Town of CANMORE

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Climate Emergency Action Plan

Data, Methods, and Assumptions Manual for Adaptation Modelling

March 2024

Acknowledgement

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Modelling Method

About CityInSight Adaptation

CityInSight Adaptation is an integrated, spatially disaggregated adaptation model developed by Sustainability Solutions Group. It is rooted in the systems dynamics approach of representing complex systems through the interrelation of its variables. There are two core modules within CityInSight Adaptation: asset inventory and hazard simulation. The interaction of the variables within these two modules is the basis for the resulting climate risk assessment and mitigation analysis.

The model accounts for physical stocks and flows spatially and through time in order to inventory assets (e.g., people, buildings, infrastructure, etc.), resulting in a detailed account of built and natural environments within a geographic boundary (e.g., a city). Population and employment projections are overlaid on and spatially placed within the built environment.

Hazards are simulated by characterizing different variations of each hazard and assigning a probability to each variation. Hazard variations are typically characterized by their extent and intensity (e.g., flood area and depth). The probability assigned to each variation is often referred to as the return period (e.g., a flood with a return period of 100 would have a 1% chance of occurring in any given year).

The hazard sets are then applied to the spatial asset inventory in order to estimate risk, which is expressed as probabilities of incurring different levels of damage. As these risks are the result of an integrated causal network of dynamic variables, risk estimates will change over time as a function of dynamic inputs. For the purposes of an adaptation analysis, the key dynamic inputs are climate (i.e., Representative Concentration Pathway (RCP) scenarios) and assets (i.e., population, buildings, infrastructure, natural environment, etc.).

Table 1. Characteristics of CityInSight Adaptation.

Characteristic	Description
Integrated	CityInSight Adaptation is integrated in two ways. First, the variables in the model's network influence each other through causal links and feedback effects. For example, changing the characteristic of a hazard will change the risk estimates for the different assets exposed to it. Also, the effect of adding adaptive infrastructure can span multiple assets and hazards—adding green infrastructure to an urban area can reduce both population heat stress and building flood damages. Second, it fully integrates with SSG's mitigation model, CityInSight Community. For example, a building retrofit action included as a mitigation strategy will affect resilience to heat by providing more comfortable living space.
Scenario-based	Once calibrated with historical data, CityInSight enables the creation of dozens of scenarios to explore different possible futures. Each scenario can consist of either one or a combination of policies, actions, and strategies. Historical calibration ensures that scenario projections are rooted in observed data.
Spatial	Many hazards and assets are spatially distributed within a geographic boundary; their impacts and risks vary as a function of location. CityInSight Adaptation typically uses two different spatial resolutions for adaptation analysis: traffic zone/neighbourhood level for higher-level analysis and parcel level when hazard variance is highly location dependent (e.g., riverine and coastal flooding). The model can also be configured to use any other spatial resolution.
Dynamic	The core components of adaptation analysis are hazards and assets, both of which change over time. CityInSight Adaptation includes a time dimension, allowing the analysis to dynamically contrast hazard risk estimates influenced by evolving environments (built and natural) and climate. A present-day simulation of a geographic area is compared to its simulated future state by projecting these core hazard risk drivers into the future.

Characteristic	Description
Quantitative	CityInSight Adaptation includes a quantitative analysis of monetary and non-monetary costs and benefits associated with hazard risk and adaptation measures. The integrated and dynamic nature of the model allows for cost and benefit impacts spanning multiple assets and hazards to be compared through time. This approach provides guidance for strategic decisions by considering the long-term consequences of near-term investments as part of an evolving environment. The scope of hazards to which this quantitative analysis can be applied is subject to source data availability.

Stocks and Flows

The variables in the model's network are organized into a diagram of stocks and flows. Stocks are counts of similar things, classified by various properties, that change over time depending on their related flows. For example, population is modelled as a stock of people classified by age and gender. Population change over time is projected by accounting for the natural aging process, inflows (births, immigration), and outflows (deaths, emigration).

Elements of the built and natural environments are also determined by evolving stocks and flows. For example, current buildings by type, location, and construction year are represented as a base-year stock. This stock grows over time with the flow of new buildings, which is driven by development projections. Changes within a stock occur over simulation time as older stock is retired and new stock with different characteristics is added.

Sub-Models

The stocks and flows that make up each sub-model are described below.

Population, Households, and Demographics

- Total population is modelled using the "standard population cohort-survival method," which tracks population by age and gender on a year-by-year basis. It accounts for various components of change: births, deaths, immigration, and emigration.

- Population is allocated to households, and these are allocated to specific zones based on the locations of physical dwellings (see Building Land-Use Accounting sub-model).
- The age of the population is tracked over time, and this information is used for analyzing demographic trends, generational differences, and implications of hazard vulnerability, such as heat stress.

Building Land-Use Accounting

Land-use accounting tracks buildings in space and over time, through construction, retrofits, and demolitions. In the baseline, this is often directly informed by building-related geospatial data. Land-use accounting consists of the follow elements:

- Quantitative spatial projections of residential dwelling units by:
    - Type of residential structure (single-detached, semi-detached, row house, apartment, etc);
    - Development type (greenfield, intensification); and
    - Population assigned to dwelling units, using a persons-per-unit intensity.
- Quantitative spatial projections of non-residential buildings by:
    - Type of non-residential structure (retail, commercial, institutional);
    - Development type (greenfield, intensification);
    - Archetype classification (see Table 2).[1] This allows the model to account for differing intensities that would occur in relation to various non-residential buildings; and
    - Jobs allocated to zones via non-residential floor area, using a floor-area-per-worker intensity.

[1] Where possible, this data comes directly from the municipality.

- Land-use accounting takes the following "components of change" into account, year over year:
    - New development;
    - Removals/demolitions; and
    - Year of construction.
- Land-use accounting influences other aspects of the model, notably, hazard vulnerability, which can vary as a function of building location, building age, retrofit status, tree canopy cover, etc.

Table 2. Structure types represented in the model.

- Single/Double/Row
- Apartment
- Office
- Retail
- Institutional
- Restaurant
- Warehouse
- Hotel/Motel
- Vehicle/Equipment Service
- Commercial
- Industrial
- Roads
- Bridges/Culverts
- Utility Infrastructure
- Agricultural Crops

Modelling Process

CityInSight Adaptation is designed to support the process of developing a municipal strategy for climate adaptation. The process spans three phases: data collection and model calibration, the Reference Scenario, and the Adapted Scenario.

Data Collection and Model Calibration

A CityInSight Adaptation project begins with an intensive data collection and calibration exercise in which the model is systematically populated with demographic, land-use, infrastructure, and hazard data for the analysis base year. The scope of modelled hazards is determined through the municipality's knowledge of hazard vulnerability and through stakeholder engagement sessions. Additionally, in order to quantify hazard characteristics into risk, damage functions are employed. Damage functions relate hazard intensity (e.g., flood depth) to an amount of damage for different assets and damage types (e.g., building structure damage, people displaced, etc.). The end result of this phase is a highly detailed spatial model representing the municipality's current assets and hazard vulnerabilities.

Reference Scenario

Once data collection and model calibration for the base year are complete, a future representation of the municipality is simulated, spanning the analysis time frame. The simulation is developed by evolving the stocks and flows from the base-year calibrated model through demographic and land-use drivers such as population and new building projections, which results in a dynamic asset inventory (current and future population, buildings, infrastructure, etc.). Additionally, asset vulnerability is determined through physical and socioeconomic factors such as building age, building location, population income level, population age, etc.

Subsequently, future hazard characteristics (intensity and extent) are simulated through climate drivers determined by future climate scenarios (e.g., RCP 8.5).

The resulting asset and hazard simulations can then be overlaid to estimate risk for up to four different asset-hazard simulation combinations shown in Table 3.[2]

Table 3. Risk and vulnerability assessment matrix.

A. Current Assets-Current Hazards	B. Current Assets-Future Hazards
C. Current and Future Assets-Current Hazards	D. Current and Future Assets-Future Hazards

The asset-hazard combinations produce up to four distinct risk estimates and allow for the decoupling of new asset (B) and future climate (C) effects from future risk estimates (D). The Reference Scenario represents two of these asset-hazard combinations. It consists of the evolution from current risk (A) to future risk estimates (D), and the change in risk in the Reference Scenario is driven by both future assets and future climate.

Adapted Scenario

The Adapted Scenario uses a new set of input assumptions to explore the impacts of adaptation actions on risk estimates for modelled climate hazards. Often this begins with developing a list of candidate measures to address the areas at highest risk of consequence from climate hazards, as identified in the community vulnerability and risk assessment. This list is supplemented by additional measures and strategies that are identified through stakeholder engagement. These measures are used as model inputs to affect exposure and/or vulnerability of assets to the simulated hazards, which produces a new set of risk estimates. The difference in estimated risk between the Reference Scenario and the Adapted Scenario represents avoided damages from implementing adaptive measures. These avoided damages are contrasted with the cost of the measure as part of a cost-benefit analysis.

[2] Subject to source data availability.

Modelling Scope

Geographic Boundary

The geographic boundary of the modelling assessment is the municipal boundary of the town of Canmore (Figure 1). The model uses 48 neighbourhood zones (outlined in Figure 1) as the spatial dimension of the climate adaptation analysis. The model also uses parcel-level analysis for certain hazards where more spatial resolution is needed.

