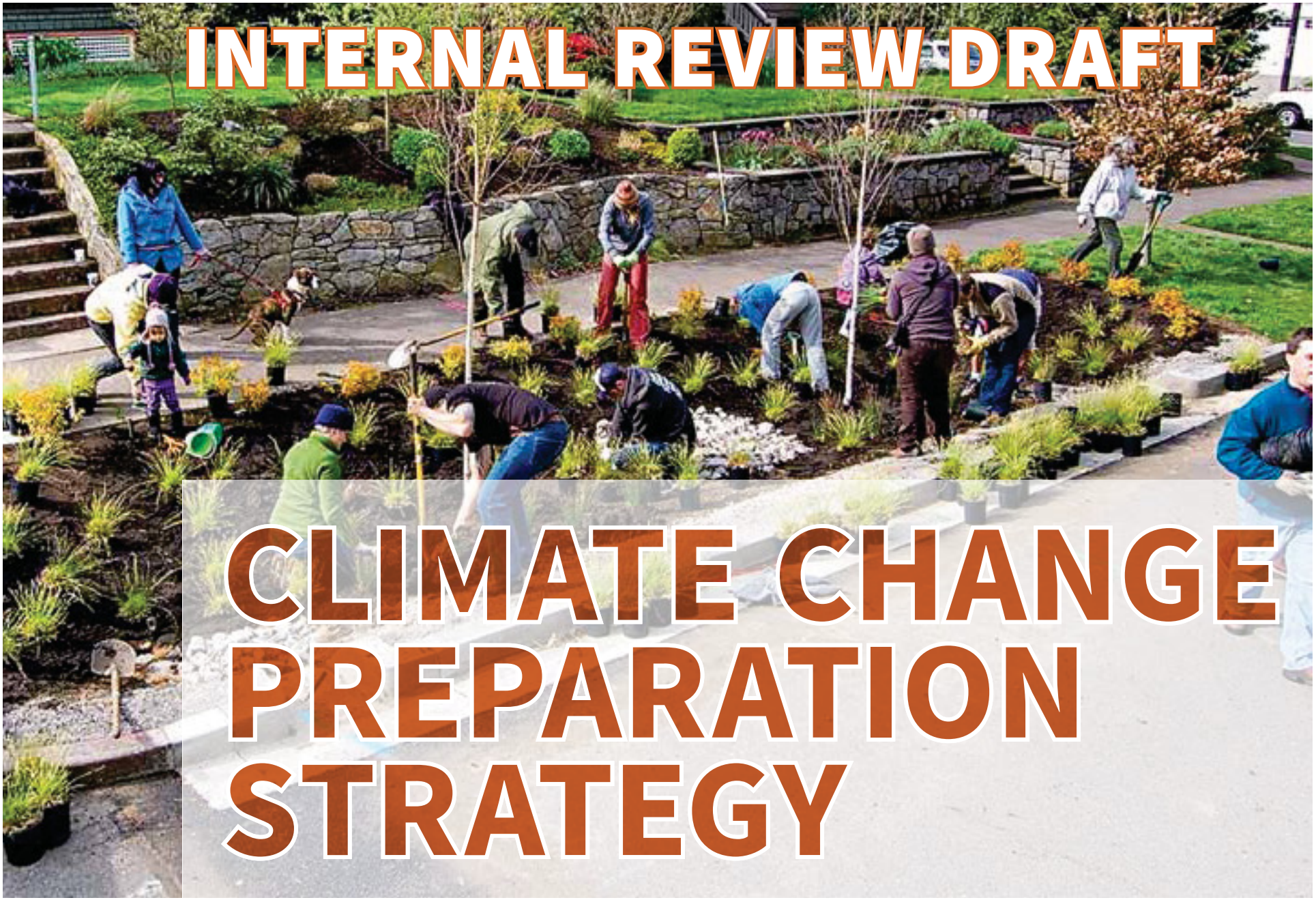
INTERNAL REVIEW DRAFT



CLIMATE CHANGE PREPARATION STRATEGY

PREPARING FOR LOCAL IMPACTS
IN PORTLAND AND MULTNOMAH COUNTY | 2014

MULTNOMAH COUNTY

CITY OF PORTLAND OREGON 1851

Acknowledgements

CITY OF PORTLAND

Bureau of Environmental Services

Virgil Adderley, Shannah Anderson, Shannon Axtel, Jane Bacchieri, Heidi Berg, Alice Brawley-Chesworth, Sara Culp, Linda Dobson, Kevin Kilduff, Nancy Hendrickson, Michele Juon, Paul Ketcham, Ericka Koss, Kaitlin Lovell, Mike Rosen, Maggie Skenderian, Paul Suto

Bureau of Planning and Sustainability

Susan Anderson, Michael Armstrong, Michele Crim, Sallie Edmunds, Ingrid Fish, Roberta Jortner,

Office of Healthy Working Rivers

*Ann Beier

Portland Bureau of Transportation

Jamie Waltz

Portland Development Commission

Irene Bowers

Portland Bureau of Emergency Management

Jonna Papaefthimiou, *Patty Reuter

Portland Parks and Recreation

Jenn Cairo, Sarah Huggins, Deborah Lev, Emily Roth,

Portland Water Bureau

Kavita Heyn, Lorna Stickel, Janet Senior

MULTNOMAH COUNTY

Department of County Human Services

Alice Busch, Jodi Shaw

Department of Community Justice

Julie Laramie-Ross

Department of County Assets

Adam Barber, Mike McBride, Adam Soplop

Health Department

Matt Davis, Jade Dodge, KaRin Johnson, Robert Johnson, Jerusha Kasch, Kari Lyons-Eubanks, *Sonia Manhas, Moriah McSharry McGrath, Lila Wickham, Chris Wirth

Multnomah County Sheriff's Office

Steve Wright

Office of Emergency Management

*Roger Hulbert, Charloette Lewis, *Joe Partridge

Office of Sustainability

*Michael Burnham, Tim Lynch, *Jamaica Robinson

EXTERNAL ADVISORS

Oregon Climate Change Research Institute

Kathie Dello

Oregon Department of Land Conservation and Development

Jeffrey Weber

Oregon Department of Geology & Mineral Industries

William Burns, Jed Roberts

Planning and Sustainability Commission

Mike Houck

Primary project coordinators and/or lead content authors.

*Former City of Portland and Multnomah County staff.

The *Climate Change Preparation Strategy: Risk and Vulnerabilities Assessment* report (separate document) serves as the foundation for this strategy and provides an overview of the science and a more detailed review of the potential impacts to health and human systems, natural systems, infrastructure and the built environment. Visit: www.portlandoregon.gov/bps/climate

Joint letter (to come)

Climate Change Preparation Strategy

Portland's future climate is expected to include warmer, wetter winters and hotter, drier summers with increased frequency of high-heat days. This Climate Change Preparation Strategy identifies actions to prepare for the changing climate in two ways: 1) reduce climate-related vulnerabilities, and 2) respond to impacts when they do occur.

Addressing the primary cause of climate change, greenhouse gas emissions, remains a crucial component of climate change preparation work. This strategy is fundamentally linked to the City of Portland and Multnomah County *Climate Action Plan*, which integrates the City and County's work to slow the effects of climate change while also preparing for the impacts that we will experience.

