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memorandum

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cc

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subject Literature Review, Available Data, and Project Partners

This memorandum documents Task 2.1 of ESA's scope of work on the Waterfront Resiliency Support Services project and includes a current list of working group members and stakeholders engaged in the project.

Introduction

The Seattle Waterfront is vulnerable to multiple risks related to climate change and sea level rise (SLR), including intensified storms and erosion. These hazards threaten property, infrastructure, and transportation and freight corridors. Led by the Port of Seattle, the Waterfront Resiliency project aims to bring together multiple Seattle Waterfront stakeholders to develop a shared strategy for synchronizing investments and regulatory approaches to improving the resilience of Seattle's waterfront infrastructure and transportation and freight corridors to SLR.

The project work includes a literature review of best available science related to waterfront infrastructure and transportation/freight mobility vulnerabilities as well as a review of policy and regulatory frameworks implemented by other ports, local or regional governments, and federal or international agencies, as documented in the memorandum.

Regulatory Framework

Several floodplain and shoreline regulations affect waterfront resilience by guiding development and building standards, environmental and habitat protection, and permitting and compliance for shoreline projects. For example:

- The Federal Emergency Management Agency (FEMA) requires shoreline jurisdictions to comply with the National Flood Insurance Program (NFIP), including adopting a Flood Insurance Rate Map (FIRM) and updating floodplain development regulations. FEMA requires standards for properties in flood hazard areas (e.g., elevation requirements for the first floor of new structures). The updated FIRM for Seattle identified new high

- hazard flood zones (VE zones) to address extreme wave action from storms. Seattle updated its regulations in August 2020 to comply with FEMA’s regulations, which incorporate projected sea level rise.
- *Emerging:* FEMA is in the process of expanding its floodplain definition from the standard 100-year flood (an area with a 1 percent chance of flooding in a given year) with critical facilities protected against the 500-year flood (0.2% chance); this standard only reflected current flood risks. The updated Federal Flood Risk Management Standard increases both flood elevation and floodplain width to reflect current and future flood risks and went into effect on September 9, 2024 (FEMA 2024).
 - The Washington State Department of Ecology (Ecology) regulates shoreline activities through the Shoreline Management Act, which requires local coastal governments to prepare Shoreline Master Programs (SMPs) to manage local shoreline use and activities. Ecology develops SMP guidelines, reviews and approves local SMPs, reviews and approves shoreline permits, conducts environmental review for shoreline projects, and enforces the requirement that SMPs and shoreline projects result in “no net loss” of ecological functions and processes. Seattle’s SMP regulates activities within 200 feet of shorelines including Puget Sound, aiming to protect natural resources, encourage water-dependent uses, and provide public access (City of Seattle 2024). This includes environmental review for shoreline projects in fish and wildlife habitat conservation areas.
 - *Emerging:* Ecology is in the process of developing requirements for local governments to address sea level rise and storm severity in Shoreline Master Programs in response to House Bill 1181. Ecology recently released the *Interim Climate Resilience Planning Guidance for Shoreline Master Programs* to provide recommendations for local governments updating comprehensive plans while these more formal requirements and rules are being established (Ecology 2024).
 - Hazard Mitigation Plans provide updated assessments of relevant natural hazards of concern to local jurisdictions, inform land use planning decisions, and align with NFIP and SMP requirements. Seattle’s All-Hazards Mitigation Plan (2021-2026) includes a comprehensive assessment of hazards relevant to shorelines and floodplains, including sea level rise and flooding, and evaluates the vulnerability of shoreline infrastructure including residential, commercial, industrial, and transportation uses (City of Seattle 2021). Mitigation strategies recommended in the plan include nature-based solutions to improve shoreline resilience, improvements to bridges and culverts to enable increased flows, and reconnecting floodplains to mitigate flood risks. Having a Hazard Mitigation Plan, or planning as a partner jurisdiction under a Regional Hazard Mitigation Plan, makes a local jurisdiction eligible for Building Resilient Infrastructure and Communities (BRIC), Hazard Mitigation Grant Program (HMGP), and other grant funds. The Port of Seattle does not have a Hazard Mitigation Plan.

