Section 3.3

Water Resources

This section discusses water resources in the study area, including:

- Longfellow, Puget, and Wolfe Creeks
- Elliott Bay
- Duwamish River
- Ship Canal / Salmon Bay
- Groundwater

Impacts described in the following sections are broad evaluations based upon the details available at the time of analysis; each future planned action will be subject to City of Seattle code, regulations, and ordinances and will need to demonstrate consistency with applicable critical area requirements.

Thresholds of significance utilized in this impact analysis include:

- Development that results in discharges to surface waters that do not meet water quality or flow control standards.
- Development that eliminates groundwater recharge or results in groundwater that does not meet water quality standards.
- Development that increases vulnerability to sea level rise.

3.3.1 Affected Environment

Study Areas

The study area consists of the primary and secondary study areas. The primary study area encompasses all industrial land in the city and includes the Ballard Interbay Northend Manufacturing Industrial Center (BINMIC) and the Greater Duwamish Manufacturing and Industrial Center (Greater Duwamish MIC). The primary study area is divided into five subareas:

- Ballard
- Interbay Dravus
- Interbay Smith Cove
- SODO/Stadium
- Georgetown/South Park

The primary study area also includes other industrial zones lands within the city.

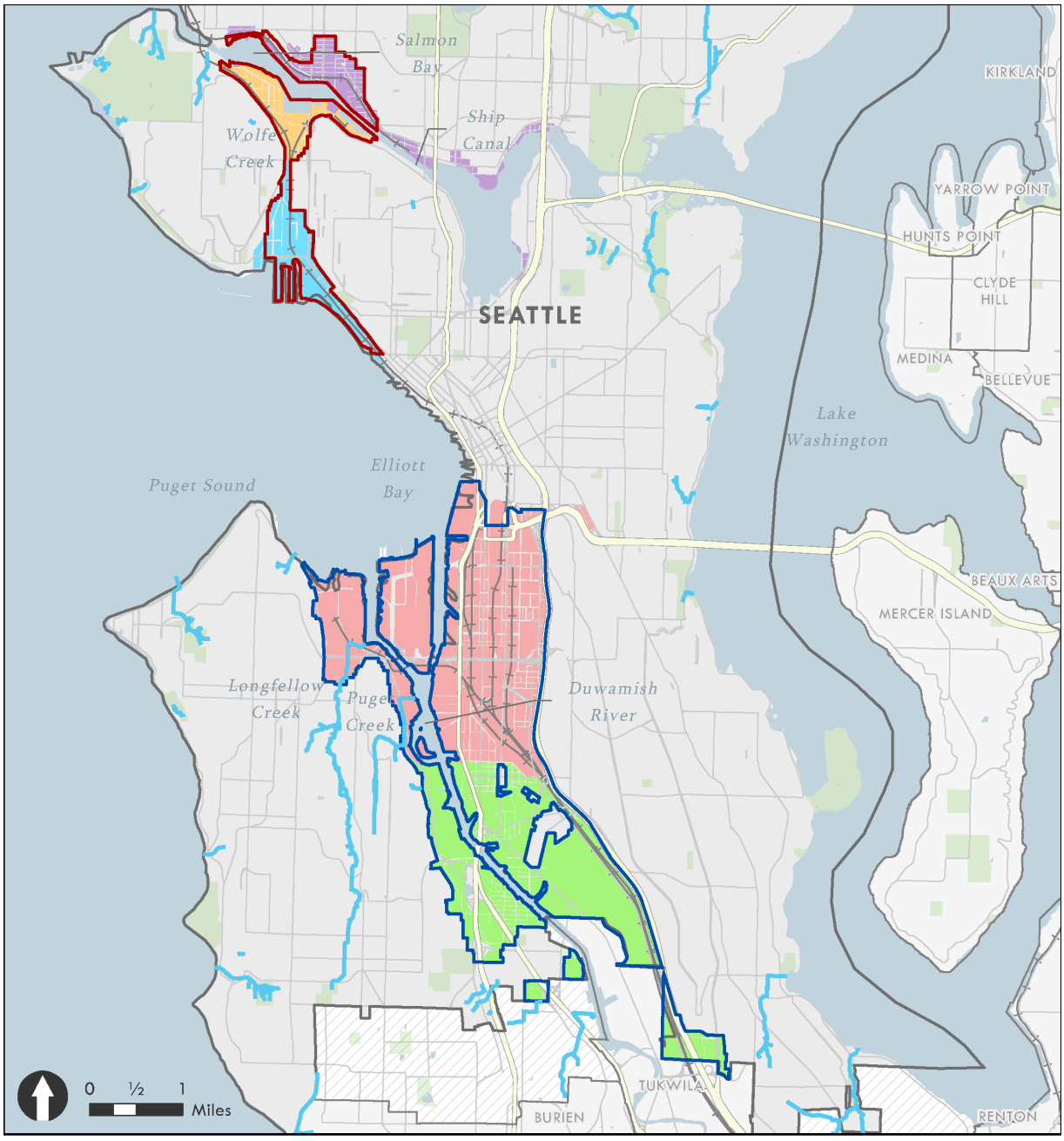
The secondary study area is defined as the area 500 feet from the primary study area because development of the Seattle Industrial and Maritime Lands could affect adjacent water resources.

Exhibit 3.3-1 lists surface water bodies located in each of the subareas, and **Exhibit 3.3-2**, **Exhibit 3.3-3** shows surface water bodies and watersheds of natural streams relative to the Secondary Study Area.