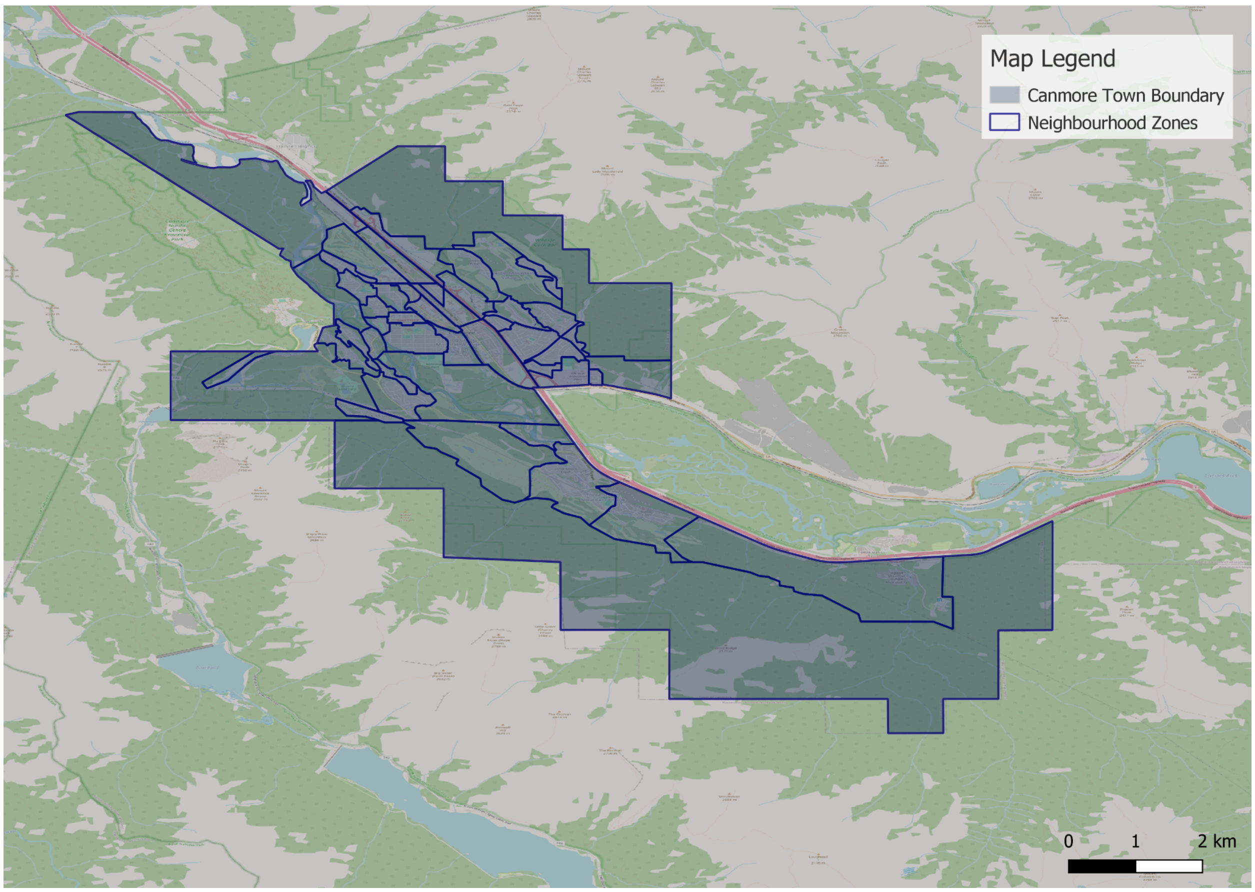


Figure 1. Map of Canmore, Alberta, divided by neighbourhood zone.

Time Scope

The analysis covers the years 2022 to 2070. The year 2022 was selected as the base year because it was the closest year to the present for which data was available. The year 2070 was chosen as the end year for two reasons:

- The availability of climate data: Canmore, AB, climate projections from Climatedata.ca are available in 30-year averages, with 2071 being the first year of the final 30-year group (2071–2100).
- The long-term implications of infrastructure decisions: The lifetimes of projects considered in the analysis range from 25 to 50 years; thus, the 48-year window between 2022 and 2070 is well suited for near-term infrastructure recommendations and could result in decades of avoided hazard damages.

The temporal dimension of the analysis is fundamental, as several key drivers of the analysis results vary with time (climate, built and natural environments, population). These will be discussed in further detail in the following sections.

Hazards Scope

The list of hazards included in the Canmore adaptation model are shown in Table 4.

Table 4. Hazard scope and definitions.

Modelled Hazard	Definition
Riverine flooding	Riverine flooding occurs when there is excessive rainfall over an extended period of time, which causes rivers or creeks to overflow.
Extreme heat	Extreme heat is a period of high heat and humidity. For the purposes of this analysis, we are specifically looking at the effect of such conditions as they relate to heat stress.

Modelling Sources and Assumptions

Whereas the previous sections have defined the general approach and framework for the analysis, the following section lists the specific sources and assumptions used for the analysis and discusses the methods used to incorporate them.

Model Inputs

The assumptions and sources used to populate the modelled asset inventory and related drivers are listed in Table 5.

Table 5. Model input assumptions/sources.

Asset	Assumptions/Source	Methodology
Current Population	Statistics Canada, 2021 census profile	Data was used to spatially distribute population by age to census tract and neighbourhood zone.
Population Projection	Projected dwelling unit growth by land-use type over 25 years 2.5 people per unit Town of Canmore	Population growth extrapolated to 2070 based on trend from 2022 to 2047. Spatial allocation of population based on future locations of residential buildings described in "Future Buildings" row below.
Socioeconomic Characteristics	Statistics Canada, Census Profile, 2021: Canada, Provinces, Territories, Census Divisions, Census Subdivisions and Dissemination Areas. Table 98-401-X2021006	Census-tract-level data were used to spatially distribute income level and age by neighbourhood zone.

Asset	Assumptions/Source	Methodology
Current Buildings	Assessment data provided by the Town of Canmore Canmore Open Data GIS layers: Canmore Municipal Buildings Canmore Building Footprints	Assessment data was used to spatially assign building characteristics (e.g., floorspace, building age) to parcels. Canmore Municipal Buildings was used to tag parcels with municipal uses. "BuildingUs" field in Canmore Building Footprints was used to assign building type to parcels.
Future Buildings	The number of residential units in Canmore is expected to increase 89% by 2050. Using the Offsite Levy data provided by the Town of Canmore, and taking into consideration the Area Structure Plans for both Smith Creek Area and Three Sisters Village, over 1,500 new dwelling units will be built by 2030 and a further 6,200 will be added by 2047, for a total of 7,800 units. Of these, 16% will be low-density housing, while the remaining 84% will be medium-density units. An additional 938 commercial and 3545 hotel units are expected to be built by 2047, which will lead to a 85% increase in non-residential floorspace to 728,000 sqm. Town of Canmore Future Development Plan Offsite Levy Data, Three Sisters Village Area Structure Plan and Smith Creek Area Structure Plan all provided by the Town of Canmore Revised Land-Use Bylaw 2018–22: Schedule A	Future building locations were assigned to land-use districts based on the permitted uses for the given land-use type. Within a neighbourhood zone, future buildings were assigned to parcels based on the building type being aligned with the land-use type of the parcel's land-use district and by land availability on a parcel. Furthermore, new buildings could not be placed in parcels currently designated to be in a flood zone.

Climate Projections

Climate projections used in the model were downloaded from Climatedata.ca for both the RCP 8.5 and 4.5 scenarios and are shown in Figure 2.[3]

These projections were principally used to inform how different return-period heat events included in the model evolve over time: yearly temperature maximum, five-year maximum, and 20-year maximum.

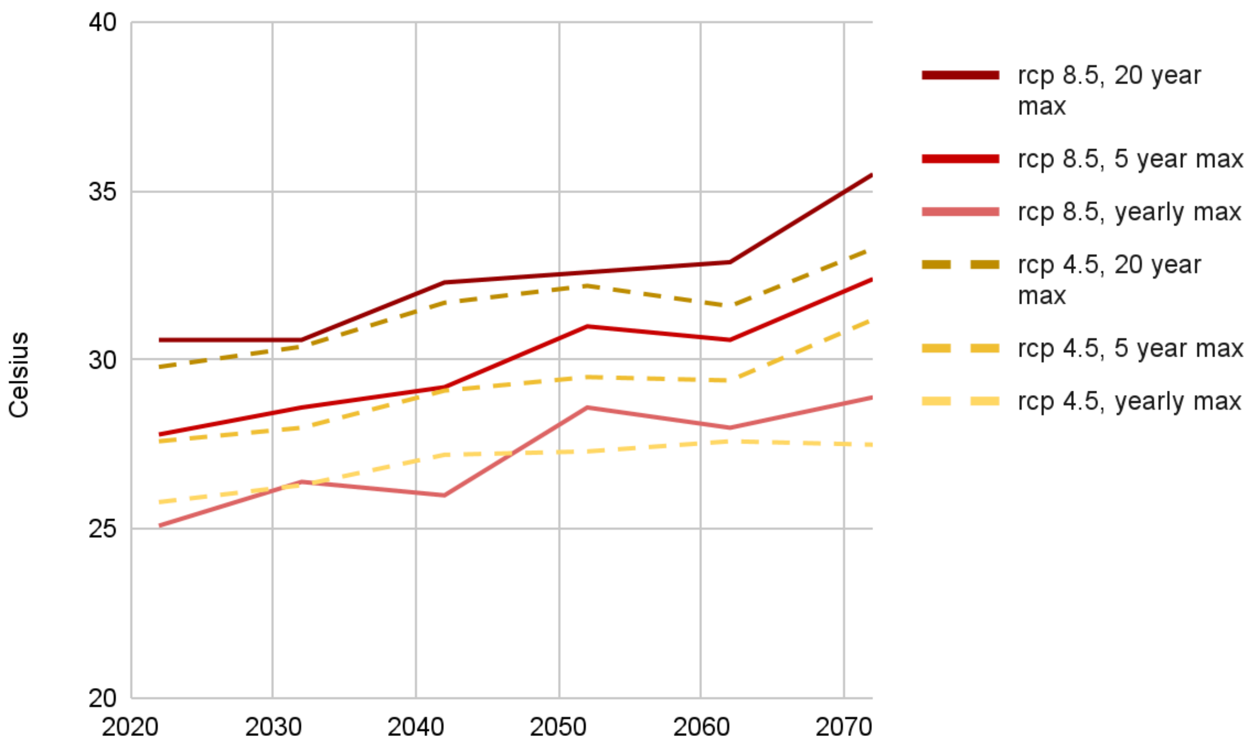


Figure 2. Projected one-year, five-year, and 20-year hottest day temperatures for RCP4.5 and RCP8.5.

[3] ClimateData.ca, Canmore, AB, Hottest Day, Annual Values, [Accessed October 2023].

