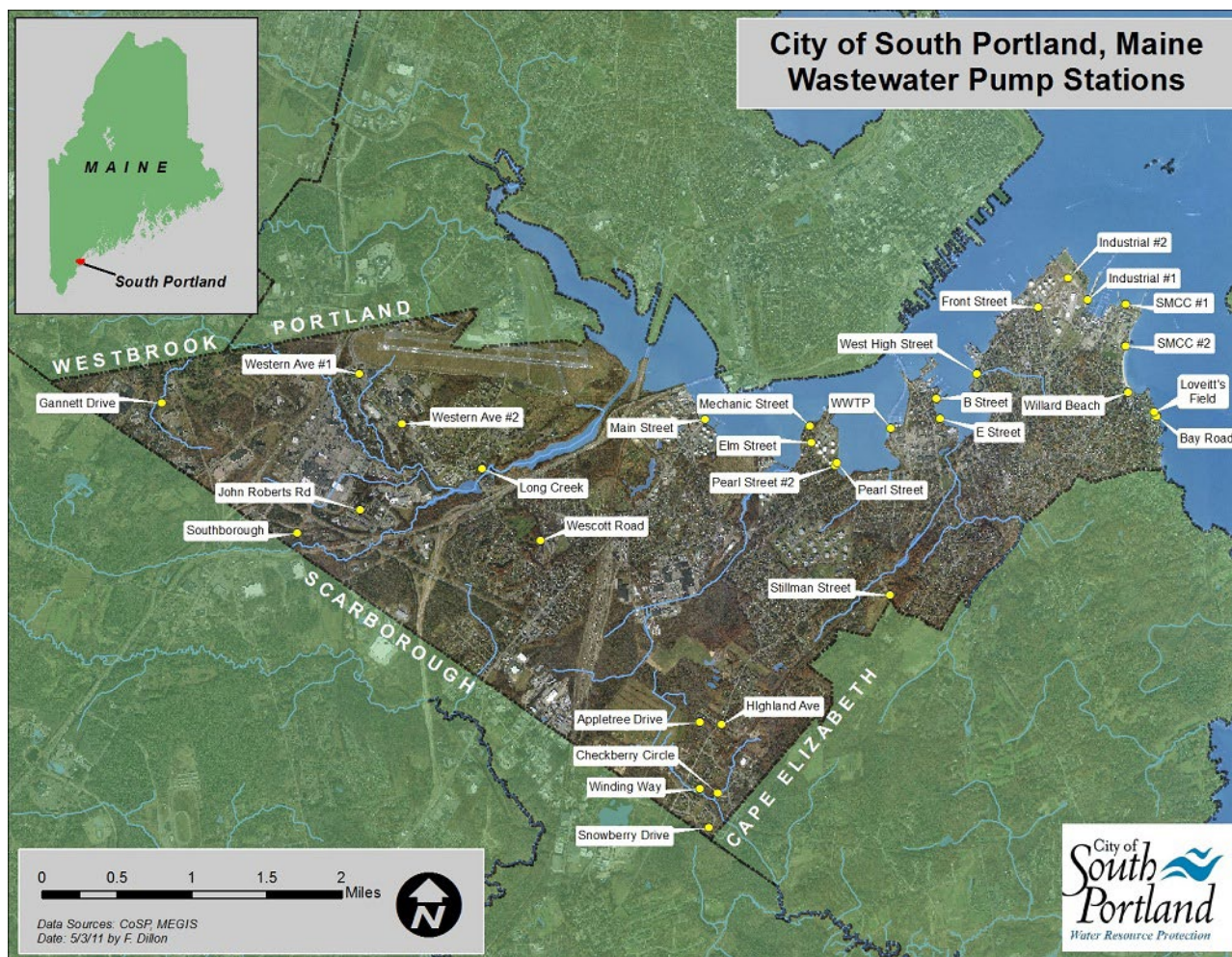


Figure 3.10. Locations of city-owned pump stations in South Portland. Figure source: City of South Portland, Water Resource Protection (2011).⁸²

MGD during peak weather events. Originally constructed in 1977, the most recent major upgrade to the WWTP was in 1995.⁷⁴ Based on City of South Portland GIS data, there are 34 pump stations in the city; **Figure 3.10** shows the locations of 30 pump stations operated by the South Portland Treatment Systems Division (2011). The city also currently has six Combined Sewer Overflow (CSO) sites, which were also evaluated for flood risk.

Data used for this analysis was received from the City of South Portland Water Resource Protection department. The sewer and stormwater infrastructure data were last updated between 2016 and 2018. Vulnerable assets and high-risk areas for the City of South Portland are discussed in the following section.

Vulnerable Assets

Table 3.6 summarizes the sewer and stormwater infrastructure in the City of South Portland that is vulnerable to flooding based on the 1% annual chance flood. Assets are tallied across three types of flood zones: VE zones are coastal, high velocity zones where flooding and wave action can be anticipated, AE zones are the base floodplain where base elevations have been provided, and A zones are areas where base flood elevations have not been determined. (See page 35 for these descriptions). All zones represent inundation areas associated with the 1% annual chance flood and are considered high risk areas.

Table 3.7 summarizes the sewer and stormwater infrastructure in the City of South Portland that is vulnerable to flooding based on four sea level rise

South Portland Sewer and Stormwater Structures in FEMA Flood Zones

Item	FEMA Flood Zones					
	VE Flood Zone		AE Flood Zone		A Flood Zone	
	Total	Percent	Total	Percent	Total	Percent
Pump stations (number)	2	6%	4	12%	0	0%
Manholes (number)	28	< 1%	65	1%	2	< 1%
CSOs (number)	0	0%	0	0%	0	0%
Pipe network (linear feet)	4,510	1%	16,310	3%	1,002	< 1%

Table 3.6. Sewer and stormwater structures in South Portland that are located in VE, AE, and A FEMA flood zones. Infrastructure in all flood zones is vulnerable to the 1% annual chance flood; infrastructure in the VE zone may also be exposed to wave action.

South Portland Sewer and Stormwater Structures Vulnerable to Sea Level Rise

Item	Sea Level Rise Scenarios							
	HAT + 1.6 Feet		HAT + 3.9 Feet		HAT + 6.1 Feet		HAT + 8.8 Feet	
	Total	Percent	Total	Percent	Total	Percent	Total	Percent
Pump stations (number)	0	0%	5	15%	9	27%	13	38%
Manholes (number)	16	< 1%	105	2%	292	6%	484	11%
CSOs (number)	0	0%	1	17%	1	17%	4	67%
Pipe network (linear feet)	7,896	1%	23,273	4%	44,244	7%	61,415	10%

Table 3.7. Sewer and stormwater structures in South Portland that are vulnerable to sea level rise based on four sea level rise scenarios for 2100. Inundation from each of the scenarios is based on sea level rise on top of the highest astronomical tide (HAT).

scenarios. Based on both sets of flood risk data, sewer and stormwater infrastructure in Knightville, Ferry Village, Simonton Cove, and Cushing Point face the greatest vulnerability. In South Portland, the pipe network and associated structures are dependent on each other for the operation of an efficient collection system, making it essential that vulnerable assets are managed proactively and properly to prevent system failure.

A) Pump Stations — Based on City GIS data, there are 34 pump stations in the City of South Portland. **Figure 3.11** displays the pump stations that may be inundated by the 1% annual chance flood. The Bay Road Pump Station and Loveitt's Field Pump Station are located in the FEMA VE flood zone. These pump stations are connected to sewer and stormwater pipes also vulnerable to flooding in this area near Willard Beach. Four additional pump stations are located in the AE flood zone:

- Pearl Street Pump Station
 - Willard Beach Pump Station
 - "Industrial Area 1" Pump Station*
 - "SMTC 1" Pump Station*
- *as described in the GIS data provided

Figure 3.12 displays the pump stations that may be affected by sea level rise. Five of South Portland's pump stations (approximately 15 percent) are predicted to be impacted at 3.9 feet of sea level rise on top of the highest astronomical tide. These include:

- Pearl Street Pump Station
 - Elm Street Pump Station
 - Front Street Pump Station
 - "Industrial Area 1" Pump Station*
 - "Industrial Area 2" Pump Station*
- *as described in the GIS data provided

South Portland Pump Stations Vulnerable to the 1% Annual Chance Flood

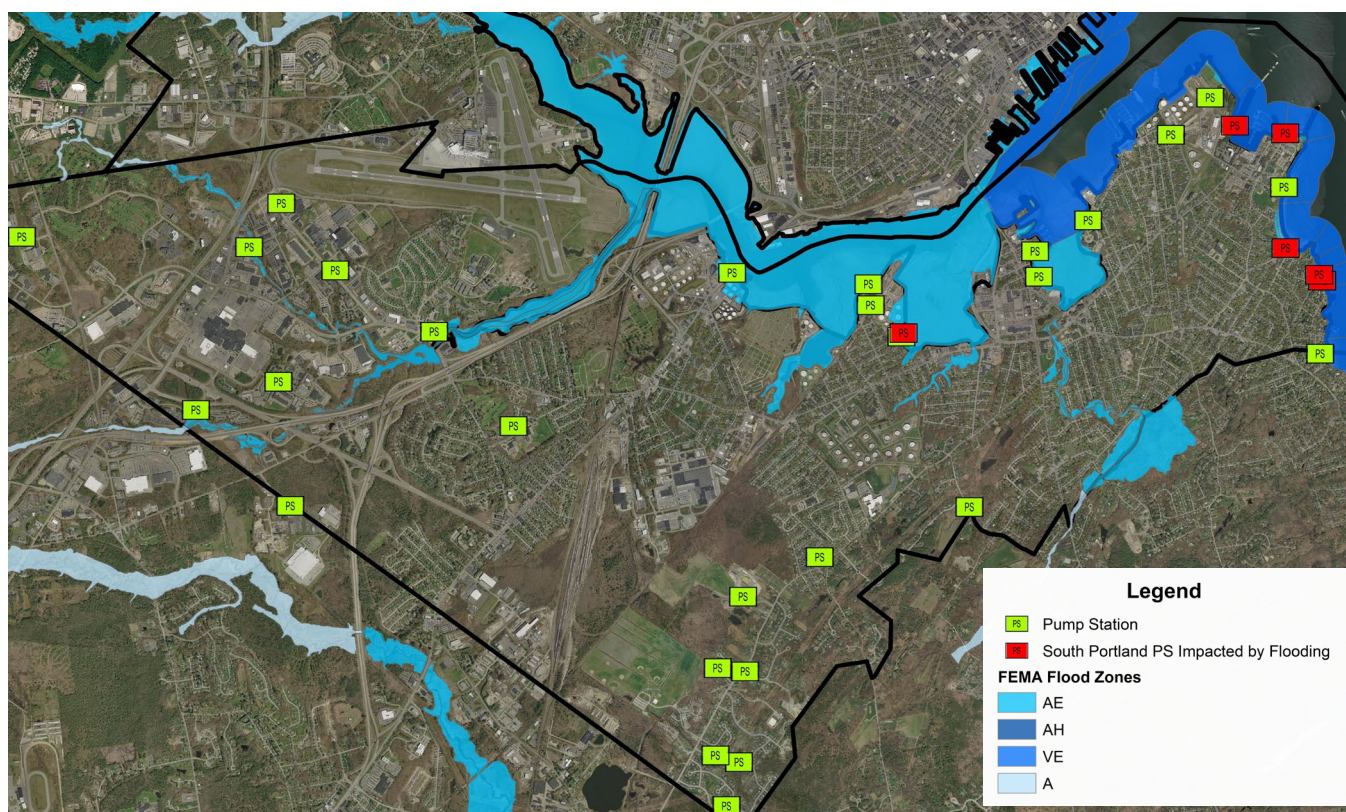


Figure 3.11. Pump stations in South Portland that are vulnerable to the 1% annual chance flood. Data from the City of South Portland and FEMA preliminary flood zones (2018).

South Portland Pump Stations Vulnerable to Sea Level Rise

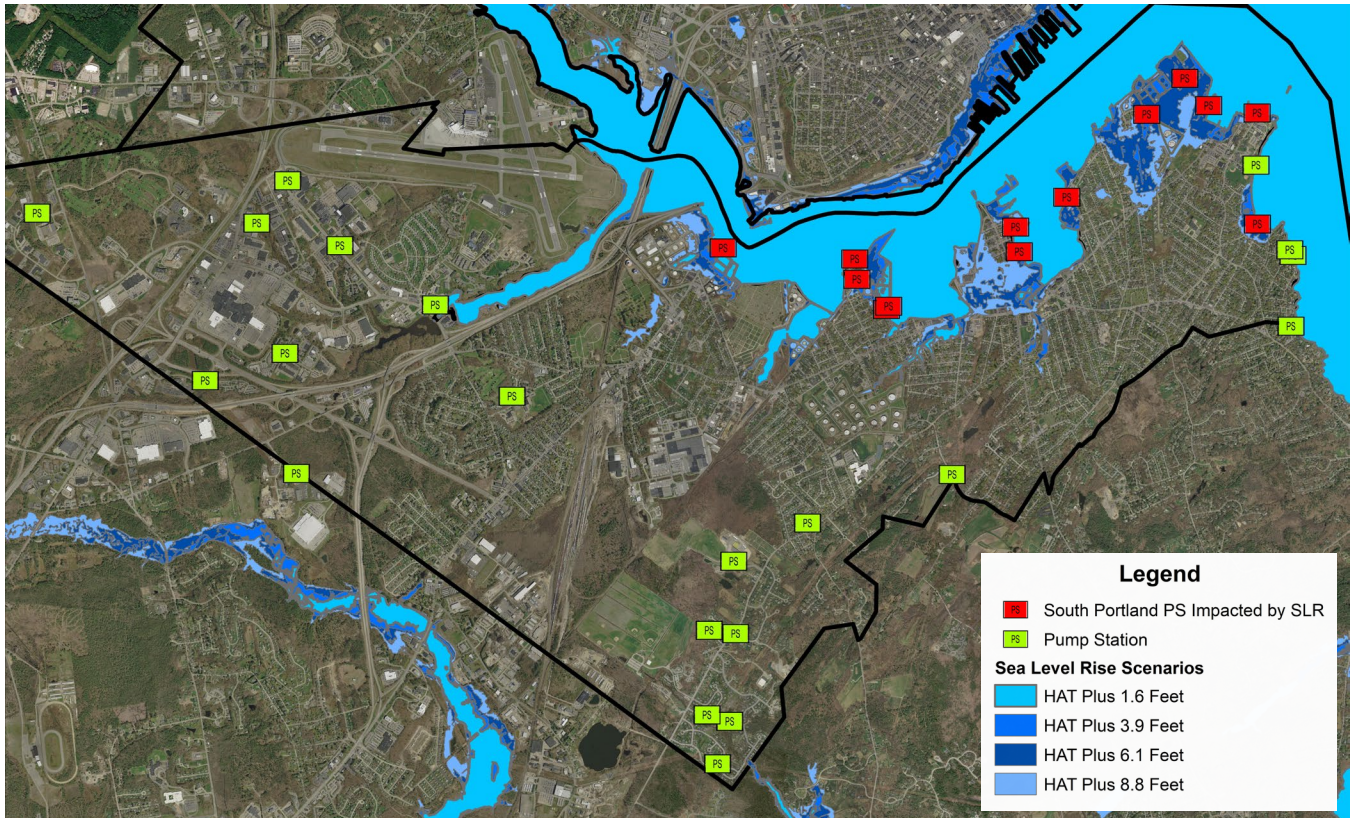


Figure 3.12. Pump stations in South Portland that are vulnerable to sea level rise based on four sea level rise scenarios for 2100. Data from the City of South Portland and Maine Geological Survey Sea Level Rise/Storm Surge Scenarios (2018).

South Portland WWTF Flood Vulnerability

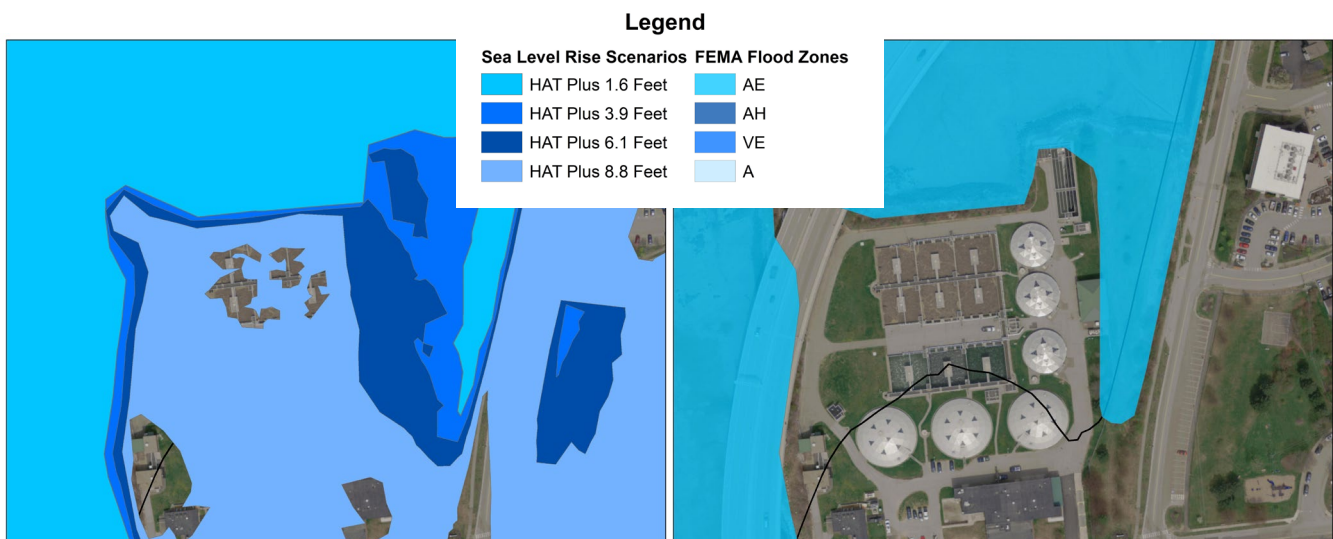


Figure 3.13. Extent of vulnerability of the wastewater treatment facility in South Portland to flooding from four scenarios of sea level rise (left) and the 1% annual chance flood (right). Data from FEMA preliminary flood zones (2018) and Maine Geological Survey Sea Level Rise/Storm Surge Scenarios (2018).

B) Wastewater Treatment Facility — The South Portland wastewater treatment plant is currently technically outside the 1% annual chance flood zone; however, the site is projected to be partially or fully inundated by sea level rise by 2100 under an Intermediate-High or High scenario, respectively (**Figure 3.13**). The facility could experience structural damage or failure due to loads from wave action and water inundation, impact from moving debris in a violent flood, or corrosion from salt exposure.

C) Manholes — Approximately 95 stormwater and sewer manholes are exposed to high flood risk based on the 1% annual chance flood. Approximately 28 manholes (less than 1 percent of all manholes in South Portland) are located within the FEMA VE flood zone; 65 manholes (approximately 1 percent) are located within the FEMA AE flood zone; and two manholes are located in the

FEMA A flood zone. Primary areas that are projected to be affected include Ferry Village, Simonton Cove, and Cushing Point.

Only 2 percent of stormwater and sewer manholes in South Portland are vulnerable to 3.9 feet of sea level rise on top of the highest astronomical tide; however, this vulnerability increases to over 10 percent under the HAT + 8.8-ft scenario. Highly impacted areas in South Portland include Knightville, Trout Brook south of Meetinghouse Hill, Cushing Point, and Simonton Cove.

D) Pipe Network — Approximately 21,822 linear feet of pipe in the South Portland sewer/stormwater pipe network are exposed to high flood risk based on the 1% annual chance flood (**Figure 3.14**). Of that total, roughly 4,510 linear feet (less than 1 percent) of the pipe network are in the VE flood zone; 16,310 linear feet are in

South Portland Pipe Network Vulnerability to the 1% Annual Chance Flood

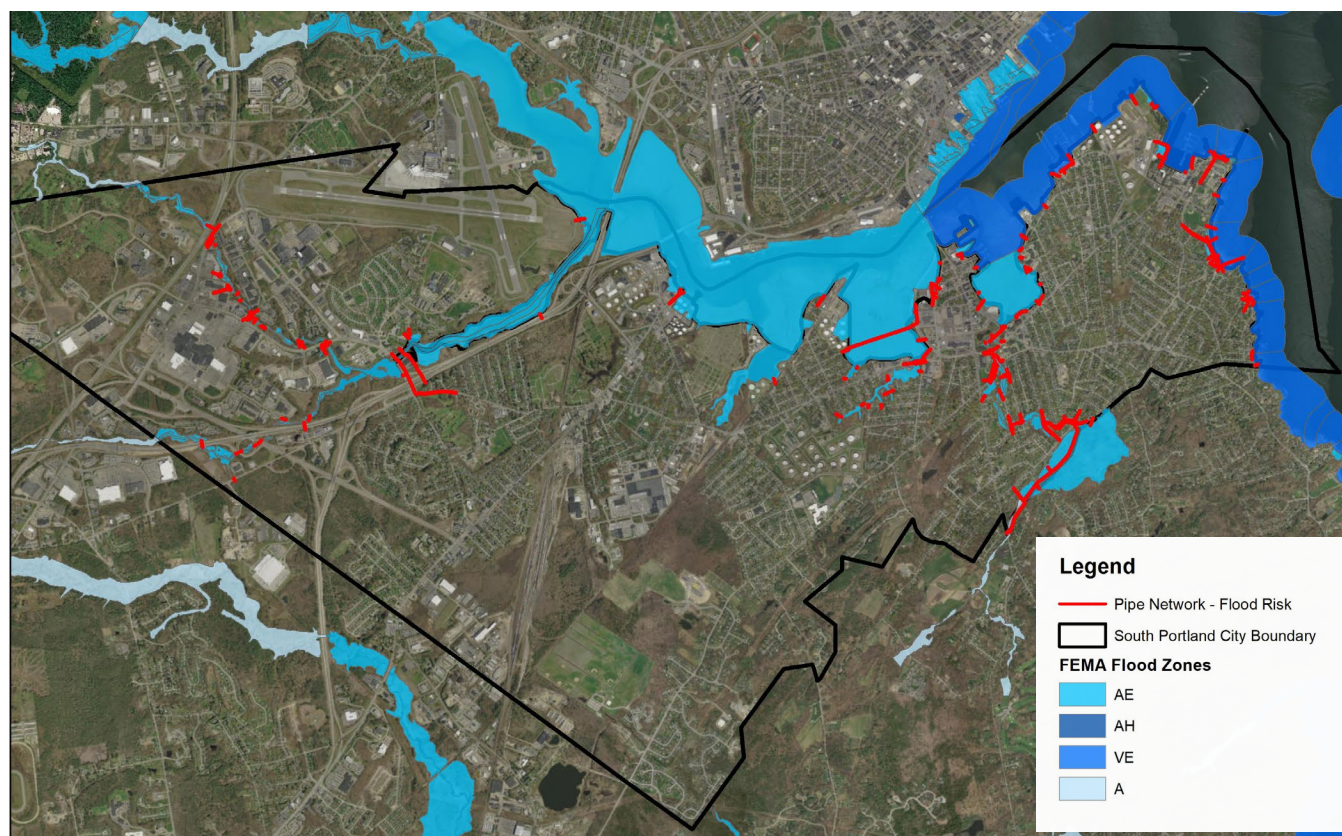


Figure 3.14. Pipe network segments in South Portland that are vulnerable to the 1% annual chance flood. Data from the City of South Portland and FEMA preliminary flood zones (2018).

the AE flood zone (approximately 3 percent of the pipe network); and roughly 1,002 linear feet are in the A flood zone (less than 1 percent of the pipe network). Areas of vulnerable pipe network are primarily along the coast and Fore River shoreline, Long Creek, and Trout Brook.

At a sea level rise scenario of HAT + 3.9 feet, approximately 4 percent of the overall South Portland pipe network will be vulnerable to inundation. The high-risk areas include Knightville, Ferry Village, Cushing Point, and Simonton Cove. In addition to the inundation of pipe networks from flooding, pipes will be increasingly subject to structural damage by more intense freeze-thaw cycles and increased groundwater salinity.

E) Combined Sewer Overflows (CSOs) — Based on the flood risk assessment, none of the six existing CSO

locations in South Portland are predicted to be impacted by flooding from the 1% annual chance flood. Of the six CSO sites, one is vulnerable to sea level rise based on the HAT + 3.9 feet scenario. This impacted CSO site is located in Ferry Village. In total, there could be four active CSO sites impacted under 8.8 feet of sea level rise on top of the highest astronomical tide. See **Figure 3.15** for locations of the four impacted CSOs.

High Priority Areas

Through this evaluation, the areas included in **Figure 3.16** were identified as high priority vulnerable areas. **Table 3.8** summarizes areas of Portland and South Portland's wastewater system that will be impacted by the 1% annual chance flood and/or the sea level rise scenarios that were discussed in this section. These areas are labeled in **Figure 3.16**.

South Portland CSO Sites Vulnerable to Sea Level Rise

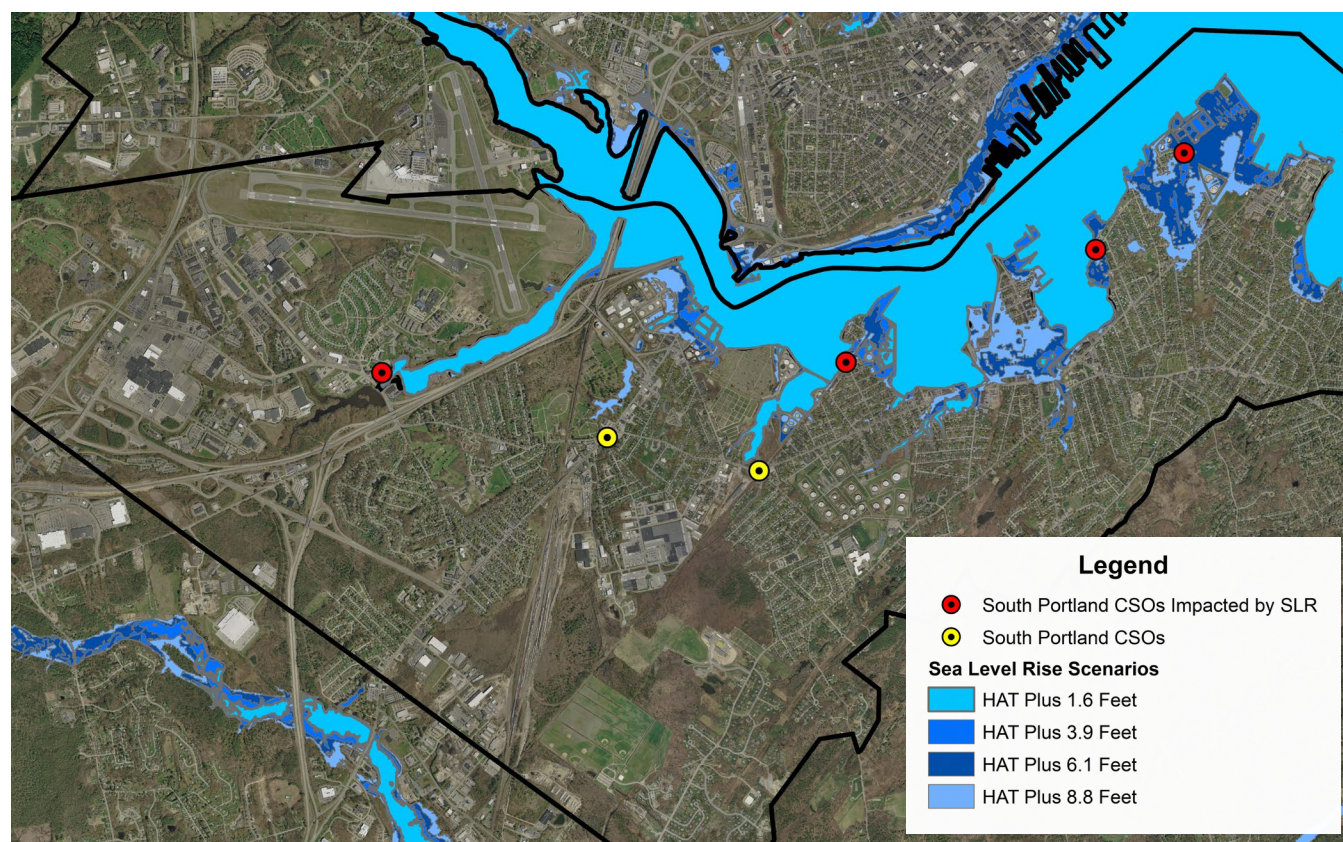


Figure 3.15. CSO locations in South Portland that are vulnerable to flooding based on four sea level rise scenarios. Data from the City of South Portland and Maine Geological Survey Sea Level Rise/Storm Surge Scenarios (2018).

Wastewater Infrastructure Impact Summary by Area

Area	City	Pump Station(s)	CSO Site(s)	Manholes	Pipe Network	WWTF
Back Cove	Portland	X	X	X	X	
Bayside	Portland	X	X	X	X	
East End	Portland	X			X	
Riverton	Portland	X				
Peaks Island	Portland	X				
Commercial Street	Portland		X	X	X	
Stroudwater	Portland	X		X		
Simonton Cove	South Portland	X		X	X	
Ferry Village	South Portland	X	X		X	
Cushing Point	South Portland	X		X	X	
Knightville	South Portland	X		X	X	X
Turner Island	South Portland	X	X	X		

Table 3.8. Summary of affected infrastructure in high priority areas in Portland and South Portland that have large numbers of stormwater and sewer infrastructure assets vulnerable to the 1% annual chance flood and/or sea level rise.

Reference Map for High Priority Areas in Table 3.8

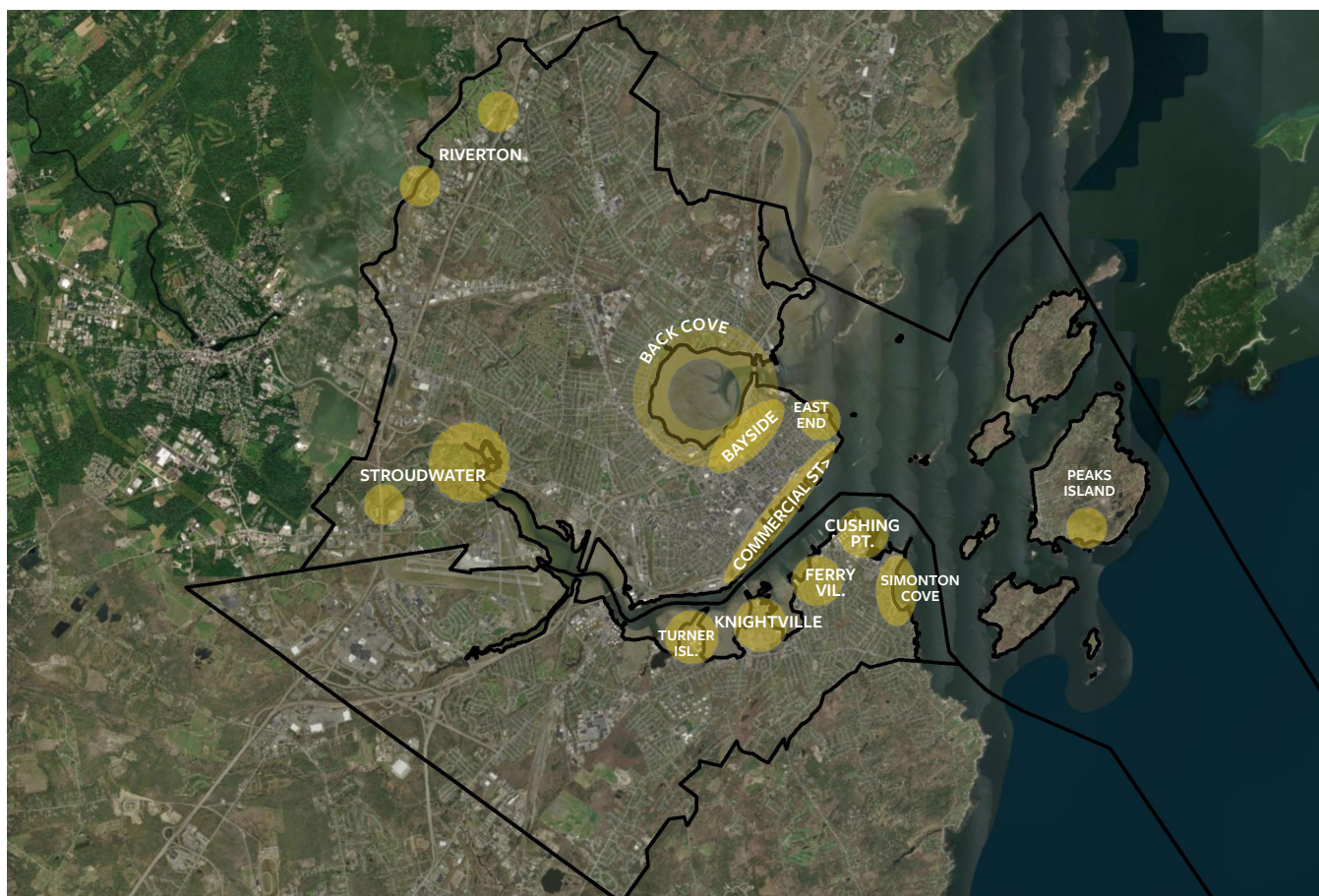


Figure 3.16. High priority areas in Portland and South Portland that have large numbers of stormwater and sewer infrastructure assets vulnerable to the 1% annual chance flood and/or sea level rise.

3.3 Transportation Infrastructure

Portland and South Portland are fortunate to have a multi-modal transportation network serving residents, businesses, visitors, and key economic sectors. The various transportation systems are designed to consider some weather interruptions; however, climate change is expected to increase the frequency, intensity, and duration of the extreme weather events, while also causing long-lasting change to the cities through sea level rise. Transportation infrastructure may face acute or chronic damage, disruption, or delay, or complete long-term loss of capacity depending on location. Adaptation will be necessary to ensure the ongoing reliability, safety, and efficiency of the local and regional transportation system. Major transportation assets in the two communities include:

Roads — Interstate highways I-95 and I-295; US Routes 1 and 302; State and local roadway networks

Air — Portland International Jetport (passenger and freight)

Rail — Pan Am Railways, St. Lawrence and Atlantic Railroad Co. (freight rail); Turner Island LLC (freight terminal and switching); Amtrak Downeaster (passenger rail); Portland Transportation Center (passenger train and bus station)

Bus — Greater Portland Transit District METRO (local bus service); South Portland Bus Service (local bus service); Shuttlebus-Zoom (local bus service); Lakes Region Explorer and Paratransit (local bus service); Concord Coach Lines (regional bus service); Greyhound Bus Lines (regional bus services); Portland Transportation Center (passenger train and bus station); Greyhound Bus Station (passenger bus station); South Portland Bus Transit Hub (passenger bus station)

Marine — Casco Bay Lines (passengers and freight ferry service); Portland OceanTerminal (passenger and freight ferry terminal); Ocean Gateway Terminal (international ferry and cruise ship terminal); International Marine Terminal (international marine freight terminal); Merrill Marine Terminal (private marine freight terminal); Many private petroleum storage and distribution terminals

Bike and Pedestrian — Networks of bike lanes, shared use pathways, neighborhood byways, sidewalks, and trails

INTERSTATES AND ROADWAYS

Activity in Portland and South Portland relies on extensive road networks, including interstates, arterials, collectors, and local roads. Arterials are high-capacity roads that transport traffic between major destinations and to interstates or highways. A collector road connects traffic between local and arterial roads. Local roads are the most common; they have high accessibility to abutting land uses and connect to collector and arterial roads. Obstructions or closures will create different types of vulnerabilities depending on the road type. Closures or obstructions of arterial roads could be considered more acute—they would quickly affect a larger number of people and make evacuation more difficult during emergency situations. Impacts to collector and local roads, however, would affect the ability of drivers to access specific areas, business, and services.

Assessment of Highway Corridor Priority Areas

As part of the Maine DOT highway asset management program, highway assets are categorized into six levels known as Highway Corridor Priorities (HCP), used for monitoring roadway conditions and prioritizing investment. Highway Corridor Priorities were set by Maine DOT based on several factors including the function of the roadway and its contribution to the overall economic health of the state. This assessment looks at the flood vulnerability of HCP categories 1 through 4 as a means for understanding the climate vulnerability of the major road networks in Portland and South Portland. Categories 1 through 4 are defined as:

- Priority 1 – Includes the Maine Turnpike, interstate system, and key principal arterials
- Priority 2 – High-value arterials
- Priority 3 – Remaining arterials and significant major collector highways
- Priority 4 – Remaining major collector highways, and minor collector highways

As outlined in the Introduction of the Infrastructure Section, two sets of flood risk data were used in this analysis, which provide complementary assessments of flood risk. The first investigation looks at FEMA Flood Rate Insurances Maps (FIRMs), which depict areas that are vulnerable to inundation by the 1% annual chance flood. (See page 35 for descriptions of the flood zone designations.) The second investigation uses geospatial data from the Maine Geological Survey, which shows relative levels of inundation from sea level rise or storm surge for the Maine coast for the year 2100 under six scenarios. The specific scenarios selected for this analysis include 1.6, 3.9, 6.1 and 8.8 feet of sea level rise on top of the highest astronomical tide (HAT), which correspond to the Low-Intermediate, Intermediate, Intermediate-High and High scenarios for 2100, respectively. By 2050, we would expect to already see 1.48 feet of relative

sea level rise under the Intermediate scenario, or 3.38 feet under the Extreme scenario specifically for the Greater Portland area. (See page 35 for further details.) The Maine DOT data for High Corridor Priorities were updated as of July 2019.

Portland — HCP roadways in the vicinity of Back Cove that may be impacted by the current 1% annual chance flood include Route 1 at Martin's Point (priority 3), and Baxter Boulevard on the north side of Back Cove (priority 4) (**Figure 3.17**). Although I-295 crosses an AE flood zone north of Back Cove and a VE flood zone at Tukey's bridge, the FEMA maps suggest that the roads are elevated enough in both locations so as not to be affected. Other HCP roadways in Portland that may be affected by the 1% annual chance flood include Congress Street (priority 2) where the route crosses the Fore

Highway Corridor Priority Roadways and FEMA Flood Zones – Back Cove



Figure 3.17. Highway Corridor Priority (HCP) areas in Portland's Back Cove overlaid with FEMA flood zones for the 1% annual chance flood. HCP roadways in the Back Cove vicinity that may be impacted include Route 1 at Martin's Point (priority 3), and Baxter Boulevard on the north side of Back Cove (priority 4). Data from Maine DOT and FEMA preliminary flood zones (2018).

River, as well as potentially a couple small pinch points on Brighton Ave (priority 2) and Capisic Street (priority 4) where the routes cross the Capisic Brook and Capisic Pond, respectively. However, culverts in both locations may prove sufficient.

With sea level rise up to 3.9 feet above the highest astronomical tide (HAT), the highest priority roads in Portland that are expected to be affected include I-295 exits 7 and 6A (priority 1); Franklin Street, State Street, High Street, Commercial Street, and Congress Street where it crosses the Fore River (priority 2); Marginal Way, Preble Street, and Elm Street (priority 3); and Baxter Boulevard and Forest Ave (priority 4). A number of additional priority roads would be potentially inundated

if sea levels reach 8.8 feet above the astronomical high tide—most critically I-295 (priority 1), as well as Fore River Parkway and Washington Ave (priority 2) (**Figures 3.18 and 3.19**). Interstate and high-value arterials tend to accumulate higher volumes of traffic on a daily basis and provide more direct routes for drivers, which makes closures on these routes most problematic.

South Portland — Based on the information available in the assessment, no High Corridor Priority roadways in South Portland are vulnerable to the 1% annual chance flood. HCP roadways also show very little vulnerability to inundation up through 3.9 feet of sea level rise on top of the astronomical high tide. Broadway where the route crosses Anthoine Creek and the Mill River (priority 2)

Highway Corridor Priority Areas Vulnerable to Sea Level Rise – Back Cove



Figure 3.18. Highway Corridor Priority (HCP) areas in Portland's Back Cove area that are vulnerable to flooding based on four sea level rise scenarios. Data from Maine DOT (HCP areas) and Maine Geological Survey (sea level rise inundation).

Highway Corridor Priority Areas Vulnerable to Sea Level Rise – Commercial Street

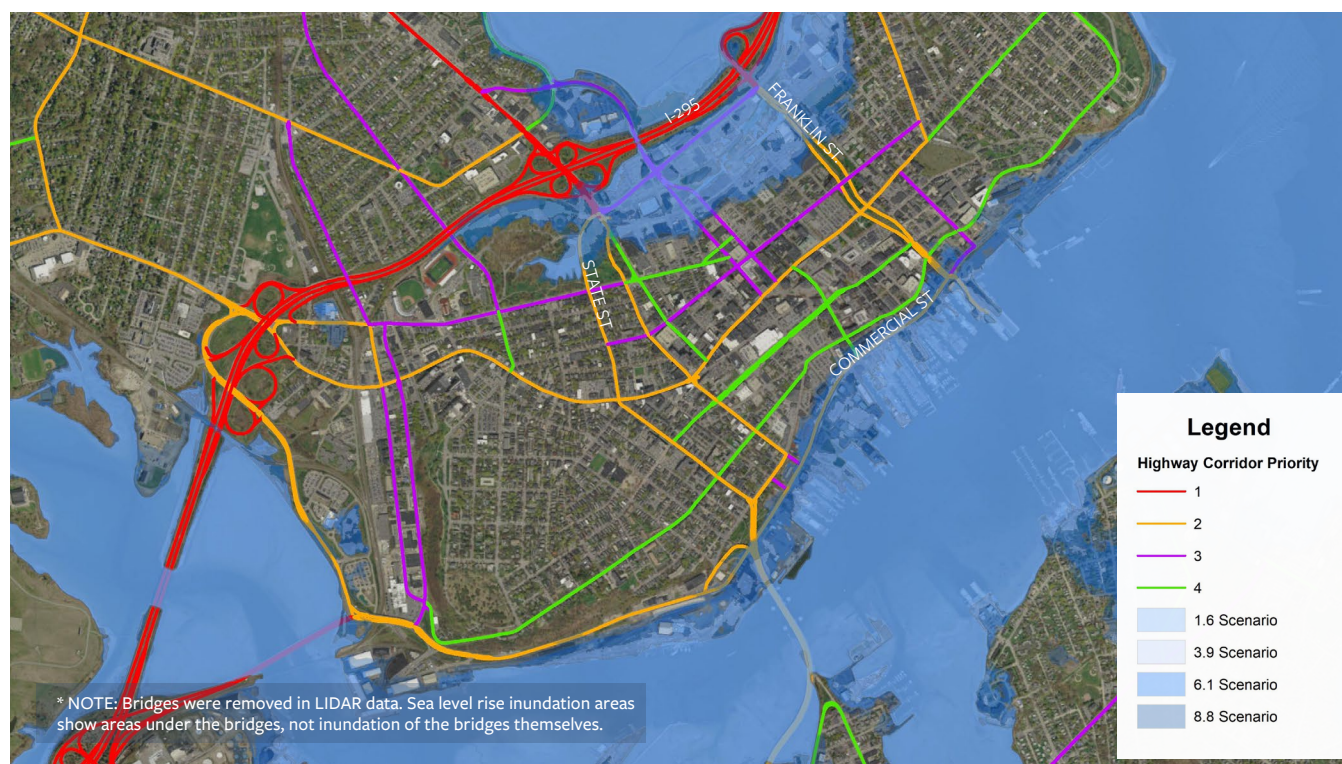


Figure 3.19. Highway Corridor Priority (HCP) areas in Portland's Commercial Street area that are vulnerable to flooding based on four sea level rise scenarios. Data from Maine DOT and Maine Geological Survey Sea Level Rise/Storm Surge Scenarios (2018).

Portland Highway Corridor Priority Roadways Impacted by Sea Level Rise

Road Segment	Ranking	Area	Note
I-295	Priority 1	Back Cove	I-295 is a major highway corridor through the City of Portland and heavily traveled. The roadway provides access to and from the City of Portland.
Franklin Street	Priority 2	Back Cove	Franklin Street connects I-295 and the waterfront, and provides access to downtown.
Washington Ave	Priority 2	Back Cove	Washington Ave provides access to the northwest side of the city (East and North Deering), and connections between I-295 and areas to access I-95.
State Street / High Street / Forest Ave	Priority 2	Back Cove	The State Street / High Street / Forest Ave intersection provides access to and from I-295 and to the waterfront through downtown Portland.
Marginal Way	Priority 3	Back Cove	Marginal Way parallels I-295, provides access to a number of the highway on-ramps, as well as area businesses.
Preble Street / Elm Street	Priority 3	Back Cove	Preble Street / Elm Street provide connections between Back Cove / Baxter Boulevard and downtown Portland.
Baxter Boulevard	Priority 4	Back Cove	Baxter Boulevard is a frequently used scenic roadway that provides access between the downtown peninsula and western portions of the city.
Commercial Street	Priority 2	Waterfront	Commercial Street is the main roadway serving the waterfront.
Fore River Parkway	Priority 2	Waterfront	Fore River Parkway provides direct access to the downtown area of the city as well as the Casco Bay Bridge which serves South Portland.

Table 3.9. Maine Department of Transportation Highway Corridor Priority (HCP) Roadways (priority categories 1-4) in the City of Portland that are projected to be impacted by sea level rise based on four sea level rise scenarios for 2100.

Highway Corridor Priority Areas Vulnerable to Sea Level Rise – Knightville and Ferry Village

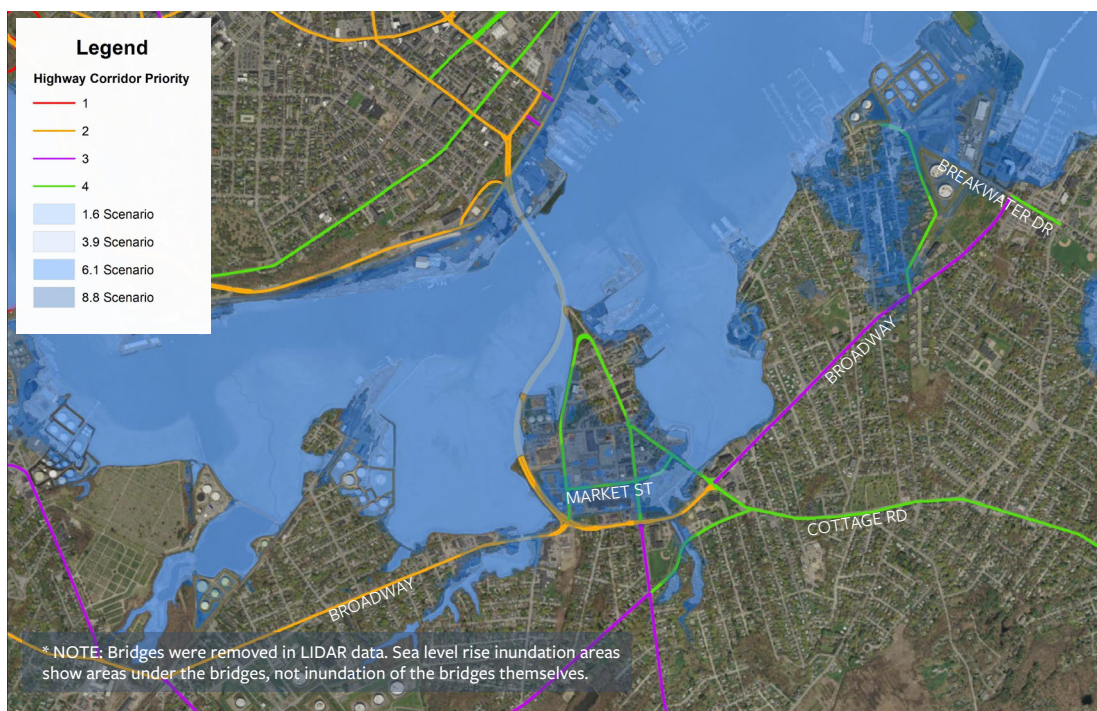


Figure 3.20. Highway Corridor Priority (HCP) areas in South Portland’s Knightville and Ferry Village neighborhoods that are vulnerable to flooding based on four sea level rise scenarios. Data from Maine DOT and Maine Geological Survey Sea Level Rise/Storm Surge Scenarios (2018).

South Portland Highway Corridor Priority Roadways Impacted by Sea Level Rise

Road Segment	Ranking	Area	Note
Casco Bay Bridge	Priority 2	Knightville	The impacts will be to the roadway from Casco Bay Bridge as it turns into Broadway, or the approach to the bridge, not to the actual Casco Bay Bridge roadway itself.
Broadway	Priority 2	Knightville	Broadway in Knightville is a heavily traveled roadway that provides access to Casco Bay Bridge, the Mill Creek shopping area and the wastewater treatment plant.
Broadway	Priority 3	Ferry Village	Broadway in Ferry Village provides access to residential, recreation, marina, commercial, retail, restaurant, and industrial uses.
Waterman Drive	Priority 4	Knightville	Waterman Drive provides access to the wastewater treatment plant, Thomas Knight Park, and South Port Marine. This area of the city also has residential, commercial, restaurant, and retail uses.
Ocean Street	Priority 4	Knightville	Ocean Street provides access to residential, commercial, and retail uses.
Hinkley Drive & Market Street	Priority 4	Knightville	Hinkley Drive / Market Street provide access between Cottage Road and Waterman Drive through the Mill Creek shopping area.
Cottage Road	Priority 4	Knightville	Cottage Road provides access to the Mill Creek shopping area and connector roads to the wastewater treatment plant.
Highland Avenue	Priority 4	Knightville	Highland Avenue provides a connection to and from South Portland to roadways leading to Cape Elizabeth and residential neighborhoods in South Portland.
Henley Street	Priority 4	Ferry Village	Henley Street provides local access to the Portland Pipeline and Gulf Oil terminals.
Preble Street	Priority 4	Ferry Village	Preble Street provides local access to the Portland Pipeline and Gulf Oil terminals.

Table 3.10. Maine Department of Transportation Highway Corridor Priority (HCP) Roadways (priority categories 1-4) in the City of South Portland that are projected to be impacted by sea level rise based on four sea level rise scenarios for 2100.

show potential vulnerable pinch points. With sea level rise up to 8.8 feet on top of the highest astronomical tide (HAT), affected HCP roadways in South Portland include Broadway near Knightville and at the junction to the Casco Bay Bridge (priority 2); Broadway at Ferry Village (priority 3); as well as Waterman Drive, Ocean Street, Market Street, Cottage Road (in Knightville), and Preble Street (in Ferry Village) (priority 4). This level of inundation cuts off access to the City's wastewater treatment plant (via Waterman Drive) (**Table 3.10**).

Annual Average Daily Traffic

Further evaluation of roadway vulnerability for Portland and South Portland was completed through the review of annual average daily traffic (AADT) data collected by Maine DOT. AADT is the accumulation of daily traffic volume measurements over the course a year, then divided by 365 to calculate an average per day. The use of AADT data is a best practice for determining the volume of traffic a road experiences and how it should be planned for, designed, or maintained.

This assessment was completed to understand which high-volume roadways are vulnerable to flooding. There is no specific threshold by which roadways are categorized as either low-volume or high-volume; this cutoff varies state-to-state. Based on the AADT data for Portland and South Portland, it was determined that any road with an AADT equal to or greater than 5,000 would be assessed for flood risk to determine high-volume roadways of concern. AADT data is based on road

High-Volume Roadways Vulnerable to the 1% Annual Chance Flood in Portland

Road Type	Miles Impacted	% of Total Miles (AADT >5000)
Interstate	2.11	5.6%
Major Collector	0.95	2.5%
Minor Arterial	0.30	0.8%
Local	0.0	0.0
Other	0.33	0.9%

Table 3.11. Extent of high-volume roadways (annual average daily traffic greater than 5,000) in FEMA A, AE, and VE flood zones in Portland. All zones represent vulnerability to the 1% annual chance flood.

segments; therefore, the maps show segments in which at least a portion of the segment is impacted by flooding.

As used in the analysis of HCP roadways, flood risk was assessed using both the preliminary FEMA flood zone data (2018) for the 1% annual chance flood and Maine Geological Survey data (2018) for four sea level rise scenarios for 2100 (Low-Intermediate, Intermediate, Intermediate-High and High scenarios).

High-Volume Roadways Vulnerable to Inundation from Sea Level Rise in Portland

Road Type	Miles Impacted	% of Total Miles (AADT >5000)
HAT + 1.6 Feet		
Interstate	0.0	0.0
Major Collector	0.0	0.0
Minor Arterial	0.1	0.3%
Local	0.1	0.3%
Other	0.0	0.0
HAT + 3.9 Feet		
Interstate	0.3	0.7%
Major Collector	0.1	0.2%
Minor Arterial	0.1	0.3%
Local	0.1	0.3%
Other	0.0	0.0
HAT + 6.1 Feet		
Interstate	2.8	7.3%
Major Collector	0.9	2.3%
Minor Arterial	1.7	4.4%
Local	0.2	0.5%
Other	0.1	0.3%
HAT + 8.8 Feet		
Interstate	3.2	8.5%
Major Collector	1.0	2.8%
Minor Arterial	2.1	5.5%
Local	0.2	0.5%
Other	0.1	0.4%

Table 3.12. Extent of high-volume roadways (annual average daily traffic greater than 5,000) in Portland that are vulnerable to sea level rise based on four sea level rise scenarios on top of the astronomical high tide (HAT).

Portland — Overall, there are five segments of Interstate and two segments of Major Collector roadways in coastal Portland, and several inland road segments, where some of the roadway is located in FEMA flood zones (**Figure 3.21**). The impacted roadways surrounding Back Cove are considered high-risk areas due to high traffic volumes. **Table 3.11** details the percentage of the heavily traveled roadways in Portland that are in any designated flood zone along with estimated AADT.

Sea level rise will further amplify the flooding experienced during the 1% annual chance storm (**Figure 3.22**). A significant number of road segments are projected to be inundated at the highest astronomical tide under 1.6 feet of sea level rise, a level that is possible for 2050. Results for each sea level rise scenario are presented in **Table 3.12**. Overall, areas of most concern include Back Cove, Bayside, and Commercial Street.

South Portland — The City of South Portland has minimal flooding impacts to high-volume roadways within the city boundary under the 1% annual chance flood (**Table 3.13** and **Figure 3.23**). The areas affected by flooding are somewhat dispersed, but primarily located along Trout Brook and Anthoine Creek.

Sea level rise will create further flood impacts on heavily traveled roadways in South Portland. There are six primary focus areas: the I-295 bridge crossing, Veterans Memorial Bridge, Pleasantdale, Knightville, Ferry Village, and Simonton Cove/Willard's Beach area (**Figure 3.24**).

High-Volume Roadways Vulnerable to the 1% Annual Chance Flood in South Portland

Road Type	Miles Impacted	% of Total Miles (AADT >5000)
Interstate	1.34	1.2%
Major Collector	0.33	0.2%
Minor Arterial	0.87	0.2%
Local	0.00	0.0
Other	0.95	0.3%

Table 3.13. Extent of high-volume roadways (annual average daily traffic greater than 5,000) in FEMA A, AE, and VE flood zones in South Portland. All zones represent vulnerability to the 1% annual chance flood.

The areas affected will likely cause bottlenecks and access issues in the roadway system. Roadways affected by the various sea level rise scenarios are presented in **Table 3.14**. No high-volume roadways will be impacted by the 1.6-ft and 3.9-ft sea level rise scenarios.

High-Volume Roadways Vulnerable to Inundation from Sea Level Rise in South Portland

Road Type	Miles Impacted	% of Total Miles (AADT >5000)
HAT + 1.6 Feet		
Interstate	0.0	0.0
Major Collector	0.0	0.0
Minor Arterial	0.0	0.0
Local	0.0	0.0
Other	0.0	0.0
HAT + 3.9 Feet		
Interstate	0.0	0.0
Major Collector	0.0	0.0
Minor Arterial	0.0	0.0
Local	0.0	0.0
Other	0.0	0.0
HAT + 6.1 Feet		
Interstate	0.0	0.0
Major Collector	0.3	1.5%
Minor Arterial	0.2	1.1%
Local	0.0	0.0
Other	0	0.0
HAT + 8.8 Feet		
Interstate	0.0	0.0
Major Collector	0.5	2.1%
Minor Arterial	0.4	1.9%
Local	0.04	0.2%
Other	0.0	0.0

Table 3.14. Extent of high-volume roadways (annual average daily traffic greater than 5,000) in South Portland that are vulnerable to sea level rise based on four sea level rise scenarios on top of the astronomical high tide (HAT).

