Vopak Pacific Canada

Potential Accidents and Malfunctions Memorandum

Vopak Development Canada Inc.

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1 Introduction

Vopak Development Canada Inc. (Vopak) is proposing to develop the Vopak Pacific Canada Project (the Project) which will utilize the existing Canadian National Railway (CN) rail line, including a 177.3 kilometers (km) section of the line that runs from the Prince Rupert Port Authority (PRPA) lands to 19 km east of Terrace, British Columbia (BC). This technical memorandum (memo) has been prepared to address information requests for additional detail regarding potential accidents and malfunctions in the marine environment presented in **Section 6 Accidents and Malfunctions** of the Environmental Effects Evaluation (EEE)/Application for an Environmental Assessment Certificate (Application) received from the Project Working Group during the EEE/Application review phase in December 2020.

1.1 Project Overview

The proposed Project includes a new bulk liquids tank storage facility in Prince Rupert, BC and a marine export terminal. The Project will store Liquefied Petroleum Gas (LPG) (i.e., propane), Clean Petroleum Products (CPP) (i.e., diesel), and methanol on behalf of Vopak's customers. All products will be transported from various locations across Western Canada to the Project via the existing CN line. Customers of Vopak will schedule the transportation of the products to the facility and will ship the products from the Project's jetty to international markets. The Project includes the receiving and unloading of customer products from rail cars on rail tracks into the Project's rail unloading area and into Project storage facilities. From the storage facilities, the product is loaded via pipeline along the Project's jetty to a berthed ship ready to take the products to their destination.

1.2 Scope of Technical Memorandum

The objective of the transit marine qualitative risk assessment (MQRA) commissioned by Vopak was to analyze the risks of loss of life related to loss of containment of bulk liquids from ships transiting to or at the facility, as well as during loading operations (DNV GL 2020). The area of navigation within scope of the MQRA using a Marine Accident Risk Calculation System (MARCS) is from the terminal to Triple Island, therefore, the spatial scope of this memo is equivalent.

The scenarios which are discussed in this document are derived from the MQRA and were presented with associated figures identifying geographical scopes in **Section 6** of the EEE/Application. It is highly recommended to read **Section 6** of the EEE/Application to understand the baseline data of this technical memo. Please note that Vopak does not own the ships in transit or loading at berth, therefore, the provided scenarios and potential effects were assessed based on Vopak's knowledge of the engineering design of their facility, its known emergency systems and the products which will be exported from the facility.

The spatial boundary of the MQRA includes the area from Project shoreline, the Project area of interest (i.e. trestle, berth, jetty, etc.), and the shipping lane to Triple Island.

The scenarios in the marine environment within the spatial area of the MQRA considered for this memo are as follows:

- Cargo transfer operations – loss of containment of CPP in the marine environment
- Cargo transfer operations – collision with the jetty while loading
- Cargo transfer operations – collision with another vessel while at berth

- Marine transit – collision with another vessel within the shipping lane (terminal to Triple Island)
- Marine transit – collisions outside the PRPA Boundary

The purpose of this memo is to:

- address round one information requests received in December 2020 during the EEE/Application review phase related to potential effects of accidents and malfunctions, as well as seeking additional information of scenarios from the MQRA; and
- provide further information on the potential effects to marine birds, marine resources (marine habitats and mammals), marine use and navigation, as well as community services and infrastructure.

2 Marine-side Accident and Malfunction Scenarios

The following subsections present the five scenarios and the related environmental consequences of these identified accidents and the potential effects on Project valued components (VCs) and subcomponents. The potential effects to VCs and subcomponents relating to the scenarios within this document are outlined in **Table 6.3-2** of the EEE/Application. The VCs presented, and their associated further description of potential effects, were chosen from information requests received from the Working Group.

2.1 Cargo Transfer Operations – Loss of Containment of Clean Petroleum Products in the Marine Environment

The following scenarios could lead to a loss of containment of CPP in the local study area (LSA):

- Striking at berth of a berthing vessel with a stationary vessel in the process of being loaded with product. Most striking incidents will have low energy and will thus not cause a cargo tank breakage (DNV GL 2020).
- Vessel collision with the trestle during berthing. This could lead to a loss of containment from one or more of the vessels resulting in a potential fire and/or water contamination and impacts to marine resources (ecosystem, habitat, fauna).
- Inadequate mooring of the vessel could result in potential vessel movement while loading. The consequence of this scenario is potential fire and/or water contamination from a spill originating from the loading hose or over water piping and impacts to marine resources (ecosystem, habitat, fauna).

2.1.1 Overview of Contributing Factors in the Marine Environment

There are many factors that can contribute to the extent of impacts related to CPP spills in the marine environment in proximity of the terminal, including:

- CPP spill size (volume), duration, and rate;
- Contaminant of Potential Concern (COPC) (i.e., type of product such as fuel, diluents, refined products, or crudes) and their environmental fate (e.g., weathering) and effects (e.g., toxicity to different marine organisms);
- Hydrodynamic conditions (i.e., wind and wave exposure, as well as tides and currents related to season or weather conditions) which affect CPP weathering, as well as transport and movement; and
- Receiving environment or Receptors of Concerns (ROCs) (i.e., marine habitats and receptors exposed to the COPCs and their relative sensitivity).