Exhibit 3.3-1 Surface Water Bodies Located in each Subarea

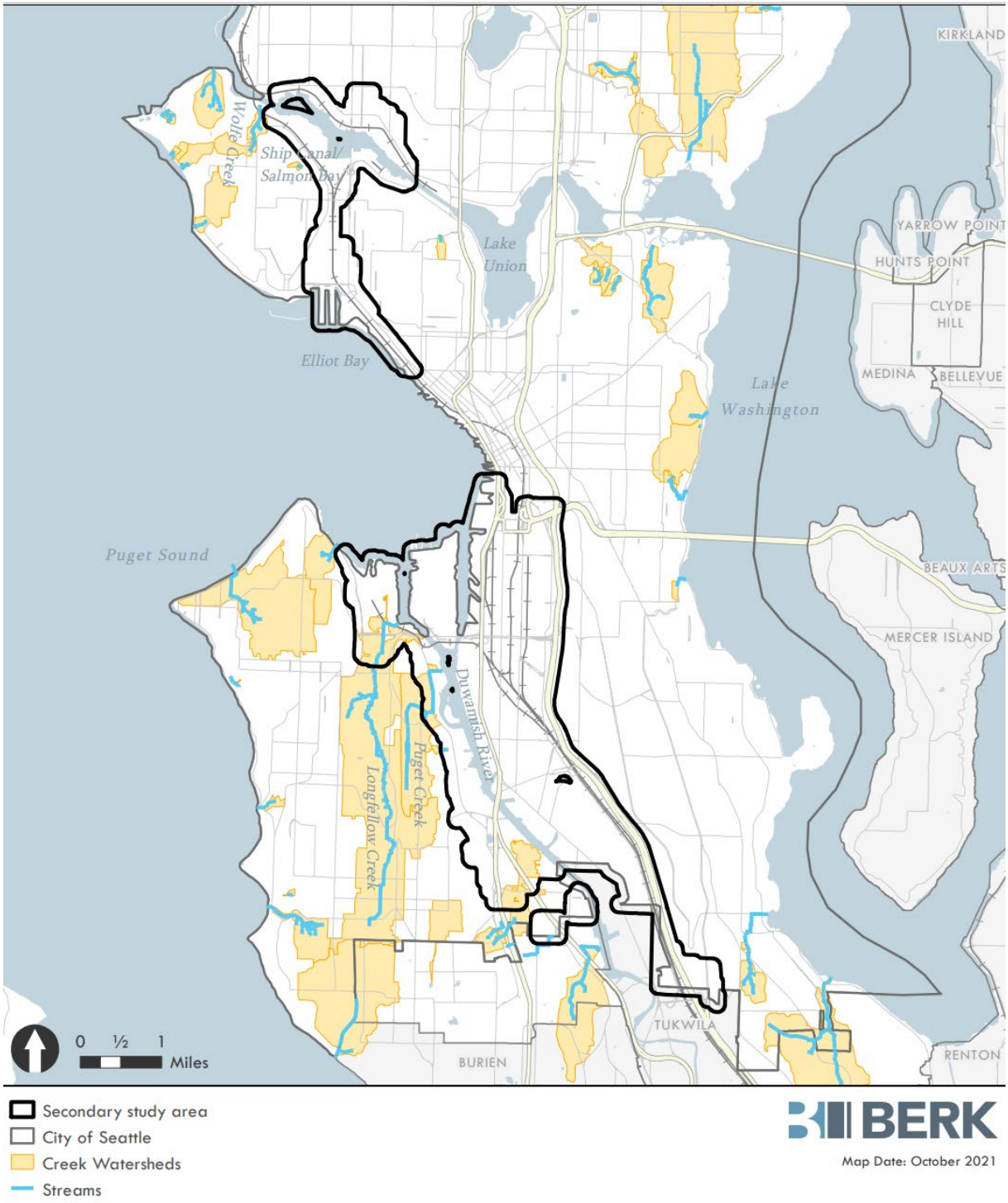
Subarea	Surface Water Bodies
Ballard	Ship Canal/Salmon Bay
Interbay Dravus	Ship Canal/Salmon Bay, Wolfe Creek
Interbay Smith Cove	North Elliott Bay, Puget Sound
SODO/Stadium	Duwamish River, Longfellow Creek, Puget Creek
Georgetown/South Park	Duwamish River

Exhibit 3.3-2 Surface Water Bodies in the Primary Study Area



Sources: Herrera, 2021.

Exhibit 3.3-3 Location of Surface Water Bodies and Watersheds of Natural Streams



Sources: Herrera, 2021.

Data & Methods

Current water quality was determined based upon the Ecology list of Category 5 impaired waters, and existing focus studies of surface, groundwater, and climate change performed in the study area and more broadly in the region.

The project team collected data from the following sources to support analysis of surface and groundwater conditions:

- Ship Canal Water Quality Project Final Facility Plan Prepared for Seattle Public Utilities (CH2M March 2017)
- Seattle Creeks State of the Waters Report (City of Seattle 2007)
- Ecology Water Quality Assessment Database (Ecology 2014)
- Duwamish Basin Groundwater Pathways Conceptual Model Report (Hart Crowser, Inc. 1998)
- Draft EIS Magnolia Bridge Replacement (KPFF Consulting Engineers Shannon and Wilson, Inc. 2005)
- Assessment of Existing Groundwater Quality Data in the Green-Duwamish Watershed, Washington Report 2019-1131 (USGS 2019)
- Wolfe Creek Drainage Feasibility Study Final Report (WR Consulting 2008)
- Projected Sea Level Rise for Washington State (Miller 2018)
- Preparing for Climate Change (City of Seattle 2017)

Current Policy & Regulatory Frameworks

Surface water quality is based upon the Washington State Department of Ecology beneficial uses for each water body in the plan area. Use designations differ for marine and fresh waters. Designated uses for marine waters in WAC 173-201A and for freshwaters in WAC 173201A-600. Aquatic life use is rated higher in Puget Sound (extraordinary) than Elliott Bay (excellent). These marine water bodies are both designated for shellfish harvesting and primary contact recreation (such as swimming), although shellfish harvesting is prohibited for all marine beaches in Seattle due to potential contamination by fecal bacteria and other pollutants.

