Chapter 5
Greenhouse Gases and Climate Change

5.1 Introduction

This chapter describes the direct greenhouse gas (GHG) emissions that would result from construction and operation of each of the build alternatives, as well as the cumulative and indirect GHG emissions from proposed and induced mines, transportation of the coal, and combustion of the coal in power plants. This chapter also describes the impacts of GHGs on climate change. The sections that follow describe the GHG and climate change study area, the methods used to analyze the impacts, and the impacts of the build alternatives on each of the following topics.

- Section 5.2, Greenhouse Gases
- Section 5.3, Climate Change

The regulations and guidance related to GHGs and climate change are summarized in Section 5.4, *Applicable Regulations*. Appendix F, *Life-Cycle Greenhouse Gas Emissions*, provides further detail on the life-cycle assessment methods and metrics. Appendix C, *Coal Production and Markets*, addresses the impacts of construction and operation of the proposed rail line on coal production, transportation, and combustion. The contribution of the proposed rail line to cumulative impacts on greenhouse gas emissions and climate change is discussed in Chapter 18, *Cumulative Impacts*.

5.2 Greenhouse Gases

This section describes the *greenhouse gas*[1] (GHG) emissions that would result from construction and operation of each of the build alternatives. OEA analyzed GHG emissions from construction and operation of the proposed rail line, downline transportation and shipping related to the proposed rail line, cumulative projects including potential mines in the project area, and combustion of coal in power plants. The potential mines in the project area are the currently proposed Otter Creek Mine and the Poker Jim Creek–O'Dell Creek and Canyon Creek Mines that could be induced by the proposed rail line (hereafter referred to as the *proposed and potentially induced mines*). Coal produced from these mines is referred to as *Tongue River coal*.

The subsections that follow describe the study area for the GHG analysis, methods used to analyze the impacts, affected environment, impacts, conclusions of this analysis, and mitigation measures. Section 5.4, *Applicable Regulations*, describes the regulations and policies relevant to GHG emissions. Appendix F, *Life-Cycle Greenhouse Gas Emissions*, provides detail on the assessment methods and metrics for this section. Appendix C, *Coal Production and Markets*, addresses the impacts of the proposed rail line on coal production, transportation, and combustion. Chapter 18, *Cumulative Impacts*, and Appendix U, *Cumulative Impacts*, provide more information on the cumulative impact analysis. Chapter 17, *Downline Impacts*, provides more information on the downline segments.

In summary, GHG emissions from construction and operation of the proposed rail line can be characterized as follows.

- Direct emissions from construction and operation of the proposed rail line—considering just the GHGs emitted from railroad fossil fuel, combustion-related construction, and operation of the proposed rail line in the project area—would range from 80,000 to 185,000 metric tons of carbon dioxide equivalent ($MTCO_2e$) per year, or 1.6 to 3.7 million metric tons of carbon dioxide equivalent ($MMTCO_2e$) accumulated between 2018 to 2037.
- The life-cycle GHG emissions from Tongue River coal would be comparable to such emissions from other competing coals. Across all coals, life-cycle GHG emissions are dominated by emissions from coal combustion.
- The northern alternatives, high coal production, high terminal capacity growth scenario would result in the highest net life-cycle GHG emissions.[2,3] The northern alternatives,

[1] Terms italicized at first use are defined in Chapter 25, *Glossary*.

[2] The Tongue River Alternatives, Colstrip Alternatives, Tongue River Road Alternatives, and Moon Creek Alternatives are referred to collectively as the *northern alternatives*. The Decker Alternatives are referred to as the *southern alternatives*.

[3] OEA modeled 21 scenarios across four analysis years (2018, 2023, 2030, and 2037) based on three sets of variables: a northern alternative or southern alternative, three levels of coal production capacity (low, medium, and high), and three levels of coal export capacity in the Pacific Northwest (zero, medium, and high). Appendix C, *Coal Production and Markets*, discusses this

low coal production, zero terminal capacity growth scenario would result in the lowest GHG emissions.

- Accumulated net GHG emissions (2018 to 2037) for all build alternatives would range from a reduction of roughly 1.7 $MMTCO_2e$ to an increase of 81 $MMTCO_2e$. The net GHG emissions estimates take into account coal and natural gas displaced by Tongue River coal.

The following statements put these results in context.

- Direct GHG emissions from the proposed rail line would be equivalent to the annual GHG emissions from approximately 16,800 to 39,000 passenger vehicles.
- The reduction of 1.7 MMTCO2e would be equivalent to taking approximately 17,600 passenger vehicles off the road for 20 years. The increase of 81 MMTCO2e would be equivalent to adding 855,000 vehicles on the road (i.e., 0.8 percent of the U.S. light-duty vehicle fleet in 2012) for 20 years.
- The high end of the average annual net life-cycle GHG emissions would be equivalent to 0.3 percent of the United States' emissions reduction target in 2020 (i.e., the target is to achieve approximately a 17 percent reduction in national emissions by 2020 compared to emission levels in 2005). The high end of the direct GHG emissions would be equivalent to just over 0.01 percent of this target.
- As another comparison, the high end of OEA's average annual net life-cycle GHG emissions estimate would be equivalent to 0.6 percent of the emissions reduction target for the U.S. Environmental Protection Agency's (USEPA) Clean Power Plan in 2030 (i.e., the target is to achieve a 30 percent reduction in power sector GHG emissions compared to emission levels in 2005). The high end of the direct emissions target would be equivalent to just over 0.02 percent of this target.

OEA concludes that direct GHG emissions from the proposed rail line would be negligible. OEA concludes that impacts from the net annual life-cycle emissions would range from a negligible positive impact to a minor adverse impact.

5.2.1 Study Area

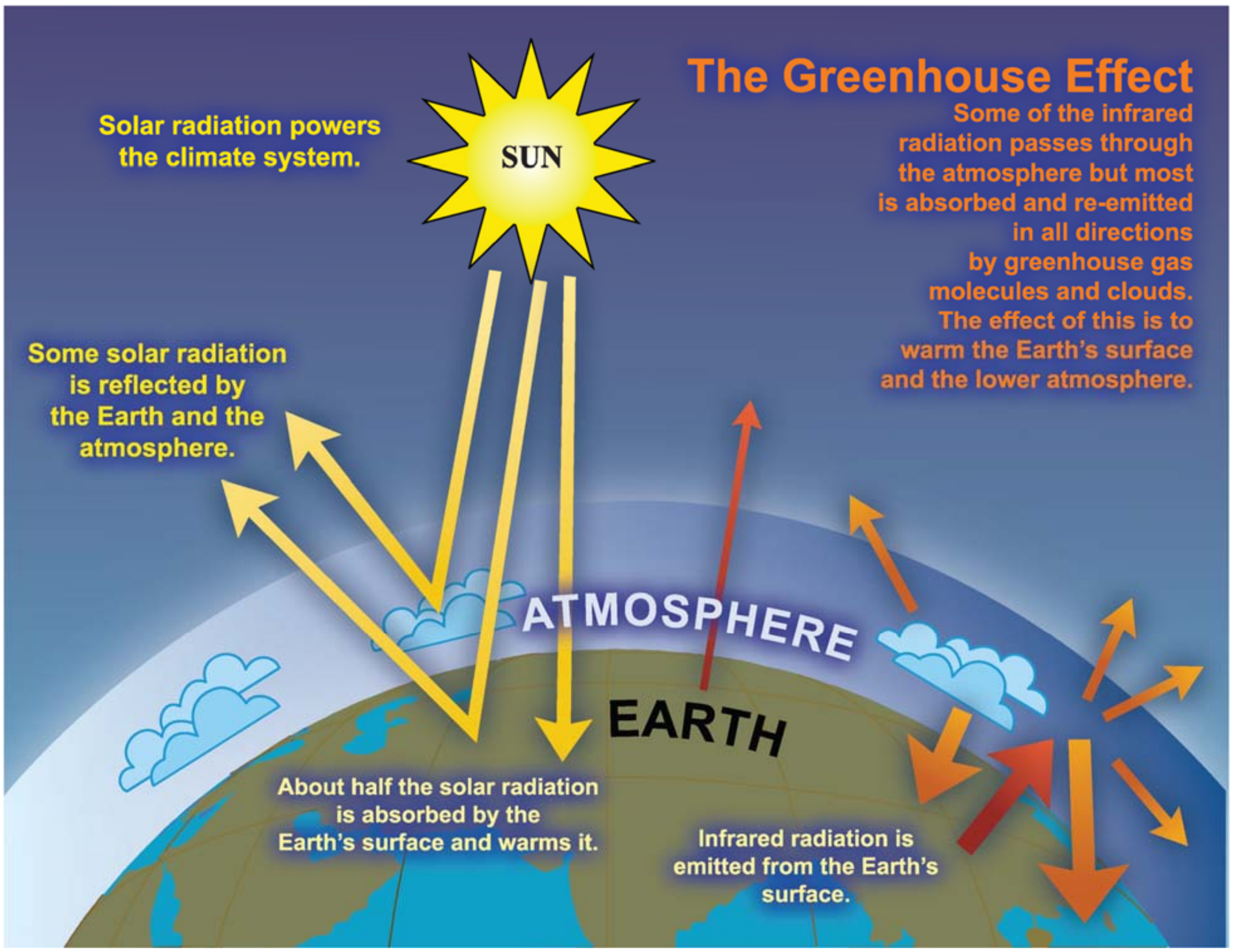
GHG emissions have a uniform impact on global warming regardless of where emissions occur. OEA defined the study area for the life-cycle GHG emissions analysis as the area that includes the emissions released from sources attributable to the proposed rail line, proposed and potentially induced coal mines, domestic and overseas transportation of Tongue River coal, and power plants that would combust the Tongue River coal.

analysis in further detail. Explanation of the scenarios as they are applied to the GHG analysis is provided in Section 5.2.2, *Analysis Methods*.

5.2.1.1 The Greenhouse Effect

The *greenhouse effect* is the process by which Earth regulates atmospheric temperature by absorbing outgoing energy and trapping it in the atmosphere, thus keeping the heat within the atmosphere and maintaining temperatures at habitable levels. Earth maintains atmospheric conditions necessary for sustaining life—temperature, composition, and air pressure—through a variety of physical mechanisms. Temperature is regulated through Earth's natural greenhouse effect. Incoming energy, in the form of solar radiation, is either immediately reflected or absorbed by Earth's surface, or to a lesser extent, its atmosphere. Likewise, Earth also radiates its own heat and energy outward into space. Figure 5.2-1 provides an overview of the greenhouse effect.

Figure 5.2-1. The Greenhouse Effect



Source: Intergovernmental Panel on Climate Change 2007

The composition of gases within Earth's atmosphere is directly responsible for the degree to which heat is absorbed and then trapped in the atmosphere. Naturally occurring gases—carbon dioxide (CO_2), methane, and nitrous oxide (N_2O)—and manufactured industrial pollutants are all GHGs and can contribute to the greenhouse gas effect. These gases are characterized according to their *global-warming potential,* a relative measure of how effective a given gas is at trapping heat. Furthermore, some gases reside longer in the atmosphere before breaking down. This metric is commonly normalized in terms of carbon dioxide equivalent (CO_2e) and then given a time horizon. For example, 1 unit of CO_2 has a 100-year global-warming potential of 1, whereas, an equivalent amount of methane has a 100-year global-warming potential of 25 (Intergovernmental Panel on Climate Change 2007).

As global atmospheric concentrations of GHGs have increased since the Industrial Revolution, Earth's atmosphere has not proportionally increased its ability to break down GHGs through natural processes. In effect, additional GHGs accumulate and increase the amount of heat trapped in the atmosphere. Since 1900, the global average temperature has risen by approximately 1.5 degrees Fahrenheit (°F) (U.S. Global Change Research Program 2009). Furthermore, the increase in global average temperatures throughout the 21st Century is expected to occur at an increased rate—estimated between 2°F and 11.5°F by 2100 (U.S. Global Change Research Program 2009).

Increases in global surface temperatures can cause changes in the atmosphere, which can reverberate through Earth's climate system. These changes then lead to tangible consequences, such as higher sea levels, changes in precipitation, and shifts in weather patterns, including a higher incidence of extreme weather events.

5.2.1.2 The Coal Life Cycle

The *coal life cycle* includes coal mine construction, coal extraction, coal transportation to domestic power plants or export terminals, coal transportation overseas, and construction of infrastructure required to extract, transport, and burn coal.

GHG emissions occur at each stage of the coal life cycle. Combustion of the coal itself accounts for the vast majority of life-cycle GHG emissions. Other major sources of GHG emissions include combustion of fossil fuels for transportation, construction, and mining vehicles and equipment, as well as methane emitted from coal mines. OEA determined that several sources of life-cycle GHG emissions were negligible for the build alternatives, including decommissioning mines and constructing or decommissioning power plants, as described in Appendix F, *Life-Cycle Greenhouse Gas Emissions*. For example, the build alternatives would not induce new power plant construction.

Life-cycle GHG emissions associated with the build alternatives would contribute to cumulative global life-cycle GHG emissions together with those of other past, present, and reasonably foreseeable future actions. Life-cycle GHG emissions differ from other environmental impacts in that they would contribute to global climate change regardless of the emissions source or geographic location where they are emitted.

5.2.2 Analysis Methods

In its revised *Draft Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in NEPA Reviews* (Council on Environmental Quality 2014), the Council on Environmental Quality (CEQ) states that "emissions from activities that have a reasonably close causal relationship to the Federal action, such as those that may occur as a predicate for the agency action (often referred to as upstream emissions) and as a consequence of the agency action (often referred to as downstream emissions) should be accounted for in the NEPA analysis (40 CFR § 1508.8)." [4]

For consistency with CEQ's draft guidance, OEA used a *life-cycle assessment* (LCA) approach to evaluate the GHG emissions of proposed rail line construction and operation, downline rail traffic and shipping, cumulative projects including proposed and potentially induced mines, and coal combustion. An LCA provides a comprehensive perspective on emissions—production, use, and disposal. A life-cycle perspective is also appropriate for a cumulative impacts analysis of GHG emissions, which have the same effect on climate change regardless of where they are emitted.

OEA's LCA involved the following components.

- OEA determined the life-cycle GHG emissions from Tongue River coal that would be transported by the proposed rail line to market. The methods OEA used are described in Section 5.2.2.1, *Method for Impact Analysis*.
- OEA determined the changes in the life-cycle GHG emissions of competing coal and natural gas that would be displaced by the supply of Tongue River coal attributed to the proposed rail line. The methods OEA used are described in Section 5.2.2.2, *Method for Competing Coal Analysis*.
- OEA evaluated net accumulated life-cycle GHG emissions. Net accumulated emissions were calculated as the sum of life-cycle GHG emissions from Tongue River coal production and reductions in GHG emissions from the displacement of other competing coal and natural gas over the 20-year study period (2018 to 2037). The methods OEA used are described in Section 5.2.2.3, *Method for Net Accumulated Greenhouse Gas Emissions*.

OEA based its life-cycle analysis on the coal market analysis presented in Appendix C, *Coal Production and Markets*. The coal market analysis uses low, medium, and high coal production scenarios as well as zero, medium, and high terminal capacity growth scenarios (collectively referred to as the six production and export scenarios). OEA did not evaluate life-cycle emissions for all of the scenarios from the market analysis, but instead selected a

[4] Revised in 2014, CEQ's Draft Guidance contains guidelines on how federal agencies can improve their consideration of GHG emissions and climate change effects during the evaluation of proposals for federal actions subject to NEPA review. In particular, the guidance focuses on GHG emissions resulting from proposed projects and their alternatives, as well as on how climate change will affect a given project and its alternatives. The revised draft guidance suggests an annual emissions threshold level of 25,000 $MTCO_2e$ or more for a proposed action, as an indicator for agencies to consider a quantitative assessment of the associated impacts.

subset of six scenarios that represent the range of coal production scenarios and export terminal growth used in the market analysis. These scenarios differ for the southern and northern alternatives and are identified in Table 5.2-1.

Table 5.2-1. Scenarios for Estimating Rail Operation and Coal Export Emissions

Scenario Description	Scenario Number[a]
Northern Alternatives[b]	
Low coal production, zero terminal capacity growth	3
Medium coal production, medium terminal capacity growth	7
High coal production, high terminal capacity growth	11
Southern Alternatives[b]	
Low coal production, zero terminal capacity growth	12
Medium coal production, medium terminal capacity growth	16
High coal production, high terminal capacity growth	20

Notes:
[a] Scenario numbers are assigned in Appendix C, *Coal Production and Markets*
[b] The northern alternatives are the Tongue River Alternatives, Colstrip Alternatives, Tongue River Road Alternatives, and Moon Creek Alternatives. The southern alternatives are the Decker Alternatives.

OEA evaluated six primary gases: CO_2, N_2O, methane, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.[5] GHG emissions from these gases were evaluated as $MTCO_2e$ using 100-year global-warming potentials. OEA evaluated the release of stored GHGs as a result of destruction of natural GHG sinks in vegetation and disturbed soils from construction of the right-of-way and proposed and potentially induced coal surface mines and future sequestration from reclamation.

5.2.2.1 Method for Impact Analysis

OEA categorized the LCA into five stages: proposed rail line construction, proposed rail line operation, downline rail traffic and shipping, cumulative impacts of proposed and potentially induced mines, and coal combustion. The analysis methods for these stages are described in the subsections that follow and further details are provided in Appendix F, *Life-Cycle Greenhouse Gas Emissions*.

Construction

OEA estimated the GHG emissions from construction of the proposed rail line by calculating the GHG emissions from construction materials and equipment based on the lengths and earthwork volumes of each build alternative. OEA used emissions factors derived from the USEPA nonroad engines, equipment, and vehicles (NONROAD) 2008 model[6] (U.S.

[5] Hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride are emitted primarily through industrial processes such as aluminum production, semiconductor manufacturing, and from refrigeration and in electrical transmission equipment (U.S. Environmental Protection Agency 2014). They are potent GHGs but form a minor component of emissions from processes in the life cycle, which are dominated by gases associated with fossil fuel combustion (CO_2, N_2O, and CH_4).

