4 Climate Change Considerations for Stormwater Planning

This chapter describes expected changes to SLR in Puget Sound and expected changes in precipitation patterns in western Washington.

Observed sea level trends show an increase in SLR of 1 inch every 55.6 years (Cherry Point, Washington tidal gage) and 1 inch every 21.3 years (Friday Harbor, Washington tidal gage). These are the closest tidal gages to Bellingham with applicable data. Bellingham has a tidal gage; however, it is relatively new with only 2 years of data, and would not be sufficient to use for analysis yet. Ideally, at least 30 years of recent data are necessary for SLR trend analysis.

Projected sea level trends were graphed with high and low greenhouse gas (GHG) estimates. Both projections show an increase in SLR.

Projected precipitation intensities were analyzed with high and low GHG estimates. The trends overall show increasing precipitation intensities.

4.1 Historical Sea Level Trends

The nearest tidal gage to Bellingham, Washington, is the Cherry Point tidal gage, which has a period of record from 1973 to 2018, shown below in Figure 4-1 (NOAA 2020). This graph shows a relative sea level trend of 0.45 millimeter per year, which equates to 0.018 inch per year or 1 inch every 55.6 years. However, these data should be used cautiously as the margin of error is twice the yearly value.

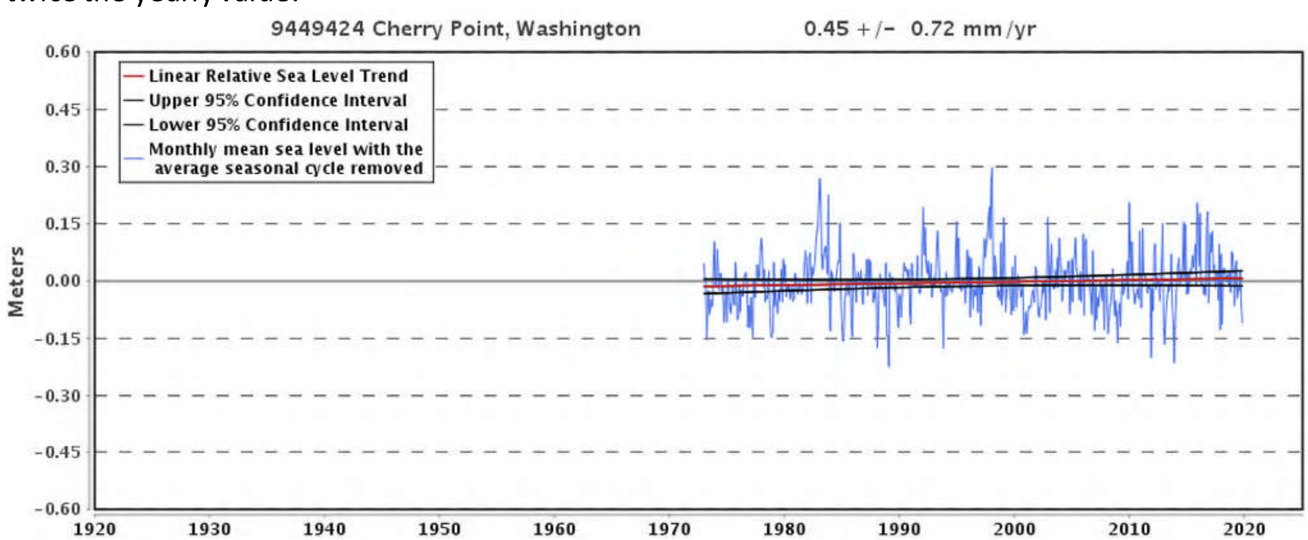

Figure 4-1. Cherry Point sea level trend

The nearby tidal gage of Friday Harbor was also analyzed as it had a longer period of record, thus providing more accurate analysis for historical trends. The period of record of the Friday Harbor tidal gage, which is from 1934 to 2018, is shown below in Figure 4-2 (NOAA 2020). This graph shows a relative sea level trend of 1.2 millimeters per year, which equates to 0.047 inch per year or 1 inch every 21.3 years. The Friday Harbor error margin is more reasonable for analysis.