Aquatic life and recreational uses for the freshwater bodies are highest (core summer habitat and extraordinary primary contact) for the Ship Canal/Lake Union, and the Duwamish River (rearing/migration and secondary contact). All freshwater bodies are designated for water supply uses with the exception that the Duwamish River is not designated for domestic water supply.

Water quality standards developed by Ecology under the Washington Administrative Code 173-201A set limits that are intended to protect aquatic life and recreational uses. The standards depend on the specific use designation for each water body, and they vary for fresh waters (streams, rivers, and lakes) and marine waters (Ecology, 2012a). Numeric standards are established for conventional parameters (common pollutants such as high temperature, low

dissolved oxygen, pH, and turbidity), some toxic substances (mostly metals and some organic chemicals), and fecal bacteria. Under Section 303(d) of the Clean Water Act, Ecology is required to prepare a water quality assessment and develop a list of surface waters (marine and fresh water) that are impaired. This list is periodically prepared by Ecology and submitted to EPA for review and approval. The current active list was published in 2014 (Ecology, 2014).

The Section 303(d) list identifies five categories of water quality impairments:

- Category 1—meets tested standards for clean waters
- Category 2—waters of concern
- Category 3—insufficient data
- Category 4—polluted waters that do not require the establishment of a total maximum daily load (TMDL) for targeted pollutant(s) to allow the achievement of the surface water quality standards
- Category 5—polluted waters that require a TMDL program to establish maximum allowable pollutant discharges.

Groundwater quality is regulated by the Washington State Department of Ecology (Ecology) under the Water Quality Standards for Groundwaters of the State of Washington (Washington Administrative Code 173-200). These standards list the maximum concentrations of contaminants that are allowed in groundwater and prohibit further groundwater contamination.

Shoreline development is regulated at the local level by the Shoreline Master Program (SMP; Seattle Municipal Code 23.60A), which mandates that all shoreline modifications be constructed and managed to achieve no net loss of ecological functions. Shoreline setbacks in the SMP are based on the Ordinary High Water Mark (OHWM) as defined by WAC 173-22-030. The Washington Department of Ecology also provides regulatory oversight of shoreline development through the State Environmental Policy Act (WAC 197-11) and Habitat Project Approval process (WAC 220-660), both of which also use the OHWM as a jurisdictional boundary.

Section 10 of the Rivers and Harbors Act, administered by the US Army Corps of Engineers (USACE), provides for permitting of any work in, over, or under navigable waters of the United Sates, or which affects the course, location, conditions, or capacity of such waters. Regulated activities include docks and piers, marinas, intake and outfall pipes, transmission lines, and dredging. The USACE Seattle District recently redefined its jurisdictional boundary to be the High Tide Line, defined as the “maximum height reached by a rising tide,” which encompasses spring high tides, but not storm surge.

The City of Seattle adopted the 2013 Climate Action Plan (CAP), 2018 Climate Action Strategy and 2017 Preparing for Climate Change includes City actions that will increase resilience to the likely impacts of climate change. Acknowledging that preparing for climate change impacts is a complex challenge, the CAP includes proactive planning for major infrastructure to include future projected conditions to prevent costly repairs or retrofits. The CAP also provides for

community equity in planning for climate impacts, with priority given to actions that help vulnerable populations moderate potential impacts. Sea level rise projections that apply to the BINMIC and Greater Duwamish MIC are described below.

Section 3.14 summarizes stormwater related policies and regulations that pertain to new development and redevelopment within the BINMIC and Greater Duwamish MIC, including City policies related to accounting for climate change in utility planning.

Current Conditions

Full Study Area

Surface Water

Water bodies located solely in the BINMIC study area include the Ship Canal (and Salmon Bay) and Wolfe Creek. Water bodies located solely in the Greater Duwamish MIC study area include the Duwamish River, Wolfe Creek, Longfellow Creek, and Puget Creek.

Puget Sound is a fjord-like estuary that stretches from Hood Canal to north of Admiralty Inlet. Freshwater flows influence water circulation in this portion of Puget Sound. Two main freshwater bodies flow into Puget Sound in the study area, the Green/Duwamish River, which enters Elliott Bay, and the Cedar River (Lake Washington drainage basin), which flows into the Sound through Lake Washington and the Ship Canal.

Elliott Bay is a partially enclosed embayment that is bordered on the north, east, and south sides by urbanized areas of Seattle and by Puget Sound on the west. The northern shoreline borders the Interbay Smith Cove Subarea, and the southern shoreline borders the SODO/Stadium Subarea. Both the southern and northern portions of Elliott Bay are heavily altered by industrial facilities.

The Lake Washington Ship Canal system is an 8.6-mile-long navigable waterway, completed in 1934, connecting Shilshole Bay in Puget Sound to Union Bay in Lake Washington. The system is bordered by the Ballard Subarea to the north and Interbay Dravus Subarea to the south. The Ship Canal includes several interconnected waterways—Hiram M. Chittenden Locks (Ballard Locks), Salmon Bay, Salmon Bay Waterway, Fremont Cut, Lake Union, Portage Bay, and Montlake Cut. The Ship Canal borders the Ship Canal Neighborhoods on the west end and the Lake Washington Neighborhoods on the east end. Lake Union is a freshwater lake that receives most of its inflow from Lake Washington via the Montlake Cut and Portage Bay.

