Millennium Bulk Terminals—Longview SEPA Environmental Impact Statement

SEPA Climate Change Technical Report

Prepared for:

Cowlitz County
207 4th Avenue North
Kelso, WA 98626
Contact: Elaine Placido, Director of Building and Planning
(360)-577-3052

in cooperation with:
Washington State Department of Ecology, Southwest Region

Prepared by:

ICF International
710 Second Avenue, Suite 550
Seattle, WA 98104
Contact: Linda Amato, AICP
(206) 801-2832

April 2016

ICF International. 2016. *Millennium Bulk Terminals—Longview, SEPA Environmental Impact Statement, SEPA Climate Change Technical Report.* April. (ICF 00264.13) Seattle, WA. Prepared for Cowlitz County, Kelso, WA, in cooperation with Washington State Department of Ecology, Southwest Region.

Contents

Tables

Figures

Acronyms and Abbreviations

°F	degrees Fahrenheit
Applicant	Millennium Bulk Terminals—Longview
BNSF	BNSF Railway Company
CFR	Code of Federal Regulations
CMIP5	Fifth Coupled Model Intercomparison Project
GHG	greenhouse gas
RCP	Representative Concentration Pathway
RCW	Revised Code of Washington
SEPA	State Environmental Policy Act
USC	United States Code
WAC	Washington Administrative Code

Chapter 1
Introduction

This technical report discusses the potential impacts of climate change related to increased greenhouse gas emissions from the proposed Millennium Bulk Terminals—Longview project (Proposed Action). This technical report also assesses the potential impacts on the Proposed Action and the No-Action Alternative as a result of climate change.

1.1 Project Description

Millennium Bulk Terminals—Longview, LLC (Applicant) proposes to construct and operate a coal export terminal in Cowlitz County, Washington, along the Columbia River (Figure 1). The coal export terminal would receive coal from the Powder River Basin in Montana and Wyoming and the Uinta Basin in Utah and Colorado via rail, then load and transport the coal by ocean-going ships via the Columbia River and Pacific Ocean to overseas markets in Asia. The coal export terminal would be capable of receiving, stockpiling, blending, and loading coal by conveyor onto ships for export. Construction of the coal export terminal would begin in 2018. For the purpose of this analysis, it is assumed the coal export terminal would operate at full capacity in 2028.

The following subsections present a summary of the Proposed Action and No-Action Alternative. For detailed information on these alternatives, see the Washington State Environmental Policy Act (SEPA) Alternatives Technical Report (ICF International 2016).

1.1.1 Proposed Action

The Proposed Action would develop a coal export terminal on 190 acres (project area). The project area is located within an existing 540-acre area currently leased by the Applicant at the former Reynolds Metals Company facility (Reynolds facility), and land currently owned by Bonneville Power Administration. The project area is adjacent to the Columbia River in unincorporated Cowlitz County, Washington near Longview city limits (Figure 2).

The Applicant currently and separately operates, and would continue to separately operate, a bulk product terminal on land leased by the Applicant. Industrial Way (State Route 432) provides vehicular access to the Applicant's leased land. The Reynolds Lead and the BNSF Spur, both operated by Longview Switching Company,[1] provide rail access to the Applicant's leased area from a point on the BNSF Railway Company (BNSF) main line (Longview Junction, Washington) located to the east in Kelso, Washington. Ships access the Applicant's leased area via the Columbia River and berth at an existing dock (Dock 1) operated by the Applicant in the Columbia River.

[1] Longview Switching Company is jointly owned by BNSF and Union Pacific Railroad.