Portland High-Volume Roadways Vulnerable to the 1% Annual Chance Flood

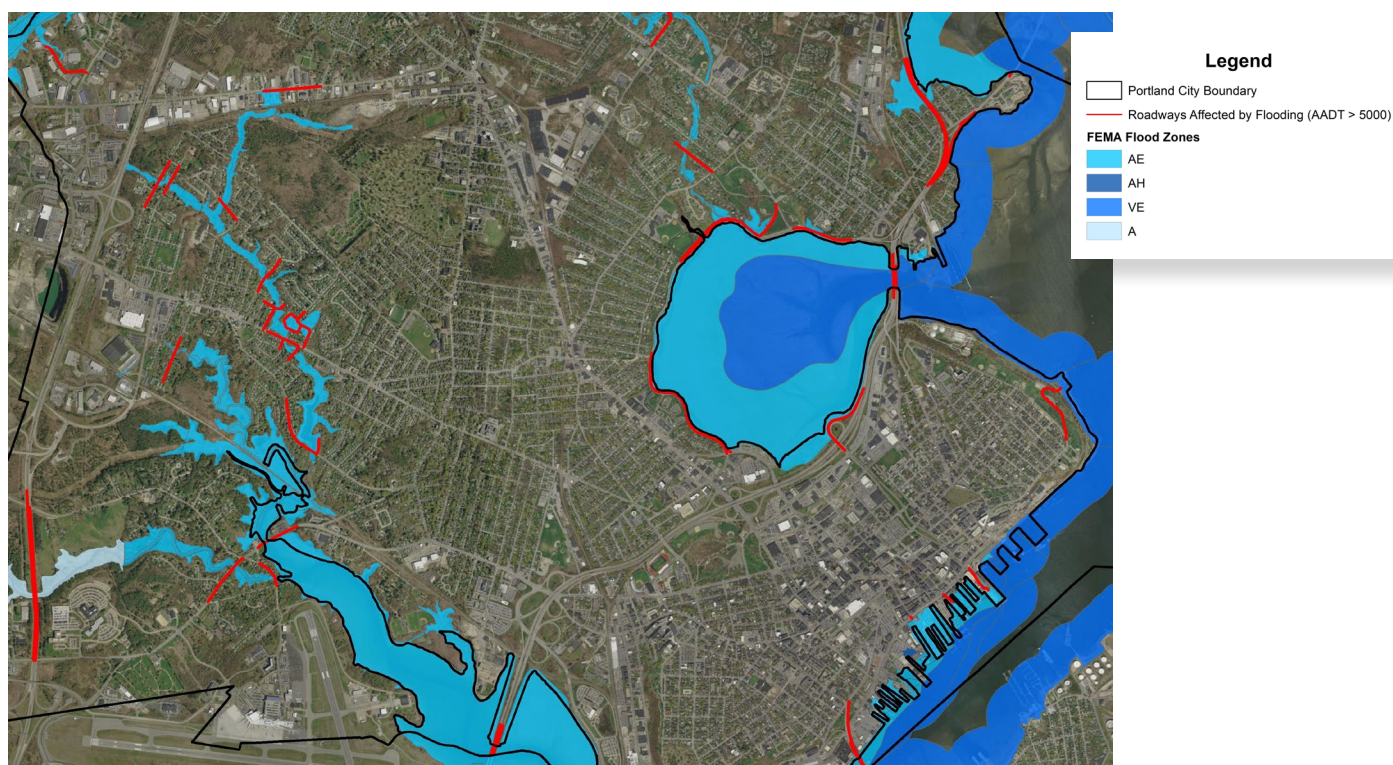


Figure 3.21. High-volume roadways (annual average daily traffic greater than 5,000) in Portland that are vulnerable to flooding from the 1% annual chance flood. Data from Maine DOT and FEMA preliminary flood zones (2018).

Portland High-Volume Roadways Vulnerable to Flooding from Sea Level Rise

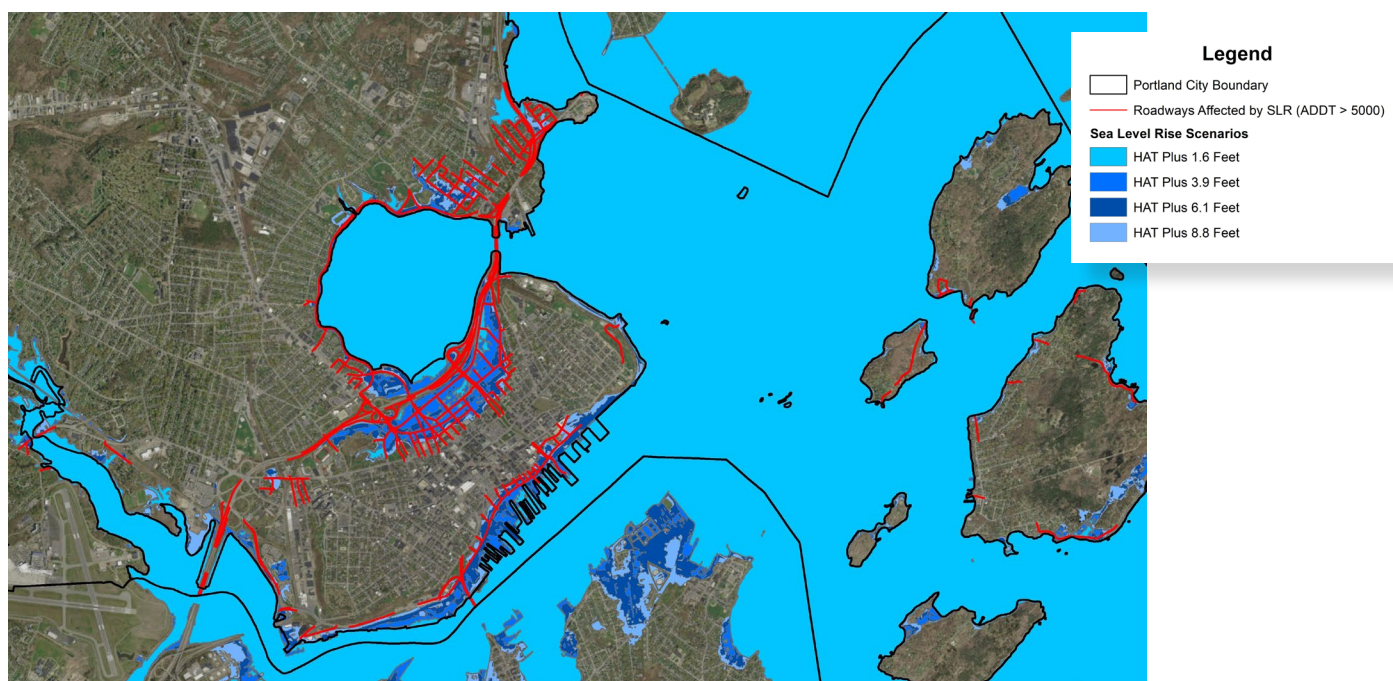


Figure 3.22. High-volume roadways (annual average daily traffic greater than 5,000) in Portland that are vulnerable to flooding based on four sea level rise scenarios. Data from Maine DOT and Maine Geological Survey Sea Level Rise/Storm Surge Scenarios (2018).

South Portland High-Volume Roadways Vulnerable to the 1% Annual Chance Flood

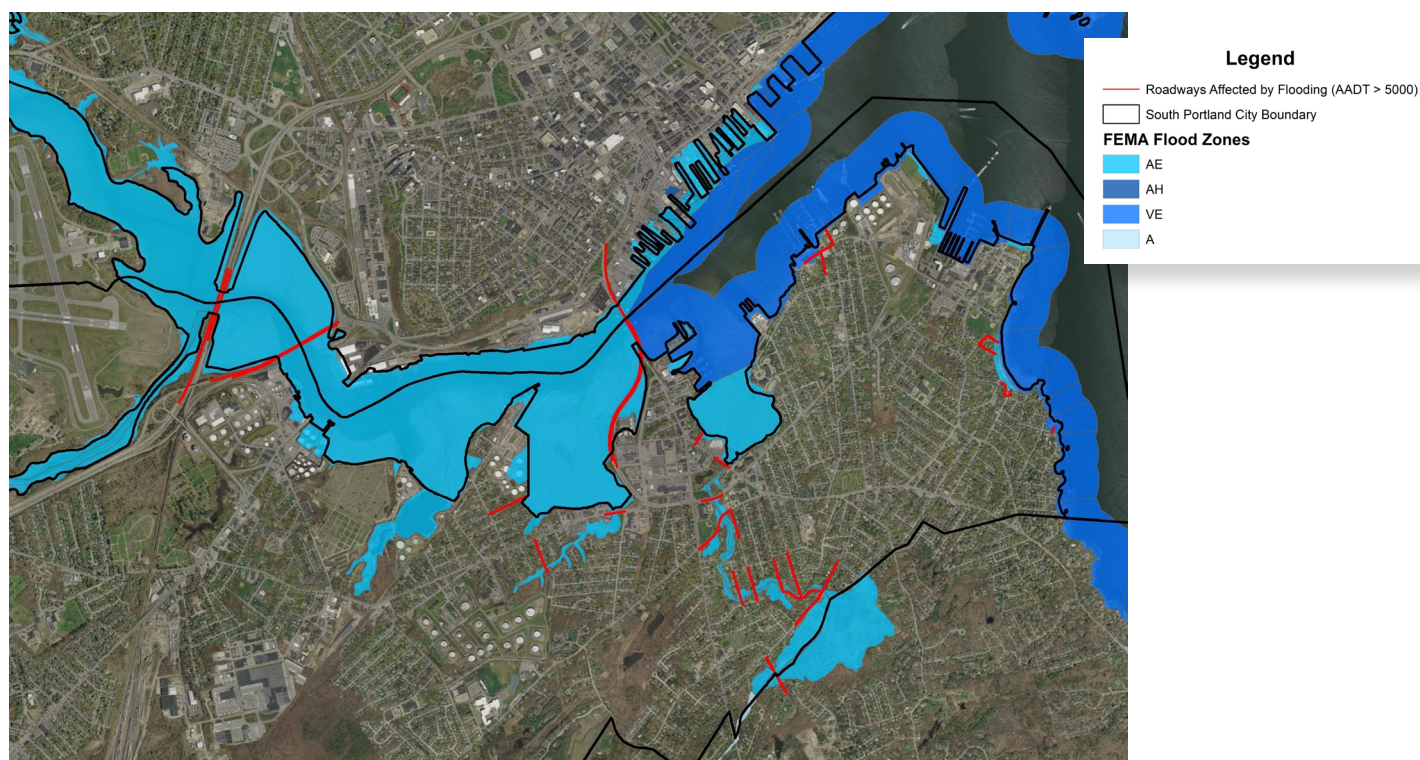


Figure 3.23. High-volume roadways (annual average daily traffic greater than 5,000) in South Portland that are vulnerable to flooding from the 1% annual chance flood. Data from Maine DOT and FEMA preliminary flood zones (2018).

South Portland High-Volume Roadways Vulnerable to Flooding from Sea Level Rise

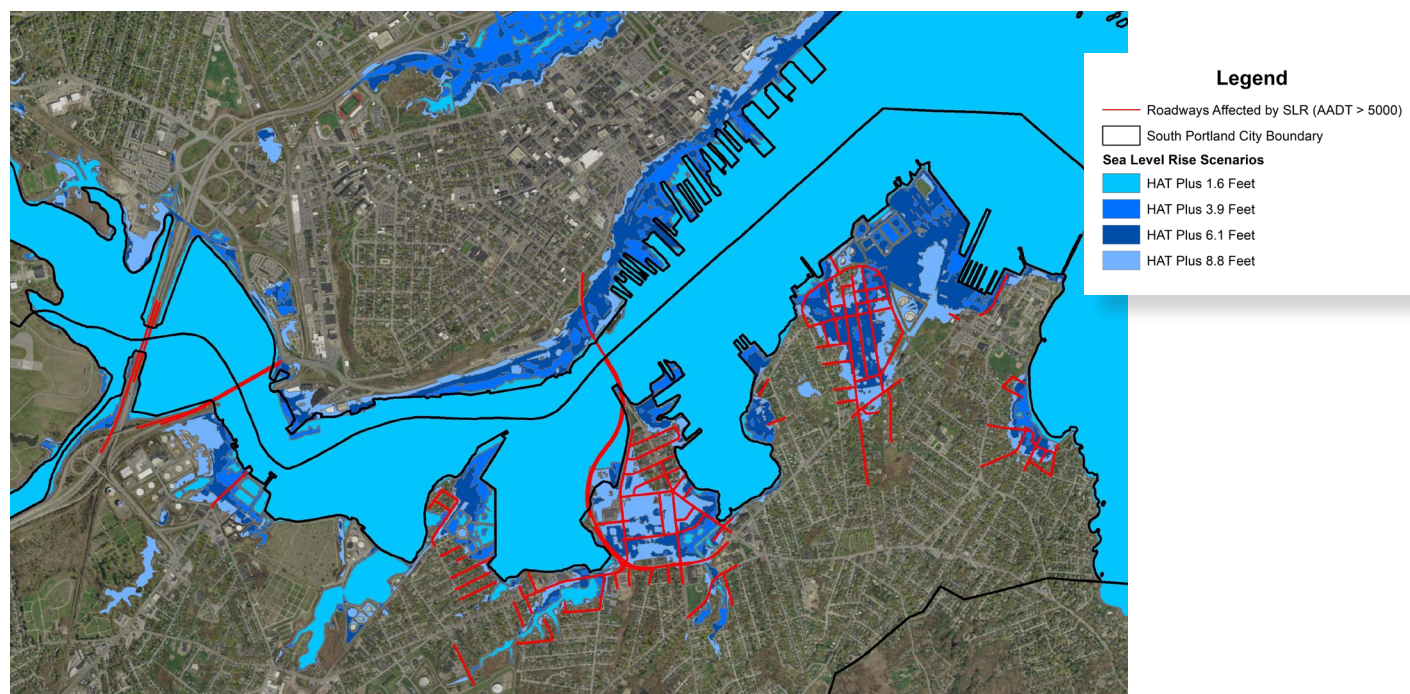


Figure 3.24. High-volume roadways (annual average daily traffic greater than 5,000) in Portland that are vulnerable to flooding based on four sea level rise scenarios. Data from Maine DOT and Maine Geological Survey Sea Level Rise/Storm Surge Scenarios (2018).

AIR TRANSPORTATION INFRASTRUCTURE

The Portland International Jetport is a small commercial airport located near the Fore River in Portland and South Portland. The Jetport has two intersecting runways and a passenger terminal, and accommodates shipping goods by air such as freight and mail. Only a portion of the Jetport's property adjacent to the Fore River is located in a FEMA 1% annual chance flood zone (**Figure 3.25**) and sea level rise is not anticipated to have direct impacts on the runways or passenger terminal. The roadway that serves the airport may be impacted near the Stroudwater area portion of Congress Street. Alternate routes, however, would be available. Potential other climate-related impacts to the Jetport may include schedule disruptions or increased turbulence due to severe storm events or wind pattern changes.

BUS TRANSPORTATION INFRASTRUCTURE

The Greater Portland METRO Bus Service and South Portland Bus Service may experience service interruptions during severe storms or a flooding event, depending on bus routes. Regional bus systems that have bus depots in Portland are Concord Coach, which is located at the Portland Transportation Center on Thompson's Point, and Greyhound, which is located at the corner of Congress Street and St. John Street. Neither of these stations are in the FEMA 1% annual chance flood zones or are projected to be impacted by sea level rise. Although stations are "fixed nodes" in a bus system, routes will likely change over time based on demand and other factors, which also means bus networks will have a level of adaptability to adjust their routes to contend with the effects of climate change.

Portland International Jetport and FEMA Flood Zones

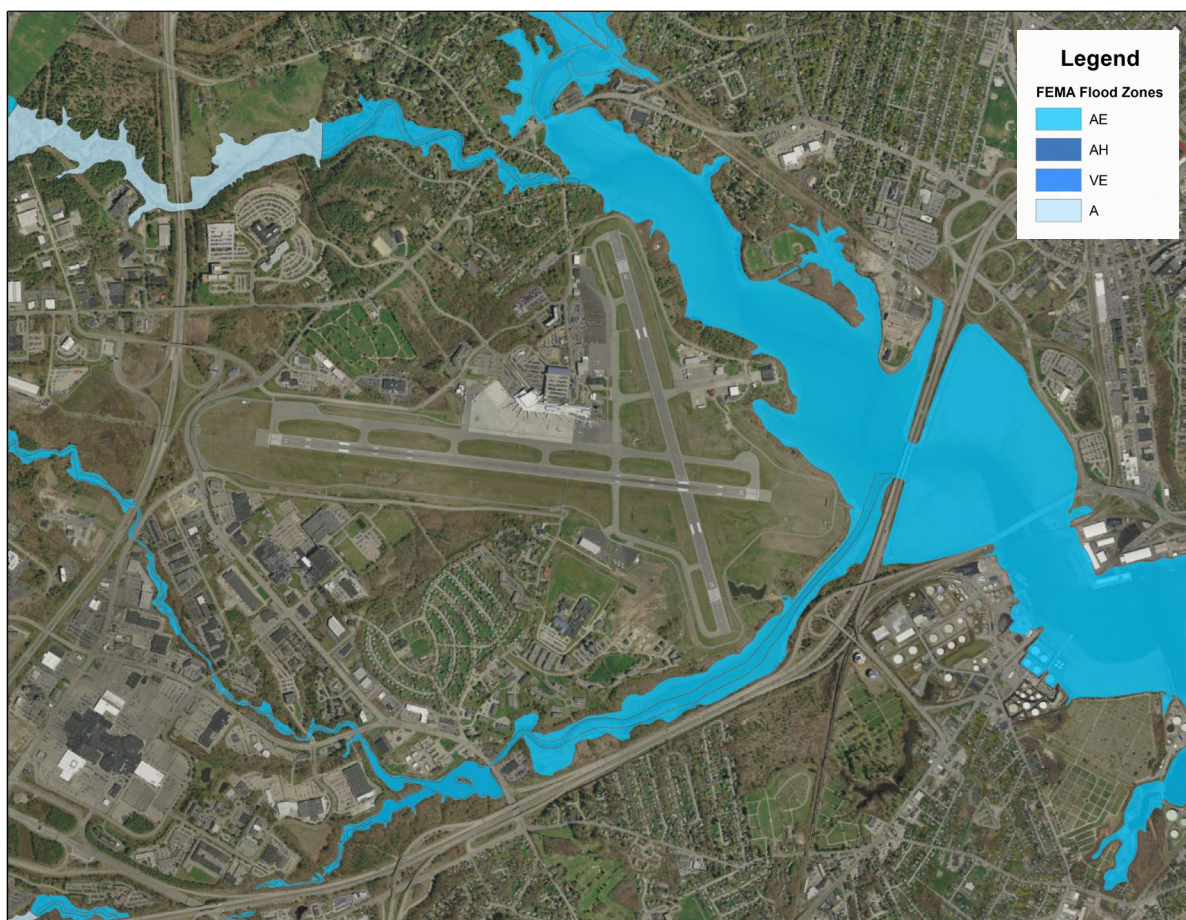


Figure 3.25. Portland International Jetport overlaid with FEMA flood zone data. Neither the passenger terminal nor the runways show vulnerability to the 1% annual chance flood. Data from FEMA preliminary flood zones (2018).

MARINE TRANSPORTATION INFRASTRUCTURE

The Portland Ferry Terminal, Ocean Gateway Terminal, International Marine Terminal, and Merrill Marine Terminal support a mix of passenger and/or freight transit services. The Portland Ferry and Ocean Gateway terminals are located in the FEMA 1% annual chance flood zone and all four terminals are projected to see impacts from sea level rise, which could alter how these services are offered in the future or require relocation or significant upgrades to the docks and terminal buildings.

This marine infrastructure provides a link to land-based infrastructure systems for passengers and the movement of goods. Therefore, without re-engineering these connections across the waterfront, the link to associated parking, trucking, or rail systems would also remain vulnerable. Direct rail connections for moving bulk cargo and container freight are particularly important for the Merrill Marine Terminal (near Veterans Memorial Bridge) and the International Marine Terminal (adjacent to the Casco Bay Bridge). In addition to the marine transportation assets listed above, private shipping terminals in the two cities, and in particular many of the South Portland terminals associated with petroleum storage and transport, are likewise vulnerable to sea level rise and storm surge. (See sections 3.1 *Energy Infrastructure* and 3.5 *Impacts to Sites of Contaminated Soil and Hazardous Waste Containment* for further details.) Extreme weather and flooding may increasingly have the following impacts:

- Interruptions or temporary closures in operations;
- Damage to property (docks, wharves), cargo (containers), or equipment;
- Increased costs from maintenance or repair;
- Need for reconfiguration of operational areas (cargo storage, docks, berths, piers, etc.);
- Increased corrosion or oxidation of equipment, tanks, and pipelines; and
- Spills or accidents that could discharge pollutants into Casco Bay.

For all marine transportation infrastructure, extreme weather may affect shipping conditions, creating greater hazards to navigation, ship, cargo, and crew that could also alter the way these facilities operate. Rising temperatures in the Arctic are likely to make new shipping lanes increasingly navigable, which may create

both new opportunities and risks for shipping transport into the Port of Portland.

RAIL TRANSPORTATION INFRASTRUCTURE

The freight and passenger rail services in the Greater Portland area serve as important transportation connections throughout Maine and New England. Greater Portland has three major freight rail operators:

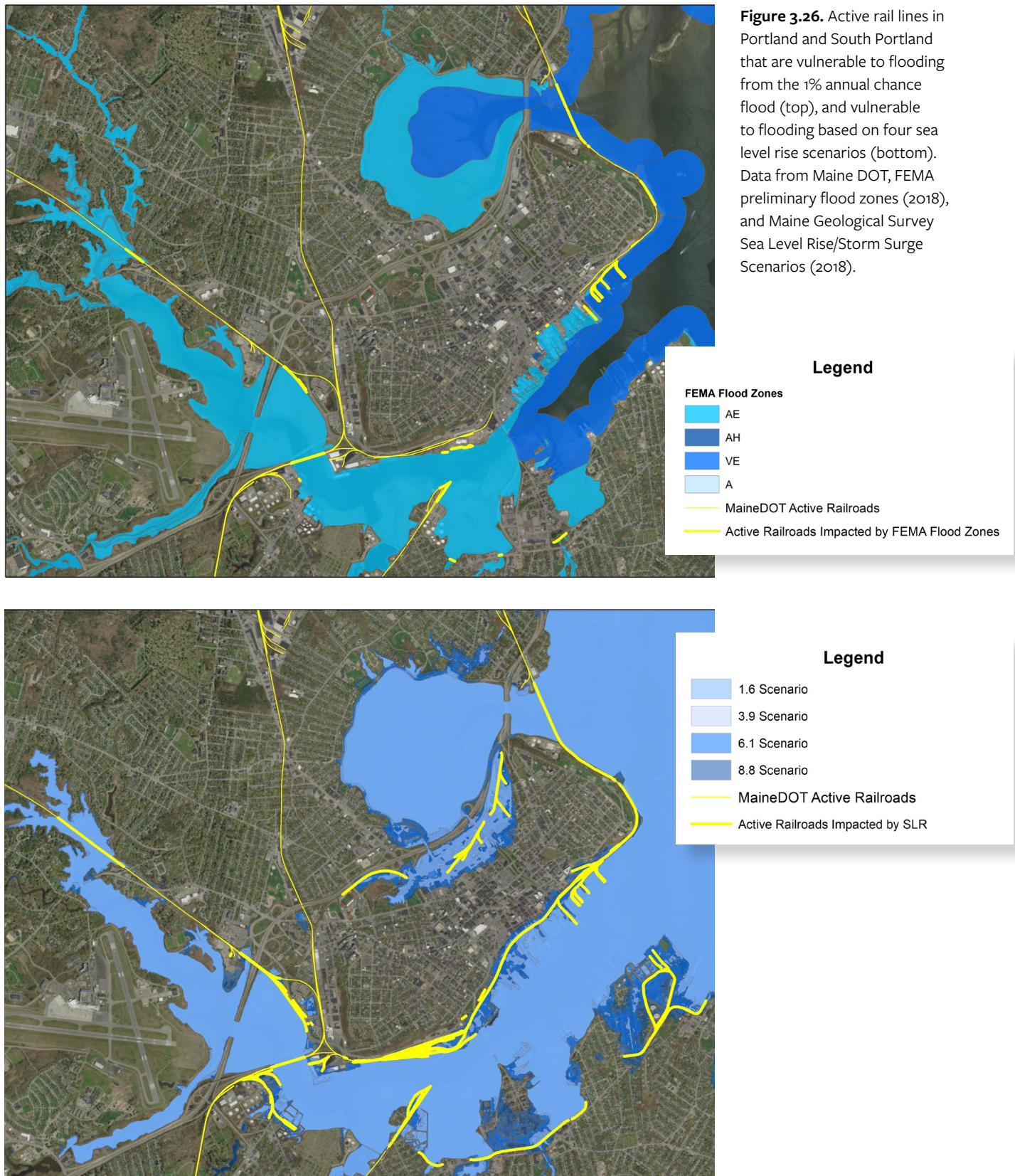
- Pan Am Railways – This operator runs a line from South Berwick, ME through Portland into Penobscot County and is a primary connection to the rest of the country.
- St. Lawrence & Atlantic Railroad Co. – This operator runs a line from Portland north to Montreal.
- Turners Island LLC – This is a terminal operator connecting Pan Am to the shipping facility in South Portland.

In addition to freight rail lines, the Downeaster passenger rail travels a route covering 143 miles between Boston and Brunswick, ME, and makes round trips from Portland to Boston numerous times per day.

Railways generally are sensitive to extreme weather. Flooding and heavy precipitation can accelerate wear on rail lines and cause erosion resulting in instability around rail tracks. Steel tracks are designed to operate in a narrow range of temperatures, based on the climate where (and when) the track was originally installed. Temperatures significantly above the optimal operating temperature can cause the metal to expand and buckle, creating what are called “sun kinks.” More days of extreme heat increase the chance of rail line failure, and train travel must be reduced or put on hold until temperatures drop to reduce stress on the tracks. Recent studies estimate that these delays will have significant economic repercussions throughout the United States, including for routes in Maine.⁸³

The rail lines serving Portland and South Portland also have portions of their tracks located in FEMA flood zones and areas that may be impacted by sea level rise. These conditions have and will cause infrastructure damage, service disruption, and wide scale ripple effects in rail transit. **Figure 3.26** displays the active rail lines in Portland and South Portland, overlaid with the FEMA flood zones and the sea level rise scenarios.

Active Rail Lines in Portland and South Portland Vulnerable to the 1% Annual Chance Flood (top) and to Sea Level Rise (bottom)



3.4 Communication Systems Infrastructure

Information and Communications Technology (ICT) systems include cell towers and facilities, fiber lines, telephone networks, data centers, and other related infrastructure. Each of these components have a service life, which has implications for how we think about the vulnerability of these components to climate hazards.

Figure 3.27 indicates that end user and system devices will likely reach their useful service life before we see the more significant impacts from climate change. Depending on the location, data center and transmission infrastructure installed today may be affected by sea level rise and storm surge seen between now and 2050. However, because their service lives are still relatively short, these systems are better able to incrementally adapt. Infrastructure with significantly longer service lives, such as copper or fiber optic cabling or buildings, will need installation and maintenance plans that consider climate hazards projected for the end of the century.

Table 3.15 summarizes the potential impacts climate change will increasingly have on ICT infrastructure. In particular, the DHS Climate Change Resiliency Assessment for Casco Bay highlighted the risk of severe storms with high winds damaging cellular and microwave towers, higher temperatures affecting electronic equipment, and flooding from heavy precipitation, storm surge, and sea level rise drowning network cables or other equipment.⁸⁴

There are two data centers located in Portland, GWI and FirstLight Portland, and none in South Portland. Both data centers are in downtown Portland near Congress Street, making flooding or sea level rise issues less of a concern. While the data centers generally have diverse underground power feeds and backup generators, potential impacts underground could occur from damage to roadways or land subsidence issues. Above ground, impacts could result from heavy precipitation or high wind events depending on what infrastructure is in place. Wireless, radio or satellite services could be impacted by temperature changes.

Service Life of ICT Infrastructure and Climate Change Impacts

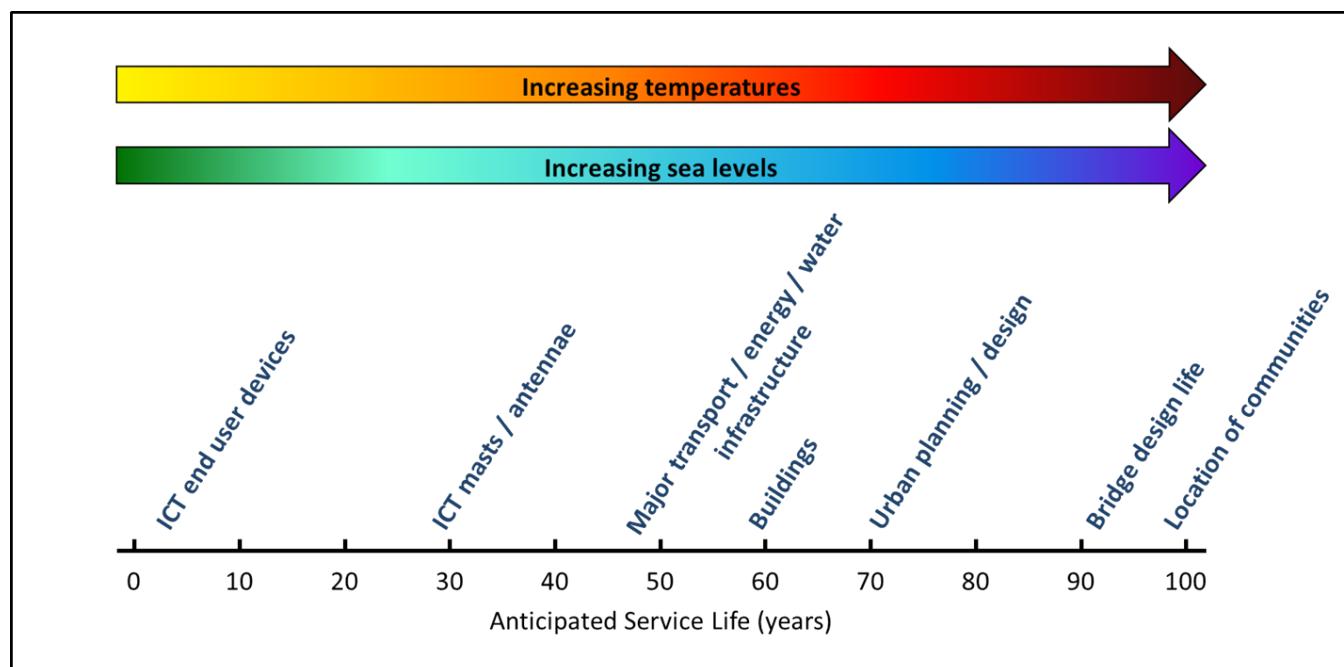


Figure 3.27. Service life of information and communications technology infrastructure with respect to climate change impacts. Source: USAID, Addressing Climate Change Impacts on Infrastructure, (2013).⁹²

Climate Change Impacts on ICT Infrastructure and Services

Climate Change Impact	Transmissions Infrastructure	Wireless Signals	Buildings and Equipment
Temperature Change	Increased heat-related health and safety risks for maintenance workers	Decreased range of wireless signal transmission, resulting in the location/density of wireless masts becoming sub-optimal	- Overheating of data centers, exchanges, base stations, etc. - Increased air-conditioning requirements and costs - Decreased heating requirements and costs
Precipitation Change	- Increased flooding of low-lying/ underground infrastructure and access points, particularly in coastal areas and floodplains - Exposed cables/trunk routes due to erosion or damage of transportation infrastructure	Reduced quality and strength of wireless service due to increased rainfall	Changes in requirements to maintain internal environments of system devices due to changes in humidity
Sea Level Rise and Increased Storm Surge	Increased flooding and salt water corrosion of infrastructure in low-lying/coastal areas	Changes in reference datum for telecommunication and satellite transmission calculations	Closure or reduced access to low-lying coastal buildings due to permanent or temporary flooding
Changes in Extreme Storms and Wind	- Fallen cell towers or telephone poles from high winds or fallen trees - Increased damage to above-ground infrastructure	Minimal Impact	Minimal Impact

Table 3.15. Potential climate change impacts on information and communications technology infrastructure and services. Table adapted from USAID, Addressing Climate Change Impacts on Infrastructure, (2013).⁹³

Any impacts to ICT infrastructure tend to be amplified due to interdependencies between infrastructure systems. ICT networks rely heavily on the power grid, and when there are service interruptions, back-up power is usually provided by petroleum generators. In order to have fuel for the generators, the transportation sector must be functioning. Similarly, infrastructure systems are usually collocated, meaning fiber and telecommunications lines are usually clustered alongside transportation infrastructure. Therefore, a bridge failure may disrupt transportation as well as ICT networks. The collocated telecommunications infrastructure on Pan Am rail bridges is one prime example.⁸⁵

3.5 Impacts to Sites of Contaminated Soil and Hazardous Waste Storage

Historically, the coastal areas of Portland and South Portland served as a home for shipping, fishing, commerce, travel and industrial uses. Portland's industrial revolution from the mid- to late-nineteenth century led to a boom in industries that produced unnatural compounds and introduced them to the environment without restriction—in particular, tanneries, paint factories, shipyards, metal foundries, railroad yards, and a coal-gas plant were the burgeoning Portland-area industrial sites that had the largest environmental impact in that time.⁸⁶

Research commissioned by the Casco Bay Estuary Partnership found that historic development in the Portland and South Portland areas closely reflected the layout of watersheds, as these industries were often reliant on water for processes, power transport, and waste removal (**Figure 3.28**). Although heavy industry is no longer the backbone of the Portland and South Portland economies, the petroleum tanks that were first established in South Portland in the 1920s have continued to make South Portland a regional hub for petroleum transportation. Strict environmental regulations now prevent pollution from the tank farms from entering the bay, and yet the historic and present-day uses of the area have led to a higher concentration of contaminated sites and hazardous material storage facilities in these areas (**Table 3.16**).

Climate hazards pose a significant threat of transporting these materials. Shoreline retreat due to sea level rise could submerge hazardous material sites currently in the floodplain, expose them to wave action, and incorporate new sites into floodplain areas. More frequent extreme weather events could likewise expose these sites to wind and wave action, and higher, salt-containing water tables, which can transport soil-bound pollutants and compromise subsurface containment systems.

Historic Development Areas in 1800s Portland and South Portland



Figure 3.28. Historic development areas in Portland and South Portland that correspond with higher levels of contaminants and hazard storage facilities based on their historic and present uses. Figure source: Hawes, E. (2014).⁹⁴

Historic Uses Associated With Development Areas in Figure 3.28

Development Area	Historic Use
Railroad Triangle	Railroad yards with machine shops, slaughterhouses, soap factory, brickyard.
West Back Cove/Deering	Tanneries, varnish and paint factory, foundry, stoneware factory, brickyard.
North Back Cove/East Deering	Pewter and Britannia metal shops, tanneries, book bindery, can factory, galvanizing and plating shop, possible brickyard.
South Back Cove/Munjoy Hill	Tannery, dump, fill at East Promenade.
South Back Cove/Industrial	Considerable filling of the cove, railroad repair yard, Portland Stove Works, machine shops and metalworking facilities.
Grand Trunk Area	Smelter, cemetery, shipyard, rail yard with machine shop, metal shops, metalworking facilities, major foundry, lead paint factory.
Central Commercial Street	Paint factory, canneries, machine shops and small foundries, galvanizing operations, boat landings.
West Commercial Street	Match factory, sugar refinery, railroad yards, gas works, hat factory, petroleum storage/distribution.
Spring Point	Military bases.
Ferry Village	Shipyard, metalworking facilities.
Knightville/Mill Cove	Dry dock, brewery, and shipyards.
Turner's Island/Pleasantdale	Heavy landfilling, cemetery, rail yard and repair facility.
Rolling Mills/Ligonian	Substantial landfilling, cemeteries, large iron rolling and fabrication facility, acid chemicals plant, kerosene refinery, paint and varnish factory.

Table 3.16. Historic uses associated with development areas in Figure 3.28. Table adapted from Hawes, E. (1994).⁹⁵

CURRENT SITES OF CONTAMINATED SOIL AND HAZARDOUS WASTE STORAGE

Today, the Maine Department of Environmental Protection (DEP) tracks data associated with water quality and potential and actual sources of contamination to groundwater in Maine. The data is referred to as the Environmental and Geographic Analysis Database (EGAD).⁸⁷ This database also includes biological and surface water sampling sites. DEP and staff from the Bureau of Remediation and Waste Management and the Bureau of Water Quality use this information to assess trends in regional surface and groundwater quality and quantity. The EGAD data was used for this vulnerability assessment to identify hazardous waste sites in Portland

and South Portland that might be of particular concern when considered with climate hazards either for the type of contamination, their location, or both. **Table 3.17** indicates the different types of sites that are included within the EGAD data and how those sites are defined by DEP.

The site types in **Table 3.17** relevant to Portland and South Portland can be grouped into two categories:

1. Sites of confirmed or suspected soil contamination, and
2. Hazardous material storage areas.

EGAD Site Type Definitions

Site Type	Definition
Large Bulk Fuel Storage/ Distribution Facility	A group of large above-ground storage tanks (ASTs) usually used to store petroleum products, (i.e., marine terminals, petroleum distribution facilities), with a total facility volume greater than 1,320 gallons.
Leaking Above-ground Storage Tank	(LAST). A container, 90% or more of which is above the ground, which is used to hold oil and other petroleum derived products. It is considered to be leaking if there is some evidence that it has released some of its contents to the environment.
Leaking Underground Storage Tank	(LUST). A container, 10% or more of which is beneath the surface of the ground, which is used to hold oil and other petroleum derived products. It is considered to be leaking if there is some evidence that it has released some of its contents to the environment.
RCRA Large Quantity Generator	A Resource Conservation and Recovery Act (RCRA) Fully Regulated Generator that generates more than 1,000 kilograms (2,205 lbs) of hazardous waste per month. Hazardous waste cannot be stored more than 90 days from date of generation.
RCRA Medium Quantity Generator	A Resource Conservation and Recovery Act (RCRA) generator that generates between 100 and 1,000 kilograms (220-2,205 lbs) of hazardous waste per month, either on average per month or exceeding 100 kg in any one month.
RCRA Small Quantity Generator	A Resource Conservation and Recovery Act (RCRA) generator that generates less than 100 kilograms (220 lbs) of hazardous waste per month AND accumulates no more than 55 gallons (1 drum; ~208 kg) of hazardous waste per month.
Sand/Salt Storage	An area at which salt, or sand-and-salt, are stored in preparation for road and highway deicing.
Sanitary & Industrial WWTF	A wastewater treatment facility (WWTF) used for treating sanitary or industrial wastewater. This may include spray irrigation sites, aerated lagoons, stabilization ponds, polishing ponds, sand filters, and other similar structures used for that purpose.
Surface Spill	A site where oil has been released onto the ground, not caused by a leak from a storage tank. Common examples include heating oil and gasoline tank overfills, tanker truck accidents, and releases from gasoline tanks mounted on vehicles.
Uncontrolled Site, All Other	An uncontrolled hazardous substance site. A location at which hazardous substances came to be located, where the site poses a threat or hazard to any person or the natural environment and requires action to abate.

Table 3.17. Environmental and Geographic Analysis Database (EGAD) site type definitions. Table adapted from Maine Department of Environmental Protection (2019).⁹⁶

Each of these site types is vulnerable in different ways due to climate hazards such as increased precipitation, extreme weather, and sea level rise. While the specific climate vulnerabilities of these sites will be touched on throughout the discussion of their locations, the vulnerabilities are more thoroughly summarized in **Table 3.18**. The sites of confirmed or suspected soil contamination in Portland and South Portland include the sites of former LASTs, LUSTs, surface spills, and salt storage, as well as uncontrolled sites. The sites of hazardous material storage include the RCRA waste generators, as they are permitted to store material on

site subject to various restrictions; the large bulk fuel storage facilities; and the one wastewater treatment facility identified as being vulnerable to the sea level rise scenarios used for this discussion. It is important to keep in mind throughout this discussion that the EGAD data identifies single points, such as the location of a tank farm, that may contain multiple hazards, such as multiple tanks.

The EGAD data was analyzed along with the Maine Geological Survey (MGS) Sea Level Rise/Storm Surge data (2018). As mentioned in the introduction to the

Impacts of Climate Hazards on Vulnerable Hazardous Material Sites

Climate Hazard	Vulnerable Site Type	Potential Effect
Changes in water tables and increased groundwater salinity	Contaminated Soil	Mobilization of contaminants (e.g., from vadose zone to groundwater) → Higher contaminant concentration/export, overpowering significant degradation rate in groundwater zone could remove natural protective barriers Altered salinity → Altered degradation rates (physical, microbial)
	Hazardous Material Storage	Higher groundwater levels → Structural damage to subsurface containments due to increased hydrostatic pressures Altered salinity → Damage to clay containing layers
Sea level rise	Contaminated Soil	Tidal erosion → Damage to site integrity, mobilization of soils Site inundation → Increased mobilization of contaminants, increased bioavailability of contaminants
	Hazardous Material Storage	Tidal erosion → Damage to containment structure integrity due to saltwater corrosion or hydrostatic loads of inundation Site inundation → Containment structure overflow, floating or spilling of improperly secured containers
Extreme weather	Contaminated Soil	Wind/wave action; surface water flow velocity → Scouring, mobilization of soils Flooding → Contaminant export
	Hazardous Material Storage	Wind/wave action; surface water flow velocity → Structural damage to containment structures by wind and hydrodynamic loads as well as debris Flooding → Structural damage to containment structures by hydrostatic loads

Table 3.18. Impacts of climate hazards on vulnerable hazardous material sites. Table adapted from Maco, et al. (2018);⁹⁷ with information from Flynn, T.J. et al. (n.d.).⁹⁸

Infrastructure Section of this report, the MGS sea level rise scenarios selected correspond with the Low-Intermediate, Intermediate, Intermediate-High, and High scenarios for 2100. Under the Intermediate scenario, we would expect to see 1.48 feet of relative sea level rise by 2050 for the Greater Portland area—or up to 3.38 feet under the Extreme scenario. For the sake of visualization, these 2050 thresholds roughly correspond with the

lower two thresholds for 2100 (1.6 and 3.9-foot rise above HAT). An overview of the sites identified within the EGAD dataset that may be specifically impacted by sea level rise is presented in **Figure 3.29**.

Vulnerabilities identified within the 1.6-ft scenario include two RCRA Small Quantity Generators (SQGs) in the Central Waterfront District of Portland, a site of

Vulnerable Hazardous Waste Sites in Portland and South Portland

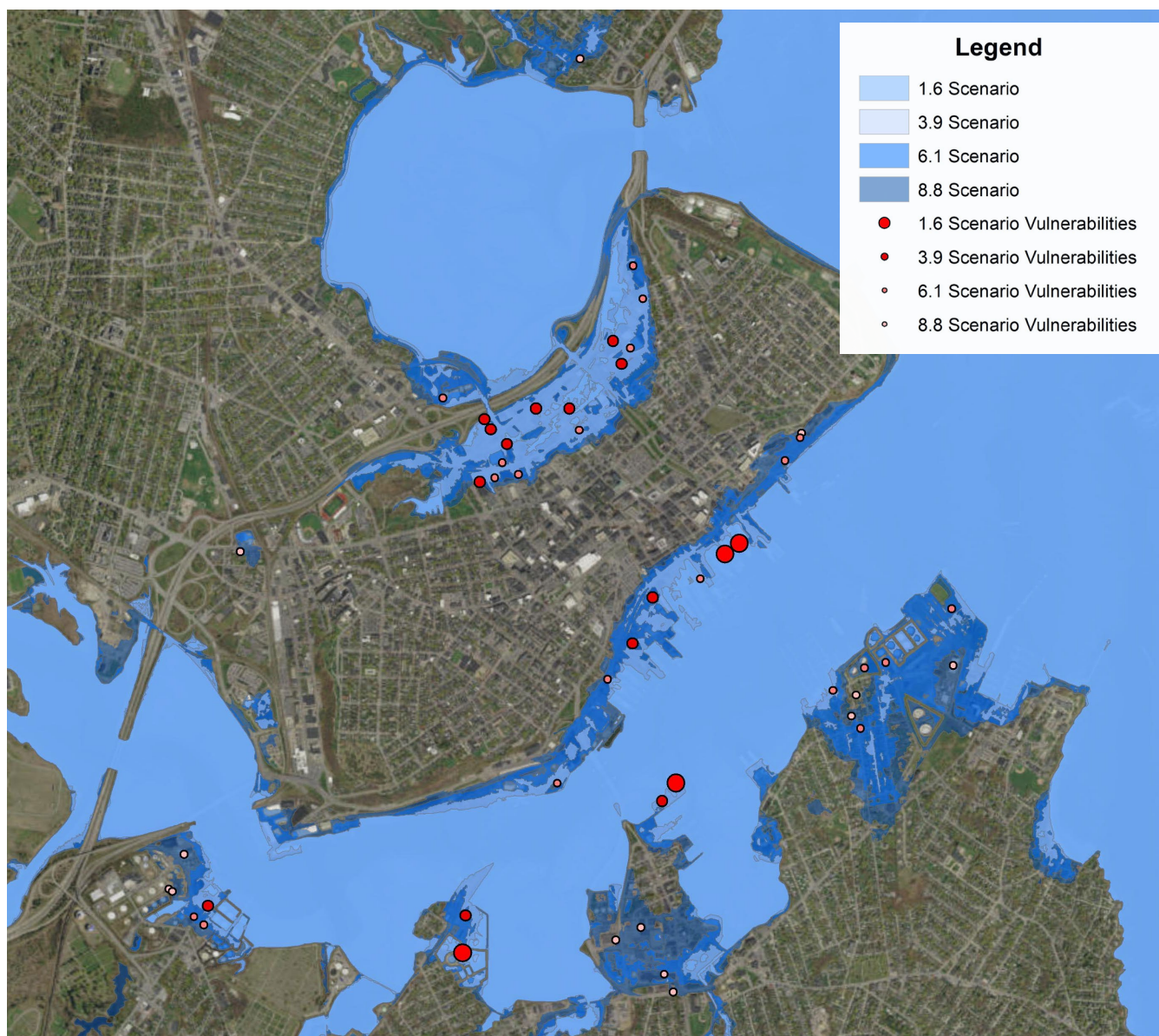


Figure 3.29. Vulnerable hazardous waste sites in Portland and South Portland based on four scenarios of sea level rise (1.6, 3.9, 6.1, and 8.8 feet on top of the highest astronomical tide). Data sources: Maine Department of Environmental Protection, EGAD (2019); Maine Geological Survey Sea Level Rise/Storm Surge Scenarios (2018).

petroleum waste sludge buried on Turner Island and potentially contained by a suspected clay layer below (considered Large Bulk Fuel Storage in the EGAD data), several aboveground storage tanks (ASTs) also on Turner Island, and an AST in the Knightville area of South Portland (**Figure 3.30** and **Table 3.19**).

According to Maine DEP, SQGs may accumulate hazardous waste on site for 180 days, though this quantity may never exceed 440 pounds or 55 gallons.⁸⁸ The EPA regulates that the waste must be managed in tanks or containers, and an emergency coordinator must always be available to respond in an emergency,

but SQGs are not required to have a written contingency plan.⁸⁹ In a worst-case scenario, a severe flood event could hit at a time when vulnerable SQGs are storing the maximum amount of waste permitted.

All 1.6-ft Sea Level Rise Vulnerabilities by Type

Vulnerability Type	Number of Sites
Large Bulk Fuel Storage	3
Small Quantity Generators	2

Table 3.19. Vulnerable hazardous waste sites in Portland and South Portland based on inundation from 1.6 feet of sea level rise on top of the highest astronomical tide (HAT).

Selected 1.6-ft Sea Level Rise Vulnerabilities



Figure 3.30. Vulnerable hazardous waste sites in Portland and South Portland based on 1.6 feet of sea level rise on top of the highest astronomical tide. Data sources: Maine Department of Environmental Protection, EGAD (2019); Maine Geological Survey Sea Level Rise/Storm Surge Scenarios (2018).

In the case of a 1.6-ft tide increase, the three sites of above-ground storage—the two SQGs and the AST—could be subject to wave action and corrosion by saltwater. Should there be a violent storm and flooding, these tanks would be the first to be subjected to damage or dislodgement by forceful wave action, or hydrostatic pressures should they be submerged.

As sea levels rise, so do groundwater levels, and the buried petroleum waste sludge may become vulnerable to migration.⁹⁰ Increased saltwater content in the groundwater could potentially allow water to permeate the clay layer suspected to contain the waste, which is normally impervious to freshwater, subjecting the waste to solution and migration.⁹¹

The vulnerabilities within the 3.9-ft scenario include four sites with contaminated soils, including the site of a former salt pile, several large ASTs, and a number of Small, Medium and Large Quantity Generators. The

All 3.9-ft Sea Level Rise Vulnerabilities by Type

Vulnerability Type	Number of Sites
Soil Contamination	5
Small Quantity Generator	4
Medium Quantity Generator	5
Large Quantity Generator	1

Table 3.20. Vulnerable hazardous waste sites in Portland and South Portland based on inundation from 3.9 feet of sea level rise on top of the highest astronomical tide (HAT).

Selected 3.9-ft Sea Level Rise Vulnerabilities



Figure 3.31. Selected vulnerable hazardous waste sites in Portland and South Portland based on 3.9 feet of sea level rise on top of the highest astronomical tide. Data sources: Maine Department of Environmental Protection, EGAD (2019); Maine Geological Survey Sea Level Rise/Storm Surge Scenarios (2018).

majority of these vulnerabilities are concentrated in the low area of Portland's Bayside area along Back Cove (**Figure 3.31** and **Table 3.20**).

According to Maine DEP, MSQs may not accumulate more than 1,320 pounds of hazardous waste on site and may store this amount for up to 180 days. LQGs do not have a limit on the amount of hazardous waste accumulated onsite, but they may only accumulate material for 90 days. LQGs must have a written contingency plan and an emergency coordinator available at all times. The vulnerable sites shown in **Figure 3.31** are largely MQGs, in addition to the two SQLs, two contaminated soil sites, and a former salt pile that are brought into the 3.9-ft HAT rise. These sites are subject to the same considerations discussed in the previous section, including damage to storage mechanisms and transport of pollutants. In addition, 7 of the 13 large

storage tanks near Bug Light, depicted in **Figure 3.32**, fall within low-lying, vulnerable areas with 3.9 feet of sea level rise. The berms will likely protect the tanks from wave action and corrosion on a regular basis, but these areas could be inundated if back-up pumps were to fail.

The particularly high density of ASTs in the Portland and South Portland area, and their vulnerability to sea level rise, is particularly evident when looking at the number of these tanks within a quarter mile of the South Portland's Fore River coastline to the east of the Veterans Memorial Bridge—there are approximately 100 ASTs in this zone, and by the time of the 6.1-ft HAT rise, 37 will be in low-lying areas that could be vulnerable to the highest astronomical tide. As previously stated, it is important to keep in mind that each point represents a site in the EGAD data that Maine DEP tracks, but each site may consist of multiple storage tanks. In **Figure 3.33**, the

Storage Tanks near Bug Light with Exposure to Sea Level Rise



Figure 3.32. Seven of thirteen storage tanks near Bug Light show vulnerability under the 3.9-foot sea level rise scenario. Tanks are protected by berms and not directly exposed to tides, but are in low-lying areas that may be vulnerable to flooding if protection systems were to fail. Data sources: Maine Department of Environmental Protection, EGAD (2019); Maine Geological Survey Sea Level Rise/Storm Surge Scenarios (2018).

large number of ASTs within the quarter mile buffer are evident, despite there being only a few points from the EGAD data, as compiled in **Table 3.21**. In addition to the ASTs, the vulnerabilities within the 6.1-ft scenario include eight contaminated soil sites, including a former salt pile, and several SQGs and MQGs.

The South Portland WWTF located at 111 Waterman Drive could experience structural damage or failure due to loads from wave action and water inundation, impact from moving debris in a violent flood, or corrosion from salt exposure. The East End and Peaks Island Wastewater Treatment Facilities, while included in the EGAD data, are at elevations such that they are not vulnerable to the sea level rise scenarios modeled. However, they are still at risk of climate hazards concurrent to sea level rise, such as more frequent and more powerful storms. As they are situated on the shoreline, it is certainly possible that during a violent coastal storm, these other treatment plants could be at risk of similar threats.

At the sites with contaminated soils, pollutants could be transported through the ground by the higher groundwater levels that would result from higher sea levels, and damage due to wave action or flooding could completely remove and transport contaminated soil layers. With respect to the many above-ground storage

All 6.1-ft Sea Level Rise Vulnerabilities by Type

Vulnerability Type	Number of Sites
Soil Contamination	8
Large Bulk Fuel Storage	3
Small Quantity Generator	8
Medium Quantity Generator	2
Wastewater Treatment Facility	1

Table 3.21. Vulnerable hazardous waste sites in Portland and South Portland based on inundation from 6.1 feet of sea level rise on top of the highest astronomical tide (HAT).

Selected 6.1-ft Sea Level Rise Vulnerabilities

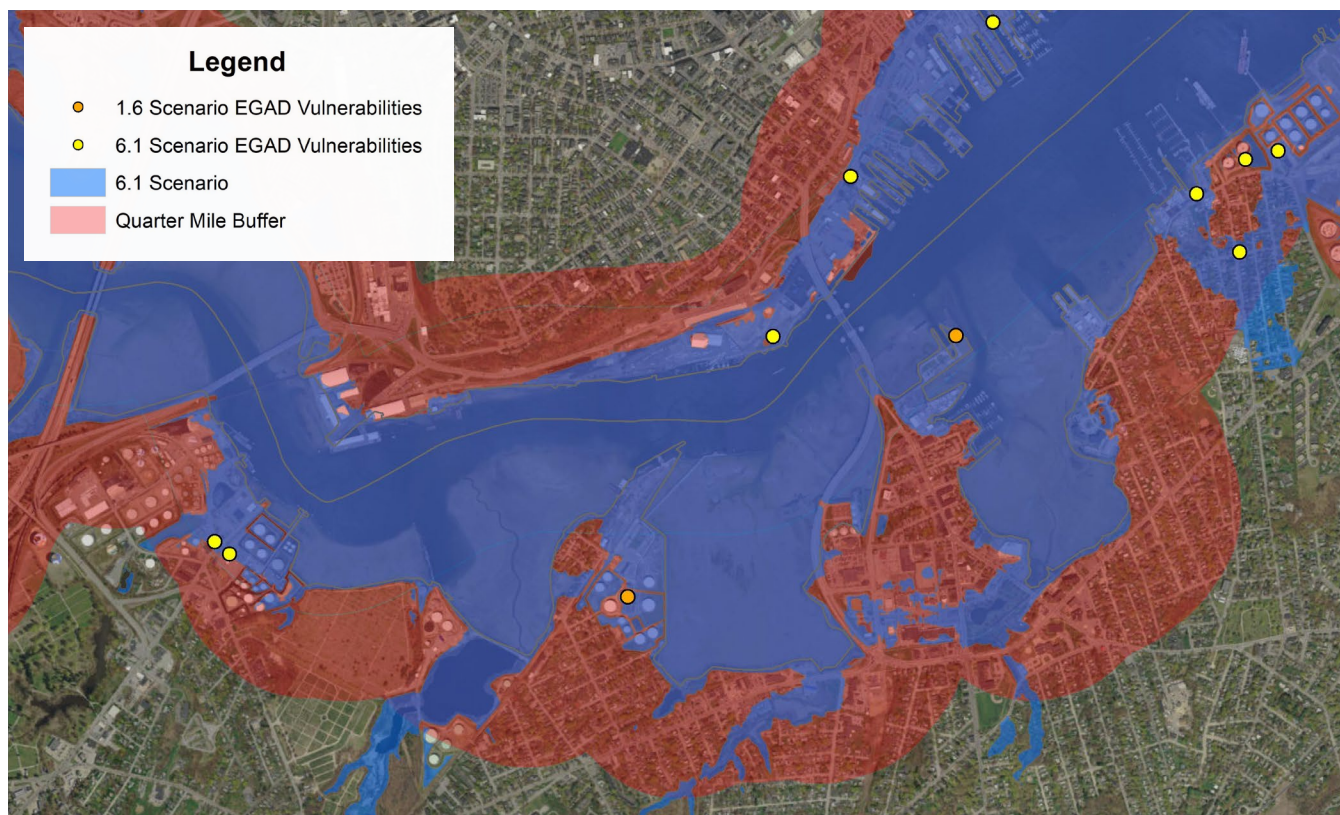


Figure 3.33. Selected vulnerable hazardous waste sites in Portland and South Portland based on 6.1 feet of sea level rise on top of the highest astronomical tide. Data sources: Maine Department of Environmental Protection, EGAD (2019); Maine Geological Survey Sea Level Rise/Storm Surge Scenarios (2018).

tanks identified within the 8.8-foot rise, tanks could be structurally damaged by debris, wave and hydrostatic pressures, and corrosion, or could even be dislodged by wave action and spill.

The vulnerabilities within the 8.8-ft scenario include 38 additional storage tanks along the South Portland coastline discussed previously, as well as several RCRA generators and sites of contaminated soils, depicted in **Figure 3.34** and listed in **Table 3.22**. The 8.8-ft scenario vulnerabilities in Portland are largely the contaminated sites and waste generators, while the vulnerabilities in South Portland are largely storage tanks.