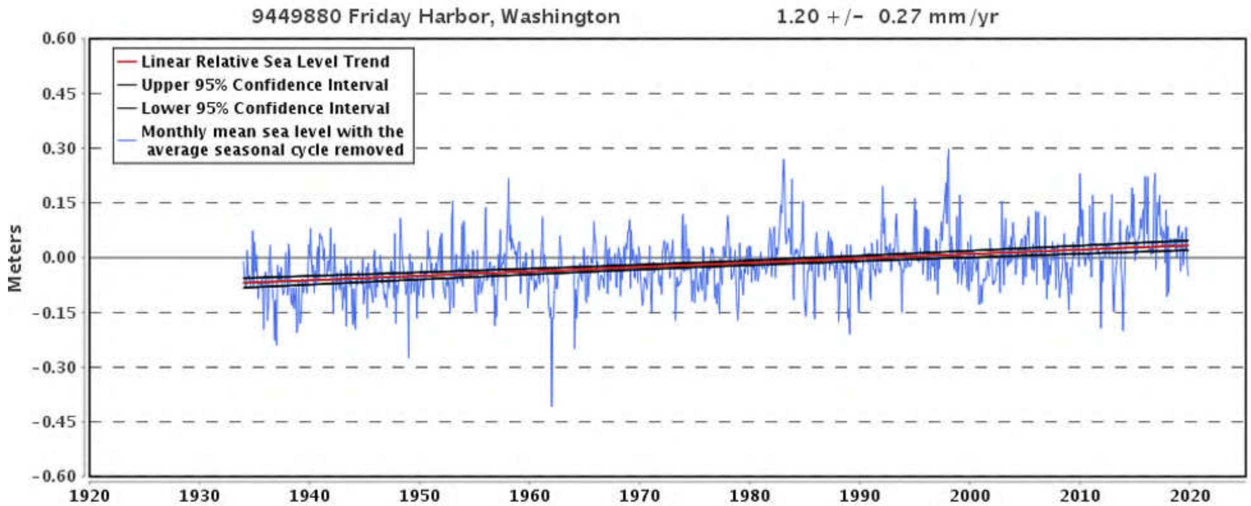

Figure 4-2. Friday Harbor sea level trend

4.2 Projected Relative Sea Level Change

A recent study of projected SLR within Puget Sound was conducted by Washington Sea Grant, University of Washington (UW) Climate Impacts Group (CIG), University of Oregon, University of Washington, and the United States Geological Survey (USGS). The report, titled “Projected Sea Level Rise for Washington State,” provides projections in SLR across the state of Washington including the city of Bellingham (UW 2018). The following evaluations are based on Representative Concentration Pathways 4.5 and 8.5. The Representative Concentration Pathway is a GHG concentration trajectory standard adopted by the Intergovernmental Panel on Climate Change (IPCC). Representative Concentration Pathway 8.5 is a predicted trajectory based on very high GHG concentrations, while Representative Concentration Pathway 4.5 is considered moderate concentrations.

Figure 4-3 and Figure 4-4, shown below, graph these SLR projections for two different forecasted GHG emissions for the years 2030, 2050, and 2100. Figure 4-3 shows a Representative Concentration Pathway of 4.5, which projects a reduction scenario in which significant GHG mitigation policy is implemented. Figure 4-4 shows a Representative Concentration Pathway of 8.5, which projects very high GHG emissions without additional efforts to constrain emissions.

The UW CIG estimates that the median value of relative SLR in Bellingham Bay will be between 0.9 foot and 1.1 feet by 2070. The modeling of the flood reduction alternatives for this SSWCP was run assuming the tidal boundary condition was raised by 1.1 feet. As can be seen in Figure 4-3, even a 2-foot rise by 2070 has approximately 1 percent probability of exceedance. Setting a higher SLR expectation may not be prudent given the minor impact to levels of service and the relative short life span of built stormwater assets (usually 50 years) compared to the SLR adjustments that can be made over the next 20 to 30 years. In comparison to the SLR analysis used on the stormwater assets, the City requirements for building structures (deemed to last considerably longer than storm sewers) along the waterfront are using 55 inches of SLR as their time frame for protection.