Damage Functions

Damage functions are used to quantify hazard exposure to risk by relating hazard intensities to incurred damage. The damage function sources used for the Canmore Climate Risk and Vulnerability Assessment are listed in Table 6. Derived damage function curves, which include adjustments to current-year dollars, are shown for office, retail, and non-apartment residential floorspace in Figures 3–6. The full set of structure and content damage curves used in this study are presented in Appendix A.

The Riverine Flooding section of this DMA describes how these damage functions are used to calculate damages to buildings during flood events in Canmore.

Table 6. Damage functions assumptions/sources.

Damage Type	Assumptions/Source
Structure ($)	Federal Flood Damage Estimation Guidelines for Buildings and Infrastructure, Appendix 12,13 (NRCAN, 2021) Adjusted to current-year dollars per recommended approach in Provincial Flood Damage Assessment Study, Chapter 4 (IBI Group, 2015).
Content ($)	Federal Flood Damage Estimation Guidelines for Buildings and Infrastructure, Appendix 12,13 (NRCAN, 2021) Adjusted to current-year dollars per recommended approach in Provincial Flood Damage Assessment Study, Chapter 4 (IBI Group, 2015).
Intangible (days of displacement and disruption)	Federal Flood Damage Estimation Guidelines for Buildings and Infrastructure, Appendix 6 (NRCAN, 2021)
Indirect (% of direct damages)	Federal Flood Damage Estimation Guidelines for Buildings and Infrastructure, Section 5.2.2 (NRCAN, 2021)

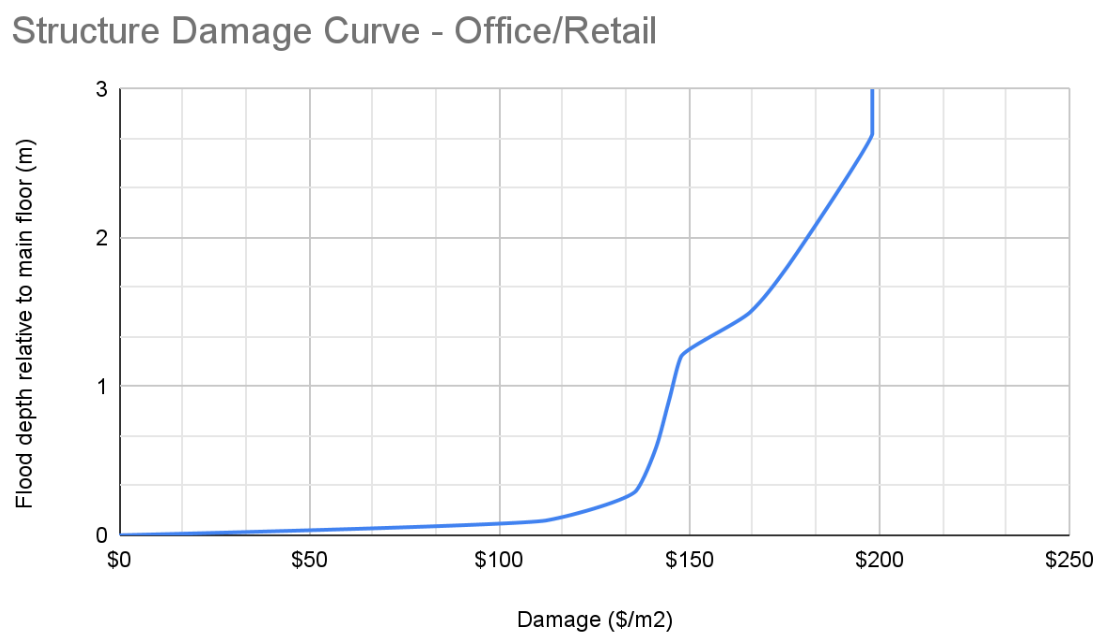


Figure 3. Structure damage curve for office retail floorspace.

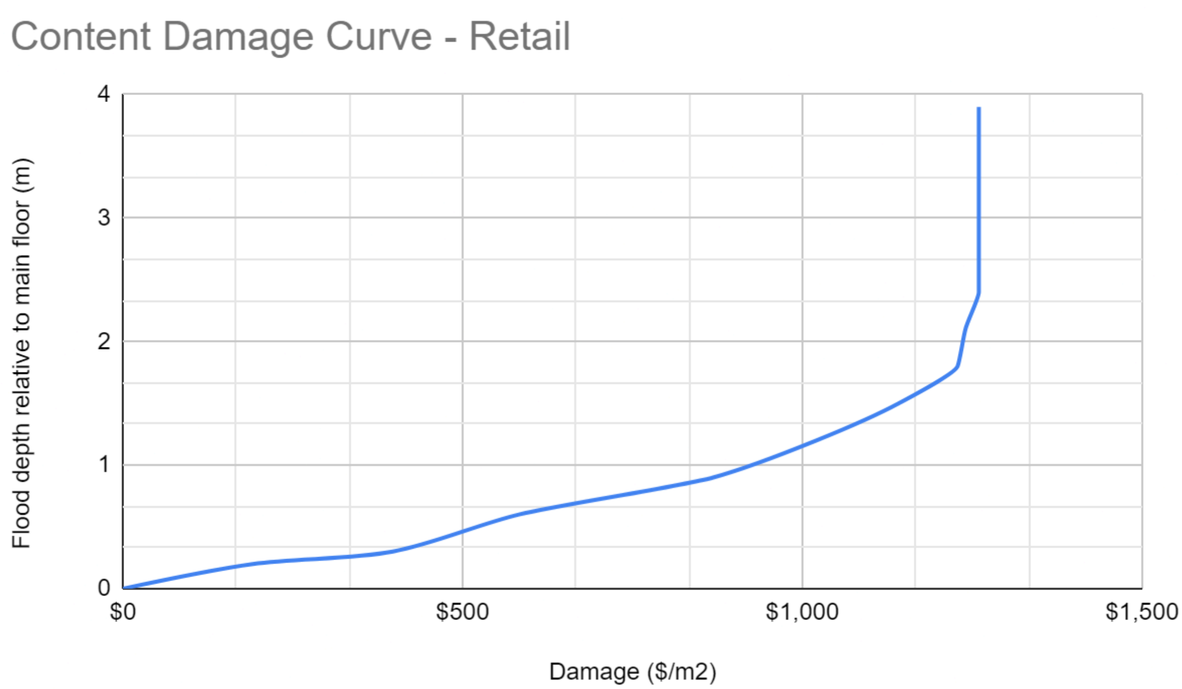


Figure 4. Content damage curve for retail floorspace.

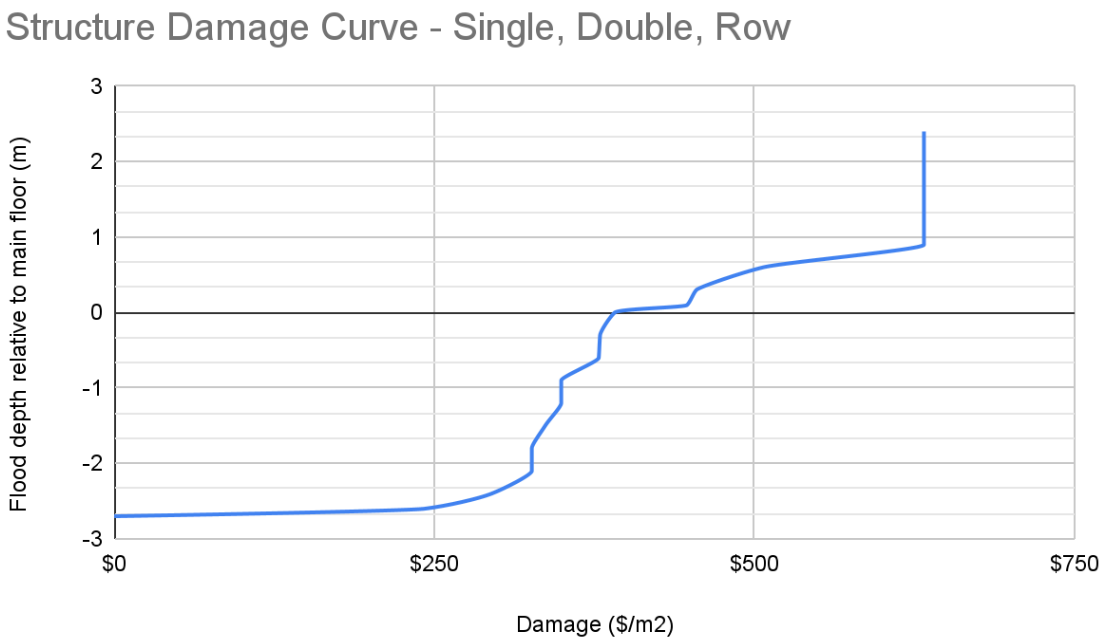


Figure 5. Structure damage curve for non-apartment residential floorspace.

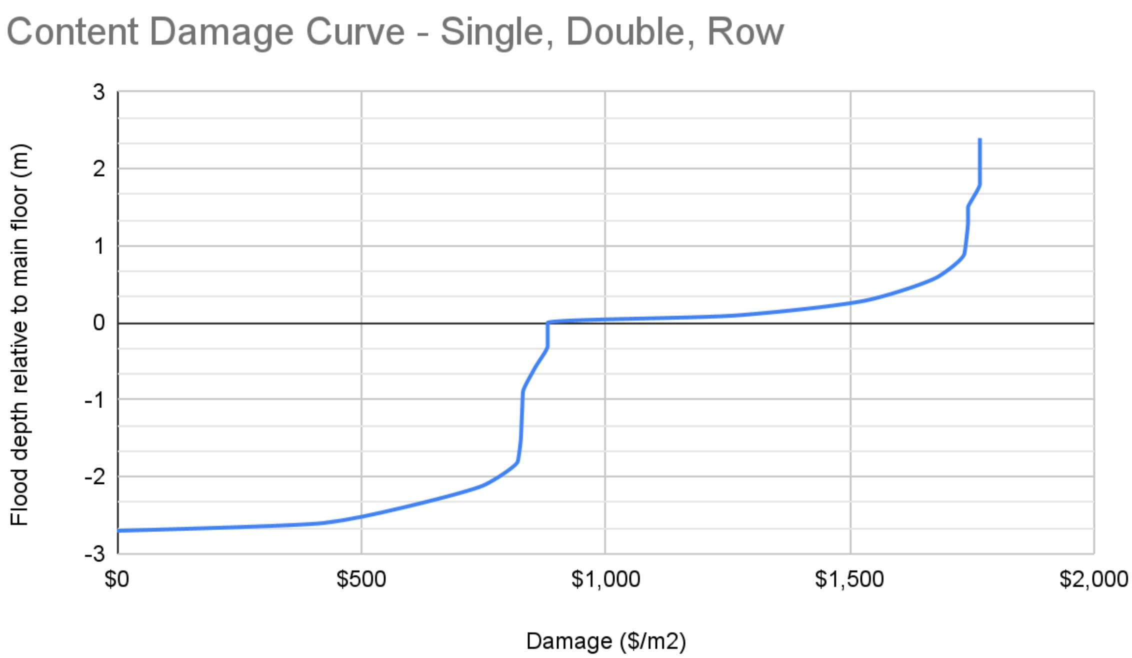


Figure 6. Content damage curve for non-apartment residential floorspace.