Project Partners

Members of the AdaptSea Waterfront Resilience Partnership represent key public agencies that own, regulate, or manage waterfront infrastructure and have a stake in resilience along Seattle's waterfront. As of June 2024, these entities include:

- Port of Seattle
- City of Seattle (Seattle Public Utilities, Parks and Recreation, Seattle City Light, Office of Planning and Community Development, Office of Sustainability and Environment, Department of Transportation, Department of Construction and Inspections)
- King County Wastewater Management
- Washington State Department of Transportation/Washington State Ferries
- Northwest Seaport Alliance

Additional entities and individuals invited to participate in an advisory capacity, include, but are not limited to, the following:

- Duwamish River Community Coalition
- Sound Transit
- Suquamish Tribe
- Muckleshoot Tribe
- Port of Olympia
- Port of Bellingham
- Port of Everett
- Washington State Department of Ecology
- National Oceanic and Atmospheric Administration (NOAA)
- Washington Public Ports Association
- King County Flood Control District
- South of Downtown (SODO) Business Improvement Area
- City of Seattle Office of Economic Development
- U.S. Army Corps of Engineers

Regional Organizations

Within the greater Seattle area there are numerous organizations working to address the impacts of climate change and SLR. For example, the Puget Sound Climate Preparedness Collaborative is a network of agencies working to advance climate change preparation and information sharing within the Puget Sound region, the King County Cities Climate Collaborative is a group of King County cities working to accelerate climate action on a county-scale, and the Duwamish Valley Resilience District is a grant-funded City of Seattle initiative focused on climate change adaptation within the lower Duwamish River Valley. The Duwamish River Sea Level Rise Working Group is a partnership established in 2024 between King County, City of Seattle, Northwest Seaport Alliance, and Port of Seattle focused on planning together, pursuing joint funding, and aligning messaging around sea level rise in Duwamish Valley communities. The AdaptSea Seattle Waterfront Resilience Partnership aims to align resilience investments on Seattle's waterfront infrastructure and transportation/freight corridors specifically within City of Seattle shoreline, including Elliott Bay from Golden Gardens in the north, to Duwamish River Mile 4.5 and around West Seattle to Brace Point.

Existing Studies

This literature review includes the best available science related to waterfront infrastructure and transportation/freight mobility vulnerabilities and the state of practice in waterfront resilience in general and Seattle Waterfront infrastructure in particular. It also includes a review of policy and regulatory frameworks implemented by other ports, local or regional governments, and federal or international agencies.

Sea Level Rise Projections

In 2018, as part of the Washington Coastal Resilience Project (WCRP), the University of Washington Climate Impacts Group (CIG) published Projected Sea Level Rise for Washington State, a 2018 Assessment. The study was an update to the 2012 National Research Council projections of sea level rise with a focus on coastal Washington State. The report provides an updated set of SLR projections that incorporates the latest science and provides community-scale projections, including vertical land movement at 171 locations. These projections, as well as CIG's 2018 publication, Guidelines for Mapping Sea Level Rise Inundation for Washington State, and their 2019 publication, Extreme Coastal Water Level in Washington State – Guidelines to Support Sea Level Rise Planning all help assess future exposure to flooding along Washington's coastline and City of Seattle shorelines and will be used as guides for mapping flooding along City of Seattle shoreline.

