



REPORT

To: Chair and Directors

Date: December 10, 2019

From: Trish Morgan, General Manager of Community Services

Subject: **2020 UBCM CEPF Flood Mapping Grant Application**

RECOMMENDATION: *[Corporate Unweighted]*

That the Regional Board authorize an application be submitted to the Community Emergency Preparedness Fund – Flood Mapping for a grant of up to \$150,000 to conduct flood plain mapping west of Chetwynd, around Moberly Lake, south of Pouce Coupe and in the Tomslake and Tupper areas.

BACKGROUND/RATIONALE:

The deadline for the 2020 grant application is January 24, 2020. The Regional District submitted the same grant application in 2019 but was unsuccessful in obtaining the grant to conduct flood plain mapping.

The Community Emergency Preparedness Fund provides grant funding in four phases to support flood hazard risk reduction:

Phase	Type	Maximum Grant Available	Status
1	Flood Hazard Risk Assessment	\$150,000, 100% of cost	Completed
2	Flood Plain Mapping	\$150,000, 100% of cost	Grant application proposed for 2020
3	Mitigation Planning	\$150,000, 100% of cost	Grant application may be proposed upon completion of flood plain mapping
4	Structural Flood Mitigation Works	\$750,000, 100% of cost	Grant application may be proposed upon completion of mitigation planning

In 2018 the Regional District received funding from the National Disaster Mitigation Program to conduct flood hazard risk assessments for the areas west of Chetwynd, around Moberly Lake, south of Pouce Coupe. The projects were completed in January 2019 by DWB Consulting. A full copy of the report is attached for your reference.

The report makes a number of recommendations for the Regional District to consider:

- PRRD should have regulations to limit or control development in the floodplains.
- Develop flood risk and community plans including make changes to the response plans to ensure they account for the results.
- Watershed study to examine the debris effects.
- Land use regulations especially Chetwynd corridor and upper reaches of the creeks.
- Development of acceptable adaptation tools and models for prediction and standards that should be followed in the region and adopted for the purposes of planning and design.

Staff Initials:

Dept. Head: 

CAO: 

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- Determination of appropriate flood frequency for design and development –Q100or Q200or whatever is deemed appropriate.
- Recovery planning for residents by PRRD should be formulated. Policy should be developed for what can be done to help post flooding and post event with better warning systems for flood risk including evacuation order.
- More hydrometric stations including policy or agreements with MoTI or MoFLNRORD.
- The funding will be used to address the flood risk as identified by a flood risk assessment. This will include:
 - Acquisition of elevation data and mapping,
 - Hydrologic and hydraulic information to calculate flood elevation for selected flood events,
 - Geospatial, mapping and modelling activities,
 - Identifying locations of structures, people, and assets that might be affected by flooding.
- First Nations consultation will be a major part of the next phases of the project, around Moberly Lake the two First Nations groups that will be involved with the consultation are Moberly Lake First Nations and the Saulneau First Nations Band.
- Continued Public Consultation.
- Floodplain Mapping.
- Mitigation Planning.

Due to the severity of the events that the PRRD has seen in the past it is important to create thorough floodplain mapping and develop mitigation plans to ensure the health and safety of residents and protect properties and infrastructure from possible damage in potential future flood events. The UBCM CEPF funding is intended to assist government bodies to develop flood maps that address flood risks identified in the flood risk assessment. Creating these flood maps may include the acquisition of elevation data and mapping, plotting of historical flood data and inundation mapping, hydrologic and hydraulic information to calculate flood elevations for selected flood events, geospatial mapping and modelling activities, and identifying locations of structures, people and assets that might be affected by flooding.

ALTERNATIVE OPTIONS:

1. That the Regional Board defer submitting an application to the Community Emergency Preparedness Fund – Flood Mapping for a grant of up to \$150,000 to conduct flood plain mapping west of Chetwynd, around Moberly Lake, south of Pouce Coupe and in the Tomslake and Tupper areas until 2021.
2. That the Regional Board decline to submit an application to the Community Emergency Preparedness Fund for flood plain mapping west of Chetwynd, around Moberly Lake, south of Pouce Coupe and in the Tomslake and Tupper areas until 2021.
3. That the Regional Board provide further direction.

STRATEGIC PLAN RELEVANCE:

- Responsive Service Delivery
 - Enhance Emergency Planning and Response Capacity
- Advocacy
 - Emergency Response Capacity for Local Governments

FINANCIAL CONSIDERATION(S):

The total cost of the project is estimated at \$150,000. Only if the Regional District is successful in obtaining the grant will the project proceed, otherwise no funds will be spent.

COMMUNICATIONS CONSIDERATION(S):

NONE

OTHER CONSIDERATION(S):

Attachments:

1. Peace River Regional District Flood Risk Assessment Report



DWB Consulting Services Ltd.

Peace River Regional District Flood Risk Assessment



Engineering | Environmental | Forestry

Prepared for: Peace River Regional District
Attn: Deborah Jones-Middleton



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Date: January 23rd 2019 | DWB file: 18347-324 | Revisions: A



OQM | Organizational Quality Management Program

January 9, 2020

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We do not represent, warrant, undertake or guarantee:

- That all project information has been received.
- That regulations and standards of practices shall remain constant through the duration of the project.
- That the use of guidance in the report will lead to any particular outcome or result; or, in particular,
- That by using the guidance in the report, the client will be approved by the contract holder for the applied works.

Signature Page

DWB Consulting Services Ltd. is pleased to submit this report for your review. This report has been prepared using sound technical and professional judgement, based on our knowledge and experience, applicable regulatory framework, industry best management practices, and current understanding of project conditions, design, and project setting.

Report Title: Peace River Regional District Flood Risk Assessment

Prepared For: Peace River Regional District

Revision: A

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REVISION HISTORY			
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1.0 INTRODUCTION

The Peace River Regional District (PRRD) has retained DWB Consulting Services Ltd. (DWB) to prepare a Flood Risk Assessment Report and Union of BC Municipalities - Community Emergency Preparedness Fund (UBCM CEPF) Application for funding the Flood Mapping proposed works in and around the Chetwynd, Moberly Lake, and Pouce Coupe/ Tomslake areas of the PRRD. In this report, the study areas are presented in geographical order, approximately west to east and not by degree of importance. The study area covers the Chetwynd Fringe (along Highway 97 west of Chetwynd to Willow Flats), Moberly Lake, and Pouce Coupe/Tomslake areas of the PRRD.

1.1 PROJECT OVERVIEW

In the past, areas within the PRRD surrounding Chetwynd, Moberly Lake, and Pouce Coupe have experienced several severe flooding events that resulted in substantial damage to infrastructure including highways, access roads, railways, a school, residences, and businesses. Most recently, the 2011 and 2016 floods caused significant damage in the PRRD requiring extensive repairs and continuing work to mitigate future flood risks. Flooding in the region is mainly caused by heavy rainfall during the freshet period. Debris and sedimentation issues continue to plague all of the areas within the project scope.

Currently, federal and provincial governments have taken initiatives and encouraged municipalities to identify the main causes of flooding, and develop or modernize flood maps to accurately determine their vulnerabilities in relation to flood risks identified by a flood risk assessment. In return, the provincial government provides some support to the municipalities for the development of the flood maps.

1.2 PROJECT OBJECTIVE

The objective of this project is to identify the primary causes of flooding in the Chetwynd, Moberly Lake, and Pouce Coupe areas within the PRRD and to develop a basis for flood mapping to address the flood risk identified by the flood risk assessment. As part of the project DWB was asked to:

- Provide a summary of historical flooding including historical events, flood risk, impact, and recovery.
- Provide a preliminary map showing areas that have historically been effected by flooding in the area and may be effected by future flooding (based on the available information from 2011 and 2016 floods).
- Assist in the development of a funding application to UBCM CEPF for future flood mapping.

As part of the flood risk assessment DWB was asked to:

- Identify flood hazards, compounding hazards, potential flooding areas, and characteristics of the areas.
- Perform a likelihood assessment including meteorological and seasonal conditions, climate change impacts.
- Provide maps of potential future flood risk area.
- Identify vulnerabilities and the social, economic and environmental impacts that potential future flood events could have on the communities within the study area.
- Identify the community resilience in the study area.

1.3 PROJECT LIMITATIONS

The works completed were limited by the scope of the project set out in the contribution agreement. The project limitations included:

- Flood Risk assessment primarily based on review of historical events, desk top study and field reconnaissance.
- No floodplain mapping, modelling, detailed quantitative analysis has been completed. This is a preliminary flood risk assessment aiming to apply for funding to prepare detailed floodplain mapping.
- Detailed assets, population, land use of the potential impact areas are preliminary estimates as floodplain analysis and mapping has not been completed.
- Impact from debris obstructing the channel is not included and may increase the size of the potential impacted areas.
- Site reconnaissance did not include flood assessments or a full flood risk evaluation.

2.0 METHODOLOGY

2.1 REVIEW OF EXISTING INFORMATION

To complete the project tasks and to understand the works carried out in the project areas, substantial effort was spent on the review of historical information. PRRD provided relevant information that was reviewed and considered for the flood risk assessment. Federal, provincial and municipal legislations and the guidelines were also reviewed. Events before 2011 as found in D. Septer's Flooding and Landslide Events in Northern British Columbia 1820-2006, the 2011, and the 2016 flood events were reviewed extensively. Similarly, rainfall and discharge data sets observed at different climate stations and Water Survey of Canada (WSC) gauging stations in the area were reviewed. Rainfall data for the 2011 and 2016 flood events is presented in Appendix B of the report and reviewed in the respective flood events sections. The WSC stream flow gauge annual maximum and minimum daily discharge show a clear spike in the data for 2011 that is 8-9 times the average for the Pouce Coupe River below Henderson Lake, and the Moberly River near Fort St. John had a daily discharge spike that is 2-3 times the average in 2011. The annual maximum and minimum daily discharge data for the Pine River at East Pine shows a spike in the data in 2016 that is approximately 2 times the average and shows multiple historical events with spikes ranging from 2-3 times the average. A summary of the review efforts can be found in Section 3.0 of this report.

2.2 UTILITIES AND INFRASTRUCTURE

Flooding poses a large threat to utilities and infrastructure in the study area. Many utilities run through the Highway 97 corridor including transmission lines as well as oil and gas pipelines. It is vital to the communities to protect utilities in a flood event to ensure resident safety and reduce the environmental impact of flood events. All utilities that run through the Highway 97 corridor run across the drainages within the study area and should be taken into consideration during the next phases of works.

Moving forward, bridges and culverts should be a main concern with flood mapping and mitigation planning. Recently, 7 bridges have been installed in the Chetwynd fringe to replace culverts; the bridges were designed to meet the changing hydraulic requirements of the drainages in the area and allow large woody debris (LWD) and other debris to pass in a rain event. Along with vehicle bridges, the rail line runs downstream and parallel to Highway 97 creating significant corridor challenges. Residents have expressed their concerns about the rail lines, noting that culverts are often undersized or non-existent posing a significant threat of flooding during high intensity rainfall events.

Residents in the Tomslake area expressed their concerns that during flood events all the bridges in the area become plugged with LWD and compound the flooding issues. The bridges in the Tomslake and Swan Lake areas are potentially undersized for the predicted size of future rainfall and spring runoff events. The trestle rail bridge near Pouce Coupe could be at risk in the event of a significant flood event and should be closely looked at in further studies.

2.3 FIELD RECONNAISSANCE

As part of the flood risk assessment, field reconnaissance was conducted in October 2018 to visit residences and infrastructures that may be impacted by potential future flooding events and not previously worked on in the 2016 mitigation works. The field reconnaissance areas were determined by reviewing the documents that recorded the flooding extents located within the project scope areas during the 2011 and 2016 floods. DWB also reviewed the satellite imagery and Google Earth elevation information to include infrastructure where no reports were available but may be within the potential future flood risk area.

Field reconnaissance included UAV survey and ground site visits. The purpose of UAV survey was to produce an up-to-date aerial imagery of potential future flood risk areas, where the impact of flooding may be significant (i.e. multiple structures are within the flood risk area) and to better understand the zones of flood risk. The aerial imagery produced from the UAV surveys can be found in Appendix E. Ground site visits were conducted at other areas where potential future flood risk could not easily be determined from the use of satellite imagery only, or where potential future flood risk was present for a single infrastructure.

3.0 REVIEW OF HISTORICAL EVENTS

3.1 EVENTS BEFORE 2011

A summary of the historical information on weather events and their impacts, for the period from 1820-2006 is presented in the article, *Flooding and Landslide Events Northern British Columbia 1820-2006* by D. Septer. The record included information of 29 flood events in the PRRD and nearby areas. A summary of some flooding events and the list of recorded dates are presented in Appendix A. Preliminary floodplain mapping was completed for the Peace River by the Ministry of Environment outside of the study area in 1985 but no other mapping reports were identified.

3.2 2011 FLOOD

In mid - May of 2011, a late spring freshet caused the Moberly Lake water level to rise. The damage included the foreshore, yards, boat houses, and summer use properties. Spencer Tuck Park experienced some water above its banks. Heavy rainfall events occurred in the southern Peace Region in 3 different periods of June and July of 2011, which caused significant flooding on the Pine River, several of its tributaries, and nearby areas. A total of 128.5mm of rainfall was observed at Chetwynd from June 22 – 25, 2011 and higher records were shown in other stations too. The rainfall data observed at the Chetwynd and Dawson Creek stations of Environment Canada and the Hudson Hope and Lemoray stations of the BCFS are given in Appendix B. On June 24, 2011 Chetwynd received 72.0mm of rain in a 24 hour period, this is only 3.7mm less than the Canadian Climate Normals monthly average of 75.7mm for June. That same rain event delivered 79.6mm to Hudson Hope and 125.0mm to Lemoray within 24 hours, far exceeding the monthly average for the area.

