APPENDIX 4-A
Basis of Design

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Basis of Design

Roberts Bank Terminal 2
Environmental Impact Statement Phase
Container Capacity Improvement Program

2015-03-10-01-10400-BOD-0030-Rev0-PMV-RBT2 Basis of Design

Technical Report/Technical Data Report Disclaimer

The Canadian Environmental Assessment Agency determined the scope of the proposed Roberts Bank Terminal 2 Project (RBT2 or the Project) and the scope of the assessment in the Final Environmental Impact Statement Guidelines (EISG) issued January 7, 2014. The scope of the Project includes the project components and physical activities to be considered in the environmental assessment. The scope of the assessment includes the factors to be considered and the scope of those factors. The Environmental Impact Statement (EIS) has been prepared in accordance with the scope of the Project and the scope of the assessment specified in the EISG. For each component of the natural or human environment considered in the EIS, the geographic scope of the assessment depends on the extent of potential effects.

At the time supporting technical studies were initiated in 2011, with the objective of ensuring adequate information would be available to inform the environmental assessment of the Project, neither the scope of the Project nor the scope of the assessment had been determined.

Therefore, the scope of supporting studies may include physical activities that are not included in the scope of the Project as determined by the Agency. Similarly, the scope of supporting studies may also include spatial areas that are not expected to be affected by the Project.

This out-of-scope information is included in the Technical Report (TR)/Technical Data Report (TDR) for each study, but may not be considered in the assessment of potential effects of the Project unless relevant for understanding the context of those effects or to assessing potential cumulative effects.

Table of Contents

List of Tables

List of Figures

1.0 INTRODUCTION

1.1 GENERAL

This document presents the Basis of Design (BoD) for the Roberts Bank Terminal 2 (RBT2) development at Roberts Bank as part of Port Metro Vancouver's (PMV's) Container Capacity Improvement Program (CCIP). The purpose of the BoD is to define the criteria to be used as part of the engineering design. It is to be considered as an approved source of input data for the engineering team and others as appropriate.

The investments that have been through Canada's Asia-Pacific Gateway and Corridor Initiative, and will be made through Canada's New Building Canada Fund, have the clear objective of enhancing Canada's national, provincial, and regional economies through improvements to the transportation of goods between the Asia-Pacific Economies and North American regions.

The opportunity for Canada to continue to be a major gateway will be realised through efficient and integrated transportation services for shippers and their customers. PMV's vision for a second major container terminal at Roberts Bank with a design capacity of handling 2.4 million twenty-foot equivalent units (TEUs) of containers per year is an essential component of the overall transportation initiative.

Port Metro Vancouver has an opportunity to make orderly preparations for the provision of new container capacity over the next 20 years to meet forecasts for increased container traffic.

Roberts Bank Terminal 2 is proposed to be a greenfield marine container terminal project that supports Canada's trade and transportation objectives. The RBT2 Project would result in the construction of a three-berth container terminal with a design capacity of 2.4 million vessel TEUs annually.

1.2 SITE DESCRIPTION

The proposed RBT2 is located at Roberts Bank, adjacent to the existing Westshore Terminals and Deltaport Terminal as shown in **Figure A**.

Figure A Proposed Roberts Bank Terminal 2 Site Location

1.3 DEVELOPMENT CONCEPT

The proposed RBT2 development includes the following components:

1.3.1 Marine Terminal

- A marine terminal site with an estimated 108 ha of useable area, created by fill from dredged and/or imported material (based on a preliminary 1,500 m average length x 700 m width footprint, with a 1,300 m berth length);
- Three deep-sea berths and wharf structure equipped with Ship-to-Shore (STS) gantry cranes capable of accommodating the latest and future generations of container ships;
- Mooring dolphin located at the east end of the wharf;
- Dredged marine approach areas and berth pocket;
- Navigational aids;
- Provision for potential future short-sea-shipping;
- Shoreline protection;

- Container Yard (CY) for handling and storage of containers;
- Rail Intermodal Yard (IY) on the terminal with car repair capability allowances in the design;
- Truck gate and driver support service facilities;
- Fencing and gates;
- Utility systems;
- Power and lighting systems;
- Security systems;
- Vessel shore power (cold ironing) availability at the berths;
- Power, conduit, raceway, cabling, and communications systems to support the terminal operating system (TOS) and computerised automation control system (CACS);
- Terminal support facilities including administration building, CBSA building, maintenance building, longshore break room building, equipment fuelling facilities, and customs' vehicle and cargo inspection system (VACIS) facilities; and
- Parking structure and designated areas for terminal equipment and personal vehicles.

The terminal layout is shown in **Figure B** and is based on the proposed equipment types and terminal configuration developed in the AECOM Roberts Bank Terminal 2 Planning and Capacity Study report.

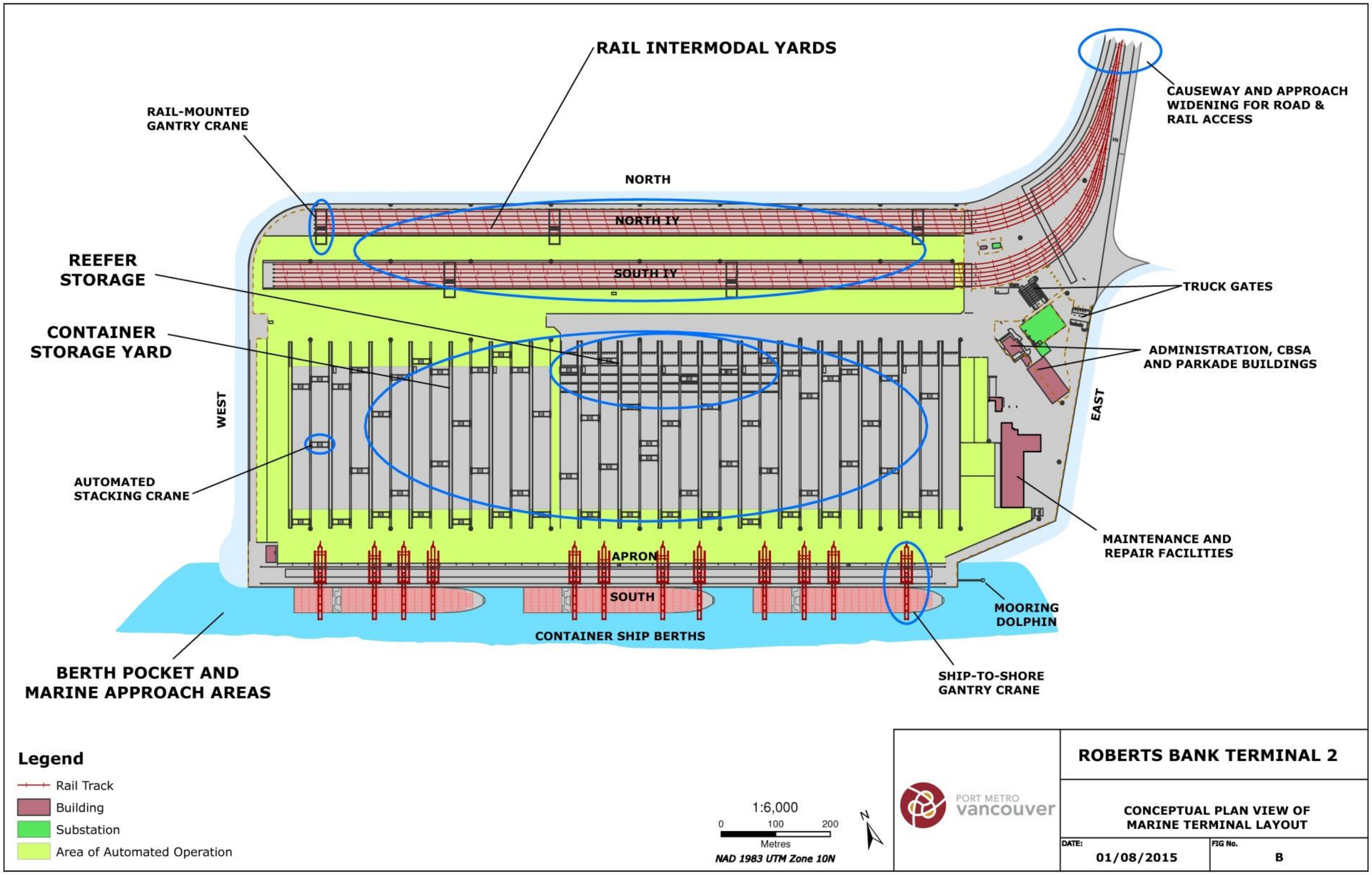
1.3.2 Roberts Bank Causeway Improvements

- Widening of the existing causeway for road and rail access and provision for utilities;
- Rail support tracks and a dedicated rail link from the Roberts Bank Rail Corridor (RBRC), including support/switching rail tracks located in a new RBT2 T-Yard on the causeway;
- An overpass and access road over the rail tracks on the widened causeway that would provide safe vehicular access from Roberts Bank Way North to RBT2;
- A vehicle access control system (VACS) on the new access road to RBT2; and
- A new DPU/Bad Order Setout Yard on the causeway dedicated to setting out mainline and distributed power unit (DPU) locomotives, and bad order cars for servicing/storage.

1.3.3 Roberts Bank Tug Basin Expansion

- Additional tug moorage through expansion of the existing Roberts Bank tug facilities.

Figure B Terminal Layout



2.0 GENERAL INFORMATION

2.1 ABBREVIATIONS

Key abbreviations used in this report are presented in **Appendix 1**.

2.2 UNITS

In general, the SI system of units shall be used for this Project.

2.3 LANGUAGE

All documentation shall be in the English language.

2.4 PROJECT DATUM AND SURVEY CONTROL

All terminal elevations shall be referenced to chart (hydrographic) datum (CD). Off-terminal road and rail elevations are referenced to geodetic datum (GD). Conversion from chart datum to geodetic datum shall be as follows:

- EL. 0.0 m Chart Datum = EL. -2.975 m Geodetic Datum.

The reference benchmark for the Project shall be the deep-seated monument 81H T001. The UTM (NAD 83) coordinates and CD elevation of Monument 81H T001 are as follows:

- Northing (m): 5429549.647
- Easting (m): 488207.802
- Elevation (m): 6.411

3.0 CODES, STANDARDS, SPECIFICATIONS, AND REGULATORY REQUIREMENTS

3.1 GENERAL

The precedence applying for use of the codes, standards, specifications, and regulatory requirements for this Project is as follows:

1. Regulatory Requirements;
2. Canadian Standards; and
3. International Standards.

In the event of an inconsistency, conflict, or discrepancy between any of the standards, specifications, and regulatory requirements, the most appropriate and stringent requirement applicable to the Project shall prevail to the extent of the inconsistency, conflict, or discrepancy.

The RBT2 preliminary design completed in 2012 is based on the latest relevant codes and standards as of January 2012. They are referred to in the Basis of Design as appropriate and are listed in **Appendix 2**. Future design and construction shall accommodate updates in codes and standards.

3.2 Regulatory Requirements

All aspects of the Project (i.e., design, construction, commissioning, and operation) shall comply with the requirements of the latest versions of all relevant regulatory requirements.

3.3 Canadian Codes and Standards

The design, construction, and installation must comply with relevant Canadian codes and standards.

3.4 International Standards

Where applicable Canadian standards do not exist, or cannot be applied, other industry recognised international standards and recommended practices, such as British standards, US standards, and PIANC may be used.

3.5 Authority Having Jurisdiction

Port Metro Vancouver is the authority having jurisdiction with the exception of emergency services. The design shall be reviewed with The Corporation of Delta as the provider of emergency services and the provider of water supply.

4.0 FACILITY FUNCTIONAL REQUIREMENTS

Design criteria for Project components are presented in **Sections 4.2** to **11.0**.

4.1 Design Life

The facility shall be designed for the following service lives:

- All wharf and buildings structures shall be designed for a minimum service life of 75 years;
- The tug basin and wharf fender system shall be designed for a minimum service life of 25 years;

- Pavements shall be designed for a minimum service life of 20 years; and
- Site Services shall be designed for a minimum service life of 50 years.

The service lives are subject to the implementation of the following inspection and maintenance strategies:

- Routine inspection for deterioration and damage, under the direction of a professional engineer; and
- Repair of deteriorated and damaged areas.

"Service Life" is defined as the period of time over which the financial model indicates that it will be economically practical to carry out regularly scheduled maintenance and periodic refurbishment of the item in question in order to maintain the design load carrying capacity and operational function.

4.2 MARINE DEVELOPMENT

The functional requirements for marine development for RBT2 are based on the reports "Functional Requirements - Design Vessels 09409-01-MA-REP-10016-200 Rev 0", and the 2012 AECOM "Roberts Bank Terminal 2 - Fast-time Ship Navigation Simulation Study Report, Rev. D".