These factors represent key considerations and should be characterized as soon after the spill as possible.

CPPs are light products (e.g., diesel) with swift spreading abilities in the marine environment, however, the level of evaporation over a two-day period is estimated at up to two-thirds of the initial spill volume. Most importantly, CPPs are known to have little sedimentation but do have potential for long-term contamination, including long-term intertidal contamination and potential for subtidal impacts. When CPPs are spilled into the marine environment their properties begin to change through various physical, chemical and biological processes referred to as weathering (Hook et al. 2016, Lee et al. 2015). Weathering processes are complex, dynamic, and interdependent. These processes can disperse CPP and transport it between media physically, which can chemically alter or degrade the product and mix with other background sources. Weathering processes are dependent on physical-chemical properties of the CPP and constituent compounds, the duration and location of the spill, and environmental conditions. For example, “light” CPP and compounds typically dissolve into water and evaporate.

For the potential effects described in this loss of containment scenario, the CPP used for a loss of containment scenario at the jetty is the transfer of CPP (such as diesel) from the terminal to the ship at berth.

2.1.2 Potential Effects to Marine Resources - Marine Birds

Spills to the marine environment could affect marine birds directly via contamination of feathers leading to loss of buoyancy and waterproofing and subsequent mortality due to exposure, and ingestion, inhalation or contact with the spilled product could lead to morbidity (including chronic long-term effects) and mortality (Leighton 1993). CPP could also be transferred to the surface of marine bird eggs from contact with contaminated feathers of incubating adults (Leighton 1993). Indirect effects could include loss or contamination of marine bird prey within the areas affected.

The vulnerability of various seabird species to spills in the LSA is dependent on the morphology and biology of the species, including their foraging behaviour and nesting locations, as well as their population densities within the LSA. A relative vulnerability index of 1-100 (lowest to highest vulnerability; King and Sanger 1979) has been used to assess the susceptibility of marine bird species to spills in the marine environment.

A summary of marine bird species known to frequent the LSA is provided in **Section 5.4.6.4.4.** of the EEE/Application. Species known to be present in the LSA with the highest vulnerability to this scenario (70-88) are the alcids (e.g., Marbled Murrelet, Common Murre [*Uria aalge]*, Rhinoceros Auklet [*Cerorhinca monocerata]*). These species:

- forage by diving, which is impaired by loss of buoyancy;
- form large aggregations;
- have relatively high populations in the northwest coast;
- are breeding residents (and thus could transfer CPP to eggs during incubation, and feed contaminated prey to young); and
- are winter residents (and thus are present at the coldest times of year, when impaired thermoregulation is most critical and when CPP persists longest).

For other species observed within the Project area, Black Scoters (*Melanitta americana*) and White-winged Scoters (*Melanitta deglandi*) are also assessed as higher vulnerability (72), gulls, such as the Glaucous-winged Gull (*Larus glaucescens)*, and cormorants (e.g., Double-crested Cormorant [*Phalacrocorax auratus]*) are considered low to moderately vulnerable (32-66), Canada Goose (*Branta canadensis*) and dabbling ducks such as the Mallard (*Anas platyrhynchos*) are generally low vulnerability (34-50), shorebirds such as Black Turnstone are moderately vulnerable (57), and sandpipers such as Baird's Sandpiper (*Calidris bairdii*), Least Sandpiper (*C. minutilla*) and Western Sandpiper (*C. mauri*) were assessed as lower vulnerability (34 - 47).

The likelihood of a direct effect on marine birds is considered low because of expected low numbers of marine birds within the highest risk contour, (i.e., within the established marine safety zone) at the time of an accident, and the distance between the shipping routes, jetty and marine bird colonies. Containment measures would be immediately implemented in the event of a spill, and the noise and visual disturbance of emergency response activities are expected to cause marine birds to avoid the area while cleanup is ongoing. Potential impacts of a spill on marine bird prey species are described in **Section 2.1.4**.

2.1.3 Potential Effects to Marine Resources – Marine Habitats

Three generalized substrate types and associated communities were identified and characterized within the 2019 Vopak Marine Habitats LSA: rocky, gravel and soft bottom substrates (see **Section 5.4.3.4.4 Baseline Description of the EEE/Application**).

Rocky habitats occur on rocky shorelines, rocky reefs, and rock outcroppings and are composed of varying combinations of bedrock, as well as areas of boulders with greater than 5% cover (which are minimal and generally occur in the shallow subtidal zone (< -5 m depth relative to CD) at the base of bedrock areas). Rocky habitats occur along the Ridley and Coast islands shorelines, and the drying islet between Ridley and Coast islands, and the rocky subtidal outcroppings north of the trestle/east of the vessels and twin multi-buoy mooring (MBM) berths.