All 8.8-ft Sea Level Rise Vulnerabilities by Type

Vulnerability Type	Number of Sites
Soil Contamination	5
Large AST	2
Small Quantity Generator	4
Medium Quantity Generator	3

Table 3.22. Vulnerable hazardous waste sites in Portland and South Portland based on inundation from 8.8 feet of sea level rise on top of the highest astronomical tide (HAT).

Selected 8.8-ft Sea Level Rise Vulnerabilities



Figure 3.34. Selected vulnerable hazardous waste sites in Portland and South Portland based on 8.8 feet of sea level rise on top of the highest astronomical tide. Data sources: Maine Department of Environmental Protection, EGAD (2019); Maine Geological Survey Sea Level Rise/Storm Surge Scenarios (2018).

PRIORITY AREAS

Based on the assessment above, there appear to be two most critical areas for all the projected scenarios:

- Portland's Bayside area along Back Cove, and
- The low-lying areas of South Portland along the Fore River with a high concentration of large bulk storage tanks.

The most critical vulnerable sites are the hazardous material storage areas; in particular, the Large ASTs and Medium and Large Quantity Generators. For this reason, the Fore River Shoreline appears to be of highest concern. All the ASTs in this area, along with the 8.8-ft scenario for reference, are highlighted in **Figure 3.35**.

For the Low-Intermediate sea level rise scenario, relevant to 2050, the most critical vulnerability appears to be the ASTs that enter into the inundation area for the 1.6-

foot rise in HAT along the Fore River, but even the sites that are not brought into the tidal zone are subject to the impacts of extreme weather. For the Intermediate scenario, more ASTs along the Fore River shoreline are brought into the tidal zone, as well as some MQGs and an LQG, and these are the most critical areas of concern.

There are many contaminated soil sites in the Portland and South Portland area monitored by Maine DEP and included in the EGAD data, as well as the many more that likely exist as a result of the areas' industrial past. Most of the soils in the area are held in place by development, and the transport of their contaminants would not be as acute a threat as the potential transport of the huge volumes of hazardous materials stored in containment systems along the Fore River shoreline in South Portland and, to a lesser extent, those materials potentially stored by RCRA Generators in the Bayside Area of Portland.

ASTs Along the Fore River Shoreline

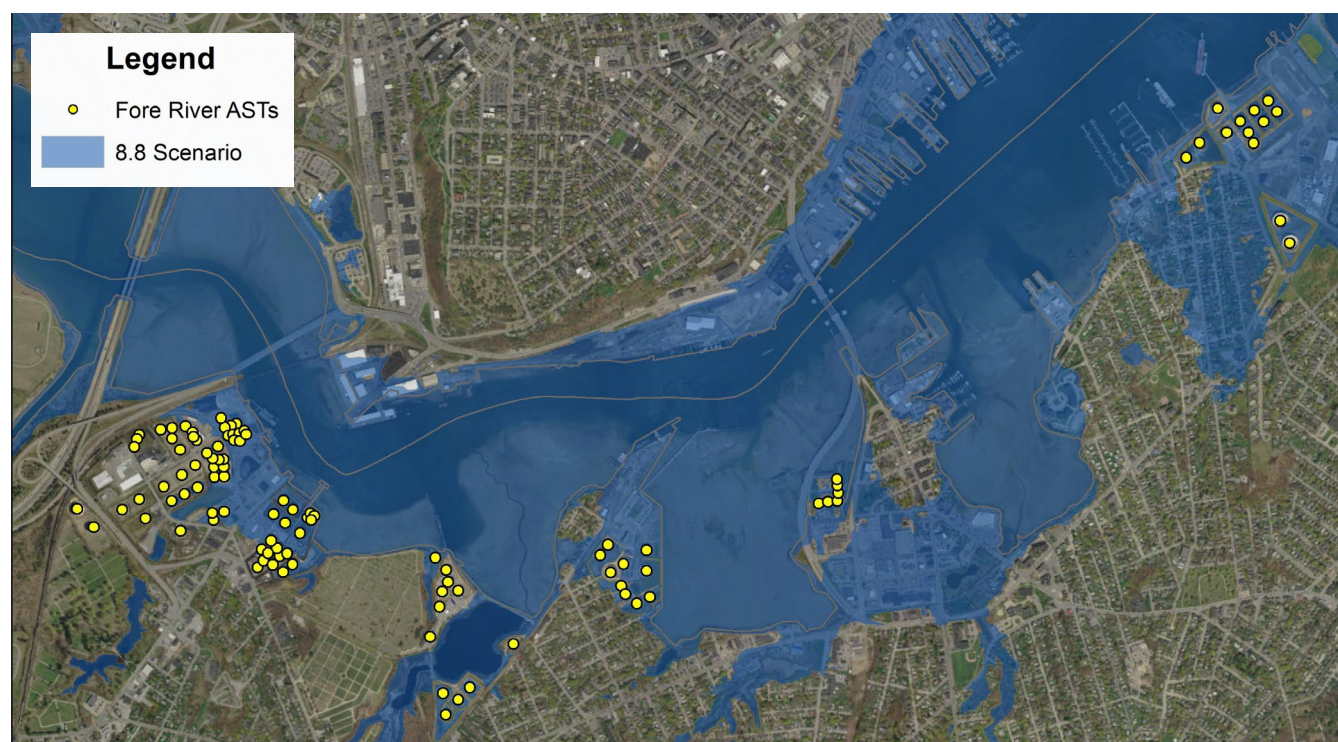


Figure 3.35. Above ground storage tanks (ASTs) along the Fore River shoreline overlaid with projected inundation from 8.8 feet of sea level rise on top of the astronomical high tide. A portion of the ASTs are far enough inland and/or protected by berms so as not to be directly affected by tidal inundation. Further hydrological study is necessary, however, to assess the flood risk of these tanks, particularly in low-lying areas. Data sources: Maine Department of Environmental Protection, EGAD (2019); Maine Geological Survey Sea Level Rise/Storm Surge Scenarios (2018).

SECTION THREE ENDNOTES

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4. Environmental Exposure, Risk, and Vulnerability

Portland's and South Portland's ecosystems are already changing in response to climate change.

ENVIRONMENTAL CONTEXT

The Casco Bay Watershed spans nearly 1,000 square miles in southern Maine. It is rich with forests, soils, and wetlands that support wildlife, filter air and water, help to buffer extreme temperatures, and enhance our quality of life. The water from snowmelt, streams, rivers, and rainwater collect and travel through 42 communities within the watershed, running into Casco Bay and the broader Gulf of Maine. The Gulf of Maine and Casco Bay are closely intertwined, exchanging nutrients and marine life that are collectively impacted by the acidity, temperature, and salinity conditions of these environments.

Portland and South Portland's connection to water resources serves as a defining feature for both cities. Portland and the majority of South Portland sit within the far eastern edge of the Casco Bay Watershed, where the watershed meets the bay (**Figure 4.1**). (The southern edge of South Portland sits within the Saco River Watershed, which drains into Saco Bay.) The Fore, Presumpscot, and Stroudwater Rivers, as well as numerous other freshwater streams that run into the Fore River, serve as some of the cities' primary water conduits. Both the Fore River and Back Cove—Portland's large tidal basin—offer important habitat for estuary ecosystems. Likewise, Casco Bay and the Gulf of Maine support abundant marine species, many of which generate key value to the coastal economy.

Despite being urban in nature, Portland and South Portland also have important land-based environmental

Casco Bay Watershed



Figure 4.1. Map of the Casco Bay Watershed. Figure source: Casco Bay Estuary Partnership (2017).

resources. Roughly 4 percent of Portland's area is made up of parks, land bank properties, and Portland Trail networks;⁹⁹ likewise, roughly 4 percent of South Portland's area includes city-managed parks, fields, and open space,¹⁰⁰ and roughly 400 acres in South Portland are conservation land.¹⁰¹ Although few areas are undisturbed or contiguous, these spaces provide habitat for small animals and plant life. Portland, in particular, highlights its native, old-growth tree stands—most notably Deering Oaks and Baxter Woods. These resources, including the parks, multiuse trails, passive open spaces, and water access points, play a role in creating healthy and thriving places to live, work, and play.

Climate change has already begun to create strain on ecosystems and has the potential to lead to long-term impacts to the cities' critical environmental resources. While the cities' water ecosystems provide significant assets to the cities, they in particular show significant vulnerability. Five specific environmental issues are highlighted in this section:

- Marsh Migration
- Coastal Erosion
- Compromised Natural Water Systems
- Shifting Habitats, Pests, and Invasives
- Species Health Impacts from Ocean and Coastal Acidification

Understanding how and where the environment is vulnerable will help inform the necessary choices and strategies for ensuring the cities' environmental resources remain healthy despite a changing climate.

4.1 Marsh Migration

Climate hazards, and in particular sea level rise, are known to impact sensitive tidal areas including marshes and wetlands. These coastal ecosystems provide tremendous benefit to wildlife, plant species, and the surrounding built environment by serving as habitat and a protective barrier against storm surge and rising sea levels by buffering wave action. Marshes also have the natural ability to filter various types of pollution and slow the impacts of erosion, which can cause property damage in developed areas. In Maine, marshes are a unique resource since much of the coastline has a steep topography. Preserving and protecting marsh and wetland areas are of interest to many coastal communities due to the benefits they provide.

In mostly urban environments such as Portland and South Portland, marshes have already been significantly reduced or degraded from development and from pollution from stormwater runoff.¹⁰² Infrastructure, including roads, bridges, dams, and railroads that cross tidal wetlands interfere with the way water exchanges from one side of the infrastructure to the other, and can

increase water flow velocity, create scour, and undermine the resilience of the marshes. As sea levels rise, marshes will continue to lose suitable habitat, particularly at these points.

The process by which tidal marshes gradually shift inland onto formerly dry land or nontidal areas as sea levels rise is known as marsh migration. Migration is possible where there are not constraints from the developed environment or steep slopes. In areas where marshes are buffered by the built environment, shifting may not be possible. Losing these critical marsh ecosystems will impact the plant and animal habitats that thrive there as well as decrease natural flooding buffers, making the areas further inland more vulnerable to storm surge.

In 2013, the Casco Bay Estuary Partnership (CBEP) looked at the impacts of sea level rise on wetlands throughout Casco Bay. The study specifically identified four primary areas in Portland and three in South Portland where marsh migration is likely to occur due to sea level rise, and where these areas may come into conflict with existing development:

- Upper Fore River Area (**Figure 4.2**)
- Back Cove Area (**Figure 4.3**)
- Commercial Street Area (**Figure 4.4**)
- East Deering Area (**Figure 4.5**)
- Bug Light and Southern Maine Community College Area (**Figure 4.6**)
- Mill Creek and Turner Island Area (**Figure 4.7**)
- Forest City Cemetery Area (**Figure 4.8**)

For each site, CBEP assessed the marsh migration driven by one foot and three feet of sea level rise. Flood extents are determined by static inundation modeling based on storm tide levels overlaid with LIDAR data. The figures for three feet of sea level rise are included below. To see the analysis at one foot, see the Portland and South Portland editions of *Sea Level Rise and Casco Bay's Wetlands: A Look at Potential Impacts* (2013).¹⁰³

Upper Fore River Area – A portion of the Upper Fore River is shown in **Figure 4.2**. A three-foot rise in sea level would lead to marsh migration inland in a number of directions, and would likely result in conflicts with

existing infrastructure and developed areas. Potential instances where marsh migration comes into conflict with the built environment include:

- Stroudwater Village Causeway
- Low-lying areas of Stroudwater Village including portions of outer Congress Street
- Three culverts where the railroad tracks cross the Fore River Sanctuary
- Developed areas associated with Starbird Lane, Winding Way, Meadowbrook Lane, Frost Street, Cliff Street, Yellowbird Road

The points where marshes are impeded by infrastructure and development creates heightened risk for losing wetland ecosystems. In the upper Fore River this vulnerability is mitigated slightly by the Fore River Sanctuary where the natural area and elevations are suitable in some spots for inland marsh migration.

Back Cove Area – Figure 4.3 shows potential marsh migration in Back Cove, driven by three feet of sea level rise. Baxter Boulevard and the Bayside area are at elevations where marsh migration would “naturally” occur, yet the land use precludes marsh migration. The brooks near Back Cove Estates and Payson Park allow

Potential Marsh Migration: Upper Fore River

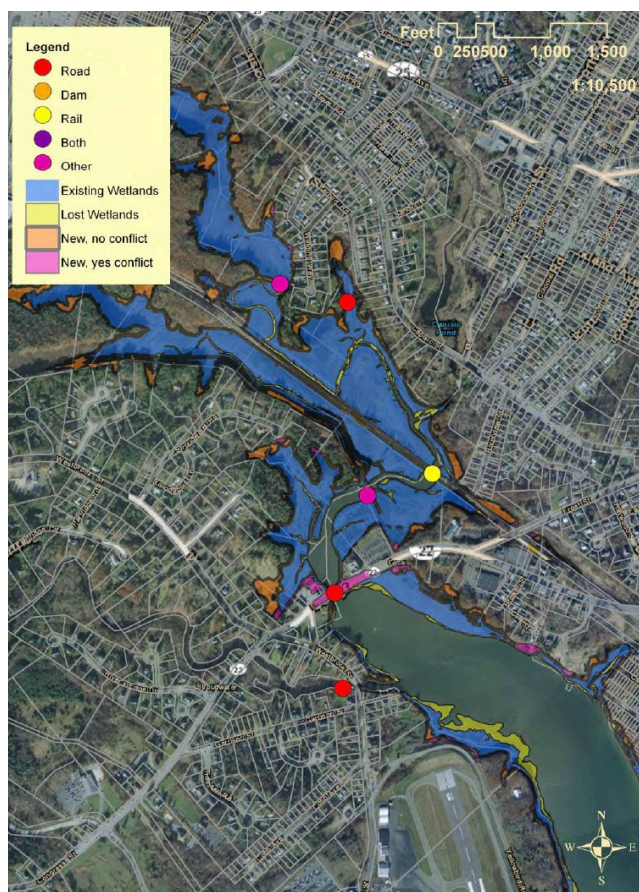


Figure 4.2. Potential marsh migration and areas of conflict in the Upper Fore River (Stroudwater) under 3 feet of sea level rise. Yellow areas represent existing wetlands that will be lost, and pink areas represent areas where wetlands would naturally migrate, but are prevented due to development. Dots specify conflict points between marshes and infrastructure. Figure source: Casco Bay Estuary Partnership (Bohlen et al., 2013).

Potential Marsh Migration: Back Cove



Figure 4.3. Potential marsh migration and areas of conflict in Back Cove under 3 feet of sea level rise. Yellow areas represent existing wetlands that will be lost, and pink areas represent areas where wetlands would naturally migrate, but are prevented due to development. Dots specify conflict points between marshes and infrastructure. Figure source: Casco Bay Estuary Partnership (Bohlen et al., 2013).

for more natural tidal movement, already support marsh ecosystems, and would likely be places for further marsh migration; However, the road crossings and culverts create limitations for this movement. The current edge of Back Cove, including the small freshwater brooks by Back Cove Estates, are within the City's Shoreland Overlay Zone, which offers some protection from development.

Commercial Street Area – Only small patches of wetland exist around the piers in the Commercial Street Waterfront, some of which will likely be lost with three feet of sea level rise (**Figure 4.4**, yellow areas). There are

few suitable areas for marsh migration at this edge of the waterfront. The primary possible area surrounds the current location of Portland Yacht Services.

East Deering Area (Martin's Point) – A thin band of wetlands currently stretches around Martin's Point, and into the cove on the western side of Interstate 295. These wetlands are vulnerable to the effects of sea level rise, and their area will likely be significantly reduced under a three-foot scenario (**Figure 4.5**). The I-295 road crossing that mediates the water exchange between the bay and the cove is suggested to further hinder the health of the marshes.

Potential Marsh Migration: Commercial Street



Figure 4.4. Potential marsh migration and areas of conflict in the Commercial Street area under 3 feet of sea level rise. Yellow areas represent existing wetlands that will be lost, and pink areas represent areas where wetlands would naturally migrate, but are prevented due to development. Figure source: Casco Bay Estuary Partnership (Bohlen et al., 2013).

Potential Marsh Migration: East Deering



Figure 4.5. Potential marsh migration and areas of conflict in the East Deering area under 3 feet of sea level rise. Yellow areas represent existing wetlands that will be lost, and pink areas represent areas where wetlands would naturally migrate, but are prevented due to development. Dots specify conflict points between marshes and infrastructure. Figure source: Casco Bay Estuary Partnership (Bohlen et al., 2013).

Bug Light and Southern Maine Community

College Area – A ring of marshland surrounds the coast around Bug Light Park, Simonton Cove, and the adjacent industrial and marine waterfronts. **Figure 4.6** illustrates where these marshes will likely be lost with three feet of sea level rise. This area has very little room for marsh migration, impeded by industrial, commercial, and residential development. Losing some of these marshlands may make this area's waterfront uses, including Willard Beach, increasingly vulnerable to storm surge and erosion.

Potential Marsh Migration: Bug Light & SMCC



Figure 4.6. Potential marsh migration and areas of conflict in the Bug Light and Southern Maine Community College (SMCC) area under 3 feet of sea level rise. Yellow areas represent existing wetlands that will be lost, and pink areas represent areas where wetlands would naturally migrate, but are prevented due to development. Figure source: Casco Bay Estuary Partnership (Bohlen et al., 2013).

Mill Creek and Turner Island Area – The area spanning Turner Island and Mill Creek (Knightville) includes a number of small creeks that run into the Fore River, creating estuaries with substantial stretches of existing wetlands. Under three feet of sea level rise, this area is likely to lose marshes at the edges of the coves, particularly at the mouths of these creeks (**Figure 4.7**). Unlike many other areas along Portland and South Portland's coasts, however, this area does offer some areas for marsh migration—notably within Mill Creek. (The map also captures the area across the Fore River in Portland, adjacent to Portland Yacht Services, which was a previously mentioned area for potential marsh

Potential Marsh Migration: Mill Creek & Turner Island



Figure 4.7. Potential marsh migration and areas of conflict in the Mill Creek and Turner Island area under 3 feet of sea level rise. Yellow areas represent existing wetlands that will be lost, and pink areas represent areas where wetlands would naturally migrate, but are prevented due to development. Dots specify conflict points between marshes and infrastructure. Figure source: Casco Bay Estuary Partnership (Bohlen et al., 2013).

migration.) A number of road crossings over both Mill Creek and Anthoine Creek, however, are likely to degrade the health of marshes in these locations and amplify their vulnerability to sea level rise.

Forest City Cemetery Area – The outfall of Barberry Creek is a significant site for existing wetlands, and the CBEP studies suggest this site has little vulnerability to sea level rise up to three feet (**Figure 4.8**). The primary losses for wetlands in the Forest City Cemetery area are projected to occur along the coast of the cemetery. Industrial uses on both the South Portland and Portland side of the Fore River in this area prevent any significant space for new marsh migration. Consequently, three feet

4.2 Coastal Erosion

Portland and South Portland are both susceptible to coastal or shoreline erosion. Coastal erosion is a process where events including severe storms, flooding, storm surge, sea level rise and human-related activities wear away beaches and dunes over time. Erosion can occur due to an acute weather-related event or a long-term change in the coastline as waves or currents remove sand or rocks from the shoreline. Erosion can result in a reduction in the storm buffering capacity of beaches and dunes, and habitat loss for sensitive coastal ecosystems. Coastal erosion thus also becomes a threat to adjacent properties and infrastructure, as changes in the shoreline leave them more vulnerable to other severe storms or weather patterns. Shoreline erosion is partially driven by the elevation of high tides, which will continue to increase as sea levels rise.

In the recent 2017 Cumberland County Hazard Mitigation Plan, coastal erosion was included as one of the five highest priority natural hazards impacting communities in this region, including Portland and South Portland. In the two communities, the area of most concern for coastal erosion is Willard Beach in South Portland (**Figure 4.9**). The beach is approximately four acres, located between Fisherman's Point and Southern Maine Community College, and used extensively for recreational activities. Historically, South Portland has protected the sand dunes at Willard Beach through a proactive beach management initiative, which has allowed the city to avoid any beach nourishment efforts for decades. The size of the dunes and beach will fluctuate year to year, and different areas of the beach will grow and erode depending on given forces. As a whole, Willard Beach has been accretive with a mean dune change rate of +1.3 ft/yr over the period from 2007-2019 due to management efforts.¹⁰⁴ Dry beach width (DBW), the distance between the mean high water line and the dunes or seawall, is a good indicator of the buffering capacity of the beach to storms. DBW declined slightly between 2018 and 2019, particularly in the southern half of the beach.¹⁰⁵ Although these

Potential Marsh Migration: Forest City Cemetery

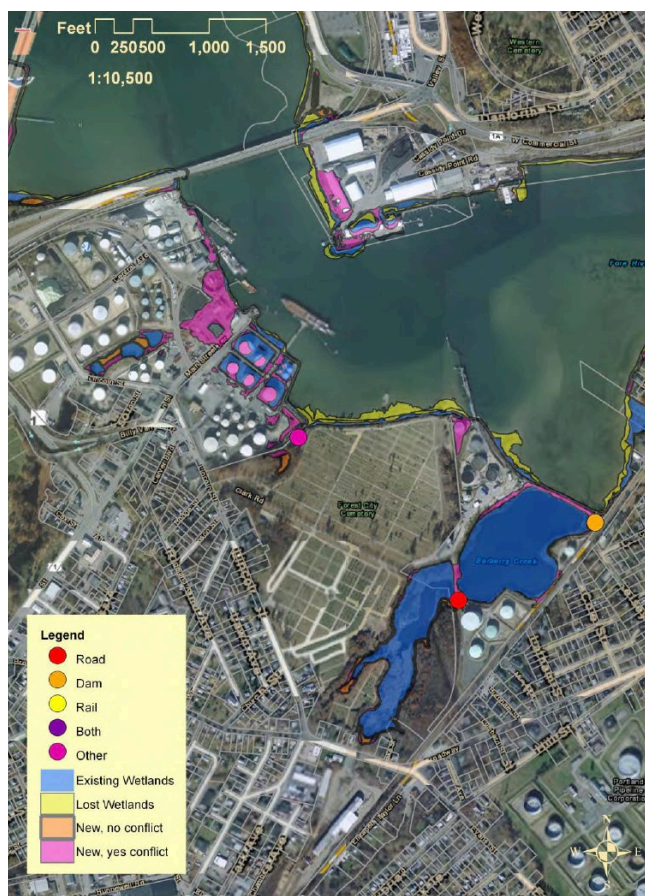


Figure 4.8. Potential marsh migration and areas of conflict in the Forest City Cemetery area under 3 feet of sea level rise. Yellow areas represent existing wetlands that will be lost, and pink areas represent areas where wetlands would naturally migrate, but are prevented due to development. Dots specify conflict points between marshes and infrastructure. Figure source: Casco Bay Estuary Partnership (Bohlen et al., 2013).

dimensions tend to fluctuate, attendees at the Resilience Workshop held in May 2019 voiced concern in continuing to keep erosion at bay at Willard Beach, specifically highlighting the increasing risk sea level rise and storm surge would create for beach erosion.

Other areas of Portland and South Portland that are also vulnerable to erosion and that could affect critical infrastructure include the Stroudwater Area of Congress Street (a heavily traveled roadway), Back Cove Pump Station, and the South Portland Wastewater Treatment Plant. Ecological impacts from coastal erosion can result in habitat loss as the natural coastal wetlands and beach areas deteriorate.

Willard Beach Erosion Hazard Area



Figure 4.9. Willard Beach and the surrounding residential areas. “D1” (Dune 1) marks the frontal dune closest to the water; “D2” (Dune 2) marks the back dunes that lie inland of the frontal dune. The area marked with red hatch delineates the Erosion Hazard Area (EHA), which includes “any portion of the coastal sand dune system that can reasonably be expected to become part of a coastal wetland in the next 100 years” due to a number of forces including long-term erosion or short-term erosion from the 100-year storm. Areas vulnerable to storm surge with two feet of sea level rise, or otherwise included in the AO zone in FEMA flood maps are included in the EHA.¹²⁶

4.3 Compromised Natural Water Systems

Both freshwater and saltwater systems in the Casco Bay Watershed are increasingly affected by climate change, particularly heavy rainfall and higher temperatures. Increased precipitation duration and intensity will create more stormwater runoff, which can deliver larger quantities of pollutants into streams, rivers, estuaries, and the bay. Higher temperatures further degrade water quality, primarily through facilitating algal blooms.

STORMWATER POLLUTION

Stormwater runoff is often contaminated by nutrients, sediment, bacteria, or even trash, which accumulates as it enters source waters. In Casco Bay, many of the stormwater contaminants are from nonpoint sources such as pet waste, failing septic systems, fuel spills from boats, pesticides washing off lawns, or oil leaking from cars. In particular, the Casco Bay Estuary Partnership has identified high levels of polycyclic aromatic hydrocarbons (PAHs), which are primarily from the combustion of fossil fuels.¹⁰⁶ PAHs accumulate in sediment, as well as travel up the food chain through bottom dwellers, to fish, and to mammals including humans.

A greater volume of stormwater amplifies the pollution entering water bodies particularly when it overwhelms undersized or aging stormwater controls. Overwhelmed controls are especially problematic for cities with combined sewer systems, which carry all collected sewage and stormwater in the same pipe network and transport it to the treatment plant where it is treated and discharged into a water body. When heavy precipitation or snowmelt increases the amount of stormwater in the system and it exceeds the capacity of the pipes, all effluent is dumped directly into the ocean untreated, causing a combined sewer overflow.

NUTRIENT LOADING AND ALGAL BLOOMS

Water quality data collected by the Friends of Casco Bay show that nitrogen concentrations are notably high in parts of Casco Bay.¹⁰⁷ Stormwater carrying fertilizers and pet waste, as well as sewage and air pollutants can contribute to elevated nitrogen levels. Excessive nutrient

levels, including high levels of nitrogen, make Casco Bay increasingly susceptible to harmful algal blooms, or the rapid increase in a population of algae. Algal blooms decrease water quality, lower dissolved oxygen, and lead to potential plant and wildlife die-offs.

In recent years, there have been documented algal blooms in both Back Cove in Portland and Mill Cove in South Portland. This issue can be exacerbated by not only excess nitrogen, but also warmer ocean temperatures and higher levels of carbon dioxide absorbed from the atmosphere, which further increase the vulnerability of Casco Bay to algal blooms.

IMPACTS ON AQUATIC ECOSYSTEMS

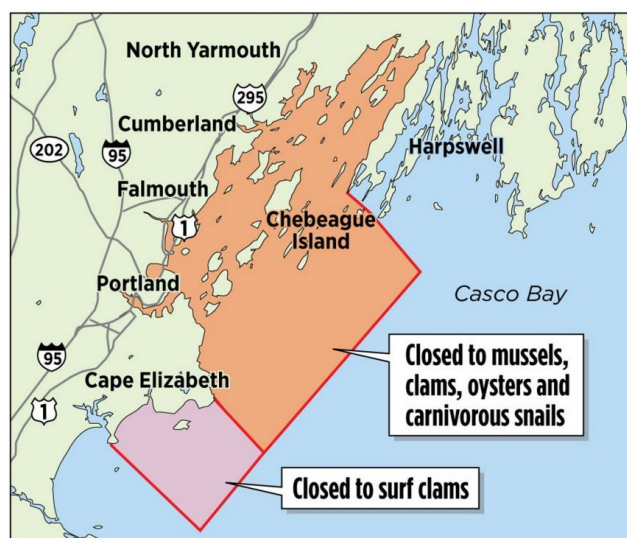
Pollutants and nutrient loading from stormwater runoff have a wide range of negative effects on water quality and on freshwater and saltwater ecosystems.¹⁰⁸ Some of these cascading impacts include:

- Coastal acidification;
- Low or reduced dissolved oxygen levels, resulting in fish die-offs;
- Toxic algal blooms;
- Closure of areas of Casco Bay to shellfishing;
- Loss of eelgrass beds;
- Damage to aquatic habitats;
- Loss of ecological diversity and changes to ecosystem function.

The shellfish industry in Casco Bay, and specifically surrounding Portland and South Portland, has seen repeated and continuous closures due to related water quality challenges, all driven by factors that show potential to worsen with climate change. As mentioned previously, stormwater runoff, often in areas with combined sewer systems, can lead to higher bacteria levels. The Maine Department of Marine Resources has five shellfish classification categories that reflect water quality. The area of Casco Bay around Portland and South Portland is classified as prohibited which means closed to shellfish harvest at all times when water quality testing either shows elevated levels of fecal bacteria or when an area is near a wastewater treatment plant outfall or another source of pathogens.

In adjacent areas where shellfishing is not prohibited, the industry has still experienced closures due to toxic algal blooms. In winter of 2017, a harvesting ban stretched from Portland to Harpswell when shellfish showed elevated domoic acid levels, a biotoxin produced by a large phytoplankton bloom (**Figure 4.10**).¹⁰⁹ Likewise, as of July 2019, Maine DMR had issued a red tide closure for mussels, oysters, clams and snails for an area of Casco Bay including Portland and South Portland.¹¹⁰ These closures impact shellfish harvesting, fisheries operations, local jobs and the economy. Rising temperatures from climate change are expected to make similar toxic algal blooms increasingly hard to contain.

Shellfish Closures in 2017 due to Biotoxin Levels



SOURCE: Department of Marine Resources STAFF GRAPHIC | MICHAEL FISHER

Figure 4.10. Shellfish harvesting closures in 2017 due to elevated levels of the biotoxin domoic acid caused by a large phytoplankton bloom. Domoic acid is known to make people sick, and can induce brain damage. Figure source: Department of Marine Resources, as reported in the Portland Press Herald (2017).

4.4 Shifting Habitats: New Pests and Invasive Species

Portland and South Portland are likely to see substantial changes to ecosystems both on land and in water as climate change brings more precipitation and warmer air and water temperatures. While climate change impacts on habitats and species are not fully understood, it is known that habitats will shift or redistribute. Climate change will provide opportunities for invasive species that may never have survived in this area in the past a chance to thrive, grow, reproduce and survive in environmental conditions that were not previously known to this area. In addition to the introduction and expansion of invasive species, a decline in native species can be expected that may have favored past climate conditions which no longer exist (or that have shifted further north). The interactions of climate change with other related stressors and human activities has the potential to magnify the impacts and threats to marine and terrestrial ecosystems.

Casco Bay Estuary Partnership has specifically identified impacts and key potential areas of concern associated with shifting habitats, new pests, and invasive species as the following:

- Warmer ocean water temperatures cause shifts in species' geographic ranges and the community structure of Casco Bay's ecosystem, leading to declines in some existing fisheries, resources, and increases in some invasive species, pathogens, pests, and disease vectors.
- Climate change leads to changes in marine and coastal food webs, altering species composition, making coastal ecosystems less resilient to other stressors like invasive species, elevated nutrients and habitat destruction, and raising chances of the ecosystem hitting a tipping point.
- Sea level rise and altered hydrology in tidal wetlands (due to multiple climate stressors) shifts species composition, causes both gains and losses of tidal wetland area, and makes the wetlands more susceptible to invasion by invasive plants.

MARINE ECOSYSTEMS

Invasive Species – Casco Bay's marine ecosystems are vulnerable to the threat of invasive species, which are species that tend to spread to the point that they can cause harm to ecosystems. Research completed by Casco Bay Estuary Partnership on invasive species in Casco Bay found that at two specific locations studied in 2013, between one-fifth and one-third of all identified marine species were not native.¹¹¹ Some of these species¹¹² that are known marine invasives include:

- Asian Shore Crab
- European Green Crab
- Dead Man's Fingers
- Lacy Crust Bryozoan
- Hairy-Clawed Shore Crab
- Chinese Mitten Crab
- Common Periwinkle
- Rapa Whelk

One example documented by CBEP is associated with a decline in eelgrass beds, which is a native seagrass that provides critical habitat and food for other marine species. Eelgrass plays a valuable role in maintaining healthy water quality by managing nutrients in the water and stabilizing sediment. It can also sequester carbon at a high rate, which is beneficial when there is excess in the water. Among other environmental stressors, eelgrass stands are declining due to the European green crab, a species whose population has exploded in Casco Bay in recent years due in part to warming waters.

Figure 4.11 shows areas of Portland and South where there has been a change in eelgrass distribution over time.¹¹³ While pockets around the islands have seen some growth in density, the eelgrass area adjacent to the East End Beach has seen a loss in density and extent, while most of the areas at South Portland's water edge have seen either no change or a loss in extent. According to CBEP, between 2001/2002 and 2013, Casco Bay lost more than half of its eelgrass beds.¹¹⁴

Shifting Native Habitats – Changes in climate will shift habitats in Casco Bay, affecting ecosystems, species distributions, as well as the marine resource economy. One such concern is the susceptibility of Maine's lobster

Change in Density and Extend of Eelgrass Beds (1997 – 2010)



Figure 4.11. Change in eelgrass distribution (density and extent of beds) in the Portland Harbor between 1997 and 2010. Figure source: Maine Department of Marine Resources, Historical Eelgrass Coverage Viewer (n.d.).

fishing industry to warming water temperatures. Like much of southern New England, Maine's lobster industry could see a decline or a shift in habitat northward as the ocean continues to warm. **Figure 4.12** illustrates how the density of lobster catches has already shifted significantly since 1970. Recent research predicts that lobster populations are likely to shift 200 miles further north as a result of climate change.¹¹⁵

In addition to lobster, increasing ocean temperatures are resulting in a shift to the north for a number of other species in the Gulf of Maine. The timeframe for species shifting their habitats will depend on the pace of climate change and the adaptability of an individual species.¹¹⁶ Atlantic Cod populations in the Gulf of Maine, in particular, have been declining since before 1990, and recent research suggests that the remaining habitat for the species in the North Atlantic could shrink by over

90 percent by 2100 due to warming waters.¹¹⁷ The same study suggests that scallops, shrimp and groundfish—all significant species in Maine—could shift northward to waters in Canada if ocean temperatures continue to rise. In the meantime, the Gulf of Maine is likely to see increases in other species that are more accustomed to warmer waters. In particular, the Gulf is seeing increasing Black Sea Bass populations.

TERRESTRIAL ECOSYSTEMS

Invasive Species – Climate change can both inhibit and facilitate growth of invasive plant species. Widespread impacts and changes are not understood but as with other environmental systems, the range and abundance of invasive plants are likely to change. Invasive plants tend to be better able to tolerate or adjust to new climates than native species, outcompeting native species for nutrients, water, sunlight, or pollinators.

Changing Density of Lobster Catch (1970 - 2017)

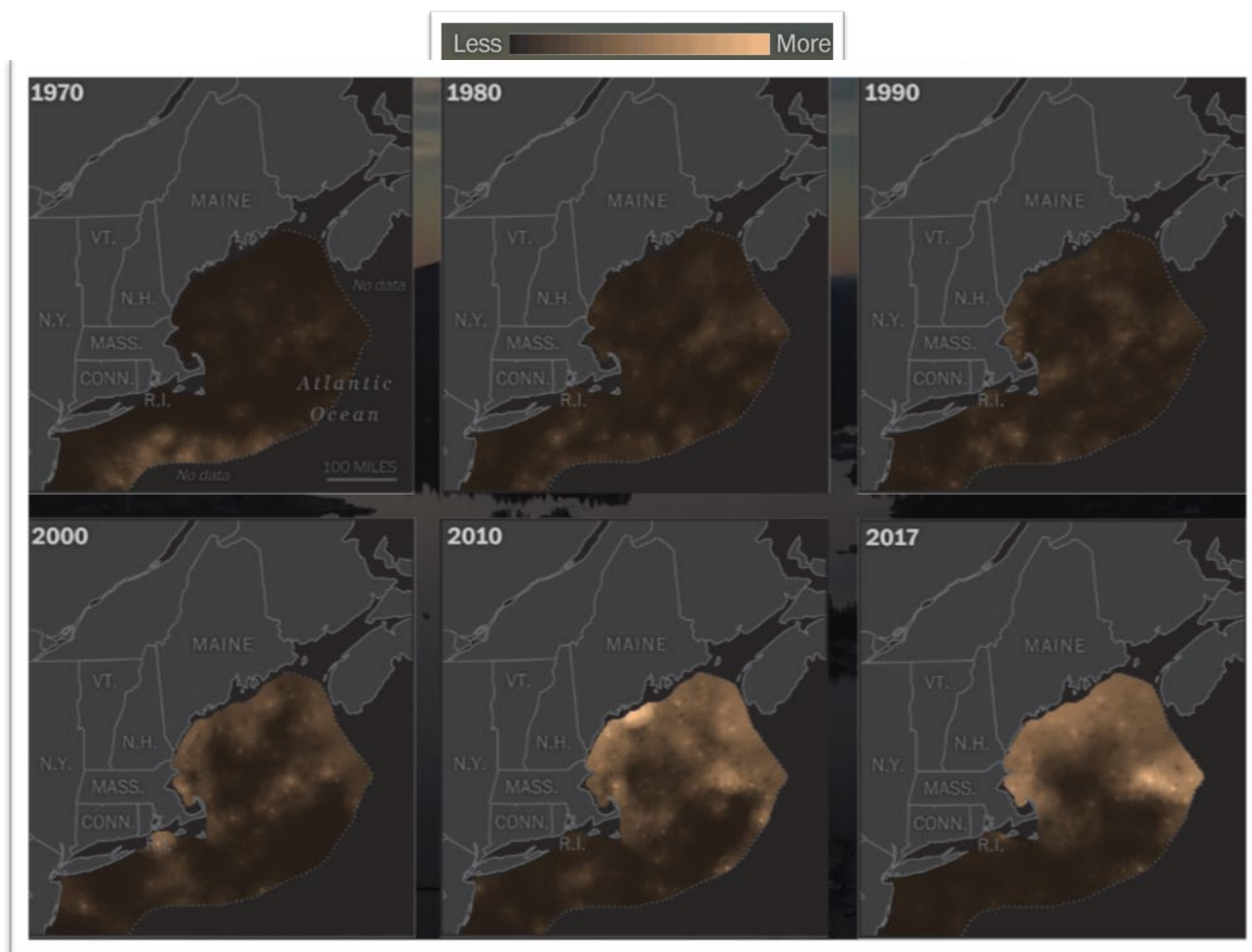


Figure 4.12. Changing density of lobster catches off the coast of Northern New England from 1970 to 2017. Lobster catches have shown a distinctive shift northward, suggesting that the population will continue to shift northward as oceans continue to warm. Source: The Washington Post, “Gone in a Generation” (2019).¹²⁷

Invasive plant species are disrupting ecosystems in Maine by developing self-sustaining populations that are dominant or disruptive to native species. The aggressive growth of invasive plants can affect forest regeneration and reduce the value of habitat for other species. After habitat loss, invasive species are the second most critical threat to ecosystem diversity. Invasive plant species in Maine with wide distribution are listed in **Table 4.1**.¹¹⁸

In particular, longer warm seasons and earlier springs have provided an advantage for the growth of purple loosestrife, a plant introduced from Europe that now chokes wetland habitats by overtaking cattails and

other marsh plants that support wetland wildlife. Purple loosestrife has been able to respond quicker to warming temperatures, and is blooming several weeks earlier than its native competitors.¹¹⁹

Forest Pests – Pests are insects or animals that cause destruction to plant species. Throughout the Northeast, pests have caused significant damage to native tree species, as well as forest ecosystems. Climate change has the potential to amplify this impact, by expanding the range and the intensity of pest infestation. **Table 4.2** catalogs pests that have already started impacting the forest ecosystems in Maine.¹²⁰

Widespread Invasive Plant Species in Maine

Norway Maple	Garlic Mustard	Japanese Barberry
Asiatic Bittersweet	Autumn Olive	Winged Euonymus
Japanese Knotweed	Glossy Buckthorn	Dame's Rocket
Yellow Iris	Morrow's Honeysuckle	Tatarian Honeysuckle
Purple Loosestrife	Black Locust	

Table 4.1. Fourteen of the most widespread invasive plant species in Maine. Source: Maine Department of Agriculture, Conservation, and Forestry (2017).

Invasive Pest Species in Maine

Emerald Ash Borer	Brown Spruce Longhorn Beetle
Asian Longhorn Beetle	Winter Moth
Hemlock Woolly Adelgid	European Wood Wasp
Elongate Hemlock Scale	

Table 4.2. Seven of the most invasive pest species affecting trees and forest ecosystems in Maine. Source: University of Maine, Maine Invasive Species Network (n.d.).

In particular, Portland and South Portland have seen evidence of Hemlock Woolly Adelgid (HWA) outbreaks, a pest that infests hemlock trees throughout the northeast and up the southern Maine coastline. Nearly all hemlock trees infested with HWA eventually die, creating broader ecosystem repercussions, such as loss of primary habitat for the blue-headed vireo and Blackburnian warbler, and the replacement of hemlocks with black oaks, black birch and other hardwoods.¹²¹ There is a significant risk that warming temperatures will allow this pest to expand in distribution, including inland and further up the coastline. Likewise, warmer winters are likely to expand the tree decimation cause by winter moth and emerald ash borer, which currently affect areas within Portland and South Portland and/or in neighboring municipalities.

Vector-borne Diseases – Rising temperatures can lengthen breeding seasons and expand the distribution of insects carrying vector-borne diseases, such as Lyme disease and West Nile Virus. For further details on the risk and health impacts from vector-borne disease see section 5.4 *Health*.

4.5 Acidification Impacts on Species Health

Broadly defined, ocean acidification is caused by the release of carbon dioxide into the atmosphere from burning fossil fuels (cars, buses, homes, industries) and when the carbon dioxide mixes with water, it becomes more acidic. The Friends of Casco Bay have documented a rise in the acidity of Casco Bay over the past 15 years.¹²²

Coastal acidification is driven by freshwater runoff from streams, rivers, and stormwater that have high levels of nutrients, such as nitrogen from pet waste, fertilizer, and wastewater, entering coastal waters. The excess nitrogen results in algal blooms and when they die, the process of bacterial decomposition consumes oxygen and releases carbon dioxide, creating unnatural acidic conditions for coastal habitats and wildlife. See Section 3: *Compromised Water Systems* for further details on algal blooms.

Coastal and ocean acidification can result in the inability of species that live in Casco Bay to survive and flourish due to two simultaneous factors: an increase in acidity and a decrease in carbonate availability.

Marine species with hard protective shells, including clams, lobsters, mussels, shrimp, oysters, scallops, sea urchins, and cold water coral, combine calcium and carbonate found in seawater in order to build calcium carbonate shells. Higher levels of carbon dioxide decrease the carbonate ion concentration in the water, making it difficult for marine life to grow healthy shells. As a result, these species have slower growth, thinner shells, and their mortality rates rise.¹²³

In Maine, 87 percent of the landings value of harvested or grown species comes from organisms that make calcium carbonate shells, suggesting that acidification may have significant ramifications for the health of Maine fisheries.¹²⁴ **Figure 4.13** shows recent data from

the Friends of Casco Bay indicating that levels of calcium carbonate, or shell building material, in Casco Bay are already not sufficient enough for organisms to build and maintain their shells. Under severe conditions, high acidity can dissolve calcium carbonate shells at a faster rate than they can be formed.

Additionally, more acidic marine environments compromise the health and life stages of many marine organisms. Many types of fish and invertebrate larvae are unable to develop properly or lose capacity to avoid predators under more acidic conditions.¹²⁵ Stunted growth or survival at the larval stage will eventually constrict the growth of adult populations.

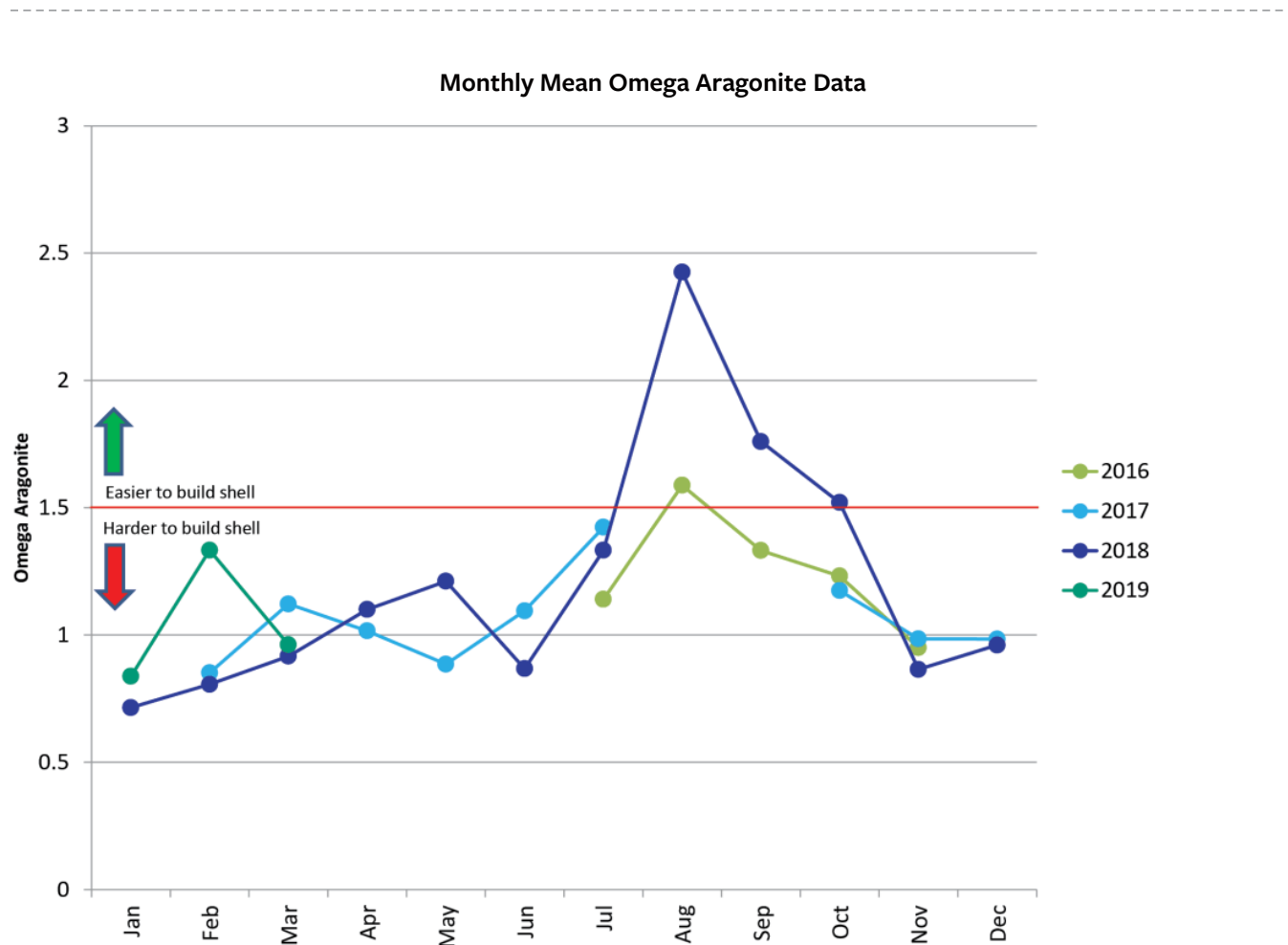


Figure 4.13. Monthly mean omega aragonite, the scientific term for the calcium carbonate saturation state, in Casco Bay from January 2016 through March 2019. Other than a few months in 2018, calcium carbonate has not been readily available for shell-building species. Source: Friends of Casco Bay, Casco Baykeeper (2019).¹²⁸

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5. Socioeconomic Exposure, Risk, and Vulnerability

Climate hazards will likely create repercussions for our local economy, livelihoods, housing security, food security, and public health.

As adjacent coastal cities in Cumberland County, Portland and South Portland are closely connected in many ways by their populations, economies, institutions, and organizations. The two cities make up the two largest cities in the Greater Portland Metropolitan Area (**Figure 5.1**)—an area comprising of three counties and nearly half the state’s population. While South Portland’s demographics more closely resemble Maine’s as a whole,

both cities’ populations continue to shift towards what you typically see in urban areas: younger, more educated, and more racially and ethnically diverse (**Table 5.1**).

Both Portland and South Portland have vibrant and diverse economies. The number of jobs in Portland now exceeds its population, making up 39 percent of jobs in Cumberland County, 12 percent of jobs in Maine, and overall a significant economic driver for the region.¹²⁹ Portland’s leading sectors by number of jobs include healthcare and social assistance; finance and insurance; and professional, scientific, and technical services, followed closely by accommodation and food services. Likewise, South Portland’s leading sectors include

Population Density in the Greater Portland Area

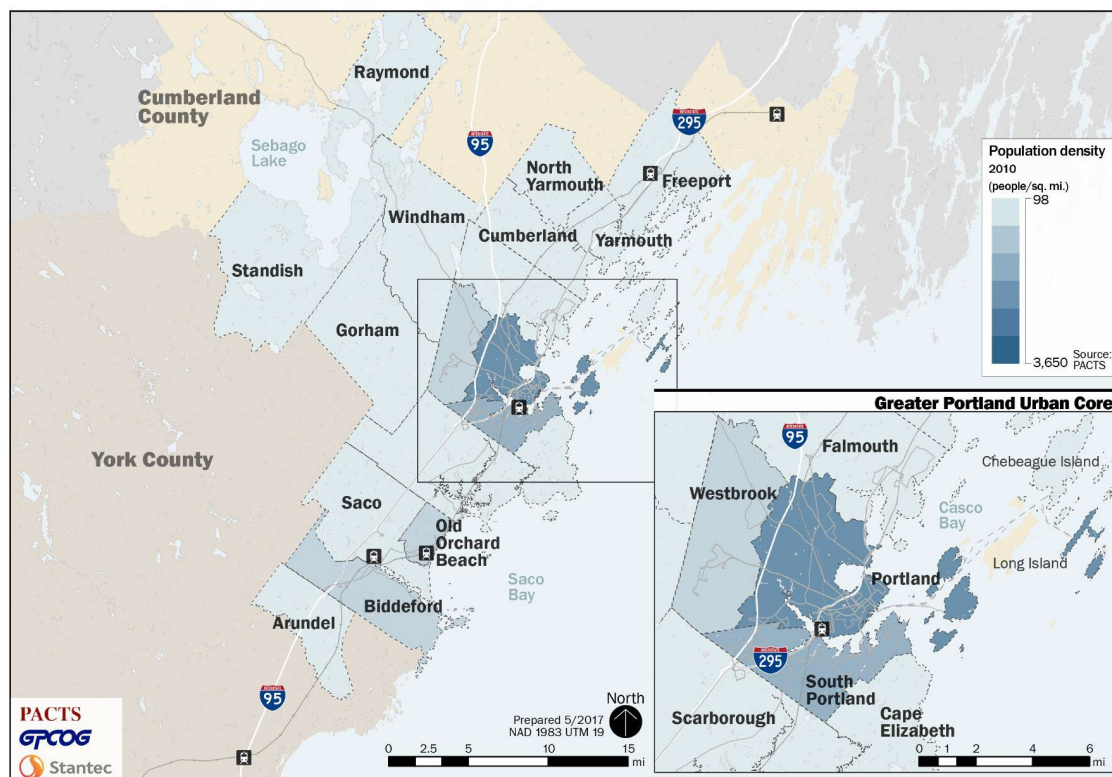


Figure 5.1. Population density in the Greater Portland area (2010). Figure Source: PACTs, GPCOG & Stantec (2017).¹⁸⁴

retail; healthcare and social assistance; and finance and insurance, also followed closely by accommodation and food services. Despite robust economies, both cities have seen the proportion of households living below the poverty rate roughly double since 2000.¹³⁰

Climate hazards not only bring risks to Portland and South Portland's built and natural environments, but are also likely to create repercussions on these social and economic aspects—including the local economy, livelihoods, housing security, food security, and public health. Sea level rise and storm surge may inundate some of the cities' commercial and industrial areas; affect the cost of doing business; influence both property values

and housing affordability; and create challenges in food access. Likewise, higher temperatures, vector-borne diseases, and poor air quality may further affect our public health.

The potential impacts, outlined in the following sections, cross regional, local, household, and individual scales. It is important to note that the burden climate change brings on these many facets will not necessarily be felt equally. How we can continue to strive towards social equity in our communities thus becomes an increasing concern. Our quality of life and ability to grow into even more vibrant, prosperous, and equitable cities will require addressing the potential impacts in the following section.

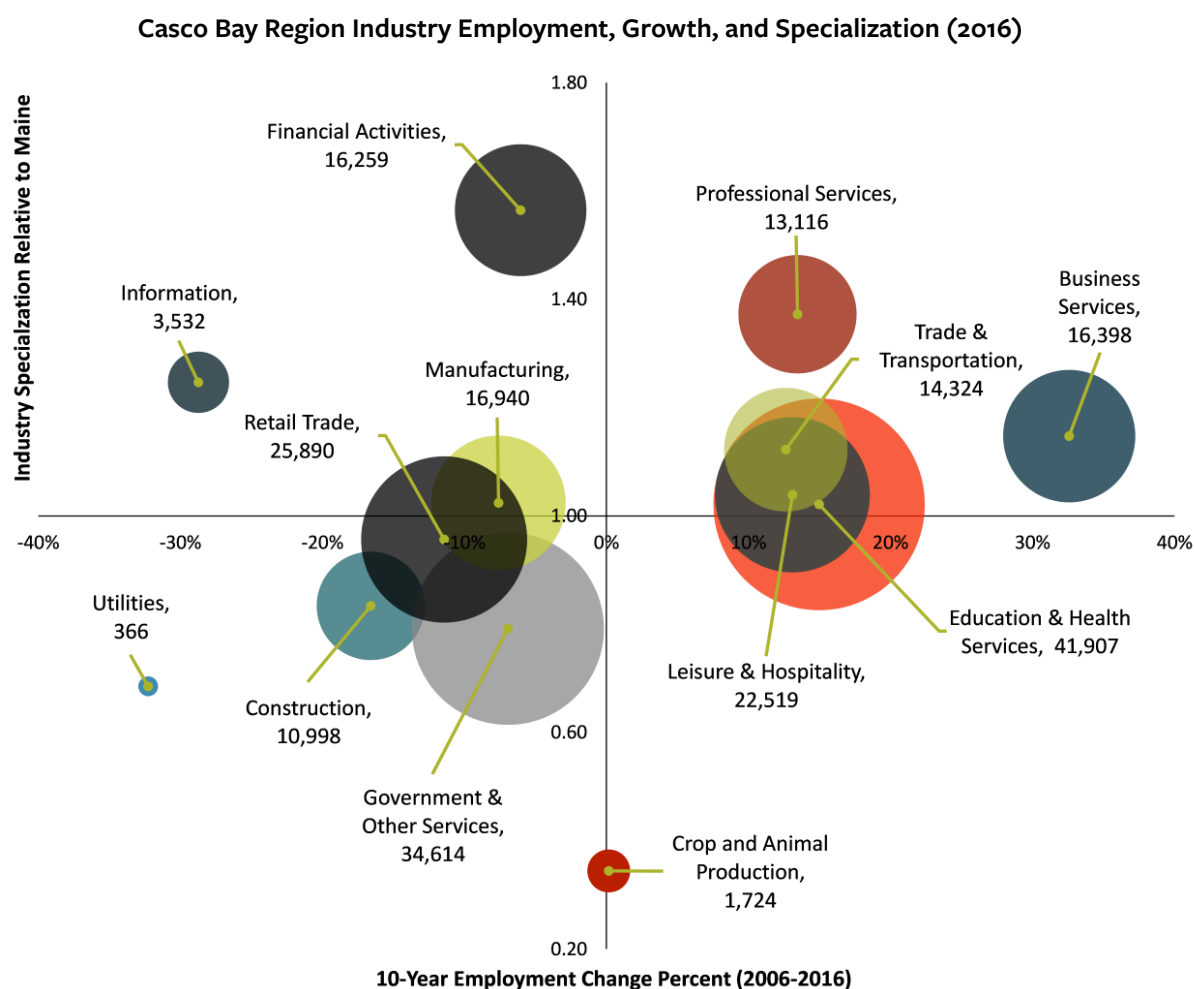


Figure 5.2. Industry employment, growth, and specialization for the Casco Bay region (2016). The bubble size is proportional to the amount of employment. The X-axis plots the 10-year percent change in employment. The Y-axis plots specialization, which is measured relative to the state of Maine and expressed as a location quotient. A value greater than 1 indicates specialization in the region and a value less than 1 indicates a smaller relative share of the industry in the region. Figure source: Maine Center for Business and Economic Research and rbouvier consulting (2017).¹⁸⁵

Population Characteristics

Characteristic	Portland	South Portland	Maine
Population	66,417	25,606	1,338,404
Population Density (people per square mile)	3,107	2,086	43
Median Age	36	40.8	44.6
Percent People Over Age 65	13.7%	15.4%	20.6%
Percent People Under Age 18	16.5%	18.3%	18.7%
Percent People of Color	18.9%	7.5%	6.9%
Percent Foreign-Born	13.4%	5.7%	3.6%
Percent with Bachelor's Degree or Higher	47.6%	42.9%	30.3%
Median Household Income	\$51,430	\$59,515	\$53,024
Median Property Value	\$261,100	\$235,700	\$179,900
Percent Homeowners	44%	62%	72%
Poverty Rate	18.3%	12.4%	11.1%

Table 5.1. A selection of population characteristics for Portland, South Portland, and Maine.¹⁸⁶

5.1 Local Economy and Livelihoods

The impact climate change will have on regional or local economies is difficult to predict—particularly when tied to global markets and supply chains. Climate change is expected to impact the growing capacity of a large range of natural resources globally, thereby affecting the price of feedstocks, fodder, and food, and in turn altering the decision-making calculus for a number of industries. Likewise, disruptions in IT systems, transactions, and product distribution due to power outages, flooding, or road closures has significant economic costs. The Maine Department of Transportation reports that a trucker incurs \$350 of added cost for every hour of unscheduled delay, and on average, poor roads in Maine cost motorists \$263 million per year on average (2009 USD).¹³¹

IMPACT TO ECONOMIC SECTORS

While the impact of climate change on most economic sectors in Portland and South Portland remains unknown (and is outside the scope of this assessment), the impact on the “ocean economy” has been explored for the Casco Bay region. The ocean economy—which includes species harvesting and processing, marine transportation, marine construction, ship and boat building, and tourism

and recreation—accounts for an estimated 4 percent of gross regional product (GRP) in the Casco Bay watershed region, and 8.4 percent of total employment.¹³²

Harvesting, Processing, and Packaging – Harvesting, processing, and packaging of marine species accounts for 11 percent of the Casco Bay ocean economy GRP (\$76 million in 2016), and approximately 1,139 jobs. Although this sector makes up a small portion of the full economy of the Casco Bay region, it holds strong social and cultural importance, including a draw for coastal tourism.

