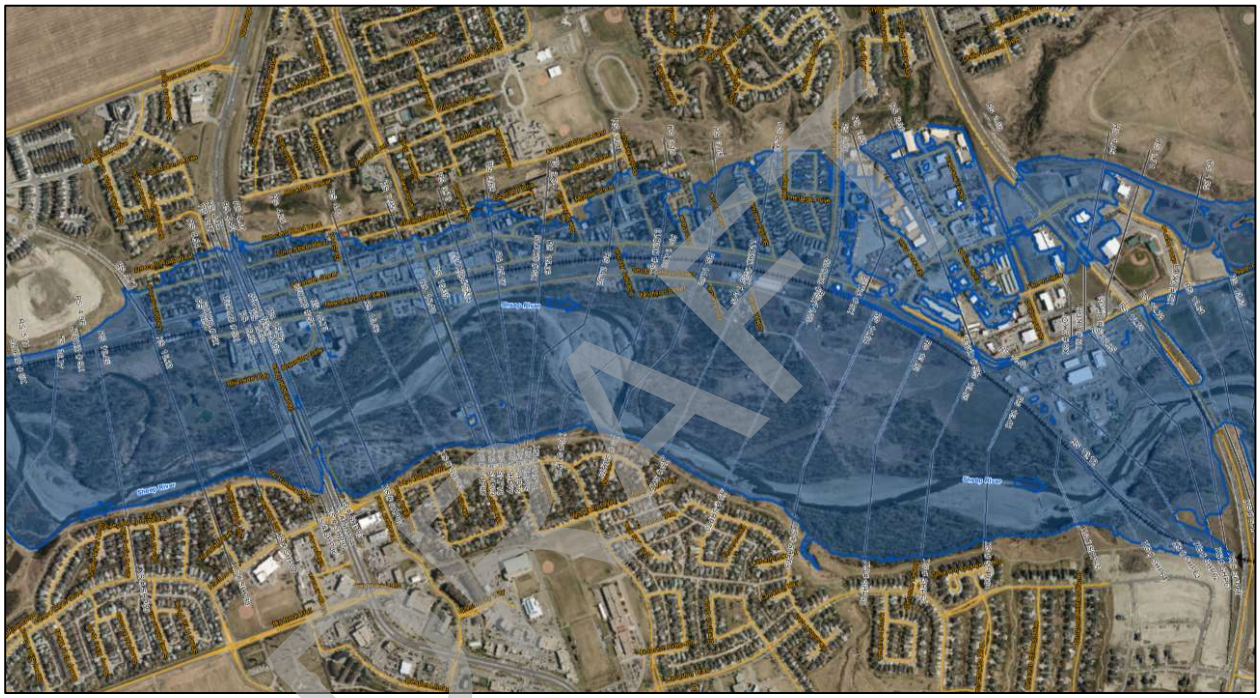
March 2023

Sheep River Flood Hazard Study

Flood Risk Assessment Inventory



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Flood Risk Assessment Inventory

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Executive Summary

Alberta Environment and Parks retained Hatch to complete a flood hazard study for a reach of the Sheep River (the Study). The primary purpose of the Study is to assess and identify river and flood hazards along an approximately 60-kilometer-long reach of the Sheep River, and a 35-kilometer-long reach of Threepoint Creek in the Municipal District of Foothills No. 31. This includes the Towns of Black Diamond, Turner Valley, Okotoks and the Hamlet of Millarville.

The study is being completed under the provincial Flood Hazard Identification Program (FHIP), the goals of which include enhancement of public safety and reduction of future flood damages through the identification of river and flood hazards. Project stakeholders include the government of Alberta, the towns of Okotoks, Turner Valley, and Black Diamond, the Municipal District of Foothills No. 31, and the public.

The Sheep River Hazard Study includes multiple components and deliverables. This report documents the methodology and results of the Flood Risk Assessment and Inventory component of the study. This component of the study defines and quantifies flood risks in the study area. The component combines the open water flood inundation with collected and interpreted spatial data. Using the projected inundation, a basic inventory of the land parcels, buildings, infrastructure, and population at risk was produced under different flood scenarios. This was done for all open water flood events (the 2-, 5-, 10-, 20-, 35-, 50-, 75-, 100-, 200-, 350-, 500-, 750-, and 1,000-year open water floods).

Flood statistics were then prepared to summarize and quantify flood impacts to:

- Land Parcels
- Residential buildings including
    - Single family houses
    - Multifamily buildings
    - Retirement homes
- Non-residential buildings
    - Hospitals and other health care facilities,
    - Schools
    - Commercial facilities
    - Power line networks

  - Critical infrastructure such as water treatment plants, and wastewater treatment plants

- Transportation Infrastructures including
  - Highway networks
  - Road networks
  - Bridges within the study area,
  - Railroad networks

In summary, the 1000-year open water event would have the largest impact among the scenarios that were tested. Under this scenario, 1,570 people would be at risk, 510 residential buildings and 150 non-residential buildings would be impacted. In addition, ten bridges, a 35 km length of roadways, a 1.4 km length of Highway 2A, and a 0.6 km length of Highway 2 would be impacted. Non-residential buildings impacted include the wastewater treatment plant in Okotoks, the Okotoks water treatment plant, and the Sheep River Medical Clinic in Okotoks.

The design flood event for the study area is a scenario involving passage of the 100-year open water flood, and this reflects the most severe flood hazard in each reach. Statistics were also assembled for the design flood hazard event.

Impacts during this event would include:

- Inundation of 337 residential buildings, resulting in a population at risk of approximately 1029 residents.
- Inundation of 87 non-residential buildings, including flooding of the waste water treatment facility in Okotoks.
- Transportation infrastructure impacts would consist of:
  - Inundation of an 800 m stretch of Highway 2A adjacent to the Sheep River
  - Impacts to an approximately 25 km length of roadway in the study area.

The lower chords would be submerged on two bridges on the Sheep River – the Highway 2A crossing in Okotoks and the Highway 22 crossing in Black Diamond.

Acknowledgements

The authors express their special thanks to Kurt Morrison, Peter Bezeau, and Pat Stevenson of Alberta Environment and Parks (AEP), who provided overall study management, background data, and technical guidance for this study.

The following members of Hatch completed the hydraulic modelling component of this study:

- Joe Groeneveld, Project Manager and technical advisor
- Babak Alinejad, Project Engineer and flood risk assessment inventory
- Soheil Zare, Hydraulic modelling and mapping
- Mark Orton, Hydrology review
- Shayla Murphy, Mapping
- Nadia Langenberg, Mapping
- Rachel Groeneveld, Mapping and flood risk assessment inventory

The study team would also like to thank the following agencies, each of which provided valuable information and assistance in the completion of this portion of the study:

- Municipal District of Foothills No. 31;
- Town of Black Diamond;
- Town of Okotoks;
- Town of Turner Valley;
- Water Survey of Canada; and
- Informatics Branch of Alberta Environment and Parks
- Amec Foster Wheeler (initial investigator, who supplied the surveys and cross sectional data)

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1. Introduction

Alberta Environment and Parks retained Hatch to complete a flood hazard study for a reach of the Sheep River (the Study). The primary purpose of the Study is to assess and identify river and flood hazards along an approximately 60 kilometer long reach of the Sheep River, and a 35 kilometer long reach of Threepoint Creek in the Municipal District of Foothills No. 31. This includes the Towns of Black Diamond, Turner Valley, Okotoks and the Hamlet of Millarville.

The upstream limit of the study reach is located approximately 60 km upstream of the Highwood confluence, just to the west of section 20-19-3-W5M. This is approximately 8 km southwest of Turner Valley. The Threepoint Creek study reach extends from its confluence with the Sheep River, 35 km upstream, to its confluence with Ware Creek (just to the northwest quarter of 23-20-04-W5M).

1.1 Study Background

As described by AEP, "the study will be completed under the provincial Flood Hazard Identification Program (FHIP), the goals of which include enhancement of public safety and reduction of future flood damages through the identification of river and flood hazards. Project stakeholders include the provincial government, local authorities, and the public."

This project was originally awarded to Amec Foster Wheeler (AFW) in 2015, and AFW completed a portion of the scope before their contract ended. Hatch was retained to complete the remainder of the study.

1.2 Study Objectives

Similar to other flood hazard studies undertaken by the Province, the Sheep River Study includes multiple components and deliverables:

- Survey and Base Data Collection Report (Previously completed by AFW)- Volume 1;
- Hydraulic Model Creation, Calibration, and Open Water Flood Inundation Map Production Report - Volume 2;
- Open Water Flood Hazard Identification Report – Volume 3;
- Governing Design Flood Hazard Mapping Report – Volume 4 (not required for this study, since open water flood conditions govern for this reach);
- Flood Risk Assessment and Inventory Report – Volume 5; and
- Channel Stability Investigation Report – Volume 6.

This document represents Volume 5 and provides details of the Sheep River Hazard Study flood risk assessment and inventory. Within this context, the following tasks were undertaken for this component of the study.