Figure 1. Project Vicinity

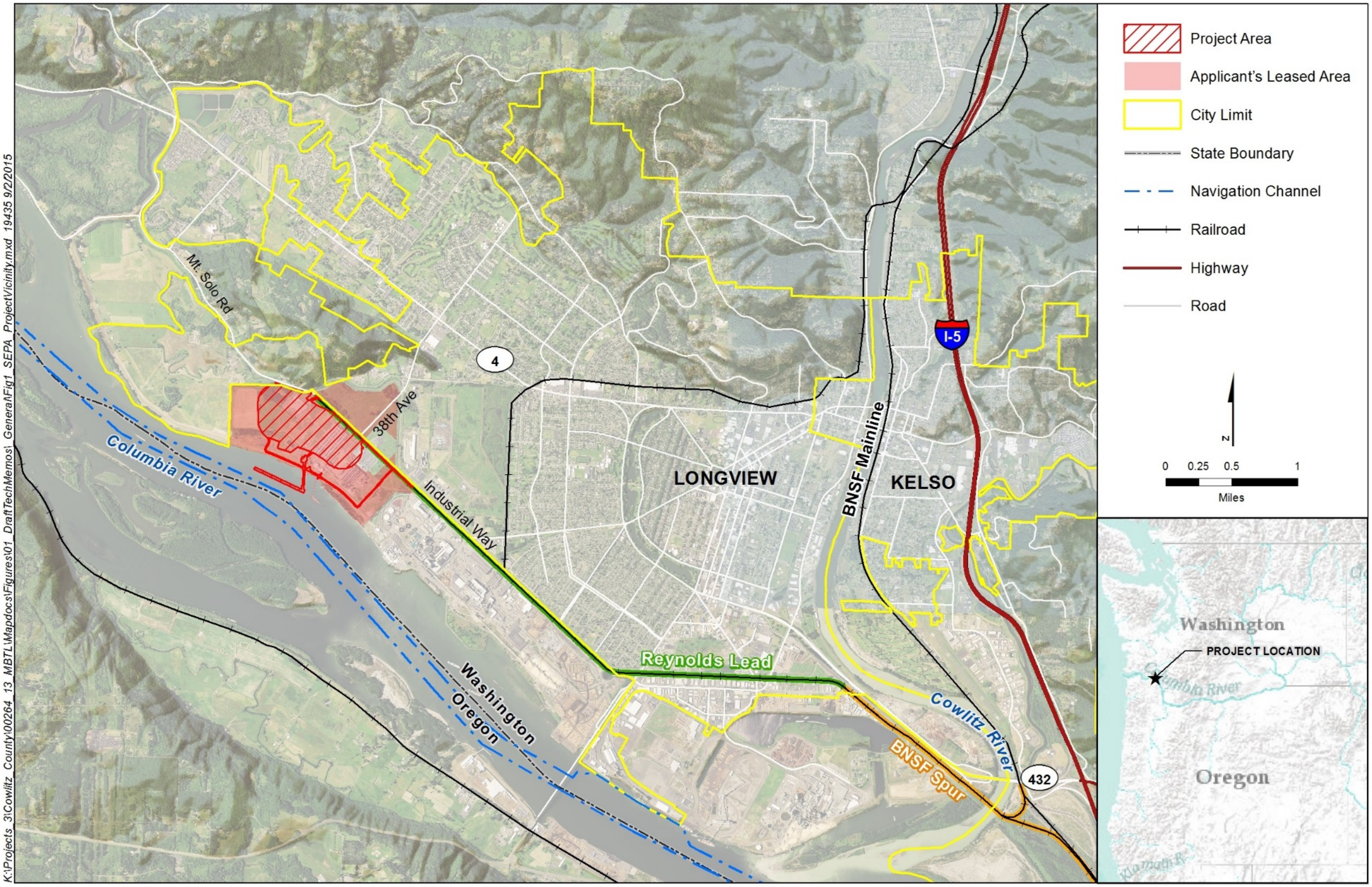
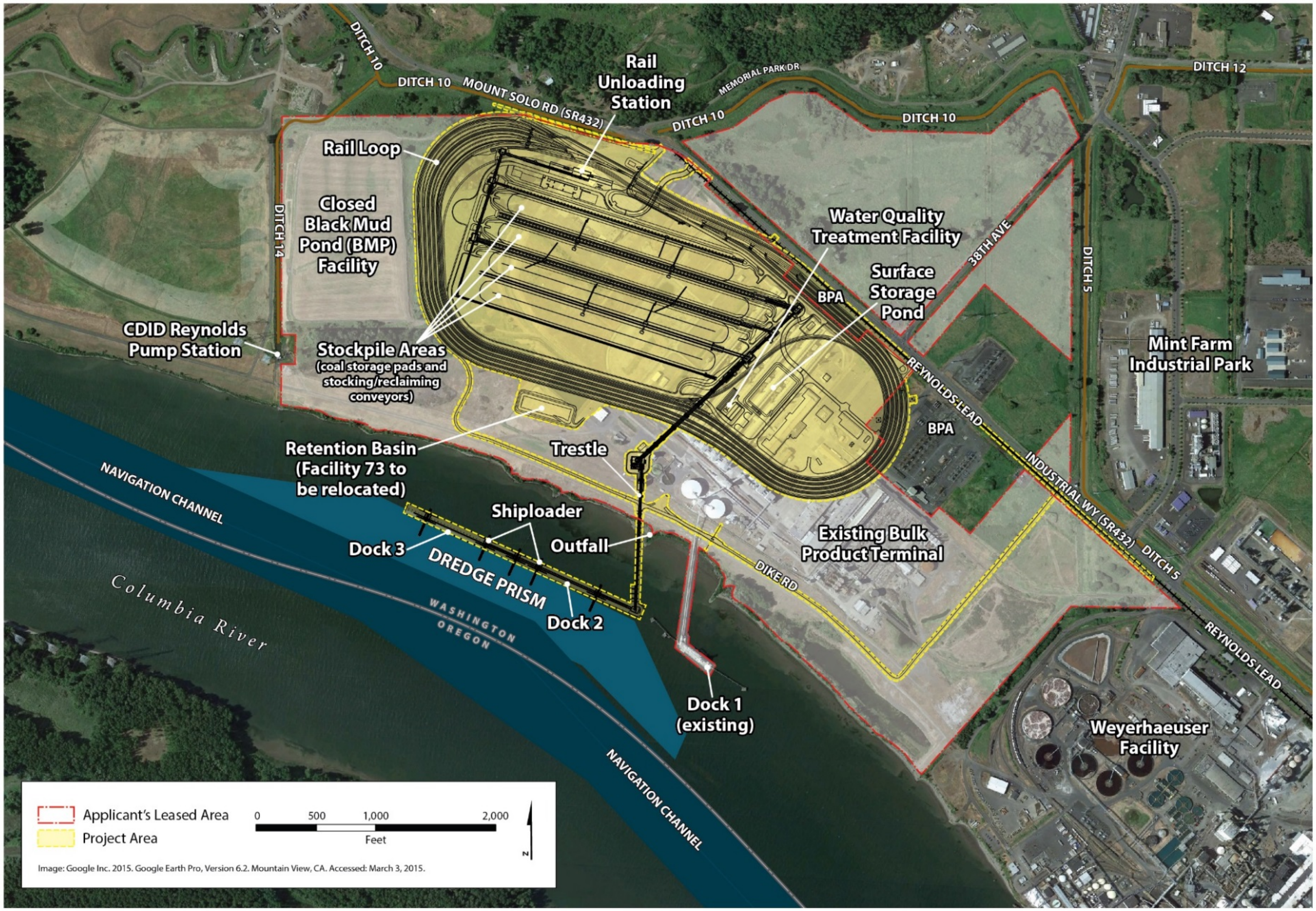


Figure 2. Proposed Action



Under the Proposed Action, BNSF or Union Pacific Railroad trains would transport coal in rail cars from the BNSF main line at Longview Junction, Washington, to the project area via the BNSF Spur and Reynolds Lead. Coal would be unloaded from rail cars, stockpiled and blended, and loaded by conveyor onto ocean-going ships at two new docks (Docks 2 and 3) on the Columbia River for export.

Once construction is complete, the Proposed Action would have an annual throughput capacity of up to 44 million metric tons.[2] The coal export terminal would consist of one operating rail track, eight rail tracks for the storage of rail cars, rail car unloading facilities, stockpile areas for coal storage, conveyor and reclaiming facilities, two new docks in the Columbia River (Docks 2 and 3), and ship-loading facilities on the two docks. Dredging of the Columbia River would be required to provide access to and from the Columbia River navigation channel and for berthing at the two new docks.

Vehicles would access the project area from Industrial Way (State Route 432). Ships would access the project area via the Columbia River and berth at one of the two new docks. Terminal operations would occur 24 hours per day, 7 days per week. The coal export terminal would be designed for a minimum 30-year period of operation.

1.1.2 No-Action Alternative

Under the No-Action Alternative, the proposed export terminal would not be constructed. Current operations of the bulk product terminal, which include the storage and transport of alumina and up to 150,000 metric tons per year of coal. Importing of alumina would continue and increase in the project area using Dock 1. The Applicant could expand the existing bulk product terminal onto the 190-acre project area, developing storage and shipment facilities to bulk product terminal operations. Coal and alumina would continue to be stored, transferred, and shipped. Additional bulk product transfers activities involving products such as calcine pet coke, coal tar pitch, cement, fly ash, and sand or gravel could also be pursued, and new or revised permits could be required. These operations would involve storage and upland transfer of bulk products, which would use existing or new buildings. Construction of new buildings could involve demolition and replacement of existing buildings and new or modified permits. Any new construction would be limited to uses allowed under existing Cowlitz County development regulations and federal and state permits.

1.2 Regulatory Setting

The jurisdictional authorities and corresponding regulations, statutes, and guidance for determining potential climate change impacts are summarized in Table 1.

[2] A metric ton is the U.S. equivalent to a tonne per the International System of Units, or 1,000 kilograms or approximately 2,204.6 pounds.

Table 1. Regulations, Statutes, and Guidelines for Climate Change

Regulation, Statute, Guideline	Description
Federal	
National Environmental Policy Act (42 USC 4321 *et seq*.)	Requires the consideration of potential environmental effects. NEPA implementation procedures are set forth in the President's Council on Environmental Quality's Regulations for Implementing NEPA (49 CFR 1105).
Clean Air Act of 1963 (42 USC 7401)	Directs the control of air pollutants nationally. The U.S. Supreme Court in 2007 established that greenhouse gases are air pollutants, and are therefore covered under this Act.
State	
Washington State Environmental Policy Act (WAC 197-11, RCW 43.21C)	Requires state and local agencies in Washington to identify potential environmental impacts that could result from governmental decisions.
Requirements of Strategy—Initial Climate Change Response Strategy (RCW 43.21M.020)	Directs state agencies to develop an integrated climate change response strategy to enable state, tribal, and local governments and public and private organizations to prepare for and adapt to the impacts of changing climate conditions. *Preparing for a Changing Climate: Washington State's Integrated Climate Change Response Strategy* outlines strategies for protecting human health, safeguarding infrastructure and transportation systems, improving water management, reducing losses to agriculture and forestry, protecting sensitive and vulnerable species, and supporting communities by involving the public.
Washington State's Growth Management Act (WAC 365-195-920)	Requires counties and cities to include the "best available science" when developing policies and development regulations. Suggests the use of adaptive management as an interim approach for managing scientific uncertainty.
Local	
Cowlitz County SEPA Regulations (CCC 19.11)	Provide for the implementation of SEPA in Cowlitz County.