The extensive number of feedback loops and uncertainties in ecosystem dynamics make it largely infeasible to model the impact of climate change on individual commercial marine species. Nevertheless, scientists from the National Oceanic and Atmospheric Administration (NOAA) have published a recent assessment of the climate exposure, biological sensitivity, and potential change in species distribution for a number of marine invertebrates and vertebrates.¹³³ Twelve of the species evaluated are of commercial significance to Casco Bay, and ten of those are predicted to have an overall negative response to climate change within the Northeast Atlantic region. The Maine Ocean and Coastal Acidification Partnership (MOCA) has been

further working to expand the state's understanding of the effects of ocean acidification, in particular, on commercially viable species. See *Section 3: Environmental Exposure, Risk, and Vulnerability* for further details.

If populations begin to collapse, growth rates shift, or species distributions change, fisheries will need to alter management regimes to adapt. If supply decreases for particular species, landing prices will likely increase to compensate. Likewise, higher safety costs from more extreme storms, rising fuel prices, and needing to travel further distances to reach new locations for their catch can all contribute to these rising costs. Although consumers may pay higher prices, they may also switch to alternative species (or alternative proteins), leading to a decrease in revenue for these industries. There is also the risk that a particular stock and fishery would collapse altogether, resulting in loss of jobs and revenue if substitution was not readily feasible.

Wallace et al. (2017). also highlight the equity implications of changes in the harvesting and processing sector due to climate change: more minimally-equipped, smaller operations that have less flexibility in their fishing operations will not fare as well as larger, more mobile operations that have greater access to financial capital and substitute fisheries. This may lead to the consolidation and dominance of fewer, larger operations.¹³⁴

Other Marine Industry – Marine transportation, which primarily consists of shipping and warehousing, makes up 18 percent of the gross regional product (GRP) of the Casco Bay ocean economy, followed by marine construction of port-related infrastructure (1%) and ship and boat building (0.4%). Of these three sectors, marine transportation is likely to be most impacted by climate change. As the polar ice cap continues to melt, new shipping lanes in the Arctic may become increasingly navigable, particularly in summer months. Using the Northwest passage as opposed to the Panama Canal will make the trip from Asia to Europe over a week shorter, with Portland the first port on that course.¹³⁵ With these new routes come substantial new risks and uncertainties.

Additionally, stronger weather patterns, sea level rise, and storm surge will likely have a significant effect on marine industries. Large storms will likely lead to

disruptions in shipping routes and delays in transit, leading to increased costs. Likewise, a substantial amount of coastal infrastructure—including industrial or commercial shipping and storage, passenger and recreational transport facilities, as well as boat engineering, fabrication, and assembly facilities—may need to be restructured to accommodate for rising sea levels. **Figure 2.7** shows the projected impact of sea level rise on Portland and South Portland's waterfronts, including inundation of the Portland piers and the areas surrounding South Portland's petroleum terminals.

Tourism and Recreation – Tourism and recreation makes up 70 percent of the gross regional product of the ocean economy in Casco Bay.¹³⁶ Studies suggest that tourism and recreation will likely be affected both positively and negatively due to climate change—with more out-of-state visitors traveling to Maine to escape increasingly uncomfortable summer weather. Besides effects from crowding, tourism may be impacted by degradation of coastal infrastructure from sea level rise and storm surge, beach erosion and decreased water quality (although Willard Beach and the East End Beach are predominantly utilized by residents), as well as decreases in recreational fishing due to the decline in cold water recreational fishing species.

IMPACT TO COMMERCIAL AREAS

A number of commercial and industrial areas within Portland and South Portland are particularly vulnerable to climate impacts. In Portland, businesses and the waterfront industry along Commercial Street and the piers/wharfs are particularly vulnerable to sea level rise and storm surge, as are the businesses and industry located in the Bayside area (**Figures 2.7** and **2.8**). See section *Section 5.2 Housing and Built Environments* for further analysis of the impacts to these areas specifically. In South Portland, land surrounding the oil terminals is most vulnerable to sea level rise and storm surge in the near term, along with small portions of commercial activity in Knightville, particularly around Thomas Street and the South Port Marina, and along the waterfront in Ferry Village. Any commercial activity in Ferry Village will become increasingly vulnerable to sea level rise and storm surge towards the end of the century.

The vulnerability of these areas will likely increase overhead, operations, and maintenance expenses for

businesses and industries, making it more costly to operate in these specific areas. Any businesses that choose to close or relocate outside the cities will create repercussions for the cities' immediate job markets, economic vibrancy, and tax base.

In addition to the localized impacts from sea level rise and storm surge, the increasing risk of power failures—from high winds, storms, flooding, or high heat—will have cascading economic impacts for businesses across the two cities. Whereas large institutions, such as Maine Medical Center, are equipped with backup generators, most businesses will face significant economic costs from IT disruptions, lost transactions, and temporary business closures. This impact is particularly acute for the cities' restaurants and food industry due to the perishable nature of their inventory.¹³⁷ In a Massachusetts-based study, 70 percent of over 900 businesses interviewed across 20 municipalities voiced concern about the reliance of the power grid and the risk of power failures for their business.¹³⁸ Businesses in Portland and South Portland are similar in profile to those in the study, and are exposed to similar power failure risk from storms. Extreme weather will also have a detrimental impact for commercial businesses reliant on pedestrian traffic.

LIVELIHOOD VULNERABILITY

Residents whose livelihoods rely on the sectors discussed above—specifically marine species harvesting, processing, and packaging, as well as marine transportation—may experience some of highest livelihood vulnerability tied to a specific sector. Changes in species distribution and abundance, as well as added operations and maintenance costs for waterfront infrastructure may create long-term impacts that lead to closures or consolidation. In a better case scenario, climate change may alter the scope of these industries (as well as tourism and recreation, and marine construction) without leading to any job loss for individuals working in these sectors.

More significant risks will come for small business owners who are unable to weather severe impacts from inventory or property loss, as well as self-employed individuals who may lose substantial income if a climate hazard prevents working for a period of time. A significant number of employees within Portland and South Portland commute into the cities on a daily basis (**Figure 5.3**), increasing the risk that any road closures

Population Commuting to Portland

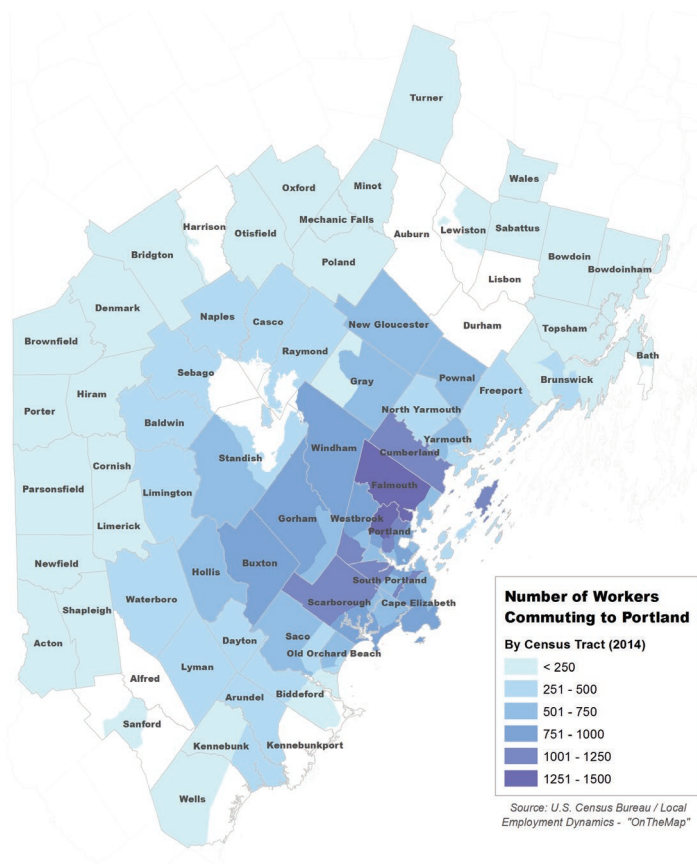


Figure 5.3. Number of workers commuting to Portland. Figure source: Portland's Plan 2030 (2017).

will affect business continuity. Business closures, road closures, and interruptions in public transportation can in particular lead to significant loss of income for residents relying on hourly wages and/or tips. Employees who work in Portland's large food services industry may be particularly hard hit in these scenarios.

5.2 Housing and Built Environments (Economic and Social Implications)

The real estate market, housing affordability, and the quality of the cities' housing stock are all likely to be affected by climate change. Cities have begun documenting the ways in which property values have already begun to shift, creating higher demand for land

at higher elevations and an increasing need for higher density to compensate for lower elevations that may be consumed by frequent flooding. Any substantial loss or damage to the cities' housing stocks due to storms or flooding will ultimately compound with ongoing stresses for housing security, affordability, and quality which may become increasingly important concerns over the course of the next thirty years.

Participants in the One Climate Future Resilience Workshop, hosted in April 2019, highlighted that a large number of Portland's public and subsidized housing units, in particular, are located in the Bayside neighborhood, which is likely to see increasing risk of flooding in the coming years. All but a few Portland Housing Authority (PHA) properties and their adjacent access roads are at elevations safe from flooding up to 3.3 feet of sea level rise, and PHA is working to increase the resilience of its portfolio through federal repositioning programs.¹³⁹ Nevertheless, in addition to 1,000 units of PHA housing, PHA supports another 2,000 families through Housing Choice Vouchers. These families must find housing in the market place—a process that becomes increasingly difficult if sea level rise constricts the housing market, availability drops, and prices rise. Families that can no longer afford to live in Portland or South Portland will be driven further outside the cities, limiting job access, requiring higher commuting costs (in both direct expenses and time), and creating greater vulnerability for climate-related transportation interruptions. Maintaining housing security, affordability, and quality within the cities thus becomes a priority for the region's resilience.

DIRECT ECONOMIC COSTS FROM PROPERTY DAMAGE

Flooding, predominantly from sea level rise and storm surge, poses the most direct economic impacts to Portland and South Portland through infrastructure, building, and property damage. A number of studies have attempted to quantify this impact.

In 2013, Catalysis Adaptation Partners modeled the economic vulnerability of Portland's Commercial Street waterfront area using the COAST (COastal Adaptation to Sea level rise Tool) approach and software. This methodology calculated potential building damage over time, assuming a scenario of two feet of sea level rise by 2050 and four feet of sea level rise by 2100. **Table 5.2** summarizes the expected damage costs to buildings from the 100-year storm in the given year, as well as the accumulated costs for buildings and improvements from all storms (due to sea level rise and storm surge) between 2013 and the given year. Modeling suggests that based on the 2013 buildout of the Commercial Street waterfront area, Portland is projected to see \$26.4 million in damages to buildings in that area from a single 100-year storm in 2100. Furthermore, at the time of the modeling \$46.4 million in building value was located on parcels that are predicted to be permanently inundated by the daily high tide (MHHW) if no action is taken.

Likewise, in 2012 the New England Environmental Finance Center at the University of Southern Maine used the COAST approach and software to model the impact of sea level rise and storm surge on real estate in Portland's

Estimated costs of building damage: Commercial Street Waterfront

Year	Damage from a single 100-year storm	Cumulative damage from all storms 2013 – given year	Value of buildings on permanently inundated parcels
2050	\$16.0 million	\$32.9 million	\$8.7 million
2075	\$25.2 million	\$69.6 million	\$11.9 million
2100	\$26.4 million	\$111.5 million	\$46.4 million

Table 5.2. COAST model output for the Portland Commercial Street waterfront area. Data show the estimated costs of potential building damage for the 100-year storm in 2050, 2075, and 2100; the cumulative damage from all storms from 2013 to the designated year; and the value of buildings on permanently inundated parcels by the given year if no action is taken. All modeling assumes a scenario of four feet of sea level rise by 2100 above 2013 mean higher high water (MHHW). For further details see Catalysis Adaptation Partners (2013).¹⁸⁷

Back Cove area. Based on a 2012 buildout of the Back Cove area, the study suggested that Portland could see \$447 million to \$3.68 billion in damage to Back Cove real estate from a 100-year storm with 1.6 feet of sea level rise and 5.9 feet of sea level rise above MHHW, respectively.¹⁴⁰

While looking thirty to eighty years into the future, the modeling underscores the sheer magnitude of the economic impact and how that cost will accumulate over time if no action is taken. Many studies have begun emphasizing the intergenerational environmental justice concerns of a “wait and see” approach, stressing that any tax dollars saved now for avoided capital investments will ultimately lead to larger and more simultaneous costs for future generations that could be financially catastrophic.

IMPACTS ON PROPERTY VALUES, TAX BASE, AND MUNICIPAL FUNDING

New research from Columbia University underpins the impact that frequent flooding may have on the decline of property values. For properties in the southeast United States that were expected to flood completely during a tidal flood (king tide) in the next fifteen years, the study shows their property values already declining by \$3.08 per square foot annually.¹⁴¹ Homes within a quarter mile of a road that will flood completely in 15 years had likewise begun to decline in value by \$3.71 per square foot annually—roughly \$5,565 per year for a 1,500 square foot home. First Foundation and Columbia University have since applied the methodology to eighteen states, with results suggesting that properties in Portland and South Portland have lost a total of \$701,833 and \$460,033, respectively, between 2005 and 2019.¹⁴² These losses are from years with relatively minimal nuisance flooding when compared to expected future flooding.

High-risk properties are also more likely to be put on the market with each passing year, and the study notes the trend in which the purchase price continues to decline as fewer people want to buy high-risk properties. While wealthier homeowners, businesses, or neighborhoods may have more cumulative value to lose, those with more limited financial means risk losing a much larger portion of their wealth. Lower income homeowners become forced to weigh the tradeoff between costly flood-proofing investments (as discussed in the next section) and defaulting on loans, and homeowners with

rapidly devaluing properties can be left with mortgages that exceed the value of their homes.¹⁴³ Financial risk is then extended to lenders, particularly small local banks concentrated in coastal areas who carry a large number of these risky mortgages. Real estate investors and developers can also risk insolvency if a large portion of their portfolios are on the coast.

In many more ways, changes in property value have implications beyond the individual property (**Figure 5.4**). Neighborhoods in affected areas can begin to lose value as residents move out or adjacent properties decline in quality or value. In Portland and South Portland, it will be important to consider the ways in which these trends increase market affordability in specific areas, but in doing so may exacerbate patterns where residents with fewer financial resources increasingly live in areas with higher flood risk. Furthermore, full communities

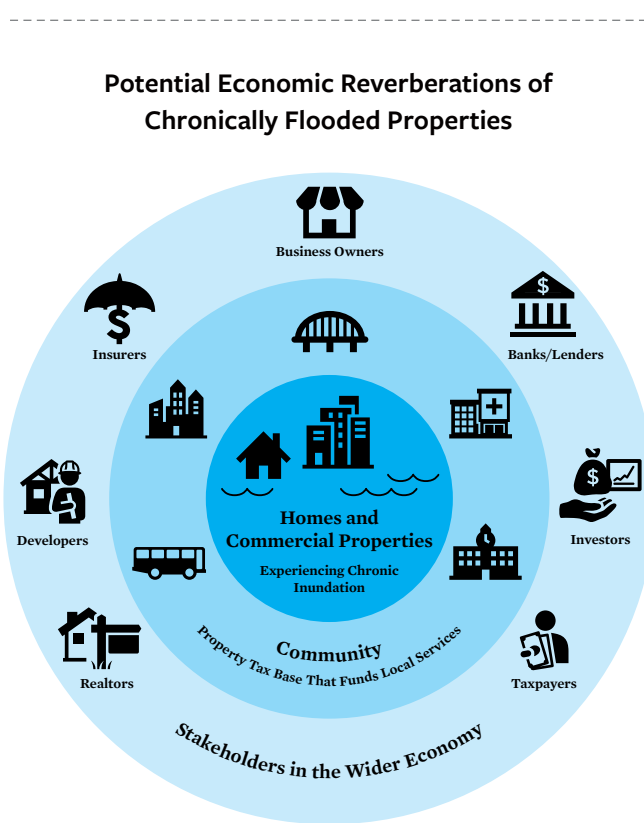


Figure 5.4. Properties lose direct value with chronic flooding, but the economic implications affect the broader community. Municipalities lose tax base to fund public services and many other sectors such as banks/lending institutions, developers, and insurance companies—as well as tax payers—may feel the economic repercussions. Figure source: Union of Concerned Scientists (2018).¹⁸⁸

feel the impact of declining property values when municipalities are forced to either raise tax rates to compensate for lower tax bases, or reduce public funding for transportation, schools, emergency services, or other public goods. Residents who most rely on these public services will be disproportionately affected.

Lastly, the ability of the cities to access additional capital, specifically through bond markets, will depend on municipal credit ratings—a factor that is affected by both the cities’ financial health and exposure to risk. If the financial health of the cities were to decrease as exposure to chronic flooding increases, the cities may face more limited options for financing resilience investments, a vicious circle that could leave the cities increasingly vulnerable to flood risk.

ADDED HOUSEHOLD COSTS

A number of factors driven by climate change will likely increase household costs for both renters and homeowners. Rising costs for flood insurance contribute to higher household costs for homeowners in flood risk areas. The average yearly flood insurance premium in Maine under the National Flood Insurance Program (NFIP) is \$1,065, 52 percent higher than the national average due to the relative higher risk that many Maine communities face. Recent updates to FEMA floodplain designations in Maine communities have indicated potential increases in insurance rates for many homeowners, if and when adopted. While the NFIP risk rating system is currently under revision, it is unclear the average effect it will have for Maine homeowners when the new system rolls out in October 2020.¹⁴⁴

While flood insurance premiums are an added expense, so too are building retrofits and repairs. Many home and business owners are choosing to elevate or increase the freeboard on their buildings, as well as invest in other forms of wet and dry floodproofing, both to decrease insurance premiums and to reduce the risk from flood damage in the future. Damage to buildings from floods, as well as high winds in heavy storms, are expected to increase household financial burden due to climate change. Residents have expressed concern that extreme weather and flooding are already beginning to drive up the costs for buildings to operate effectively.¹⁴⁵ They further note that most older buildings—without investing

in retrofits—lack the capacity to maintain habitable indoor temperatures in cold weather or high heat during an extended power outage.

Based on 2013-2017 data, roughly 11% of homeowners and 24% of renters across Portland and South Portland are “extremely cost-burdened” by housing costs, meaning such costs are 50% or more of household income.¹⁴⁶ (Roughly 28% of homeowners and 48% of renters pay 30% or more in housing costs.) These residents are likely to be most vulnerable in facing higher housing expenses, and least able to retrofit their homes to accommodate increased climate risk.

5.3 Community Resources and Food Security

Portland and South Portland have a wealth of social service organizations, healthcare facilities, mental health services, community centers, places of worship, public libraries, and City services that support the health and wellbeing of residents in a wide number of ways. Such formal resources, as well as the informal social networks fostered in formal and informal gathering spaces, prove crucial to supporting the resilience of any community.

Increasing stresses from climate change—whether financial, physical, or emotional—will likely expand the need for social services and resources in the coming years. Residents likewise point to the fact that Portland and South Portland may continue to become a settlement location for refugees, and in particular climate refugees, as people are displaced due to climate hazards nationally and globally.¹⁴⁷ Organizations and City services risk becoming overstrained and ineffective without deliberate strategies to consider this expanded need.

While increasing this need, climate hazards may simultaneously limit residents’ ability to access services and resources. **Table 5.3**, for example, documents the number of addresses that become inaccessible to emergency medical service providers at various scenarios of sea level rise. The table also documents the estimated extent of investment needed to road infrastructure to maintain accessibility.

Inaccessible Addresses and Costs for Road Upgrades

Sea Level Rise	Number of Inaccessible Addresses		Costs to Upgrade Roads (MM USD)	
	Portland	South Portland	Portland	South Portland
2 feet	43	0	\$2.85	\$0.05
3.3 feet	126	40	\$8.41	\$0.71
6 feet	697	373	\$23.72	\$8.71

Table 5.3. Number of addresses that are inaccessible to emergency medical service providers under various sea level rise scenarios, and the estimated costs to upgrade roads to prevent inaccessibility. Inaccessible addresses are those adjacent to roads that are inundated by any depth of water at the particular sea level increase on top of the highest annual tide. While roads will not be completely impassable in every case, the data suggests the extent of roads that have a high risk of being impassable. Data from the Maine Coastal Risk Explorer Project.¹⁸⁹

Challenges to emergency response highlight a direct and immediate vulnerability in thinking about climate hazards. Storms, flooding, and even high heat can also limit our ability to access resources that ensure health and wellbeing on a day-to-day basis—whether that’s healthy food, childcare, routine health services, a sustainable income, or a sense of community and support. Participants in the One Climate Future Resilience Workshop, for example, voiced concern that much of Portland’s social service network that supports some of Portland’s lowest income households is also located in Bayside, an area vulnerable to sea level rise and flooding.¹⁴⁸

The full scope of resources and services that residents depend on varies greatly based on the context of the

neighborhood and each household. The case study included below begins to scratch the surface in terms of understanding how community assets in the Bayside area may be affected by flooding, and the compounded impact of assets being affected simultaneously.

While outside the scope of this assessment, this exploratory case study could benefit from being carried out in further depth and for neighborhoods across both cities—and ideally through a process led by residents who could discuss and describe the formal and informal resources they rely on. Visualizing this network and understanding potential gaps and vulnerabilities could help inform how resource “nodes” (or “resilience hubs”) can support and augment the formal and informal resources currently in neighborhoods across both cities.

Case Study: Bayside Community Assets

The social and economic impact of a climate hazard tends to be additive, or even multiplicative, when full neighborhoods (or furthermore, cities or regions) are affected simultaneously. The extent of impact comes not only from direct property or infrastructure damage, but also through the immediate and longer-term loss of access to resources, services, social networks, or other community assets that support health and

wellbeing. The full extent of this impact in any event is complex and nuanced, and yet looking at the types of community resources within an impacted area can give a sense of how impacts to certain properties may create more permeating challenges for neighborhoods and communities. The following case study looks at Portland’s Bayside area in a flood scenario with 3.3 feet of sea level rise—a level that is possible by the year 2050.

Figure 5.4. shows the roads in the Bayside area that would be “inundated” by any amount of water covering the surface of the road at 3.3 feet on top of the highest annual tide (red dashed lines). While not all of these road segments would be impassable, the map identifies the segments that are most likely to be obstructed under such conditions, which most significantly include Marginal Way, Somerset Street, Fox Street, Anderson Street, and the connection between Franklin and I-295. **Figure 5.4** also highlights the buildings that would be impacted by this level of flooding (yellow building outlines). It likewise notes the number of addresses

in each Census block group that would lose access to emergency medical service (EMS) providers, and notes the estimated cost to upgrade roads to ensure that access for EMS providers can be maintained. Collectively, **Figure 5.4** begins to explore the extent of the potential physical impact, as well as how it creates immediate access concerns during emergency response.

In the longer-term aftermath, **Figure 5.5** looks further at sets of community resources within the area—specifically schools, grocery stores, community centers and/or public libraries, government facilities, places of worship, health

Vulnerable Bayside Community Assets - Investigation 1



Figure 5.5. Flood vulnerability in the Bayside area. The map shows roads that would be inundated under 3.3 feet of sea level rise on top of the highest annual tide, as well as properties that may be affected. White circles denote the number of addresses in each Census block that would lose access to emergency medical service providers, as well as the cost required per Census block to upgrade roads to prevent loss of access.¹⁹⁰

facilities, and open space. These resources are often important to a community's fabric, providing access to food and household supplies, healthcare services, access to information, as well as free public spaces that are often key to creating and strengthening social relationships. The loss of a number of these resources in close proximity to each other can exacerbate the harm caused by an extreme event. For example, flooding has the potential to affect access to three grocery stores in the area—which has broader implications for food delivery and access for the city. At the neighborhood scale, residents who do not have access to a private

vehicle may have trouble reaching an alternative grocery store at a further distance. Beyond grocery stores, the mapping exercise highlights a significant number of healthcare and social service locations, as well as a school and community center that may be affected. When daily life becomes significantly disrupted, the support and constancy from neighbors and community resources becomes increasingly important. Losing this social fabric is one of the most significant socioeconomic vulnerabilities associated with climate hazards, and is particularly acute when extreme events lead to community displacement. ■

Vulnerable Bayside Community Assets - Investigation 2



Figure 5.6. Flood vulnerability for a set of community assets in the Bayside area in Portland. Flooding across a neighborhood can have significant repercussions when a number of community resources—such as schools, grocery stores, community centers, health facilities, libraries, and open space—are closed or compromised for an extended period of time.¹⁹¹

FOOD SECURITY

Our access to healthy and affordable food in Portland and South Portland may be increasingly affected by climate change. Food security means that “all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their food preferences and dietary needs for an active and healthy life,” as defined by the United Nations’ Committee on World Food Security. A city’s food system expands well beyond its borders, and includes the integration of agriculture and food harvesting, production and processing, distribution, as well as food access. A number of studies now point to the ways climate change could drive up global food costs—from damage to crops, new pests, and water scarcity—in addition to higher fuel prices and higher global food demand.¹⁴⁹ The impacts of these higher costs are likely to have rippling effects through global, regional, and local food systems.

Food Sourcing, Growing, and Harvesting – On average, 90 percent of food consumed by Mainers comes from outside the state.¹⁵⁰ At any particular time, certain food sectors may be affected by climate shocks outside Maine; likewise, food shipments into the state can be disrupted from extreme weather. Because of the fragmented nature of supply sourcing, however, it is unlikely that Portland or South Portland would experience comprehensive supply shortages, unless widespread fuel shortages were to occur. Nevertheless, food research groups continue to advocate for strengthening regional food production in Northern New England and Maine as a means to advance both the sustainability and resilience of local food systems.¹⁵¹

Climate change is also expected to impact food grown and harvested locally in Maine. Agriculture, aquaculture, and fisheries contribute to the 10 percent of food sourced within the state—with potatoes, dairy products,

eggs, wild blueberries, apples, lobster, herring, mussels, and farmed salmon being some of the primary food commodities.¹⁵² Roughly 8,000 farms (approximately 700 of which are in Cumberland County) produce 80 different crops. Although many people believe that Maine’s agriculture will benefit from a longer growing season, this opportunity is in many ways countered by detrimental climate impacts. Warmer temperatures bring new pests to Maine and allow current pests to reproduce more within a single growing season.¹⁵³ Temperature increases may also decrease yields for some of Maine’s signature crops that grow best in cooler climates (such as potatoes), and unseasonably warm springs can cause fruit trees and other perennial crops to bloom before the last frost, leading to freeze damage. Apple harvests in 2016 were low, for example, because trees blossomed too early throughout much of Maine.¹⁵⁴ Climate change is also expected to bring heavier, more sporadic rain events that damage crops, increase soil erosion and nutrient runoff, and prevent soil from retaining moisture. A lower capacity to retain water combined with warmer and drier summers can be particularly problematic for much of Maine’s unirrigated cropland. Without new management approaches, these vulnerabilities are likely to strain the economic sustainability of Maine’s farms.

Likewise, rising water temperatures and acidification are impacting the health and distribution of species in the Gulf of Maine, with uncertain implications for fisheries and aquaculture along Maine’s coast. In a recent study conducted by NOAA, ten of twelve marine species with commercial significance to Casco Bay showed an overall negative response to climate change within the Northeast Atlantic region.¹⁵⁵ See sections 4.4 *Shifting Habitats: New Pests and Invasive Species*; 4.5 *Acidification Impacts on Species Health*; and 5.1 *Local Economy and Livelihoods* for further details on climate change impacts to fisheries and aquaculture.

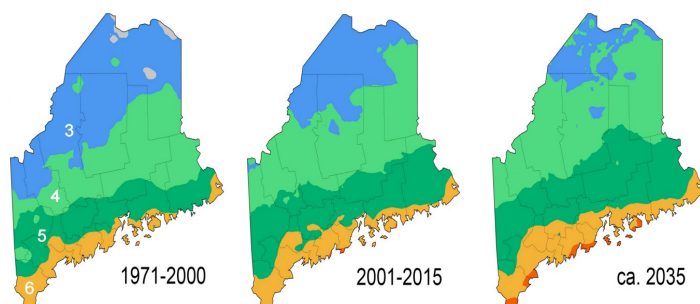


Figure 5.7. Recent, current, and future projected plant hardiness zones, which are shifting northward in Maine due to warmer temperatures. Zones are labeled in the left map. Figure source: University of Maine, Maine Climate and Agriculture Network. Data from PRISM Climate Group, Oregon State University.¹⁹²

Food Processing – The Greater Portland area hosts a significant number of food processing and manufacturing facilities, which make up a sector targeted for further growth. Because most facilities focus on a single product (and most food consumed in Maine is sourced outside the state), interruptions in production or business closures due to climate hazards would have an economic impact for the cities, but create relatively minimal vulnerability for local food availability. Milk processing, however, tends to be one exception. Because of its high level of perishability, milk tends to be sourced primarily from regional processors. Two of Maine’s four milk processing facilities—Oakhurst Dairy and H.P. Hood—are located in Portland. The H.P. Hood facility could be vulnerable to sea level rise or storm surge, but only in very high or extreme scenarios. The Oakhurst Dairy site does not show any notable flood risk.

Food Distribution – A significant number of food wholesalers and distributors are located within the Greater Portland area; most within the two cities, however, are primarily for single products, such as

fish and seafood or beer and wine.¹⁵⁶ Supermarket warehouses and distribution centers are primarily located outside of the two cities, except for the Hannaford Distribution Center at the Rumery Industrial Park in South Portland. This location does not suggest any risk from sea level rise or storm surge. Even if distribution centers are not affected, however, nearly all food products travel to retail locations by truck, and road closures can prevent food delivery. In some cities food distribution trucks are not considered emergency vehicles; case studies illustrate the ways in which these regulations have posed food delivery problems during emergency travel bans or road closures.¹⁵⁷

Portland and South Portland have a wide array of small groceries and food markets, and approximately eleven major stores, or supermarkets, that are over 1,000 square feet. Five of the eleven supermarket locations show vulnerability to sea level rise and storm surge, particularly at Intermediate-High, High, and Extreme scenarios (**Table 5.4**).

Flood Vulnerability of Portland and South Portland Supermarkets

Supermarket	Sea Level Rise Scenario (on top of Highest Astronomical Tide)					
	1.2 ft	1.6 ft	3.9 ft	6.1 ft	8.8 ft	10.9 ft
Hannaford – Riverside (787 Riverside St, Portland)						
Hannaford – Back Cove (295 Forest Ave, Portland)						
Hannaford – Gorham Road (415 Philbrook Ave, S. Portland)						
Hannaford – Mill Creek (50 Cottage Rd, S. Portland)						
Shaw’s – Northgate Plaza (91 Auburn St, Portland)						
Shaw’s – Bradley’s Corner (1364 Congress St, Portland)						
Shaw’s – Mill Creek (180 Waterman Dr, S. Portland)						
Whole Foods – Bayside (2 Somerset St, Portland)						
Trader Joe’s (87 Marginal Way, Portland)						
Save a Lot (268 St John St, Portland)						
Portland Food Coop (290 Congress St, Portland)						

Table 5.4. Five of eleven supermarkets in Portland and South Portland show vulnerability to sea level rise and storm surge. Dark yellow indicates full inundation of the site; medium yellow indicates some flooding of the site; light yellow indicates smaller patches of flooding to the parking lot or adjacent streets.

Food Access – Beyond closures and interruptions to food processing, distribution, and retail, climate change can impact food access at a household level. As of 2017, 12.2 percent of residents in Cumberland County were food insecure, and 16.6 percent of children.¹⁵⁸ Participants in the *One Climate Future* Resilience Workshop emphasized that the South Portland Food Cupboard and area resources are utilized monthly by many residents, in addition to the USDA Supplemental Nutrition Assistance Program (SNAP). If food costs rise, as predicted, this may amplify food insecurity for households across both South Portland and Portland. Likewise, the City of South Portland recently disseminated a survey to understand how people are using the bus system, which illustrated that residents use public transit to get to work, medical services, as well as for groceries. Roughly 5,880 total households across Portland and South Portland (17% of Portland households, and 8% of South Portland households) do not have access to a vehicle. For those who rely on public transit, closures or disruptions in the bus system may create significant limitations in food access, particularly if closer stores temporarily close.

5.4 Health

Extensive research documents the health impacts of climate change across the United States and in Maine.¹⁵⁹ Higher temperatures, more intense storms, flooding, changes in exposure to pathogens, as well as heightened stress are all expected to wear on our immune systems and create new public health concerns. The following sections summarize some of the more significant health impacts that we expect to feel in Portland and South Portland now and in the coming decades.

HEAT STRESS

According to the Environmental Protection Agency (EPA), heat is the leading weather-related cause of death in the United States.¹⁶⁰ Although Maine is not expected to see the same extreme temperatures as other parts of the country, the impact of a high heat day (such as one day over 95° F) or a heat wave (such as three days over 90° F) has a very different impact depending on the region and time of the year. Unseasonably hot days, extreme heat, as well as extended heat waves can have a significant physiological impact on people whose bodies

are less acclimated to warmer weather, which both affects people in historically cooler climates and makes extreme temperatures in the spring more deadly than those later in the summer.¹⁶¹

Likewise, air conditioning is much less prevalent in homes, businesses, and public spaces in northern parts of the United States, including Portland and South Portland. Both due to human physiology and due to infrastructural cooling capacity, cities in cooler climates tend to see more heat-related deaths and hospitalizations.¹⁶² Studies show that human bodies can increase their heat tolerance over time, but in the near-term, public infrastructure that can provide cooling capacity will be a necessary public health intervention.

Health issues from extreme heat most directly stem from the body's inability to regulate internal temperatures, which can lead to heat exhaustion, heat stroke, and hyperthermia. Prolonged exposure to heat also exacerbates asthma, heart disease, and diabetes, leading to more hospitalizations for kidney, cardiovascular, and respiratory disorders. A string of days that also have high minimum temperatures (i.e., hot nights) prevents bodies from being able to recover, amplifying the health risk.

Although all portions of the cities will feel the effects of higher temperatures, residents who live and work in areas with more impervious surfaces and less green space will likely feel high heat more acutely. Impervious surfaces (such as buildings, roads, sidewalks, and parking lots) retain more heat and lead to higher surface temperatures; meanwhile vegetation, and trees in particular, help keep cities cooler both through evapotranspiration and by providing shade. **Figure 5.8** shows the impervious surfaces and green spaces across Portland and South Portland as a proxy for understanding which areas of the cities may feel the effects of extreme heat more than others. Areas with a significant portion of red shading (impervious surfaces)—such as South Portland's West End—will likely feel hotter due to higher surface temperatures.

Residents who work in outdoor occupations, such as construction or landscaping, will have greater vulnerability to periods of high heat. Children, older adults, residents with disabilities, and residents without

Pervious and Impervious Surfaces in Portland and South Portland

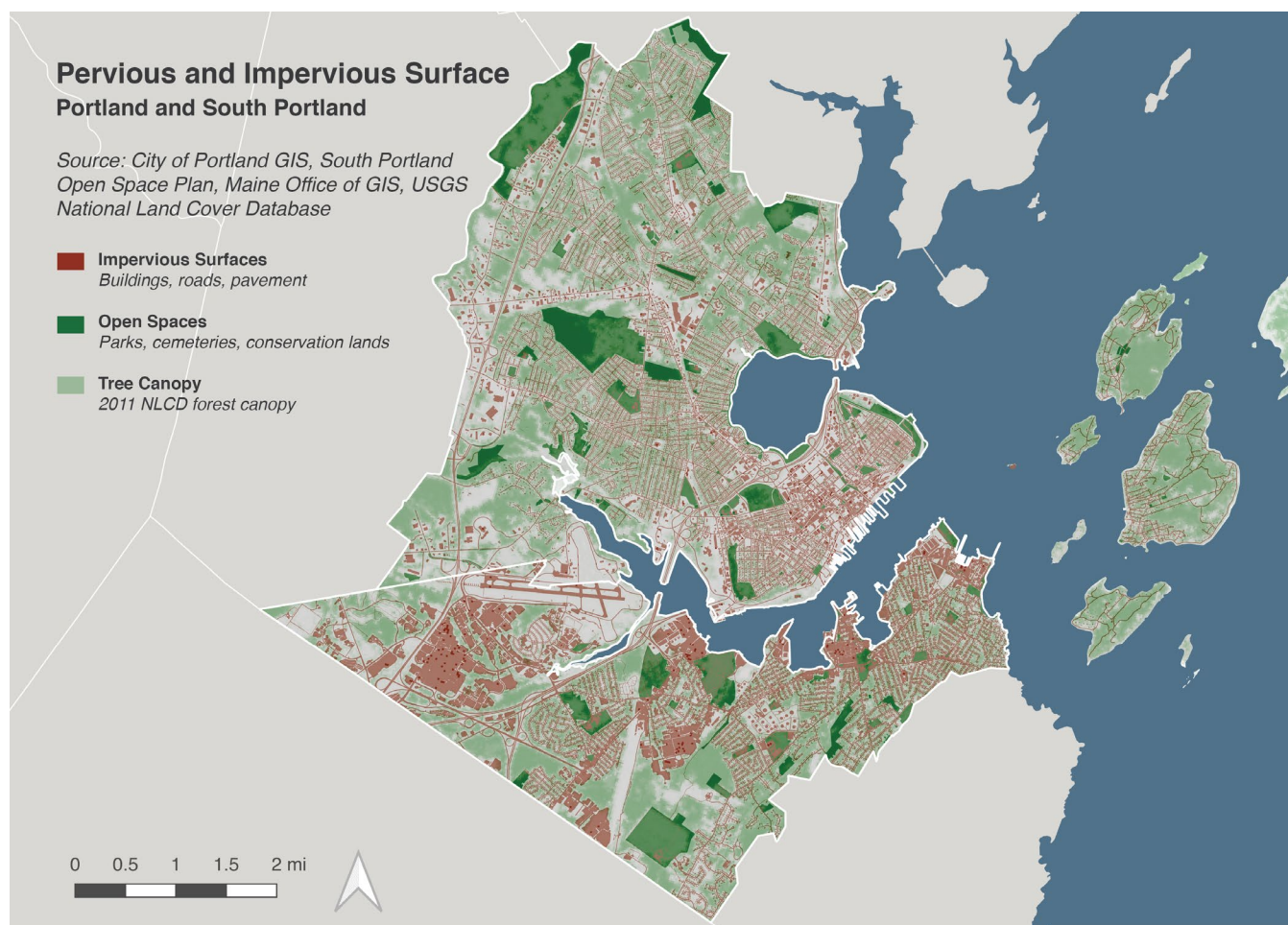


Figure 5.8. Pervious and impervious surfaces across Portland and South Portland. Areas with higher proportions of impervious surfaces will likely feel warmer than other areas on days with high heat.¹⁹³

access to air conditioning will also be more vulnerable. See *Section 5: Social Vulnerability and Adaptive Capacity* for further details on these heightened vulnerabilities.

VECTOR-BORNE DISEASE

Vector-borne diseases are illnesses caused by pathogens that are transmitted from “vectors” such as ticks and mosquitoes. There are fourteen vector-borne diseases that are concerns in the United States, and nine of those diseases (two mosquito-borne and seven tick-borne) have been identified in Maine. Lyme disease, which is spread by black-legged ticks or deer ticks, is the primary and most common vector-borne disease in Maine as of 2019.¹⁶³ Symptoms for Lyme disease in humans usually include a fever, headache, fatigue, and a skin rash called

erythema migrans. If left untreated, the infection can spread, resulting in chronic joint pain and neurological dysfunction.¹⁶⁴

Changes in the climate, including warmer winters, higher humidity, and more precipitation, impact the breeding and survival rates of ticks and mosquitoes, as well as the reproductive rate of the pathogens. Rates of Lyme disease have increased significantly in the past couple decades from less than 100 reported cases in 2000 to 1,373 reported cases in 2018 (280 of which were in Cumberland County).¹⁶⁵ In 2018, Cumberland County also had 71 reported cases of anaplasmosis, 20 cases of babesiosis, 7 cases of ehrlichiosis, and 1 case of Spotted Fever Rickettsiosis. Rates of anaplasmosis and babesiosis,

Reported Lyme Disease Cases in 1996 and 2014

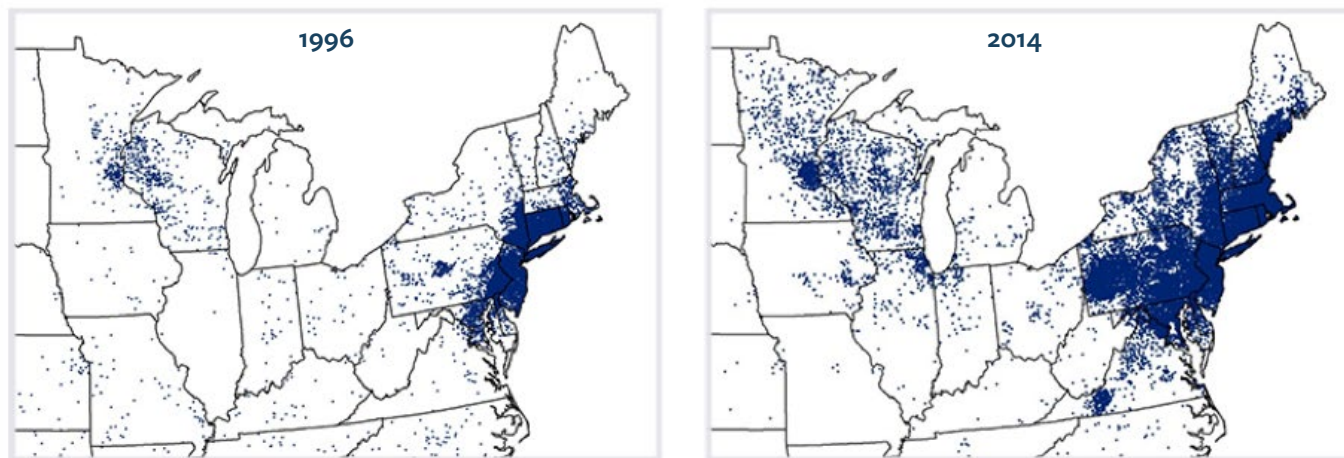


Figure 5.9. The distribution and number of reported Lyme disease cases has increased significantly in the northeast United States over an 18-year timespan from 1996 to 2014. Figure source: Center for Disease Control and Prevention Lyme disease data and statistics (2015).¹⁹⁴

in particular, have increased significantly in Maine in the past ten years.¹⁶⁶ **Figure 5.9** illustrates the drastic increase in reported cases of Lyme disease across the northeast from 1996 to 2014. Southern Maine saw a significant increase in cases over the 18-year timespan.

HEALTH AND SAFETY HAZARDS FROM STORMS AND FLOODING

Major storms, including associated heavy precipitation, high winds, and flooding, bring a wide range of health and safety risks. Most directly, these climate hazards lead to injuries and fatalities due to drowning; blunt injuries from falling objects or debris moving in floodwater currents; electrocution from exposure to electrical systems and electric shocks transmitted through flood waters; as well as vehicle accidents due to slick, eroded, or obstructed roadways.¹⁶⁷

Impaired infrastructure and building damage can likewise lead to cascading health risks through loss or disruption in electricity/power, transportation, communication, and water and sanitation systems. All of these factors in themselves create heightened health risks, which can be amplified by an inability to access medical care, medical equipment, or medications. For example, compromised road and transportation systems restrict access for first responders, and limit access to medical care. Power failures are particularly dangerous for residents who rely

on electric medical equipment such as ventilators or on refrigerated medications. Transportation interruptions and service closures are also hazardous for people reliant on routine medical services such as dialysis, blood transfusions, chemotherapy, or medication treatment for addiction.

Beyond the implications for medical care, power outages create unsafe situations through the loss of lighting, heat, and cooling. Studies show that storms and floods lead to increases in hospital visits and fatalities from carbon monoxide poisoning due to improper use of backup and portable generators as well as combustion appliances (such as charcoal grills or kerosene stoves) intended for outdoor use.¹⁶⁸ Loss of refrigeration—at residential, commercial, and industrial scales—also can compromise food safety and lead to foodborne illnesses.

Likewise, waterborne illness is a major concern stemming from power outages and flooding—both due to risks from contaminated drinking water as well as exposure to contaminated floodwaters. Flooding can lead to both chemical and bacterial water contamination through displaced or overturned chemical storage tanks, bacterial release from sewer systems, or chemical release from waste sites. Exposure to contaminated water can cause gastrointestinal illness as well as irritations and infections of the skin, eyes, nose, and throat.¹⁶⁹

AIR QUALITY AND ALLERGENS

A number of sources including the burning of fossil fuels, wildfires, wood stoves, and agricultural dust contribute to poor air quality by creating smog, particulate matter, and air toxics. A large number of studies now show that climate change will likely exacerbate poor air quality over time. Rising temperatures speed up the chemical reactions that create smog, specifically ground-level ozone. Changes in wind patterns may also result in more stagnant air, which reduces circulation and traps pollution and pollution precursors at ground level. Studies suggest that the northeast will see higher concentrations of ground-level ozone due to both these factors.¹⁷⁰ In 2016, the Portland-South Portland area had 13 days where half or more pollution monitoring locations reported elevated levels of ozone and 17 days with elevated particulate matter (PM_{2.5}).¹⁷¹

While atmospheric ozone is important for protecting us from ultraviolet radiation, ozone at ground level can cause significant public health concerns by causing inflammation in the lungs. This inflammation leads to coughing and throat irritation in the short-term; over the long-term, lung tissues become less elastic, more sensitive to allergens, and more prone to infections—often leading to chronic conditions like asthma.¹⁷² Changes in meteorological factors such as higher humidity and stagnation could also lead to higher levels of particulate matter, which has shown to trigger cardiovascular problems (such as heart attacks, strokes, and congestive heart failure), as well as lead to premature birth, stunted lung development in children, higher rates of asthma, and higher risk of autism and dementia.¹⁷³ As of 2017, Maine had one of the highest asthma rates in the country (11.2% of adults).¹⁷⁴

Likewise, climate change is predicted to exacerbate aeroallergens, which are airborne substances such as pollen and spores that cause allergic reactions. Higher levels of carbon dioxide, higher temperatures, and more precipitation change the quantity, spatial distribution, and seasonal timing of aeroallergens, as well as the intensity of humans' allergic reactions to these substances.¹⁷⁵ With climate changes, we are expected to see earlier flowering, more pollen production, and potentially a longer pollen season, which is predicted to trigger allergic responses, asthma, and other respiratory stress. Studies also suggest that tree species that have more allergenic pollen will

likely fare better than other tree species with climate change.¹⁷⁶ **Figure 5.10** published in a report by the National Wildlife Federation and the Asthma and Allergy Foundation of America illustrates how the distribution of highly allergenic species may expand by 2100 under a high emissions scenario. Maine is highlighted as a “high risk” state for increases in allergenic pollen.

Higher levels of humidity and dampness may also increase mold growth and fungal spores in the air, particularly with increased precipitation, heavy storms, and flooding in indoor spaces.¹⁷⁷ Mold growth has been

Annual Tree Pollen Potential

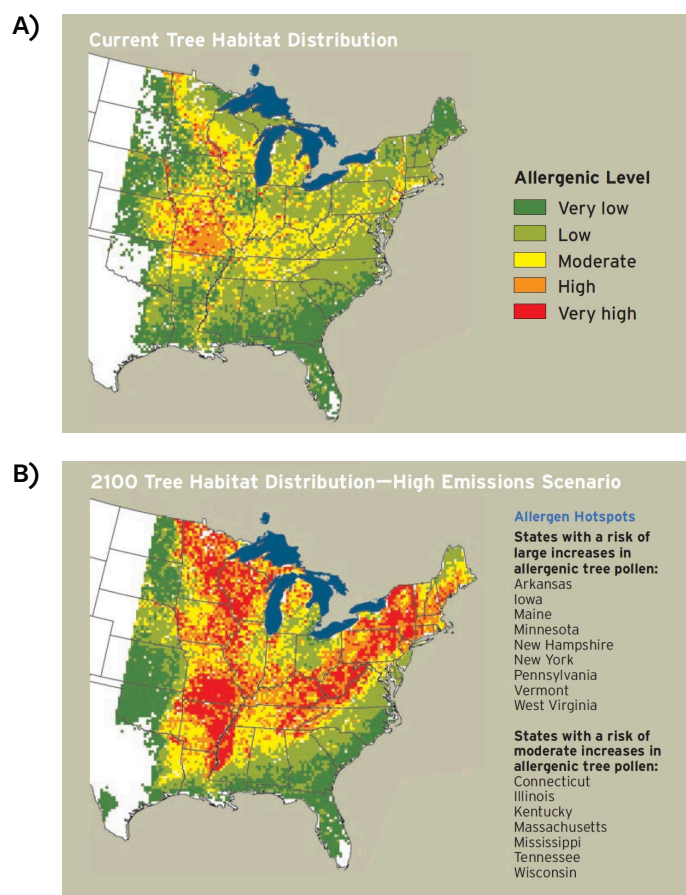


Figure 5.10. Annual allergenic potential from tree pollen from the current distribution of tree species (A) and the potential distribution of tree species under a high greenhouse gas emissions scenario for the year 2100 (B). Maine is listed as a state with “high risk” for increases in allergenic pollen. Figure source: National Wildlife Federation and the Asthma and Allergy Foundation of America (2010).

a particular public health concern in the aftermath of major storms and hurricanes, and is a leading cause for worsened asthma and respiratory infections in the United States.¹⁷⁸ Damp or wet building materials can also lead to higher bacterial growth and elevated off-gassing of volatile organic compounds (VOCs), both of which further exacerbate respiratory stress.¹⁷⁹ Mold growth has recently been highlighted as a concern in the cities, specifically for the South Portland fire station at Cash Corner.¹⁸⁰

MENTAL HEALTH IMPACTS

The health effects of climate change are not only physical, but also mental and emotional. They stem from the immediate trauma from a local climate-related event; from the ongoing emotional toll of processing information about climate change and its consequences; and from stress induced by witnessing changes in the environment and a loss of a sense of place or identity.¹⁸¹

The resulting mental health repercussions range from temporary stress and distress, to extended grief and bereavement, to clinical disorders like post-traumatic stress disorder (PTSD), anxiety, and depression. Data point to higher suicide rates both after catastrophic events, such as major hurricanes and flooding, as well as during “slow” stressors, specifically extended periods of high heat.¹⁸² Climate-related shocks also tend to be followed by higher rates of substance use and misuse, particularly for people with preexisting substance use disorders.

While direct disaster-related factors such as injury, loss of a loved one, loss of possessions or property, and displacement are a primary influence on mental health, other life factors can amplify the mental toll and lingering impacts. These are often compounded by correlated impacts such as losing a job, financial concerns, loss of social networks, or underlying and unrelated sources of family stress. A number of studies show that the mental health toll is particularly acute for people who experience repeated disasters, pregnant and post-partum mothers, emergency responders, elderly, children, economically disadvantaged, people who are homeless, and people with preexisting mental illness—all of whom show higher rates of mental health consequences after extreme events. While most people are able to recover over time

after a traumatic event, roughly 20 percent of individuals show chronic and lasting psychological impacts.¹⁸³ Variations in the extent to which residents may feel the effects of climate change is further explored in *Section 5. Social Vulnerability and Adaptive Capacity*.

5.5 Social Equity

There is a recurring pattern throughout this assessment: climate change will not affect all of us equally. Those of us who rely on lower-wage, hourly employment and public transportation will be more affected by service and business closures; those of us who use food assistance programs will more directly feel rising food costs; and those of us with preexisting health conditions will be more directly affected by high heat. Some of the many factors that tend to increase the impact of climate change on individuals and households are further explored in the following section, *Section 5. Social Vulnerability and Adaptive Capacity*.

A potentially even more significant and related risk, however, is the way in which climate change may drive even greater social inequity. Climate change is expected to impact livelihoods, housing security, food security, and health—thereby enhancing many of the vulnerabilities that make the impacts of climate change more acute for specific individuals and households. In other words, climate change creates a negative feedback loop that creates vulnerability, and with that, more susceptibility to climate impacts.

Portland and South Portland invest greatly in supporting residents with a number of resources and services. These city services are significantly expanded by a vast array of nonprofits and social service organizations that likewise seek to address some of the core roots of poverty, food insecurity, and social marginalization. Supporting and expanding systems for addressing these challenges will be needed in order to address heightened social vulnerability from climate change. Likewise, it will be critical to ensure that equitable processes and outcomes are at the forefront of resilience planning to ensure that further sources of inequity do not become a byproduct of climate change response.

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6. Social Vulnerability and Adaptability

6.1 Factors of Social Vulnerability

Many climate hazards, such as more intense storms or higher temperatures, will affect all areas of Portland and South Portland. The impact of those hazards, however, will be felt very differently across communities and households. Existing stresses—which can include health conditions, social discrimination, poverty, or other factors—can impact our ability to adapt and ultimately amplify the harm caused by climate change. The following sections explore a number of demographic or social contextual factors for individuals and households in Portland and South Portland that may create greater social vulnerability to acute and chronic stresses caused by climate change.

IMPORTANT TO NOTE

These “factors of vulnerability” are overlapping and highly varied: a large proportion of Portland’s and South Portland’s populations experience at least one of these vulnerabilities. In many cases, “vulnerability” points to physical conditions or barriers, but it is important to recognize the degree to which social marginalization and inequities play a significant role in making those characteristics a vulnerability.

It is also important to note that the following list of social vulnerabilities includes only a snapshot of factors, and include characteristics that are most easily mapped. Vulnerabilities ultimately come in many different forms; residents seeking asylum, experiencing homelessness, or suffering from addiction are some of many other factors that may increase risk and challenges when responding to climate hazards.

6.2 Age and Health

OLDER ADULTS

In Portland and South Portland collectively, 14 percent of residents (approximately 13,042 individuals) are over age 65.¹⁹⁵ Climate change brings greater risk for older adults who are more likely to have compromised health and a higher susceptibility to climate or environmental hazards.

The likelihood of pre-existing medical conditions—ranging from chronic disease, to reduced cognitive capacity, to restricted mobility—increases with age. These existing stresses compromise the capacity of older adults to adapt to incremental climate changes or respond quickly in emergency situations.¹⁹⁶ These limitations may come in the form of limited physical ability to drive or relocate in an emergency; limited financial resources for added expenses due to living on a fixed income; or health limitations such as needing regular medications, medical care, or medical resources that may be less accessible in an emergency. These risks become amplified for residents over age 65 who are living alone and may be more socially isolated.

Likewise, research indicates that a number of climate hazards will have more significant health repercussions for older adults. Adults over age 65 have a greater sensitivity to air pollution, such as particulate matter, dust, and ground-level ozone—all of which are expected to increase with climate change due to more wildfires, wind storms, and increased temperatures.¹⁹⁷ Age is also the greatest determinant for whether a person will be adversely impacted by extreme heat.¹⁹⁸ Heat stroke occurs at rates 12 to 23 times higher for individuals 65 years old and older, compared to other age groups.¹⁹⁹ Older adults have higher rates of cardiopulmonary diseases and diabetes, which increase the risk for heat-related illness, and certain medications commonly used by older adults also can compromise thermoregulatory

capacity. Seniors thus experience disproportionate rates of heat-related morbidity and mortality.

