3.5 GREENHOUSE GASES

Gases that trap heat in the atmosphere are referred to as greenhouse gases (GHGs) because, like a greenhouse, they capture heat radiated from the earth. The accumulation of GHGs has been identified as a driving force in global climate change. Definitions of climate change vary among regulatory authorities and the scientific community. In general, however, climate change can be described as the changing of the earth's climate caused by natural fluctuations and human activities that alter the composition of the global atmosphere. This section quantifies major sources of GHG emissions associated with the project.

Methods for Studying the Affected Environment

Emissions of GHGs at the state and county level have been estimated and published by Ecology and King County as well as Bellevue, Redmond, and Renton in the study area.

While GHG concentrations are global and not localized, the study area for this analysis consists of the areas where the project would directly or indirectly result in GHG emissions or where the project could result in a reduction of carbon sequestration rates (defined in Section 3.5.2).

3.5.1 Greenhouse Gas Compounds Considered in this Analysis

The principal GHGs of concern include the following:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Sulfur hexafluoride (SF_6)

Electrical utilities, including PSE, often use SF_6 in electrical equipment at substations because of its effectiveness as an insulating gas.

Each of the principal GHGs has a long atmospheric lifetime, existing in the atmosphere for 1 year to several thousand years. In addition, the potential heat-trapping ability of each of these gases varies significantly. For example, CH_4 is 28 times as potent as CO_2 at trapping heat, while SF_6 is 23,500 times more potent than CO_2 (IPCC, 2013). The ability of these gases to trap heat is called global warming potential.

In emissions inventories, GHG emissions are typically reported in terms of metric tons of CO_2 equivalents (CO_2e). CO_2e are calculated as the product of the mass emitted of a given GHG and its specific global warming potential. While CH_4, N_2O, and SF_6 have much higher global warming potential than CO_2, CO_2 is emitted in such vastly higher quantities that it accounts for the majority of GHG emissions in CO_2e, both from residential developments and human activity in general.

The primary human activities that release GHGs include combustion of *fossil fuels* for transportation, heating, and electricity; agricultural practices that release CH_4, such as livestock production and decomposition of crop residue; and industrial processes that release smaller amounts of gases with high global warming potential such as SF_6. Deforestation and land cover conversion also contribute to global warming by reducing the earth's capacity to remove CO_2 from the air and altering the earth's albedo (surface reflectance), thus allowing more solar radiation to be absorbed.

3.5.2 Carbon Sequestration

Terrestrial carbon sequestration is the process in which atmospheric CO_2 is taken up into plants or soil and subsequently "trapped." Terrestrial sequestration can occur through planting trees, restoring wetlands, land management, and forest fire management. This analysis focuses on the terrestrial sequestration associated specifically with trees and shrubs, as related to the project.

Trees and shrubs act as both *carbon sinks* and carbon sources. Vegetation can act as a carbon sink by absorbing CO_2 from the atmosphere, releasing oxygen through photosynthesis, and retaining the carbon within the vegetation. Trees also act as a carbon source when they are dying and decomposing; the carbon that was stored in the trees is released and reacts with oxygen in the air to form CO_2. Younger trees that are growing rapidly can store more carbon in their leaves than older trees. However, the total amount of carbon sequestered annually by healthy, large trees is greater than younger trees because the greater number of leaves compensates for the lower productivity of larger trees (USDA, 2011; Stephenson et al., 2014).

Trees suffering from disease will slow and eventually arrest the process of photosynthesis, thus limiting the ability of the affected tree to act as a carbon sink. Therefore, maintaining healthy trees keeps carbon stored in trees; however, certain landscape maintenance activities can generate modest GHG emissions (USDA, 2011). For example, water use, fertilizer use, exhaust from gas- and diesel-powered landscape equipment, and vehicle trips for maintenance crews result in CO_2 emissions. Carbon sequestration varies with both the species of trees as well as the age of trees; as a general example, 1,000 pine trees sequester approximately 32 metric tons of CO_2e per year (CAPCOA, 2013).