[6] The NONROAD2008 model is used for estimating air pollution emissions from nonroad vehicles (e.g., construction equipment) by professional mobile source modelers, such as state air quality officials and consultants.

Environmental Protection Agency 2008) and Motor Vehicle Emissions Simulator (MOVES) model[7] (U.S. Environmental Protection Agency 2010) to estimate emissions from construction equipment and motor vehicles, respectively. For purposes of this analysis, OEA included the GHG emissions associated with manufacturing the steel for the tracks, concrete, and gravel for the ballast.

Operation

OEA estimated the GHG emissions associated with operation of the proposed rail line in the project area (i.e., before the proposed rail line would join the main line at a junction specific to each build alternative) based on rail traffic estimates for each of the six production and export scenarios (Appendix C, *Coal Production and Markets*). OEA estimated fuel consumption by calculating the total round trip ton-miles traveled by each build alternative. To estimate total GHG emissions, OEA multiplied the total increase in fuel consumption by an emissions factor for rail diesel locomotives (U.S. Environmental Protection Agency 2013).

Downline Rail Traffic and Shipping to International Markets

OEA estimated the GHG emissions associated with downline operation of the proposed rail line based on rail traffic estimates for each of the six production and export scenarios (Appendix C, *Coal Production and Markets*). Construction and operation of the proposed rail line would affect up to 53 rail segments downline from the project area. Across each segment, OEA determined the net increase in rail traffic for each build alternative and estimated fuel consumption by calculating the total additional round trip ton-miles traveled by coal trains. To estimate downline GHG emissions for each build alternative, OEA multiplied the total increase in fuel consumption by an emissions factor for rail diesel locomotives (U.S. Environmental Protection Agency 2013).

For scenarios in which Tongue River coal would be exported to Asia, the market analysis found that changes in international coal production would only occur in the Pacific Basin, due to changes in coal types exported out of the Pacific Northwest to the Pacific Basin, and from Colombia to the United States. All other coal production remained the same between the proposed and no-action scenarios.

OEA estimated GHG emissions from ocean transport by estimating the net change in ton-kilometer coal shipments and multiplying this by an ocean transport emission factor (Ecoinvent Centre 2007) to calculate the net change in shipments. OEA selected Japan to illustrate the total transportation costs, because it has historically imported more coal than any other Pacific Basin country and is one possible destination for Powder River Basin coal exports. Powder River Basin coal exports to other countries, such as China, South Korea, or Taiwan, would be similar, except that the shipping distances would be longer by 130 to

[7] The Motor Vehicle Emission Simulator (MOVES) modeling system estimates emissions for mobile sources covering a broad range of air pollutants.

1,500 miles. Under any build alternative, Tongue River coal exports would displace other U.S. coal exports relative to the No-Action Alternative on a tonnage basis. The differences in energy content between Tongue River coal and other competing U.S. coal would result in a net impact on emissions. OEA estimated the downline and export emissions for Tongue River coal based on the six production and export scenarios (Appendix C, *Coal Production and Markets*).

Cumulative Impacts of Proposed and Potentially Induced Mines

OEA estimated the GHG emissions associated with construction and operation of proposed and potentially induced mines based on annual production under the six production and export scenarios (2018 to 2037). OEA used estimates of energy requirements and direct GHG emissions for mine construction and operation from relevant literature sources. Sources of GHG emissions include energy used for mine construction and coal extraction, upstream emissions from the production of coal mine construction and operation equipment and materials, upstream emissions from the production of energy used in coal mine construction and operation, and direct methane emissions from the mine face. OEA assumed that all coal would be most efficiently extracted through surface mining. As described in Appendix C, *Coal Production and Markets*, Powder River Basin coal is almost entirely produced with surface mining technology; there is only one underground mine in the basin and additional underground mining is considered unlikely.

To determine the incremental change in mining emissions from the proposed and potentially induced mines, OEA compared the coal mining emissions estimates for Tongue River coal to the decrease in mining GHG emissions from competing coal, calculated as described above.

Coal Combustion

Two components of OEA's estimates of the change in GHG emissions from fuel combustion are associated with the build alternatives: the change in international coal combustion and the change in domestic natural gas combustion. OEA assessed the change in coal combustion for the build alternatives relative to the No-Action Alternative. OEA estimated aggregate coal production (2018 to 2037) for four regions: Tongue River coal, other Powder River Basin coal, other U.S. coal, and international coal (Appendix C, *Coal Production and Markets*). OEA applied coal basin-specific heat-content factors and coal-rank-specific carbon-content-factors to the change in coal tonnages to calculate the average annual change in CO_2 emissions from coal combustion for coal from each of the three regional categories across each build alternative.

Similar to the approach for coal, OEA assessed changes in natural gas combustion for the build alternatives relative to the No-Action Alternative. OEA applied heat content and carbon content factors to the change in natural gas combustion to estimate the average annual change in CO_2 emissions from natural gas combustion for each build alternative. Lastly, OEA applied precombustion GHG emissions factors to estimate the emissions resulting from upstream extraction, production, and processing of natural gas prior to combustion.

5.2.2.2 Method for Competing Coal Analysis

The market analysis (Appendix C, Coal Production and Markets) indicates that under most scenarios most Tongue River coal would be distributed to the Upper Midwest, where it would displace coal from other U.S. mines. Historically, Powder River Basin coal displaces eastern bituminous coal in the domestic market (Appendix C, Chapter 2, *Historical Powder River Basin Production and Markets*). If the proposed rail line is constructed, Tongue River coal would largely displace other Powder River Basin coal. Under the scenarios involving expansion of Pacific Northwest export terminal capacity (i.e., medium and high terminal capacity growth scenarios), Powder River Basin coal could also be exported to international markets. Internationally, Tongue River coal is likely to displace Australian, Indonesian, and/or Chinese coal in key Asian markets, including Japan, China, and South Korea.

To determine life-cycle GHG emissions of competing coal, OEA relied on a comprehensive survey of 270 references, which standardized common assumptions across studies. OEA then compared the results from 53 studies to produce a range of life-cycle GHG emissions varying by coal combustion technology type (Whitaker et al. 2012). OEA used the results from Whitaker et al. (2012) to analyze the emissions profile of different coals, expressed as GHG emissions per kilowatt hour of electricity produced from the coal. This allowed OEA to compare different coal on a common basis. OEA also estimated competing coal mining emissions from the Whitaker et al. (2012) survey.

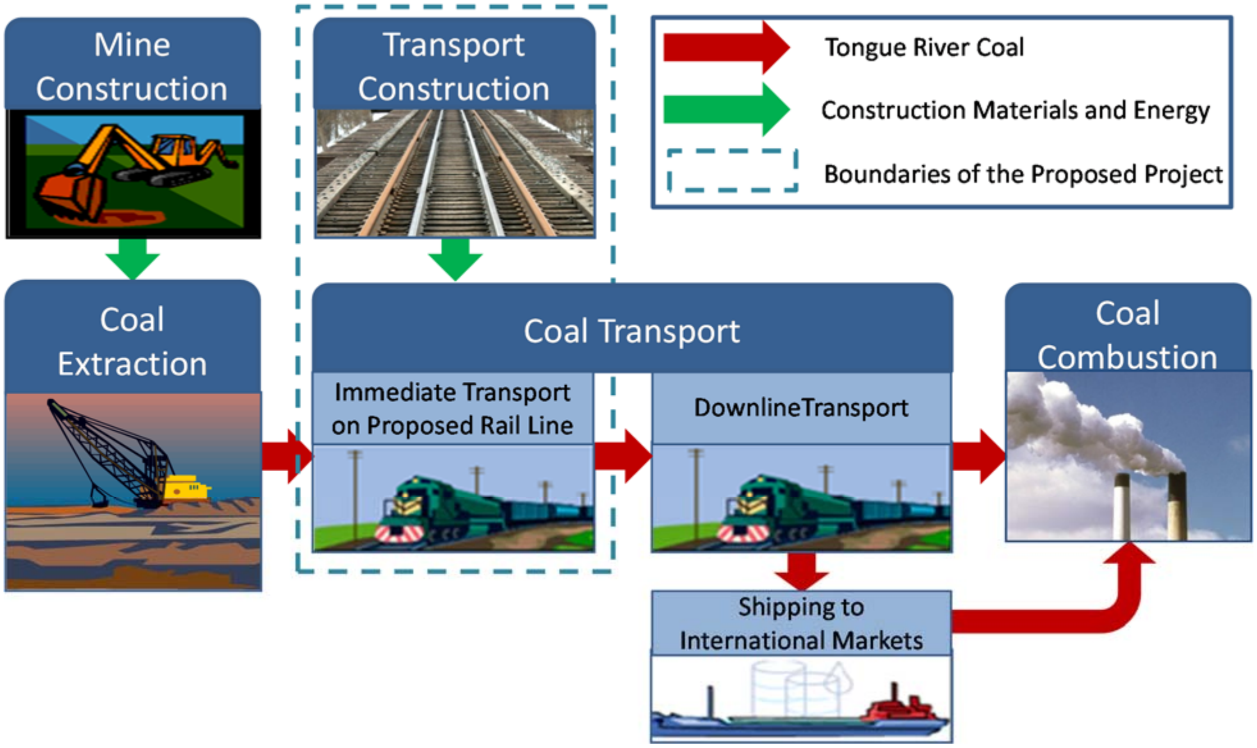
5.2.2.3 Method for Net Accumulated Greenhouse Gas Emissions

To calculate the net accumulated life-cycle GHG emissions related to construction and operation of the build alternatives (2018 to 2037), OEA compared life-cycle GHG emissions for Tongue River coal in each of the six scenarios in Table 5.2-1 to GHG emissions from competing coals in the No-Action Alternative. For this result, OEA applied the GHG emission estimates from the impact analysis and the competing coal analysis to the changes in coal production, rail traffic, and coal combustion from the market analysis in Appendix C, *Coal Production and Markets*.

5.2.3 Affected Environment

The boundaries of the direct emissions from construction and operation of the proposed rail line, relative to the broader life cycle, are indicated by a dashed box in Figure 5.2-2. In other words, direct GHG emissions from other sources would result from rail line construction and operation in the project area. Indirect and cumulative emissions would result from downline rail traffic and shipping, proposed and potentially induced mines, and coal combustion. This figure does not account for sources of GHG emissions estimated to be negligible by OEA and does not show the life cycle of natural gas production and consumption that may be affected by the proposed rail line.

Figure 5.2-2. Life Cycle for Direct, Indirect, and Cumulative Emissions



5.2.4 Environmental Consequences

Impacts on life-cycle GHG emissions would result from construction and operation of any build alternative. These impacts include the direct impacts from construction and operation, as well as indirect and cumulative impacts of the proposed rail line. These impacts are best understood in the context of the global coal market and the GHG impacts of competing coal.

Section 5.2.4.1, *Impacts*, presents direct impacts from construction and operation of the proposed rail line and indirect impacts from downline rail traffic and shipping, cumulative impacts from proposed and potentially induced mines, and indirect impacts from coal combustion.

Section 5.2.4.2, *Comparison with Competing Coal*, provides context for understanding the GHG impacts of Tongue River coal by comparing the mining, combustion, and life-cycle emissions of Tongue River coal with other Powder River and U.S. coal.

Section 5.2.4.3, *Net Accumulated Greenhouse Gas Emissions*, provides the net life-cycle change in GHG emissions from the proposed rail line by summing direct, indirect, and cumulative impacts across the six production and export scenarios and comparing these impacts to life-cycle GHG emissions from competing coals in the No-Action Alternative.

Section 5.2.4.4, *Conclusions*, summarizes the net GHG impacts of the proposed rail line and compares these impacts to competing coal.

Section 5.2.4.5, *No-Action Alternative*, summarizes the GHG impacts of the No-Action Alternative.

Section 5.2.4.6, *Mitigation and Unavoidable Environmental Consequences*, provides recommended mitigation and unavoidable consequences.

5.2.4.1 Impacts

Construction

TRRC anticipates that partial-year construction of the northern 83.7-mile-long Tongue River Alternative and the southern 49.6-mile-long Decker East Alternative would take 24 months and 20 months, respectively, over a period of 3 years. For consistency with the coal market analysis in Appendix C, *Coal Production and Markets*, OEA used the Tongue River Alternative and Decker East Alternative to represent the northern and southern alternatives. The emissions associated with construction would be one-time impacts that would result from the combustion of fossil fuels in equipment used during the construction period. These emissions would be 1.2 $MMTCO_2e$ for the Tongue River Alternative and 1.1 $MMTCO_2e$ for the Decker East Alternative. Table 5.2-2 provides an overview of railroad construction emissions. Emissions from maintaining the rail segments are anticipated to be negligible and were not estimated for this analysis.

Table 5.2-2. Direct Construction Emissions

Build Alternative Emissions by GHG	Emissions (thousand $MTCO_2e$)
Tongue River Alternative	
CO_2	987
CH_4	33
N_2O	173
Total:	**1,193**
Decker East Alternative	
CO_2	794
CH_4	48
N_2O	254
Total:	**1,095**

Sources: U.S. Environmental Protection Agency 2008, 2010

GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent; CO_2 = carbon dioxide; CH_4 = methane; N_2O = nitrous dioxide

In addition to the direct emissions, OEA estimated the upstream GHG emissions associated with manufacturing raw materials used to construct the tracks (e.g., steel, concrete, and gravel for tracks and ballast system) using a similar approach as for mine construction emission estimates. OEA estimated the metric tons of concrete, gravel, and steel required to build both the Tongue River Alternative and Decker East Alternative on a per-mile basis (Hill et al. 2012) and applied emission factors to estimate embedded GHG emissions from manufacturing of the construction materials (Ecoinvent Centre 2007). Table 5.2-3 shows the GHG emissions associated with the upstream manufacturing of raw materials for construction of the build alternatives.

Table 5.2-3. Upstream Material Demand and GHG Emissions for the Northern and Southern Alternatives

Emissions Source	Material Demand (metric tons)	Upstream Material Manufacture GHG Emissions (thousand $MTCO_2e$)
Tongue River Alternative		
Steel demand	37,986	58
Concrete demand	133,355	16
Gravel demand	1,070,882	188
Total	**--**	**262**
Decker East Alternative		
Steel demand	22,510	34
Concrete demand	79,025	9
Gravel demand	634,597	112
Total	**--**	**155**

Notes:
Sources: Ecoinvent Centre 2007, Hill et al. 2012
$MTCO_2e$ = metric tons of carbon dioxide equivalent

Recognizing that CEQ's revised draft guidance on considering GHG emissions in National Environmental Policy Act (NEPA) reviews defines GHG emissions as including the "release of stored GHGs as a result of destruction of natural GHG sinks such as forests and coastal wetlands, as well as future sequestration capability" (Council on Environmental Quality 2014), OEA estimated GHG emissions associated with terrestrial soil carbon disturbance (i.e., the release of stored GHGs from the disturbance of carbon stored in vegetation and soils) for construction of the proposed rail line. Emissions from changes in land use would vary by the build alternative; assuming the right-of-way is not reclaimed, the emissions from lost vegetation and soil carbon storage could range from 0.24 $MMTCO_2e$ under the Decker East Alternative, assuming low vegetation carbon stocks, to a maximum of 0.53 MMTCO2e under the Tongue River Alternative, assuming high vegetation carbon stocks. Further information is available in Appendix F, *Life-Cycle Greenhouse Gas Emissions*.

Operation

The proposed rail line would transport Tongue River coal from the proposed and potentially induced mines to the main line and beyond. GHG emissions resulting from transport within the project area (to the junction of the build alternative and the main line) would vary according to the length and terrain of each build alternative. Outside factors such as the production and export scenario and natural gas prices would also affect operation, because these factors would affect the demand for Powder River Basin coal and, consequently, the level of rail traffic necessary to transport it to market. These factors are discussed in Section 5.2.4.1, subsection *Downline Rail Traffic and Shipping*.

Table 5.2-4 summarizes the annual and total net GHG emissions (2018 to 2037) from operation of the northern and southern alternatives in the project area under the different production scenarios.

Table 5.2-4. Annual and Total Net GHG Emissions from Proposed Rail Line Operation in the Project Area (2018–2037)

Scenario and Build Alternative	Annual Net GHG Emissions (thousand $MTCO_2e$/year)	Total Net GHG Emissions (thousand $MTCO_2e$)
Northern Alternatives		
Low production	44	877
Medium production	62	1,248
High production	99	1,985
Southern Alternatives		
Low production	13	263
Medium production	32	644
High production	70	1,395

Notes:
Negative GHG emissions indicate that the net traffic on downline segments will decrease as Tongue River trains displace other coal trains that had been traveling longer distances to deliver coal.
$MTCO_2e$ = metric tons of carbon dioxide equivalent

Downline Rail Traffic and Shipping to International Markets

Downline Rail Traffic

In addition to new rail traffic along the proposed rail line itself, construction and operation of the proposed rail line would affect downline rail traffic (the 51 rail segments downline of the project area). The net impact of the proposed rail line on downline rail traffic and consequent GHG emissions would be highly dependent on the build alternative. This analysis uses the Tongue River Alternative and Decker East Alternatives as proxies for the northern and southern alternatives. Overall transportation distances would be longer and costs to deliver the coal to market would be slightly higher under the Decker East Alternative.

The net impact of the proposed rail line on downline rail traffic could vary depending on how the market reacts to the production of Tongue River coal. The proposed rail line may facilitate the production of coal from certain potentially induced mines, resulting in increased rail traffic between these mines and power plants primarily in the Midwest. Separately, increases in export terminal capacity could increase coal exports to Asian markets, thereby increasing rail traffic to export terminals on the west coast. At the same time, increased transportation of Tongue River coal would offset other Powder River Basin and non-Powder

River Basin coal shipments; in certain scenarios, this displacement would result in a net decrease in overall rail traffic.