- Collection of data generated by the previous components and other data for the area including:
    - Available cadastral data
    - Available infrastructure inventory (e.g. transportation, hospitals, and water treatment)
    - Census data
- Interpretation of the collected data.
- Categorization of infrastructure inventory.
- Flood risk statistics assessment.

1.3 Study Area & Reach

Figure 1-1 summarizes the study area. As shown, the downstream end of this study reach is the confluence of Highwood River and Sheep River downstream of the Town of Okotoks. The upstream limit of the study reach is located approximately 60 km upstream of the Highwood confluence, just to the west of section 20-19-3-W5M. This is approximately 8 km southwest of Turner Valley. The Threepoint Creek study reach extends from its confluence with the Sheep River, 35 km upstream, to its confluence with Ware Creek (just to the northwest quarter of 23-20-04-W5M).

The 60 km Sheep River study reach includes the key points listed below. The stationing shown is listed in kilometers, as measured from the downstream end of the study reach and extending upstream.

- Confluence with the Highwood River - km 0.0
- Highway 2 Bridge - km 6.98
- Town of Okotoks – between km 11.25 and km 17.45
- Confluence with Threepoint Creek - km 34.52
- Town of Black Diamond - between km 39.9 and km 42.5
- Town of Turner Valley - between km 43.9 and km 48.2

The 35 km Threepoint Creek study reach includes the key points listed below.

- Confluence with the Sheep River - km 0.0
- 192 Street W Bridge Crossing (in the vicinity of the Millarville Race Track) - km 11.36

- Highway 22 Bridge Crossing (in the vicinity of the community of Millarville) - km 20.2
- Confluence with Fisher Creek - km 26.3
- Confluence with Ware Creek and upstream end of study area - km 34.79

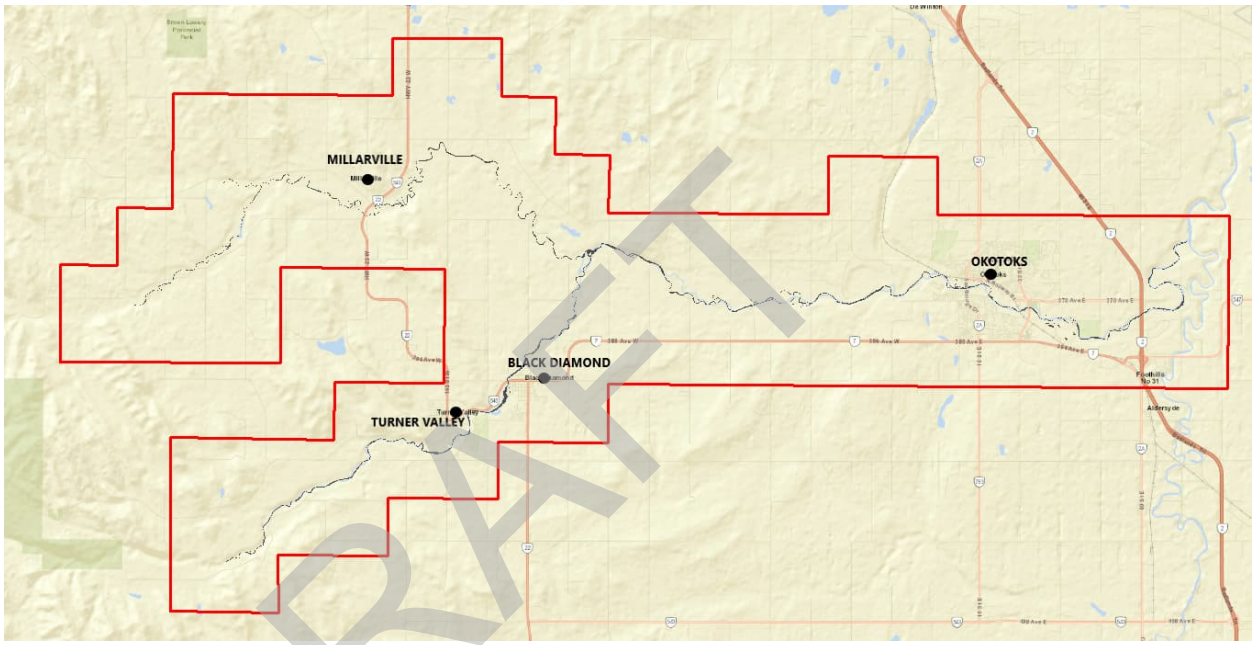

Figure 1-1: Study Reach

2. Available Spatial Data

As a first step in this assessment, it was necessary to compile all readily available spatial data representing development in the study area. This included the collection of available cadastral data, infrastructure data, and census data. Each data source is further described below.

2.1 Cadastral

The cadastral information required for the study includes recent data on building footprints and land parcels. This data has been provided by AEP.

Building footprint data were available for the town of Okotoks. This dataset covers potentially impacted areas in the community. Aerial photos have also been collected by AEP and were provided to complete this assessment. Google Earth aerial imagery and Bing Aerial Imagery

(available through ARC-GIS) have been used to interpret building utilization where the AEP-supplied aerial photos were not clear or complete.

2.2 Infrastructure

Information on key infrastructure in the reaches was also required and collected, including details on:

- Highway networks: the study area includes both Highway 2 and 2A
- Road networks: The study covers urban areas in Turner Valley, Black Diamond, and Okotoks, with their associated road networks
- Bridges within the study area, which include crossings for:
    - HWY 204 bridge
    - HWY 22 near Millarville
    - 192 St W bridge
    - Township Road 210 bridge
    - Decalta Road bridge
    - HWY 22 bridge near Black Diamond
    - HWY 2A (2 bridge crossings)
    - Okotoks Pedestrian bridge
    - CPR bridge
    - 32 Street bridge
    - HWY 2 bridge
- Power line networks
- Railroad networks
- Hospitals and other health facilities, summarized in Table 2-1.

Table 2-1: Alberta Health Services Facilities Within the Study Area

Facility Name	Facility Type
Okotoks Health and Wellness Centre	Public Health Centre
Oilfields General Hospital	Hospital
Okotoks Mental Health Centre	Mental Health Centre

- Retirement homes: There are five senior care facilities located within the study area – 3 in the community of Okotoks and 2 in the community of Black Diamond.

2.3 Census

Recent census reports were also collected and reviewed to provide up-to-date information on the population statistics in the study area. For this study, data was used from the 2016 census.

The 2016 census reports that the total population in the Foothills No. 31 Municipal district is 22,766. The report also indicates that Okotoks is home to 28,833 residents, Turner Valley is home to 2,559 residents, and that Black Diamond is home to 2,552 residents. Again based on the 2016 census results, the average number of people per dwelling is 3.0 in Okotoks, 2.3 in Black Diamond and 2.6 in Turner Valley. The average number of people per dwelling in the Foothills No. 31 Municipal district is reported to be 2.7.

3. Interpreted Spatial Data

In order to perform a flood risk assessment for land parcels, buildings, infrastructure and the local population, an inventory of available spatial data was required. It was necessary to better understand the nature of development in the study area, and to help categorize this development. In order to compile this flood risk inventory, the compiled spatial information was processed so that it could be used more easily within the context of this study. Activities undertaken to expedite the utilization of this data include:

- Interpretation of all aerial imagery
- Generation of a spatially referenced centroid point for each building footprint and land parcel

3.1 Aerial Photography

Aerial photos have been collected by AEP and was provided to complete this assessment. Google Earth aerial imagery and Bing Aerial Imagery (available through ARC-GIS) have been used where the collected aerial photo was not clear.

For buildings where the utilization was not clear, Google street view was utilized to help clarify data interpretation.

3.2 Building Utilization

Centroids were provided for each identified building and land parcel in the area. The buildings were then classified into residential and non-residential structure categories. The residential structures were further sub-categorized into single-family homes, multi-family homes, multi-unit residential buildings, and retirement homes. Only primary residential structures were tallied in the statistics. It was found that in some cases, land parcels would contain two separate building footprints, and when this occurred, it was generally a garage and a house. For this inventory, only the house was included in the analysis. Secondary structures such as residential garages, sheds, and outbuildings were not included.

Non-residential structures included commercial buildings, schools, religious buildings, health facilities and hospitals, water and wastewater treatment facilities, and government buildings.

The utilization for these buildings was assessed using aerial imagery and street view images available through Google Earth. In order to generate the building utilization field for the building dataset, the following steps have been taken:

- For all residential lots where there were two buildings in the lot, the second, smaller building was normally identified as a "Garage" and although retained in the database, was not included in the statistical summary.
- All buildings smaller than 50 m^2 in area, other than those identified specifically as a "Garage", were identified as "Shed, Garage, or Service building" (unless it was an obvious commercial building e.g. Starbucks).
- All buildings in residential areas with footprints larger than 50 m^2 were identified as being residential buildings. Unless the available information identified a structure as being commercial in nature, it has been considered to be a residential building.
- All condos and apartments in the residential category were recategorized as multifamily buildings.

The results of this assessment are provided in Table 3-1, and building counts were provided for the various types of development in this area.