Wolf Creek is a small stream located in the Dravus Bay subarea, with a watershed of approximately 90 acres, located in the Magnolia Neighborhood, which flows into Salmon Bay. It is highly modified with approximately 3,100 feet of open channel.

The Duwamish River originates at the confluence of the Green and Black Rivers near Tukwila and flows northwest for approximately 12 miles, splitting at the southern end of Harbor Island

to form the East and West Waterways before discharging into Elliott Bay. The Duwamish River extends through both the SODO/Stadium and Georgetown/South Park subareas. The downstream portion of the Duwamish River serves as a major shipping route for bulk and containerized cargo. A portion of the lower Duwamish River is maintained as a federal navigation channel by the Corps of Engineers.

Longfellow Creek is approximately 3.5 miles in length and is a tributary of the Duwamish River discharging to the Duwamish River in the SODO/Stadium Subarea. It is one of the four largest streams in the City of Seattle with a watershed size of 2,685 acres. The creek originates in the Roxhill Park neighborhood, flows north along the valley of the Delridge Neighborhood of West Seattle, and then flows into the Duwamish Waterway.
Puget Creek is located in the SODO/Stadium Subarea on the eastern side of West Seattle and drains to the Duwamish River.

Groundwater

Because of the presence of a municipal water system in the Seattle area and the sources not located in the study area, groundwater use is generally limited to emergency and industrial supply wells for non-drinking use. No drinking water wells, wellhead protection areas, critical aquifer recharge areas, or sole source aquifers are identified in the study area. Numerous observation and test groundwater quality monitoring wells are present in the study areas due to historical industrial contamination and monitoring of clean-up projects.

Sea Level Rise

Seal levels in Elliot Bay have been monitored by the National Oceanic and Atmospheric Administration since 1899 (gauge #9447130). Observations are representative of the unrestricted tidal regions in the study area, but not the waterways within the Ship Canal system, which are controlled by the system of locks. Sea levels at the gauge have historically risen at a rate of 0.68 feet in 100 years. By comparison, recent work by the UW Climate Impacts Group (Miller et al. 2018) provide central to high-end estimates of future sea level rise of 2.3-5.1 feet by 2100. Sea level rise projections apply to all tidally influenced water bodies including Puget Sound, Elliott Bay, and the Duwamish River and may also affect water levels near the outlets of creeks in the primary study area. Ship Canal and Lake Union are above the Hiram M. Chittenden Locks so they are not affected by sea level rise. Sea level rise may also affect groundwater levels in the study area, which has the potential to cause flooding and affect underground infrastructure, including the wastewater, combined sewer, and stormwater infrastructure described in **Section 3.14 Utilities**.

Subareas

Ballard & Interbay Dravus

King County has characterized water in the Ship Canal and Lake Union as “fair” for most parameters important to fish and wildlife (temperature, dissolved oxygen, pH, and nutrients) and to humans (fecal coliform bacteria). The water in these areas is flushed rapidly with good quality outflow from Lake Washington. Salmon Bay is on the 303(d) list for total phosphorus, fecal coliform bacteria, lead, and aldrin.

There is no summary water quality data for Wolfe Creek and no 303(d) category 5 listings.

Groundwater elevation in the Ship Canal area is generally a shallow confined aquifer and ranges from 10 to 30 feet below the ground surface. Groundwater discharge from the shallow unconfined aquifer is primarily into the Ship Canal. Shallow groundwater wells have shown contamination for petroleum hydrocarbons (oil and gasoline), heavy metals (such as arsenic, chromium, lead, and mercury), dry cleaning and degreasing solvents (such as trichloroethylene and tetrachloroethylene) and asbestos.

Interbay Smith Cove

In general, the overall water quality in Puget Sound and Elliott Bay is good based on water quality parameters such as bacteria, nutrients, temperature, chlorophyll, dissolved oxygen, solids, and transparency. However, fecal coliform bacteria have exceeded allowable levels in some areas of these marine waters, most notably Elliott Bay, that are included on the 303(d) list of impaired waters.

The predominant groundwater flow system area consists of a shallow unconfined aquifer system. A lesser predominant system includes a deep artesian aquifer located approximately 300-400 feet below sea level (KPFF Consulting Engineers Shannon and Wilson, Inc. 2005). Groundwater elevations in the north Elliott Bay area is generally a shallow unconfined aquifer that ranges from 5 to 15 feet below the ground surface. Groundwater discharge from the shallow unconfined aquifer is primarily into Elliott Bay to the south. Contaminants detected in shallow groundwater include petroleum hydrocarbons, volatile organic compounds (VOC's), polycyclic aromatic hydrocarbons (PAH's), polychlorinated biphenyls (PCBs), and dissolved metals (KPFF Consulting Engineers Shannon and Wilson, Inc. 2005).

SODO/Stadium

The Duwamish River is included on Ecology’s 303(d) category 5 list as impaired waters for fecal coliform bacteria, temperature, pH, and dissolved oxygen.

Longfellow Creek is included on Ecology’s 303(d) category 5 list as impaired waters for fecal coliform bacteria, temperature, pH, and dissolved oxygen.

There is no summary surface water quality data for Puget Creek and no 303(d) category 5 listings.

The groundwater flow system is common between the Georgetown/South Park and SODO/Stadium subareas. Groundwater is generally a regional discharge due to its low elevation and surface water outlet at Elliott Bay. Groundwater is typically 5 to 15 feet below the ground surface. Tidal influence is present within 300 to 500 feet of the river where groundwater may fluctuate several feet and may rise in elevation as a result of sea level rise. Groundwater flow is generally to the Duwamish River (Hart Crowser, 1998). A recent summary of shallow groundwater wells by USGS showed contamination for all classes of chemicals selected for research. Contaminants researched and confirmed were petroleum hydrocarbons (oil and gasoline), heavy metals (arsenic, zinc, and copper), polychlorinated biphenyls (PCBs), and phthalates (USGS 2019).