Our Climate Is Changing

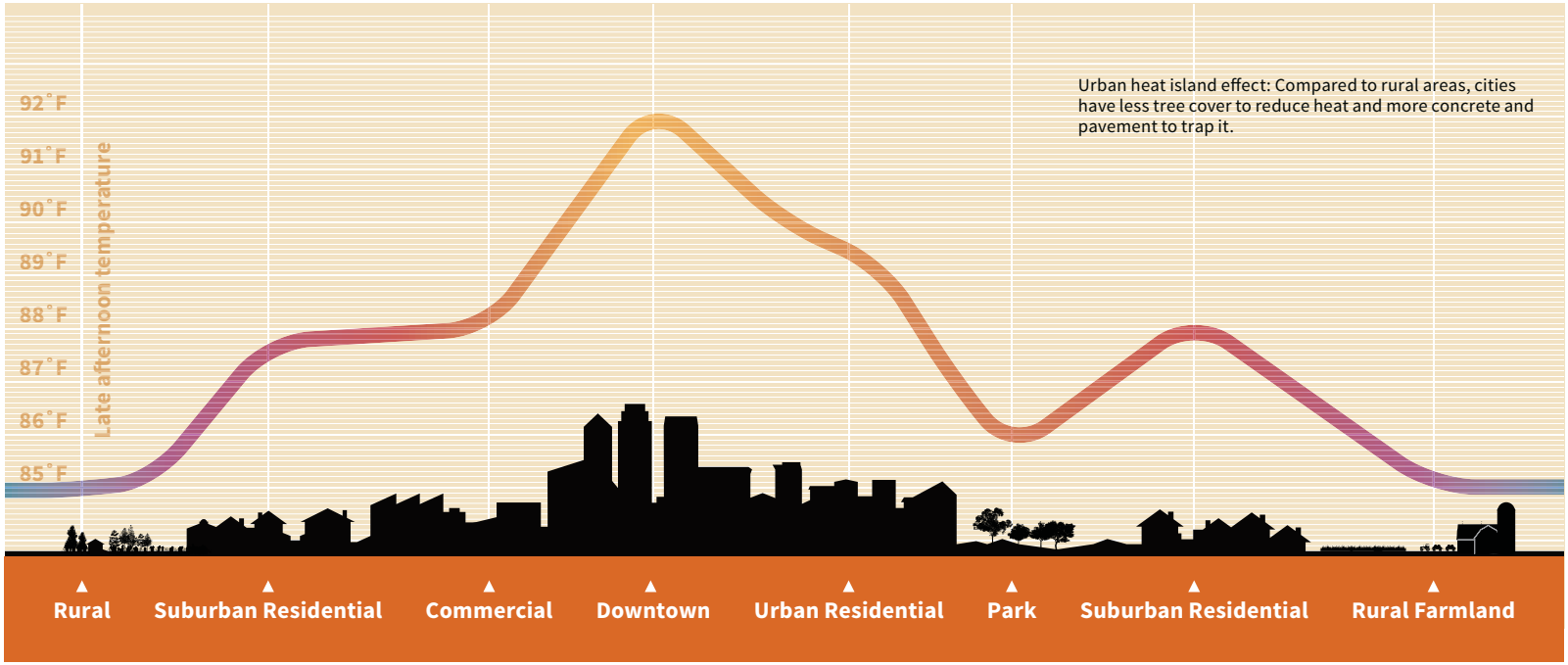
Nestled between the Cascade Mountains and the Pacific Ocean at the confluence of the Willamette and Columbia Rivers, Portland and Multnomah County are home to vibrant communities known for a high quality of life and abundant natural resources. Portland has a climate marked by warm, dry summers and cool, wet winters. Climate helps define iconic characteristics of the Portland region, creating an ideal environment for growing roses, drinking coffee, and watching Great Blue Herons.

Portland's climate is changing, however. Temperatures have increased over the past century by 1.5 °F (Pacific Northwest regional average) and regional precipitation has increased, especially in the spring (Kunkel et al., 2012; Mote 2003). Carbon emissions from the burning of fossil fuels and from land use changes, including deforestation, are the primary drivers for the climate change we are experiencing today and expect to see in the future. Computer models indicate the magnitude of impacts of climate change depends largely on the trajectory of future global carbon emissions. Even dramatic reductions in carbon emissions will not eliminate all climate change, and the legacy of past practices will continue to cause changes in climate patterns.

In the Pacific Northwest, average annual temperature is projected to increase 3.3 °F to 9.7 °F by the end of this century (depending on future carbon emission scenarios), with greater warming happening in the summers. According to global climate models for the Pacific Northwest region, summer precipitation is projected to decrease by as much as 30 percent, and winter precipitation is projected to increase over the coming century, on average (Mote & Salathé, 2010).

In short, Portland's future climate is projected to be characterized by hotter, drier summers with an increased frequency of high-heat days; and warmer, wetter winters (IPCC, 2012; OCCRI, 2010). While these changes in the climate are significant, Portland is unlikely to suffer the severity of impacts related to super storms, intense drought and sea level rise as many cities around the world will face.