In 2022, NOAA prepared a report called Global and Regional Sea Level Rise Scenarios for the United States (Sweet et al. 2022). This study was based on downscaled outputs from the United Nations Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (2021). NOAA's report summarizes the key messages in the executive summary:

1. Multiple lines of evidence provide increased confidence, regardless of the emissions pathway, in a narrower range of projected global, national, and regional sea level rise at 2050 than previously reported.
2. By 2050, the expected relative sea level will cause tide and storm surge heights to increase and will lead to a shift in U.S. coastal flood regimes, with major and moderate high tide flood events occurring as frequently as moderate and minor high tide flood events occur today. Without additional risk-reduction measures, U.S. coastal infrastructure, communities, and ecosystems will face significant consequences.
3. Higher global temperatures increase the chances of higher sea level by the end of the century and beyond. The scenario projections of relative sea level along the contiguous U.S. coastline are about 0.6–2.2 m in 2100 and 0.8–3.9 m in 2150 (relative to sea level in 2000); these ranges are driven by uncertainty in future emissions pathways and the response of the underlying physical processes.
4. Monitoring the sources of ongoing sea level rise and the processes driving changes in sea level is critical for assessing scenario divergence and tracking the trajectory of observed sea level rise, particularly during the time period when future emissions pathways lead to increased ranges in projected sea level rise.

Compared to the 2018 Washington projections, the 2022 NOAA projections are very similar for “processes with medium confidence or better”. When low-likelihood, high-impact processes, like ice sheet instability processes are included, the projections vary more. Assuming just the processes with medium confidence or better are included, the 2018 Washington 1% projections line up well with the NOAA “high” scenario, the 17% likelihood scenario lines up with the “intermediate” scenario, and the 83% likelihood scenario lines up with the “intermediate low” scenario.

Local Studies

Prioritizing Sea-Level Rise Exposure and Habitat Sensitivity Across Puget Sound

Washington Sea Grant and Coastal Geologic Services prepared a report and mapping products to assess the relative sea-level rise vulnerability across Puget Sound on a parcel-basis (2022).

According to the report, the sea level rise vulnerability index:

1. Accounts for potential impacts to both the built environment (homes, roads, and critical infrastructure) and the natural environment (coastal habitats);
2. Uses only publicly-available data;
3. Is based on exposure to both erosion and flooding;
4. Provides insights about differences in vulnerability between individual parcels in Puget Sound;

5. Enables new insights about the spatial distribution of vulnerability in Puget Sound, and helps to prioritize locations where vulnerability is highest.

Washington Sea Grant has received funding to further this work, which is in progress.

The Northwest Seaport Alliance Resilient Gateway Vulnerability Assessment and Response Framework Summary

In 2023, as part of the Resilient Gateway Project, the Northwest Seaport Alliance (NWSA) developed a Vulnerability Assessment and Response Framework (VARF) to ensure the long-term economic success of the northwest region. The assessment identifies eight primary hazards: coastal flooding, flooding, severe weather, wildfires and smoke, landslides, earthquakes, tsunamis, and volcanic activity. Each risk factor is assigned a ranking of low, medium, or high and then characterized as an emerging threat, chronic hazard, or shock. The report presents resiliency strategies and supporting potential actions. Coastal flooding is characterized as an emergent threat that may be countered by identifying the most at-risk facilities to help prioritize improvements and using nature-based solutions, such as natural shoreline hardening methods, to reduce vulnerability to hazards.

Seattle City Light Climate Change Vulnerability Assessment and Adaptation Plan

Seattle City Light completed a Vulnerability Assessment (VA) and Adaptation Plan summarizing the impacts of climate change on the utility and identifying potential actions to reduce vulnerability and increase resilience. The VA describes eight climate change factors, including SLR and storm surges, that may impact City Light's operation and infrastructure. The assessment presents a range of projected SLR based on the National Research Council's 2012 study for the years 2030, 2050, and 2100, using low, moderate, and high GHG emission scenarios. They selected the mean projection for a moderate warming scenario or an increase of 2.6 inches by 2030 (0.22 feet), 6.5 inches (0.54 feet) by 2050, and 24.3 inches (2.03 feet) by 2100. The study also presents data from the Climate Resiliency Group at Seattle Public Utilities, showing the projected change in the frequency of tidal flooding using the 100-year, annual, monthly, and daily return periods. While the study does not identify specific infrastructure at risk, it does identify the most at risk areas, including the Shilshole Bay Marina, Harbor Island and West Marginal Way, and the South Park neighborhood. The mapping utilizes a bathtub modeling approach, which assumes all areas under a target elevation are inundated, regardless of hydrologic connectivity, and does not include waves. The results are displayed for 2, 3, 4, and 5 feet of SLR above MHHW.