The shoreline of the SODO/Stadium Subarea surrounding the Lower Duwamish River and the mouths of Longfellow Creek and Puget Creek are vulnerable to sea level rise.

Georgetown/South Park

The Duwamish River and groundwater system extends through both the Georgetown/South Park and SODO/Stadium subareas so that the current conditions described above for that subarea apply in the Georgetown/South Park Subarea. Significant portions of both the Georgetown and South Park neighborhoods are susceptible to sea level rise. Areas in Georgetown are primarily vulnerable to rising groundwater levels, including areas northeast and southwest of Marginal Way, while South Park is primarily vulnerable to water overtopping the banks of the Duwamish River.

3.3.2 Impacts

Impacts Common to All Alternatives

Surface Water & Groundwater

Rainfall runoff from a portion of the Study Area discharges to natural streams including, Longfellow Creek, Puget Creek, and Wolf Creek, which are sensitive to increased flow rates or water quality impacts that could result from increases in impervious surfaces. Other water bodies including the Duwamish River, Puget Sound, and Ship Canal / Salmon Bay are only sensitive to changes in water quality that could be caused by increases in impervious surfaces or changes in land use. However, nearly all the Study Area that is feasible to develop has already been covered with a high percentage of impervious surface. Therefore, redevelopment expected under all Alternatives is not expected to significantly increase total impervious area or result in significant increases in flow rates or water quality impacts.

The Seattle Stormwater Code (SMC Title 22, Subtitle VIII) requires redevelopment projects in the Study Area to implement on-site stormwater management to infiltrate, disperse, and retain stormwater runoff to the maximum extent feasible. Where the developed site's stormwater flow rates or pollutant generation potential is expected to exceed the allowable thresholds, flow control and/or water quality treatment are required. As a result of these requirements and given that much of the existing development predates modern stormwater requirements, it is expected that there would be a reduction in uncontrolled flow rates and an increase in water quality in the Primary Study Area under all of the alternatives where new construction is anticipated.

The 2021 Stormwater Code also supports incentives for retrofitting existing development, such as opportunities for property owners to reduce their drainage rate if they install flow control and/or treatment facilities designed per the Code, which can include reducing impervious surfaces.

Under all Alternatives, including Alternative 1 No Action, implementation of on-site stormwater management and continuation of retrofit incentives would continue to reduce adverse impacts to all surface water bodies in the Study Area.

Under all alternatives, development and redevelopment projects have the potential to generate stormwater pollution during construction. The Seattle Stormwater Code requires all projects to implement Temporary Erosion and Sediment Control (TESC) stormwater management best management practices (BMPs) during construction that will minimize these impacts.

Under all Alternatives, traffic would increase within the Study Area, which has the potential to introduce metals and other pollutants to ground surfaces, which could contribute to surface water or groundwater pollution. In portions of the Study Area where stormwater discharges to the combined sewer system, these pollutants would be treated by the West Point Wastewater Treatment Plant, so no water resource impacts are expected from these areas. In areas where stormwater discharges to surface water bodies, improvements in vehicle standards and the application of stormwater requirements described above as parcels and roadways are redeveloped and upgraded is expected to offset the increase in traffic and potentially lead to a net decrease in surface water pollution.

The Seattle Stormwater Code requires redevelopment projects in the Study Area to consider infiltration as a means of managing stormwater, which could improve groundwater recharge under all Alternatives. The Code also requires review of the existing site conditions for potential soil or groundwater contamination, which would make infiltration infeasible in cases where the infiltration could mobilize existing pollutants in the soil (see **Section 3.5 Contamination**). In places where infiltration is feasible, the 2021 Stormwater Code requires infiltration facilities to protect groundwater quality.

With growth there is the potential for increased risk of spills from industrial activities, industrial processes, or use of industrial chemicals or other organics (see **Section 3.5 Contamination**). The Seattle Stormwater Code and Washington State Industrial Stormwater General Permit

require implementation of source control measures for developments that store liquids that could be spilled and impact groundwater. The use of source control BMPs would limit that risk, and any spills would be cleaned up quickly consistent with applicable state and local requirements and no significant impacts to surface or groundwater are anticipated. None of the Alternatives are expected to reduce groundwater recharge, increase the potential for groundwater contamination, or increase mobilization of groundwater pollutants relative to existing conditions.

Sea Level Rise

Under all alternatives, low-lying areas adjacent to tidally influenced water bodies (Puget Sound, Elliott Bay, the Duwamish River, and the mouths of Longfellow Creek and Puget Creek) have the potential to be affected by sea level rise. These areas include portions of the Interbay Smith Cove, SODO/Stadium, and Georgetown/South Park subareas. Sea level rise vulnerability mapping is available from the City of Seattle and through the project StoryMap. Both maps portray results of the 2018 Washington Coastal Resilience Project report ("Projected Sea Level Rise for Washington State"). King County has infrastructure in these areas including wastewater pump stations, wastewater regulator stations, and wastewater odor control facilities that could be affected by sea level rise. The Interbay Dravus and Ballard Subareas are above the Hiram M. Chittenden Locks so they are not affected by sea level rise.

Under all Alternatives, proposed development in areas that are susceptible to impacts from extreme high tides would be required to comply with critical areas regulations for frequently flooded areas, which is regulated through the City's Environmentally Critical Areas (ECA) Code; the requirements of the Shoreline Master Program (SMP; Seattle Municipal Code 23.60A) also apply to development along the shoreline. Compliance with these codes may reduce vulnerability of those developments to sea level rise impacts relative to existing conditions.

