MILLENNIUM BULK TERMINALS—LONGVIEW SEPA ENVIRONMENTAL IMPACT STATEMENT

SEPA GREENHOUSE GAS EMISSIONS TECHNICAL REPORT

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April 2016

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

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Acronyms and Abbreviations

°F	degrees Fahrenheit
Applicant	Millennium Bulk Terminals—Longview, LLC
BNSF	BNSF Railway Company
Btu	British thermal unit
CARB	California Air Resources Board
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
COLE	Carbon Online Estimator
eGRID	Emissions & Generation Resource Integrated Database
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
FR	Federal Register
GHG	greenhouse gas
GWP	global warming potential
hp	horsepower
$kgCO_2e$	kilograms of carbon dioxide equivalent
kg CO_2e/MWh	kilograms of carbon dioxide equivalent per megawatt hour
LVSW	Longview Switching Company
MMBtu	million British thermal units
$MMTCO_2e$	million metric tons of carbon dioxide equivalent
$MtCO_2e$	metric tons of carbon dioxide equivalent
NEPA	National Environmental Policy Act
PUD	Public Utility District
RCW	Revised Code of Washington
SEPA	Washington State Environmental Policy Act
UP	United Pacific Railroad
USC	United States Code
WAC	Washington Administrative Code

Chapter 1
Introduction

This technical report assesses the potential greenhouse gas (GHG) emissions impacts of the proposed Millennium Bulk Terminals—Longview project (Proposed Action) and No-Action Alternative. For the purposes of this assessment, GHG emissions include the emissions from construction and operation of the Proposed Action as well as the indirect, market-influenced transportation and end-use fossil fuel combustion emissions from operations. This report describes the regulatory setting, establishes the method for assessing potential GHG emissions impacts, presents the historical and current GHG conditions in the study area, and assesses potential impacts from GHG emissions.

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, 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] The Longview Switching Company (LVSW) is jointly owned by BNSF Railway Company (BNSF) and Union Pacific Railroad.

Figure 1. Project Vicinity

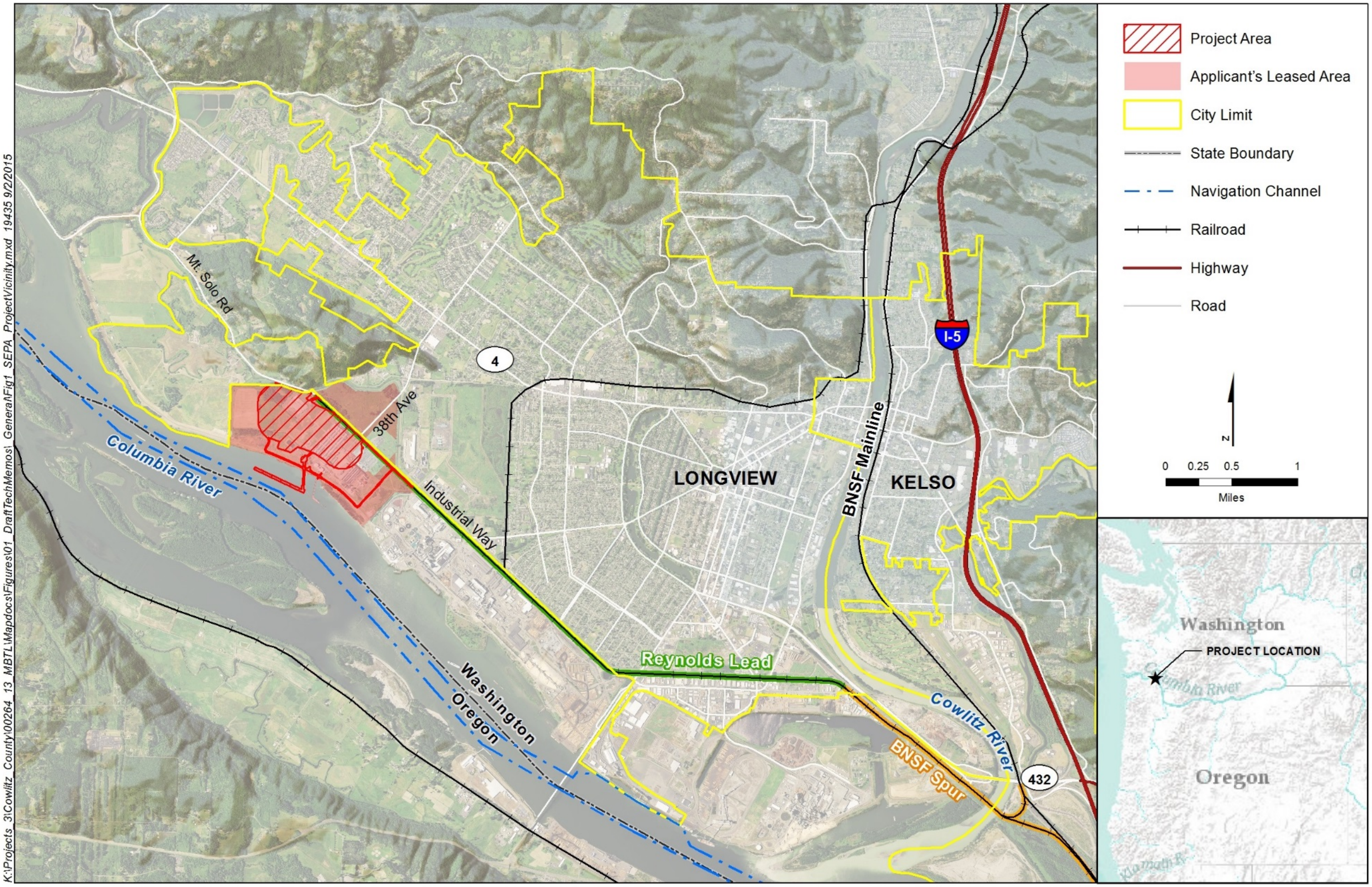
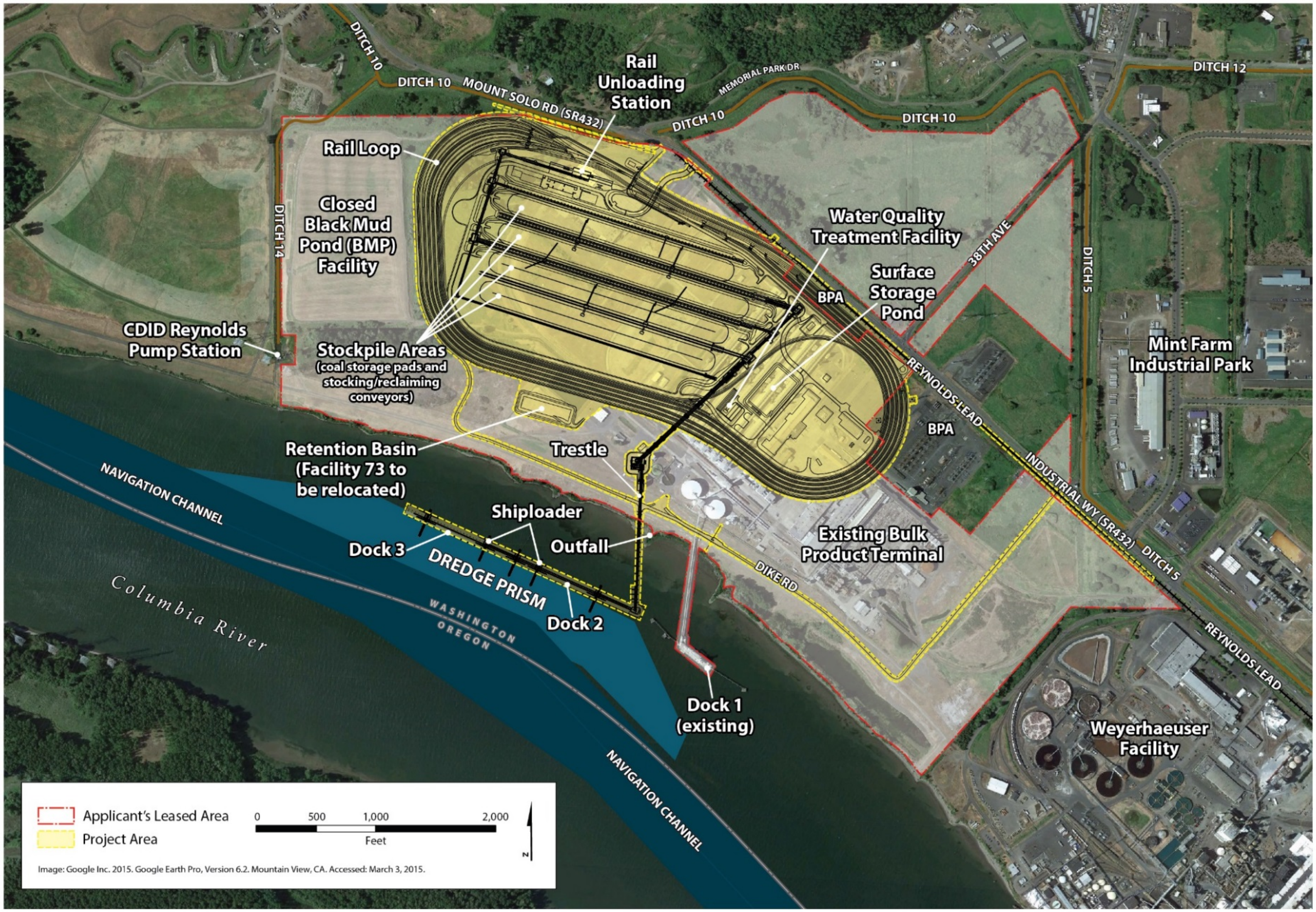


Figure 2. Proposed Action



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 impacts on GHG emissions 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 Guidance for Greenhouse Gases

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) as amended	In 2007, the U.S. Supreme Court ruled that GHGs are air pollutants under the Clean Air Act.
The President's Climate Action Plan (2013)	Sets forth plan for cutting carbon pollution, preparing for the impacts of climate change, and leading international efforts to address climate change (Executive Office of the President 2013).
Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units	In 2015, under the Clean Power Plan, EPA set state-specific target emissions reductions to reduce CO_2 emissions in the power sector by 32% below 2005 levels by 2030 (80 FR 64661). The rate-based CO_2 emission goal for Washington state is 983 pounds of CO_2 per net MWh (80 Federal Register 64962) and the mass-based CO_2 emission goal for Washington state for the 2 year block of 2030–2031 is 21,478,344 short tons of CO_2 (80 Fedeal Register 64963) (or a final goal of 10,739,172 short tons of CO_2 (80 Federal Register 64825)). The greenhouse gas analysis uses the proposed Clean Power Plan. The final Clean Power Plan was released in August 2015, after the modeling was completed for the greenhouse gas analysis.
United States Submittal to the United Nations Framework on Climate Change	U.S. and other nations submitted Intended Nationally Determined Contribution to the United Nations in 2015.
Revised Draft Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in NEPA Reviews	The Council on Environmental Quality (CEQ) has published revised draft guidance on how NEPA analysis and documentation should address greenhouse gas emissions and the impacts of climate change.
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.
Limiting Greenhouse Gas Emissions (RCW 70.235)	Requires state to reduce overall GHG emissions as compared to a 1990 baseline and report emissions to the governor bi-annually. Specific goals include achieving 1990 GHG emissions levels by 2020; 25% below 1990 levels by 2035; and 50% below 1990 levels by 2050 or 70% below the state's expected emissions that year.

Regulation, Statute, Guideline	Description
Washington Clean Air Act (RCW 70.94)	Establishes rules regarding preservation of air quality and penalties for violations. CO_2 mitigation fees are evaluated as part of the permit required by the Clean Air Act (RCW 70.94.892) to reflect requirements from RCW 80.70. RCW 70.94.151 states that the department will be responsible for adopting rules requiring reporting of emissions defined by 70.235.010 from facility, source, site, or fossil fuel supplier that meet or exceed 10,000 metric tons of CO_2e annually.
Washington Carbon Pollution and Clean Energy Action (Executive Order 14-04, 2014)	In December 2014, Governor Inslee established the Governor's Carbon Emissions Reduction Taskforce to provide recommendations to the 2015 legislative session on the design and implementation of a carbon emissions limits and market mechanisms program for Washington State.
Washington's Leadership on Climate Change (Executive Order 09-05, 2009)	In 2009, Governor Gregoire ordered the state to assess the effectiveness of various GHG reduction strategies by estimating emissions, quantifying necessary reductions, and identifying strategies and actions that could be used to meet the 2020 target. Assessments were done across multiple sectors and sources of emissions, including industrial facilities, the electricity sector, low-carbon fuel standards, vehicle miles traveled, coal plants, and forestry.
Path to a Low-Carbon Economy: An Interim Plan to Address Washington's Greenhouse Gas Emissions (2010)	The second Climate Comprehensive Plan report to the Governor and State Legislature outlines a plan to achieve emissions reductions to 1990 levels by 2020, as required by RCW 70.235.
Local	
Cowlitz County SEPA Regulations (CCC 19.11)	Provide for the implementation of SEPA in Cowlitz County.

Notes:

[a] In 2009, EPA proposed the Endangerment Finding and the Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act. The Endangerment Findings determined that the current and projected concentrations for carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorinated chemicals, and sulfur hexafluoride posed a threat to the health and welfare of current and future generations (U.S. Environmental Protection Agency 2009). This sets the legal foundation for regulating GHG emissions from sources of these six well-known GHGs, such as vehicles, industrial facilities, and power plants.

[b] Light duty vehicles include passenger cars, light-duty trucks, and medium-duty passenger vehicles.

USC = United States Code; CFR = Code of Federal Regulations; EPA = U.S. Environmental Protection Agency; FR = *Federal Register*; GHG = greenhouse gas; CO_2 = carbon dioxide; CO_2e = carbon dioxide equivalent; WAC = Washington Administrative Code; RCW = Revised Code of Washington; SEPA = Washington State Environmental Policy Act; CCC = Cowlitz County Code

1.3 Study Area

GHG emissions contribute to the global greenhouse effect, which is the process by which the Earth retains heat (Section 2.1, *Greenhouse Effect*). GHGs emitted anywhere in the globe affect the global environment.[3] The study area for GHG emissions for Cowlitz County as a Washington State Environmental Policy Act (SEPA) co-lead agency is defined as Cowlitz County. GHG emissions for the Washington State Department of Ecology as a SEPA co-lead agency were studied based on the expected transportation routes and emissions from the combustion of coal. While the study areas for the co-lead agencies are different, the analysis used the same approach to calculate GHG emissions.

[3] Some short-lived climate pollutants, such as black carbon, have only a local impact, and are not considered in this analysis.

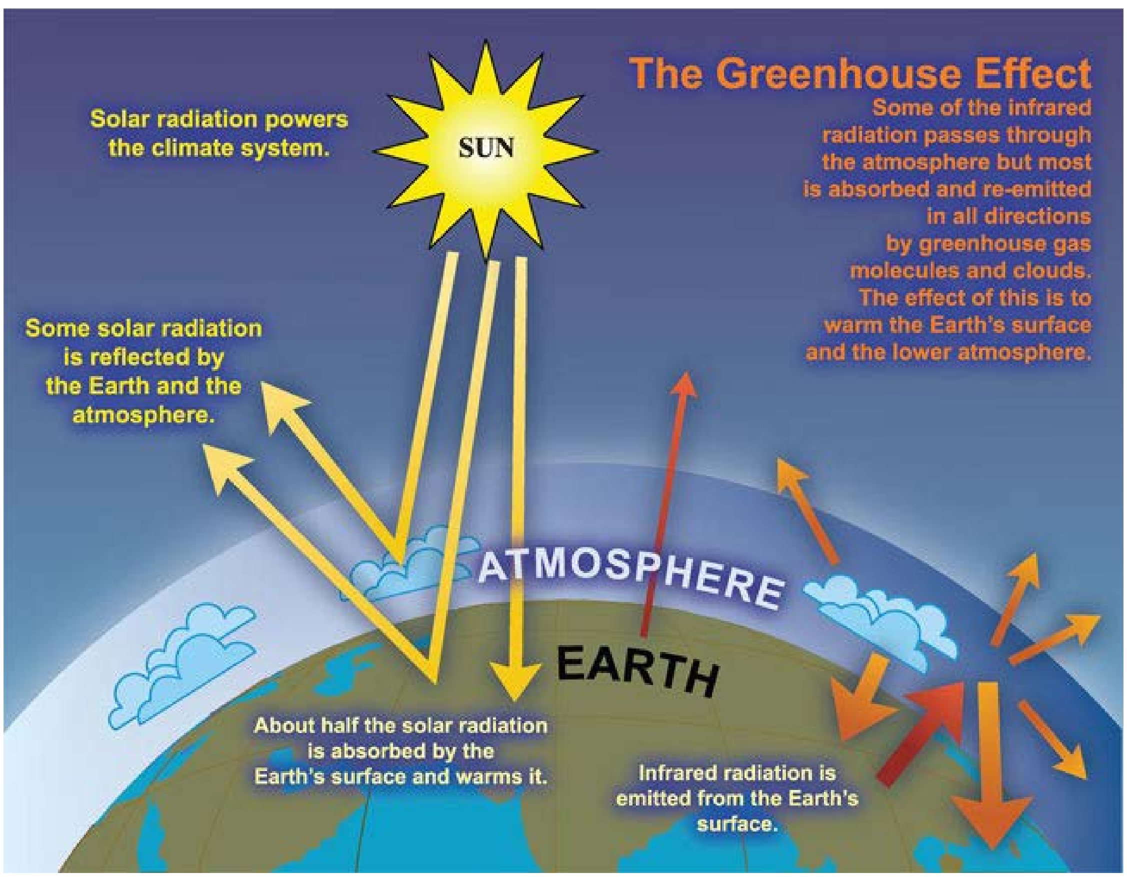
Chapter 2
Existing Conditions

This chapter introduces the greenhouse effect, which is the primary consequence of GHG emissions. The chapter then describes the sources of information and methods used to characterize the existing conditions and assess the potential impacts of the Proposed Action.

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.

Figure 3. Model of the Natural Greenhouse Effect



Source: Intergovernmental Panel on Climate Change 2007

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. Some naturally occurring gases, such as carbon dioxide (CO_2), methane, and nitrous oxide, trap outgoing energy and contribute to the greenhouse effect. Additionally, manufactured pollutants, such as hydrofluorocarbons, can contribute to the greenhouse effect. Unlike most air pollutants (e.g., sulfur dioxide and particulate matter) that have only a local impact on air quality, GHGs affect the atmosphere equally regardless of where they are emitted, and thus they are truly global pollutants. Therefore, 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.

The extent to which a given GHG traps energy in the atmosphere and contributes to the overall greenhouse effect is characterized by its global warming potential (GWP). Some gases are more effective at trapping heat, while others may be longer-lived in the atmosphere. The reference gas against which others are compared is carbon dioxide, and GWP is thus expressed in terms of carbon dioxide-equivalent (CO_2e). CO_2e reflects both a gas's ability to trap heat and the rate at which it breaks down in the atmosphere. Most analyses use 100 years as the period of reference for GWPs, and this technical report conforms to that convention. For example, 1 unit of carbon dioxide has a 100-year GWP of 1, whereas an equivalent amount of methane has a GWP of 25. Over a 500-year period, that same amount of methane has a GWP of 7.6 (Intergovernmental Panel on Climate Change 2007). For the purposes of this analysis, a 100-year period will be used.

GHG emissions occur from both natural as well as human-made (anthropogenic) sources. Examples of natural sources include decomposition of organic matter and aerobic respiration. Anthropogenic GHG emissions are predominantly from the combustion of fossil fuels, although other sources including industrial processes, land-use change, agriculture, and waste management are also significant.

The increase of GHGs in the atmosphere has been determined to pose risks to human and natural systems (Intergovernmental Panel on Climate Change 2014). Atmospheric concentrations of GHGs have increased since the Industrial Revolution, but the natural processes that remove those GHGs from the atmosphere have not scaled proportionally. Additionally, concentrations of long-lived manufactured pollutants such as hydrofluorocarbons have increased in recent decades. 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 2.5°F to 11°F above pre-industrial levels by 2100 (U.S. Global Change Research Program 2014).

The impacts of higher global surface temperatures include widespread changes in the Earth's climate system. This may affect weather patterns, biodiversity, human health, and infrastructure. A discussion of climate impacts as they relate to the Proposed Action is provided in the SEPA Climate Change Technical Report (ICF International 2016b)

2.2 Methods

This section presents the data sources and methods used to estimate project related GHG emissions for the study area. First, the data sources that were used are summarized. Second, the methods used to estimate each source of GHG emissions are described.

2.2.1 Data Sources

The technical reports supporting the SEPA Draft Environmental Impact Statement (EIS) for the Millennium Bulk Terminals—Longview project provided activity data and emissions data to support the GHG analysis. The following sources of information were used to evaluate the GHG emissions from construction and operation of the Proposed Action, the combustion of coal from coal exported from the Proposed Action, domestic and international transport of the coal, and changes in the use of coal and natural gas in response to the operation of the Proposed Action.

- SEPA Air Quality Technical Report (ICF International 2016c)
- SEPA Coal Market Assessment Technical Report (ICF International 2016d)[4]
- SEPA Energy and Natural Resources Technical Report (ICF International 2016e)
- SEPA Rail Transportation Technical Report (ICF International and Hellerworx 2016)
- SEPA Vessel Transportation Technical Report (ICF International 2016f)

To estimate the GHGs emitted as a result of the processes described in the above reports, ICF used those reports' estimates of fuel consumption and vehicle operation, referred to as activity data, and combined that data with GHG emission factors in order to estimate GHG emissions for the Proposed Action.[5] The GHG emission factors were drawn from the following sources.

- California Air Resources Board (CARB). 2011. Appendix D: Emissions Estimation Methodology for Ocean-Going Vessels.
- Clean Cargo Working Group, 2014. Global Maritime Trade Lane Emissions Factors.
- Energy Information Agency 1994. CO_2 Emission Factors for Coal Study for International Coals.
- U.S. Environmental Protection Agency. 1996. AP-42, Section 3.4 Large Stationary Diesel and All Stationary Dual-fuel Engines.
- U.S. Environmental Protection Agency. 2009a. NONROAD Model (Non-road engines, equipment, and vehicles).
- U.S. Environmental Protection Agency. 2009b. Emission Factors for Locomotives.
- U.S. Environmental Protection Agency. 2014a. MOVES (Motor Vehicle Emission Simulator).

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[4] The SEPA Coal Market Assessment Technical Report (ICF International 2016d), hereafter referred to as the coal market assessment, provides estimates on the net changes in international coal combustion, domestic substitution of natural gas for coal and resulting combustion, domestic transport of coal to the proposed project, and international transport of the coal to importing countries. The report provides estimates for several scenarios to cover a range of potential changes in net GHG emissions because of the Proposed Action.

[5] An activity is a practice or ensemble of practices that take place on a delineated area over a given period of time. Activity data are data on the magnitude of a human activity resulting in emissions or removals taking place during a given period of time (e.g., data on energy use, data on equipment used during construction of the Proposed Action) (Intergovernmental Panel on Climate Change 2006).

- U.S. Environmental Protection Agency. 2015c. U.S. Greenhouse Gas Inventory Report: 1990-2013.