Heat

Risk Assessment

Spatial Temperature Differences and Urban Heat-Island Effect

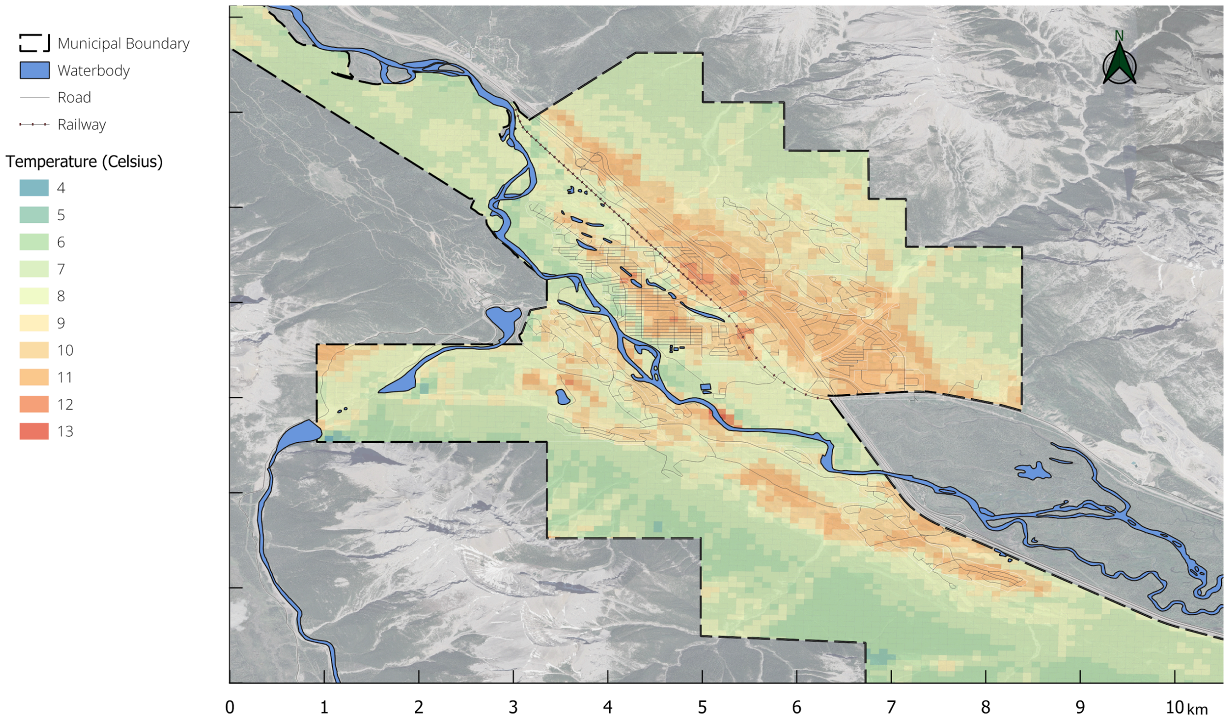
The spatial difference in temperature for high-temperature days was estimated using land surface temperature data captured by a NASA satellite on August 7, 2022, at 12:45 pm MDT.[4] The satellite instrument used to capture the data was the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER), which produces high-resolution images. Each pixel in the image represents a 90 m^2 area, providing sufficient resolution to detect differences in temperature among the neighbourhood zones shown in Figure 1 and to estimate urban heat-island effects.

Nighttime Temperature

The selected satellite image for this analysis was taken on a high-temperature day with very little cloud coverage; however, it was captured during the day. Our risk analysis of extreme heat events focuses on temperatures at night when vulnerable populations have fewer resources to cool off overnight during a heat wave, leading to negative health impacts. The measured daytime temperature from the ASTER data in the satellite image is therefore adjusted downward to estimate the nighttime temperature. The nighttime adjustment factor used is 0.28, which is the ratio of the recorded temperatures at the Banff Marine Aviation Weather Station at 1:00 am MDT and 1:00 pm MDT on August 7, 2022.

Figure 7 shows the estimated nighttime temperature with the spatial distribution of heat captured in the ASTER data.

[4] Data from the ASTER instrument (available from: https://search.earthdata.nasa.gov) was used for an image taken over Canmore, AB, on August 7th, 2022, at 12:45 pm (GMT-6).



Source: City of Canmore, base map sourced from Google Satellite imagery.

Figure 7. Canmore estimated nighttime land surface temperature on August 7th, 2022.

Zonal Averages

In order to obtain average temperature difference by zone, the 90 m^2 resolution ASTER data is grouped by neighbourhood zone and the average value of all temperature raster pixels within each zone is taken. The nighttime adjustment factor is applied to the zonal average to estimate the average nighttime temperature by zone. Finally, to obtain the zonal differences in temperature shown in Figure 8, the difference between the average nighttime temperature for each zone and temperature recorded at the Banff Marine Aviation Weather Station at 1:00 am on August 7, 2022, is calculated.

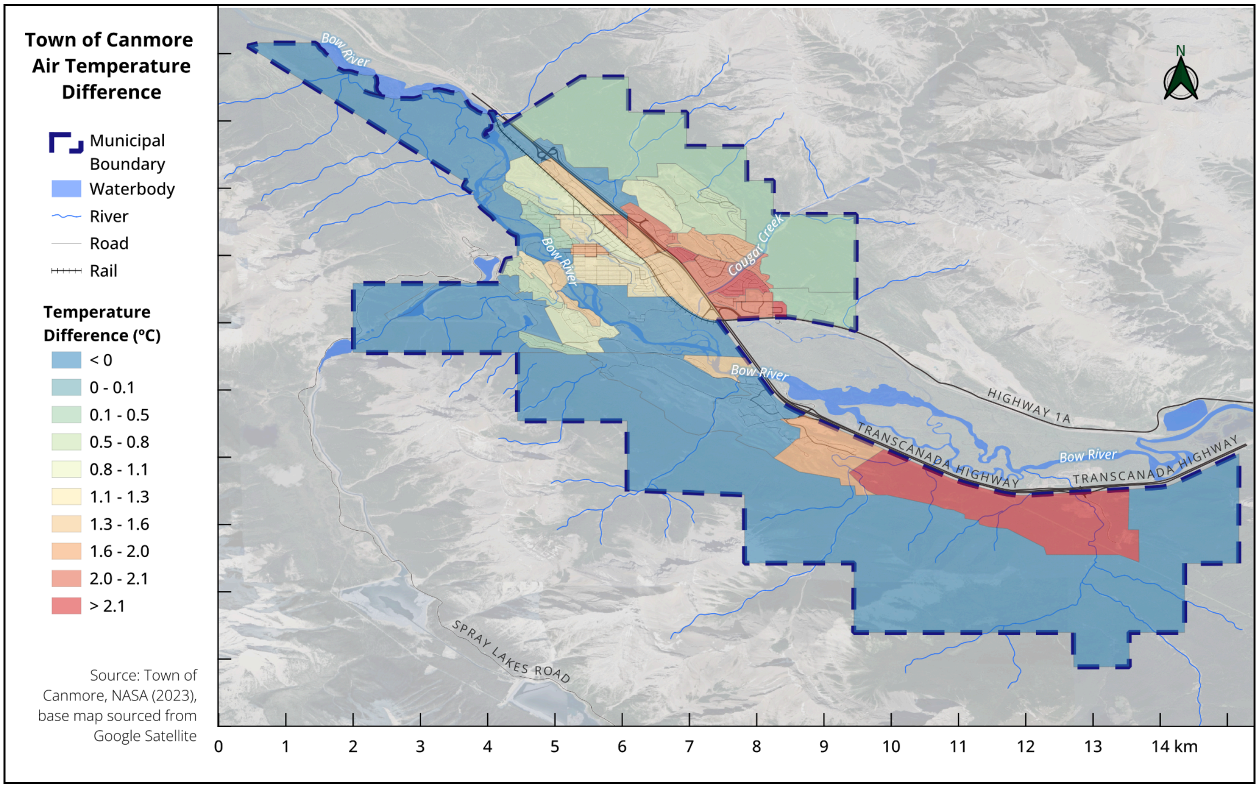


Figure 8. Estimated difference in nighttime air temperature for each neighbourhood zone.

Heat Projections

Projected temperatures by zone are obtained by combining summer temperature projections shown in the Climate Projections section of this document. The temperature of the Banff Marine Aviation Weather Station is assumed to increase according to the different RCP scenarios shown in Figure 2, and the temperature of all other zones is adjusted according to the estimated base year zonal difference shown in Figure 8.