The Seattle City Light Adaptation Plan lists thirteen potential impacts of climate change on their infrastructure and operations, stemming from each of the eight climate factors. The potential impacts are associated with risk to one or more of City Light's mission objectives, including financial costs, environmental responsibility, reliability, and safety. For each of the thirteen impacts, the plan discusses exposure, sensitivity, adaptive capacity, and potential adaptation actions, in both the near-term and long-term. Impacts to the Port of Seattle include more frequent inundation and flooding of City Light properties and facilities near Puget Sound and more

frequent flooding and salt water corrosion of transmission and distribution equipment near Puget Sound. To combat these threats, City Light plans to map projections of SLR and identify facilities and equipment at risk and establish a utility-wide policy that will consider future SLR before constructing any new facilities.

Seattle Public Utilities Sea Level Rise Map

Seattle Public Utilities (SPU) has developed an online map viewer that displays four different levels of SLR within City of Seattle Puget Sound shorelines. The mapping utilizes a bathtub modeling approach, similar to the Seattle City Lights Vulnerability Assessment. SLR is measured relative to mean higher high water (MHHW), which for Seattle, is approximately 9 feet on the North American Vertical Datum of 1988 (NAVD88). Mapping includes 2 feet, 3 feet, 4 feet, and 5 feet of SLR, which corresponds to elevations of 11 feet, 12 feet, 13 feet, and 14 feet NAVD88, respectively. These projections are based on the 2018 Washington Coastal Resiliency Project (WCRP) by Miller et al. (2018) but do not include mapping of any storm events. Infrastructure and assets shown on the SPU SLR Map may be used in the Port of Seattle Waterfront Resiliency Asset Inventory to determine assets that are exposed to SLR flooding impacts.

SPU also published a Risk and Resiliency Framework in 2018, which defines resiliency principles for the utility, and provides guidelines for assessment, planning, and implementation of resilience strategies. It provides a planning framework, and focus areas for its business units to evaluate when assessing and planning for resilience, including climate change, economy and affordability, disaster management, and other focus areas.

Seattle Parks & Recreation Climate Resiliency Study

In January 2022, Seattle Parks & Recreation published a study on climate resiliency in Seattle's parks and recreation system. The report discusses the projected impacts of climate change in Washington State, including hotter days, reduced snowpack, higher winter streamflows, lower summer streamflows, and SLR. Based on data from CIG, the projected 2100 SLR in King County is 1.9 feet for the low greenhouse gas (GHG) scenario and 2.3 feet for the high GHG scenario. SLR was measured relative to sea levels in King County between 1991 and 2009. The study focuses on identifying opportunities and actions within the Parks and Recreation System to develop climate resiliency and uses SPU's SLR mapping to display projected SLR. Some opportunities that may be adapted to the Waterfront Resiliency project, include assessing park facilities near shorelines, including docks and boat launches, for their vulnerability to SLR and flooding, planning future adaptive techniques, and incorporating resilient design and soft shoreline techniques when developing shorelines. The study does not identify specific assets that are at risk.