For example, net rail traffic would decrease for the Tongue River Alternative and increase under the Decker East Alternative. This is a result of the longer rail distances to primary markets under the southern alternatives, whereas the shorter distances and lower costs for the northern alternatives result in a net displacement of rail traffic on downline segments. Under high export cases, the additional traffic to reach Pacific Northwest export terminals would displace coal shipments from further inland, reducing the net gross metric ton kilometers shipped.

Table 5.2-5 summarizes the annual and total net GHG emissions (2018 to 2037) from operation of the northern and southern alternatives in the downline segments, as described in Appendix C, *Coal Production and Markets*.

Table 5.2-5. Annual and Total Net GHG Emissions from Proposed Rail Line Operation in Downline Segments (2018–2037)

Scenario and Build Alternative	Annual Net GHG Emissions (thousand $MTCO_2e$/year)	Total Net GHG Emissions (thousand $MTCO_2e$)
Northern Alternatives		
Low production	-63	-1,254
Medium production	-96	-1,928
High production	-144	-2,881
Southern Alternatives		
Low production	28	554
Medium production	52	1,046
High production	1	13

Notes:
Negative GHG emissions indicate that the net traffic on downline segments will decrease as Tongue River trains displace other coal trains that had been traveling longer distances to deliver coal.
$MTCO_2e$ = metric tons of carbon dioxide equivalent

Shipping to International Markets

Domestic coal could be exported to Asian markets from export terminals in British Columbia, Canada, and the Pacific Northwest. The coal market analysis in Appendix C, *Coal Production and Markets*, considered zero, medium, and high terminal capacity growth scenarios ranging from annual coal exports of 8 million to 122 million tons to Asian markets. In these scenarios, the amounts of coal exported would range from 0 to 53 percent of annual coal production from the proposed and potentially induced mines. However, the total tonnage of coal exported to Asia would not differ between the build alternatives and the No-Action Alternative. All exported Tongue River coal would displace other Powder River coal that otherwise would have been exported rather than incrementally adding to the total tonnage of coal exported.

Coal export terminals in the Pacific Northwest receive coal from rail and transfer it to ocean freighters for export to Asian markets. Terminals generate GHG emissions from fossil fuel combustion and electricity consumption for powering equipment and facilities, including rotary dumpers, conveyors, and stacker-reclaimers. The Westshore Export Terminal in Vancouver, British Columbia is expected to export 36 million metric tons of coal and emit 21,000 $MTCO_2e$ annually by 2018, or approximately 0.6 $MTCO_2e$ per thousand metric tons of coal (Westshore Terminals 2013). OEA assumed that this emissions factor is representative of other coal export terminals on the west coast. This assumption may be conservative because newer terminals would likely have lower emissions intensities because they are able to incorporate newer, more efficient equipment. OEA estimated that total GHG emissions from export facilities handling Tongue River coal would be between 7,000 to 12,000 $MTCO_2e$ per year (or 0.1 and 0.2 $MMTCO_2e$ accumulated from 2018 to 2037) across the two export scenarios.

Under all of the six production and export scenarios, the total amount of coal exported to Asia would depend on how many coal export terminals are constructed (i.e., export capacity available), as well as the market for coal in Asia, not on which build alternative is licensed. Due to differences in heat content between Tongue River coal and other competing U.S. coal, the net tonnage of coal transported in Asia changes according to the different export scenarios. Table 5.2-6 summarizes the annual and total GHG emissions from the combustion of fuel oil used by freighters during ocean transport.

Table 5.2-6. Annual and Total Net GHG Emissions from Ocean Transport of International Coal in Response to the Proposed Rail Line (2018–2037)

Scenario and Build Alternative	Annual Net GHG Emissions (MTCO2e/year)	Total Net GHG Emissions from 2018 to 2037 (MTCO2e)
Northern Alternatives		
Low production, zero export terminal capacity growth	-91	-1,830
Medium production, medium export terminal capacity growth	1,639	32,784
High production, high export terminal capacity growth	11,492	229,845
Southern Alternatives		
Low production, zero export terminal capacity growth	-76	-1,514
Medium production, medium export terminal capacity growth	-38	-754
High production, high export terminal capacity growth	-6,039	-120,772

Sources: Appendix C, *Coal Production and Markets*, Ecoinvent Centre 2007
$MTCO_2e$ = metric tons of carbon dioxide equivalent

Cumulative Impacts of Proposed and Potentially Induced Mines

The proposed rail line would serve the proposed Otter Creek Mine and could induce development of the Poker Jim Creek–O'Dell Creek Mine, which would be accessed by any build alternative. The Decker Alternatives (southern alternatives) could also induce development of the Canyon Creek Mine.

Construction and operation of proposed or potentially induced mines would result in GHG emissions from the production of mining equipment and materials (e.g., steel and ammonium nitrate), direct methane emissions from surface mines, energy consumption (electricity, gasoline fuel, and diesel fuel) for mine construction and operation, and changes in terrestrial soil carbon storage released from disturbance of vegetation and soils during mine operation..

Table 5.2-7 summarizes the low, medium, and high production capacities for the proposed and potentially induced mines and their associated build alternatives. Table 5.2-8 summarizes the maximum production capacities for the low, medium, and high production scenarios assuming all these mines are in production. These production capacities represent the maximum annual coal production at each mine for the given production level and build alternative and do not take into account other market impacts that could lead to lower levels of production in certain years at some mines.

Table 5.2-7. Production Capacities of Proposed and Potentially Induced Mines

Proposed or Potentially Induced Mine	Build Alternatives	Production Level	Production Quantity (million metric tons of coal per year)[a]	Online Year
Otter Creek	All	Low	18.14	2018
Otter Creek	All	Medium	18.14	2018
Otter Creek	All	High	30.84	2018
Poker Jim Creek–O'Dell Creek	All	Low	0	--[b]
Poker Jim Creek–O'Dell Creek	All	Medium	10.89	2023
Poker Jim Creek–O'Dell Creek	All	High	14.51	2023
Canyon Creek	Southern	Low	0	--[b]
Canyon Creek	Southern	Medium	0	--[b]
Canyon Creek	Southern	High	19.96	2028

Notes:
[a] Expresses production quantity at full capacity in each scenario; production ramps up during the first 2 years after each mine comes online
[b] Denotes mines that do not enter production in a given scenario

Table 5.2-8. Maximum Production Capacities Assuming All Proposed and Potentially Induced Mines are Productive (million metric tons of coal per year)

Year	No-Action Alternative	Northern Alternatives			Southern Alternatives		
		Production Level					
		Low	Medium	High	Low	Medium	High
2018	0	18.14	18.14	30.84	18.14	18.14	30.84
2023	0	18.14	29.03	45.36	18.14	29.03	45.36
2030	0	18.14	29.03	45.36	18.14	29.03	65.32[a]
2037	0	18.14	29.03	45.36	18.14	29.03	65.32[a]

Notes:
[a] Production capacities for the southern alternatives in the high production scenario reflect the Canyon Creek mine beginning production in 2028.

Construction

OEA determined that GHG emissions from mine construction could account for a large fraction of life-cycle GHG emissions from Tongue River coal. Detailed data on the energy and equipment needed for coal surface mine construction, however, are not currently available. To develop an estimate, OEA scaled construction emissions proportionally with mine capacity, given the surface mining equipment assumptions in Spath et al. (1999) and the additional construction activities needed for larger mines. OEA assumed that construction of surface mines would require 30 percent of the annual electricity, fuel, and materials needed for mine operation at full production capacity based on the types of equipment used for mine operation and reclamation in Spath et al. (1999).

Construction of the proposed Otter Creek Mine is assumed to occur over 30 months based on the estimated construction period in the permit application (2015 to 2017). For purposes of this analysis, construction of the potentially induced Poker Jim Creek–O'Dell Creek Mine is projected to occur from 2020 to 2022, and construction of the potentially induced Canyon Creek Mine is projected to occur from 2025 to 2027. Table 5.2-9 summarizes the GHG emissions for construction of the proposed and potentially induced mines, including construction energy-related emissions and the embedded emissions in materials used for mine construction (e.g., emissions from the production of steel in steel mills). Appendix F, *Life-Cycle Greenhouse Gas Emissions*, provides details on the approaches used to estimate these emissions.

Table 5.2-9. Total GHG Emissions for Construction of Proposed and Potentially Induced Mines—Low, Medium, and High Production Scenarios

Scenarios and Emissions Source	Annual Construction GHG Emissions ($MMTCO_2e$/year of construction)	Total (30-month) Construction GHG Emissions ($MMTCO_2e$)
Low Production Scenarios (Northern and Southern Alternatives)[a]		
Construction energy	0.08	0.21
Construction material embedded emissions	0.04	0.09
Total	**0.12**	**0.30**
Medium Production Scenarios (Northern and Southern Alternatives)[b]		
Construction energy	0.13	0.33
Construction material embedded emissions	0.06	0.15
Total	**0.19**	**0.48**
High Production Scenarios (Northern Alternatives)[b]		
Construction energy	0.21	0.51
Construction material embedded emissions	0.09	0.23
Total	**0.30**	**0.74**
High Production Scenarios (Southern Alternatives)[c]		
Construction energy	0.30	0.74
Construction material embedded emissions	0.13	0.33
Total	**0.43**	**1.07**

Notes:
[a] Includes the Otter Creek (Tract 2) mine
[b] Includes the Otter Creek Mine (Tract 2) and Poker Jim Creek–O'Dell Creek deposit
[c] Includes the Otter Creek Mine (Tract 2) and Poker Jim Creek–O'Dell Creek and Canyon Creek deposits
Sources: Estimated using data from Ecoinvent Centre 2007, Montana Department of Environmental Quality 2001, Spath et al. 1999, U.S. Environmental Protection Agency2014a, 2013
$MMTCO_2e$ = million metric tons of carbon dioxide equivalent

Operation

TRRC expects that mining would begin gradually at the proposed Otter Creek Mine. The first year of operation is expected to produce 10.89 million metric tons of coal, or about 60 percent of the anticipated permitted production of 18.14 million metric tons per year. The second year of operation is expected to produce 14.51 million metric tons, or about 80 percent of the anticipated permitted production. This gradual startup was applied similarly to the potentially induced Poker Jim Creek–O’Dell Creek Mine and Canyon Creek Mine production rates for years 1 and 2 of mine operation. Because operation at these mines emit GHGs in proportion to the tonnage of coal mined and processed (Spath et al. 1999, U.S. Environmental Protection Agency 2013), OEA assumed the first and second years of mine operation for each mine would emit 60 percent and 80 percent, respectively, of the total GHG emissions of each mine operating at full production capacity. Table 5.2-10 provides the total GHG emissions for proposed and potentially induced mine operation for the low, medium, and high production scenarios. Appendix F, *Life-Cycle Greenhouse Gas Emissions*, provides details on the approaches OEA used to estimate these emissions.

OEA estimated GHG emissions from the "release of stored GHGs as a result of destruction of natural GHG sinks such as forests and coastal wetlands, as well as future sequestration capability" (Council on Environmental Quality 2014) associated with proposed and potentially induced mine development. During mine reclamation, soil and vegetation replacement occurs as sections of the mine are depleted of coal and no longer actively mined, rather than occurring after mining for the entire tract is completed. This approach minimizes the period during which soil and vegetation would be removed from the mine acreage and therefore minimizes the avoided carbon sequestration resulting from plant growth.

Based on estimates of the existing terrestrial carbon stock and carbon stocks following surface mine reclamation, OEA found that net carbon disturbance from reclaimed surface mines could range from a slight increase in carbon sequestration to a loss of 27 metric tons per hectare. Absolute GHG emissions would vary by the production scenario and build alternative; the largest changes would occur under the southern alternatives, high production scenario, with GHG emissions ranging from a reduction of 0.5 $MMTCO_2e$ (i.e., a slight increase in net terrestrial carbon storage) to an increase of 1.5 $MMTCO_2e$. Further information is available in Appendix F, *Life-Cycle Greenhouse Gas Emissions*.

Table 5.2-10. Total GHG Emissions for Operation of Proposed and Potentially Induced Mines—Low, Medium, and High Production Scenarios (2018–2037)

Scenario	Operation Year 1 GHG Emissions[d] ($MMTCO_2e/yr$)	Operation Year 2 GHG Emissions[e] ($MMTCO_2e/yr$)	All Other Operation Years GHG Emissions ($MMTCO_2e/yr$)	Total GHG Emissions ($MMTCO_2e$)
Low Production Scenarios (Northern and Southern Alternatives)[a]				
Operation energy	0.16	0.22	0.27	5.31
Operation material embedded emissions	0.06	0.08	0.10	1.90
Direct methane from mine face	0.22	0.30	0.37	7.18
Total	**0.44**	**0.59**	**0.74**	**14.39**
Medium Production Scenarios (Northern and Southern Alternatives)[b]				
Operation energy	0.26	0.35	0.44	7.68
Operation material embedded emissions	0.09	0.13	0.16	2.75
Direct methane from mine face	0.36	0.47	0.59	10.38
Total	**0.71**	**0.95**	**1.19**	**20.81**
High Production Scenarios (Northern Alternatives)[b]				
Operation energy	0.41	0.55	0.68	12.18
Operation material embedded emissions	0.15	0.20	0.25	4.37
Direct methane from mine face	0.56	0.74	0.93	16.47
Total	**1.11**	**1.48**	**1.86**	**33.02**
High Production Scenarios (Southern Alternatives)[c]				
Operation energy	0.59	0.79	0.99	15.01
Operation material embedded emissions	0.21	0.29	0.36	5.41
Direct methane from mine face	0.80	1.07	1.33	20.29
Total	**1.60**	**2.14**	**2.67**	**40.72**

Notes:

[a] Includes the Otter Creek Mine (Tract 2).

[b] Includes the Otter Creek Mine (Tract 2) and Poker Jim Creek–O'Dell Creek deposit

[c] Includes the Otter Creek Mine (Tract 2) and Poker Jim Creek–O'Dell Creek and Canyon Creek deposits

[d] Includes the total emissions for the first year of operation for all potentially induced mines for the scenario across the first operation year for each mine (2018 for Otter Creek Mine, 2023 for Poker Jim Creek–O'Dell Creek deposit, and 2028 for Canyon Creek deposit)

[e] Includes the total emissions for the second year of operation for all potentially induced mines for the scenario across the second operation year for each mine/deposit (2019 for Otter Creek Mine, 2024 for Poker Jim Creek–O'Dell Creek deposit, and 2029 for Canyon Creek deposit)

Sources: Estimated using data from Ecoinvent Centre 2007, Montana Department of Environmental Quality 2001, Spath et al. 1999, U.S. Environmental Protection Agency 2014a, 2013

$MMTCO_2e$ = million metric tons of carbon dioxide equivalent

Coal Combustion

OEA assumed that all coal transported by the proposed rail line would be combusted at power plants to generate power. Table 5.2-11 shows the estimated GHG emissions from the combustion of Tongue River coal under the six production and export scenarios.

Table 5.2-11. Change in GHG Emissions from Tongue River Coal Combustion (2018–2037)

Scenario and Build Alternative	Average Annual Tongue River Coal Combusted (million metric tons/year)	Average Annual GHG Emissions from Tongue River Coal Combustion ($MMTCO_2e$/year)	Total GHG Emissions from Tongue River Coal from 2018-2037 ($MMTCO_2e$)
Northern Alternatives			
Low Production, Zero Export Terminal Capacity Growth[a]	18.14	33.19	663.78
Medium Production, Medium Export Terminal Capacity Growth[b]	26.31	48.40	968.04
High Production, High Export Terminal Capacity Growth[b]	41.73	76.71	1,534.11
Southern Alternatives			
Low Production, Zero Export Terminal Capacity Growth[a]	12.82	23.44	468.88
Medium Production, Medium Export Terminal Capacity Growth[b]	25.67	47.21	944.20
High Production, High Export Terminal Capacity Growth[c]	51.71	96.02	1,920.42

Notes:
[a] Includes coal production from Otter Creek Mine
[b] Includes coal production from Otter Creek Mine and potentially induced coal production from Poker Jim Creek–O'Dell Creek deposit
[c] Includes coal production from Otter Creek Mine and potentially induced coal production from Poker Jim Creek–O'Dell Creek and Canyon Creek deposits
Source: Appendix C, *Coal Production and Markets*
$MMTCO_2e$ = million metric tons of carbon dioxide equivalent

5.2.4.2 Comparison with Competing Coal

To provide context for GHG emissions related to the proposed rail line and to assess the net life-cycle GHG emissions that would result from the displacement of competing coal, OEA compared the life-cycle GHG emissions of Tongue River coal with other Powder River Basin coal and U.S. coal. This section compares mine emissions, coal combustion emissions, and life-cycle emissions for Tongue River coal and competing coal.

Mine Emissions

OEA compared the coal mining GHG emissions for Tongue River coal (based on the medium production scenario, northern and southern alternatives) to emissions for competing coal that could be displaced by Tongue River coal (Section 5.2.2.2, *Method for Competing Coal Analysis*). The results are presented in Table 5.2-12.

Table 5.2-12. Mining GHG Emissions for Tongue River Coal Compared to Competing Coal

Coal Source	Median Estimate ($MTCO_2e$/metric ton of coal)
Tongue River coal	0.041
Competing coal	
Other Powder River Basin coal	0.041
Other U.S. coal	0.129
International coal	0.142

Sources: Emissions for other U.S. coal and international coal were estimated using data from National Energy Technology Laboratory 2010, Spath et al. 1999, Dyncorp 1995, Martin 1997, May and Brennan 2003, Hondo 2005
$MTCO_2e$ = metric tons of carbon dioxide equivalent

In the results shown in Table 5.2-12, operation material embedded emissions were added based on Spath et al. 1999 data, where missing, to better align with Tongue River coal emissions estimate boundaries. Mine construction emissions were not included for the competing coal because increased Tongue River coal production potentially induced by the proposed rail line is not anticipated to affect competing coal mine construction. Like Tongue River coal, other Powder River Basin coal is assumed to be mined entirely through surface mining. Mining other Powder River Basin coal would result in the same level of emissions from mining as Tongue River coal. Powder River Basin coal is almost entirely produced via surface mining; there is only one underground mine in the basin and additional underground mining is considered unlikely. Fifty-five percent of other U.S. coal is estimated to be mined from underground mines and 45 percent is estimated to be mined through surface mining. Fifty percent of international coal is estimated to be mined from underground mines, and 50 percent is estimated to be mined through surface mining (Mine Safety and Health Administration 2013). OEA used these rates to weight underground and aboveground mining GHG results from the literature to calculate the medians for other U.S. and international coal.