Figures 6.1 and 6.2 show the percentage of residents within each Census Block who are over age 65 and over age 65 and living alone, respectively. Certain neighborhoods in South Portland (Knightville, south of Meetinghouse Hill, and south of Crocket's Corner), in particular, have slightly higher proportions of older residents and older residents living alone.

RESIDENTS LIVING WITH A DISABILITY

In Portland and South Portland collectively, 9 percent of residents (approximately 8,272 individuals) under age 65 live with a disability.²⁰⁰ In this context, a disability is defined

Residents over Age 65

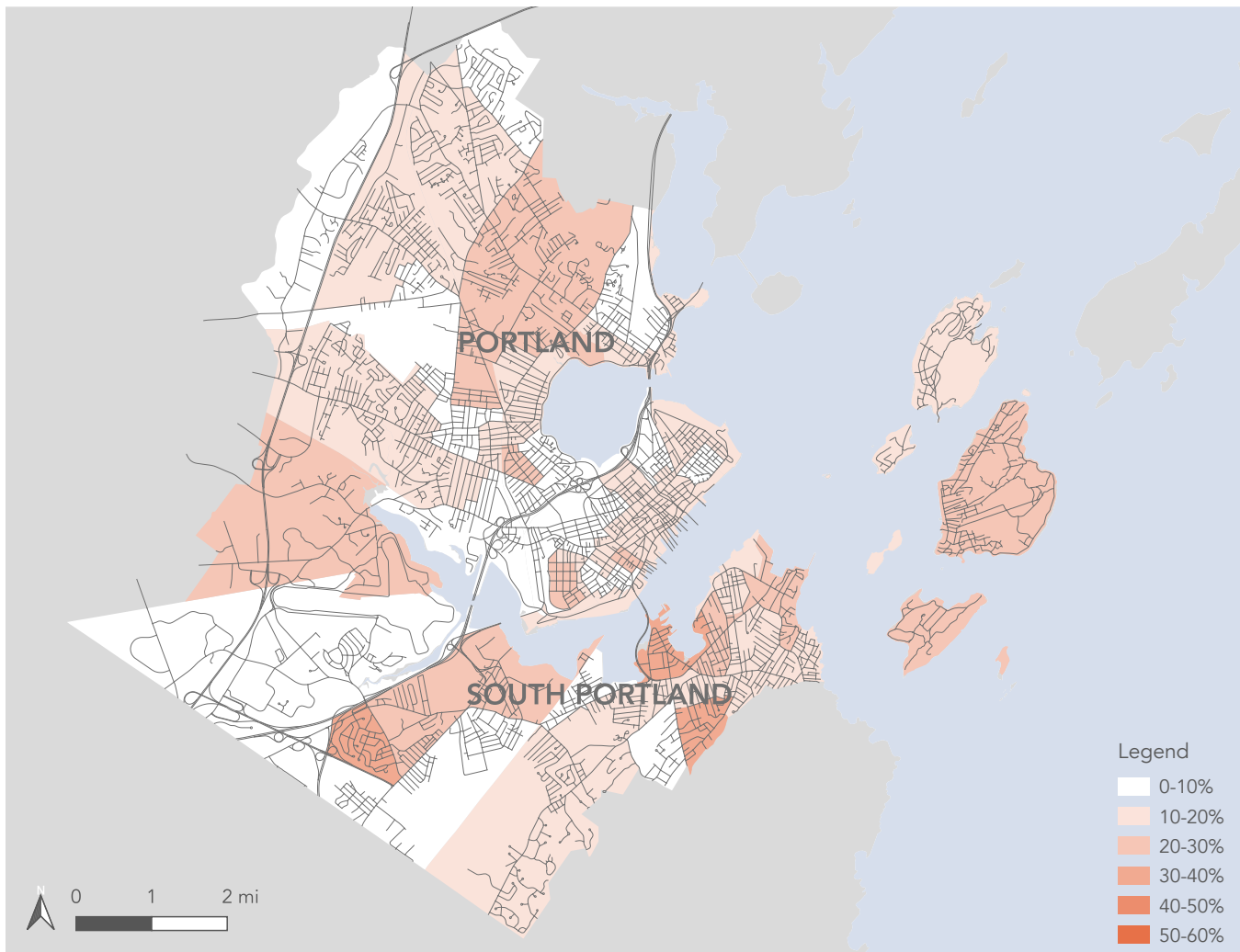


Figure 6.1. Percentage of residents in Portland and South Portland over age 65 by Census Block. Data source: U.S. Census Bureau, American Community Survey (2012-2016).

Residents over Age 65 and Living Alone

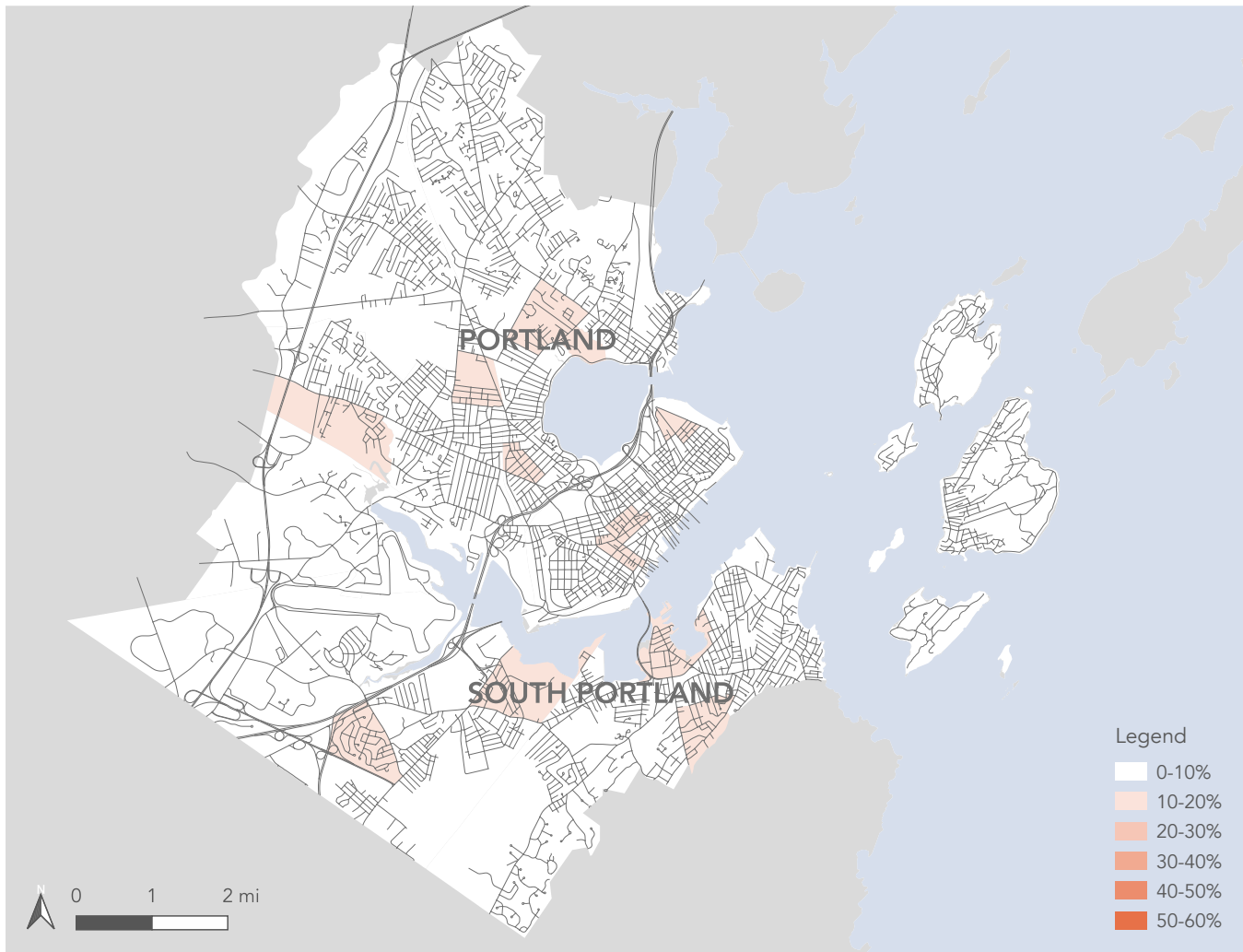


Figure 6.2. Percentage of residents in Portland and South Portland over age 65 and living alone by Census Block. Data source: U.S. Census Bureau, American Community Survey (2012-2016).

as a physical or mental impairment that creates difficulty with hearing, vision, cognitive tasks, ambulatory tasks, self-care, and/or independent living.

Because disabilities take a wide range of forms, the disability-related challenges created by climate change hazards are equally as varied. Broadly speaking, however, many of the challenges faced by individuals with a disability are similar to those for older adults, including reduced mobility due to physical limitations or an inability to drive, limited financial resources for added expenses due to fixed or limited incomes, and greater need for care and medical resources in an emergency situation. Residents with certain disorders or cognitive disabilities, such as autism or Alzheimer's, experience

additional stress and disorientation during emergencies when forced out of a familiar routine or location.²⁰¹

Likewise, residents with hearing impairments and/or non-verbal residents will face increased communication barriers in providing and receiving information in emergency situations.

Certain disabilities also amplify the sensitivity of individuals to extreme heat. A number of disabilities including, for example, multiple sclerosis, schizophrenia, and spinal cord injuries can impact a person's thermoregulation, increasing the risk of heat-related illness.²⁰² Certain antipsychotic medications also contribute to dysfunction in a body's ability to thermoregulate.

Physical and mental disabilities disproportionately affect individuals with other types of vulnerabilities, including people with lower incomes, older adults, and unemployed individuals, which therefore compounds the challenges people with disabilities experience from climate change.²⁰³ Underlying these connections is the degree to which inequity and social marginalization play a role in creating or heightening climate vulnerability. Studies have pointed to the degree to which people with disabilities have been disadvantaged by the design and delivery of emergency relief, whether due to inaccessible shelters, information inaccessibility, or the exclusion of disabled persons from adaptation efforts.²⁰⁴ Physical and social barriers that limit residents' abilities to access resources on a day-to-day basis ultimately play a significant role in creating or increasing climate vulnerability.

Figure 6.3 shows the percentage of households within each Census Block in Portland and South Portland that have one or more individuals who currently live with a disability. The western side of Portland and South Portland have a greater proportion of households with residents with disabilities, particularly the neighborhoods directly south of Crocket's Corner in South Portland.

RESIDENTS UNDER AGE 18

In Portland and South Portland collectively, 17 percent of residents (approximately 15,645 individuals) are under age 18.²⁰⁵ Adolescents, children, and infants are more susceptible to negative health impacts from climate and environmental hazards, both for physiological and behavioral reasons. Children are less able to adapt to

Households with One or More Persons with a Disability

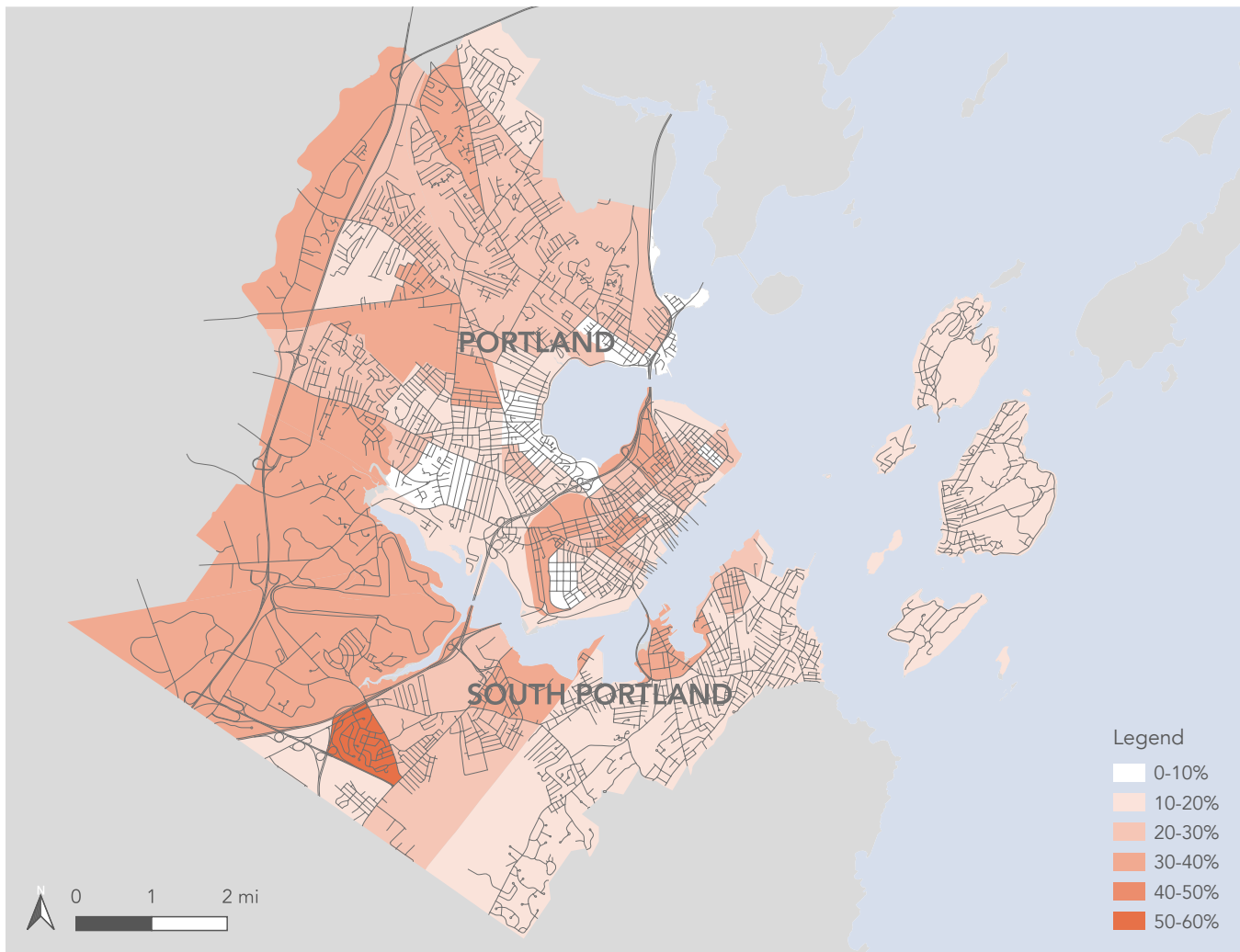


Figure 6.3. Percentage of households in Portland and South Portland with one or more individual living with a disability. Data source: U.S. Census Bureau, American Community Survey (2012-2016).

high heat because they produce more metabolic heat per mass, have higher heat gain, and less capacity to sweat.²⁰⁶ Children also are less likely to manage their heat risk by staying hydrated, and have less control of their exposure to heat due to more limited independence.²⁰⁷

Like older adults, children and adolescents also have a higher risk of respiratory problems from particulate matter, dust, and ground-level ozone, because they spend more time outside and have faster breathing rates.²⁰⁸ Due to time spent outside, children may also be more exposed to vector-borne disease.

Broadly speaking, the vulnerability of infants, children, and adolescents is also impacted by their dependence

on caregivers to ensure their safety and wellbeing. Households with children ultimately have a greater set of financial, social, and emotional needs that add to the challenges of adapting to climate change and responding to emergencies. While children generally show an “innate resilience” to negative events, children are more likely to be impaired by a climate hazard, and tend to show higher rates of lingering post-traumatic stress disorder (PTSD) symptoms than adults.²⁰⁹

Figure 6.4 show the percentage of residents within each Census Block who are under age 18. The Riverton neighborhood in Portland, particularly west of I-95 and south of Warren Ave have the highest proportions of residents under age 18.

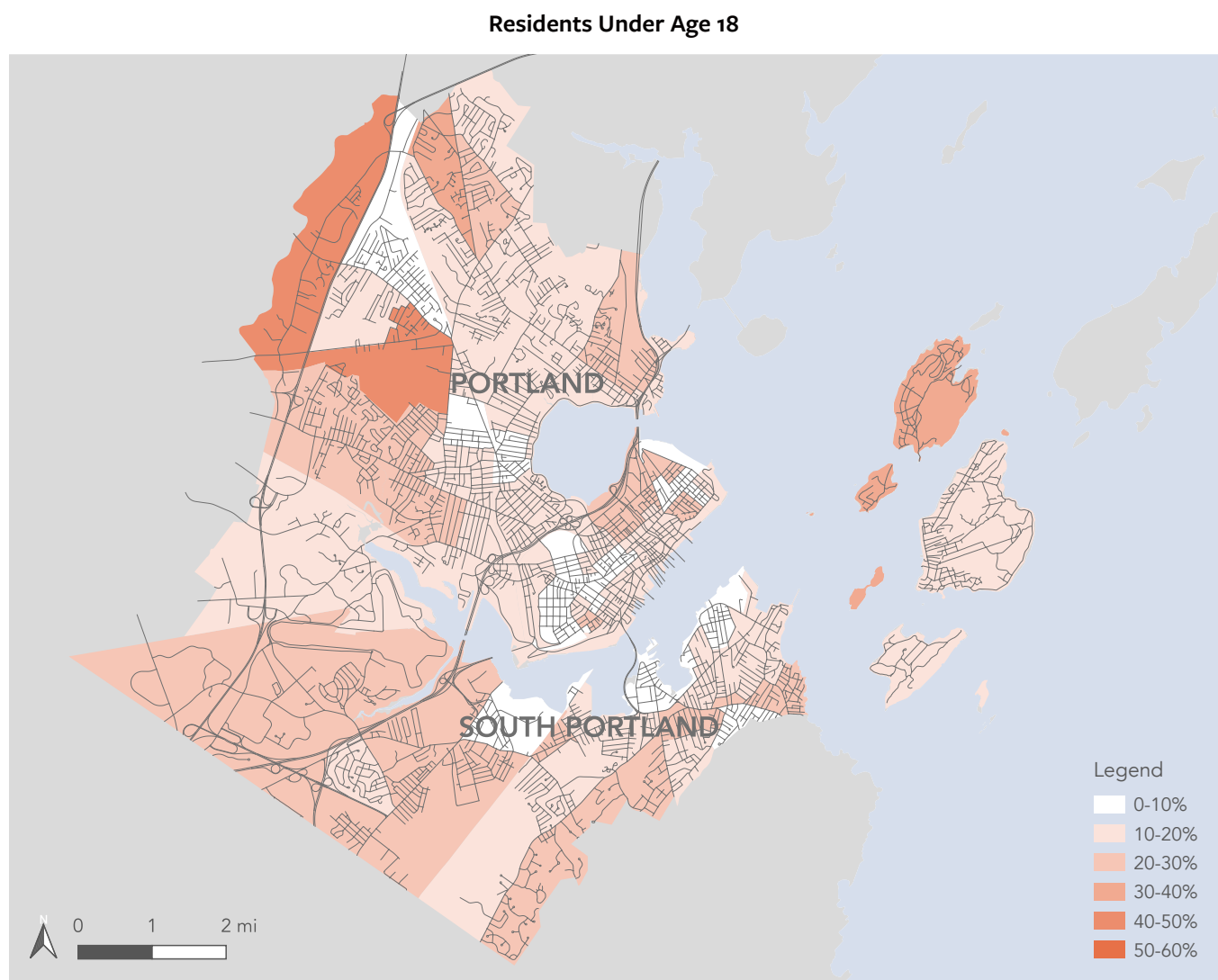


Figure 6.4. Percentage of residents in Portland and South Portland under age 18 by Census Block. Data source: U.S. Census Bureau, American Community Survey (2012-2016).

6.3 Language, Race, and Ethnicity

PEOPLE WHO SPEAK ENGLISH LESS THAN WELL

In Portland and South Portland collectively, roughly 3 percent of the population over age 5 (approximately 2,593 people) speak English less than well.²¹⁰ However, it is possible that this population is larger due to undercounting in the Census. French, Spanish, Arabic, and Portuguese are the most commonly spoken languages other than English across the two cities.

The majority of systems in the United States, including those in Portland and South Portland,

assume participants have a basic fluency in English. These systems can include healthcare, social services, professional and educational systems, transportation, financial services, among others. Residents with limited English language skills are thus more likely to have inadequate access to services or resources both on a day-to-day basis or in an emergency—both due to language barriers and in many cases due to navigating an unfamiliar context and culture after having immigrated.

The City of Portland offers a system for routine notifications and emergency alerts in over 60 languages. Signing up for the system, however, requires knowledge

Residents Who Speak English “Less than Well”

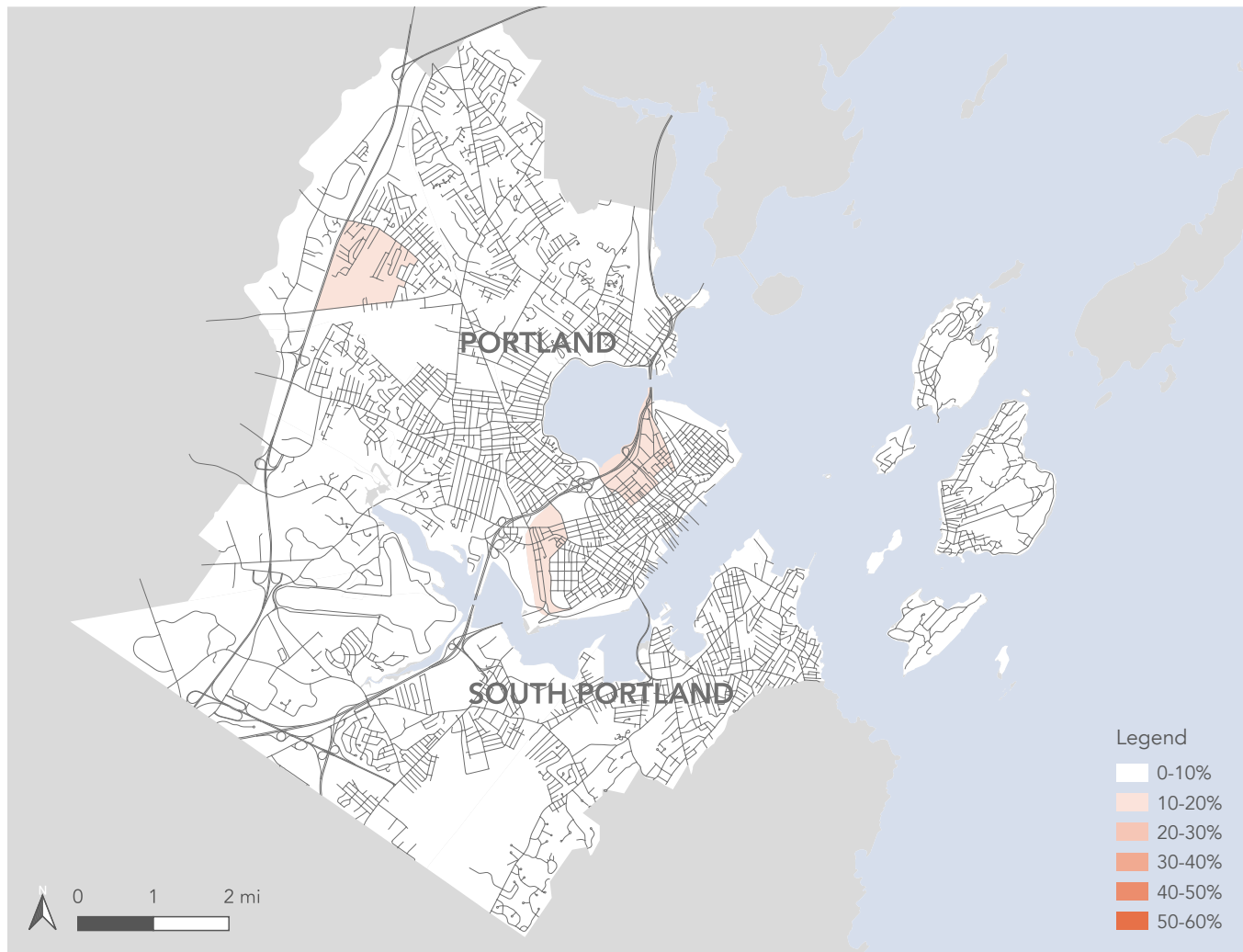


Figure 6.5. Percentage of residents in Portland and South Portland who speak English “less than well” by Census Block. Data source: U.S. Census Bureau, American Community Survey (2012-2016).

of the service or navigation of the website in English. Furthermore, residents with limited English proficiency will have more difficulty with all other formal and informal communication during emergency situations. Conversations around long-term adaptation to climate change and the resources and strategies available are also currently less accessible.

Figure 6.5 shows the percentage of residents within each Census Block who speak English less than well. Portland neighborhoods East and West Bayside, Valley Street, and Riverton south of Route 302 have the largest proportions of residents who do not speak English well.

PEOPLE OF COLOR

People of color include all residents in Portland and South Portland, except for those who identify as both white and non-Hispanic/Latinx. People of color make up 13.4 percent of residents in the two cities (approximately 12,300 individuals).²¹¹ However, it is possible that the population of people of color is larger due to undercounting in the Census, specifically of New Mainers.

National and local studies show that as a result of historical and persistent patterns of structural racism, people of color are more likely to have fewer financial resources than white populations, have lower access to health care, and are more likely to be exposed to environmental hazards. The State of Working Maine

Residents of Color

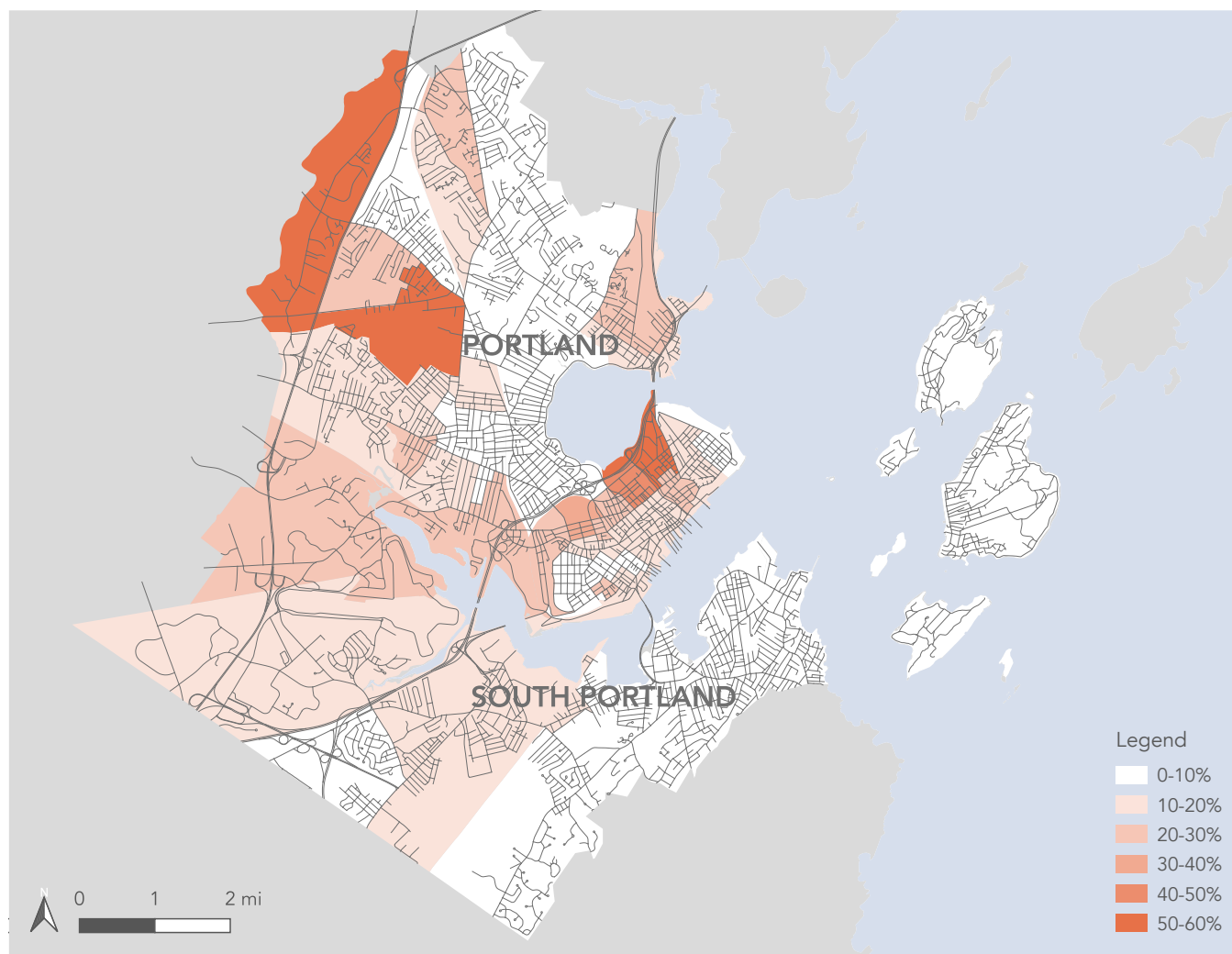


Figure 6.6. Percentage of residents in Portland and South Portland who are people of color by Census Block. People of color include everyone except white, non-Hispanic/Latinx individuals. Data source: U.S. Census Bureau, American Community Survey (2012-2016).

Report (2017) states that “full-time, year-round workers of color earn 85 cents for every dollar earned by white non-Hispanic Mainers.” (Women of color make only 67 cents on every dollar earned by white men.)²¹² Additional structural inequities, such as hiring discrimination, further limit the earning power of people of color. Black Mainers with a bachelor’s degree tend to have the same level of unemployment as white Mainers with only a high school education. Consequently, Maine has some of the highest poverty rates for people of color: roughly 45 percent of black Mainers live in poverty.²¹³

A lack of economic equality makes it so that Mainers of color are twice as likely as their white neighbors to be unable to afford healthcare, despite having higher exposure to many environmental health risks.²¹⁴ Rates of asthma are significantly higher for people of color in Maine (19 percent of adults of color, versus 15 percent of white adults).²¹⁵ Lower income residents, including New Mainers in particular, also face greater exposure to building toxins, such as lead, from older and lower quality rental housing. Both of these health risks are expected to increase with climate change, as air quality decreases and more flooding and precipitation erode housing quality and lead to mold growth and chemical leaching.

Racial bias is also evident in Maine’s education and criminal justice systems. Black students are 2.4 times as likely to be suspended from school, and black Mainers are 6 times as likely to be incarcerated than their white counterparts.²¹⁶ While seemingly separate from climate adaptation concerns, all of these factors create added social vulnerability for people of color by restricting economic and educational opportunity, access to health resources, and the ability to respond to additional economic and health impacts from climate change.

Figure 6.6 shows the percentage of residents who are people of color within each Census Block. Portland neighborhoods East Bayside, West Bayside, and Riverton, particularly west of Interstate 95 and south of Warren Ave, have the highest proportion of people of color.

6.4 Income and Access to Resources

RESIDENTS FACING POVERTY AND/OR UNEMPLOYMENT

In Portland and South Portland collectively, 16.6 percent of the population (approximately 15,329 individuals) live in households whose incomes fall below the poverty threshold.²¹⁷ Poverty thresholds are set at a national scale and vary based on household size. For example, the threshold for 2018 was \$12,793 for a single-person household, and \$25,707 for a four-person household.²¹⁸

Climate hazards disproportionately impact people with lower incomes due to many factors including higher exposure to health risks that are further exacerbated by climate change, limited financial safety nets to absorb additional expenses, and subsequently, more acute emotional stress from the harm posed by climate hazards.

Low-quality living environments, high levels of stress, and poor physical and mental health are all highly correlated for people with lower incomes. Residents facing poverty tend to live in poorer quality housing and in areas with greater exposure to particulate matter, mold, ground-level ozone, and other toxins, with those exposures expected to increase with climate change. At the same time, residents facing poverty tend to have worse mental and physical health, including higher rates of asthma, diabetes, pulmonary disease, and depression.²¹⁹ Over 30 percent of adults in Maine making less than \$15,000 a year reported poor mental health and poor physical health, separately—which is more than double the rates for poor mental and physical health for individuals who make \$25,000–\$34,000 per year.²²⁰ Simultaneously, low-income individuals are much less likely to have health insurance; residents without health insurance make up 8 percent of people in Portland and South Portland.²²¹

Households with incomes at or below the poverty line are also less likely to have property insurance or savings for added or unexpected expenses, such as higher energy or food costs, costs to repair building or property damage, and/or lodging or transportation costs in the

need to evacuate. These added expenses are particularly detrimental for individuals who are unemployed and currently living on fixed or no personal income. Likewise, many residents with lower incomes work hourly jobs without paid time off; consequently, disruptions in transportation or business continuity that restrict being able to work lead to significant loss of income.

Residents with limited disposable income are able to spend fewer dollars on mitigating the impacts of climate hazards. For example, in needing to reduce extra expenses, people tend to avoid purchasing or running air conditioners, fans, or heat, making periods of extreme heat or cold more dangerous for financially-burdened households. Furthermore, studies have shown that

residents who live in higher floors of multistory buildings or who live in smaller housing units tend to face greater stress from extreme heat.²²²

Figures 6.7 and 6.8 show the percentage of residents within each Census Block who have incomes below the poverty line and who are unemployed, respectively. Many areas on the Portland peninsula (i.e., the West Bayside, India Street, and Valley Street neighborhoods), as well as North Deering, specifically between Washington Ave and Route 100, have some of the highest proportions of residents facing poverty. Generally speaking, similar areas see higher unemployment for Portland; Knightville and Pleasantdale/Cash Corner see higher proportions of people who are unemployed in South Portland.

Residents with Household Incomes below the Poverty Threshold

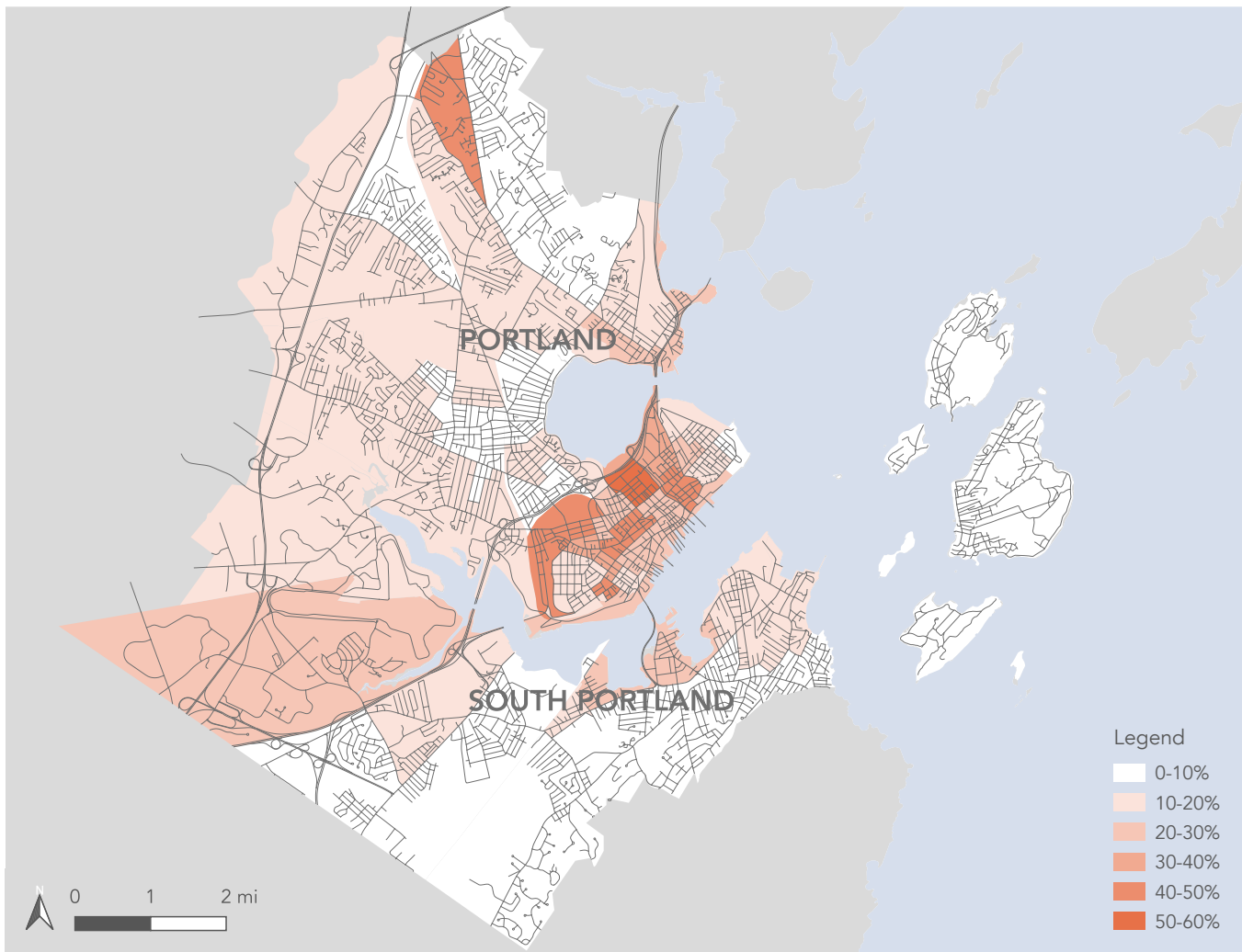


Figure 6.7. Percentage of residents in Portland and South Portland whose household incomes are below the poverty threshold by Census Block. Data source: U.S. Census Bureau, American Community Survey (2012-2016).

Residents who are Unemployed

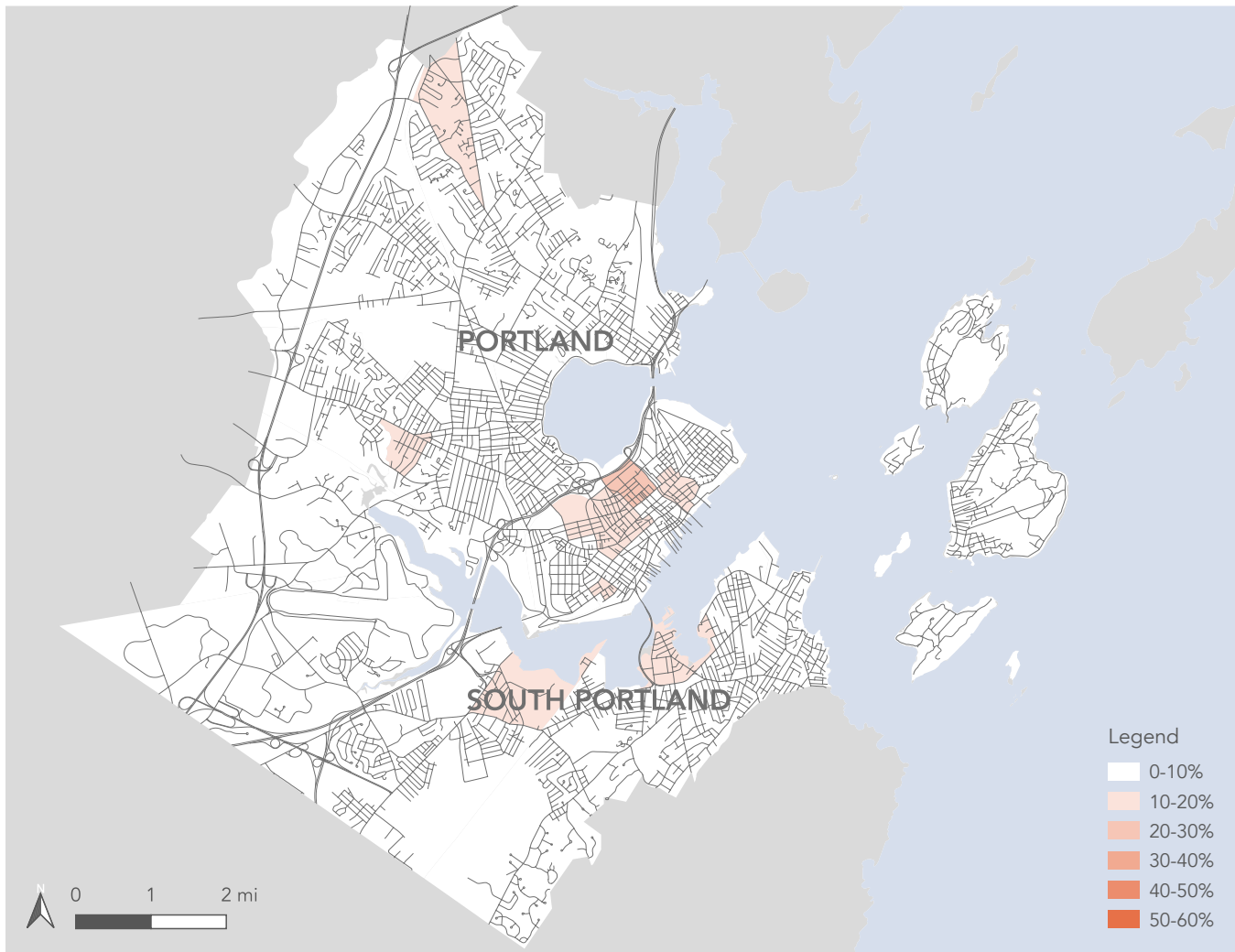


Figure 6.8. Percentage of residents in Portland and South Portland who are over age 16 and unemployed by Census Block. Data source: U.S. Census Bureau, American Community Survey (2012-2016).

RESIDENTS WITHOUT A HIGH SCHOOL DIPLOMA

In Portland and South Portland collectively, 7 percent of residents over the age of 25 (approximately 4,395 individuals) do not have a high school diploma.²²³

Generally speaking, adults without a high school diploma have a lower earning potential. Therefore, much of the enhanced vulnerabilities to climate change overlap with those who are facing poverty or unemployment, as well as the socioeconomic, health, and environmental factors (based on one's neighborhood or housing) that correlate with having lower financial security. Studies at a global scale suggest that educational attainment is one of the most significant indicators of adaptive capacity to climate

disasters, particularly since it is a primary determinant of other socioeconomic outcomes.²²⁴

Additionally, education has shown to play a role in increasing a person's connections to other people and information. People with more formal education tend to have greater access to communication sources and risk information, and a greater capacity to plan for longer timeframes.²²⁵ Likewise, studies also suggest that individuals with more education have stronger social capital, which includes a person's social networks and support.²²⁶ Individuals who did not complete high school may have fewer connections to support networks and information by comparison.

Residents without a High School Diploma

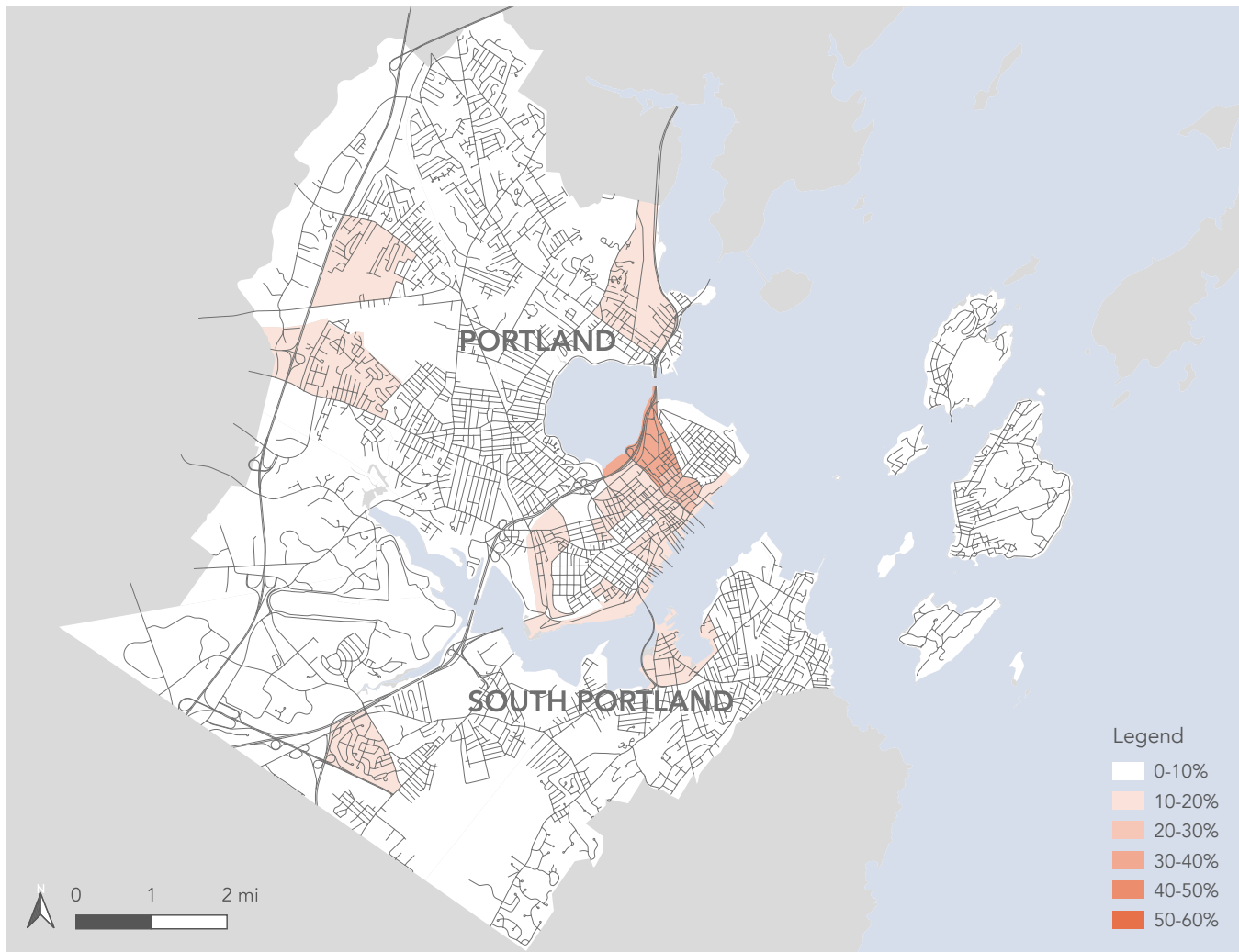


Figure 6.9. Percentage of residents in Portland and South Portland who are over age 25 and do not have a high school diploma by Census Block.

Figure 6.9 shows the percentage of residents over age 25 within each Census Block who do not have a high school diploma. The East Bayside neighborhood in Portland has the highest percentage, followed by a number of areas on the Portland peninsula, East Deering, a portion of Riverton, Nason's Corner, Knightville, and the neighborhoods south of Crocket's Corner.

6.5 Compounding Social Vulnerability and Climate Hazards

While each individual factor discussed in the previous section will increase an individual's or household's vulnerability to climate change, many of these vulnerabilities "overlap" in ways that create new and compounding vulnerability. Additional challenges emerge when many of these individual vulnerabilities are experienced simultaneously. For example, an elderly individual living alone may face challenges during a power

outage; these challenges may be more significant if their closest family member has young children, little financial means, and is reliant on public transportation, which may not be running at that point in time.

The Social Vulnerability Index is a way of looking at a large number of factors collectively to see which neighborhoods have greater social vulnerability across a number of factors. **Figure 6.10** shows a Social Vulnerability Index that was developed specifically for Maine communities by the Maine Coastal Risk Explorer Project.²²⁷ The index integrates 17 factors by percentile,

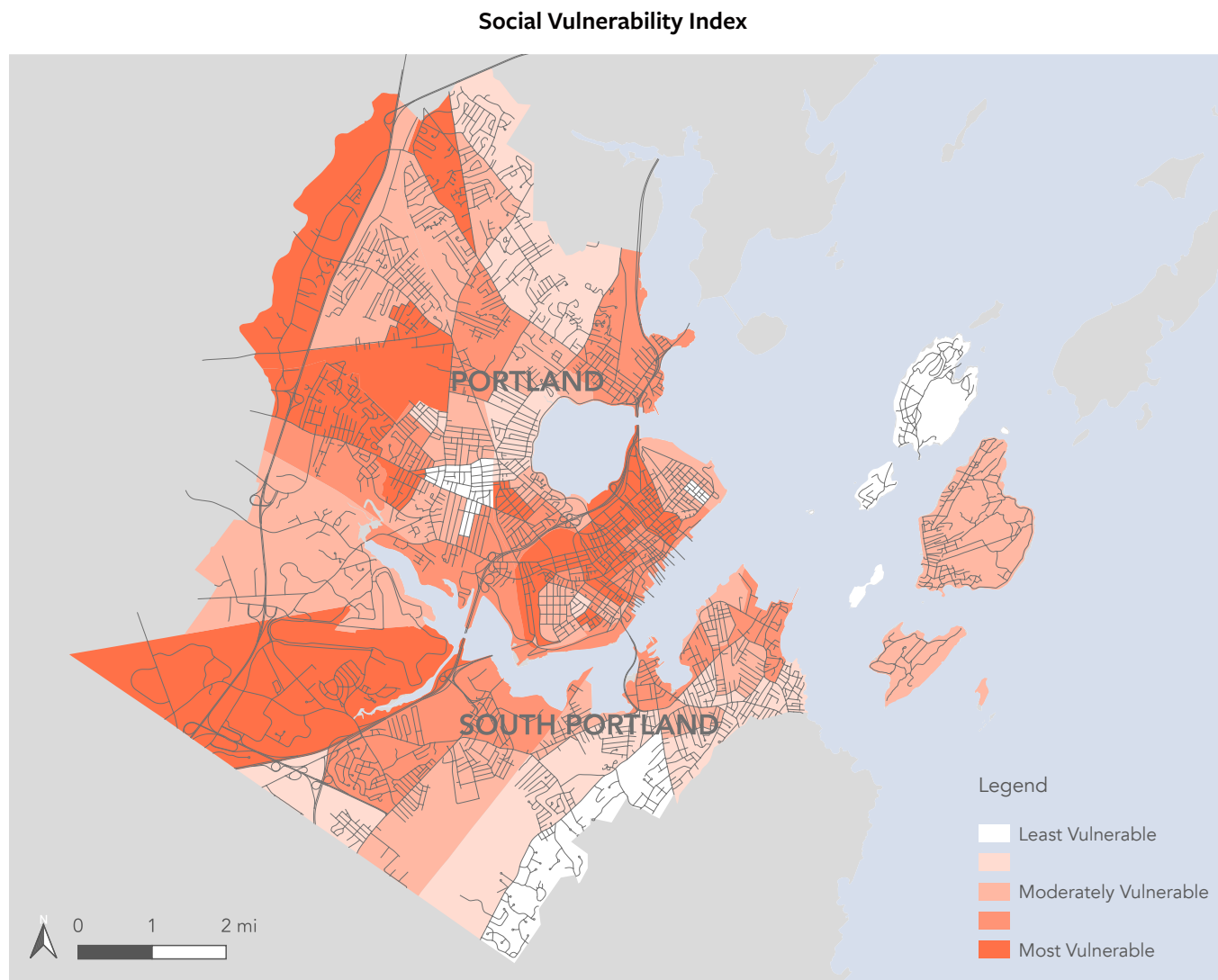


Figure 6.10. Social Vulnerability Index (SVI), aggregating 17 measures of social vulnerability, by Census Block. The SVI was developed specifically for Maine communities by the Maine Coastal Risk Explorer Project. For further information on the development of the SVI see Johnson et al. (2018).²²⁸

Factors Included in the Social Vulnerability Index

SVI Factor:	Description:	Percent Calculation Based On:
Below the poverty level	Ratio of income to poverty level up to 0.99	Total population for whom population is established
Unemployed	Unemployed population in labor force	Population 16 years or over in the labor force
Natural resource occupation	Population employed in a natural resource occupation (agriculture, forestry, fishing and hunting, and mining)	Population 16 years or over in the labor force
Self employed	Population that is self-employed in own incorporated business	Population 16 years or over in the labor force
Income	Per capita income for total population	Per capita income for total population
No high school diploma	Population who has not completed a high school education	Total population 25-years-old and older
Age 65 or over	Population 65-years-old and older	Total population
Age 65 or over and living alone	Population 65-years-old and older and living alone	Total population
Age 18 or younger	Population 18-years-old and younger	Total population
Disability	Households with one or more members with a disability	Total households
Single parent household	Household with single parent and children under age 18	Total households
People of Color	All persons except white, non-Hispanic	Total population
Speaks English less than well	Population with ability to speak English “not well” or “not at all”	Total population 5-years-old and older
Multi-unit structure	Housing in structures with 10 or more units	Total housing units
Mobile homes	Mobile homes	Total housing units
Crowding	Instances where there are more people than rooms in a household (including owner-occupied and renters)	Total households
No vehicle	Households with no vehicle available	Total households

Table 6.1. Factors in the Social Vulnerability Index (SVI) developed as part of the Maine Coastal Risk Explorer Project. For further information on the development of the SVI see Johnson et al. (2018).²²⁹

listed in **Table 6.1**. Based on the aggregation of these factors, South Portland’s West End, as well the portions of Rivertown west of I-95 and south of Warren Ave, a portion of North Deering west of Auburn Street/SR 100, a portion of Oakdale near the USM campus, as well as much of the western side of the Portland peninsula show the highest levels of social vulnerability.

Some climate change hazards—particularly flooding from sea level rise and storm surge—will affect some areas of Portland and South Portland more than others. The following maps illustrate how impacts from climate hazards may be spatially concentrated, and how these impacts overlap with social vulnerability in the cities.

Figure 6.11 illustrates the Social Vulnerability Index, as well as roads that will be inundated or inaccessible to emergency responders and addresses that would be inaccessible to emergency responders with 3.3 feet of sea level rise on top of the highest annual tide. East and West Bayside in Portland show the most significant impact from this level of flooding, on top of high social vulnerability.

While higher temperatures will impact all of Portland and South Portland, areas with greater amounts of

impervious surface will likely feel the effects of higher heat more acutely. Impervious surfaces such as pavement and asphalt tend to absorb and retain more heat, creating higher surface temperatures. Consequently, the quantity of impervious surfaces in a given area can serve as a proxy for understanding which areas of the cities will likely feel warmer on any given day. **Figure 6.12** illustrates the Social Vulnerability Index overlaid with impervious surfaces within the cities. South Portland's West End in particular has a substantial amount of impervious surface on top of relatively high social vulnerability.