On June 30, 2011, personnel from Ministry of Forests, Lands, Natural Resource Operations and Rural Development (MFLNROD) and PRRD conducted helicopter tours for carrying out assessment of watercourses and the impact of the rainfall. Watercourses assessed included:

- Wildmare Creek,
- Bissette Creek,
- Boulder Creek,
- Widmark Creek,
- Windrem Creek,
- Pine River,
- Moberly Lake,
- Peace River – Peace Island Park,
- Pingel Creek near Taylor,
- Saskatoon Creek northwest of Dawson Creek,
- Fur Thief Creek,
- Dawson Creek,
- Centurion Creek,
- Pouce Coupe River,
- Klukas Creek at Tomslake,
- Tupper River,
- Swan Lake, and
- Kelly Lake were assessed.

The region experienced flooding, log jams, landslides, debris flows, and bed-load deposits which resulted in damages including:

- damage to residences, businesses and other infrastructure,
- ponding,
- washing away of the railway intersection,
- severe erosion of the creek banks,
- erosion of open faced cut-banks,
- channel braiding,
- scattered wood debris,
- channel avulsion,
- trees mowed over by the mud debris and flood flow,
- washing away of driveway accesses and culverts,
- derailment of locomotives,
- washing away of railway tracks,
- power failure,
- damage to the crops,
- exceeding capacity of the sewer treatment facility,
- surcharging manholes,
- catastrophic debris torrent,
- landslides,
- water and debris overtopping the road,
- significant flooding of farm land,
- rivers changing the course,
- inundating low lying properties, and
- rising of the lake levels above natural boundaries.

Roads in the Peace Region were damaged in over 150 locations and Highway 97 (Pine Pass) was closed due to multiple impacts on June 24, 2011.

After the June 24 weather event the public was encouraged to report their damages. 81 residences called in their damages to the PRRD. Emergency response was conducted mostly by community partners and stakeholders. Between July 7 and July 9 another weather system delivered heavy rains with upwards of 80 to 100mm of rain over mostly the South Peace along the Alberta border. Damage due to this event was limited mainly to areas surrounding waterbodies and there were no significant impacts to transportation routes. Representatives from the Disaster Financial Assistance Program (DFA) briefed with 230 residents from the Chetwynd, Moberly Lake, Hasler Flats, and Willow Flats areas for outlining the eligibility requirements for residents and small businesses and the process to apply for funding under the DFA program. The representatives also explained the Resilience Centre and the services it provides.

Rural residents were reminded that their water and sewer systems may not be working properly and water may be contaminated. Recommendations from Northern Health prompted the PRRD to recommend that all residents use bottled water for drinking and cooking until they could get their water systems tested.

The PRRD Emergency Operations Centre (EOC) conducted in-stream works on Fur Thief Creek to realign the creek, remove debris and to assist in protecting Highway 97 from further damage. The repair works were going on and alternative routes through Alberta to the Peace had to be established due to the closure of the Pine Pass for nearly 2 weeks. As of December 2011, 85% of the repairs were complete and it was planned to continue over the winter and be completed in the summer of 2012. As a result of the damage and the severity, the June 24, 2011 flood was assessed at generally a 1:100 year flood event. Over \$1.3 million in claims had been paid out to the private sector, home and farm owners. Estimated local government claims are in the range of \$2 million. Conference calls and meetings were also held on an as needed basis with stakeholders- MOT, BC Hydro, Telus, engineering consultants, River forecast consultant, Red Cross, disaster relief committee and Northern Health. The Red Cross Joint Resiliency Centre was organized by the Chetwynd Emergency Program Coordinator and the PRRD Community Services Coordinator. Operated by Red Cross volunteers, the Centre provided information, relief and recovery services and support to affected families. As of July 27, 2011 the Red Cross reported that 64 people registered at the Joint Resiliency Centre of which many identified a need for psychosocial/emotional support, clean up assistance, and rebuilding/construction assistance. A Disaster Response Committee was formed that included representatives from PEP, PRRD, Chetwynd, Mennonite Disaster Services, the local and provincial Salvation Army, Christian Reformed World Relief Committee, Samaritan's Purse, Northern Health, and Indian and Northern Affairs Canada.

3.3 2016 FLOOD

In June of 2016, additional flooding events impacted the Pine Pass / Peace Regions including the following three areas:

- Chetwynd Fringe, south and west along the Highway 97 corridor,
- Moberly Lake, and
- Pouce Coupe and surrounding area.

The rainfall data observed at the Chetwynd and Dawson Creek stations of Environment Canada and the Hudson Hope and Lemoray stations of the BCFS are given in Appendix B. On June 15, 2016 Chetwynd received 86.8mm of rain in a 24 hour period, exceeding the Canadian Climate Normal of 75.7mm total precipitation for the month of June. In the same 24 hour period on June 15, 2016, Dawson Creek received 89.8mm of rain far exceeding the total monthly average of 67.4mm calculated by Canadian Climate Normal.

DWB carried out assessments to gather information and make recommendations for rehabilitation of the stream channels, the residences impacted by the events, and access routes except Highway 97 right of way following the events. The scope of work included making recommendations for remediation works to reduce flooding risks to residences only as directed by the PRRD and included impacts on and surrounding eleven creeks.

DWB's site visit along with information available from different sources revealed that the creeks had insufficient capacity to handle the flood volumes that contributed to stream destabilization. Heavy bedload and large woody debris (LWD) constituted the majority of the flood risks and the highway structures did not have sufficient conveyance capacity especially with bedload and debris sources upstream. Severe erosion of the banks of the creeks and massive deposition of sediment from the creeks on the floodplains also occurred. The streams are expected to show morphological changes including widening and lateral movement, creation of new channels, and changes in deposition and erosion zones. Many residences, roads, access roads, highways, parks and recreation areas, infrastructure and one school were impacted by the 2016 flood events within the study area.

Some prescriptions to provide stability, reduce risks to public safety and infrastructure, and reduce downstream impacts through removal of debris, widening channels and recontouring banks, bedload removal, and bank and crossing protection were recommended. Due to the massive and virtually endless supply of LWD, bedload gravels and boulders, these problems can neither be controlled nor eliminated but risk may be reduced to some extent. Based on the recommendations of DWB, PRRD received funding from the BC government and again retained DWB to propose a work plan in consultation with the Ministry of Transportation and Infrastructure (MOTI) and landowners. Construction / rehabilitation works in all eleven creeks in Chetwynd, Moberly Lake, and Pouce Coupe areas started in December 2016 and completed in March 2017.

4.0 FIELD RECONNAISSANCE

As part of the flood risk assessment, DWB completed a thorough desktop study that was backed up with a field reconnaissance. The field reconnaissance included ground assessments, completed both in 2017 and 2018, and drone surveys completed both in 2017 and 2018. The ground assessments were performed to better understand which areas were affected the most and the drone survey was used to capture images of those areas that were considered potential flood risk areas after the desktop study and ground assessment was completed.

First Nations land falls within the study area around Moberly Lake. Both the Moberly Lake First Nations Band and the Saulteau First Nations Band will be consulted with and involved in further stages of the project including further floodplain mapping, data collection, and mitigation planning.

4.1 GROUND ASSESSMENT

Ground assessments were continued in 2018 after an overview assessment was completed in the office to determine areas that required further assessment. These areas included those not covered by works in 2017 along with additional sites identified outside of the 2017 area scope with potential flood risk. The site visits were conducted in person and a summary of the work is included in Appendix D. The shaded entries in the Master Damages list provided in Appendix D are in areas outside the scope of the assessment, the names have been removed from all entries for privacy purposes. The summary tables include the observations and information gained by the site visits.

4.2 DRONE SURVEY

In 2018, a plan was developed including formulating a list of areas with identified potential flood risk. The list of risk areas were assessed in the office using available imagery. Those areas accessible for UAV imagery capture were visited and flown by our qualified UAV pilot. Images were taken with a DJI Phantom 4 PRO and were Geolocated using the onboard GPS. All images were processed and combined into orthomosaic images using PIX4D Mapper PRO. 3D models of the surveyed areas are possible but were not produced for this exercise. As a follow up from the works in 2016/2017, some areas where works were completed, aerial surveys were done in 2017 to gather data to submit to agencies. The drone surveys completed in 2017 were done on areas that were deemed high importance, requiring immediate works. The areas were flown after construction works were completed.

The following areas were flown in June of 2017:

Areas Flown June 2017		
Latitude	Longitude	Area

55° 42' 36"	-120° 07' 31"	Bissette Creek
55° 36' 43"	-121° 57' 51"	Boulder Creek
55° 36' 49"	-121° 53' 04"	Commotion Creek
55° 38' 49"	-122° 10' 29"	Fur Thief Creek
55° 50' 02"	-121° 48' 45"	La Bleu Creek
55° 50' 06"	-121° 42' 59"	Medicine Woman Creek
55° 42' 47"	-120° 07' 18"	Pouce Coupe River
55° 48' 44"	-121° 45' 01"	Pys Creek
55° 37' 05"	-121° 49' 38"	Stone Creek
55° 40' 05"	-121° 43' 30"	Wildmare Creek

The following areas were flown in 2018 as part of the 2018 Flood risk assessment and UBCM CEPF funding application:

Areas Flown June 2017		
Latitude	Longitude	Area
55° 48' 42"	-121° 47' 05"	S Moberly 10Km
55° 48' 43"	-121° 46' 21"	S Moberly 9.5km
55° 49' 03"	-121° 44' 50"	S Moberly (Yips Subdivision)
55° 48' 44"	-121° 43' 20"	S Moberly (Benson Creek)
55° 48' 38"	-121° 42' 36"	S Moberly(west of Park)
55° 49' 52"	-121° 43' 13"	N Moberly (Medicine Woman)
55° 48' 36"	-121° 41' 08"	S Moberly (East of Park)
55° 49' 55"	-121° 44' 52"	N Moberly (Caroline St)
55° 49' 53"	-121° 45' 49"	N Moberly (Holiday Beach)
55° 49' 34"	-121° 49' 31"	N Moberly (Cove Lane)
55° 40' 06"	-121° 43' 58"	Wildmare 01
55° 40' 02"	-121° 42' 35"	Wildmare 02
55° 40' 02"	-121° 42' 07"	Wildmare 03
55° 36' 30"	-121° 58' 11"	Bolder Creek(Hassler)
55° 49' 44"	-121° 47' 58"	N Moberly (Le Bleu)
55° 49' 55"	-121° 45' 13"	N Moberly (Caroline St)

55° 50' 00"	-121° 43' 40"	N Moberly (Centennial West)
55° 42' 36"	-120° 08' 46"	Upper Bissette above trestle (Pouce)
55° 42' 37"	-120° 08' 33"	Upper Bissette below trestle (Pouce)
55° 31' 06"	-120° 01' 37"	Swan Lake Sub
55° 30' 46"	-120° 01' 33"	Tupper Village Way
55° 30' 36"	-120° 01' 36"	Tupper Village Sub
55° 30' 30"	-120° 01' 40"	RC Campground Rd

5.0 PUBLIC MEETING INFORMATION

Public information meetings were held in Chetwynd on January 16th, 2019, and in Tomslake on January 17th, 2019. These meetings were held to help inform the public of process that the PRRD has undertaken to submit an application for funding through the UBCM CEPF with the help of DWB. Discussions with all attendees took place for several hours where the preliminary maps were discussed and attendees concerns and comments were noted.

Feedback forms were given out at each of the meetings to allow the public to express their concerns and have greater input on the project. The response to the public meetings was positive overall. Some of the public comments and concerns include but are not limited to the comments summarized below;

- The 2011 and 2016 flood events were the worst events that the areas within the study had ever seen.

The public indicated that concern should be given to the following;

- Implementation of mitigation plans put in place that could include but are not limited to
 - Plans to remove large woody debris from the watersheds,
 - Alternate route plans,
 - Beaver management plans, and
 - Plans to widen bridges in the affected areas.
- Implementation of legislation and regulations to control the construction of structures in potential flood risk areas.
- Implementation of legislation to allow residents to control the weir at the outlet to Swan Lake.
- Protection and update of rail lines and utilities in the area.
- Using local equipment during clean-up efforts of future flood damages rather than bringing in equipment from elsewhere.

6.0 FLOOD RISK ASSESSMENT

6.1 FLOOD HAZARD IDENTIFICATION

As part of the project the potential flood hazards in the areas of concern were identified. These flood hazards were identified based on the findings of the historical flood event review, and field

reconnaissance. The flood hazards summary within the study area include but may not be limited to those listed below.

- Type of flood hazard – riverine flooding including high water and erosion by overland flooding due to high intensity rainfall and/or snow melt.
- Type of flood hazard – Lake flooding including high water on floodplains due to increased volume of water entering lakes from high intensity rainfall and/or snow melt.
- Landslide may develop due to heavy rainfall saturating the soil. Also, saturated soil on banks may be more vulnerable to erosion.
- Raised groundwater table may force springs to the surface and cause flooding (as seen on Campbell Rd properties in Chetwynd).
- Watershed assessment conducted by DWB in 2016 for 11 creeks in the assessment area found the upper reaches of the creeks contained abundant source of debris and bedload that could be mobilized by flood water and obstruct the channel.
- Driveway, road, and highway crossings that are located on floodplains or have the potential to constrict or cause backflow that may increase the flood impacts.