The Impacts Are Already Evident

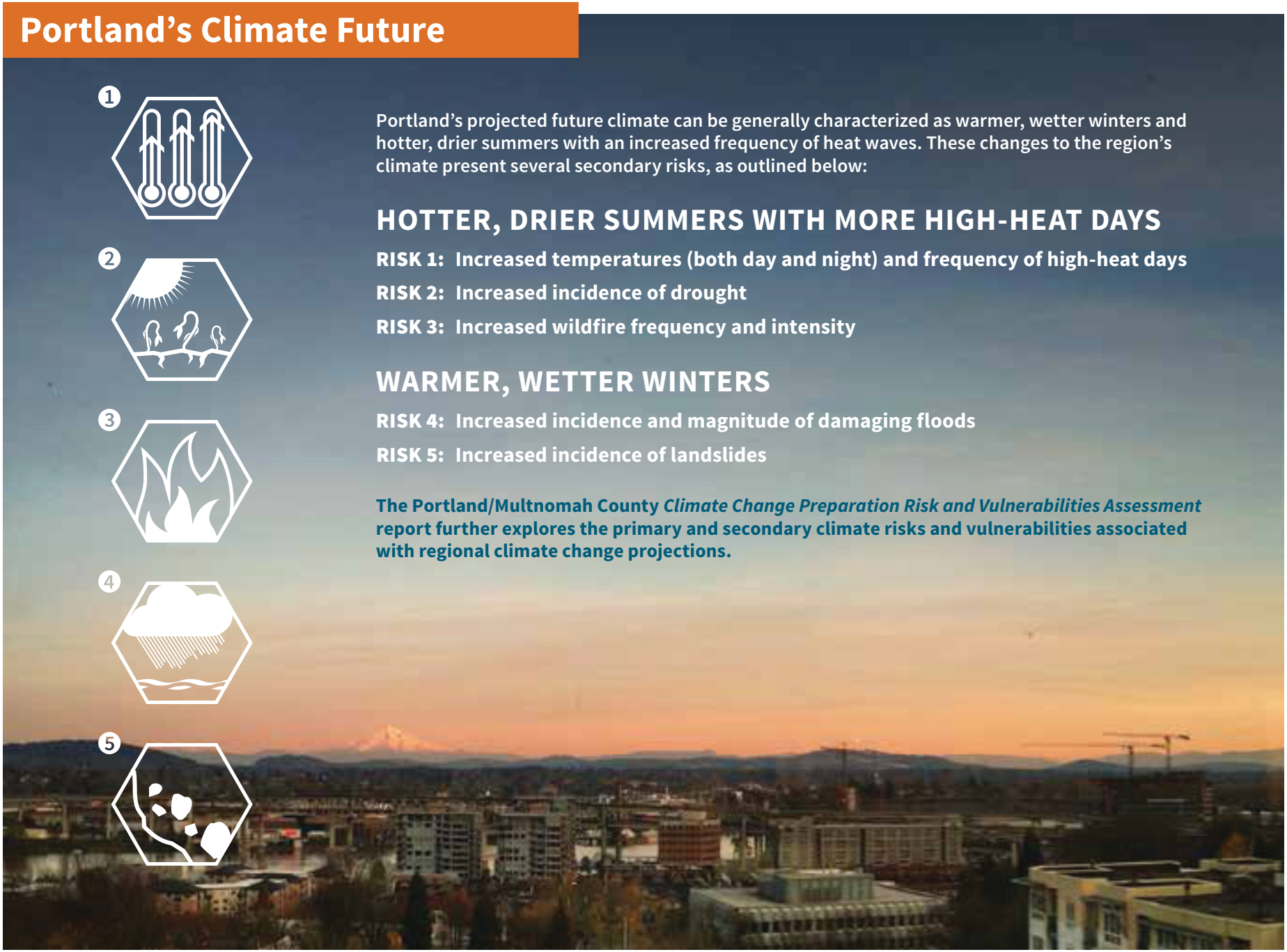


On a statewide basis, increasing temperatures and shifts in seasonal precipitation patterns are already evident. For example, reduced mountain snowpack and earlier springtime melting of snow are decreasing summer river and stream flows, making it more difficult to meet water demands for both out-of-stream and in-stream needs (OCCRI, 2012).

The Portland region has experienced an increase in average temperatures of 0.5 °F to 1 °F in the past century. These average temperature increases are magnified by a phenomenon called the urban heat island effect because the higher concentrations of concrete and steel buildings and paved surfaces retain much of that heat in the urban environment. In addition, nighttime heat waves have increased in western Oregon over the last century, causing problems for public health (Bumbaco et al., 2013).

Many of the areas most impacted by Portland's urban heat island effect, including downtown, along major roads and in and around industrial areas, are also areas where many low-income people live and where increased air pollution, including diesel emissions, can be found (see the Portland/Multnomah County *Climate Change Preparation Risk and Vulnerabilities Assessment* report for more information and a map of Portland's urban heat island effect). Many of these people will become more vulnerable to heat-related climate change impacts due to: 1) lack of air conditioning or access to cooling centers; 2) aggravation of existing respiratory diseases like asthma; and 3) social isolation because of language or other cultural barriers.

Portland's Climate Future



Portland's projected future climate can be generally characterized as warmer, wetter winters and hotter, drier summers with an increased frequency of heat waves. These changes to the region's climate present several secondary risks, as outlined below:

HOTTER, DRIER SUMMERS WITH MORE HIGH-HEAT DAYS

RISK 1: Increased temperatures (both day and night) and frequency of high-heat days

RISK 2: Increased incidence of drought

RISK 3: Increased wildfire frequency and intensity

WARMER, WETTER WINTERS

RISK 4: Increased incidence and magnitude of damaging floods

RISK 5: Increased incidence of landslides

The Portland/Multnomah County *Climate Change Preparation Risk and Vulnerabilities Assessment* report further explores the primary and secondary climate risks and vulnerabilities associated with regional climate change projections.

The Impacts Will Become More Significant

HOTTER, DRIER SUMMERS WITH MORE HIGH-HEAT DAYS

Hotter, drier summers may result in several significant impacts for the Portland area. Higher temperatures lead to increased surface water temperatures, reduced flows in streams and negative impacts on aquatic habitats and the fish and wildlife they support. Higher temperatures also result in increased air pollution, such as ground-level ozone and pollen counts, exacerbating Portland's already high incidence of respiratory illnesses and allergies.

Hotter, drier summers also mean an increased potential, over time, of wildfire in the urban forest, natural parks and open-space areas within Portland's urban environment. Such fires often have significant detrimental impacts on air quality and human health, and can damage or destroy public and private property.

In addition, hotter, drier summers may negatively affect urban forest health, increasing major forest pest damage and mortality of plant and tree species now common to the area. Hotter, drier summers may also create large-scale vegetation losses, negatively impact upland habitats and the wildlife they support, and reduce the effectiveness of green infrastructure services.

Increased heat-related illnesses and death during heat waves are of particular concern, especially for vulnerable populations such as older adults and low-income residents. Transportation infrastructure may also be impacted during heat waves as a result of issues with bridge expansion joints, pavement integrity and the possible warping of light-rail tracks.

WARMER, WETTER WINTERS

Warmer, wetter winters may continue to stress Portland's existing systems for managing stormwater runoff and urban flooding. More rain falling in winter may also increase the incidence of landslides, particularly following prolonged periods of precipitation that happen when the soil is already saturated with water. With more rain, the groundwater may not have time to drain and large deep landslides may occur, similar to the Aldercrest-Banyon landslide near Kelso, Washington, after the consecutively wet winters of 1996 through 1998.

Any increases in winter precipitation amounts may also have far-reaching impacts locally, including the potential economic, social and environmental impacts from flooding that Portland has experienced in the past. These impacts may include water damage to homes and businesses as well as roads, railroad tracks located within the floodplain, levees, bridges and culverts. Additional costs due to emergency response, business closures, lost productivity and cleanup costs can be expected.

	Potential impacts from hotter, drier summers with more high-heat days	Potential impacts from warmer, wetter winters
Human Systems	▪ Heat-related illness (heat stroke, heat exhaustion) and exacerbation of existing medical conditions. ▪ Increased demand for cooling centers, especially for vulnerable populations. ▪ Earlier and extended allergy seasons affecting those with asthma and respiratory disease.	▪ Demands on emergency response services during flooding events. ▪ Changes to mosquito populations requiring additional vector control efforts. ▪ Increase in mold spores which can trigger asthma and other chronic health conditions.
Natural Systems	▪ Lower summer stream flows. ▪ Reduced water quality due to higher water temperatures. ▪ Increased risk of wildfire. ▪ Vegetation, habitat and wildlife shifts, fragmentation and death. ▪ Increase in invasive species.	▪ Increased flooding and groundwater level rise. ▪ Higher river levels. ▪ Increased erosion and potential for channel migration. ▪ Increased landslide risks.
Infrastructure and the Built Environment	▪ Increased waste water temperatures causing water quality changes, wastewater treatment process impacts and increased odors. ▪ Pavement buckling. ▪ Increased outdoor water demand for watering landscaping, etc. ▪ Shifting demand for different types of indoor and outdoor recreation activities at parks and community centers.	▪ Increased erosion and the potential for turbidity events in the Bull Run water supply system. ▪ Increased chance of landslides impacting transportation and pipe infrastructure. ▪ Increased bridge scour and damage to docks, boat ramps and floats. ▪ Increased flooding of roads, sidewalks, bikeways and trails. ▪ Increased pumping of treated wastewater.

We Must Prepare for a Range of Possible Futures

These impacts are substantial and serious, and preparing for them requires significant change in City and County policies, investments, and programs. At the same time, the Portland area is not immediately vulnerable to some of the gravest threats to other communities, such as sea-level rise, tropical storms and drought.

Sea-level rise is an example of a risk that the City and County will continue to monitor carefully, since tidal influence reaches as far inland as Willamette Falls and Bonneville Dam. Oregon's coast is currently experiencing tectonic uplift, however, which could mitigate the impacts of sea-level rise in some coastal areas (OCCRI, 2010). Nonetheless, changes in sea level may raise local river levels, which in turn could increase river-flooding levels by a small factor in the mid-term and by a more significant factor in the longer-term, depending on dam operations, and the operation and maintenance of the local levee system.