Subarea Impacts

As described above, all alternatives are expected to result in a net improvement in water resources as newer development with modern stormwater management facilities replaces older development that lacks onsite stormwater management or flow control and water quality facilities. In general, alternatives that would result in more redevelopment would result in more improvements to water resources. Based on the square footage of new employment space and housing units added under each alternative, improvements to water resources are expected to be highest under Alternative 4 and lowest under the No Action Alternatives (see **Exhibit 3.3-4**).

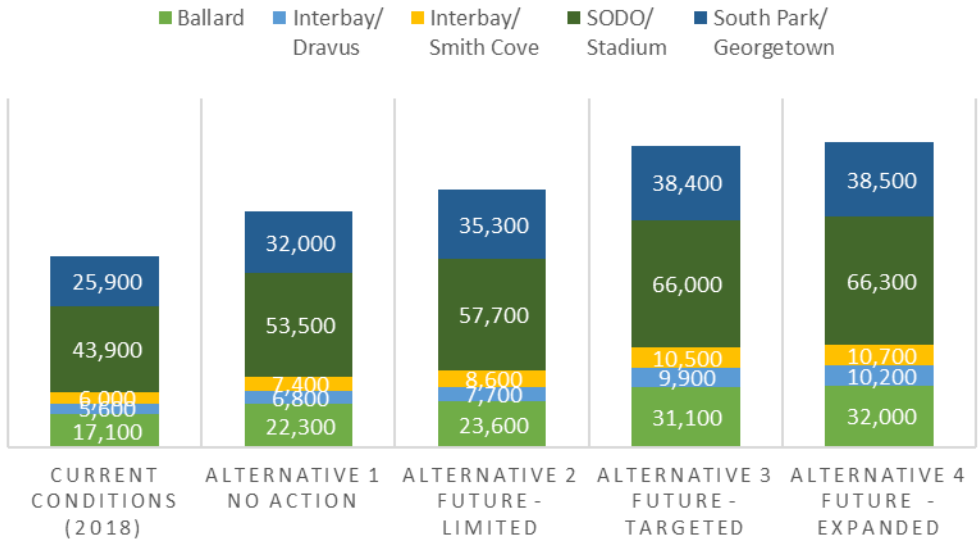
Exhibit 3.3-4 Comparison of Relative Water Resource Improvements Between Alternatives

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Square Footage of New Employment Space	11,230,000	19,805,000	27,400,000	27,760,000
Housing Units Added	75	80	1,688	3,273
Relative Rank of Improvements to Water Resources	4th	3rd	2nd	1st

Sources: City of Seattle, 2021; BERK, 2021; Herrera, 2021.

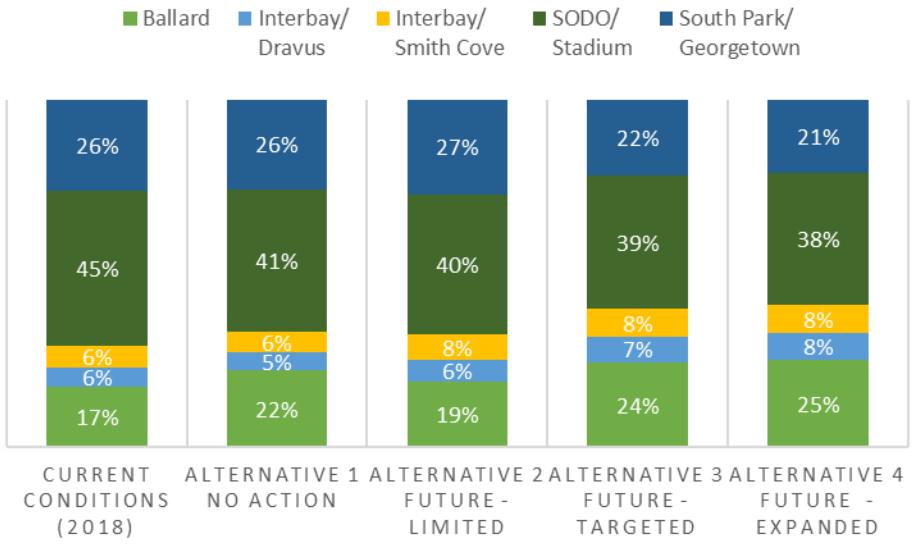
Total jobs in each subarea shows that the SODO/Stadium and Georgetown/South Park subareas have the most jobs currently and would still have the most jobs in the future. See **Exhibit 3.3-5**. The Ballard Subarea would increase its share of jobs particularly in alternatives 3 and 4 compared to other alternatives. See **Exhibit 3.3-6**. To a smaller degree the Interbay Dravus and Interbay Smith Cove subareas would also increase their share of jobs under the Action Alternatives compared to current or Alternative 1 No Action conditions.

Exhibit 3.3-5 Total Jobs by Subarea Current and Future



Sources: City of Seattle, 2021; BERK, 2021.

Exhibit 3.3-6 Share of Job Growth by Subarea Compared to Existing



Sources: City of Seattle, 2021; BERK, 2021.

Ballard

Salmon Bay is listed as an impaired water body for total phosphorus and fecal coliform bacteria. Redevelopment sites may be required to provide phosphorus treatment if discharging to Salmon Bay. Water quality treatment at redevelopment sites will reduce fecal bacteria impacts at sites that redevelop. Ballard is not expected to be vulnerable to sea level rise because it is above the Ballard Locks.

Interbay Dravus

Salmon Bay is listed as an impaired water body for total phosphorus and fecal coliform bacteria. Redevelopment sites may be required to provide phosphorus treatment if discharging to Salmon Bay. Water quality treatment at redevelopment sites will reduce fecal bacteria impacts at sites that redevelop. Interbay Dravus is not expected to be vulnerable to sea level rise because it is above the Ballard Locks.

