

NHC Ref. No. 3002329

7 December 2016

Parrish & Heimbecker Ltd.
355 Burrard Street, Suite 640
Vancouver, BC
V6C 2G8

Attention: Michael Balasescu, P.Eng.
Project Manager, FGT

Copy to: Michel Vander Noot, P.Eng.
Vice-President, CMC Engineering and Management Ltd.

Via email: mbalasescu@pandh.ca
mvandemoot@cmcengineering.com

**Re: Fraser Grain Terminal
Flood Inundation Assessment - Final**

Dear Mr. Balasescu:

This letter report summarizes the flood inundation assessment conducted for the proposed Fraser Grain Terminal (FGT) development located on Vancouver Fraser Port Authority (VFPA) property in the City of Surrey. The study involved reviewing existing information, producing an inundation map for the site, and providing comment and recommendations for improving flood protection at the site.

1 AVAILABLE INFORMATION

NHC has previously completed two relevant documents for Hemmera Envirochem and BHP Billiton:

- BHP Potash Export Facility EA, Fraser Surrey Docks Flood Protection Plan Review - Draft (NHC, 2016b)
- BHP Billiton Fraser River Potash Handling Facility, Preliminary Hydrology (NHC, 2016a)

NHC reviewed the following additional information as part of the study:

- Surrey Dock Lands Master Drainage Plan (Delcan, 2004)
- Fraser Surrey Docks Emergency Response Plan (Fraser Surrey Docks, 2014)
- Available site topography (LiDAR) provided by BHP Billiton

- Lower Fraser River Floodplain Map, BC Ministry of Environment March 2008
- 200-year Floodplain Boundary, City of Surrey, COSMOS, accessed 14 March 2016
- Concept drawings of the proposed development from CM Engineering and Management Ltd. September 2016

2 SITE DESCRIPTION

Fraser Surrey Dock (FSD) is located on the left bank (facing downstream) of the Fraser River, in Surrey, British Columbia. The site is within the Provincially designated Fraser River floodplain (NHC, 2008), as shown in **Figure 1**. The City of Surrey (CoS) also shows the property to be within their 200-year¹ floodplain boundary (**Figure 2**). The site is not protected by a dike, and no other structural mitigation protects the site from Fraser River flood hazards. Trifurcation Training Walls I and II reduce flow velocities at the FSD berths. The FSD site is zoned industrial (City of Surrey, 2016), and is characterized by a high percentage of impervious surface (Delcan, 2004; NHC, 2016a).

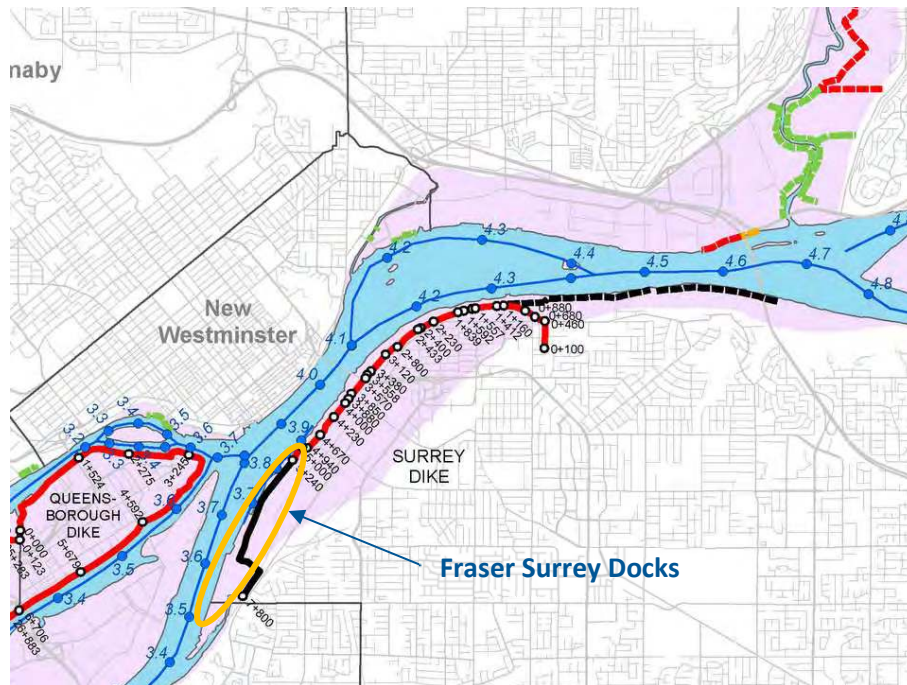


Figure 1. FSD is within the Ministry of Environment Fraser River floodplain boundaries (NHC, 2008). The flood profile shown here does not include freeboard or climate change allowances.