Gravel habitats generally consist of cobble and pebble greater than 30% cover and boulder less than 5% cover. These habitats are restricted to transitional areas between rocky substrates and fine-grained substrates. The majority of the rocky and gravel habitats were located in the intertidal zone of Ridley and Coast islands.

Soft bottom habitats generally consist of varying combinations of sand and mud with or without areas of pebble and cobble less than 30% cover. The majority of this soft bottom habitat within the LSA is subtidal with fine and medium-grained sediments being predominant. These intertidal soft bottom habitats include a moderately sloping sandy beach on Ridley Island (south of the proposed Project trestle and firewater pump platform), and a small, sandy pocket beach located on the inside of Coast Island.

The following sections describe the potential impacts to marine habitats within the LSA in the event of a loss of containment of diesel, including eel grasses and salt marshes.

2.1.3.1.1 INTERTIDAL COMMUNITIES

The intertidal zone is along the marine shoreline bounded by the highest high tide mark and the lowest low tide mark. As this zone is uncovered and exposed to the air during low tides, marine plant/algae and invertebrate communities are relatively hardy, due to exposure to significant variations in temperature, salinity and extremes in wave action. Intertidal zones and the biota that live there vary greatly based on substrate type, shoreline slope and protection. Marine plants, algae and invertebrates associated with soft bottom habitats, as well as eelgrass beds, are discussed in the subsections below.

2.1.3.1.2 EELGRASS BEDS

Eelgrass in BC includes the native *Zostera marina* L. and invasive *Zostera Japonica* species. Eelgrass is a vascular marine macrophyte which grows in sandy or muddy substrates on the Pacific coastline (den Harto 1970) and goes through seasonal patterns of growth and die-back. The presence of eelgrass is associated with a narrow range of conditions, heavily dependent on salinity, temperature and currents. Eelgrass beds occur within the Project's marine habitat LSA, so CPPs deposited here may be persistent. If water column nutrient concentrations are too high, the plants may not survive due to increased shading. Once established, eelgrass plants can form extensive intertidal (and some shallow subtidal) perennial beds, widely recognized as important and unique nearshore habitat for invertebrates and fish (Short and Wyllie-Echeverria 1996, Chamber et al. 1999). The beds provide cover from predation, reduce local current regimes (allowing for settlement of organisms) and increase secondary productivity by adding to local habitat complexity and surface area (Chambers et al. 1999, Bostrom et al. 2002, Duarte 2002, Laurel et al. 2003). Eelgrass beds form important nursery and feeding areas for many marine animals, including invertebrates and fish (Vandermeulen 2005).

Eelgrasses are sensitive to the exposure of CPPs which lead to decreased growth rates, smothering of leaves, changes in the chlorophyll content of leaves and reduced photosynthetic ability (Peters et al. 1997); however, other studies have found that CPP tends to have minimal observable impact on the *Zostera* plants themselves (except for some blackening of the leaves and temporarily reduced growth rates; e.g., Howard et al. 1989, Jacobs 1980 and Dean et al. 1998). The vulnerability of eelgrass communities to CPP will depend greatly on the flushing rate of seawater through the bed and on the way in which CPP is distributed. CPP and dispersed CPP can have significant effects on fauna living in and on the sediments and on the leaves (e.g., Jewett et al. 1999).

2.1.3.1.3 SALT MARSHES

The 2019 intertidal survey identified several small salt marsh patches at the southeast end of the LSA on the Ridley Island shoreline (see **Section 5.4.3.4.4. Baseline Description** in the EEE/Application). More substantial perched marsh areas were identified on Coast Island, which is not within the marine Project components footprint.

Saltmarsh leaves are often corrugated, which can provide a large surface area to which CPP can adhere; plant stems and leaves may then be damaged by chemical toxicity (IPIECA 2016a). In a review of 32 spill studies the estimated recovery of impacted saltmarshes was within two years for approximately half of the studies, within ten years for a third of the studies, and more than ten years in six cases, varying based on the persistence of the product (IPIECA 2016a).

2.1.3.1.4 FISH

Fish are an economically and ecologically important component of the marine ecosystem of the Pacific Coast of Canada. Marine fishes are an incredibly large group, with a diverse array of species and multiple life stages, including intertidal soft and hard bottom habitats, subtidal soft and hard bottom habitats and the pelagic zone of nearshore and offshore environments. Additionally, many fish rely on the unique nearshore vegetation habitats described above (e.g., eelgrass beds and kelp forests) for spawning, larval development and rearing.

While fish are generally considered to be pelagic (from the larval to adult stages), some are closely associated with the seafloor substrate; these are known as benthic or demersal fish. Most fish species spend most of their adult stage in the pelagic zone, where there is limited exposure to CPP in the water column, and thus, the adult, pelagic life stages of fish are not as affected by CPP than other life stages. Fish that use intertidal, nearshore subtidal and estuarine habitats for spawning or during more sensitive early life stages (i.e., larval and juvenile stages) are more likely to have exposure to CPP or CPP COPCs.

