31.0 ACCIDENTS OR MALFUNCTIONS

31.1 INTRODUCTION

This section assesses the effects of potential accidents or malfunctions that could occur during construction and operation of the Project, including their potential effects. For this assessment:

- An accident is an unexpected occurrence, unplanned event, or unintended action that can result in an adverse effect.
- A malfunction is the failure of a piece of equipment, device, or system that can result in an adverse effect.

31.1.1 Identification of Potential Accidents or Malfunctions Scenarios

Accidents or malfunctions are infrequent and generally short term in nature. The focus of this section is on accidents or malfunctions that could result in effects that may exceed acceptable levels without implementation of specified mitigation measures, even if their likelihood of occurrence is low. The types of Project-related accidents or malfunctions considered scenarios are identified in the Application Information Requirements (BCEAO 2014). They are based on previous experience with similar projects and environmental assessments, and with input from government agencies and Aboriginal groups.

The types of accidents or malfunctions considered in this assessment are:

- hazardous material spills
- release of drilling muds
- leakage or failure of the pipeline during operation
- motor vehicle or helicopter accidents
- marine vessel accidents
- forest fire
- fly rock from blasting
- explosion or fire
- sediment release into watercourses or marine environment.

31.1.2 Methods Used to Assess the Potential Risk of an Accident or Malfunction

For each accident or malfunction event considered, the following steps describe the approach taken to assess the potential risk:

- the potential event for project construction and operation
- the likelihood and circumstances under which the potential accidents, malfunctions, or unplanned events might occur
- measures proposed to reduce the likelihood or consequences of an event
- effects that might result from the event, should contingency plans not be fully effective, in a manner generally consistent with the direct effects assessment
- the likelihood of the effects occurring
- contingency, clean-up, or restoration work that would be required immediately following, or in the long-term, after potential accidents or malfunctions to mitigate the effects
- the significance of residual effects that might persist after clean-up or restoration work
- conclusions about risk.

The assessment is also supported by previous experience and trends reported in recent pipeline performance reports published by the British Columbia (BC) Oil and Gas Commission (OGC) and the National Energy Board (NEB). Although the Project will not be regulated by the NEB, NEB sources have been used to augment the information available from the OGC.

Potential interactions between project activities and valued components (VCs) that could result in an accident or malfunction are presented in Table 31-1. Interactions are assigned a Rank of 0, 1, or 2, and are described as follows:

- Rank 0 are not assessed as they are expected to have no interaction.
- Rank 1 are described but not assessed further as the resulting effect can be managed to negligible or acceptable levels through standard operating procedures and/or through the application of best management or codified practices.
- Rank 2 could result in effects that may exceed acceptable levels without implementation of specified mitigation measures and as such are assessed in further detail in Section 31.3 to Section 31.11.

Table 31-1: Potential Interactions
Accidents or Malfunctions and Valued Components

Valued Component	Hazardous Material Spills	Release of Drilling Muds	Leakage or Failure of the Pipeline during Operation[1]	Motor Vehicle or Helicopter Accidents[2]	Marine Vessel Accidents[2]	Forest Fire[3]	Fly Rock from Blasting	Explosion and Fire[4]	Sediment Release into Watercourses or Marine Environment
Air Quality	1	0	0	0	0	2	0	1	0
Acoustic Environment	0	0	0	0	0	0	0	1	0
Freshwater Aquatic Resources	2	2	1	0	0	2	1	1	2
Marine Resources	2	2	1	0	2	0	1	1	2
Wildlife and Wildlife Habitat	1	1	1	1	0	2	1	1	0
Vegetation and Wetland Resources	2	1	1	0	0	2	0	1	0
Soils	1	1	1	0	0	1	0	1	0
Greenhouse Gases	0	0	1	0	0	1	0	1	0
Water Quality	2	2	1	0	1	2	0	0	1
Hydrology	0	0	0	0	0	1	0	0	1
Employment	0	0	0	0	1	1	0	0	0
Infrastructure and Services	1	1	1	1	0	1	0	1	0
Transportation	1	0	1	1	1	2	0	1	0
Visual Quality	1	0	0	0	0	2	0	1	0
Land and Resource Use	1	1	1	0	0	2	0	1	0
Heritage and Archaeological Resources	0	0	0	0	0	1	0	1	0
Human Health	1	1	1	2	2	2	2	2	0

Notes:

[1] Explosions and fires resulting from pipeline failure are assessed under Explosions or Fires.

[2] Interactions of motor vehicle or helicopter collisions or marine vessel accidents that result in spills or fires are assessed under Hazardous Material Spills and Explosion or Fire.

[3] This also includes other types of fire.

[4] Interactions for the Explosion or Fire scenario are ranked for explosion because interactions related to fire are addressed under the Forest Fire scenario.

0 = No interaction.

1 = Interaction occurs; however, based on past experience and professional judgment, the resulting effect can be managed to negligible or acceptable levels through standard operating procedures and/or through the application of best management or codified practices. No further assessment is warranted.

2 = Interaction occurs, and resulting effect may exceed acceptable levels without implementation of specified mitigation measures. Further assessment is warranted.

The criteria and significance thresholds used for the assessment of effects of potential accidents or malfunctions are consistent with those used in the effects assessments for each VC in this Application for an Environmental Assessment Certificate (EAC). The categories of likelihood and consequence used to describe each accident or malfunction (as they might occur over the life of the project or applicable activity) are defined following the risk assessment approach used by TransCanada:

- Likelihood (post-mitigation)
  - Remote (<5%)
  - Low (>5% - <25%)
  - Moderate (>25% - <50%)
  - High (>50% - <75%)
  - Very High (>75%)
- Consequence (post-mitigation)
  - Very Low (localized short-term effect; recovery within days or weeks)
  - Low (localized long-term effect; recovery within the life of the project)
  - Moderate (widespread effect; recovery within the life of the project)
  - High (widespread effect; not recoverable within the life of the project)
  - Very High (loss of a considerable portion of a VC).

Data and trends, where available, were used to inform the determination of likelihood.

The assessment of the potential risk of effects resulting from accidents or malfunctions involves the use of a risk matrix, where the product of likelihood (post-mitigation) and consequence (post-mitigation) identifies the level of potential risk (Figure 31-1). Risk levels are colour coded to provide a visual means of expressing risk, the definitions of which are provided in Figure 31-2.

31.2 EMERGENCY RESPONSE PLANNING

Prince Rupert Gas Transmission Limited (PRGT) has the following emergency response and contingency planning in place (also described in more detail in Section 36):

- Emergency Response Plan
- Adverse Weather Contingency Plan
- Flood and Excessive Flow Contingency Plan
- Wet Soils Contingency Plan
- Fire Suppression Contingency Plan
- Soil Erosion Contingency Plan

- Spill Contingency Plan
- Directional Drilling Procedures and Instream Drilling Mud Release Contingency Plan.

TransCanada Pipelines Limited (TransCanada) has numerous environmental management plans that apply to operations across North America. As the Project enters the operation phase, TransCanada's operating procedures for environmental management will take effect.

The accidental event scenarios, project phase, and associated response plans are summarized in Table 31-2. The plans referenced in this section are also described in more detail in Section 36 (Summary of Proposed Environmental and Operational Management Plans).

Table 31-2: Accidental Event Scenario According to Project Phase and Associated Response Plan

Plan	Hazardous Material Spills	Release of Drilling Muds	Leakage or Failure of the Pipeline during Operation[1]	Motor Vehicle or Helicopter Accidents[2]	Marine Vessel Accidents[2]	Forest Fire[3]	Fly Rock from Blasting	Explosion or Fire[4]	Sediment Release into Watercourses or Marine Environment
Construction Phase									
Emergency Response Plan	X	X		X	X	X	X		X
Fire Suppression Contingency Plan						X			
Spill Contingency Plan	X								
Drilling Mud Release Contingency Plan		X							
Soil Erosion Contingency Plan									X
Wet Soils Contingency Plan									X
Flood and Excessive Flow Contingency Plan									X
Operation Phase									
Emergency Response Plan			X	X		X		X	
Fire Suppression Contingency Plan						X		X	
Spill Contingency Plan	X								

Notes:

[1] Explosions and fires resulting from pipeline failure are assessed under Explosions or Fires.

[2] Interactions with spills or fires resulting from motor vehicle or helicopter collisions or marine vessel accidents are assessed under Hazardous Material Spills and Explosion or Fire.

[3] This also includes other types of fire.

[4] Interactions for the Explosion or Fire scenario are ranked for explosion because interactions related to fire are addressed under the Forest Fire scenario.

31.3 HAZARDOUS MATERIAL SPILLS

The effects resulting from a hazardous material spill (including those that could result from vehicle/helicopter accidents and marine vessel accidents) are assessed in this section. The release of natural gas is not considered a hazardous material spill and is assessed in Section 31.5. Vehicle/helicopter accidents and marine vessel accidents that do not result in a hazardous materials spill are addressed in Sections 31.6 and 31.7, respectively.

31.3.1 Description of the Potential Event

Under the provincial *Environmental Management Act (2003)* Spill Reporting Regulation, a spill is any release or discharge into the environment, not authorized under the *Act*, of a substance in an amount equal to or greater than the amount provided in the Schedule specified by the Spill Reporting Regulation. Spills considered in this assessment include both small and large scale releases of materials such as:

- fuels (e.g., gasoline, diesel, and propane) and lubricants (e.g., engine oil and hydraulic oil) (used during construction only)
- methanol (used during construction only)
- ethylene glycol (used during operation only)
- paint and solvents (used during construction only).

If not contained and managed properly, hazardous materials can pose a threat to the environment. A number of hazardous materials contain components that are toxic to various VCs, even in small quantities. Some are readily flammable or explosive (Section 31.10).

31.3.1.1 Small Scale Releases of Hazardous Materials

The accidental release of hazardous materials on land or in an aquatic environment (freshwater or marine) could occur during construction and operation, including during the conduct of maintenance activities. Potential spills could occur during materials transfer (e.g., vehicle refueling), could involve the rupturing of a fuel or hydraulic line, or could result from a vehicle/vessel accident (either on land or in the marine environment). Equipment failure or operator error could be contributing factors to these possible scenarios.

31.3.1.2 Large Scale Releases of Hazardous Materials

For the purposes of this assessment, large scale releases of hazardous materials (on land or in an aquatic environment) are characterized by those that would trigger the *Environmental Management Act (2003)* Spill Reporting Regulation, and are those that are more likely to result in potential residual environmental effects.

Large scale releases of hazardous materials could result from road accidents involving fuel trucks where the tank is ruptured and fuel is released into the environment (terrestrial or aquatic), or marine vessel collisions or groundings that also result in the release of large quantities of fuel, oils, or lubricants into the marine environment.

31.3.2 Likelihood that the Potential Event Could Occur

31.3.2.1 Small Scale Releases of Hazardous Materials

Non-pipeline liquid spills include hydraulic oil, lubricant oil, paints and solvents, ethylene glycol, valve operator fluids, or equipment fuels. These materials have the potential to be released primarily during construction. Non-pipeline liquid spills related to NEB-regulated pipelines are typically small (approximately 0.2 m^3 per spill [NEB 2011]). In 2009, there were 18 leaks less than or equal to 1.5 m^3 with a total leaked volume of 5 m^3. Small scale releases of hazardous materials are anticipated to have a moderate to high likelihood of occurring during construction.

Based on TransCanada's experience, the likelihood for hazardous spills to occur during operation is primarily limited to events at the compressor stations, and is considered to be low. A hazardous spill event at a compressor station would be contained within the station.

31.3.2.2 Large Scale Releases of Hazardous Materials

Spills in quantities that would trigger the *Environmental Management Act (2003)* are considered to have a remote likelihood of occurring during construction or operation due to project design, plans and controls specifically intended to limit such a possibility.