The Portland region may also experience a wide range of regional and global impacts from climate change. These range from the very likely—higher electricity prices resulting from the combination of higher summer demand and reduced availability of water for summer hydropower production—to the very difficult to predict, such as the potential for population growth beyond current projections due to an influx of new residents moving from other areas more significantly impacted by climate change. Similarly, the global economy could experience significant disruptions from weather-related catastrophes or benefits (for example, Arctic shipping routes or Siberian wheat production), the shift to low-carbon products and services, or many other direct or indirect impacts of climate.

The City and County recognize that these larger social changes may have major impacts that are difficult to anticipate. While this strategy focuses on issues for which the City and County have unique responsibilities, monitoring and anticipating these global and regional economic and social changes is an essential supplement to the focused objectives and actions described here. As a result, this strategy takes an adaptive management approach that prioritizes resilience across a range of future scenarios and emphasizes the need to monitor and respond to changes.

What Can We Do?

To prepare for climate change impacts we must reduce exposure to increasing risks and strengthen the capacity to respond. These activities are often referred to as "climate adaptation."

Preparing for climate change requires an adaptive management approach

Successful climate change preparation requires steps to understand how climate change may affect people most vulnerable to expected impacts, particularly heat, poor air quality and flooding. Portland and Multnomah County need to ensure that, where possible, climate change preparation actions are prioritized in areas facing current and historical disparities, including low-income communities and communities of color.

Climate Change preparations benefit the community in other ways

Many of the actions that help prepare for climate change are already underway today because they benefit the community in other ways. One example is Portland's long-established regulations and practices to protect, manage, and expand the City's green spaces and urban forest. These efforts help to improve air quality and reduce the urban heat island effect. To reduce flooding and improve stormwater management, significant work has been done to acquire and restore natural areas and floodplains, and to install green infrastructure such as bioswales and ecoroofs. In addition, the development of Portland's groundwater well system not only supplements the region's primary drinking water supply, the Bull Run watershed, but also improves Portland's resilience to withstand potential impacts to the water supply system due to current climate variability as well as future climate change.

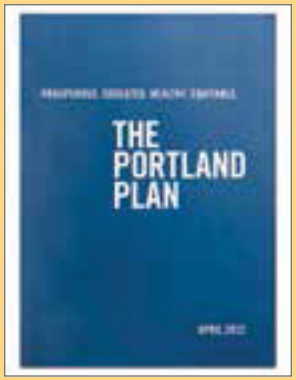
Preparing for impacts to public health

Similarly, to protect public health, the County currently monitors a variety of mosquito species that can carry vector-borne diseases such as West Nile Virus. As the climate changes, non-native mosquito species may establish themselves due to the warmer summers and pools of standing water from winter and spring rains. Existing vector control and integrated pest management efforts enable better identification and response to new mosquito species of concern that may migrate here due to climate change.

All of these activities benefit the community and improve resilience to natural hazards today, regardless of future climate conditions.

IMPLEMENTING THE PORTLAND PLAN

The Climate Change Preparation Strategy helps to implement several elements of the Portland Plan. The Portland Plan brought together more than 20 agency partners, including Multnomah County, and thousands of residents, businesses and nonprofit organizations to create a strategic plan to make Portland prosperous, healthy, educated and equitable. It provides a structure for aligning budgets and projects across numerous public agencies, guiding policies with an eye toward the year 2035. The Portland Plan is a strategic plan with equity at its core.



Improved resiliency is one outcome from the successful implementation of the Portland Plan. Individuals, communities, economic systems and the natural and built environments will have improved capacity to rebound rapidly from natural disasters, changes in the climate and economic shifts.

This Climate Change Preparation Strategy identifies priorities and actions that will help achieve many of the goals outlined in the Portland Plan, including healthier people, a safer city, more complete neighborhoods and healthy watersheds.

HOW THIS STRATEGY WAS DEVELOPED

To develop this strategy, three inter-departmental staff teams were created focused on health and human services, natural resources, and infrastructure. Each team conducted a vulnerability assessment and developed recommended actions to address major vulnerabilities to climate change. The figure below outlines the process that the City and County are following to develop and implement this strategy.

GUIDING PRINCIPLES FOR IMPLEMENTATION

In implementing this Climate Change Preparation Strategy, the City and County are guided by these principles:

- Use the best available science at the time, and stay abreast of new developments.
- Use an adaptive management approach to assemble information needed to improve efforts and promote flexible approaches that leave a range of future options available.
- Leverage existing efforts, funding, policies and programs.
- Maximize the co-benefits, improve equity outcomes and meet the needs of vulnerable populations.
- Institutionalize climate change preparation into operational and decision-making processes.
- Engage the community, and coordinate and implement climate preparation efforts with other local and regional partners.

This Climate Change Preparation Strategy builds on existing work to understand how the climate affects the community today, how those effects are expected to change in the coming century, and what can be done to prepare. The *Climate Change Preparation Risk and Vulnerabilities Assessment* report (separate document) serves as the foundation for this strategy and provides an overview of the science and a more detailed review of the potential impacts to health and human systems, natural systems, infrastructure and the built environment. In addition to identifying risks and vulnerabilities, this strategy outlines priority actions in the areas of policy development, operations,planning, human services, as well as infrastructure and natural resource management. These actions will help to minimize risks, reduce vulnerabilities and contribute to a more resilient community.

How Does this Strategy Address Equity?

All populations are affected by climate change, but not all communities have the same ability to respond. As a result, some are more vulnerable than others. In Portland, communities of color and low-income communities experience disparities that will be exacerbated by the impacts of climate change. These disparities include greater risk of poor health, reduced access to housing, un- and under-employment, limited access to transportation options and parks, higher mortality rates and the legacy of inequitable public policy.

This strategy seeks to create a climate-resilient community. The federal Interagency Climate Change Adaptation Task Force describes climate resilience as the capability to anticipate, prepare for, and recover from climate impacts on public health and safety, the built environment, the local economy, and natural resources. By pursuing climate resilience, the City and County seek to ensure that the benefits of taking actions to prepare for climate change are shared by the whole community and across multiple generations.

Putting equity into practice requires asking new questions, looking at relevant data and prioritizing equity in decision-making. To ensure the most equitable outcomes possible, these or similar questions will be explored at different phases of a climate change preparation project, policy or program:

1. What are the desired results or outcomes of the action?
2. What are the current and historical racial disparities related to the action (or similar actions in the past)?
3. Does the action involve land or space? If yes, how is any historical connection to the land and the populations who hold such connections considered in decision-making?
4. Who primarily benefits from the action?
5. Are racial, ethnic, low-income communities or older adults positively affected by the action? Is there a missed opportunity to reduce existing disparities?
6. Are there unintended consequences or negative impacts of this action for racial, ethnic, low-income communities or older adults? If so, what are the strategies to mitigate negative impacts?
7. How does the proposed action promote a) meaningful engagement of those most impacted, and b) transparent, inclusive and empowering collaboration?

THE PORTLAND PLAN – A FRAMEWORK FOR EQUITY

The City and County will use the Portland Plan's "Framework for Equity" as a guide when implementing actions outlined in this strategy. The Portland Plan's definitions for equity and resilience are outlined below. The full framework is available at www.pdxplan.com.