Fish are typically exposed to hydrocarbons via uptake of water across membranes and through contact with dispersed CPP droplets, ingestion of contaminated prey items, or maternal transfer of CPP COPCs accumulated by a fish into her eggs (Lee et al. 2015).

2.1.4 Potential Effects to Marine Resources - Marine Mammals

Groups of mammals include cetaceans (whales and dolphins), pinnipeds (seals and sea lions) and mustelids (sea otters). According to Jarvela Rosenberg et al. (2017), these marine mammals can also be classified by those which are fully aquatic (cetaceans) and those which are semi-aquatic (pinnipeds and mustelids). A third group of semi-aquatic maritime mammals that live and feed in coastal environments include species, such as bears, wolves, and river otters.

The impacts to marine mammals from CPP can have both lethal and sub-lethal effects. Awareness of the impacts to marine mammals – including cetaceans - from spills is growing. Jarvela Rosenberger et al. (2017) identified oil exposure pathways as direct contact, adhesion, inhalation, direct ingestion and ingestion through contaminated prey. Exposure to CPPs can impact marine mammals in a variety of ways including respiratory impacts, skin or mucous membranes (e.g., eyes and mouths) irritations, internal bleeding impaired wound healing, chemical burns, infections, acute or chronic toxicity, ability to feed – particularly for baleen whales and benthic feeders, the inability to thermoregulate leading to hypothermia or hyperthermia, exhaustion, dehydration, or starvation.

Animals that become unable to maintain body temperature and buoyancy may drown, while others may seek the relative safety of the shore (IPIECA 2014). This habitat shift can have effects on the animals' ability to forage effectively and communication with conspecifics. Furred marine mammals, including pinnipeds and sea otters, risk ingesting the CPP during grooming, and the CPP can impair their ability to swim.

Inhalation of toxic substances can lead to respiratory irritation, inflammation, emphysema, or pneumonia (NOAA 2018). Ingestion of CPP, either through direct ingestion or through contaminated prey, can lead to acute and chronic health problems including gastrointestinal distress, vomiting, maldigestion, ulcers, bleeding, diarrhea, anemia, liver dysfunction, endocrine dysfunction, kidney dysfunction, impaired brain function, immune suppression, damaged lungs, reproductive impairment or failure, or reduced neonatal or juvenile survival, or death (IPIECA 2014, Takeshita et al. 2017, NOAA 2018, IPIECA 2017).

Other impacts to marine mammals from spills could include loss of prey resources, habitat loss, and habitat quality decline. The long-term consequences of these indirect effects are difficult to quantify but could have serious consequences at the species or population levels.

2.1.5 Potential Effects to Marine Use and Navigation

2.1.5.1 Potential Effects to Marine Use for Commercial Fisheries

Any loss of CPP may have the potential to impact marine use for commercial fisheries. Major fisheries within the region include shrimp (trawl), Dungeness crab (trap), and the five key species of Pacific salmon (seine and gillnet), (Stantec 2014b) (see **Section 5.9 Marine Use and Navigation Figure 5.9-6, Figure 5.9-7, Figure 5.9-8**).

2.1.5.2 Potential Effects to Marine Use for Recreational Fisheries

Several recreational fisheries occur throughout the RSA including salmon, crab, prawn, shrimp, scallops, rockfish, halibut, herring, sardine, groundfish, and euphausiids (BCMCA 2018) (**Figure 5.9-9**). Recreational fishing occurs around the north coast of Stephen's Island, Triple Island, Rachael Islands, Lucy Islands, the

Kinahan Islands, and Kitson Island (BCMCA 2018). Locations of recreational fisheries are summarized below in Table 1. In addition, Aboriginal fishery species and locations are further described in **Section 5.9.1.4.4.6** of the EEE/Application (Commercial, Recreational and Aboriginal Fisheries).

2.1.5.3 Potential Effects to Marine Use for Recreation

Any potential CPP spill also has the potential to affect other recreational uses such as kayaking, camping and recreational boating in the area but this effect would is expected to be short term upon completion of spill response activities. Sea kayaking primarily occurs around Kaien Island with the most popular areas on the west side of Kaien Island, Chatham Sound, and towards Porcher Island (Stantec 2014b). There are also a number of coastal campsites in the region including Kitson Island Marine Provincial Park (Kitson Island and Kitson Islet).

2.2 Cargo Transfer Operations: Collision with Jetty while Loading

A vessel collision with the trestle during berthing could lead to a loss of containment from one or more of the vessels resulting in a potential fire or water contamination and impacts to marine resources (ecosystem, habitat, fauna). Another consequence of this scenario is damage to the trestle resulting in a disruption of operations.

Inadequate mooring of the vessel could result in potential vessel movement while loading. The consequence of this scenario is potential fire and/or water contamination from a spill originating from the loading hose or over water piping and impacts to marine resources (ecosystem, habitat, fauna).