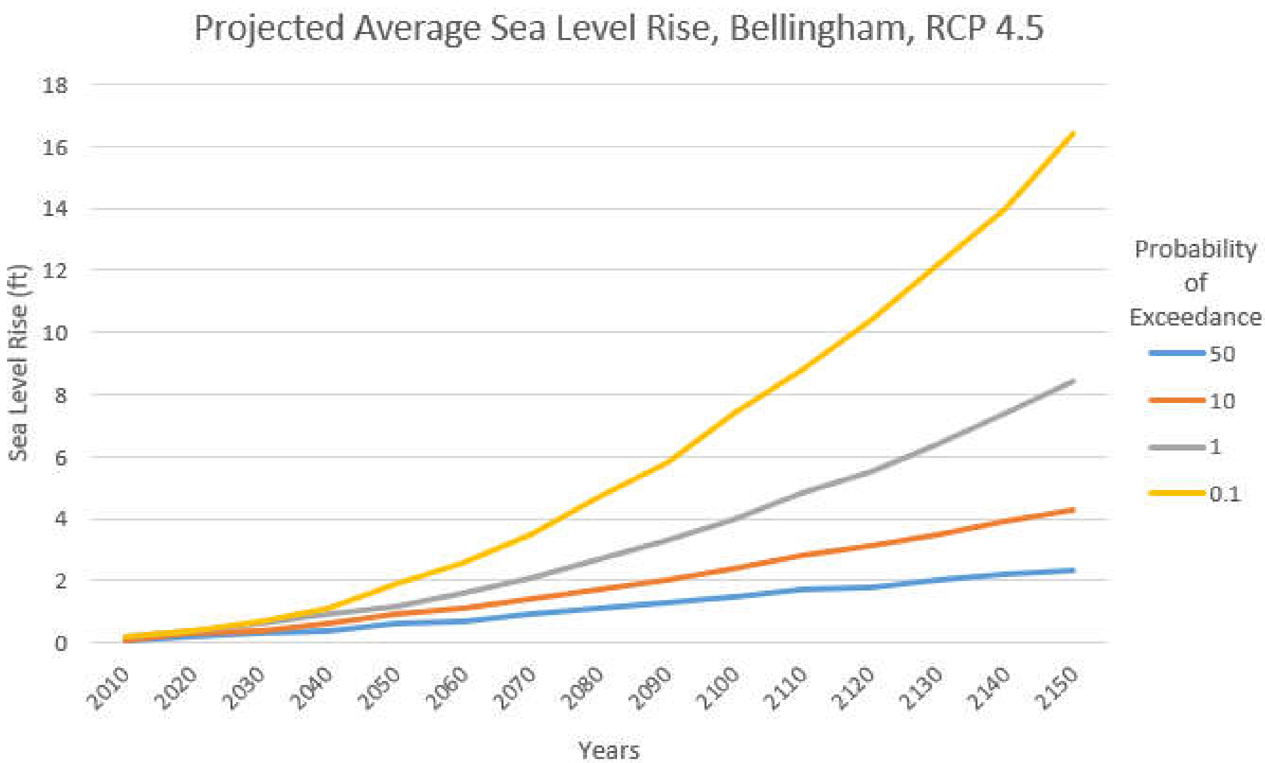

Figure 4-3. Bellingham projected sea level rise, Representative Concentration Pathway 4.5