Interbay Smith Cove

Elliott Bay is listed as an impaired water body for fecal coliform bacteria. Water quality treatment at redevelopment sites will improve fecal bacteria impacts at sites that redevelop. Minor portions of Interbay Smith Cove at Pier 90 and Elliott Avenue are vulnerable to sea level rise.

SODO/Stadium

The Duwamish River and Longfellow Creek are each listed as an impaired water bodies for fecal coliform bacteria, temperature, pH, and dissolved oxygen. Water quality treatment at

redevelopment sites will reduce fecal bacteria and other pollutant impacts. The shoreline of the SODO/Stadium Subarea surrounding the Lower Duwamish River and the mouths of Longfellow Creek and Puget Creek are vulnerable to sea level rise and all alternatives, including the No Action Alternative, would increase the concentration of people in these vulnerable areas. Compliance with requirements of the SMP and frequently flooded areas requirements at redevelopment sites, in addition to adaptation measures listed in the mitigation section, may help reduce vulnerability to sea level rise in some portions of the subarea.

Georgetown/South Park

The Duwamish River and Longfellow Creek are each listed as an impaired water body for fecal coliform bacteria, temperature, pH, and dissolved oxygen. Water quality treatment at redevelopment sites will reduce fecal bacteria and other pollutant impacts at sites that redevelop.

Significant portions of both Georgetown and South Park neighborhoods are susceptible to sea level rise and all Alternatives, including the No Action Alternative, would increase the concentration of people in these vulnerable areas. Compliance with requirements of the SMP and frequently flooded areas requirements at redevelopment sites, in addition to adaptation measures listed in the mitigation section, may help reduce vulnerability to sea level rise in some portions of the subarea.

Other Industrial Zoned Lands

Growth would result in mitigation of stormwater at redevelopment sites. Lake Union is listed as an impaired water body for fecal coliform bacteria and temperature. Elliott Bay is listed as an impaired water body for fecal coliform bacteria. Water quality treatment at redevelopment sites will reduce fecal bacteria and other pollutant impacts at sites that redevelop.

Equity & Environmental Justice Considerations

Increases in impervious surface can negatively affect surface water quality, which can disproportionately affect populations with a higher reliance on water resources for sustenance, such as subsistence fishers or Tribes. Poor water quality also poses health risks for populations that come in physical contact with surface water bodies. As described above, all Alternatives are expected to result in a net improvement in water quality and therefore reduce negative impacts on these populations as they relate to water resources.

The Seattle Mapping Inventory of Changing Coastal Flood Risk provides a screening level picture of the impacts of sea level rise on Seattle. The analysis reveals that the communities most impacted by flooding are also disproportionately characterized by high levels of social vulnerability, most notably in the Georgetown/South Park Subarea.

Impacts of Alternative 1 No Action

Surface Water & Groundwater

Impacts resulting from Alternative 1 No Action would be the same as described in the discussion of Impacts Common to All Alternatives. Compared to the Action Alternatives, there is likely to be less redevelopment in the Primary Study Area and the least improvements in surface water and groundwater that would result from installation of onsite stormwater management, flow control, and water quality treatment at redevelopment sites.

Sea Level Rise

Impacts resulting from Alternative 1 No Action would be the same as described in the discussion of Impacts Common to All Alternatives.

Impacts of Alternative 2

Surface Water & Groundwater

Alternative 2 includes greater change and densification of industrial zones than Alternative 1 which would result in increased implementation of on-site stormwater management and improvements to water resources on sites that redevelop. Alternative 2 would apply a mix of II and UI zone concepts in approximately 10% of current MIC areas. These concepts would increase the number of trees and landscaping, and green spaces, which would provide opportunities for stormwater treatment and water resource improvements. Water quality and flow control improvements would be less than alternatives 3 and 4.

Sea Level Rise

Alternative 2 includes more growth in the SODO/Stadium and Georgetown/South Park subareas than Alternative 1. These areas are substantially susceptible to sea level rise so Alternative 2 may increase vulnerability to sea level rise more than Alternative 1 by bringing more people into vulnerable areas. Through compliance with SMP and frequently flooded areas requirements, some of the development could reduce sea level rise vulnerability in areas near the shoreline more than Alternative 1, but less than alternatives 3 and 4.

Impacts of Alternative 3

Surface Water & Groundwater

Alternative 3 increases job growth and housing units in industrial and non-industrial areas more than alternatives 1 and 2 but less than Alternative 4. Implementation of on-site stormwater management at redevelopment sites would continue to reduce adverse impacts to

all surface water bodies in the Study Area. Alternative 3 would apply a mix of II and UI zone concepts in approximately 14% of current MIC areas, the most of any alternative, which would increase the number of trees and landscaping, and green spaces, which would provide opportunities for stormwater treatment and water resource improvements. Alternative 3 has greater residential growth than Alternatives 1 or 2 but less than Alternative 4. With increased residential units, pet waste and fecal coliform pollution may be increased.

Relative water resource improvement under Alternative 3 would be greater than alternatives 1 and 2 but less than Alternative 4.

Sea Level Rise

Alternative 3 includes more growth in the SODO/Stadium and Georgetown/South Park subareas than alternatives 1 and 2. These areas are substantially susceptible to sea level rise so Alternative 3 may increase vulnerability to sea level rise more than alternatives 1 and 2 by bringing more people into vulnerable areas. Through compliance with SMP and frequently flooded areas requirements, and incorporation of adaptation measures, some of the development could reduce sea level rise vulnerability in areas near the shoreline more than alternative 1 and 2, but less than Alternative 4.