2.2.1 Potential Effects to Marine Resources - Marine Birds

The potential of direct mortality from a collision itself is very low due to very low odds of marine birds being present within the impact zone of a collision. Marine birds could be affected by loss of containment of cargo during transfer operations for more information on these effects please see **Section 2.12**.

2.2.2 Potential Effects to Marine Resources – Marine Mammals

Please refer to **Section 2.1.3 and 2.1.4** for potential effects of a CPP spill in the marine environment near the loading terminal.

2.2.3 Potential Effects to Marine Use and Navigation

Collisions with the jetty while loading has the potential to impede navigation and affect marine use. It is likely that the berth would be contained within a safety zone and thus impacts to recreational vessels would be limited. Any potential impacts to navigation due to a collision at the berth would be limited to commercial vessels and likely on those associated with Vopak's commercial activities. Vessel collision, grounding or loading arm malfunction are unlikely scenarios with Project design features to address navigational safety which are described in **Section 2 Project Description** and **Section 2.6. Project Design and/or Alternative Means of Carrying out the Project**. PRPA harbour procedures and protocol and the mitigation measures to address communications and navigation. With these measures in place, the potential adverse effect on marine use and navigation would be expected to be minimal.

2.2.4 Potential Effects to Community Services and Infrastructure

In the event of a fire, explosion, or collision at the Vopak site or otherwise involving the Vopak Project, workers injured in the accident would be treated by either Vopak's on-site first aid system (minor injuries), or at the Prince Rupert Regional Hospital or Mills Memorial Hospital in Terrace, depending on severity and type of injury as well as capacity at either hospital (it is also possible that the injured are transported to Prince George or Vancouver if specialized care is required).

With a total expected operational workforce of about 39 full-time equivalents (see **Section 2.5.3.1** of the EEE/Application), and only a small portion of this operational workforce at work on a given day and at an accident location, the number of injured would at most be in the double digits, however, given the background strain on health care capacity in the region and the small scale of capacity (i.e., number of intensive care beds, number of physicians and specialists – see **Section 5.9.2.4.4.2** of the EEE/Application), even without COVID-19 considered, the added pressure of an industrial accident would be challenging. Health care in the region is already determined to be strained and 'beyond threshold'. While anticipated to be of low likelihood, an accident would have a substantial, albeit shorter-term, impact on health care in the regional study area (RSA).

2.3 Cargo Transfer Operations: Collision with Another Vessel

The types of vessels that will be accessing the MBM berth (associated platform and trestle structures) include:

- Medium-Range Chemical Tanker: Length Overall (LOA) 170 metres (m) – 186 m; Beam 28 m – 32.2 m; Loaded Draft 11 m – 12.8 m.
- Very Large Gas Carrier (VLGC): LOA 230 m; Beam 36.6-37.2 m; Loaded Draft 12.5 m.
- Product Tanker: LOA 230 m; Beam 32.2 m; Loaded Draft 14.5 m.
- Panamax size tankers.

Vopak estimates 171 Project carriers will call at the terminal annually, all double-hulled (DNV GL 2020). The associated annual numbers of transits are:

- Methanol carrier (chemical tanker or medium range): 116 calls.
- VLGC: 25 calls.
- Panamax (product tanker or large range): 30 calls.

The loading time is assumed to be 30 hours. The loading lines are kept liquid full and the loading arms are purged after each load. The total turnaround time for a vessel is 40 hours. Loading is assumed to start within a couple of hours after the vessel is berthed (assumed to occur during the day-time) (DNV GL 2020), where:

- Preparation for loading: 4 hours (approximate)
- Cargo loading time: 30 hours
- Preparation for departure: 6 hours (approximate)
- Total: 40 hours

Striking at berth of a berthing vessel with a stationary vessel in the process of being loaded with product could lead to a loss of containment from one or more of the vessels resulting in a potential fire and/or water contamination and impacts to marine resources (ecosystem, habitat, fauna).

The frequency of striking does not reflect the frequency of a cargo release because most of the striking incidents will have low energy and will thus not cause a cargo tank breakage (DNV GL 2020). The striking frequencies for vessels impacting the Vopak vessel at berth are calculated based on the vessel traffic analysis. Since no anticipation of cargo tank breakage is anticipated, this scenario does not consider a loss of bunker fuel into the marine environment (see **Section 2.6**).

Two scenarios were designed based on the most current design information using the Project vessels include:

- a Project vessel struck by a passing vessel during loading; or
- the trestle struck by a passing vessel during a Project vessel loading.

2.3.1 Potential Effects to Marine Use and Navigation

Please refer to **Section 2.2.3. Potential Effects to Marine Use and Navigation**.

2.3.2 Potential Effects to Community Services and Infrastructure (Health)

Please refer to **Section 2.2.4. Potential Effects to Community Services and Infrastructure.**

2.4 Cargo Transfer Operations: Fire or Explosion in the Marine Environment

Fire or explosion aboard a vessel/carrier could occur while in transit resulting from collision of a vessel with a Project vessel, grounding, or spill of cargo in the presence of an ignition source. Fire or explosion can result in risks to personnel and to assets. Above-water releases generally have higher release rates, larger pool formation, and higher evaporation rates that increase the size of the flammable or thermal hazard zone (DNV GL 2020).