Table 3-1: Building Utilization Summary

Building Type	Number of Buildings				
	Okotoks	Black Diamond	Turner Valley	Foothills District No. 31	Total
Residential	8,386	1,152	1,135	647	11,320
Single Family	8,208	1,061	1,132	645	11,046
Multifamily	65	3	1	0	69
Retirement Home	3	2	0	0	5
Mobile	105	84	0	0	189
Hotel	5	2	2	2	11
Non-Residential	320	105	60	35	520
Commercial	278	93	45	25	441
Religious	8	2	3	2	15
Government	3	2	2	0	7
Health Services	8	2	0	0	10
Emergency Services	2	0	2	0	4
Recreation	5	1	2	3	11
School	10	2	1	1	14
Parkade	1	0	0	0	1
Campground	1	1	0	2	4
Airport	1	0	0	0	1
Industrial	2	0	5	2	9
Hospital	0	1	0	0	1
Water/Wastewater	1	1	0	0	2
Total	8,706	1,257	1,195	682	11,840

Table 3-2: Identified Retirement Homes

Name	Address
Revera The Heartland Retirement Residence	47 Riverside Gate, Okotoks
Tudor Manor	200 Sandstone Drive, Okotoks
Foothills Foundation	101 Centre Court, Okotoks
High Country Lodge	707 Government Road, Black Diamond
Ridgestone Lodge	115 Ridgestone Lane, Black Diamond

3.3 Residential Structures

As Table 3-1 presents, 11,320 of the building are residential buildings by nature, and these were carried forward in the assessment. These structures include single family homes, multi-family homes, and retirement homes.

3.4 Non-Residential Structures

There were a total of 518 non-residential buildings that have been identified in the reach, as summarized in Table 3-1 above. Non-residential structures include all commercial buildings, emergency services buildings, hospitals, care giving facilities, government buildings, industrial buildings, parkades, religious buildings, schools, water and wastewater treatment facilities. It should be noted that this does not include secondary buildings, such as garages and sheds that may be impacted by a flood event.

3.5 Major Transportation Infrastructure

Infrastructure spatial data has also been collected and used. This includes information on area roads and highways, bridges, and railways as noted in Section 2.2.

4. Flood Risk Assessment & Inventory

After the spatial data had been compiled, all inundated buildings were then identified by overlaying the inundation raster dataset with the structure/infrastructure dataset, and buildings falling within the inundation footprint were flagged as being potentially impacted by the flood event.

Flood statistics were then generated by tallying all impacted development for the following structure and infrastructure categories:

- Residential buildings
- Non-residential buildings
- Major transportation infrastructure

The following sections provide further information on the methodology of analysis, and the results of the assessment.

4.1 Methodology

Using the inventory dataset developed and described in Section 3, flood statistics were generated for the various flood events considered in this study. This information was then used to define flood risks in the study area, by combining the results of the open water flood inundation maps with the collected and interpreted spatial dataset.

One of the key tasks associated with this review involves the development of population estimates of those directly impacted by a given flood event. This requires careful review of where residential dwellings may lie relative to the expected flood inundation zones. After

reviewing the available data, it was judged that the most accurate way to estimate the number of impacted dwellings and the associated population at risk would be to consider dwellings on an individual basis rather than as part of pre-determined blocks of data, such as those used in recent census surveys of the area.

With this in mind, the methodology to generate these flood statistics consisted of the following five basic steps:

- Water surface elevation and depth raster datasets were previously generated for different return periods for open water flood events. The cases considered include all thirteen open water return period events (2-, 5-, 10-, 20-, 35-, 50-, 75-, 100-, 200-, 350-, 500-, 750-, and 1000-year open water floods, and the governing flood hazard event, in which the flood hazard area is divided into floodway and flood fringe zones (including high hazard flood fringe areas).
- For each flood event, the inundation raster dataset was overlain onto the structure/infrastructure database within GIS. All parcels, buildings, and infrastructure were then classified as being “at risk” if their centroids are located in the inundation area. Other properties were assessed as being out of the flooded area. Road and highway lengths impacted by a flood event were also assessed using specialized scripts within GIS based on the road centerline.
- The nature of each building was then assessed – each had previously been identified as a residential building (single and multi-family homes) or a commercial building. For multi family homes, the equivalent number of dwellings was estimated based on the number of stories of the building, and it’s overall square footage. It was assumed that each dwelling would occupy, on average 125 m^2.
- The affected population associated with each residential building type shown in Table 3-1 was then calculated based on the number of impacted dwellings, estimated in the two bullets above, and the estimated population density per dwelling. The 2016 census data was used to obtain a regional average for population density.
- The flood statistics for each category were then gathered and summarized in a series of excel based tables.

When these statistics are presented in tabular or graphical form for the governing flood hazard area, the flood fringe and high hazard flood fringe zones are considered separately. The statistics for the governing design flood hazard area reflect the sum of statistics from the floodway and flood fringe zones (including high hazard flood fringe areas). Statistics reported for the flood fringe on a standalone basis do not include high hazard flood fringe areas, which are accounted for separately.

The inundation extent was quantified separately for two different inundation classifications:

- Directly inundated areas (DI). These are areas that are inundated and have a direct overland connection to the main river channels.
- Flood control structure failure areas (FCS). Potential inundation areas due to flood control structure (FCS) failure correspond to areas that would flood if the flood control structure protecting the area failed. When the water surface elevations did not indicate overtopping of a FCS, the area behind the FCS was shown as potential inundation due to FCS failure. The inundation extent is determined by assuming that the flood control structure is ineffective. When the water surface elevations indicated that all or portions of the FCS are overtopped or outflanked, then areas behind the FCS were mapped as direct inundation areas.

Flood inundation areas were previously developed for 13 open water flood cases. The inundation polygons associated with these events were compared against the spatial inventory dataset to identify properties that may be at risk of flooding – either due to direct inundation, or due to potential failure of a flood control structure. Flood statistics were generated for each scenario, and these cases are presented in order of increasing return period in the following tables and sections. These tables summarize the results for each return period of flood event in terms of their impact on land parcels, residential buildings, non-residential buildings, and infrastructure.

4.1.1 Land Parcels

The summary of inundated land parcels is presented in Table 4-1. As shown, some land parcels would be impacted even for open water flood events with return periods as low as 2 years.

Table 4-1: Summary of Land Parcel Inundation – Open Water

Scenario	Direct Inundation	Flood Control Structure Failure	Total
2-Year	514	0	514
5-Year	586	0	586
10-Year	678	54	732
20-Year	829	92	921
35-Year	872	150	1022
50-Year	926	169	1095
75-Year	1462	318	1462
100-Year	1221	654	1548
200-Year	1592	0	1592
350-Year	1632	0	1632
500-Year	1668	0	1668
750-Year	1686	0	1686
1000-Year	1704	0	1704

Table 4-2: Summary of Land Parcel Inundation in Okotoks

Scenario	Direct Inundation	Flood Control Structure Failure	Total
2-Year	187	0	187
5-Year	227	0	227
10-Year	284	0	284
20-Year	312	0	312
35-Year	327	0	327
50-Year	333	0	333
75-Year	333	294	627
100-Year	334	320	654
200-Year	670	0	670
350-Year	707	0	707
500-Year	729	0	729
750-Year	736	0	736
1000-Year	748	0	748

Table 4-3: Summary of Land Parcel Inundation in Black Diamond

Scenario	Direct Inundation	Flood Control Structure Failure	Total
2-Year	9	0	9
5-Year	12	0	12
10-Year	13	53	66
20-Year	16	90	106
35-Year	13	137	150
50-Year	11	155	166
75-Year	170	0	170
100-Year	173	0	173
200-Year	178	0	178
350-Year	179	0	179
500-Year	181	0	181
750-Year	182	0	182
1000-Year	183	0	183

Table 4-4: Summary of Land Parcel Inundation in Turner Valley

Scenario	Direct Inundation	Flood Control Structure Failure	Total
2-Year	27	0	27
5-Year	28	0	28
10-Year	32	0	32
20-Year	40	0	40
35-Year	39	11	50
50-Year	39	12	51
75-Year	40	20	60
100-Year	57	3	60
200-Year	63	0	63
350-Year	63	0	63
500-Year	64	0	64
750-Year	65	0	65
1000-Year	65	0	65

Table 4-5: Summary of Land Parcel Inundation in the Municipal District of Foothills No. 31

Scenario	Direct Inundation	Flood Control Structure Failure	Total
2-Year	291	0	291
5-Year	319	0	319
10-Year	349	1	350
20-Year	461	2	463
35-Year	493	2	495
50-Year	543	2	545
75-Year	601	4	605
100-Year	657	4	661
200-Year	681	0	681
350-Year	683	0	683
500-Year	694	0	694
750-Year	703	0	703
1000-Year	708	0	708

4.1.2 Residential Structures

The summary of inundated Residential Structures is presented in Table 4-6, and includes the total number of impacted buildings, as well as a breakdown of buildings affected by direct and flood control structure failure inundation.