As the comparison shows, Tongue River—and Powder River—coal mine emissions are on the lower end of the estimates for competing coal. However, because the results in Table 5.2-12 draw from several independent LCA studies, the variation in emissions across the coal types is not solely influenced by different coal mining practices. The results are also influenced by the following differences in study design and modeling assumptions.

- The underlying data on mine operation and emissions that the studies apply.
- The representativeness of mining technologies modeled in the LCA studies of national coal mining processes.
- Differences in study boundaries (e.g., the inclusion and treatment of construction and upstream fuel production emissions).
- Study design factors such as the timeframe of analysis.

Acknowledging these limitations, the results in Table 5.2-12 demonstrate that mining emissions from Tongue River coal and other Powder River Basin coal are likely to be at least equivalent to, and perhaps lower than, other competing coal. Further details on OEA's comparison of coal mining GHG emissions between Tongue River coal and competing coal are provided in Appendix F, *Life-Cycle Greenhouse Gas Emissions*.

Combustion Emissions

The production and delivery of Tongue River coal to the global coal market could increase or decrease combustion of competing coal, including other Powder River Basin coal, other U.S. coal, and international coal. Tongue River coal could also increase or decrease production and consumption of natural gas in the United States. OEA analyzed the impact on consumption for each of these coal types and for natural gas, as described in Appendix C, *Coal Production and Markets*.[8]

To illustrate the range of GHG emissions, OEA estimated the change in global coal combustion GHG emissions and U.S. natural gas precombustion and combustion GHG emissions based on the six production and export scenarios (2018 to 2037). The results of this analysis are presented in Tables 5.2-13 and 5.2-14 for coal and natural gas, respectively.

Table 5.2-13. Change in GHG Emissions from Coal Combustion from the Proposed Rail Line (2018–2037)

Scenario and Build Alternative	Average Annual Change in Coal Combusted (million metric tons/year)	Average Annual Change in GHG Emissions ($MMTCO_2e$/year)	Total Change in GHG Emissions from 2018-2037 ($MMTCO_2e$)
Low Coal Production, Zero Export Terminal Capacity Growth Scenario (Northern Alternatives)[a]			
Tongue River coal	18.14	33.19	663.78
Other Powder River Basin coal	-12.47	-23.20	-463.97
Other U.S. coal	-5.77	-9.61	-192.22
Pacific Basin and Other International coal	0.00	0.00	-0.09
Total	**-0.10**	**0.38**	**7.50**
Medium Coal Production, Medium Export Terminal Capacity Growth Scenario (Northern Alternatives)[b]			
Tongue River coal	26.31	48.40	968.04
Other Powder River Basin coal	-22.42	-41.21	-824.19
Other U.S. coal	-2.26	-4.73	-94.69
Pacific Basin and Other International coal	0.03	0.06	1.21
Total	**1.66**	**2.52**	**50.37**
High Coal Production, High Export Terminal Capacity Growth Scenario (Northern Alternatives)[b]			
Tongue River coal	41.73	76.71	1,534.11
Other Powder River Basin coal	-29.23	-52.90	-1,058.05

[8] For this market analysis, OEA applied a simplifying assumption that the maximum production quantities for each of the Tongue River potentially induced mines are modeled without a ramp-up period. This assumption is conservative as it tends to overestimate the Tongue River coal production and therefore is slightly inconsistent with the amount of coal assumed to be extracted from potentially induced mines from 2018 to 2037 in the potentially induced mine analysis. Additionally, the market analysis found that changes in international coal production would only occur in the Pacific Basin, due to changes in coal types exported out of the Pacific Northwest, and into the Pacific Basin from Colombia. All other coal production remained the same between the proposed and no-action scenarios.

Scenario and Build Alternative	Average Annual Change in Coal Combusted (million metric tons/year)	Average Annual Change in GHG Emissions ($MMTCO_2e$/year)	Total Change in GHG Emissions from 2018-2037 ($MMTCO_2e$)
Other U.S. coal	-8.96	-17.64	-352.89
Pacific Basin and Other International coal	0.17	0.33	6.65
Total	**3.71**	**6.49**	**129.81**
Low Coal Production, Zero Export Terminal Capacity Growth Scenario (Southern Alternatives)[a]			
Tongue River coal	12.82	23.44	468.88
Other Powder River Basin coal	-9.12	-16.97	-339.37
Other U.S. coal	-3.88	-6.01	-120.11
Pacific Basin and Other International coal	0.00	0.00	-0.07
Total	**-0.19**	**0.47**	**9.32**
Medium Coal Production, Medium Export Terminal Capacity Growth Scenario (Southern Alternatives)[b]			
Tongue River coal	25.67	47.21	944.20
Other Powder River Basin coal	-21.98	-40.36	-807.19
Other U.S. coal	-2.44	-5.19	-103.90
Pacific Basin and Other International coal	0.00	0.00	-0.03
Total	**1.25**	**1.65**	**33.08**
High Coal Production, High Export Terminal Capacity Growth Scenario (Southern Alternatives)[c]			
Tongue River coal	51.71	96.02	1,920.42
Other Powder River Basin coal	-38.10	-68.93	-1,378.60
Other U.S. coal	-10.71	-20.46	-409.13
Pacific Basin and Other International coal	-0.15	-0.28	-5.68
Total	**2.76**	**6.35**	**127.01**

Notes:
[a] Includes coal production from Otter Creek Mine
[b] Includes coal production from Otter Creek Mine and potentially induced coal production from Poker Jim Creek–O'Dell Creek deposit
[c] Includes coal production from Otter Creek Mine and potentially induced coal production from Poker Jim Creek–O'Dell Creek and Canyon Creek deposits
Source: Appendix C, *Coal Production and Markets*
$MMTCO_2e$ = million metric tons of carbon dioxide equivalent

Table 5.2-14. Change in GHG Emissions from Natural Gas Precombustion and Combustion from the Proposed Rail Line (2018–2037)

Scenario and Emissions Source	Average Annual Change in Natural Gas Combusted (TBtu/year)	Average Annual Change in GHG Emissions ($MMTCO_2e$/year)	Total Change in GHG Emissions from 2018-2037 ($MMTCO_2e$)
Low Coal Production, Zero Export Terminal Capacity Growth Scenario (Northern Alternatives)[a]			
U.S. natural gas combustion	0.24	0.01	0.26
U.S. natural gas precombustion	NA	0.00	0.07
Total	**0.24**	**0.02**	**0.33**
Medium Coal Production, Medium Export Terminal Capacity Growth Scenario (Northern Alternatives)[b]			
U.S. natural gas combustion	-7.14	-0.38	-7.59
U.S. natural gas precombustion	NA	-0.11	-2.13
Total	**-7.14**	**-0.49**	**-9.72**
High Coal Production, High Export Terminal Capacity Growth Scenario (Northern Alternatives)[b]			
U.S. natural gas combustion	-26.58	-1.41	-28.23
U.S. natural gas precombustion	NA	-0.40	-7.93
Total	**-26.58**	**-1.81**	**-36.16**
Low Coal Production, Zero Export Terminal Capacity Growth Scenario (Southern Alternatives)[a]			
U.S. natural gas combustion	0.13	0.01	0.14
U.S. natural gas precombustion	NA	0.00	0.04
Total	**0.13**	**0.01**	**0.18**
Medium Coal Production, Medium Export Terminal Capacity Growth Scenario (Southern Alternatives)[b]			
U.S. natural gas combustion	-5.95	-0.32	-6.31
U.S. natural gas precombustion	NA	-0.09	-1.77
Total	**-5.95**	**-0.40**	**-8.09**
High Coal Production, High Export Terminal Capacity Growth Scenario (Southern Alternatives)[c]			
U.S. natural gas combustion	-26.75	-1.42	-28.41
U.S. natural gas precombustion	NA	-0.40	-7.98
Total	**-26.75**	**-1.82**	**-36.39**

Notes:

[a] Includes coal production from Otter Creek Mine (Tract 2)

[b] Includes coal production from Otter Creek Mine (Tract 2) and potentially induced coal production from Poker Jim Creek–O'Dell Creek deposit

[c] Includes coal production from the Otter Creek Mine (Tract 2), and potentially induced coal production from Poker Jim Creek–O'Dell Creek deposit, and Canyon Creek deposit

Sources: Appendix C, Coal Production and Markets, Franklin Associates 2010

$MMTCO_2e$ = million metric tons of carbon dioxide equivalent; TBtu = trillion British thermal units; NA = not available

Life-Cycle Emissions

In general, the net impact of increased Powder River Basin coal on global life-cycle GHG emissions would depend on the following factors.

- GHG emissions from the increased volumes of Tongue River coal that are mined, transported, and combusted because of the proposed rail line.
- GHG emissions from mining, transportation, and combustion of competing coal and natural gas that would fluctuate in response to Tongue River coal entering the market.

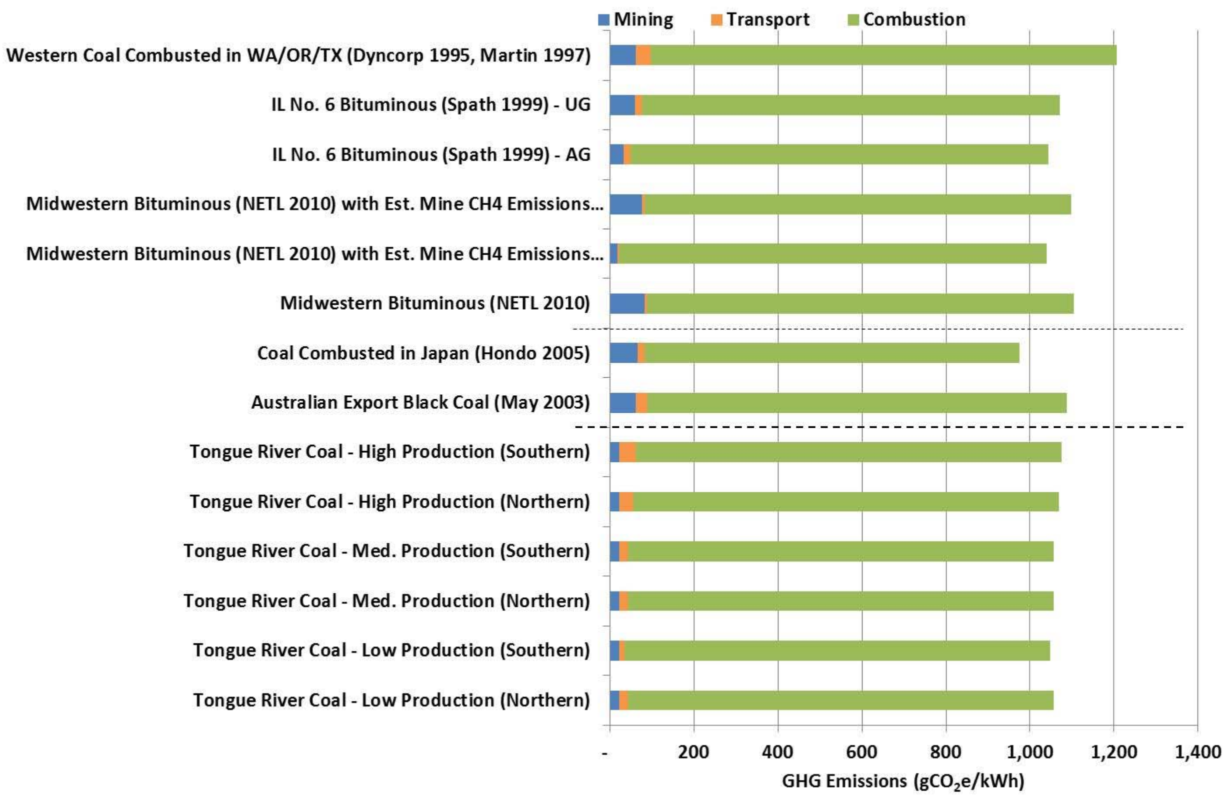
If increased Tongue River coal production displaces coal from other U.S. or international sources with greater carbon intensity, the GHG impact of increased Tongue River coal production would be a reduction in emissions. This occurs because Tongue River coal would have lower carbon intensity than the coal that it would displace from the market. Alternatively, if increased Tongue River coal production displaces other U.S. or international coal with a lower carbon intensity, the GHG impact of increased Tongue River coal production would be an increase in emissions.

Figure 5.2-3 shows the expected life-cycle GHG emissions for Tongue River coal and competing coal. The Tongue River coal emissions are exhibited for the low, medium, and high coal production scenarios for all build alternatives. Life-cycle GHG emissions would range from a low of about 1,048 grams of CO_2e per kilowatt-hour (gCO_2e/kWh) to a high of about 1,076 gCO_2e/kWh. This range is relatively comparable to most of the competing coal life-cycle emissions, except for the higher emissions of western coal combusted in Washington, Oregon, and Texas.

Figure 5.2-3 also shows the relative contributions of mining, transport, and combustion to life-cycle GHG emissions. For all coals, combustion emissions dominate the life cycle, accounting for 92 to 97 percent of total life-cycle GHG emissions. The share of emissions from mining (i.e., mine construction, embedded material emissions, coal extraction, and mine methane emissions) would vary from 2 to 8 percent, with fugitive mine methane emissions being the largest contributor. In general, mining emissions are higher for underground mines compared to surface mines similar to the potentially induced mines. The share of transport emissions is larger only for the high productions scenarios of Tongue River coal.

Because the results presented in Figure 5.2-3 draw from several independent LCA studies, the variation in emissions across the coal types is also influenced by differences in the life-cycle boundaries, study design, and modeling assumptions across the studies. Even so, the results demonstrate that life-cycle GHG emissions from Tongue River coal would be within the range of emissions for other competing coal, and that for all coal types, life-cycle GHG emissions would be dominated by the coal combustion stage.

Figure 5.2-3. Life-Cycle GHG Emissions Comparison of Tongue River Coal and Competing Coal



Notes:
The boundaries of the studies were harmonized where feasible. Tongue River production and export scenarios include emissions from construction of the potentially induced mines allocated across mine production from 2018 to 2037; mine construction emissions contribute 0.1% of total GHG emissions. The National Energy Technology Laboratory (2010) also includes mine construction emissions. None of the other studies included mine construction emissions.
The mining results (National Energy Technology Laboratory 2010) relied on estimates from a single underground mine, the Galatia Mine in Illinois. To examine methane emissions results for a broader set of Illinois mines, OEA separately estimated underground and aboveground methane emissions from Illinois mines using the same approach used to estimate Tongue River potentially induced coal mine emissions. The results using the separate estimates of mine emissions are shown in the figure above with the labeling "Est. Mine CH4 Emissions."
Literature results reflect a single coal-fired electricity generation technology, viz., subcritical pulverized coal combustion.
Variation in combustion results between the southern and northern alternatives for the Tongue River coal high production scenario is a function of the different heat contents of the coal extracted from the different potentially induced mines. The southern alternative scenarios include coal from the potentially induced Canyon Creek deposit; the northern alternative scenarios do not include Canyon Creek deposit coal. The average heat content of Tongue River coal is 17.2 MMBTU/short ton for the Otter Creek Mine, 17.5 MMBTU/short ton for the Poker Jim Creek–O'Dell Creek deposit and 18.2 MMBtu/short ton for the Canyon Creek deposit.

Absent from Figure 5.2-3 is Chinese coal because the data are not available. Dones et al. (2004) reports aggregated life-cycle results for coal combusted in China that range from 1,048 to 1,648 gCO_2/kWh. On average, Chinese coal mines emit 33 percent more methane than U.S. mines, because the majority of Chinese mines are underground (U.S. Environmental Protection Agency 2012, U.S. Energy Information Administration 2014). The Chinese coal mining methane emissions profile is within the range of that for other Asian coal. Uncontrolled coalbed fires[9] are another potentially significant source of upstream emissions from coal in China. An estimated 10 to 200 million metric tons of coal per year are burned in these fires in China and result in CO_2 emissions that would range from 7 to 134 gCO_2e/kWh (Dones et al. 2007). Chinese coal production might change based on changes in the heat content of coal exported from the United States.

5.2.4.3 Net Accumulated Greenhouse Gas Emissions

This section presents the estimated net life-cycle GHG emissions that would accrue from rail transportation of Tongue River coal relative to emissions from competing coals and natural gas under the No-Action Alternative.

The analysis in this section is based on information presented earlier in this chapter.

- GHG emissions for each stage of the Tongue River coal life cycle.[10]
- Mining GHG emissions for other reference coals.
- The change in rail line transportation and international coal shipments for each scenario relative to the No-Action Alternative.
- The change in coal combustion for each scenario relative to the No-Action Alternative.[11]

[9] Coalbed fires occur when coal is allowed to burn uncontrolled in underground coal mines, coal waste piles, and unmined coal beds. They include both self-ignited, naturally occurring coal fires and fires resulting from human activities (U.S. Geological Survey 2009).

[10] GHG emissions from terrestrial soil carbon disturbance are not included in the net GHG emission estimates in order to consistently compare the life cycle GHG emissions sources from Tongue River coal to competing coals. The source of life cycle estimates for reference coals (Whitaker et al. 2012) did not include land use change emissions because this source is not consistently captured across baseline coal studies in the LCA literature. Further, OEA found that GHG emissions from land use change at proposed and potentially induced mine sites are highly variable depending on the existing and final land cover when reclamation occurs, and net carbon stock changes from both rail line and mining disturbances amount to a small proportion of total life cycle emissions. Consequently, the results have been reported separately in the relevant sections above.