¹ It is unclear if CoS has adopted the 200-year flood profile (contrary to Provincial recommendations), or if this information actually represents the Fraser River design flood (1894 flood of record) and is mis-labelled on their website.

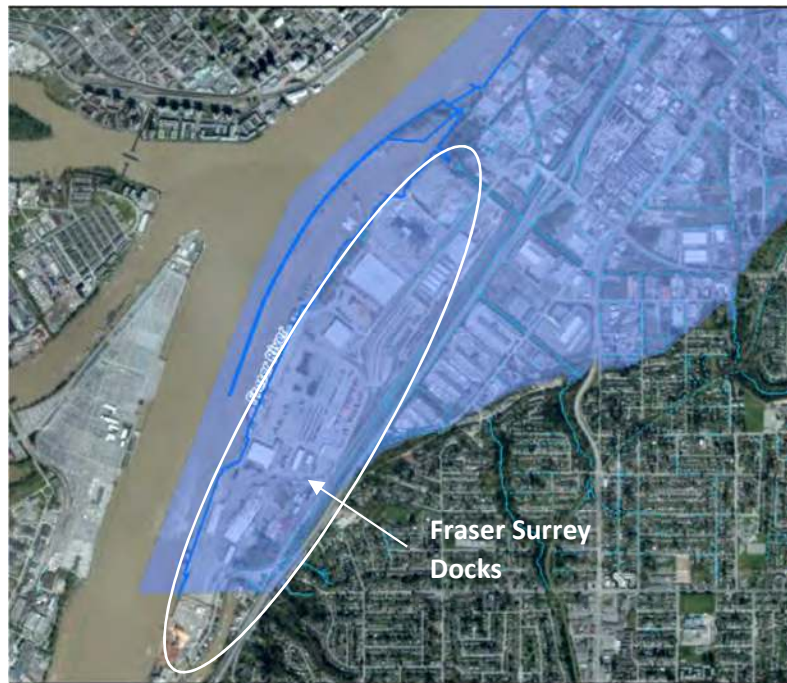


Figure 2. FSD is within CoS designated Fraser River 200-year floodplain, shown in purple shading (City of Surrey, 2016).

3 INUNDATION MAPPING

The standard design event for flood hazard on the Fraser River is the 1 in 500 Annual Exceedance Probability (AEP) event with moderate climate change (CC) allowance and 1.0 m Sea Level Rise (SLR). The Project & Environmental Review Application Submission Requirements from VFPA specifies that the flood protection assessment be conducted using the 1 in 200 year AEP event, with moderate CC allowance and 0.5 metre SLR as presented in “Simulating the Effects of Sea Level Rise and Climate Change Scenarios on Fraser River Flood Scenarios” (FLNRO, 2014). Flood levels for this scenario range from El. 3.98 m in the downstream end of the property near Berth 2 to El. 4.10 m in the upstream end of the property near Berth 6.

An inundation map was produced to assist with the assessment. While industry best practices were followed to produce the map, actual depths and extents of inundation may vary from those shown. Such variations can result from the inherent uncertainty and assumptions in all stages of the process including discharge measurement, stage-discharge rating, estimates of historical flood frequency distribution, estimates of projected sea level rise and climate change effects, numerical modelling of river flows, and topographic data collection.

The inundation map does not account for emergency measures or precautions which may be taken in anticipation of a flood, such as temporary lock block walls and sandbag berms. Such measures are laid out in FSD’s Emergency Response Plan (Fraser Surrey Docks, 2014).

Figure 3 shows the predicted depths and extents of flooding. Direct ingress from the Fraser River is limited to the area fronting Berths 2 through 6. Most of the area between the berths and rail lines would experience ponding of water up to 1.0 m deep. The footprint of the proposed administration building, parking, shuttle conveyors and storage silos remains mostly dry, but its western side is in contact with flooded ground.

4 CLOSURE

We trust this information suits your needs. Feel free to contact me by phone at 604-980-6011 or email at ewang@nhcweb.com if you have comments or questions.

Sincerely,

Northwest Hydraulic Consultants Ltd.

Prepared by:



Edwin Wang, M.Eng, PEng
Hydrotechnical Engineer

Reviewed by:

A handwritten signature in blue ink, likely belonging to Matt Gellis.