In reviewing these results, it is noted that:

- In the Municipal District of Foothills No. 31, the first residential flooding would occur for an open water event with a return period of 5 years.
- In Black Diamond, the first residential flooding would occur for an open water event with a return period of 10 years. Under passage of the 100 year event, up to 125 buildings could be impacted.
- In Turner Valley, the first residential flooding would occur for an open water event with a return period of 20 years. Under passage of the 100 year event, up to 11 buildings could be impacted.
- In Okotoks, the first residential flooding would occur for an open water event with a return period of 20 years. Under passage of the 100 year event, up to 158 buildings could be impacted.
- One retirement home would be impacted in Okotoks during flood events with a return period of 500-years or greater. This home would not be impacted for lesser flood events.

Table 4-6: Summary of Impacts to Residential Structures

Property	Number of impacted Residential Structures												
	2-Year	5-Year	10-Year	20-Year	35-Year	50-Year	75-Year	100-Year	200-Year	350-Year	500-Year	750-Year	1000-Year
Total	0	2	14	59	98	125	246	337	372	457	476	496	510
Single Family	0	2	14	59	98	125	199	266	290	357	368	386	399
Retirement Home	0	0	0	0	0	0	0	0	0	0	1	1	1
Multifamily	0	0	0	0	0	0	2	3	5	7	9	9	9
Mobile	0	0	0	0	0	0	43	66	75	91	96	98	99
Hotel	0	0	0	0	0	0	2	2	2	2	2	2	2
Direct Inundation	0	2	5	13	27	34	150	202	372	457	476	496	510
Single Family	0	2	5	13	27	34	149	201	290	357	368	386	399
Retirement Home	0	0	0	0	0	0	0	0	0	0	1	1	1
Multifamily	0	0	0	0	0	0	0	0	5	7	9	9	9
Mobile	0	0	0	0	0	0	0	0	75	91	96	98	99
Hotel	0	0	0	0	0	0	1	1	2	2	2	2	2
Flood Control Structure Failure	0	0	9	46	71	91	96	135	0	0	0	0	0
Single Family	0	0	9	46	71	91	50	65	0	0	0	0	0
Retirement Home	0	0	0	0	0	0	0	0	0	0	0	0	0
Multifamily	0	0	0	0	0	0	2	3	0	0	0	0	0
Mobile	0	0	0	0	0	0	43	66	0	0	0	0	0
Hotel	0	0	0	0	0	0	1	1	0	0	0	0	0

Table 4-7: Summary of Impacts to Residential Structures in Okotoks

Property	Number of impacted Residential Structures												
	2-Year	5-Year	10-Year	20-Year	35-Year	50-Year	75-Year	100-Year	200-Year	350-Year	500-Year	750-Year	1000-Year
Total	0	0	0	3	11	16	112	158	186	260	277	289	295
Single Family	0	0	0	3	11	16	65	87	104	160	169	179	184
Retirement Home	0	0	0	0	0	0	0	0	0	0	1	1	1
Multifamily	0	0	0	0	0	0	2	3	5	7	9	9	9
Mobile	0	0	0	0	0	0	43	66	75	91	96	98	99
Hotel	0	0	0	0	0	0	2	2	2	2	2	2	2
Direct Inundation	0	0	0	3	11	16	19	23	186	260	277	289	295
Single Family	0	0	0	3	11	16	18	22	104	160	169	179	184
Retirement Home	0	0	0	0	0	0	0	0	0	0	1	1	1
Multifamily	0	0	0	0	0	0	0	0	5	7	9	9	9
Mobile	0	0	0	0	0	0	0	0	75	91	96	98	99
Hotel	0	0	0	0	0	0	1	1	2	2	2	2	2
Flood Control Structure Failure	0	0	0	0	0	0	93	135	0	0	0	0	0
Single Family	0	0	0	0	0	0	47	65	0	0	0	0	0
Retirement Home	0	0	0	0	0	0	0	0	0	0	0	0	0
Multifamily	0	0	0	0	0	0	2	3	0	0	0	0	0
Mobile	0	0	0	0	0	0	43	66	0	0	0	0	0
Hotel	0	0	0	0	0	0	1	1	0	0	0	0	0

Table 4-8: Summary of Impacts to Residential Structures in Black Diamond

Property	Number of impacted Residential Structures												
	2-Year	5-Year	10-Year	20-Year	35-Year	50-Year	75-Year	100-Year	200-Year	350-Year	500-Year	750-Year	1000-Year
Total	0	0	9	46	70	90	109	125	140	142	142	144	145
Single Family	0	0	9	46	70	90	109	125	140	142	142	144	145
Retirement Home	0	0	0	0	0	0	0	0	0	0	0	0	0
Multifamily	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile	0	0	0	0	0	0	0	0	0	0	0	0	0
Hotel	0	0	0	0	0	0	0	0	0	0	0	0	0
Direct Inundation	0	0	0	0	0	0	109	125	140	142	142	144	145
Single Family	0	0	0	0	0	0	109	125	140	142	142	144	145
Retirement Home	0	0	0	0	0	0	0	0	0	0	0	0	0
Multifamily	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile	0	0	0	0	0	0	0	0	0	0	0	0	0
Hotel	0	0	0	0	0	0	0	0	0	0	0	0	0
Flood Control Structure Failure	0	0	9	46	70	90	0	0	0	0	0	0	0
Single Family	0	0	9	46	70	90	0	0	0	0	0	0	0
Retirement Home	0	0	0	0	0	0	0	0	0	0	0	0	0
Multifamily	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile	0	0	0	0	0	0	0	0	0	0	0	0	0
Hotel	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 4-9: Summary of Impacts to Residential Structures in Turner Valley

Property	Number of impacted Residential Structures												
	2-Year	5-Year	10-Year	20-Year	35-Year	50-Year	75-Year	100-Year	200-Year	350-Year	500-Year	750-Year	1000-Year
Total	0	0	0	2	6	7	10	11	17	20	21	21	21
Single Family	0	0	0	2	6	7	10	11	17	20	21	21	21
Retirement Home	0	0	0	0	0	0	0	0	0	0	0	0	0
Multifamily	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile	0	0	0	0	0	0	0	0	0	0	0	0	0
Hotel	0	0	0	0	0	0	0	0	0	0	0	0	0
Direct Inundation	0	0	0	2	5	6	6	11	17	20	21	21	21
Single Family	0	0	0	2	5	6	6	11	17	20	21	21	21
Retirement Home	0	0	0	0	0	0	0	0	0	0	0	0	0
Multifamily	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile	0	0	0	0	0	0	0	0	0	0	0	0	0
Hotel	0	0	0	0	0	0	0	0	0	0	0	0	0
Flood Control Structure Failure	0	0	0	0	1	1	3	0	0	0	0	0	0
Single Family	0	0	0	0	1	1	3	0	0	0	0	0	0
Retirement Home	0	0	0	0	0	0	0	0	0	0	0	0	0
Multifamily	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile	0	0	0	0	0	0	0	0	0	0	0	0	0
Hotel	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 4-10: Summary of Impacts to Residential Structures in the Municipal District of Foothills No. 31

Property	Number of impacted Residential Structures												
	2-Year	5-Year	10-Year	20-Year	35-Year	50-Year	75-Year	100-Year	200-Year	350-Year	500-Year	750-Year	1000-Year
Total	0	2	5	8	11	12	16	43	29	35	36	42	49
Single Family	0	2	5	8	11	12	16	43	29	35	36	42	49
Retirement Home	0	0	0	0	0	0	0	0	0	0	0	0	0
Multifamily	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile	0	0	0	0	0	0	0	0	0	0	0	0	0
Hotel	0	0	0	0	0	0	0	0	0	0	0	0	0
Direct Inundation	0	2	5	8	11	12	16	43	29	35	36	42	49
Single Family	0	2	5	8	11	12	16	43	29	35	36	42	49
Retirement Home	0	0	0	0	0	0	0	0	0	0	0	0	0
Multifamily	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile	0	0	0	0	0	0	0	0	0	0	0	0	0
Hotel	0	0	0	0	0	0	0	0	0	0	0	0	0
Flood Control Structure Failure	0	0	0	0	0	0	0	0	0	0	0	0	0
Single Family	0	0	0	0	0	0	0	0	0	0	0	0	0
Retirement Home	0	0	0	0	0	0	0	0	0	0	0	0	0
Multifamily	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile	0	0	0	0	0	0	0	0	0	0	0	0	0
Hotel	0	0	0	0	0	0	0	0	0	0	0	0	0

4.1.3 Non-Residential Structures

The non-residential category includes major structures for commercial, cultural, emergency services, government, and similar activities. The summary of inundated non-residential buildings is presented in Table 4-11 through to Table 4-23. Table 4-11 to Table 4-15

summarize the total number of impacted buildings in the reach and in each community. Table 4-16 to Table 4-20 provide a breakdown of buildings affected by direct inundation. Table 4-21 and Table 4-23 provide a summary of buildings that would be impacted by a flood control structure failure. Secondary buildings, such as garages and outdoor sheds, are not included in these totals.