Notes:
USC = United States Code; RCW = Revised Code of Washington; WAC = Washington Administrative Code; CCC = Cowlitz County Code

1.3 Study Area

The study area for potential impacts from climate change effects is defined as the project area for the Proposed Action and the access roads and rail leading to the project area.

Chapter 2
Climate Change and Projected Changes to Climate

This section summarizes the recent and projected future climate conditions in the study area. Trends and projections in temperature, precipitation, and snowfall are provided for current and historical conditions (generally from 1950 to 2005), the near-term future (2025 to 2049), and the midterm future (2050 to 2075)[3]. Midterm future conditions are typically considered in climate change analyses and are consistent with the likely operation of the Proposed Action. Future changes in climate will depend on the concentration of greenhouse gases (GHG) released to the atmosphere by human activities in the coming decades. As a result, climate projections are provided for both moderate and high GHG concentration scenarios.[4]

2.1 Greenhouse Effect

The Earth retains outgoing thermal energy and incoming solar energy in the atmosphere, thus maintaining heat temperature levels suitable for biological life. This retention of energy by the atmosphere is known as the greenhouse effect. When solar radiation reaches the Earth, most of it is either reflected or absorbed by the Earth's surface—or to a lesser degree, its atmosphere. Simultaneously, the Earth radiates its own heat and energy out into space. Factors such as the reflectivity of the Earth's surface, the abundance of water vapor, or the extent of cloud cover affects the degree to which solar radiation may be absorbed and reflected. Figure 3 shows the energy flows to and from Earth and the role that the greenhouse effect plays in maintaining heat in the atmosphere.

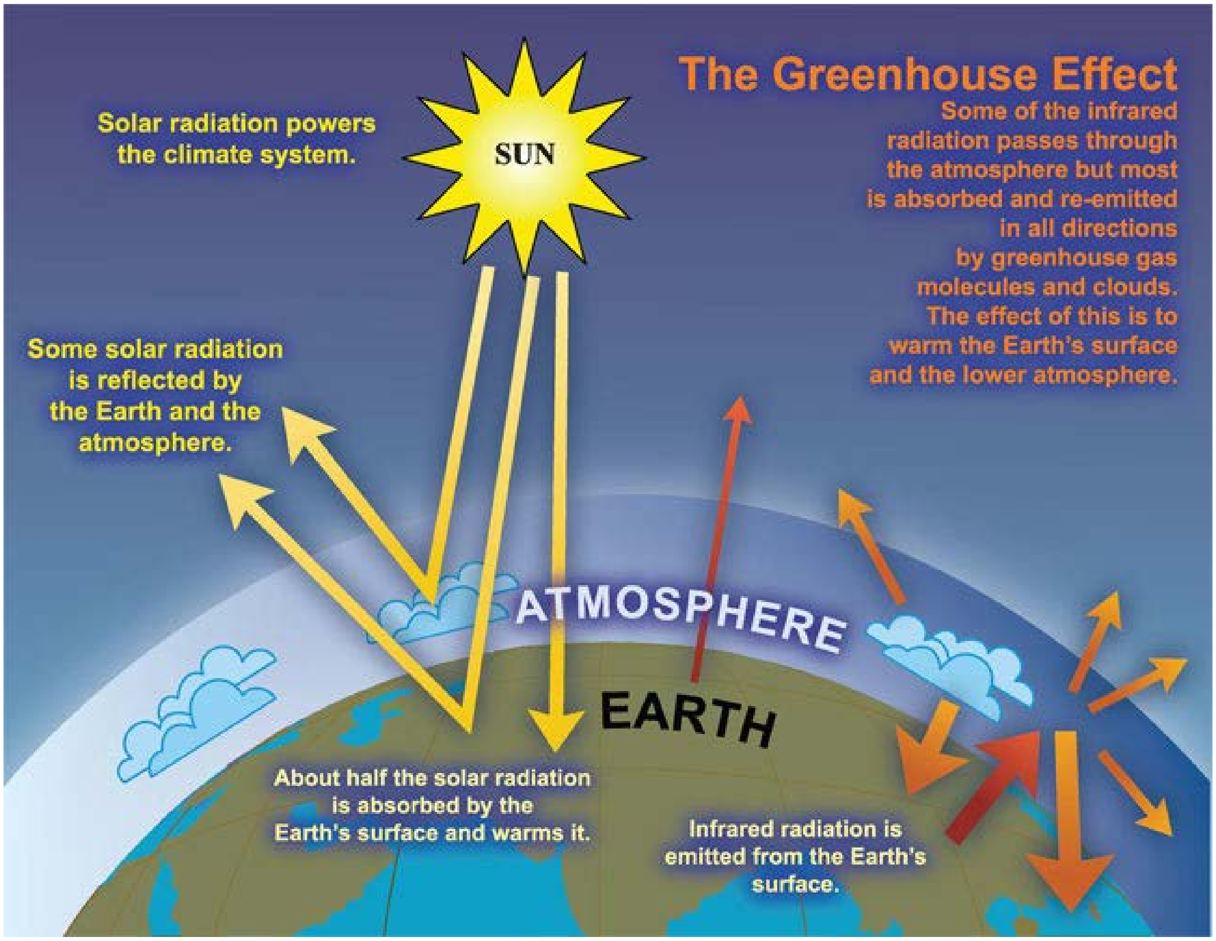
The composition of gases in the Earth's atmosphere determines the amount of energy absorbed and re-emitted by the atmosphere or simply reflected back into space. The predominant gases in the Earth's atmosphere, nitrogen and oxygen (which together account for nearly 90% of the atmosphere) exert little to no greenhouse effect. Gases such as carbon dioxide, methane, and nitrous oxide, trap outgoing energy and contribute to the greenhouse effect. These greenhouse gases are pollutants under the federal Clean Air Act. Additionally, manufactured pollutants, such as hydrofluorocarbons, can contribute to the greenhouse effect. Unlike most air pollutants (e.g., particulate matter) that have only a local impact on air quality, GHGs affect the atmosphere equally regardless of where they are emitted, and thus are global pollutants. A ton of methane emissions in Asia affects the global atmosphere to the same degree as a ton of methane emissions in the United States.

---

[3] The very near term 2006–2024 is not addressed here. This term is typically covered by existing procedures and examination of current conditions are adequate for planning purposes. Further, the very near term does not allow for future climatic changes to be realized and assessed. Hence this time period is excluded from consideration in this report.