Duwamish Valley Action Plan & Duwamish Valley Resilience District

The Duwamish Valley Resilience District was created in 2020 and utilizes a place-based strategy focused on climate change adaptation, community wealth building, and community stabilization. SLR is one of the resilience district's focus areas and the district plans to develop a holistic SLR adaptation strategy, identifying preferred physical infrastructure to protect Duwamish Valley communities from flooding. Additionally, the District plans to deliver on key actions identified in

the 2018 Duwamish Valley Action Plan. Actions mentioned in the plan include working with the U.S. Army Corps of Engineers (USACE) to study overland flooding from the Duwamish River into the South Park neighborhood and to develop community resilience strategies, with an emphasis on SLR. Although the Duwamish Valley Action Plan does not strictly focus on SLR or flooding, the Waterfront Resiliency project will include assets from the plan in their vulnerability assessment.

City of Seattle Climate Vulnerability Assessment

In June 2023, the City of Seattle published a Climate Vulnerability Assessment, which describes how the City is already experiencing impacts from climate change and climate-related hazards, and projects how each of these hazards will affect City of Seattle infrastructure and operations in the future. The Climate Vulnerability Assessment uses the climate vulnerability framework, combining exposure, sensitivity, and adaptive capacity to evaluate a system's vulnerability to climate change. The assessment focuses on themes of Economy, Public Health, Community Amenities and Wellbeing, Infrastructure, and Natural Systems, and considers physical and socioeconomic vulnerabilities within each of these themes. It assesses Social and Economic Vulnerability, Physical Vulnerability, and Compounding and Cascading Impacts. The assessment concludes with a list of broad areas for potential investment to improve climate resilience, including investment in community services, improving grid capacity and resilience, protecting and expanding the City's tree canopy, and other opportunities across the City. The Waterfront Resiliency project may consider incorporating some of these recommendations into development of joint projects and funding requests, and integrating them into each jurisdiction's capital improvement plans.

Other Jurisdictions

City of Olympia & Port of Olympia Sea Level Rise Response Plan

In 2019, the City of Olympia, along with the Port of Olympia (Port) and the LOTT Clean Water Alliance (LOTT) developed a Sea Level Rise Response Plan for the downtown Olympia area. The partnership between the City of Olympia, the Port of Olympia, and LOTT is an interlocal agreement (ILA), allowing for continued coordination on SLR response measures to the mutual benefit of all parties. The response plan includes an overview of Olympia-specific SLR projections, including projections from the 2018 WCRP by Miller et al. (2018), SLR vulnerability and risk, their approach to adaptation, the cost of adaptation and implementation and monitoring of next steps. The SLR vulnerability and risk assessment takes inventory of key assets and then evaluates them on their exposure, sensitivity, and adaptive capacity. The plan's adaptation strategy uses a phased approach that identifies near-term, mid-term, and long-term actions as well as physical, operational, informational, and governance strategies. Adaptation strategies include retreating from downtown (in select areas), focusing on public property, and strengthening partnerships. The AdaptSea Partnership has discussed the potential adoption of a similar model in the future to formalize the collaboration between partners.

City of Tacoma Climate Change Resiliency Study

The 2016 study conducted by the City of Tacoma begins by discussing climate drivers, including temperature, precipitation, flood risk, stream temperature, landslides and sediment transport, extreme wind events, SLR, and ocean acidification. The study then identifies key features in the built environment, such as the transportation system and the surface water system and evaluates their criticality, exposure, sensitivity, and adaptive capacity, and then considers their relative vulnerability. Adaptation strategies are divided by “Near-Term Needs” and “Windows of Opportunities”, “Low-Hanging Fruit”, and “Longer-Term Projects”. This process is repeated for natural systems at risk, like marine ecosystems and the Puyallup River, and social systems. The study concluded by listing recommended adaptation strategies by Near-Term Strategies, Strategies with Multiple Benefits, and Longer-Term Strategies.

The City of Tacoma study did not perform any SLR mapping, instead recommending marine inundation mapping as an area for future study. However, the study does offer a template for identifying key assets and evaluating their relative vulnerability based on criticality, exposure, sensitivity, and adaptive capacity that may be replicated in the Waterfront Resiliency project.