3.5.3 Relevant Plans, Policies, and Regulations

Air quality and GHG emissions in the Puget Sound region are regulated and enforced by federal and state agencies—the U.S. Environmental Protection Agency (EPA) and Ecology. The cities of Bellevue, Redmond, and Renton have plans or policies addressing GHG emissions (Newcastle has no plans or policies that specifically address GHGs). King County provides overarching guidance policy for the region on GHGs and climate change through implementation of its Strategic Climate Action Plan (King County, 2015). King County has committed to reducing countywide sources of GHG emissions, compared to a 2007 baseline, by 25 percent by 2020, 50 percent by 2030, and 80 percent by 2050 (King County, 2015). King County implemented the King County-Cities Climate Collaboration (K4C), of which Bellevue, Kirkland, Redmond, and Renton, among others, are members. They have partnered to coordinate and enhance the effectiveness of local government climate and sustainability actions by:

1. Collaborating through the Growth Management Planning Council, Sound Cities Association, and other partners to adopt countywide GHG emissions reduction targets, including mid-term milestones needed to support long-term reduction goals.

2. Building on King County's commitment to measure and report on countywide GHG emissions by sharing data between cities and partners, establishing a public dashboard for tracking progress, and using the information to inform regional climate action.

3. Developing and adopting near-term and long-term government operational GHG reduction targets that support countywide goals, and implementing actions to reduce each local government's GHG footprint.

Federal, state, and local regulations and plans are described in detail on pages 4-4 through 4-9 of the Phase 1 Draft EIS. This section of the Phase 1 Draft EIS also describes actions taken by the Partner Cities to reduce GHG emissions, such as campaigns to reduce the cost of solar electricity, pursuing natural resource conservation projects, reducing emissions associated with government operations, and implementing climate action implementation plans. Bellevue, Renton, and Redmond have also developed GHG inventories to track emissions.

Of particular applicability is Chapter 173-441 WAC – Reporting of Emissions of Greenhouse Gases, because the quantitative emission limits of this rule were used in the development of impact assessment criteria for the project. This rule institutes mandatory GHG reporting for facilities that emit at least 10,000 metric tons of GHGs per year in Washington or suppliers of liquid motor vehicle fuel, special fuel, or aircraft fuel that supply products equivalent to at least 10,000 metric tons of CO_2 per year in Washington.

In a recent development that has occurred since release of the Phase 1 Draft EIS, on August 2, 2016, the federal Council on Environmental Quality released final guidance for federal agencies on how to consider the impacts of their actions on global climate change in their National Environmental Policy Act (NEPA) reviews (CEQ, 2016). This final guidance does not recommend quantitative thresholds that would indicate a substantial impact related to GHG emissions but, rather, provides a framework for agencies to consider both the effects of a proposed action on climate change, as indicated by its estimated GHG emissions, and the effects of climate change on a proposed action. While this guidance applies to proposed federal agency actions that are subject to NEPA analysis, similar guidance does not currently exist at the state or local level, and consideration of GHG sources identified in the guidance was used in the impact assessment that follows.

In current state regulation developments, Ecology has adopted a Clean Air Rule to cap and reduce GHGs in Washington under the state's Clean Air Act. The Clean Air Rule addresses activities responsible for about two-thirds of carbon pollution in Washington, such as transportation, refining, and manufacturing. Under the Clean Air Rule, natural gas distributors, petroleum fuel producers and importers, large manufacturers, electricity generating plants, waste facilities, and other organizations that are responsible for more than 100,000 metric tons of GHGs are required to reduce their emissions or sponsor projects to offset those emissions beginning in 2017. Every 3 years, the threshold will be lowered and more emitters brought into the program, through 2035 (Ecology, 2016). Although PSE operates electricity generating plants, such infrastructure is not proposed in any of the alternatives. The newly adopted Clean Air Rule does not apply to the proposed alternatives and, given its relatively large threshold, is not applied in the following impact analysis.