Matt Gellis, PEng
Associate

DISCLAIMER

This document has been prepared by Northwest Hydraulic Consultants Ltd. in accordance with generally accepted engineering practices and is intended for the exclusive use and benefit of Parrish & Heimbecker Ltd. and their authorized representatives for specific application to the Fraser Grain Terminal in Surrey, BC, Canada. The contents of this document are not to be relied upon or used, in whole or in part, by or for the benefit of others without specific written authorization from Northwest Hydraulic Consultants Ltd. No other warranty, expressed or implied, is made. Northwest Hydraulic Consultants Ltd. and its officers, directors, employees, and agents assume no responsibility for the reliance upon this document or any of its contents by any parties other than Parrish & Heimbecker Ltd.

REFERENCES

- City of Surrey (2016). COSMOS. City of Surrey Mapping Online System. [online] Available from: <http://cosmos.surrey.ca/external/> (Accessed 13 March 2016).
- Delcan (2004). *Surrey Dock Lands Master Drainage Plan* (EB3612). Report prepared by Delcan Corporation for Fraser River Port Authority. 51 pp.
- FLNRO (2014). *Simulating the Effects of Sea Level Rise and Climate Change on Fraser River Flood Scenarios*. Report prepared by BC Ministry of Forests, Lands and Natural Resource Operations.
- Fraser Surrey Docks (2014). *Emergency Response Plan 2014*. 67 pp.
- NHC (2008). *Fraser River Hydraulic Model Update* (Final Report). Report prepared by Northwest Hydraulic Consultants for the BC Ministry of Environment. 31 pp.
- NHC (2016a). *BHP Billiton Fraser River Potash Handling Facility, Preliminary Hydrology*. Report prepared by Northwest Hydraulic Consultants Ltd. for Hemmera Envirochem Ltd. 7 pp.
- NHC (2016b). *Fraser Surrey Docks Flood Protection Plan Review - Draft*. Report prepared by Northwest Hydraulic Consultants for Hemmera Envirochem. 20 pp.

FIGURES

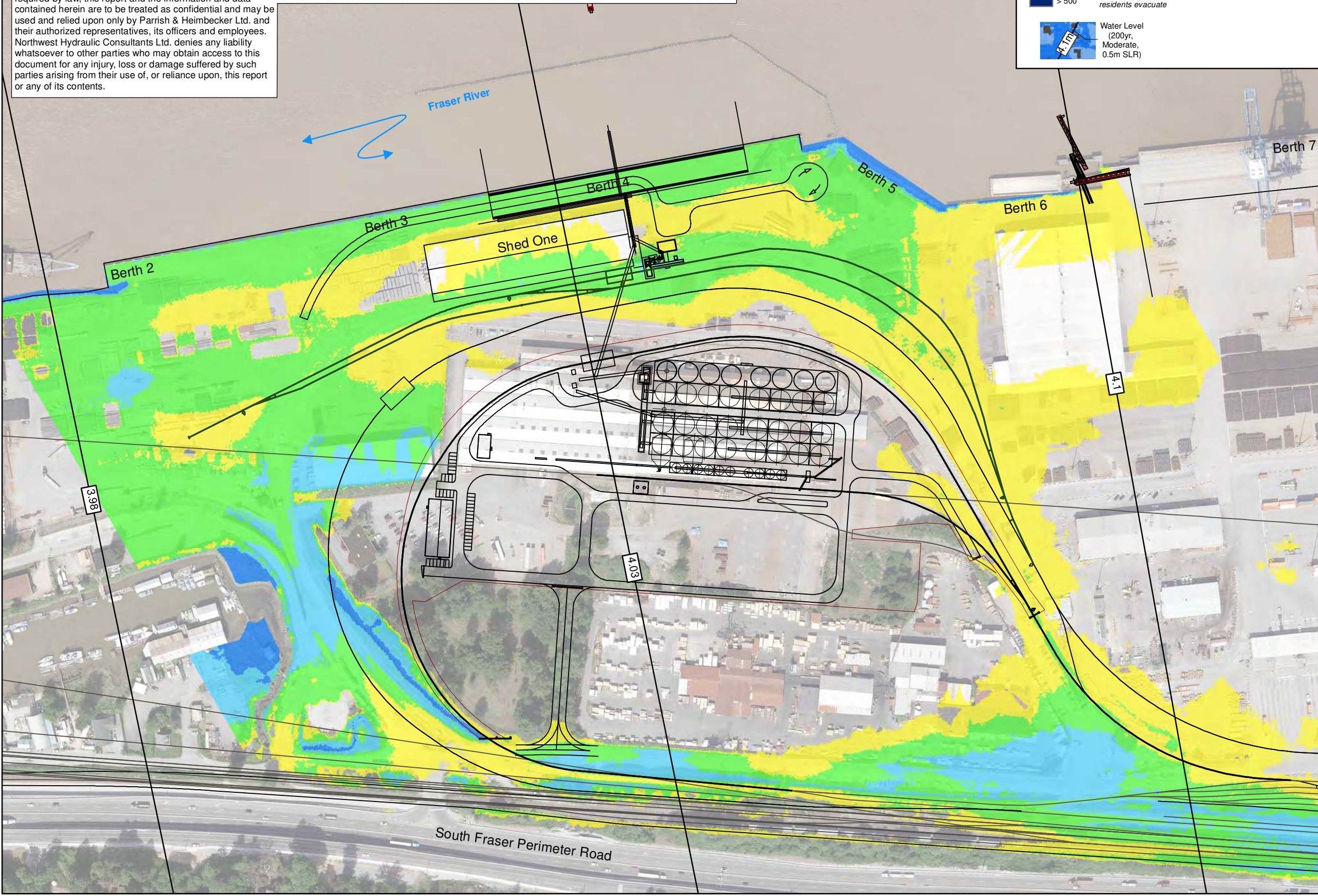
Disclaimer:
 This document has been prepared by Northwest Hydraulic Consultants Ltd. for the benefit of Parrish & Heimbecker Ltd. and their authorized representatives for specific application to the Fraser Grain Terminal. The information and data contained herein represent Northwest Hydraulic Consultants Ltd. best professional judgment in light of the knowledge and information available to Northwest Hydraulic Consultants Ltd. at the time of preparation, and was prepared in accordance with generally accepted engineering practices. Except as required by law, this report and the information and data contained herein are to be treated as confidential and may be used and relied upon only by Parrish & Heimbecker Ltd. and their authorized representatives, its officers and employees. Northwest Hydraulic Consultants Ltd. denies any liability whatsoever to other parties who may obtain access to this document for any injury, loss or damage suffered by such parties arising from their use of, or reliance upon, this report or any of its contents.