Only one non-pipeline liquid spill related to NEB-regulated pipelines was in excess of 1.5 m^3 in 2009 (NEB 2011), which would require reporting under the *Environmental Management Act*. Between 2000 and 2009, only eight spills with volumes greater than 1.5 m^3 have occurred.

31.3.3 Design Measures to Reduce the Likelihood of the Event and Consequences of an Effect

The Project will be designed, operated, and managed to reduce the potential for hazardous spills of any size. The transportation, storage, and handling of hazardous materials will be conducted in accordance with the *Transportation of Dangerous Goods Act*, Workplace Hazardous Materials Information System (WHMIS), and any other applicable regulations. Additionally, PRGT will adhere to the Spill Contingency Plan that is being developed for the project and will be implementing TransCanada's Chemical and Waste Management Plan, both of which will reduce the likelihood and consequence (i.e., effect) of a spill occurring. Both plans are described in Section 36.

Spill prevention is a key mitigation measure to reduce the likelihood of a hazardous materials spill of any size. Reportable spill amounts will follow those outlined for substances listed in the schedule provided under the BC *Environmental Management Act* Spill Reporting Regulation. In the marine environment particularly, provisions for spill reporting, containment, and clean-up are also included under the *Canadian Environmental Protection Act*, in conjunction with the *Canada Shipping Act* and *Fisheries Act* and will be followed where applicable.

PRGT also has a waste and hazardous materials program that outlines spill response during operation of the pipeline. The following are examples of mitigation measures and processes used to reduce the likelihood and consequence of hazardous material spills:

- The project does not create hazardous materials as a by-product.
- Facility sites will be designed to contain any hazardous material spills. Any required secondary containment will comply with applicable federal, provincial, and municipal requirements.
- Project personnel who would come in contact with hazardous materials will receive training in the proper handling, identification, documentation, and storage of wastes and hazardous materials (e.g., WHMIS training and Transportation of Dangerous Goods certification) as outlined in the Spill Contingency Plan.
- Equipment will be kept clean and in good operating condition and will be regularly inspected.
- Spill response equipment and materials will be kept onsite and on pipelay vessels and will be readily available.
- Hazardous materials storage and refueling areas will be located more than 100 m (or in accordance with applicable *Acts* and regulations) from wetlands, watercourses, or waterbodies, unless secondary containment is provided.
- Existing pipelines will be identified using BC One Call and clearly marked before ground is disturbed.
- Fuel tank and transfer facility design will follow federal and provincial regulatory guidance to mitigate and reduce the likelihood of accidents or malfunctions.
- Marine supply vessels will refuel larger construction vessels at sea and will follow established safety protocols.
- Marine vessels will adhere to Annex I of the *International Convention for the Prevention of Pollution from Ships* (MARPOL 73/78).

31.3.4 Description of the Potential Residual Effect

Smaller scale releases are considered to be readily mitigated and cleaned up by the measures PRGT will have in place during construction and operation (e.g., adherence to applicable regulations, and the implementation of WHMIS, the Spill Contingency

Plan and the Chemical and Waste Management Plan). Only the potential residual effects of large scale releases are therefore described further below.

A large scale hazardous material spill is not expected to interact with the acoustic environment, greenhouse gases, hydrology, employment, and heritage and archaeological resources valued components (and have therefore been assigned Rank 0 as per Table 31-1); no further assessment is required.

With the mitigation measures described above in place, interactions with air quality, wildlife and wildlife habitat (with the exception of marine birds), soils, infrastructure and services, transportation, visual quality, land and resource use, and human health can be managed to negligible or acceptable levels (Rank 1 as per Table 31-1). Residual effects are likely to be not significant and no further assessment is warranted.

Large scale spills affecting vegetation and wetland resources, freshwater aquatic resources, freshwater quality, marine resources, marine birds, and marine water quality could result in effects that may exceed acceptable levels primarily during construction (Rank 2 as per Table 31-1). These potential effects are assessed in more detail below.

31.3.5 Likelihood of the Effect Occurring

The likelihood of a large scale hazardous materials spill to occur during construction that would affect vegetation and wetland resources, freshwater aquatic resources, freshwater quality, marine resources, and marine water quality is considered remote based on the design prevention measures outlined in Section 31.3.3.

The likelihood of a large scale hazardous materials spill to occur during operation that would result in residual effects to the receiving environment (in this case vegetation and wetland resources) is also considered remote based on the design prevention measures outlined in Section 31.3.3.

31.3.6 Contingency, Clean-up, and Restoration Methods

In the unlikely event of a large scale spill, measures outlined in the Spill Contingency Plan would be implemented. These measures have been developed to provide a rapid and coordinated response to the spill event, reducing effects on the environment. The Spill Contingency Plan contains:

- steps for initial response
- spill containment and clean-up procedures
- reporting contacts and procedures.

The Spill Contingency Plan will include procedures for all spills of hazardous materials. Should the spill occur in the marine environment, the Environmental Response Branch of the Canadian Coast Guard (located in Prince Rupert) will also be notified for assistance with containment and clean-up as required.

31.3.7 Assessment of Residual Effects and their Significance

As presented in Table 31-1, large scale spills affecting freshwater aquatic resources, freshwater quality, marine resources, marine birds, marine water quality, and vegetation and wetland resources could result in effects that may exceed acceptable levels without the implementation of specified mitigation measures and as such are assessed in further detail.

31.3.7.1 Effects on Freshwater Aquatic Resources and Freshwater Quality

A large-scale spill scenario during construction that could affect the freshwater environment could consist of an accident involving a fuel truck that results in the release of fuel into a fish-bearing stream. Freshwater habitat, fish (including species of conservation concern and those that are part of, or support, a commercial, recreational, or Aboriginal fishery), and water quality could be adversely affected.

Diesel fuel is often a light, refined petroleum product that will generally disperse and evaporate naturally within 24 hours or less depending on the quantity spilled (NOAA 2014). When spilled into an aquatic environment, diesel can spread quickly into a thin film that is then dispersed by waves and currents (NOAA 2014). Given the properties of diesel fuel, it is not anticipated that a long-term effect on freshwater quality will result, particularly once spill response procedures have been implemented.

Fuel spills can have immediate and toxic effects on aquatic biota (e.g., stream invertebrates and fish) but recovery is possible in the short term (e.g., within a few years), particularly with respect to invertebrates (Lytle and Peckarsky 2001). Recovery of in-stream and riparian habitat is expected to occur over longer periods of time, particularly if clean-up efforts required the removal of vegetation. Depending on the volume of material released, the size of the stream, and the speed of the initial spill response and containment, the geographic extent could vary between a localized extent to one that is more widespread.

31.3.7.2 Effects on Marine Resources, Marine Birds, and Marine Water Quality

Large-scale spills of hazardous materials, including those resulting from a marine vessel accident, can alter marine water quality and potentially harm marine resources, including marine birds. The extent of effects would depend in part on the toxicity and quantity of the material spilled and the currents and tidal cycle in the marine environment. Effects are assessed for the construction phase as it is considered unlikely that spills occurring during operation would result in effects to the marine environment that could not be readily mitigated.

Marine diesel fuel, which is the most likely hazardous material to be involved in a spill in the marine environment, is considered to be a non-persistent hydrocarbon (as compared to a persistent hydrocarbon such as crude oil) which dissipates rapidly (i.e., within days) from the water surface when released (Environment Canada 1999). Even in calm sea conditions, up to 40% of the volume released can be lost to evaporation within two days (Environment Canada 1999). Given these properties, marine diesel fuel is not anticipated to have a long-term effect on marine water quality, particularly following the implementation of spill response procedures. Marine diesel can still pose a threat to marine organisms, particularly birds, if they are exposed to the spill.

Diesel is known to have an immediate toxic effect on many intertidal organisms, including periwinkle, limpet, gastropods, amphipods, and many meiofaunal organisms (Stirling 1977; Cripps and Shears 1997). However, literature suggests coastal habitats such as eelgrass beds and salt marshes are relatively resilient to effects of oiling and recovery typically occurs within two to three years (Laurel et al. 2003; DeLaune and Wright 2011; Lin and Mendelssohn 2012).

There is also potential for diesel fuel to reduce habitat quality through contamination from hydrocarbons, including potential effects on plankton. Phytoplankton might have limited or inhibited air-sea gas exchange and light penetration and could experience reduced productivity and growth near a hydrocarbon spill (González et al. 2009; Abbriano et al. 2011). Zooplankton responses to hydrocarbons vary by species, with mortality being more dependent on exposure time than the concentration of oil at the site (Lee et al. 1977; Abbriano et al. 2011). Full recovery of zooplankton communities are expected to occur soon after a spill due to their short generation time and high fecundity (Seuront 2011).

The effects of a diesel spill on marine birds can be toxicological in nature if birds are directly exposed to the fuel, and can also potentially result in a change or decline in the distribution or abundance of bird numbers if valuable habitats (e.g., breeding or feeding areas, including effects to fish and invertebrates that serve as prey species) are degraded by the spill. Due to the highly volatile nature of marine diesel fuel, potential effects are anticipated to be short term (with respect to how long diesel remains in the environment) to longer-term (with respect to bird recovery), localized, and reversible, particularly following the implementation of spill response measures. Effects to marine birds may be acute; however, it is not anticipated that they will result in widespread effects to local marine bird populations.

All mobile equipment and refueling areas will be supplied with appropriate spill kits so that if a spill occurs, the primary containment response can be rapidly deployed and will help limit the extent and magnitude of a hazardous materials spill.

The effects of a hazardous materials spill on marine water quality, marine birds, and marine resources could be moderate in magnitude, local or regional in extent (depending on the volume of material spilled and the potential influence of tides and currents), of short term duration, and reversible.

With the application of mitigation measures, it is expected that residual effects would be not significant because a spill is unlikely to result in long-term or widespread effects to marine water quality or result in an overall reduction in the productive capacity of marine bird habitat, marine fish habitat, or fish and bird populations.

31.3.7.3 Vegetation and Wetlands

Potential effects of a large scale hazardous materials spill on terrestrial vegetation would be limited to the immediate area of the spill and the effects would be effectively mitigated with the implementation of PRGT's Spill Contingency Plan.

Due to the aquatic component of wetlands (compared to terrestrial vegetation), the extent of the effects of a hazardous materials spill would vary depending on the type of wetland affected, type of material spilled, volume of material spilled, surface and subsurface water flow, the speed of natural removal, species sensitivity, and time of year of the spill. Effects on vegetation could be worsened by disturbance associated with clean-up activities. PRGT's Spill Contingency Plan will also outline measures to clean up spills that affect wetlands.

Hazardous materials will be stored more than 100 m (or in accordance with applicable *Acts* and regulations) from a wetland, watercourse, or waterbody, thereby reducing the probability of a large spill interacting with these features. Petroleum products will be transported in approved containers by qualified drivers who have emergency and spill response equipment on hand. If hazardous materials were to interact with wetlands, response and clean-up activities would reduce residual effects, and care would be taken so that the clean-up activities would not substantially contribute to wetland damage.

The effects of a hazardous materials spill on wetlands are likely to be low in magnitude, limited to the area near the spill, short to medium term in duration, and reversible. It is unlikely that a large spill would occur at any stage of the Project due to the mitigation measures and management plans that will be in place. As residual effects of a hazardous materials spill would be limited in extent (e.g., less than 10% of wetland areas in the regional assessment area as per Section 13) and reversible, residual environmental effects are predicted to be not significant.

31.3.8 Conclusion on the Potential Risk of Hazardous Material Spills

With mitigation and the implementation of management and contingency plans, the likelihood of a large-scale hazardous materials spill into a fish-bearing watercourse occurring during the life of the project is considered to be remote. The potential consequence is considered to be very low for freshwater quality (localized short-term effect with recovery possible within days or weeks) and low to moderate for freshwater aquatic resources (localized long-term effect with recovery within the life of the project and widespread effect that is recoverable within the life of the project, respectively). For both freshwater quality and freshwater aquatic resources, the potential risk is remote (the risk is acceptable and no additional risk mitigation required).