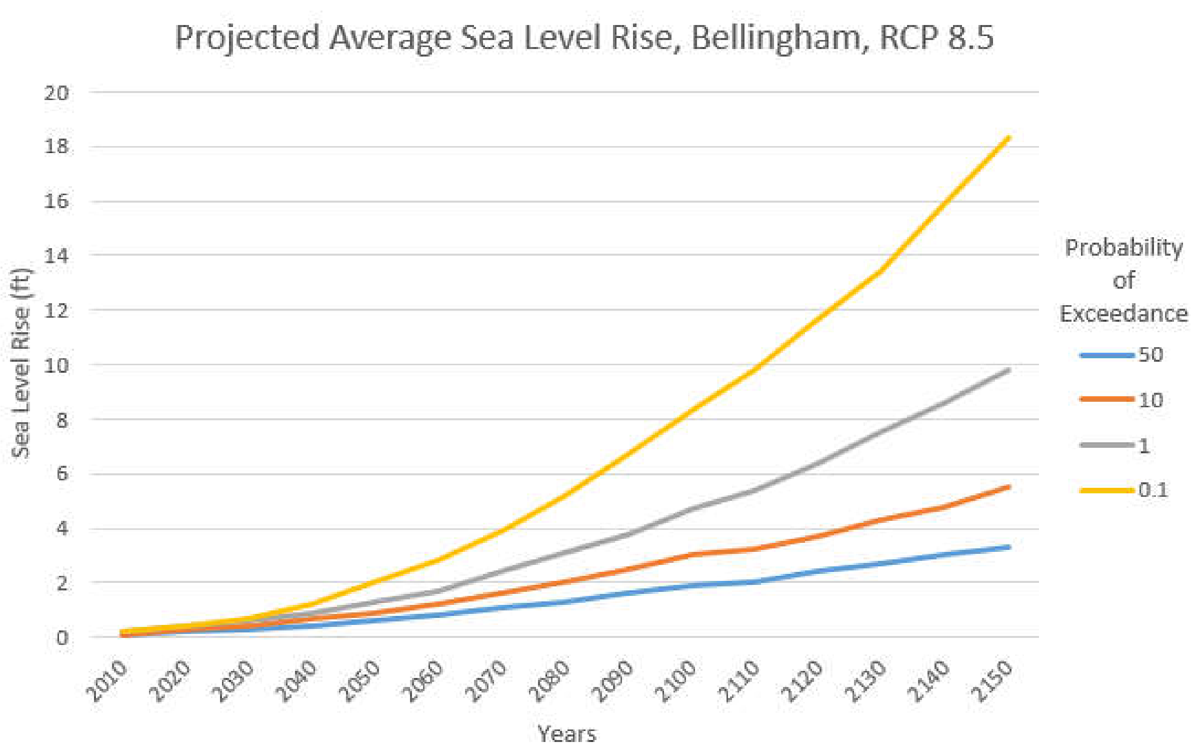

Figure 4-4. Bellingham projected sea level rise, Representative Concentration Pathway 8.5

4.3 Projected Trends and Changes in Precipitation Intensities

The UW CIG developed a study titled “Regional Model Projections of Heavy Precipitation for Use in Stormwater Planning” (CIG 2019). The future climate projects from this study show increasing precipitation intensities in western Washington that are likely to continue and consequently produce more intense hydrologic extremes. The study used a National Oceanic and Atmospheric Administration (NOAA) rain gage in nearby Burlington, approximately 20 miles to the south, which is characterized by a climate similar to that in Bellingham. A correction factor was applied given the proximity. Figure 4-5 shows the locations of rain gages that were used in the study.

Figure 4-6 through Figure 4-8 show the projected change in 24-hour precipitation at the Burlington location as a percentage of the recent climatological mean (e.g., 1980−2009) at the future time scales of 2030s (Figure 4-6), 2050s (Figure 4-7), and 2080s (Figure 4-8). The high-end precipitation values were produced using a Representative Concentration Pathway value of 8.5 and the low-end precipitation values were produced with a Representative Concentration Pathway value of 4.5.

The figures show that the projections of future climate scenarios demonstrate an overall increase in precipitation extremes. This can be important in long-range resilience planning for critical infrastructure and public safety.