4.2.1 Dredged Marine Approach Areas

The marine approach areas shall provide safe navigation for access and departure of fully laden design vessels under the following conditions:

- At all normal tide levels (i.e., above LLWL); and
- Wind and wave conditions due to the 10-year storm event.

Dredged slopes shall be stable under the action of waves, current, and drainage from the intertidal zone. Dredged slopes shall have slope protection as necessary to minimise erosion. Dredged slopes shall have crest protection as necessary to minimise the formation of dendritic channels.

4.2.2 Berth Pocket

Water depth at the berths shall provide safe under-keel clearance at LLWL for the fully laden design vessel with allowance for out of trim, and wave induced motion in the 50-year storm event.

4.2.3 Wharf Structure and Mooring Dolphin

The three-berth wharf structure at the terminal shall be designed to meet the following functional requirements:

- Accommodate one "EEE" class, 400 m long (18,000 TEU) vessel, and two Panamax-2014 class, 366 m long (12,000 TEU) vessels simultaneously, at all normal tide levels and laden conditions, with all vessels berthed "port-side-to";
- The berth length shall be 1,300 m based on the following considerations:
    - Avoid the need for mooring lines to cross;
    - Allow a minimum spacing between berthed vessels of 40 m; and
    - Allow adequate terminal vehicle circulation at the western and eastern extremities of the berths (20 m clearance from a quay crane working the last row of containers on vessels at the outer berths).
- Allow adequate circulation along the wharf for lashing crews, vessel service vehicles, and other two-way truck traffic between the STS crane legs and along the wharf face;
- A section of the western terminal face shall be capable of being configured to accommodate a potential future barge terminal to support short-sea-shipping of containers;
- Allow for hatch cover storage on the wharf deck between the STS portal legs;
- The deck elevation of the berth structures shall be high enough to ensure that the mean rate of discharge due to wave overtopping does not exceed the following limits:
    - 10 litres/s/m of berth during the 10-year storm event; and
    - 50 litres/s/m of berth during the 50-year storm event.
- The wave overtopping scenario may be considered independently of rainstorm events;
- An allowance of 0.5 m for future sea level rise over the design life of the facility shall be made in determining the wharf deck elevation;
- An allowance of 0.25 m for post-construction settlement shall be made in determining the wharf deck elevation;
- The berth structures and their foundations shall be designed to accommodate future vessels with draughts of up to 19 m. In the absence of specific data on these future vessels, it has been determined that the corresponding berth navigation depth will be assumed as EL -21.6 m CD. Due to the form of caisson wharf construction, this requirement establishes the initial build depth of the caisson wharf;

- A mooring dolphin shall be located off-shore of the east end of the wharf to handle the bow lines from the eastern most vessel;
- The fender system shall be designed to accommodate berthing impact from the design vessels at all normal tide levels and laden conditions, and forces from moored vessels during the 50-year storm event;
- Mooring bollards shall have sufficient capacity to resist mooring loads from the largest design vessel during the 50-year storm event;
- Scour and slope protection shall be provided to prevent erosion at the wharf structure due to design vessel propeller wash, bow thrusters, wave action, and storm surge;
- The wharf structure shall be capable of accommodating the following equipment and storage:
    - Ship-to-Shore gantry cranes;
    - Uniform distributed loads, and point loads due to vessel hatch covers; and
    - Wheel loads due to service vehicle traffic.
- Vessel shore power facilities, shall be provided at each of the three berths;
- Fire hydrants shall be provided along the wharf apron area adjacent to the security fence line behind the landside STS crane rail;
- Potable water service shall be provided in two ship servicing pits at each berth;
- Electrical and communications service shall be provided in ship servicing pits at each berth;
- Wharf structures shall be designed as a minimum to meet or exceed the 475 year seismic performance criteria outlined in **Table A**. These criteria are based on PIANC guidelines and supplemented by MOTEMS criteria; and
- The three-berth wharf and terminal shall not be designed explicitly to withstand a tsunami event.

Table A Seismic Performance Criteria (Three-berth Wharf Structure)

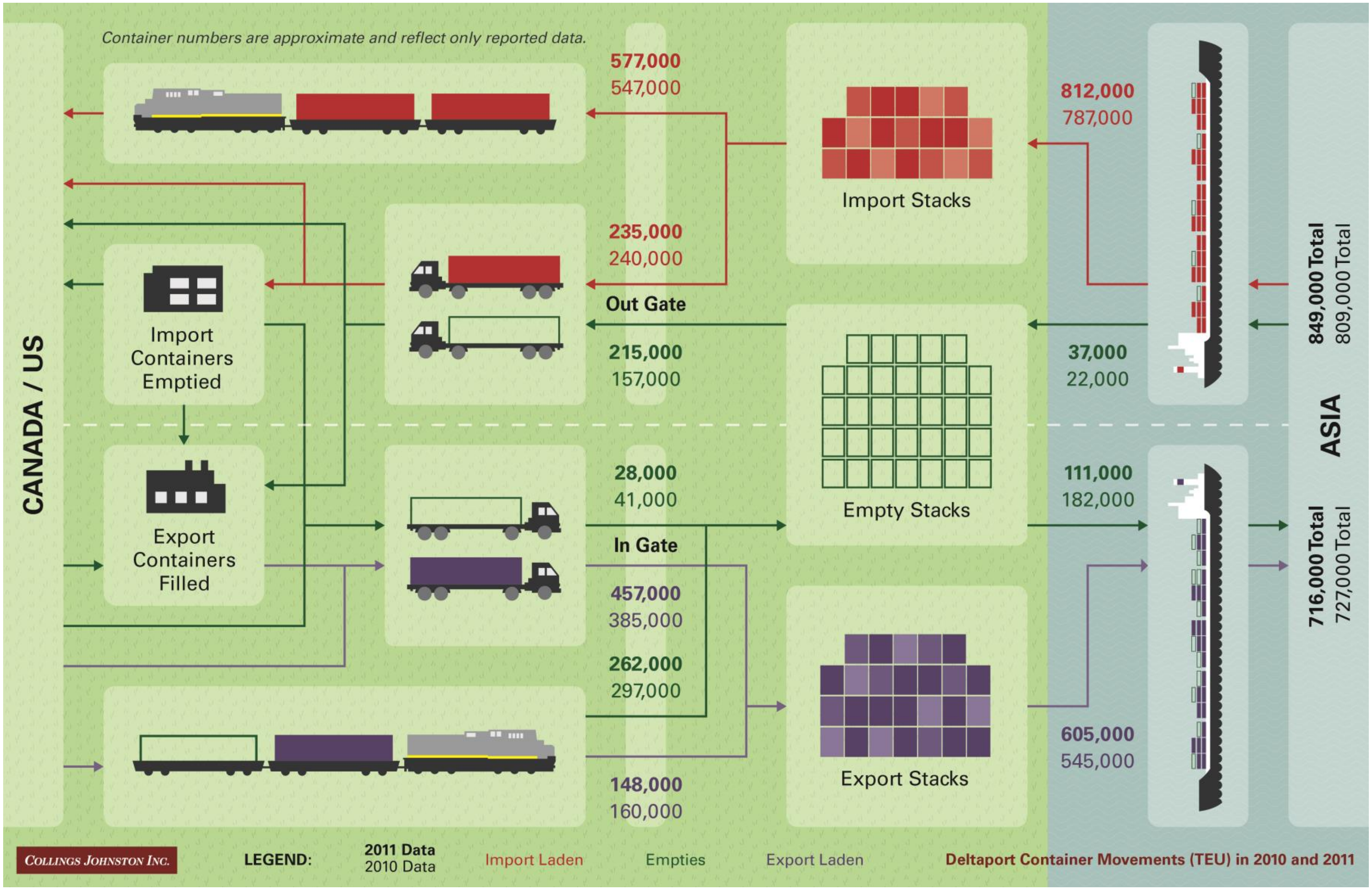
Design Level Earthquake	Level of Service	Operation Criteria	Level of Structural Damage	Residual Horizontal Displacement at Top of Caisson	Rotation
100 years	Serviceable	Fully operational	Minor easily repairable or no damage	Not larger than 75 mm	No more than 0.5 degree
475 years	Repairable	Temporary loss of operations with 1 month to restore full operations	Controlled repairable damage	Not larger than 300 mm	No more than 1.0 degree
Subduction	Repairable	Temporary loss of operations with 3 to 6 months to restore full operations	Significant damage is acceptable, but no collapse. Caisson re-float not required.	Not larger than 750 mm	No more than 2.0 degrees
2,475 years	Near Collapse	Long-term or complete loss of serviceability	Extensive damage in near collapse	Not larger than 3,000 mm	No more than 8.0 degrees

4.3 TERMINAL DEVELOPMENT

4.3.1 Container and Intermodal Yards

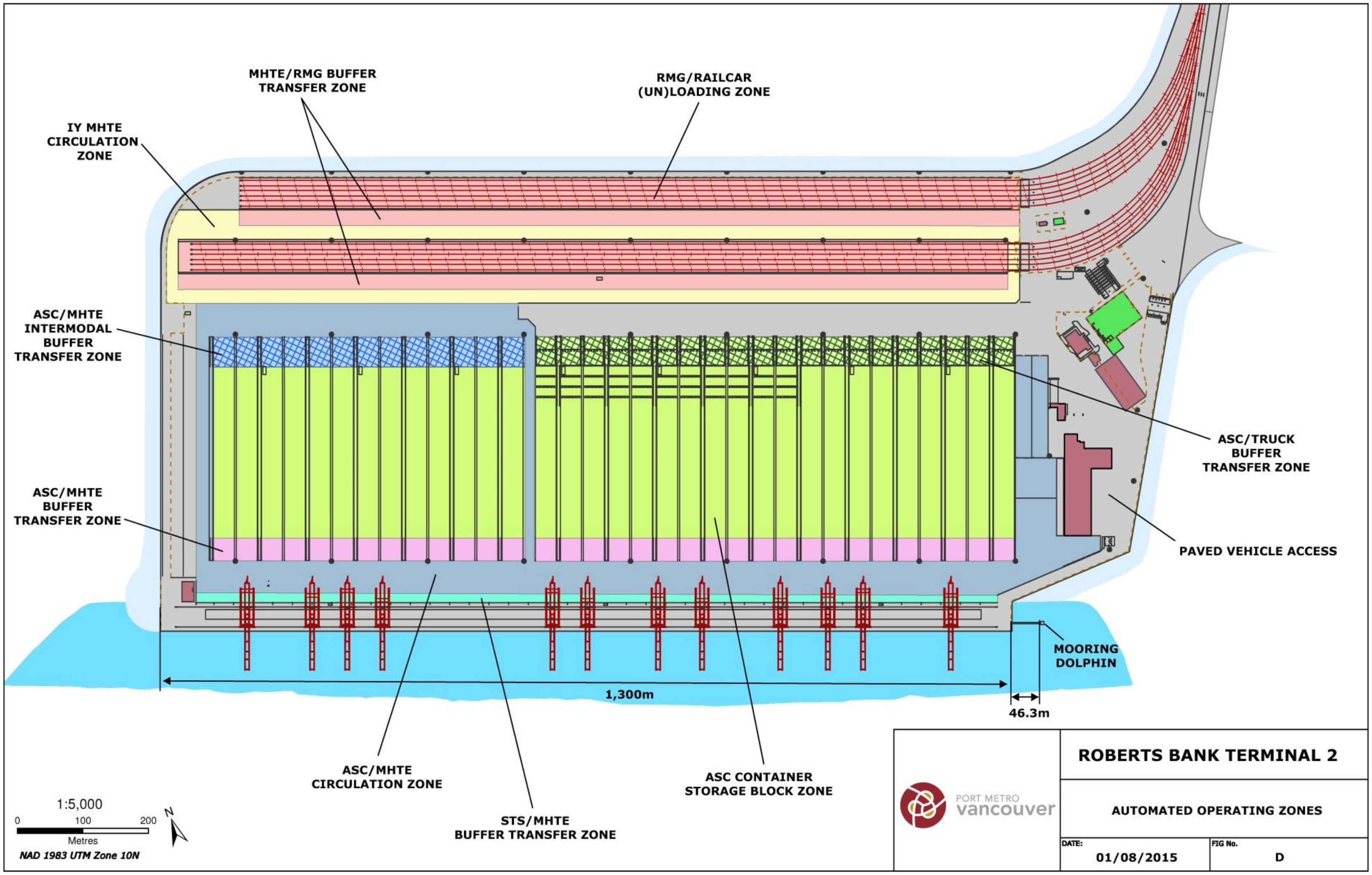
The terminal shall be designed to accommodate 2.4 million Vessel TEUs per year. Up to 55% of this volume is expected to pass through the truck gates (Gate), and up to 70% of this volume is expected to pass through the Rail intermodal yard. The total Gate and Rail flow is greater than 100% to account for empty containers (Rail to Gate moves) which exit the terminal and subsequently return to the terminal for Export. The Vessel/Gate/Rail container movements from 2010-2011 Deltaport Terminal data are illustrated in **Figure C**. The TEU per container ratio for the Project is expected to be 1.70 TEU to 1.75 TEU.