EQUITY DEFINED: Equity is when everyone has access to the opportunities necessary to satisfy their essential needs, advance their well-being and achieve their full potential. We have a shared fate as individuals within a community and communities within society. All communities need the ability to shape their own present and future. Equity is both the means to healthy communities and an end that benefits us all.

RESILIENCE: Without healthy, thriving, prepared people we cannot achieve our highest goals, implement our best plans for dealing with climate change or secure Portland's position in the global economy. Without a city that is physically designed to last, future generations will not benefit. We want a city where we are better on a good day so we can bounce back from a bad day. It requires that everyone thrive and everyone participate.

There Are Multiple Benefits from Climate Change Preparation

By preparing for the impacts of climate change now, Portland and Multnomah County can become more resilient to disruptions in services and damage to social and environmental systems. Actions to prepare for hotter, drier summers and warmer, wetter winters often have multiple community benefits, also known as co-benefits. Many preparation strategies already in place in the Portland metropolitan area help manage existing challenges such as infrastructure maintenance, emergency preparedness and response, respiratory illnesses, environmental degradation and flooding.

For example, Portland has been installing vegetated stormwater facilities, known as green streets, to help manage stormwater runoff. These same facilities will help the community be more resilient to increased winter precipitation in the future. Similarly, existing efforts to increase the urban tree canopy provide multiple health and environmental benefits today — and will help cool the city in the future as temperatures rise. In turn, these efforts reduce demand for emergency and social service response by minimizing the impacts from flooding and extreme heat events. Not only do climate preparation actions improve resiliency against future climate impacts, but in many cases they also generate multiple quality-of-life benefits for the community today.

The City and County Will Collaborate

Portland and Multnomah County seek to lead by example as well as involve other jurisdictions, organizations, businesses and the public through outreach and engagement. Because climate change impacts are not bound by city and county lines, climate preparation must be a joint effort across jurisdictions and disciplines.

Portland and Multnomah County will continue to participate in regional climate change preparation efforts, including sharing information with other metropolitan areas in the Pacific Northwest such as Seattle and Vancouver, BC, as well as the local jurisdictions throughout the Willamette Valley. In addition, the City and County will continue to work with partner organizations such as Metro, Portland State University, the Department of Geology and Mineral Industries and the Oregon Climate Change Research Institute to understand local climate projections, impacts and preparation strategies. Also, awareness will be raised among the general public and health professionals of new and changing public health risks associated with climate change.

Climate Change Preparation Strategy: Objectives and Actions

Climate variability and change needs to be routinely considered in virtually all aspects of City and County work including setting policy, making budget decisions, updating code, investing in infrastructure, delivering health services, and emergency preparedness. The City and County want to ensure that the benefits of taking action to prepare for climate change are shared by all residents.

A multi-bureau/department climate preparation coordination team will be established to:

- Review climate research, trends and regulation.
- Foster cross-disciplinary collaboration between agencies and program areas.
- Follow an adaptive management approach by collaborating on the development of implementation plans that consider available resources and prioritize the implementation of actions that have the most impact and are most cost effective.
- Report on progress toward implementing the actions outlined in this strategy at least once every other year.
- Reexamine and update the key findings and actions of this strategy periodically.
- Ensure actions are implemented equitably and prioritize populations and natural systems most vulnerable to climate change impacts.

HOTTER, DRIER SUMMERS WITH INCREASED INCIDENCE OF EXTREME HEAT DAYS

1	**2030 Objective 1:** Decrease the urban heat island effect, especially in areas with vulnerable populations.
2	**2030 Objective 2:** Minimize health issues caused by extreme heat days, especially for vulnerable populations.
3	**2030 Objective 3:** Increase the resilience of Portland's water supply to drier summers.
4	**2030 Objective 4:** Increase the resilience of natural systems to respond to increased temperatures and drier summers.
5	**2030 Objective 5:** Manage the risk of wildfires as a result of drier summers.

WARMER, WETTER WINTERS

6	**2030 Objective 6:** Increase the resilience of the natural and built environment to increased winter rainfall and associated flooding.
7	**2030 Objective 7:** Manage the increased risk of disease due to warmer, wetter winters.
8	**2030 Objective 8:** Manage the increased risk of landslides due to increased winter rainfall.

BUILDING CAPACITY TO PREPARE FOR AND RESPOND TO CLIMATE CHANGE

9	**2030 Objective 9:** Strengthen emergency management capacity to respond to extreme weather events.
10	**2030 Objective 10:** Institutionalize climate change preparation planning and best practices.
11	**2030 Objective 11:** Improve the capacity of the community, especially vulnerable populations, to understand, prepare for and respond to climate impacts.
12	**2030 Objective 12:** Improve monitoring, evaluate effectiveness of climate change preparation actions and advance new research to support climate change preparation efforts.

To develop this strategy, three inter-departmental staff teams were formed to focus on human systems, natural resources and infrastructure. Each team conducted a vulnerability assessment and developed recommended actions to address the greatest vulnerabilities to climate change in those sectors. In addition, staff reviewed potential climate change risks related to the built environment, food systems, climate migrants, energy systems and the economy.

The strategy details 12 specific objectives for 2030 and identifies actions to build resiliency into the City and County's policies, operations, services and infrastructure. The actions below outline a set of efforts that should be significantly underway in the near-term (e.g., by the end of 2017) to begin preparing for climate change.

In prioritizing the implementation of the actions outlined, City bureaus and County departments will:

- Consider available resources and opportunities to leverage new resources.
- Take into account carbon emission reduction opportunities and other co-benefits, equity, urgency and window of opportunity.
- Integrate implementation plans into routine work planning.

Using an adaptive management approach, these actions will be reviewed and updated periodically to evaluate progress and incorporate the most up-to-date scientific data. To assist with implementation and accountability, lead City bureaus and County departments are identified, although successful implementation will often require collaboration and coordination with other partners.

Lead partners

City acronyms
BDS = Bureau of Development Services
BES = Bureau of Environmental Services
BPS = Bureau of Planning and Sustainability
OGR = Office of Government Relations
OMF = Office of Management and Finance
PBEM = Portland Bureau of Emergency Management
PBOT = Bureau of Transportation
PFR = Portland Fire and Rescue
PPR = Portland Parks and Recreation
Water = Portland Water Bureau

County acronyms
DCA = Department of County Assets
DCHS = Department of County Human Services
DCJ = Department of Community Justice
DCS = Department of Community Services
HD = Health Department
MCEM = Multnomah County Office of Emergency Management
MCSO = Sheriff's Office
OS = Multnomah County Office of Sustainability

HOTTER, DRIER SUMMERS WITH INCREASED INCIDENCE OF EXTREME HEAT DAYS

1 2030 Objective 1: Decrease the urban heat island effect, especially in areas with vulnerable populations.