The potential effects of a large-scale spill on marine water quality are anticipated to have a remote likelihood of occurrence (post-mitigation) and a very low consequence given the dispersal properties of marine diesel fuel. The potential risk is considered to be remote.

The potential effects of a large-scale spill on marine resources such as plankton, intertidal organisms, fish, and marine birds are anticipated to have a remote likelihood of occurrence (post-mitigation) and be of low consequence overall, resulting in a potential risk that is considered to be remote.

The potential effects of a large-scale spill on vegetation and wetland resources are anticipated to have a remote likelihood of occurrence (post-mitigation) and be of low consequence overall (localized long-term effect with recovery possible within the life of the project). The overall risk to vegetation and wetland resources is therefore considered to be remote.

31.4 RELEASE OF DRILLING MUDS

The effects resulting from a release of drilling muds are assessed in this section.

31.4.1 Description of the Potential Event

Drilling muds are used during construction to support horizontal directional drilling (HDD) under watercourses and at marine entry/exit locations. A description of HDD is provided in the project overview section (Section 1.2.6.2 Construction – Land Based). The potential for release of drilling muds is limited to the construction phase. During the HDD process, drilling muds could be lost into seams of coarse material and fissures. A “frac-out” occurs when pressurized muds are returned to the surface through a fracture in the substrate. This process can release drilling muds into water (freshwater or marine) or onto land. Effects to aquatic ecosystems are possible depending on the volume and location of the frac-out.

31.4.2 Likelihood that the Potential Event Could Occur

The likelihood of a release of drilling muds during construction from frac-outs, material handling, or transfer is low given the geotechnical testing that is conducted prior to drilling, the application of standard drilling procedures, and use of experienced drill crews.

There is no likelihood of a release of drilling mud occurring during operation as drilling is not a planned activity during this phase.

31.4.3 Design Measures to Reduce the Likelihood of the Event and Consequences of an Effect

The Project will be designed, operated, and managed to minimize the potential for a release of drilling muds. Fisheries and Oceans Canada (DFO) has an operational statement on directional drilling under BC and Yukon Territory freshwater systems that includes *Measures to Protect Fish and Fish Habitat when High-Pressure Directional Drilling* (DFO 2007), which must be incorporated into planning directional drilling to cross a watercourse. Such planning must also include evidence that there is a low risk of frac-out and that there is an emergency frac-out response plan and a contingency crossing plan in place. PRGT will be developing a Directional Drilling Procedures and Instream Drilling Mud Release Contingency Plan which will be adhered to during all drilling activities.

Mitigation measures that will be implemented to reduce the likelihood and consequence of a drilling mud release for this project include:

- preventing any release, where possible, through pre-construction investigative drilling to confirm sediment suitability for HDD
- conducting directional drilling in adherence to the DFO (2007) operational statement and PRGT's Directional Drilling Procedures and Instream Drilling Mud Release Contingency Plan
- using a drilling mud comprising nontoxic, bentonite clay-based material
- using appropriate storage containers and handling procedures for drilling muds
- PRGT will report any drilling mud release in accordance with applicable legislation.

31.4.4 Description of the Potential Residual Effect

The potential release of drilling muds is not expected to interact with air quality, the acoustic environment, greenhouse gases, hydrology, employment, transportation, visual quality, and heritage and archaeological resources (i.e., assigned Rank 0 as per Table 31-1); no assessment is required.

With the mitigation measures described above in place, interactions with wildlife and wildlife habitat, vegetation and wetland resources, soils, infrastructure and services, land and resource use, and human health can be managed to negligible or acceptable levels (Rank 1 as per Table 31-1). Residual effects are likely to be not significant and no further assessment is warranted.

The release of drilling muds could affect freshwater aquatic resources, marine resources, and water quality in a manner that may exceed acceptable levels (Rank 2 as per Table 31-1). These potential effects are assessed in greater detail below.

Effects are described for the construction phase only as drilling is not an activity planned to occur during operation. Effects also focus on frac-outs, as these releases are anticipated to have a greater potential effect than those resulting from handling or transfer. Releases from handling or transfer can be readily mitigated by the Spill Contingency Plan.

31.4.5 Likelihood of the Effect Occurring

The likelihood that a release of drilling muds during construction would affect freshwater aquatic resources, marine resources, or water quality is considered to be low given the low likelihood of the event itself occurring and the design and mitigation measures that will be in place to prevent or address any potential releases.

31.4.6 Contingency, Clean-up, and Restoration Methods

In the event of a frac-out, PRGT's Directional Drilling Procedures and Instream Drilling Mud Release Contingency Plan will be implemented. This contingency plan will include protocols to monitor, contain, and clean up a potential frac-out, as well as review the details of what caused the frac-out so measures can be adjusted and implemented to prevent reoccurrence.

31.4.7 Assessment of Residual Effects and their Significance

The potential effects of a drilling mud release on water quality, freshwater aquatic resources, and marine resources are further assessed below.

HDD drilling is proposed for several watercourse crossings. If an accidental release of drilling mud were to occur in watercourses that provide habitat for commercial, recreational, or Aboriginal (CRA) fish or fish species that support CRA fish, it could affect these species present in the immediate vicinity or downstream of the release. The Directional Drilling Procedures and Instream Drilling Mud Release Contingency Plan includes measures to contain and clean up the mud. Drilling mud could be transported downstream of a spill site depending upon the composition of the drilling mud; however, any effects would be short to medium term in duration, and reversible. Streamflow would likely flush drilling mud from the point of discharge.

HDD may also be used to install the pipeline at the entry to, and exit from, the marine environment, depending on substrate type. If HDD drilling proceeds, the potential exists for a release of drilling muds into the marine environment. Similar to a freshwater release, it could affect CRA fish or fish species that support CRA fish present in the immediate vicinity of the release. The Directional Drilling Procedures and Instream Drilling Mud Release Contingency Plan include measures to contain and clean up the mud. Effects are likely to be short to medium term in duration, and reversible.

A release of drilling mud is unlikely to result in an overall reduction in the productive capacity of fish habitat or fisheries following the implementation of mitigation measures. It is also unlikely to increase fish mortality or cause serious harm to fish. In the unlikely event that a release of drill muds was determined to have caused serious harm to CRA fish and related fish species, offsetting measures would be undertaken so that there would be no net loss in productive capacity. After mitigation measures are implemented, residual environmental effects are predicted to be not significant.

31.4.8 Conclusion on the Potential Risk of Release of Drilling Muds

With mitigation and the implementation of applicable management and contingency plans, the likelihood that a release of drilling mud will affect water quality, freshwater aquatic resources, and marine resources is considered to be low with a low consequence. This results in an overall risk that is considered to be low (the risk is tolerable and continued monitoring of the potential risk will be conducted; however, no additional risk mitigation would be required).

31.5 LEAKAGE OR FAILURE OF THE PIPELINE DURING OPERATION

Based on industry available data (2002 to 2013) from Canada (Canadian Energy Pipeline Association or CEPA) and the United Stated (PHSMA) and industry data (2001 to 2010) from Europe (EGIG), TransCanada's rate of pipeline leakage and ruptures is better than industry.

The scenario involving an explosion or fire subsequent to a leak is assessed under the explosions and fires scenario (Section 31.10).

31.5.1 Description of the Potential Event

There a potential for failure or leakage of any natural gas pipeline after installation and commencement of operation. Major causes of pipeline failures during operation include third-party damage, mechanical damage, or corrosion of the pipe wall (due to either long-term transport of the product or influences of the external environment). The dispersion of natural gas without ignition poses little hazard to the biophysical or human environment. Pipeline leakages or failures can result in explosion and fire, which are addressed in Section 31.10.

31.5.2 Likelihood that the Potential Event Could Occur

Canadian pipelines are safer when compared to US and European pipelines as measured by rupture frequency; using average statistics from CEPA (of which TransCanada is a member), applied to PRGT, statistically, one rupture in every 48 years of operation may be expected. This frequency is based on existing, older pipelines that employ a broad application of various pipeline material and coating technologies. It is expected that new pipelines such as PRGT will perform better with advanced technologies and construction techniques.

In 2012, there were four incidents reported for the 18,125 km of natural gas pipeline in BC (frequency = 0.22 incidents/1,000 km pipeline); three of the incidents resulted from materials or manufacturing issues (defects in fitting, construction, or components), and the fourth resulted from a geotechnical failure (BC OGC 2014). This is down from ten incidents reported in 2011 for 19,159 km of natural gas pipeline (frequency = 0.52 incidents/1,000 km pipeline); seven of the incidents were a result of material or manufacturing issues, two were from external interference (external activities causing damage to the pipe), and one was a result of pipeline or equipment failure (BC OGC 2013).

Between 2009 and 2013 the average number of gas release incidents reported under the *Onshore Pipeline Regulation*-99 (OPR-99) was 42 per year (NEB 2013a). In 2009, there were seven pipe body failure (ruptures and leaks) releases and 50 operational equipment (venting through valves and seepage at flanges through gaskets) pipeline gas leaks in NEB-regulated pipelines. In 2009, the gas release frequency in NEB-regulated pipelines was 0.15 per 1,000 km, which represented a 63% reduction from 2008; the ten-year average was approximately 0.1 releases per 1,000 km. In 2009, operational gas leaks (comprised of leaks from pipeline components, such as flanges, valves, pumps, or storage tanks, and exclude leaks from pipe bodies) from NEB-regulated pipeline systems were approximately 0.9 per 1,000 km (NEB 2011).

In 2009, five ruptures (four from metal loss or cracking and one from a contractor strike to the line) were recorded on NEB-regulated gas pipeline systems. Corrosion due to cracking (38%) and metal loss (27%) was the primary cause of ruptures on NEB-regulated pipeline systems between 1991 and 2009. The third most-recorded reason (16%) was other causes such as improper operation and fire. Other reasons for ruptures on NEB-regulated pipeline systems from 1991 to 2009 included external interference (8%), geotechnical failure (5%), and material, manufacturing, or construction (5%) (NEB 2011).

The marine section of the pipeline will be up to 120 km of twin 914 mm diameter (NPS 36) pipeline. Based on historical spill incident data for the Gulf of Mexico from 1996 to 2006, applied to PRGT, statistically one rupture in every 250 years of operation may be expected (MMS 2009 in IntecSea Worley Parsons Group 2014). Subsea pipeline failure mechanisms were identified as (from most to least common)

external loads, corrosion, material, other/unknown, and construction damage (OGP 2010 in IntecSea Worley Parsons Group 2014).

The likelihood of a pipeline failure and resultant release of gas that does not result in a fire or explosion is predicted to be remote because the pipeline will be designed and constructed according to Canadian Standards Association (CSA) Z662, the national design and construction standard for oil and gas pipeline systems. The pipeline will be controlled from the TransCanada Operations Control Centre (OCC). The OCC is staffed 24 hours per day and uses a comprehensive supervisory control and data acquisition system to continuously monitor and control pipeline operations. This would allow for rapid response (e.g., valve shut-offs) in the event of a failure.

31.5.3 Design Measures to Reduce the Likelihood of the Event and Consequences of an Effect

The Project will be designed, operated, and managed to reduce the potential for a leakage or failure of the pipeline. In particular, the pipeline will be designed and constructed according to Canadian Standards Association (CSA) Z662. Design measures include selecting an appropriate wall thickness of the pipeline for the conditions, applying corrosion protection, and executing monitoring systems. Pipeline wall thickness has a designed-in safety factor and is selected in accordance with criteria indicated by adjacent land uses. Heavy wall pipe will be installed at watercourse crossings, locations with a higher potential for geohazards, and in proximity to more populated areas. The pipeline will also be coated both internally and externally to protect against corrosion.