In reviewing these results, it is noted that:

- In the Municipal District of Foothills No. 31, the first non-residential flooding would occur for an open water event with a return period of 5 years. This would involve the flooding of a campground area.
- In Black Diamond, the first non-residential flooding would occur for an open water event with a return period of 10 years with the inundation of a campground area. Under passage of the 100 year event, up to 26 buildings could be impacted.
- In Turner Valley, no non-residential flooding would occur for any return periods.
- In Okotoks, the first non-residential flooding would occur for an open water event with a return period of 5 years with the inundation of a camping area. Under passage of the 100 year event, up to 60 buildings could be impacted.
- The Okotoks waste water treatment facility located just upstream of the 32nd St E bridge crossing, would begin to be affected for floods with return periods equal to or exceeding the 100 year event.
- The Okotoks water treatment facility, located in Sheep River Park, would be impacted for flood events exceeding approximately 200 years. However, road access to the water treatment facility can be cut off at much lower return period events – as low as a 1:5 year open water flood.
- No hospitals would be impacted in the region.
- Buildings in Okotoks and Black Diamond will be affected in the case of Flood Control Structure Failure.

Table 4-11: Total Number of Impacted Non-Residential Buildings

Property	Number of impacted Non-Residential Structures												
	2-Year	5-Year	10-Year	20-Year	35-Year	50-Year	75-Year	100-Year	200-Year	350-Year	500-Year	750-Year	1000-Year
Total Non-Residential	0	2	3	6	20	28	70	87	97	123	135	144	150
Commercial	0	0	0	3	17	25	63	79	87	113	124	133	138
Religious	0	0	0	0	0	0	2	2	2	2	2	2	3
Government	0	0	0	0	0	0	2	2	2	2	2	2	2
Health Services	0	0	0	0	0	0	0	0	0	0	1	1	1
Emergency Services	0	0	0	0	0	0	0	0	0	0	0	0	0
Recreation	0	0	0	0	0	0	0	0	0	0	0	0	0
School	0	0	0	0	0	0	0	0	0	0	0	0	0
Parkade	0	0	0	0	0	0	0	0	0	0	0	0	0
Campground	0	2	3	3	3	3	3	3	4	4	4	4	4
Airport	0	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0	0
Hospital	0	0	0	0	0	0	0	0	0	0	0	0	0
Water/Waste water Treatment	0	0	0	0	0	0	0	1	2	2	2	2	2

Table 4-12: Total Number of Impacted Non-Residential Buildings in Okotoks

Property	Number of impacted Non-Residential Structures												
	2-Year	5-Year	10-Year	20-Year	35-Year	50-Year	75-Year	100-Year	200-Year	350-Year	500-Year	750-Year	1000-Year
Total Non-Residential	0	1	1	3	5	7	45	60	67	93	105	112	118
Commercial	0	0	0	2	4	6	42	56	62	88	99	106	111
Religious	0	0	0	0	0	0	1	1	1	1	1	1	2
Government	0	0	0	0	0	0	1	1	1	1	1	1	1
Health Services	0	0	0	0	0	0	0	0	0	0	1	1	1
Emergency Services	0	0	0	0	0	0	0	0	0	0	0	0	0
Recreation	0	0	0	0	0	0	0	0	0	0	0	0	0
School	0	0	0	0	0	0	0	0	0	0	0	0	0
Parkade	0	0	0	0	0	0	0	0	0	0	0	0	0
Campground	0	1	1	1	1	1	1	1	1	1	1	1	1
Airport	0	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0	0
Hospital	0	0	0	0	0	0	0	0	0	0	0	0	0
Water/Waste water Treatment	0	0	0	0	0	0	0	1	2	2	2	2	2

Table 4-13: Total Number of Impacted Non-Residential Buildings in Black Diamond

Property	Number of impacted Non-Residential Structures												
	2-Year	5-Year	10-Year	20-Year	35-Year	50-Year	75-Year	100-Year	200-Year	350-Year	500-Year	750-Year	1000-Year
Total Non-Residential	0	0	1	2	14	20	24	26	28	28	28	29	29
Commercial	0	0	0	1	13	19	21	23	25	25	25	26	26
Religious	0	0	0	0	0	0	1	1	1	1	1	1	1
Government	0	0	0	0	0	0	1	1	1	1	1	1	1
Health Services	0	0	0	0	0	0	0	0	0	0	0	0	0
Emergency Services	0	0	0	0	0	0	0	0	0	0	0	0	0
Recreation	0	0	0	0	0	0	0	0	0	0	0	0	0
School	0	0	0	0	0	0	0	0	0	0	0	0	0
Parkade	0	0	0	0	0	0	0	0	0	0	0	0	0
Campground	0	0	1	1	1	1	1	1	1	1	1	1	1
Airport	0	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0	0
Hospital	0	0	0	0	0	0	0	0	0	0	0	0	0
Water/Waste water Treatment	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 4-14: Total Number of Impacted Non-Residential Buildings in Turner Valley

Property	Number of impacted Non-Residential Structures												
	2-Year	5-Year	10-Year	20-Year	35-Year	50-Year	75-Year	100-Year	200-Year	350-Year	500-Year	750-Year	1000-Year
Total Non-Residential	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0	0
Religious	0	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0	0
Health Services	0	0	0	0	0	0	0	0	0	0	0	0	0
Emergency Services	0	0	0	0	0	0	0	0	0	0	0	0	0
Recreation	0	0	0	0	0	0	0	0	0	0	0	0	0
School	0	0	0	0	0	0	0	0	0	0	0	0	0
Parkade	0	0	0	0	0	0	0	0	0	0	0	0	0
Campground	0	0	0	0	0	0	0	0	0	0	0	0	0
Airport	0	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0	0
Hospital	0	0	0	0	0	0	0	0	0	0	0	0	0
Water/Waste water Treatment	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 4-15: Total Number of Impacted Non-Residential Buildings in the Municipal District of Foothills No. 31

Property	Number of impacted Non-Residential Structures												
	2-Year	5-Year	10-Year	20-Year	35-Year	50-Year	75-Year	100-Year	200-Year	350-Year	500-Year	750-Year	1000-Year
Total Non-Residential	0	1	1	1	1	1	1	1	2	2	2	3	3
Commercial	0	0	0	0	0	0	0	0	0	0	0	1	1
Religious	0	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0	0
Health Services	0	0	0	0	0	0	0	0	0	0	0	0	0
Emergency Services	0	0	0	0	0	0	0	0	0	0	0	0	0
Recreation	0	0	0	0	0	0	0	0	0	0	0	0	0
School	0	0	0	0	0	0	0	0	0	0	0	0	0
Parkade	0	0	0	0	0	0	0	0	0	0	0	0	0
Campground	0	1	1	1	1	1	1	1	2	2	2	2	2
Airport	0	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0	0
Hospital	0	0	0	0	0	0	0	0	0	0	0	0	0
Water/Waste water Treatment	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 4-16: Summary of Directly Inundated Non-Residential Buildings

Property	Number of impacted Non-Residential Structures												
	2-Year	5-Year	10-Year	20-Year	35-Year	50-Year	75-Year	100-Year	200-Year	350-Year	500-Year	750-Year	1000-Year
Total Non-Residential	0	2	2	4	7	9	38	45	97	123	135	144	150
Commercial	0	0	0	2	5	7	32	38	87	113	124	133	138
Religious	0	0	0	0	0	0	2	2	2	2	2	2	3
Government	0	0	0	0	0	0	1	1	2	2	2	2	2
Health Services	0	0	0	0	0	0	0	0	0	0	1	1	1
Emergency Services	0	0	0	0	0	0	0	0	0	0	0	0	0
Recreation	0	0	0	0	0	0	0	0	0	0	0	0	0
School	0	0	0	0	0	0	0	0	0	0	0	0	0
Parkade	0	0	0	0	0	0	0	0	0	0	0	0	0
Campground	0	2	2	2	2	2	3	3	4	4	4	4	4
Airport	0	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0	0
Hospital	0	0	0	0	0	0	0	0	0	0	0	0	0
Water/Waste water Treatment	0	0	0	0	0	0	0	1	2	2	2	2	2

Table 4-17: Summary of Directly Inundated Non-Residential Buildings in Okotoks

Property	Number of impacted Non-Residential Structures												
	2-Year	5-Year	10-Year	20-Year	35-Year	50-Year	75-Year	100-Year	200-Year	350-Year	500-Year	750-Year	1000-Year
Total Non-Residential	0	1	1	3	5	7	13	18	67	93	105	112	118
Commercial	0	0	0	2	4	6	11	15	62	88	99	106	111
Religious	0	0	0	0	0	0	1	1	1	1	1	1	2
Government	0	0	0	0	0	0	0	0	1	1	1	1	1
Health Services	0	0	0	0	0	0	0	0	0	0	1	1	1
Emergency Services	0	0	0	0	0	0	0	0	0	0	0	0	0
Recreation	0	0	0	0	0	0	0	0	0	0	0	0	0
School	0	0	0	0	0	0	0	0	0	0	0	0	0
Parkade	0	0	0	0	0	0	0	0	0	0	0	0	0
Campground	0	1	1	1	1	1	1	1	1	1	1	1	1
Airport	0	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0	0
Hospital	0	0	0	0	0	0	0	0	0	0	0	0	0
Water/Waste water Treatment	0	0	0	0	0	0	0	1	2	2	2	2	2