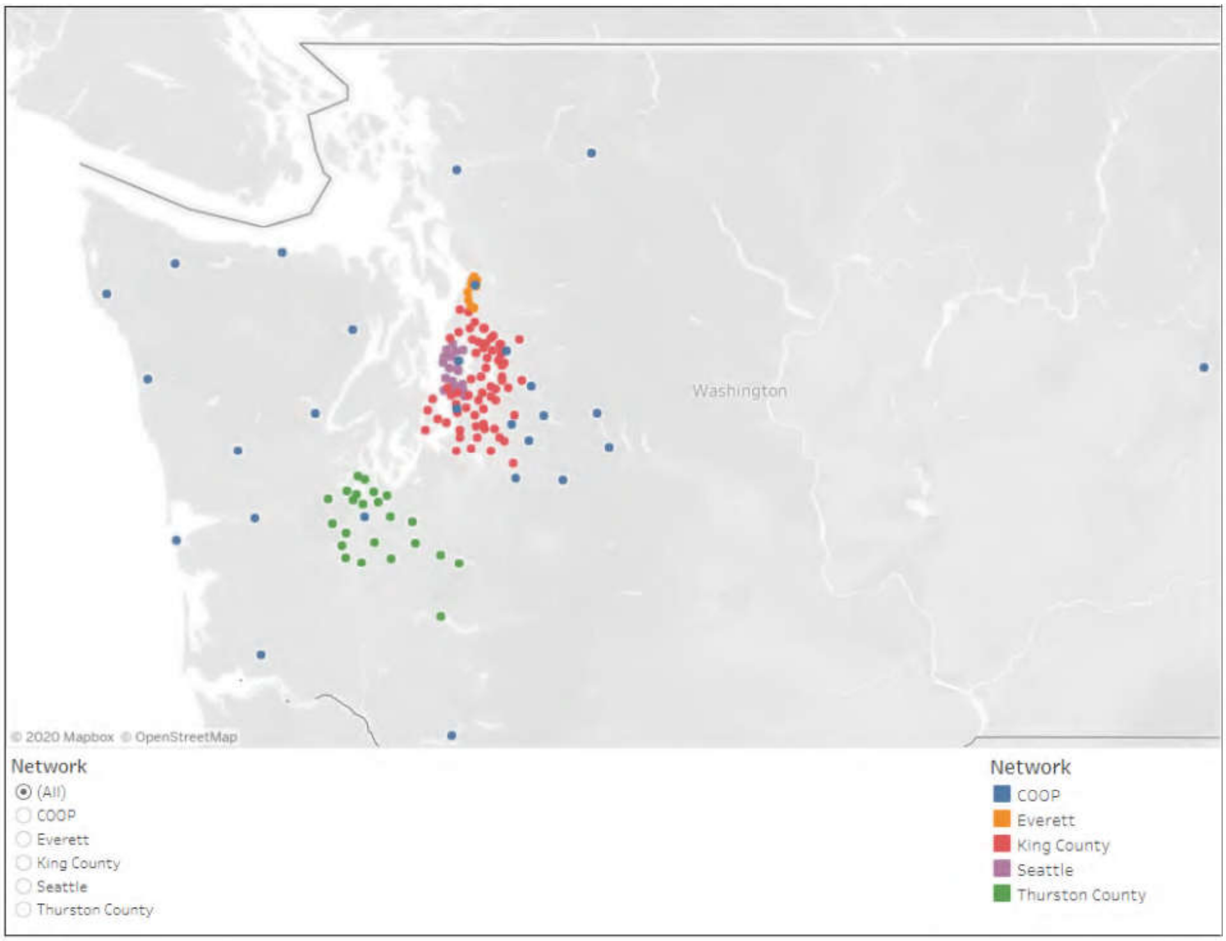

Figure 4-5. Locations of rain gages

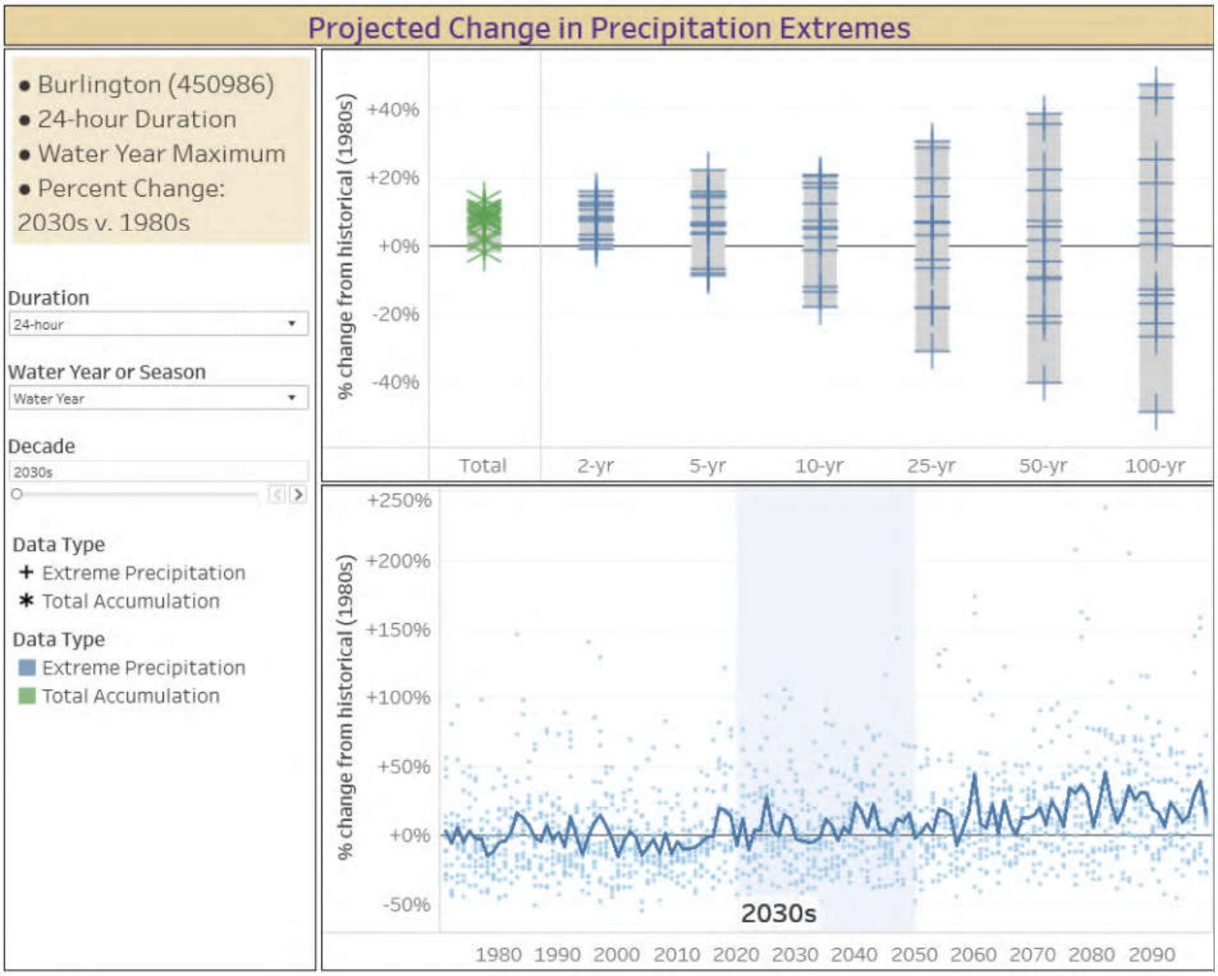

Figure 4-6. Projected change in precipitation extremes for Burlington, Washington, by 2030