3.5.4 Greenhouse Gases in the Study Area

Ecology estimated that in 2010, Washington produced about 96 million gross metric tons (about 106 million U.S. tons) of CO_2e (Adelsman, 2014). Sources of GHG emissions in the state are shown in Figure 3.5-1.

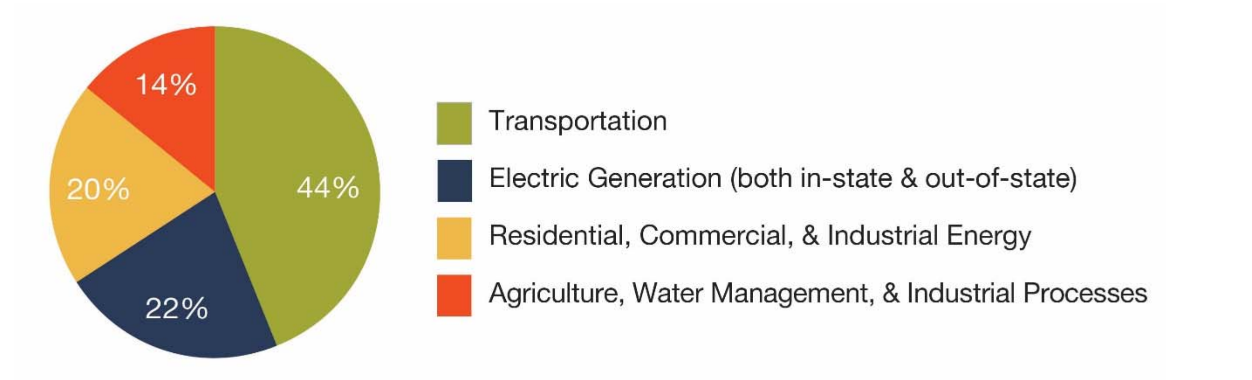

Figure 3.5-1. Sources of GHG Emissions in Washington State

King County last inventoried countywide GHG emissions for the year 2012. Community consumption-based emissions (which include some lifecycle emissions associated with food consumed within the county but grown elsewhere) totaled 55 million metric tons of CO_2e (King County, 2015), although only about 15 million metric tons were emitted within the county.

As described on page 4-9 of the Phase 1 Draft EIS, the cities of Bellevue and Renton have developed GHG inventories.

3.5.5 Long-term (Operation) Impacts Considered

3.5.5.1 Methods for Analyzing Long-term Impacts

The project could result in an increase of GHG emissions from the potential loss of sequestered carbon from the removal of trees and vegetation to accommodate the new powerlines and substation. The potential loss of carbon sequestration from tree removal is based on tree inventory data prepared for PSE (The Watershed Company, 2016) for each project segment and option, and sequestration calculations using the iTree model. i-Tree is a state-of-the-art, peer-reviewed software suite from the USDA Forest Service that provides urban and rural forestry analysis and benefits assessment tools (i-Tree, 2016). See Section 3.10, *Economics*, for information about the i-Tree model and for a discussion of the monetary value of lost *ecosystem services* due to reduced tree cover. This analysis compares the estimated change in GHG emissions for the project to the State of Washington GHG reporting thresholds (Chapter 173-441 WAC, *Reporting of Emissions of Greenhouse Gases*). The analysis of GHG emissions represents a cumulative impact analysis because impacts are only important due to cumulative effects GHG emissions have had and are having on global climate. Impacts are assessed based on the project's potential to result in a cumulatively considerable contribution to the state and overall global GHG burden. Potential mitigation measures to minimize or eliminate greenhouse gas emissions associated with the project are considered, as warranted.

A quantitative assessment of GHG emissions of sulfur hexaflouoride (SF_6) is also included in the analysis. SF_6 is a potent GHG used as an electrical insulator in some high-voltage equipment in substations and is 23,900 times more potent than carbon dioxide as a GHG. The analysis describes the state of fugitive SF_6 control that is currently used in electrical equipment manufacturing standardized by the International Electrotechnical Commission in Standard 62271-1 in 2004 (Carey, 2013), and predicted fugitive emission rates associated with large-scale electrical substations and estimates fugitive SF6 emissions based on a standardized leakage rate.