Figure C Container Imports and Exports (Representative from Deltaport Terminal)



- The CY shall be divided into seven automated operating zones, shown in **Figure D**, as follows:
  - STS/mobile horizontal-transfer equipment (MHTE) container buffer transfer zone (BTZ);
  - MHTE/Automated Stacking Crane (ASC) circulation zone;
  - MHTE/ASC container BTZ;
  - ASC container storage block zone;
  - ASC/Truck container transfer zone (CTZ);
  - ASC/MHTE intermodal container BTZ; and
  - MHTE/IY circulation zone.
- The IY shall be divided into two automated operating zones, shown in **Figure D**, as follows:
  - MHTE/Rail Mounted Gantry (RMG) crane container BTZ; and
  - RMG rail car container (un)loading zone.
- Safety sub-zones shall be established in the IY that will allow manual (de)coning operations to take place at one end of a string of rail cars while concurrently allowing IY RMG operations in adjacent sub-zones.
- IY Container Loading Mode: automated RMG Cranes
- Container Handling to/from CY/IY and CY/Wharf: MHTE
- CY Container Stacking Block Height/Width: 5 high x 10 wide
- CY Empty Container Stacking Block Height/Width: 5 high x 10 wide
- Container BTZ: 2 high x 6 wide
- ASC/Truck CTZ: 6 stalls per runway

Figure D Automated Operating Zones



4.3.2 Reefer Storage Facilities

The reefer facilities shall be designed to meet the following functional requirements:

- Reefer towers shall be installed within the ASC storage zone with surface aisle access to facilitate manual reefer plugging and servicing;
- Number of Reefer Outlets: 1,628; and
- Reefer Area Stacking Height/Width: 5 high x 10 wide.

Two container slots on the first tier of each set of three racks per storage block shall be kept clear, with a structural roof above for human circulation within that block.

4.3.3 Truck Gates

The terminal truck entry gate shall include lanes equipped with portals and/or T-poles supporting Optical Character Recognition (OCR) and Licence Plate Reader (LPR) cameras, Radio Frequency Identification (RFID) readers, along with in-lane communications pedestals, and stop arms. Equivalent technology shall be incorporated at the time of the detail design.

4.3.4 Terminal Buildings and Facilities

The following buildings and facilities shall be incorporated into the terminal design to house the various functions required in order to operate and maintain the terminal and its equipment.

4.3.4.1 Administration Building

The administration building shall include the following functional areas:

- Terminal Management Offices;
- Terminal Administration Offices;
- Security Office;
- Port Metro Vancouver Office;
- Marine, CY, and IY Planning and Operations Centre;
- CY ASC and MHTE Control Room;
- IY RMG and Rail Control Room;
- TOS and CACS Equipment Room;
- Labour Relations and Dispatching Office;

- Conference and Meeting Rooms;
- Lunch and Break-rooms;
- Other Support Facilities;
- Critical areas of the administration building shall be supported by stand-by power facilities, and essential systems shall be backed up by Uninterruptible Power Supply (UPS); and
- LEED requirement: Silver (minimum), Gold (included in the preliminary design).

4.3.4.2 Maintenance and Repair Building

The Maintenance and Repair Building shall include the following functional areas:

- Maintenance Management Offices;
- Support Office Facilities;
- Crane Maintenance Facilities;
- MHTE Service Bays;
- Spreader Service Bays;
- Steam Cleaning Service Areas with Oil/Water Separation and Processing;
- Parts receiving and storage;
- Lavatory, Shower, and Locker Facilities;
- Lunch and Break Room Facilities;
- First Aid Facilities with access from both the inside and outside of the building;
- Lashing Gear Locker;
- Other Support Facilities; and
- Standby power for life safety elements within the maintenance and repair building.

4.3.4.3 Driver Service Building

The Driver Service Building shall include the following functional areas:

- Gate Management Offices;
- Gate Clerk Operations;
- Trouble Service Office and Service Counter; and
- Gate Operations shall be fully supported by stand-by power facilities.

4.3.4.4 Longshore Break Room Building

The Longshore Break Room Building shall include the following functional areas:

- Lashing Gear Locker; and
- Lavatory and Break Room Facilities.

Note: This facility is to be expandable to incorporate potential future short-sea-shipping terminal operational offices on a future second level.

4.3.4.5 VACIS Facility

The VACIS Facility shall include the following functional areas:

- Fenced VACIS Container Inspection Yard;
- Personnel/MHTE Gate Interlock System;
- ASC/chassis "airlock" for Customs container load-outs; and
- Support Facilities.

4.3.4.6 Personal Owned Vehicle (POV) Parking Facility

Provisions for longshore and terminal staff, plus visitor parking, shall be as follows:

- Number of POV Parking Spots: 448; and
- Dimensions of Parking Spots: 2.6 m wide x 5.5 m long (minimum).

4.3.5 Terminal Equipment Parking

Provisions for parking of terminal vehicles and support equipment shall be based on the following:

- Terminal Tractors: 6
- Terminal Chassis: 8
- Mobile horizontal-transfer equipment: 86
- Pickup Trucks: 30
- Vans, etc.: 3
- Top-Picks: 1
- Man-Lifts: 4
- Panel Truck: 3
- Flatbed Delivery Truck: 1
- 2,000 litre Fuel Truck: 1
- Forklifts: 6

- Street Sweeper: 1
- 15 Ton Rubber Tired Hydraulic Crane: 1

MHTE parking shall be accommodated within the automated circulation area behind the wharf and within the MHTE fuelling area adjacent to the maintenance and repair building.

4.3.6 Fuelling Facilities

The fuelling facilities shall be designed to meet the following functional requirements:

- Fuelling facilities shall be in accordance with Canadian Council of Ministers of the Environment (CCME) guidelines, and located near the maintenance and repair building;
- One system for both gasoline and diesel fuel would service the manually operated terminal equipment. Two fuel pumping stations shall be provided for each system;
- One system would be located adjacent to the automated section of the yard for servicing the MHTE. Eight automated MHTE fuelling stations shall be provided within the automated section of the yard;
- Infrastructure for fuelling facilities shall be provided to suit above ground, monitored tanks with integral fill and dispensing equipment so that no piping exists external to the tanks, with one week's storage capacity as follows:
  - Diesel Fuelling Tank: 150,000 L
  - Gasoline Fuelling Tank: 19,000 L
- Fuelling facilities shall be secured inside the terminal fence and be protected on all sides by guard posts.

4.3.7 Electrical and Control Systems

Electrical and control systems for the terminal shall be designed to meet the following functional requirements:

- Shore Power facilities shall be provided at each of the three berths at bow and stern locations per berth as a minimum. Preliminary design allows for three locations per berth;
- Power to the terminal's main substation shall be supplied by tapping off from the existing BC Hydro 69 kV service line 60L58. The feasibility of this will be subject to a future BC Hydro system impact study, for all anticipated Roberts Bank terminal loads. Power demands for Deltaport Terminal and Westshore Terminals have not been taken into consideration in the RBT2 design;
- The main substation shall be an outdoor type substation;

- Terminal power distribution shall be fed underground from the main electrical building;
- Recharging stations shall be provided to support all battery powered mobile equipment;
- Lighting intensities and illumination levels shall be as tabulated in **Section 11.0 Electrical Design Criteria**, and if not listed, shall be in accordance with Illuminating Engineering Society (IES) standards;
- The controls methodology and approach for the terminal, and the degree of automation will be fully defined and refined once a Terminal Operator Concessionaire has been selected;
- Standby power generators shall be provided to feed the reefer substations, and to operate the essential loads for all the buildings, gate operations, terminal security systems, and terminal security lighting;
- All essential systems in the terminal shall be provided with filtered and surge protected power via a UPS system. These would include terminal communications, and computers operating automation systems; and
- All buildings shall be provided with communications and data services, via underground ducting.

The controls methodology, approach and degree of automation for the new facility will be fully developed and refined once a Terminal Operator Concessionaire has been selected and their system is integrated within the design. The computerised TOS and CACS are normally specified and procured by the terminal operator. The conduit paths, communications links, computer and telecommunications rooms, cable pulling spaces, and control rooms will be configured to accommodate these systems once they are fully defined by the Terminal Operator Concessionaire.

Currently the control systems and automation/manual safety interlocks for the terminal are planned to be interlinked through the TOS and CACS and include the following:

- Entry and Exit Gate operations;
- ASC operations;
- Automated RMG operations;
- MHTE operations;
- Automation/Manual airlocks and safety interlocks:
    - ASC service aisle gates;
    - Reefer service gates;

- VACIS operating area gates;
- IY access gates and manual operating zones;
- ASC/Truck container buffer transfer zone;
- MHTE circulation area service access gates; and
- Automation area intrusion detection systems.

4.3.8 Control Rooms and Local Control

Centres of operation and degree of centralised control will be fully developed and refined once a Terminal Operator Concessionaire has been selected. The designed control centres for the terminal are primarily located in the administration building and include the following:

- Entry and Exit Gate operations;
- ASC and MHTE operations; and
- IY rail and container operations.

The operating status for the above functions would be monitored and controlled by gate clerks and remote crane operators housed in control rooms within the administration building. All "airlock" gate functions that interface automated and manual operational areas would be interlinked and controlled through the CACS to preclude automated equipment operation immediately adjacent to manual activities such as IY (de)coning, reefer service, and ASC and MHTE maintenance.

The MHTE test area would be adjacent to, and controlled from, within the maintenance and repair building.

4.3.9 Stand-by Power

Backup diesel engine powered generators shall be installed to provide stand-by power for the following:

- Essential loads for all the buildings;
- Terminal security systems;
- Terminal security lighting;
- Reefer substations; and
- Entry and Exit Gate Systems.

4.3.10 UPS Feed

Uninterruptible Power Supply systems shall be installed to provide power for "Mission Critical" systems in the terminal, including terminal communications, building controls, and computers operating automation systems.

4.3.11 Shore Power

Three shore power facilities have been included in the preliminary design for each berth. However, developing industry standards for container vessels indicate that bow and stern connections only will prevail. Therefore, during detail design the prevailing industry standards and best practices for container vessels will need to be revisited. Each vault shall be provided with internal lighting, fibre optic communications, two power receptacles, and pneumatic boosted hinged covers for ease of access.

4.3.12 Utilities

The utilities for the terminal shall be designed to meet the following functional requirements:

- Oil interceptors shall be installed to treat storm drainage water;
- On site sanitary treatment facilities shall be provided to meet effluent standards set by regulatory authorities;
- Fire protection shall be installed; and
- Ship service water shall be provided at the wharf, shall be separately metered, and shall be equipped with backflow protection.

4.3.13 Fencing and Security

Fencing and security gates shall be designed to meet the following functional requirements:

- Fencing with intrusion sensing systems shall be installed around the perimeter of the terminal and all automated operational areas including IY rail tracks, and locally around high voltage equipment yards;
- Security infrastructure, including intrusion sensing, security cameras, personnel and vehicle access gates, card key readers, biometrics, and other such technologies shall be designed to fulfill requirements of the terminal security plan;
- Pan-Tilt-Zoom (PTZ) and fixed cameras shall be installed at gates, offices, CY, IY, berths, and other areas as required for both security and operational oversight;
- Card access readers and access control systems shall be installed at gates and buildings;

- Security systems shall be installed for equipment and truck identification;
- Radiation Portal Monitors (RPMs) shall be provided in the MHTE circulation zone behind the wharf, for screening of all import containers;
- Manual/Automation “Airlocks” shall be installed to provide controlled and interlocked safety access gates for staff access into all automated operational areas;
- ASC service aisle and reefer tower access gates shall be interlocked with adjacent ASC operations to preclude ASC operations when ASC and reefer service personnel are present;
- IY manual access gates shall be interlocked with RMG operations and/or railcar movements to preclude IY operations when service and inter-box connector (IBC) operations personnel (also referred to as coning and deconing personnel) are present within the IY; and
- New security technology that develops prior to the RBT2 final design and construction shall be evaluated and applied as appropriate.