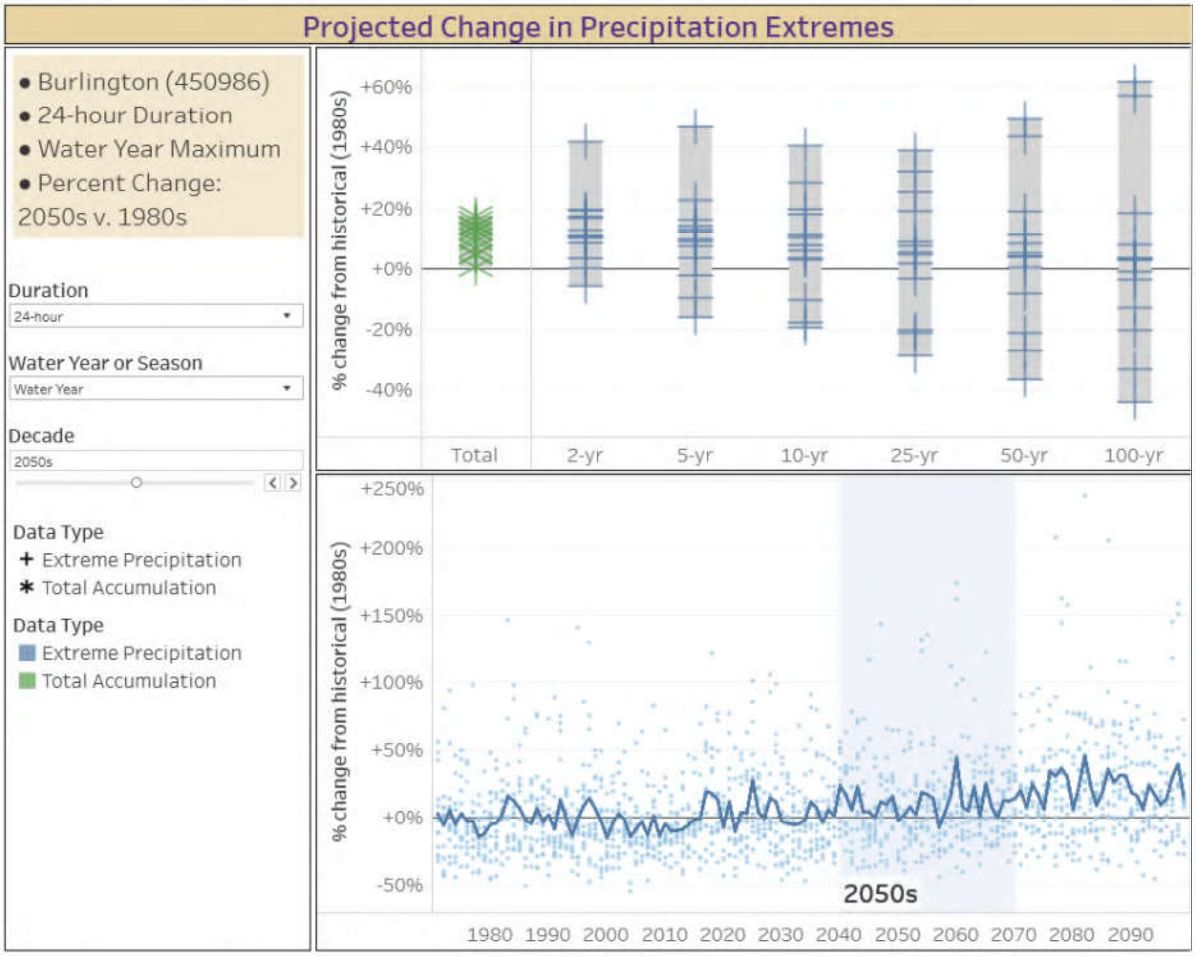

Figure 4-7. Projected change in precipitation extremes for Burlington, Washington, by 2050