6.2 EVENT FOR BASIS OF FLOOD RISK ASSESSMENT

The 2011 and 2016 flood events that caused significant damage to the study area were used as a basis for the flood risk assessment. Based on the 2011 and 2016 events along with historical data, the flood risk event used for the flood risk assessment is a 1-in-100 year return period flood. From a 1-in-100 year risk event the following conclusions can be made:

- **The event used as a basis of the assessment** is a 1-in-100-year return period flood. The event is based on the 2011 and 2016 floods which were both considered in the range of 100-year floods. The risk event is likely to occur between April to July during the freshet. The magnitude of the risk event is a 1-in-100-year return period flood. However, 1-in-100-year flood events have occurred in 1987, 2001, 2011, and 2016; the number of years between these events were 14, 10, and 5. Therefore the time period for this risk event to occur may be approximately 10 years.
- **The area impacted** by the risk event included the Chetwynd Fringe (valley along BC Highway 97 west to Willow Flats and East to Chetwynd) not including the Town of Chetwynd, Moberly Lake, and Pouce Coupe / Tomslake. Municipalities affected were the Village of Pouce Coupe and District of Chetwynd. Additional rural communities in the affected area were: Hasler Flats, Tomslake, and Swan Lake.
- **Flooding in the defined geographic areas** were caused by heavy rains with addition of snow pack melting. Residences along the lake shore and multiple creeks were directly affected. Transportation was disrupted with highways, roadways, and private access roads washed out. There are several camp grounds that were inundated and one significantly destroyed at Bissett Creek at the confluence of the Pouce Coupe River. Two other parks are within the geographic area including Moberly Lake Provincial Park and Swan Lake Provincial Park.
- **The cause of the risk events** involves several mechanisms and includes but not limited to the following:
 - High stream flow in the creeks that occurs during freshet in May and June when temperature rises and the snow pack melts. The 2011 and 2016 flood events occurred at this time when the freshet flow from snow pack melting was combined with a 1-in-100-year rainfall event.

- In May 2017, freshet flows caused the Windrem Creek to wash out a road in the District of Chetwynd. The BC River Forecast Centre issued a Flood Watch in the South Peace Region as a prolonged rain event was forecasted in the area.
- In April 2018, snow pack melting caused flooding in Dawson Creek (outside but approximate to the study area). Highway 97 between Dawson Creek and Chetwynd was reduced to single lane traffic due to pooling water. In July 2018, a Flood Warning was issued for Pouce Coupe River due to a flood, which was rated between a 100 and 200 year return period observed after localized storms.
- **Climate change impacts** to the region are considerable and continue to increase flood risk as noted in the increased frequency of the events and discussed in section 6.4.

6.3 REVIEW OF RESPONDERS TO A FLOOD EVENT

Local authorities including PRRD, District of Chetwynd, and Village of Pouce Coupe provide emergency response to local residences. The general response from public meetings indicated that residents were happy with the emergency response efforts from local authorities. Residents commended the local emergency response team, stating that they had a more prompt response to the 2016 flood event than the 2011 event. This suggests that the local authorities are learning from previous floods and looking to better their response to potential future flood events.

Multiple provincial government authorities provide assistance to the local authorities. The Emergency Management BC (EMBC) will coordinate response activities between the provincial authorities and local authorities. The Ministry of Transportation and Infrastructure will respond to provincial highways and roadways that are disrupted by flood. The Ministry of Forests, Lands, Natural Resource Operations & Rural Development oversees the flood hazard investigation during flooding response. The Ministry of Environment will respond if any spill of contaminants is discovered.

6.4 LIKELIHOOD ASSESSMENT AND CLIMATE CHANGE

Meteorological and seasonal conditions that have impacted the region are described in Section 6.2. Of greatest concern in recent years is the climate change impacts that are being realized in the region. From the Pacific Climate Impact Consortium and the Plan2Adapt model, it is projected that climate change in the next 30 years for this Peace region include increased annual precipitation in the range of 25% along with up to 20% increase in snowfall into 2080. Shorter time frame projections are lower but similar in magnitude.

Along with the increase in the potential amount of rain and snow expected to fall on the region in the future, pine beetle infestation has caused an abundance of large woody debris (LWD) and an increased amount of deforestation in the area. The increased amount of LWD in streams poses a potential flood risk for blocking culverts and preventing water from running off in future flood events. Large areas of deforestation causes water to runoff the catchment areas at a higher rate, reaching the streams faster and causing higher peaks in the volume of water running in the streams. This increases the likelihood of flooding in the area.

6.5 MAPPING (PRELIMINARY)

Limited mapping has been completed, only identifying potential areas of potential flood risk. Mapping is preliminary as no modelling or floodplain mapping was completed. Mapping was based on historical information, site reconnaissance, and public meeting input.

6.6 VULNERABILITY AND CHARACTERISTICS OF AFFECTED AREAS

The defined geographic area includes three main areas located within the South Peace Region of the Peace River Regional District in northeastern British Columbia. The three main areas are: Chetwynd Fringe (valley along BC Highway 97 west to Willow Flats and East to Chetwynd), Moberly Lake, and Pouce Coupe / Tomslake. Village of Pouce Coupe, District of Chetwynd, and multiple rural communities are located within the area. Moberly Lake Provincial Park and Swan Lake Provincial Park are within the defined geographic area.

According to the 2016 Census, the population of Peace River Electoral Area D and E that included the defined geographic area was 5920 and 2949 respectively. The municipalities' populations were 2503 for Chetwynd and 792 for Pouce Coupe. The total population in the defined geographic area was 12164. There are no significant population variances. The majority of the population lives in the defined areas of Chetwynd and Pouce Coupe and includes the highest population densities.

Main economic areas of interest: agriculture, retail, tourism, forestry, and oil and gas.

Residences living along the creeks and lakes with flooding risk within the assessment area were mostly located on potential floodplains where the creek slope is flat and bedload deposition occurs. These residences are identified as vulnerable populations. Compared to the rest of the assessment area, Chetwynd and Pouce Coupe have a relatively high degree of urbanization with higher population density as well as proximity to emergency service. Some areas west of Chetwynd on Highway 97 are not covered in cellphone service range. Many rural communities rely on one road/highway for access and evacuation.

Flooding causes significant economic loss by impacting the main industries in the area including agriculture, oil and gas, mining. Washouts of highways and roads disrupt normal operation of the main industries. The access highway through these communities provides the only corridor for the movement of goods and workers from the central interior regions of Fraser- Fort George Regional District to the northern regions through BC. Several pipeline routes already exist through these regions.

6.7 COMMUNITY RESILIENCE

The residents in and around Chetwynd including the Highway 97 corridor, Moberly Lake, and Pouce Coupe, Tomslake and Swan Lake have shown a great deal of resiliency in the past and continue to demonstrate their ability to recover, rebuild, and learn after the devastating effects of the floods.

New residents at Moberly Lake have been consulting with neighbours and residents that have been there through the floods to ensure that new homes are built above the previous floods high water marks. Existing residents in Chetwynd and Moberly Lake are concerned about alternative routes in and out of Chetwynd during flood events and have proposed routes through to Tumbler Ridge.

At Swan lake, residents are monitoring the outlet weir to the lake on their own time. When the weir is not frozen over the residents monitor it weekly and during freshet they monitor it daily. At their own cost residents have retained Environmental Dynamics Inc. (EDI) to perform an assessment of Swan Lake to determine the condition/state of the lake. During the 2016 flood events, which many residents stated was the worst ever, equipment was relocated by the volunteer fire department to both ends of the lake at the onset of the flood, before it was too late. The relocated equipment played a vital role in protecting the residents around the lake. Residents reported that the lake rose 6 feet on the night of June 16-17, 2016.

Residents throughout the Peace River Regional District are being proactive, looking for ways to mitigate the flood effects and better prepare for potential flood events in the future. Residents want to see debris mitigation plans put into place, alternative access routes planned and maintained in the event of washouts, bridge structures widened in areas where the amount of debris is high and where the expected volume of water exceeds current capacities, and any other mitigation actions that may protect the area.

7.0 CONCLUSION

The areas surrounding the Chetwynd Fringe, Moberly Lake, and Pouce Coupe/Tomslake within the Peace River Regional District have experienced several severe flooding events. Most recently, the 2011 and 2016 flood events caused significant damage to private, corporate and public infrastructure in the area. Highway 97 and Highway 27 were both affected by the events and at some points were shut down due to damage from flooding. These flood events not only directly affect the health and safety of the local residences, they affect property, businesses, and infrastructure. Significant monies has been spent in the region as part of flood relief, repair and mitigation works.

Currently, there is no floodplain mapping or mitigation planning done in the study area. Due to the severity of the events that the Peace River Regional District has seen in the past it is crucial to create thorough floodplain mapping and develop mitigation plans to ensure the health and safety of residents and protect properties and infrastructure from possible damage in potential future flood events. The UBCM CEPF funding is intended to assist government bodies to develop flood maps that address flood risks identified in the flood risk assessment. Creating these flood maps may include the acquisition of elevation data and mapping, plotting of historical flood data and inundation mapping, hydrologic and hydraulic information to calculate flood elevations for selected flood events, geospatial mapping and modelling activities, and identifying locations of structures, people and assets that might be affected by flooding.

Through an extensive review of historical data and a thorough field reconnaissance DWB was able to complete a flood risk assessment on the area in order to submit a funding application through UBCM CEPF for further flood mapping and mitigation planning. As part of the field reconnaissance UAV survey was performed on potential flood risk areas (as defined in section 6.5 of this report). The UAV survey data was used to create preliminary maps and further assess potential hazards areas. The survey data can be used to create 3D images of the area including all elevation data and can be used to assist in further flood mapping efforts. DWB worked identifying and reviewing the potential flood hazards, defining a risk event used as the basis of assessment for future flooding, reviewing responders of the previous events, and defining the characteristics of the area by flooding and meteorological and seasonal conditions. DWB completed a NDMP Risk Assessment Information Template (RAIT), and created preliminary maps. This flood risk assessment can be used to assist in developing planning and mapping tools to help mitigate future flood events. Public consultation with the local residents is invaluable to determining the areas of potential flood risk and understanding the extent of damages that have occurred in the past. This information is vital for moving forward with floodplain mapping, and mitigation planning to ensure the health and safety of the residents and the infrastructure in the area is protected.

There multiple potential flood risk areas in the region and more study needs to be done to understand the details including population assets. The Union of BC Municipalities - Community Emergency Preparedness Fund (UBCM CEPF) has funding available for flood mapping, and mitigation planning, tools that can be used to reduce the impact of future flood events. DWB has written an application for funding through the UBCM CEPF as part of the works with the PRRD including a work plan and cost estimate, Peace River Regional District Flood Mapping Development – Work Plan (DWB, 2019).

8.0 RECOMMENDATIONS AND NEXT STEPS

The following list provides the recommendations that are considered essential for the region and include but are not limited to:

- PRRD should have regulations to limit or control development in the floodplains.
- Develop flood risk and community plans including make changes to the response plans to ensure they account for the results.
- Watershed study to examine the debris effects.
- Land use regulations especially Chetwynd corridor and upper reaches of the creeks.
- Development of acceptable adaptation tools and models for prediction and standards that should be followed in the region and adopted for the purposes of planning and design.
- Determination of appropriate flood frequency for design and development – Q_{100} or Q_{200} or whatever is deemed appropriate.
- Recovery planning for residents by PRRD should be formulated. Policy should be developed for what can be done to help post flooding and post event with better warning systems for flood risk including evacuation order.
- More hydrometric stations including policy or agreements with MoTI or MFLNRORD.
- The funding will be used to address the flood risk as identified by a flood risk assessment. This will include:
 - Acquisition of elevation data and mapping,
 - Hydrologic and hydraulic information to calculate flood elevation for selected flood events,
 - Geospatial, mapping and modelling activities,
 - Identifying locations of structures, people, and assets that might be affected by flooding.
- First Nations consultation will be a major part of the next phases of the project, around Moberly Lake the two First Nations groups that will be involved with the consultation are Moberly Lake First Nations and the Saulneau First Nations Band.
- Continued Public Consultation.
- Floodplain Mapping.
- Mitigation Planning.