Impacts of Alternative 4

Surface Water & Groundwater

Alternative 4 has the greatest increase of job growth and housing units in industrial and non-industrial areas. Because this alternative has the highest potential for redevelopment, it would also likely have the highest increase in on-site stormwater management flow control or water quality treatment, which could result in the greatest improvements in surface water and groundwater. Alternative 4 would apply a mix of II and UI zone concepts in approximately 13% of current MIC areas, only slightly less than Alternative 3, and would result in the creation of green spaces and landscaped areas that provide similar opportunities for stormwater retrofits and water resource improvements.

Alternative 4 has the greatest increase in residential units and therefore the highest potential for pet waste and fecal coliform pollution.

Sea Level Rise

Alternative 4 targets the highest growth in the SODO/Stadium and Georgetown/South Park subareas. These areas are substantially susceptible to sea level rise so Alternative 4 may increase vulnerability to sea level rise more than other Alternatives bringing the most people into vulnerable areas. Through compliance with SMP and frequently flooded areas requirements, and incorporation of adaptation measures, some of the development could reduce sea level rise vulnerability in areas near the shoreline more than the other Alternatives.

3.3.3 Mitigation Measures

Incorporated Plan Features

There are no incorporated plan features.

Regulations & Commitments

Regulatory requirements for addressing water resource impacts would be met under each Alternative, as discussed above in **Section 3.3.1 Affected Environment**, below, and in the Utilities Section. If thresholds listed in the City's stormwater management standards are exceeded as redevelopment occurs, projects would be required to provide BMPs to the maximum extent feasible to infiltrate, disperse, or retain stormwater runoff. Projects would also be required to provide water quality treatment to reduce pollution levels in stormwater, and flow control to reduce flow rates as thresholds are exceeded. Compliance with these regulations is anticipated to result in a net benefit to water resources under all Alternatives.

A majority of development and redevelopment projects would be parcel-based and require source control BMPs to the extent necessary to prevent prohibited discharges and to prevent contaminants from coming in contact with drainage water or being discharged to the drainage system, public combined sewer, or directly into receiving waters (City of Seattle Stormwater Manual, Volume 1, Chapter 2).

An individual project's plan for the type of surface that is new and replaced determines the requirement for water quality treatment. In general, pollution-generating hard surfaces (vehicular traffic, industrial activities, storage of wastes or chemicals) require a higher level of treatment over pollution-generating pervious surfaces (lawns, landscaping areas, parks).

Development and redevelopment projects would be required to conduct a downstream analysis of the runoff leaving the project site. This analysis is based upon the receiving water or point of discharge and is subject to review and approval or disapproval by the SPU Director. Due to the complexity of the City drainage system (creeks, ditches, combined sewer with capacity, combined sewer without capacity, small lakes, and designated receiving water) each project will be unique for the analysis and result.

Surface and groundwater quality at industrial and business sites are protected through ongoing inspection programs, which also applies to new development. Industrial permits issued and managed by the Washington State Department of Ecology and held by individual properties are inspected and held to source control BMPs. In some cases, depending on the industrial activity, properties are held to chemical discharge limits. Seattle Public Utilities conducts site inspections of all industrial and business properties with the potential to pollute surface and groundwaters through its NPDES Stormwater Phase 1 permit-requirements and local code (SMC 22.803.040).

Other Potential Mitigation Measures

Alternatives 3 and 4 result in the greatest increase in housing in portions of the Ballard and SODO/Stadium Subareas, which could create a larger concentration of pets and associated animal waste and a potential to impact local surface water quality. An increased emphasis on pet waste management through education and outreach and increased pet waste disposal stations should be implemented in areas surrounding these housing developments to prevent negative impacts on water quality.

All Alternatives, including the No Action Alternative, would increase the concentration of people in SODO/Stadium and Georgetown/South Park Subareas, which have large geographic areas that are vulnerable to sea level rise impacts. The City of Seattle Office of Sustainability and Environment (2017) has identified the following adaptation strategies that should be prioritized by the City and partner agencies as a means of reducing vulnerability to sea level rise in the Study Area:

- Explore further opportunities to incentivize or require existing building upgrades to improve preparedness for future climate conditions.
- Develop mechanisms to incorporate climate preparedness and passive survivability into the planning and development processes for new development.
- Consider the disproportionate impacts of climate change on communities of color and lower income communities in planning, policies, and programs, and prioritize programs and incentives that mitigate those impacts.
- To reduce flood risk and reduce flood insurance rates, evaluate the benefits and costs of participating in the National Flood Insurance Community Rating System program.
- Evaluate the requirements of the Floodplain Development Ordinance to identify additional opportunities to reduce food hazards, including the base flood elevation threshold, the definition of a substantial improvement, and the regulation of footbridges and other potential obstructions to stream flow.
- Regularly update flood prone area maps to incorporate the latest data near creeks, shorelines, and other emerging urban flooding areas.
- Conduct a detailed coastal study of the Duwamish River to better delineate the current and increasing risk of flooding and identify a range of mitigation strategies to pursue.
- Assess the benefits of incorporating rolling easements into the next update of the Shoreline Master Plan.
- Continue to incorporate Green Stormwater Infrastructure (GSI) into development regulations.
- The City should also evaluate vulnerability of underground infrastructure to higher groundwater levels.

3.3.4 Significant Unavoidable Adverse Impacts

Under all proposed alternatives, any redevelopment or new development will require compliance with all applicable regulations to avoid, minimize, or mitigate any impacts to water resources. Development will need to meet stormwater requirements to protect surface and groundwater from increased flow or water quality impacts. Therefore, no significant unavoidable adverse impacts are anticipated on water resources under any of the proposed alternatives.