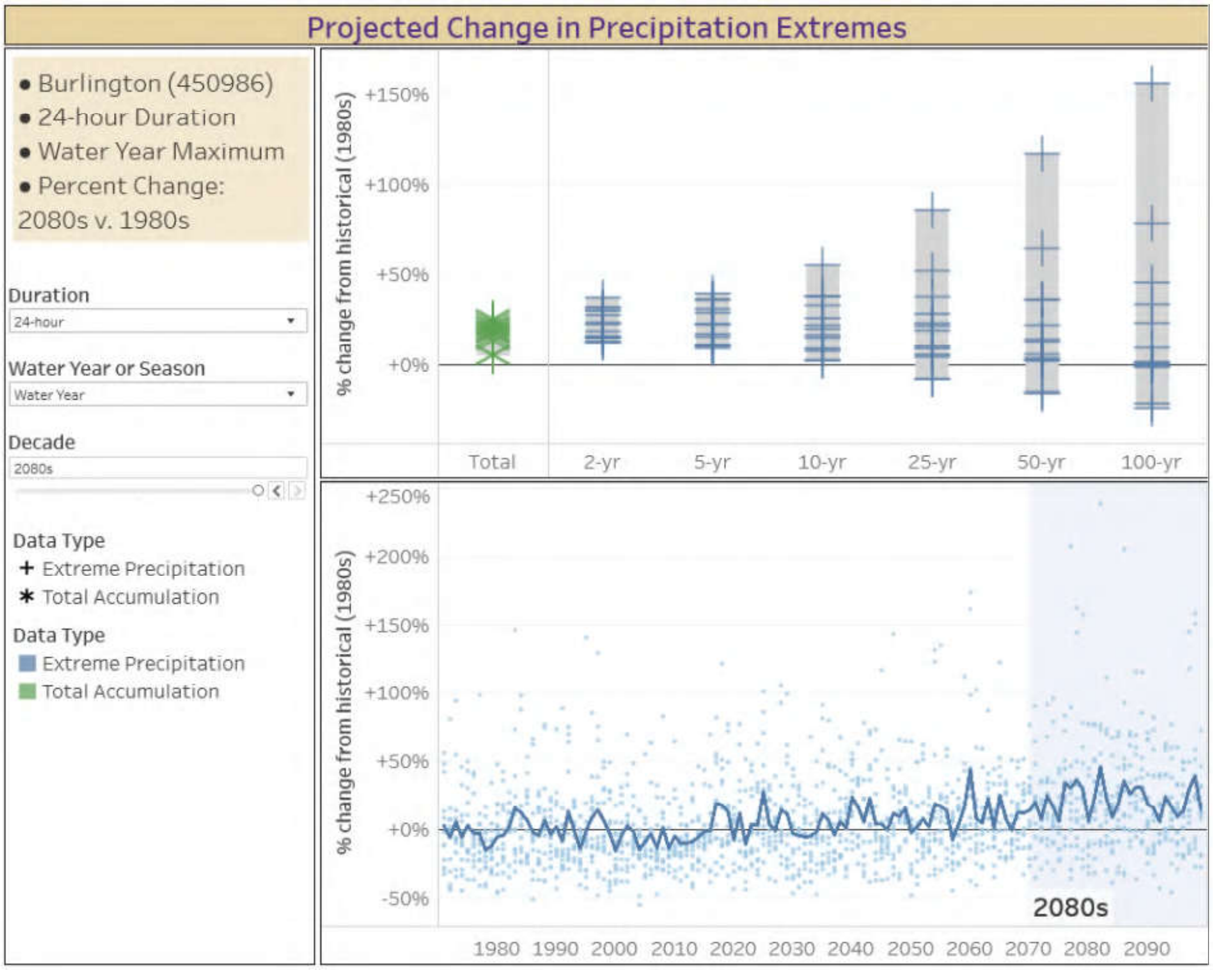

Figure 4-8. Projected change in precipitation extremes for Burlington, Washington, by 2090