[11] GHG emissions from operation of coal export terminals are not included in the net GHG emission estimates because the market analysis found that coal terminals would operate at full capacity across all scenarios and the No-Action Alternative. Export terminal emissions will therefore be the same whether the proposed rail line is built or not. Furthermore, OEA estimated that export terminal GHG emissions from handling Tongue River coal would be between 0.1 and 0.2 $MMTCO_2e$, which is less than 0.1 percent of life cycle GHG emissions from Tongue River coal.

The net accumulated life-cycle emissions for Tongue River coal are compared with such emissions for competing coal in Table 5.2-15. The increased mining, transportation, and combustion emissions for Tongue River coal appear in the first column. The second column shows the incremental change (positive or negative) in mining, transport, and combustion of other competing coal. The net accumulated emissions are the sum of these two effects, shown in the third column. The changes in natural gas emissions are provided in Table 5.2-16. Table 5.2-17 sums the totals of Tables 5.2-15 and 5.2-16 to present the final net results by build alternative (northern and southern).

Table 5.2-15. Coal Accumulated and Net Life-Cycle GHG Emissions Results (2018–2037)

	Tongue River Coal GHG Emissions ($MMTCO_2e$)			Change in Competing Coal GHG Emissions ($MMTCO_2e$)			Net Change in GHG Emissions from 2018 to 2037 ($MMTCO_2e$)		
	Low	**Medium**	**High**	**Low**	**Medium**	**High**	**Low**	**Medium**	**High**
Northern Alternatives									
Mining	15	21	34	-25	-24	-47	-11	-3.2	-13
Transport	13	19	48	-12	-18	-47	1.1	0.8	0.8
Combustion	664	968	1,534	-656	-918	-1,404	7.5	50	130
Total	**691**	**1,008**	**1,616**	**-693**	**-960**	**-1,498**	**-2.0**	**48**	**117**
Southern Alternatives									
Mining	15	21	42	-18	-24	-60	-2.9	-3.4	-18
Transport	7.5	18	72	-5.4	-15	-69	2.1	2.9	2.5
Combustion	469	944	1,920	-460	-911	-1,793	9.3	33	127
Total	**491**	**983**	**2,034**	**-483**	**-951**	**-1,923**	**8.4**	**33**	**112**

Notes:
Low, medium, and high refer to production levels and coal export capacity
$MMTCO_2e$ = million metric tons of carbon dioxide equivalent

Table 5.2-16. Natural Gas Accumulated Change in Life-Cycle GHG Emissions (2018–2037)

	Change in GHG Emissions ($MMTCO_2e$)		
	Low[a]	**Medium**[a]	**High**[a]
Northern Alternatives			
Precombustion	0.07	-2.13	-7.93
Combustion	0.26	-7.59	-28.23
Total	**0.33**	**-9.72**	**-36.16**
Southern Alternatives			
Precombustion	0.04	-1.77	-7.98
Combustion	0.14	-6.31	-28.41
Total	**0.18**	**-8.09**	**-36.39**

Notes:
[a] Low, medium, and high refer to production levels and coal export capacity
$MMTCO_2e$ = million metric tons of carbon dioxide equivalent

Table 5.2-17. Accumulated and Net Life-Cycle GHG Emissions Results (2018–2037)

	Tongue River Coal Emissions ($MMTCO_2e$)			Change in Competing Coal and Natural Gas GHG Emissions ($MMTCO_2e$)			Net Change in GHG Emissions from 2018 to 2037 ($MMTCO_2e$)		
	Low [a]	Medium [a]	High [a]	Low [a]	Medium [a]	High [a]	Low [a]	Medium [a]	High [a]
Northern Alternatives									
Total	691	1,008	1,616	-693	-970	-1,534	-1.7	38	81
Southern Alternatives									
Total	491	983	2,034	-482	-959	-1,959	9	25	75

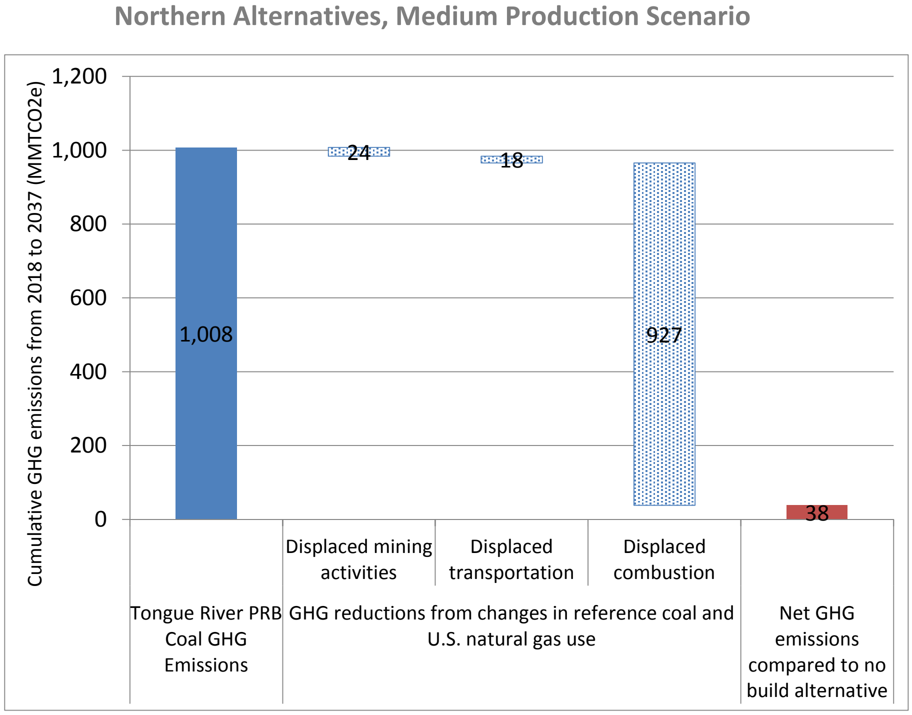
Notes:
[a] Low, medium, and high refer to production levels and coal export capacity
$MMTCO_2e$ = million metric tons of carbon dioxide equivalent

Figure 5.2-4 shows the results for the medium production scenario graphically.[12] GHG emissions (2018 to 2037) for both the northern and southern alternatives are presented. The figure shows life-cycle GHG emissions from the Tongue River coal transported by the proposed rail line (left-most column) and the extent to which this coal displaces emissions from mining, transportation, and combustion of other competing coals and natural gas (stippled bars). The right-most bar shows the remaining net change in GHG emissions from the proposed rail line.

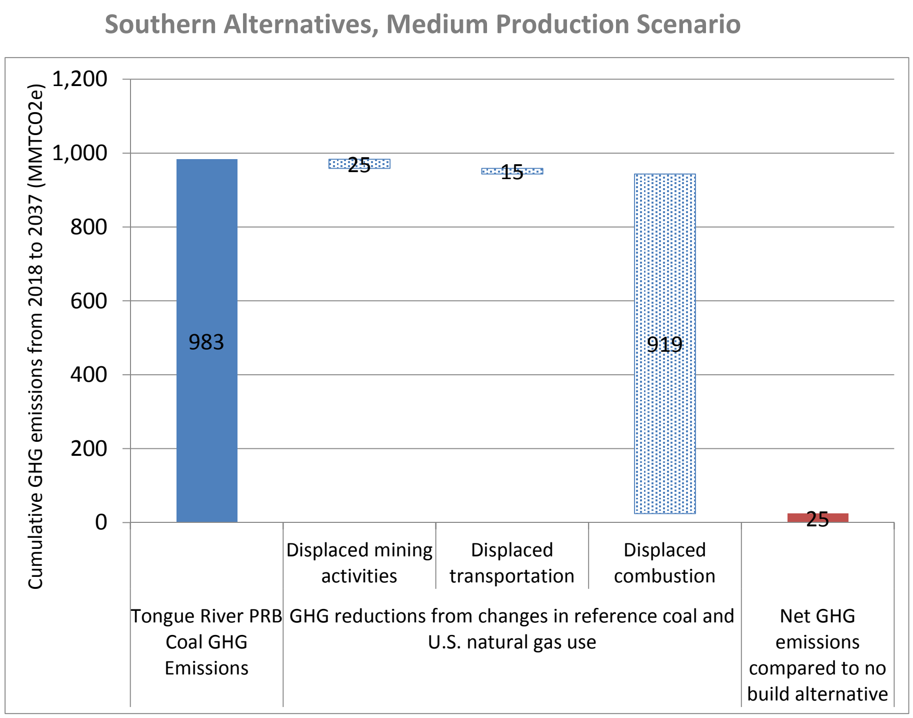
The results show that, while absolute GHG emissions from the additional Tongue River coal would be between 491 and 2,034 $MMTCO_2e$ (2018 to 2037) across all low, medium, and high scenarios, most or all of these emissions would be offset by reduced mining, transportation, and combustion of other coal and natural gas that Tongue River coal would displace. Whether net emissions from the project would be negligible, or constitute a minor increase depends on the build alternative routes considered, coal production levels, and export terminal capacities. In all but one of the six scenarios examined, enough additional Tongue River coal would be mined and combusted so that, regardless of the GHG intensity of competing coals, there would be a net increase in GHG emissions.

[12] The selection of the medium scenario in Figure 5.2-4 is arbitrary; it was selected as a medium point between the high and low cases in order to show the results of one scenario graphically for easier interpretation.

Figure 5.2-4. Accumulated Tongue River Coal Life-Cycle GHG Emissions, GHG Reductions from Competing Coal and Natural Gas Displacement, and Net Accumulated GHGs



Note: The displaced combustion emissions include displaced coal combustion, natural gas combustion, and natural gas pre-combustion emissions. Net GHG emissions may not match totals due to rounding.



Note: The displaced combustion emissions include displaced coal combustion, natural gas combustion, and natural gas pre-combustion emissions. Net GHG emissions may not match totals due to rounding.

5.2.4.4 Conclusions

This section presents the conclusions of this analysis of GHG impacts of the proposed rail line. GHG emissions contribute to the greenhouse effect by trapping additional heat in the atmosphere. This effect has been linked to impacts on public health and welfare, ecosystems, wildlife, and natural resources through more frequent and intense extreme events (such as heat waves, heavy downpours, intense storms, drought), sea level rise, and gradual changes in seasonal and annual average temperatures and precipitation (Melillo et al. 2014: Intergovernmental Panel on Climate Change 2014).

OEA recognizes that one of the challenges of analyzing global climate change is that these impacts are not attributable to any single action, but rather are the result of many individual sources of emissions to the atmosphere. OEA has therefore taken a life cycle approach in examining the cumulative impacts of the proposed project. The life cycle approach quantifies GHG emissions from all direct and indirect activities potentially associated with the proposed rail line from coal mining, transportation, and final use.

GHG emission results are presented as follows.

- Direct GHG emissions associated with construction of the proposed rail line and operation of the rail segments that would join the main line.
- Net accumulated life-cycle GHG emissions (including direct, indirect, and cumulative GHG emission sources) across each scenario relative to the No-Action Alternative.

This final section puts these GHG emissions in context by comparing them to two different points of reference: GHG emissions from U.S. light-duty vehicles and GHG emission reduction targets from several federal programs.

Direct Greenhouse Gas Emissions

Direct emissions from construction and operation of the proposed rail line—considering just the GHGs emitted from land use change along the right-of-way, railroad construction, and operation of the proposed rail line within the project area—would range from an annual average of 80,000 to 185,000 $MTCO_2e$ per year (or 1.6 to 3.7 $MMTCO_2e$ accumulated between 2018 to 2037), depending on the build alternative and the level of coal production. Direct emissions from the northern alternatives would range from 2.4 to 3.7 MMTCO2e, and southern alternatives would range from 1.6 to 2.9 MMTCO2e.

Revised draft guidance from CEQ on considering GHG emissions in NEPA reviews sets an annual emissions threshold of 25,000 $MTCO_2e$ for a proposed action (Council on Environmental Quality 2014). At or above this threshold, the lead agency should consider a quantitative assessment of the associated impacts. The CEQ guidance is described in Section 5.4, *Applicable Regulations*.

Net Accumulated Greenhouse Gas Emissions

Across all production and export scenarios, accumulated net emissions from the proposed rail line would range from a slight reduction of 1.7 $MMTCO_2e$ to an increase of 81 $MMTCO_2e$ for the northern alternatives, and an increase of 8.6 to 75 $MMTCO_2e$ for the southern alternatives.

The one scenario where emissions are reduced is the northern alternative with low coal production and zero export scenarios. This build alternative would offset the most competing U.S. coal outside the Power River Basin of all six scenarios. Other U.S. coal has higher mining methane emissions than Tongue River or Powder River Basin coal. The lower mining emissions from Tongue River coal production would be large enough to offset the increased combustion from additional coal being supplied to the market.

Emissions in Context

To provide a frame of reference for these emissions estimates, OEA compared both direct and net accumulated life-cycle GHG emissions to equivalent tailpipe emissions from U.S. light-duty vehicles and to GHG emission reduction targets from several federal programs.

Direct GHG emissions from the proposed rail line would range from 80,000 to 185,000 $MTCO_2e$ per year across the scenarios. This is equivalent to adding approximately 16,800 to 39,000 passenger vehicles on the road.

Net accumulated life-cycle GHG emissions would range from a reduction of 1.7 $MMTCO_2e$ to an increase of 81 $MMTCO_2e$. On an annual basis over 20 years, the low end of the net life-cycle GHG emissions estimated by OEA is a GHG reduction, equivalent to taking approximately 17,600 vehicles off the road. The high end of the estimate is equivalent to the annual GHG emissions from 855,000 vehicles on the road, or about 0.8 percent of the U.S. light-duty vehicle fleet in 2012.[13]

The United States has committed to reduce its GHG emissions by approximately 17 percent by 2020 from emissions in 2005 (U.S. Department of State 2010). This is equivalent to an annual reduction of 1,230 million metric tons in GHG emissions.[14] The high end of the average annual net life-cycle GHG emissions estimated by OEA would be equivalent to 0.3 percent of this reduction target. The high end of the direct GHG emissions would be equivalent to just over 0.01 percent of this target.

[13] Equivalencies based on USEPA's GHG Equivalency Calculator (http://www.epa.gov/cleanenergy/energy-resources/calculator.html). Looking at the net change in emissions resulting from the proposed rail line in comparison to the competing coal and natural gas scenarios, the net annual emissions would range from a decrease of 0.08 to an increase of 4.06 $MMTCO_2e$ per year for the northern alternatives and an increase of 0.43 to 3.76 $MMTCO_2e$ per year for the southern alternatives. In 2012, there were 111 million light-duty vehicle registrations in the United States (Oak Ridge National Library 2014).

[14] U.S. GHG emissions were 7,254 $MMTCO_2e$ in 2005 (U.S. Environmental Protection Agency 2014b).

On June 2, 2014, USEPA announced its Clean Power Plan, which is expected to reduce GHG emissions from the U.S. power sector by 30 percent in 2030 compared to 2005 levels. This is equivalent to a 734 $MMTCO_2e$ reduction target.[15] The high end of the average annual net life-cycle GHG emissions estimated by OEA from the proposed rail line would be equivalent to 0.6 percent of this reduction target. The high end of the direct emissions target would be equivalent to just over 0.02 percent of this target.

5.2.4.5 No-Action Alternative

Under the No-Action Alternative, TRRC would not construct and operate the proposed Tongue River Railroad. Under this alternative, the proposed Otter Creek Mine and potentially induced Poker Jim Creek–O'Dell Creek and Canyon Creek Mines would not be developed. Tongue River coal would not be transported to domestic coal-fired power plants and downline rail traffic would be unaffected. The tonnage of coal exported to international markets would remain the same, but different coal types with different heat contents would be exported, affecting coal shipments within Asia and the Pacific. The production and combustion of other non-Tongue River coals from the Powder River Basin, other U.S. coal, and Pacific Basin coal would not be affected.

Under the No-Action Alternative, there would be no direct GHG emissions from construction and operation of the proposed rail line. Due to the dynamic effects of the proposed rail line on downline rail traffic and domestic and international coal markets, OEA estimated emissions from the No-Action Alternative relative to the build alternatives, rather than in terms of absolute GHG emissions in the No-Action Alternative.

The results are presented in Table 5.2-17 and show that, depending on the scenario, net accumulated life-cycle GHG emissions from 2018 to 2037 could be slightly greater (1.7 $MMTCO_2e$) under the No-Action Alternative than under the proposed rail line or they could be lower by up to 81 MMTCO2e.

5.2.4.6 Mitigation and Unavoidable Environmental Consequences

To avoid or minimize the GHGs from construction of the proposed rail line, OEA is recommending that the Board impose eight mitigation measures (Chapter 19, Section 19.2.3, *Greenhouse Gases and Climate Change*). These measures would require TRRC to implement an anti-idling policy and provide operator fuel efficiency training programs for construction equipment, source fuels with a minimum biodiesel content of 5 percent (a B5 blend) as available, evaluate the feasibility of hybrid-electric diesel equipment in procurement decisions, evaluate options for microgeneration of renewable energy at construction site offices and accommodations to offset fossil fuel-powered electricity generation, provide group transportation for construction personnel to and from the site to

[15] U.S. electricity generation GHG emissions were 2,446 $MMTCO_2e$ in 2005 (U.S. Environmental Protection Agency 2014b).

minimize traffic, conduct regular preventative maintenance of equipment, minimize vegetation clearing and expedite revegetation of disturbed land, ensure the regular inspection and maintenance of engine powered equipment, and submit a wildfire management plan.[16]

OEA is not recommending additional measures because the Board generally does not impose operating limitations (such as limits on the number of trains per day or equipment requirements) and OEA determined that there are no other reasonable mitigation measures for operation over a relatively short rail line. Further, OEA is not recommending mitigation measures for indirect or cumulative life-cycle GHG emissions impacts from construction and operation of the proposed and potentially induced mines, or coal combustion. The Board's consistent practice has been to mitigate only those impacts that result directly from the proposed project, and these life-cycle emissions would fall outside of the direct impacts of the proposed rail line. In addition, the Board has no jurisdiction or authority over the proposed and potentially induced mines or the combustion of coal by power plants. As a result, the Board has no authority to impose any conditions on those activities.