2.2.2 Impact Analysis

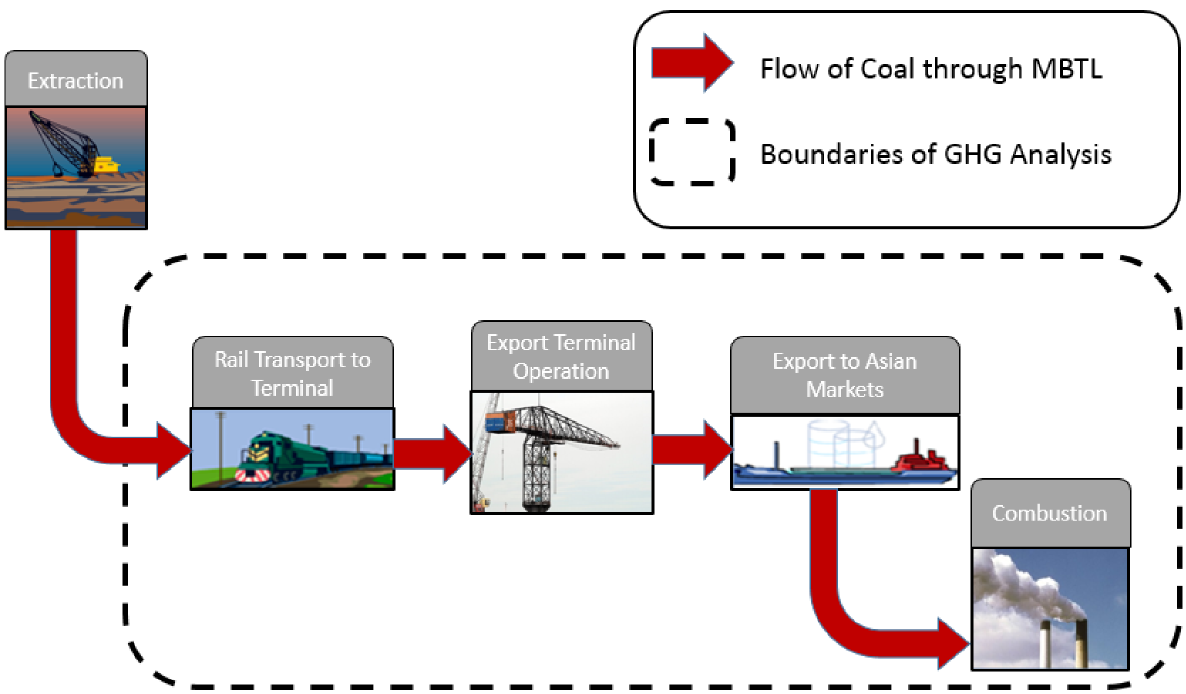
This section describes the methods used to evaluate the potential impacts of the Proposed Action on GHG emissions. The method for estimating the GHG emissions associated with each emissions source is described, along with that source's activity data and the calculations used to estimate its associated GHG emissions. The GHG analysis addresses the same set of sources addressed in the SEPA Air Quality Technical Report (ICF International 2016c), plus several additional sources (e.g., transportation emissions beyond a 5-mile radius, net emissions from changes in domestic and international coal use).

2.2.2.1 Scope of Analysis

The Proposed Action would emit GHGs during construction and operation, both in the United States and abroad. The emissions would come predominantly from the combustion of fossil fuels for construction and operation, as well as changes in the combustion of coal, both domestically and internationally.

This analysis includes activity data from the technical reports described in Section 2.2.1, *Data Sources.* Additionally, the GHG analysis evaluates emissions scenarios based on the ultimate flow of coal to and through the coal export terminal (ICF International 2016d). Figure 4 shows the pathway of coal from extraction to transport to terminal operation to export to its final combustion.

Figure 4. Coal Export Stages and GHG Analysis Boundaries



Geographically, the analysis of GHG emissions from the Proposed Action includes the transportation of Powder River Basin and Uinta Basin coals to Cowlitz County from their points of extraction, bulk terminal operation activity in Cowlitz County, final transport to Asia, and the end-use combustion displacement in China, Hong Kong, Japan, South Korea, and Taiwan. Changes in coal combustion elsewhere in Asia (e.g., India) are included in this analysis where coal use would be affected by the import of coal from the coal export terminal. The substitution of natural gas for coal in the United States because of an increase in domestic coal prices is also evaluated.[6]

This analysis of GHG emissions does not include future coal extraction in the Powder River Basin and the Uinta Basin. This exclusion is based on their coverage in separate GHG analyses as part of the National Environmental Policy Act (NEPA) requirements for these coal mines. Additionally, any future coal mine leases will require separate GHG analyses as part of the NEPA requirements for new coal mines. The EISs and lease applications that mention GHG emissions for coal mines that could provide coal to be shipped through the Proposed Action are summarized in Chapter 4, *Supplementary Data*.

The scope of the GHG emissions analysis considers the following elements.

- **Time horizon.** To be consistent with activity data from the other technical reports, this analysis considers construction, operation, transportation, and fossil fuel combustion emissions from 2018 through 2038.
- **Direct sources of GHG emissions.** Direct emissions refer to GHG emissions from coal export terminal construction, operation, and transportation within Cowlitz County. The following processes are included.
  - Rail transport of coal in Cowlitz County
  - Vehicle-crossing delay
  - Coal export terminal construction
  - Coal export terminal operation—equipment use
  - Vessel idling and tugboat use at the coal export terminal
  - Vessel transport of coal in Cowlitz County
  - Employee commuting
- **Indirect sources of GHG emissions.** Indirect emissions refer to GHG emissions that would result from the Proposed Action but are not concurrent with construction or operation on the project area, or that would occur outside of Cowlitz County. The following are indirect sources of GHG emissions.
  - Rail transport of coal from extraction sites to Washington State
  - Rail transport of coal within Washington State
  - Consumption of electricity used for coal export terminal operations
  - Helicopter and pilot boat trips for pilot transfers to vessels
  - Vessel transport of coal between Cowlitz County and international waters

[6] The proposed coal terminal could increase the demand for U.S. coal, resulting in a corresponding increase in coal prices.

  - Vessel transport of coal from the United States to markets in China, Hong Kong, Japan, South Korea, and Taiwan
  - Coal combustion in Asia and the United States
  - Induced natural gas combustion in the United States

- **Geographic scope.** The geographic scope includes GHG emissions that would occur because of the Proposed Action at multiple geographic scales. Direct emissions that occur on the project area include those from mobile sources during construction and operation. Additional direct emissions would occur in Cowlitz County and Washington State from transport of the coal; in the United States from the transport of coal from extraction sites to the project area; and in international waters from the transport of coal to Asian markets. GHG emissions are also estimated that would result from shifts in coal combustion and demand in Asian markets and from induced natural gas combustion due to the shift from coal as coal prices increase (relative to the no-action as defined in the coal market assessment) in the United States.
- **Induced demand for energy.** This analysis addresses coal combustion in Asia that would result from the increased supply of coal due to the operation of the Proposed Action. The addition of 44 million metric tons to the supply of coal in Asia would increase supply and lower international coal prices. Asian coal markets would respond to lower prices by consuming more coal overall. This additional demand for coal that is a result of shifts due to the shift in the price of coal is referred to as induced demand.
- **Offset energy sources.** Operation of the Proposed Action could offset demand for other energy sources, nationally and internationally. Depending on the scenario, operations could affect production of coal from Australia, China, and Indonesia and its consumption throughout Asia. Additionally, this analysis considers the increased use of U.S. natural gas as a substitute for coal combustion. Consequently, changes in GHG emissions are estimated assuming that coal shipped through the coal export terminal would replace other sources of coal (e.g., coal imported from Australia, China, and Indonesia) and for the substitution of natural gas for U.S. coal.
- **Coal market assessment scenarios.** Each coal market assessment scenario represents a range of GHG emissions estimates, based on economic and policy projections from 2020 to 2040. For each scenario, the GHG emissions from Asian coal combustion, U.S. coal combustion, and U.S. natural gas combustion are influenced by factors such as coal prices, transportation costs, and competing energy sources. Estimates of coal transport, coal consumption, and natural gas substitution are informed by projections in the coal market assessment, which considers four scenarios based on economic and policy projections from 2020 to 2040.[7] The scenarios represent a range of GHG emissions estimates determined using a multi-dimensional model. Two model runs were conducted for each scenario: a no action model and an action model in which the coal export terminal is built. The resulting net GHG emissions are influenced by the relative differences in coal combustion, distribution, and substitution for each of these model runs.

[7] In some other studies, scenarios of economic and policy conditions are compared against a common baseline. For this GHG Analysis, the baseline is redefined for each scenario. This approach is used to capture the range of economic and policy conditions that could exist in the future (i.e., 2025, 2030, and 2040).

The coal market assessment kept the throughput of exported coal constant at 44 million metric tons for the 3 years modeled (2025, 2030, and 2040) for the Proposed Action.[8] However, for the GHG analysis and as described in Section 2.2.2.2, *Method for Assembling an Emissions Time Series,* the coal market assessment results were adjusted to account for changes in quantities of exported coal from 2021 to 2028 when the coal export terminal would be constructed and would ramp up operations. The four scenarios and their key concepts are described below and summarized in Table 2.

- **2015 Energy Policy Scenario.** The 2015 Energy Policy scenario represents the potential impact of an international climate policy.[9] The World Energy Outlook New Policies Scenario represents international coal demand (International Energy Agency 2014). Functionally, this scenario is the same as the Past Conditions (2014) (described below) except for two parameters. First, the international thermal coal demand is taken from the International Energy Agency World Energy Outlook demand forecast for the New Policy scenario.[10] Second, this scenario includes the proposed Clean Power Plan, which will reduce coal consumption in the United States (U.S. Environmental Protection Agency 2014b). This analysis uses the proposed Clean Power Plan in the modeling because the final Clean Power Plan was not released until August, 2015, which was after the modeling was completed for the Coal Market Assessment and GHG analysis. See Table 2 for differences between the proposed and final Clean Power Plan.
- **Past Conditions (2014) Scenario.** The Past Conditions (2014) scenario represents the state of the energy markets as of 2014. Consequently, it does not include the impacts of the Clean Power Plan and does not therefore reflect current energy policy conditions. The international thermal coal demand growth rate varies by country, following trends and "business-as-usual" projections. Of the modeled countries, China's coal consumption continues to grow at the highest rate of 1.7%, while Korea has a negative growth rate of -0.7%. Coal demand elasticity is moderate, with every 1.0% change in delivered coal cost resulting in 0.4% change in demand in the opposite direction.[11]

  Under this scenario, Powder River Basin coal prices are $12 per short ton for 8,800 British thermal units (Btu) per pound of coal, and Uinta Basin coal prices are $40 per short ton for

[8] As described in the coal market assessment, 44 million metric tons was modeled for each year rather than a gradual increase as the coal export terminal reached full capacity.

[9] This scenario is intended to reflect the November 2014 climate negotiations between the United States and China (i.e., a 26 to 28% decrease in 2005 CO_2 emissions in the United States by 2025, and peak in CO_2 emissions and 20% renewable energy deployment in China by 2030). The World Energy Outlook models a range of scenarios that cover current policies, new policies, and the 450 Scenario. The 450 Scenario is the most aggressive in reducing GHG emissions. Per the International Energy Agency, the 450 Scenario sets out an energy pathway that is consistent with a 50 percent chance of meeting the goal of limiting the long-term increase in average global temperature to 2 °C compared with pre-industrial levels. The New Policies Scenario was used rather than the 450 Scenario as the 450 Scenario significantly exceeds China's goal and would underestimate coal demand and resulting CO_2 emissions.

[10] The International Energy Agency's New Policy Scenario was found to be a more realistic representation of energy markets than the 450 Scenario as the 450 Scenario results in scenario where both China and the United States significantly exceed climate policy goals (i.e., the demand for coal and resulting GHG emissions are lower than the demand that would be expected for the meeting the goals under the U.S.-China Joint Announcement on Climate Change and Clean Energy Cooperation).

[11] Additional details on the data sources used to define each scenario are provided in the SEPA Coal Market Assessment Technical Report (ICF International 2016d).

11,700 Btu per pound coal.[12] Rail transportation costs are $30 to $36 per short ton for coal transported from the Powder River Basin and Uinta Basin to the project area. This scenario assumes that no additional national climate policies will be enacted.

- **Lower Bound Scenario.** Due to uncertainty over future coal consumption trends, the coal market assessment constructed the Upper and Lower Bound scenarios in a way that they produce illustrative results to provide a broad range of outcomes. The Lower Bound scenario represents a plausible low estimate of global CO_2 emissions from coal combustion. This scenario evaluates the net CO_2 emissions of the construction and operation of the Proposed Action in which the induced coal demand from the coal export terminal is minimized. This scenario is designed to be a plausible and reasonable lower bound, and does not attempt to model an absolute lowest bound of CO_2 emissions or CO_2 emissions. The energy market under the Lower Bound scenario could reflect a large component of renewable energy resulting in reduced demand for coal combustion.

  Under this scenario, international coal prices are assumed to be 10% less than the Past Conditions (2014) scenario, reflecting the impact of high renewable energy use (i.e., prices are lower due to less demand for coal). Powder River Basin and Uinta Basin coal prices are assumed to be 25% and 10% higher than the Past Conditions (2014) scenario, respectively. Transportation costs are assumed to be 20% higher than the Past Conditions (2014) scenario. Coal demand is assumed to be less elastic than in the Past Conditions (2014) scenario; a 1.0% change in delivered coal cost results in a 0.11% change in coal demand in the opposite direction. These changes will cause a reduced level of induced demand relative to the Past Conditions (2014) scenario and thus lower CO_2 emissions because the export of coal will cause a smaller, or no reduction, in international delivered coal prices compared to the Past Conditions (2014) scenario.

  International thermal coal demand in the Lower Bound scenario is obtained from the International Energy Agency World Energy Outlook demand forecast for their New Policy scenario, which assumes a climate policy for China (International Energy Agency 2014). The Lower Bound scenario assumes that no U.S. national climate policies will be enacted.

- **Upper Bound Scenario.** The Upper Bound scenario represents an upper bound estimate of global CO_2 emissions and assumes that the induced demand from the Proposed Action is maximized. Coal plant construction and thus coal demand is higher than in the Past Conditions (2014) scenario. This higher demand causes both international coal consumption and prices to increase. This scenario does not attempt to model an absolute upper bound of global CO_2 emissions or CO_2 emissions that would result from the Proposed Action.[13]

  Under this scenario, international coal prices are assumed to be 50% higher than in the Past Conditions (2014) scenario, reflecting a greater demand. Asian markets with high prices react more strongly to the availability of cheaper coal exported from the United States. Additionally, Powder River Basin and Uinta Basin coal prices are assumed to be 10% lower. Transportation costs are assumed to be 20% lower for Powder River Basin and Uinta Basin

[12] British thermal units (Btu) are a standardized measurement of the heat content of coal.

[13] Due to uncertainty over future coal consumption trends, the coal market assessment constructed the Upper and Lower Bound scenarios to illustrate a broad range of outcomes but not the most extreme possibilities.

coal movements to the project area. This scenario will result in higher induced demand and CO_2 emissions.

Under this scenario, coal demand is more elastic than in the Past Conditions (2014) scenario. A 1.0% change in delivered coal cost results in a 1.2% change in coal demand in the opposite direction. To the extent that there is a change in delivered coal costs, this assumption will cause the induced demand to be greater than it would be under the Past Conditions (2014) scenario. International thermal coal demand in the Upper Bound scenario is obtained by increasing the Past Conditions (2014) scenario coal demand growth rates by 50%, unless the country had a negative growth rate. In this case, the negative growth rate was set to zero, to obtain a flat demand. This scenario assumes that no national climate policies will be enacted in the United States.

Table 2. Differences Between the Proposed and final Clean Power Plan

Clean Power Plan Component	Proposed Rule	Final Rule
Implementation	2020	2022
Interim standards	1 step 2020–2029	3 steps, 2022–2024, 2025–2027, 2028–2029
Best System of Emission Reduction (BSER) application	State-specific	Interconnection, to develop national technology specific standards
BSER Building Blocks	Four	Three (removed nuclear and existing RE from BB3 and all of BB4-EE)
State Standard derivation	BSER applied to 2012 baseline	National technology-specific rates applied to 2012 adjusted baseline
Standard types	Rate-based	Rate- and mass-based
Potential for trading	Allowed with joint plan	Allowed with joint plan or trading-ready option

Table 3 summarizes the scenarios modeled for the coal market assessment.[14] Many factors would affect the future export and consumption of coal for the Proposed Action. The scenarios reflect a range of potential outcomes. For each scenario, the table provides the following information.

- Purpose: the phenomena that the scenario is intended to represent,
- U.S. coal markets: the domestic coal market reacts to changes in coal demand due to changes in supply and pricing.
- Asian coal markets: the international coal market reacts to changes in coal demand due to changes in supply pricing.
- Coal prices: a range of coal prices capture increases and decreases in coal production and transportation costs relative to the Past Conditions (2014) scenario.
- Climate policy: one scenario captures the effect of the Proposed Action when the proposed Clean Power Plan and U.S.-China Climate Negotiations of 2014 goals are met.

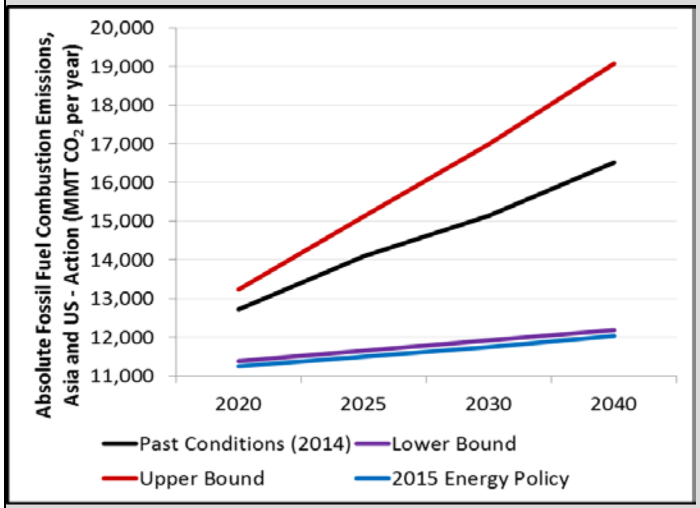
[14] Additional details on the modeling assumptions for each of the scenarios are provided in the SEPA Coal Market Assessment Technical Report (ICF International 2016d).

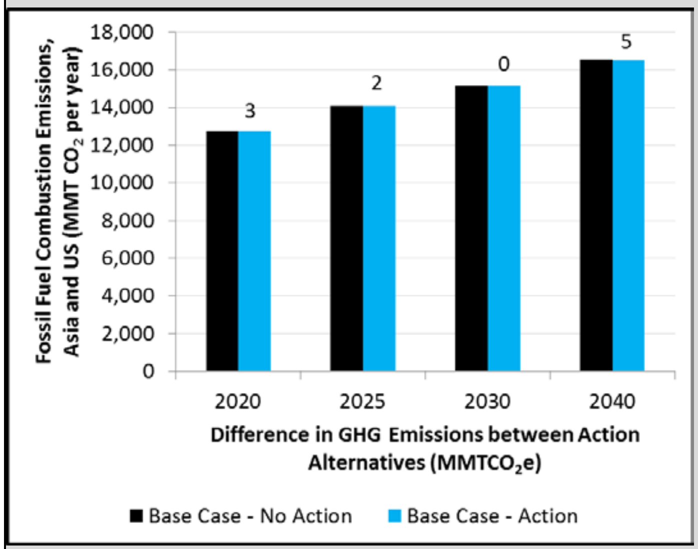
Table 3. Scenarios in the Coal Market Assessment

Scenario	Purpose	U.S. Coal Market Conditions (Relative to Baseline Assumptions)	Asian Coal Market Conditions (Relative to Baseline Assumptions)	Coal Prices Conditions (Relative to Baseline Assumptions)	Climate Policy
2015 Energy Policy	Represents impacts of an international climate policy on the coal market as enacted by 2014 and the proposed domestic Clean Power Plan	Coal demand is *less* sensitive to price changes because coal demand is very low due to climate policies	Coal demand is *less* sensitive to price changes because coal demand is very low due to climate policies	Baseline assumptions	Climate policy resembling implementation of proposed Clean Power Plan and meeting goals of 2014 U.S.-China Climate Negotiations
Past Conditions (2014)	Represents the assumed future state of energy markets in the absence of climate policies	Baseline assumptions	Baseline assumptions	Baseline assumptions	No climate policy
Lower Bound	Represents energy markets where renewable penetration is high and international coal prices and demand are low, making domestic coal exports less attractive to international markets	• Lower coal demand due to higher Powder River Basin and Uinta Basin coal prices • Decreased coal combustion emission factors • Overall *less* sensitive to price changes	• Lower coal demand due to increased renewables • Lower coal prices due to lower demand • Decreased coal combustion emission factors • Overall *less* sensitive to price changes	• Higher Powder River Basin and Uinta Basin coal prices due to assumed higher production costs • Higher U.S. rail transportation costs due to higher overall system utilization	No climate policy; however, assumes significant renewable energy use
Upper Bound	Represents energy markets where coal consumption is high, leading to high international demand and prices, making domestic coal exports	• Higher coal demand due to lower Powder River Basin and Uinta Basin coal prices • Higher coal combustion emission factors	• Higher coal demand resulting in higher coal prices • Higher coal combustion emission factors	• Lower Powder River Basin and Uinta Basin coal prices due to assumed lower production costs	No climate policy

Scenario	Purpose	U.S. Coal Market Conditions (Relative to Baseline Assumptions)	Asian Coal Market Conditions (Relative to Baseline Assumptions)	Coal Prices Conditions (Relative to Baseline Assumptions)	Climate Policy
	more attractive to international markets	• Overall *more* sensitive to price changes	• Overall *more* sensitive to price changes	• Lower U.S. rail transportation costs due to continuing low oil prices and increased competition with trucking	
Cumulative[a]	Represents the impact of other planned export terminals in the Pacific Northwest	Coal demand is *more* sensitive to price changes because coal prices are more affected by multiple coal export terminals	Coal demand is *more* sensitive to price changes because coal prices are more affected by multiple coal export terminals	Baseline assumptions	No climate policy

[a] Further details on the Cumulative Scenario can be found in Section 3.1.1.13, *Net Greenhouse Gas Emissions.*
[b] Scenario conditions are defined relative to the Past Conditions (2014) scenario.





Comparison of GHG Emissions Across Coal Market Assessment Scenarios

Each coal market assessment scenario represents a range of GHG emissions estimates, based on economic and policy projections from 2020 to 2040. For each scenario, the GHG emissions from Asian coal combustion, U.S. coal combustion, and U.S. natural gas combustion are influenced by a variety of factors, such as coal prices, transportation costs, and the penetration of competing energy sources.

The first chart on the left shows absolute emissions under each coal market scenario for the Proposed Action (noted as the Action Alternative). The scenarios display a significant variation in GHG emissions for coal and natural gas combustion. There is a difference of about 7,000 million metric tons of carbon dioxide equivalent ($MMTCO_2e$) between the 2040 GHG emissions in the Upper Bound and 2015 Energy Policy scenarios. The difference in emissions under the first chart is almost entirely due to the underlying market conditions rather than the influence of the proposed coal export terminal.