Estimating Heat Risk

Current heat risk is based on zonal temperature estimates and the population living in these zones. Results were estimated for both total population by zone and vulnerable population by zone (lower income, age 65+). The temperature risk threshold was set at 14°C nighttime temperature based on Environment Canada's heat warning criteria for most of Alberta, as shown in Figure 9.[5]

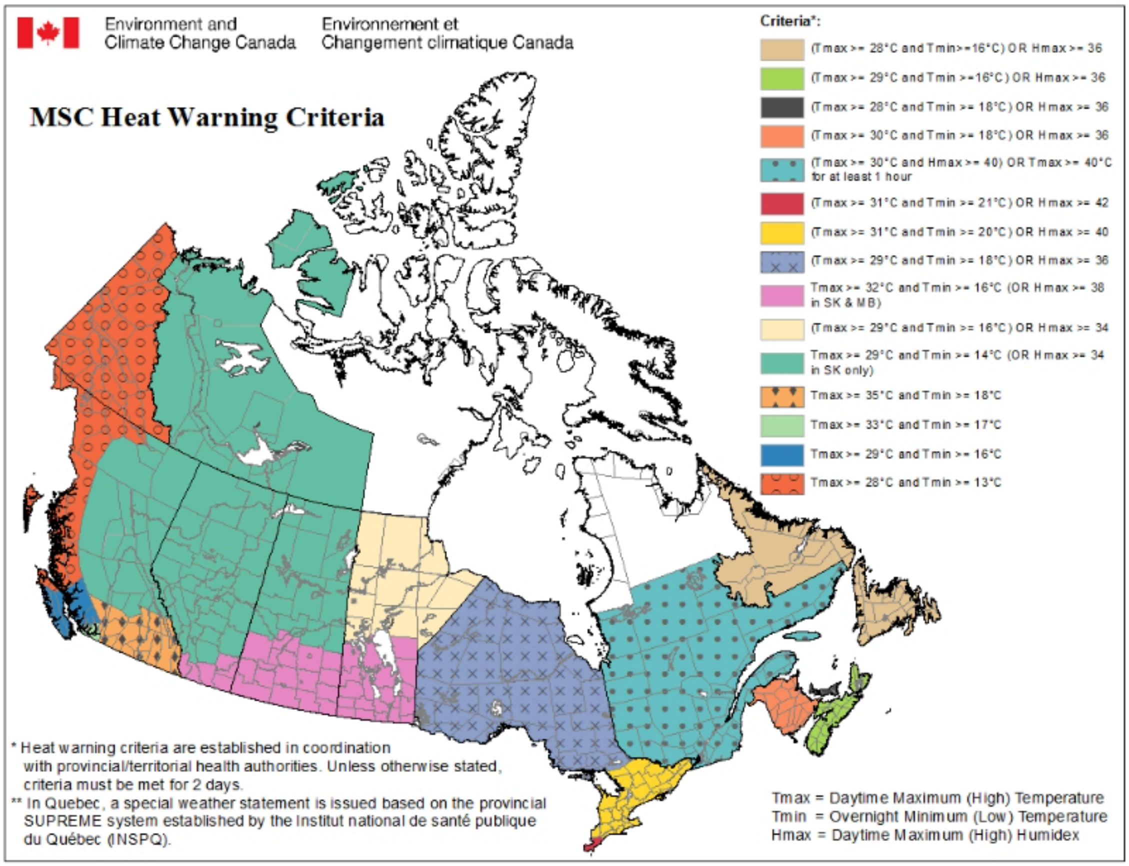


Figure 9. Heat warning criteria map from Environment Canada (2022).

Similarly, future heat risk is determined by combining future zonal heat projections described in the previous section with zonal population projections described in Table 5.

[5] Environment and Climate Change Canada, 2020. MSC Heat Warning Criteria. Issued when two or more consecutive days of daytime maximum temperatures are expected to reach 29°C or warmer and nighttime minimum temperatures are expected to fall to 14°C or warmer.

Riverine Flooding

Risk Assessment

CityInSight Adaptation uses the following steps to estimate the risk of damage from riverine flooding:

1. Characterize the location, type, and value of buildings throughout Canmore.
2. Derive the flood depth by return period present in each parcel within the Bow River watershed.
3. Calculate the damages from flooding by return period given the building characteristics and flood depth in a parcel by applying the corresponding damage functions.

Buildings

The primary data source for buildings in Canmore is property assessment records provided by the Town. These records provide the following characteristics for buildings in the town:

- Location
- Dwelling type for residential records
- Property type for non-residential records
- Year built
- Total floorspace
- Assessment value

Flood Depth

CityInSight Adaptation derives the riverine flood depth in each parcel from the Alberta flood mapping GIS dataset that was used for the Upper Bow River Flood Study. This flood mapping data is the result of a hydrological assessment and hydraulic modelling completed by the Government of Alberta. The GIS data provided flood depths as raster data at 0.5 m resolution.

Data availability on flood depth by recurrence interval is summarized in Table 7.

Table 7. Data availability on flooding return periods.

Water Body	**Flood Return Interval (Years)**						
	5	**10**	**20**	**50**	**100**	**200**	**350**
	Nuisance		**Frequent**	**Rare**		**Very Rare**	
Bow River	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Due to the number of recurrence intervals available, return periods were grouped into the four categories shown in Table 7. These categories are named based on how often a person with the average lifespan of 85 years can expect to experience a flood event of a specific magnitude.

- Nuisance: Events occurring often in a lifetime.
- Frequent: Events that may occur several times in a lifetime.
- Rare: Events that may occur once or twice in a lifetime.
- Very Rare: Events that may occur once, if at all, in a lifetime.

CityInSight Adaptation uses the flood depth raster data to assign a single flood depth value to each parcel. For parcels with existing buildings, CityInSight Adaptation assigns the maximum flood depth value within the building footprint on that parcel, as shown in Figure 10. For vacant parcels, CityInSight Adaptation assigns the average flood depth value across the parcel, as shown in Figure 11. In both figures each blue hexagon represents a raster data point with a flood depth value. The flood depth values increase from light to dark along the colour gradient. For parcels with existing buildings (Figure 10), the highest flood depth value from the raster points within the building outline is assigned to the parcel. For vacant parcels (Figure 11), the average flood depth value across all the raster points within the parcel outline is weighted by the fraction of parcel area covered by the raster points to derive a weighted average depth. The greater the fraction of parcel area covered by the raster data, the higher the weighted average depth will be.

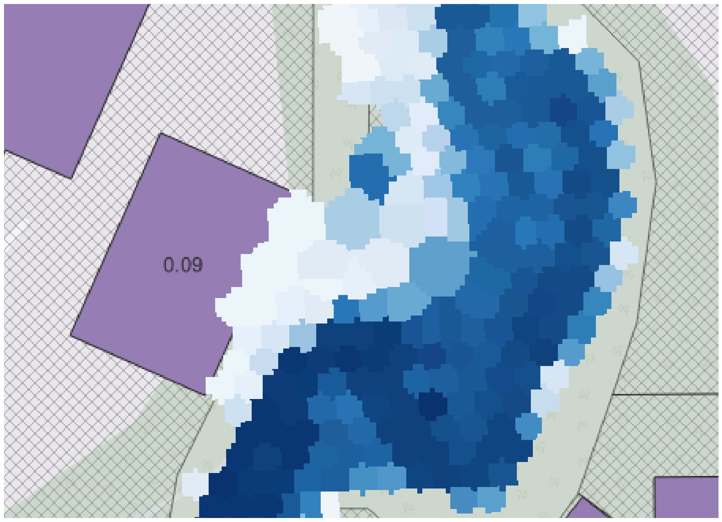


Figure 10. Example of flood depth levels within a building footprint.

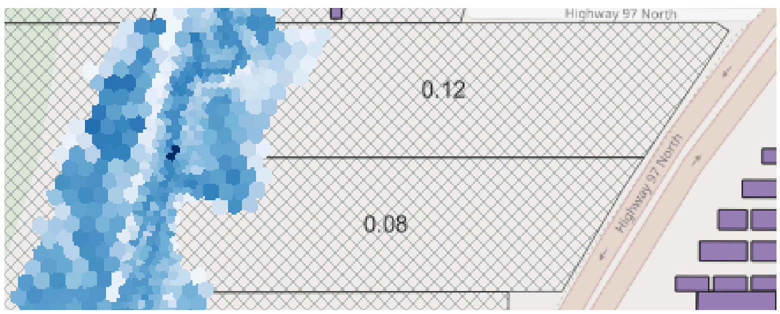


Figure 11. Example average flood depth level within vacant parcels.

Vertical Offsets

The vertical offset of a building is the height of the main floor relative to surface elevation, as illustrated in Figure 12. A vertical offset assumption of 300 mm for single-detached residential buildings and non-residential buildings was used for this analysis.

Figure 12. Vertical offset.[6]

Existing single-detached residential buildings were assumed to have basements 2.5 m below ground and that no damages occur until the basement flood level is at least 100 mm above ground level. New single-detached buildings in the Upper Bow River floodplain were conservatively assumed to have basements in the Reference Scenario. However, new single detached buildings in the Upper Bow River floodplain were assumed to **not** have basements in the Adapted Scenario.

The vertical offset and basement assumptions were used to calculate direct damages from flooding, as described in the next section.

Damages

CityInSight Adaptation calculates different types of damages by using the derived flood depth and the type of impacted building to look up the associated damages described in the Damage Functions section. There are three different types of damages: direct, indirect, and intangible.

Direct damages are damages that are quantifiable in terms of replacement value or repair cost. The sub-types of direct damage included in the analysis are structure damage and content damage (e.g., furniture, electronics, etc.).

[6] Associated Engineering. (2019). Kelowna Flood Risk Assessment. Figure B-3.

For buildings without basements, the structure and content damage functions were shifted to remove damages below the main floor level, as shown in Figure 13. Vertical offsets are subtracted from the flood depth value to derive an adjusted flood depth to use as the lookup value in the damage curves.