4.3.14 Operations

The operations at RBT2 shall be based on the following:

- Berth Operating Days per Year: 358 days (Accounts for shutdowns for statutory holidays and 10 shifts for Union Meetings);
- Rail System Operating Days per Year: 364 days (Accounts for shutdown for Christmas);
- CY Operating Days per Year: 358 days (Accounts for shutdowns for statutory holidays and 10 shifts for Union Meetings);
- IY Operating Days per Year: 358 days (Accounts for shutdowns for statutory holidays and 10 shifts for Union Meetings);
- Berth Operating Hours per Day: 24 hours;
- Rail System Operating Hours per Day: 24 hours;
- CY Operating Hours per Day: 22.5 hours;
- IY Operating Hours per Day: 22.5 hours; and
- Truck Gate Operating Hours per Day: 22.5 hours.

4.3.15 Staffing

Roberts Bank Terminal 2 would be a year-round staffed facility with the following assumed staffing levels associated with each of the following functions:

- Administration: 100
- Maintenance and Repair: 110
- Equipment Operators: 70

4.3.16 Maintainability

The container handling equipment and support systems at RBT2 shall be designed to minimise disruptions in operations due to equipment breakdowns and system failures. The following support systems shall be provided at RBT2:

- Appropriate maintenance facilities shall be provided for all equipment types being employed in the terminal;
- Appropriate spare parts storage facilities shall be provided;
- Serviceable equipment shall be provided with safe and adequate access; and
- Access platforms and man-lifts shall be provided to allow access to elevated maintenance service points on container handling equipment and facility elements.

4.3.17 Sparing Philosophy

The on-terminal spare parts inventory shall be determined for the mix and number of each type of equipment being employed on the terminal based upon recommendations from the respective equipment suppliers. Suppliers of major container handling equipment shall be required to have a ready stock of major replacement components such as reducers, motors, brakes, etc. within North America with a one-day's delivery time to the terminal guaranteed.

4.4 Roberts Bank Tug Basin Expansion

The tug basin shall be designed as an expansion of the existing Roberts Bank Tug Basin facility. The expansion shall meet the following functional requirements:

- Accommodation of two tug operation contractors, with separate floats/pontoons for independent pedestrian access for the two operations;
- Each operator to be provided with moorage for:
    - Three 30/80 class berthing/escort class tugs dedicated to operations at Roberts Bank terminals (Deltaport Terminal, Westshore Terminals, and RBT2), length 30 m, beam 12.6 m, and draught 5.3 m;

    - Two 18 m long line handling boats; and
    - Two 6 m long small craft.
- Minimum width of mooring floats/pontoons to be 8 m. Re-use of the existing Mooring Barge No. 912 is assumed. Nominal freeboard of newly constructed mooring floats/pontoons to be 1.5 m;
- Provision of a navigation water depth of 6.5 m below LLWL;
- The perimeter dyke adjacent to the expanded tug basin (deepened to accommodate the expanded tug basin) shall withstand the A100 seismic design event; and
- As floating structures make up the majority of the tug berth facility, no allowance is to be made for future sea level rise, nor is seismic loading considered applicable (except as indicated for the perimeter dyke).

4.5 Storm Event, Settlement and Seismic Performance (Non-Berth Elements)

The shoreline protection, terminal land development, and causeway widening shall be designed to meet the following functional requirements:

- The shoreline protection shall be designed to withstand the loads from a 100-year storm event;
- The shoreline protection and the crest elevation of the reclaimed fills shall be designed to ensure wave overtopping does not exceed 50 litres/s/m during the 50-year storm event;
- Long Term Settlement:
    - Shoreline Protection Areas (Perimeter of Terminal Land Development Area):

      275 ±110 mm over 5 to 15 years.
    - Terminal Land Development Area:

      385 ±110 mm over 5 to 15 years;
    - S Bend (Widened causeway adjacent to Deltaport Terminal Pod 3 and Westshore Terminals Pod 2) Area:

      220 ±110 mm over 5 to 15 years;
    - West widened causeway from chainage 21 +300 to the S Bend Area:

      165 ±55 mm over 5 to 15 years; and
    - East widened causeway from the mainland to chainage 21 + 300:

      110 ±55 mm over 5 to 15 years.
- Seismic performance of shoreline protection and reclaimed fills:

- 1 in 100-Year Seismic Event:
  - Fully operational with minor (easily repairable) damage.
- 1 in 475-Year Seismic Event:
  - Lateral displacements not to exceed 1.0 m at crest of foreshore slope;
  - Temporary loss of operations: Rail realignment, and repairs to structural elements and site services may be required to restore full operations; and
  - Maximum downtime for repairs: Shall be two to three months to restore full operations, with non-critical repairs allowed beyond that time-period.

4.6 WIDENED CAUSEWAY

The existing causeway leading from the foreshore to the Roberts Bank terminals shall be widened on its north side to accommodate the transportation and servicing requirements for RBT2. The causeway widening shall be designed to meet the following functional requirements:

- Infrastructure to be accommodated on the widened part of the causeway shall include:
  - Yard and lead rail tracks to service the RBT2 IY;
  - RBT2 road overpass of Westshore Terminals' coal tracks;
  - Three-lane access road to RBT2 with one lane being a truck staging lane located between the RBT2 overpass and the RBT2 entrance gate;
  - Two-lane emergency access and sustainability route (8 m wide gravel road);
  - Overpass road lighting; and
  - Utility corridor in which the water main for RBT2 could be located, as well as buried power distribution lines for railway switch lighting.

4.7 RBT2 OVERPASS

A new overpass shall be constructed to connect Roberts Bank Way North to the RBT2 access road, and to separate road and rail traffic on the causeway. The overpass shall have the following functional requirements:

- Located on the north side of the existing causeway near the west end, and would extend onto the widened causeway;

- Span four North Yard tracks leading to Westshore Terminals. The existing North Yard tracks will require realignment to accommodate the overpass structure and approach roadways;
- Provide a minimum vertical clearance of 7.2 m over rail tracks;
- Allow for a signal-controlled intersection at the top of the overpass to connect road access to RBT2, Westshore Terminals, and Deltaport Terminal Gate 2; and
- Accommodate the TAC WB36 (turnpike double) design vehicle: a tractor-trailer with two trailers, each capable of transporting a 16.2 m (53 ft.) domestic container.

4.8 VEHICLE ACCESS AND CONTROL SYSTEM

A VACS shall be constructed to regulate access to RBT2. The VACS gate could be located either along the RBT2 access road, or at the DTRRIP VACS location.

The VACS shall include two gates for westbound vehicles and one gate for eastbound trucks exiting the terminals. The preliminary design and installation of the VACS gates for DTRRIP governs lane widths, island widths and lengths, and lane taper dimensions.

4.9 RAIL SYSTEM

The rail system shall be designed to meet the operating conditions and the requirements of the RBT2 IY, causeway support tracks, and all connecting tracks to the mainline. Simulation studies conducted by Mainline Management Inc. were used to define the infrastructure and equipment requirements to be implemented as part of this Basis of Design.

Yard and support tracks shall be designed to meet the following functional requirements:

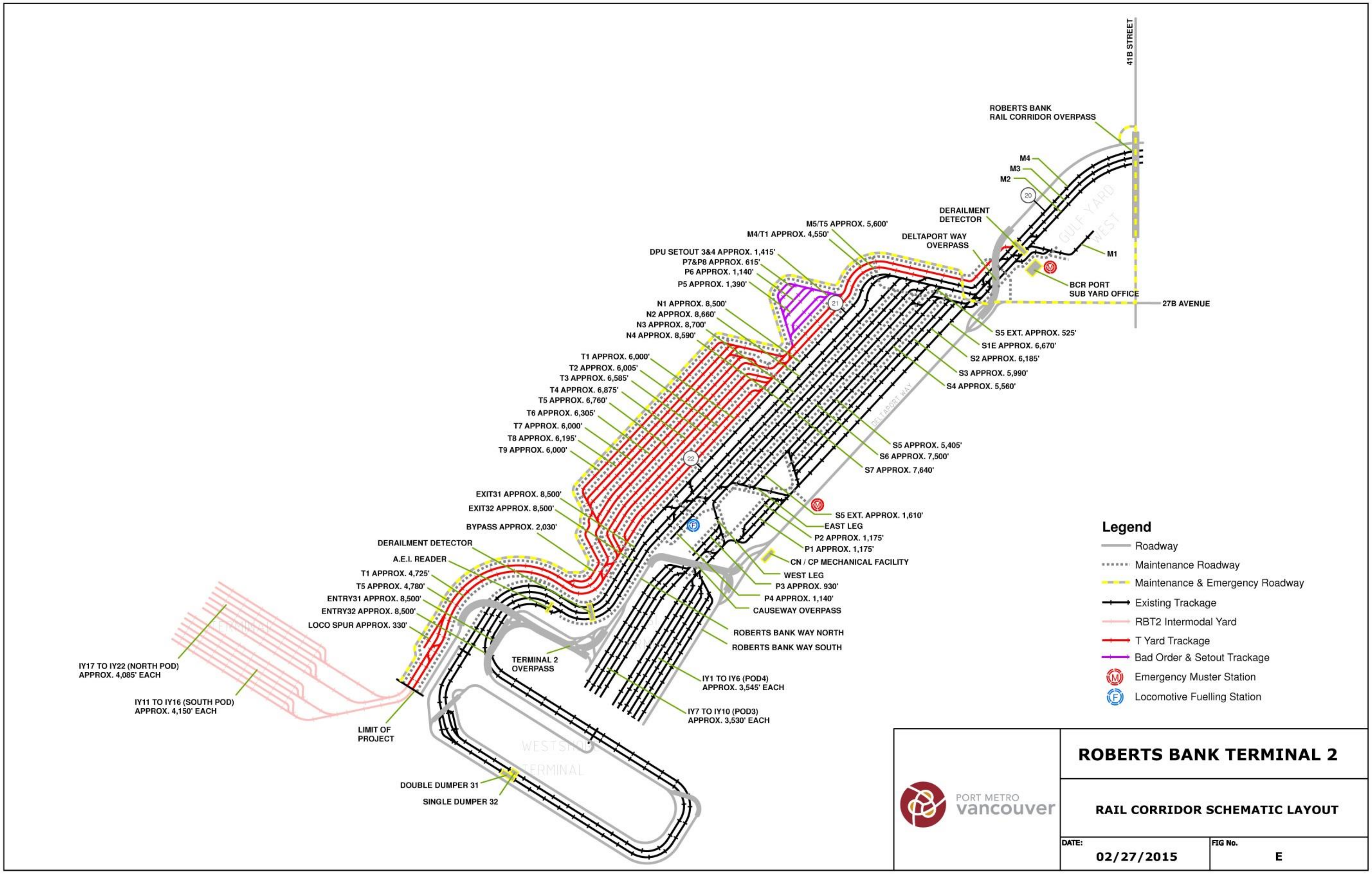
- Accommodate inbound and outbound train lengths of 3,660 m (12,000 ft.);
- Support tracks shall be used to support rail activity including railcar storage and crew changes;
- Support tracks shall be located in close proximity to the IY working tracks to minimise railcar switching;
- Support track shall have sufficient length to accommodate efficient breaking and building of railcar strings in lengths appropriate for the IY tracks; and
- Lead tracks shall be designed to accommodate inbound and outbound switching requirements.

Rail track switches servicing the IY adjacent to the terminal shall have both remote power and manual controls. The remote switch operations shall be controlled from the rail operation control centre located in the administration building.

Automated IY RMG operation, and railcar positioning and servicing operations, shall be interlinked to preclude concurrent manual and automated operations within the same zone.

The proposed rail schematic is shown in **Figure E**.

Figure E Rail Corridor Schematic Layout



4.9.1 T-Yard

The T-Yard is the largest rail feature on the widened causeway. The T-Yard shall have the following functional requirements:

- Nine rail tracks, including two lead tracks, for spotting railcar strings into the IY or receiving railcar strings from the IY; and
- Each pair of tracks shall have a maintenance road to be used to inspect railcars.

4.9.2 DPU/Bad Order Setout Yard

The DPU/Bad Order Setout Yard shall be located on the causeway as shown in **Figure E**. The yard shall have the following functional requirements:

- Two tracks for light servicing of locomotives and synchronising DPUs;
- Four tracks for bad order car setout/repairs; and
- A maintenance road on the south side of the DPU setout tracks to allow access for servicing of locomotives.

The spacing between pairs of tracks shall be as follows:

- 12.2 m (40 ft.) of space between working repair tracks. This space is based on the minimum manoeuvrable room required for the jacking equipment to lift railcars to be repaired; and
- 4.3 m (14 ft.) of additional space between the DPU setout tracks (3 and 4) and track P5 for a total width of 16.5 m (54 ft.). The extra space shall serve as a storage area for wheel sets, room for servicing locomotives, and space for portable toilets and a remote shelter.