Operational GHG impacts would result primarily from the removal of trees and vegetation that would reduce ongoing sequestration of CO_2 from the atmosphere. To a lesser degree, GHG emissions impacts would result from employee vehicle trips to maintain the new facilities. Additionally, there may be some fugitive emissions from substation equipment that use SF_6 as an insulating gas.

The following specifically defines project-level long-term (operational) impacts to GHGs:

Less-than-Significant – The project would result in operational GHG emissions below the State of Washington reporting threshold of 10,000 metric tons of CO_2e in a given year.

Significant –The project (after implementing mitigation measures) would result in operational GHG emissions at or above the State of Washington reporting threshold of 10,000 metric tons of CO_2e in a given year.

3.5.6 Long-term Impacts: No Action Alternative

Under the No Action Alternative, no infrastructure improvements, changes to vegetation management activities, or new or relocated maintenance yards would be required. No new employee vehicle trips are envisioned under the No Action Alternative. While there would be GHG generated by ongoing maintenance and operation activities, selecting the No Action Alternative would neither increase nor decrease such activities. Consequently, there would be no operational GHG impacts associated with the No Action Alternative.

3.5.7 Long-term Impacts: Alternative 1 (New Substation and 230 kV Transmission Lines)

3.5.7.1 Impacts Common to all Components

Any combination of segment and option routes and the Richards Creek substation site would result in some level of sequestration losses due to tree removal. Additionally, Alternative 1 would result in fugitive SF_6 emissions from gas-insulated circuit breakers at the Richards Creek, Sammamish, and Talbot Hill substations. The least impactful combination would be the Existing Corridor Option of the Bellevue Central Segment combined with the Willow 1 Option in the Bellevue South Segment, which would result in a project-wide sequestration loss of 134 metric tons of CO_2e per year. The most impactful combination would be Bypass Option 1 of the Bellevue Central Segment combined with the Oak 2 Option in the Bellevue South Segment, which would result in a project-wide sequestration loss of 194 metric tons of CO_2e per year. In all cases, however, the emissions would be substantially below the State of Washington reporting threshold of 10,000 metric tons and, therefore, less-than-significant. Figure 3.5-2 presents the sequestration losses associated with each segment, and the following narrative describes the tree losses associated with each segment or option.