With respect to monitoring, PRGT has an integrity management program to manage the integrity of the pipeline for its lifetime and a damage prevention program to mitigate damage from third parties, including membership in BC One Call. Regular maintenance and operational procedures will include cathodic protection monitoring, periodic inspection of the permanent right-of-way, and monitoring systems to alert staff of potential leakages or failures. The pipeline will be continuously controlled and monitored from the TransCanada OCC. In the event of a pipeline failure, PRGT will work with local emergency responders to limit effects on people and the environment by restricting access, evacuating residents if required, and assisting with ongoing incident management.

For the marine section of the route, remotely operated isolation valves will be installed at the onshore tie-in location on Lelu Island and at the shore crossing at the other end of the subsea section. Where risks are identified and where warranted, additional protection of the subsea pipeline, such as the use of heavy wall pipe, burial, or rock placement, will be used. Concrete weight coating will also be used on most sections of the marine pipeline.

31.5.4 Description of the Potential Residual Effect

The potential effect of a leakage or failure of the pipeline during operations is not expected to interact with air quality, the acoustic environment, hydrology, employment, visual quality, and heritage and archaeological resources (i.e., assigned Rank 0 as per Table 31-1); therefore no further assessment is required.

With the mitigation measures described above in place, interactions with freshwater aquatic resources, marine resources, wildlife and wildlife habitat, vegetation and wetland resources, soils, greenhouse gases, water quality, infrastructure and services, transportation, land and resource use, and human health can be mitigated to negligible or acceptable levels (Rank 1 as per Table 31-1). Residual effects are likely to be not significant and no further assessment is warranted, although further discussion is provided below.

No interactions were assigned a Rank 2; the discussion below is focused on Rank 1 interactions.

In the event that a subsea pipeline leak or failure is detected, pipeline valves will be closed as per the land-based pipeline. Residual gas in the marine portion of the pipeline will be released into the water column. The volume of gas released would result in a residual effect to marine water quality and marine resources that is not significant due to its low magnitude, localized geographic extent, short term duration, singular occurrence, and reversibility in the short term.

In the event of a subsea pipeline failure, effects on marine water quality and marine resources gas could manifest as seabed scour, depending on the location and extent of the subsea pipeline failure. Effects are anticipated to be temporary and short term in duration; therefore residual effects to the marine environment are expected to be negligible and not significant.

Greenhouse gases resulting from a land-based or subsea pipeline rupture would also be emitted and would be reported under applicable regulatory requirements.

A pipeline leakage or failure (not resulting in a fire or explosion) could result in effects to transportation and land and resource use if the affected area was evacuated and access temporarily restricted until such time as the failure had been resolved. NAV CANADA would also be contacted for purposes of air traffic management. The effect would represent a localized, temporary, and reversible change in transportation and land and resource use. Infrastructure and services could also be affected in the short term if emergency response personnel were required for support. Because these effects would be temporary and short-term, they are expected to be not significant.

Any potential effect to human health would be eliminated through the identification and implementation of appropriate notification and evacuation procedures.

31.5.5 Likelihood of the Effect Occurring

The likelihood that an unignited leakage or failure of the pipeline during operation would affect the surrounding environment (biophysical or human) is considered to be remote given the low likelihood of the event itself occurring and the design and mitigation measures that will be in place to prevent or address any potential for a leak or failure.

31.5.6 Contingency, Clean-up, and Restoration Methods

In the unlikely event of a leakage or failure of the pipeline, PRGT would activate the Emergency Response Plan. The section of pipe would be isolated through valve control procedures to eliminate the release of gas as soon as possible. Responders would be deployed to the site where repairs would be made, and pipeline performance would be monitored. PRGT would also deploy site security and limit access to the public. In the event of a subsea rupture, a safety zone will be established at the surface.

31.5.7 Assessment of Residual Effects and their Significance

All potential effects associated with an unignited leakage or failure of the pipeline during operation have been assigned Rank 0 or Rank 1, where potential effects can be mitigated to negligible or acceptable levels. Residual effects are likely to be not significant.

31.5.8 Conclusion on the Potential Risk of Release of Leakage or Failure of the Pipeline During Operation

With mitigation in place, as well as the implementation of standard operating procedures, best management practices, and applicable management and contingency plans, the likelihood of an unignited leakage or failure of the pipeline during operation on any valued component is considered to be remote with a very low consequence (localized, short-term effect with recovery possible within days or weeks). The overall risk is therefore considered to be remote (the risk is acceptable and no additional risk mitigation is required).

31.6 MOTOR VEHICLE OR HELICOPTER ACCIDENTS

The effects resulting from a vehicle or helicopter accident are assessed in this section. Scenarios involving a hazardous material spill or forest fire subsequent to such an event occurring is assessed in the hazardous materials spills and forest fire sections (Sections 31.3 and 31.8, respectively).

31.6.1 Description of the Potential Event

Motor vehicles and helicopters will be used primarily in the construction phase, with a reduced need in the operation phase. Motor vehicle or helicopter accidents can result in serious injury or death to humans and wildlife, as well as damage to property.

Vehicle collisions with moose and deer can occur throughout their ranges. Bears travel long distances in search of optimal foraging sites, often using roads as corridors to follow when terrain is blocked or difficult to traverse; this makes susceptible to vehicle collisions. Bears and other wildlife may also cross roadways or occupy roadsides when an attractive food source (e.g., berries, herbaceous, or shrubby vegetation) is present.

Helicopter accidents can involve emergency landings, mid-air collisions, or collisions with the surrounding terrain.

31.6.2 Likelihood that the Potential Event Could Occur

Project construction will result in a higher frequency and volume of vehicle traffic, and personnel may be travelling during hours of low visibility or high wildlife activity. The potential for vehicle-related accidents would also be a consideration during the operation phase, although to a lesser extent compared to construction. The likelihood of a vehicle accident is expected to be low during both phases of the Project.

From 2002 to 2011, the number of aircraft accidents per year ranged from 33 to 59 (including helicopters) in BC (PWGSC, 2003 to 2012). In 2012, 19% (46) of Canadian-registered aircraft accidents occurred in BC (PWGSC 2013).

31.6.3 Design Measures to Reduce the Likelihood of the Event and Consequences of an Effect

Mitigation measures to reduce the risk of collisions or motorized vehicle (including helicopter) accidents will be outlined in the Traffic Management Plan. Measures will include managing project-related traffic during construction, limiting the use of helicopters to transport personnel and equipment only when required, providing multi-passenger vehicles to transport construction personnel between camps and construction sites to the extent practical, and complying with applicable traffic, road-use, and safety laws.

PRGT will notify potentially affected members of the public regarding project initiation, and the location and schedule of project activities including traffic. Project information will also be provided to applicable municipal and provincial authorities prior to the start of construction activities. The use of construction camps will help reduce daily traffic on roads.

Contractors will be required to have a Safety and Security Management Plan (or equivalent) that will specify safety measures to be used while working on the project. PRGT will also use TransCanada's prequalification program to screen potential helicopter service providers to assess the rigour and adequacy of their management systems. Only those helicopter companies that meet or exceed the requirements of this assessment will be contracted. Helicopters used for the project will be regularly inspected and flown by experienced pilots

31.6.4 Description of the Potential Residual Effect

A motor vehicle or helicopter accident is not expected to interact with air quality, the acoustic environment, freshwater aquatic resources, marine resources, vegetation and wetland resources, soils, greenhouse gases, water quality, hydrology, employment, visual quality, land and resource use, and heritage and archaeological resources (i.e., assigned Rank 0 as per Table 31-1); therefore, no further assessment is required.

With the mitigation measures described above in place, potential interactions with wildlife and wildlife habitat, infrastructure and services, and transportation can be managed to negligible or acceptable levels (Rank 1 as per Table 31-1). Residual effects are likely to be not significant and no further assessment is warranted.

For wildlife and wildlife habitat, any injury or mortality to wildlife as a result of vehicle collisions would be infrequent, single events that are not predicted to reduce the long-term sustainability of any population, and therefore would be not significant.

Transportation may be temporarily limited or rerouted due to a vehicle accident. A vehicle collision or helicopter crash would likely result in a call to 911 and use of emergency response services. However, a vehicle collision or helicopter crash is unlikely to result in any large-scale event, and therefore, the response is likely to be within the capacity of local emergency response services (i.e., not significant).

A vehicle collision or helicopter crash would also be a single event that would rarely occur and therefore any strain on infrastructure and services would be short term and sporadic and unlikely to affect capacity in an adverse way.

Motor vehicle or helicopter accidents have the potential to affect human health (Rank 2) and as such are assessed below.

31.6.5 Likelihood of the Effect Occurring

Accidents involving motorized vehicles or helicopters may occur during construction and operation; however, efforts will be taken to prevent this event from occurring and affecting human health. The implementation of the Traffic Management Plan and overall safety measures that will be in place for the project will work to reduce potential effects. With these measures in place, the likelihood of an effect to human

health is considered to be low. Accidents that could result in the loss of human life, (e.g., a worst-case scenario) however, are considered to have a remote likelihood of occurrence.

31.6.6 Contingency, Clean-up, and Restoration Methods

In the unlikely event of an accident, an emergency response procedure would be implemented, including contacting appropriate authorities, transporting medical personnel to site, and transporting injured parties to medical facilities, if required.

In the event that the accident involves wildlife, local police or the BC Conservation Officer Service will be contacted in addition to other required authorities (e.g., medical personnel).

31.6.7 Assessment of Residual Effects and their Significance

As presented in Table 31-1, human health could be affected by vehicle collisions or a helicopter crash, particularly as project activities could be expected to incrementally increase the risk of vehicle accidents or helicopter crashes due to increased traffic volumes. Although accidents are unlikely to occur, the effect on human health could be significant, depending on the severity and extent.

31.6.8 Conclusion on the Potential Risk for Motor Vehicle or Helicopter Accidents

The potential risk to human health from a motor vehicle or helicopter accident is considered to be low overall (the risk is tolerable and requires continued monitoring, however no additional risk mitigation is required) with a low likelihood of occurrence and low consequence (localized long-term effect with recovery possible within the life of the project).

Motor vehicle or helicopter accidents that could result in the loss of human life, however (i.e., a worst case scenario) are considered to have a remote likelihood of occurrence and a very high consequence (loss of a considerable portion of a VC). The resulting risk is considered to be low overall (the risk is tolerable and requires continued monitoring, however, no additional risk mitigation is required).

31.7 MARINE VESSEL ACCIDENTS

The effects resulting from a marine vessel accident are assessed in this section. A scenario involving a hazardous material spill subsequent to such an event is assessed in the hazardous materials spills section (Section 31.3).

31.7.1 Description of the Potential Event

The potential for a project-related marine vessel accident is limited to the construction phase when the pipeline is being installed and during periodic inspections and maintenance of the pipeline during operation. The types of accidents could include collisions (involving two or more vessels under way), capsizing, foundering or sinking, grounding, striking (impact with a stationary object or a vessel not under way), fire or explosion, propeller, rudder, or structural damage, or flooding (TSBC 2012).

The containment and clean-up of spills (e.g., the release of oil or fuels) following a marine vessel accident is usually at the forefront of accident response activities, however, recent vessel groundings in the United States have raised awareness regarding the importance of measures for salvaging the vessel, off-loading cargo and fuels, and removing wreckage to prevent or minimize further environmental damage (EnviroEmerg Consulting 2008).