To illustrate the relatively small influence of the proposed coal export terminal, the second chart on the left indicates the changes in fossil fuel combustion[a] emissions that would occur in Asia and the United States because of the Proposed Action under Past Conditions (2014) scenario conditions. For example in 2040, the no-action under the Past Conditions (2014) scenario would result in combustion emissions of 16,512 $MMTCO_2e$ while the combustion emissions resulting from the Proposed Action under Past Conditions (2014) scenario conditions are 16,507 $MMTCO_2e$. The resulting net difference is 5 $MMTCO_2e$, or 0.03% of emissions. Likewise, changes in absolute emissions between the no-action and the Proposed Action for the other four coal market assessment scenarios are relatively small.

[a] Fossil fuel combustion emissions refer to coal combustion in Asia and the U.S., as well as U.S. natural gas combustion (ICF International 2016d).

2.2.2.2 Method for Assembling an Emissions Time Series

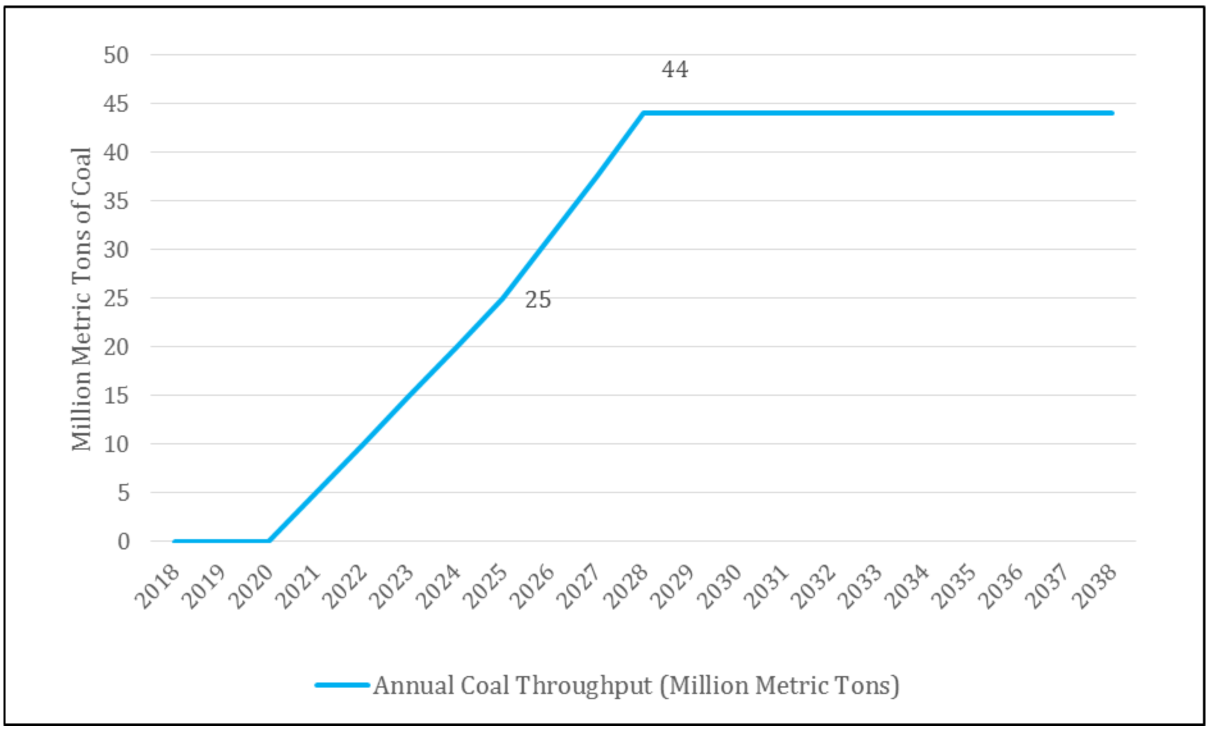
Because GHGs accumulate in the atmosphere, a complete assessment of GHGs associated with the Proposed Action requires a characterization of the GHGs over a full analysis period (2018 to 2038). The GHG analysis estimates emissions for each year during this analysis period as well as for each scenario.

Assembling a complete emissions time series for the GHG analysis required interpolation of estimates from other studies (i.e., coal market, air, and vessel) for the following reasons.

- The coal market assessment provides estimates for 2020, 2025, 2030, and 2040.
- The activity data that characterize coal export terminal operations represents conditions in 2028, when the facility is expected to be fully operational. These data do not reflect coal export terminal start-up, in which the coal throughput increases from zero immediately after construction in 2020 to its full capacity of 44 million metric tons by 2028.

In order to generate estimates of GHG emissions for the full time series, the expected coal throughput was increased linearly from zero in 2020 to 25 million metric tons (27.5 million short tons) in 2025. Between 2025 and 2028, the throughput was increased linearly at a slightly faster rate to reach full capacity at 44 million metric tons (48.4 million short tons) by 2028. For this approach, market-influenced emissions are assumed to be directly proportional to the amount of coal processed by the Proposed Action. The total coal exports for this time series add up to 627 million metric tons of coal, including 7 start-up years between 2021 and 2028 and 11 full years of operation from 2028 to 2038 (Figure 5).

Figure 5. Annual Coal Throughput, 2018-2038



The coal market assessment does not consider a start-up period, so the activity data and emissions estimates for 2025, which assume a full 44 million metric ton throughput, are prorated by 57%; i.e., the ratio of the projected 25 million metric tons of the start-up period and the full 44 million metric ton throughput. This proration factor is applied to all data outputs from the coal market assessment in 2025, including coal throughput, fossil fuel combustion emissions,[15] and ocean vessel traffic. Assuming that *net* emissions and activity from the Proposed Action are zero in 2020, the analysis assumes a linear growth to the prorated 2025 data, reaching full operation in 2028, and linear growth between the 2030 and 2040 data outputs.

Activity data and emissions estimates are derived only for 2028. Emissions estimates are directly proportional to the throughput of the Proposed Action and can be expressed as emissions per unit of coal throughput. The total net emissions from these sources are calculated by scaling the per-unit emissions by the total throughput of the Proposed Action for the entire time series.

2.2.2.3 Method for Impact Analysis

This section describes the method and approach for each emissions source. Multiple emissions sources that are calculated the same way (e.g., locomotive operation) are grouped together.

Vegetation and Wetlands Cover

To estimate the loss of upland and riparian land carbon stocks, estimates of vegetation and soil carbon stocks in the project area were based on average carbon stock per area estimates for Cowlitz County taken from the Carbon Online Estimator (COLE) developed by the National Council for Air and Stream Improvement and the U.S. Department of Agriculture, Forest Service.[16] These average values possibly overestimate the actual carbon stocks in the project area since the average estimates for Cowlitz County likely include areas with higher carbon stocks (e.g., managed production forests).

These estimates of the carbon stock per area for forested, scrub-shrub, and herbaceous[17] upland and riparian land vegetation cover types were multiplied by the corresponding impact areas to estimate the change in carbon stocks associated with construction (i.e., vegetation clearing and surface soil removal). These emission estimates possibly overestimate the actual construction emissions in the project area but are representative for average areas in Cowlitz County.

Loss of ongoing carbon sequestration for the forested, scrub-shrub, and herbaceous[18] upland and riparian land vegetation cover types were then estimated based on IPCC guidelines (Intergovernmental Panel on Climate Change 2006: Volume 4).[19] These estimates of the lost sequestration per area for forested, scrub-shrub, and herbaceous[20] upland and riparian land

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[15] Changes in domestic and international coal combustion are assessed separately.

[16] Available online at http://www.ncasi2.org/COLE/.

[17] The same carbon stock density was applied for both herbaceous and managed herbaceous vegetation cover types since the carbon in both of these systems predominantly resides in the soil.

[18] The annual carbon sequestration for the forested and scrub-shrub vegetation types was based on the aboveground net biomass growth in natural temperate continental forests in North America. The annual carbon sequestration for the herbaceous vegetation type was assumed to be zero because the soil carbon gains and losses were assumed to have reached an equilibrium for an established herbaceous system.

[19] Available online at http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html.

[20] The same carbon stock density was applied for both herbaceous and managed herbaceous vegetation cover types since the carbon in both of these systems predominantly resides in the soil.

vegetation cover types were multiplied by the corresponding impacts areas and the 20-year analysis period to estimate the lost sequestration. Table 4 shows the emission factors derived for the upland and riparian land cover types.

Table 4. Upland and Riparian Land Emission Factors

Land Cover Category	Vegetation Cover Type	GHG Emission Factor (metric tons CO_2e/acre)	Lost Sequestration Factor (metric tons CO_2e/acre/year)
Upland	Forested	510.5	2.8
	Scrub-shrub	325.6	2.8
	Herbaceous	140.7	0
	Managed herbaceous	140.7	0
Riparian land	Forested	510.5	2.8
	Scrub-shrub	325.6	2.8
	Herbaceous	140.7	0

Notes:
GHG = greenhouse gas; CO_2e = carbon dioxide equivalent

To estimate the loss of wetland carbon stocks, estimates of vegetation carbon stocks in the project area were again based on average carbon stock per area estimates for Cowlitz County taken from the COLE tool, with the soil carbon stocks taken from a study by the U.S. Department of Agriculture Forest Service (Trettin and Jurgensen 2003). These estimates of the carbon stock per area for forested, scrub-shrub, and herbaceous wetland cover types were multiplied by the corresponding impact areas to estimate the change in carbon stocks associated with construction.

To estimate the loss of ongoing carbon sequestration for the forested, scrub-shrub, and herbaceous wetland vegetation cover types, estimates of annual carbon sequestration were taken from a study by Hansen (2009). Based on values reported by Trettin and Jurgensen (2003), these annual carbon sequestration estimates were adjusted to include the reduction in annual CO_2 and methane emissions that would otherwise have been released from the wetland impact areas.

These adjusted estimates of the lost sequestration or reduction in emissions per area for forested, scrub-shrub, and herbaceous wetland vegetation cover types were multiplied by the corresponding impacts areas and the 20-year analysis period to estimate the lost sequestration or reduction in emissions. Table 5 shows the emission factors derived for the wetland cover types.

Table 5. Wetland Emission Factors

Land Cover Category	Vegetation Cover Type	GHG Emission Factor (metric tons CO_2e/acre)	Lost Sequestration Factor (metric tons CO_2e/acre/year)
Wetland	Forested	451.43	-5.51
	Scrub-shrub	266.52	-2.12
	Herbaceous	81.61	1.26

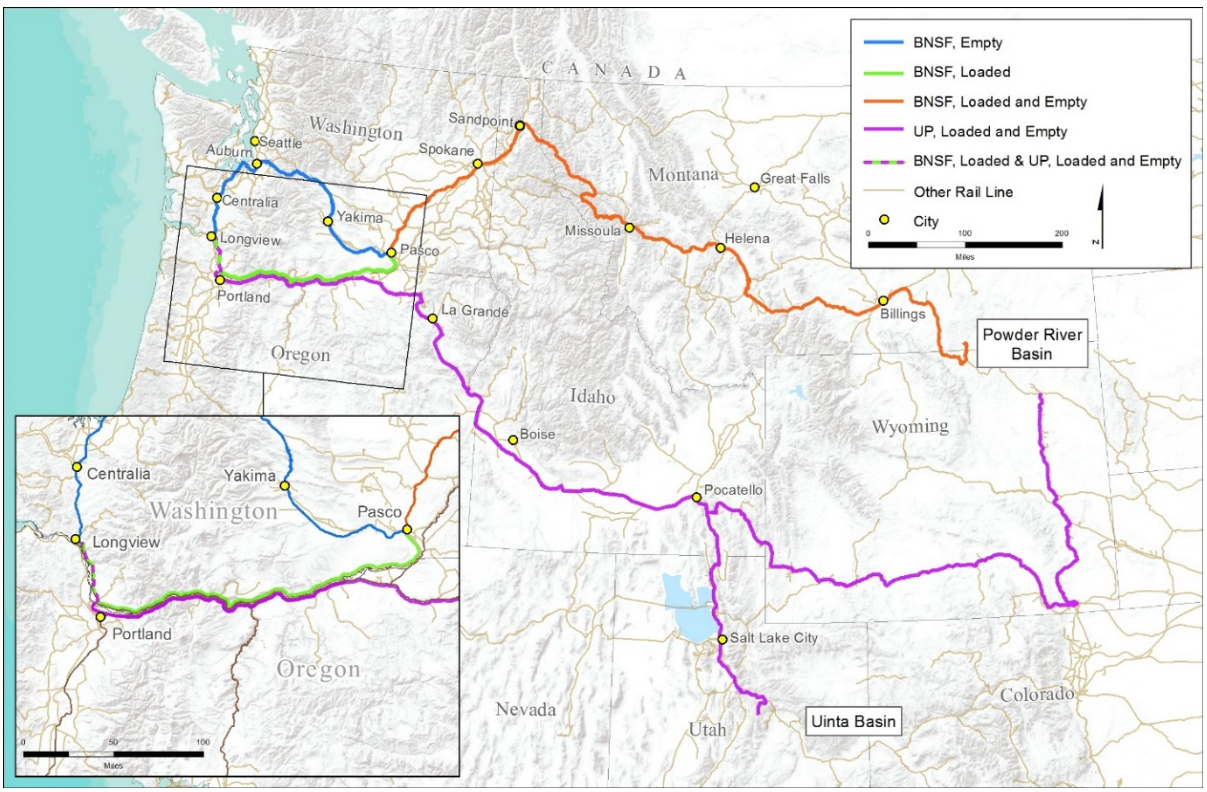
Notes:
GHG = greenhouse gas; CO_2e = carbon dioxide equivalent

Rail Transport

Rail Transport of Coal from Extraction Sites to Washington State

Indirect sources of GHG emissions from coal transport from the Uinta and Powder River Basins to Washington State include diesel combustion emissions from locomotive operation in both directions. The Uinta Basin is located in Colorado and Utah, whereas the Powder River Basin is located in Montana and Wyoming. The distances from five coal extraction sites (one each in Colorado, Montana, and Utah; two in Wyoming) to Washington State range from 627 miles to 946 miles by rail. For this analysis, each train is assumed to consist of three locomotives and 125 rail cars, each loaded with 121 metric tons of coal[21] (ICF International and Hellerworx 2016). For the return trip, this analysis assumes that the train would make a return trip to the coal basins with three locomotives and empty rail cars. Figure 6 provides an illustration of coal train routes from extraction sites to the project area.

Figure 6. Rail Transport of Coal to the Project Area



To calculate emissions, the gross mass of the loaded and empty coal trains was derived from BNSF data to determine the gross ton-miles of rail traffic associated with each scenario.[22] Table 6 provides an overview of the mass associated with the locomotives, the loaded coal, and the rail cars.

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[21] The approximate amount of coal that would be required to transport 44 milion metric tons in 8 loaded unit trains, 125 rail cars per day, 365 days per year.

[22] Gross-ton miles refer to ton-miles travelled that include the mass of the railcars and locomotives in addition to the mass of the cargo.

Table 6. Mass of Coal Train Components

Train Component	Mass (Metric Tons)
Locomotive (one)	196
Rail car (one)	19
Coal per car	121
Gross train mass (full)	18,026
Gross train mass (empty)	2,958

Source: ICF International and Hellerworx 2016

The mass of the trains was multiplied by the total distance traveled to bring coal from mines in Colorado, Montana, Utah, and Wyoming to Washington State. The relative amount of train traffic from each extraction site is dependent on the scenario and year. For example, as the coal throughput at the coal export terminal remains constant, the relative shares of coal coming from the Uinta and Powder River Basins shifts. Table 7 provides estimates of rail distances from coal extraction sites to Washington State for the five coal types that would be likely exported from the project area.

Table 7. Coal Types and Distances to Washington State

Coal Type	Rail Distance to Washington State (Miles)
Montana Powder River Basin Coal	797
Wyoming Powder River Basin Coal (8,400 Btu/lb)	946
Wyoming Powder River Basin Coal (8,800 Btu/lb)	946
Colorado Uinta Basin Coal	839
Utah Uinta Basin Coal	1,013

Source: Distances estimated via GIS mapping.
Btu/lb = British thermal units per pound; GIS = geographic information system

The fuel consumption for transport to Washington State is estimated by multiplying the ton-miles travelled for each data year by a fuel consumption per ton-mile factor for average locomotive diesel consumption.[23] The GHG emissions are estimated by multiplying the total fuel consumption by a rail diesel-specific combustion factor, as shown in Table 8.

Table 8. Emission Factors from Rail Diesel Fuel

Greenhouse Gas	Emission Factor ($MtCO_2e$/1,000 gallons)
Carbon dioxide	10.26
Methane	0.01
Nitrous oxide	0.02
Total	**10.29**

Source: U.S. Environmental Protection Agency 2015a
$MtCO_2e$ = metric tons of carbon dioxide equivalent

[23] An estimate of 833 gross-ton miles per gallon of diesel is used (BNSF Railway Company 2013).

Rail Transport of Coal within Washington State (excluding Cowlitz County)

Indirect sources of GHG emissions from rail transport of coal in Washington State include diesel combustion emissions from locomotives. GHG emissions from rail transport of coal within Washington State to the border of Cowlitz County were estimated using the same approach as for transport to the state. Powder River and Uinta Basin coal are transported through Washington State to Cowlitz County on a southern route (through the Columbia River Gorge), entering Cowlitz County from Woodland. However, empty trains returning to the Powder River Basin take a longer northern route (via Stampede Pass) whereas empty trains returning to the Uinta Basin return along the southern route. Therefore, returns to Powder River Basin are slightly longer (Table 9).

Table 9. Coal Types and Distances within Washington State

Coal Type	Loaded Train Distance (Miles)	Empty Train Distance (Miles)
Powder River Basin coal	401	488
Uinta Basin Coal	401	405

Source: Distances estimated via GIS mapping
Note: Estimate does not include distance travelled within Cowlitz County

Rail Transport of Coal from Cowlitz County Border to Project Area

Direct sources of GHG emissions from rail transport of coal in Cowlitz County include diesel combustion emissions from the operation of locomotives to the project area and in the county. Emissions include round-trip emissions from loaded trains entering the county up to the point that empty trains leave the county. Within the county limits, this source includes locomotive travel on the BNSF main line as well as the spur leading to the project area. Loaded trains travel to the project area from Woodland, whereas empty trains travel along the BNSF main line to Vader. GHG emissions from rail transport of coal from the border of Cowlitz County to the project area were estimated using the same approach as for the transport outside the county. Emissions are estimated from the project area to the county border; a distance of 25.1 miles for loaded trains entering Cowlitz County and 28.5 miles for empty trains leaving the county (Table 10).

Table 10. Rail Distances Traveled within Cowlitz County

Rail Route	Loaded Train Distance (Miles)	Empty Train Distance (Miles)
Cowlitz County Border to Longview Junction	17.9	-
Longview Junction to project area	7.1	7.1
Longview Junction to Cowlitz County Border	-	21.4
Total	**25.1**	**28.5**

Source: Distances estimated via GIS mapping

Locomotive Operation

Direct GHG emissions at the project area for the Proposed Action would include emissions from the movement of coal trains around the 1.65- mile loop at the coal export terminal, the on-site idling of coal trains, and the operation of a switch locomotive to move cars and assemble trains for departure. The analysis assumes that it takes 1.85 hours to unload a 125-car unit train, each train has a 5-hour idle period prior to departing the facility, and the switch locomotive operates for 8 hours a day. This emissions source includes the sum of these three activities. Emission factors for line-haul locomotives are based on projected changes in the locomotive fleet over the next 30 years (U.S. Environmental Protection Agency 2009b). These emission factors are based on engine load and associated fuel consumption during transport to and from the facility, time to unload coal from the train cars, and total annual coal throughput. The power demand is proportional to engine load, which varies in intensity depending on whether the locomotive is hauling freight or idling. The fuel consumption is estimated based on the power demand, which is estimated based on the engine load and duration of the activity. That fuel consumption is then multiplied by fuel combustion emission factors for locomotives as provided in Table 11.

Table 11. Emission Factors for Locomotives

Greenhouse Gas	Emission Factor ($MtCO_2e$/ 1,000 gallons)
Carbon dioxide	10.23
Methane	<0.1
Nitrous oxide	0.1
Total	**10.31**

Source: U.S. Environmental Protection Agency. 2009b. *Emission Factors for Locomotives.*
$MtCO_2e$ = metric tons of carbon dioxide equivalent

Vehicle-Crossing Delay

Direct sources of GHG emissions from vehicle-crossing delay include the incremental fuel emissions caused by vehicle delay at grade crossings due to train traffic to the project area. This emissions source is based on existing rail infrastructure. GHG emissions were determined by estimating the gate downtime per day at grade crossings along the BNSF Spur and Reynolds Lead (between the BNSF main line and the project area) and at public at-grade crossings along the BNSF main line in Cowlitz County, and then estimating the average delay per vehicle for each crossing. The emissions estimate does not consider any track improvements to the Reynolds Lead and BNSF Spur. Emissions are estimated based on the average volume of vehicle traffic for each crossing. The fleet mix, or relative shares of vehicle types delayed at the crossing, is assumed representative of Cowlitz County as a whole, and is derived from the MOVES model (U.S. Environmental Protection Agency 2014a). The MOVES model provides emission factors for each vehicle type in grams per mile travelled, which are converted into vehicle delay emissions by multiplying by the assumed average vehicle speed of 2.5 miles per hour.[24] The mix of vehicles and their contribution to the weighted average Cowlitz County vehicle traffic emission factor is shown in Table 12.

[24] The MOVES emission factor for vehicle idling is based on a slow operation speed of 2.5 miles per hour.

Table 12. Weighted Vehicle Fleet Mix for Cowlitz County, 2028

Vehicle Type	Vehicle Speed (mph)	Emission Factor (g/mi)[a]	Fraction of Each Vehicle (%)	Weighted Emission Factor (g CO_2e/ vehicle-hour)
Combination long-haul truck	2.5	1,866	1.13	52.71
Combination short-haul truck	2.5	1,821	0.82	37.33
Intercity bus	2.5	1,909	0.01	0.48
Light commercial truck	2.5	375	8.07	75.57
Motor home	2.5	1,259	0.88	27.70
Motorcycle	2.5	443	3.22	35.67
Passenger car	2.5	273	48.12	328.01
Passenger truck	2.5	367	33.14	304.23
Refuse truck	2.5	1,839	0.15	6.90
School bus	2.5	1,253	0.36	11.28
Single unit long-haul truck	2.5	1,108	0.16	4.43
Single unit short-haul truck	2.5	1,153	3.92	112.99
Transit bus	2.5	1,648	0.04	1.65
Total			**100.00**	**998.95**

Notes: MOVES assumes a vehicle speed of 2.5 miles per hour to simulate idling emissions.
Source: [a] U.S. Environmental Protection Agency 2014a.

The delay was estimated for each road segment in the county and described as the total minutes of delays (in vehicle-hours) as well as the total vehicles affected. The emissions were estimated by multiplying the above fleet mix by vehicle-specific emission factors (in grams per vehicle-hour of delay) and then by the total amount of delay over the period of a year (Table 13).