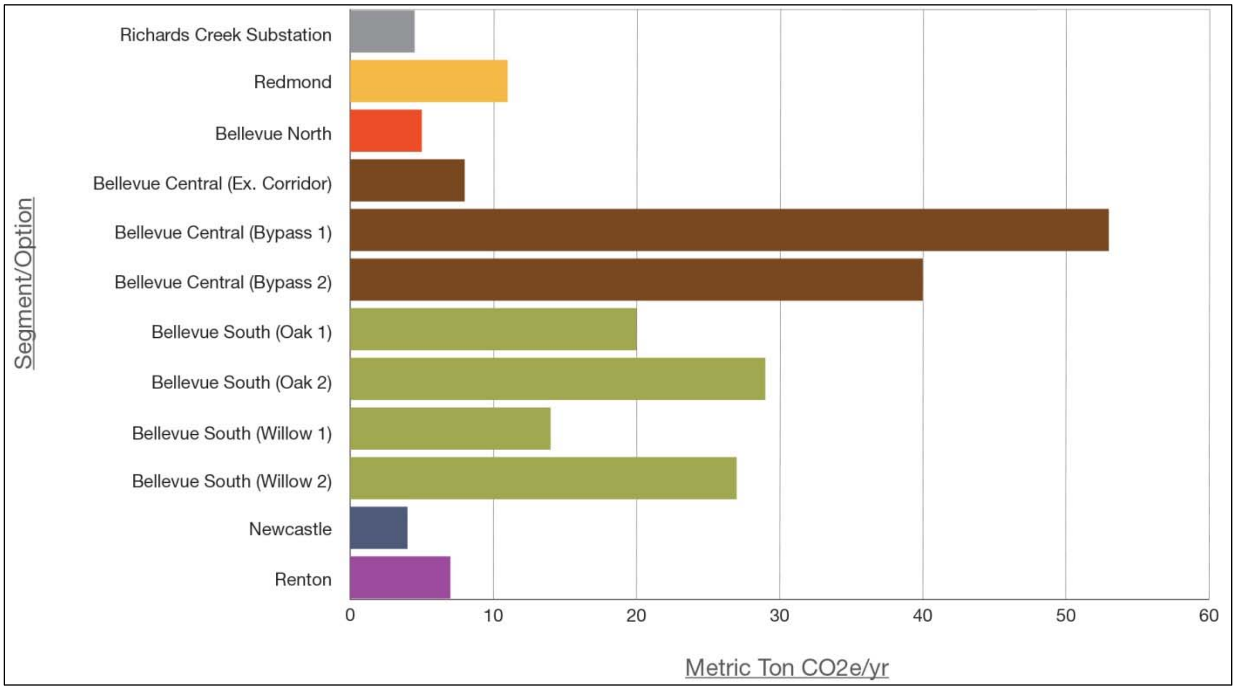

Figure 3.5-2. Estimated GHG Sequestration Losses in Project Segments

3.5.7.2 New Richards Creek Substation and other Substation Improvements

The total lot area for the substation site is 7.8 acres in size, and the substation yard would cover 1.9 acres within a fenced lot. Approximately 170 trees would be removed to allow for the installation of the substation and equipment (The Watershed Company, 2016). The loss of annual CO_2 sequestration associated with the removal of trees was estimated using the i-Tree model. Tree removal at the Richards Creek substation site would result in 4.03 metric tons of CO_2e per year in sequestration losses. These emissions would be substantially below the State of Washington reporting threshold of 10,000 metric tons and, therefore, less-than-significant.

A small number of vehicle trips are expected to be generated when the completed substation is operational. As described in the Phase 1 Draft EIS (Chapter 4, Greenhouse Gas Emissions), such trips would be infrequent and would not result in appreciable GHG emissions. Therefore, such trips would have a negligible effect on GHG emissions.

The substation would include a 115 kV circuit breaker with a nameplate capacity[1] of 128 pounds of SF_6 and five 230 kV circuit breakers, each with a nameplate capacity of 161 pounds. Additionally, one 230 kV circuit breaker would be installed at the Sammamish substation and two 230 kV circuit breakers would be installed at the Talbot Hill substation, each with a nameplate capacity of 161 pounds. Consequently, all new breakers would total an SF_6 load of approximately 1,416 pounds. Average leakage rate for gas-insulated switchgear equipment is 0.5 percent per year as standardized by the International Electrotechnical Commission in Standard 62271-1 in 2004 (Blackman et al., 2006). This would result in fugitive SF_6 emissions of approximately 7.08 pounds per year, which is equivalent to 75 metric tons of CO_2e per year.

[1] The total SF_6 containing capacity (lbs.) in installed equipment during a year. Note, that "total nameplate" capacity refers to the manufacturer recommended full and proper charge of the equipment, rather than to the actual charge, which may reflect leakage.

3.5.7.3 Redmond Segment

Approximately 630 trees would be removed to allow for the installation of power lines and poles along the Redmond Segment (The Watershed Company, 2016). Tree removal along the Redmond Segment would result in 11 metric tons of CO_2e per year in sequestration losses. These emissions would be substantially below the State of Washington reporting threshold of 10,000 metric tons and, therefore, less-than-significant.

3.5.7.4 Bellevue North Segment

Approximately 510 trees would be removed to allow for the installation of power lines and poles along the Bellevue North Segment (The Watershed Company, 2016). Tree removal along the Bellevue North Segment would result in 5.5 metric tons of CO_2e per year in sequestration losses. These emissions would be substantially below the State of Washington reporting threshold of 10,000 metric tons and, therefore, less-than-significant.