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Appendix A - Historical Review (D. Septer)

Appendix A – Historical Review (from D. Septer)

No.	Date	Event type	Precipitation	Descriptions
1	May-June 1894	Spring runoff flooding	Not applicable	<p>The spring of 1894 was cold and wet. Towards the end of May the weather turned hot and sultry. Rapid snowmelt caused province-wide flooding. The “Great Flood of 1894” in the Northwest continued for 57 days (The Daily Alaska Empire, May 29, 1948).</p> <p>In a letter to the Omineca Herald and Terrace News, long-time Terrace resident called the “Great Flood of 1894” being less than the 1936 flood. However, according to another resident, the 1894 flood was much bigger than the flood of 1936: “Our high-water of 1936 was a baby in comparison. There has never been a high- water to equal it since.”</p>
2	March 25, 1939	Ice jam flooding	Not applicable	<p>At the end of March, extreme mild weather throughout the central Interior caused a sudden breakup. The Fraser River opened up about 10 days earlier than usual. Warm temperatures and heavy rain in the mountains caused river ice to break up and ice jams to form. Quesnel recorded temperatures ranging above 60° F (15.6° C). High water conditions prevailed due to ice jams. Some loss of mining equipment was reported.</p> <p>Early on March 25 following several days of rain and chinook winds, ice jams caused the Murray River to suddenly overflow its banks at East Pine, 27 mi. (43.2 km) west of Dawson Creek. Residents of the flooded area were bewildered with the speed with which the flood occurred. Survivors described the flood as, “a great wall of ice that suddenly swept on the houses.”</p> <p>Floodwaters swept away a house with eight occupants asleep. An estimated 25 people escaped and one family was marooned on the far side of the Murray River. On March 26, floodwaters covered 20-30 mi. (32-48 km) of low-lying land along the banks of the Pine and Murray rivers threatening the community of East Pine. Ice jams in the river were reported to be 60 to 70 ft. (18 to 21m) high. On March 27, floodwaters receded after taking a total of nine lives.</p>
3	Winter 1942-1943	Icejam flooding?	Not applicable.	<p>During the winter, ice took out part of the temporary bridge over the Peace River at Taylor Flats just south of Fort St. John (Cohen 1992).</p>
4	May 25-June 10 1948	Spring runoff flooding	Not applicable	<p>The 1948 spring runoff due to hot weather caused severe flood conditions in British Columbia, Washington, Oregon, Montana, Idaho, and elsewhere. On May 31, Premier Byron Johnson declared a state of emergency. Military authorities were given the power to conscript citizens and requisition transport. By June 2, some 9,000 people in British Columbia were homeless as a result of flooding. Four thousand Canadian soldiers were involved in the rescue operations. The Fraser River inundated parts of Quesnel and Prince George. The Skeena and Bulkley rivers caused the “worst flood since ’36.” (The Interior News, May 27, 1948).</p> <p>A late spring and the previous week’s heat wave caused the “highest water ever recorded” on the Peace River. Herbie Taylor, “first white man on Taylor Flat and the oldest old-timer in Peace River” in his entire experience had not seen high water on the Peace like this year’s.</p> <p>The Peace River rose 2 ft. (60 cm) in 24 hours flowing 4-5 ft. (1.2-1.5 m) over the cofferdam. Floodwaters caused the loss of livestock. A dozen or more families were flooded out. Down from the bridge on the other side, a family was forced to leave their home. A washout occurred on Hudson’s Hope road at the Halfway Bridge. Maximum temperatures recorded at Fort St James on May 20, 21, 24, 29 and 30, respectively, were 81.8° F (27.7° C), 84° F (28.9° C), 82.2° F (27.9° C), 83.2° F (28.4° C) and 84.5° F (29.2° C).</p>
5	July 12-14, 1956	Flooding	Not available	<p>On July 12-13, sudden floods caused washouts of culverts and bridges along a 300-mi (480 km) stretch of the Alaska Highway. The washouts left at least 20 crews from oil companies stranded in the Peace River area.</p> <p>On July 14, about 500 tourists were stranded in Dawson Creek. Additional flood damage reported along the Alaska Highway would delay reopening of the highway till July 17.</p>
6	May 18-20, 1957	Spring runoff flooding	Not available	<p>Around May 19, a 200-ft. (60 m) stretch of newly built rail line toppled into the Peace River near Taylor. Apparently undermined by high water, a 100 ac. (40 ha) area of land collapsed, destroying a section of grade and blocking the road for a distance of 1,000 ft. (300 m). According to construction officials, the line could not be fully restored until the ground would have settled.</p>
7	October 16, 1957	Severe scour	Not applicable	<p>On October 16, the north end of the Peace River bridge at Taylor Flats just south of Fort St. John collapsed. The northern span of the multi-million dollar bridge tore from its moorings and crashed into the river. The centre portion of the collapsed span was</p>

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No.	Date	Event type	Precipitation	Descriptions
				badly warped out of shape. A sag in the 930-ft. centre span of the two-lane bridge aroused fears that it also could drop into the Peace River. Possible causes were given as a shift in the shale bed of the river or due to the intensive industrial traffic. The oil industry was one of those most acutely affected by the bridge's collapse. Earlier in 1957, a water line, which was strung underneath the structure, ruptured sending high-pressure water into the river. This scoured out gravel once again from beneath the north abutment.
8	June 8-15, 1964	Spring runoff flooding	Not applicable	According to BC Hydro's co-chairman, the 1964 flood on the Peace River was the "worst in history" and was causing concern for construction of the Portage Mountain hydro dam at Hudson's Hope. The river had reached 295,000 cfs (8,354 m ³ /s) well above the previous record of 267,000 cfs (7,561 m ³ /s) in 1922. On June 11, the water level at the cofferdam that held back the Peace River from the dry riverbed where the dam was being constructed rose 1.5 ft. (45 cm). There was still 8.5 ft. (2.55 m) to go before the water would reach the top of the cofferdam. If it would become necessary, another 5 ft. (1.5 m) could quickly be added. Three tunnels diverted the river from the construction area. The capacity of the tunnels was 320,000 cfs (9,062 m ³ /s).
9	February 3, 1970	Icejam flooding	Not applicable	On February 3, warm weather, coupled with an icejam caused a sharp increase in the level of the Peace River at Taylor. An icejam below Clayburst caused the Peace River to back up for 22 mi. (35.2 km). Residents of South Taylor, 40 mi. (64 km) northwest of Dawson Creek, reported an 18-ft. (5.4 m) rise in the Peace River. According to the district superintendent for the ministry of highways at Fort St. John, the real rise had been closer to only 5 ft. (1.5 m). Overnight February 3-4, the river dropped 2 ft. (60 cm) from its crest but not before it had damaged Peace Island Park in this unorganised territory on the south bank of the Peace. The drop reduced the flood threat to the community. A South Taylor hotel operator and president of the Taylor Chamber of Commerce, stated that a rise of another 5 ft. (1.5 m) would flood the flatland area. Concerned were 150 residents and 110 pupils in an elementary school 250 yd. (225 m) from the riverbank. According to the school principal, the river appeared to have risen 14 ft. (4.2 m) in his area and on February 3 was about 2.5 ft. (75 cm) from overflowing. The sudden rise was attributed to a massive icejam stretching 20 mi. (32 km) downstream to the Alberta border. On February 4, snowdrifts 3-4 ft. (0.9-1.2 m) high blocked many roads, trapping local residents. The hardest hit districts were Fellers Heights, Rolla, Progress and Kilkerran. Winds were blowing at 30 mph (48 km/h) with gusts to 50 mph (80 km/h).
10	July 11-12, 1971	Flooding	Not available	On July 11, heavy rain in the Peace River country caused a section of track on the PGE line near Chetwynd to wash out. The line was blocked for approximately 30 hours. On the morning of July 12, Dawson Creek rose to a high level. Both ends of the rotary bridge from the parking lot to the artificial lake flooded.
11	June 12-16, 1972	Spring runoff flooding	Not applicable	On June 13 north of Prince George, Highway 97 closed after the Pine River washed out the road near Pine Pass. On June 14, after crews built a detour around the washout the highway reopened. At Peace River, the Peace River crested on June 14 at 6 p.m. after having forced 60 families out of their homes. One business firm was also evacuated.
12	May 26, 1973	Clay slump	Not available	On May 26 west of Fort St. John, a clay slump dammed the Peace River some 20 mi. (32 km) upstream from Fort St. John for about 12 hours. On May 27, a lake began to form after the embankment collapsed and blocked the Peace River. The water rose 30-40 ft. (9-12 m) creating a lake 20 mi. (32 km) long before starting to make channels through the slide on the afternoon of May 27. No houses were endangered in the sparsely populated region. At one point on May 27, a family-owned 10,000-ac. (4,000 ha) ranch, on the north bank of the Peace River with the ranch house directly across the river from the slide, was threatened. The rancher said he was concerned about 200 ac. (80 ha.) of bottomland and considered asking officials to "turn off" the Peace River's safety valve at the W.A.C. Bennett Dam, 35 mi. (56 km) upstream from the slide. By nightfall, it was estimated that 50% of the water was getting through. The danger of the dam bursting and flooding areas downstream passed at that time. A combination of factors probably averted a more serious disaster. The heavy, deep clay soil of

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No.	Date	Event type	Precipitation	Descriptions
				<p>the region, ideal for grain, contains few rocks. After ending up in the middle of the Peace River, it quickly turned into mud allowing to quickly forming new channels. Also, before the completion of the W.A.C. Bennett Dam, the flow of the Peace River at runoff time would have been much higher. Now with BC Hydro's generators in operation, allows for an even, lower flow.</p> <p>The Attachie Slide involved over 24 million m³ of sediment. According to an RCMP officer at nearby Hudson's Hope, the slide "looked a lot like the Hope Slide (on the Hope-Princeton highway)." He said it took away a 2,000-ft. (600 m) slice of the riverbank at the junction of the Peace and Halfway rivers. The force of the slide hurled trees across the river, a distance of about 500 yd. (450 m).</p>
13	June 13-25, 1974	Spring runoff flooding	Not applicable	<p>On June 13, about 1,500 ft. (450 m) of rail grade slipped downhill 12 mi. (19.2 km) south of Fort St. John. The landslide also dragged along a 125-ton \$450,000 locomotive. The massive landslide came down about 0.5 mi. (800 m) east of the bridge across the Peace River. The four-man crew on the engine-and-caboose switching train escaped injury in the derailment. Debris from the hillside spilled into the river.</p> <p>The rail link to the northern Peace River region was expected to be closed for two weeks but by nightfall the gap kept widening. Railway officials later noted that it might take 2.5 months to rebuild the track along Peace River Hill some 400 ft. (120 m) above the river level. The problem facing the railway was how and where to relocate the line, which made a long switchback curve to the top of the hill 800 ft. (240 m) above the gorge. According to businessmen in Fort St. John, the cut in the line would cripple lumber and sulphur shipments to the south.</p>
14	July 15-18, 1974	Spring runoff flooding	Dease Lake (34.5 mm/1 day), July 16, 1974	<p>In the middle of July, torrential rain and late melting snow caused floods and washouts in northwest and northern British Columbia. There had been exceptionally heavy snowfalls the previous winter. The following summer was cool, and mountain snowmelt slow. Warm weather arrived in early July, to be followed by exceptionally heavy rainfall starting on July 15.</p> <p>The Alaska Highway experienced some of the worst flooding in its history. Within a matter of hours, dozens of miles of the highway had been rendered impassable. The storm continued, interrupting telecommunications and stranding hundreds of travellers. Of the people stranded in the washed-out sections, 50 were at Summit Lake, 50 at Toad River Lodge, others at isolated sites, and the largest group, 175 trapped at Muncho Lake. The Provincial Emergency Planning Group, assisted by the Royal Canadian Mounted Police, flew food and other supplies (as well as a social worker and a public health nurse to the group at Muncho Lake) to the stranded travellers.</p> <p>The Muncho Lake area was turned into an island, as the raging water cut off the highway at both ends and brought the level of the lake to unheard of levels. Miles of the highway simply disappeared; at Muncho Lake, Trout River, and elsewhere in the district. In total, 130 miles of the highway were rendered impassable. The Racing River bridge, its foundations eaten away by the raging waters, lost one of its approach spans. To complicate matters further, the Stewart- Cassiar Road, an alternate road access to the outside, washed out in the same storm, stranding the entire Northwest and adding to the urgent need to reopen the Alaska Highway.</p> <p>On July 18, the provincial government chartered a plane to fly about 2,600 lbs. (1,180 kg) of food into Muncho Lake. Here at a lodge, 150 mi. (240 km) northwest of Nelson, about 150 tourists were stuck. Some food was flown by helicopter to some 50 other tourists stranded at lodges and campsites between Muncho Lake-Racing River, about 40 mi. (64 km) south. Here, a 40-ft. (12 m) span bridge was cut by floodwaters. There were also six quarter-mile (400 m) washouts on a 30-mi. (48 km) stretch north of Muncho Lake. At Mile 479, about 1,000 yd. (900 m) of the Alaska Highway washed out. An estimated 340 telephone poles went down along the highway north of Fort Nelson.</p>
15	July 26-27, 1975	Flooding and mudslide	Not available	<p>On July 26 and 27, washouts forced the closure of the Rocky Mountain section of the Alaska Highway. Following heavy rain on July 26-27, a section of the Alaska Highway closed after it washed out in about 14 places and three bridges were knocked out. Climatically, it was a replay of the previous year, another summer of exceptionally heavy rain, when a series of washouts stranded hundreds of travellers in the same area. The rapidity and severity of the runoff, this year, caused greatest damage to</p>