[4] Unless otherwise noted, the moderate concentration scenario corresponds to Representative Concentration Pathway (RCP) 4.5; the high concentration scenario corresponds to RCP 8.5. RCPs project increases in atmospheric concentrations of GHGs between now and 2100. They are used in international climate modeling to develop consistent future scenarios of climate change and have been adopted by the Intergovernmental Panel on Climate Change in its Fifth Assessment Report.

Figure 3. An Idealized Model of the Natural Greenhouse Effect



Source: Intergovernmental Panel on Climate Change 2007

As the atmospheric concentrations of GHGs increase, the atmosphere's ability to retain heat increases as well. Since the instrumental record began in 1895, the U.S. average temperature has risen by approximately 1.3 to 1.9 degrees Fahrenheit (°F) (U.S. Global Change Research Program 2014). Furthermore, U.S. average temperatures throughout the 21st century are expected to increase at a faster pace, by 3°F to 10°F by 2100 above a 1970 to 1999 baseline (U.S. Global Change Research Program 2014).

The impacts of higher global surface temperatures include widespread changes in the Earth's climate system. Increased surface temperatures is causing sea level to rise both from thermal expansion of seawater as well as increased melting of ice sheets in the most northerly and southerly reaches. It is also changing weather patterns, including the frequency, severity, and duration of heat waves, drought and extreme precipitation events. Incidences of drought are expected to become more frequent.

Climate change also affects the natural environment and virtually all aspects of society, including biodiversity, invasive species, human health, cultural resources, infrastructure, and other sectors. The impacts will vary by location and depend on the nature of the hazards experienced. Coastal areas are particularly at risk because of their exposure to sea level rise.

2.2 Climate Change Projections

This section describes the data and methods used to identify projected changes in climate and to evaluate the impacts of climate change on the Proposed Action and No-Action Alternative.

This report assesses available information on historical climate and projected changes in climate change for southwestern Washington State using[5] the U.S. Geological Survey National Climate Change Viewer (2014) and the 2014 National Climate Assessment (Melillo et al. 2014).

- **National Climate Change Viewer.** The National Climate Change Viewer contains historical and future climate projections at watershed, state, and county levels for the continental United States. The viewer contains *multimodel ensemble data* (*mean model*), combining the results from 30 independent climate models developed by researchers around the world under the coordination of the Fifth Coupled Model Intercomparison Project (CMIP5).[6] Multimodel data increases the robustness of projections and provides information on the level of uncertainty in the direction and magnitude of future climate trends. Climate information in the viewer has been *downscaled*, or processed using statistical analysis to provide projections with higher geographic resolution of temperature, precipitation, and snowfall. Historical values and future projections of temperature were examined for Cowlitz County where the Proposed Action would be located. Historical values and future projections of precipitation and snowfall were examined for the Lower Columbia River Basin.
- **2014 National Climate Assessment.** The 2014 National Climate Assessment was conducted by the U.S. Global Change Research Program (Melillo et al. 2014). This assessment summarizes the current and future impacts of climate change on the United States. Its findings, which have undergone extensive public and expert peer review, were compiled by a team of more than 300 experts guided by the 60-member Federal Advisory Committee of the National Academy of Sciences. The report uses multimodel ensemble projections developed under CMIP5, supplemented by information from an earlier phase of the project, CMIP3, where necessary. This report relies heavily on the chapters devoted to impacts in the Pacific Northwest whose convening lead authors were Phillip Mote, Oregon State University and Amy Snover, Climate Impacts Group, University of Washington.

This section provides an overview of the likely climate impacts affecting the Pacific Northwest. The following sections focus more directly on the anticipated impacts at the project's location.

Temperatures have already increased across the Pacific Northwest by 1.3°F since 1895. Precipitation has, as well, but to date these increases are small and vary with location within the region. Under the changing climate, temperatures could rise by as much as 9.7 °F by the end of the century. Future trends in average precipitation are very uncertain and may increase or decrease, but summer precipitation is projected to decrease by as much as 30% by 2100.

---

[5] Both information sources rely on climate information developed by CMIP5. CMIP5 is the fifth phase of the World Climate Research Programme's Coupled Model Intercomparison Project, which has established a standard set of simulations for coordinated climate experiments among international climate modeling groups. CMIP5 data is accessible over the internet and has been used in the Intergovernmental Panel on Climate Change's (IPCC) Fifth Assessment Report, an internationally vetted and authoritative report on global climate change.

[6] A list of the climate models can be found in Appendix 5 of the National Climate Change Viewer Tutorial (U.S. Geological Survey 2014b).

Snow pack averaged over the Cascade Mountains has declined by about 20% since 1950 (Mote et al. 2014). In the future, snowpack is expected to continue its downward trend, causing declines in snowmelt. According to Eisner, et al., The snow water equivalent on April 1 could decline by almost half (46%) by the 2040s and virtually disappear by the 2080s, greatly reducing streamflow in some areas. The incidence of extreme precipitation, which causes important impacts on infrastructure in the region, may have increased over time, but it has not yet been demonstrated to be statistically significant. It varies with location within the region. Under the changing climate in the Pacific Northwest, the number of days with daily rainfall greater than one inch could increase by 13% in the 2041–2070 period (Mote et al. 2014).

Sea levels are rising but uplift of the land in parts of the Pacific Northwest mitigates possible impacts from sea-level rise. By contrast, areas around Puget Sound are subsiding and causing larger than average increases in sea levels. For the Pacific Northwest, sea level rise is expected to be as little as five inches or less to greater than four feet by the end of the century. The impacts of the El Nino South Oscillation phenomenon on climate variability can be significant. During El Nino years regional sea levels can increase by 4 to 12 inches and last for many months (Mote et al. 2014).

Climatic changes in precipitation could have far-reaching effects for the Pacific Northwest. Reduced summer rainfall and reductions in snowmelt – demonstrated under all emission scenarios and with near 100% likelihood -- will probably result in reduced streamflow. This trend could cause trade-offs among the many water uses, including transport, agriculture, recreation, and others, and a possible reduction in hydropower. Human activities have extracted so much water that conflicts have already occurred in dry years. Despite these summertime reductions, increases in extreme precipitation could lead to increased flooding, especially in basins that derive their water from both rain- and snowfall. Rising sea-levels could also lead to flooding of public and private property including ferry terminals, and roads and railways in coastal areas. Increasing temperatures and reduced precipitation could lead to an increase in wildfires which are driven in part by water deficits. By the 2080s the median area burned annually in the Pacific Northwest could quadruple compared to the 1916 to 2007 period (Mote et al. 2014).

2.3 Existing and Future Conditions

This section presents the historical and projected changes in temperature, precipitation, and the snowfall for the study area. Ocean acidification is not addressed here since its impacts on the Proposed Action are anticipated to be minimal.

2.3.1 Historical and Projected Changes in Temperature

Washington State has a varied climate with significant differences in temperature and precipitation on the east and west sides of the Cascade Mountains. Temperatures across the Pacific Northwest have increased from 1895 to 2011 by 1.3°F (Mote et al. 2014). West of the Cascades, where the study area is located, the climate is characterized by mild temperatures, and heavy annual rain and snow. From 1950 to 2005, the highest monthly average temperatures[7] in Cowlitz County were more than 75°F, cooler than Washington State as a whole (77.5°F) but warmer than the lower Columbia

[7] The highest temperatures and precipitation are taken as the top 10% (i.e., 90th percentile) of temperature and precipitation readings or projections. The lowest temperatures and precipitation values are the bottom 10% (i.e., 10th percentile) of all readings or projections.