3.5.7.5 Bellevue Central Segment, Existing Corridor Option

Approximately 600 trees would be removed to allow for the installation of power lines and poles along the Bellevue Central Segment, Existing Corridor Option (The Watershed Company, 2016). Tree removal along the Existing Corridor Option would result in 8.49 metric tons of CO_2e per year in sequestration losses. These emissions would be substantially below the State of Washington reporting threshold of 10,000 metric tons and, therefore, less-than-significant.

3.5.7.6 Bellevue Central Segment, Bypass Option 1

Approximately 1,790 trees would be removed to allow for the installation of power lines and poles along the Bellevue Central Segment, Bypass Option 1 (The Watershed Company, 2016). Tree removal along the Bypass Option 1 alignment would result in 53 metric tons of CO_2e per year in sequestration losses. These emissions would be substantially below the State of Washington reporting threshold of 10,000 metric tons and, therefore, less-than-significant.

3.5.7.7 Bellevue Central Segment, Bypass Option 2

Approximately 1,200 trees would be removed to allow for the installation of power lines and poles along the Bellevue Central Segment, Bypass Option 1 (The Watershed Company, 2016). Tree removal along the Bypass Option 2 alignment would result in 40 metric tons of CO_2e per year in sequestration losses. These emissions would be substantially below the State of Washington reporting threshold of 10,000 metric tons and, therefore, less-than-significant.

3.5.7.8 Comparison of Bellevue Central Options

All options would result in GHG emissions from fugitive releases of SF_6 used as an electrical insulator in some high-voltage equipment at the Richards Creek, Sammamish, and Talbot Hill substations, while the amount of GHG sequestration losses from tree removal would vary depending on which option is selected. The potential impacts to these resources are compared below by option (Table 3.5-1).

In the Bellevue Central Segment, the Existing Corridor Option would avoid the most sequestration losses of GHGs although GHG emissions associated with all options in this segment would be well below State of Washington reporting thresholds and would result in minor adverse impacts.

Table 3.5-1. Comparison of Bellevue Central Options

Segment / Option	GHGs from Sequestration Loss of Segment Option (MT CO_2e/year)	GHGs from Sequestration Loss of Other non-optional Segments (MT CO_2e/year)	Fugitive Loss of SF(from New Gas-Insulated Substatio Equipment (MT CO_2e/year)	Total GHG Losses (MT CO_2e/year)
Existing Corridor Option	8.5	37	75	121
Bypass Option 1	53	37	75	165
Bypass Option 2	39	37	75	151

3.5.7.9 Bellevue South Segment, Oak 1 Option

Approximately 1,030 trees would be removed to allow for the installation of power lines and poles along the Bellevue South Segment, Oak 1 Option (The Watershed Company, 2016). Tree removal along the Oak 1 Option would result in 20 metric tons of CO_2e per year in sequestration losses. These emissions would be substantially below the State of Washington reporting threshold of 10,000 metric tons and, therefore, less-than-significant.

3.5.7.10 Bellevue South Segment, Oak 2 Option

Approximately 1,600 trees would be removed to allow for the installation of power lines and poles along the Bellevue South Segment, Oak 2 Option (The Watershed Company, 2016). Tree removal along the Oak 2 Option would result in 29 metric tons of CO_2e per year in sequestration losses, the highest losses of any of the Bellevue South Segment options. These emissions would be substantially below the State of Washington reporting threshold of 10,000 metric tons and, therefore, less-than-significant.

3.5.7.11 Bellevue South Segment, Willow 1 Option

Approximately 1,030 trees would be removed to allow for the installation of power lines and poles along the Bellevue South Segment, Willow 1 Option (The Watershed Company, 2016). Tree removal along the Willow 1 Option would result in 14 metric tons of CO_2e per year in sequestration losses, the lowest losses of any of the Bellevue South Segment options. These emissions would be substantially below the State of Washington reporting threshold of 10,000 metric tons and, therefore, less-than-significant.