The DPU/Bad Order Setout Yard shall be paved to allow for equipment with a tight-turn radius.

4.9.3 North Yard

The North Yard is dedicated to rail traffic serving Westshore Terminals. For the RBT2 Project, the following work would be required in the North Yard:

- Realignment as required to accommodate the RBT2 overpass.

4.9.4 Causeway Lead Track Improvements

An additional lead track (M5) at the mainland end of the causeway is proposed to allow trains destined for RBT2 to bypass the North Yard.

5.0 ENVIRONMENTAL LOADS AND EFFECTS

Environmental loads for structural design shall be in accordance with the data published in the current supplement to the National Building Code of Canada (NBCC), or as developed from analysis of other site-specific data obtained from Environment Canada or other sources. The relevant NBCC data assumed in the preliminary design, together with other site-specific information, is included here.

5.1 WIND

Design wind speeds shall be as specified in the NBCC for Ladner, BC and are shown in **Table B**.

Table B One-Hour Wind Speeds and Pressures for Varying Return Period from the NBCC

Description	Return Period	
	10 Years	50 Years
One-Hour Wind Speed (km/h)	86	99
One-Hour Wind Pressure (kPa)	0.37	0.49

5.2 SNOW

Snow loads for the terminal shall be as specified in the NBCC for Ladner, BC, and are as follows:

- Ground Snow Load: S_S 1.3 kPa
  S_R 0.2 kPa

5.3 ICE

It is anticipated that ice floes are negligible in the vicinity near the terminal.

5.4 TEMPERATURE

Temperature effects shall be analysed in accordance with CAN/CSA-S6 (Canadian Highway Bridge Design Code) using publicly available data from the Environment Canada Climate Normals, Averages, and Extremes website. The extreme temperature values considered are as follows:

- Extreme Maximum: +33.3 deg. C

- Extreme Minimum: -17.8 deg. C

5.5 RAINFALL

Rainfall data to be used for the design of terminal buildings shall be as specified in the NBCC for Ladner, BC, and are as follows:

- Fifteen (15) Minutes: 10 mm
- One Day: 80 mm (extreme recorded at YVR is 89.4 mm)
- Annual Total Precipitation: 1,000 mm (extreme recorded at YVR is 1,199 mm)
- Rainfall for the remainder of the terminal shall be as per the Ladner Intensity-Duration-Frequency (IDF) data.

5.6 SEISMIC DATA

Roberts Bank Terminal 2 would be located in one of the areas of higher seismic risk designations in Western Canada. Site-specific ground motion parameters as published by Natural Resources Canada (NRC) for site coordinates of 49.022 degrees north and 123.173 degrees west are presented in **Table C** (see NRC website http://www.earthquakescanada.nrcan.gc.ca/hazard-alea/interpolat/index_2010-eng.php).

Table C Site Specific Ground Motion Parameters

Description	Return Period of Ground Motions		
	1 in 100-Year	**1 in 475-Year**	**1 in 2,475-Year**
Probability of Exceedance per Annum	0.01	0.002	0.0004
Probability of Exceedance in 50 Years	40%	10%	2%
PGA	0.14 g	0.30 g	0.56 g
S_a (0.2 s)*	0.27 g	0.60 g	1.12 g
S_a (0.5 s)*	0.18 g	0.39 g	0.75 g
S_a (1.0 s)*	0.09 g	0.20 g	0.36 g
S_a (2.0 s)*	0.04 g	0.09 g	0.18 g

*Spectral acceleration values

Applicable short and long period amplification factors, Fa and Fv, for the site will be determined during detail design.

6.0 METOCEAN DATA

Metocean data for analysis of mooring forces and design of scour and slope protection at the site shall be based on site-specific studies using available wind and current data. This data is presented in detail in the report "Roberts Bank Terminal 2 Metocean Desktop Study, Document number 2014-09-23-01-20000-REP-0026-Rev0." Information from the Metocean Desktop study is provided in the following subsections.

6.1 WAVES

The design wave heights immediately offshore of Roberts Bank are as provided in **Table D**.

Table D Design Wave Heights and Exceedance Frequency at the Project Site (Offshore)

Exceedance Frequency	Significant Wave Height (m)	
	SE	NW
1 in 100-Year Event	3.3	3.6
1 in 50-Year Event	3.0	3.3
1 in 10-Year Event	2.35	2.5

6.2 CURRENTS

The maximum surface flood and ebb currents adjacent to Roberts Bank, according to the available current measurement data, are provided in **Table E**.

Table E Design Current Speeds

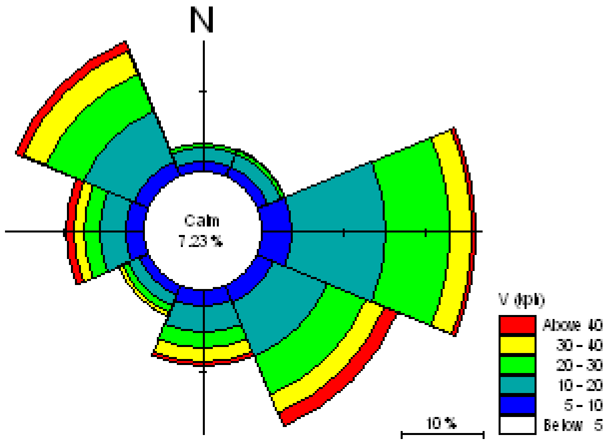
Description	Tide Condition	
	Flood Current (knots)	Ebb Current (knots)
Current Speed	2.0	1.5

Current at the berths shall be determined by analysis.

6.3 WIND

Wind data used for the mooring analysis and determining wind generated wave heights are based on historic data from the Sand Heads site. This is presented in the form of a wind rose in **Figure F**.

Figure F Wind Rose for All Data from Sand Heads Station



Based on the above wind rose data, it can be seen that the majority of the winds are from the east direction with the predominant storm wind direction being southeast.

The design wind speeds at the site for various return periods by the site-exposed compass directions is provided in **Table F**.

Table F Sand Heads Directional Return Period Design Wind Speeds (km/h)

Storm Direction	Return Period (Year)							
	1	2	5	10	25	30	50	100
All-Directions	74	78	82	86	89	90	92	95
E	49	55	60	63	67	68	70	73
SE	68	76	80	83	86	87	88	91
S	55	59	64	68	72	73	76	79
W	59	63	69	73	77	78	81	85
NW	64	69	76	80	87	88	91	95
N	<50	<50	<50	54	63	65	70	76

Note: Above are hourly average wind speeds.

6.4 DESIGN WATER LEVELS

6.4.1 Normal Water Levels

Water levels for Tsawwassen as published by the Canadian Hydrographic Service (CHS) and referenced to CD, are as follows:

- Higher High Water Level (Large Tide): 4.8 m
- High Water Level (Mean Tide): 4.1 m
- Mean Water Level: 3.0 m
- Low Water Level (Mean Tide): 1.1 m
- Lower Low Water Level (Large Tide): 0.1 m

Allowance shall be made in the design for adjustments to tide levels to account for extreme events and for future sea level rise during the lifetime of the facility.

6.4.2 Extreme Water Levels

The extreme water levels at the site were determined by extrapolating historical maximum and minimum water levels at Point Atkinson and using the adjustment values presented in the 2010 Tide Book (CHS's Canadian Tide and Current Tables) to determine associated water heights at Tsawwassen. These design water levels are presented in metres referenced to CD in **Table G**.

Table G Design Water Levels at the Site (Not Including Sea Level Rise)

Description	Return Period (Year)						
	2	5	10	15	30	50	100
Extreme High Water Level (m, CD)	5.02	5.15	5.22	5.26	5.31	5.35	5.39
Extreme Low Water Level (m, CD)	0.02	-0.09	-0.14	-0.17	-0.20	-0.22	-0.25

6.4.3 Sea Level Rise

Allowance shall be made in the design for future sea level rise due to climate change. According to BC Ministry of Environment's most recent report (Ausenco Sandwell, 2011), the predicted sea level rise by 2100 is 1.0 m. The Metocean study recommends 0.25 m be added to the 50-year value in **Table G** and 0.5 m be added to the 100-year value in **Table G**.

7.0 GEOTECHNICAL DATA

The proposed RBT2 Project is located at Roberts Bank which forms the western boundary of the modern day Fraser River delta. The Fraser River delta is a geologically young feature, being typically about 10,000 years old. Roberts Bank is an even younger feature than the Fraser River delta, representing the geologically most recent depositions associated with deltaic formation, likely over no more than the last 2,000 years. Over the last few hundred years, the Main Arm of the Fraser River has been discharging sediment to the Strait of Georgia and has been shifting northwards along Roberts Bank to its current location.

The delta consists of layered sands and fine sediments washed down from the Coast Mountains. Results of geotechnical investigations indicate that:

- The RBT2 site is underlain by a granular soil unit consisting of loose to compact recently deposited sands, silts, and inter-bedded sand and silts, that vary in thickness from 75 m to in excess of 100 m;
- This is followed by fine-grained clayey marine soils, that vary in thickness from several metres to in excess of 30 m; and
- This is followed by till-like soils to depths in excess of several hundred metres.

Roberts Bank Terminal 2 is located in a zone of high seismic risk in Western Canada. The seismicity at the subject site results from the thrusting (sub-ducting) of the offshore Juan de Fuca Plate beneath the continental North America Plate, that could result in earthquakes of magnitude varying from M6 to M8+ occurring at epicentral distances varying from tens of kilometres to about 130 km.

The upper interlayered sands and silts are prone to liquefaction and have the potential to compress and settle upon loading. The lower marine soils are not prone to liquefaction, but are compressible and have the potential to induce long-term site settlements upon loading. The deep till-like soils form competent bearing strata.

Geotechnical data for design of foundations, seismic soil-structure interaction response, land reclamation fill, and soil improvements were obtained from the site-specific geotechnical investigations and evaluations carried out over the course of trade-off studies and preliminary design of the facilities at RBT2 including:

- Geotechnical Investigations for Terminal Layouts W1 and W2 - Golder Associates Ltd., August 22, 2011;
- Geotechnical Evaluations for Land Reclamation and Perimeter Dikes – Golder Associates Ltd., October 5, 2011;
- Terminal 2 (T2) Preliminary Geotechnical Design Input - Golder Associates Ltd. March 8, 2012; and
- Pavement Design for Roberts Bank Terminal 2 (RBT2) - Golder Associates Ltd. February 10, 2012.

Stability of reclaimed areas, marine structures, buildings, causeway, rail/road corridors, and utilities will require geotechnical assessments and input on:

- Settlements (long and short term);
- Stability of slopes and containment dykes;
- Soil bearing pressures of shallow foundations and geotechnical load carrying capacity of deep (pile) foundations;
- Suitability of dredged material for use as reclamation fill;
- Fill placement and compaction;
- Seismic performance of site soils including permanent soil displacements and soil/structure interaction response; and
- Pavement Design.

The site soils will require extensive ground improvement measures to reduce liquefaction potential, control earthquake-induced deformations, and enhance the load carrying capacity. The site soils will also require preloading (surcharging) to reduce, but not eliminate, short-term site settlements. The extent of ground improvement and duration of preloading will affect post-construction performance of soils. Preliminary geotechnical design input is summarised in the documents listed above.

The geotechnical design of marine structures, terminal facilities, and site utilities shall conform to the project specific design criteria contained in this Basis of Design and permissible settlement tolerances required for safe terminal operation.

Building foundations shall be designed in accordance with the design provisions in the latest version of the NBCC and guidelines given in the Canadian Foundation Engineering Manual.

Overall geotechnical design of the facilities including rail/road corridors, and site utilities shall be in accordance with the professional engineering principles and practices generally accepted as best industry practices in the Province of British Columbia.

The design of pavement structures shall be in accordance with the project specific criteria and parameters contained in this Basis of Design and guidelines given in American Association of State Highway and Transportation Officials (AASHTO) and Structural Design of Heavy Duty Pavements for Ports and Other Industries. A design life of 20 years shall be considered with linearly increasing traffic volumes over the first 15 years, and constant thereafter.

8.0 MARINE DESIGN CRITERIA

8.1 DESIGN VESSELS

Design vessels for the terminal shall be as shown in **Table H**.