River Basin of which it is part (73.4°F). The highest monthly average temperature in Cowlitz County over this period was a moderate 77.2°F (August) (U.S. Geological Survey 2014a). In general, the lowest monthly average temperatures in Cowlitz County during winter[8] were below 31.6°F from 1950 to 2005. The area has experienced a warming trend in the past five decades; the annual average maximum temperatures have increased by 0.9°F (U.S. Geological Survey 2014a).

In the near-term future, seasonal temperatures in the study area are projected to increase. In Cowlitz County, hot summer temperatures could rise by as much as 4.3°F in the high GHG concentration scenario from 2025 to 2049, compared to baseline (U.S. Geological Survey 2014a)[9]. Cold winter temperatures are projected to increase by 2.4 to 3.0°F in moderate and high GHG concentration scenarios over this period (U.S. Geological Survey 2014a). This warming trend continues into the midterm future (2050 and 2075), where hot summer temperatures in Cowlitz County are projected to increase by 5.4 to 7.2°F. Coldest temperatures are expected to increase by as much as 5.2°F (U.S. Geological Survey 2014a). These increases will likely bring the coldest temperatures near to or above the freezing point[10]. While some models project higher or lower increases in temperature, all 30 models agree that temperatures will increase in Cowlitz County. Table 2 summarizes these historical and projected changes in temperature.

Table 2. Historical and Projected Changes in Temperature in Cowlitz County, WA

Historical climate and observed changes (1950–2005)	Near-term projected changes (2025–2049 compared to 1950–2005)	Midterm projected changes (2050–2075 compared to 1950–2005)	Level of certainty in projections
The average monthly summer and winter temperatures (approximately 75°F and 32°F, respectively) reflect the moderate climate of the area.	Summer and winter temperature extremes are projected to increase.	Summer and winter temperature extremes are projected to increase.	There is excellent agreement across models on the direction of change.
Highest average monthly summer temperatures (top 10%, or 90th percentile) were above 75.0°F. Max monthly average temperature for August was 77.2°F.	90th percentile temperature is projected to increase by 3.8 to 4.3°F under moderate and high emissions scenarios.	90th percentile temperature is projected to increase by 5.4 to 7.2°F under moderate and high emissions scenarios.	Monthly average temperature is projected to increase in all months across all models compared to 1950–2005.
Lowest monthly average winter temperatures (10th percentile) were below 31.6°F.	10th percentile temperature is projected to increase by 2.4 to 3.0°F under moderate and high emissions scenarios.	10th percentile temperature is projected to increase by 4.0 to 5.2°F under moderate and high emissions.	

[8] For seasonal results, winter averages December, January, and February; spring averages March, April, and May; summer averages June, July, and August; and fall averages September, October, and November.

[9] The baseline is defined as 1950 to 2005 which is thought to represent a period during which relatively few changes had occurred as a result of climate change.

[10] Note that while the average monthly temperatures during winter will likely rise above 32°F, cold temperatures on any given day could still be below freezing.

2.3.2 Historical and Projected Changes in Precipitation

Extreme precipitation especially during the winter months has frequently led to flooding events in the Pacific Northwest. These storms have resulted in billions of dollars of loss and were responsible for about two-thirds of the presidential disaster declarations since 1955. Major flooding in January 2009 closed Interstate 5, heavily damaged the Howard Hanson Dam and put tens of thousands of people at risk. (Warner et al. 2012) A key driver of these precipitation events is the phenomenon of atmospheric rivers that form in the Pacific Ocean and move eastward toward the Pacific Northwest. In December 2105, an atmospheric river formed and made landfall along the Washington coast, resulting in almost 16 inches of precipitation over three days across Oregon, Washington, and British Columbia, Canada.

The Columbia River is the fourth largest river in North America. It is influenced by multiple river basins from multiple states and British Columbia. The geographic and hydrologic characteristics of the river, which drains a 259,000 square mile basin, are suited to beneficial multiple-purpose storage development. Since the 1930s, numerous dams, both Federal and private, have been built to store water for flood control, to generate hydroelectric power, and for other purposes. Total storage capacity of these dams is about 25 percent of the 156 million acre foot average annual runoff volume for the Columbia River at its mouth. Federal projects in the basin have 19,900 megawatts of existing hydroelectric capacity, and non-federal projects add 10,700 megawatts (USACE 2015)

According to the National Climate Assessment (Mote et al. 2014), the anticipated change in annual precipitation in the Pacific Northwest ranges from decreases (-11%) to increases (+12%) from 2030 to 2059 for the B1, A1B, and A2 scenarios.[11] This variability makes the analysis of potential impacts problematic. Typically, average monthly precipitation is greatest in winter (December through February) and least in summer (June through August) (U.S. Geological Survey 2014a). From 1950 to 2005, precipitation in the lower Columbia River Basin averaged 0.40 inch per day in winter (U.S. Geological Survey 2014a) and about half that in spring (0.22) and fall (0.25). By contrast, only 0.07 inch per day fell during the summer months.

In the near-term future, the mean model indicates slight increases in the winter, spring, and fall compared to the 1950 to 2005 average. The largest increase in precipitation is projected to occur in fall (4.1 to 2.1%)[12] and winter (2.3 to 4.8%). Very little increase is projected for the spring (0 to 1%) (U.S. Geological Survey 2014a). By contrast, summers in the near-term future are projected to become drier by 10 to 12%, although some climate models disagree and instead project that summer precipitation will remain the same or increase (U.S. Geological Survey 2014a). Overall, model agreement on precipitation is not strong. For example, in some cases just 19 models project decreases in June precipitation (and 11 indicate increases) for the near-term future. Agreement for the month of August, however, was closer, with 26 models showing decreases and only four demonstrating increases.

---

[11] The B1, A1B, and A2 scenarios refer to emissions scenarios from the Intergovernmental Panel on Climate Change's Special Report on Emissions Scenarios (2000). These scenarios have been superseded in the international climate modeling by Representative Concentration Pathway scenarios. The B1 and A2 scenarios are generally considered to be low and high emissions scenarios, respectively. The A1B scenario falls between them. Since not all projections have been updated with the latest GHG concentration scenarios, these scenarios have been retained where new information is not yet available.

[12] By convention, the value from the moderate emissions scenario is presented first even though the value from the high emissions scenario is lower.

Similar changes are projected to continue in the midterm future: the winter, spring, and fall seasons could become wetter, while summers could become drier. In the lower Columbia River Basin, winter and fall precipitation levels are projected to increase by 4.9 to 7.1% and 3.6 to 1.5%, respectively, while spring levels remain relatively constant (0 to 1.8% increase) in moderate and high scenarios compared to the 1950 to 2005 average. Extreme precipitation[13] could increase as the highest events could increase by 5.0 to 6.1% in the near-term future and 6.1 to 8.0% in the midterm future (U.S. Geological Survey 2014a), but studies of past trends in observed changes in extreme precipitation have yielded ambiguous results (Mote et al. 2014). Model discrepancies are similar with most models showing increases and others showing decreases. Table 3 summarizes these historical and projected changes in precipitation.