31.7.2 Likelihood that the Potential Event Could Occur

The marine area of the North Coast and Haida Gwaii (which includes Prince Rupert and Alice Arm) supports abundant marine traffic, including a rapidly expanding cruise ship industry and port-related activities in Prince Rupert and Kitimat, as well as fishing activities (Johannessen et al. 2007). Between 2003 and 2012, TSBC recorded 1,019 shipping accidents in the western region of Canada (ranging from a high of 141 in 2003 to a low of 78 in 2012); this resulted in a loss of 84 vessels and a total of 65 fatalities (Minister of PWGSC 2013b). The number of tugs and barges involved in shipping accidents between 2003 and 2012 was 319 (Minster of PWGSC 2013b).

In 2012, the most frequent type of shipping accident involved groundings, strikings, and accidents involving fire/explosions (TSBC 2012). The total number of groundings decreased by 27% in 2012 compared to the five-year average, while fire/explosion accidents decreased by 39%. The number of striking accidents remained approximately the same. Fishing vessels were involved in the most shipping accidents in 2012 overall (consistent with the five-year average trend). After fishing vessels, cargo/bulk carrier and tugs/barges were also involved most often in shipping accidents (TSBC 2012). In general, shipping accidents reached a 38-year low in 2012 and the overall trend in accidents has been declining since 2003 (TSBC 2012).

According to a navigational risk assessment conducted for the Prince Rupert Port Authority (Det Norske Veritas 2012), grounding was the most likely accident type to occur in the area assessed (primarily the approach from open water towards Ridley Island). Grounding was also determined to be the accident type most effectively mitigated through the use of tug escorts and pilots.

The overall likelihood of a marine vessel accident occurring during the execution of project activities is considered to be remote due primarily to the engagement of experienced captains and crews, the generally slow speeds marine vessels will be travelling at, and the use of pilot vessels, where required.

31.7.3 Design Measures to Reduce the Likelihood of the Event and Consequences of an Effect

Marine vessels used during construction of the marine portions of the pipeline will be regulated, in part, by the *Canada Shipping Act, 2001*, which is one of the primary pieces of legislation governing marine transport, pollution, safety, and protection of the marine environment from damage resulting from navigation and shipping activities. The Collision Regulations further identify the appropriate codes of conduct for vessels in order to prevent or avoid a collision.

The *Pilotage Act* and Pacific Pilotage Regulations require every ship over 350 gross tons (that is not a pleasure craft) to comply with pilotage requirements while travelling in Canadian waters designated as compulsory pilotage areas (e.g., port of Prince Rupert). The navigational risk assessment conducted for the Prince Rupert Port Authority (Det Norske Veritas 2012) identified the use of pilots as one measure that effectively mitigated the potential grounding of vessels.

Other measures to reduce the likelihood of a vessel-related accident during marine pipeline installation will include: routine inspection and maintenance of vessels; use of established communication and navigation procedures; adherence to Transport Canada, Canadian Coast Guard, and Prince Rupert Port Authority (in the event that vessels are operating within the port limits of Prince Rupert) requirements; and employee awareness training.

A temporary safety zone will be established and maintained around the construction vessels to safeguard against vessel collisions, particularly when visibility is poor. For pipelay vessels, the safety zone could be approximately 500 m around the vessel, and would be finalized by the marine contractor based on the actual vessel used and input from the OGC, the Prince Rupert Port Authority, and the Canadian Coast Guard. Support vessels would be used to help maintain and manage the safety zone.

31.7.4 Description of the Potential Residual Effect

The potential for a marine vessel accident (that does not result in a spill of hazardous materials) is not expected to interact with air quality, the acoustic environment, freshwater aquatic resources, wildlife and wildlife habitat, vegetation and wetland resources, soils, greenhouse gases, freshwater quality, hydrology, infrastructure and services, visual quality, land and resource use, and heritage and archaeological resources (i.e., assigned Rank 0 as per Table 31-1); therefore no further assessment is required.

With the mitigation measures described above in place, interactions with marine water quality, employment, and transportation can be managed to negligible or acceptable levels (Rank 1 as per Table 31-1). Residual effects are likely to be not significant and no further assessment is warranted.

A marine vessel accident could affect marine resources and human health in a manner that may exceed acceptable levels (i.e., Rank 2 as per Table 31-1). These potential effects are assessed in more detail below, with the potential effects of a hazardous materials spill following a marine vessel accident discussed previously in Section 31.3.

31.7.5 Likelihood of the Effect Occurring

The likelihood that a marine vessel accident would affect the marine environment or human health is considered to be remote given the remote likelihood of the event itself occurring and the design and mitigation measures that will be in place.

31.7.6 Contingency, Clean-up, and Restoration Methods

In the unlikely event there is an accident involving a marine vessel, the Emergency Response Plan and Spill Contingency Plan would be implemented to direct response activities and contain and clean up any resulting spill to mitigate potential effects. The Spill Contingency Plan in particular contains steps for initial response, regulatory reporting contacts, and a spill scene checklist and report form.

Additionally, appropriate regulatory authorities (e.g., Canadian Coast Guard, Prince Rupert Port Authority, Transport Canada, Environment Canada, BC MOE), would be notified in the event of an accident and would assist with the coordination of clean-up and restoration activities.

31.7.7 Assessment of Residual Effects and their Significance

As presented in Table 31-1, marine vessel accidents that do not lead to a spill of hazardous materials could result in potential effects to marine resources and human health that could exceed acceptable levels without the implementation of specified mitigation measures.

The grounding of a marine vessel has the potential to affect marine resources by physically disturbing the seabed, which could result in a change in fish habitat. The area affected would be highly localized, and effects would be reversible within the long-term, depending on the substrate (e.g., rocky-substrate areas would take longer to recover than softer substrates). The effects of a vessel capsizing or sinking would have a similar effect, in that marine habitat would be altered by the presence of the vessel itself. Assuming the vessel was salvaged, recovery of the area would begin shortly after salvage operations have ceased. Residual effects are likely to be not significant.

Other accident types (e.g., vessel collisions or strikes with stationary objects such as wharves) are unlikely to have a direct effect on marine resources and are anticipated to be not significant should they occur.

While they may not be specifically considered a marine vessel accident, vessel collisions or strikes with marine mammals, although remote, may occur during the course of construction (primarily while vessels are in transit) and could result in injury or mortality to marine mammals. Quantifying population-level effects of ship strike mortality on cetaceans (for example) has proven difficult, largely as collisions frequently go unnoticed and therefore unreported (Williams and O'Hara 2010). Williams and O'Hara (2010) identified that areas with the highest relative risk of a ship strike occurred in "bottleneck" regions, where whale and vessel densities are both concentrated. One such bottleneck region was identified at the north end of Haida Gwaii, northwest of Prince Rupert. The likelihood that a ship working specifically on the project would collide with a marine mammal is considered remote with a very low consequence (localized, short term impact, despite the potential for injury or mortality to the marine mammal). It is highly unlikely that this event would affect the population health of marine mammals present in the area, should it occur. Residual effects are likely to be not significant

Although considered to be remote, a marine vessel accident could result in a significant effect on human health (e.g., loss of human life), depending on the severity and extent of the accident (e.g., capsizing or sinking of the vessel).

31.7.8 Conclusion on the Potential Risk for Marine Vessel Accidents

With mitigation and the implementation of applicable management and contingency plans, the likelihood that a marine vessel accident will affect marine resources is considered to be remote with a low consequence (localized long-term effect with recovery possible within the life of the project). The overall risk to marine resources is also considered to be remote (the risk is acceptable and no additional risk mitigation is required).

Marine vessel accidents that could result in the loss of human life, however (i.e., a worst case scenario) are considered to have a remote likelihood of occurrence and a very high consequence (loss of a considerable portion of a VC). The resulting risk is considered to be low overall (the risk is tolerable and requires continued monitoring, however, no additional risk mitigation is required).

31.8 FOREST FIRE

The effects resulting from a fire caused by Project activities, including facility fires, pipeline explosions that result in fire, and forest fires, are assessed in this section. Section 32 (Effects of the Environment on the Project) discusses the potential effects of wildfires on project infrastructure and activities.

31.8.1 Description of the Potential Event

Accidents resulting in fires can be caused by project activities (e.g., pipeline explosion resulting in fire) or anthropogenic sources such as the burning of wood debris or careless smoking. A fire that is limited to a project site or spreads to nearby forests and becomes more wide spread has the potential to affect a number of VCs. The primary concern in the event of any fire, including a forest fire, is human health and safety; additional concerns include direct mortality to wildlife and aquatic organisms, terrestrial and freshwater habitat loss (i.e., increased sedimentation, increased water temperatures), loss or damage of property, and long-term changes in land use. The emissions from a fire would likely consist mainly of smoke (particulate matter) and carbon dioxide (CO_2); emissions could also include carbon monoxide (CO), nitrogen oxides (NO_X), sulphur dioxide (SO_2), and other products of incomplete combustion.

It is understood from Working Group comments that the mountain pine beetle outbreak could pose an additional risk associated with forest fires (i.e., increased dry, combustible material associated with dead trees), which has been considered in the assessment.

31.8.2 Likelihood that the Potential Event Could Occur

While the common notion is that the number of fires and those caused by humans are important, most area burned by forest fires is caused by lightning and only during certain periods of the summer when there are long periods of dry weather (Macias Fauria and Johnson 2008, Johnson 1992). Given that these circumstances are rare, by definition, large fires are rare.

The large areas of dead pine stands resulting from the mountain pine beetle infestation represent a potential fire hazard that the Province has been working to address since the release of the Firestorm Provincial Review report (Filmon 2004). Recommendations from the report that have been implemented included harvesting

affected stands to reduce the potential fire hazard and the amount of fuel present. Efforts focussed primarily on interface zones (areas where wilderness and urban development coincide). However, recent studies suggest that mountain pine beetle outbreaks do not increase the risk of fire (Simard et. al 2011).

Fires caused by project activities could occur during both the construction and operation phases although the overall likelihood is considered to be remote given project design and the procedures that will be in place to prevent such occurrences.

31.8.3 Design Measures to Reduce the Likelihood of the Event and Consequences of an Effect

PRGT will develop a Fire Suppression Contingency Plan and will have firefighting capabilities and training onsite. Any fires that originate from project activities would be contained by rapid response of project personnel, reducing the potential for a forest fire to spread offsite.

The primary mitigation measure for project-related forest fires is prevention, followed by fire control and suppression. Potential risks will be identified and evaluated, and a plan for risk management and forest fire prevention measures will be developed, reducing the likelihood of a forest fire. Forest fire prevention measures and responses include:

- all materials within compressor station yards will be made of metal or non-combustible materials and station yard will be covered with gravel
- all buildings will be made of steel
- typical site design will include a cleared setback (usually 40 m) outside the fence line, providing a barrier to the tree line
- designating areas for smoking (no smoking in the vicinity of compressor site at all; designated non-hazardous smoking areas will be outside the fence limits only)
- training that includes the proper disposal methods for welding rods, cigarette butts, and other hot or burning material
- burning slash in accordance with applicable regulations and permits and only if permission is granted from the regulating authorities and if conditions permit
- identifying the Fire Danger Class at each location, which will also be communicated regularly to onsite personnel
- designating a fire boss during construction, who will be familiar with firefighting techniques and equipment
- maintaining firefighting equipment onsite according to the BC *Wildfire Act* and regulations so that firefighting hand tools are available for each person who works onsite
- carrying a fully charged fire extinguisher on all motorized equipment

- specific fire prevention methods include no spark emitting equipment, use of spark barriers, all equipment to contain fire extinguishers, compressor buildings to have fire detection equipment inside as well as within the turbine enclosure, use of spark arrestors, and fire watch monitors
- in the event of a fire, clean up, and restoration of the construction and/or permanent right-of-way would occur.

31.8.4 Description of the Potential Residual Effect

The potential effects of a forest fire are not expected to interact with the acoustic environment and marine resources (i.e., assigned Rank 0 as per Table 31-1); therefore, no further assessment is required.