Table H Container Vessel Characteristics

Vessel Name	Capacity (TEU)	Deadweight (tonnes)	Unofficial Displacement (tonnes)	LOA (m)	Beam (m)	Moulded Depth (m)	Loaded Draught (m)
Emma Maersk "e" Class	13,500	156,907	236,000	398	56.4	30	16.0
Maersk "EEE" Class **	18,000	165,000	250,000	400	59	---	14.5
Post-Panamax (2014)	12,000	140,000	---	366	49	---	15.2
Seaspan 4250	4,250	50,500	66,000	260	32.3	19.3	11.0

Note also that as per **Section 4.2.3** the berth structure and its foundation shall be designed to accommodate future vessels with draughts of up to 19 m. However, those future vessels are not considered as "design vessels" for the purposes of navigation studies, mooring analyses, marine fenders, or berth scour protection.

The primary design vessel for the tug basin shall be as shown in **Table I**. Other smaller vessels that would use the tug basin include 18 m long line handling boats, and 6 m long small craft, as listed in **Section 4.4**.

Table I Tug Basin Design Vessel Characteristics

Vessel Name	Brake Horse Power (BHP)	Bollard Pull (tonnes)	LOA (m)	Beam (m)	Moulded Depth (m)
80 tonne tug	6,000	80	30	12.6	5.3

Design vessels for the potential future short-sea-shipping berth could be as shown in **Table J**.

Table J Short-sea-shipping Berth Design Vessel Characteristics

Vessel Name	LOA (m)	Beam (m)	Moulded Depth (m)	Loaded Draught (m)
200 Series Flat Deck Barge (5,500 tonne capacity)	80	20	5.5	5.0

8.2 WATER DEPTH

The minimum water depth at the RBT2 wharf shall be sufficient to accommodate the fully laden largest design vessel with under-keel clearance to allow out of trim and wave induced vessel motions in the 50-year storm event. Under-keel clearance is to be a minimum of 10% of loaded draught.

The minimum water depth at berth shall be 18.4 m at LLWL (i.e., EL -18.3 m).

The minimum depth in the approach areas to the RBT2 wharf shall be sufficient to accommodate the fully laden design vessel with under-keel clearance to accommodate squat effects, out of trim, and wave induced vessel motion in the 5-year storm event.

The minimum water depth at the approach areas shall be 18.4 m at LLWL (i.e., EL -18.3 m).

Since the preliminary design for RBT2 was based on a future potential container ship draught of 19 m, the design water depth of the approach areas and the berth pocket is 21.7 m at LLWL (i.e., EL -21.6 m CD).

8.3 FENDER SYSTEM

The fender system shall be designed to accept the berthing impact of the design vessels at any tide level, and load conditions.

Berthing criteria shall be as shown in **Table K**.

Table K Berthing Criteria (from PIANC)

Vessel Type	Approach Angle	Point of Impact	Approach Velocity (Perpendicular to Berth Face)
Emma Maersk - "e" Class or Maersk EEE Class	5 degrees	¼ point	0.12 m/s
Post-Panamax (2014)	5 degrees	¼ point	0.12 m/s
Seaspan 4250	10 degrees	¼ point	0.20 m/s

8.4 Mooring Loads

Mooring loads shall be determined based on dynamic mooring analysis. Mooring system shall be designed to withstand loads under the 50-year storm event.

8.5 Angles for Line Pull

- Breasting Lines (Plan): 90 degrees to 35 degrees
- Breasting Lines (Vertical): Flat to +30 degrees
- Spring Lines (Plan): 10 degrees
- Spring Lines (Vertical): Flat to +30 degrees
- Minimum Number of Bow Lines: 4
- Minimum Number of Stern Lines: 4
- Minimum Number of Bow Spring Lines: 2
- Minimum Number of Stern Spring Lines: 2

Mooring line numbers are based on the design vessels in AECOM's Dynamic Mooring Analysis.

8.6 Scour Protection

Scour protection shall be designed to be stable under marine propulsion equipment for the design vessels with the following assumed characteristics:

- Emma Maersk "e" Class vessel: One main propeller 9.6 m diameter with six blades, approximately 80,000 kW (110,000 BHP). Two bow thrusters and two stern thrusters, each with 25 tons transverse thrust;
- Maersk "EEE" Class vessel: Two engine/two propeller system, 9.8 m propeller diameter, four blades per propeller, approximately 30,000 kW per engine. Bow thrusters only with no stern thrusters (thrust details not available); and

- As noted in **Section 4.2.3** and **Section 8.1**, the berth structures are to be designed to accommodate future vessels with draughts of up to 19 m. However, those future vessels are not considered as "design vessels" for the purposes of berth scour protection.

9.0 STRUCTURAL DESIGN CRITERIA

9.1 WHARF STRUCTURAL LOADS

The following imposed loads due to operational usage shall be accommodated on the wharf structure. The structural loads are based on the proposed terminal operations as shown in AECOM's preliminary design drawings.

9.1.1 Container Handling Equipment and Vehicle Wheel Loads

The following equipment and vehicle loads shall be accommodated on the wharf:

- Terminal Tractor and Trailer Units:
  - Front Wheel: 27 kN
  - Rear Wheel: 40 kN

An impact allowance of 20% shall be added to the above loads.

9.1.2 Wharf Storage Loads

The following storage loads shall be accommodated on the wharf:

- Uniformly Distributed:
  - Generally: 48 kPa
  - In Combination with Crane Loading: 36 kPa
  - During Wharf Construction: 24 kPa
  - Seaward of Waterside Crane Rail: 24 kPa
  - Beyond Crane Rail Stops: 24 kPa
  - Seismic Event: 10 kPa
  - Settlement Allowance: 10 kPa
- Hatch Covers:
  - Self-Weight: 285 kN
  - Corner Load: 344 kN
  - Storage Location: Between crane rails
  - General Vehicle Allowance: 225 kN GVW + Dynamic Load allowance

9.1.3 Crane Loads

The following live loads from a Tandem Lift STS Crane shall be accommodated on the wharf:

- Lifting Capacity (Twin 40 ft. and Quad 20 ft.): 80 tonnes
- Outreach (24 Containers) w/ 2º list: 70.5 m
- Setback from wharf face: 6.4 m
- Rail Gauge: 30.48 m
- Back-Reach: 27.6 m
- Wheel Spacing (at each truck): 1.375 m (minimum) - 1.5 m (maximum)
- Number of Wheels per Rail: 16 (2 gantry drive assemblies per rail, 8 wheels per gantry drive assembly)
- Distance between the load centres of the two corners on a rail = 13.3 m (minimum, i.e., 3.675 m gap between centre wheels) to 14.1 m (maximum, i.e., 3.6 m gap between centre wheels).
- Overall length of crane (bumper to bumper): 27.0 m.

Loads from the crane wheels on each crane rail are presented in **Table L**.

Loads imparted by crane impact at each crane stop to be determined by rational analysis, based on an assumed crane impact speed of 150 ft./min. (0.762 m/s), and a buffer impact height of 1.20 m. The crane mass for this impact analysis (including trolley and lift system, but no live load) is assumed to be 1,900,000 kg (1,900 tonnes). It is assumed that the crane's hydraulic bumpers will absorb 50% of the crane's kinetic energy at impact, the remaining 50% being transmitted into the crane stop system (25% per crane stop).

Table L Crane Rail Loads

Description	Vertical Loads (tonnes)		Horizontal Loads
	Waterside	Landside	Perpendicular Rail (tonnes)
Operating (Boom Down)			
Normal Operating	115	90	10
Dead Load	---	---	---
Extreme Operating	130	105	13
Stowed (Boom Up)			
Dead Load	---	---	---
Maximum Storm Wind (boom fully stowed)	130	110	13
Seismic (Operating with Wind but No Lift Load)	135	120	13
Crane Stop	---	---	---

Consideration shall be given to loads resulting from the delivery of fully erected cranes.

- Gantry equaliser assembly (per corner), four trucks, two wheels per truck, total eight wheels; and
- Maximum Lateral Load (applied at top of rail) = 18.6 tonnes per wheel.

9.2 YARD STRUCTURAL LOADS

The following imposed loads due to operational usage are to be accommodated in the CY and IY.

9.2.1 Container Handling Equipment and Vehicle Wheel Loads

The following container handling equipment loads shall be accommodated within the container yard:

- CY Automated Stacking Crane:
  - The nominal weight of the machine: 200,000 kg
  - Maximum Vertical Operating Wheel Load: 312 kN
  - Maximum Horizontal Operating Wheel Load: 48 kN
- Mobile Horizontal Transfer Equipment (based on Shuttle Carrier):
  - The nominal weight of the machine: 51,000 kg

  - Maximum Vertical Operating Wheel Load (40 MT container): 264.0 kN
  - Maximum Vertical Operating Wheel Load (no container): 144 kN
- IY Rail Mounted Gantry:
  - The nominal weight of the machine: 490,000 kg
  - Maximum Vertical Operating Wheel Load: 284 kN
  - Maximum Horizontal Operating Wheel Load: 58 kN.
- Highway Trucks:
  - Maximum Axle Load: Based on Truck CL-625 in CSA-S6-06
- Top-pick:
  - The nominal weight of the machine: 68,950 kg
  - Maximum Vertical Operating Axle Load: 943 kN

9.2.2 Yard Storage Loads

The following storage loads shall be accommodated in the CY based on 5-high container stacking:

- Container Stacking Loads:
  - Total Average Corner Load: 500 kN
  - Total Maximum Corner Load: 280 kN

9.2.3 Rail Loads

The following rail loads shall be accommodated in the IY:

- Rail Locomotive:
  - American Railway Engineering and Maintenance-of-Way Association (AREMA) Cooper’s E90 loading.
- Railcar Unit:
  - 286,000 lbs. (1,272 kN) on four axles.

9.2.4 Storage Load Allowance for Long Term Settlement

An equivalent uniformly distributed sustained preload/storage load of 30 kPa on the terminal area was considered in the long-term settlement analysis.

9.3 BUILDING LOADS

All occupied and other critical buildings shall be designed in accordance with the NBCC, which requires that buildings withstand the A2475 seismic event with no collapse. Therefore, the soils underlying the Administration Building, Maintenance and Repair Building, CBSA Building, the Parking Structure, and Main Substation Building shall be densified to minimise the risk of soil liquefaction and the resulting large lateral ground movements. No ground improvement is needed for the lightly loaded buildings with smaller footprints.

Live loads due to use and occupancy of buildings, catwalks, and miscellaneous structures shall be in accordance with Part 4 of the NBCC.

9.4 LOAD COMBINATIONS

Structural elements in the wharf, CY, and the IY shall be designed to resist the factored loads and load combinations that will be finalised during detail design.

10.0 CIVIL DESIGN CRITERIA

10.1 GRADES AND DRAINAGE

In general, drainage grades on the wharf and in the CY shall be 1.5% or less. Up to 2% will be permissible in limited areas to promote drainage.

Grading contours shall be either parallel or perpendicular to the long axis of grounded containers. Ridges and valleys shall be located in aisles between, or away from, container stacks.

In the IY, grades parallel to the tracks shall be 0.2% or less. Grades perpendicular to the tracks shall be 1% or less.

Trench drains, manholes, and catch basins shall be located in areas to minimise conflict with equipment operating areas. Underground structures and grates shall be designed to support equipment wheel loading.

The following design criteria shall be used for storm drainage:

- Storm drainage systems shall be designed using Ladner IDF data to accommodate the rainfall flows generated from a 1 in 10-year rainstorm, with a 15-minute time of concentration. The rational method of design may be used;

- All catch basin manholes and trench drain grates shall be rated for the design loadings for the wharf apron, CY, IY, and other facilities;
- Minimum cover in the wharf apron and CY is 1.0 m;
- Minimum cover in the IY is 1.22 m;
- All storm sewers in the IY shall be reinforced concrete Class IV; and
- Slot drain interceptor pipes shall be minimum 375 mm diameter high-density polyethylene pipe (HDPE), or corrugated steel pipe (CSP).

Collected drainage water shall be passed through oil interceptors that shall be installed to CCME standards. Oil interceptor design flows shall be based on the 1 in 10-year flows. In addition the storm outfalls shall be fitted with shutoff valves to terminate flow from site should a sizeable spill occur. A sizeable spill is one in excess of 100 L.

Independent oil and waste containment systems shall be provided at the container/reefer wash facility, at the fuelling facility, and at the transformer yards. Trash baskets shall be provided to collect debris and grit for removal from the site. Drainage water from these areas shall be collected via a closed drain system and passed through coalescing plate oil water separators to the storm sewer system. Oil water separators shall be sized for a minimum hydraulic flow rate of a 10-year return, one-hour storm event. In addition, the containment systems shall be equipped with stop valves local to each facility to contain spills.

Storm outfall structures shall consist of a prefabricated pipe outlet and a rip-rap pad. The pipe outlet shall consist of an integral saddle, pipe, and apron. The pipe effluent velocities shall be controlled to 1 m/s to minimise scouring. Outfall pipes shall be positioned with top of pipe at -5.0 m CD.