Table 3. Historical and Projected Changes in Precipitation in the Lower Columbia River Basin

Historical climate and observed changes (1950–2005)	Near-term projected changes (2025–2049 compared to 1950–2005)	Mid-term projected changes (2050–2075 compared to 1950–2005)	Level of certainty in projections
Average annual precipitation was 0.24 inch/day.	Wetter winter, spring, and fall seasons; possible drier summers.	Wetter winter, spring, and fall seasons; possible drier summers.	Some models show increases in precipitation while others show decreases. Incidence of extreme precipitation is more likely to increase.
The highest (90th percentile) monthly average precipitation was 0.43 inch/day.	Change in average precipitation by season under moderate and high emission scenarios. • Winter: +2 to 5% • Spring: 0 to +1% • Summer: -10 to -12% • Fall: +4 to +2%	Change in average precipitation by under moderate and high emission scenarios • Winter: +5 to +7% • Spring: +0 to +2% • Summer: -10 to -16% • Fall: +4 to +2%	A majority of models (18 to 26 of 30, depending on the scenario and timeframe) project that precipitation will decrease in the summer.
The lowest (10th percentile) monthly average precipitation was 0.06 inch/day.	Intensity of extreme precipitation could increase. • 90th percentile precipitation is projected to increase by 5 to 6% under moderate and high emissions scenarios	Intensity of extreme precipitation could increase. • 90th percentile precipitation is projected to increase by 6 to 8% under moderate and high emissions scenarios	Most models (20 of 30) project an increase in extreme precipitation.

[13] Extreme precipitation is determined as the magnitude of rain events in the 90th percentile (i.e., top 10% of all rain events for precipitation in a given period).

2.3.3 Historical and Projected Changes in Snowfall

Snowfall in the Canadian Rockies and the Cascade Mountains provides much of the water flowing in the Columbia River. In contrast to the variable projections in overall precipitation, the anticipated changes in snowfall are large and model agreement is very high.

Average annual snowfall was 5.6 inches per month from 1950 to 2005. Average winter and spring snowfall, when virtually all snowfall occurs, was about 29.7 and 33.3 inches, respectively. These levels are expected to decline by 39 to 45% in the near-term future for the moderate and high GHG emissions scenarios. This substantial decrease is projected to occur within relatively narrow bands (winter: 33 to 40%; spring: 41 to 47%). All models indicate decreases in annual, winter, and spring snowfall (U.S. Geological Survey 2014a).

In the midterm future, these trends are expected to intensify. Winter snowfall could decline by as much as 62% (ranging from 49 to 62% under the moderate and high emissions scenarios); spring snowfall could decrease by as much as 75% under the moderate emissions scenario and 68% under the high emissions scenario.[14] Again, all models agree that snowfall will decline over time. Table 4 summarizes these historical and projected changes in snowfall.

Table 4. Historical and Projected Changes in Snow in the Lower Columbia River Basin

Historical climate and observed changes (1950–2005)	Near-term projected changes (2025–2049 compared to 1950–2005)	Mid-term projected changes (2050–2075 compared to 1950–2005)	Level of certainty in projections
Heaviest snowfall occurs in the winter and spring leading to high average annual snowfall totals	*Average annual, winter and spring snowfall will likely decline under the moderate and high emission scenarios in the near term*	*Average annual, winter and spring snowfall will likely decline under the moderate and high emission scenarios in the mid-term*	*There is excellent agreement on the direction of change*
Average annual snowfall was 5.6 inches/month	Change in average monthly snowfall could decline by 39 to 45%	Change in average monthly snowfall could decline by 54 to 66%	All models agree on the direction of the impact
Average winter and spring snowfall was 29.7 and 33.3 inches, respectively	Change in average winter and spring snowfall under moderate and high emission scenarios • Winter: -33 to -40% • Spring: -41 to -47%	Change in average winter and spring snowfall under moderate and high emission scenarios • Winter: -49 to -62% • Spring: -75 to -68%	All models agree that snowfall will decline in the winter and spring in near- and mid-terms

[14] Higher emissions do not necessarily equate to increases in precipitation. Note that under the higher emissions scenario, average precipitation declines can be either more or less than under the moderate emissions scenario. Existing models must take other variables such as weather patterns and topography into account when projecting future precipitation levels.

Chapter 3
Impacts of Climate Change on the Proposed Action

This chapter describes the potential impacts of climate change effects on the Proposed Action and the No-Action Alternative.

Changes in current and historical patterns of temperature and precipitation may affect the infrastructure, operation, and service of the coal export terminal. Climate change considerations can be incorporated into design, construction, operation, and maintenance plans to provide for robust and resilient service now and in the future.

Impacts on the coal export terminal and to transportation routes could be caused by the following climate change impacts

- **Low water levels.** Decreased snowfall in the lower Columbia River Basin, especially in the winter and spring, coupled with potential declines in rainfall in the summer could lead to abnormally low levels of water in the Columbia River, which could impede the passage of large ships to and from the docks at the project area. With the coal export terminal located some 50 miles inland from the Columbia River estuary, the main impact of sea level rise at the project area is expected to be minimal in and of itself, but may reduce the potential for service disruptions from low water and exacerbate the potential for flooding at discrete project locations.
- **Flooding**. Potential precipitation increases and intense downpours could cause the Cowlitz or Columbia Rivers to flood, affecting the rail lines and docks that access the project area or the project area itself.
- **Wildfire**. Higher temperatures could increase the likelihood of wildfire, although wetter summers with reduced wildfire likelihood cannot be ruled out.

3.1 Potential Service Disruptions from Low Water

Decreased snowfall, especially in the winter and spring, coupled with potential declines in summer rainfall in the Lower Columbia River Basin, could lead to abnormally low levels of water in the Columbia River. Low water levels could impede the passage of large ships to and from the docks of the project area. Low water levels could raise costs for electricity or otherwise force difficult choices on competing water usage. Operational changes to the water management of the Columbia River system may be sufficient to address these potential impacts.

Snowfall is expected to decline substantially in the near and midterm futures (Section 2.3.3, *Historical and Projected Changes in Snowfall*). In the lower basin of the Columbia River, the amount of snow could be reduced by almost half and two-thirds by 2075 (U.S. Geological Survey 2014a). And, while not all models agree, spring and summer precipitation levels could remain flat or decline over the same periods.

Drought is already of concern. Washington State defines drought as 75% of normal water conditions (Revised Code of Washington 43.83B.400). In the past century, drought occurred from 1928 to 1932, 1992 to 1994, and1996 to 1997, and most recently this year (2015). Drought has caused shipping costs to rise, sometimes requiring wheat growers to move their product by rail or truck instead of barge transport. Washington State estimates that it will experience severe or extreme drought 5% of the time in the future and more frequently east of the Cascade Mountains (Washington State Emergency Management Division 2012a). This year's drought emergency includes all of Washington State (Washington State Department of Ecology 2015).