		Lead partners
1a	Adopt Comprehensive Plan policies and encourage design and development strategies that reduce the urban heat island effect in public and private development, especially in areas with vulnerable populations.	City (BPS, PDC, BPS, BDS, BES, PBOT, PPR); County (DCS, HD)
1b	Integrate strategies that reduce urban heat island effects into green building policies for City and County buildings.	City (OMF, PPR); County (DCA)
1c	Increase the total ecoroof acreage in the city, and identify heat-mitigation alternatives such as reflective roofs if ecoroofs are not possible.	City (BES, BPS)
1d	Implement the recently adopted tree codes and evaluate their impact.	City (PPR, BDS)
1e	Implement and expand the City's Urban Forest Management Plan, revegetation, restoration and land acquisition programs.	City (PPR, BES)
1f	Update environmental codes, regulations, plans, zoning and permit reviews to support strategies that reduce the urban heat island effect.	City (BPS, BDS, PPR, BES);
1g	Consider vulnerable populations living in urban heat islands when making decisions about tree planting, protection and maintenance, green infrastructure placement, and access to vegetated open spaces and natural areas.	City (PPR, BES); County (HD, DCHS)
1h	Add or modify park plantings in underutilized areas, and increase maintenance to sustain mature tree canopy, decrease tree hazards and delay tree replacement needs.	City (PPR)
1i	Consider latest climate science in revision of urban tree canopy goals for the City and address tree canopy disparities in neighborhoods where vulnerable populations live.	City (PPR)
1j	Adopt a site development performance standard to achieve high quality green infrastructure similar to Seattle's Green Factor for new development and redevelopment sites.	City (BES, BPS)
1k	Research, evaluate and pilot porous paving, "de-pave" and/or vegetation in parking area design options to reduce impervious surfaces, particularly in urban heat island areas with vulnerable populations.	City (PBOT, BES); County (DCS)
1l	In project design, consider plantings and infrastructure specifications and materials that will be most resilient to heat-related climate change impacts, and be cost effective over the lifetime of the asset.	City (PBOT, BES, PPR); County (DCS)

HOTTER, DRIER SUMMERS WITH INCREASED INCIDENCE OF EXTREME HEAT DAYS

2 **2030 Objective 2:** Minimize health issues caused by extreme heat days, especially for vulnerable populations.

		Lead partners
2a	Strengthen the Extreme Heat Response Procedure by creating a comprehensive Extreme Heat Response Plan through collaboration with community stakeholders and vulnerable populations.	County (MCEM, HD)
2b	Identify vulnerable populations and places by developing and analyzing relevant demographic and hazard data and maps (urban heat islands, air quality, flooding, and landslides) to better understand potential localized climate impacts and to prioritize co-benefit solutions.	County (HD); City (BPS)
2c	Work with health care and social services providers to ensure their ability to provide appropriate services during extreme heat events.	County (HD, DCHS)
2d	Partner with tribes, community based organizations and local service providers to seniors and people with disabilities to assess the need for and coordinate the operation of cooling centers that are readily accessible.	County (DCHS, HD, MCEM); City (PBEM)
2e	Develop early warning systems and response plans that alert community members when projected heat conditions or poor air quality days pose a health risk.	County (DCHS, HD, MCEM); City (PBEM)
2f	Continue to invest in initiatives linking environmental conditions to health outcomes like asthma, such as the County Healthy Homes and Weatherization Assistance Program.	County (HD)
2g	Expand the capacity to educate health care providers to recognize and report patterns of heat-related illnesses and injuries, and to inform the public about preventive actions.	County (HD)
2h	Ensure detention facilities are capable of adequate cooling during extreme heat events.	County (DCJ, MCSO)
2i	Ensure public safety staff is properly trained to recognize and respond to physical and behavioral signs of heat-related illness.	County (DCJ, MCSO)

HOTTER, DRIER SUMMERS WITH INCREASED INCIDENCE OF EXTREME HEAT DAYS

3 2030 Objective 3: Increase the resilience of Portland's water supply to drier summers.

		Lead partners
3a	Incrementally expand the groundwater capacity of the Columbia South Shore Well Field as back up to Bull Run, as detailed in the City's Water Management and Conservation Plan.	City (Water)
3b	Continue to implement water conservation education and outreach programs in retail service areas (business, industry and government) and continue participation in the Regional Water Providers Consortium conservation education and outreach activities.	City (Water)
3c	Support regulatory efficiency programs (e.g., low flow plumbing fixtures, Water Sense Program for appliances).	City (Water)
3d	Update the assessment of climate impacts on Bull Run watershed hydrology by completing the Pilot Utility Modeling Application as a member of the Water Utility Climate Alliance (i.e., develop a hydrologic model, run more recent global climate model outputs through this model, and assess impacts on hydrology of the watershed).	City (Water)
3e	Consider design and management methods to minimize water use and waste in fountains, parks and other landscaped publicly owned or managed properties while still maintaining thriving vegetation.	City (PPR, BES, Water); County (DCA)

HOTTER, DRIER SUMMERS WITH INCREASED INCIDENCE OF EXTREME HEAT DAYS

4 **2030 Objective 4:** Increase the resilience of natural systems to respond to increased temperatures and drier summers.

		Lead partners
4a	Identify habitat diversity and connectivity needs (e.g., links to and between existing natural areas, anchor locations) and prioritize corridors for protection and enhancement, including through acquisition, restoration, regulations and innovative techniques such as vegetated streets, to create an interconnected network of terrestrial and aquatic habitats.	City (PPR, BES, BPS)
4b	Identify opportunities to locate and relocate infrastructure away from streams to minimize impervious area, and allow for greater vegetation and increased floodplain access.	City (PPR, BES, BPS, BDS, PBOT)
4c	Review city codes and drainage rules to evaluate their ability to protect and improve stream flows, seeps, springs, water quality, vegetation and habitat, and stormwater management in the face of climate change, including wetland functions and water temperature. Use the Natural Resource Inventory to track gains and losses, and propose revisions as necessary. Evaluate and pilot planting native species that are currently considered to be at the "northern" edge of their range in Portland.	City (BES, PPR, BPS)
4d	Evaluate if existing e-zones, tree codes and specifications for tree planting and street design are sufficient to protect natural resource functions needed to adapt to climate change.	City (BPS, BDS, BES, PPR)
4e	Explore new and support expansion of existing voluntary programs promoting increased native, drought tolerant vegetation and reduced hardscape on private property such as Audubon and East Multnomah Soil and Water District's "Backyard Habitat," the City's "Treebate," and the DePave programs.	City (BES, BPS, Water)
4f	Research and experiment with different plant palettes for planting in natural areas, restoration sites, green streets, ecoroofs, rain gardens, and other built infrastructure that are more tolerant to summer drought conditions and provide habitat for current and new species expanding their range.	City (PPR, BES)
4g	Continue to implement and fund the invasive species control programs: Integrated Pest Management, Protect the Best, Early Detection and Rapid Response, and public and private invasive species control.	City (PPR, BES)
4h	Update the voluntary best management practices for nesting birds and seek opportunities to incorporate bird-friendly building design approaches into City plans, programs, projects and work with Portland residents, building managers, architects and developers to do the same.	City (BES, PPR, BPS)
4i	Purchase private water rights if useful to enhance instream flows or limit conflicts, and consider water marketing as a potential means of dealing with specific drought events.	City (BES)

HOTTER, DRIER SUMMERS WITH INCREASED INCIDENCE OF EXTREME HEAT DAYS

5 2030 Objective 5: Manage the risk of wildfires as a result of drier summers.