Table 13. Activity Data for Vehicle Delay in Cowlitz County, 2028

Street	Daily Trains	Avg. Train Length (feet)	Train Speed (mph)	Avg. Daily Traffic in Both Directions (veh/day)	Number of Lanes in Both Directions	Total Delay (min /day)	Vehicles Delayed per Day (veh/day)
Study Crossings along the Reynolds Lead and BNSF Spur							
Industrial Way (SR 432)	16	6,844	10	12,100	2	5,617	1,113
Oregon Way (SR 433)	16	6,844	10	18,770	4	8,304	1,726
California Way	16	6,844	8	4,800	2	3,134	545
3rd Avenue (SR 432)	16	6,844	8	20,720	4	14,219	2,353
Dike Road	16	6,844	10	1,100	2	433	101
Project access (opposite 38th Avenue)	16	6,844	5	1,340	2	1,998	239
Weyerhaeuser Access (opposite Washington Way)	16	6,844	8	3,900	4	2,403	443

Street	Daily Trains	Avg. Train Length (feet)	Train Speed (mph)	Avg. Daily Traffic in Both Directions (veh/day)	Number of Lanes in Both Directions	Total Delay (min /day)	Vehicles Delayed per Day (veh/day)
Weyerhaeuser Norpac Access	16	6,844	10	800	2	312	74
Public At-Grade Crossings along the BNSF Main Line in Cowlitz County							
Taylor Crane Road in Castle Rock	8	6,844	50	50	2	0.6	0.6
Cowlitz Street in Castle Rock	8	6,844	50	1,450	2	18	17
Cowlitz Gardens Road in Kelso	8	6,844	60	850	2	8	8
Mill Street in Kelso	8	6,844	40	3,000	2	55	41
S River Road/ Yew Street in Kelso	8	6,844	40	2,200	2	39	30
Toteff Road/ Port Road in Kalama	8	6,844	60	1,450	2	14	14
W Scott Avenue in Woodland	8	6,844	60	3,100	2	29	31
Davidson Avenue in Woodland	8	6,844	60	2,350	2	22	23
Whalen Road in Woodland	8	6,844	60	1,800	2	17	18

Notes:
Source: U.S. Environmental Protection Agency 2014a.

Coal Export Terminal Construction

Direct sources of GHG emissions from construction would include operation of the construction equipment itself as well as the vehicles to bring employees and construction materials to the project area. Fossil fuels are combusted for the operation of mobile combustion equipment used for demolition and earthwork to prepare the site.

Table 14 summarizes the required equipment and duration of use.

Table 14. Major Construction Activities and Typical Equipment Fleets[a]

	Rail Infrastructure and Rotary Car Dump Station		Conveyors, Transfer Stations and Surge Bins		Shiploader, Dock, and Trestles	
Construction Equipment Type	**Max Qty. per Month**	**Duration (months)**	**Max Qty. per Month**	**Duration (months)**	**Max Qty. per Month**	**Duration (months)**
Mobile cranes (25–50 ton)	2	18	2	18	2	18
Mobile cranes (50–150 ton)	2	18	2	18	2	18
Mobile cranes (150–300 ton)	1	18	1	18	1	18
Water trucks	1	12	1	12	0	0
Dump trucks	3	12	1	12	0	0
Dozers	1	5	0	0	0	0
Excavators	1	9	2	12	1	3
Rollers	2	9	2	12	1	3
Graders	2	9	0	0	1	3
Compactors	2	9	2	12	1	3
Track laying machine	1	2	0	0	0	0
Drill rigs	1	2	2	6	0	0
Impact piling rigs	2	6	2	6	2	6
Loaders	1	12	1	12	1	9
River barge	0	0	0	0	2	18
Generator	2	18	2	18	2	18
Air compressor	2	18	2	18	2	18

Notes:

[a] Typical construction fleet may be modified with equivalent items as construction activities demand.

Sources: URS Corporation 2014b; ICF International 2016c

Combustion emissions estimates were obtained from the NONROAD emissions model (U.S. Environmental Protection Agency 2009a) for the nonroad equipment. Construction activity was assumed to occur 8 hours per day, 5 days a week, 52 weeks per year, with the exception of the track- laying machine, which operates 4 hours per day. Emission factors were applied to the maximum numbers of equipment operated, duration of use, and horsepower, to obtain annual emissions.

Table 15 provides information on the emission factors for construction equipment.

Table 15. Construction Equipment Activity Data and Emission Factors

Equipment Type	Engine Size	Fuel Type	Number of Units	Emission Factor ($MtCO_2e$/year per Unit)[c]
Crane, 50-ton	165	Diesel	2	109.3
Crane, 150-ton	280	Diesel	2	183.0
Crane, 300-ton	450	Diesel	1	195.4
Water trucks	350	Diesel	1	98.8
Dump trucks	350	Diesel	4	98.8
Dozers	185	Diesel	0.4	396.5
Excavators	230	Diesel	2	886.6
Rollers	350	Diesel	3.8	100.3
Graders	185	Diesel	1.8	132.7
Compactors	25	Diesel	3.8	0.2
Track laying machine	[a]	Diesel	0.5	416.8
Drill Rigs	(NONROAD Default)[b]	Diesel	1.2	57.1
Impact Piling Rigs	(NONROAD Default)[b]	Diesel	3	57.1
Loaders	140	Diesel	1	416.8
Generator	30	Diesel	6	108.8
Air Compressor	25	Diesel	6	0.3

Notes:

[a] Assumes track-laying machine uses one diesel locomotive and one front end loader engine. Assumes full-time locomotive used 4 hours/day, 5 days/week.

[b] Horsepower and weight estimates are based on capacity ratings and industry specifications, or average ratings per equipment type. Where horsepower could not be assumed, an average horsepower rate in NONROAD for the equipment type was used.

[c] To calculate annual emissions, this emission factor is multiplied by 1.5 years to estimate the emissions for 18 months of construction.

Source: ICF International 2016c

$MtCO_2e$ = metric tons of carbon dioxide equivalent

The impact of construction employee commuting was calculated using the MOVES model (U.S. Environmental Protection Agency 2014a), assuming that construction workers would use single-occupant vehicles with a mean round-trip travel time of 48.2 minutes. The analysis assumes that the 200 workers would be commuting during construction. At an estimated speed of 35 miles per hour, this amounts to 1,462,067 miles per year travelled. This distance was multiplied by emission factors for typical commuting vehicles provided by the MOVES model to calculate annual emissions.[25]

For the construction barges (operating under their own power or pushed/towed by another vessel), emissions were calculated using the U.S. Environmental Protection Agency's (EPA) AP-42 method for large diesel engines (U.S. Environmental Protection Agency 1996). The analysis assumes that the construction barges would have a positioning time of 1 hour with 1 round trip per day, 5 days per week, 52 weeks per year. Summaries of the barge activity and emission factors are available in Table 16 and Table 17, respectively.

[25] The analysis assumes a 50/50 mix of gasoline and E-85 for construction employee commuting vehicles.

Table 16. Barge Activity and Energy Use for Coal Export Terminal Construction

Barge Activity	Energy Consumption Variables
Barges used	2
Engine size (propulsion)	3,500 hp
Positioning time	1 hour
Total power per trip	7,000 hp
Construction trips	260 trips per year
Annual power	1,820,000 MMBtu per year

Notes:
Source: ICF International 2016c
hp = horsepower; MMBtu= million British thermal units per year

Table 17. Emission Factors for Construction Barges

Greenhouse Gas	$kgCO_2e$ per MMBtu	Emission Factor ($MtCO_2e$/ 1,000 gallons)
Carbon dioxide	74.8	10.23
Methane	0.1	0.1
Nitrous oxide	0.1	0.1
Total	75.0	10.25

Notes:
Source: U.S. Environmental Protection Agency 1996
$kgCO_2e$ = kilograms of carbon dioxide equivalent; MMBtu = million British thermal units; $MtCO_2e$ = metric tons of carbon dioxide equivalent

The project area does not have an existing barge dock. Therefore, the material from incoming barges would be off-loaded at an existing dock elsewhere on the Columbia River and transported to the project area by truck. Emissions from trucks hauling construction material to the project area were estimated by determining the annual miles traveled by trucks going to and from the construction site and then multiplying those miles traveled by a per-mile emission factor from EPA's MOVES model. The peak annual trips for the Proposed Action are assumed to be 56,000 round trips (88,000 throughout the entire construction period) (URS Corporation 2015). Short-haul combination tractor-trailer trucks were assumed to move construction material with 47 roundtrip miles of travel in the county. The GHG emission factor was taken from a MOVES model run for Cowlitz County, Washington, for the year 2018 (i.e., 1,561 to 1,930 grams of CO_2e per mile, depending on operating conditions).

Coal Export Terminal Operation—Equipment Operation

Direct sources of GHG emissions from equipment operation include fossil fuel emissions. Examples of equipment used for coal export terminal operation include loaders, maintenance vehicles, and cranes. This equipment uses diesel, gasoline, and propane fuels. Emissions from mobile combustion sources were estimated by first determining the equipment necessary for typical operation and maintenance and then using the NONROAD model (U.S. Environmental Protection Agency 2009a) to estimate annual exhaust emissions from that mobile equipment (Table 18).

Table 18. Coal Export Terminal Equipment and Emission Factors

Equipment Type	Engine Size	Fuel Type	Number of Units	Emission Factor ($MtCO_2e$/year per Unit)
Loader	300 hp	Diesel	1	671.7
Bobcat	50 hp	Diesel	2	16.6
10-Ton Truck	300 hp	Diesel	2	98.8
Crane	50 hp	Diesel	1	0.0
Forklift	40 hp	Propane	1	0.1
Maintenance Trucks	300 hp	Gasoline	4	0.2

Notes:
Source: U.S. Environmental Protection Agency 2009a
$MtCO_2e$ = metric tons of carbon dioxide equivalent; hp = horsepower

Coal Export Terminal Operation—Electricity Consumption

Indirect sources of GHG emissions for electrical consumption include fuel combustion emissions at off-site power plants to produce electricity consumed at the coal export terminal. The local energy grid would provide electricity for operation of coal export terminal facilities. The additional electricity consumption that would be required for the Proposed Action is assumed to be similar to the annual energy use for the existing bulk product terminal (Chany pers. comm.). To estimate net annual increase in GHG emissions from electricity consumption, the monthly electricity demand for the existing bulk product terminal was annualized in kilowatt-hours, as shown in Table 19.

Table 19. Monthly and Annual Electricity Demand for Coal Export Terminal

Time Period	Usage	Unit
Monthly	552,000	kWh
Annual	6,624	MWh

Notes: Additional demand is assumed to occur throughout the entire project period, including construction.
Source: Chany pers. comm.
kWh = kilowatt hour; MWh = megawatt hour

To derive additional GHG emissions from electricity consumption for coal export terminal operations, the electricity fuel mix for an average water year was obtained from the Cowlitz Public Utility District (PUD). Emission factors for each fuel type were then derived from individual plant data for each fuel in the Western Electricity Coordinating Council Northwest subregion as provided in the Emissions & Generation Resource Integrated Database (eGRID). These individual fuel emission factors were combined using the Cowlitz PUD fuel mix to obtain a weighted average emission factor to apply to electricity consumption from the Proposed Action. Table 20 provides the fuel mix and emission factors used to derive GHG emissions from electricity consumption for coal export terminal operations.

Table 20. Average Fuel Mix and Fuel-Specific Emission Factor for the Cowlitz PUD Region

Fuel Source	Share of Electricity Fuel Mix (%)	Carbon Dioxide (kg CO_2e/MWh)	Methane (kg CO_2e/MWh)	Nitrous Oxide (kg CO_2e/MWh)	Total (kg CO_2e/MWh)
Hydro	84.64%	0	0	0	0
Nuclear	9.70%	0	0	0	0
Wind	2.66%	0	0	0	0
Coal	2.08%	1,095.8	0.3	5.5	1,101.5
Natural Gas	0.79%	436.8	0.2	0.3	437.3
Other[a]	0.13%	302.0	0.1	1.4	303.5
Weighted Average	**100%**	**26.6**	**0.01**	**0.1**	**26.8**

[a] Other is made up of biomass, cogeneration, geothermal, landfill gas, petroleum, solar, and waste incineration.
Source: Cowlitz PUD 2015, U.S. Environmental Protection Agency 2015b

Employee Commuting

Direct sources of GHG emissions from employee commuting include the emissions from fossil fuel combustion associated with the daily commuting traffic for employees to and from the site. The GHG emissions from employees commuting to the project area were calculated using the MOVES model (U.S. Environmental Protection Agency 2014a), assuming that employees would use single-occupant vehicles with a mean round-trip travel time of 48.2 minutes. The analysis assumes that there are 135 employees, with 25 commuting 5 days per week and 110 commuting 7 days per week. At an estimated speed of 35 miles per hour, this amounts to 1,092,051 miles per year travelled. This distance was multiplied by emission factors for typical commuting vehicles provided by the MOVES model to calculate annual emissions.[26]

Vessel Idling and Tugboat Use at Coal Export Terminal

Direct sources of GHG emissions from vessel idling and tugboat use at the coal export terminal include current vessel operations at the coal export terminal, as vessels use main and auxiliary motors to maneuver in and out of the loading area. Additionally, this source includes fossil fuel combustion emissions from tugboats that are used to assist in vessel maneuvering at the project area.

GHG emissions from vessel idling and tugboat use were calculated by estimating the power consumed by idling vessels, converting the power demand into fuel consumption, and multiplying that fuel consumption by a fuel combustion emission factor. An average of 13 hours would be needed to load each vessel with coal, and during this period, the vessel would be hoteling using auxiliary engines. For each vessel, the typical main and auxiliary engine size was based on Lloyd's Register of Ships Sea-web, which has a database of ship characteristics for ships over 100 gross tons (Sea-web 2015). Each vessel receiving coal is assumed to need three tugs to maneuver the ship. These tugs would operate for 3 hours to assist with docking and departing. The time spent operating the vessels in each mode, multiplied by the estimated engine load and size provided power demand for both the idling vessels and tugboats. The power demand was then multiplied by the emission factors provided in Table 21.

[26] The analysis assumes a 50/50 mix of gasoline and E-85 for employee commuting vehicles.

Table 21. Emission Factors for Idling Vessels and Tugboats

Greenhouse Gas	Main Engine Emission Factor (g CO_2e per kWh)	Auxiliary Engine Emission Factor (g CO_2e per kWh)
Carbon dioxide	588	690
Methane	1.75	2.25
Nitrous oxide	0.12	0.12
Total	**590**	**692**

Notes:
Source: California Air Resources Board (CARB). 2011. *Appendix D: Emissions Estimation Methodology for Ocean-Going Vessels.*
gCO_2e = grams of carbon dioxide equivalent; kWh = kilowatt-hour

Helicopter and Pilot Boat Trips

Indirect sources of GHG emissions for helicopter and pilot boat transfers include fossil fuels burned to pilot vessels along the Columbia River. GHG emissions from helicopter and pilot boat trips that transfer pilots to vessels were calculated as described in the SEPA Vessel Transportation Technical Report (ICF International 2016f). The trips for both vehicle types were multiplied by the distance for each trip to derive the total mileage and fuel consumption for each trip. Assuming that at full capacity, the Proposed Action would service 840 vessels annually and each vessel would require piloting in and out of the Columbia River, this use equates to 1,680 pilot transfers per year. However, because the pilot is both dropped off and picked up in separate trips, the total number of trips would be 3,360. Helicopters are used for offshore transfer of Columbia River Bar pilots 70% of the time, with the remaining 30% of the offshore transfers conducted using a pilot boat due to more challenging weather conditions (Table 22).

Table 22. Annual Helicopter and Pilot Boat Transfers per Vessel, 2028

Project Year	Total Number of Vessels Exiting and Entering the Columbia River	Number of Pilot Transfers		Total Number of Pilot Transfers
		Helicopter	**Pilot Boat**	**All**
2028	840	2,352	1,008	3,360

Notes:
Source: ICF International 2016f

Incoming and outgoing vessels are piloted 15 nautical miles (17 standard miles) from the mouth of the harbor, for an average distance of 30 nautical miles (34 standard miles) per trip. The trips are multiplied by the distance to estimate the total nautical miles travelled per mode of transport, as shown in Table 23.

Table 23. Helicopter and Pilot Boat Trips and Nautical Miles Travelled

Project Year	Helicopter		Pilot Boat	
2028	**Trips**	**Total Miles**	**Trips**	**Total Miles**
	2,352	81,200	1,008	34,800

Notes:
Source: ICF International 2016f

GHG emissions from each mode of transport were based on the time of travel from shore to the vessels. The average trip time for helicopters was assumed to be 18 minutes (Ellenwood pers. comm.). For pilot boats, an average speed of 14 miles per hour was assumed (Columbia River Bar Pilots 2015), resulting in a roundtrip travel time of 2.5 hours. For helicopters, the fuel consumption rate of 1 gallon per minute was obtained directly from Brim Aviation (Ellenwood pers. comm.). Fuel consumption and aviation gasoline emission factors are presented in Table 24 and Table 25, respectively. The emissions were calculated by first estimating the amount of fuel consumed per helicopter trip, multiplying that by the emission factor for aviation gasoline, and then by the number of helicopter trips.

Table 24. Helicopter Fuel Consumption

Aircraft	Average Fuel Consumption Rate (Gallons per Minute)	Average Trip Time (Minutes)
Sikorsky S-76 "Seahawk"	1	18

Notes:
Source: Ellenwood pers. comm.

Table 25. Combustion Emissions for Aviation Gasoline

Greenhouse Gas	Emission Factor ($MTCO_2e$/1,000 gallons)
Carbon dioxide	8.31
Methane	0.18
Nitrous oxide	0.03
Total	**8.52**

Notes:
Source: U.S. Environmental Protection Agency 2015a
$MTCO_2e$ = metric tons of carbon dioxide equivalent

GHG emissions from pilot boats were based on the energy required for the pilot boat to make one trip based on the estimated round-trip duration of 2.5 hours. Energy was converted into gallons of residual fuel and multiplied by an emission factor for residual fuel combustion in order to calculate the GHG emissions for a single pilot boat trip. This value was then multiplied by the total number of annual pilot boat trips to estimate the total annual GHG emissions. The factors used to estimate the energy consumption and the emissions for pilot boats are shown in Table 26 and Table 27, respectively.

Table 26. Factors for Pilot Boat Fuel Consumption

Factor	Magnitude
Trip duration	2.5 hours
Horsepower of engines[a]	1,800 hp
Average engine load over trip[b]	45%
Energy consumed, hp per hour	2,025 hp per hour
Energy consumed, MMBtu[c]	5.1 MMBtu
Energy in residual fuel[d]	0.15 MMBtu per gallon
Gallons of residual fuel consumed	34.4 gallons per trip

Notes:
[a] Brusco Tug and Barge Undated
[b] California Air Resources Board 2011
[c] Estimated by converting horsepower per hour to MMBtu
[d] U.S. Environmental Protection Agency 2015a
hp = horsepower; MMBtu = million British thermal units

Table 27. Combustion Emissions for Residual Fuel

Greenhouse Gas	Emission Factor ($MtCO_2e$/1,000 gallons)
Carbon dioxide	11.24
Methane	0.003
Nitrous oxide	0.17
Total	**11.41**

Notes:
Source: U.S. Environmental Protection Agency 2015a
$MTCO_2e$ = metric tons of carbon dioxide equivalent

Vessel Transport

Vessel transport of coal is calculated in three phases: the local transport of coal to the border of Cowlitz County, the transport of coal up the Columbia River through Washington State, and lastly, the transport of coal to markets in Asia.

Within Cowlitz County

Direct sources of GHG emissions from vessel transport in Cowlitz County include fossil fuel combustion associated with current vessel transport from the coal export terminal down the Columbia River to the border of Cowlitz County, an 11.35-mile distance. This distance is repeated to account for empty vessels returning to the site. GHG emissions from vessel transport were calculated using the same method as for air emissions and summarized in the SEPA Air Quality Technical Report (ICF International 2016c). This analysis assumes that the coal export terminal would be serviced by a mix of Panamax (80%) and Handymax (20%) vessels. To incorporate this assumption, the engine size was considered a weighted average of Panamax and Handymax vessels. For each vessel, the typical main and auxiliary engine size was based on Lloyd's Register of Ships Sea-web, which has a database of ship characteristics for ships over 100 gross tons (Sea-web 2015).

GHG emissions from vessel idling and tugboat use were calculated by estimating the energy consumed by vessels exiting Cowlitz County, which was a factor of the duration to enter or exit the county, the engine size, and engine load for loaded ships in transit. The annual energy demand was multiplied by an emission factor for main engine vessel use for loaded transit. The one-way transit time within Cowlitz County was assumed to be 0.9 hour. The annual energy demand was then multiplied by the emission factors provided in Table 28.

Table 28. Emission Factors for Vessels in Transit

Greenhouse Gas	Main Engine Emission Factor (g CO_2e per kWh)	Auxiliary Engine Emission Factor (g CO_2e per kWh)
Carbon dioxide	588	690
Methane	1.75	2.25
Nitrous oxide	0.12	0.12
Total	590	692

Notes:

Source: California Air Resources Board (CARB). 2011. *Appendix D: Emissions Estimation Methodology for Ocean-Going Vessels.*

kgCO_2e = kilograms of carbon dioxide equivalent; kWh = kilowatt-hours

Through Washington State

Indirect sources of GHG emissions from vessel transport outside of Cowlitz County but within Washington State include fossil fuel combustion. GHG emissions were calculated by first calculating the ton-miles of shipping, then multiplying that amount by a per-ton-mile emission factor for cross-Pacific Ocean transport. This approach was taken due to the uncertainty of the duration of the trip over longer distances, which creates uncertainty when using estimates that rely on hours of engine operation. This analysis assumes a distance of 51.49 miles, which takes the vessels from the border of Cowlitz County to 3 nautical miles past the mouth of the Columbia River. This distance is repeated for empty vessels returning to the state to pick up coal.

The emission factor for long-distance vessel transport of coal is derived from an emission factor for the unrefrigerated shipping of bulk cargo in Asia, provided in units of CO_2e per each 20-foot equivalent unit of cargo transported 1 mile. A 20-foot equivalent unit refers to a unit of cargo capacity such as an intermodal container. For coal, this unit is estimated to hold 26 short tons (Rodrigue 2012). Table 29 shows the calculation of emission factors for long-distance vessel transport.

Table 29. Calculation of the Emission Factor for Long-Distance Vessel Transport of Coal

Factor	Magnitude
Shipping emission Factor, Intra-Asia [a]	87.5 g CO_2e/TEU-km
Coal per TEU, full capacity [b]	26 short tons
Shipping emission factor, Intra-Asia	0.005 kg CO_2e/ton-mile

Notes:

[a] Clean Cargo Working Group 2014

[b] Rodrigue 2012

TEU = 20-foot equivalent unit—a unit of cargo capacity which denotes one intermodal container; CO_2e/TEU-km = carbon dioxide equivalent per 20-foot equivalent unit per kilometer

To Asian Markets

Indirect sources of GHG emissions from vessel transport from vessel transport to Asian markets include fossil fuel combustion. GHG emissions were based on ton-miles of shipping from the coal market assessment, which provides yearly total ton-miles of coal shipped throughout the Pacific Basin for both the action and no-action models for each scenario. The difference in ship traffic between these scenarios was used to estimate the change in ton-miles attributable to the Proposed Action. The ton-miles travelled for coal exported to Asia were estimated by multiplying the tonnage of coal exported to each destination by the distance to that destination. Depending on the scenario and year, the total ton-miles varied based on the destinations. Table 30 summarizes the distances to Asian markets from the United States.