The Proposed Action would require ships of the Panamax class to berth at existing and newly installed docks to receive coal shipments. Panamax ships are midsized cargo ships, the largest that could fit through the Panama Canal prior to expansion. They have a capacity of 60,000 to 100,000 deadweight tonnage and require a draft of 42 to 49 feet. The depth of the Columbia River at Longview varies by season. Periodic dredging, as needed, part of the Proposed Action. If precipitation from snow and rain is reduced and low water levels occur on the Columbia River, shipping may be restricted or more dredging may be required.

At the project area, the Columbia River experiences tidal fluctuation, although less than at the mouth of the river. Tidal forces could replace some or all of the water needed for ship passage in the event of low runoff from reduced snowmelt and rainfall. Nonetheless, the impact of low tides on ship passage should be considered. The potential for low water disruptions may also be reduced by future sea level rise. Sea levels are expected to increase by as much as four feet in the Pacific Northwest, but this could be significantly less if the project area is—as much of the Pacific Northwest is—subject to uplift. The Columbia River is also highly managed to provide water for multiple competing uses. For example, low water levels upstream of the project area have constrained recreational boating at times.

Washington State is heavily dependent on hydropower for electricity. Approximately 75% of its electricity comes from hydropower generated by its systems of rivers and dams. The rivers also supply water for irrigation, municipalities, and industry. Drought-induced loss of hydropower could raise costs. As the supply of locally generated hydropower is reduced, utilities must seek additional sources of electricity, which could drive up prices for the coal export terminal (Washington State Emergency Management Division 2012a). Both the Proposed Action could be similarly affected by these potential impacts, as both would require Panamax ships to berth and electricity for operations.

3.2 Likelihood of Damage and Service Disruptions from Flooding

The project area is directly on the Columbia River about 5 miles from the confluence of the Columbia and Cowlitz Rivers (ICF International 2016b). The study area, including Longview, is protected from flooding by a levee maintained by the Consolidated Diking Improvement District, which is 34 feet above the Columbia River Datum.[15] It is also protected by a system of sloughs, ditches, and drains. The Federal Emergency Management Agency classifies the project area as Zone B in its Flood Insurance Rate Map, meaning the area is expected to flood every 100 to 500 years.

Water levels in the Columbia River vary by season and year, depending on the snow mass in the upper watershed. Historic crests on the Columbia River range from 13 to 24 feet with flood stage at

[15] The Columbia River Datum is the lowest level recorded on the river, which occurred on October 6, 1886. It is about 2.5 feet above the North American Vertical Datum 1988, which is the national standard geodetic reference for heights.

13.5 feet. Historic crests on the Cowlitz River range from 21 to 29.5 feet and have been recorded well above flood stage (21 feet). Above 28.5 feet, major flooding at Kelso (across the river from Longview) is expected. This flood stage could overtop the levee and increase erosion rates (ICF International 2016b).

Under current conditions, flooding is expected to be minimal at the project area for the Proposed Action (ICF International 2016b). In the future, flooding could be of concern, particularly from the Cowlitz River. In August 2014, the U.S. Army Corps of Engineers found that sediment buildup on the Cowlitz River was increasing the potential for flooding, Without further action, the flood risk level on the river (0.6%) would be exceeded by 2018 (U.S. Army Corps of Engineers 2014). While future precipitation is somewhat uncertain, the mean model indicates increases in fall and winter for both the near and midterm futures, which could increase flood risk. Future flood risk could be exacerbated by sea level rise in the Pacific Northwest. Seas are expected to rise by as little as five inches to as much as four feet depending on vertical land movements (either uplift or subsidence).

The BNSF Spur and Reynolds Lead that would carry Proposed Action-related trains to the project area could be subjected to flooding. The rail line crosses the Cowlitz River near the confluence with the Columbia River and runs near the rivers for the 5 miles to the project area. Because historical and recent crests have been reported on the Cowlitz River, flood risk from sedimentation is increasing, and future precipitation could increase, flooding of the Reynolds Lead is possible. Cowlitz River flooding at this location would likely disrupt rail and terminal operations, and ballast supporting the rail line could be dislodged. Therefore, Proposed Action-related trains could be affected by a Cowlitz River flood.

3.3 Possible Service Disruptions from Fires

Wildfire is a threat in Washington. Cowlitz County is considered a high-risk area (Washington State Emergency Planning Division 2012c). Wildfires in Cowlitz County numbered more than 350 from 2004 to 2013, burning more than 561 acres. In late summer and early fall, dry easterly winds can produce extreme fire conditions. This threat has increased over time because of four factors: earlier snowmelt, higher summer temperatures, longer fire season, and an expanded vulnerable area of high-elevation forests. These factors are caused by increases in summer temperatures and past increases can be attributed to climate change (Washington State Emergency Planning Division 2012c). Increasing temperatures, extreme heat events, and drought could have an effect on fire regimes in Washington State by influencing the length of the fire season and contributing to drier conditions and the availability of readily combustible fuel for fires (Mote et al. 2014).

Maximum temperatures are predicted to increase while summer precipitation is predicted to decrease in the study area, although there is some disagreement among the models, and some indicate that summers could become slightly wetter (Section 2.3.1, *Historical and Projected Changes in Temperature;* Section 2.3.2, *Historical and Projected Changes in Precipitation*). Hotter and drier summers will increase the likelihood of wildfires. The Proposed Action would be similarly affected by the risk of wildfire.

3.4 Mitigation

Based on the findings in this technical report, the co-lead agencies (Cowlitz County and Washington State Department of Ecology) determined mitigation measures are not required.

Chapter 4
References

Angel, J. no date. *The 1995 Heat Wave in Chicago*, Illinois. State Climatologist Office for Illinois. Illinois State Water Survey. Available: http://www.isws.illinois.edu/atmos/statecli/general/1995chicago.htm. Accessed: May 28, 2015.

Bonneville Power Administration. *The Columbia River System Inside Story.* U.S. Bureau of Reclamation and U.S. Army Corps of Engineers. 2nd Edition. April.

California Department of Transportation. 2012. *Director's Policy--Climate Change*. DP-30. Available: http://www.dot.ca.gov/hq/tpp/offices/orip/climate_change/documents/DP-30_Climate_Change.pdf#zoom=75. Accessed: May 28, 2015.

Council on Environmental Quality. 2014. *Revised Draft Guidance for Greenhouse Gas Emissions and Climate Change Impacts*. Draft published for public review and comment Dec 2014. Available: https://www.whitehouse.gov/sites/default/files/docs/nepa_revised_draft_ghg_guidance_searchable.pdf. Accessed: May 29, 2015.

Elsner, M.M. Cuo, L. Voisin, N. Deems, J.S. Hamlet, A.F. Vano, J.A. Mickelson, K.E.B. Lee, S.Y. Lettenmaier, D.P. 2010. Implications of 21st century climate change for the hydrology of Washington State. *Climatic Change.* 1(2):225–260.

Executive Office of the President. 2013. *The President's Climate Action Plan.* Final.

Federal Railroad Administration. 2014. *Continuous Welded Rail*. Available: https://www.fra.dot.gov/Page/P0123. Accessed: May 29, 2014.

ICF International. 2016a. *Millennium Bulk Terminals —Longview, SEPA Environmental Impact Statement, SEPA Alternatives Technical Report*. April. Seattle, WA. Prepared for Cowlitz County. Kelso, WA, in cooperation with Washington State Department of Ecology, Southwest Region.