With the mitigation measures described above in place, interactions with soils, greenhouse gases, hydrology, employment, infrastructure and services, and heritage and archaeological resources can be managed to negligible or acceptable levels (Rank 1 as per Table 31-1). Residual effects are likely to be not significant and no further assessment is warranted.

Fire can alter the nutrient properties, physical and chemical characteristics, moisture content, and temperature of soils; however, these effects are often short term and low in magnitude (BC Range 2004), and forest fires do not typically burn hot enough to damage organic soil layers.

Depending on the extent and severity of a forest fire, there will be an increase in the amount of greenhouse gases (carbon dioxide, and nitrous oxide) near the event.

Hydrology could be affected if the source of water to fight the forest fire is a local watercourse; however, this is not likely to result in a long-term effect to the quantity or flow of the watercourse (i.e., the effect would be not significant).

A forest fire could temporarily affect infrastructure such as transportation if roads were temporarily closed due to public health and safety risks. The potential effect on community services such as a requirement for first responders and other emergency personnel would also be short term. Therefore, residual effects of a forest fire on infrastructure and services is expected to be not significant. Fire would likely only result in a localized and temporary restriction on project activities; therefore, any subsequent residual effects on employment are expected to be not significant.

Forest fires do not typically burn hot enough to cause damage or alteration to subsurface archaeological sites, although above-ground resources such as culturally modified trees, could be affected. Additionally, the activities associated with responding to a forest fire could disturb resources by altering or destroying the cultural object and landscape. The known effects of naturally-occurring forest fires

are incorporated when interpreting the archaeological record. Residual effects of a forest fire on heritage and archaeological resources are expected to be not significant.

A forest fire could affect air quality, freshwater aquatic resources, wildlife and wildlife habitat, vegetation and wetland resources, water quality, transportation, visual quality, land and resource use, and human health in a manner that may exceed acceptable levels (i.e., Rank 2 as per Table 31-1). These potential effects are assessed in more detail.

31.8.5 Likelihood of the Effect Occurring

The likelihood that a forest fire caused by project activities would affect a range of terrestrial VCs is considered to be remote given the remote likelihood of the event occurring and the design and mitigation measures that will be in place to prevent fires from occurring.

31.8.6 Contingency, Clean-up, and Restoration Methods

In the unlikely event of a project-created forest fire, PRGT will implement a Fire Suppression Contingency Plan. The fire boss or company designate will report wildfires and relevant information to PRGT's environmental advisor and construction manager, BC's Forest Fire Reporting Centre, the Regional Fire Centre, municipal by-law officers, and applicable local fire departments. Clean-up and restoration procedures, as required, will be addressed in the Plan.

31.8.7 Assessment of Residual Effects and their Significance

Further assessment of interactions with Rank 2 (Table 31-1) is provided in the following sections.

Any project-related forest fire could be a source of particulate matter: CO, SO_2, NO_X, and volatile organic compounds. This would be a short-term effect within proximity to the fire, provided that the mitigation measures to control and extinguish the forest fire as rapidly as possible are implemented. A large project-related forest fire could increase air contaminant levels beyond the ambient air quality standards over distances of several kilometres. The residual effects of a widespread forest fire on air quality would be considered high in magnitude, extending beyond the immediate vicinity of the pipeline, reversible, and short term in duration (forest fires can be contained and extinguished within hours, days, or, on very rare occasions, weeks). A project-related forest fire and its associated effects on air quality would have a low likelihood of occurring. While a forest fire may cause a temporary exceedance in air quality objectives, air quality would be expected to return to pre-fire conditions very soon after the fire is extinguished and it would not be a frequent occurrence. Therefore, residual effects of a forest fire on air quality are expected to be not significant.

Fire can have indirect effects on the aquatic environment resulting from extraction of surface water used to control the fire or contaminated surface runoff into the aquatic environment. The management of a forest fire would depend on the location of the forest fire (i.e., water used to extinguish the forest fire could be from a local source or a more distant source). Surface runoff could enter the aquatic environment and potentially cause harmful alteration to water quality and resources (fish habitat) due to increases in suspended particulate matter (e.g., ash or sediment); minor traces of hydrocarbon could also be possible.

Forest fires are ultimately temporary in nature (whether naturally occurring or project related) and do not typically spread over large extents. The potential effects of a fire on water quality and freshwater resources are likely to be primarily related to temporary increases in suspended particulate matter (e.g., ash or sediment) and would likely not persist for more than a season because they would typically be flushed out over time or during the first large precipitation event following the fire.

The effects of a forest fire on water quality and freshwater aquatic resources could be low in magnitude, regional in extent (depending on the extent of the fire), short term in duration, and reversible. With the application of mitigation, residual effects are likely not significant because a forest fire is unlikely to result in an overall reduction in the productive capacity of CRA fish habitat or fisheries.

A forest fire ignited from project-related activities has the potential to result in a change in terrestrial wildlife habitat and wildlife populations, including species listed under the *Species at Risk Act* (SARA). A widespread fire could modify wildlife habitat (such as the loss of breeding, nesting, rearing, or other habitat for birds and other wildlife species), and could potentially result in direct mortality to individuals that are slow moving or not mobile, such as young birds and other wildlife that are unable to leave a nest or den. A forest fire during the breeding season could potentially influence the sustained presence of wildlife populations or communities.

A forest fire could also result in the fragmentation of habitat that is important for some species that require large home ranges or regularly move around in a landscape to exploit resources that are seasonally available. For some mammals and herpetiles that rely heavily on forested habitats for at least some of their life requisites, habitat alteration from a forest fire would be a long-term effect for the species. Some SARA-listed species use forest edges and openings, while others use shrubby habitats.

For some species, the effect of habitat change can be expected to be longer term because of the reliance on forested habitat. However, given that the conditions required for a large fire are rare, it is unlikely that this habitat alteration would occur over widespread areas. Conversely, a forest fire can also support the creation of browse habitat (shrubs and grasses) for some species (such as seasonal foraging by moose and grizzly bear) and can provide important edge habitat for others (such as short-eared owl breeding and foraging areas).

It is unlikely that a forest fire resulting from project-related activities would result in the significant loss or alteration of available habitat for most species because available habitat is widely distributed along the pipeline route. A forest fire, while resulting in injury or mortality for some individuals, is unlikely to result in a population-level change.

The effects of a project-related forest fire on wildlife and wildlife habitat are likely to be contained within proximity to the pipeline, medium to long-term in duration (although early successional stages can provide valuable habitat to many species as the habitat returns to pre-fire conditions), and reversible.

Additionally, a forest fire is not likely to result in stated management or conservation objectives for wildlife populations becoming unachievable. Therefore, residual effects on wildlife and wildlife habitat are expected to be not significant.

While a forest fire could result in loss or alteration of tree cover, the potential for change or loss of wetland function is limited as wet soils and associated seed banks would most likely remain intact. The resilience of these wetland types would be high as the wet soil and duff layer would typically remain intact, although graminoid-dominated wetlands can burn under dry conditions.

Vegetation could be partially or completely removed from an area as a result of a project-related forest fire; the size would vary depending on (amongst other things) the intensity of the fire, the nature of the stand, and weather conditions. Factors such as wind, precipitation, topography, forest structure and composition, and fuel moisture would also influence the likelihood and extent of a forest fire. Fires that consume understory vegetation can result in delays before the vegetation community regenerates, particularly if soil organic layers are burned.

The effects of forest fires are considered a natural part of the environment and over the long term, forest fires can contribute to increased biodiversity by changing the composition and density of forests (BC MFLNRO 2013). Many species have adapted to fire and can benefit from its effects, such as lodgepole pine and black spruce, two species specially adapted to fires to open their cones and release large amounts of seed within a short window of time. Naturally occurring forest fires can reduce outbreaks of insects and disease by killing the pathogens infecting a stand.

If a forest fire were to spread to areas supporting SARA-listed or special status plant species, ecological communities of conservation concern, or to old growth management areas, however unlikely, it is possible that the affected area could exceed management objectives for these areas.

A forest fire could have a medium to long-term effect on species composition within an affected area. However, given that the conditions required for a large fire to occur are rare, it is also not expected that a forest fire would result in an overall loss of

species diversity of common vegetation communities along the pipeline given the resilience of vegetation to adapt and recover from fire, or result in a loss of wetland function on a long-term basis. Therefore, residual effects on non-listed vegetation species and wetlands are expected to be not significant. If a forest fire were to affect areas that support SARA-listed plants, species of special status, ecological communities of conservation concern, or old growth management areas, there is potential for a significant effect to occur; however, this is considered unlikely. With fire prevention a priority and response procedures in place as described in Section 31.8.3, the risk of these areas being affected by a forest fire originating from a project source would be lower than the risk of forest fire from natural sources such as lightning.

A project-related forest fire could limit transportation in the immediate area of the forest fire while fire control measures are implemented. Once the fire is contained and extinguished, access to areas near the fire (such as forestry roads or access roads to cabins) may be temporarily impeded until debris from the forest fire is removed.

A forest fire is not expected to affect a large area. Given the temporary nature of the effects and the small area that would be affected relative to the length of the pipeline route, residual effects to transportation are expected to be not significant.

A project-related forest fire could cause effects on visual quality by altering the landscape and depleting the forest and brush cover. While a fire would reduce the visual quality in the immediate area for up to several years, the effects of a forest fire are reversible because the area would be revegetated through natural succession. Therefore, it is predicted that residual effects will be not significant.

A project-related forest fire could temporarily limit the use of an affected area for various land and resource use activities, including fishing, hunting, trapping, or recreational use, potentially reducing or eliminating the distribution of currently harvested flora and fauna. Fire could also damage or destroy habitation sites.

A forest fire is not expected to affect a large area with rapid and effective response procedures in place. While a fire would limit resource use in the immediate area for up to several years, it would be re-vegetated through natural succession and once again become available for resource use. Loss or damage to property, such as cabins, would be mitigated through compensation if liability is attributed. Recently burned areas can provide preferred forage (such as berries) for some harvested species. It is likely that resource harvesting and use patterns would adjust without causing an overall decline or decrease in activities along the pipeline route.

The effects of a forest fire on land and resource use would likely be medium term in duration, and reversible. With mitigation, a forest fire is unlikely to remove any substantive quantity of land available along the pipeline route for any single land use. Therefore, residual effects are expected to be not significant.

A rapidly spreading forest fire can affect human health because there is risk to emergency responders and members of the public in the area from fire and smoke inhalation. Any forest fire that was the result of a project activity would be reported immediately, and implementation of the Fire Suppression Contingency Plan would also be immediate to limit the potential for uncontrolled spread. The protection of human health would be the highest priority, and if necessary, potentially affected areas would be evacuated. Given the mitigation measures and emergency response procedures that will be in place, residual effects on human health are expected to be not significant.

31.8.8 Conclusion on the Potential Risk for Forest Fire

The likelihood that a forest fire caused by project activities will affect terrestrial VCs is considered to be remote with a moderate to high consequence depending on the vegetation type affected (e.g., shrubs vs. mature forest). A moderate consequence is characterized by a widespread effect that is recoverable within the life of the project, while a high consequence is characterized by a widespread effect that is not recoverable within the life of the project. The latter consequence would be associated with the burning of a mature forest landscape.

The overall risk to the terrestrial environment ranges from remote (risk is acceptable and no additional risk mitigation is required) given a moderate consequence to low (risk is tolerable and should continue to be monitored, however, no additional risk mitigation is required) given the high consequence.

For the human environment, the likelihood is considered to be remote with a low consequence, resulting in a remote overall risk.

31.9 FLY ROCK FROM BLASTING

The effects resulting from fly rock are assessed in this section. The general effects from blasting are assessed for each VC in Sections 5 to 29, where applicable.