Port of San Diego Vulnerability Assessment & Coastal Resiliency Report

In 2019, the Port of San Diego published a vulnerability assessment and coastal resiliency study. The report uses historic SLR measurement in San Diego Bay as well as SLR projections from the California Ocean Protection Council (OPC) and the United States Geological Survey’s CoSMoS 3.0 model (see section below on CoSMoS) to map the extent of coastal flooding associated with a 100-year storm in specific Port planning districts. Various assets, including roads, buildings, and terminals are quantified by distance, area, or count and rated on their sensitivity and adaptive capacity and then ranked by the percent of assets exposed to inundation under various levels of SLR and under the 100-year event. The report also quantifies financial impacts of a 100-year event under a No Action Scenario.

The adaptation planning focuses on three types of adaptation strategies: protect, accommodate, and adjust. The report discusses different examples of natural or nature-based adaptation strategies, shoreline strategies, and building and infrastructure strategies and unit costs associated with each. Like the Port of San Diego’s study, flood mapping for the Waterfront Resiliency project will utilize a 2-dimensional wave model to more accurately generate the extent of flooding within the project area. The study also provides one potential method of quantifying and ranking vulnerability of assets potentially impacted by flooding.

Sea Level Rise Modeling

Many of the previous studies discussed above use the simplified “bathtub” approach to mapping sea level rise inundation. This method assumes that the increase in sea level is uniform across all areas and does not consider the dynamic aspect of water, such as waves or the impact of storms. Bathtub models are appropriate for understanding how typical tides may change, but they do not

consider the complex hydrodynamic processes associated with storms. To assess future flooding with storm events, wave modeling is required.

Modeling must then be paired with asset mapping to determine the degree to which economic, social, or institutional assets and infrastructure are exposed to sea level rise impacts.

Proposed Modeling for This Project

The flood hazard assessment for this project involves a two-step modeling process to determine total water levels during the 10- and 100-year events with 2 and 5 feet of sea-level rise. Once the total water level is determined, it can be mapped along the shoreline to show areas that would be inundated during those scenarios.

In the first modeling step, the total water level during a storm event is calculated using a representative shoreline slope rather than relying on the intricate site topography and bathymetry. This approach offers a less computationally intensive method to create a time series of total water levels (e.g., water elevations every hour for a 30-year period). This time series can then be used to determine the total water level recurrence interval (e.g., the 100-year event) at each location across the waterfront.

In the second step, one specific event (rather than the whole time series) is identified based on the results of the first step to model specific sites in more detail. This event (e.g., the 10- or 100-year event) is then modeled using detailed site topography and bathymetry and more complex wave processes like wave reflection, diffraction, breaking, and dissipation to provide a more comprehensive and precise assessment of the flood extent. This type of hydrodynamic modeling, while more intensive, is more accurate than using the bathtub approach.

CoSMoS

The USGS's Coastal Storm Modeling System (CoSMoS) provides storm-induced coastal flood hazard mapping for current and future conditions and is currently being developed for Puget Sound. The USGS have modeled wave generation and propagation in the Salish Sea as described in Crosby et al. (2023) and are currently applying the CoSMoS framework, which assesses regional water levels, waves, and compound flooding over large geographic areas and high resolution (1 meter), to Puget Sound (Nederhoff et al. 2022). The CoSMoS dataset has 50+ combinations of sea-level rise (e.g., 0 to 5 meters, or 0 to 16.4 feet, of sea-level rise) and storm scenarios (no storm, king tide, 1-year, 5-year, 10-year, 20-year, 50-year, and 100-year coastal events).¹ King County model results are expected to be completed and available for use in early 2025. The proposed modeling for this project is very similar to the CoSMoS modeling and will provide a good comparison. Since “all models are wrong, but some are useful”, being able to

¹ Note, the return period events in the model are based on current coastal storm return periods. Return periods are based on historic storm frequencies and indicate that such a storm is about 67% likely to occur or be exceeded at least once during the period. This analysis assumes that sea-level rise is linearly additive such that the X-year storm provides the same increase above the still water sea level whether under existing conditions or in the future. In reality, the recurrence of flood conditions may not be stationary, which means they may change with future climate changes or as our length of record increases and we observe more events.

compare the two models, once CoSMoS is available, will allow the Port to focus investment on areas where the models consistently demonstrate higher exposure. Where the models diverge, there may be an indication that further study may be necessary.