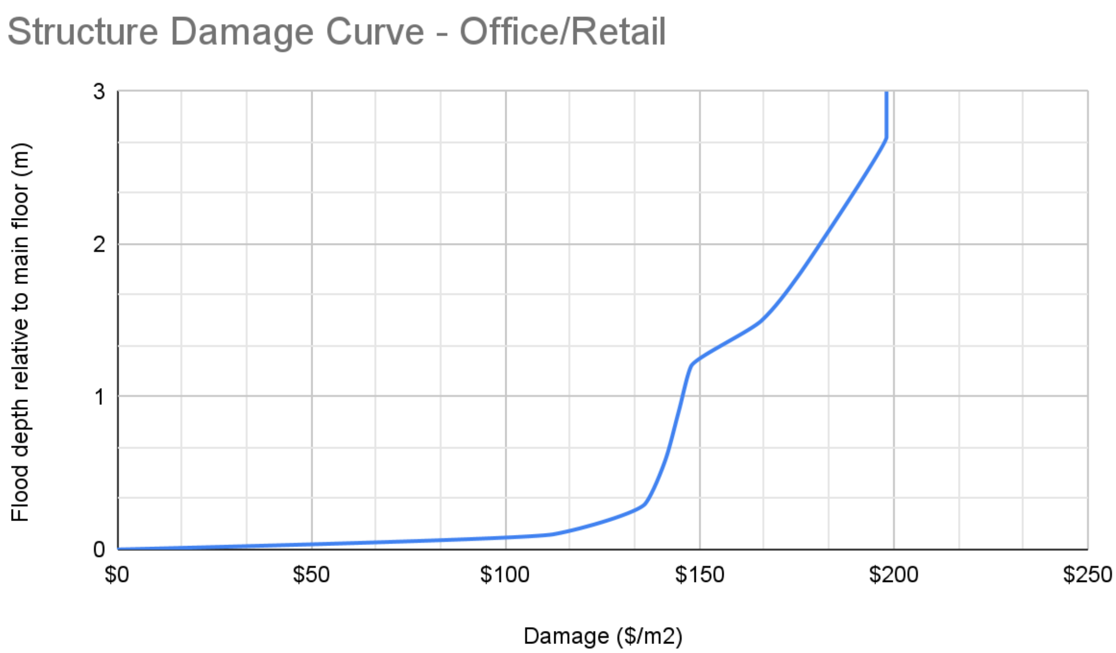
Figure 13. Shifted damage curve.

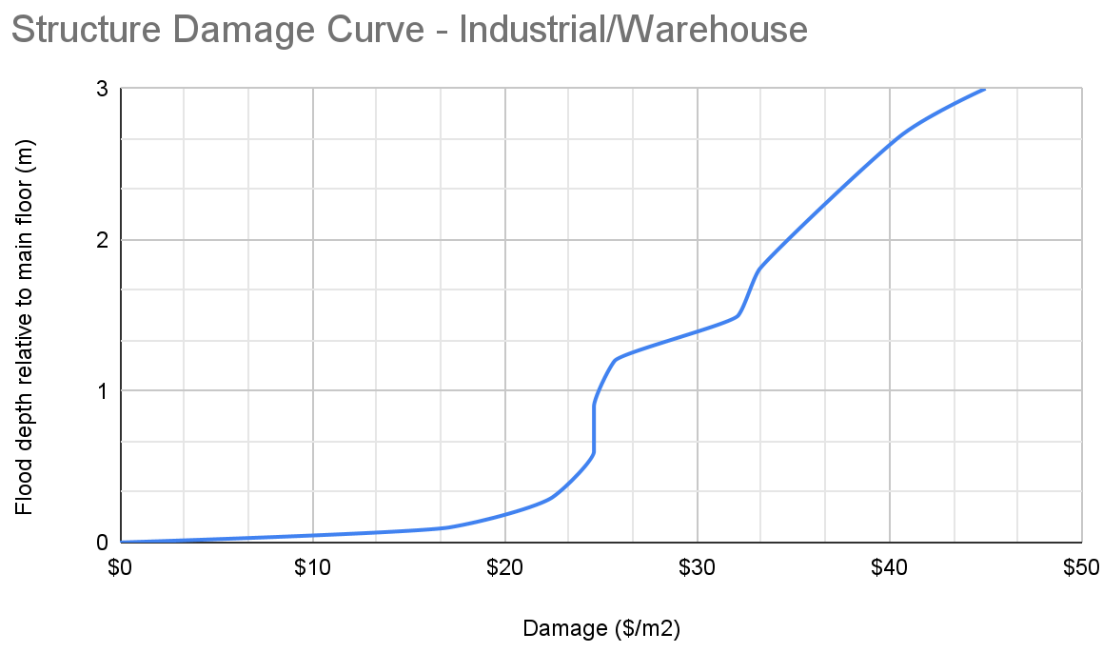
Indirect damages are calculated as a percentage of direct damage incurred and are subdivided into road and utility infrastructure damage. Indirect damage intensities are based on Federal Flood Damage Estimation Guidelines for Buildings and Infrastructure, Section 5.2.2 (NRCAN, 2021). A coefficient of 20% was used for road damage and 15% for utility damages. For example, for a given neighbourhood zone, road damage is estimated to be 20% of structure damage occurring within the zone.

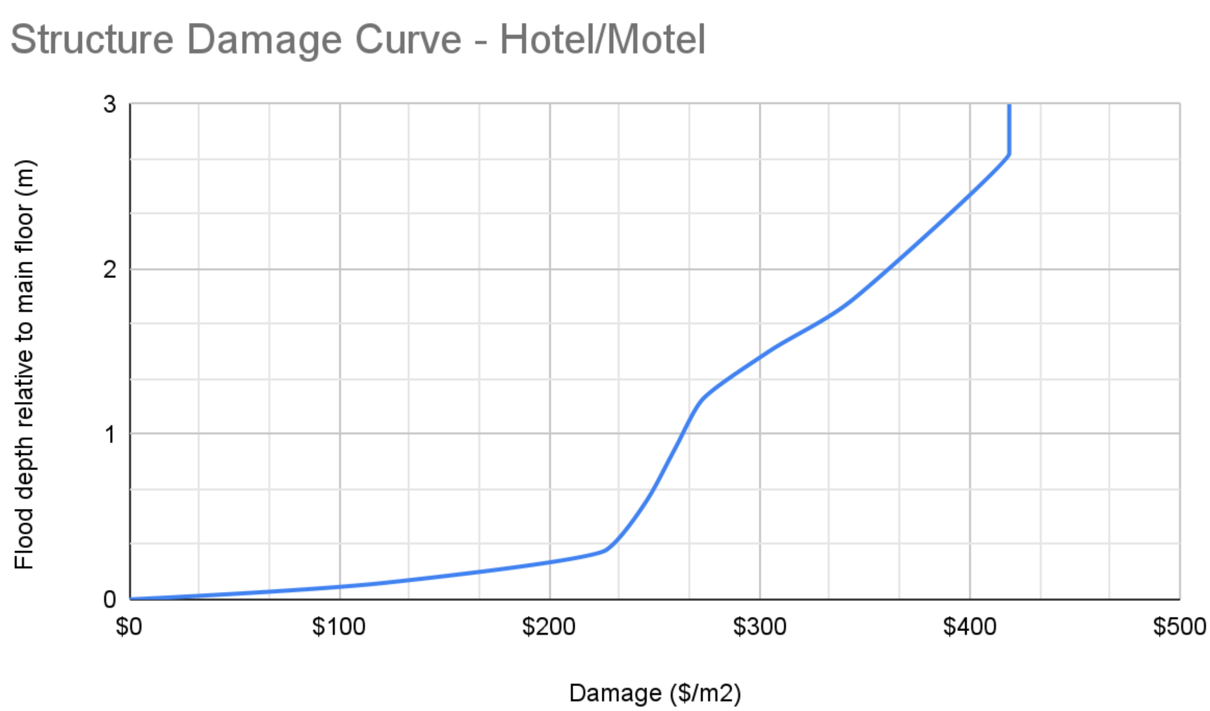
Intangible damages represent damage due to population displacement (hotel, meals, etc.) and business disruption (lost productivity). Intangible damage functions are based on Federal Flood Damage Estimation Guidelines for Buildings and Infrastructure, Appendix 6 (NRCAN, 2021).