		Lead partners
5a	Continue to work in a co-management role with the Oregon Department of Forestry, US Forest Service, and local fire departments to respond to fires in and near the Bull Run watershed.	City (Water)
5b	Review feasibility of adopting nationally recognized codes to strengthen building standards in wildfire risk areas.	City (PBEM, PFR, BDS)
5c	Complete an assessment to characterize high priority wildfire risk areas, known as Wildfire Urban Interface Zones, and develop recommendations to reduce risks in and around these areas (e.g., specific building codes, vegetation management approaches).	City (PBEM, PFR, PPR, BPS); County (MCEM)
5d	Implement the 2011 Multnomah County Community Wildfire Protection Plan to reduce risk through community outreach and education, vegetation control/fuel reduction, restoration of fire-adapted ecosystems, and optimization of emergency preparedness and response capacity through interagency coordination.	City (PBEM, PFR); County (MCEM)
5e	Develop and implement habitat guidance for fire-adapted ecosystems that withstand natural recurring wildfires such as oak/savannah, and the species that depend on them.	City (BES, PPR)
5f	Increase corridors and buffer areas around wildfire prone areas through mechanisms such as protection, acquisition, zoning, incentives and public education in order to increase effectiveness of the transition zones between the urban-wildfire interfaces.	City (BPS, BES, PPR, BDS)

WARMER, WETTER WINTERS

6	**2030 Objective 6:** Increase the resilience of the natural and built environment to increased winter rainfall and associated flooding.	
		Lead partners
6a	Encourage the FEMA (Federal Emergency Management Agency) to update the floodplain mapping program to reflect potential changes due to climate change variability in the 100 year floodplain maps. Work with FEMA and Oregon Department of Land Conservation and Development (DLCD) to incorporate floodplain protection measures into the Community Rating System to minimize flood insurance rate impacts in Portland.	City (BES, BPS)
6b	Address floodplain hazards through the Comprehensive Plan update and provide guidance to regulate or manage development in the floodplain.	City (BPS, BDS, BES)
6c	Use updated floodplain data (see action 7a) to inform City and County land use (e.g. ensure space below the base flood elevation is not converted to habitable space), transportation and other infrastructure planning processes.	City (PBOT, BES, Water, PPR, BPS); County (DCS)
6d	Participate in federal flood protection efforts on the Columbia and Willamette Rivers, such as the Columbia River Treaty renegotiation.	City (OGR)
6e	Participate in state and federal efforts to align the National Flood Insurance Program with the Endangered Species Act.	City (BES, BPS)
6f	Continue and expand floodplain restoration.	City (BES)
6g	Implement the Portland Watershed Management Plan to restore normative processes to watersheds using strategies such as land acquisition, revegetation, green infrastructure and habitat restoration.	City (BES, PPR, PBOT)
6h	Better manage stormwater by reducing the overall impervious area (currently 34%) within the city through depaving, green infrastructure (greenstreets, ecoroofs, trees, and raingardens), and expanding the urban forest canopy, natural areas and open space. Encourage or require private property owners and developers to implement climate change preparation measures, including limiting or reducing impervious area at site-specific and district scales.	City (BES, BDS, BPS)
6i	Develop the Stormwater Systems Plan, and update the Stormwater Management Manual and the drainage rules to better manage increased winter precipitation, including reevaluating the modeled “24 hours” storm event design standard.	City (BES)
6j	Research and evaluate porous paving for public roadways and private development.	City (BES, PBOT); County (DCS)
6k	Support existing pollution prevention programs and identify additional strategies to reduce the pollution-related impacts of flooding (e.g., in industrial areas).	City (BES, PBOT)

WARMER, WETTER WINTERS

7	**2030 Objective 7:** Manage the increased risk of disease due to warmer, wetter winters.	
		Lead partners
7a	Investigate zoning and other code improvements to require new developments in at-risk areas to include features that mitigate health risks from, and reduce habitat for, vector populations.	County (HD, DCS); City (BPS, BDS)
7b	Develop and distribute culturally competent and accessible materials about vector-borne disease prevention.	County (HD)
7c	Expand the capacity to educate health care providers to recognize and report patterns of vector-borne disease illnesses and injuries, and to inform the public about preventive actions.	County (HD)
7d	Enhance the coordination between local natural resource agencies and vector control programs to ensure vector populations are managed in a way that protects human health and ensures ecological integrity and vitality.	County (HD); City (BES, PPR)
7e	Continue to update the response plan for emerging vector-borne diseases, including increased capacity for health services that are triggered by certain case thresholds.	County (HD)

WARMER, WETTER WINTERS

8	**2030 Objective 8:** Manage the increased risk of landslides due to increased winter rainfall.	
		Lead partners
8a	Identify and monitor landslide hazard areas based on topographic and subsurface data, including those associated with the Bull Run water supply; coordinate efforts with surrounding jurisdictions.	City (BDS, PBOT, PPR, BES, Water, PBEM); County (MCEM, DCS)
8b	Update code requirements based on updated landslide hazard mapping, when available.	City (BDS)
8c	Incorporate landslide hazard reduction techniques into public infrastructure projects.	City (PBOT, BES, PPR, Water); County (DCS)
8d	Provide education and outreach to the public regarding ways to reduce the risk of landslides on private property.	City (BDS, PBEM); County (DCS, MCEM)
8e	Advocate for local or state level landslide disaster response funding.	City (PBEM); County (MCEM)

BUILDING CAPACITY TO PREPARE FOR AND RESPOND TO CLIMATE CHANGE

9	**2030 Objective 9:** Strengthen emergency management capacity to respond to extreme weather events.	**Lead partners**
9a	Develop, test, train, and update emergency response plans that address hazards likely to become more frequent or intense as the climate changes, including flood, extreme heat, landslides and wildfire.	City (PBEM); County (MCEM)
9b	Increase capacity of City and County emergency management to respond in emergency conditions and protect life, health, environment, and infrastructure assets.	City (PBEM, PPR); County (MCEM)
9c	Promote equity in mitigation, response and recovery activities, and incorporate knowledge of vulnerable populations into all plans and exercises.	County (MCEM, DCHS); City (PBEM)
9d	Ensure that service providers, including contractors, have the education and tools to succeed in their disaster planning, preparedness, response and recovery efforts.	County (MCEM, DCHS); City (PBEM)
9e	Prepare after-action reports after extreme-weather events to summarize effectiveness, deficiencies and resources needed for building resilience.	County (MCEM, DCA, DCHS, DCJ, MCSO); City (PBEM)
9f	Through training, educational materials and other resources, strengthen capabilities of individuals and organizations that assist in disaster response to prepare for potential climate change impacts, including disproportionate impacts on vulnerable populations.	County (MCEM, DCHS); City (PBEM)
9g	Plan and staff for potential increases in weather-related displacement (food and housing) and the resulting potential for increased violence, mental illness, chemical dependency and addiction.	County (DCHS, DCJ, MCSO)

BUILDING CAPACITY TO PREPARE FOR AND RESPOND TO CLIMATE CHANGE

10 2030 Objective 10: Institutionalize climate change preparation planning and best practices.