ICF International. 2016b. *Millennium Bulk Terminals —Longview, SEPA Environmental Impact Statement, SEPA Surface Water and Floodplains Technical Report*. April. Seattle, WA. Prepared for Cowlitz County. Kelso, WA, in cooperation with Washington State Department of Ecology, Southwest Region.

Intergovernmental Panel on Climate Change. 2000. *Special Report on Emission Scenarios (SRES). Intergovernmental Panel on Climate Change*. Available: http://www.ipcc.ch/pdf/special-reports/spm/sres-en.pdf. Accessed: May 28, 2014.

Intergovernmental Panel on Climate Change. 2007. *Climate Change 2007: Impacts, Adaptation and Vulnerability, Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. van der Linden, and C. E. Hanson (Eds.). Cambridge University Press, ISBN 978-0-521-88010-7(pb: 978-0-521-70597-4).

Intergovernmental Panel on Climate Change. 2014. *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D.

Mastrandrea, T. E. Bilir, L. L. White (Eds.). Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press. Available: http://ipcc-wg2.gov/AR5/report/. Accessed: May 31, 2014.

Lower Columbia Estuary Partnership. 2011. *Management Plan for the Lower Columbia River*. Available: http://www.estuarypartnership.org/sites/default/files/ CCMP%20Action%20Update%20Final%200212.pdf. Accessed: May 28, 2015.

Melillo, J. M., T.C. Richmond, and G.W. Yohe (Eds.). 2014. *Climate Change Impacts in the United States: The Third National Climate Assessment.* U.S. Global Change Research Program. 841 pp. doi:10.7930/J0Z31WJ2.

Mote, P., A. K. Snover, S. Capalbo, S. D. Eigenbrode, P. Glick, J. Littell, R. Raymondi, and S. Reeder. 2014. *Ch. 21: Northwest. Climate Change Impacts in the United States: The Third National Climate Assessment*. U.S. Global Change Research Program, 487-513. doi:10.7930/J04Q7RWX.

National Research Council. 2008. *The Potential Impacts of Climate Change on U.S. Transportation. Transportation Research Board Special Report 290*. Available: http://www.trb.org/news/blurb_detail.asp?ID=8794. Accessed: May 26, 2014.

Occupational Safety and Health Administration. 2011. *OSHA's Campaign to Prevent Heat Illness in Outdoor Workers: Using the Heat Index, A Guide for Employers*. Available: https://www.osha.gov/SLTC/heatillness/heat_index/index.html. Accessed: May 29, 2014.

Office of the Federal Coordinator for Meteorology.2002. *Weather Information for Surface Transportation: National Needs Assessment Report.* U.S. Department of Commerce / National Oceanic and Atmospheric Administration. No. FCM-R18-2002.

Schwartz, H. G., M. Meyer, C. J. Burbank, M. Kuby, C. Oster, J. Posey, E. J. Russo, and A. Rypinski. 2014. Chapter 5: Transportation. Climate Change Impacts in the United States. *The Third National Climate Assessment*. U.S. Global Change Research Program, 130-149. doi:10.7930/J06Q1V53.

U.S. Army Corps of Engineers. 2014. *Mount St. Helens Long-Term Sediment Management Plan Update*. Available: http://www.nwp.usace.army.mil/Portals/24/docs/projects/MSH_EIS/ Final_Draft_MSH-LRR.pd. Accessed: May 28, 2015.

U.S. Army Corps of Engineers, Northwestern Division. 2015. *Mission-Water Management*. Available: http://www.nwd.usace.army.mil/Missions/Water.aspx. Accessed: December 4, 2015.

U.S. Department of Transportation. 2012. Assessing the Sensitivity of Transportation Assets to Climate Change in Mobile, Alabama. Final Report, Task 2.4. *The Gulf Coast Study, Phase 2*. U.S. Department of Transportation (DOT). Available: http://www.fhwa.dot.gov/environment/climate_change/adaptation/ongoing_and_current_research/gulf_coast_study/phase2_task2/sensitivity_report/index.cfm. Accessed: January 8, 2013.

U.S. Geological Survey. 2004. *Landslide Types and Processes, Fact Sheet 2004-3072*. Washington, DC.

U.S. Geological Survey. 2014a. *National Climate Change Viewer (NCCV), Washington, Cowlitz County, and the Lower Columbia River Basin. Mean Model Results*. U.S. Geological Survey (USGS). Last revised May 6, 2014. Available: http://www.usgs.gov/climate_landuse/clu_rd/nex-dcp30.asp. Accessed: May 24, 2014.

U.S. Geological Survey. 2014b. *National Climate Change Tutorial.* Available: http://www.usgs.gov/climate_landuse/clu_rd/apps/nccv_documentation_v1.pdf.

U.S. Global Change Research Program. 2014. *National Climate Assessment.* Available: http://nca2014.globalchange.gov/. Accessed: May 18, 2015.

Michael D. Warner, Clifford F. Mass, and Eric P. Salathé Jr., 2012: *Wintertime Extreme Precipitation Events along the Pacific Northwest Coast*: Climatology and Synoptic Evolution. *Mon. Wea. Rev.*, 140, 2021–2043. doi: http://dx.doi.org/10.1175/MWR-D-11-00197.1.

Strzepek, K., G. Yohe, J. Neumann, and B. Boehlert, 2010: *Characterizing Changes in Drought Risk for the United States from Climate Change*. Environmental Research Letters, 5, 044012, doi:10.1088/1748-9326/5/4/044012. Available: http://iopscience.iop.org/1748-9326/5/4/044012/pdf/1748- 9326_5_4_044012.pdf. Accessed: May 30, 2014.

The Sanborn Mapping Company. 2012. *West Wide Wildfire Risk Assessment: Final Report*. Oregon Department of Forestry. December 19, 2012.

Washington State Department of Ecology. 2012. *Washington State Integrated Climate Change Response Strategy*. Available: http://www.ecy.wa.gov/climatechange/ ipa_responsestrategy.htm#REPORT. Accessed: May 28, 2015.

Washington State Department of Ecology. 2015. *Order and Determination by the Director*. Available: http://www.ecy.wa.gov/drought/images/pdf/05212015-droughtorder.pdf. Accessed: July 5, 2015.

Washington State Emergency Management Division. 2012a. *Washington State Hazard Mitigation Plan: Drought* Profile. October 2012. Available: http://mil.wa.gov/uploads/pdf/emergency-management/drought_hazard_profile.pdf. Accessed: May 7, 2015.

Washington State Emergency Management Division. 2012b. *Washington State Hazard Mitigation Plan: Landslide Profile.* October 2012. Available: http://mil.wa.gov/uploads/pdf/emergency-management/flood_hazard_profile.pdf. Accessed: May 6, 2015.

Washington State Emergency Management Division. 2012c. *Washington State Hazard Mitigation Plan: Wildfire Profile.* October 2012. Available: http://mil.wa.gov/uploads/pdf/emergency-management/wildfire/wildland_fire_hazard_profile.pdf. Accessed: May 8, 2015.

Westerling, A. L., H. G. Hidalgo, D. R. Cayan, and T. W. Swetnam. 2006. Warming and Earlier Spring Increase Western U.S. Forest Wildfire Activity. *Science* 313(5789), 940–943. doi:10.1126/science.1128834.