Social Vulnerability and Flood Risk

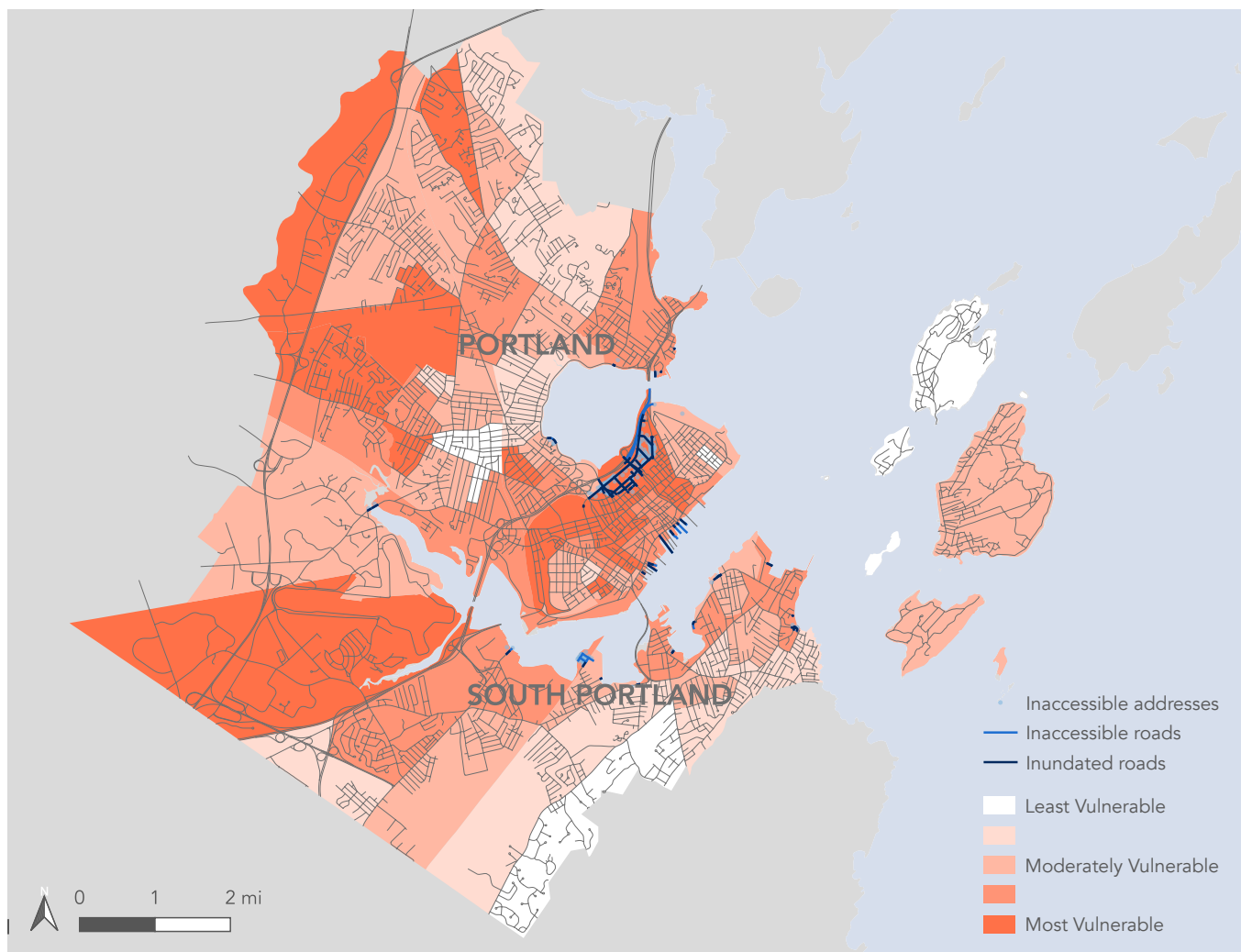


Figure 6.11. The Social Vulnerability Index by Census Block, as well as inundated roads, inaccessible roads, and inaccessible addresses with 3.3 feet (1 meter) of sea level rise on top of the highest annual tide. Inundated roads are road sections of the Maine E911 road data set that could be covered by water and therefore not passable at highest annual tide. Inaccessible roads are road sections of the Maine E911 road dataset that are adjacent to inundated roads and could be inaccessible to emergency responders from the nearest Emergency Management Service (EMS) station. Inaccessible addresses are address points that are adjacent to Inaccessible Roads and could be inaccessible to EMS stations at the highest annual tide. Data source: Maine Coastal Risk Explorer Project. See Johnson et al. (2018) for further details.²³⁰

Social Vulnerability and Impervious Surfaces

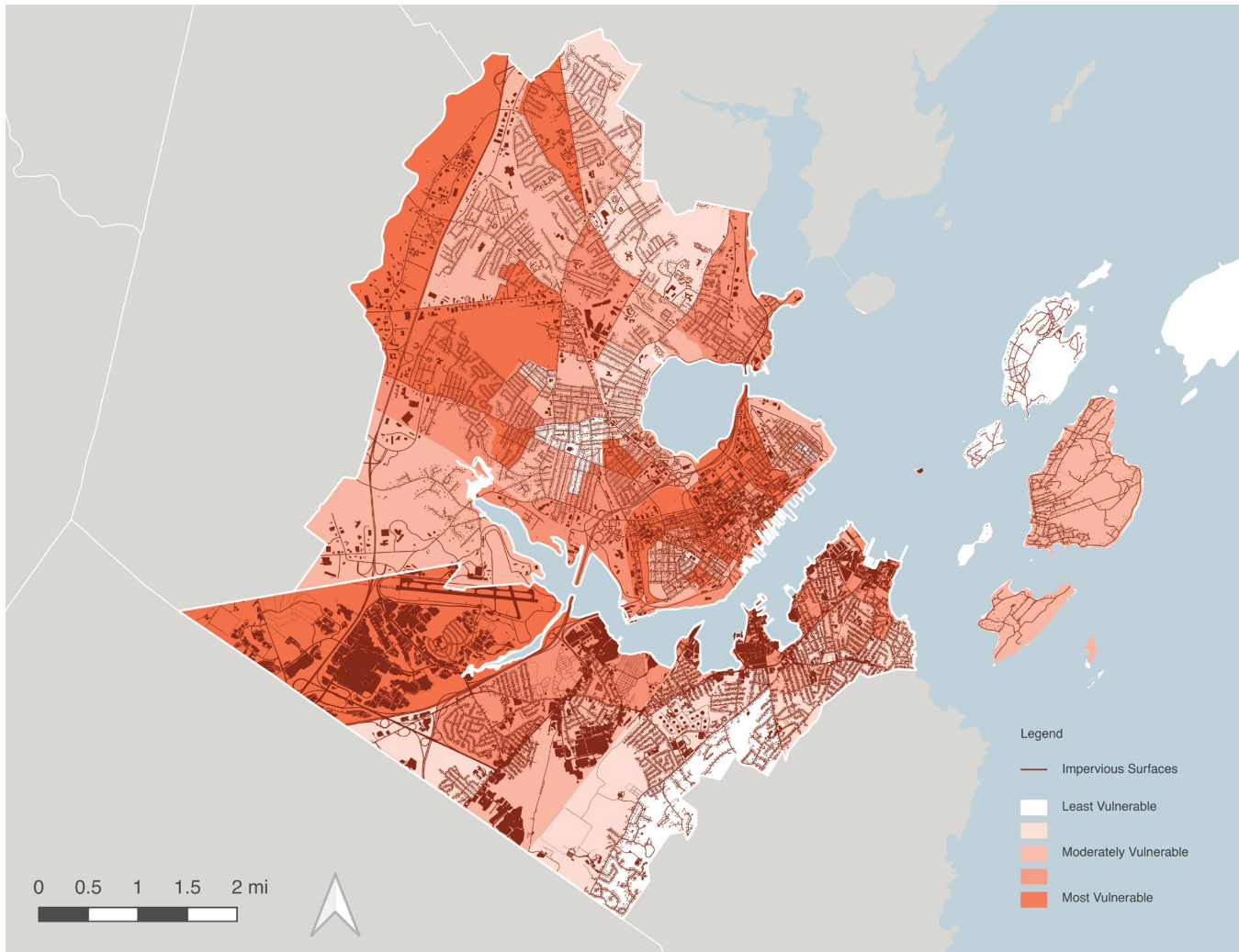


Figure 6.12. The Social Vulnerability Index (SVI) by Census Block overlaid with impervious surfaces across Portland and South Portland. Impervious surfaces can serve as a proxy for understanding which areas of the cities may feel warmer on high heat days. SVI data from the Maine Coastal Risk Explorer Project;²³¹ Impervious surface data from the Cities of Portland and South Portland.

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7. Conclusion

With greater knowledge of our vulnerability, we'll have greater capacity to act.

We know that climate change will bring significant challenges to Portland and South Portland. Sea level rise, storm surge, ocean acidification, more extreme weather, and higher air and water temperatures create new risk and exacerbate existing vulnerabilities across our infrastructure, environment, economy, and communities. This vulnerability assessment investigates the many vulnerabilities our cities will need to consider, highlighting the need and opportunity to work together for solutions.

Driven by the research, conversations, workshops, and analyses that informed this assessment, ten key areas of vulnerability rise to the surface. These are described in full in the Executive Summary, and briefly re-summarized below (not in any particular order).

1. RELEASE OF HAZARDOUS WASTE

There is high risk that shoreline retreat due to sea level rise, changes in groundwater tables, as well as wind and wave action from severe storms will submerge or erode hazardous waste sites, causing structural damage to above ground or subsurface hazardous waste containments, as well as releasing soil-bound contaminants.

2. GRID SYSTEM RELIABILITY AND BUSINESS CONTINUITY

The New England electrical power system is undergoing significant change, and climate hazards are expected to reduce system function and reliability. Power outages are a high concern for businesses and tend to be the most frequent root cause of cascading system failures across other infrastructural systems.

3. IMPACT TO PROPERTY VALUES, COMMERCIAL AREAS, AND TAX BASE

Rising sea levels and storm surge are expected to damage buildings and property, as well as create more lasting effects on property values, real estate markets, commercial centers, and the cities' tax bases. The cities' access to additional capital for resilience investments is also dependent on municipal credit ratings, which can be lowered based on flood risk.

4. DISRUPTION TO CRITICAL TRANSPORTATION ROUTES

Sea level rise and storm surge are expected to increasingly inundate roads, and most critically portions of I-295. A category 2 hurricane could cut off connections between the two cities by affecting all bridges that cross the Fore River within the two cities.

5. VULNERABILITY OF SEWER AND STORMWATER CRITICAL ASSETS

The sewer and stormwater systems in both cities show vulnerability to storms and sea level rise in areas along the waterfronts. The South Portland wastewater treatment facility is vulnerable to storm surge under a category 2 hurricane or higher, as well as to 6.1 feet of sea level rise above the highest astronomical tide.

6. DEGRADATION OF ECOSYSTEM HEALTH

Sea level rise may lead to habitat loss for sensitive tidal wetlands, and higher volumes of stormwater runoff may exacerbate coastal ecosystem degradation. Changes in temperature and precipitation patterns are also allowing new invasive species and pests to thrive.

7. PUBLIC HEALTH CHALLENGES, PARTICULARLY HIGH HEAT

Unseasonably hot days, extreme heat, as well as extended heat waves could lead to more heat-related hospitalizations and deaths. Climate change is also likely to exacerbate asthma from worsened air quality, bring higher rates of vector-borne disease, and affect mental health.

8. GREATER NEED FOR SOCIAL SERVICES

Without proactive plans to support, fund, modify, coordinate, and/or expand social service networks and systems in the cities, current programs risk becoming overstrained and under-resourced to adapt to changing social service needs.

9. VULNERABILITY OF FOOD SYSTEMS

Sea level rise and storm surge will likely restrict food delivery, and impact a large proportion of the cities' major supermarkets. Residents that rely on public transportation and/or food assistance will likely face greater food insecurity driven by closures in public transportation, social services, or rising food prices.

10. RISK OF INCREASING SOCIAL INEQUITY

There is a significant risk that climate change may contribute to greater social inequity, by exacerbating factors (such as poverty) that enhance vulnerability. Evidence from other cities have shown ways in which adaptation measures have also inadvertently enhanced inequity by continuing to invest in areas that have more resources.

These vulnerabilities are complex and intertwined. Yet as we continue to understand these climate risks, we become more and more equipped in how we take action.

WHAT COMES NEXT

Through June 2020, Portland and South Portland are charting a course for reducing climate vulnerability as part of the joint climate action and adaptation planning process: *One Climate Future*.

Driven by input from residents, businesses, organizations, and City staff, the plan will take the information from this vulnerability assessment and develop a set of pathways for becoming more resilient—first and foremost addressing the ten key areas outlined above.

The strategies will address infrastructure upgrades, design standards, and zoning revisions, and will serve as a reference and roadmap for concurrent and future planning processes, including ReCode Portland and the South Portland Waterfront Masterplan.

In addition to enhancing the resilience of the built environment, the strategies will also focus on programs and initiatives that will strengthen our communities, protect our health, and allow us all to better adapt to new acute and chronic stresses.

Through focusing on these vulnerabilities and expanding our strengths, we have the capacity to become increasingly inclusive, vibrant communities where residents and businesses can thrive in a changing climate.

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Appendix

APPENDIX A - SEA LEVEL RISE MAPS

- Figure A.1 Sea Level Rise Scenarios in Greater Portland up to Intermediate Scenario
- Figure A.2 Sea Level Rise Scenarios in Greater Portland up to Intermediate-High Scenario
- Figure A.3 Sea Level Rise Scenarios in Greater Portland up to High Scenario
- Figure A.4 Sea Level Rise Scenarios in Greater Portland up to Extreme Scenario
- Figure A.5 Sea Level Rise Scenarios in Back Cove up to Intermediate Scenario
- Figure A.6 Sea Level Rise Scenarios in Back Cove up to Intermediate-High Scenario
- Figure A.7 Sea Level Rise Scenarios in Back Cove up to High Scenario
- Figure A.8 Sea Level Rise Scenarios in Back Cove up to Extreme Scenario
- Figure A.9 Sea Level Rise Scenarios in South Portland and Portland Waterfronts up to Intermediate Scenario
- Figure A.10 Sea Level Rise Scenarios in South Portland and Portland Waterfronts up to Intermediate-High Scenario
- Figure A.11 Sea Level Rise Scenarios in South Portland and Portland Waterfronts up to High Scenario
- Figure A.12 Sea Level Rise Scenarios in South Portland and Portland Waterfronts up to Extreme Scenario

APPENDIX B - HURRICANE SURGE INUNDATION MAPS

- Figure B.1 Storm Surge Inundation from Hurricane Category 1 in Greater Portland
- Figure B.2 Storm Surge Inundation from Hurricane Category 2 in Greater Portland
- Figure B.3 Storm Surge Inundation from Hurricane Category 3 in Greater Portland
- Figure B.4 Storm Surge Inundation from Hurricane Category 4 in Greater Portland
- Figure B.5 Storm Surge Inundation from Hurricane Category 1 in Back Cove
- Figure B.6 Storm Surge Inundation from Hurricane Category 2 in Back Cove
- Figure B.7 Storm Surge Inundation from Hurricane Category 3 in Back Cove
- Figure B.8 Storm Surge Inundation from Hurricane Category 4 in Back Cove
- Figure B.9 Storm Surge Inundation from Hurricane Category 1 in South Portland and Portland Waterfronts
- Figure B.10 Storm Surge Inundation from Hurricane Category 2 in South Portland and Portland Waterfronts
- Figure B.11 Storm Surge Inundation from Hurricane Category 3 in South Portland and Portland Waterfronts
- Figure B.12 Storm Surge Inundation from Hurricane Category 4 in South Portland and Portland Waterfronts

APPENDIX C - TEMPERATURE AND PRECIPITATION GRAPHS

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- Figure C.2 Cooling Degree Days
- Figure C.3 Heating Degree Days
- Figure C.4 Average Maximum Summer Temperature
- Figure C.5 Average Minimum Summer Temperature
- Figure C.6 Average Maximum Fall Temperature
- Figure C.7 Average Minimum Fall Temperature

Figure C.8 Average Maximum Winter Temperature
 Figure C.9 Average Minimum Winter Temperature
 Figure C.10 Average Maximum Spring Temperature
 Figure C.11 Average Minimum Spring Temperature
 Figure C.12 Number of Days Below 0°F Per Year
 Figure C.13 Temperature on the Coldest Night of the Year
 Figure C.14 Temperature on the Coldest Day of the Year
 Figure C.15 Temperature on the Hottest Night of the Year
 Figure C.16 Average Summer Precipitation
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 Figure C.18 Average Winter Precipitation
 Figure C.19 Average Spring Precipitation
 Figure C.20 Days with Over 4 Inches of Precipitation
 Figure C.21 Precipitation on the Wettest Day of the Year

APPENDIX D - IMPACTS TO UPCOMING CAPITAL IMPROVEMENT PROJECTS

Figure D.1 FY19 and FY20 Construction Projects in Portland Vulnerable to Sea Level Rise
 Table D.1. FY19 – FY20 Vulnerable Projects Underway
 Figure D.2 FY19 and FY20 Construction Projects in Portland Vulnerable to the 1% Annual Chance Flood
 Figure D.3 South Portland Areas Vulnerable to the 1% Annual Chance Flood
 Figure D.4 South Portland Areas Vulnerable to Sea Level Rise
 Figure D.4 South Portland Wastewater Treatment Facility Flood Vulnerability

ON THE FOLLOWING PAGES...

Appendix A: Sea Level Rise Maps

Appendix B: Hurricane Surge Inundation Maps

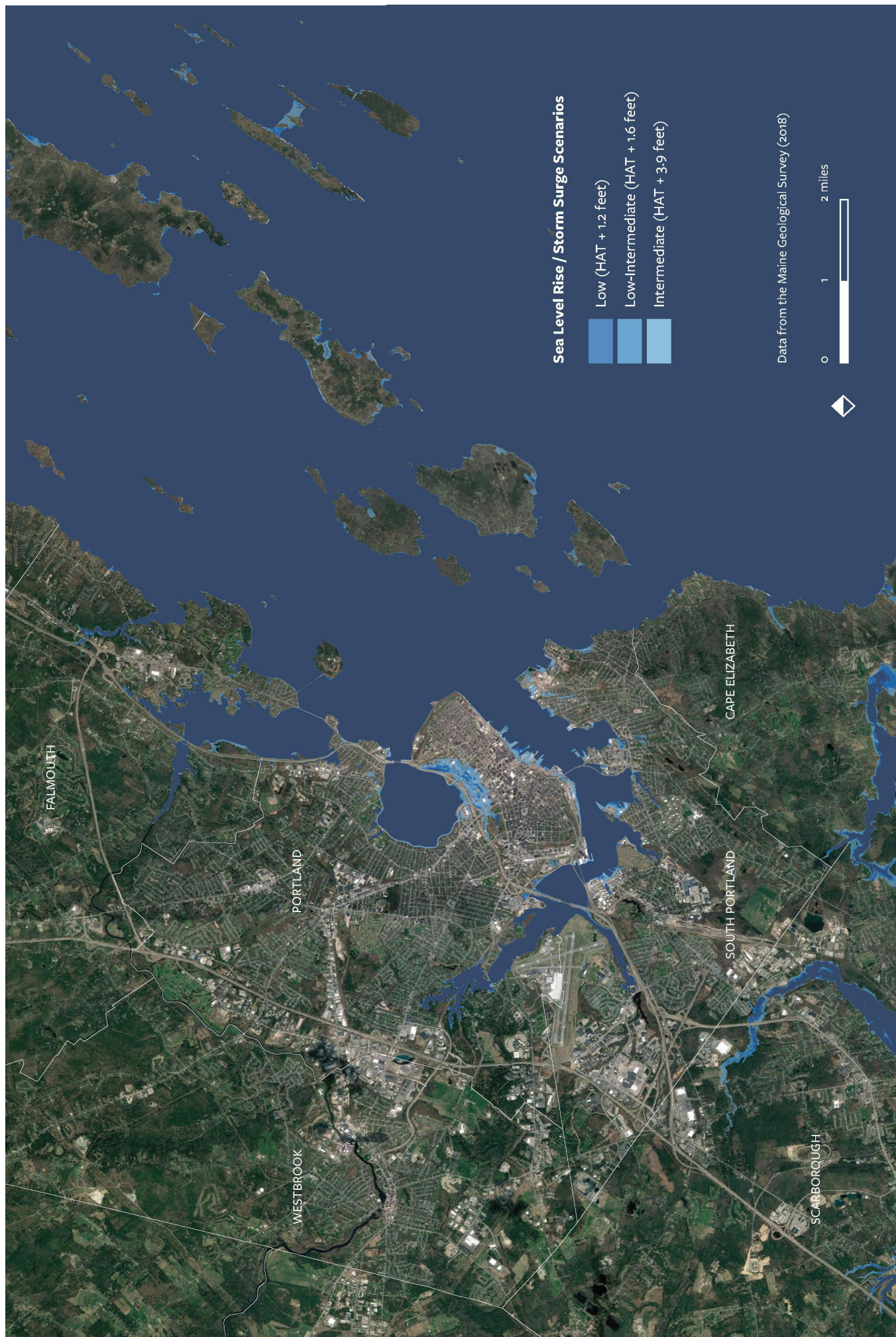


Figure A.1. Sea level rise scenarios for the year 2100 in the Greater Portland area up to 3.9 feet above the highest astronomical tide (HAT) (Intermediate scenario). Data source: Maine Geological Survey Sea Level Rise/Storm Surge Data (2018).

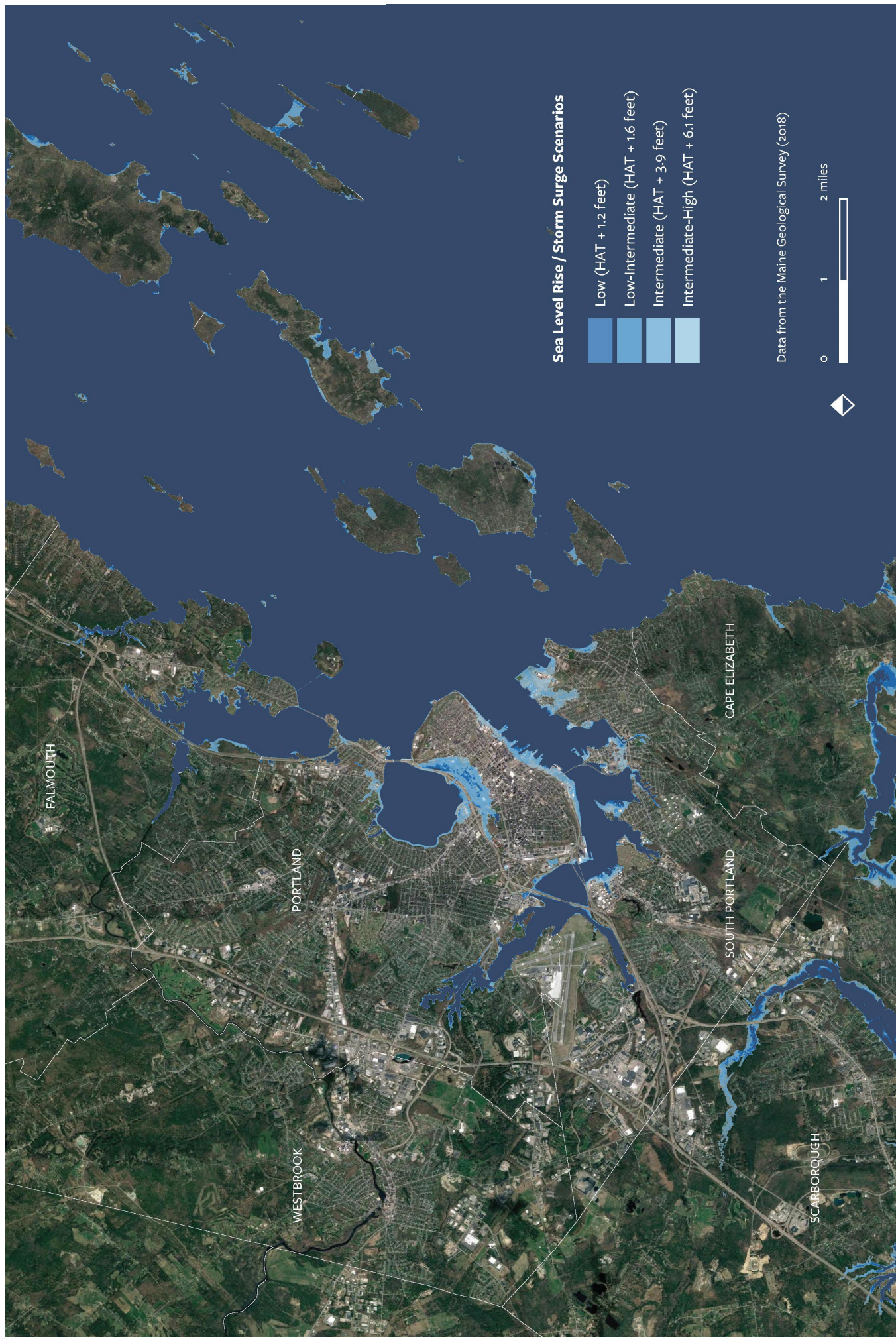


Figure A.2. Sea level rise scenarios for the year 2100 in the Greater Portland area up to 6.1 feet above the highest astronomical tide (HAT) (Intermediate-High scenario). Data source: Maine Geological Survey Sea Level Rise/Storm Surge Data (2018).

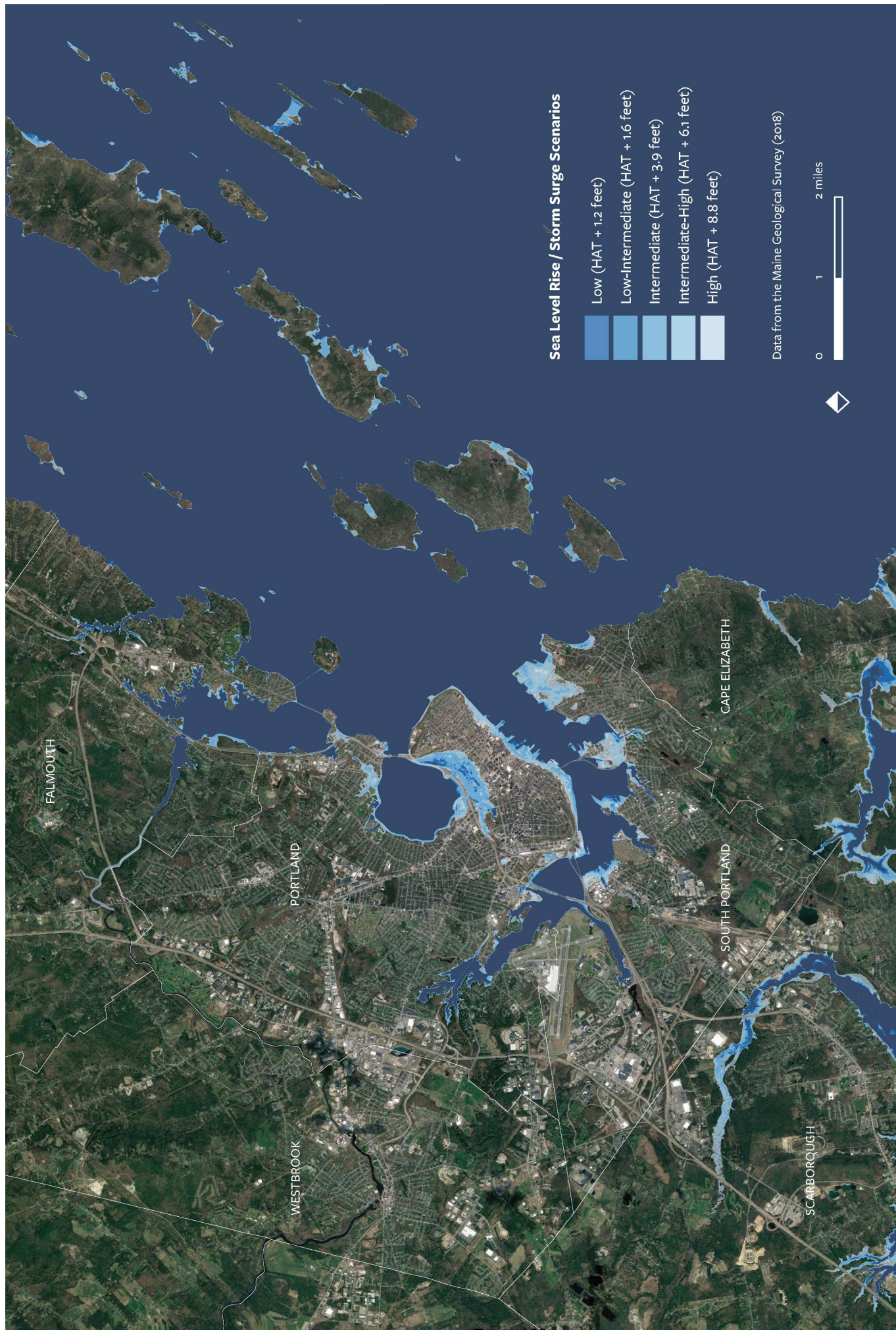


Figure A.3. Sea level rise scenarios for the year 2100 in the Greater Portland area up to 8.8 feet above the highest astronomical tide (HAT) (High scenario). Data source: Maine Geological Survey Sea Level Rise/Storm Surge Data (2018).

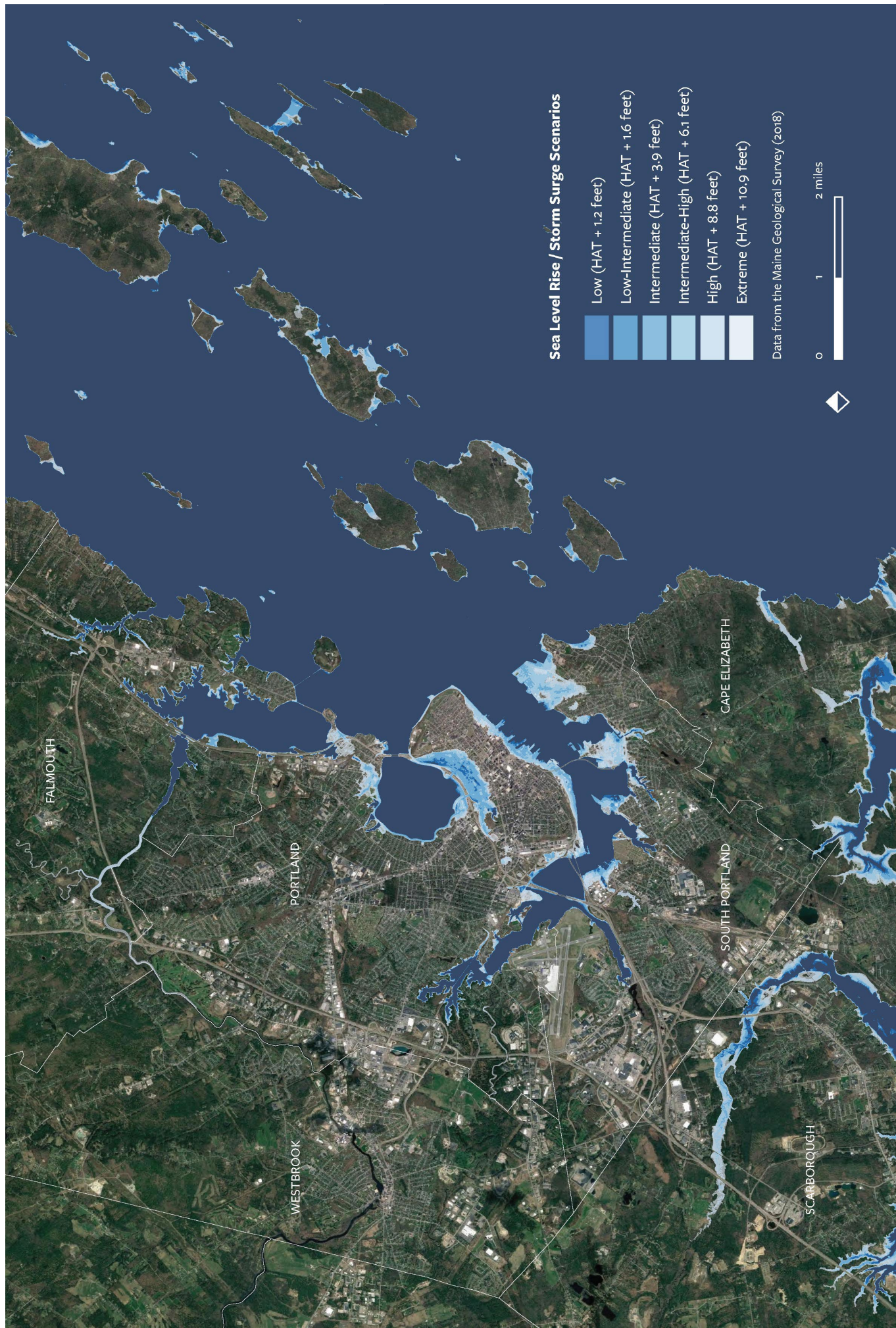


Figure A.4. Sea level rise scenarios for the year 2100 in the Greater Portland area up to 10.9 feet above the highest astronomical tide (HAT) (Extreme scenario). Data source: Maine Geological Survey Sea Level Rise/Storm Surge Data (2018).



Figure A-5. Sea level rise scenarios for the year 2100 in the Back Cove area of Portland up to 3.9 feet above the highest astronomical tide (HAT) (Intermediate scenario). Data source: Maine Geological Survey Sea Level Rise/Storm Surge Data (2018).



Figure A.6. Sea level rise scenarios for the year 2100 in the Back Cove area of Portland up to 6.1 feet above the highest astronomical tide (HAT) (Intermediate-High scenario). Data source: Maine Geological Survey Sea Level Rise/Storm Surge Data (2018).



Figure A.7. Sea level rise scenarios for the year 2100 in the Back Cove area of Portland up to 8.8 feet above the highest astronomical tide (HAT) (High scenario). Data source: Maine Geological Survey Sea Level Rise/Storm Surge Data (2018).



Figure A.8. Sea level rise scenarios for the year 2100 in the Back Cove area of Portland up to 10.9 feet above the highest astronomical tide (HAT) (Extreme scenario). Data source: Maine Geological Survey Sea Level Rise/Storm Surge Data (2018).



Figure A.9. Sea level rise scenarios for the year 2100 for the South Portland and Portland waterfronts up to 3.9 feet above the highest astronomical tide (HAT) (Intermediate scenario). Data source: Maine Geological Survey Sea Level Rise/Storm Surge Data (2018).



Figure A.10. Sea level rise scenarios for the year 2100 for the South Portland and Portland waterfronts up to 6.1 feet above the highest astronomical tide (HAT) (Intermediate-High scenario). Data source: Maine Geological Survey Sea Level Rise/Storm Surge Data (2018).



Figure A.11. Sea level rise scenarios for the year 2100 for the South Portland and Portland waterfronts up to 8.8 feet above the highest astronomical tide (HAT) (High scenario). Data source: Maine Geological Survey Sea Level Rise/Storm Surge Data (2018).



Figure A.12. Sea level rise scenarios for the year 2100 for the South Portland and Portland waterfronts up to 10.9 feet above the highest astronomical tide (HAT) (Extreme scenario). Data source: Maine Geological Survey Sea Level Rise/Storm Surge Data (2018).

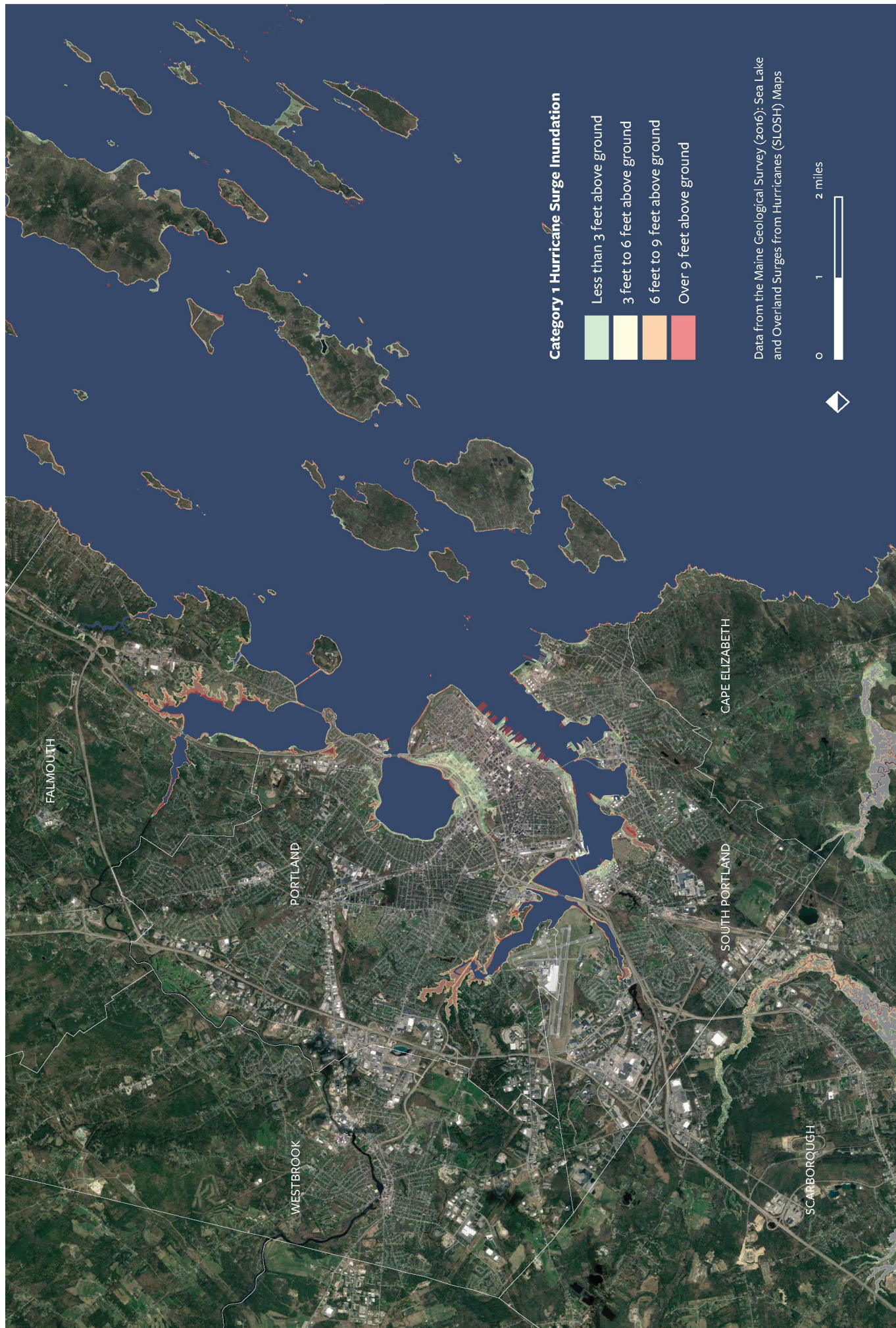


Figure B.1. Areas in the Greater Portland area that would be potentially inundated by storm surge from a category 1 hurricane at mean high tide. Data source: Maine Geological Survey Sea, Lake, and Overland Surges from Hurricanes (SLOSH) Data (2016).

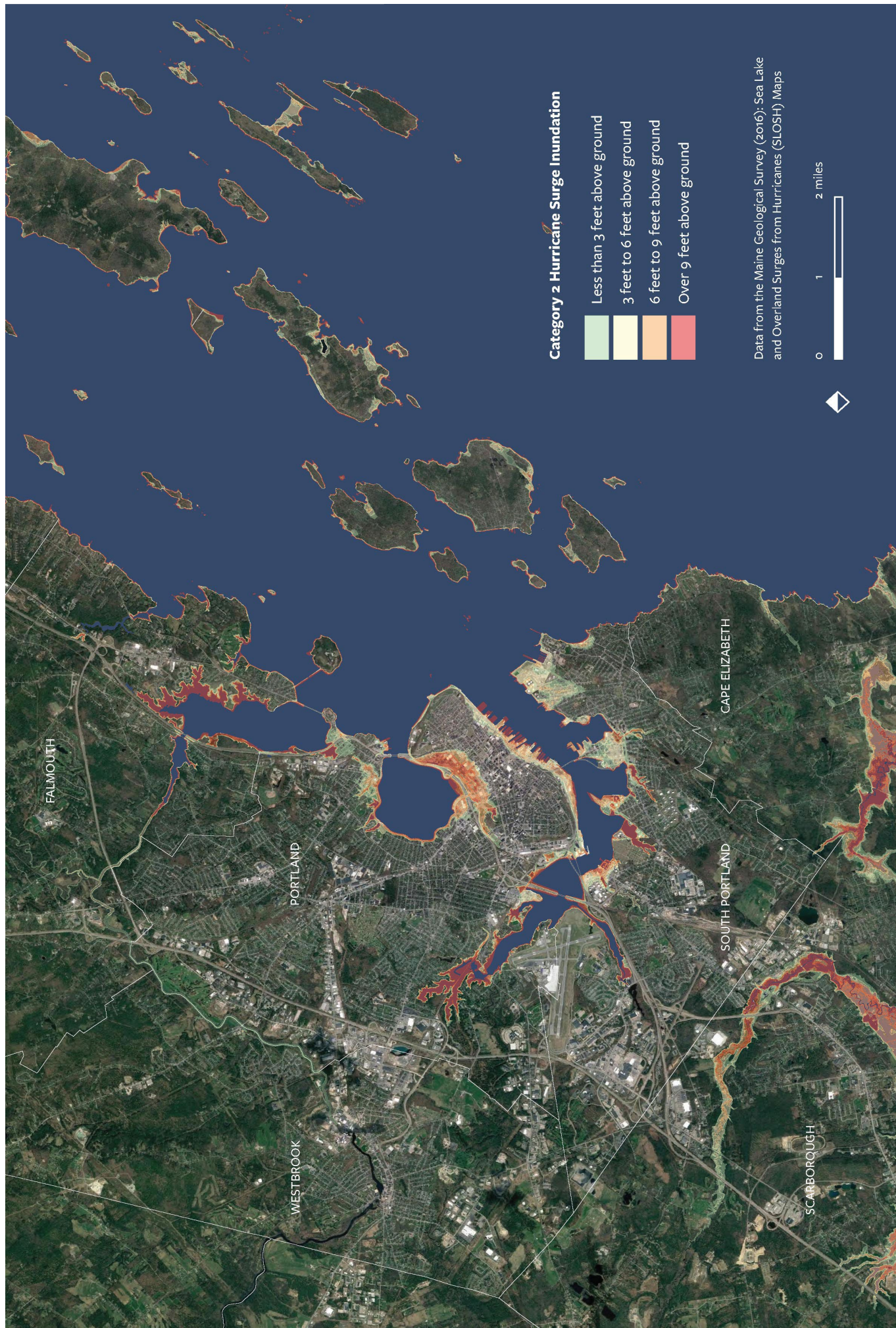


Figure B.2. Areas in the Greater Portland area that would be potentially inundated by storm surge from a category 2 hurricane at mean high tide. Data source: Maine Geological Survey Sea, Lake, and Overland Surges from Hurricanes (SLOSH) Data (2016).

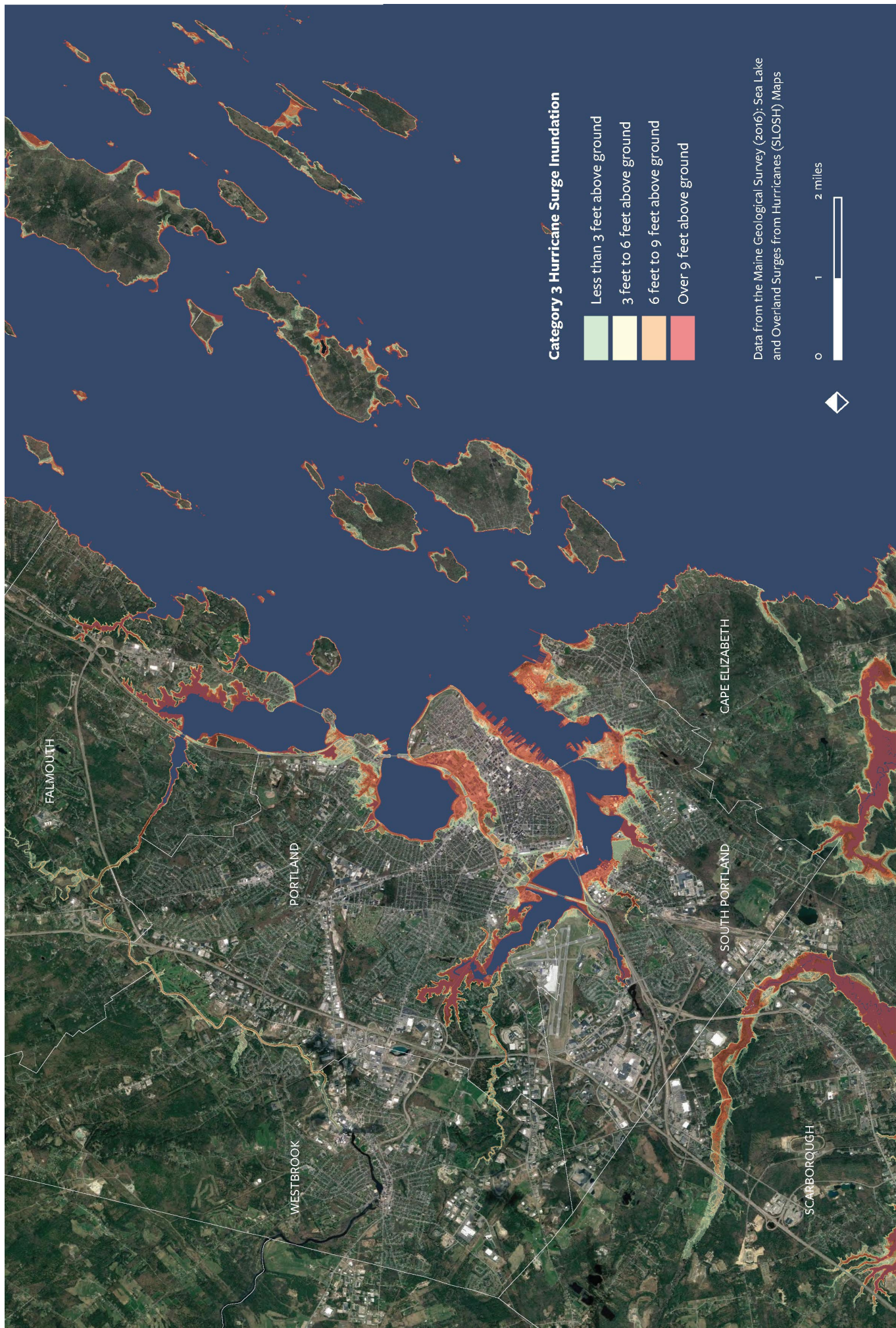


Figure B.3. Areas in the Greater Portland area that would be potentially inundated by storm surge from a category 3 hurricane at mean high tide. Data source: Maine Geological Survey Sea, Lake, and Overland Surges from Hurricanes (SLOSH) Data (2016).

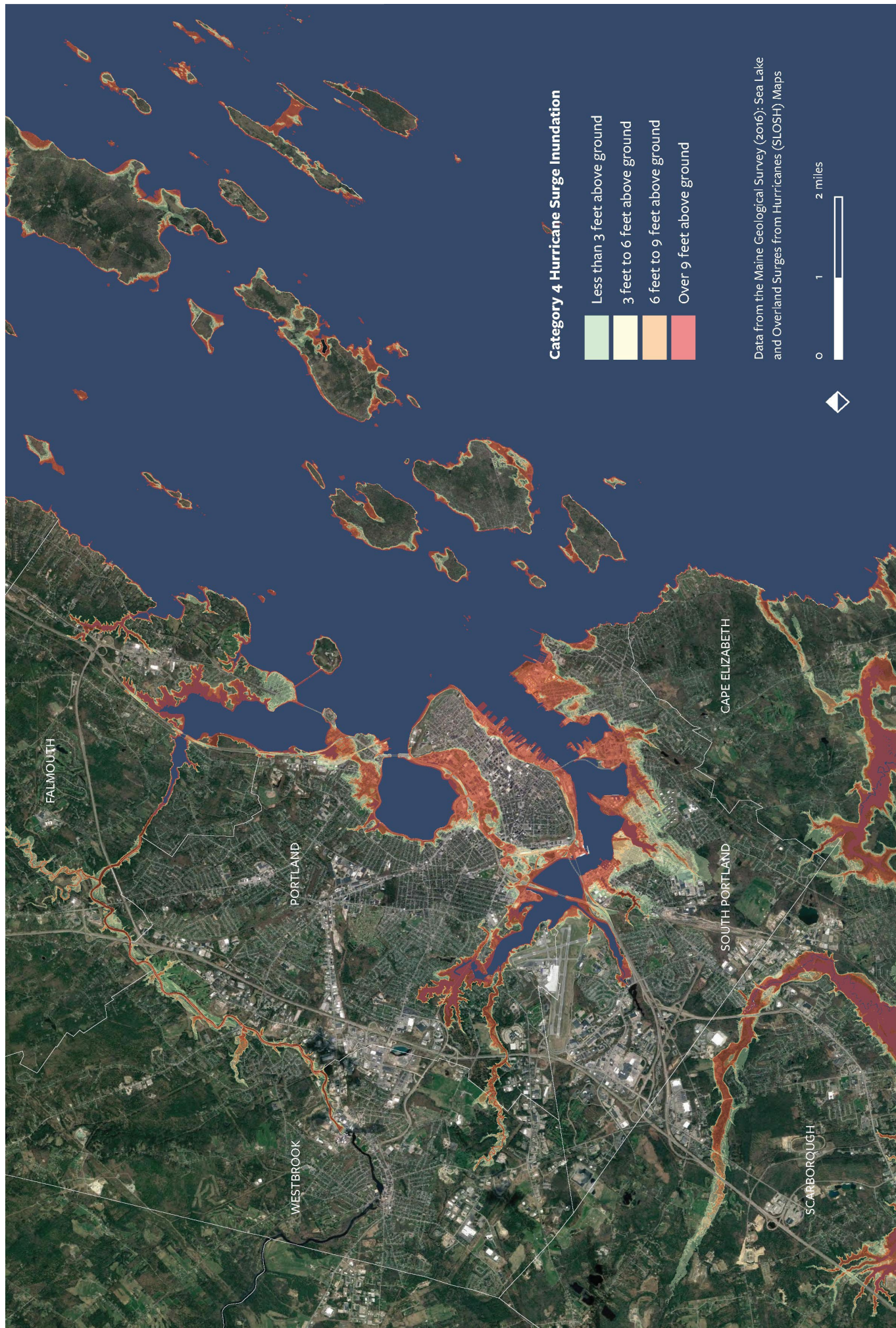


Figure B.4. Areas in the Greater Portland area that would be potentially inundated by storm surge from a category 4 hurricane at mean high tide. Data source: Maine Geological Survey Sea, Lake, and Overland Surges from Hurricanes (SLOSH) Data (2016).

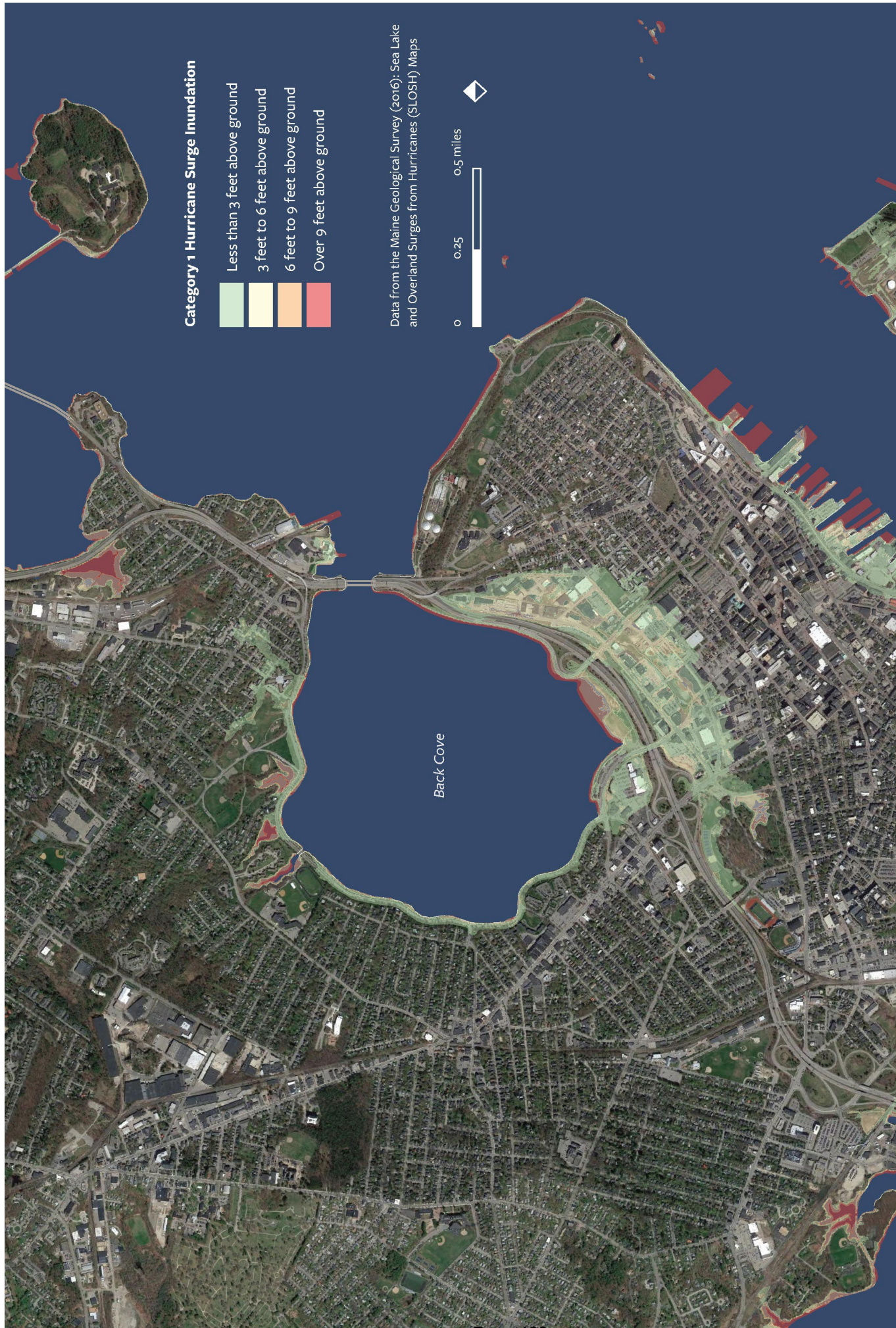


Figure B.5: Areas in the Back Cove area of Portland that would be potentially inundated by storm surge from a category 1 hurricane at mean high tide. Data source: Maine Geological Survey Sea, Lake, and Overland Surges from Hurricanes (SLOSH) Data (2016).



Figure B.6. Areas in the Back Cove area of Portland that would be potentially inundated by storm surge from a category 2 hurricane at mean high tide. Data source: Maine Geological Survey Sea, Lake, and Overland Surges from Hurricanes (SLOSH) Data (2016).



Figure B.7. Areas in the Back Cove area of Portland that would be potentially inundated by storm surge from a category 3 hurricane at mean high tide. Data source: Maine Geological Survey Sea, Lake, and Overland Surges from Hurricanes (SLOSH) Data (2016).

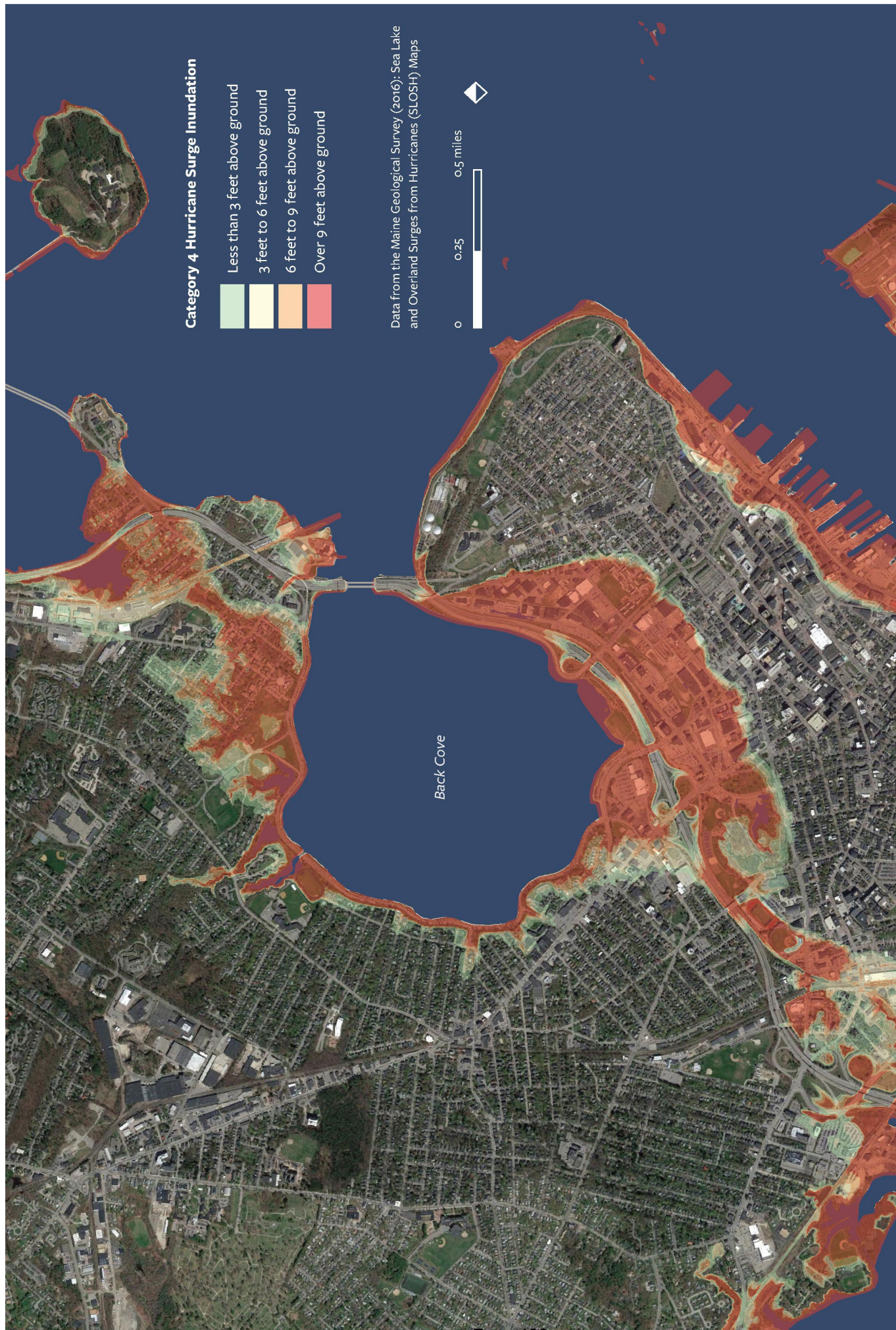


Figure B.8. Areas in the Back Cove area of Portland that would be potentially inundated by storm surge from a category 4 hurricane at mean high tide. Data source: Maine Geological Survey Sea, Lake, and Overland Surges from Hurricanes (SLOSH) Data (2016).