Table 30. Distances from United States to Asian Markets by Ship

Destination	Distance (miles)
China (Fuzhou)	6,093
Hong Kong	6,530
Japan (Nagoya)	5,003
Korea (Wonsan)	5,161
Taiwan (Kaohsiung)	6,283

Notes:
Source: ICF International 2016d

For changes in coal shipments within the Pacific Basin, GHG emissions were based on an estimate in the coal market assessment of the total net change in ton-miles traveled within the Pacific Basin. This estimate considers the total change in Pacific Basin coal traffic as a result of the Proposed Action, not including the new coal coming from the United States. However, it does include shifts in coal shipments from producers in Indonesia and Australia.

The total change in Pacific Basin ton-miles travelled is multiplied by the same shipping emission factor as the shipping traffic for coal from the Proposed Action. The net impact of this emissions source is the sum of the new emissions (delivery of coal from the Proposed Action) to Asian markets and the emissions offset from changes in Pacific Basin coal traffic. In addition to the five Asian markets importing coal as identified in the coal market assessment, the effect of the Proposed Action on coal markets could cause shifts in additional Asian markets as Australian and Indonesian coals find new markets. The additional countries include India and other smaller consumers in the Pacific Basin.[27] For example, if China displaces some of its consumption of Australian coals with coal exported from the Proposed Action, India may purchase some of the coal displaced from Australia. The return distance from Asia is not modeled for this analysis because vessels traveling back from Asia are assumed to be transporting other goods.

Coal Combustion in Asia and the United States

Indirect sources of GHG emissions from coal combustion include the change in both U.S. and Pacific Basin coal consumption that would result from a new coal export terminal. The coal market assessment estimates the net coal combustion in Asia and the United States. These estimates are presented in the GHG analysis for each scenario relative to the no-action model. This analysis

[27] This category includes Malaysia, Thailand, and Vietnam, as well as smaller importers of coal.

considers the worldwide combustion coal supplied by the Proposed Action, as well as the offsets in coal combustion in Asian markets (China, Hong Kong, Japan, South Korea, and Taiwan) that would result. This analysis considers the indirect effect on coal combustion in other Asian countries (e.g., India) and the United States caused by supply and price changes resulting from the new coal export terminal capacity.

GHG emissions from coal combustion include those associated with market effects, which dictate the total amount of coal produced and combusted in the United States and the Pacific Basin in response to supply and price. Emissions also reflect coal substitution, which is driven by the difference in carbon content between Powder River Basin coal, Uinta Basin coal, and coals produced in the Pacific Basin. Table 31 summarizes the differences in carbon and heat contents among the coals assessed in the coal market assessment.

Table 31. Heat Content and Carbon Coefficients for U.S. and Pacific Basin Reference Coals

Source	Coal Type	Heat Content (MMBtu per ton)	CO_2 Emission Factor (pounds per MMBtu)
Powder River Basin—WY	Subbituminous	17.6	214.3
Powder River Basin—MT	Subbituminous	18.6	215.5
Uinta—CO	Bituminous	21.5	209.6
Uinta—UT	Bituminous	23.4	209.6
Australia	Bituminous	24.1	205.3
Indonesia	Bituminous	23.7	205.3
Indonesia	Subbituminous	19.44	212.7
China	Bituminous	20.88	205.3
China	Lignite	9.79	215.4

Notes:
Source: ICF International 2016d
MMBtu = million metric British thermal units ; CO_2 = carbon dioxide

Induced Natural Gas Consumption in the United States

Indirect sources of GHG emissions from induced natural gas consumption would result from changes in consumption as a function of changes in the coal market. As coal prices increase due to the increased demand by the project for coal to export, the United States' natural gas consumption is expected to increase.

The Proposed Action could result in supply and price shifts in the coal markets, which affect the consumption of natural gas in the United States. The coal market assessment describes the substitution of natural gas for coal and estimates the GHG emissions from induced natural gas consumption in the United States. Depending on the scenario, natural gas consumption changes based on coal prices and U.S. coal consumption. As more coal is exported from the United States, coal prices increase, resulting in increased demand for natural gas.

2.3 Existing Conditions

The existing environmental conditions related to GHG emissions in the study area are described in the sections that follow.

2.3.1 Applicant's Leased Area

The existing bulk product terminal in the Applicant's leased area is already operational and draws electricity from the regional electricity grid, amounting to 552,000 kilowatt hours of electricity demand per month, or 6,624 megawatt hours of electricity annually (Chany pers. comm.). The emissions from this source are already occurring and will continue whether or not the coal export terminal is constructed. Electricity usage results in indirect emissions of approximately 2,545 metric tons of CO_2e annually, as estimated in Section 3.1.1.6, *Coal Export Terminal Terminal Operation—Electricity Consumption.*

The current vessel traffic at Dock 1 is six ships per year. Using the method described in Section 2.2.2.3, *Method for Impact Analysis, Vessel Transport Within Cowlitz County,* and assuming that the vessels are docking for approximately 13 hours per trip, maneuvering for 1 hour, and transiting within Cowlitz County for 0.9 hour, their operation emissions total 66 metric tons of CO_2e annually. Table 32 describes the current vessel transport activity at the project area. The current emissions from the project area for the Proposed Action are relatively small compared to the scale of emissions from the Proposed Action and are thus not taken into account when estimating the net emissions associated with the Proposed Action.

Table 32. Current Vessel Transport Activities in the Project Area

Transport Type	Transport Activity	Facility Activity
Handymax Class Vessel	6 ships per year	Ships currently deliver alumina over Dock 1; the cargo is temporarily stored and then shipped to Chelan County by train

Notes:
Source: ICF International and Hellerworx 2016, and ICF International 2016f

2.3.2 Cowlitz County

Approximately 7 trains per day consisting of approximately 78 cars typically pass between the BNSF Spur and main line (ICF International and Hellerworx 2016). Using the method described in Section 2.2.2.3, *Method for Impact Analysis, Rail Transport of Coal from Cowlitz County Border to Project Area,* and assuming that the trains haul 121 metric tons of material per rail car, use two locomotives, and travel 23.4 miles through Cowlitz County to and from the north on the main line and BNSF Spur, the annual emissions from those trains are currently 7,652 metric tons of CO_2e. Baseline traffic on the Reynolds Lead at the project area in Cowlitz County is about two trains per day. Assuming that the trains traveling on the Reynolds Lead also haul 121 metric tons of material per rail car, use one locomotive, and travel the approximately 5-mile length of the Reynolds Lead, the annual emissions from those trains are currently 1,635 metric tons of CO_2e. These totals include trains delivering grain as well as trains connecting to other port facilities.

2.3.3 Washington State

Washington State's total GHG emissions were 92.0 MMTCO_2e in 2012, the most recent year for which a GHG Inventory was conducted. Of that total, 42.5 MMTCO_2e (46.2%) are attributable to the transportation sector, and 12.1 MMTCO_2e (13.2%) are attributable to coal combustion in the electricity sector (Washington State Department of Ecology 2016).

Rail traffic in Washington is heavy in areas, with some route segments seeing as many as 70 trains per day (ICF International and Hellerworx 2016). Existing rail capacity provides passenger service as well as transport for a variety of goods. The rail network accommodates empty and full coal trains as well as intermodal, grain, and general manifest trains from both BNSF and UP. Similarly, existing vessel traffic along the Columbia River is heavy due to the amount of bulk cargo transported in the region. The gross tonnage of vessel traffic in a 1-year period (averaged from 2010 to 2014) is approximately 91 million gross short tons (ICF International 2016f).

Chapter 3
Impacts and Mitigation

This chapter describes the GHG emissions impacts that would result from construction and operation of the Proposed Action or the ongoing activities of the No-Action Alternative.

3.1 Impacts

Net GHG emissions are presented for the Proposed Action. These net emissions represent the increase in emissions above no-action emissions.

3.1.1 Proposed Action

The GHG emissions are presented in terms of the 2028 emissions and total net emissions over the 2018 to 2038 time series. The total net emissions are the sum of emissions for the total time series, including construction beginning in 2018 and operation through 2038.

The results are presented by emissions sources, which are described in Section 2.2.2.3, *Method for Impact Analysis*. The source emissions are then combined into an estimate of total GHG emissions.

3.1.1.1 Vegetation and Wetlands Cover

As previously mentioned, the vegetation clearing and surface soil removal associated with construction of the Proposed Action would result in the loss of vegetation carbon stocks plus the loss of ongoing carbon sequestration (and reduction in annual emissions in the case of certain wetland vegetation cover types) over the 21-year analysis period. Table 33 presents the estimated emissions associated with construction of the Proposed Action and the ongoing loss of carbon sequestration.

Table 33. Vegetation and Wetlands Emissions (Mt CO_2e)

Emission Source	2015 Energy Policy	Lower Bound	Upper Bound	Past Conditions (2014)
Emissions from Carbon Stock Losses During 12-Month Construction Period	11,776	11,776	11,776	11,776
Annual Emissions, 2028	16	16	16	16
Total Emissions, 2018–2038	12,119	12,119	12,119	12,119

Notes:
MtCO_2e = metric tons of carbon dioxide equivalent

Due to the construction of the Proposed Action, carbon stocks losses are estimated to be 11,776 metric tons of CO_2e over the 12-month construction period, and total (2018 to 2038) emissions are estimated to be 12,119 metric tons of CO_2e. The annual emissions of 16 reflect lost sequestration during 2018 to 2038.

3.1.1.2 Rail Transport

Model results indicate that rail transport across the four scenarios is relatively constant, with slight fluctuations occurring depending on the share of Uinta Basin coal exported via the Proposed Action relative to the Powder River Basin coal. Although the distance from the Uinta Basin to Washington State is shorter than the distance from the Powder River Basin, the majority of the transport emissions occur from the transport of Powder River Basin coal, as its lower price results in higher demand despite the longer distances. The largest source of rail transport emissions is from domestic transport of the coal to Washington State. The second largest source of emissions from rail transport is from the transport of coal within Washington, which is approximately half the distance as that from the coal extraction sites to Washington State. Once the return trip is taken into account, the difference in emissions between the two routes taken from the different coal basins increases, as the empty Uinta Basin trains return along the same route. Empty Powder River Basin coal trains, however, travel a longer northern route to the Powder River Basin (ICF International and Hellerworx 2016).

Emissions from transport of coal within Cowlitz County also vary slightly for Powder River Basin and Uinta Basin coal due to the different directions travelled for empty Powder River Basin and Uinta Basin coal trains. However, due to the small distances involved, this difference does not have a large impact on emissions. The coal market assessment captures changes in the transportation routes from extraction sites to the project area due to shifts in coal demand and prices. Consequently, the emissions change across the scenarios. In Table 35 and Table 36, the Lower Bound scenario has slightly higher total emissions than the Past Conditions (2014) and the Upper Bound scenarios because less coal from the Uinta Basin is transported under this scenario. In the Lower Bound scenario, less coal is transported from the Uinta Basin because the higher coal prices assumed under this scenario make the Powder River Basin coal more economical to export than the Uinta Basin coal. Thus, total emissions are higher under the Lower Bound scenario because the total ton-miles of coal transported is greater than in the Past Conditions (2014) or Upper Bound scenarios, as the distance from the Powder River Basin is greater than from the Uinta Basin. The on-site emissions are equal across all scenarios, as those emissions are proportional solely to coal throughput for the Proposed Action. Table 34, Table 35, and Table 36 summarize rail emissions from each scenario.

Table 34. Locomotive Emissions from Extraction Sites to Washington State ($MtCO_2e$)

Period	2015 Energy Policy	Lower Bound	Upper Bound	Past Conditions (2014)
Annual Emissions, 2028	627,772	627,772	693,588	627,772
Total Emissions, 2018–2038	9,240,632	9,116,598	9,774,949	9,166,339

Notes:
$MtCO_2e$ = metric tons of carbon dioxide equivalent

Table 35. Locomotive Emissions within Washington State (Excluding Cowlitz County) ($MtCO_2e$)[28]

Period	2015 Energy Policy	Lower Bound	Upper Bound	Past Conditions (2014)
Annual Emissions, 2028	323,734	323,734	203,740	323,734
Total Emissions, 2018–2038	4,108,952	4,335,086	3,145,776	4,244,399

Notes:
$MtCO_2e$ = metric tons of carbon dioxide equivalent

Table 36. Locomotive Operation Emissions within Cowlitz County ($MtCO_2e$)

Emissions Source	2015 Energy Policy	Lower Bound	Upper Bound	Past Conditions (2014)
Locomotive Operation, BNSF Main Line & Spur				
Annual Emissions, 2028	20,083	20,083	20,083	20,083
Total Emissions, 2018–2038	286,255	286,255	286,255	286,255
Locomotive Operation, at Terminal Loop				
Annual Emissions, 2028	1,405	1,405	1,405	1,405
Total Emissions, 2018–2038	20,058	20,058	20,058	20,058
Subtotal				
Annual Emissions, 2028	21,489	21,489	21,489	21,489
Total Emissions, 2018–2038	306,313	306,313	306,313	306,313

Notes:
$MtCO_2e$ = metric tons of carbon dioxide equivalent

3.1.1.3 Vehicle-Crossing Delay

The GHG emissions from vehicle-crossing delays are consistent across all four scenarios, as they are directly proportional to the throughput of the Proposed Action. After the start-up period, emissions from this source remain constant throughout the time series (Table 37).

Table 37. Vehicle-Crossing Delay Emissions from Fossil Fuel Combustion from Vehicles Idling within Cowlitz County ($MtCO_2e$)

Track Section\Period	2015 Energy Policy	Lower Bound	Upper Bound	Past Conditions (2014)
Study Crossings along the Reynolds Lead and BNSF Spur				
Annual Emissions, 2028	221	221	221	221
Total Emissions, 2018–2038	3,161	3,161	3,161	3,161
Public At-Grade Crossings along the BNSF Main Line in Cowlitz County				
Annual Emissions, 2028	1	1	1	1
Total Emissions, 2018–2038	17	17	17	17
All Vehicle Crossings				
Annual Emissions, 2028	223	223	223	223
Total Emissions, 2018–2038	3,178	3,178	3,178	3,178

$MtCO_2e$ = metric tons of carbon dioxide equivalent

[28] Locomotive operation within Cowlitz County is not included in this table, thus results from Table 34, Table 35, and Table 36 are additive.

3.1.1.4 Coal Export Terminal Construction

Coal export terminal construction emissions is assumed to occur in an 18-month period prior to the operation of the Proposed Action. Because construction dates are unknown, the GHG analysis assumes that the 18-month construction period would occur at some point between the years 2018 and 2020. For the purposes of estimating emissions associated with coal export terminal operation, the GHG analysis assumes that construction would be completed before December 31, 2020. As the construction would be structurally similar across the four scenarios, construction GHG emissions are equal across all four scenarios (Table 38). The emissions from the operation of construction equipment would exceed those of the barges used for bringing construction materials to the project area.

Table 38. Coal Export Terminal Construction Emissions ($MtCO_2e$)

	Scenario			
Emissions Source	**2015 Energy Policy**	**Lower Bound**	**Upper Bound**	**Past Conditions (2014)**
Construction Equipment				
Emissions During 12 Months of Construction Period	5,349	5,349	5,349	5,349
Total Emissions, 2018–2038[a]	8,024	8,024	8,024	8,024
Employee Commuting				
Emissions During 12 Months of Construction Period	465	465	465	465
Total Emissions, 2018–2038[a]	698	698	698	698
Construction Trucks Carrying Materials to Project Area				
Emissions During 12 Months of Construction Period	1,081	1,081	1,081	1,081
Total Emissions, 2018–2038 [a]	1,621	1,621	1,621	1,621
Construction Barges Carrying Materials to Project Area				
Emissions During 12 Months of Construction Period	955	955	955	955
Total Emissions, 2018–2038 [a]	1,433	1,433	1,433	1,433
Subtotal				
Emissions During 12 Months of Construction Period	7,851	7,851	7,851	7,851
Total Emissions, 2018–2038	11,776	11,776	11,776	11,776

Notes:

[a] Construction emissions occur over an 18-month period prior to the operation of the coal export terminal; therefore, emissions from 2021 through 2038 are zero. Given the 18 month period for construction, total construction emissions are those for the 12-month period multiplied by 1.5.

$MtCO_2e$ = metric tons of carbon dioxide equivalent

3.1.1.5 Coal Export Terminal Operation—Equipment Operation

GHG emissions from mobile equipment used for routine operation of the coal export terminal are consistent across all four scenarios, as they are directly proportional to the throughput of the Proposed Action (Table 39). After the start-up period, emissions from this source would remain constant throughout the time series.

Table 39. Coal Export Terminal Operation Emissions from Mobile Combustion ($MtCO_2e$)

	Scenario			
Period	2015 Energy Policy	Lower Bound	Upper Bound	Past Conditions (2014)
Annual Emissions, 2028	903	903	903	903
Total Emissions, 2018–2038	12,894	12,894	12,894	12,894

Notes:
$MtCO_2e$ = metric tons of carbon dioxide equivalent

3.1.1.6 Coal Export Terminal Operation—Electricity Consumption

Electricity consumption emissions for operation of the new coal export terminal are assumed constant across all years of the time series and for all scenarios (Table 40).

Table 40. Coal Export Terminal Operation—Indirect Emissions from Electricity Consumption ($MtCO_2e$)

	Scenario			
Period	2015 Energy Policy	Lower Bound	Upper Bound	Past Conditions (2014)
Annual Emissions, 2028	177	177	177	177
Total Emissions, 2018–2038	3,191	3,191	3,191	3,191

Notes:
$MtCO_2e$ = metric tons of carbon dioxide equivalent

3.1.1.7 Employee Commuting

GHG emissions from employee commuting are consistent across all four scenarios, as they are directly proportional to the throughput of the Proposed Action (Table 41). After the start-up period, emissions from this source would remain constant throughout the time series.

Table 41. Employee Commuting ($MtCO_2e$)

	Scenario			
Period	2015 Energy Policy	Lower Bound	Upper Bound	Past Conditions (2014)
Annual Emissions, 2028	275	275	275	275
Total Emissions, 2018–2038	3,922	3,922	3,922	3,922

Notes:
$MtCO_2e$ = metric tons of carbon dioxide equivalent

3.1.1.8 Vessel Idling and Tugboat Use at Coal Export Terminal

GHG emissions from idling vessels and tugboats are consistent across all four scenarios, as they are directly proportional to the throughput of the Proposed Action (Table 42). Tugboats emit approximately twice as many emissions as idling vessels. After the start-up period, emissions from this source will remain constant throughput the time series.

Table 42. Emissions from Vessel Idling and Tugboat Use at Coal Export Terminal ($MtCO_2e$)

	Scenario			
Emissions Source	**2015 Energy Policy**	**Lower Bound**	**Upper Bound**	**Past Conditions (2014)**
Vessel Idling at Terminal				
Annual Emissions, 2028	2,498	2,498	2,498	2,498
Total Emissions, 2018–2038	35,660	35,660	35,660	35,660
Tugboat Operation				
Annual Emissions, 2028	4,840	4,840	4,840	4,840
Total Emissions, 2018–2038	69,081	69,081	69,081	69,081
Subtotal				
Annual Emissions, 2028	7,338	7,338	7,338	7,338
Total Emissions, 2018–2038	104,740	104,740	104,740	104,740

Notes:
$MtCO_2e$ = metric tons of carbon dioxide equivalent

3.1.1.9 Helicopter and Pilot Boat Trips

GHG emissions from pilot transfers are consistent across all four scenarios, as they are directly proportional to the throughput of the Proposed Action (Table 43). Helicopters emit about the same GHGs as pilot boats and are assumed responsible for 70% of the pilot transfers. After the start-up period, emissions from this source would remain constant throughout the time series.

Table 43. Emissions from Helicopter and Pilot Boat Trips for Pilot Transfers to Vessels ($MtCO_2e$)

	Scenario			
Emissions Source	**2015 Energy Policy**	**Lower Bound**	**Upper Bound**	**Past Conditions (2014)**
Helicopter Operation				
Annual Emissions, 2028	361	361	361	361
Total Emissions, 2018–2038	5,148	5,148	5,148	5,148
Pilot Boat Operation				
Annual Emissions, 2028	396	396	396	396
Total Emissions, 2018–2038	5,648	5,648	5,648	5,648
Subtotal				
Annual Emissions, 2028	756	756	756	756
Total Emissions, 2018–2038	10,796	10,796	10,796	10,796

Notes:
$MtCO_2e$ = metric tons of carbon dioxide equivalent

3.1.1.10 Vessel Transport

Vessel transport GHG emissions are equivalent across all scenarios within Cowlitz County and Washington State but diverge for international transport (Table 44 and Table 45). The differences in international transport emissions result from different destinations for the exported coal and the extent to which demand for existing sources of Pacific Basin coal is displaced, primarily by coal from Indonesia and Australia. Consequently, the net emissions from international transport of coal include both transport to the Asian market and the adjustment for the displaced vessel transport from Indonesia and Australia to the Asian market (Table 46). In the Upper Bound scenario, for example, the high demand for coal means that the addition of 44 million metric tons of coal per year from the United States would not reduce a similar amount of coal traffic within the Pacific Basin. In other words, prices shift such that there is additional induced demand beyond the 44 million metric tons of coal exported via the Proposed Action.

Table 44. Emissions from Vessel Transport within Cowlitz County ($MtCO_2e$)

	Scenario			
Period	2015 Energy Policy	Lower Bound	Upper Bound	Past Conditions (2014)
Annual Emissions, 2028	8,232	8,232	8,232	8,232
Total Emissions, 2018–2038	118,573	118,573	118,573	118,573

Notes:
$MtCO_2e$ = metric tons of carbon dioxide equivalent

Table 45. Emissions from Vessel Transport within Washington State (Excluding Transport within Cowlitz County) ($MtCO_2e$)[29]

	Scenario			
Period	2015 Energy Policy	Lower Bound	Upper Bound	Past Conditions (2014)
Annual Emissions, 2028	39,495	39,495	39,495	39,495
Total Emissions, 2018-2038	563,696	563,696	563,696	563,696

Notes:
$MtCO_2e$ = metric tons of carbon dioxide equivalent

Table 46. Net Emissions from Changes in International Vessel Transport to Asian Markets ($MtCO_2e$)[a]

	Scenario			
Period	2015 Energy Policy	Lower Bound	Upper Bound	Past Conditions (2014)
Net Annual Emissions, 2028	256,517	618,096	1,540,555	631,149
Net Total Emissions, 2018–2038	2,595,112	2,168,462	22,161,047	6,947,758

Notes:
[a] Net GHG emissions represent the difference between the Proposed Action and the no-action.
$MtCO_2e$ = metric tons of carbon dioxide equivalent

[29] This table does not include emissions generated from vessel transport within Cowlitz County for the results in Table 44, Table 45, and Table 46 to be additive.

3.1.1.11 Coal Combustion

Coal combustion in the United States and the Pacific Basin is one of the largest and most variable sources of GHG emissions associated with the Proposed Action. Model results indicate that this source of emissions varies significantly throughout the time series and between scenarios, indicating that it is sensitive to policy and market factors. For most scenarios, the coal combustion emissions in the United States decrease while coal combustion emissions in the Pacific Basin increase, to varying degrees. The key factor behind this shift is U.S. and Asian markets' reactions to price and supply shifts for coal. As the Proposed Action exports U.S. coal, prices in the United States go up in response to supply decreasing, thus reducing coal combustion. Likewise, the increased supply of coal in Asia decreases prices and facilitates additional coal combustion.