References:
 Ausenco-Sandwell (2011). Climate Change Adaptation Guidelines for Sea Dikes and Coastal Flood Hazard Land Use: Guidelines for Management of Coastal Flood Hazard Land Use. Prepared by Ausenco-Sandwell for BC Ministry of Environment.
 BC FLNRO. (2014). Simulating the Effects of Sea Level Rise and Climate Change on Fraser River Flood Scenarios (Final Report). Report prepared by Flood Safety Section, May 2014. 202 pp.
 NHC (2008). Fraser River Hydraulic Model Update (Final Report). Report prepared for the BC Ministry of Environment. 31 pp.
 Delcan (2004). Surrey Dock Lands Master Drainage Plan (EB3612). Report prepared by Delcan Corporation for Fraser River Port Authority. 51 pp.

Flood Depths (cm)

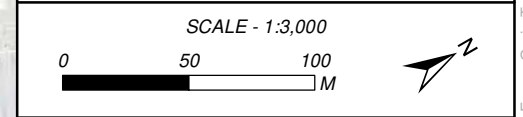
0 to 50	most houses are dry; walking in moving water or driving is potentially dangerous; basements and underground parking may be flooded, potentially causing evacuation
50 to 100	water on ground floor; basements and underground parking flooded, potentially causing evacuation; electricity failed; vehicles are commonly carried off roadways
100 to 200	ground floor flooded; residents evacuate
200 to 500	first floor and often roof covered by water; residents evacuate
> 500	first floor and often roof covered by water; residents evacuate

Water Level
 (200yr, Moderate, 0.5m SLR)



Notes:
 Inundation map was produced for review of existing flood protection planning at Fraser Surrey Docks as described in NHC (2016). They do NOT represent floodplain mapping and should not be used as such. Industry best practices were followed to generate the flood maps, however actual flood levels and extents may vary from those shown and Northwest Hydraulic Consultants Ltd. (NHC) does not assume any liability for such variations. For limitations in the modelling, Digital Elevation Model (DEM), and mapping refer to NHC (2016).

Data Sources:
 Background image from Esri World Imagery
 Index basemap from National Geographic and Esri.
 Infrastructure Labels Adapted from Delcan (2004)



Coordinate System: NAD 1983 CSRS UTM ZONE 10N
 Units: METRES

Job: 3002329 | Date: 07-DEC-2016

**FRASER GRAIN TERMINAL
 FLOOD INUNDATION ASSESSMENT
 FLOOD INUNDATION
 1 IN 200 AEP
 "MODERATE" CLIMATE CHANGE EFFECT
 0.5 M SLR**

DRAFT

FIGURE 3

MSN & JXD: \mainfile-van\Projects\Active\3002329 Fraser Grain Terminal\Flood Level Study\95 GIS\3002329_JXD_Map_FloodInundation_FR0.mxd