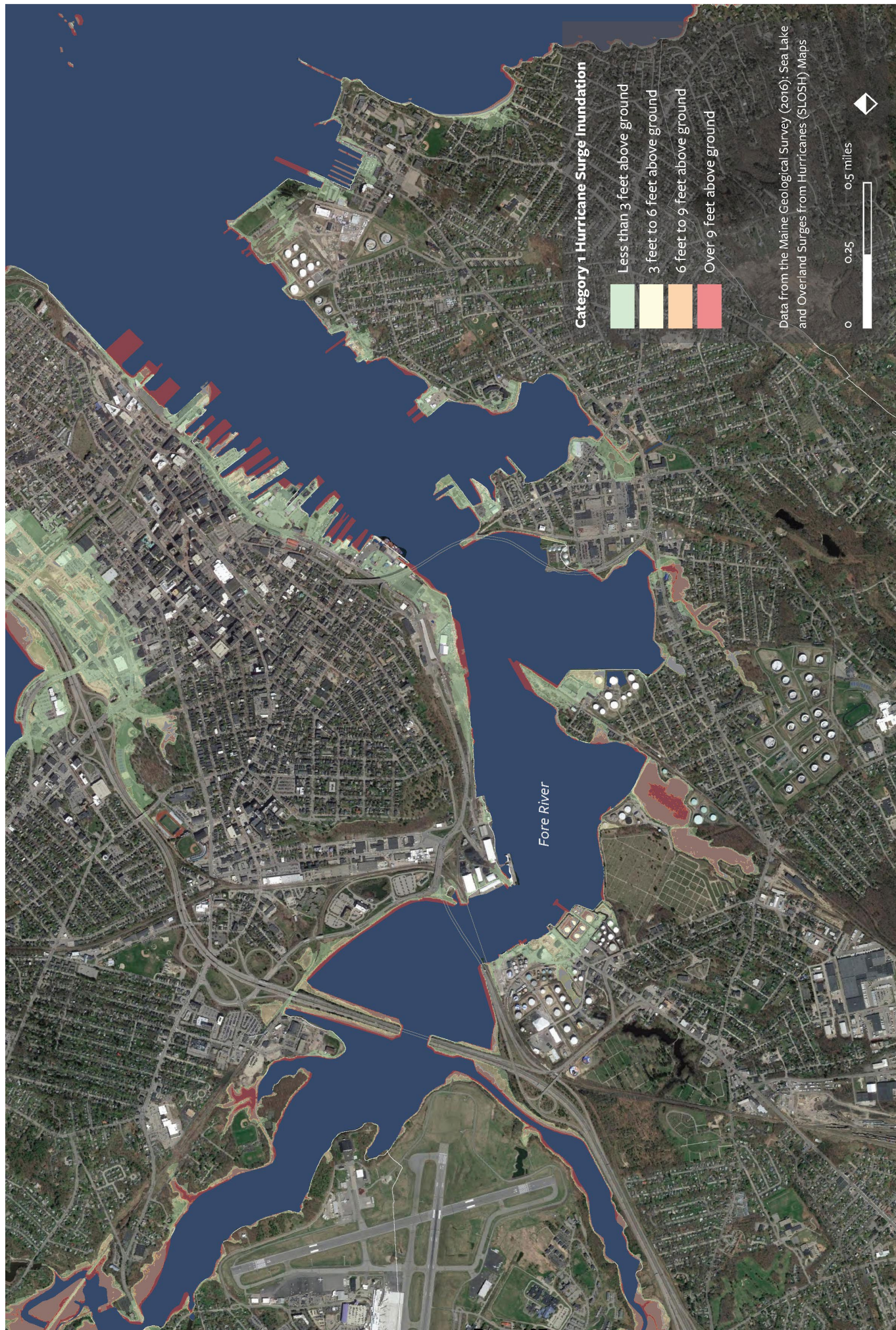


Figure B.9. Areas in the South Portland and Portland waterfronts that would be potentially inundated by storm surge from a category 1 hurricane at mean high tide. Data source: Maine Geological Survey Sea, Lake, and Overland Surges from Hurricanes (SLOSH) Data (2016).

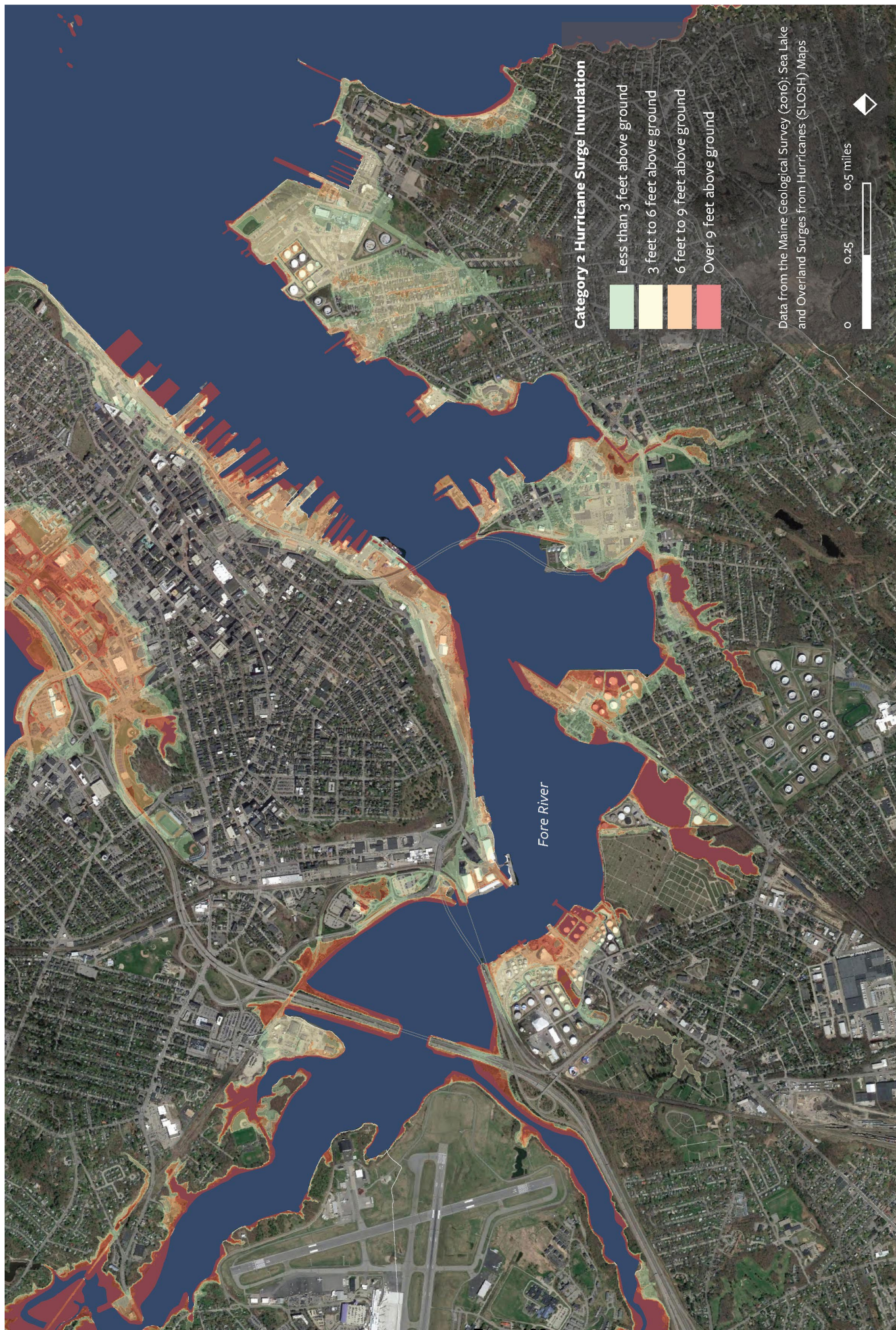


Figure B.10. Areas in the South Portland and Portland waterfronts that would be potentially inundated by storm surge from a category 2 hurricane at mean high tide. Data source: Maine Geological Survey Sea, Lake, and Overland Surges from Hurricanes (SLOSH) Data (2016).

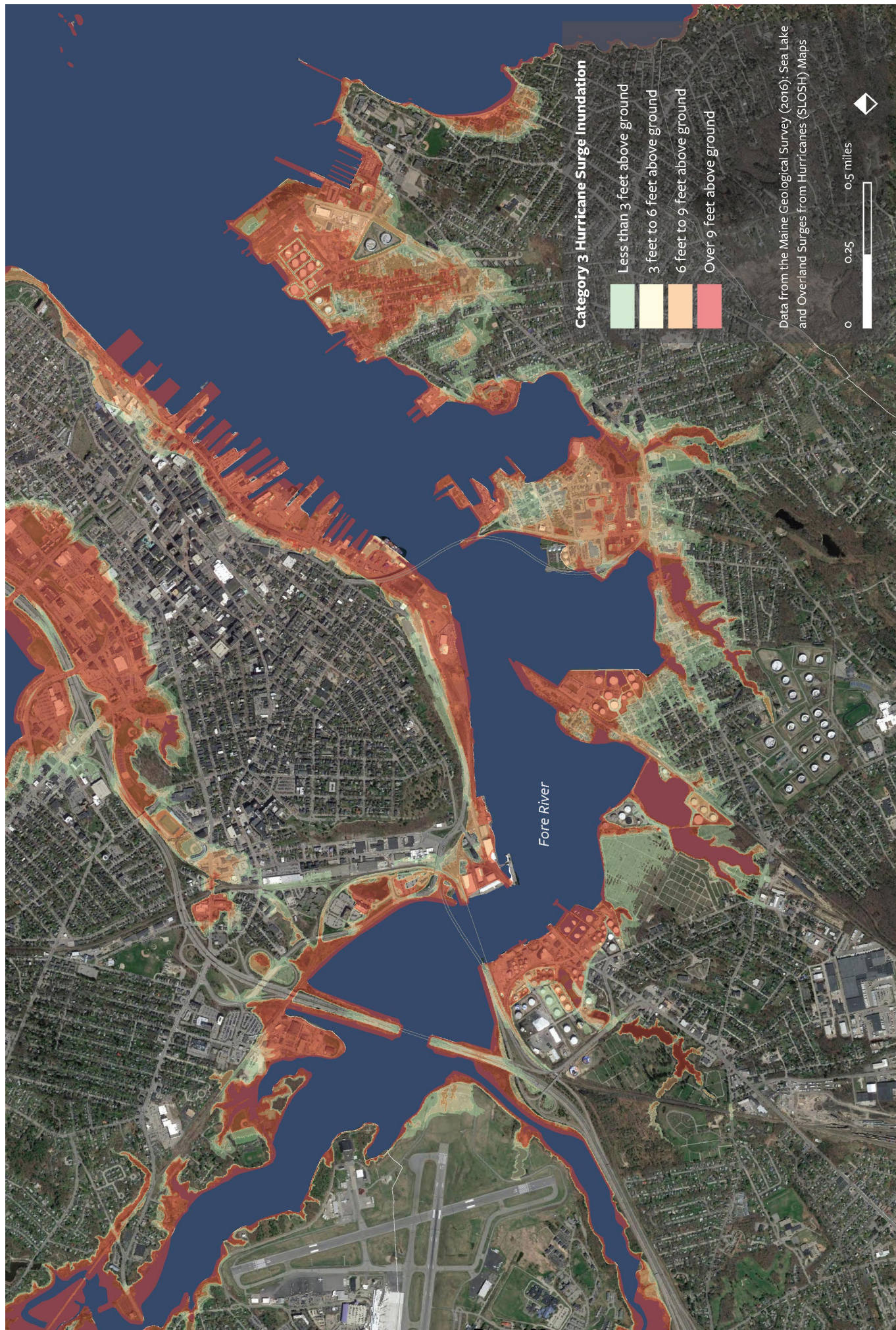


Figure B.11. Areas in the South Portland and Portland waterfronts that would be potentially inundated by storm surge from a category 3 hurricane at mean high tide. Data source: Maine Geological Survey Sea, Lake, and Overland Surges from Hurricanes (SLOSH) Data (2016).

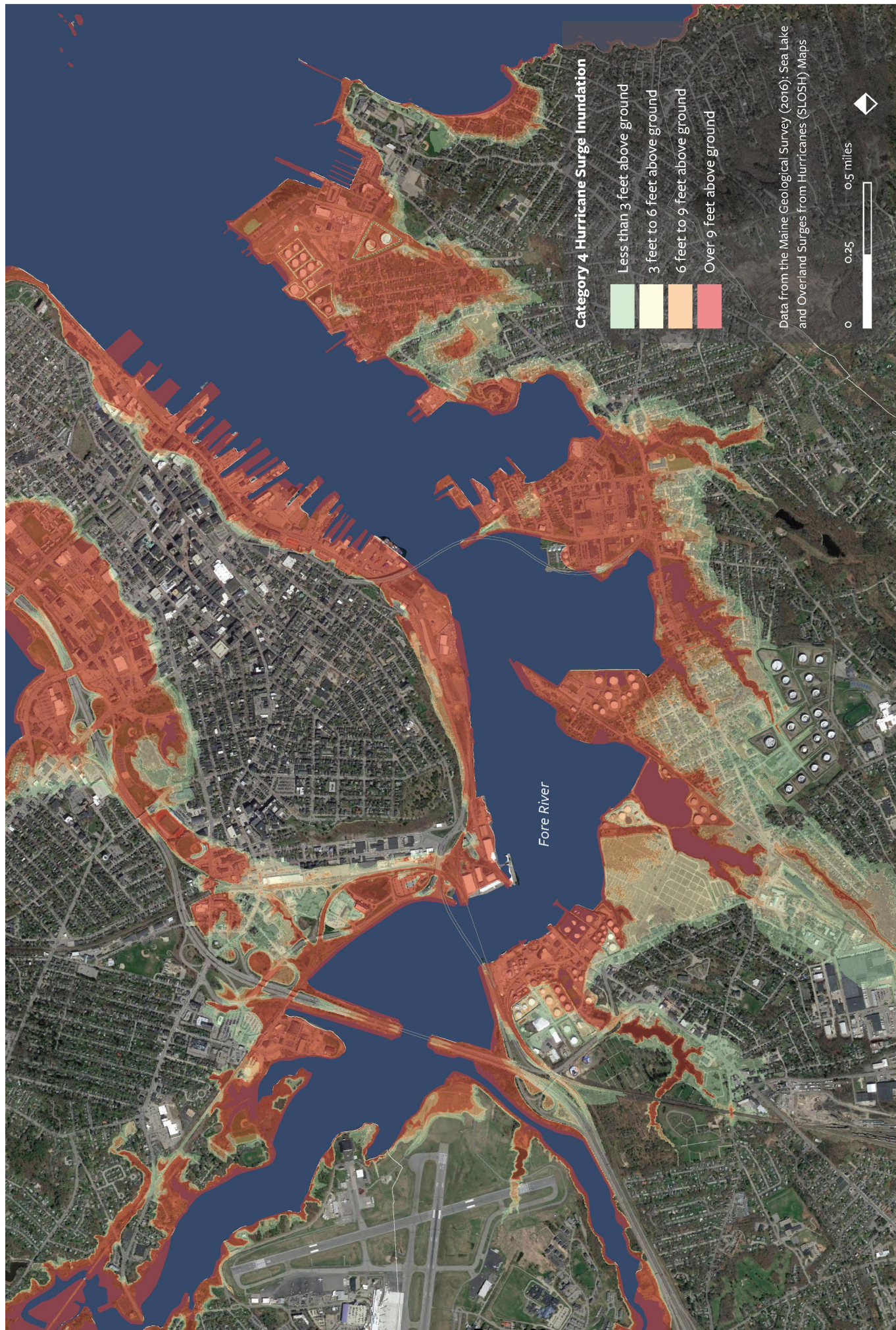


Figure B.12. Areas in the South Portland and Portland waterfronts that would be potentially inundated by storm surge from a category 4 hurricane at mean high tide. Data source: Maine Geological Survey Sea, Lake, and Overland Surges from Hurricanes (SLOSH) Data (2016).

Appendix C: Temperature and Precipitation Graphs

Caption for all temperature and precipitation graphs on subsequent pages. Historical simulations (1980–2005) and future projections (2006–2099) in [insert Y-axis variable] from a 29-member, high resolution (4 km) statistically downscaled Coupled Model Intercomparison Project (CMIP5) ensemble mean lower (RCP 4.5 - blue line) and higher (RCP 8.5 - orange line) representative concentration pathway (RCP) emission scenarios. Orange and blue lines for the period 1980–2005 are identical. The light blue (light orange) shading represent the highest and lowest values from the 29 different model RCP 4.5 (RCP 8.5) simulations for each year. Graphs from Elizabeth Burakowski and Cameron Wake, Earth System Research Center/EOS, University of New Hampshire.

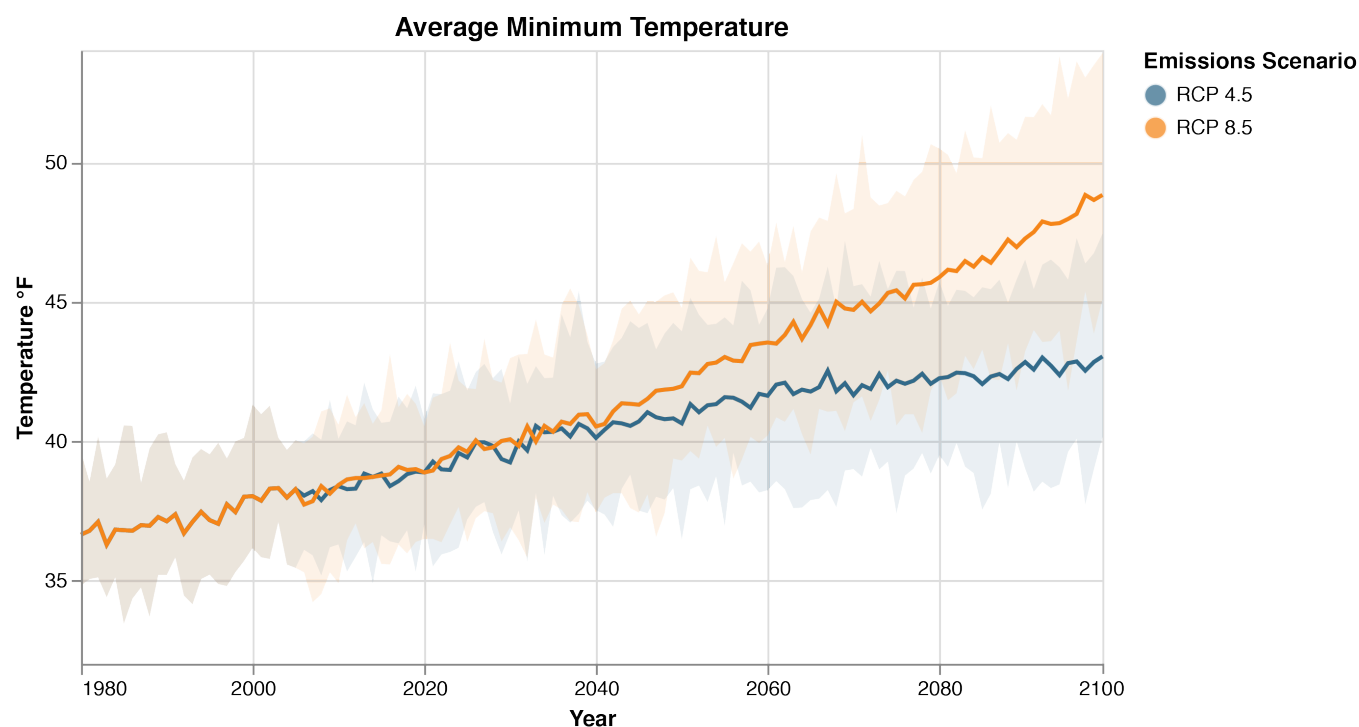


Figure C.1. Historical simulations (1980–2005) and future projections (2006–2099) for average minimum temperature in Greater Portland. See first page of Appendix C for full caption.

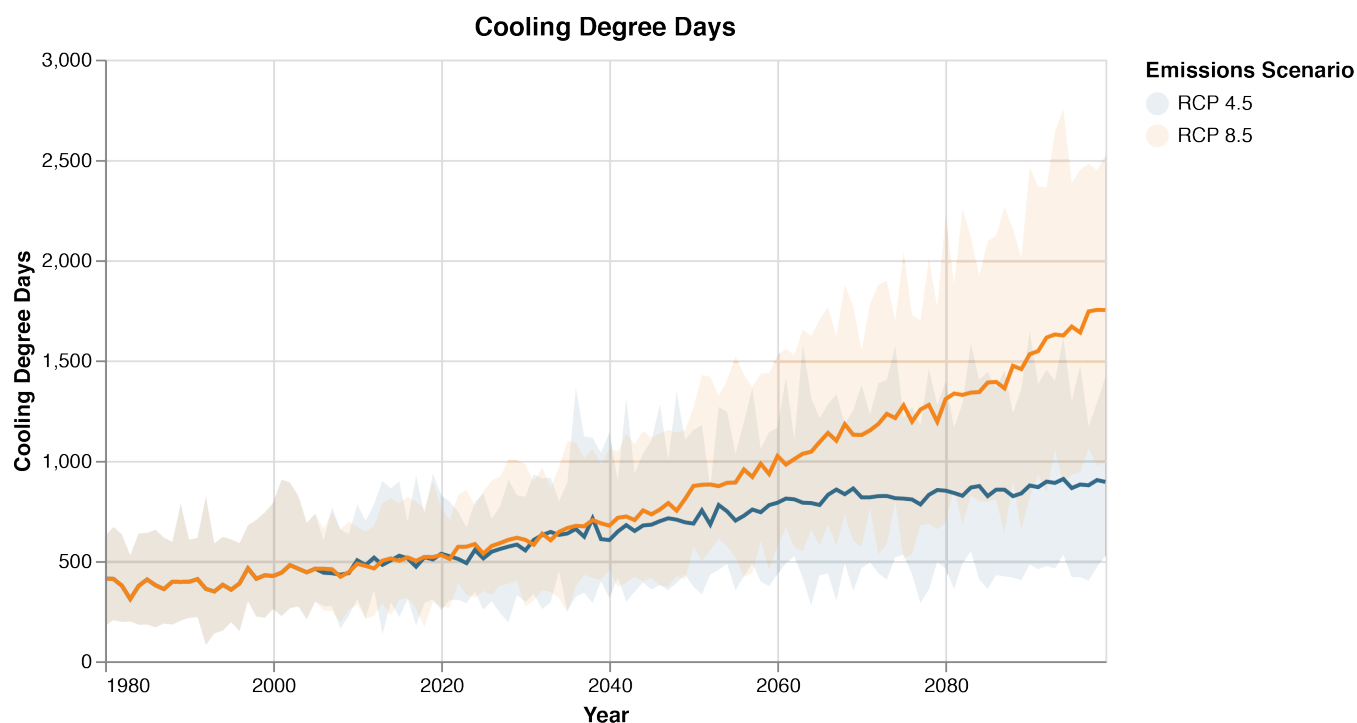


Figure C.2. Historical simulations (1980–2005) and future projections (2006–2099) for cooling degree days in Greater Portland. See first page of Appendix C for full caption.

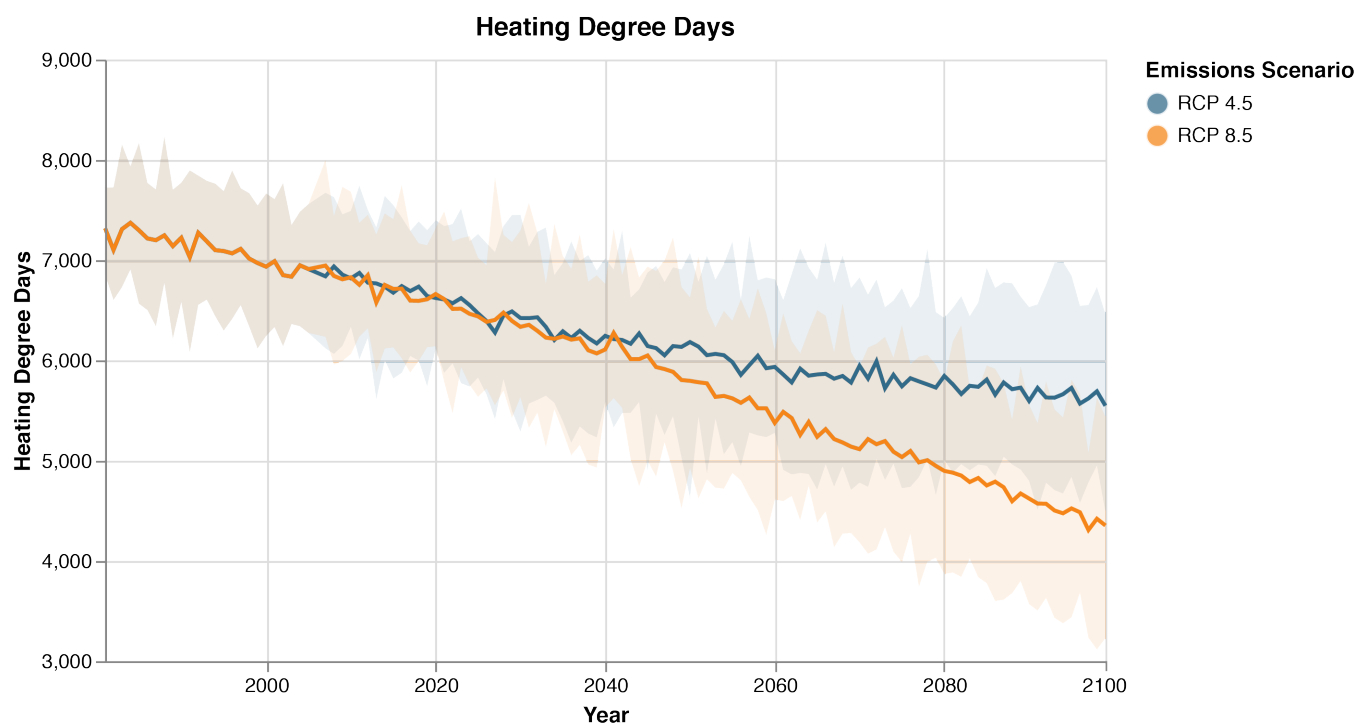


Figure C.3. Historical simulations (1980–2005) and future projections (2006–2099) for heating degree days in Greater Portland. See first page of Appendix C for full caption.

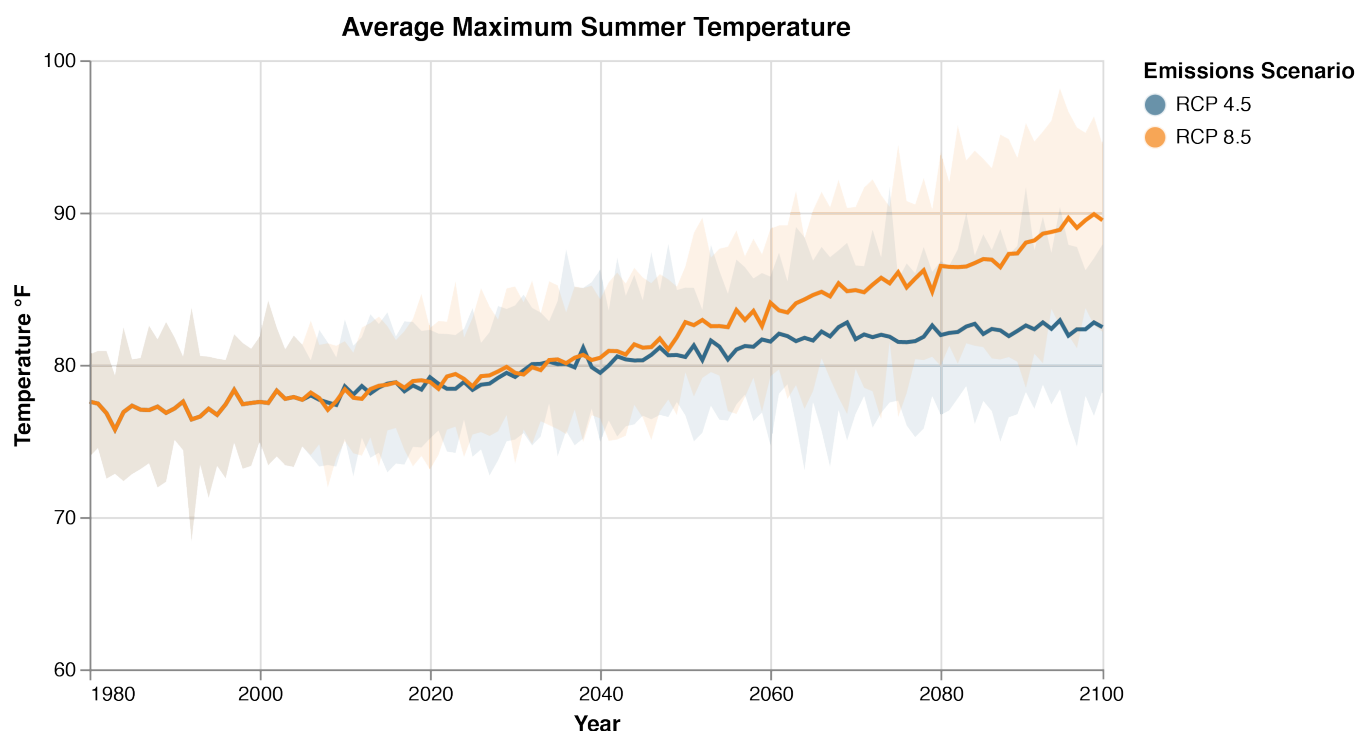


Figure C.4. Historical simulations (1980–2005) and future projections (2006–2099) for maximum summer temperature in Greater Portland. See first page of Appendix C for full caption.

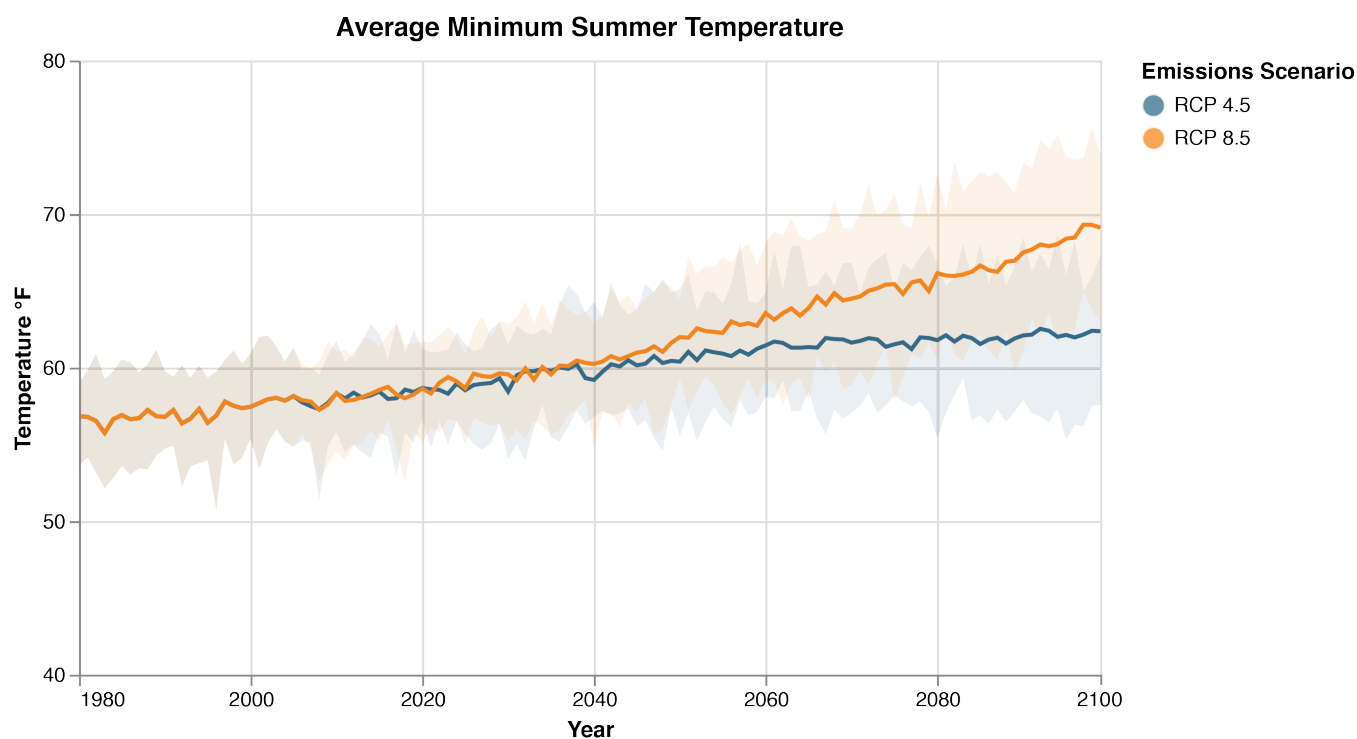


Figure C.5. Historical simulations (1980–2005) and future projections (2006–2099) for minimum summer temperature in Greater Portland. See top of Appendix C for full caption.

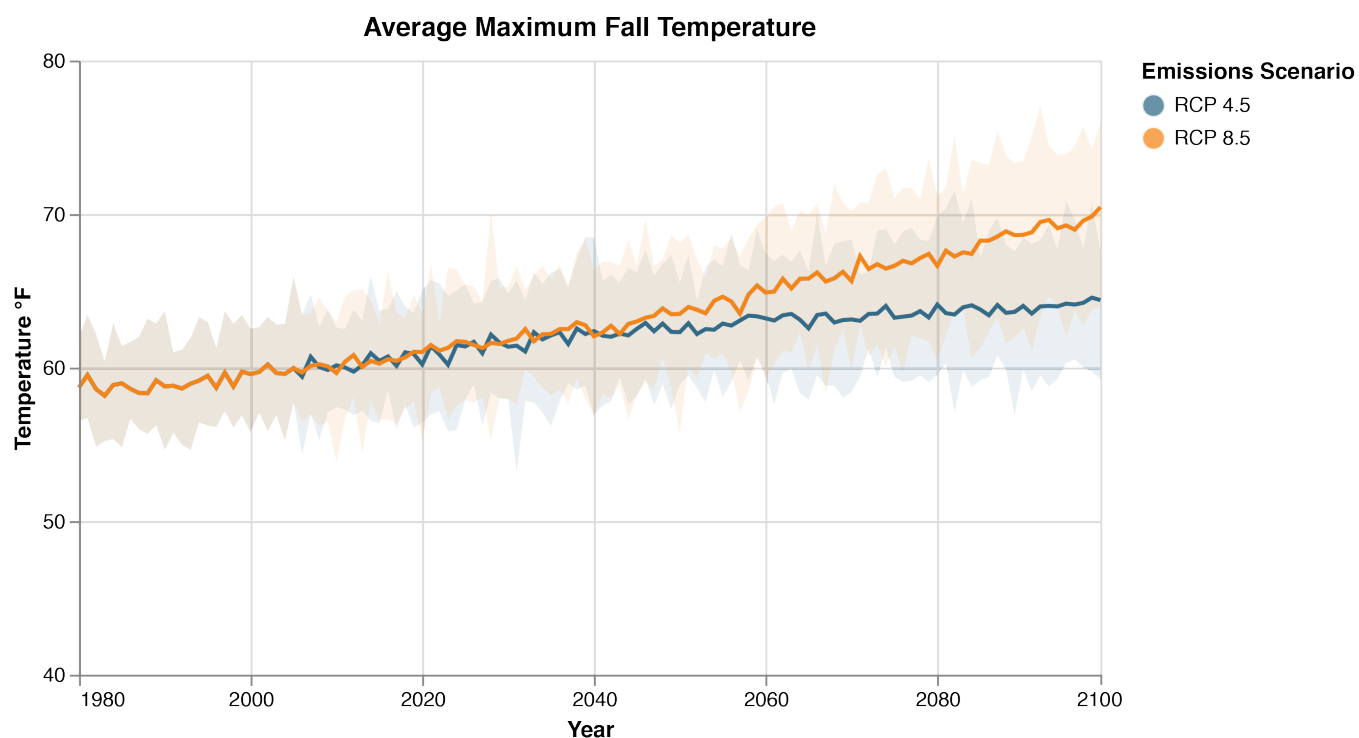


Figure C.6. Historical simulations (1980–2005) and future projections (2006–2099) for maximum fall temperature in Greater Portland. See top of Appendix C for full caption.

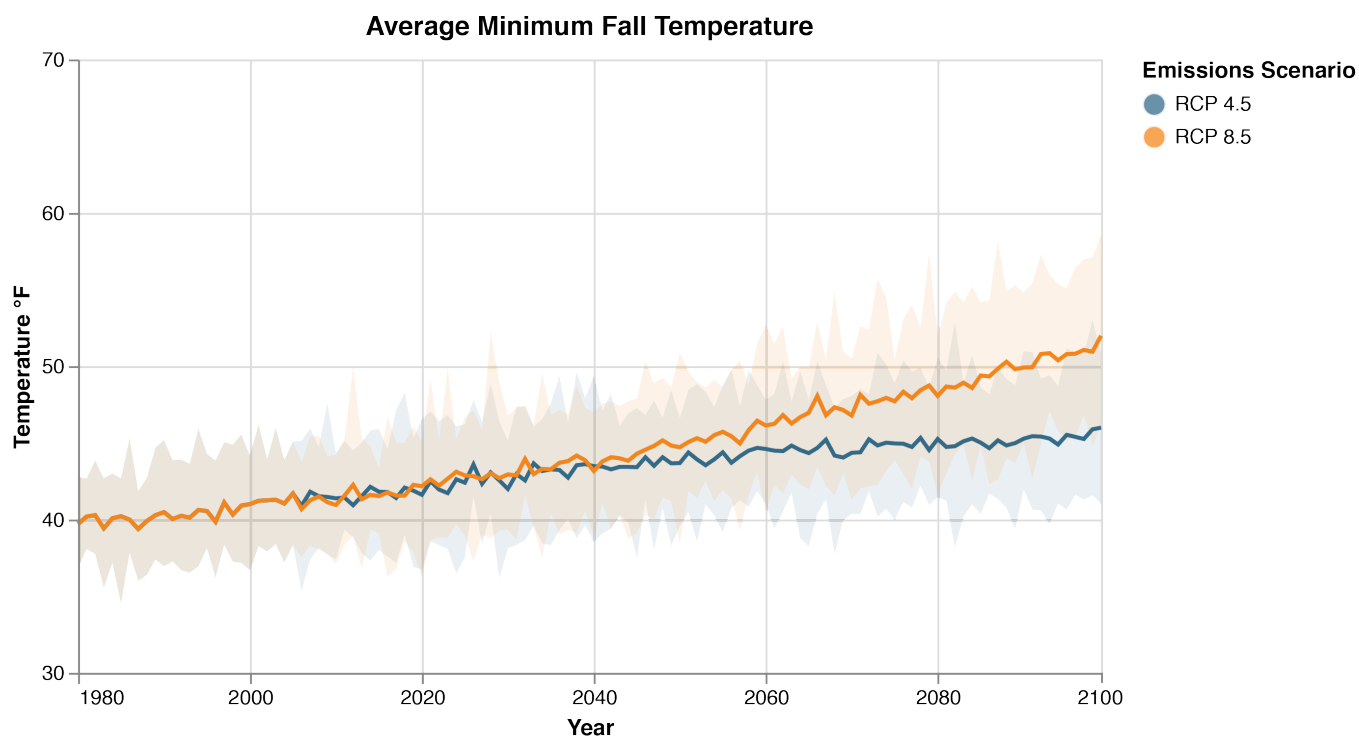


Figure C.7. Historical simulations (1980–2005) and future projections (2006–2099) for minimum fall temperature in Greater Portland. See top of Appendix C for full caption.

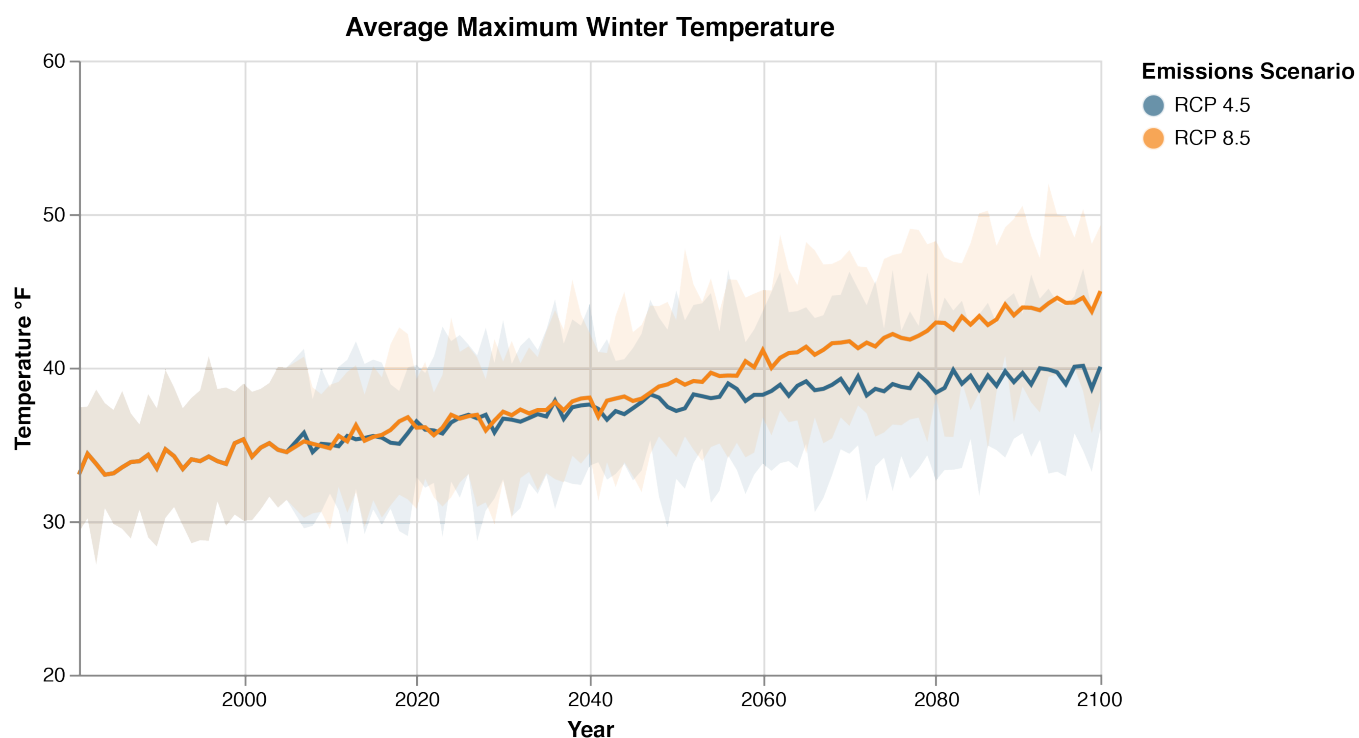


Figure C.8. Historical simulations (1980–2005) and future projections (2006–2099) for maximum winter temperature in Greater Portland. See top of Appendix C for full caption.

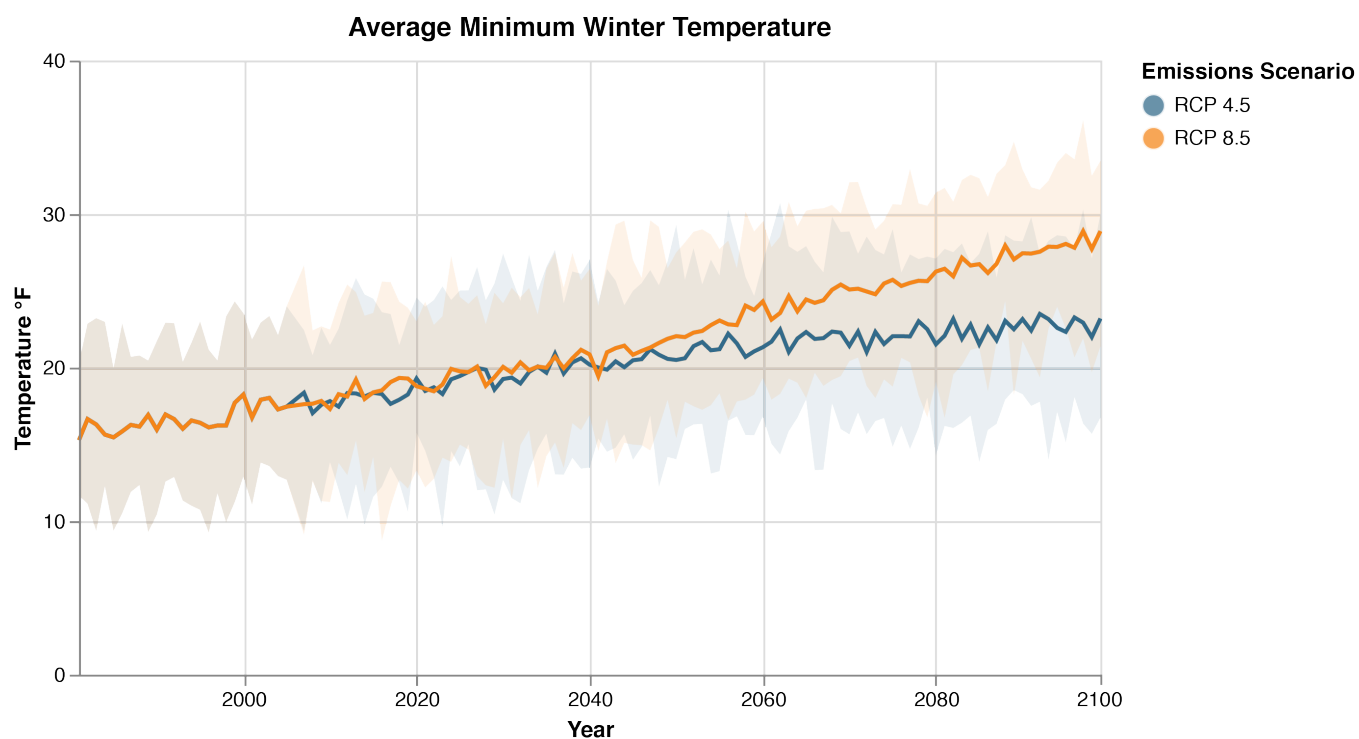


Figure C.9. Historical simulations (1980–2005) and future projections (2006–2099) for minimum winter temperature in Greater Portland. See top of Appendix C for full caption.

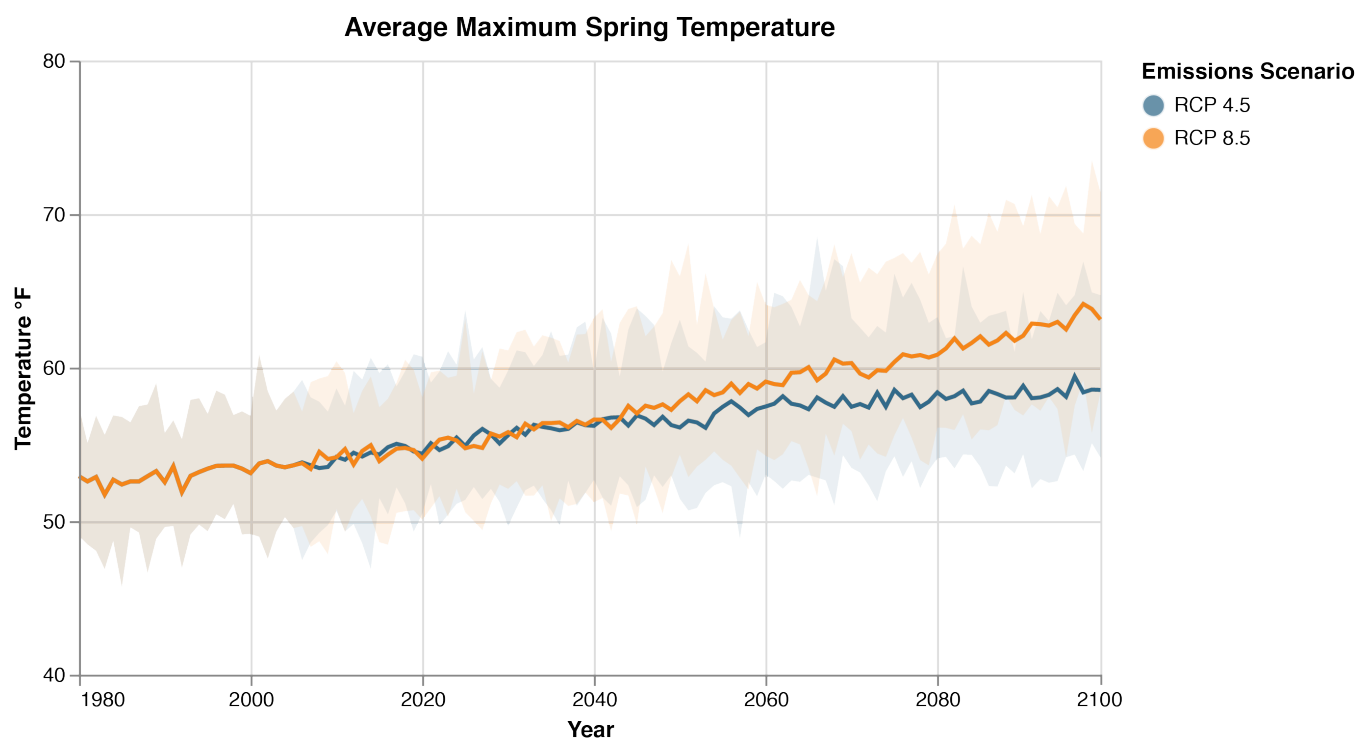


Figure C.10. Historical simulations (1980–2005) and future projections (2006–2099) for maximum spring temperature in Greater Portland. See top of Appendix C for full caption.

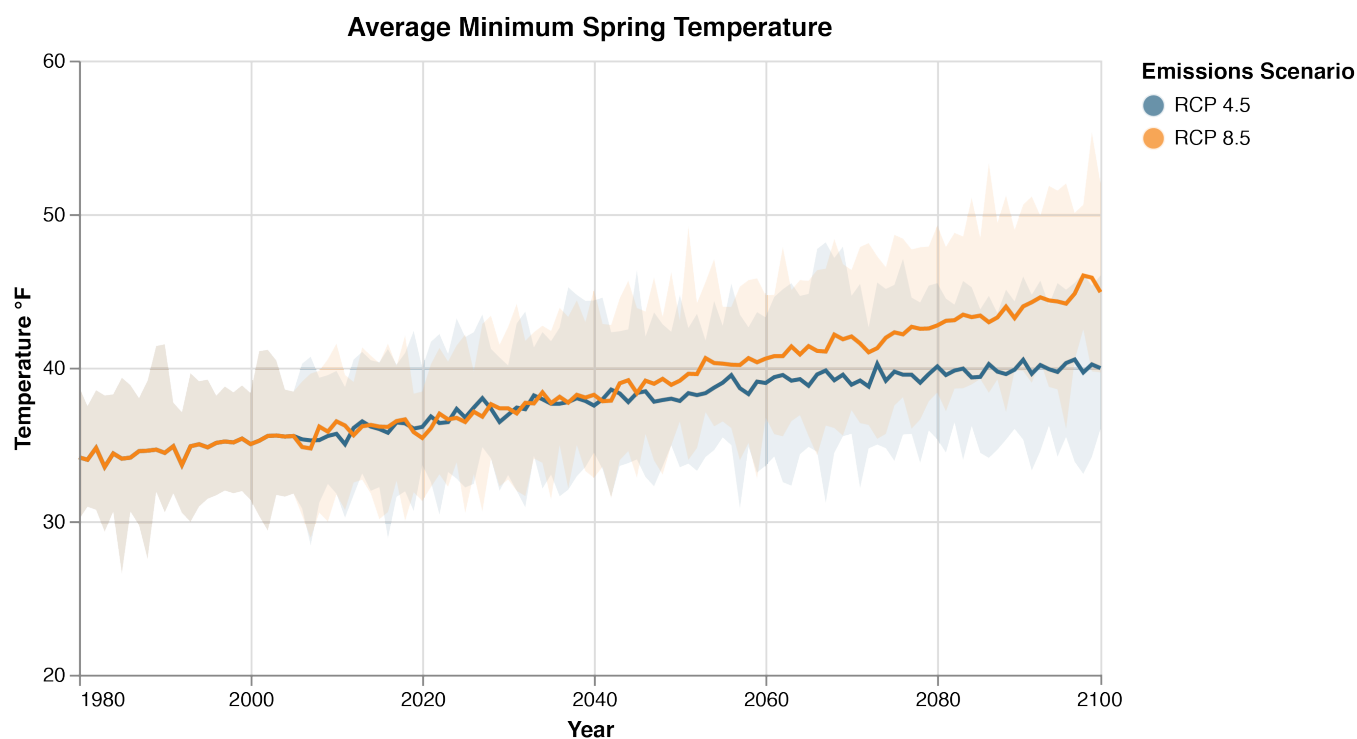


Figure C.11. Historical simulations (1980–2005) and future projections (2006–2099) for minimum spring temperature in Greater Portland. See top of Appendix C for full caption.

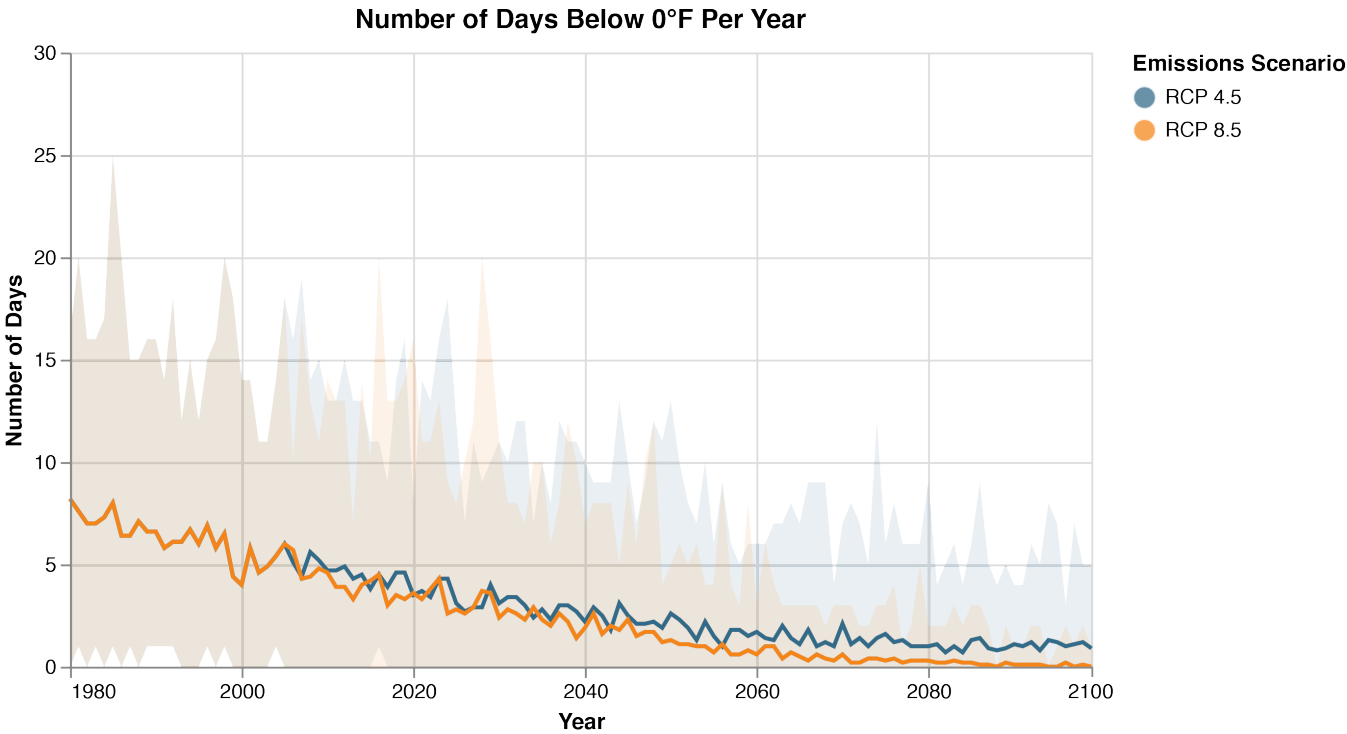


Figure C.12. Historical simulations (1980–2005) and future projections (2006–2099) for number of days below 0°F per year in Greater Portland. See top of Appendix C for full caption.