OEA recognizes, however, that relevant, reasonable mitigation measures may be discussed even if they are outside of the Board's jurisdiction (Council on Environmental Quality 1981) or not recommended for mitigation so as to provide information on the full spectrum of mitigation options. As a result, in addition to the mitigation measures recommended above, OEA has identified mitigation measures described for freight rail operation (Association of American Railroads 2014; Federal Railroad Administration 2009, 2014; Federal Highway Administration 2009; Vyas et al. 2013). Mitigation measures for reducing rail operation emissions include redesigning rail cars to increase their freight capacity; replacing or retrofitting older locomotives with new, more efficient models; improving aerodynamics to reduce drag; adopting new technologies that improve fuel efficiency such as idle-reduction, stop-start technologies, hybrid-electric locomotives, and distributed power control technologies that place locomotives in the middle and the ends of trains for more efficient acceleration and braking; optimizing train speeds and routing; improving train monitoring, control, and maintenance practices; providing training to engineers on best practices such as procedures for shutting down engines, reducing idling, and accelerating and decelerating efficiently; and using alternative fuels such as biofuels, compressed or liquefied natural gas, or hydrogen fuel cells.

There are federal and global programs to address climate change. These programs include the President's Climate Action Plan, which proposed a plan to cut carbon pollution from power plants. More specifically, USEPA's proposed Clean Power Plan would regulate CO_2 emissions of existing generating units through state-level CO_2 emission rate standards. USEPA derived the standards by evaluating potential options for emission reductions in each

[16] OEA's recommendation of these mitigation measures was based on an assessment of available measures for improving fuel efficiency and reducing GHG emissions from construction equipment. In identifying these measures, OEA consulted studies from the U.S. Environmental Protection Agency (2007) and the American Association of State Highway and Transportation Officials (2010). OEA also reviewed measures recommended for mitigation of other environmental impacts that were also relevant to GHG emission impacts from construction activities.

state from generating units and across the broader electric sector. USEPA estimates that the rule will reduce total U.S. power sector emissions by 30 percent from 2005 levels by 2030. The requirements, according to USEPA, could lead to a doubling in coal unit retirements and triple energy efficiency.

5.3 Climate Change

This section analyzes how climate change could affect the proposed rail line and how the proposed rail line could affect the surrounding environment subsequent to projected climate change. This section also includes a discussion of potential climate change inputs to the proposed rail line to provide background for the discussion of how climate change may affect the impacts of the proposed rail line. The affected resources in their current state are identified in Chapter 8, *Biological Resources*, Chapter 9, *Water Resources*, Chapter 11, *Cultural Resources*, Chapter 12, *Land Resources*, Chapter 13, *Geology, Soils, and Paleontological Resources,* and Chapter 15, *Socioeconomics*.

In a recent National Climate Assessment, the U.S. Global Climate Research Program[1] found that extreme weather events, higher temperatures and heat waves, and precipitation changes are affecting the reliability and capacity of transportation systems across the United States, including freight rail, and that these impacts are projected to increase (Schwartz et al. 2014). Climate change could also affect the ability of ecosystems to improve water quality; regulate water flows; buffer against extreme events such as wildfire, floods, and storms; and support plant and animal life (Groffman et al. 2014). These effects could alter the impacts of the proposed rail line on natural resources, including habitat fragmentation, degradation of land and water quality, loss of vegetation, displacement of wildlife, spread of invasive species, soil erosion and displacement, and wildfires.

OEA concludes that adverse impact both on the proposed rail line and on affected resources would range from minor to moderate.

5.3.1 Study Area

The study area for climate change varies by resource area but encompasses all of the areas studied with respect to biological resources, water resources, land resources, cultural and historical resources, geology and soils, and socioeconomics.[2]

5.3.2 Analysis Methods

OEA used the following methods and information to identify projected changes in climate, evaluate climate change impacts on the proposed rail line, and evaluate climate change impacts on affected resources.

[1] The U.S. Global Climate Research Program is a federal program with a mandate is to help the United States and the world better understand, assess, predict, and responds to human and natural causes of climate change. Thirteen federal departments and agencies participate in interagency working groups to implement and coordinate global change research.

[2] See Chapter 8, *Biological Resources*, Chapter 9, *Water Resources*, Chapter 11, *Cultural Resources*, Chapter 12, *Land Resources*, Chapter 13, *Geology, Soils, and Paleontological Resources*, and Chapter 15, *Socioeconomics*.

5.3.2.1 Projected Climate Change Impacts

OEA reviewed two authoritative summaries[3] on historical climate and projected climate change for the state of Montana:[4] the U.S. Geological Survey (USGS) National Climate Change Viewer (U.S. Geological Survey 2014) and the U.S. Global Climate Research Program 2014 National Climate Assessment (Melillo et al. 2014).

The USGS National Climate Change Viewer contains historical and future climate projections at regional, state, and county levels for the continental United States. The viewer comprises *multimodel ensemble data*,[5] meaning the results have been combined across 30 independent climate models developed by researchers around the world that were run under the coordination of the 5th Coupled Model Intercomparison Project (CMIP5).[6] Multimodel data increase the robustness of projections and provide information on the level of uncertainty in the direction and magnitude of future climate trends. The National Aeronautics and Space Administration (NASA) processed the global climate information from CMIP5 using statistical analysis to provide higher geographic resolution of temperature and precipitation projections. This process, known as *downscaling*, provides more detail on how climate might change for a specific area or region. USGS has implemented this downscaled data in its National Climate Change Viewer to provide detailed regional information on projected changes in climate in the United States.

U.S. Global Climate Research Program conducted the National Climate Assessment in 2014 (Melillo et al. 2014). The assessment summarizes the current and future impacts of climate change on the United States. Its findings—which have undergone extensive public and expert peer review—were compiled by a team of more than 300 experts guided by the 60-member Federal Advisory Committee of the National Academy of Sciences. The report uses multimodel ensemble data projections developed under CMIP5, supplemented by information from an earlier phase of the project, CMIP3, where necessary.

OEA summarized information on historical and projected changes in seasonal temperatures and precipitation maximums for the state of Montana. OEA verified that the trends in climate change at the state level apply to the study area by validating these trends against

[3] These sources are publicly available, peer-reviewed, citable sources that are made available by U.S. government agencies and programs. The National Climate Assessment is based on peer-reviewed scientific literature and has been reviewed by multiple U.S. government agencies, the public, and experts. The USGS National Climate Change Viewer draws upon climate information produced by an internationally coordinated body of climate modelers; this is the same dataset used by the Intergovernmental Panel on Climate Change's (IPCC) latest Assessment Report. IPCC reports are based on peer-reviewed scientific literature and vetted by the international scientific community and public stakeholders.

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

[5] Terms that are italicized at first use are defined in Chapter 25, *Glossary*.

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

county-level projections in the National Climate Change Viewer for Custer, Rosebud, Powder River, and Big Horn Counties.

5.3.2.2 Impacts on the Proposed Rail Line

OEA applied the U.S. Department of Transportation Sensitivity Matrix to identify relevant climate change impacts on the proposed rail line (U.S. Department of Transportation 2012).[7] The Sensitivity Matrix documents the relationship between climate hazards (such as extreme heat and intense precipitation) and impacts on transportation systems, including railroads. OEA used information on projected climate changes (Section 5.3.3, *Affected Resources*) and the Sensitivity Matrix to identify the following relationships between climate effects and impacts on railroads in the study area.

- Increased precipitation, particularly in the form of more intense precipitation events and earlier spring thaws, could increase flooding along rivers in the study area, causing damage to the railroad or disrupting rail service.
- Increased precipitation could increase soil erosion or trigger slumping and landslides that could damage the railroad or disrupt rail service.
- Higher temperatures and drier summers could create favorable conditions for wildfires in the area.
- Increases in extreme heat episodes during the summer could increase heat stress on railroad workers, affecting operation and maintenance activities, and could increase the risk of buckling along the railroad tracks.
- Warmer and wetter winters could reduce service delays from extreme cold temperatures, but may increase impacts from heavy snowfall.

For each climate change impact on the proposed rail line, OEA determined how changes in climate could affect the build alternatives by comparing climate change projections against the following.

- Historical records of relevant events or climate hazards.
- Current maps and risk or hazard indices (e.g., flood rate insurance maps, soil classification indices, and wildfire hazard maps).
- Established temperature or precipitation thresholds at which climate impacts on the proposed rail line are expected to become more severe.
- Information on engineering, design, and operational characteristics of the proposed rail line.

[7] The original Sensitivity Matrix documented in Choate et al. (2012) only assessed climate impacts relevant to transportation assets in the Mobile, Alabama area. It did not include impacts from winter storms and snowfall. The U.S. Department of Transportation has been working to expand the relevance of the Sensitivity Matrix to other areas of the United States by incorporating additional information. OEA used a more recent version of the matrix for this analysis that includes impacts from extreme cold and heavy snowfall.

Key sources of this information included the resource chapters in this Draft EIS that corresponded to each impact area, the *2014 National Climate Assessment* (U.S. Global Climate Research Program 2014), the *2013 Update State of Montana Multi-Hazard Mitigation Plan Statewide Hazard Assessment* (Montana Department of Environmental Services 2013), and scientific literature.

5.3.2.3 Impacts on Affected Resources

OEA assessed how projected climate changes for the state of Montana could influence the environmental impacts of the proposed rail line on the study area. OEA reviewed both the anticipated impacts of the proposed rail line on affected resources (identified in the environmental impacts sections of each resource area in this Draft EIS) and the projected changes in seasonal temperature and precipitation maximums for the state of Montana (Section 5.3.3, *Affected Resources*) to determine which impacts of the proposed rail line could be further affected by climate change impacts. The analysis focuses primarily on natural resources (biological, water, land, atmospheric, and geology and soils), but also addresses cultural, social, and economic resources. OEA's assessment relied on recent, authoritative, and peer-reviewed assessments of climate change impacts on resources in the United States, including the *2014 National Climate Assessment* (Melillo et al. 2014), published research that provided insight into the impacts of climate change on specific natural resources, and Intergovernmental Panel on Climate Change assessment reports (Intergovernmental Panel on Climate Change 1996, 2007, 2014).

5.3.3 Affected Environment

This section summarizes the recent and future climate conditions in Montana and the study area; it provides trends and projections in temperature and precipitation for current and historic conditions (1950 to 2005), the near-term future (2020 to 2040), and the midterm future (2040 to 2060).[8] Future changes in climate will depend on the concentration of *greenhouse gases* (GHGs) in the atmosphere resulting from emissions caused by human activities. As a result, climate projections are provided for both moderate and high GHG concentration scenarios.[9]

[8] These periods are roughly consistent with the historic, near-term future and midterm future periods in the USGS National Climate Change Viewer. The near-term period roughly corresponds to the analysis period of the EIS. Given the long-term behavior of climate change, OEA included midterm climate projections in addition to near-term projections.

[9] Unless otherwise noted, the moderate concentration scenario corresponds to Representative Concentration Pathway (RCP) 4.5, and the high concentration scenario corresponds to RCP 8.5. RCPs are scenarios of how the atmospheric concentration of GHGs might increase between now and 2100. They are used in international climate modeling to develop consistent future scenarios of climate change and were adopted by IPCC in its Fifth Assessment Report (AR5).

5.3.3.1 Historical and Projected Changes in Temperature

Montana has a varied climate with relatively cool summers and cold winters. From 1950 to 2005, the highest temperatures[10] in the state reached above 80 degrees Fahrenheit (°F) and the highest monthly average temperature in the summer (June through August) was 83°F (U.S. Geological Survey 2014). In Southeast Montana between 1971 and 2000, the hottest 7 days of the year exceeded temperatures of 95°F (Shafer et al. 2014: Figure 19.3). Annual average temperatures in Custer, Powder River, Rosebud, and Big Horn Counties were several degrees higher than the state average, which was 54.5°F from 1950 to 2005 (U.S. Geological Survey 2014).

The lowest temperatures in Montana during winter (December through February) were below 11°F, and the minimum monthly temperature in the winter was 4.5°F from 1950 to 2005. The study area has experienced a warming trend in the past five decades, and annual average maximum temperatures have increased by 1.4°F (U.S. Geological Survey 2014).

Seasonal temperatures in the study area are projected to increase in the near term.[11] Across Montana, hot summer temperatures (those at the 90th percentile) could rise by 4.8 to 5.0°F in moderate and high GHG concentration scenarios from 2025 to 2050, relative to the 1950 to 2005 period (U.S. Geological Survey 2014). Cold winter temperatures (those at the 10th percentile) are projected to increase by 3.8 to 4.5°F in moderate and high GHG concentration scenarios over 2025 to 2050, relative to the 1950 to 2005 period.

This trend continues into the midterm,[12] where the 90th percentile temperature in Montana is projected to increase by 6.5 to 8.9°F between 2050 and 2075. The number of days exceeding 95°F for Southeast Montana are projected to increase from 7 days currently, to 13 days in a low GHG emissions scenario, and to 19 days in a high emissions scenario between 2040 to 2060 (Shafer et al. 2014: Figure 19.3).[13]

5.3.3.2 Historic and Projected Changes in Precipitation

Typically, the average monthly precipitation is greatest from April through September in Montana, with most precipitation falling as rain during the April-September growing season (U.S. Geological Survey 2014). May and June are usually the wettest months of the year (Montana Department of Environmental Quality 2003a). The southeastern portion of the

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

[11] Unless otherwise noted, *near term* corresponds to the time period from 2020 to 2040.

[12] Unless otherwise noted, *midterm* corresponds to conditions from 2040 to 2060.

[13] The low and high emissions scenarios here refer to B1 and A2 emissions scenarios, respectively, from the 2000 IPCC *Special Report on Emissions Scenarios*. The B1 scenario involves lower population and economic growth that results in lower, more gradual increases in GHG emissions over the coming decades than the A2 scenario, which envisions stronger population growth and development with limited technologies to reduce GHG emissions. These scenarios have been superseded in the international climate modeling by RCP scenarios. Not all projections have been updated with the latest GHG concentration scenarios, so the older emissions scenarios have been retained where new information is not yet available.

state receives slightly less rainfall than the statewide average. From 1950 to 2005, precipitation in Montana averaged 0.04 and 0.06 inch per day in spring and winter, respectively (U.S. Geological Survey 2014). The wettest 7 days of each year in southeast Montana averaged 0.5 to 0.6 inch of precipitation per day from 1970 to 2000 (Shafer et al. 2014: Figure 19.4). The maximum number of consecutive dry days in southeast Montana was 25 to 35 days between 1970 and 2000 (Shafer et al. 2014: Figure 19.5).

In the near term, most climate models project that winter, spring, and fall will become wetter compared to the average from 1950 to 2005. Summers are projected to become slightly drier, although some climate models disagree and instead project that summer precipitation will remain the same or increase. The full spread of projections ranges from a 32 percent decrease to a 19 percent increase in July precipitation relative to historic summer precipitation (U.S. Geological Survey 2014). The largest increases in precipitation are projected to occur in spring and winter. Precipitation levels across the state could increase by 8 and 10 percent in the winter and spring, respectively, in a moderate GHG emissions scenario (U.S. Geological Survey 2014). In a high GHG emissions scenario, winter and spring precipitation could increase by 7 and 12 percent, respectively.

Similar changes are projected to continue in the midterm: the winter, spring, and fall seasons are predicted to become wetter, while summers could become drier, although this is less certain—ranging from a 50 percent decrease to a 25 percent increase in July precipitation relative to historic summer temperatures (U.S. Geological Survey 2014). Across Montana, winter and spring precipitation levels are projected to increase by 9 and 15 percent, respectively, in a moderate GHG emissions scenario compared to the 1950 to 2005 average. Under a high GHG emissions scenario, winter and spring precipitation could increase by 13 and 18 percent, respectively (U.S. Geological Survey 2014). The maximum number of consecutive dry days between 2040 and 2070 is projected to remain the same as the period from 1970 to 2000, or could increase slightly by 1 to 3 additional days under low and high emissions scenarios.[14] (Shafer et al. 2014: Figure 19.5) The precipitation trends for Southeast Montana are similar in magnitude to statewide projections (U.S. Geological Survey 2014). Table 5.3-1 presents the historical and projected climate changes in Montana.

[14] The low and high emissions scenarios here refer to B1 and A2 emissions scenarios, respectively, from the 2000 IPCC *Special Report on Emissions Scenarios*. These scenarios have been superseded in the international climate modeling by RCP scenarios. Not all projections have been updated with the latest GHG concentration scenarios, so the older emissions scenarios have been retained where new information is not yet available.