All storm pipes crossing under rail tracks shall meet CN pipeline crossing specification requirements.

The roads on the causeway shall be graded for stormwater to drain into and infiltrate through the gravel shoulder.

10.2 SANITARY SEWER

On site sanitary treatment facilities shall be provided to meet effluent standards set by the Ministry of Environment. The characteristics of the discharge shall be:

- Five-Day Biochemical Oxygen Demand (BOD5): 45 mg/L, maximum;

- Total Suspended Solids (Non-Filterable Residue): 45 mg/L, maximum; and
- Toxicity: LT50 96 hours, minimum.

The following design criteria shall be used for sanitary sewers:

- Minimum cover is 1.0 m;
- All pipes shall be PVC DR 28, minimum diameter 150 mm;
- Pipe shall be sized on basis of minimum velocity of 0.91 m/s; and
- Ocean outfall elevation: Top of pipe at -10.0 m CD.

10.3 RAIL SYSTEM

Rail design criteria shall be developed to meet the operating conditions and the requirements of the RBT2 IY, causeway support tracks, and new track construction in the T-Yard and DPU/Bad Order Setout Yard. In general, the rail design shall follow the BC Rail Properties' (BCRP) Design Brief Document No. 290050-PM-230-S0-0001, Rev. 1 regarding track structure and geometry wherever possible and practicable. Exceptions to this standard will require approval from BCRP.

10.4 CLEARANCES

A standard clearance envelope for industrial track shall be applied from all fixed features. For determining clearances, mobile equipment on fixed runways working adjacent to tracks, such as rail mounted gantry cranes shall be considered fixed features.

10.4.1 Intermodal Yard

The IY shall be configured with two parallel RMG runways, each servicing six working tracks for the loading/unloading of double-stack rail cars. The characteristics of the IY shall be as follows:

- The IY shall be fenced to preclude uncontrolled manual access into the automated RMG operating areas;
- "Airlock" gates, remotely operated from the IY control centre in the administration building, shall be provided to control train and service staff access into the automated RMG operating areas;
- Service aisles within the IY shall be paved;
- In-ground compressed air supply piping shall be installed in pits to serve IY working tracks;

- A lock-out procedure shall be implemented to prevent switching of railcars in the IY whenever people and equipment are working around railcars;
- A train, or railcar, motion warning system shall be implemented in the IY;
- RFID and OCR railcar position management/railcar position detection system shall be provided;
- MHTE crossing aisles shall be paved with cast concrete panels; and
- The IY operating areas shall be "zoned" to allow concurrent automated loading/unloading and manual (de)coning operations.

10.4.2 Train and Railcar Data

The terminal and rail support yards shall be designed for receiving containerised trains as indicated in **Table M** and **Table N**.

Table M Railcar Design Data*

Description	Parameter
Design Railcar	Five-platform Double Stack
Length	80.81 m (265 ft. 1½ in.) Maximum
Height (Maximum)	6.15 m (20 ft. 2 in.)
Light Weight	788 kN (177,200 lbs.)
Loaded Weight Limit	1,272 kN (286,000 lbs.) on 4 Axles 3,560 kN (800,500 lbs.) per 5 cars

*(Based on a Greenbriar Five Platform Double Stack Unit)

Table N Train and Locomotive Data

Description	Parameter
Maximum Train Length	3,660 m (12,000 ft.)
Design Train Length	3,660 m (12,000 ft.)
Number of Locomotives	Determined by Distributed Power Calculation
Maximum Design Speed for RBT2 IY Tracks	8.05 km/h (5 mph)

10.4.3 Track Geometry

Track and alignment shall be in accordance with AREMA guidelines. The parameters shown in **Table O** shall be used for design purposes.

There are no significant grade limitations on the site.

Support tracks shall have a 0% gradient or be so designed to prevent accidental fouling of adjacent tracks.

Maximum degree of curvature for the rail layout is 9 degrees to permit breaking and coupling of trains on curves as required.

Track Centres - as per **Table O**.

Table O Track Geometry and Capacities

Description	**Parameter**
Design Speed (excluding RBT2 IY)	24.1 km/h (15 mph maximum)
Maximum Curvature	9 degrees (194.241 m radius)
Vertical Curve Length Minimum	30.5 m (100 ft.)
Vertical Curve Length Design	As per AREMA Design Guidelines
Maximum Grades	±0.2% Running Tracks 0% Support and IY Tracks
Track Centres [(1)]	4.27 m (14 ft.) minimum in general
Track Centres - Causeway (T-Yard)	4.27 m (14 ft.) for Support Track Pairs; 8.53 m (28 ft.) between Support Track Pairs; Allowance for maintenance road
Track Centres -Causeway (DPU/Bad Order Setout Yard)	4.27 m (14 ft.) for Bad Order Track Pairs; 12.19 m (40 ft.) between Bad Order Track Pairs16.46 m; (54 ft.) between DPU Setout Tracks and P5
Track Centres - Intermodal Yard	6.88 m (22.6 ft.) for IY Track Pairs; 15.39 m (50.5 ft.) between IY Track Pairs
Railcar Clearances	2.55 m (8.38 ft.) Horizontal from Track Centre and 7.01 m (23 ft.) Vertical from Top of Rail
Turnout Clearance	60.96 m (200 ft.) from Point of Switch to Foul Point
Minimum Turnout / Crossover	Lead No. 12; Yard No. 10; Set-out No. 8 (Light Duty)
Minimum Number of Intermodal Working Tracks	6 in North IY, 6 in South IY
Total Length of Intermodal Working Tracks	14,725 m (48,300 ft.)

Notes:

[(1)] The track centres were determined in consultation with BCR and their Design Brief 290050-PM-230-S0-0001, Rev. 1.

10.4.4 Track Section Data

Track structure for tracks outside of the IY shall be standard wood tie and ballast construction on sub-ballast, consisting of jointed rail set on steel tie plates, fastened with cut spikes, and mounted on No. 1 hardwood crossties based on BCRP Basis of Design document.

Where practical, lateral cross fall shall be applied across the track section between tracks to promote positive drainage. Track section data is presented in **Table P**.

Table P Track Section Data

Description	Parameter
Rail Section	New 136 RE High Strength Rail in Curves and Turnouts; New 136 RE Intermediate Rail on Tangents; New 115 RE Rail in IY
Rail Joints	Bolted (6-hole, AREMA std.)
Rail Plates	356 mm (14 in.)
Cross-Ties	No. 1 Treated Hardwood with End Plates
Ballast	229 mm (9 in.) Depth Under Tie
Sub-Ballast (1)	305 mm (12 in.) Depth
Turnouts	No. 10 CN plan TS-011 A/V
Railcar Scale	Not Required
Rail End Stops	Suitable for Marine Terminal Application

Notes:
(1) Sub-ballast depth is subject to geotechnical review.

10.5 WATER SERVICES

Fire and potable water is expected to be supplied from The Corporation of Delta to RBT2 by a water main proposed to be constructed on the widened Roberts Bank causeway.

The water distribution system on the terminal shall be installed in accordance with NFPA 307 – "Standard for the Construction and Fire Protection of Marine Terminals, Piers and Wharves".

Hydrants shall be provided throughout the site for fire flow supply. Wherever possible, hydrants shall be located adjacent to high mast light poles and protected with bollards. Hydrants in traffic areas shall be below grade to avoid damage.

Potable water shall be provided to all building facilities and ship berths.

Metering shall be installed for ships' water supply line complete with electric heat tracing. Backflow from ships to site shall be prevented.

10.6 Fire Protection

Fire protection shall be installed in accordance with NFPA 307 - "Standard for the Construction and Fire Protection of Marine Terminals, Piers, and Wharves".

The fire water distribution system shall be designed to satisfy 200 L/s fire flow demand at all hydrants for fire protection for buildings, CY, and IY. The duration of fire flow demand shall be 4.0 hours, in accordance with NFPA 307 guidelines.

The following design criteria shall apply to potable water and fire water:

- Minimum cover shall be 1.0 m;
- All water mains shall be rated for 1,380 kPa (200 psi) working pressure;
- All water mains 100 mm - 300 mm diameter to be PVC C900 Class 200 DR 14. Mains 350 mm - 600 mm diameter to be PVC C905 Class 235, DR 18;
- Fire hydrant leads shall be 150 mm diameter, PVC Class 200 DR 14;
- Thrust blocks required at all bends and fittings;
- Pipe sizes smaller than 100 mm diameter shall be HDPE;
- Minimum pipe slope shall be 0.1%;
- Water mains under rail tracks shall be encased with steel casing pipe; and
- A mobile fire suppression system shall be utilised in the DPU/Bad Order Setout Yard.

10.7 Fencing

All security fencing shall consist of a concrete barrier rail with posts and chain link mesh above, topped with three strands of barbed wire mounted on 45 degree brackets having a fence height of 3.0 m.

Security fencing shall be equipped with intrusion detection devices and positioned at the following locations:

- Perimeter of the entry and exit gate facilities;
- Perimeter of the POV parking areas;
- Perimeter of the IY;
- Perimeter of the VACIS area;

- Western edge of the CY;
- Between the IY MHTE circulation lanes and the CY truck manoeuvring area;
- Between the wharf and the CY MHTE load lanes; and
- Perimeter of the high voltage equipment yard.

The IY rail access gates shall be automated and controlled from the rail operations centre.

Vehicle access gates shall be operated by a card access system interlinked with the IY automation control system for the RMGs.

10.8 ROAD WORKS AND RBT2 OVERPASS

By-laws, regulations, specifications, and design guidelines of the following relevant authorities shall be adhered to:

- Causeway Section: BC Ministry of Transportation Supplement to TAC Geometric Design Guide;
- RBT2 Overpass: CSA-S6-06 and BC Ministry of Transportation Supplement to CHBDC S6-06; and
- CY and other onsite facilities: The TAC Geometric Design Guide for Canadian Roads (1999), and the BC Ministry of Transportation Supplement to TAC Geometric Design Guide.

10.8.1 Roadway Design Criteria

Design criteria for roadways shall be as presented in **Table Q**.

Table Q Roadway Design Criteria

Item	Causeway	Inter-Terminal Roads and Interchanges	Onsite	Comments/Notes
Design Classification	UAU	UAU	ULU	UAU = Urban Arterial Undivided ULU = Urban Local Undivided
Posted Speed (km/h)	80	50	30	---
Design Speed (km/h)	80	50	30	The application of where UAU 80 or 50 apply will depend on terminal access layout.
Basic Lanes	2	2	2	---
Minimum Radius (m)	250	90	20	These minimum Radii are for super-elevated roadway sections.
Minimum K Factor Sag	25 - 32	11 - 12	4	Headlight control used road shall be illuminated.
Minimum K Factor Crest	24 - 36	6 - 7	2	Based on TAC Stopping Sight distance.
Maximum Grade (%)	5	5	6	5% for the UAU 50 is lower than the TAC 6% because of the large number of trucks anticipated.
Minimum Grade (%)	0.5	0.5	0.5	---
Maximum Super-Elevation (%)	6%	6%	4%	---
Minimum SSD (m)	114 - 140	60 - 65	30	---
Minimum DSD (m)	315	200	---	Avoidance Manoeuvre E.
Lane Width (m)	3.6	3.6	3.6	Existing lane width is 3.6 m.
Vertical Clearance (m)	5.2	5.2	5.2	5.0 m plus 200 mm for future overlays
Shoulder Width (m)	2.5	2.5	1.5**	** In location where a disabled vehicle will cause major disruptions to terminal operations, a 2.5 m shoulder should be used.
Design Vehicle	TAC WB-36	TAC WB-36	TAC WB-36	The WB-36 is a truck with two 16.2 m trailers capable of transporting two 53 ft. domestic containers. The wheel base of the truck is 36 m.

11.0 ELECTRICAL DESIGN CRITERIA

11.1 SYSTEM VOLTAGES

The nominal transmission voltage provided by BC Hydro is 69 kV. However, the actual voltage is closer to 64 kV. Other than for equipment ratings, the nominal voltage will be used in the criteria description.

A 69 kV underground distribution service shall be supplied from BC Hydro's line to the new port facility's main substation, which consists of an outdoor switchyard and an electrical building. The main substation's transformers are proposed to be outdoor, liquid filled, 64 kV - 12.47 kV type with fully redundant secondary selective system.

System voltages shall be as presented in **Table R**.