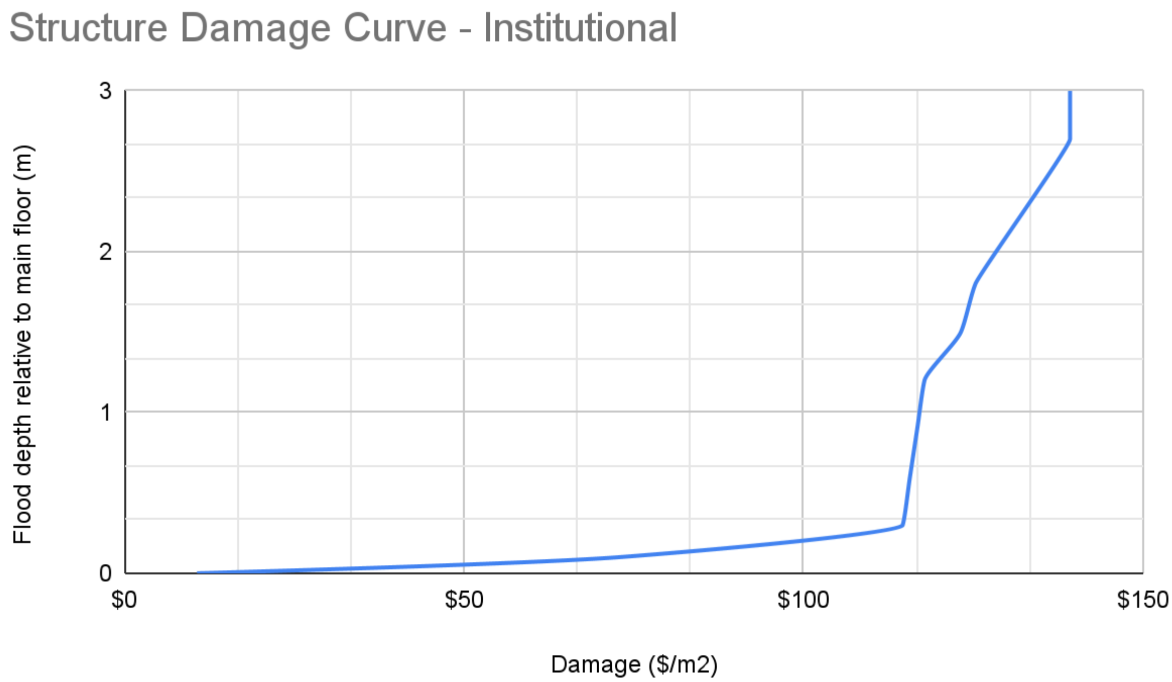
Appendix A - Damage Curves

Non-Residential Structure

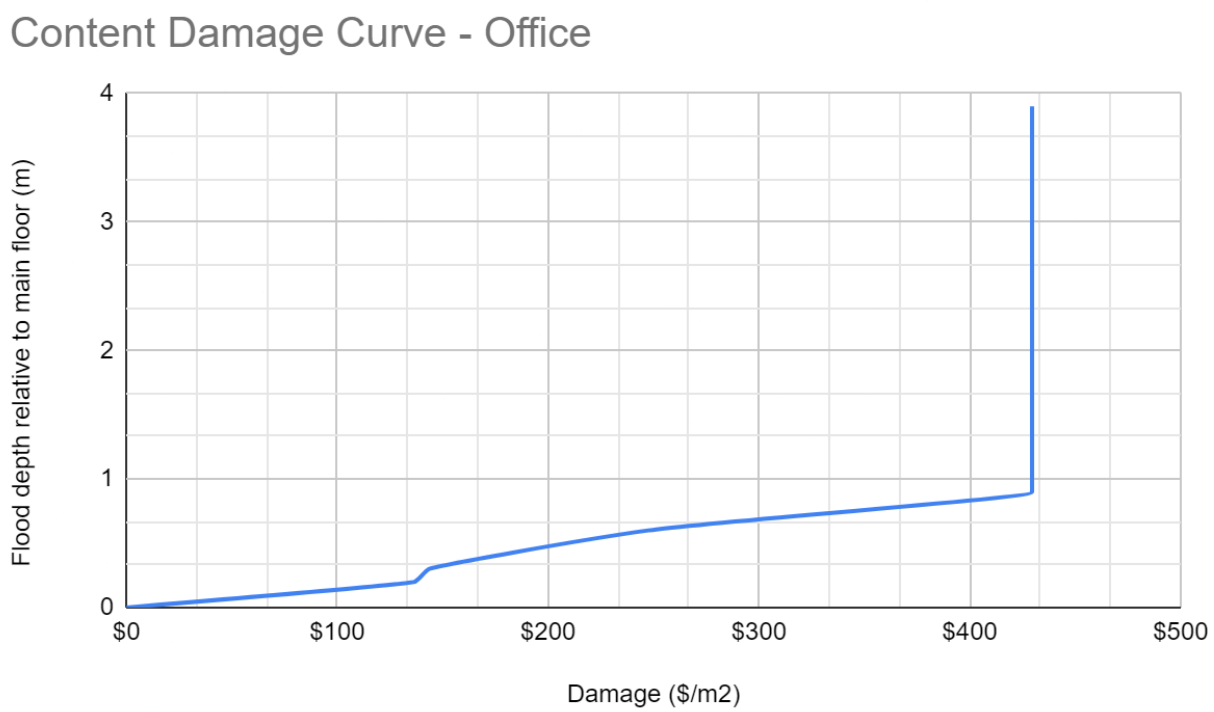


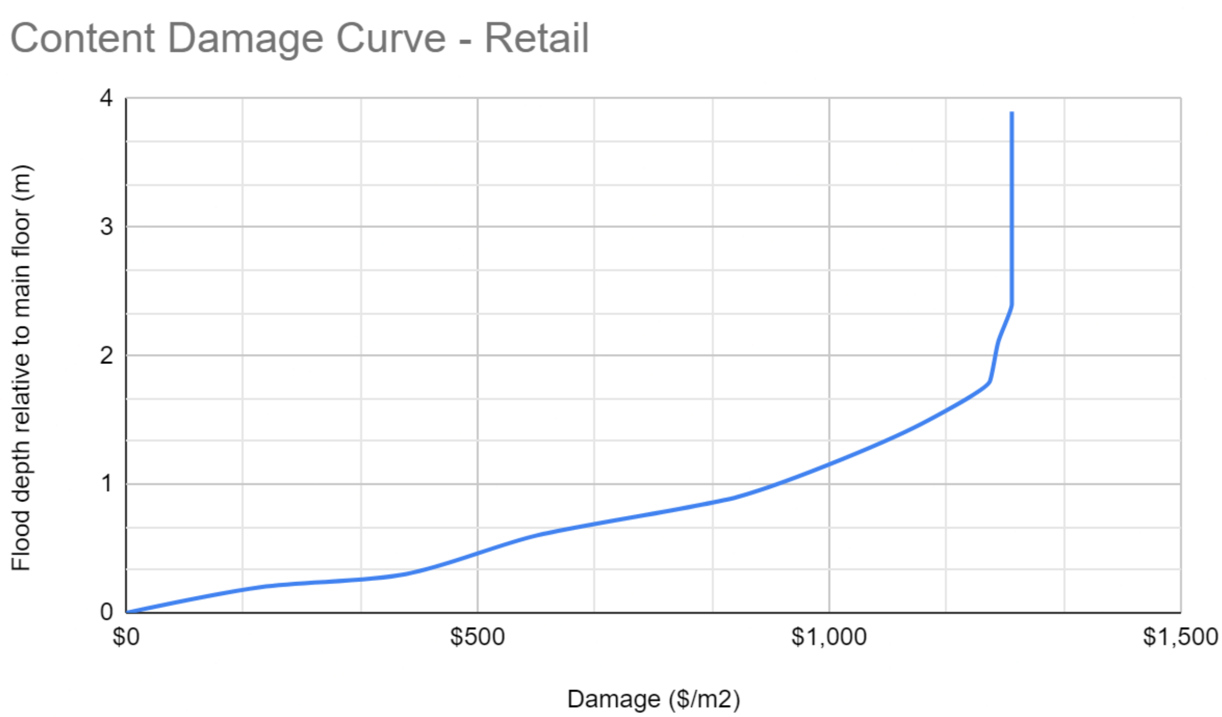

Structure Damage Curve - Industrial/Warehouse
Flood depth relative to main floor (m)
3
2
1
0
$0
$10
$20
$30
$40
$50
Damage ($/m2)

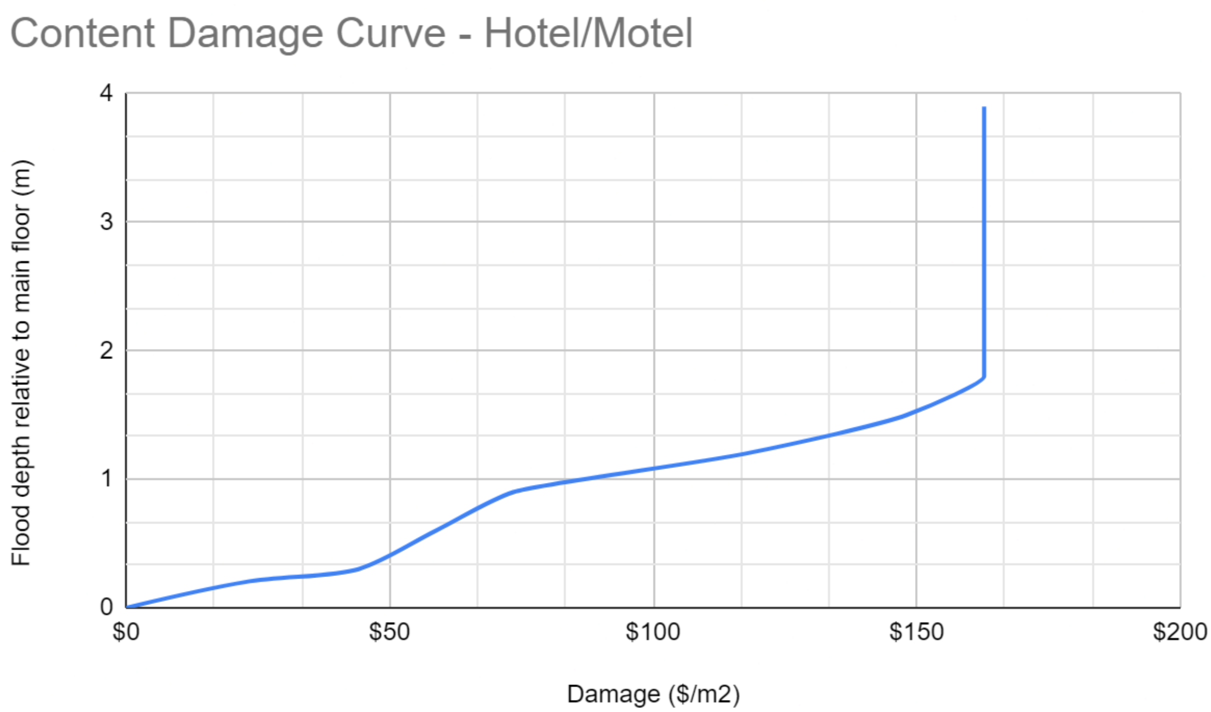

Structure Damage Curve - Hotel/Motel
Flood depth relative to main floor (m)
3
2
1
0
$0
$100
$200
$300
$400
$500
Damage ($/m2)