Table 5.3-1. Historical and Projected Climate Changes in Montana

Climate Variable	Historical Climate and Observed Changes	Short-Term Projected Changes (2020–2040)	Medium-Term Projected Changes (2040–2060)	Level of Certainty in Projections
Temperature	Summer: • Highest temperatures (top 10%, or 90th percentile) in Montana were above 80.6°F between 1950 and 2005 (U.S. Geological Survey 2014) • Hottest seven nights annually in Southeast Montana reached temperatures of 95°F between 1970 and 2000 (Shafer et al. 2014:Figure 19.3) Winter: • Lowest temperatures (bottom 10%, or 10th percentile) were below 11.1°F (U.S. Geological Survey 2014)	Summer and winter temperature extremes are projected to increase: • 90th percentile temperature in Montana is projected to increase by 4.8 to 5.0°F under moderate and high emissions scenarios between 2025 and 2050 compared to 1950 to 2005 (U.S. Geological Survey 2014) • 10th percentile temperature in Montana is projected to increase by 3.8 to 4.4°F under moderate and high emissions scenarios between 2025 and 2050 compared to 1950 to 2005 (U.S. Geological Survey 2014)	Summer and winter temperature extremes are projected to increase: • 90th percentile temperature in Montana is projected to increase by 6.5 to 8.9°F under moderate and high emissions scenarios between 2050 and 2075 compared to 1995 to 2005 (U.S. Geological Survey 2014) • In Southeast Montana, the number of days above 95°F would increase by 13 to 16 days in a low emissions scenario (B2), and 19 to 22 days in a high emissions scenario (A2) (Shafer et al. 2014:Figure 19.3) • 10th percentile temperature in Montana is projected to increase by 6.1 to 7.8° F under moderate and high emissions scenarios between 2050 and 2075 compared to 1950 to 2005 (U.S. Geological Survey 2014)	• Monthly temperature is projected to increase in all months across all models compared to 1950 to 2005 (U.S. Geological Survey 2014)

Climate Variable	Historical Climate and Observed Changes	Short-Term Projected Changes (2020–2040)	Medium-Term Projected Changes (2040–2060)	Level of Certainty in Projections
Precipitation	Average precipitation in winter and spring in Montana was 0.04 and 0.06 inch/day, respectively, between 1950 and 2005 (U.S. Geological Survey 2014) The highest (i.e., top 10% or 90th percentile) monthly average precipitation in Montana was 0.08 inch/day between 1950 and 2005 (U.S. Geological Survey 2014) Maximum number of consecutive dry days in Southeast Montana was 25 to 35 days between 1970 and 2000 (Shafer et al. 2014: Figure 19.5)	Wetter winter, spring, and fall seasons; likely drier summers: Change in average precipitation by season in Montana under moderate and high emission scenarios between 2020 and 2040 compared to 1950 to 2005 average (U.S. Geological Survey 2014): Winter: +7 to +8% Spring: +10 to +12% Summer: -2% Fall: +3 to +5% Intensity of extreme rainfall[a] could increase: 90th percentile precipitation in Montana is projected to increase by 7 to 10% under moderate and high emissions scenarios by 2025 to 2050 compared to 1950 to 2005 (U.S. Geological Survey 2014)	Wetter winter, spring, and fall seasons; likely drier summers: Change in average precipitation by season in Montana under moderate and high emission scenarios between 2040 and 2060 compared to 1950 to 2005 average (U.S. Geological Survey 2014): Winter: +9 to +13% Spring: +15 to +18% Summer: -3 to -4% Fall: +3 to +6% Intensity of extreme rainfalla could increase: 90th percentile precipitation in Montana is projected to increase by 8% under both moderate and high emissions scenarios by 2050 to 2075 compared to 1950 to 2005 (U.S. Geological Survey 2014)	Uncertainty in magnitude and direction of change in precipitation is highest in spring and summer months (U.S. Geological Survey 2014): Most models (25 of 30) project that monthly average precipitation will increase in winter, spring, and late fall compared to 1950 to 2005 A majority of models (19 of 30) project that precipitation will decrease in the summer compared to 1950 to 2005

Notes:

Unless otherwise noted, the moderate emissions scenario corresponds to RCP 4.5, the high emissions scenario corresponds to RCP 8.5.

B2 and A2 scenarios refer to emissions scenarios from the *Special Report on Emissions Scenarios* (Intergovernmental Panel on Climate Change 2000). These scenarios have been superseded in the international climate modeling by RCP scenarios. Since not all projections have been updated with the latest GHG concentration scenarios, these scenarios have been retained where new information is not yet available.

For seasonal results, winter is an average of December, January, February months; spring: March, April, May; summer: June, July, August, and fall: September, October, November.

[a] Intensity of extreme rainfall is the magnitude of rain events in the 90th percentile (i.e., top 10% of all rain events for precipitation in a given time period).

Source: U.S. National Aeronautics and Space Administration

5.3.4 Environmental Consequences

Climate change impacts on the proposed rail line could affect operation of any build alternatives. Climate change could also influence the impacts of the proposed rail line on resources in the study area. Climate change impacts on the proposed rail line are presented first, followed by climate change impacts that could influence the impacts of the proposed rail line on affected resources for all build alternatives. The degree to which a specific build alternative is exposed to climate impacts is discussed where information is available.

5.3.4.1 Climate Change Impacts on the Proposed Rail Line

Changes in current and historical patterns of temperature and precipitation could affect operation and maintenance of the proposed rail line. This section identifies impacts of climate change on the proposed rail line.

- **Increase Flooding**

  Anticipated changes in precipitation in the Tongue River, Otter Creek, and Rosebud Creek watersheds could affect the frequency and intensity of flooding in the Tongue River basin. Flooding could damage the proposed rail line, washout *ballast*, cause *scour* at water crossings and culverts, place debris in rights-of-way, and disrupt service along the railroad and access to related facilities.

  Chapter 9, Section 9.4, *Floodplains*, found that flood events have rarely reached major flood status along the Tongue River, Otter Creek, and Rosebud Creek basins, although there are historical cases of moderate and minor floods on the Tongue River downstream of the Tongue River Dam. Section 9.4 also identified floodplains in the study area by reviewing existing Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRMs) that have been developed for Custer, Rosebud, Powder River, and Big Horn Counties and a National Resource Conservation Service (NRCS) classification of the frequency at which soils in the area flood. Section 9.4, Table 9.4-4, *Road Relocation and Rail Line Floodplain Impacts within the Right-of-Way*, presents the results of this analysis, which shows that the Tongue River Alternatives, Colstrip Alternatives, and Tongue River Road Alternatives would cross the current 100-year FEMA floodplain in the Tongue River and Rosebud Creek watersheds, respectively; the Moon Creek East Alternative and Decker Alternatives would not. The rights-of-way of any build alternative would intersect with NRCS soils that flood at least one to five times every 100 years in the Tongue River and Rosebud Creek basins.

  Streamflows along the Tongue River and Rosebud Creek are driven by precipitation and snowmelt (Hydro Solutions 2011, Montana Department of Environmental Quality 2003b), so changes in extreme precipitation and the timing of snowmelt would likely affect streamflow and the frequency and magnitude of flood events. Both average seasonal precipitation and the magnitude of extreme precipitation events in the winter and spring are projected to increase in the study area and upstream of the Tongue River in the near and long term. Spring precipitation is projected to increase by 10 to 12 percent in the short term and 15 to 18 percent in the midterm compared to historical climate data; the magnitude of the top 10 percent of precipitation episodes is projected to increase by roughly 8 percent over the short- and midterm (U.S. Geological Survey 2014).[15] There is some disagreement among climate models over whether precipitation will increase in the spring and summer; under drier conditions in the spring and summer, the risk of flooding from heavy rainfall events would be reduced. Spring temperatures are also projected to increase, leading to earlier and faster spring thaws that may increase downstream *ice-jam flooding* in the study area. These trends suggest that the frequency or magnitude of flood events, or both, along the Tongue River and Rosebud Creek could increase in the future.

The relationship between precipitation and flooding is complicated and varies in terms of the pattern and timing of precipitation over the Tongue River and Rosebud Creek basins, the lag time between snowfall and snowmelt, and flow control from the Tongue River Dam on the Tongue River (Hydro Solutions 2011). Although increases in winter and spring precipitation could increase both the incidence and magnitude of flood exposure along the rights-of-way where they intersect with FEMA (for the Tongue River Alternative, Colstrip Alternative, and Tongue River Road Alternative) or NRCS floodplains (any build alternative), it is difficult to establish a direct spatial and temporal link between precipitation and streamflow.

- **Increase Landslides and Soil Erosion**

  Changes in precipitation in the study area could affect the likelihood of soil slumping and slope failure, or landslides. Landslides can be triggered by precipitation, human activities, seismic activity, or a combination of these factors, in areas with topographic and geologic conditions that are susceptible to slides (Montana Department of Environmental Services 2013). Although landslides are primarily associated with mountainous landscapes, low-relief areas can also be susceptible to land movement, particularly in areas where cut-and-fill techniques are used for construction (U.S. Geological Survey 2004).

  Although a recent update to the *Montana Pre-Disaster Mitigation Plan* (Montana Department of Environmental Services 2013) indicates that the study area does not have a significant history of landslides, these geologic hazards are among the most common in the state (Montana Department of Environmental Services 2013). Landslides in the area could directly damage the proposed rail line and associated facilities. Furthermore, landslides along nearby rivers in the study area could alter the flow of water and cause subsequent flooding. The study area is characterized by terrain that ranges from gently sloping to very steep and many of the build alternatives contain soils that have moderately poor qualities for supporting rail tracks. Chapter 13, *Geology, Soils, and*

[15] Ranges in climate projections are given for moderate and high GHG concentration scenarios (i.e., RCP 4.5 and 8.5).

Paleontological Resources, Figures 13-1c and 13-1d, show that the Tongue River Alternative, Colstrip Alternative, Tongue River Road Alternative, Moon Creek Alternative, and both Decker Alternatives would follow the Tongue River in steeper areas with slopes exceeding a 5 percent grade. Chapter 13, *Geology, Soils, and Paleontological Resources*, Figures13-3c and 13-3d, show that these alignments would pass through Yamac-Havre and Yamac-Kirby-Cabbart-Birney soil associations, which have fair to moderately poor qualities for rail subgrade.

Each build alternative would require *cut and fill* to meet ruling grade requirements, which can affect slope stability. Some areas may be more susceptible to slumping or slope failure in wet conditions. Steeper terrain would require more cut and fill than flatter terrain, so the build alternatives with a greater share of steep slopes (i.e., grades exceeding 5 percent) would generally have more cut and fill than others. Chapter 13, *Geology, Soils, and Paleontological Resources*, Table 13-3, shows that over one-third of the land in each of the build alternatives has a slope that exceeds a 5 percent grade. The Tongue River Alternatives, Tongue River Road East Alternative, and Moon Creek East Alternative would have the longest lengths of track (between 30 and 33 miles) at grades exceeding 5 percent. The shortest build alternatives—the portions of new track required for either of the Colstrip Alternatives—would also have the shortest track length at grades greater than 5 percent (between 15 and 18 miles).

Slope saturation by water is a primary cause of landslides (U.S. Geological Survey 2004). Intense rainfall, increased runoff, and extended periods of soil saturation are associated with landslides. Therefore, the potential for landslides could increase given the 7 to-10 percent projected increase in the highest (90th percentile) monthly average precipitation by 2025 to 2050, compared to the 1950-to-2005 baseline (U.S. Geological Survey 2014).[16] Similarly, increased snowfall and rapid spring warming, coupled with more intense rainfall, could produce additional runoff and conditions suitable for landslides. Drier conditions, which cannot be ruled out, would reduce the potential for slope saturation to trigger landslides in the area.

A direct relationship between precipitation and landslides does not exist because landslide vulnerability is a function of location (precipitation, topography, and geology), human activity, use, and historical landslide activity. In addition, the exact nature of soils in a right-of-way and the potential for slope failure can only be determined in detailed geologic and engineering studies. Currently, terrain in the study area is not prone to landslides but may become more prone to landslides because of permanent land disturbances from cut-and-fill and increased precipitation in the winter, spring, and fall.

- **Increase Frequency of Wildfires**

  Increased temperatures and drier conditions in summer could increase the likelihood of wildfires in the study area under all of the build alternatives. Three factors influence

[16] Ranges in climate projections are given for moderate and high GHG concentration scenarios (i.e., RCP 4.5 and 8.5).

wildfire behavior: fuel, weather, and topography. These components increase the likelihood of a fire, the speed and direction at which a fire travels, and the intensity at which it burns, as well as the ability to control and extinguish a fire. Wildfire behavior varies as wind, slope, and fuel moisture change (FireSafe Montana 2009). Wildfires could directly damage railroad infrastructure and facilities by warping rails and metal bridge components (National Research Council 2008). Smoke from wildfires could reduce visibility and cause delays.

Chapter 8, Section 8.2, *Vegetation*, determined that wildfires are a common occurrence in Montana. A history of recent wildfires in the study area, increased temperatures, earlier spring snowmelt, and drier summer conditions have contributed to an increase in wildfire risks. Fire risks for all build alternatives would be categorized as low risk: between 60 to 90 percent of the right-of-way acreage in low-risk areas and 6 to 30 percent in medium-risk areas (the 6 percent estimate corresponds to the Moon Creek Alternative; the 30 percent estimate corresponds to the Colstrip Alternative). Only the Tongue River Alternative, Colstrip Alternative, Tongue River Road Alternative, and Moon Creek Alternative would have rights-of-way in high-risk areas, totaling 2 to 5 percent of the total acreage (Chapter 8, Section 8.2, *Vegetation*, Figure 8.2-2).[17]

Increasing temperatures, extreme heat events, and drought could affect fire regimes by influencing the length of the fire season and contributing to drier conditions and the availability of readily combustible fuel for fires (Mote et al. 2014). In the Northern Rockies, researchers have identified a transition in the mid-1980s from large, infrequent, and short-lived wildfires to more frequent and longer-burning fires resulting from warmer springs, longer summer dry seasons, drier vegetation, and longer fire seasons (Westerling et al. 2006).

Results from the 30 climate models in the National Climate Change Viewer project that spring and summer temperatures will increase across Montana, with the maximum monthly summer temperature increasing by 3.5 to 4°F in the short term, and 5 to 7°F in the midterm. At the same time, projections from the majority of climate models in the National Climate Change Viewer indicate that summer precipitation could decrease in the study area between 2 to 4 percent, although there is some disagreement among the models, and some indicate that summers could become slightly wetter[18] (U.S. Geological Survey 2014). The longest period of consecutive dry days in the midterm is projected to remain about the same or slightly increase compared to current conditions (Shafer et al.

[17] Chapter 8, Section 8.2, *Vegetation*, examined wildfire risk using a recent assessment that included Montana (Oregon Department of Forestry, Western Forestry Leadership Coalition, and Council of Western State Foresters 2012). The assessment developed a Fire Threat Index (FTI) that classifies land into different wildfire risk categories. The FTI does not assign low, medium, or high categories; rather fire threat is scored on a scale of 1 (lowest risk) to 9 (highest risk). For the purposes of summarizing results from the FTI, OEA grouped areas scoring 1 to 3 as low risk, areas scoring 4 to 6 as medium risk, and areas scoring 7 to 9 as high risk.

[18] Ranges in climate projections are given for moderate and high GHG concentration scenarios (i.e., RCP 4.5 and 8.5).

2014).[19] Projections, therefore, point to hotter and possibly drier summers. Consequently, wildfires are likely to increase across all build alternatives, though there is also a potential for wetter summers with reduced wildfire. It is uncertain if or where these changes would increase low- or medium-level risks to high-risk areas along each build alternative because of the various components that influence wildfire risk.

- **Alter Frequency and Intensity of Extreme Heat Events**

  Changes in the frequency and intensity of extreme heat events in the study area could affect the long-term operation and maintenance of the proposed rail line. Rapid swings in temperature and extreme heat can increase the risk of *buckling* from thermal expansion of the rail. Since buckling is a known cause of rail accidents, higher temperatures could increase accident frequency and may require delays in service or speed restrictions to avoid derailments. Increased incidence of buckling can occur at temperatures exceeding 110°F (Office of the Federal Coordinator for Meteorology 2002), but speed restrictions have been imposed at lower temperatures.

  The proposed rail line would use continuously welded rail for the track construction (Chapter 2, Section 2.2.12.3, *Siding Tracks and Set-Out Tracks*). Although it is easier to maintain than jointed rail, given proper maintenance and monitoring, continuously welded rail is generally more susceptible to temperature-related buckling (Office of the Federal Coordinator for Meteorology 2002) because there are no, or few, breaks in the track to relieve internal stress. Consequently, track owners must establish a federally approved CWR plan for installing, adjusting, inspecting, and maintaining continuously welded rail track (Federal Railroad Administration 2014).

  Extreme heat may also increase the risk of worker heat exhaustion (Office of the Federal Coordinator for Meteorology 2002), requiring frequent breaks or shifting daytime maintenance activities to nighttime. The Occupational Health and Safety Administration (OSHA) recommends that workers exposed to temperatures above 91°F implement precautions such as frequent rest breaks; at temperatures above 103°F, OSHA recommends shifting strenuous work to earlier or later in the day and enforcing work/rest schedules (Occupational Safety and Health Administration 2011). Expected rail operation staffing includes two track inspectors, two carmen/inspectors, and a three-person section gang (Chapter 2, Section 2.3.2, *Staffing*, Table 2-4). These seven employees would be most exposed to high outdoor temperatures, which would put them at higher risk of heat exhaustion and require longer and more frequent rest periods that could slow inspection and repairs.

  Finally, extreme heat may affect the reliability of grid electricity for communications towers and signals, requiring the use of backup power systems (ICF International 2013). The proposed rail line would require *single-phase distribution lines* of relatively low

[19] The range in number of consecutive dry days is given for low and high GHG emissions scenarios (i.e., B2 and A2 scenarios). B2 and A2 scenarios refer to emissions scenarios from the *Special Report on Emissions Scenarios* (Intergovernmental Panel on Climate Change 2000).

voltage to support the signal systems and detectors that identify dragging rail equipment and hot wheel bearings (Chapter 2, Section 2.2.12.4, *Power Distribution Lines*). Consequently, reduced grid reliability during periods of extreme heat could affect the operation of these systems, or increase the reliance on backup power systems.

The impacts of extreme heat on these assets and personnel could become more pronounced under future changes in climate, but the current projections do not provide sufficient clarity on whether future maximum temperatures would increase the frequency or severity of impacts on the proposed rail line. The number of days above 95°F is anticipated to increase by 12 to 16 days in a low emissions scenario and 19 to 22 days in a high emissions scenario (Shafer et al. 2014: Figure 19.3), which would increase the possibility that such impacts could be realized.