Table R System Voltages

Description	Voltage
Incoming power to the terminal	69 kV, 3-phase, 60 Hz
Incoming power to the area substations	12.47 kV, 3-phase, 60 Hz
STS Cranes, RMGs, ASCs and major equipment (as required) supply voltage	12.47 kV, 3-phase, 60 Hz
Shore power	6.6 kV, 3-phase, 60 Hz
General 3-phase equipment above 149 kW except in cases where there is consideration for minimising spares. For VFD applications refer to the electric motors section	4.16 kV, 3-phase, 60 Hz
General 3-phase equipment 149 kW and below. For VFD applications refer to the electric motors section	600 V, 3-phase, 60 Hz
Service and control voltage	120/208 V, 3-phase, 60 Hz; 120/240 V, single-phase, 60 Hz
Building interior lighting, utility loads, and services	120 V, single-phase, 60 Hz
PLC analog signals and instrument loops	24 VDC (4-20 mA)
PLC discrete signals	24 VDC; 120 V, single-phase, 60 Hz
Instrument power supply	120 V, single-phase, 60 Hz
Area exterior lighting	347 V, 208 V, or 120 V, single-phase, 60 Hz

11.2 SEISMIC RESISTANCE

Substation equipment, including transformers and switchgear shall be anchored to foundations in accordance with the NBCC.

Electrical equipment vendor shall state the seismic load resisting capacity of their equipment. Delivery schedules and costs preclude complete seismic analysis and testing, so equipment supports only will be capable of providing seismic resistance.

11.3 ELECTRIC MOTORS

All motors and associated drives shall be energy efficient and shall comply with IEEE 841 standards for inverter duty motor applications.

Motors shall generally conform to the provisions in **Table S**. Exceptions shall be evaluated on a case-by-case basis.

Table S Motor Details

Power	Voltage	Phase	Enclosure
Motors below 0.5 kW.	208 V	1	IP65, TEFC
Motors 0.5 kW to 149 kW. For VFD applications 373 kW and below.	575 V	3	IP65, TEFC
Motors above 149 kW except in cases where there is consideration for minimising spares. For VFD applications above 373 kW.	4 kV	3	IP65, TEFC

11.4 LIGHTING

Lighting intensities and illumination levels shall be in accordance with IES standards and consistent with local practices. Where equipment lighting and area lighting are both present, the 150 Lux requirement recently associated with container loading and unloading areas has been interpreted as the sum of yard lighting plus localised lighting being provided by the machine that is performing the work. Since the interpretation of the 150 Lux requirement is still under debate whether it applies to container handling terminals, or to container loading/unloading docks at warehouses, this requirement will need to be revisited during detail design, if deemed applicable.

General luminance levels for the various terminal areas shall be as shown in **Table T**.

Table T Lighting Levels

Area Name	Luminance (Minimum Average)
Control Rooms	500 Lux
Electrical Substations	500 Lux
Office Buildings	800 Lux
Operations Buildings	300 Lux
Stairways	20 Lux
Walkways	20 Lux
General Yard Areas	10 Lux
Machinery Platforms	100 Lux
Staffed Areas within the Container Yard	50 Lux
Intermodal Yard	50 Lux
Container Loading/Unloading Areas (1)	150 Lux

Notes:
(1) Actual intent of regulation still under review.

12.0 SAFETY IN DESIGN

A "safe design" approach begins in the design and planning phase with an emphasis on making choices about the design, methods of construction, and materials used, based on health, safety and environment (HSE) considerations. Reducing and controlling risks to health and safety during the design process is a well-recognised strategy for preventing or minimising occupational fatalities, injuries, and disease.

The opportunities to address HSE in the design and planning of construction works are considerable. It is possible to design out hazards or incorporate risk control measures that are compatible with the original design concept, and with the engineering and functional requirements of a project.

The design process of the RBT2 Project shall follow the design Codes and Standards and ensure that the final product is based on HSE considerations.

13.0 REFERENCES

AECOM, "Roberts Bank Terminal 2 - Preliminary Design Drawings", December 2014

AECOM, "Roberts Bank Terminal 2 - Dynamic Mooring Analysis", January 2012

AECOM, "Roberts Bank Terminal 2 – Planning and Capacity Study, Rev. 3", May 2012

AECOM, "Roberts Bank Terminal 2 - Fast-time Ship Navigation Simulation Study Report, Rev. D", April 2012

Ausenco Sandwell, "BC Ministry of Environment: Climate Change Adaption Guidelines for Sea Dikes and Coastal Flood Hazard Land Use Draft Policy Discussion Paper," January 2011, website: www.env.gov.bc.ca

British Columbia Rail Properties, "Design Brief - 290050-PM-230-S0-0001, Rev. 1", June 1, 2011

Canadian Hydrographic Service, Fisheries and Oceans Canada, "Canadian Tide and Current Tables 2010, Volume 5 – Juan de Fuca Strait and Strait of Georgia", 2010

Environment Canada, "Canadian Climate Normals",
website: http://climate.weather.gc.ca/climate_normals

Golder Associates Ltd., "Roberts Bank Terminal 2 Geotechnical Investigations for Terminal Layouts W1 and W2, Rev. V1", August 2011

Golder Associates Ltd., "Geotechnical Evaluations for Land Reclamation and Perimeter Dikes", October 5, 2011

Golder Associates Ltd., "Pavement Design for Roberts Bank Terminal 2", February 2012

Golder Associates Ltd., "Terminal 2 (T2) Preliminary Geotechnical Design Input", March 8, 2012

Natural Resources Canada, "Determine 2010 National Building Code of Canada seismic hazard values", website: http://www.earthquakescanada.nrcan.gc.ca/hazard-alea/interpolat/index_2010-eng.php

Seaport, “Functional Requirements - Design Vessels 09409-01-MA-REP-10016-200, Rev 0”, January 2012

WorleyParsons Canada Services Ltd., “Roberts Bank Terminal 2 - Metocean Desktop Study, Rev. 0”, September 2014

Appendix 1 - Basis of Design Abbreviations

APPENDIX 1 – BASIS OF DESIGN ABBREVIATIONS

Abbreviation	Description
AASHTO	American Association of State Highway and Transportation Officials
AGV	Automated Guided Vehicle
ANSI	American National Standards Institute
API	American Petroleum Institute
AREMA	American Railway Engineering and Maintenance-of-Way Association
ASC	Automated Stacking Crane
ASTM	American Society for Testing and Materials
BC	British Columbia
BCFC	BC Fire Code
BCR	British Columbia Railway
BCRP	BCR Properties Ltd., a subsidiary of British Columbia Railway Company, a Crown Corporation
BHP	Brake Horse Power
BOD or BoD	Basis of Design
BOD5	Five-day Biochemical Oxygen Demand
BTZ	Buffer Transfer Zone
CACS	Computerised Automation Control System
CBSA	Canada Border Services Agency
CCIP	Container Capacity Improvement Program
CCME	Canadian Council of Ministers of the Environment
CD	Chart Datum
CEC	Canadian Electric Code
CEM	Coastal Engineering Manual
CHS	Canadian Hydrographic Service
CN	Canadian National Railway
CP	Canadian Pacific Railway

CSA	Canadian Standards Association
CSP	Corrugated Steel Pipe
CTZ	Container Transfer Zone
CY	Container Yard
DFO	Fisheries and Oceans Canada
DPU	Distributed Power Unit
DTRRIP	Deltaport Terminal, Road and Rail Improvement Project
EA	Environmental Assessment
EEE	"Economic, Energy Efficient, Environmentally Improved" class of container ship
EL	Elevation
GD	Geodetic Datum
HDPE	High-density Polyethylene
HSE	Health, Safety, and Environment
IBC	Inter-box Connector (aka cone)
ICEA	Insulated Cable Engineers Association
IDF	Intensity Duration Frequency
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
IES	Illuminating Engineering Society
IESNA	Illuminating Engineering Society of North America
ISA	International Society of Automation
ISO	International Organization for Standardization
IY	Intermodal Yard
LEED	Leadership in Energy and Environmental Design
LLWL	Low Low Water Level
LOA	Length overall
MHTE	Mobile Horizontal Transfer Equipment
MOTEMS	Marine Oil Terminal Engineering and Maintenance Standards
NBCC	National Building Code of Canada
NEMA	National Electrical Manufacturers Association

NFPA	National Fire Protection Association
NPC	National Plumbing Code
OCIMF	Oil Companies International Marine Forum
OCR	Optical Character Recognition
PGA	Peak Ground Acceleration
PIANC	Permanent International Association of Navigation Congresses
PLC	Programmable Logic Controller
PMV	Port Metro Vancouver
POV	Personal Owned Vehicle
PTZ	Pan, Tilt, and Zoom
RBRC	Roberts Bank Rail Corridor
RBT2	Roberts Bank Terminal 2
RFID	Radio Frequency Identification
RMG	Rail-Mounted Gantry Crane
RPM	Radiation Portal Monitor
SI	International System of Units
STS	Ship-to-Shore (usually in conjunction with Crane)
TEFC	Totally Enclosed Fan Cooled (motor)
TEU	Twenty-foot equivalent unit
TOS	Terminal Operating System
ULC	Underwriters Laboratories of Canada
UPS	Uninterruptable Power Supply
US or USA	United States of America
UTM	Universal Transverse Mercator
VACIS	Vehicle and Cargo Inspection System
VACS	Vehicle Access and Control System
WP	WorleyParsons
YVR	Vancouver International Airport

Appendix 2 - Codes and Standards

APPENDIX 2 - CODES AND STANDARDS

Current versions of the following codes and standards will be referenced where appropriate for design, and in specifications, to define loads, performance, materials and quality:

- General:
    - WorkSafeBC
    - Labour Canada
- Geotechnical:
    - Canadian Geotechnical Society - Canadian Foundation Engineering Manual
    - Marine Oil Terminal Engineering and Maintenance Standards (MOTEMS)
- Marine and Structural:
    - National Building Code of Canada
    - Canadian Highway Bridge Design Code (CAN/CSA-S6)
    - Environment Canada - Publication of Canadian Climate Normals
    - CSA Standard A23.3 - Design of Concrete Structures
    - CSA Standard S16 - Limit States Design of Steel Structures
    - Transport Canada - Marine Transportation Security Regulations
    - Permanent International Association of Navigation Congresses (PIANC):
        - Guidelines for the Design of Fender Systems: 2002
        - Seismic Design Guidelines for Port Structures
        - Breakwaters with Vertical and Inclined Concrete Walls - Working Group 28 MARCOM
        - Approach Channels - A Guide for Design
    - BS 6349: British Standard Code of Practice for Maritime Structures, Part I to IV
    - International Ship and Port Facility Security Code
    - Oil Companies International Marine Forum (OCIMF):
        - Mooring Equipment Guidelines
        - Guidelines and Recommendations for the Safe Mooring of Large Ships at Piers and Sea Islands
        - Effective Mooring
    - American Petroleum Institute:

        - API RP-2A-LFRD: Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms
    - US Army Corps of Engineers:
        - Shore Protection Manual
        - Engineering Manual EM-1110-2-1601 (96) Hydraulic Design of Flood Control Structures
        - Hydraulic Design Criteria Sheet 712-1 (70) Stone Stability, Velocity vs. Stone Diameter
        - Coastal Engineering Manual (CEM) EM 1110-2-1100, 2006

- Civil:
    - National Plumbing Code (NPC)
    - BC Fire Code (BCFC)
    - National Fire Protection Association (NFPA) 307 – Standard for the Construction and Fire Protection of Marine Terminals, Piers and Wharves
    - Transportation Association of Canada Geometric Design Guide for Canadian Roads
    - British Columbia Ministry of Transportation, "Supplement to TAC Geometric Design Guide" 2007
    - CN Engineering - Specification for Industrial Tracks
    - American Society for Testing and Materials (ASTM)
    - American Engineering and Maintenance Engineering and Maintenance-of-Way Association (AREMA), Manual for Railway Engineering
    - Asphalt Institute - Thickness Design - Asphalt Pavement for Heavy Wheel Loads - Manual Series No. 23
    - AASHTO – Structured Design of Heavy Duty Pavements for Ports and Other Industries
    - British Ports Association – British Precast Concrete Federation, Structural Design of Heavy Duty Pavements
- Electrical:
    - CSA - Canadian Standards Association
    - CEC - CSA C22,1 Canadian Electrical Code, Part 1 as adopted by the British Columbia Safety Authority
    - NEMA - National Electrical Manufacturers Association
    - NFPA - National Fire Protection Association

- NFPA 307- 2011 Edition - Standard for the Construction and Fire Protection of Marine Terminals, Piers and Wharves
- ULC - Underwriters Laboratories of Canada
- ICEA - Insulated Cable Engineers Association
- IES or IESNA - Illuminating Engineering Society of North America
- ISA - International Society of Automation
- ISO - International Organization for Standardization
- IEC - International Electrotechnical Commission
- IEEE - Institute of Electrical and Electronic Engineers
- ANSI - American National Standards Institute