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No.	Date	Event type	Precipitation	Descriptions
				<p>bridges and proportionally less to the road surface¹. For at least six days, the Stewart-Cassiar highway was the only road link between British Columbia and the Yukon.</p> <p>At Mile 32 between Dawson Creek-Fort St. John, travel was also restricted to one-lane after a mudslide covered the road. About 800 people were stranded in Fort Nelson and 80 were trapped between downed bridges along the 355-mi. (568 km) stretch of highway between Watson Lake-Fort Nelson. By July 3, there was still the possibility that some people might be trapped between Mile 410-437, including the stretch where the Racing River bridge was still out.</p> <p>The bridge repairs took the longest. Bridges at MacDonald Creek, Racing River, and Toad River were severely damaged, ensuring travel delays and considerable cost in bringing the highway back into service. Work started on the Racing River bridge on July 5 but was not finished until July 14. Still the washouts did not have the same crippling effect as the previous year's. Most travellers were able to return to Watson Lake or Fort Nelson, where they waited for work to be completed. As well, the Stewart-Cassiar Road remained open, providing travellers with a viable route in and out of the territory.</p> <p>By July 3, the highway reopened from Mile 410 south to Fort Nelson and was open between Mile 437 to Watson Lake "on emergency basis". Emergency repairs were still being made to portions of the highway. When the Alaska Highway reopened, initially to cars and small trucks, on July 8, the convoy south from Watson Lake comprised of only 40 vehicles. The expedition from Fort Nelson, escorted by RCMP cruisers, included 310 cars and vans, 303 campers, 120 towed trailers, 93 motor homes, and a few other vehicles. Repair work was not completed by winter freeze-up, and some of the bridgework continued through the winter. By May 1976, the highway was back to its pre-flood condition.</p>
16	August 25, 1976	Mudslide	Not applicable	<p>On August 21, a 0.25-mi. (400 m) long mudslide along 95-Mile Road blocked a dead-end road at the Halfway River, 13 mi. (20.8 km) west of the Alaska Highway and 45 mi. (72 km) northwest of Fort St. John. Rainfall totaling more than 40 mm during the previous week loosened over 1 million yd. (764,600 m³) of mud. A total of 75 people, including 25 families on the Halfway Indian Reserve and two ranch families, were isolated. The highways department repaired an abandoned oil drilling road to by-pass the slide. The continuous rain played havoc with local transportation in the Peace River area with its many dirt roads.</p>
17	December 1976	Slide potential	Not applicable	<p>On December 3, the BC Hydro chairman reported that an enormous slide, 80 % bigger than the Downie slide on the Columbia River, was creeping into the reservoir behind the W.A.C. Bennett Dam. BC Hydro engineers noted that "safety cannot be guaranteed." According to a spokesman for the Peace Valley Environmental Association from Fort St. John and speaking for concerned Peace River farmers, the Brantham Ridge slide, located above a failure zone 20 mi. (32 km) upstream from the dam, contains an estimated 1.8 billion cubic yards (1.38 billion m³) of material².</p> <p>He said that the situation was particularly critical in view of BC Hydro's intention to divert the McGregor River from the Fraser drainage system to flow north into 410,000-ac. (164,000 ha) Williston Lake. The McGregor diversion would put 20% more water in the reservoir and add to the pressure on the slide area³.</p> <p>A report by the hydro-electric design division, dated July, 1974, said that the monitoring of the unstable Brantham Ridge area showed the slide, which extends for 4 mi. (6.4 km) along the shore of Williston Lake, had moved 2 ft. (60 cm) closer to the reservoir since 1968.</p>
18	July 13-14, 1982	Flash flood	Prince George (29.2 mm/24)	<p>On July 13-14, freak storms dumped about 30 cm of rain in 36 hours in the Chetwynd area. According to the weatherman, the rain was caused by a typical summer storm with thunderclaps layered in heavy cloud, accompanied by lightning and heavy rain.</p>

¹ The 1975 flooding proved to be expensive: more than \$2 million. (Coates 1992).

² The Downie slide, the toe of which would be in the reservoir of a new dam approved for construction above Revelstoke, contains an estimated 1 billion yd.³ (0.76 billion m³), about 60 times the 1965 Hope slide (The Vancouver Sun, December 4, 1976).

³ Extensive studies were done on three large slides that fringe the reservoir on the Mica Dam on the Columbia River. The Downie slide was the major concern in considering the new dam to be built between the Mica Dam-Revelstoke (The Vancouver Sun, December 4, 1976)

Appendix A – Historical Review (from D. Septer)

No.	Date	Event type	Precipitation	Descriptions
			hours), July 13-14, 1982	<p>The torrential rains washed out culverts and damaged bridges, forcing rail line and highway closures. The extremely heavy rains cut trenches 5 m deep and up to 50 m long. Near Chetwynd, Falling Creek went on a rampage. Stan Glapysz, highways manager in Dawson Creek, put the damage figure at \$200,000.</p> <p>The Heritage Highway to Tumbler Ridge was expected to reopen on July 21. Work on the Heritage Highway and the Sukunka Highway from Chetwynd to the coalfield was returning to normal. On July 14, the heavy rain caused a washout along East Austin Road near Dawson Road. About 100 m of roadside ditch were washed out to a depth of about 3 m. City Public Works crews were expecting to have the ditch filled later on July 15.</p> <p>The BC Rail line between Chetwynd-Lemoray was shut down till July 18. The damage was estimated at several hundred thousand dollars.</p>
19	July 31-August 2, 1982	Flooding	Dawson Creek (85.6 mm/3 days), July 31-August 2, 1982.	<p>Between July 31-August 2, Dawson Creek received a record rainfall of 85.6 mm in three days. This amount by far surpassed the total precipitation for the entire months of July and August 1981.</p> <p>A number of washouts occurred on the Chetwynd-Tumbler Ridge and Dawson Creek-Tumbler Ridge highways. Though narrowed somewhat in certain sections, both highways remained open. The Boundary-Tumbler Ridge link closed due to a minor culvert washout at mile 42. This was expected to be repaired by 3 p.m. on August 3.</p> <p>The rains were so severe that some of the better grain crops in the South Peace “lodged” or went down said the Field Crops Specialist of the provincial Ministry of Agriculture and Food. Particularly hard hit was the hay crop. The rain delayed the fescue harvest. After the previous year’s drought, this hay was already in short supply. The rain also leached nutrients out of the hay, resulting in substantially lower quality feed.</p>
20	March 1985	Landslide potential	Not applicable	<p>In March, Dinosaur Lake on the Peace River was closed to the public until further notice for all recreation and sport fishing. This followed a study on the movement of a landslide, which developed on the north-shore of the reservoir near the town of Hudson’s Hope. The slide had moved 5 m in the last four years. It was feared that if it would move rapidly into the water it could create waves in excess of 4 m. Depending on how fast the slide would move, the lake could be closed for up to five years.</p>
21	May 26-29, 1986	Mudslide and flash flood	Not applicable	<p>Centurion Creek, located within the boundaries of Chetwynd flooded its banks. It appeared that a very sudden and large volume came downstream. This surge of water flushed the creek channel taking out everything in its path. There was evidence of much overland flow, especially downstream from the Legion. Besides erosion, a resident lost their water supply and had their basement flooded. There is some speculation and evidence to suggest that the plugging up of the two 8-ft. (2.4 m) culverts under the BCR line may have aggravated the situation on this creek. The BCR later replaced these two culverts with an identical pair.</p>
22	July 26-August 3, 1987	Flooding	Chetwynd (197.6 mm/month of July); (51.0 mm/12 hours), July 26, 1987; (30.0 mm), subsequent July precipitation; (63.6 mm/24 hours),	<p>Between July 31-August 1, following weeks of unseasonably heavy and prolonged wet weather in northeastern British Columbia, intense rainfall resulted in extensive flood damage to watercourses and property. On July 26, Chetwynd recorded 51 mm of rain in a 12-hour period. It was followed by a light continuous rain, which added another 30 mm. Then on August 1, 63.6 mm fell in a 24-hour period on saturated soils and creeks with higher than normal levels. On the evening of July 28, Dokie and the Wildmare area were hit by heavy rain and marble-size hailstones. The hailstones accumulated in some ditches nearly 1 ft. (30 cm) deep. Corn crops, wheat fields and greenhouses were ruined throughout the area. Many berry bushes and trees were totally stripped of their just ripening fruit and leaves. Leaves were torn off trees and shrubs. This summer hailstorm ruined corn crops, wheat fields, gardens and greenhouses. Many berry bushes were totally stripped of their just ripening fruit. Property owners in Dokie were hit by the flooding of two creeks. Numerous residences suffered damages and at least one house lost its foundations and tipped over.</p>

Appendix A – Historical Review (from D. Septer)

No.	Date	Event type	Precipitation	Descriptions
			August 1, 1987	<p>Between early August 1-4, Chetwynd recorded more than 2 in. (50 mm) of rain. More than 6 in. (150 mm) of rain fell during a weeklong period. On July 31-August 1, Chetwynd was hit by flooding causing an estimated \$500,000 damage⁴. Hardest hit was the area around the post office. Damages in the Chetwynd district were estimated at \$680,000⁵. Several businesses flooded, roads washed out, bridges collapsed and many residences suffered minor to severe damage.</p> <p>Commotion Creek overflowed its banks, affecting three culverts and stalling traffic on Highway 97, 15 mi. (24 km) west of Chetwynd. Most damage occurred in the vicinity of the District of Chetwynd but also in areas as far east as Pouce Coupe and as far north as the Fontas River. Initial restoration cost was estimated at \$733,000. (Province of British Columbia, File P87-7).</p> <p>Flooding problems occurred in the Chetwynd-Moberly Lake area (including creeks crossing Highway 97 further east); near the Villages of Pouce Coupe and Taylor; at the Halfway River Indian Band Lands and at the Indian communities of Kahntah and Fontas and along the Fontas River southeast of Fort Nelson.</p> <p>Preliminary indications were that most of the damage was sustained as a result of wood and gravel debris blockages of culverts and stream channels, and not because these facilities were otherwise inadequate.</p> <p>Numerous Dokie residences suffered damage from two flooding creeks. At least one house lost its foundations and tipped over. Following the announcement that Highway 97 would reopen on August 1 at 4 p.m., a mile-long traffic jam occurred at Dokie. Flooding streams re-routed themselves, washing out fences and driveways. A washed out culvert at Hillview Access Road, 1 mi. (1.6 km) west of Chetwynd left several families cut off.</p> <p>Starting about 9 a.m. on August 1, Commotion Creek overflowed its banks and eventually stalled traffic on Highway 97, 15 mi. (24 km) west of Chetwynd. The highway was finally closed after the bridge at Dokie, about 6 mi. (9.6 km) west of Chetwynd washed on the afternoon of August 1. Other flooding streams closed Highway 29 north towards Hudson's Hope and south towards Tumbler Ridge.</p> <p>On the night of August 1 and the morning of August 2, heavy rain caused flooding and an estimated \$680,000 of damage in Chetwynd. Not since the early 1970s had the town of 2,500 been hit so hard by rain and subsequent flooding. Runoff water severely affected culvert and bridges. Gravel washed out from the bases of several, including Windrem and Centurion Creek bridges. Large trees and other floating debris plugged near the Post Office, destroying the road pavement. When the creek re-routed severe flooding occurred to several buildings on the South Access Road.</p> <p>Hardest hit was the area near the Post Office, where a culvert in Windrem Creek was too small to handle the volume of water, and the Kal Tire/Red Rooster area where the BC Rail tracks prevented the water from escaping. The Northern Lights College and the BC Rail line also flooded.</p> <p>On the access boulevard and around the Red Rooster store small lakes formed. The Legion Subdivision was nearly flooded when Centurion Creek flooded and destroyed the footbridge. When the creek found a new route, severe flooding occurred to several buildings on the South Access Road. The sanitation sewer trunk line with aerial pipes crossing Centurion Creek washed out. It was replaced by an inverted siphon system with pipes placed under the creek.</p> <p>Near Northern Metallic and Kal Tire, floodwaters severely damaged the pavement. At the old Windrem Creek dam near the Chetwynd Public Campground waterfalls were formed. Some families at Hillview Road were isolated after floodwaters washed</p>

⁴ According to Mayor Charlie Lasser, an increase in the number of settling ponds along the creek which passes through Chetwynd would remedy the problem of accumulated gravel during the flood (Chetwynd Echo, August 11, 1987).

⁵ The provincial government approved \$6 million in assistance for victims of the July flooding in Chetwynd, Dawson Creek, Fort St. John, Fort Nelson and Tumbler Ridge. The money was to compensate residents and businesses and cover repair to roads, bridges and creeks (The Vancouver Sun, September 14, 1987). On September 10, 1988, Order in Council 1797 was approved in response to the extensive damage that occurred in the northeast of British Columbia, ordered relief to an amount not to exceed \$6 million under the Flood Relief Act.

