4.3 Risk Considerations

Impacts of a spill of oil or any hazardous material, should one occur, depend on multiple factors, such as the chemical properties of the spilled material and the environmental conditions at the time of the spill. These factors are described below.

4.3.1 How do the characteristics of spilled materials contribute to potential impacts?

The proposed action would involve the handling, storage, and transport of crude oil. These materials, described in the following subsections, have unique characteristics that contribute to spill risks and impacts.

4.3.1.1 Material Characteristics

Hazardous Materials Classification

The federal hazardous material regulations (49 CFR 171–180) require the proper classification and characterization of a material, which, in turn, determine its transportation requirements. Hazardous materials are categorized by analysis and experience into hazard classes and packing groups based on the risks they present during transportation. Characterization includes identifying the effects a material has on both the reliability and safety of the packaging that contains it. Crude oil's properties and characterization may vary considerably based on time, location, method of extraction, temperature at time of extraction or processing, and the type and extent of processing of the material (Section 4.3.1.2, *Crude Oil*).

Currently, as shipped, crude oil is classified as Class 3 flammable liquid. The U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) issued a safety alert on January 2, 2014, warning of potential crude oil variability. The alert emphasized conducting proper and sufficient testing to ensure accurate characterization and classification. The safety alert expressed PHMSA's concern that unprocessed crude oil may affect the integrity of packaging or present additional hazards related to corrosiveness, sulfur content, and dissolved gas content. The final rule issued by PHSMA in May 2015 (80 FR 26643) requires accurate classification and enhanced standards for transportation of highly flammable materials, including Bakken crude oil. The specifics of these requirements and the implications for safety in the study area are discussed in Section 4.5, *Environmental Health Risks—Rail Transport.*

Flash Point

Flash point is the temperature at which a fuel will ignite when exposed to an open flame. The flash point is used as an index of fire hazard for hazardous materials. A Class 3 flammable liquid has a flash point of not more than 140°F (60°C) (49 CFR 173.120). Bakken crude oil has a flash point of less than 73°F (23°C). Bitumen has a high flash point of 304°F (151°C). However, diluted bitumen would be expected to have a lower flash point because diluents (thinning or diluting agents) are added to make bitumen less viscous (Section 4.3.1.2, *Crude Oil*). Diluent typically makes up 20 to 30% of the volume of diluted bitumen. The flash points of various oils are presented in Table 4.3-1.

Table 4.3-1. Flash Points of Petroleum Products

Material	Flash Point
Bitumen	304°F / 151°C
Biodiesel	266°F/ 130°C
Bakken crude oil	73°F or 23°C
Heavy crude oil (conventional)	< 54°F / < 12°C
Light sweet crude	16°F/ -9°C
Diluted bitumen	-31°F/ -35°C
Gasoline	-45°F/ -43°C

Source: Jokuty 2005 in Tsaprailis 2014

Persistent and Nonpersistent Oils

Persistence describes how long oil persists in the environment. Persistence is one of many factors that determine the impacts of an oil spill and the type and effectiveness of the recovery methods employed. Therefore, along with the amount of oil spilled, the physical characteristics of the area, and the local weather conditions, the persistence of the oil is incorporated into the development of response plans and evaluation criteria used by Washington State, the U.S. Coast Guard (USCG), and the U.S. Environmental Protection Agency (EPA). The definitions of persistent and nonpersistent oils are listed in Table 4.3-2.

Table 4.3-2. Definitions of Oil Persistency for Response Plan Regulations

Nonpersistent oils (Group I)	A petroleum-based oil that consists of hydrocarbon fractions: At least 50% of which, by volume, distills at a temperature of 340°C (645°F) At least 95% of which, by volume, distills at a temperature of 370°C (700°F)
Persistent oils (Group II to Group V)	Group II: specific gravity less than 0.85 Group III: specific gravity equal to or greater than 0.85 and less than 0.95 Group IV: specific gravity equal to or greater than 0.95 and less than 1.0 Group V: specific gravity equal to or greater than 1.0

Generally, nonpersistent oils (Group I oils) such as diesel, kerosene, and gasoline have lower viscosity and dissipate quickly in the environment. However, rapid dissipation does not diminish the acute toxic effects of such oils on organisms if materials are spilled in higher quantities or on public health if the fumes are confined.

Persistent oils (Groups II through V) are heavier oils with higher viscosity that persist longer in the environment. Crude oil is a persistent oil. Bakken crude oil is a Group II oil and diluted bitumen is a Group IV or V oil (Section 4.3.1.2, *Crude Oil*).

Oil weathering (how the physical and chemical characteristics of the spilled oil change over time) can affect the persistence of oil in the environment. The processes involved in weathering, such as spreading, evaporation, dispersion, emulsification, dissolution, photo-oxidation, sedimentation and sinking, and biodegradation are described in Appendix N, *Oil Spill Modeling*.

4.3.1.2 Crude Oil

Bakken Crude Oil

As discussed in Chapter 3, Section 3.14, *Hazardous Materials*, Bakken crude oil is typically characterized as a light crude oil; it contains more volatile components and flows more easily (is less viscous) than heavier types of crude oil. It would be expected to float on both fresh water and salt water (International Tanker Owners Pollution Federation Limited 2011:2). In general, Bakken crude oil is moderately toxic. It contains a moderate amount of volatile components along with some persistent compounds that can cause long-term contamination of surface and subsurface waters (Washington State Department of Ecology 2015:389). This type of oil leaves a residue of up to one-third the volume of the spill after a few days, and it is generally possible to clean it using appropriate response measures. Under response plan regulations (Table 4.3-1), Bakken crude oil is considered a Group II Persistent Oil.