Coal combustion emissions in Asia are separated in Table 47 into two subcategories: emissions from induced coal demand and emissions from coal substitution. Induced demand emissions would occur because of lowered coal prices in response to an increase in coal supply caused by the Proposed Action. Coal substitution emissions are a result of the of higher-heat-content coal with lower-heat-content coal, which results in a net increase in emissions to generate the same amount of energy.

The differences between scenarios are driven by the following factors.

- Coal combustion emissions in the United States are less than the no-action for all scenarios (that is, the net emissions are negative). Domestic coal prices increase in every scenario in response to the export of Powder River Basin and Uinta Basin coal. The higher prices then reduce the U.S. demand for coal.
- In all but the Lower Bound scenarios, the additional coal exported to the Pacific Basin from the Proposed Action reduces the delivered Pacific Basin coal prices, inducing demand. This increases overall coal consumption even as some Asian coals from Indonesia and Australia are displaced by Powder River Basin and Uinta Basin coals.
- There is a secondary driver of emissions in Asia, as lower-heat-content coal from the United States displaces higher-heat-content coal in each scenario. This displacement of higher-heat-content coal results in additional low-heat-content coal being combusted in order to meet electricity demands (i.e., Btu demands), therefore raising emissions in Asia.[30]
- In the Lower Bound scenario, in which international coal is cheaper than in the Past Conditions (2014) scenario, the increase in coal supplied by the Proposed Action has less of an impact on prices than in the Past Conditions (2014) scenario and therefore does not induce demand in Asia; Pacific Basin emissions increase through coal substitution. This scenario also has a smaller impact on domestic coal displacement in the United States, as there is less price sensitivity domestically relative to the Past Conditions (2014) scenario.
- The Upper Bound scenario (which already has high coal prices) has a higher impact on domestic coal displacement than the Past Conditions (2014) scenario and a higher induced demand in Asian markets than the Past Conditions (2014) scenario.

[30] For example, in Japan in the Past Conditions (2014) scenario, coal consumption increases by 1.5 million metric tons in 2030 over the No-Action Alternative; however, the amount of induced demand is less than 0.5 million metric tons. Thus 1.0 million metric tons of the increase in coal consumption in Japan in 2030 is due to changes in the mix of coal consumed.

- In the 2015 Energy Policy scenario, U.S. coal combustion decreases only slightly for two reasons: First, U.S. coal prices are already very low due to a decrease in consumption from the enactment of a EPA's Clean Power Plan in 2020, as modeled. Therefore, the Proposed Action affects the market significantly less than in the Past Conditions (2014) scenario. Second, the 2015 Energy Policy scenario sees a shift from lower-emitting coals to higher CO_2-emitting coals in the United States. This result can occur because states can respond by switching to higher-emitting coals that are cheaper than natural gas yet still allow states to meet their climate policy obligations.

The SEPA Coal Market Assessment Technical Report (ICF International 2016d) provides a thorough discussion of the market.

Table 47. Net Emissions from Coal Combustion ($MtCO_2e$)[a]

	Scenario			
Emissions Source	**2015 Energy Policy**	**Lower Bound**	**Upper Bound**	**Past Conditions (2014)**
Coal Combustion, United States				
Net Annual Emissions, 2028	-266,185	-4,675,534	-10,065,930	-5,385,639
Net Total Emissions, 2018–2038	-2,518,738	-66,717,663	-160,380,593	-96,403,156
Coal Combustion from Induced Demand, Pacific Basin				
Net Annual Emissions, 2028	867,958	0	37,439,547	2,094,921
Net Total Emissions, 2018–2038	12,406,582	0	535,160,238	29,944,771
Coal Combustion from Coal Substitution, Pacific Basin				
Net Annual Emissions, 2028	1,171,889	1,072,099	-325,724	1,339,453
Net Total Emissions, 2018–2038	8,856,189	12,106,757	-1,644,717	12,964,768
Subtotal				
Net Annual Emissions, 2028	1,773,662	-3,603,435	27,047,892	-1,951,264
Net Total Emissions, 2018–2038	18,744,034	-54,610,906	373,134,929	-53,493,618

Notes:
[a] Net GHG emissions represent the difference between the Proposed Action and the no-action.
$MtCO_2e$ = metric tons of carbon dioxide equivalent

3.1.1.12 Induced Natural Gas Consumption

Natural gas substitution in the United States is a large and highly variable source of emissions. Higher coal prices in the United States induce electricity generators to switch to natural gas. Relative to the no-action, natural gas emissions increase for all scenarios, although the results display significant variation depending on the extent to which coal is displaced (Table 48). The differences among scenarios are driven by the following factors.

- In each scenario, natural gas emissions increase due to higher natural gas consumption in response to the Proposed Action. The higher domestic coal prices caused by the export of Powder River Basin and Uinta Basin coal through the Proposed Action cause a reduction in the U.S. demand for coal. This effect has the highest impact in the Upper Bound scenario, because coal demand is more elastic than in the other scenarios, resulting in higher natural gas substitution.

- The increase in natural gas consumption is smaller in the Lower Bound scenario relative to the Past Conditions (2014) scenario. The lower prices of coal in the Lower Bound scenario create less relative demand for natural gas than in the Past Conditions (2014) scenario. Correspondingly, the Upper Bound scenario has higher net natural gas emissions than the Past Conditions (2014) scenario, due to the higher global coal prices and higher domestic coal prices resulting in higher natural gas consumption.
- The decrease in coal combustion due to higher coal prices is partially offset by natural gas combustion in all but the 2015 Energy Policy scenario. In the other scenarios, the coal is replaced by natural gas, which has a lower combustion emission factor, causing a net decrease in domestic electricity generation emissions. In the 2015 Energy Policy scenario, there is less of a substitution of natural gas for coal because states can still respond to increased coal prices by switching to higher emitting coals, which are cheaper than natural gas yet still meet their climate policy obligations.

Table 48. Net Emissions from Natural Gas Substitution in the United States ($MtCO_2e$)[a]

	Scenario			
Period	2015 Energy Policy	Lower Bound	Upper Bound	Past Conditions (2014)
Net Annual Emissions, 2028	170,435	850,628	1,781,076	1,225,279
Net Total Emissions, 2018–2038	1,497,089	12,827,507	33,110,591	23,415,889

Notes:
[a] Net GHG emissions represent the difference between the Proposed Action and the no-action.
$MtCO_2e$ = metric tons of carbon dioxide equivalent

3.1.1.13 Net Greenhouse Gas Emissions

This section presents the aggregated results of each of the emissions sources described previously.

Model results indicate that the direct GHG emissions from the Proposed Action (Table 49) are the same for each of the four scenarios, as they are emitted in proportion to the throughput of the Proposed Action and are not influenced by outside economic factors. The largest contributors to the direct emissions are transportation-related emissions, including locomotive operation and vessel transport within Cowlitz County. Together, these two sources contribute about 74% of direct emissions. For the Past Conditions (2014) scenario, the total direct emissions contributed approximately 0.6 $MMTCO_2e$ (Table 49) of total net emissions of -8.3 $MMTCO_2e$ (Table 53) once market-influenced and indirect sources of emissions were considered (i.e., direct on-site emissions are positive; however, overall net emissions are negative due to domestic coal displacement).

Table 49. Direct Emissions (Generated in Cowlitz County) for the Proposed Action ($MtCO_2e$)[31]

Period	Scenario			
	2015 Energy Policy	Lower Bound	Upper Bound	Past Conditions (2014)
Annual Emissions, 2028	38,477	38,477	38,477	38,477
Total Emissions, 2018–2038	573,516	573,516	573,516	573,516

Notes:
$MtCO_2e$ = metric tons of carbon dioxide equivalent

Statewide, emissions are about 9 times as high as the county emissions, largely driven by the greater distances traveled by locomotives and vessels outside of Cowlitz County. Locomotive transport constitutes about 88% of emissions generated within Washington State and outside of Cowlitz County (Table 50).

Table 50. Emissions Generated within Washington State, Excluding Cowlitz County ($MtCO_2e$)

Period	Scenario				
	2015 Energy Policy	Lower Bound	Upper Bound	Past Conditions (2014)	Cumulative
Annual Emissions, 2028	364,162	364,162	244,169	364,162	354,363
Total Emissions, 2018–2038	4,686,634	4,912,768	3,723,459	4,822,082	4,587,418

Notes:
The Cumulative scenario is provided here for comparison and is addressed in Section 3.1.1.13, *Net Greenhouse Gas Emissions*, under Cumulative Scenario.
$MtCO_2e$ = metric tons of carbon dioxide equivalent

The total net indirect emissions from activities outside the project area and Cowlitz County attributed to the operation of the Proposed Action come from a variety of sources, including:

- Rail Transport
- Coal Export Terminal Operation – Electricty Consumption
- Helicopter and Pilot Boat Trips
- Vessel Transport
- Coal Combustion in Asia and the United States
- Induced Natural Gas Consumption in the United States

These emissions vary depending on the scenario, from a decrease of 25.2 $MMTCO_2e$ in the Lower Bound scenario to an increase of 675.7 $MMTCO_2e$ in the Cumulative scenario (Table 51).

[31] By definition, direct emissions are equivalent to emissions generated in Cowlitz County.

Table 51. Indirect Emissions for the Proposed Action ($MMtCO_2e$)

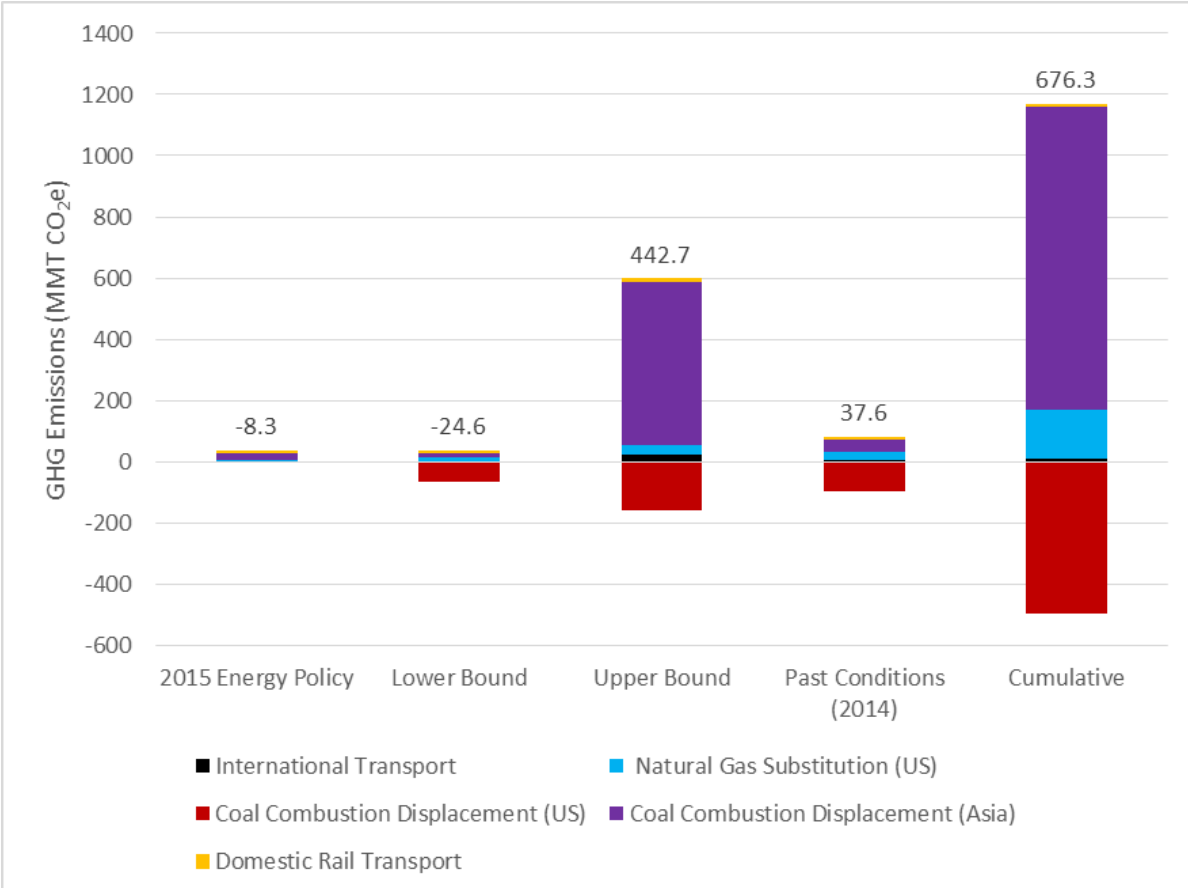
Period	Scenario: 2015 Energy Policy	Lower Bound	Upper Bound	Past Conditions (2014)	Cumulative
Annual Emissions, 2028	3.2	-1.1	31.3	0.9	39.5
Total Emissions, 2018–2038	37.0	-25.2	442.1	-8.9	675.7

Notes: The Cumulative scenario is provided here for comparison and is addressed in Section 3.1.1.13, *Net Greenhouse Gas Emissions*, under Cumulative Scenario.
$MtCO_2e$ = metric tons of carbon dioxide equivalent

The total net impacts (Direct + Indirect emissions) range from a decrease in emissions of 24.6 $MMTCO_2e$ in the Lower Bound scenario relative to the no-action to an increase in emissions of 676.2 $MMTCO_2e$ (Figure 7) in the Cumulative scenario relative to the no-action. The Past Conditions (2014) scenario, which depicts a "business as usual" projection of market conditions in the absence of climate policy, indicates a total impact of -8.3 $MMTCO_2e$ across the entire time series studied. Figure 7 depicts the range of net total emissions from the operation of the Proposed Action across the different scenarios studied.[32]

[32] The bars in this figure do not include some of the smaller sources of emissions (for instance on-site emissions are not included). However, the number for each bar denotes the total net emissions for each scenario modeled and includes all emission sources.

Figure 7. Total Net Emissions for Each Scenario, 2018-2038 ($MMTCO_2e$)[a]



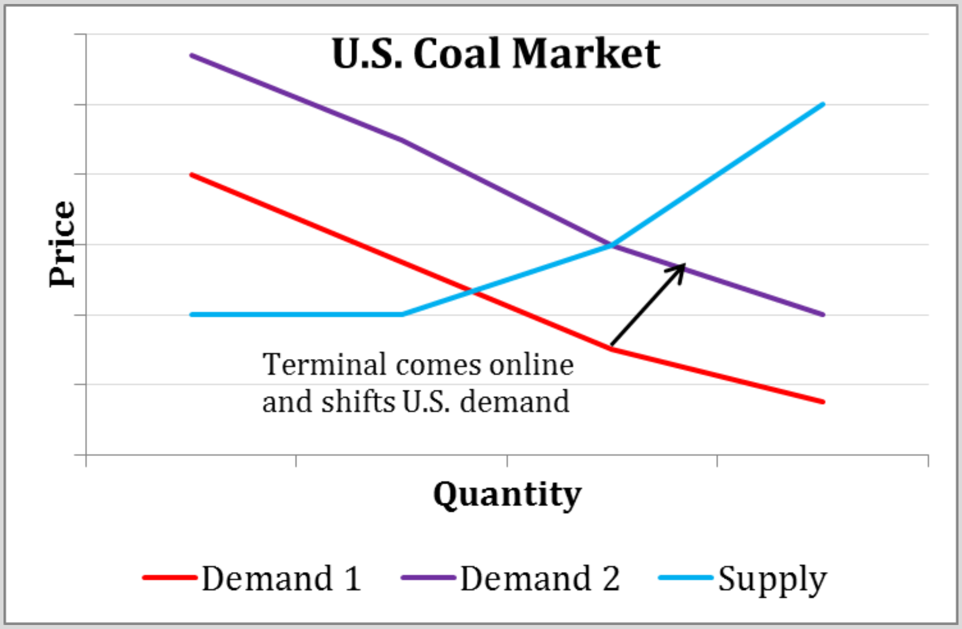
Notes: [a] Net GHG emissions represent the difference between the Proposed Action and the no-action. The bars in this figure do not include some of the smaller sources of emissions (for instance on-site emissions are not included). However, the number for each bar denotes the total net emissions for each scenario modeled and includes all emission sources. The Cumulative scenario is provided here for comparison and is addressed in Section 3.1.1.13, *Net Greenhouse Gas Emissions*, under Cumulative Scenario.

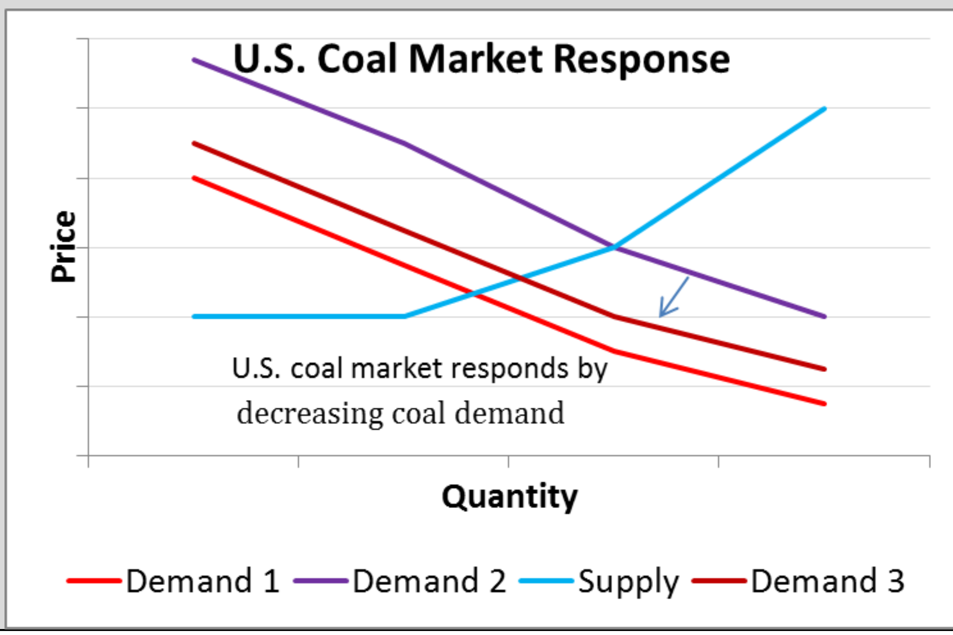
The shift in coal prices both domestically and internationally have a major impact on the resulting net GHG emissions for each scenario compared to the no-action. The textboxes that follow illustrate key concepts on the shift in coal prices. These shifts are mentioned as they influence the net change in GHG emissions as described below. For additional details, see the SEPA Coal Market Assessment Technical Report (ICF International 2016d).

Impact of the Proposed Action on Domestic Coal Supply and Demand, Assuming Coal Export Terminal Operates at Full Capacity

The operation of the Proposed Action would have the effect of improving integration of the U.S. and Asian coal markets. However, to the extent that Asian coal prices are higher than U.S. coal prices, operation of the Proposed Action would cause Asian coal prices to decline, while U.S. coal prices would increase. These changes in price would cause Asian coal demand to increase and U.S. coal demand to decrease.

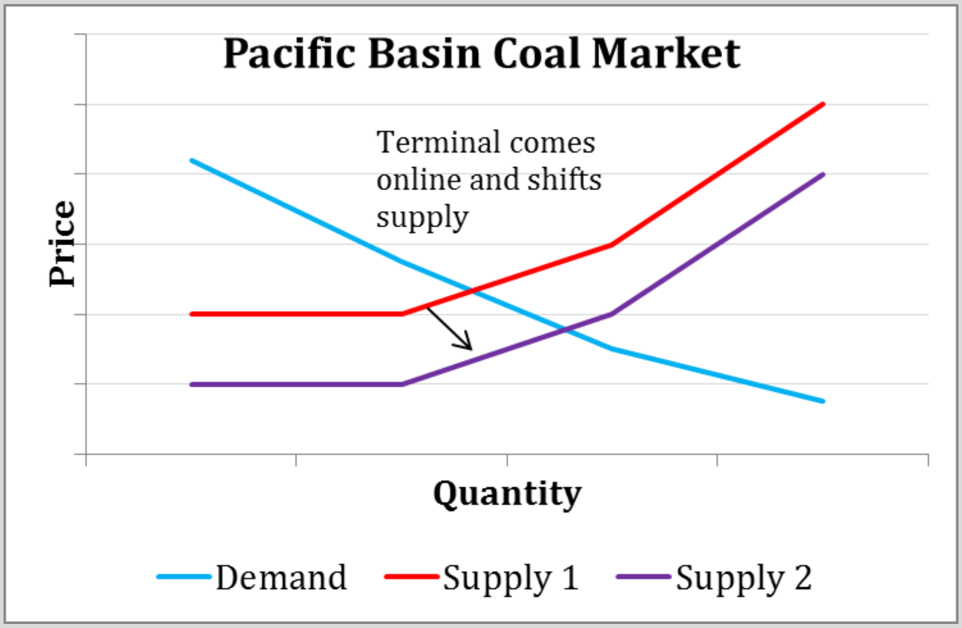
Increase in demand for U.S. coal as coal is exported from the Proposed Action would result in higher U.S. coal prices and a subsequent decrease in domestic coal demand compared to the no-action. (The coal "demand" from the coal export terminal is inelastic, while the domestic demand from coal plants is elastic and will decrease with an increase in coal prices.)

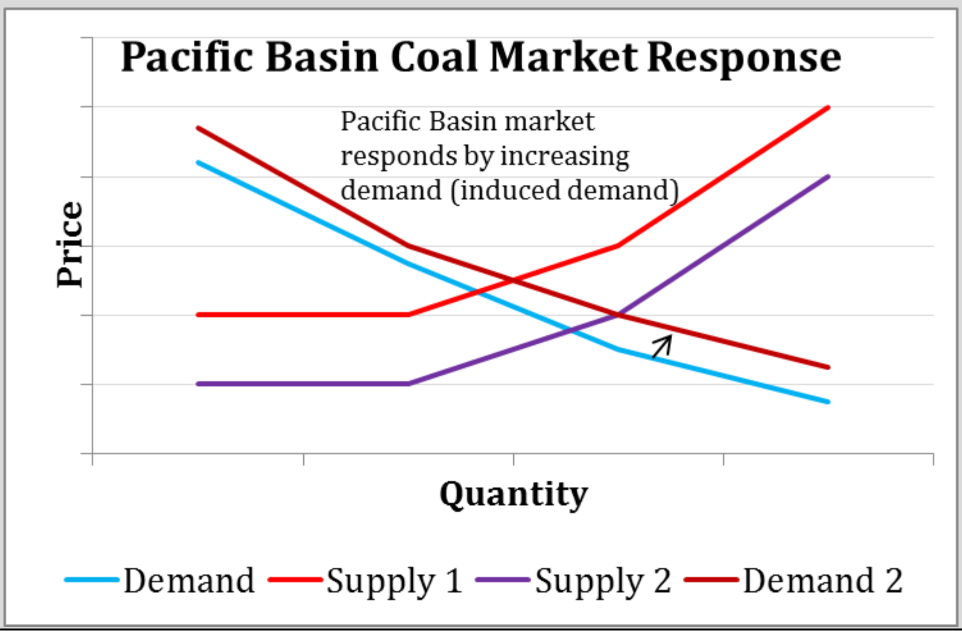




Impact of the Proposed Action on International Coal Supply and Demand, Assuming Coal Export Terminal Operates at Full Capacity

1. Increase in coal supplied to international market from the Proposed Action.
2. This increase in the coal supply in the Pacific Basin would result in lower international coal prices and a subsequent increase in international coal demand compared to the No- Action Alternative.