In the event of a fire or explosion during cargo transfer, the gas detection and Emergency Shut Down (ESD) system would immediately isolate the loading arms and stop loading within seconds to reduce volume spilled. If ignition does occur, the fire will be contained within the PRPA ‘Dynamic Safety/Security Zone’ and limited to the source of the rupture or location of spilled product.

2.4.1 Potential Effects to Marine Birds

The potential effects of fire or explosion on marine birds include direct mortality of individuals. If ignition does occur, the fire or explosion will be contained within the marine safety zone limited to the source of the rupture or location of spilled product. The likelihood of an effect on marine birds is also considered low because of low expected numbers of marine birds within the highest risk contour, (i.e., within the established marine safety zone) at the time of an accident, and the distance between the jetty and marine bird breeding colonies.

Spill containment measures would be immediately implemented in the event of a spill, and the noise and visual disturbance of emergency response activities are expected to cause marine birds to avoid the area while cleanup is ongoing.

2.4.2 Potential Effects to Marine Resources – Marine Mammals

Potential effects to marine mammals exist from an explosive event near the berth. An explosive blast would affect marine mammals through the propagation of an explosive blast followed by the impact of the impulsive blast wave, with the effect of the latter is a function of the body weight of the individual (Ward 2015). Consequences of explosions to marine mammals may result in behavioral reactions and/or tissue damage, with the auditory system being particularly sensitive (Richardson et al. 1995). Explosive events can lead to marine mammal disturbance, injury, and mortality. While an explosion can result in immediate death, there can also be effects that can compromise an individual's abilities to carry out fundamental life functions, such as foraging. This can contribute to decreased fitness which can have temporal lag consequences to the explosive event.

2.4.3 Potential Effects to Marine Use and Navigation

A fire or explosion during cargo transfer operations has the potential to impede navigation for a short period of time. The likelihood of an effect on marine use and navigation is considered very low because of restricted access during loading and berthing, and the engineered safety measures within the Project design which would efficiently work to eliminate fire or contain a spill which could potentially ignite.

2.4.4 Potential Effects to Community Services (Health)

Please refer to Section **2.2.4. Potential Effects to Community Services and Infrastructure.**

2.5 Marine Transit: Collisions with Another Vessel

Collision incidents are assumed to be side impact of a vessel while in 'transit.' This could occur for inbound (unladen) movement and outbound (laden) movement. Only laden, outbound vessels can experience a loss of containment of cargo (e.g., LPG, methanol, CPP). Historically, there have been no accidents involving LPG carriers with loss of containment from the LPG tank (DNV GL 2020). In estimating the likelihood of a tank breach, the following were considered:

- The speeds of the striking ship and the LPG carrier.
- The mass of the striking ship and the LPG carrier in longitudinal and transverse directions.
- The rotational masses of the striking ship and the LPG carrier.
- Length of the striking ship.
- Factors relating to the relative orientation of the two vessels.

All navigational transits and manoeuvres will adhere to the *Canada Marine Act* and associated federal rules and regulations, including the PRPA Port Information Guide (PRPA 2020). PRPA and BC Coast Pilot safety procedures will be followed as required.

A summary of management plans in use within the Port of Prince Rupert is provided below. These practices and procedures will be incorporated into Project operations at Ridley Island including:

- Port Information Guide (PRPA 2020), including the PRPA Practices and Procedures, applies to all vessels within the Port of Prince Rupert, and operators/tenants responsible for the safe navigation of those vessels. The Guide provides procedures and practices for:
  - Arrival, departure, notification, documentation, and reporting.
  - Port description (e.g., location, vessel size, working hours, cargo, traffic, pilot stations).

- Navigation and port traffic managed under the authority of PRPA. These procedures embody the requirements of the International Marine Organization), Transport Canada, PRPA and Vopak. This will include speed limits, rights-of-way, staging areas, anchoring locations, berthing, ballasting, bunkering, restrictions, and other port-specific requirements.
- Port safety and security, including emergency contacts, scenarios, response equipment, and reporting.
- Nautical services and communications, including Vessel Traffic Service, pilotage, tugs, mooring, and Very High Frequency channels.
- Procedures for port operations (i.e., cargo loading/discharge, vessel operations, inspections).
- Port services such as shore-based electricity, stores, waste disposal, and repairs.

2.5.1 Potential Effects to Marine Resources – Marine Birds

Please see **Section 2.1.2**.

2.5.2 Potential Effects to Marine Resources – Marine Habitats

Please refer to **Section 2.1.3.**

2.5.3 Potential Effects to Marine Resources – Marine Mammals

Please refer to **Section 2.1.4.**

2.5.4 Potential Effects to Marine Use and Navigation

Please refer to **Section 2.1.5**.