- **Alter the Intensity of Winter Storms and Snowfall**

  Changes in temperature and precipitation can affect the intensity of winter storms and cause extreme cold and snowfall in the study area. The impacts from extreme cold would likely be reduced with higher winter temperatures projected in the future. It is not clear how changes in snowfall and winter storms would affect rail operation.

  Cold weather can cause delays in operation, reduce visibility, and prevent access to equipment and facilities for maintenance operation. Tracks could become brittle at extremely low temperatures and effective braking could be reduced. As a result, rail operators may need to run shorter trains in cold conditions, resulting in reduced capacity for freight operation and potentially an increase in the number of trains per day. Icing of tracks could reduce traction and affect braking and train speed (National Research Council 2008, Peterson et al. 2008). Changes in climate would likely reduce the impacts of extremely cold temperatures on rail equipment and personnel, as minimum winter temperatures are projected to increase by 4.7 to 5°F in the short term and by less than 7°F in the midterm.

  How changes in snowfall and winter storms would affect rail operation would depend on the nature of the precipitation. Snowfall has increased in Montana since the 1920s (Kunkel et al. 2009) and winter precipitation is projected to increase by 7 to 8 percent and 9 to 13 percent over the short- and midterm, respectively.[20] If this precipitation falls as snow, it may increase delays resulting from poor visibility, reduced train speed, bottlenecks, and access problems along tracks and associated facilities.

5.3.4.2 Climate Change Effects and Affected Resources

This section discusses overall climate change impacts for the state of Montana that could alter impacts of the proposed rail line on affected resources. It focuses on the potential effects of climate change on the impacts of the proposed rail line on natural resources

---

[20] Ranges in temperature and precipitation projections are given for moderate and high GHG concentration scenarios (i.e., RCP 4.5 and 8.5).

(including biological, water, land, atmospheric, and geologic resources). This analysis describes which impacts are anticipated to be affected by projected changes in temperature and precipitation for each of these natural resource areas.

There are higher levels of certainty in projecting general climate change trends (e.g., future changes in monthly or annual average temperature) than in projecting specific climate change impacts on resources in the study area. This section focuses on summarizing the most likely and relevant impacts of concern.

- **Alter Landscapes**

  Chapter 8, *Biological Resources*, Chapter 9, *Water Resources*, and Chapter 12, *Land Resources*, discuss the impacts of rail construction and operation on biological, water, and land resources, such as altered vegetation communities, habitat loss, *degradation* and *alteration* of wildlife, wildlife displacement, and barriers to movement. Changes in flooding, landslides, extreme heat, and drier summer conditions caused by climate change may exacerbate these impacts. Increases in winter and spring rainfall and snowmelt may lead to more floods and increase the risk of landslides in the study area, while potential decreases in summer precipitation may lead to drier conditions or drought (Section 5.3.4.1, *Climate Change Impacts on the Proposed Rail Line*). These climate change impacts could exacerbate impacts resulting from the proposed rail line by further altering the land, contributing to soil erosion, displacing sediment, and increasing stress on migrating species. If increased winter precipitation falls as snow, for example, it may limit the ranges of species already stressed by habitat loss, degradation, and alteration, wildlife displacement and barriers to movement caused by construction and operation. A study linking climate change impacts to sage-grouse winter habitats found that "heavy snowfall may even further reduce the amount of suitable habitat by limiting the abundance of sagebrush above the snow" (Doherty et al. 2008). Similarly, higher temperature extremes could cause further stress on wildlife or vegetation already affected by habitat loss, degradation, or alteration resulting from the proposed rail line (Chapter 8, *Biological Resources*).

- **Exacerbate Water Quality Concerns**

  Construction and operation of the proposed rail line could lead to water quality degradation, depletion, and associated impacts on natural resources (Chapter 8, *Biological Resources*, and Chapter 9, *Water Resources*). Projected changes in precipitation and increasing temperatures could further degrade water quality and deplete water supply in summer months, exacerbating the impacts from the proposed rail line on these resources. Decreases in summer precipitation and additional *evapotranspiration* (the loss of water from the soil by evaporation and transpiration) resulting from higher summer temperatures are anticipated to intensify droughts across the Great Plains region. A slight to modest increase in the frequency and severity of drought in southeast Montana

(Strzepek et al. 2010) is anticipated. Drier conditions could exacerbate water quality concerns described in Chapter 9, Section 9.2, *Surface Water*.

Increases in average annual maximum temperatures in Montana—which are projected to rise by 3.4 to 3.8°F in the short term and by 4.9 to 6.8°F in the midterm[21] (U.S. Geological Survey 2014)—could, in turn, increase water temperatures. Changes in air and water temperatures could further stress both terrestrial and aquatic wildlife and vegetation that are sensitive to temperature changes. For example, many aquatic invertebrates require colder water temperatures followed by a rapid increase in spring temperatures to hatch their eggs. Even small increases in winter water temperature have been found to cause local extinctions of these species (Lehmkuhl 1974).

Increased precipitation (particularly during intense precipitation events in winter and spring months) may oversaturate soils and increase erosion, which could alter the hydrology of sensitive habitats (e.g., wetlands and riparian habitats) already affected by construction and operation. Erosion and sedimentation from permanent changes to the landscape resulting from cut-and-fill activities, in combination with increased precipitation, may together increase nutrient, pollution, and sediment loads that degrade water quality (as discussed in Chapter 9, Section 9.2, *Surface Water*). Steeper terrain would also require more cut and fill than flatter terrain, so the build alternatives with a greater share of steep slopes (grades exceeding 5 percent) would generally have more cut and fill than others. The Tongue River Alternatives, Tongue River Road East Alternative, and Moon Creek East Alternative have the longest lengths of track (between 30 and 33 miles) at grades exceeding 5 percent.

Precipitation increases due to climate change may also exacerbate impacts resulting from the proposed rail line, such as drainage of contaminants or pollutants from the railroad into nearby water resources (Shafer et al. 2014).

- **Exacerbate the Spread of Invasive Species and Noxious Weeds**

Rail construction and operation have the potential to introduce and increase the spread of invasive species and noxious weeds that could encroach upon and compete with native vegetation, reduce biodiversity, and alter sensitive ecosystems (Chapter 8, Section 8.2, *Vegetation*, Section 8.3, *Wildlife*; Chapter 9, Section 9.5, *Wetlands*). Climate change impacts could exacerbate the spread of invasive species and noxious weeds. Projected warmer winter temperatures, higher summer temperatures, drier summer conditions, and the resulting habitat alterations could further facilitate the survival and spread of hardier invasive species and noxious weeds that have been introduced during rail construction and operation. Chapter 8, Section 8.2, *Vegetation*, notes that invasive plant species are often more aggressive than native vegetation, and the disturbed conditions of a construction site can create an environment (bare and compact soil, disturbed surfaces)

[21] Ranges in temperature projections are given for moderate and high GHG concentration scenarios (i.e., RCP 4.5 and 8.5); short-term corresponds to a 2025 to 2050 time period; midterm corresponds to the 2050-to-2075 time period.

where noxious weeds can thrive. Observed climate-induced changes have also been linked to shifts in species distributions, declines in the abundance of native species, and the spread of invasive species (Shafer et al. 2014). Increased temperatures and drier conditions in summer months could increase evapotranspiration and decrease water availability (Strzepek et al. 2010), which could result in declines in native species (including special status species) that are less adaptable or hardy than invasive species (Shafer et al. 2014).

- **Increase Erosion Potential**

  Environmental impacts on water, biological, geologic, and atmospheric resources resulting from erosion caused by the proposed rail line are discussed in Chapter 8, Section 8.2, *Vegetation;* Chapter 9, Section 9.2, *Surface Water*, and Section 9.4, *Floodplains*; and Chapter 13, *Geology, Soils, and Paleontological Resources*. Increased temperatures and drier conditions in summer months, as well as increased precipitation in winter, spring, and fall could exacerbate soil erosion and soil instability (one of the anticipated impacts of rail construction and operation). As noted in Chapter 13, construction methods requiring "extensive cut and fill to meet ruling grade requirements…would result in substantial permanent physical impacts on the existing topography." Soil erosion that is accelerated by the proposed rail line in places "where hills or slopes are cut in erodible soils" or "where exposed soils are not protected from erosion" could be further exacerbated by climate change. Increased evaporation from hotter, drier summers could worsen wind erosion (Intergovernmental Panel on Climate Change 1996), and increased precipitation could lead to floods, unstable soil, slope failure, and nutrient runoff.

  All soils in the rights-of-way of the build alternatives have a low susceptibility to erosion,[22] although the stability of soils crossed would vary by build alternatives (Chapter 13, *Geology, Soils, and Paleontological Resources*). The Tongue River Road Alternatives and Moon Creek Alternatives would have the least-erodible soils—at least 40 percent of the soils in the rights-of-way of these alternatives possess qualities that make them resistant to erosion. Increases in precipitation may increase the soil erodibility factor of the affected soil by increasing soil saturation. Increased soil erosion and displacement may increase nutrient and water stress by reducing the water-holding capacity and organic matter contents of soils (Intergovernmental Panel on Climate Change 2007). Water and soil degradation would, in turn, affect vegetation and wildlife that are dependent on these resources, exacerbating habitat loss, land fragmentation, and water quality impacts from the proposed rail line.

[22] All soils in rights-of-way in the study area have soil erodibility factors equal to or less than 0.37, which means they are considered resistant to erosion.

- **Increase Frequency and Severity of Wildfires**

  Chapter 8, Section 8.2, *Vegetation*, and Chapter 12, Section 12.2, *Land Use*, describe the risk of railroad operation igniting wildfires in the study area and the impacts that wildfires could have on the environment (e.g., altered vegetation structure) within and extending beyond the right-of-way. Railroad operation would be responsible for a very small fraction of wildfires, and a smaller fraction of land area burned by fires. Even so, the projected hotter, drier summers could lengthen the fire season and contribute to drier conditions that could add to the availability of readily combustible fuel for fires (Mote et al. 2014). These climate changes could increase the frequency and severity of wildfires caused by railroad operation.

- **Influence Cultural, Historic, and Socioeconomic Impacts**

  While the focus of this section is on impacts of the proposed rail line on natural resources that may be exacerbated by climate change, climate change may also affect cultural, social, and economic resources that are relevant to the proposed rail line.

  It is difficult to project indirect climate change impacts and feedback effects over large resource areas. For example, increases in the frequency or severity of wildfires could lead to increased loss and damage in the built environment (e.g., homes, businesses) and agricultural lands. This loss and damage could, in turn, result in displacement of people from homes or businesses and lost income from agricultural or recreational activities. Floods could similarly cause loss, damage, and displacement. Water depletion and degradation may result in disruptions and economic losses from affected agricultural or recreational activities as well as human health issues. Some groups, such as the elderly, young, or low-income groups, are disproportionately vulnerable to these climate change impacts and have decreasing ability to adapt to the changes. Climate change may increasingly threaten culturally important animal species and ceremonial plants that are highly valued by tribes. As noted in the recent U.S. Global Climate Research Program National Climate Assessment (Shafer et al. 2014):

  > …populations such as the elderly, low-income, and non-native English speakers face heightened climate vulnerability... While tribal communities have adapted to climate change for centuries, they are now constrained by physical and political boundaries. Traditional ecosystems and native resources no longer provide the support they used to.

  Climate change may also result in some benefits to affected resources. For example, projected increases in winter temperatures could result in less cold stress on humans and animals (Shafer et al. 2014). Reduced cold stress could be beneficial to the survival of species stressed due to other proposed rail line impacts (e.g., habitat loss, degradation, and alteration resulting from construction and operation). Warmer winter temperatures may also lead to a longer growing season (Shafer et al. 2014). This change could help offset some of the anticipated loss in productivity in agricultural operations described in Chapter 15, *Socioeconomics*, and could benefit native vegetation displaced due to rail construction and operation, as well as encroaching noxious weeds and invasive species.

5.3.4.3 No-Action Alternative

Under the No-Action Alternative, TRRC would not construct and operate the proposed Tongue River Railroad, and there would be no impacts on climate change from construction or operation of the proposed rail line. The changes to the affected environment resulting from climate change would occur even if the proposed rail line was not built.

5.3.4.4 Mitigation and Unavoidable Environmental Consequences

OEA is not recommending that the Board impose mitigation measures for climate change. Although projected changes in precipitation, temperature, and extreme events are likely to affect the proposed rail line and affected resources over the coming decades, OEA cannot determine the level of adaptation necessary due to the imprecision in the timing and magnitude of the changes. OEA concludes that adverse impacts on the proposed rail line and on affected resources would range from minor to moderate.

5.4 Applicable Regulations

Over the last decade, state and federal programs have been developed to mitigate increasing levels of greenhouse gas (GHG) concentrations in the atmosphere. At the federal level, the U.S. Environmental Protection Agency (USEPA) has implemented programs requiring GHG reporting and permitting for certain facilities. Many states have contributed to regional climate initiatives and have adopted legislation to increase renewable energy sources within their state. These programs are described in Table 5.4-1.

Table 5.4-1. Regulations, Statutes, and Guidance Related to Greenhouse Gases and Climate Change

Regulation, Statute, Guideline	Explanation
Federal	
National Environmental Policy Act (42 U.S.C. § 4321 *et seq*.)	Requires the consideration of potential environmental effects, including potential effects of (or on) contaminated sites in the environmental impact statement for any proposed major federal agency action. NEPA implementation procedures are set forth in the President's Council on Environmental Quality's Regulations for Implementing NEPA (40 C.F.R. Part 1500).
Clean Air Act (42 U.S.C. § 7401 *et seq*., as amended in 1977 and 1990).	In 2007, the U.S. Supreme Court ruled that GHGs are air pollutants under the CAA. Because of this decision, in 2009, USEPA proposed the Endangerment Finding and the Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the CAA. This Endangerment Finding covers six main GHGs: CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6 (U.S. Environmental Protection Agency 2009). While these findings do not directly impose any regulations on industry, they have set the required legal foundation for regulating GHG emissions from sources including vehicles, power plants, and industrial facilities.
U.S. Environmental Protection Agency	In 2013, USEPA issued a proposal to regulate GHGs from new coal- and gas-fired power plants larger than 25 megawatts. The regulations would effectively require new coal-fired power plants to incorporate emissions-reduction technologies to meet the proposed threshold of 1,100 pounds CO_2 per megawatt-hour over a 12-month period (U.S. Environmental Protection Agency 2013). In addition, USEPA is developing regulations for existing power plants that will be less stringent than regulations for new plants. This regulation will make it more expensive to burn coal in the future, which could limit the potential market for Tongue River coal.
Council on Environmental Quality: *Revised Draft Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in NEPA Reviews* (2014)	Published in 2014, these CEQ guidelines provide direction on how federal agencies can improve their consideration of GHG emissions and climate change effects during the evaluation of proposals for federal actions subject to NEPA review. The guidance focuses on GHG emissions resulting from proposed projects and their alternatives, as well as how climate change will affect a given project and its alternatives. The draft guidance suggests that an annual direct emissions threshold level of 25,000 metric tons or more of CO_2e for a proposed action be used as a reference point for when agencies should

Regulation, Statute, Guideline	Explanation
	prepare a quantitative assessment of the associated impacts. The CEQ guidance does not recommend a comprehensive review of climate change impacts for all projects, but encourages agencies to consider the likely scale of impacts and to analyze impacts that can be readily quantified. The guidance also suggests that NEPA reviews address climate mitigation and adaptation measures when evaluating project alternatives; emissions from all stages in a project's life cycle, including emissions from indirect sources, vehicles, and material supply where feasible; and impacts from climate change on the proposed action and alternatives, as well as the affected environment for a proposed action, where relevant (Council on Environmental Quality 2014).
State Many states have developed policies to mitigate GHGs and several have developed, or plan to develop, climate adaptation plans. The following section describes some of the regional initiatives as well as Montana-specific policies.	
Western Climate Initiative	The Western Climate Initiative is a regional, multisector, GHG emissions reduction initiative that includes California and several Canadian provinces. The goal of the group is to reduce regional GHG emissions by 15 percent below 2005 levels by 2020 (Western Climate Initiative 2010). While Montana collaborated in the design of the program during 2007 and 2008, it has not yet formally joined the program (Western Climate Initiative 2013).
Climate Change Advisory Council	In 2007, Montana's Climate Change Advisory Council recommended a GHG target of reducing emissions to 1990 levels by 2020 to go along with their recommendations in Montana's *Climate Change Action Plan* (Climate Change Advisory Council 2007). This target is voluntary, as it does not appear to have been adopted formally in law.
Montana House Bill 25	In 2007, Montana passed House Bill 25 which prohibits its main utility (Northwest Energy) from acquiring an equity interest, leasing, or contracting a new coal plant unless carbon capture and storage technology is implemented to reduce CO_2 emissions by at least 50 percent. In addition to Montana, California, Oregon, Washington, and Illinois also have some form of GHG emissions performance standard from the power sector (Center for Climate and Energy Solutions 2014).
Renewable Power Production and Rural Economic Development Act	In 2005, Montana established a target for the state to obtain 15 percent of its energy from renewable sources by 2015. In addition to Montana, a significant majority of states in the western half of the United States have either a voluntary or mandatory renewable power source (North Carolina Solar Center 2014).
Local No local GHG regulations apply to the proposed rail line.	

Notes:
NEPA = National Environmental Policy Act; U.S.C. = United States Code; CEQ = Council on Environmental Quality; C.F.R = Code of Federal Regulations; GHG = greenhouse gas; CAA = Clean Air Act; USEPA = U.S. Environmental Protection Agency; CO_2 = carbon dioxide; CH_4 = methane; N_2O = nitrous oxide; HFCs = hydrofluorocarbons; PFCs = perfluorocarbons; SF_6 = sulfur hexafluoride; CO_2e = carbon dioxide equivalent ; CEQ = Council on Environmental Quality