The diagrams above explain the general impact of the Proposed Action on coal markets regardless of the scenario. What makes each scenario different, however, is that the supply and demand curves for coal each have different slopes. The slopes of the demand curves vary based on economic and policy conditions dictated by each scenario. For example, the Lower Bound scenario has a lower slope for coal demand than the Past Conditions (2014) scenario, indicating a lower elasticity of demand in response to supply changes. In effect, the differences in supply and demand curves differentiate the emissions between each scenario.[33] Table 52 compares how coal and natural gas combustion change in response to market and policy conditions. The Past Conditions (2014) scenario row compares the emissions relative to the no-action, whereas the rest of the rows compare each scenario's emissions to the Past Conditions (2014) scenario.

Table 52. Impacts on Coal and Natural Gas Combustion across Scenarios

Scenario	U.S. Coal Markets	Asian Coal Markets	U.S. Natural Gas Markets
2015 Energy Policy	Decrease in domestic coal emissions in early years, followed by a slight increase from 2030. In 2030 and later, coal is not replaced by natural gas to the same extent as other scenarios.[a]	Increase in Asian coal emissions. The Proposed Action causes a decrease in Asian coal prices from increased supply, creating induced demand. The magnitude is smaller than in the Past Conditions (2014) scenario because coal prices are already low in this scenario, and the market reacts less sharply.	Decrease in domestic natural gas emissions. Due to the high renewable penetration and the Clean Power Policy, power operators will find it more economical to switch to cheaper, higher-emitting coals than natural gas in response to price effects from the Proposed Action.
Past Conditions (2014)	Decrease in domestic coal emissions. The Proposed Action causes an increase in domestic coal prices, reducing consumption.	Increase in Asian coal emissions. The Proposed Action causes a decrease in Asian coal prices from increased supply, creating induced demand.	Increase in domestic natural gas emissions. The Proposed Action causes an increase in domestic coal prices, increasing natural gas substitution for coal to meet energy demands.
Lower Bound	Decrease in domestic coal emissions. The Proposed Action causes an increase in domestic coal prices, reducing consumption. The magnitude is smaller than the Past Conditions (2014) scenario because coal prices are already low in this scenario, and the market reacts less sharply.	Increase in Asian coal emissions. The Proposed Action causes an increase in emissions due solely to changes in the coal mix consumed.	Increase in domestic natural gas emissions. The Proposed Action causes an increase in domestic coal prices, increasing natural gas substitution for coal to meet energy demands. The magnitude is lower than in the Past Conditions (2014) scenario because domestic coal markets are less sensitive to the Proposed Action.
Upper Bound	Decrease in domestic coal emissions. The Proposed Action causes an increase in domestic coal prices, reducing consumption. The magnitude is higher than the Past Conditions	Increase in Asian coal emissions. The Proposed Action causes a decrease in Asian coal prices from increased supply, creating induced demand. The magnitude is higher than in	Increase in domestic natural gas emissions. The Proposed Action causes an increase in domestic coal prices, increasing natural gas substitution for coal to meet energy demands. The

[33] The net emissions associated with the Proposed Action in the 2015 Energy Policy scenario are higher than in the Past Conditions (2014) scenario (i.e., 38 versus -8 $MMTCO_2e$), but occur against baseline emissions that are substantially lower than the Past Conditions (2014) scenario(see textbox entitled *Comparison of GHG Emissions Across Coal Market Assessment Scenarios* in Section 2.2.2.1, *Scope of Analysis,* for graphic of baseline emissions).

Scenario	U.S. Coal Markets	Asian Coal Markets	U.S. Natural Gas Markets
	(2014) scenario because coal prices are already high in this scenario, and the market reacts more sharply.	the Past Conditions (2014) scenario because coal prices and demand are already high; adding coal from The Proposed Action to Asian markets will create induced demand with low rates of coal substitution.	magnitude is higher than in the Past Conditions (2014) scenario because domestic coal markets are more sensitive to the Proposed Action.

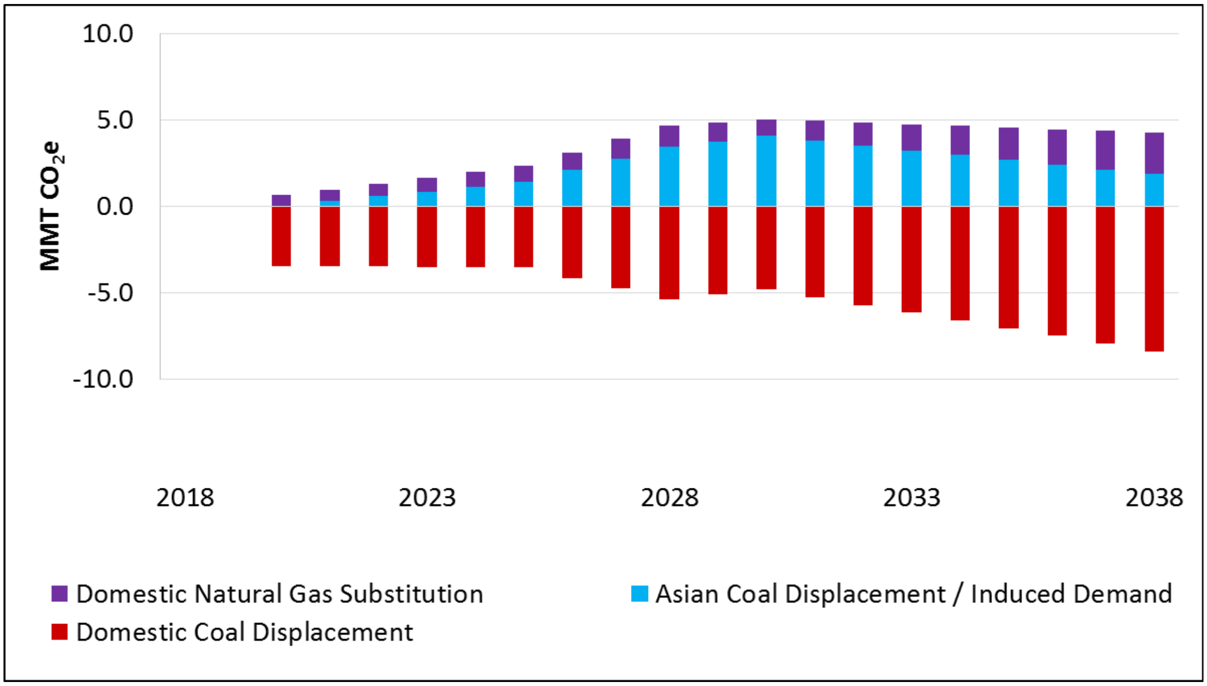
Notes:

[a] The coal emissions in the 2015 Energy Policy scenario increase in 2030 and later because the proposed Clean Power Plan modeled for this analysis is a rate-based approach, which means that the rate of emissions as measured in pounds CO_2 per megawatt-hour (MWh) must be less than the target set by EPA. Over time more renewable capacity is added to the system, which increases the denominator (MWh) without adding to the numerator (lbs CO_2). Thus as more renewables come online, additional coal or natural gas emissions can be generated without exceeding the rate limit. For example, assume a state with a target rate of 900 lbs CO_2/MWh and the state has only coal and renewable generation with emission rates of 1,800 lb CO_2/MWh and 0 lb CO_2/MWh, respectively. Then if the coal and renewable generation are equal at 1,000 MWh, the state will meet its rate of 900 lb/MWh (=(1,000 MWh x 1,800 lb/MWh + 1,000 MWh x 0 lb/MWh) / (1,000 MWh + 1,000 MWh)). Thus when the renewable generation increases, the coal generation could also increase to the same level without exceeding the rate limit.

In Figure 8, which identifies the major sources of emissions, it is clear that the largest contributors to net emissions are the extent to which coal and natural gas combustion are influenced in Asia and the United States; i.e., domestic rail transport and international transport play a much smaller role in net emissions. In the Past Conditions (2014) and Lower Bound scenarios, the single largest contributor to the net emissions is the displacement of coal combustion in the United States, driven by higher coal prices in response to the Proposed Action. In the Upper Bound scenario the emissions induced demand from lower coal prices in Asia in response to the Proposed Action outweighs the emissions from domestic coal displacement, resulting in positive net emissions.

Emissions estimated in the coal market assessment occur along a time series from when the coal export terminal would begin operating in 2021 through 2040. As shown in Figure 8, there is significant variation from year to year, as well as a ramp-up period where the coal export terminal would increase exports from zero to 44 million metric tons of coal per year.

Figure 8. Past Conditions (2014)—Net Annual Emissions, 2018–2038



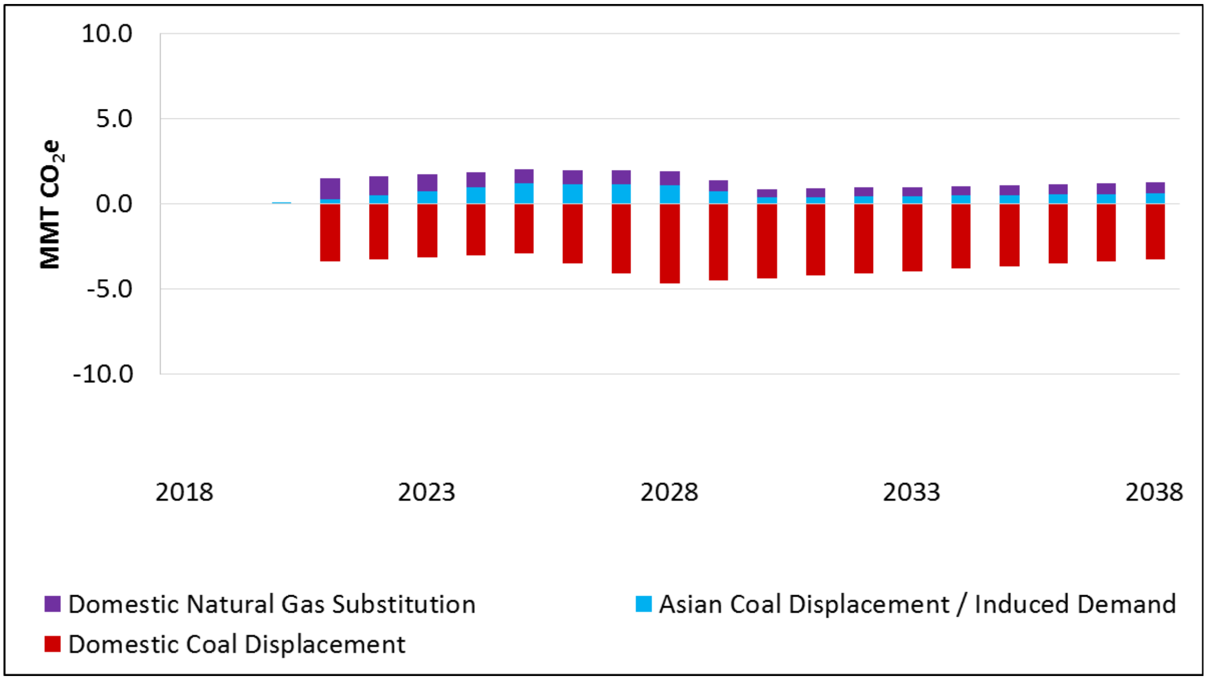
Note: Net GHG emissions represent the difference between the Proposed Action and the no-action.

Lower Bound Scenario

In the Lower Bound scenario (Figure 9), coal displacement in the United States results in a significant reduction of GHG emissions. Similarly, the lack of induced demand in Asia reduces Asian coal GHG emissions, as the increase is solely due to a shift to lower-heat-content coals. Compared to the Past Conditions (2014) scenario, the Lower Bound scenario results in higher natural gas emissions in the United States due to the deeper reduction of coal use domestically. In summary, the Lower Bound scenario results in the following emissions conditions.

- Emissions are lower than in the Past Conditions (2014) scenario.
- Coal emissions in Asia rise less than in the Past Conditions (2014) scenario because demand is not induced
- Natural gas substitution is lower because domestic prices are less sensitive to coal price changes.

Figure 9. Lower Bound – Net Annual Emissions, 2018–2038



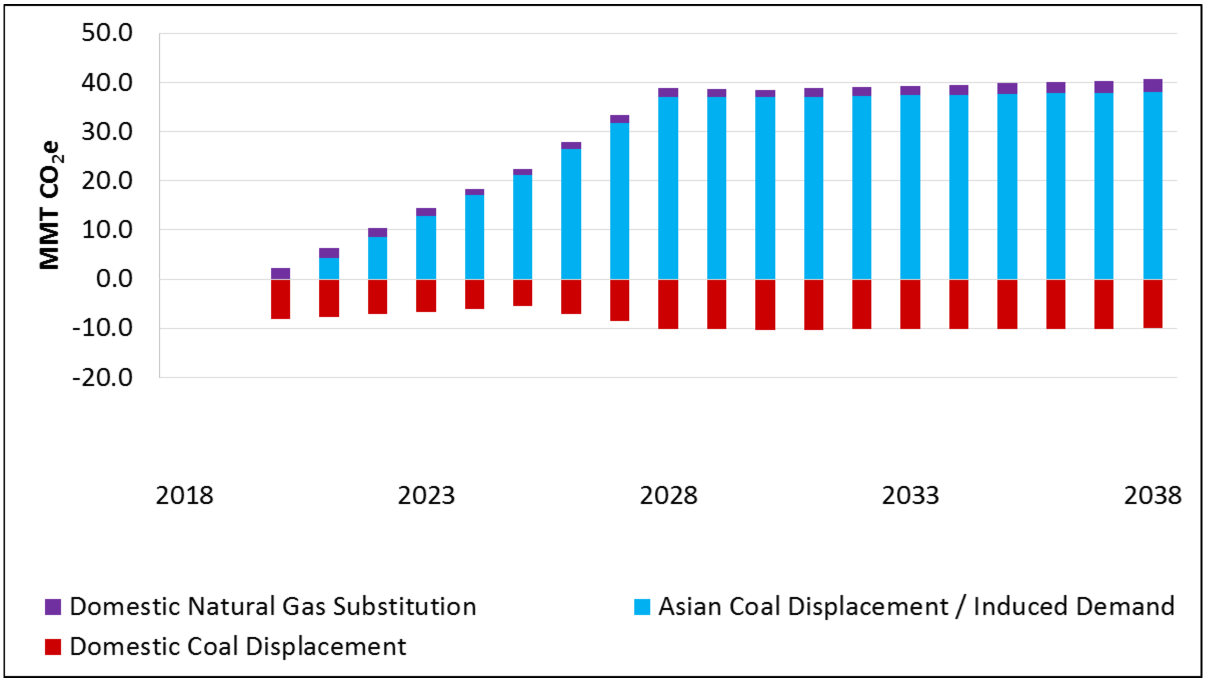
Note: Net GHG emissions represent the difference between the Proposed Action and the no-action.

Upper Bound Scenario

The Upper Bound scenario (Figure 10), which has a higher sensitivity to coal prices, exhibits stronger induced demand from Asia, resulting in higher Asian coal emissions than the Past Conditions (2014) scenario. Similarly, the sensitivity to coal prices is higher in the United States in this scenario, so more coal is displaced by natural gas relative to the Past Conditions (2014) scenario. In summary, the Upper Bound scenario results in the following emissions conditions.

- Emissions are higher than in the Past Conditions (2014) scenario.
- Coal emissions in Asia rise more than in the Past Conditions (2014) scenario because more demand is induced.
- Natural gas substitution is higher because domestic prices are more sensitive to coal price changes.

Figure 10. Upper Bound – Net Annual Emissions, 2018–2038



Note: Net GHG emissions represent the difference between the Proposed Action and the no-action.

2015 Energy Policy Scenario

The 2015 Energy Policy scenario (Figure 11) does not resemble the other scenarios, as U.S. coal displacement is significantly lower. This shift in coal displacement occurs because of the climate policy in the United States is assumed to depress coal prices and reduce coal combustion. Therefore, in this scenario, domestic coal emissions and natural gas emissions stay relatively flat throughout the time series. Net emissions in Asia increase less than in the Past Conditions (2014) scenario and are driven by a switch to lower-heat-content coals rather than by induced demand. (One important note is that, although state climate emissions goals drive up the use of renewables relative to the Past Conditions (2014) scenario, use of some coal is permissible.) The low cost of coal in the 2015 Energy Policy scenario reduces the substitution of natural gas for coal relative to the Past Conditions (2014) scenario. In summary, the 2015 Energy Policy scenario results in the following emissions conditions.

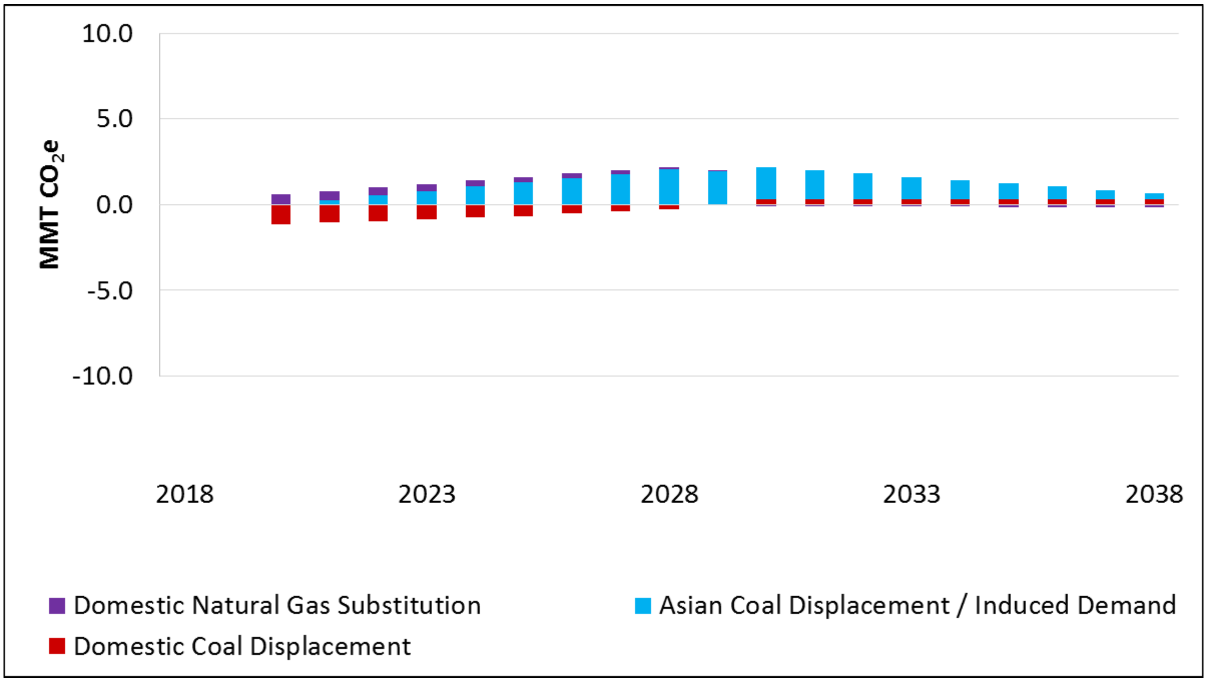
- Net emissions[34] from domestic coal combustion are less than in the Past Conditions (2014) scenario because the 2015 Energy Policy scenario is less sensitive to changes in coal prices due to lower coal demand.
- Net emissions from coal combustion in Asia increase less than in the Past Conditions (2014) scenario because coal demand under the 2015 Energy Policy scenario is less sensitive to changes in coal prices and thus there is less induced demand than in the Past Conditions (2014) scenario.
- Net GHG emissions from coal combustion in the 2015 Energy Policy scenario are primarily driven by changes in coal types consumed (i.e., low heat content versus high heat content coal)

[34] Net GHG emissions represent the difference between the Proposed Action and the No-Action.

rather than induced demand. In contrast, for the Past Conditions (2014) scenario, the induced demand drives the change in net GHG emissions from coal combustion.

- Net GHG emissions from coal combustion in the 2015 Energy Policy scenario are driven by changes in coal types consumed because induced demand is lower than in the Past Conditions (2014) scenario, where the induced demand drives the net change in GHG emissions from coal combustion.
- Net emissions from domestic natural gas combustion are lower than in the Past Conditions (2014) scenario because of the lower price of coal in the 2015 Energy Policy scenario.

Figure 11. 2015 Energy Policy—Net Annual Emissions, 2018–2038



Note: Net GHG emissions represent the difference between the Proposed Action and the no-action.

Overall, the net annual emissions across the four scenarios in 2028 range from a decrease of 1.1 $MMTCO_2e$ to an increase of 31.3 $MMTCO_2e$ relative to the no-action. Table 53 summarizes the net direct and indirect GHG emissions for each scenario.

Table 53. Net Emissions (Direct + Indirect) ($MMTCO_2e$)[a]

	Scenario			
	2015 Energy Policy	Lower Bound	Upper Bound	Past Conditions (2014)
Net Annual Emissions, 2028	3.2	-1.1	31.3	0.9
Total Net Emissions, 2018–2038	37.5	-24.6	442.7	-8.3

Notes:
[a] Net GHG emissions represent the difference between the Proposed Action and the no-action.
$MMTCO_2e$ = million metric tons of carbon dioxide equivalent

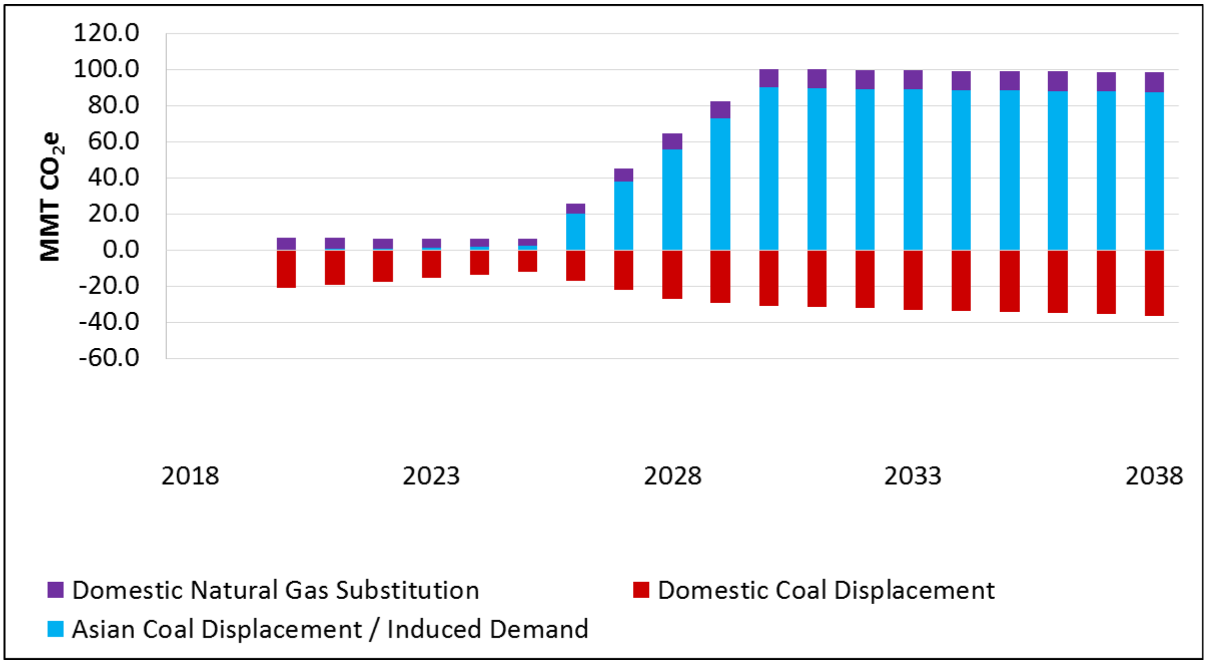
Cumulative Scenario

The Cumulative scenario includes other planned export coal terminals in the Pacific Northwest. Each terminal would operate at full capacity, for a total export tonnage of 201.3 million short tons, which includes both thermal and metallurgical coal. The emissions from the operation of the other coal export terminals are not included in the cumulative emissions analysis. Their impact is solely limited to their ability to influence coal supplies and prices. All other assumptions are the same as the Past Conditions (2014) scenario. The Cumulative scenario compares the no-action without the additional coal export terminals against the Proposed Action that includes the other coal export terminals.