31.9.1 Description of the Potential Event

Blasting may be required during construction where excavation along the pipeline route and at infrastructure sites is required in hard or rocky substrate. Fly rock is any debris that lands outside the designated blast area.

31.9.2 Likelihood that the Potential Event Could Occur

From May 2011 to February 2013, WorkSafeBC recorded seven incidents of fly rock resulting from blasting in various industries; six resulted in close calls and one incident resulted in injuries to three workers (WorkSafeBC 2013). The potential for interactions with fly rock would be limited to the construction phase, when blasting is

conducted. The likelihood that fly rock would be produced from a blast is considered to be low given standard procedures for blast design and mitigation.

31.9.3 Design Measures to Reduce the Likelihood of the Event and Consequences of an Effect

PRGT will adhere to and implement TransCanada's Blasting Specification Procedure that provides the minimum blasting requirements for use on all TransCanada projects. This procedure includes provisions for on-site and personnel safety, use of certified blasting technicians and pre-and post-blast warning signals. A blast design and an effective blasting plan will be developed, which will reduce the likelihood of fly rock being created by blasting. DFO's *Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters* (Wright and Hopky 1998) will also be followed.

31.9.4 Description of the Potential Residual Effect

The potential production of fly rock is not expected to interact with air quality, the acoustic environment, vegetation and wetland resources, soils, greenhouse gases, water quality, hydrology, employment, infrastructure and services, transportation, visual quality, land and resource use, and heritage and archaeological resources (i.e., assigned Rank 0 as per Table 31-1); therefore no further assessment is required.

With the mitigation measures described above in place, potential interactions with freshwater aquatic resources, marine resources, wildlife and wildlife habitat can be managed to negligible or acceptable levels (Rank 1 as per Table 31-1). Residual effects are likely to be not significant and no further assessment is warranted.

For wildlife specifically, injury or mortality as a result of fly rock will be mitigated by the pre-blast warning signal, which can startle wildlife away from the blast area. Safe blasting in marine environments will adhere to TransCanada's Blasting Specification Procedure as well as the guidelines outlined by Wright and Hopky (1998).

Accidents involving fly rock have the potential to affect human health (Rank 2) and as such are assessed in more detail.

31.9.5 Likelihood of the Effect Occurring

The likelihood that fly rock, should it be produced, would affect human health is considered to be remote.

31.9.6 Contingency, Clean-up, and Restoration Methods

In the event fly rock results from blasting, debris would be removed as required.

31.9.7 Assessment of Residual Effects and their Significance

The potential effects on human health are Rank 2. The use of blast shelters and implementation of the Blasting Specification Procedure will limit the production of fly rock and the potential interaction with on-site personnel, particularly to the extent that an injury or fatality results. The effect on human health, however, could be significant, depending on the severity and extent.

31.9.8 Conclusion on the Potential Risk for Fly Rock from Blasting

Accidents involving fly rock that could result in the loss of human life (i.e., a worst case scenario) are considered to have a remote likelihood of occurrence and a very high consequence (loss of a considerable portion of a VC). The resulting risk is considered to be low overall (the risk is tolerable and requires continued monitoring, however, no additional risk mitigation is required).

31.10 EXPLOSION AND FIRE

The effects resulting from a pipeline explosion that results in fire are assessed in this section. The actual effects of a fire are assessed in Section 31.8.

31.10.1 Description of the Potential Event

During pipeline operations, the pipeline may break as a result of third party damage, cracking, or metal loss. Given that the content of the pipeline is a highly flammable gas, in the event of a line break, if there is a source of ignition (e.g., a spark) along with the appropriate level of oxygen, an explosion may result as the gas ignites. An explosion and subsequent fire during operation could endanger workers, damage vegetation, damage adjacent property, and disrupt public infrastructure and services. The primary cause of a rupture would most likely be cracking or metal loss (NEB 2013b).

31.10.2 Likelihood that the Potential Event Could Occur

A pipeline explosion that results in fire would only occur during the operation phase. The likelihood of ruptures not resulting in ignition have been described in Section 31.5.2. According to the NEB database, 17 of 36 pipeline ruptures over the past two decades have resulted in ignition (either immediate or delayed) (NEB 2013b). The likelihood that a pipeline rupture would result in an explosion and subsequent fire is considered to be remote.

31.10.3 Design Measures to Reduce the Likelihood of the Event and Consequences of an Effect

Siting of the pipeline at an appropriate distance from existing structures and property would limit potential property damage in the unlikely event of an explosion and fire resulting from a pipeline failure. Project design measures to reduce the likelihood of occurrence and consequences of fire are described in Section 31.8 (Forest Fire) above.

Pipeline design mitigation measures include selecting an appropriate wall thickness of the pipeline for the conditions, applying corrosion protection, and executing monitoring systems. Pipeline wall thickness has a designed-in safety factor and is selected in accordance with adjacency criteria. The pipeline is coated internally and there is an external coating to protect against corrosion. Heavy wall pipe will be installed at watercourse crossings, locations with higher potential for geohazards, and in proximity to more populated areas.

PRGT has an integrity management program to manage the integrity of the pipeline for its lifetime and a damage prevention program to mitigate damage from third parties, including membership in BC One Call. Regular maintenance and operational procedures will include cathodic protection monitoring, periodic inspection of the permanent right-of-way, and monitoring systems that would alert staff of potential leakages or failures. The pipeline will be continuously controlled and monitored from the TransCanada OCC. In the event of a pipeline failure, PRGT will work with local emergency responders to limit effects on people and the environment by restricting access, evacuating residents if required, and ongoing incident management.

31.10.4 Description of the Potential Residual Effect

A pipeline explosion and fire is not expected to interact with water quality, hydrology, and employment (i.e., assigned Rank 0 as per Table 31-1); therefore, no assessment is required.

With the mitigation measures described above in place, potential interactions with air quality, the acoustic environment, freshwater aquatic resources, marine resources, wildlife and wildlife habitat, vegetation and wetland resources, soils, greenhouse gases, infrastructure and services, transportation, visual quality, land and resource use, and heritage and archaeological resources can be managed to negligible or acceptable levels (Rank 1 as per Table 31-1). Residual effects are likely to be not significant and no further assessment is warranted. In the case of greenhouse gases, the release would be reported under applicable regulatory requirements.

A pipeline explosion and subsequent fire could affect human health (Rank 2) and as such is assessed in more detail.

31.10.5 Likelihood of the Effect Occurring

Prevention and mitigation measures will be in place throughout the life of the project to avoid the possibility that a pipeline explosion and subsequent fire may occur. An explosion that results in fire that could affect human health, is considered remote for portions of the pipeline located in uninhabited areas. The likelihood of the pipeline rupturing and igniting such that it results in the loss of human life (i.e., worst case scenario) is also considered to be remote.

31.10.6 Contingency, Clean-up, and Restoration Methods

A thorough investigation and inspection would occur once the event is completely controlled and the area is safe to access. Any contaminated materials (including soils) and waste materials would be collected and disposed of at approved facilities. Pipeline equipment and materials would be replaced as required and remediation of the area would begin as soon as possible. Clean fill would be used to rehabilitate damaged terrestrial habitat.

31.10.7 Assessment of Residual Effects and their Significance

Through the control of potential ignition sources and the implementation of the mitigation measures outlined in Section 31.10.3, the likelihood of an explosion that results in fire interacting with the pipeline and personnel is remote. Additionally, the majority of the pipeline will be located in largely uninhabited areas, which would further reduce the potential for interactions with people. Should people be in the vicinity of the pipeline during a rupture that results in an explosion and fire, injuries or fatalities could result which would be a significant effect.

31.10.8 Conclusion on the Potential Risk for Explosion and Fire

The potential risk to human health from a pipeline explosion and fire is considered to be remote (the risk is acceptable and no additional risk mitigation is required) in uninhabited areas, given the remote likelihood of occurrence and low consequence of the effect.

In the vicinity of populated areas or areas that are more readily accessible to people, the risk matrix approach identifies an overall risk of low, based on a remote likelihood of occurrence and a very high consequence that a pipeline rupture and ignition could result in the loss of human life (i.e., worst case scenario).

In such cases, PRGT will apply additional mitigation (e.g., use of heavy wall pipe in more populated areas) to ensure that overall risk levels remain remote.

31.11 SEDIMENT RELEASE INTO WATERCOURSES OR MARINE ENVIRONMENT

The accidental release of sediment (e.g., from the failure of erosion and sediment control measures) into the freshwater or marine environment are assessed in this section. More detailed discussions of these effects are also provided in Section 10 (Freshwater Aquatic Resources) and Section 11 (Marine Resources).

31.11.1 Description of the Potential Event

The construction of the pipeline could result in an accidental release of sediment into the freshwater or marine environment. Watercourse crossings will be constructed in accordance with specific engineering design planning and regulatory approval considerations, as well as specialized equipment and crews dedicated to the task (as per *Pipeline Associated Watercourse Crossings, Third Edition* (CAPP 2005)).

31.11.2 Likelihood that the Potential Event Could Occur

Different pipeline crossing methods and stream crossing methods may result in various levels of sediment release into a watercourse or marine environment. Some methods, such as directional drilling beneath a watercourse, result in no sediment release. Specific techniques for each watercourse crossing will be finalized in the OGC Application and in DFO regulatory approvals. Section 1 (Project Overview) Section 10 (Freshwater Aquatic Resources), and Section 11 (Marine Resources) of this EAC Application describe the general approaches. The likelihood of sediment release from various pipeline installation methods is provided in Table 31-3.

Table 31-3: Likelihood of Sediment Release from Various Pipeline Installation Methods

Installation Technique	Likelihood of Sediment Release
Open Trenched – Hoe	Relatively short duration of sediment release (<24 hours), but potentially high release during excavation and backfilling
Isolated Trench – Flume	Limited, minor sediment release during dam construction and removal and as water flushes over area of construction; a slow construction/installation prolongs sediment release
Isolated Trench – Dam and Pump	Limited, minor sediment release during dam construction and removal and as water flushes over area of construction; a slow construction/installation prolongs sediment release
Isolated Trench – High Volume Pump Bypass/Sump and Pump	Limited sediment release, with no sediment release as a result of dam construction; minor sediment release as water flushes over area after construction
Trenchless – Horizontal Directional Drilling	No sediment release unless frac-out (Section 31.4.3) occurs
Aerial – Self-supporting Clear Span Bridge	No sediment release (although instream construction may be required for bridge abutments)

Source: CAPP (2005)

There may be a requirement for construction vehicles to cross watercourses during pipeline construction. A variety of temporary vehicle watercourse crossing techniques may be used during construction. The likelihood of sediment release from various temporary watercourse crossing techniques is low because there will be no fording of stream channels with flowing water.

The potential for accidental sediment release into the freshwater or marine environment is limited to the construction phase and is considered to be low overall.

31.11.3 Design Measures to Reduce the Likelihood of the Event and Consequences of an Effect

Mitigation measures will be implemented to prevent sediment release into watercourses. These could include a number of environmental mitigation procedures for the construction of pipeline-associated water crossings, including both general and specific mitigation measures (as per CAPP 2005):

- topsoil handling
- subsurface drainage control
- surface erosion and sediment control
- instream sediment control
- clean up and reclamation
- temporary vehicle crossings.

Specific parameters such as flow velocity and volume, crossing depth and width, seasonal conditions, environmental sensitivity, excavation method and streambed material will be considered when designing and installing instream sediment controls. Key mitigation measures include scheduling construction for periods of relatively low environmental sensitivity and reducing the duration of instream work where practical and in accordance with approval requirements.

The management and contingency plans being developed by PRGT (further discussed in Section 36) which will work to prevent the potential release of sediment into watercourses include:

- Erosion and Sedimentation Control Management Plan
- Watercourse Monitoring Plan
- Sediment and Related Water Quality Monitoring Plan
- Flood and Excessive Flow Contingency Plan,

Mitigation measures associated with HDD are discussed in Section 31.4.3.