3.5.7.12 Bellevue South Segment, Willow 2 Option (PSE's Preferred Alignment)

Approximately 1,640 trees would be removed to allow for the installation of power lines and poles along the Bellevue South Segment, Willow 2 Option (The Watershed Company, 2016). Tree removal along the Willow 2 Option would result in 27 metric tons of CO_2e per year in sequestration losses. These emissions would be substantially below the State of Washington reporting threshold of 10,000 metric tons and, therefore, less-than-significant.

3.5.7.13 Comparison of Bellevue South Options

All options would result in GHG emissions from fugitive releases of SF_6 used as an electrical insulator in some high-voltage equipment at the Richards Creek, Sammamish, and Talbot Hill substations, while the amount of GHG sequestration losses from tree removal would vary depending on which option is selected. The potential impacts to these resources are compared below by option (Table 3.5-2).

In the Bellevue South Segment, the Willow 1 Option would avoid the most sequestration losses of GHGs although GHG emissions associated with all options in this segment would be well below State of Washington reporting thresholds and would result in minor adverse impacts.

Table 3.5-2. Comparison of Bellevue South Options

Segment / Option	GHGs from Sequestration Loss of Segment Option (MT CO_2e/year)	GHGs from Sequestration Loss of Other non-optional Segments (MT CO_2e/year)	Fugitive Loss of SF(from New Gas-Insulated Substatio Equipment (MT CO_2e/year)	Total GHG Losses (MT CO_2e/year)
Oak 1 Option	20	37	75	132
Oak 2 Option	28	37	75	140
Willow 1 Option	14	37	75	126
Willow 2 Option	27	37	75	139

3.5.7.14 Newcastle Segment

Approximately 300 trees would be removed to allow for the installation of power lines and poles along the Newcastle Segment (The Watershed Company, 2016). Tree removal along the Newcastle Segment would result in 4.2 metric tons of CO_2e per year in sequestration losses. These emissions would be substantially below the State of Washington reporting threshold of 10,000 metric tons and, therefore, less-than-significant.

3.5.7.15 Renton Segment

Approximately 350 trees would be removed to allow for the installation of power lines and poles along the Renton Segment (The Watershed Company, 2016). Tree removal along the Renton Segment would result in 7.1 metric tons of CO_2e per year in sequestration losses. These emissions would be substantially below the State of Washington reporting threshold of 10,000 metric tons and, therefore, less-than-significant.

3.5.8 Mitigation Measures

For GHG, regulations and state and local GHG reduction programs were reviewed to identify mitigation measures. Mitigation measures specified by code would be required, whereas mitigation measures based on state and local programs would be at the discretion of the applicant to adopt or the local jurisdictions to impose as a condition of project approval.

3.5.8.1 Regulatory Requirements

Although there are no regulations specifically limiting GHG emissions, all of the segments and options would need to comply with applicable federal, state, and local regulations, some of which would mitigate the potential for long-term adverse GHG impacts. Mitigation measures required for compliance with such regulations are not appealable.

As described in Section 3.4, *Plants and Animals*, PSE would provide mitigation for impacts to plant resources, using on- and off-site habitat enhancements, developed in coordination with local, state, and federal agencies. The following measure is identified in Section 3.4, *Plants and Animals*, and would potentially offset the long-term sequestration loss impacts.

- Replace trees removed for the project based on tree protection ordinances and critical areas regulations in each jurisdiction; some of these trees would likely be planted off-site or, in the case of the City of Newcastle, mitigated by paying into an in-lieu fee program. Replacement may be based on cross-sectional diameter of trees removed, or on habitat functions lost due to trees removal, depending on applicable regulations.

3.5.8.2 Potential Mitigation Measures

Potential mitigation measures are summarized below based on review of ongoing efforts to reduce GHG emissions related to gas-insulated switchgear throughout the U.S. Long-term operational GHG impacts would be less-than-significant, and no mitigation measures are required. However, the following BMPs could be implemented to reduce GHG contributions:

Prior to Construction

- Install SF6-filled equipment with manufactured guaranteed leakage rate of 0.1 percent at the Richards Creek, Sammamish, and Talbot Hill substations. Installation of such equipment could reduce fugitive SF6 emissions by up to 80 percent over older equipment types.