Diluted Bitumen

The bitumen imported into the United States is produced from Canadian oil sands. Bitumen is a highly viscous, nearly solid type of petroleum that occurs in natural deposits along with clay, sand, and water. For transport, bitumen is diluted with diluents such as natural gas condensates, naphtha, or other light oils and called diluted bitumen (also known as *dilbit*) (National Research Council 2013: 34-35 and 47).

Although dilbit is classified as a crude oil, the added diluent means that, when spilled into the environment, dilbit will behave differently than other heavy oils (National Oceanic and Atmospheric Administration 2015). Under response plan regulations, dilbit is treated as a Group III Persistent Oil (POLARIS Applied Sciences 2013:4). Group III oils have a specific gravity equal to or more than 0.85 and less than 0.95. The specific gravity of fresh water is 1, which means that dilbit is less dense than fresh water and, if spilled in the environment, would initially float in fresh water and salt water.

If spilled dilbit were to remain in the marine environment, the lighter components would evaporate and, as experienced during a 2010 spill of dilbit (the 2010 Enbridge spill in the Kalamazoo River, Michigan), the leftover residue becomes denser than what was spilled initially.[1] The responders for the Enbridge spill found that after the oil remained in the environment for a few hours or days, it sank because its composition changed (weathered).[2] Oil that sinks below the surface of the water is harder to see and harder to recover.

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[1] The 2010 Marshal Spill (Kalamazoo River in Kalamazoo, Michigan) from the Enbridge Pipeline is the only documented spill of dilbit into an aquatic setting in the United States. The spill occurred after a 30-inch pipeline ruptured on Monday, July 26, 2010, near Marshall, Michigan. The release was estimated at 843,000 gallons.

[2] During a study conducted in Gainford, Alberta in 2013 over a 10-day period, spilled dilbit crude oil did not submerge or sink under simulated weather conditions (Witt O'Brien's et al. 2013: 61). However, the study authors note that after weathering (particularly in a fresh water environment) and with the addition of sediment dilbit could become submerged (Witt O'Brien's et al. 2013: 41 and 60).

4.3.2 What environmental factors contribute to potential impacts from an incident?

Factors such as the amount of oil spilled, product characteristics and persistence, physical characteristics of the area, local weather conditions, and water flow conditions can influence the outcome of a spill. These factors are important to consider for planning and responding to spills. This section provides information for these factors and describes how they influence the spill consequences.

4.3.2.1 Air Dispersion

Volatile vapors released from a spill may create flammable atmospheres or inhalation hazards. Air monitoring should be implemented as soon as possible by first responders. Responders should wear self-contained breathing apparatus to avoid potential exposure when responding. Climatic patterns that may affect the dispersion of vapors in the study area are presented in Appendix D, *Air Data*.

4.3.2.2 Weather Conditions

Weather conditions can influence the movement and spread of oil in the environment. Weather in the study area is typically windy and rainy in winter and relatively cool in summer, with some periods of fog in summer and, to a lesser degree, in the fall. Wind and fog conditions are often local to Grays Harbor. Winds recorded at Bowerman Airport (in Grays Harbor) are generally from the east or northeast during the winter and the west or southwest or directly from the south (less frequently) during the summer. The strongest winds, more frequent during winter storms from October through March, reach gale force (34 to 40 knots) 3 to 6% of the time. Average wind speeds year round are generally 9 to 10 miles per hour. Storms are less frequent in the spring and summer.

In the winter, rain falls on about 15 to 25 days per month. Rainfall diminishes to 8 to 15 days per month in the spring and 5 to 10 days per month in the summer. Average temperatures range from 35 to 50°F in midwinter to a high of 68 to 69°F in the hottest summer months (July to August).

Weather near the lower Chehalis River is similar to weather in Grays Harbor. Further inland along the river toward Centralia, the weather is similarly mild. The interior of western Washington has slightly less measurable rainfall on record than along the coast (150 days each year versus 190 days along the coast) and temperatures are generally 10 degrees warmer in the summer months.

4.3.2.3 Water Flow

In addition to fog and swells caused by high winds, water flow conditions in the Bar Channel Reach of the Grays Harbor Navigation Channel (at the entrance of the harbor) vary depending on ebb or flood tidal currents, speed of the Chehalis River runoff, wind, and ocean swells just outside the entrance. Average current velocity is about 1.9 knots on the flood and 2.8 knots on the ebb but velocities have been known to reach 5 knots. The direction of the current near the bar can be erratic, running north close inshore and south offshore. In the harbor, current velocities in the navigation channels seldom exceed 3 knots. The tidal cycle in Grays Harbor is mixed semidiurnal (two high tides and two low tides in a 24-hour period with varied heights), which means that tidal height relative to mean low water ranges from less than 1 foot to almost 9 feet twice a day.

The discharge rate (flow) in the Chehalis River Basin is characterized by seasonal variation, with sharp rises of relatively short duration from October to March corresponding to the period of heaviest rainfall (U.S. Army Corps of Engineers 2003). A low flow of 731 cubic feet per second is based on the period of record (1952 to 2013) for the U.S. Geological Survey stream gauge at Porter, Washington. Higher flow events range from a 2-year flood (31,000 cubic feet per second) to a 100-year flood (83,000 cubic feet per second). Flow velocities for these flow events in the lower Chehalis River average 1.3 cubic feet per second for the low flow case, 4.0 cubic feet per second for the 2-year flow case, and 4.8 cubic feet per second for the 100-year flow case. These average velocities are influenced by the shallow gradient of the river and the backwater effect of the tidally influenced portion of the river. While these velocities can vary based on the tides, they are typical for a river with similar topography and hydrologic characteristics.