Appendix A – Historical Review (from D. Septer)

No.	Date	Event type	Precipitation	Descriptions
				<p>out the culvert. The sanitation sewer trunk line, with aerial pipes crossing Centurion Creek, washed out. It was replaced with an inverted siphon system, where the pipes are placed under the creek.</p> <p>The cages along the bridge by Dixied Lee, and the industrial subdivision where the culvert was also too small to handle the extreme flow, would have to be replaced by larger ones. A beaver dam backed up water into one of the town's trailer parks, but once the dam broke, the water went down in 40 minutes.</p> <p>At about 9 a.m. on August 2, serious highway flooding started at the Commotion Creek turnoff on Highway 97. Bisset bridge, west of Chetwynd on Highway 97 washed away and the road was closed briefly. On August 3, Dokie bridge washed out, causing traffic to line up for miles before a temporary bridge could be put in. On August 1, the 36-in.culvert at Fernando Creek was partially submerged and there was evidence that it was plugged with debris.</p> <p>Watercourses impacted included: Boulder Creek; Commotion Creek; Stone Creek; Bissett Creek; Wildmare Creek; Fernando Creek; Unnamed Creek; Windrem Creek; Widmark Creek; Centurion Creek; Medicine Woman Creek; Le Bleu Creek; Pingel Creek; 8-Mile Creek; Halfway River; Townsend Creek; Prespatou Creek and Rolla Creek, Tremblay Creek and Meikle Creek.</p> <p>Deposition of Boulder Creek bedload in the Pine River, at their confluence immediately upstream from a secondary road crossing plugged the channel of the Pine River to an average depth of about 3.5 m. Being plugged from the left bank to mid channel, the flow was diverted towards the eroding right bank. It endangered a cabin, the highway bridge and to a lesser extent, a nearby house. Estimated cost to remove 4,500 m of gravel was \$22,000.</p> <p>At Commotion Creek, significant damage was confined to the vicinity of three Highway 97 culverts. At Stone Creek, a contractor completed the clean-up work, including the restoration of a private driveway to a mobile home. Bissett Creek suffered very severe damage at a direct consequence of log jam formation throughout an approximately 700-m reach upstream from the Highway 97 crossing. Here, properties on both banks were directly endangered; those on the left bank, including a small subdivision or mobile home park, from erosion and the one on the right bank from overbank flow, surface scour and deposition. A small house was balanced precariously on the left bank and was uninhabitable. Downstream from the highway, much of the creek is bound by Provincial Park Reserve where restoration is not believed to be necessary. Estimated cost to burn logs or restore channel upstream was \$18,000.</p> <p>On the right bank of Wildmare Creek upstream from Highway 97, rapid erosion posed a potential threat to a home and, further upstream, massive log jams resulted in channel relocation and posed a direct threat to both the home and to a mobile home, contractor's yard and storage building. Estimated cost to restore channel and riprap at the home was \$40,000. Downstream from Highway 97, the channel of Wildmare Creek infilling occurred adjacent to another home, resulting in extensive right overbank flow and bedload deposition. Estimated cost for channel restoration \$5,000. Unnamed Creek west of Chetwynd, a small creek culvert under Campbell Road, infilled both sides of the road culvert and downstream of a house. In the Chetwynd District, Windrem Creek caused the majority of the flood-related problems within the Municipality. Upstream of the Ski Lodge/Rod and Gun Club, significant erosion of the channel's right bank took place in the cleared land used for shooting ranges. Estimated cost for 650 m riprap was \$16,000; Adjacent to the lodge, right bank erosion area adjacent to the main buildings and from which, as a precautionary measure, a mobile home was removed, required 330 m riprap estimated at \$8,000. The access road to the lodge and gun club washed out partially after the creek slightly changed channels. At the Municipal Campsite immediately downstream from the old Windrem Creek dam the left bank eroded. Estimated cost on the North Access Road Crossing, repairs to the bridge support structure, gabion basket approach and downstream wingwalls, replacement of two footbridges and minor channel restorations was \$60,000. 50 Street crossing and BC Railway crossing washed out.</p> <p>Restoration cost of Widmark Creek was \$45,000. An 11.5-m high culvert on Centurion crossing the BC Railway line Dawson Creek failed. A 96-in. multi-plate culvert and two 48-in. dia. culverts replaced the previous three 48-in.dia. culverts. Downstream, at the Highway 97 crossing, two footbridges were swept away and a sewer crossing was destroyed, while, further downstream, evacuations were necessary. The estimated cost of restoration was \$67,000;</p>

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No.	Date	Event type	Precipitation	Descriptions
				<p>In the Moberly Lake area north of Chetwynd: Medicine Woman Creek: extensive damage to private properties resulted when the Highway 29 pipe-arch culvert plugged with debris, diverting floodwater east along the highway before it passed through local drainage culverts under the highway. Camp Sagatawa was but one of the nine or more downstream properties to suffer damage. Le Bleu Creek: problems in this area resulted from extremely high runoff rather than debris blockages. Overbank flow caused damage at a residence's property. Further upstream, another property suffered extensive flood damage from overbank flow. In the Pouce Coupe area: estimated cost bedload deposition leading to left bank erosion was \$18,000 at a local property. Regional District Park right bank erosion protection totally destroyed throughout its former 110-m length downstream from the Highway 2 bridge crossing. Estimated riprap replacement cost \$30,000.</p> <p>Near Taylor, Pingle Creek was the most seriously damaged of all the areas visited. Upstream from the Highway 97 bridge, much of the original channel throughout the first 1,300 m upstream from the highway was completely infilled with silty-sand, balls of clay and massive quantities of wood debris. Estimated cost to re-excavate the channel and riprap left bank for 150 m was \$44,000. 8-Mile (Tower) Creek: overbank flow was reported to have caused crop damage. Flooding at the confluence of the Kahntah and Fontas rivers resulted in some property damage. A huge log jam at the BC Railway crossing is believed to have been responsible for upstream flooding which damaged two houses in the Fontas Indian Community-Fort Nelson I.B. In case of the old house, floodwater was 2+ m above the floor level and in the new house it was 1.2 m deep. Band members reported additional logjams further downstream. They attributed them to material moved from upstream of the bridge by BC Railway. Halfway River: Indian and Northern Affairs reported a total loss of riprap protecting the community water intake, and a change in the main channel which is directing the flow at the intake. Rain and high water were both reportedly continuous through to at least August 13; Townsend Creek (tributary to Halfway River): the timber bridge crossing to this Christian Community washed away, which was not an infrequent occurrence. On Prespatou Creek a problem was reported, possibly a debris jam. Rolla Creek: crop damage was reported as a result of a creek blockage.</p> <p>All BC Rail traffic halted after floodwaters covered the tracks with debris. In several locations, foundations washed out up to 10 ft. (3 m) under the track. Floodwaters washed out the bridge over Bissett Creek, making Highway 97 impassable. Bissett Creek suffered very severe damage due to the formation of a logjam throughout an approximately 700-m reach upstream from the Highway 97 crossing. Properties on both banks were directly endangered. Those on the left bank, including a small subdivision or mobile home park, from erosion and the one on the right bank from overbank flow, surface scour and deposition. After the bridge at Dokie, about 6 mi. (9.6 km) west of Chetwynd washed out on the afternoon of August 1, the highway was later closed to all traffic. Other flooding creeks caused the closure of Highway 29 North toward Hudson's Hope and Highway 29 South to Tumbler Ridge. The road closures affected hundreds of southbound vehicles. A number of stranded motorists were evacuated by helicopter from isolated areas.</p> <p>On the morning of August 1, just before the lakeside road washed out, the Moberly Lake provincial campground at was evacuated. When flooding rivers caused Moberly Lake to rise rapidly, 50 people were evacuated from Camp Sagatawa and five camping units. Waves up to 3 ft. (90 cm) high were forced over its shore. Five people were evacuated by boat from the south side of the lake. Camp Sagatawa was inundated by a 3-ft. (90 cm) stream, which became 30 ft. (9 m) wide. Near Camp Sagatawa, Highway 97 was threatened. Near Sagatawa, an 8-ft. (2.4 m) culvert at Medicine Woman Creek became plugged. Near Moberly, Le Bleu Creek washed out the approach to the bridge by Ken's Place.</p> <p>The gravel road between Highway 29 and the park washed out in four places, including the Martin Creek bridge, and was not expected to be repaired within two or three weeks. After both approaches to the Martin Creek bridge washed out, about 20 Sukunka River campers were cut off from Highway 29. On August 2, 19 people were evacuated by helicopter: 14 campers staying at the Sukunka Falls Provincial Park and five hikers at Kinuseo Falls. A local resident rescued a two-year old child from a camper hung up on the edge of a collapsed bridge.</p>

January 9, 2020

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No.	Date	Event type	Precipitation	Descriptions
23	May 31- June 7, 1990	Spring runoff flooding		During the early part of June, four large areas (Okanagan, Kelowna and Kamloops areas, Prince George, including Williams Lake and Dawson Creek) experienced flooding. Flood conditions hampered the area's logging and tree planting operations. Forest Service roads (FSR) in the Anzak and Carp Lake areas were closed. North Fraser FSR was closed at 17 km and 57 km; Bowron FSR at 12 km; McGregor-Sande FSR at 9 km; McGregor-Logan FSR at 57 km; Carp FSR at 13.78 km; (The Carp Provincial Park Road remained open); McGregor-Gleason FSR at 3.5 km and the Chuchinka-Colbourne FSR at 51 km.
24	June 9-12, 1990	Spring runoff flooding and debris slide	Prince George (45.2 mm), midnight on June 9-June 12, 1990; Dawson Creek A (106 mm), evening of June 10 to about 5 p.m. on June 12, 1990	The heavy rainfall caused flash flooding and erosion damage in the Dawson Creek area. (East Pine bridge-north to the Peace River and south to Tumbler Ridge). Around June 12, parts of downtown Dawson Creek experienced "thigh-high" water. On June 13, floodwaters subsided. The Dawson Creek area flooding was caused by heavy rain whereas the other areas experienced damage due to a combination of snowmelt and rain. The total cost of channel restoration, log clearing and repair work was estimated to be \$2,575,980. A further \$883,080 was needed for enhancement work. (O.I.C. 919 Task No. 910077) Dates of flooding occurred between May 28-June 30.
25	June 14, 1996	Sinkholes	Not applicable	During the summer, two sinkholes were found in the W.A.C. Bennett Dam ⁶ . On June 14, a tourist noticed the first one, about 40 m deep, in a road across the bridge. Drilling tests showed the sinkhole was caused by a 110-m long pipe about 15 cm in diameter that had been left in the dam when the construction was completed in 1967. In September, a smaller sinkhole was discovered surrounding a second survey pipe embedded in the dam. The discovery of the two holes in June and September caused alarm. It was feared that the dam might breach and spill the contents of the 1,120-mi. ² (2,900 km ²) Williston Lake Reservoir, the largest in North America. Hand compaction of material around the benchmark pipes during the construction of the dam was believed to be the cause of the two sinkholes. According to BC Hydro spokesman, also the 30-ft. (9 m) areas around the sinkholes were not firm as could be and silt in the core of the dam had been moving. The sinkholes were refilled and the road across the dam rebuilt. To stiffen up the core of the dam the holes were filled by compaction grouting. Work for each hole was expected to cost about \$7 million (Peace River Block Daily News, January 15, 1997). In May, the level of Williston Lake behind the dam dropped significantly, causing dust storms in some shoreline areas. By June, the reservoir started to refill. B.C. Hydro officials expected the lake to reach its normal level in September.
26	January 27-29, 1997	Ice jam flooding	Not applicable	Late on January 27, ice build up in the Peace River about 5 km downstream from Taylor caused the level of the Peace River to rise behind it. To alleviate the potential flooding of properties along the river in South Taylor, BC Hydro cut back the outflow from the W.A.C. Bennett Dam about 5,000 cfs (141.6 m ³ /s). BC Hydro spokesman noted, "I don't think it will get any worse than it did last year."

⁶ The huge earth dam in northeastern British Columbia contains 57 Million m³ of fill, mostly compacted till. Across-section of the dam resembles a giant triangle, 800 m at the base, 12 m across the top and 185 m high. The dam, completed in 1967, is 13 m above the level of Williston Lake, which stretches about 100 km west behind it. It provides about one third of British Columbia's hydroelectric needs (Canadian Press, June 6, 1997). The sinkholes are columns of loose material 8 ft. (2.4 m) across and about 100-120 ft. (30-36 m) deep. It is basically a round elevator shaft that is not at the specified density (Peace River Block Daily News, January 15, 1997).

Appendix A – Historical Review (from D. Septer)

No.	Date	Event type	Precipitation	Descriptions
				As of the morning of January 29, there were no reports of shoreline homes in danger of flooding. In response to warm weather patterns the ice jam south of Taylor and potential flooding receded. The ice front slowly made its way down the Peace River. By January 30, it was situated at the Taylor Bridge. The ice jam later receded 2.5 km downstream of Highway 97 bridge. The water level at South Taylor dropped 1.5 m.
27	June 10-13, 2001	Flooding	Not available	<p>During the second week of June, extreme precipitation caused many rivers in the Peace River area to overflow their banks. Flooding caused significant damage to at least three roads in the area: Cypress Road, 65 km northwest of Fort St. John; Farrell Creek and Upper Halfway Road between Fort St John-Hudson's Hope.</p> <p>Two major washouts of about 200-300 m in length, one at each bridge, made Cypress Road impassable⁷. At the Cypress Creek bridge, the end fills were completely gone. Repairs were estimated at \$250-300,000. According to one local resident, this was the "worst flooding to have occurred here since 1965."</p> <p>On the Upper Halfway Road, another substantial washout of 500-1,000 m in length obliterated the road and its right-of-way. Water flows at the Halfway River bridge were high and the approaches appeared to be holding. Repairs were estimated at \$500-600,000. Repairs to a major culvert failure on Farrell Creek Road were estimated at \$400-600,000.</p> <p>On Highway 29, ten downpipes were demolished. Repairs were estimated at \$200,000. There were two new slides on Highway 29 at the Halfway and three more at Cache Creek hill with an estimated repair cost of \$1 million. Many other significant washouts occurred along this route. As the water table changed, more slides were anticipated over the coming weeks. Significant damage was done to private roads, driveways, oil and gas facilities and roads.</p> <p>Around June 13 near Smithers, two or three blocked culverts caused substantial flooding on the last 2 km on Driftwood Road. A piece of road washed out around 3 km from the gate.</p>
28	January 18-24, 2005	Flooding, icejam flooding and mudslide	Not available	On the morning of January 24, highway and rail connections in the Pine Pass were disrupted by a mudflow and flooding. A mudflow in the Pine Pass area about 20 km north of the MacKenzie junction temporarily closed Highway 97. Soon after the highway reopened to single lane alternating traffic, it was closed again just before noon when Rollston Creek jumped its banks. The area had recently experienced higher than normal temperatures and heavy rain and snowmelt.
29	June 13, 2005	Landslip	Not available	On the night of June 13, a 200-300-m section of Highway 29 between Chetwynd-Tumbler Ridge collapsed. Prior to the collapse, a "significant amount of rain" fell in the area. The highway closure forced traffic to make a 150- km detour.