31.11.4 Description of the Potential Residual Effect

The effect of sediment release into watercourses or the marine environment is not expected to interact with air quality, the acoustic environment, wildlife and wildlife habitat, vegetation and wetland resources, soils, greenhouse gases, employment, infrastructure and services, transportation, visual quality, land and resource use, heritage and archaeological resources, and human health (i.e., assigned Rank 0 as per Table 31-1); therefore no further assessment is required.

With the mitigation measures described above in place, potential interactions with freshwater aquatic resources, marine resources, water quality, and hydrology can be managed to negligible or acceptable levels (Rank 1 as per Table 31-1). Residual effects are likely to be not significant and no further assessment is warranted.

The release of sediment into watercourses could affect freshwater aquatic resources and marine resources in a manner that may exceed acceptable levels (Rank 2 as per Table 31-1). These potential effects are assessed in more detail.

Effects are described for the construction phase only as project activities in and around water that could result in sediment production are not anticipated to occur during operations.

31.11.5 Likelihood of the Effect Occurring

The likelihood that the accidental release of sediment into watercourses or the marine environment during construction as a result of a failure of erosion and sediment control measures is considered to be low given the low likelihood of the event itself occurring and the design and mitigation measures that will be in place to prevent or address any potential releases.

31.11.6 Contingency, Clean-up, and Restoration Methods

In the event of an accidental release of sediment into a watercourse, PRGT would implement the Soil Erosion Contingency Plan, Wet Soils Contingency Plan (traffic planning, timing, mats), and the Flood and Excessive Flow Contingency Plan.

31.11.7 Assessment of Residual Effects and their Significance

The installation of the pipeline across streams and at marine entry/exit points using HDD or trenching methods could result in the production of sediment (e.g., an increase in total suspended solids). Should this occur, the effects to the freshwater and marine environment are anticipated to be of low to moderate magnitude, restricted to the local assessment area, short to medium term in duration and would be reversible.

With the application of mitigation measures, it is expected that the effects would be not significant because release of sediment is unlikely to result in an overall reduction in the productive capacity of freshwater or marine CRA fish or associated fish species and fisheries.

31.11.8 Conclusion on the Potential Risk for Sediment Release into Watercourses or Marine Environment

The potential risk to the aquatic receiving environment (freshwater aquatic resources and marine resources) from an accidental release of sediment due to the failure of erosion and sediment control measures is considered to be low overall (the risk is tolerable and should continue to be monitored, however, no additional risk mitigation is required). The likelihood of the effect occurring is considered to be low, with a low consequence (localized long-term effect with recovery possible within the life of the project).

31.12 CONCLUSIONS ON POTENTIAL RISK FROM ACCIDENTS OR MALFUNCTIONS

Each accident or malfunction scenario is summarized in Table 31-4, along with the proposed mitigation measures to reduce the likelihood.

Table 31-4: Summary of Likelihood of Accidents or Malfunctions

Scenario	Phase	Likelihood of Event	Proposed Key Measures to Reduce Likelihood of Event and/or Consequence of Effect	Potential Residual Effect	Likelihood of Effect	Conclusion
Hazardous Material Spills (including those resulting from motor vehicle/ helicopter or marine vessel accidents)	Primarily during construction; a spill during operation will be contained within compressor station locations	Small-scale releases – moderate during construction and low during operation Large-scale releases – remote during both construction or operation	• Project designed, operated, and managed to prevent and minimize the potential for hazardous spills of any size • Adherence to applicable *Acts*, regulations, and guidelines as well as the Spill Contingency Plan and waste and hazardous materials program for hazardous materials transport, handling, and storage • Equipment will be kept clean and in good operating condition with regular inspections • Spill response equipment and materials kept onsite (including on pipelay and support vessels)	Small-scale releases readily mitigated by measures that will be in place during construction and operation Large-scale release could affect freshwater quality, freshwater aquatic resources, vegetation and wetland resources, marine resources, marine birds, and marine water quality	Large-scale hazardous materials spill during construction or operation considered to be remote	Residual effects are likely not significant. Potential risk to the receiving environment from a large-scale hazardous material spill is considered to be remote overall with a low to moderate consequence for freshwater aquatic resources, very low consequence for freshwater and marine water quality, and low consequence for marine resources, marine birds, and vegetation and wetland resources.
Release of Drilling Muds	Construction only	Low	• Spills of drilling mud are most likely to occur when directional drilling under watercourses is underway • PRGT will comply with DFO guidelines • PRGT is also developing a Directional Drilling Procedure and Instream Drilling Mud Release Contingency Plan which will be adhered to during all drilling activities • Pre-construction investigative drilling will be conducted to confirm sediment suitability for directional drilling	Potential residual effect to freshwater aquatic resources, marine resources, and water quality	Low	Residual effects are likely not significant. Potential risk to the receiving environment considered to be low with a low consequence.
Leakage or Failure of the Pipeline during Operation (non-ignitable)	Operation only	Remote	• The pipeline will be designed and constructed according to CSA standards (e.g., Z662, the national design and construction standard for oil and gas pipeline systems) • The pipeline will be remotely controlled and monitored	Interactions can be managed to negligible or acceptable levels	Remote	Residual effects are likely not significant. Potential risk to the receiving environment considered to be remote with a very low consequence.

Table 31-4: Summary of Likelihood of Accidents or Malfunctions (cont'd)

Scenario	Phase	Likelihood of Event	Proposed Key Measures to Reduce Likelihood of Event and/or Consequence of Effect	Potential Residual Effect	Likelihood of Effect	Conclusion
Leakage or Failure of the Pipeline during Operation (non-ignitable) (cont'd)	Operation only (cont'd)	Remote (cont'd)	…(cont'd) • The pipeline will be visually inspected periodically by helicopter • Corrosion protection will be applied • Pipeline integrity management will be implemented • Marine sections of the pipeline will contain isolation valves that are remotely operated • Additional protection of the subsea pipeline will include use of heavy wall pipe, concrete coating, burial, or rock placement			
Motor Vehicle or Helicopter Accidents	Construction and operation, but primarily during construction	Low for both construction and operation Site-specific	• Project roads will be designed and operated according to applicable safety regulations • Regular inspection and maintenance of roads will be conducted • Traffic Management Plan will be implemented • Contractors will have a Safety and Security Management Plan • The use of construction camps will reduce daily traffic on roads • Prequalification program for helicopter services will be implemented. PRGT will only use helicopter companies that meet or exceed the requirements of this assessment • Helicopters used for this Project will be regularly inspected and flown by experienced pilots	Potential residual effect to human health	Remote (worst case scenario) to Low	Residual effects are likely not significant for accidents with a low likelihood of occurrence and low consequence. Overall risk considered to be low. Potential for significant residual effect to human health under worst-case scenario (e.g., loss of human life). Remote likelihood with very high consequence, resulting in low risk overall.

Table 31-4: Summary of Likelihood of Accidents or Malfunctions (cont'd)

Scenario	Phase	Likelihood of Event	Proposed Key Measures to Reduce Likelihood of Event and/or Consequence of Effect	Potential Residual Effect	Likelihood of Effect	Conclusion
Marine Vessel Accidents	Construction and operation	Remote	• Adherence to applicable *Acts*, regulations, and guidelines • Vessels will meet regulatory standards • Work will be planned in consideration of other nearby activities • PRGT will comply with Transport Canada, Canadian Coast Guard, and Prince Rupert Port Authority requirements, where applicable • Experienced pilots and staff will be hired • Establishment of temporary safety zone around construction vessels	Potential residual effect to marine resources, marine water quality, and human health	Remote	Residual effects to marine resources and marine water quality likely not significant. Potential risk to the receiving environment considered to be remote with a low consequence. Potential for significant residual effect to human health under worst-case scenario (e.g., loss of human life). Potential risk considered to be low with a very high consequence.
Forest Fire	Construction and operation	Remote	• Fire protocols (e.g., designated smoking areas, waste disposal) will be in place • Fire danger classes will be posted • Designated fire boss will be on site • Firefighting training and equipment will be on site • Increasing fire prevention methods as fire hazard increases	Potential residual effect to air quality, freshwater aquatic resources, wildlife and wildlife habitat, vegetation and wetland resources, water quality, transportation, visual quality, land and resource use, and human health	Remote	Residual effects to terrestrial and human environment likely not significant. Potential risk to terrestrial environment considered remote to low with a moderate to high consequence (respectively), depending on the vegetation type affected. Potential risk to human environment considered remote with a low consequence.

Table 31-4: Summary of Likelihood of Accidents or Malfunctions (cont'd)

Scenario	Phase	Likelihood of Event	Proposed Key Measures to Reduce Likelihood of Event and/or Consequence of Effect	Potential Residual Effect	Likelihood of Effect	Conclusion
Fly Rock from Blasting	Construction only	Low	• Adherence to TransCanada's Blasting Specification Procedure • Development of detailed blast design and blasting plan • Pre-blast warning signal will be used • Blast mats and shelters will be used where appropriate • Adherence to *Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters* (Wright and Hopky 1998) for blasting near freshwater and marine environments	Potential residual effect to human health	Remote	Potential for significant residual effect to human health under worst-case scenario (e.g., loss of human life). Potential risk considered to be low with a very high consequence.
Explosion and Fire	Operation only	Remote	• Pipelines will be designed to CSA standards • Selecting appropriate pipe wall thickness for the conditions • Corrosion protection (both internally and externally) will be applied • Heavy wall (thicker) pipe will be used at crossings and locations with higher potential for geohazards and in more populated areas.	Potential residual effect to human health	Remote	In uninhabited areas, residual effect to human health likely not significant. Remote risk overall with a remote likelihood of occurrence and low consequence. In the vicinity of populated areas or areas more accessible by people, potential for significant residual effect to human health under worst-case scenario (e.g., loss of human life). Remote likelihood of occurrence with very high consequence, resulting in low risk overall, however, additional mitigation measures will be in place to ensure overall risk to human health is remote.

Table 31-4: Summary of Likelihood of Accidents or Malfunctions (cont'd)

Scenario	Phase	Likelihood of Event	Proposed Key Measures to Reduce Likelihood of Event and/or Consequence of Effect	Potential Residual Effect	Likelihood of Effect	Conclusion
Sediment Release into Watercourses or Marine Environment	Construction only	Low	• Adherence to several management and contingency plans developed for the project related to sediment release • Environmental controls (e.g., sedimentation fencing) will be applied • Progressive site rehabilitation will be implemented	Potential residual effect to freshwater aquatic resources and marine resources	Low	Residual effects likely not significant. Potential risk to the aquatic receiving environment considered to be low with a low consequence.

Likelihood Post-Mitigation						
	Very High	Low	Moderate	High	Very High	Very High
	High	Low	Moderate	Moderate	High	Very High
	Moderate	Remote	Low	Moderate	Moderate	High
	Low	Remote	Low	Low	Moderate	Moderate
	Remote	Remote	Remote	Remote	Low	Low
		Very Low	**Low**	**Moderate**	**High**	**Very High**
		Potential Consequence Post-Mitigation				

Figure 31-1: Risk Matrix Showing Colour-coded Risk Levels

Legend		Description
	Remote	Risk is acceptable; no additional risk mitigation required
	Low	Risk is tolerable; continue to monitor risk; no additional risk mitigation required
	Moderate	Risk may be tolerable; more detailed review required; if warranted, additional mitigation may be required
	High	Risk is unacceptable; appropriate risk mitigation needs to be applied
	Very High	Risk is imminent; mitigation needs to be applied; long term risk reduction plan needs to be developed and implemented

Figure 31-2: Risk Level Legend