Existing Data

ESA has gathered pertinent datasets to develop flood maps and asset exposure counts. These datasets provide information on asset exposure to sea level rise and inundation, but do not provide information on asset vulnerability. Per Port of Seattle staff, upon completing interviews with Port Engineering staff, no comprehensive datasets are known to exist that provide asset sensitivity information for Port of Seattle infrastructure. This constitutes a gap that would need to be addressed in order to conduct a vulnerability assessment.

Existing datasets and documents include:

IPCC

- [Climate Change 2021, the Physical Science Basis]

Climate Impacts Group

- Guidelines for Mapping Sea Level Rise Inundation for Washington State (Conservation Innovation Grant) (Climate Impacts Group & Sea Grant 2018)
- Washington Sea Level Rise Projections Visualization Tools (UW Climate Impacts Group 2018)
- Sea Level Rise Projections for Washington (Miller et al. 2018)
- Extreme Coastal Water Levels in Washington State, Guidelines to Support Sea Level Rise Planning (Climate Impacts Group et al. 2019)

Department of Archeology and Historic Preservation

- DAHP National Register Historic Properties listed or determined eligible. GIS Data. (DAHP, 2024).

Federal Emergency Management Agency

- Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps and Flood Insurance Study for the City's coastlines

King County

- King County and Local Sewer Agency Treatment Plants. GIS Data. King County, 2005.
- Street Address. GIS Data. (King County, 2005).
- Trails in King County. GIS Data. (King County, 2006).
- Wastewater Conveyance of King County. GIS Data. (King County, 2008).

- Common Points of Interest for King County. GIS Data. (King County, 2009).
- Wastewater Treatment Facilities of King County. GIS Data. (King County, 2015).
- Parks in King County. GIS Data. (King County, 2016).
- Solid Waste Facilities Location. GIS Data. (King County, 2016).
- Public Parcels in King County. GIS Data. (King County, 2017).
- Wastewater Combined Sewer Overflow (CSO) Outfall Locations of King County. GIS Data. (King County, 2018).
- Metro Sub Stations in King County. GIS Data. (King County, 2018).

Microsoft

- Microsoft Washington buildings layer. GIS Data. (Microsoft, 2023).

NOAA

- NOAA Sea Level Rise Viewer & NOAA Coastal Flood Exposure Mapper
- Adapting to Climate Change: A Planning Guide for State Coastal Managers National Oceanic and Atmospheric Administration (NOAA 2010)
- [2022 Sweet et al.]

Port of Seattle

- Lift Station Tracking Marine Maintenance Points. GIS Data. (Port of Seattle, 2024).
- Substation Inventory Maintenance Points. GIS Data. (Port of Seattle, 2024).

Seattle Public Utilities

- Storm Outfall Points. GIS Data. (SPU, 2024).
- Pump Station Polygons. GIS Data. (SPU, 2024).
- Overflow Control. GIS Data. (SPU, 2024).
- Wetland Polygons. GIS Data. (SPU, 2024).
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- Bioretention Swale. GIS Data. (SPU, 2024).
- Open Ditches & Culverts. GIS Data. (SPU, 2024).

- Railroads Including Trams and Light Rail. GIS Data. (SPU, 2024).

USGS

- [HERA – Hazard Exposure Reporting and Analytics]
<https://www.usgs.gov/apps/hera/floodTool.php>

Washington Department of Ecology

- Washington State Coastal Atlas (Ecology, 2014) Accessible at:
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