Table 4-18: Summary of Directly Inundated Non-Residential Buildings in Black Diamond

Property	Number of impacted Non-Residential Structures												
	2-Year	5-Year	10-Year	20-Year	35-Year	50-Year	75-Year	100-Year	200-Year	350-Year	500-Year	750-Year	1000-Year
Total Non-Residential	0	0	0	0	1	1	24	26	28	28	28	29	29
Commercial	0	0	0	0	1	1	21	23	25	25	25	26	26
Religious	0	0	0	0	0	0	1	1	1	1	1	1	1
Government	0	0	0	0	0	0	1	1	1	1	1	1	1
Health Services	0	0	0	0	0	0	0	0	0	0	0	0	0
Emergency Services	0	0	0	0	0	0	0	0	0	0	0	0	0
Recreation	0	0	0	0	0	0	0	0	0	0	0	0	0
School	0	0	0	0	0	0	0	0	0	0	0	0	0
Parkade	0	0	0	0	0	0	0	0	0	0	0	0	0
Campground	0	0	0	0	0	0	1	1	1	1	1	1	1
Airport	0	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0	0
Hospital	0	0	0	0	0	0	0	0	0	0	0	0	0
Water/Waste water Treatment	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 4-19: Summary of Directly Inundated Non-Residential Buildings in Turner Valley

Property	Number of impacted Non-Residential Structures												
	2-Year	5-Year	10-Year	20-Year	35-Year	50-Year	75-Year	100-Year	200-Year	350-Year	500-Year	750-Year	1000-Year
Total Non-Residential	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0	0
Religious	0	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0	0
Health Services	0	0	0	0	0	0	0	0	0	0	0	0	0
Emergency Services	0	0	0	0	0	0	0	0	0	0	0	0	0
Recreation	0	0	0	0	0	0	0	0	0	0	0	0	0
School	0	0	0	0	0	0	0	0	0	0	0	0	0
Parkade	0	0	0	0	0	0	0	0	0	0	0	0	0
Campground	0	0	0	0	0	0	0	0	0	0	0	0	0
Airport	0	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0	0
Hospital	0	0	0	0	0	0	0	0	0	0	0	0	0
Water/Waste water Treatment	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 4-20: Summary of Directly Inundated Non-Residential Buildings in the Municipal District of Foothills No. 31

Property	Number of impacted Non-Residential Structures												
	2-Year	5-Year	10-Year	20-Year	35-Year	50-Year	75-Year	100-Year	200-Year	350-Year	500-Year	750-Year	1000-Year
Total Non-Residential	0	1	1	1	1	1	1	1	2	2	2	3	3
Commercial	0	0	0	0	0	0	0	0	0	0	0	1	1
Religious	0	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0	0
Health Services	0	0	0	0	0	0	0	0	0	0	0	0	0
Emergency Services	0	0	0	0	0	0	0	0	0	0	0	0	0
Recreation	0	0	0	0	0	0	0	0	0	0	0	0	0
School	0	0	0	0	0	0	0	0	0	0	0	0	0
Parkade	0	0	0	0	0	0	0	0	0	0	0	0	0
Campground	0	1	1	1	1	1	1	1	2	2	2	2	2
Airport	0	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0	0
Hospital	0	0	0	0	0	0	0	0	0	0	0	0	0
Water/Waste water Treatment	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 4-21: Summary of Flood Control Structure Failure for Non-Residential Buildings

Property	Number of impacted Non-Residential Structures												
	2-Year	5-Year	10-Year	20-Year	35-Year	50-Year	75-Year	100-Year	200-Year	350-Year	500-Year	750-Year	1000-Year
Total Non-Residential	0	0	1	2	13	19	32	42	0	0	0	0	0
Commercial	0	0	0	1	12	18	31	41	0	0	0	0	0
Religious	0	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	1	1	0	0	0	0	0
Health Services	0	0	0	0	0	0	0	0	0	0	0	0	0
Emergency Services	0	0	0	0	0	0	0	0	0	0	0	0	0
Recreation	0	0	0	0	0	0	0	0	0	0	0	0	0
School	0	0	0	0	0	0	0	0	0	0	0	0	0
Parkade	0	0	0	0	0	0	0	0	0	0	0	0	0
Campground	0	0	1	1	1	1	0	0	0	0	0	0	0
Airport	0	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0	0
Hospital	0	0	0	0	0	0	0	0	0	0	0	0	0
Water/Waste water Treatment	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 4-22: Summary of Flood Control Structure Failure for Non-Residential Buildings in Okotoks

Property	Number of impacted Non-Residential Structures												
	2-Year	5-Year	10-Year	20-Year	35-Year	50-Year	75-Year	100-Year	200-Year	350-Year	500-Year	750-Year	1000-Year
Total Non-Residential	0	0	0	0	0	0	32	42	0	0	0	0	0
Commercial	0	0	0	0	0	0	31	41	0	0	0	0	0
Religious	0	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	1	1	0	0	0	0	0
Health Services	0	0	0	0	0	0	0	0	0	0	0	0	0
Emergency Services	0	0	0	0	0	0	0	0	0	0	0	0	0
Recreation	0	0	0	0	0	0	0	0	0	0	0	0	0
School	0	0	0	0	0	0	0	0	0	0	0	0	0
Parkade	0	0	0	0	0	0	0	0	0	0	0	0	0
Campground	0	0	0	0	0	0	0	0	0	0	0	0	0
Airport	0	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0	0
Hospital	0	0	0	0	0	0	0	0	0	0	0	0	0
Water/Waste water Treatment	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 4-23: Summary of Flood Control Structure Failure for Non-Residential Buildings in Black Diamond

Property	Number of impacted Non-Residential Structures												
	2-Year	5-Year	10-Year	20-Year	35-Year	50-Year	75-Year	100-Year	200-Year	350-Year	500-Year	750-Year	1000-Year
Total Non-Residential	0	0	1	2	13	19	0	0	0	0	0	0	0
Commercial	0	0	0	1	12	18	0	0	0	0	0	0	0
Religious	0	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0	0
Health Services	0	0	0	0	0	0	0	0	0	0	0	0	0
Emergency Services	0	0	0	0	0	0	0	0	0	0	0	0	0
Recreation	0	0	0	0	0	0	0	0	0	0	0	0	0
School	0	0	0	0	0	0	0	0	0	0	0	0	0
Parkade	0	0	0	0	0	0	0	0	0	0	0	0	0
Campground	0	0	1	1	1	1	0	0	0	0	0	0	0
Airport	0	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0	0
Hospital	0	0	0	0	0	0	0	0	0	0	0	0	0
Water/Waste water Treatment	0	0	0	0	0	0	0	0	0	0	0	0	0

4.1.4 Major Transportation Infrastructure

As indicated earlier, the study area includes a length of Highway 2 and 2A and a portion of these highways can be impacted during large flood events. The total inundated length of each highway is summarized in Table 4-24. The total inundated length of the area road network is summarized in Table 4-25 through to Table 4-29. Finally, the impact on area bridges is summarized in Table 4-30.

Table 4-24: Highway Inundation Summary

	Length of Highway Inundation (m)						
Highway	75 Year Flood	100 Year Flood	200 Year Flood	350 Year Flood	500 Year Flood	750 Year Flood	1000 Year Flood
2A	614	807	1030	1168	1281	1353	1447
2	210	213	218	366	487	524	570

Table 4-25: Summary of Impacted Roads – Open Water Floods

Flood Scenario	Total Length of Impacted Roadway (m)		Number of Impacted Roads	
	Direct Inundation	Flood Control Structure Failure	Direct Inundation	Flood Control Structure Failure
2-Year	637	0	13	0
5-Year	1861	0	18	0
10-Year	2672	853	22	9
20-Year	5108	1839	33	13
35-Year	6942	2502	41	18
50-Year	8063	2912	44	17
75-Year	13715	5985	63	26
100-Year	15269	6930	62	28
200-Year	25914	0	96	0
350-Year	29041	0	101	0
500-Year	31911	0	102	0
750-Year	33646	0	103	0
1000-Year	35003	0	105	0

Table 4-26: Summary of Impacted Roads – Open Water Floods in Okotoks

Flood Scenario	Total Length of Impacted Roadway (m)		Number of Impacted Roads	
	Direct Inundation	Flood Control Structure Failure	Direct Inundation	Flood Control Structure Failure
2-Year	238	0	3	0
5-Year	300	0	4	0
10-Year	581	0	7	0
20-Year	1740	0	14	0
35-Year	2279	0	15	0
50-Year	2521	0	15	0
75-Year	3708	5927	19	25
100-Year	4260	6930	12	28
200-Year	12519	0	42	0
350-Year	14161	0	43	0
500-Year	15277	0	43	0
750-Year	15982	0	43	0
1000-Year	16304	0	44	0