⁷ The Cypress Creek Road is 44 km long, with three bridges and has a number of short side roads attached to it. While the first 22 km and the first bridge remained intact, about 12 families were left isolated beyond this point. (Ministry of Transportation). There are no alternate routes for Cypress, Upper Halfway or Farrell Creek roads.

Appendix B - Summary of Rainfall Data (2011, 2016)

Appendix B - 2011 and 2016 Rainfall Data for PRRD Areas

Summary of Rainfall Data at different Stations 2011				
DATE	ENV. Canada	BCFS Sta.	BCFS Sta.	ENV. Canada
	Chetwynd	Hudson Hope	Lemoray	Dawson Creek
	(mm)	(mm)	(mm)	(mm)
22/06/2011	3.2	0.0	0.0	0.3
23/06/2011	27.5	0.4	6.0	19.2
24/06/2011	72.0	79.6	39.2	54.4
25/06/2011	25.8	45.2	125.0	8.8
26/06/2011	0.0	7.6	10.4	0
Total Rainfall (mm)	128.5	132.8	180.6	82.7
DATE	ENV. Canada	BCFS Sta.	BCFS Sta.	ENV. Canada
	Chetwynd	Hudson Hope	Lemoray	Dawson Creek
	(mm)	(mm)	(mm)	(mm)
07/07/2011	17.9	0.0	0.2	0.0
08/07/2011	43.6	26.6	26.8	50.3
09/07/2011	10.3	11.8	12.4	29.1
10/07/2011	5.6	6.0	12.4	2.3
11/07/2011	5.2	18.4	5.6	7.1
Total Rainfall (mm)	82.6	62.8	57.4	88.8
DATE	ENV. Canada	BCFS Sta.	BCFS Sta.	ENV. Canada
	Chetwynd	Hudson Hope	Lemoray	Dawson Creek
	(mm)	(mm)	(mm)	(mm)
14/07/2011	15.2	1.0	4.0	N/A
15/07/2011	11.4	0.0	3.8	N/A
16/07/2011	2.8	28.0	0.8	6.8
17/07/2011		12.6	11.8	3
Total Rainfall (mm)	29.4	41.6	20.4	9.8

Summary of Rainfall Data at different Stations 2016				
DATE	ENV. Canada	BCFS Sta.	BCFS Sta.	ENV. Canada
	Chetwynd	Hudson Hope	Lemoray	Dawson Creek
	(mm)	(mm)	(mm)	(mm)
13/06/2016	0.0	0.0	0.2	0.0
14/06/2016	48.0	1.6	18.8	8.8
15/06/2016	86.8	41.2	92.2	89.8
16/06/2016	0.6	1.4	6.0	12.0
17/06/2016	0.0	0.0	0.0	N/A
Total Rainfall (mm)	135.4	44.2	117.2	110.6

Appendix C - Desktop assessment maps

Appendix D - Master Damages List

Appendix D - Master Damages PRRD Flood Risk Assessment			
Date	911 Address	Description	General Location
23-Jun-16	208 Road	2 culverts washed out in 2 driveways on property, lives in Kamloops will be in Dawson Creek tomorrow.	Arras
29-Jun-16	Riley Crossing	Property flooded due to Pouce River; property borders directly beside the Pouce River - some property loss; HD equipment; 54' tractor trailer fully loaded, boat, 3 trucks all submerged underwater; river took out entire fence of lower field approx 2-3 acres damaged; haven't done anything yet; has some insurance - adv to speak with them; DFA.	Briar
04-Jul-11	235 Road, Cecil Lake	Dirt walled basement caved in, pushing on furnace and hot water tank.	Cecil Lake
29-Jun-11	Hwy 97 S	No main road access (quad trail only way out). Primary residence. Has had major land erosion. Lost fence & one older shed, but only concerned with future prevention of erosion and is interested in information on water management plans.	Chetwynd
16-Jun-16	Dokie School Road	Flooded yard, creek broke banks, sent to Chetwynd to wait for directions.	Chetwynd
18-Jun-16	Hwy 97 S	Flooded basement, ground/property damage.	Chetwynd
27-Jun-11	Hasler Road	Boulder Creek has destroyed their property, massive amounts of debris in yard and no driveway access to main road.	Chetwynd
27-Jun-11	Hasler Sub	Devastation of neighbours, including destroyed homes and farmers' fields - she will advise them to call the PRRD. Main concern is for neighbour, who lives on Hasler Rd. but is away. His home & shop have been totally flooded. Only damage is to her well. She is not looking for compensation as they can fix it themselves.	Chetwynd
29-Jun-11	Old Hasler Road	2 people have called on behalf of a neighbour who was away & has now had to take his wife with alzheimers to a sisters in Terrace because he couldn't bring her home to a mess. Advised that the house is a permanent residence - there is at least 4 inches of water in the house - yard and outbuildings destroyed - well full of silt.	Chetwynd
29-Jun-11		Home was submerged in 3.5 feet of water & he had to walk out at 3:00am. This happened 3 weeks ago and was the first incident of flooding at Hasler. His property was shown on the front page of the Chetwynd paper at that time. He lost his truck, tools, 2 skidoos, BBQ, Camper, & furniture. His main concern is the roadway - he can't get in to get any remaining items that may be left. Is staying at contact phone number & is looking for a new place to live.	Chetwynd

30-Jun-11	Hasler	No access to house - Boulder Creek diverted went through driveway, can't get in or out with a vehicle - deep ravine - not sure about septic tank, it seems to be working. Power shed has water damage and is surrounded by water, outbuildings and fencing all damaged, field, whatever equipment was outside, chain saws, everything in shop, well damaged, lost bridge on property, firepits, landslides, looks like a war zone, vehicles and campers imbedded in rock.	Chetwynd
16-Jun-16	Hasler Road	Lost her house, shop, everything.	Chetwynd
18-Jun-16	Hwy 97	Boulder Creek is etching out the foundation of his home and he is wondering who might be able to help him; Cabin is falling into river, has supplies coming.	Chetwynd
18-Jun-16	Old Hasler Road	Property Flooded.	Chetwynd
July 5, 2016	Hwy 97 S	Concerned about further erosion to land causing house to fall into Boulder Creek; 12 ft cliff about 3 ft from back door; house is situated on property backing onto creek; some cracks in foundation; afraid they are going to lose house if it's left too long without any work done to it as land is sloughing; will not allow kids to stay at house as its not safe.	Chetwynd
27-Jun-11	McDonough Rd	Lost bridge deck on a 16' x 55' bridge on property, pump house for livestock waterers is lost, lost fencing, water was 35ft deep.	Chetwynd
28-Jun-11	Hwy 97S	Commotion Creek isolated their home, removed their septic field and potentially have no suitable access.	Chetwynd
28-Jun-11	Tricker Rd	Driveway is washed out -culvert washed away - water in basement caused damage - has a loader that he made a trail to get to town.	Chetwynd
20-Jun-16	Tricker Rd	Road into residence is totally washed out - made a goat trail so can get in and out - rerouted creek back into culvert.	Chetwynd
29-Jun-11	Fernando Sub	Has a 2' ditch across his garden that is washed away, he lost a tent and his wooden shed is water damaged. Back in 2011 MoT replaced the culvert but didn't remove the debris in the creek, consequently this flood backed up over people's property. The whole creek needs to be cleaned out.	Chetwynd
30-Jun-11	Moreland Sub	4 ft wall around the bottom of the house that is on a hillside had water coming over the wall & the wall cracked & water was coming through until yesterday (June 28th). He stayed on top of the water pouring into his basement with the shop vac (just barely kept up). Main concern is damage to wall.	Chetwynd
27-Jun-11	West Hayward Rd	Driveway culvert damaged.	Chetwynd
28-Jun-11	Houde Road	Well flooded, driveway access impacted, water in basement, fencing lost, hay fields on 70 acres, possible equipment damage.	Chetwynd

28-Jun-11	Ganson Rd	Took out well - still have water from cistern that can use - don't know the extent of silt in wells - pressure tank broke off - the pump is broken - have 5 children living in residence.	Chetwynd
28-Jun-11	Hasler Rd	Field and pasture under water(500 acres), fences flattened, lost a dozen skidoos in power shed. Lots of items not located like motors - 2 hay barns under water, balers, cutters, etc. - don't really know extent of all the damage or loss.	Chetwynd
30-Jun-11	Wildmare Rd	Lost some of the river frontage and the roadway to cabin - wells are flooded and full of silt.	Chetwynd
30-Jun-11	Fernando Road	Private roads on farm have been washed out.	Chetwynd
27-Jun-11	Hwy 97 S	No power due to flood, driveway damage.	Chetwynd
18-Jun-16	Stone Ck Sub	Property damage - ground/electrical.	Chetwynd
18-Jun-16	Stone Creek Sub	2 cars swept away, 500 meters of timber destroyed, 20 acres of juvenile timber taken out, 3 days of work with loader restoring creek putting back into boundaries, creek crossing got taken out (2 big culverts).	Chetwynd
18-Jun-16	Campbell Sub	Water came in along through the garage, the driveway is a mud hole - they dug trenches to try to get the water away from the house, water came into the dining room, -the bottom half of the window & wall down in dining room has damage, the floor is damaged - water dripped down the stairs - water came in the basement filled the heat ducts & damaged flooring and carpet.	Chetwynd
18-Jun-16	Hwy 97 S	Primary residence - driveway is mush, basement flooded, sewer backed up, furnace, 2 hot water tanks, iron remover, pressure tank damaged. Yard is a "sponge" and house is sinking in one corner. Ten acre hay field is underwater.	Chetwynd
29-Jun-11	Willow Flats	Whole backyard flooded - yard full of gravel - well is wrecked full of silt - car full of gravel - creek running in yard - lawn mower covered in gravel - silt & gravel everywhere - water in house next door.	Chetwynd
18-Jun-16	Campbell Sub	Basement flooded, drywall and insulation damaged, lagoon starting to flow over, worried about landslides in subdivision.	Chetwynd
27-Jun-11	Hwy 97 S	Lots of property damage.	Chetwynd
29-Jun-11	Hwy 97 S	Property damage.	Chetwynd
29-Jun-11	Hwy 97 S	Property damage.	Chetwynd
28-Jun-11	Hwy 97 S	Property damage.	Chetwynd
30-Jun-11	Hwy 97 S	Property damage - ground/electrical.	Chetwynd
16-Jun-16	Hwy 97 S	Has hay (40 acres) and pasture land that is under 10 feet of water & has lost fences. He is concerned about wet land habitats & the location of a culvert being installed by CN Rail were their tracks have washed out at CN Track no. 646.11. If Minisy of Environment notices the location of his 6 missing cows (2 cows, 2 calves, 2 steer) during there fly over he would appreciate a call to direct him to their location.	Chetwynd
16-Jun-16	Hwy 97 S	Lots of property damage	Chetwynd

18-Jun-16	Waters Sub	Damage to outside property and outbuildings, creek has redirected itself through his yard about 2 ft from house.	Chetwynd
29-Jun-16	Wildmare Rd	Flooding in basement - carpet destroyed.	Chetwynd
29-Jun-11	Wildmare Rd	Driveway & culvert completely washed out. No road access in/out. Gap in roadway is 25' wide by 10 - 12' deep. Has minor damage to gardens and greenhouse. Wildmare creek used to pass roughly 200 metres south of the house-it now seems to be about 50 metres to the north!!	Chetwynd
18-Jun-16	Wildmare Rd	Log jam causing pooling on property, well shed gone, no water, fencing destroyed.	Chetwynd
30-Jun-11	Wildmare Rd	Lagoon damaged, driveway damaged, MOT working to fix culvert which will help with driveway.	Chetwynd
27-Jun-11	Wildmare Rd	Is not home, husband is home and stranded, he is choosing to stay to try to save house and keep generator going with sump pump; He is stranded but stated he is safe (self-assessed).	Chetwynd
28-Jun-11	Wildmare Rd	House has river running through it and 10 acres of property are under water. House is uninhabitable, severe ground or slope failure, proximity risks.	Chetwynd
28-Jun-11	Wildmare Rd	Self evacuating from Wildmare - house is completely flooded, water running through, excavator in creek is tipped over. Asking for assistance.	Chetwynd
30-Jun-11	Waters Sub	Major damage to basement electrical system due to flooding.	Chetwynd
28-Jun-11	Wildmare Rd	Flooding in large storage; property damage at corner of property 2/3 away across land @ 5 acres, creek just ripped land area apart, uprooted tree, great deal of silt, well water damaged, at least a foot or two deep of debris.	Chetwynd
30-Jun-11	West Fraser Rd	Lost culverts throughout the property. 9 ft culvert, two large culverts, two smaller culverts washed away. He is unable to get across the river to see if further culverts are gone - cattle pen is completely filled with mud - rocks & debris everywhere.	Chetwynd
04-Jul-11	Willow Ck FSR	Old farm, access washed out	Chetwynd
27-Jun-11	Cypress Creek	Lost driveway, fences, road washed out.	Cypress Creek
28-Jun-11	Charlie Lake Cres	Water ran down hill and ripped through yard damaging all the landscaping - took out culvert - overflowed creek - took out 1/2 the driveway which was freshly gravelled.	Fort St John
04-Jul-11		Flooding in basement.	Fort St John
21-Jun-16	Rose Prairie	Basement flooded - carpets ruined.	Fort St John
28-Jun-11	257 Road, Airport Sub	Wall in basement and floor in basement damaged from water.	Fort St John
18-Jun-16	Upper Halfway Road	10 acres of land lost, lost fencing, farming is primary income.	Halfway River
27-Jun-11	FSR 69	Driveway is washed out.	Halfway River
27-Jun-11	Coulson rd HH	Basement flooded.	Hudson's Hope