4.4 Recommendations Based on Changes in Precipitation Data

Because of the increasing precipitation values discussed in Section 4.3, some recommendations in this section are provided to help improve the effectiveness of stormwater facilities. Horsley Witten Group, a private consulting firm that specializes in sustainable water resource engineering practices, performed an assessment for Massachusetts to evaluate the effects of climate change on stormwater facilities and provided recommendations on how to contribute to stormwater BMP resilience (Horsley Witten Group 2015). Even though this assessment was performed in Massachusetts, many of the recommendations apply as the area is experiencing similar precipitation and SLR effects as what is occurring in the Puget Sound region because of climate change.

The study found that when designing vegetated facilities, practices should be used that are acceptable for existing site conditions and are adaptable for future conditions. For example, the report suggests that selecting plants that can handle higher rainfall intensities and wetter environments builds resilience into the design. The term “green infrastructure” is used to define stormwater infrastructure that contains a natural or vegetative element for controlling and/or treating stormwater runoff, whereas “gray infrastructure” is used to define the more traditional stormwater infrastructure comprising pipes, culverts, manholes, and catch basins. Gray infrastructure with higher precipitation surges generally requires more maintenance to function properly. The report also suggests that choosing green infrastructure over gray infrastructure when possible helps with facility performance.

Modifying design standards to create redundancy in facility design reduces the effects of climate change on stormwater facilities. For example, increasing the design standards for sizing facility forebays dampens the effects of additional sediment being deposited in facilities located near shorelines because of SLR and storm surges. A larger forebay would also reduce the maintenance schedule. Other examples of redundancy would be using combination inlets instead of grate inlets to provide additional inlet capacity or upsizing pipes to allow for larger storm surges.

Another recommendation from the report is to increase maintenance to help facilities perform correctly. Greater storm surges can increase the risk of clogging in inlets, outlets, or pipes as well as increased sediment transportation. As the facilities receive higher flows, it is even more important to keep the facilities well maintained and functioning properly.

Green infrastructure is more adaptable to changing environments than gray infrastructure. A large concrete vault cannot change or adapt to increasing storm surges. It will only perform for the storms it was designed to manage and beyond that it will overtop. In contrast, green infrastructure can adapt to increased rainfall or increased storm surges. When the correct soils and vegetation are selected, the green infrastructure can adapt to changing environments, just as it does in nature.

4.5 Conclusions

This chapter has presented the predicted effects of climate change consisting of rising sea levels and increasing precipitation intensities. These effects of climate change will provide a challenge that government agencies and designers alike will need to adapt to. In May 2018 the Bellingham City Council passed Resolution 2018-06 to create the Climate Action Plan Task Force to develop recommendations to achieve accelerated 100 percent renewable energy targets, taking into account financial, technological, and societal challenges resulting from such a transition. On December 9, 2019, the task force presented its report to the City Council. Recent actions and future activities by the City and across the region clearly indicate the importance placed in understanding and planning for climate change.

In response to the effect of climate change, this chapter also discussed recommendations in how the design of stormwater facilities can adapt to the effects of climate change. The purpose of these recommendations is to help provide general guidance on selection and design for future stormwater improvement projects, and is not intended to be a comprehensive or exhaustive approach that sets firm policy. However, the City should continue to engage with regional and state leaders in developing an approach that is widely supported. The City is currently contracting with USGS to produce a local climate model that will include SLR and anticipated increased storm surge. As such, climate change data and information will continuously be refined.

As the region and state continue to examine SLR and precipitation increases and set widely agreed-upon values for both, the City should equally adopt these as design standards for future infrastructure improvements, and for development approval. From a short-term perspective, the City should be diligent in keeping all facilities well maintained and functioning properly. Each new project should include an SLR analysis to examine if proposed improvements need SLR-related modifications. From a long-term perspective, the City should maintain an inventory of locations in the city that are at risk from extreme precipitation and SLR that may impact emergency evacuation routes, and other key transportation corridors and facilities for protection. For example, continued assessment of the City's inventory to identify at-risk stormwater facilities and vulnerability assessments should be conducted including adaptation strategies for all new public and private critical aboveground assets.