Table 4-27: Summary of Impacted Roads – Open Water Floods in Black Diamond

Flood Scenario	Total Length of Impacted Roadway (m)		Number of Impacted Roads	
	Direct Inundation	Flood Control Structure Failure	Direct Inundation	Flood Control Structure Failure
2-Year	3	0	1	0
5-Year	4	0	1	0
10-Year	4	854	1	9
20-Year	5	1839	1	13
35-Year	6	2502	1	18
50-Year	17	2912	2	17
75-Year	3264	0	19	0
100-Year	3405	0	19	0
200-Year	3649	0	19	0
350-Year	3710	0	19	0
500-Year	3744	0	19	0
750-Year	3778	0	19	0
1000-Year	3810	0	19	0

Table 4-28: Summary of Impacted Roads – Open Water Floods in Turner Valley

Flood Scenario	Total Length of Impacted Roadway (m)		Number of Impacted Roads	
	Direct Inundation	Flood Control Structure Failure	Direct Inundation	Flood Control Structure Failure
2-Year	38	0	1	0
5-Year	44	0	1	0
10-Year	46	0	1	0
20-Year	543	0	4	0
35-Year	621	0	4	0
50-Year	696	0	4	0
75-Year	723	58	4	1
100-Year	885	0	5	0
200-Year	1046	0	5	0
350-Year	1180	0	5	0
500-Year	1414	0	5	0
750-Year	1442	0	5	0
1000-Year	1474	0	5	0

Table 4-29: Summary of Impacted Roads – Open Water Floods in the Municipal District of Foothills No. 31

Flood Scenario	Total Length of Impacted Roadway (m)		Number of Impacted Roads	
	Direct Inundation	Flood Control Structure Failure	Direct Inundation	Flood Control Structure Failure
2-Year	358	0	8	0
5-Year	1513	0	12	0
10-Year	2042	0	13	0
20-Year	2820	0	15	0
35-Year	4037	0	22	0
50-Year	4829	0	24	0
75-Year	6019	0	26	0
100-Year	6720	0	27	0
200-Year	8701	0	31	0
350-Year	9990	0	35	0
500-Year	11476	0	36	0
750-Year	12445	0	37	0
1000-Year	12354	0	38	0

Table 4-30: Summary of Impacted Bridges

River	River Station	Structure	Description	Bottom Cord Elevation	2 Year	5 Year	10 Year	20 Year	35 Year	50 Year	75 Year	100 Year	200 Year	350 Year	500 Year	750 Year	1000 Year	Above Bottom Cord Elevation
Threepoint Creek	32.38	Bridge	HWY 204	1253.85	1251.41	1251.88	1252.26	1252.65	1252.97	1253.18	1253.44	1253.57	1254.12	1254.18	1254.21	1254.22	1255.01	>100 Year
Threepoint Creek	19.965	Bridge / Culvert	HWY 22 - Millarville	1186.75	1184.07	1184.82	1185.48	1186.08	1186.36	1186.5	1186.53	1186.58	1186.71	1186.82	1186.89	1186.96	1187.02	>200 Year
Threepoint Creek	11.12	Bridge	192 St W	1164.07	1159.02	1160.05	1160.86	1161.67	1162.24	1162.55	1162.87	1163.07	1164.68	1164.99	1165.14	1165.28	1165.36	>100 Year
Threepoint Creek	4.31	Ford	Township Road 210	N/A	1140.6	1141.18	1141.67	1142.18	1142.6	1142.76	1143.05	1143.16	1143.44	1143.79	1144.37	1144.57	1144.62	N/A
Sheep River	46.078	Bridge	Decalta Road	1200.37	1196.03	1196.82	1197.44	1198.12	1198.58	1198.96	1199.41	1199.75	1200.61	1202.07	1203.84	1204.05	1204.21	>100 Year
Sheep River	42.221	Bridge	HWY 22 - Black Diamond	1176.23	1173.34	1174.01	1174.57	1175.36	1175.72	1176.3	1176.56	1176.72	1177.17	1177.43	1177.61	1177.78	1177.91	>50 Year
Sheep River	15.89	Bridge	HWY 2A	1055.8	1052.49	1053.29	1053.91	1054.34	1054.72	1054.99	1055.39	1055.9	1056.89	1057.29	1057.59	1057.77	1058.2	>75 Year
Sheep River	15.88	Bridge	HWY 2A	1056.21	1052.31	1053.14	1053.79	1054.17	1054.51	1054.8	1055.17	1055.52	1056.56	1056.93	1057.24	1057.36	1057.81	>100 Year
Sheep River	15.36	Bridge	Okotoks Pedestrian	1053.14	1050.65	1051.32	1051.67	1051.99	1052.22	1052.41	1052.68	1052.81	1053.2	1053.25	1053.45	1053.64	1053.79	>100 Year
Sheep River	13.13	Bridge	CPR	1054.7	1041.62	1042.32	1042.81	1043.32	1043.73	1044.06	1044.46	1044.75	1045.53	1046.35	1047.73	1048.64	1048.81	>1000 Year
Sheep River	12.741	Bridge	32 Street	1045.55	1040.1	1040.94	1041.65	1042.05	1042.57	1043.46	1043.92	1044.26	1045.26	1046.08	1046.63	1048.09	1048.38	>200 Year
Sheep River	7.005	Bridge	HWY 2	1020.63	1014.82	1015.88	1016.62	1017.33	1017.98	1018.42	1018.93	1019.31	1020.24	1021.24	1021.47	1021.99	1022.43	> 200 Year

4.1.5 Population

The average number of people per dwelling is 3.0 in Okotoks, 2.3 in Black Diamond and 2.6 in Turner Valley. The average number of people per dwelling in Alberta is 2.6, so this number was used for the Municipal District of Foothills No. 31. Table 4-31 summarizes the number of inundated dwellings and the population at risk for each scenario. Table 4-32 to Table 4-35 provide a breakdown for the various communities in this study.

Table 4-31: Number of Inundated Dwellings and Population at Risk

	2-Year Flood	5-Year Flood	10-Year Flood	20-Year Flood	35-Year Flood	50-Year Flood	75-Year Flood	100-Year Flood	200-Year Flood	350-Year Flood	500-Year Flood	750-Year Flood	1000-Year Flood
Number of Dwellings Inundated in the Study Area													
Directly Inundated	0	2	5	13	27	34	150	202	372	457	476	496	510
Flood Control Structure Failure	0	0	9	46	71	91	96	135	0	0	0	0	0
Population at Risk in the Study Area													
Directly Inundated	0	6	13	36	75	96	366	561	1106	1397	1475	1532	1570
Flood Control Structure Failure	0	0	21	106	163	209	329	468	0	0	0	0	0

Table 4-32: Number of Inundated Dwellings and Population at Risk in Okotoks

	2-Year Flood	5-Year Flood	10-Year Flood	20-Year Flood	35-Year Flood	50-Year Flood	75-Year Flood	100-Year Flood	200-Year Flood	350-Year Flood	500-Year Flood	750-Year Flood	1000-Year Flood
Number of Dwellings Inundated in the Study Area													
Directly Inundated	0	0	0	3	11	16	19	23	186	260	277	289	295
Flood Control Structure Failure	0	0	0	0	0	0	93	135	0	0	0	0	0
Population at Risk in the Study Area													
Directly Inundated	0	0	0	9	33	48	57	153	663	927	999	1035	1053
Flood Control Structure Failure	0	0	0	0	0	0	321	468	0	0	0	0	0

Table 4-33: Number of Inundated Dwellings and Population at Risk in Black Diamond

	2-Year Flood	5-Year Flood	10-Year Flood	20-Year Flood	35-Year Flood	50-Year Flood	75-Year Flood	100-Year Flood	200-Year Flood	350-Year Flood	500-Year Flood	750-Year Flood	1000-Year Flood
Number of Dwellings Inundated in the Study Area													
Directly Inundated	0	0	0	0	0	0	109	125	140	142	142	144	145
Flood Control Structure Failure	0	0	9	46	70	90	0	0	0	0	0	0	0
Population at Risk in the Study Area													
Directly Inundated	0	0	0	0	0	0	251	288	322	327	327	332	334
Flood Control Structure Failure	0	0	21	106	161	207	0	0	0	0	0	0	0

Table 4-34: Number of Inundated Dwellings and Population at Risk in Turner Valley

	2-Year Flood	5-Year Flood	10-Year Flood	20-Year Flood	35-Year Flood	50-Year Flood	75-Year Flood	100-Year Flood	200-Year Flood	350-Year Flood	500-Year Flood	750-Year Flood	1000-Year Flood
Number of Dwellings Inundated in the Study Area													
Directly Inundated	0	0	0	2	5	6	6	11	17	20	21	21	21
Flood Control Structure Failure	0	0	0	0	1	1	3	0	0	0	0	0	0
Population at Risk in the Study Area													
Directly Inundated	0	0	0	6	13	16	16	29	45	52	55	55	55
Flood Control Structure Failure	0	0	0	0	3	3	8	0	0	0	0	0	0

Table 4-35: Number of Inundated Dwellings and Population at Risk in the Municipal District of Foothills No. 31

	2-Year Flood	5-Year Flood	10-Year Flood	20-Year Flood	35-Year Flood	50-Year Flood	75-Year Flood	100-Year Flood	200-Year Flood	350-Year Flood	500-Year Flood	750-Year Flood	1000-Year Flood
Number of Dwellings Inundated in the Study Area													
Directly Inundated	0	2	5	8	11	12	16	43	29	35	36	42	49
Flood Control Structure Failure	0	0	0	0	0	0	0	0	0	0	0	0	0
Population at Risk in the Study Area													
Directly Inundated	0	6	13	21	29	32	42	112	76	91	94	110	128
Flood Control Structure Failure	0	0	0	0	0	0	0	0	0	0	0	0	0

4.2 Design Flood Inundation Areas

Open water flood events present the most severe flood hazard in each reach, and therefore the design flood event for the reach has been selected as the 1:100 year open water flood. The statistics for the governing design flood hazard area reflect the sum of statistics from the floodway and flood fringe zones (including both high hazard flood fringe and protected flood fringe areas), which are defined below:

Floodway

When a floodway is first defined on a flood hazard map, it typically represents the area of highest flood hazard where flows are deepest, fastest, and most destructive during the 100-year design flood. The floodway generally includes the main channel of a stream and a portion of the adjacent overbank area. Previously mapped floodways do not typically become larger when a flood hazard map is updated, even if the flood hazard area gets larger or design flood levels get higher, but there may be areas of high hazard outside of either an updated or newly-mapped floodway.