2.5.5 Potential Effects to Community Services and Infrastructure

Please refer to **Section 2.2.4.**

2.6 Marine Transit: Collisions Outside the PRPA Boundary

The MQRA evaluated the risk of a release of LPG/methanol/CPP and flammable consequences in transit and in the absence of emergency response actions and mitigation measures. The scenarios above may lead to a leak or release of product during outbound (laden) vessel transit either above or below the waterline. Vopak is only able to assess marine scenarios related to activities within the PRPA water lot. All vessels transiting outside of the waterlot must adhere to emergency and spill response procedures and notification systems regulated through the following federal and provincial legislation, and shipowners are specifically responsible for pollution from their ships:

- *Canadian Environmental Protection Act*
- *Canada Marine Act*
- *Canada Shipping Act*
- *Canadian Transportation Accident Investigation and Safety Board Act*
- *Fisheries Act* and regulations
- *Marine Liability Act*
- *Pilotage Act*

- *Transportation of Dangerous Goods Act*, regulations, and standards (Emergency Response Assistance Plan [ERAP] approval)
- BC *Environmental Management Act* (EMA)
- BC EMA Hazardous Waste Regulation
- BC EMA Spill Reporting Regulation
- BC Safety Standards Act and regulations

Specifically, *Article 3 Liability of the Shipowner* of the *Marine Liability Act* states, "1 Except as provided in paragraphs 3 and 4, the shipowner at the time of an incident shall be liable for pollution damage caused by any bunker oil on board or originating from the ship…." (Marine Act, 2001).

A bunker fuel spill has an environmental impact to the marine environment, rather than a safety impact (DNV GL 2020). Bunkering in Prince Rupert is uncommon, since there are no local bunkering facilities, but bunkering does happen from time to time if vessel agents order fuel to be delivered from Vancouver, BC. Bunkering activities will not take place as part of this Project.

2.6.1 Potential Effects to Marine Resources – Marine Birds

Please see **Section 2.1.2**.

2.6.2 Potential Effects to Marine Resources – Marine Habitats

Please refer to **Section 2.1.3.**

2.6.3 Potential Effects to Marine Resources – Marine Mammals

Please refer to **Section 2.1.4.**

2.6.4 Potential Effects to Marine Use and Navigation

Please refer to **Section 2.1.5.**

2.6.5 Potential Effects to Community Services and Infrastructure

Please refer to **Section 2.2.4.**

3 Conclusions

The conclusions of the potential effects of the scenarios provided in this memo are provided in the tables below. For information on the Project and Potential Accidents and Malfunctions, please see **Section 6** of the EEE/Application.

Table 1: Potential Effects of Accidents and Malfunctions: Cargo Transfer Operations – Loss of Containment of CPP (Diesel)

Valued Component	Potential Effects
Marine Resources - Marine Birds	› Spills to the marine environment could affect marine birds directly via contamination of feathers leading to loss of buoyancy and waterproofing and subsequent mortality due to exposure, and ingestion, inhalation or contact of toxic materials leading to morbidity (including chronic long-term effects) and mortality (Leighton 1993). › The likelihood of a direct effect on marine birds is considered low because of expected low numbers of marine birds within the highest risk contour, (i.e., within the established marine safety zone) at the time of an accident, and the distance between the shipping routes, jetty and marine bird colonies.
Marine Resources – Marine Habitats	› The vulnerability of eelgrass communities to CPP will depend greatly on the flushing rate of seawater through the bed and on the way in which CPP is distributed. CPP and dispersed CPP can have significant effects on fauna living in and on the sediments and on the leaves (e.g., Jewett et al. 1999). › Saltmarsh leaves are often corrugated, which can provide a large surface area to which CPP can adhere; plant stems and leaves may then be damaged by chemical toxicity (IPIECA 2016a). › Fish that use intertidal, nearshore subtidal and estuarine habitats for spawning or during more sensitive early life stages (i.e., larval and juvenile stages) are more likely to have exposure to CPP or CPP COPCs.
Marine Resources – Marine Mammals	› Changes within the water column that affects the visibility within aquatic habitat may result in increased difficulty for visual detection of prey by marine mammals. This would likely affect marine mammals that use acoustic prey detection to a lesser extent than those which use visual prey detection. › Other impacts to marine mammals from spills could include loss of prey resources, habitat loss, and habitat quality decline. The long-term consequences of these indirect effects are difficult to quantify but could have serious consequences at the species or population levels. › Any loss of CPP such as diesel may have the potential to impact marine use.