		Lead partners
10a	Establish a multi-bureau/multi-department adaptive management coordination team to: review emerging climate research, trends and regulations at least once a year; revise the strategy in coordination with the update of the *Climate Action Plan.*	City (BPS); County (OS)
10b	Share information among City and County infrastructure agencies and explore the feasibility of guidelines for including climate change variable in future infrastructure decision-making	City (BES, Water, PPR, PBOT, BPS); County (DCA, DCS)
10c	Utilize an equity framework or lens to ensure preparation actions are implemented in ways that improve equity and prioritize vulnerable populations.	City (BDS, BES, BPS, OMF, PBEM, PBOT, PFR, PPR, Water); County (DCA, DCHS, DCS, HD, MCEM, OS, DCJ, MCSO),
10d	Develop maps, data resources and other tools to better understand localized climate change impacts, including potentially disproportionate impacts to vulnerable populations.	City (BPS, Water, PBOT, BES, PPR, PBEM); County (HD, DCHS, MCEM)
10e	Address climate preparation in the Comprehensive Plan Update and in future updates to this and other plans (e.g., infrastructure, watershed, urban forest, hazard mitigation, etc.).	City (BPS, Water, BES, PBOT, PPR, PBEM)
10f	Acknowledge climate variables as a risk in asset management.	City (BPS, Water, PBOT, BES, PPR); County (DCA, DCS)
10g	Prepare for shifts and expansion of ranges of existing species and influxes of new invasive species by identifying and prioritizing species by level of concern and response; institutionalizing and increasing the Early Detection and Rapid Response programs; and increasing management activities on priority areas.	City (BES, PPR)
10h	As appropriate, coordinate with or require health and safety service providers to support recommendations of the Climate Change Preparation Strategy (e.g., provide education and resources about climate risks to vulnerable populations; development of continuity of operations plans).	County (DCHS, HD)
10i	Continue to raise awareness among the public, health organizations and other medical providers of new and increasing public health risks associated with climate change.	County (HD)
10j	Continue to pursue energy efficiency opportunities to minimize impacts from rising energy costs and increased cooling demands.	City (OMF, PPR, BES, PBOT, Water)
10k	Considering climate change impacts and risks, implement optimal maintenance interventions to cost effectively maximize infrastructure system efficiencies.	City (OMF, PPR, BES, PBOT, Water).

BUILDING CAPACITY TO PREPARE FOR AND RESPOND TO CLIMATE CHANGE

11	**2030 Objective 11:** Improve the capacity of the community, especially vulnerable populations, to understand, prepare for and respond to climate impacts.	**Lead partners**
11a	Provide education and resources about climate risks to the public, especially vulnerable populations.	County (HD, DCHS)
11b	Continue to update existing emergency preparedness and response plans with increased emphasis on protecting and serving vulnerable populations during weather-related emergencies.	County (DCJ, MCSO, MCEM); City (PBEM)
11c	Develop and distribute culturally competent and accessible materials about extreme heat and respiratory-related illness, especially to vulnerable populations.	County (HD, DCHS, MCEM)
11d	Link vulnerable populations to services that help reduce safety, health and financial risks associated with climate change impacts.	County (HD)
11e	Explore opportunities to provide financial resources for climate preparation efforts to culturally specific organizations with established community relationships.	County (HD, DCHS)

BUILDING CAPACITY TO PREPARE FOR AND RESPOND TO CLIMATE CHANGE

12 2030 Objective 12: Improve monitoring, evaluate effectiveness of climate change preparation actions and advance new research to support climate change preparation efforts.

		Lead partners
12a	Assess data gaps and identify, compile and regularly update priority data for the Portland area (e.g., hydrology, floodplains, fires) for climate change trend tracking.	City (BES, PPR, PBOT, Water); County (HD)
12b	Implement the Portland Area Watershed Monitoring and Assessment Program (PAWMAP) which monitors stream flow and temperature quarterly, as well as key fish and wildlife species.	City (BES)
12c	Continue to support federal and state monitoring of river levels such as US Geological Survey gauge monitoring, and coordinate and strategically supplement the data with additional flow and water quality data collected through PAWMAP.	City (BES)
12d	Continue to update the City's Natural Resource Inventory.	City (BPS)
12e	Monitor impacts of climate change on aquatic and upland habitats, including forested areas and critical habitat types (e.g., wetlands, native oak), and aquatic and terrestrial fish and wildlife species. Determine if additional management strategies are warranted.	City (BES, PPR, Water)
12f	Track Combined Sewer Overflow/Sanitary Sewer Overflow design storms (every five years).	City (BES)
12g	Track the condition of major assets (e.g., roads, bridges, retaining walls, parks assets, etc.) to determine if maintenance needs to be more frequent due to weather patterns that cause damage.	City (PBOT, PPR); County (DCS)
12h	Monitor river levels and bridge lift frequencies.	City (BES); County (DCS)
12i	Begin rainfall event-based monitoring of sediment accumulation in pipes and stormwater facilities.	City (BES)
12j	Monitor stormwater and wastewater temperatures.	City (BES)
12k	Continue to monitor recreation trends and literature regarding climate change and effect on recreational trends.	City (PPR)

BUILDING CAPACITY TO PREPARE FOR AND RESPOND TO CLIMATE CHANGE

12	**2030 Objective 12:** Improve monitoring, evaluate effectiveness of climate change preparation actions and advance new research to support climate change preparation efforts.	**Lead partners**
12l	Continue to monitor Best Management Practices (e.g., durable and resilient materials that hold up well to climate changes; energy and water efficiencies of water play/spray features; climate resilient planting materials).	City (PPR)
12m	Monitor heat-related illness and impacts of air quality on health status through review of data such as death certificates and hospital discharges.	County (HD)
12n	Monitor response capability (resources) as climate change impacts increase demand for emergency response.	City (PBEM); County (MCEM, DCHS)
12o	Monitor, diagnose and investigate health problems and hazards in the community related to extreme heat and high ozone days.	County (HD)
12p	Investigate possible new diseases, insects, molds, fungi and invasive trees that will affect fish, wildlife, and habitats.	City (BES, PPR)
12q	Survey and monitor for vector-borne diseases by collecting, analyzing, and interpreting data related to vector ecology and emerging public health threats.	County (HD)
12r	Coordinate with Centers for Disease Control and Prevention on information about changes in vector-, water- and food-borne diseases across the country.	County (HD)
12s	Monitor the potential for accelerated regional population growth due to national or global changes in the climate.	City (BPS)
12t	Research the potential impacts of climate change on local food safety and security.	County (OS)
12u	Establish research partnerships with institutions of higher learning to (1) gather local data around the linkage between increased temperature, air quality (specifically ground-level ozone), and health outcomes and disparities; (2) identify tree species most suitable for future climate change conditions.	City (PPR, BES); County (HD)

References

1. Bumbaco, K.A., K.D. Dello, N.A. Bond. 2013. History of Pacific Northwest Heat Waves: Synoptic Pattern and Trends. *Journal of Applied Meteorology and Climatology.* 52, 1618–1631. doi: http://dx.doi.org/10.1175/JAMC-D-12-094.1 In press.
2. Intergovernmental Panel on Climate Change (IPCC). (2012). Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the
3. Intergovernmental Panel on Climate Change [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, UK, and New York, NY, USA
4. Kunkel, K.E., L.E. Stevens, S.E. Stevens, E. Janssen, and K.T. Redmond (2012). Climate of the Northwest U.S. Prepared for the use of chapter authors of the 2013 National Climate Assessment Report
5. Mote, P.W., (2003). Trends in temperature and precipitation in the Pacific Northwest during the twentieth century. *Northwest Science,* 77, 271-282
6. Mote, P.W. and E.P. Salathé, (2010). Future climate in the Pacific Northwest. Climatic Change, 102, 29-50
7. Oregon Climate Change Research Institute (OCCRI) (2010). Oregon climate assessment report. [Field, K.D. Dello and P.W. Mote (eds)]. College of Oceanic and Atmospheric Sciences, Oregon State University, Corvallis, OR
8. Oregon Climate Change Research Institute (OCCRI) (2012). Water and Climate in the Pacific Northwest. College of Oceanic and Atmospheric Sciences, Oregon State University, Corvallis, OR. Retrieved on December 3, 2013 from http://water.oregonstate.edu/sites/default/files/water_and_climate_in_the_pacific_northwest_v3.pdf

▶ www.portlandoregon.gov/bps/climate