Flood Fringe

The flood fringe is the portion of the flood hazard area outside of the floodway. The flood fringe typically represents areas with shallower, slower, and less destructive flooding during the 100-year design flood. However, areas with deep or fast moving water may also be identified as high hazard flood fringe within the flood fringe. Areas at risk behind flood berms may also be mapped as protected flood fringe areas.

4.2.1 *Land Parcels*

The summary of inundated land parcels for the design event is presented in Table 4-36 . These statistics are very similar to those prepared and summarized for the 100-year open water event earlier.

Table 4-36: Summary of Land Parcel Inundation

Scenario	Land Parcel Inundation				
	Okotoks	Black Diamond	Turner Valley	Foothills District No. 31	Total
Floodway	283	17	43	495	840
Flood Fringe	47	38	9	160	254
High Hazard Flood Fringe	13	118	6	6	143
Protected Flood Fringe	320	0	3	4	327

* Many Land Parcels were inundated by two or more of the Floodway, Flood Fringe and High Hazard Flood Fringe and were classified according to the most dangerous zone that was present on each Land Parcel.

4.2.2 *Residential Buildings*

The summary of residential buildings impacted during the design event is presented in Table 4-37. These statistics are very similar to those prepared and summarized for the 100-year open water event earlier.

Table 4-37: Total Impacts to Residential Structures

Property	Okotoks				Black Diamond				Turner Valley				MD of Foothills No. 31				Total			
	Flood Fringe	Floodway	High Hazard Flood Fringe	Protected Flood Fringe	Flood Fringe	Floodway	High Hazard Flood Fringe	Protected Flood Fringe	Flood Fringe	Floodway	High Hazard Flood Fringe	Protected Flood Fringe	Flood Fringe	Floodway	High Hazard Flood Fringe	Protected Flood Fringe	Flood Fringe	Floodway	High Hazard Flood Fringe	Protected Flood Fringe
Single Family	20	2	0	65	63	0	62	0	7	2	2	0	7	36	0	0	97	40	64	65
Retirement Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Multifamily	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Mobile	0	0	0	66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	66
Hotel	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Total	21	2	0	135	63	0	62	0	7	2	2	0	7	36	0	0	98	40	64	135

4.2.3 Non-Residential Buildings

The summary of non-residential buildings impacted during the design event is presented in **Table 4-38**.

4.2.4 Roadways

The summary of roadways impacted during the design event is presented in **Table 4-39**. In addition, the predicted water surface profile would be high enough to impact the bottom chord of the bridge for both the Highway 22 Sheep River crossing in Black Diamond, and the Highway 2A crossing of the Sheep River in Okotoks

Table 4-38: Total Impacts to Non-Residential Structures

Property	Okotoks				Black Diamond				Turner Valley				MD of Foothills No. 31				Total			
	Flood Fringe	Floodway	High Hazard Flood Fringe	Protected Flood Fringe	Flood Fringe	Floodway	High Hazard Flood Fringe	Protected Flood Fringe	Flood Fringe	Floodway	High Hazard Flood Fringe	Protected Flood Fringe	Flood Fringe	Floodway	High Hazard Flood Fringe	Protected Flood Fringe	Flood Fringe	Floodway	High Hazard Flood Fringe	Protected Flood Fringe
Commercial	12	1	1	42	19	1	3	0	0	0	0	0	0	0	0	0	31	2	4	42
Religious	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
Government	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Health Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Emergency Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Recreation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
School	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parkade	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Campground	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	2	0
Airport	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hospital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Water/Wastewater Treatment	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Total	14	1	2	43	21	1	4	0	0	0	0	0	0	1	0	0	35	3	6	43

Table 4-39: Summary of Impacted Roads

Property		Total Length of Impacted Roadway (m)	Number of Impacted Roads
Okotoks	Flood Fringe	2752	17
	Floodway	793	8
	High Hazard Flood Fringe	642	5
	Protected Flood Fringe	6984	29
Black Diamond	Flood Fringe	1207	14
	Floodway	7	1
	High Hazard Flood Fringe	2195	16
	Protected Flood Fringe	0	0
Turner Valley	Flood Fringe	380	4
	Floodway	227	3
	High Hazard Flood Fringe	278	2
	Protected Flood Fringe	0	0
MD of Foothills No. 31	Flood Fringe	2149	22
	Floodway	7341	20
	High Hazard Flood Fringe	3	1
	Protected Flood Fringe	0	0
Total	Flood Fringe	6488	57
	Floodway	7341	32
	High Hazard Flood Fringe	3117	24
	Protected Flood Fringe	6984	29

4.2.5 Inundated Dwellings and Population at Risk

The summary of non-residential buildings impacted during the design event is presented in Table 4-40.

Table 4-40: Number of Inundated Dwellings and Population at Risk

Property	Okotoks				Black Diamond				Turner Valley				MD of Foothills No. 31				Total			
	Flood Fringe	Floodway	High Hazard Flood Fringe	Protected Flood Fringe	Flood Fringe	Floodway	High Hazard Flood Fringe	Protected Flood Fringe	Flood Fringe	Floodway	High Hazard Flood Fringe	Protected Flood Fringe	Flood Fringe	Floodway	High Hazard Flood Fringe	Protected Flood Fringe	Flood Fringe	Floodway	High Hazard Flood Fringe	Protected Flood Fringe
Number of Dwellings Inundated	21	2	0	135	63	0	62	0	7	2	2	0	7	36	0	0	98	40	64	135
Population at Risk	63	6	0	468	145	0	143	0	19	6	6	0	19	94	0	0	246	106	149	468

5. Conclusions

Flood risk inventory studies have been completed to define and quantify flood risks in the Sheep River study area. This was done by first developing a basic inventory of the land parcels, buildings, infrastructure, and population in the study area. After that, the open water flood inundation and governing design flood hazard maps with collected and overlain with the building and infrastructure inventory in order to identify flood susceptible development. This was done for all open water events (the 2-, 5-, 10-, 20-, 35-, 50-, 75-, 100-, 200-, 350-, 500-, 750-, and 1,000-year open water floods) and for the governing design flood event.

Flood statistics were then prepared to summarize and quantify flood impacts to:

- Residential structures
- Non-residential structures
- Major transportation infrastructure

The study results show that flood risk and impact is greatest during the passage of open water flood events.

In summary, the 1000-year open water event would have the largest impact among the scenarios that were tested. Under this scenario, 1,570 people would be at risk, 510 residential buildings and 150 non-residential buildings will be impacted. In addition, ten bridges, a 35 km length of roadways, a 1.4 km length of Highway 2A, and a 0.6 km length of Highway 2 will be impacted in the study area.

The design flood event for the study area is a scenario involving passage of the 100-year open water flood, and this reflects the most severe flood hazard in each reach. Statistics were also assembled for the design flood hazard event.

Impacts during this event would include:

- Inundation of 337 residential buildings, resulting in a population at risk of approximately 1029 residents.
- Inundation of 87 non-residential buildings.
- Transportation infrastructure impacts would consist of:
    - Inundation of an 800 m stretch of Highway 2A adjacent to the Sheep River
    - Impacts to an approximately 25 km length of roadway.
    - The lower chords would be submerged on two bridges on the Sheep River – the Highway 2A crossing in Okotoks and the Highway 22 crossing in Black Diamond.

6. References

AEP (Alberta Environment and Parks). 2011. *Flood Hazard Identification Program Guidelines*. July 2011

Canada, 2016. *Statistics Canada Census Profile, Okotoks, Turner Valley, Black Diamond, and Municipal District of Foothills No. 31, https://www12.statcan.gc.ca/census-recensement/2016, 2016.*

Hatch. 2019a. *Sheep River Hazard Study – Hydraulic Model Creation, Calibration and Inundation Mapping Report, July* 2019.

Hatch. 2019b. *Sheep River Hazard Study – Open Water Flood Hazard Identification Report, July* 2019.

Google (n.d.). *Imagery @2022 Maxar Technologies, S. Alberta MD's and Counties*. 2022