Table 2: Potential Effects of Accidents and Malfunctions: Cargo Transfer Operations – Collision with Jetty while Loading

Valued Component	Potential Effects
Marine Resources - Marine Birds	› The potential of direct mortality from a collision itself is very low due to very low odds of marine birds being present within the impact zone of a collision. Marine birds could be affected by loss of containment of cargo. › Changes within the water column that affects the visibility within aquatic habitat may result in increased difficulty for visual detection of prey by marine mammals. This would likely affect marine mammals that use acoustic prey detection to a lesser extent than those which use visual prey detection. › Any discharge of potentially deleterious materials or accidental releases of hydrocarbons (fuel, CPP, hydraulic fluid), or spills of uncured concrete may degrade both shoreline and marine habitat and have impacts on the prey species populations of marine mammals.
Marine Use and Navigation	› Collisions with the jetty while loading has the potential to impede navigation and affect marine use. It is likely that the berth would be contained within a safety zone and thus impacts to recreational vessels would be limited. Any potential impacts to navigation due to a collision at the berth would be limited to commercial vessels and likely on those associated with Vopak's commercial activities.
Community Services and Infrastructure	› While anticipated to be of low likelihood, an accident would have a substantial, albeit shorter-term, impact on health care services in the regional study area.

Table 3: Potential Effects of Accidents and Malfunctions: Cargo Transfer Operations – Collision with Another Vessel

Valued Component	Potential Effects
Marine Resources - Marine Birds	› The likelihood of a direct effect on marine birds is considered low because of expected low numbers of marine birds within the highest LSIR risk contour (see Section 6 of the EEE/Application), (i.e., within the established marine safety zone) at the time of an accident, and the distance between the shipping routes, jetty and marine bird colonies. Containment measures would be immediately implemented in the event of a spill, and the noise and visual disturbance of emergency response activities are expected to cause marine birds to avoid the area while cleanup is ongoing.
Marine Use and Navigation	› The potential adverse effect on marine use and navigation would be expected to be minimal.
Community Services and Infrastructure	› While anticipated to be of low likelihood, an accident would have a substantial, albeit shorter-term, impact on health care services in the regional study area.

Table 4: Potential Effects of Accidents and Malfunctions: Fire or Explosion in the Marine Environment of the Local Study Area

Valued Component	Potential Effects
Marine Resources - Marine Birds	› The likelihood of an effect on marine birds is also considered low because of low expected numbers of marine birds within the highest LSIR risk contour (see Section 6 of the EEE/Application), (i.e., within the established marine safety zone) at the time of an accident, and the distance between the jetty and marine bird breeding colonies.
Marine Resources – Marine Mammals	› Explosive events can lead to marine mammal disturbance, injury and mortality.
Marine Use and Navigation	› The likelihood of an effect on marine use and navigation is considered very low because of restricted access during loading and berthing, and the engineered safety measures within the Project design which would efficiently work to eliminate fire or contain a spill which could potentially ignite.
Community Services and Infrastructure	› While anticipated to be of low likelihood, an accident would have a substantial, albeit shorter-term, impact on health care services in the regional study area.

Table 5: Potential Effects of Accidents and Malfunctions: Marine Transit – Collisions with Another Vessel

Valued Component	Potential Effects
Marine Birds	› The potential of direct mortality from a collision itself is very low due to very low odds of marine birds being present within the impact zone of a collision at sea, as marine birds are expected to displace from shipping lanes when vessels approach.
Marine Habitat	› Changes within the water column that affects the visibility within aquatic habitat may result in increased difficulty for visual detection of prey by marine mammals. This would likely affect marine mammals that use acoustic prey detection to a lesser extent than those which use visual prey detection.
Marine Mammal	› Changes within the water column that affects the visibility within aquatic habitat may result in increased difficulty for visual detection of prey by marine mammals. This would likely affect marine mammals that use acoustic prey detection to a lesser extent than those which use visual prey detection. › Other impacts to marine mammals from spills could include loss of prey resources, habitat loss, and habitat quality decline. The long-term consequences of these indirect effects are difficult to quantify but could have serious consequences at the species or population levels.
Marine Use and Navigation	› The potential adverse effect on marine use and navigation would be expected to be minimal.
Community Services and Infrastructure	› While anticipated to be of low likelihood, an accident would have a substantial, albeit shorter-term, impact on health care services in the regional study area.

Table 6: Potential Effects of Accidents and Malfunctions: Marine Transit – Collisions outside of the PRPA Boundary

Valued Component	Potential Effects
Marine Birds	› The potential of direct mortality from a collision itself is very low due to very low odds of marine birds being present within the impact zone of a collision at sea, as marine birds are expected to displace from shipping lanes when vessels approach.
Marine Habitat	› Changes within the water column that affects the visibility within aquatic habitat may result in increased difficulty for visual detection of prey by marine mammals. This would likely affect marine mammals that use acoustic prey detection to a lesser extent than those which use visual prey detection.
Marine Mammal	› Changes within the water column that affects the visibility within aquatic habitat may result in increased difficulty for visual detection of prey by marine mammals. This would likely affect marine mammals that use acoustic prey detection to a lesser extent than those which use visual prey detection. › Other impacts to marine mammals from spills could include loss of prey resources, habitat loss, and habitat quality decline. The long-term consequences of these indirect effects are difficult to quantify but could have serious consequences at the species or population levels.

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