Similar to the 2015 Energy Policy scenario, the Cumulative scenario displays some unique behavior relative to the Past Conditions (2014) scenario (Figure 12.). The operation of multiple coal export terminals drives down domestic coal consumption more than in any other scenario, which is only partially offset by increased natural gas consumption in the United States. Consequently, this scenario has even lower net domestic emissions than the Lower Bound scenario, despite an economic and policy context that resembles the Past Conditions (2014) scenario. However, Asian coal displacement from a large increase in induced demand outweighs any reduction in domestic emissions. In summary, the Cumulative scenario results in the following emissions conditions.

- Net emissions relative to the no-action are higher than the Past Conditions (2014) scenario (676.3 $MMTCO_2e$ versus -8.3 from 2018 to 2038).
- Induced demand is higher than the Past Conditions (2014) scenario due to the effects of all coal export terminals.
- Coal use in the United States declines more relative to the Past Conditions (2014) scenario because domestic prices are more sensitive to multiple coal export terminals.
- Natural gas substitution is *significantly* higher than in the Past Conditions (2014) scenario because domestic prices are more sensitive to coal price increases from the combined impact of multiple coal export terminals.

Figure 12. Cumulative Scenario—Net Annual Emissions, 2018–2038



Note: Net GHG emissions represent the difference between the Proposed Action and the no-action.

3.1.2 No-Action Alternative

Under the No-Action Alternative[35], the Applicant would not construct the coal export terminal and GHG emissions would not be affected by construction or operation. However, the Applicant has indicated that the operation of the current bulk product terminal would continue and increase on the project area. The Applicant would not construct Docks 2 and 3. Dock 1 would continue to be used for bulk cargo, primarily alumina, and might be used for general cargo.

Alternative uses of the project area would be expected to result in minimal increases in GHG emissions relative to current conditions in Cowlitz County. Under the No-Action Alternative, the Applicant anticipates importing from Asia up to 600,000 tons of calcined pet coke a year. This material would arrive by vessel and be stored in a building at the facility. Approximately 200,000 tons of coal tar pitch per year could also be imported by vessel, as well as an undetermined amount of cement. Future operations also result in two additional daily trains arriving and departing the facility with an average rail car length of 30 cars carrying bulk product. Each train is composed of two locomotives. In addition, an average of 26 Panamax-sized vessels arrive and depart each year, an increase of 20 vessels compared to the 6 vessels that currently arrive and depart. Truck haul emissions associated with the transport of coal to the nearby Weyerhaeuser facility are also included. Emissions from the consumption of electricity at the bulk product terminal would increase due to the planned terminal expansion; however, the extent of this increase is uncertain. The estimated emissions are shown in Table 54.

Table 54. No-Action Alternative Annual Average Emissions from Rail, Vessel and Haul Trucks Operating within Cowlitz County

Source	Maximum Annual Average Emissions ($MtCO_2e$)
Locomotive Combustion	593
Vessel Combustion	411
Haul Trucks	238
Total	**1,242**

The no-action in coal market assessment contains different boundaries than the emission sources above. While the no-action for the coal market assessment examines the implications of not building the coal export terminal, net emissions between a given coal market scenario and the no-action do not consider changes in emissions from emission sources described in Table 54. In particular, the coal market analysis no-action does not evaluate net impacts associated with existing vessel traffic and traffic.

3.2 Emissions in Context

To provide a frame of reference for these emissions estimates, the projected direct and total net emissions from the Proposed Action are compared to emissions from the transportation and coal combustion sectors in the United States as well as to GHG reduction targets from state and federal programs.

Across all scenarios, the total direct (construction, operation on site, transportation within Cowlitz County)[36] emissions associated with the Proposed Action are 573,516 $MtCO_2e$ from 2018 to 2038, with annual emissions of 38,477 $MtCO_2e$ occurring in 2028 when the coal export terminal reaches full export capacity (see Table 49). This is equivalent to adding 8,100 passenger cars on the road (U.S. Environmental Protection Agency 2015c). Washington State's total GHG emissions were 92.0 $MMTCO_2e$ in 2012, the most recent year for which a GHG inventory was published. Of that total, 42.5 $MMTCO_2e$ (46.2%) are attributable to the transportation sector and 12.1 $MMTCO_2e$ (13.2%) are attributable to coal combustion in the electricity sector (Washington State Department of Ecology, 2016). Based on 2012 emissions data, if the Proposed Action were operating today, direct annual emissions would amount to 38,477 $MtCO_2e$, or less than 0.05% of Washington State's total annual emissions.

In 2015, the EPA finalized state-specific targets to reduce CO_2 emissions in the power sector by 32% below 2005 levels by 2030. The statewide mass-based CO_2 performance goal for Washington state is approximately 10.74 million short tons (U.S. Environmental Protection Agency 2015d). The 2028 direct emissions for the Proposed Action would be approximately 0.3% of that total.

After factoring the indirect emissions, the net emissions from the Proposed Action in 2028 would range from an emissions reduction of 1.1 $MMTCO_2e$ to an emissions increase of 31.3 $MMTCO_2e$, with a net of 0.9 $MMTCO_2e$ emissions for the Past Conditions (2014) scenario (Table 53). Coal

[36] Direct emissions refer to GHG emissions from bulk terminal construction, operation, and transportation within Cowlitz County, including rail transport of coal in Cowlitz County, vehicle-crossing delay, bulk terminal construction, bulk terminal operation—equipment use, vessel idling and tugboat use at terminal, and vessel transport of coal in Cowlitz County.

combustion emissions in the United States were 1,658.1 $MMTCO_2$ in 2013, whereas the total transportation emissions in the United States were 1,718.4 $MMTCO_2$ (U.S. Environmental Protection Agency 2015a).

Washington State legislation, Revised Code of Washington (RCW) 70.235.050, Limiting Greenhouse Gas Emissions, requires annual GHG emissions to be reduced to 1990 levels (88.4 $MMTCO_2e$) by 2020. The Washington State goal represents an annual reduction of 3.3 MMTCO2e below the 2011 state emissions levels. The statewide emissions associated with the Proposed Action, approximately 0.4 $MMTCO_2e$ across the four scenarios, are about 12% of the emissions reduction goal.

The United States has committed to reduce its GHG emissions by approximately 17% from 2005 levels (7,350.2 $MMTCO_2e$) by 2020—a decrease of about 1,250 $MMTCO_2e$ (Executive Office of the President 2013). As part of the nonbinding climate policy agreement with China, the United States has set an emissions reduction target to reduce emissions 26 to 28% below 2005 emissions (6,428 MMTCO2e) by 2025 (White House Office of the Press Secretary 2014). This policy would therefore reduce annual emissions to a level of 4,628 to 4,757 MMTCO2e by 2025. The reduction in annual emissions would range from 1,035 to 1,163 $MMTCO_2e$ below 2013 annual emissions. If the target were reached through consistent annual reductions, the United States would have to reduce annual emissions by 86 to 97 $MMTCO_2e$ each consecutive year, beginning in 2014.

On the global scale, the International Energy Agency's 450 Scenario projects an energy pathway that is consistent with a 50% chance of meeting the goal of limiting the long-term increase in average global temperature to 2°C compared with preindustrial levels (International Energy Agency 2011). The 450 Scenario results in energy-related CO_2 emissions decreasing from 31.6 gigatons in 2012 to 25.4 gigatons in 2030.

3.3 Mitigation

Based on the findings in this technical report, the co-lead agencies (Cowlitz County and Washington State Department of Ecology) developed potential Applicant mitigation measures. The SEPA Draft EIS presents these mitigation measures.

Chapter 4
Supplementary Data

4.1 Interpolated Results from Coal Market Assessment

The coal market assessment evaluated changes in domestic and international coal demand for 2020, 2025, 2030, and 2040. For the GHG analysis, the years 2020, 2025, 2028, and 2038 are extracted from the full, interpolated time series and presented below. As mentioned in 2.2.2.2, *Method for Assembling an Emissions Time Series,* the coal market analysis values were adjusted to capture the gradual increase in coal exports from 2020 to 2025 (from zero to 25 million metric tons) and 2028 (full capacity of 44 million metric tons). This chapter presents the interpolated results based on the coal market assessment results. The following tables are presented.

- Table 55. Interpolated Coal Market Assessment Results, 2015 Energy Policy
- Table 56. Interpolated Coal Market Assessment Results, Lower Bound
- Table 57. Interpolated Coal Market Assessment Results, Upper Bound
- Table 58. Interpolated Coal Market Assessment Results, Past Conditions (2014)
- Table 59. Interpolated Coal Market Assessment Results, Cumulative

Table 55. Interpolated Coal Market Assessment Results, 2015 Energy Policy

	2020	2025	2028	2038
Coal Exported Through the Proposed Action (million metric tons)	0.0	25.0	44.0	44.0
Coal by Origin exported Through the Proposed Action (million metric tons)	0.0	0.0	0.0	0.0
Powder River Basin - Total	0.0	25.0	44.0	27.8
MT PRB	0.0	25.0	44.0	27.8
Powder River Basin WY 8400	0.0	0.0	0.0	0.0
Powder River Basin WY 8800	0.0	0.0	0.0	0.0
Uinta Basin - Total	0.0	0.0	0.0	16.2
Colorado	0.0	0.0	0.0	0.0
Utah	0.0	0.0	0.0	16.2
Total U.S. CO_2 Emissions - Coal (thousand metric tons)	**-1,141.4**	**-654.4**	**-266.2**	**316.9**
Total Pacific Basin CO_2 Emissions - Coal (thousand metric tons)	**0.0**	**1,315.1**	**2,039.8**	**359.8**
Asia - Other	0.0	0.0	-2.9	-1.0
Australia	0.0	0.0	0.0	0.0
China	0.0	4.4	3.1	0.0
Hong Kong	0.0	0.0	0.0	0.0
India	0.0	0.0	0.0	0.0
Indonesia	0.0	0.0	0.0	0.0
Japan	0.0	0.5	1.0	-1.0
Korea	0.0	0.1	0.1	-0.1
Taiwan	0.0	0.0	0.1	0.1
Total U.S. Natural Gas Consumption (TBtu)	**11.2**	**5.9**	**3.2**	**-3.0**
Total U.S. CO_2 emissions - Natural Gas (thousand metric tons)	**597.1**	**313.1**	**170.4**	**-156.7**
Pacific Basin Coal Exported by Vessel (non-project) by Destination (million Metric Ton-Miles)	0.0	-75,514.6	-165,711.7	-181,598.4
Asia - Other	0.0	0.0	-45,908.0	-15,302.7
Australia	0.0	0.0	0.0	0.0
China	0.0	0.0	0.0	0.0
Hong Kong	0.0	19.8	34.8	34.8
India	0.0	0.0	0.0	0.0
Indonesia	0.0	0.0	0.0	0.0
Japan	0.0	-75,737.0	-120,195.2	-161,477.1
Korea	0.0	131.5	231.4	-5,179.0
Taiwan	0.0	71.2	125.2	325.6

Table 56. Interpolated Coal Market Assessment Results, Lower Bound

	2020	2025	2028	2038
Coal exported through the Proposed Action (million metric tons)	0.0	25.0	44.0	44.0
Coal by Origin (million metric tons)	0.0	0.0	0.0	0.0
Powder River Basin - Total	0.0	25.0	44.0	35.0
MT PRB	0.0	25.0	44.0	35.0
Powder River Basin WY 8400	0.0	0.0	0.0	0.0
Powder River Basin WY 8800	0.0	0.0	0.0	0.0
Uinta Basin - Total	0.0	0.0	0.0	9.0
Colorado	0.0	0.0	0.0	0.0
Utah	0.0	0.0	0.0	9.0
Net Total U.S. CO_2 Emissions - Coal (thousand metric tons CO_2)	**-2,155.8**	**-2,934.5**	**-4,675.5**	**-3,248.9**
Net Total Pacific Basin CO_2 Emissions - Coal (thousand metric tons)	**0.0**	**1,203.2**	**1,072.1**	**608.5**
Asia - Other	0.0	0.0	0.0	0.0
Australia	0.0	0.0	0.0	0.0
China	0.0	6.4	4.5	0.0
Hong Kong	0.0	0.0	-0.2	-0.1
India	0.0	0.0	0.0	0.0
Indonesia	0.0	0.0	0.0	0.0
Japan	0.0	0.5	0.9	-3.1
Korea	0.0	0.0	-0.9	-2.6
Taiwan	0.0	0.0	0.0	0.0
Total U.S. Natural Gas Consumption (TBtu)	**15.0**	**15.1**	**16.0**	**11.8**
Total U.S. CO_2 Emissions - Natural gas (thousand metric tons)	**795.4**	**802.6**	**850.6**	**625.9**
Pacific Basin Coal Exported by Vessel (non-project) by Destination (million metric ton-miles)	0.0	-61,478.1	-129,664.0	-272,009.7
Asia - Other	0.0	0.0	0.0	0.0
Australia	0.0	0.0	0.0	0.0
China	0.0	0.0	0.0	0.0
Hong Kong	0.0	0.0	-3,674.4	-1,224.8
India	0.0	0.0	0.0	0.0
Indonesia	0.0	0.0	0.0	0.0
Japan	0.0	-61,478.1	-108,201.5	-202,060.9
Korea	0.0	0.0	-17,788.0	-68,724.0
Taiwan	0.0	0.0	0.0	0.0

Table 57. Interpolated Coal Market Assessment Results, Upper Bound

	2020	2025	2028	2038
Coal Exported Through the Proposed Action (million metric tons)	0.0	25.0	44.0	44.0
Coal by Origin Exported Through the Proposed Action (million metric tons)	0.0	0.0	0.0	0.0
Powder River Basin - Total	0.0	11.8	26.9	33.0
MT PRB	0.0	11.8	26.9	33.0
Powder River Basin WY 8400	0.0	0.0	0.0	0.0
Powder River Basin WY 8800	0.0	0.0	0.0	0.0
Uinta Basin - Total	0.0	13.2	17.1	11.0
Colorado	0.0	0.0	0.0	0.3
Utah	0.0	13.2	17.1	10.6
Net Total U.S. CO_2 Emissions - Coal (thousand metric tons CO_2)	**-8,222.8**	**-5,519.4**	**-10,065.9**	**-10,042.3**
Net Total Pacific Basin CO_2 Emissions - Coal (thousand metric tons)	**0.0**	**21,245.4**	**37,113.8**	**38,023.8**
Asia - Other	0.0	0.0	0.0	0.0
Australia	0.0	0.0	0.0	0.0
China	0.0	0.9	-1.5	-0.2
Hong Kong	0.0	0.1	0.2	0.2
India	0.0	8.1	13.2	15.8
Indonesia	0.0	0.0	0.0	0.0
Japan	0.0	1.4	1.5	2.7
Korea	0.0	0.6	1.6	2.5
Taiwan	0.0	0.5	0.9	1.0
Total U.S. Natural Gas Consumption (TBtu)	**43.3**	**22.5**	**33.5**	**48.8**
Total U.S. CO_2 Emissions - Natural Gas (thousand metric tons)	**2,296.9**	**1,194.3**	**1,781.1**	**2,592.2**
Pacific Basin Coal Exported by Vessel (non-project) by Destination (million metric ton-miles)	0.0	-34,785.9	-38,610.2	-49,520.2
Asia - Other	0.0	0.0	0.0	0.0
Australia	0.0	0.0	0.0	0.0
China	0.0	0.0	-5,443.7	-43,002.3
Hong Kong	0.0	203.6	358.3	724.2
India	0.0	25,027.2	64,246.5	15,542.4
Indonesia	0.0	0.0	0.0	0.0
Japan	0.0	-62,223.1	-101,408.3	-24,198.5
Korea	0.0	1,452.8	719.5	-2,564.4
Taiwan	0.0	753.5	2,917.6	3,978.4

Table 58. Interpolated Coal Market Assessment Results, Past Conditions (2014)

	2020	2025	2028	2038
Coal Exported Through the Proposed Action (million metric tons)	0	25.0	44.0	44.0
Coal by Origin (million metric tons)	0	0.0	0.0	0.0
Powder River Basin - Total	0	25.0	44.0	32.1
MT PRB	0	25.0	44.0	32.1
Powder River Basin WY 8400	0	0.0	0.0	0.0
Powder River Basin WY 8800	0	0.0	0.0	0.0
Uinta Basin - Total	0	0.0	0.0	11.9
Colorado	0	0.0	0.0	0.0
Utah	0	0.0	0.0	11.9
Net Total U.S. CO_2 Emissions - Coal (thousand metric tons CO_2)	**-3,454.4**	**-3,539.4**	**-5,385.6**	**-8,390.4**
Net Total Pacific Basin CO_2 Emissions - Coal (thousand metric tons)	**0.0**	**1,418.8**	**3,434.4**	**1,856.1**
Asia - Other	0.0	0.0	0.0	0.0
Australia	0.0	0.0	0.0	0.0
China	0.0	1.3	3.6	0.9
Hong Kong	0.0	0.0	0.0	0.0
India	0.0	0.0	0.0	-1.0
Indonesia	0.0	0.0	0.0	0.0
Japan	0.0	0.6	1.3	-0.9
Korea	0.0	0.1	0.2	0.2
Taiwan	0.0	0.1	0.2	0.2
Total U.S. Natural Gas Consumption (TBtu)	**11.9**	**17.1**	**23.1**	**45.3**
Total U.S. CO_2 Emissions - Natural Gas (thousand metric tons)	**630.2**	**906.4**	**1,225.3**	**2,404.5**
Pacific Basin Coal Exported by Vessel (non-project) by Destination (million metric ton-miles)	0.0	-74,888.8	-128,362.7	-174,822.3
Asia - Other	0.0	0.0	0.0	0.0
Australia	0.0	0.0	0.0	0.0
China	0.0	0.0	0.0	0.0
Hong Kong	0.0	46.2	81.3	164.4
India	0.0	0.0	0.0	0.0
Indonesia	0.0	0.0	0.0	0.0
Japan	0.0	-75,435.1	-129,415.7	-176,838.8
Korea	0.0	329.8	580.4	1,042.2
Taiwan	0.0	170.3	391.3	809.9

Table 59. Interpolated Coal Market Assessment Results, Cumulative

	2020	2025	2028	2038
Coal Exported Through the Proposed Action (million metric tons)	0.0	25.0	44.0	44.0
Coal by Origin exported Through the Proposed Action (million metric tons)	0.0	0.0	0.0	0.0
Powder River Basin - Total	0.0	25.0	42.6	28.1
MT PRB	0.0	25.0	42.6	28.1
Powder River Basin WY 8400	0.0	0.0	0.0	0.0
Powder River Basin WY 8800	0.0	0.0	0.0	0.0
Uinta Basin - Total	0.0	0.0	1.4	15.9
Colorado	0.0	0.0	0.0	0.0
Utah	0.0	0.0	1.4	15.9
Net Total U.S. CO_2 Emissions - Coal (thousand metric ton CO_2)	**-20,880.3**	**-12,240.5**	**-27,234.2**	**-36,326.1**
Net Total Pacific Basin CO_2 Emissions - coal (thousand metric tons)	**51.5**	**2,267.9**	**55,510.8**	**87,508.1**
Asia – Other	0.0	0.0	-1.3	-3.9
Australia	0.0	0.0	0.0	0.0
China	0.3	3.0	5.0	0.9
Hong Kong	0.0	0.0	0.1	-0.7
India	0.0	0.0	28.9	48.2
Indonesia	0.0	0.0	0.0	0.0
Japan	0.0	0.7	2.5	0.8
Korea	0.0	0.3	2.0	-1.9
Taiwan	0.0	0.2	-2.4	-3.1
Total U.S. Natural Gas Consumption (TBtu)	**126.4**	**71.0**	**168.1**	**202.1**
Total U.S. CO_2 emissions - Natural gas (thousand metric tons)	**6,711.5**	**3,769.2**	**8,926.0**	**10,731.9**
Pacific Basin Coal Exported by Vessel (non-project) by Destination (million metric ton-miles)	1,998.4	-60,582.8	-65,178.0	-260,674.3
Asia – Other	0.0	0.0	-21,176.5	-62,107.2
Australia	0.0	0.0	0.0	0.0
China	0.0	0.0	-11,605.3	-3,868.4
Hong Kong	0.0	67.1	176.4	-13,390.3
India	0.0	0.0	0.0	0.0
Indonesia	0.0	0.0	0.0	0.0
Japan	1,998.4	-46,156.0	-4,739.3	-66,240.4
Korea	0.0	-14,741.4	-16,310.3	-119,896.4
Taiwan	0.0	247.4	-11,522.9	4,828.5

4.2 Evaluation of Coal Extraction Studies

The GHG emissions from induced coal extraction in the Powder River Basin and the Uinta Basin because of the Proposed Action are not included in the GHG analysis. This exclusion assumes that any future coal mine leases would require separate GHG analyses as part of the NEPA process for new coal mine leases. This section identifies EISs and lease applications that mention GHG emissions for coal mines relevant to the Proposed Action. The scopes of these EISs and lease applications for coal mines in the Powder River Basin and Uinta Basins are compared to the scope of this GHG analysis (Table 60). This table demonstrates that the emissions from mining associated with the Proposed Action are accounted for in separate analyses. As indicated, several EISs address GHGs from coal extraction, coal processing, rail transport, and operations of the coal mine.

Table 60. Comparison of Coal Mine Environmental Impact Statements and Lease Applications to Scope of This GHG Analysis

Mine	Extraction	Processing	Rail Transport to/from Project Area	Rail Transport within Project Area	Infrastructure Operation—Electricity Use
Quantitative Analysis					
West Antelope II Coal Lease Application EIS	✓	✓	✓	✓	✓
West Hay Creek EIS	✓	✓			
South Gillette Area Coal Lease Application EIS	✓	✓			✓
Spring Creek Coal Mine EIS	✓	✓	✓		✓
Wright Area Coal Lease Application EIS	✓	✓			✓
Qualitative Analysis					
Maysdorf Coal Lease Application EIS	✓	✓			
North Jacobs Ranch EIS	✓	✓			

Chapter 5
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