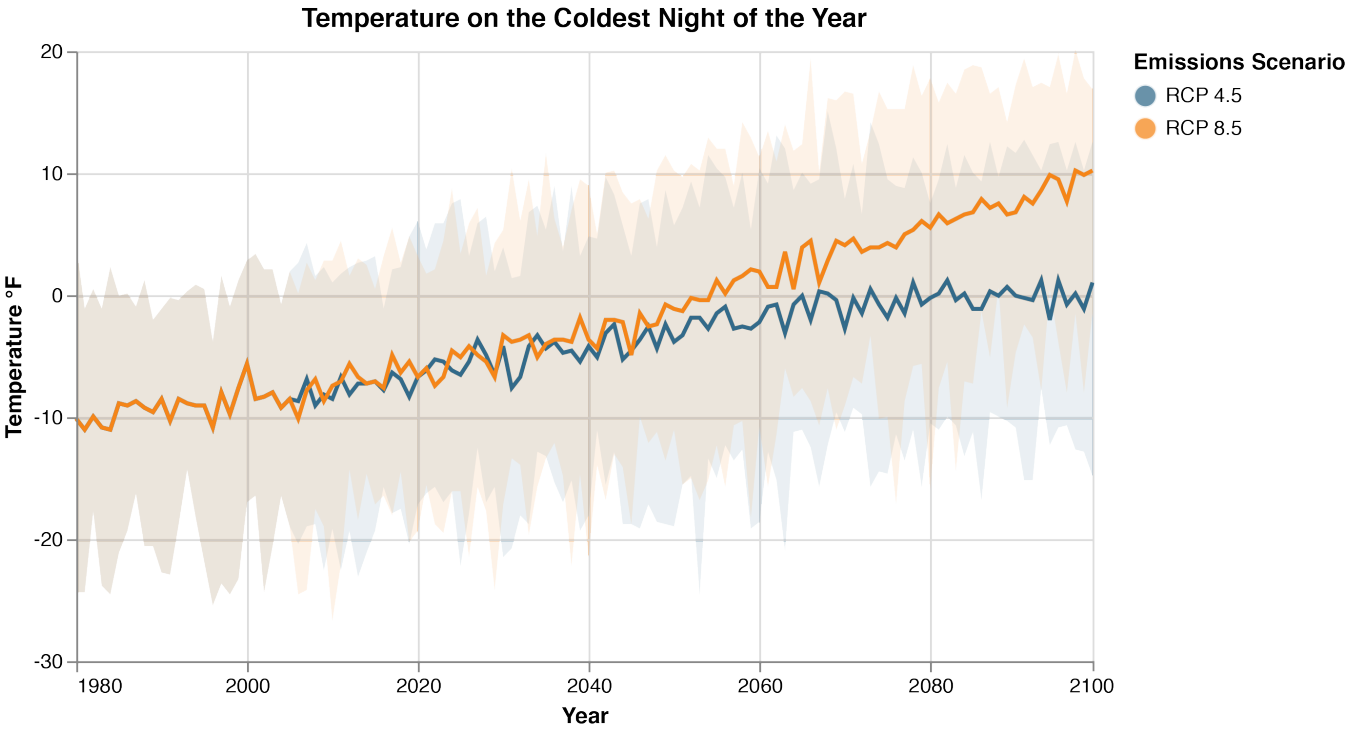


Figure C.13. Historical simulations (1980–2005) and future projections (2006–2099) for temperature on the coldest night of the year in Greater Portland. See top of Appendix C for full caption.

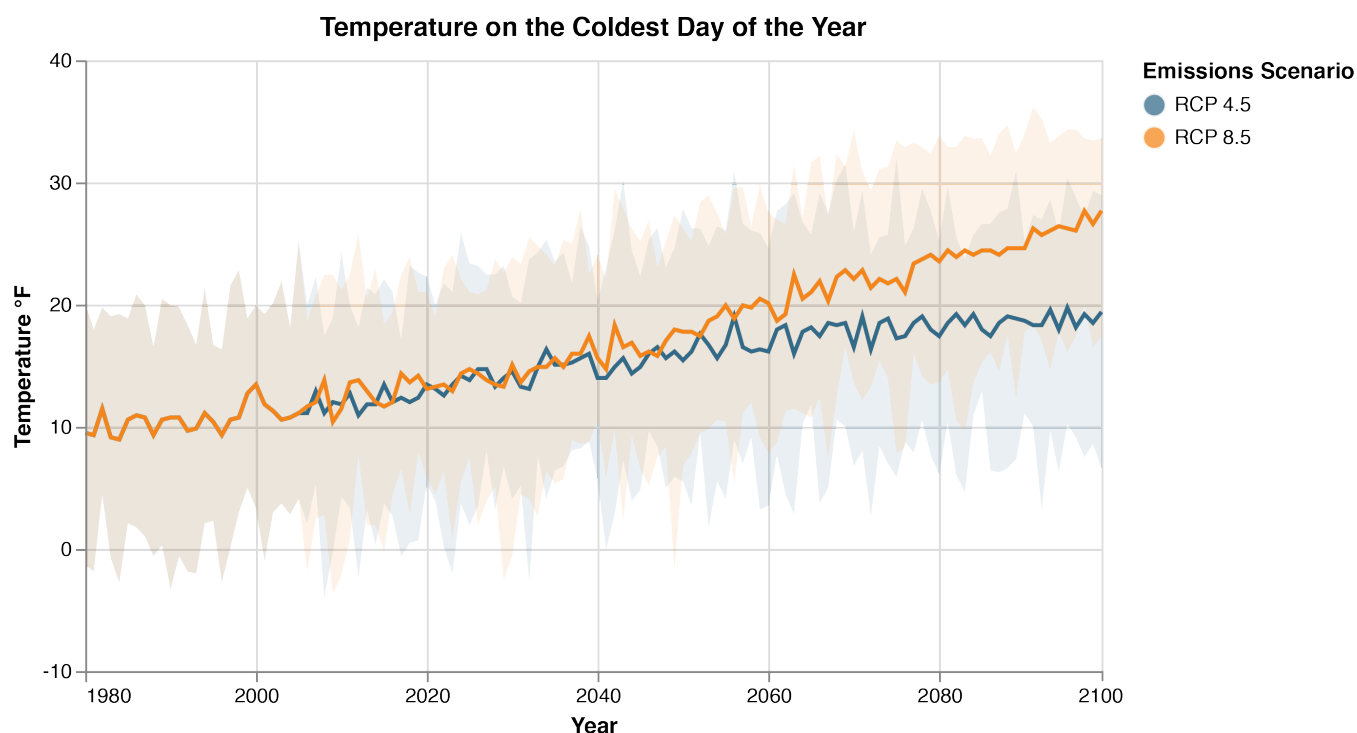


Figure C.14. Historical simulations (1980–2005) and future projections (2006–2099) for temperature on the coldest day of the year in Greater Portland. See top of Appendix C for full caption.

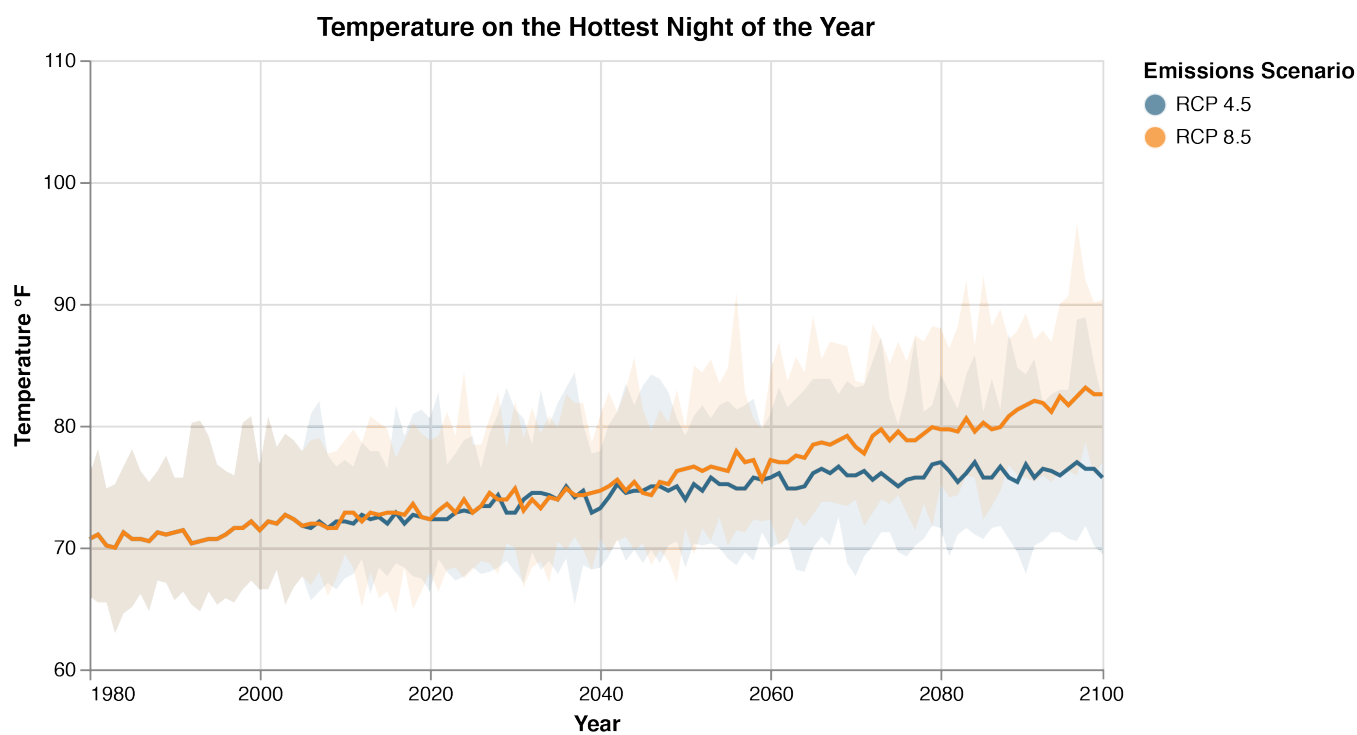


Figure C.15. Historical simulations (1980–2005) and future projections (2006–2099) for temperature on the hottest night of the year in Greater Portland. See top of Appendix C for full caption.

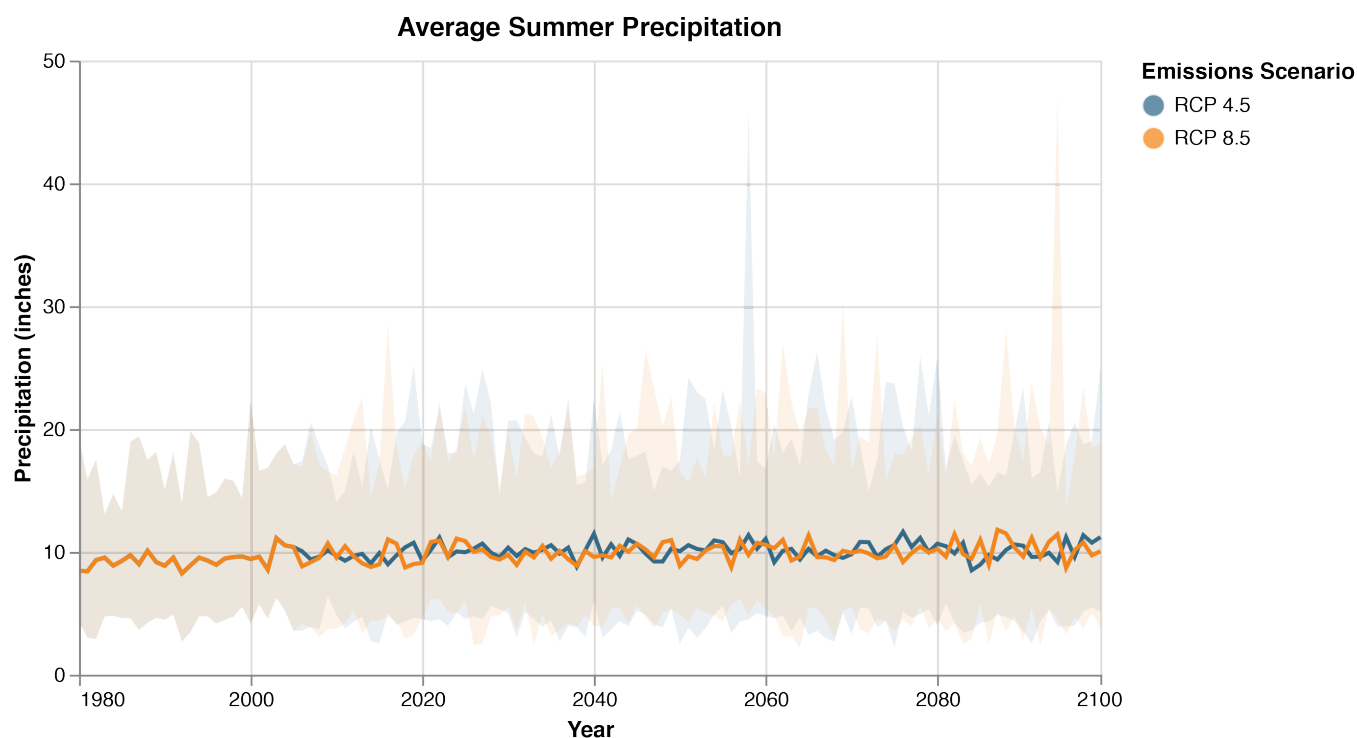


Figure C.16. Historical simulations (1980–2005) and future projections (2006–2099) for average summer precipitation in Greater Portland. See top of Appendix C for full caption.

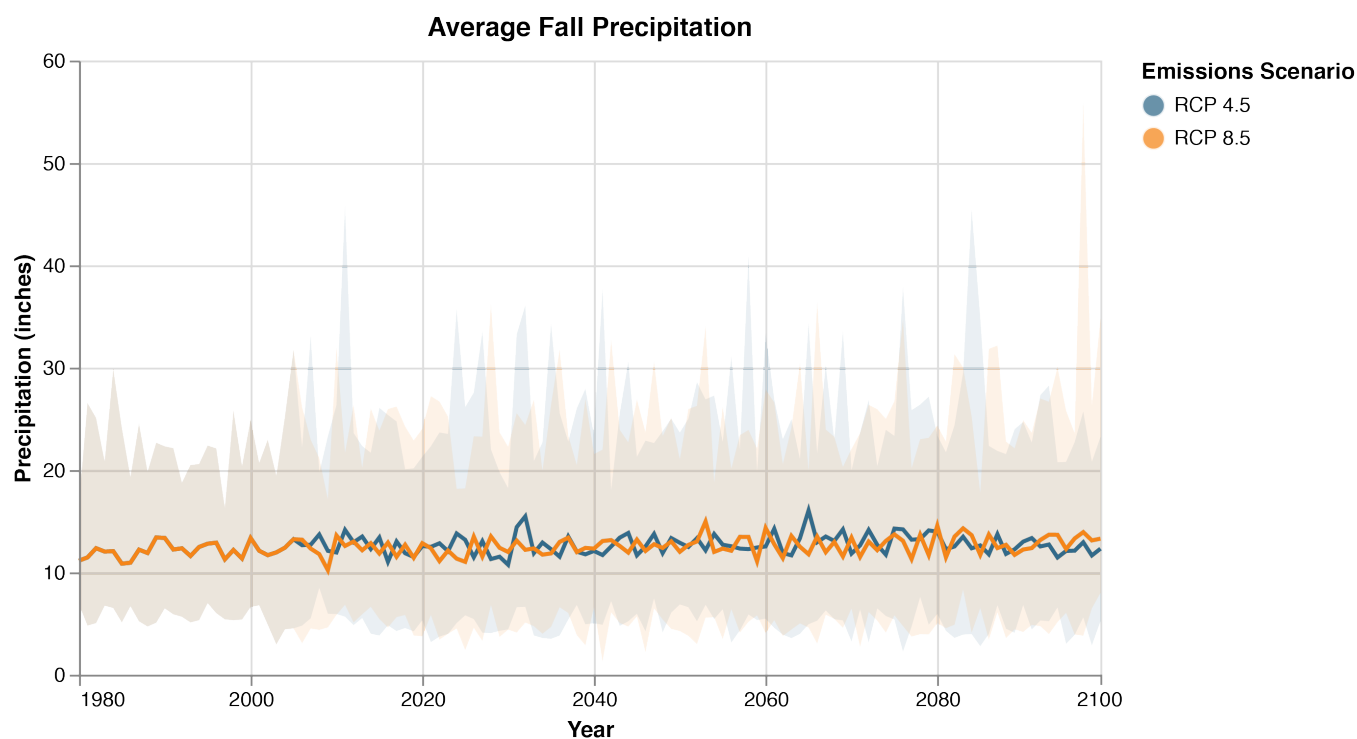


Figure C.17. Historical simulations (1980–2005) and future projections (2006–2099) for average fall precipitation in Greater Portland. See top of Appendix C for full caption.

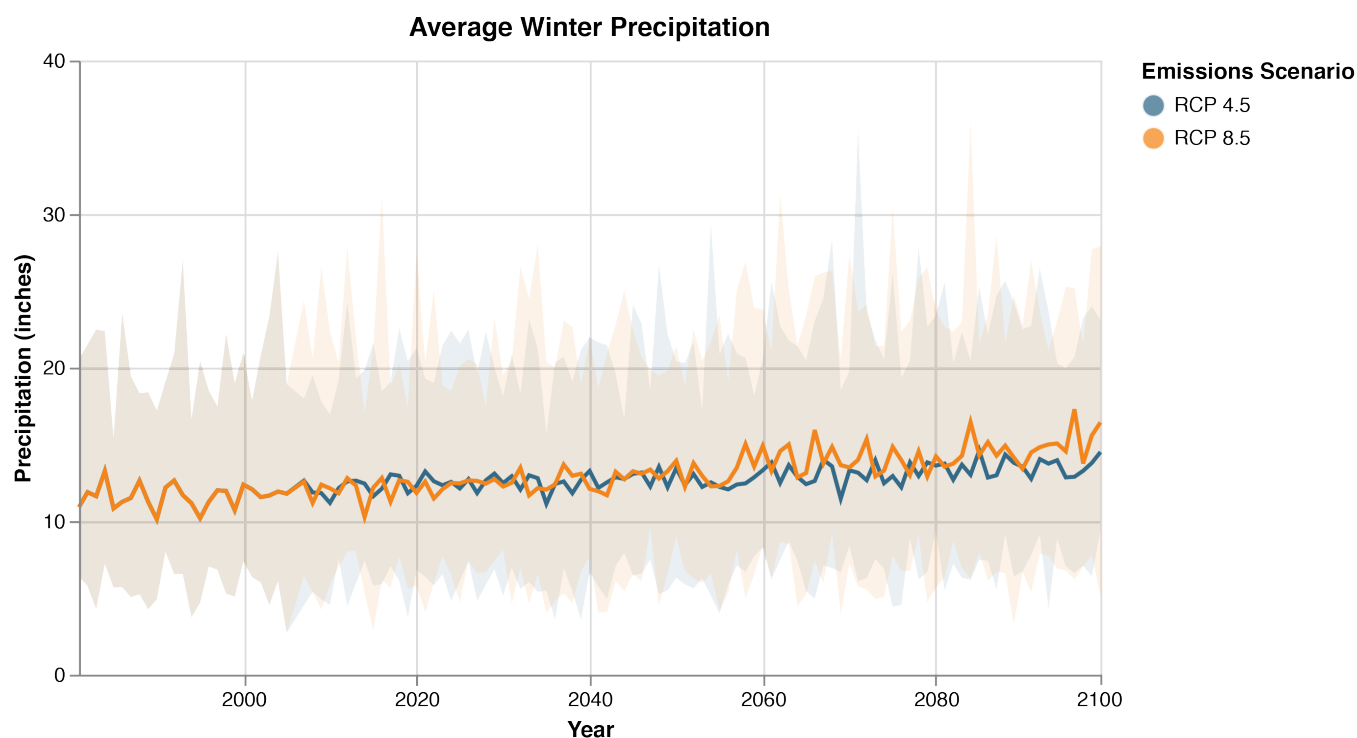


Figure C.18. Historical simulations (1980–2005) and future projections (2006–2099) for average winter precipitation in Greater Portland. See top of Appendix C for full caption.

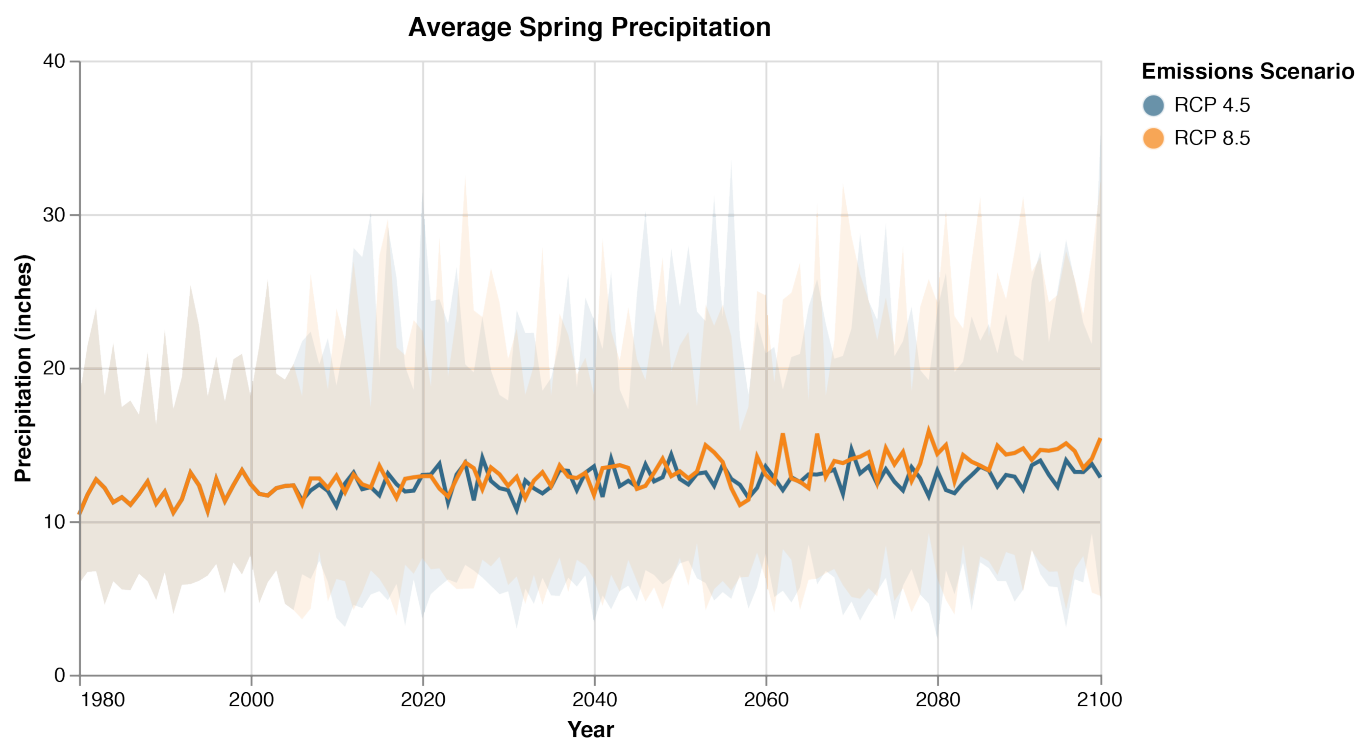


Figure C.19. Historical simulations (1980–2005) and future projections (2006–2099) for average spring precipitation in Greater Portland. See top of Appendix C for full caption.

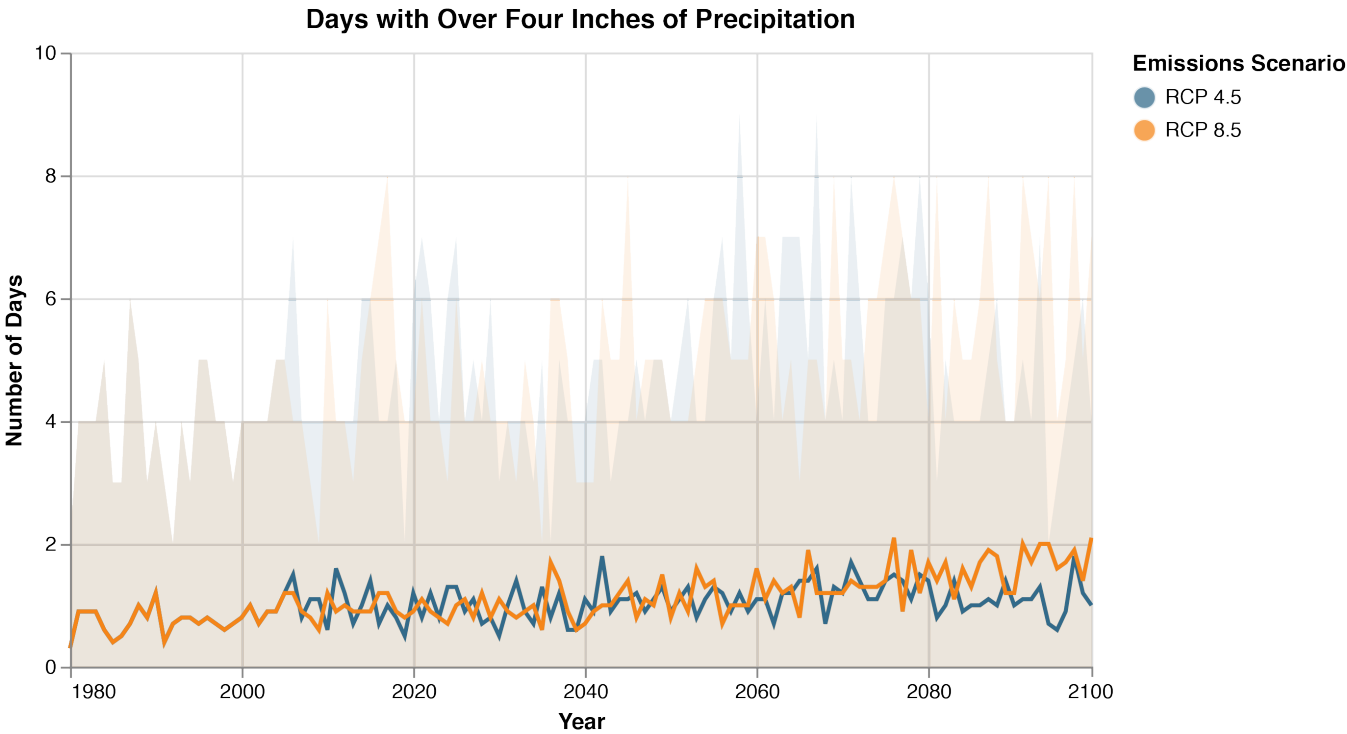


Figure C.20. Historical simulations (1980–2005) and future projections (2006–2099) for number of days per year with over four inches of rain in Greater Portland. See top of Appendix C for full caption.

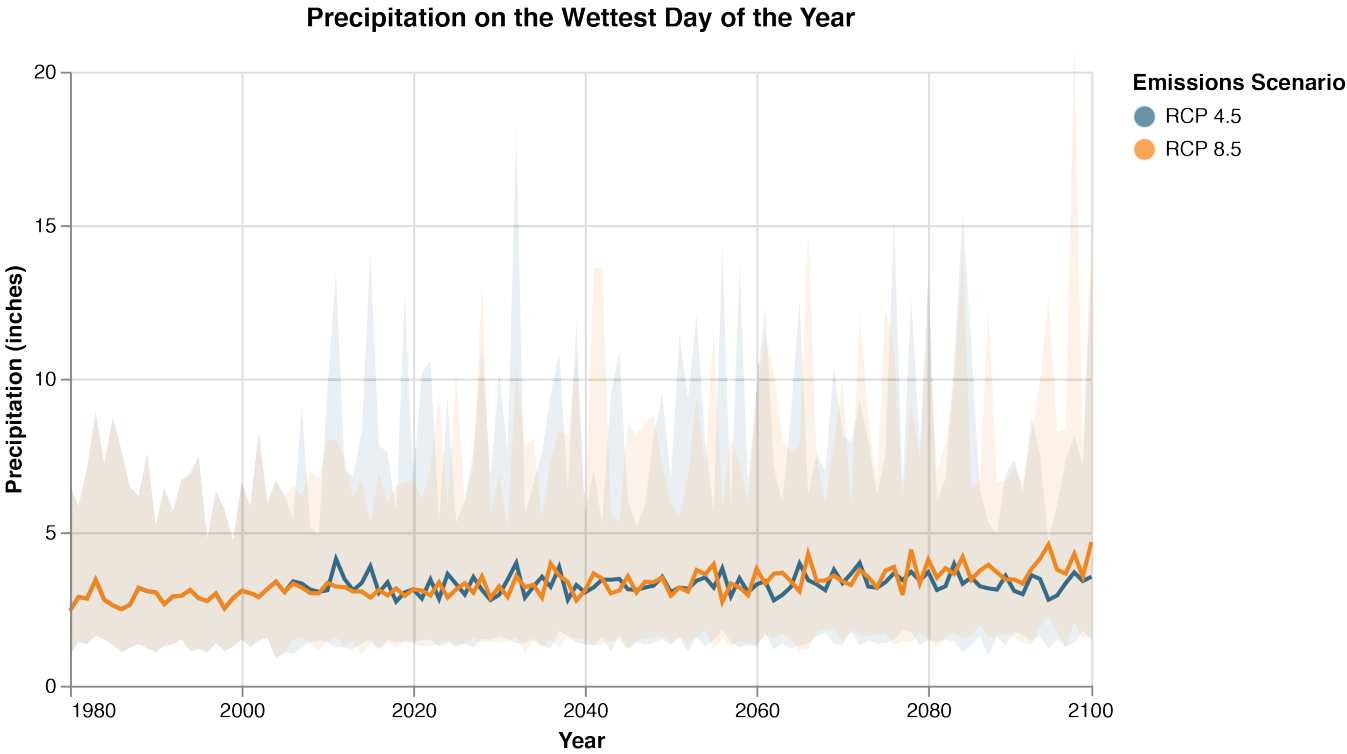


Figure C.21. Historical simulations (1980–2005) and future projections (2006–2099) for amount of precipitation on the wettest day of the year in Greater Portland. See top of Appendix C for full caption.

Appendix D: Impacts to Upcoming Capital Improvement Projects

Incorporating climate change projections and hazard mitigation goals into a municipality's Capital Improvement Planning (CIP) process is becoming a best practice for supporting climate resilience. Joining the two efforts provides an opportunity to fund efforts to reduce vulnerability through projects that are already being planned. The Capital Improvement Plans currently in place for Portland and South Portland both have projects that will likely play a role in reducing climate vulnerability, and may be vulnerable to future impacts from climate change.

Projects in locations that will fall within future inundation areas from the highest astronomical tide face a greater risk of damage from direct exposure to seawater, including inundation, erosion and scour due to tidal action, and corrosion by saltwater. Even projects outside this zone are vulnerable to the effects of changing precipitation and more intense weather patterns, including structural damage by wind and hydrodynamic loads, as well as debris.

Portland — The City of Portland Capital Improvement Plan represents the City's capital needs for 2019 through 2023. Projects included in the plan require a significant capital investment, therefore necessitating communication and planning. A large number of projects focus on environmental or climate mitigation goals—such as bike and pedestrian infrastructure improvements or energy efficiency—which can play a role in decreasing the city's infrastructure vulnerability in a number of ways.

Projects in the FY 2020 – FY 2023 CIP are also vulnerable to climate change based on either location, project type, or both. Location vulnerabilities include improvements near the coast, such as the West Commercial Street Pathway Greenway along Back Cove. Project type vulnerabilities include the 21 sewer and stormwater project requests for FY 2020 – FY 2023, including several CSO abatements. These CSO abatements will ultimately play a role in decreasing environmental vulnerability—abating some of the pollution impacts of increased

**Portland FY2019 – FY2020
Potentially Vulnerable CIP Projects Underway**

Project Category	Project Name
Sewer	State Street Sewer - Forest to Cumberland
Sewer	Back Cove West Storage Conduit
Sewer	Mackworth Ocean Walton Sewer Sep. & Water Repl.
Sewer	Preble Street Sewer Separation
Sewer/Stormwater	Bedford Street CSO
Sewer/Stormwater	Back Cove South Storage Facility
Sewer/Stormwater	Diamond Tide Gate
Sewer/Stormwater	Franklin St Pump Station
Transportation	Bayside Trail – Eastern Promenade Trail Junction Plaza
Transportation	Forest Avenue at State and High Intersection Work
Transportation	Forest Avenue at State and High Intersection Work
Transportation	State Street Sidewalk Rehab
Transportation	West Commercial St Pathway Phase II
Transportation	Route 22 Paving
Transportation	Valley Street
Transportation	Somerset Street Reconnection
Transportation	Somerset Street Reconnection
Transportation	Somerset Street Reconnection
Transportation	High Street Paving Project Part 1
Transportation	High Street Paving Project Part 2
Transportation	Bayside Trail-Planet Dog Pathway Enhancement
Transportation	Fox Street Paving
Transportation	Dana Street Reconstruction
Transportation	Thames St Extension
Transportation	Preble St Sidewalk Reconstruction Project (CDBG)
Transportation	Waldo Street Paving
Transportation	Fore River Parkway Paving Project
Transportation	Forest Ave at Marginal Way Sidewalk
Transportation	Forest Ave at State and High Intersection Sidewalk

Table D.1. City of Portland capital improvement projects underway that are vulnerable to sea level rise based on four sea level rise scenarios for the year 2100.

precipitation and subsequent overflows—but require careful consideration in the design of new drainage systems to ensure they will be able to handle increased precipitation.

In addition to these future projects, Portland has specific construction projects underway that include addressing CSOs, paving, intersection improvements, pump station rehabilitation, sidewalk reconstruction and improvements, storm drain extensions, trail improvement, water quality improvements, and sewer system rehabilitation.

Figure D.1 displays FY 2019 and FY 2020 Capital Improvement Projects alongside Maine Geological Survey Sea Level Rise/Storm Surge data to illustrate which projects are vulnerable to sea level rise under a number of scenarios. In the case of roadway projects, the specific length of the project that falls within the sea level rise area of inundation is bolded, but the whole length of the project is visible in yellow. The vulnerable projects are summarized in **Table D.1** with the majority of them being located along Back Cove and in the low-lying Bayside area. All the projects seen in bold along Back Cove are sanitary or sanitary/sewer projects.

FY19 and FY20 Construction Projects in Portland Vulnerable to Sea Level Rise



Figure D.1. City of Portland construction projects that are planned or underway for fiscal years 2019 and 2020, overlaid with the extent of inundation from four sea level rise scenarios (1.6 feet, 3.9 feet, 6.1 feet, and 8.8 feet on top of the highest astronomical tide). Data source: City of Portland ArcGIS Online Major Construction Projects Map (2019); Maine Geological Survey, Sea Level Rise/Storm Surge Map (2018).

Further evaluation of these capital project locations in conjunction with FEMA Flood Zones provides further information on flood vulnerability. **Figure D.2** shows the portions of projects that may be impacted by the 1% annual chance flood event. No vertical projects are within FEMA flood zones, but many roadway projects are. The majority of these projects are near Capisic Brook and Back Cove.

From a vulnerability perspective, new capital improvement projects located around Back Cove, along the waterfront/Fore River, and along Capisic

Brook should integrate design considerations for higher exposure to flooding and storm surge, as well as heavy precipitation, if they have not already. Projects may be brought into flood or tidal zones in the future and become subject to the damaging forces of waves and saltwater, including erosion, scour, corrosion and inundation.

FY19 and FY20 Construction Projects in Portland Vulnerable to the 1% Annual Chance Flood

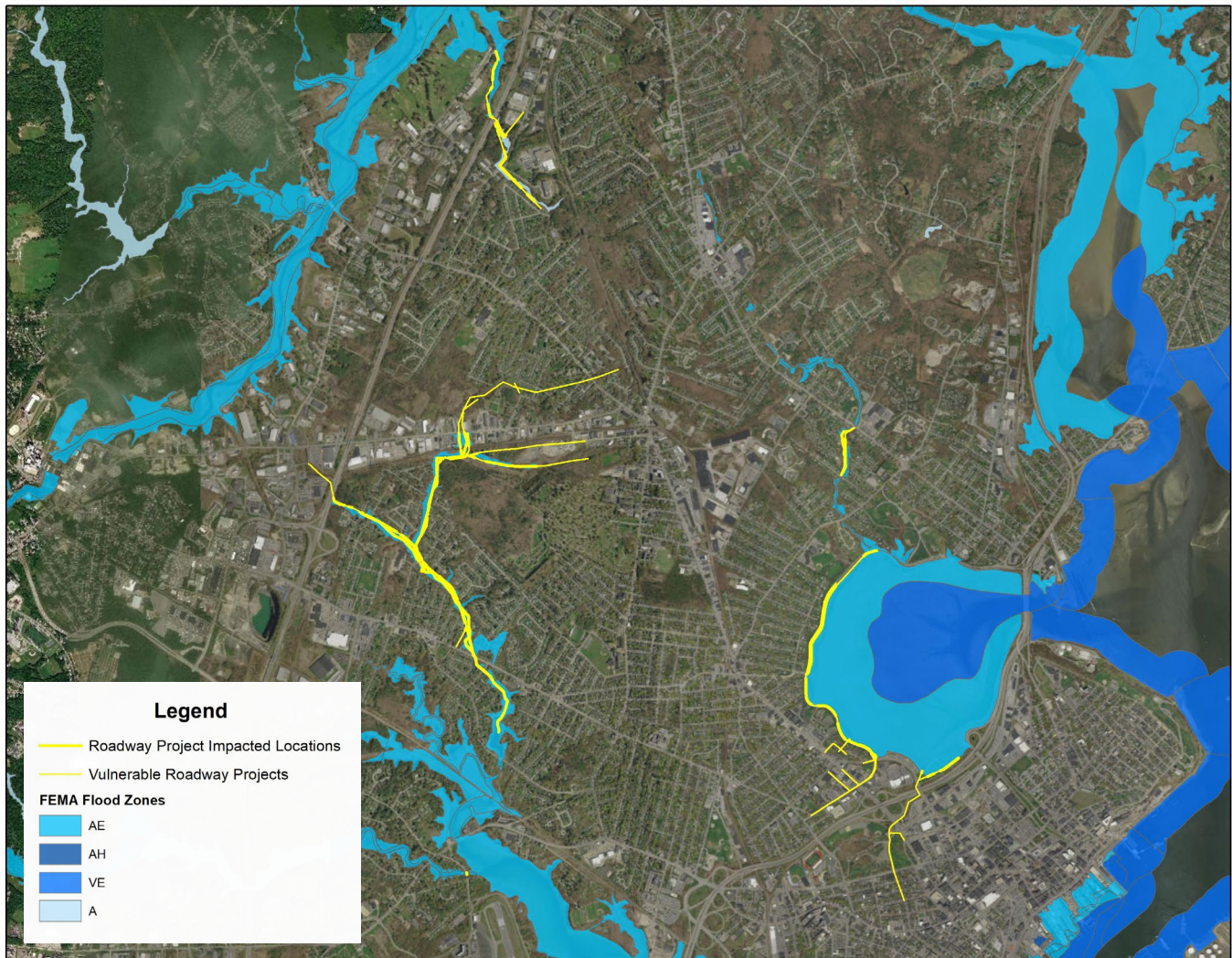


Figure D.2. City of Portland construction projects that are planned or underway for fiscal years 2019 and 2020, overlaid with the extent of inundation from the 1% annual flood. Data sources: City of Portland ArcGIS Online Major Construction Projects Map, 2019 (construction projects); FEMA preliminary flood zones (2018).

South Portland — Though unable to access geospatial data for South Portland’s ongoing or upcoming CIP projects for this report, in looking at the FEMA Flood Map and the Maine Geological Survey Sea Level Rise/ Storm Surge data, it is apparent that the specific areas of concern for South Portland with regard to flooding and sea level rise are along the Fore River and Long Creek.

The FY 2019 South Portland Capital Improvement Plan includes projects that may help reduce environmental vulnerability that will be exacerbated by climate hazards. Some of the projects are also located in areas that are vulnerable to sea level rise or storm surge, as identified in **Figure D.3** and **Figure D.4**.

- **CSOs | Pleasantdale Separation Project** – Separating CSOs decreases the vulnerability of the stormwater system by reducing the environmental impact of increased precipitation and flooding events. The FY19 CIP included the Pleasantdale Separation Project to address the Elm Street CSO. The project is designed for co-benefits including replacing aging utilities by Portland Water District and Unutil and when the street is reconstructed, incorporating Complete Street Principles.
- **Marsh Road Sewer Replacement** – This CIP request was for the replacement of 565 feet of sewer pipe located next to Trout Brook along Marsh Road (existing pipe dates back to the 1940s and is cracked). Trout Brook is an urban impaired stream and the City of South Portland has been working to address its degradation for almost ten years through its Watershed Management Plan. Replacing the line will eliminate sewage entering Trout Brook, thereby reducing the vulnerability of the stream ecosystem. Marsh Road is in a FEMA 1% annual chance flood zone. Infrastructure in this area of the city may be vulnerable to flooding impacts.
- **Electrical System Upgrades to the Wastewater Treatment Plant** – Over \$1 million dollars in electrical system upgrades are included in the CIP, which has the potential to decrease the vulnerability of the WWTP to climate hazards if upgrades incorporate redundancy and flood- and weather-proofing of the system. While the WWTP assets are not technically in a FEMA floodplain (**Figure D.5**) the site will be impacted by sea level rise starting at 3.9 feet above the highest astronomical tide. The plant’s components will be impacted at 6.1 feet of sea level rise and the full site is projected to be inundated at 8.8 feet (**Figure D.5**).

South Portland Areas Vulnerable to the 1% Annual Chance Flood

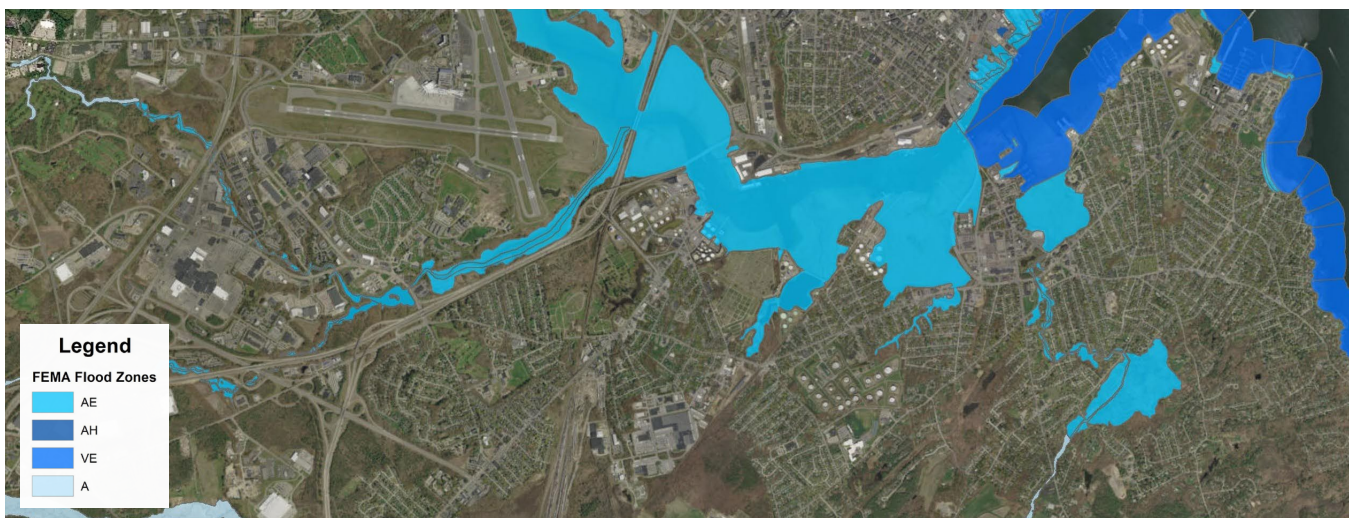


Figure D.3. Areas vulnerable to inundation from the 1% annual flood in South Portland. Data source: FEMA preliminary flood zones (2018).

South Portland Areas Vulnerable to Sea Level Rise



Figure D.4. Areas vulnerable to inundation from four sea level rise scenarios (1.6 feet, 3.9 feet, 6.1 feet, and 8.8 feet on top of the highest astronomical tide). Data source: Maine Geological Survey Sea Level Rise/Storm Surge Scenarios (2018).

South Portland Wastewater Treatment Facility Flood Vulnerability

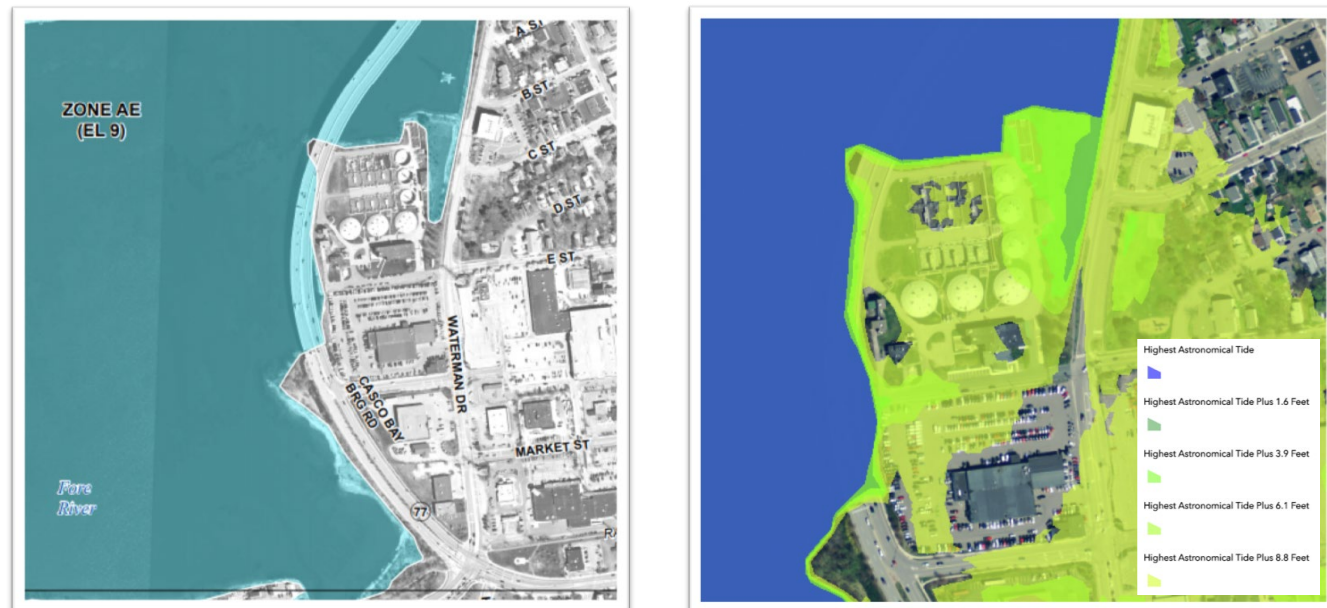


Figure D.5. The South Portland wastewater treatment facility overlaid with FEMA flood zones for the 1% annual flood (left) and overlaid with sea level rise projections based on four sea level rise scenarios for 2100 (right). Data source: FEMA preliminary flood zones (2018); Maine Geological Survey Sea Level Rise/Storm Surge Scenarios (2018).

Community Resilience Partnership

Program Contact: Brian Ambrette
brian.ambrette@maine.gov

[Community Resilience Partnership | Office of Policy Innovation & Future \(maine.gov\)](#)

Community Resilience Self-Evaluation

Instructions: This tool is intended to help organize your community's approach to increasing resilience to natural hazards and climate change impacts. Answer the questions to the best of your knowledge and seek information from your colleagues in municipal and county government and organizations in your community. Provide any relevant information in the explanation field. If it is difficult to give a clear yes or no response to a question, use the explanation field to explain why. **There are no wrong answers and the responses here will not affect your community's eligibility to receive grants.** Where the response to a question is no, that may indicate an area of opportunity to address through a Community Action Grant.

Community name:	City of Portland
Self-Evaluation responses provided by: Please include contact info	Troy Moon thm@portlandmaine.gov 207-756-8362
Date:	1/15/2022
Was this evaluation discussed during a community workshop? Include the date of the workshop.	Sustainability and Transportation Committee meeting January 12, 2022

Once the questions on the following pages are complete, use these prompts to identify potential next steps for your community:

What are two things your community is doing well?	We have a City Council approved, comprehensive climate action and adaptation plan – One Climate Future -developed in collaboration with South Portland. Portland actively supports the seafood economy as a low carbon, local food system.
What are two areas that could be improved in the short-term?	Working with the community including private property owners to prepare for the impacts of sea level rise. Address resilience and threats from climate change in land use code / adopt resilience overlay zones.

What is important for your community to address in the long-term?	Ensure that the transition to a clean energy economy includes all members of the community and that everyone has equitable access to energy resources. Ensure access to wild harvest seafood and aquaculture resources in a future where species shifts and dynamic environmental conditions become the norm.
What specific 3 to 5 actions are priorities for your community?	Electrification of homes and business Electrification of transportation Revising the land use code to support goals established in One Climate Future and Plan 2030 (Comp plan) Implementing Climate Resilience Overlay Zones described in One Climate Future. Support the Portland Fish Exchange as the state's largest landing location for groundfish.

Minimizing Risk and Exposure to Hazards	
1) Has your community assessed the likelihood of various types of hazards or disruptive events?	X Yes ☐ No
Your local or county hazard mitigation plan is a good starting place to find this information. Hazards can include storms, floods, wind, fire, extreme temperatures, drought, etc. Likelihood could be indicated either numerically or qualitatively as low, medium, or high.	Explanation: The City conducted a comprehensive climate vulnerability assessment to inform the strategies in One Climate Future. It analyzes the City's risk for a wide range of impacts related to climate change including damage to vital infrastructure, discharges of hazardous materials, energy disruptions, heat, and disease outbreaks. It maps the location of individuals who may be at higher risk to climate impacts because of race, income, age, and other factors to help the City plan for equitable outcomes in climate action. City also participates in development of the County Hazard Mitigation Plan and has shared our Climate Vulnerability Assessment to help prepare responses to climate change at a regional scale.
2) Has your community assessed how the likelihood of each hazard has changed over time and may change in the future?	X Yes ☐ No
If your community has not tracked trends historically, you might infer past trends by determining if current priorities have shifted compared to past hazard mitigation plans. For example, drought or wildfire might be an emerging concern.	Explanation: The Climate Vulnerability Assessment documents how things like sea level rise, precipitation events, and heat have changed during the past century. It describes anticipated future conditions the City should prepare and establishes sea level rise projects to guide decision making regarding future development in vulnerable parts of the city.
3) Has your community assessed the impacts or consequences of each type of hazard for the community?	X Yes ☐ No
For example, flooding on Main Street impedes emergency services or affects local businesses.	Explanation: Yes – the Climate Vulnerability Assessment addresses the consequences of broad categories of threat and the broad impact they may have on the community.
4) Is your community taking steps to reduce exposure to multiple risk types?	X Yes ☐ No
Your local or county hazard mitigation plan probably contains this information.	Explanation: Yes – we participate closely with the County in the development and implementation of the regional emergency management plan. Our Climate Vulnerability Assessment identifies a broad spectrum of threats related to climate change that has informed local and regional emergency management plans. Our Emergency Management Coordinator uses risk assessment tools to gauge our preparedness for emergencies. Flooding response protocols are in place to mitigate flooding risk during high tides and storm surge events.

6) Is your community preparing for low-probability-but-high-consequence events?	X Yes ☐ No
These events could be, for example, a 1-in-100 year flood, or a prolonged electricity outage or heating fuel shortage. What events might the community need to consider?	Explanation: Yes – in addition to identifying hazards in the Climate Vulnerability Assessment, the City coordinates planning and preparation with the County and State emergency management agencies. The City has an Emergency Management Coordinator who helps prepare plans and contingencies, draws on local, State, and Federal resources, and coordinates with partners in government, the non-profit sector, and businesses to prepare for and respond to emergencies.
7) Has your community assessed the consequences of multiple events or different types of hazards occurring in geographic or temporal proximity?	X Yes ☐ No
Examples could include back-to-back flooding events or a power outage during a heat wave.	Explanation: Yes – our Climate Vulnerability Assessment describes the consequences of multiple hazards and how impacts from one hazard cause or compound additional hazards. For example, a flooding event on the waterfront could cause the discharge of hazardous waste from petroleum storage facilities or from businesses that store hazardous materials. Also, infrastructure damage could prevent delivery of vital goods and services to the public, exacerbating risks to vulnerable populations.
8) Is your community assessing emerging risks (e.g. drought, wildfire) and identifying blind spots?	X Yes ☐ No
In addition to natural hazards, consider public health threats that might be worsened by climate change, such as contamination of drinking water sources and vector-borne diseases from ticks and mosquitos.	Explanation: Yes – we commissioned the Climate Vulnerability Assessment to help us identify the full spectrum of impacts from climate change but we also employ our Emergency Management Coordinator to keep abreast of new threats to our community.

Understanding Sensitivity and Building Resilience	
9) Is your community tracking underlying societal characteristics and trends that increase vulnerability?	X Yes ☐ No
This information might be found in your community's comprehensive plan or economic development plan. Examples of characteristics and trends might include older or low-income populations, low housing availability, reliance on a single economic driver, aging infrastructure, environmental degradation, etc.	Explanation: As part of the Climate Vulnerability Assessment we used demographic information to map neighborhoods with populations that may face greater threat to climate change. Factors include race, immigration status, age, income level, and education, amongst others. More recently we have used a Tree Equity Score tool to identify neighborhoods that may be more vulnerable to urban heat island effect, flooding, and air pollution due to lack of tree canopy.

10) Is your community proactively addressing vulnerabilities associated with these underlying characteristics?	X Yes ☐ No
Look in your community's comprehensive plan or economic development plan for strategies that might address these trends.	Explanation: Yes – the City is aggressively seeking opportunities to adding housing for vulnerable populations. As noted above, our mapping exercises , identifying populations at risk from sea level rise, heat, and other impact of climate change. The City has begun exploring the creation of resilience overlay zones to ensure that new construction is prepared for the impacts of climate change including sea level rise. Our climate action plan calls for the creation of a neighborhood resilience program to enhance the adaptive capacity of existing neighborhoods by creating social bonds amongst community members through participation in projects that make their community more sustainable such as tree planting, neighborhood clean ups, and home weatherization.
10) Does your community have financial resources in reserve to cope with or absorb shocks?	☐ Yes X ☐ No
For example, a rainy-day fund.	Explanation: The City of Portland has a strong track record of good fiscal management and has operating reserves to address emergencies. However, extended periods without economic activity that require extraordinary expenditures present fiscal challenges. This was evident in the COVID-19 pandemic when the City was forced to reduce staffing and operations due to revenue reductions coupled with significant ongoing expenditures.
12) Is your community building flexible human capacity that can be drawn on in emergencies?	X Yes ☐ No
For example, community emergency response teams (CERT) or mutual aid agreements with neighboring communities.	Explanation: Yes – the City has formal agreements with neighboring communities for mutual aid. We have an EM Coordinator who coordinates with partners at the County, State, and Federal levels. We have a CERT team for our largest island community. We plan to implement a neighborhood sustainability program to increase adaptive capacity in neighborhoods around the city.

Improving Long-term Adaptive Capacity	
13) Does your community have plans or policies that anticipate future climate risks and community sensitivity trends?	X Yes ☐ No

Examples might include a comprehensive plan chapter that describes how the community is planning for climate change impacts, or a capital improvement plan that requires construction projects to consider future conditions like sea level rise, extreme rain, or drought.	Explanation: Yes – the City created and adopted a comprehensive climate action plan and commissioned a detailed vulnerability assessment to help us prepare for climate change. These established a planning threshold for sea level rise and call for the creation of resilience overlay zones to create standards for new construction to address threats from climate change. We have a local ordinance that requires new construction that benefits from City contributions to meet high performance standards for roofs, energy performance, and solar energy. The City adopted the voluntary energy code, IECC 2021, to ensure new construction is energy efficient.
14) Are there resources to sustain new capacity when needed?	X Yes ☐ No
This is different from Question 10 in that these resources would need to sustain a new long-term commitment rather than a one-time, short-term response. For example, if flooding emerges as an issue, a revenue source such as a stormwater utility fee could sustain a new community stormwater management program.	Explanation: The City of Portland established a stormwater utility funded by a stormwater utility fee that has been actively addressing stormwater issues including flooding. Having this discreet program allows the City to address future hazards proactively. We also have a stormwater impact fee that requires developers to contribute funds to address future stormwater issues. The City also has impact fees for transportation and parks. We contemplate the creation of a sustainability fund that could be used to fund climate mitigation and adaptation projects that advance One Climate Future.
15) Does the community have policies in place to build back smarter or recover with resilience after a disruptive event?	X Yes X No
Examples might include a flood ordinance that requires compliance with the current building codes after substantial damage, or a communitywide post-disaster recovery plan.	Explanation: While new construction after a disaster would be required to meet existing building codes, the City does not currently have an adequate policy framework to ensure that post disaster recovery reduces vulnerability to future events or disasters.
16) Does the community stress test to ensure plausible risks are manageable?	X Yes ☐ No
This might be a table-top exercise with emergency management and community stakeholders, or a financial health analysis.	Explanation: Emergency responders conduct regular training to respond to emergencies and also conduct table top exercises to prepare for things like mass casualty events, plane crashes, or fires on an island.
17) Does the community have a policy or process for managing uncertainty?	X Yes ☐ No
Does the community have a way of making important decisions when information is incomplete or unavailable?	Explanation: The City has a strong leadership team including the City Manager and department staff with varied expertise to address specific conditions whether it be a public health emergency, fire, or weather. Our Emergency Management Coordinator supports decision making with vital information about conditions and resources. Our City Council meets twice a month and

	holds emergency meetings as required to consider policies that may be required to address an emergency situation.
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