27-Jun-11	Nichols Dr. Jackfish Lake	The access road has been destroyed - the only way in or out is via a quad trail at the back of the property (are able to get their 4X4 truck through it) home-based business (hair dresser) is suffering as her clients can't access. Her home is ok but her yard and field is a disaster (gravel, mud, debris).	Jackfish Lake
27-Jun-11	Nichols Sub, Jackfish	Shop destroyed by mudslide, tools lost, boat damaged.	Jackfish Lake
28-Jun-11	Nichols Rd	Yard and road washed out damage under trailer.	Jackfish Lake
28-Jun-11	217 Road	50 acres of field that was totally under water and he may have lost his canola crop located north of the creek on 219 Road.	Kilkerran
28-Jun-11		Power is out - cannot get there - will lose everything in deep freezer - had halibut.	Lemoray
29-Jun-11	Cowie Ck Road	Water through roof; leaking through roof on top floor through to main floor. No drywall - ceiling is wood; water came in through slats; house has resettled off overhang; pillars are off foundation (slab on ground). Well water is brown b/c it is a spring-fed well.	Lone Prairie
29-Jun-11	17.5 km past S. Moberly Road, past Dokie Creek	No access to house.	Moberly Lake
29-Jun-11	Cottonwood Place	2.5" water on floor, drywall, debris, possibly water & sewer.	Moberly Lake
29-Jun-11	Cottonwood Place	2.5" water on floor, drywall, debris, possibly water & sewer.	Moberly Lake
29-Jun-11	Cottonwood Place	Flooded, creek damage.	Moberly Lake
29-Jun-11	Centennial Rd West	Various	Moberly Lake
29-Jun-11	Hwy 29	Horse pasture along the creek & all fencing destroyed. Garden destroyed including 80 lbs of potatoes that were planted.	Moberly Lake
29-Jun-11	Lakeshore Dr	Driveway eroded, guest cabin has 1 1/2 ft water in it, water system to primary home may be damaged.	Moberly Lake
30-Jun-11	Centennial Rd W	Water running through yard has affected water system, crawl space is flooded and driveway lost	Moberly Lake
June 30 2011	Yips Sub Moberly	Primary residence - basement flooded via sump pump hole (basement 1/2 finished) drywall, flooring, furniture ruined. Also lost shed that contained 2 outboard motors, 2 chain saws, gas pump, woodworking saws, meat saw). Holiday trailer had water up to windows and was flipped on its side. In morning water was within 30 feet of house and couldn't get out as the bridge was washed out.	Moberly Lake
30-Jun-11	Pioneer Rd	Water flooded crawl space and first floor of house - floor ruined - up 4 inches on walls - will be wet insulation - possibly damage to bottom of cupboards - 3 portable cabinets damaged - pump house with pressure system all ruined - some flooding in outbuildings - stucco possible damaged on house - shop built on beams - up to floor joists - skirting was soaked.	Moberly Lake

30-Jun-11	Moberly Lake Rd	Renting house - 1 1/2 feet of water in house on main floor and 5 feet in basement - cannot live in house - staying at the neighbours - damage to all furniture - septic and well flooded too.	Moberly Lake
27-Jun-11	West Centennial Access Rd	Cabin engulfed in water - foundation and floor underneath damaged and eroding - not sure about water pump - deck work is floating - water system in cabin for the house - so have cut power to it - front of cabin tipping into lake - house - crawlspace had 6 inches of water - have been able to pump - not sure if hot water tanks have been damaged - H-Vac system not sure if it's functional - yard is floating all under water - garden gone - gazebo engulfed in water - have no water and not using sewer system - power is ok at this point at house.	Moberly Lake
27-Jun-11	Yip	Wet insulation - not a permanent residence.	Moberly Lake
27-Jun-11	Yips Sub	Primary residence completely surrounded in water. Garden under water. -Footing of the large deck is tilted & deck is starting to pop off. Debris is floating and damaging skirting & siding. Unable to look under skirting to assess damage. Lots of items stored under there are still submerged. All gravel that was banked around the house is washing away. Concerned sewer may be damaged & her well may be contaminated. Most of the driveway has been eaten out. Previously had 70 loads of gravel to beach area & will have to wait until water receded to assess damage there. Luckily she had her company bull dozer on the property and used it to divert water for 3 neighbours as well as herself to help save a lot of property. Dock ripped apart & mostly floated away. Also lost picnic table & treated wood horse-shoe pits.	Moberly Lake
27-Jun-11	W Centennial (Mob Lk)	Seasonal property on Moberly Lake -can't get to the property, but can see it is under about 3 feet of water. They have a fully furnished 3 bedroom cabin, (with 3 beds, couches chairs, rugs, etc. -lots of items including telescope, 3 fridges, deep freeze) A 4 bedroom bunkhouse with 2 queen & 4 single beds and a guest house with 2 single beds and a tool shed, & water shed. \$1500 BBQ with oven & ice box is submerged. Patio furniture is floating away along with the deck. The dock is gone. Will take pictures of damage once they can get to the property.	Moberly Lake
27-Jun-11	S. Moberly Rd	Seasonal cabin on Moberly lake. Can't currently get to the cabin because the water is too deep. Will be able to assess damage to cabin and two outbuildings once water recedes.	Moberly Lake
28-Jun-11	Holiday Beach Rd	Primary residence - over 42 inches of water in basement - damage to water pump, tank, water softener, pressure tank, hot water tank, sewing room, workshop, deep freeze, lots of storage items & gyprock.	Moberly Lake
28-Jun-11	Holiday Beach Rd	Seasonal Residence but is primary from May to Sep each year. - Water up around cabin & is still submerged. Haven't been able to get to it yet to assess damage.	Moberly Lake

28-Jun-11	Yip Road	Property damage - fallen trees, concerned about a log jam on 3rd bridge.	Moberly Lake
28-Jun-11	Holiday Beach Rd	Boat house totally flooded - under cabin is flooded.	Moberly Lake
04-Jul-11	Park Rd Yips Sub	Basement flooded, outbuildings flooded. Equipment wrecked, holiday trailer damaged, cut swath through yard, yard full of debris,.	Moberly Lake
04-Jul-11	Cottonwood Place Moberly	Cabin totally flooded (5 feet of water) everything wrecked - outhouses flooded everything going into the lake.	Moberly Lake
	Lakeshore Drive	2 structures with 4ft water inside.	Moberly Lake
	Cottonwood Place	Under 6ft of water, boat house is submerged.	Moberly Lake
	Cottonwood Place	Under 6ft of water, boat house is submerged.	Moberly Lake
	Yips Sub	Foundation damage, flooding & drywall, furniture, debris and silt in yard, driveway under water.	Moberly Lake
19-Jun-16	Holiday Beach Rd	Water surrounded house, flooding damaged, drywall, permanent residences.	Moberly Lake
19-Jun-16	Yip Sub	Water 36" in crawl space, 7" water on main floor, flooring damage, in-floor heating, electrical damage, debris in yard, power shed damaged, some furniture.	Moberly Lake
19-Jun-16	Yip Sub	Driveway washed out, yard destroyed, 2' water in crawl space.	Moberly Lake
19-Jun-16	W Centennial Rd Moberly	Property damage, ground water backed up into house damaging hot water tank and heating system.	Moberly Lake
19-Jun-16	Cottonwood Place	Water 5 ft around house-3ft in house.	Moberly Lake
19-Jun-16	Lake shore drive	Land and structures flooded.	Moberly Lake
19-Jun-16	Lake shore drive	Land and structures flooded.	Moberly Lake
19-Jun-16	Lakeshore drive	Land and structures flooded.	Moberly Lake
19-Jun-16	Lakeshore dirve	Land and structures flooded.	Moberly Lake
19-Jun-16	Cove Ln	Beach erosion.	Moberly Lake
19-Jun-16	Cove Ln	Beach erosion.	Moberly Lake
19-Jun-16	Cove Road	Minimal damage.	Moberly Lake
19-Jun-16	Cove Ln	Dock damage.	Moberly Lake
04-Jul-11	Pioneer Road	Bank washed out, damage is pretty bad, bank is sloughing really bad.	Moberly Lake
04-Jul-11	S Moberly Lake Road	Dock damage.	Moberly Lake
18-Jun-16	Yips Sub	House is locked but appears to have damage.	Moberly Lake
27-Jun-16	Yips Sub	Flooding to boat house and power shed.	Moberly Lake
06-Jul-16	Yips Sub	Crawl space flooded, minimal damage.	Moberly Lake
19-Jun-16	Yips Sub	Issue from creek.	Moberly Lake
19-Jun-16	Yips Sub	Septic damage in crawl space.	Moberly Lake
07-Jul-16	Yips Sub	Creek washed through.	Moberly Lake
	254 Rd	Fields washed away 12ft wide ruts 1 ft deep left behind.	North Pine
	Cypress rd Pink Mountain	Land damage and debris on land.	Pink Mountain
	211 Road	Culvert damaged; driveways washed out; CRS will not take responsibility for culverts; would like CRS to get funding to fix the driveways and cuverts.	Pouce Coupe

	Radar Laker Road	West Bissette Cat Bridge on South Loop; East Bissette cat bridge; Log Cabin Footbridge (2 span) West Bridge approach and downstream end of culvert and wash south side of hill; Culver near Wolf footbridge (below Radar Lake); Kiwanis trail culvert North end Kiwanis Trail; culvert near Bissette single span footbridge and two span footbridge; culvert on Martin Trail (2nd culvert below Radar Lake).	South Dawson
	Agricultural Land	Agricultural property, farmland leased out; person who is leasing land to farm cannot access field. MOTI Road allowance that flooded happened in 2011; large culvert washed causing hole in road.	South Dawson
	Independent Road	2 cabins under water, RV under water, woodshed fallen over.	Tomslake
	Tate Creek Road 17	Major lagoon clean up needed due to flooding of Tate Creek and Kluskas creek (creeks join on property) which brought in debris - trees, rocks, beaver dam sticks; debris prevents lagoon from working properly; cannot currently get to lagoon to assess due to excessive silt on land and dampness - causes vehicle/tractors to sink; has had 1 contractor come out but stated be sometime before silt dries enough to work on; corrals are also damage, but 1st priority is lagoon; owners farm land.	Tomslake
	Independent Rd	Water flooding into field.	Tomslake
	Tumbler Ridge Hwy S	Lost land, creek that goes through course is now a river, lost culverts, need to replace gravel.	Tumbler Ridge
Jan-19	209 Road	2016 highest they have seen by 4-5 feet	Pouce Coupe
Jan-19		Kluskas Lake - flooded driveways moved 215 and SW of 202, pickups moved by the water down Tate Creek towards and joining Bissette Creek	Tomslake
Jan-19		Concerned about the debris in and around the creeks. Beavers fell trees that are taken in the floods and end up plugging up bridges.	Tomslake
Jan-19	Old Edmonton Hwy	Erosion has changed the flow of the river in some areas which changes the floodplain.	Tomslake
Jan-19	Hwy 97 North of Chetwynd	Railway culverts are too small or non existent. No Road detour routes in case of washouts. Debris diversions in the creeks.	Chetwynd
Jan-19	Houde Road	2013 - MOTI burned 6 buildings and farm equipment during the 2011 flood cleanup, no investigation allowed by the Ministry of Transportation or the Ministry of Environment. There was a 1 meter cube oil spill that has yet to be cleaned up. 2013 MOTI on flood clean up blasts pickup sized rock from submarine pit for enbridge pipeline to vancouver. This resulted in 500 loads of rock put on ALR which has not been cleaned up yet. MOTI diverted Commotion Creek into Strand Lake with approx. 50 railway ties and pavement. PCB's and creosote in the asphalt and ties has likely polluted the fish bearing lake. These need to be removed ASAP (from the 2016 Flood). Fur Thief Creek needs to be cleaned up. Build road through Monkman Pass.	Chetwynd

Jan-19	Moberly Lake	Consider Access routes from Chetwynd to Tumbler ridge in the event of washouts.	Moberly Lake
Jan-19	Moberly Lake	Widen the bridge at the outlet of Moberly Lake, it plugs with debris and can not handle the volume of water during flood events.	Moberly Lake
Jan-19	Tomslake	Residents are concerned that all the bridges in the area are undersized and do not allow enough water to flow underneath them. The bridge get plugged with large woody debris and other debris found in the watersheds.	Tomslake
Jan-19	Swan Lake	Residents manage the weir at the outlet of the lake. The weir is not large enough to handle the volume of water during flood events. The residents want legislation allowing them to control the amount of water flowing over the weir.	Swan Lake

LEGEND	Residents that fall outside the study area.
	Concerns brought up at Public Meetings by residents.

Appendix E - Flight Overview – Aerial Images

Appendix F - Detailed Flight Images

Appendix G - Identified Potential Risk Areas