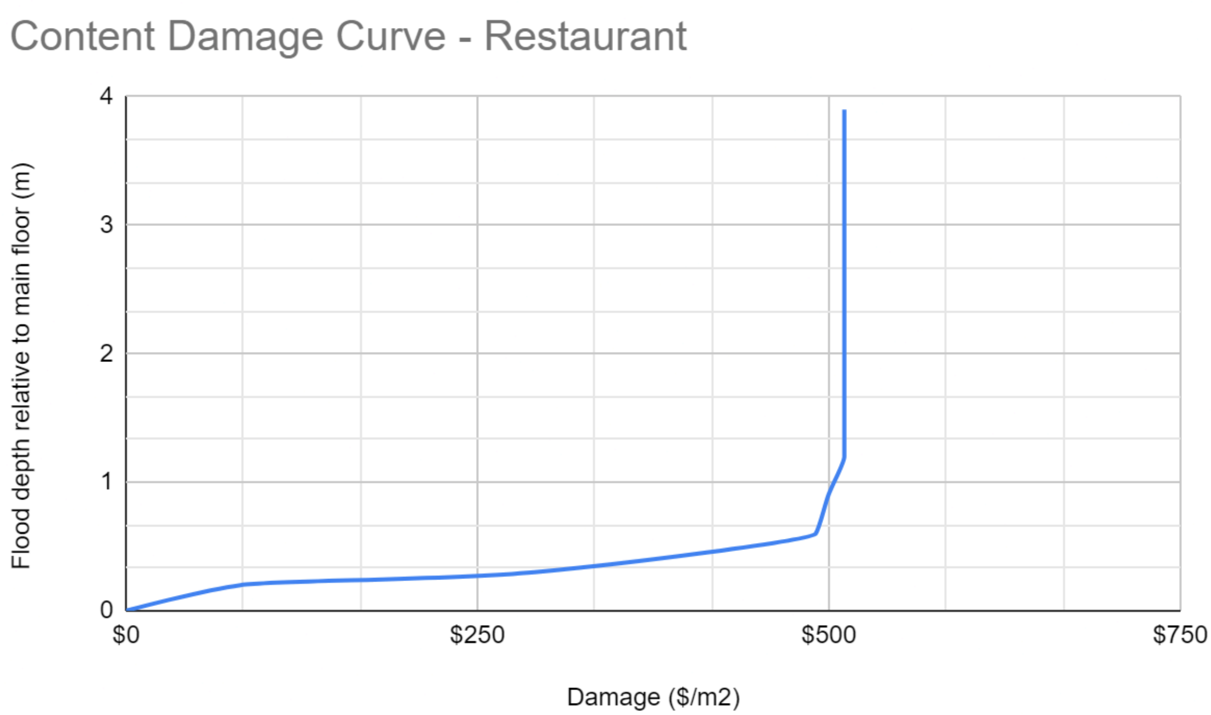

Structure Damage Curve - Institutional
Flood depth relative to main floor (m)
3
2
1
0
$0
$50
$100
$150
Damage ($/m2)

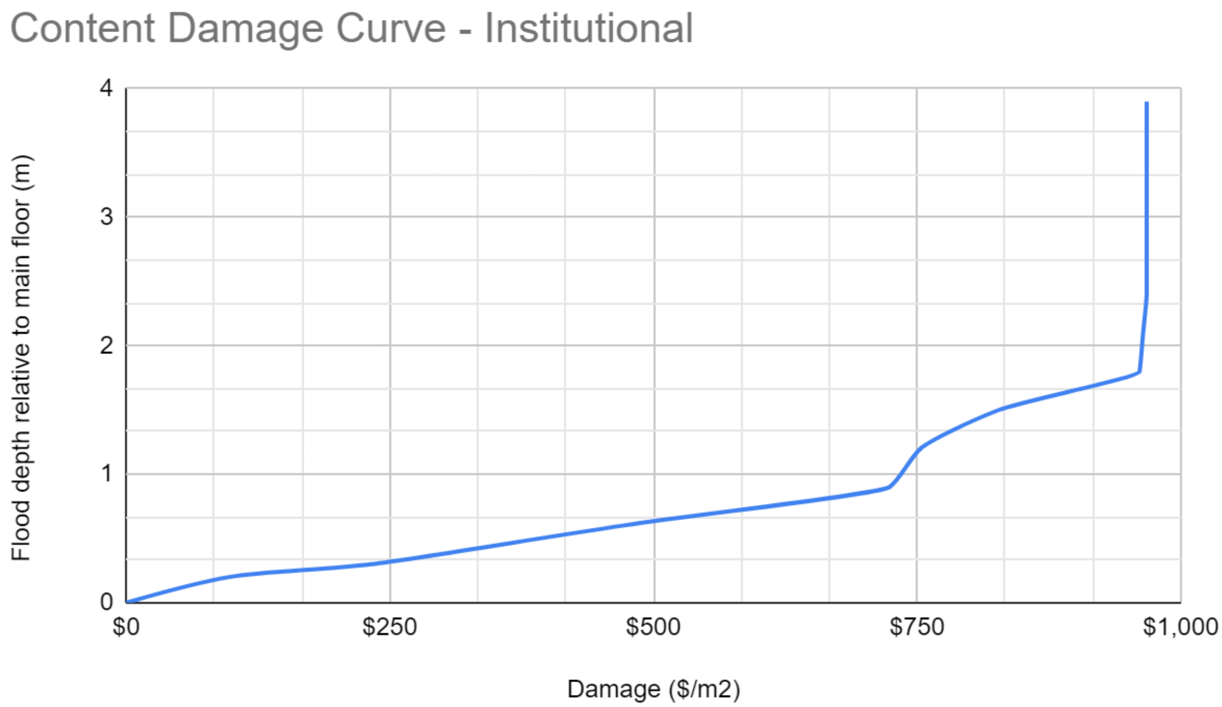
Non-Residential Content

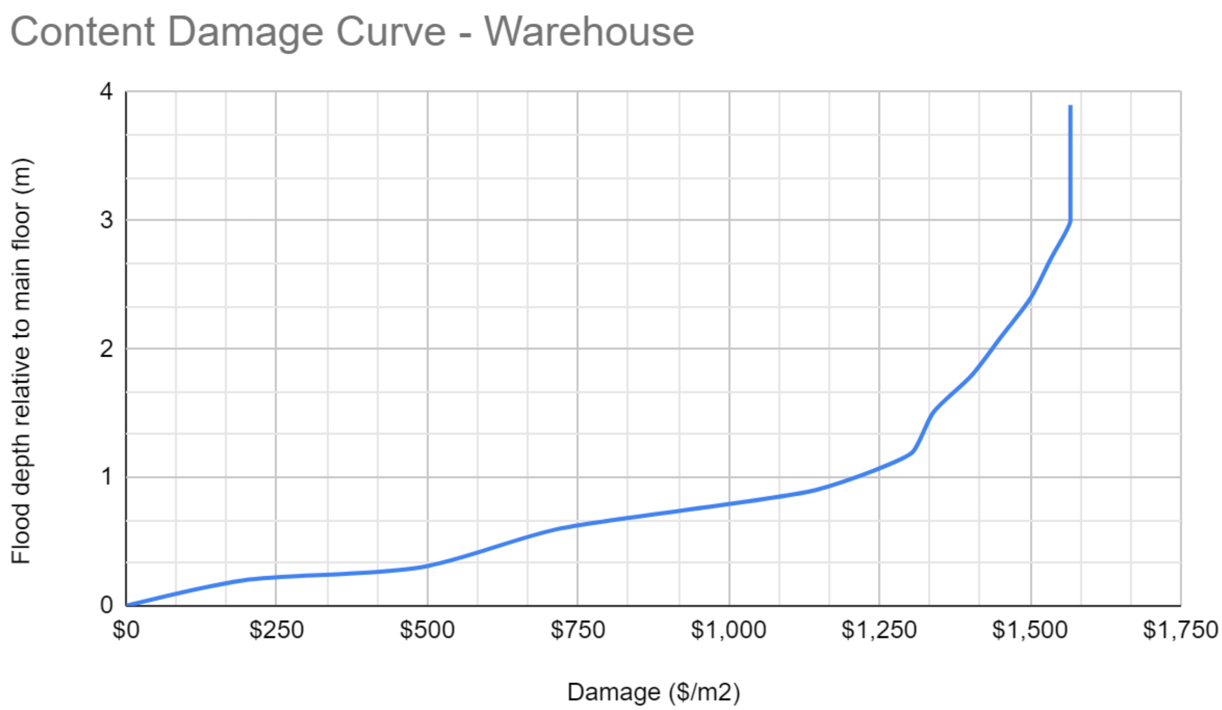




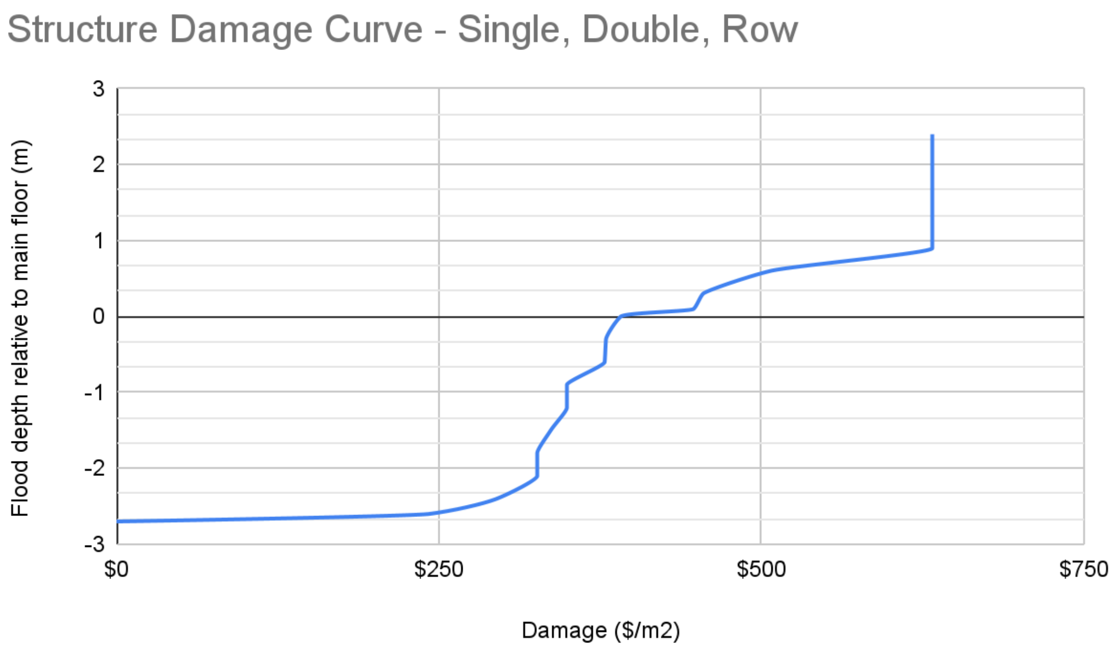

Content Damage Curve - Hotel/Motel
Flood depth relative to main floor (m)
0
1
2
3
4
$0
$50
$100
$150
$200
Damage ($/m2)

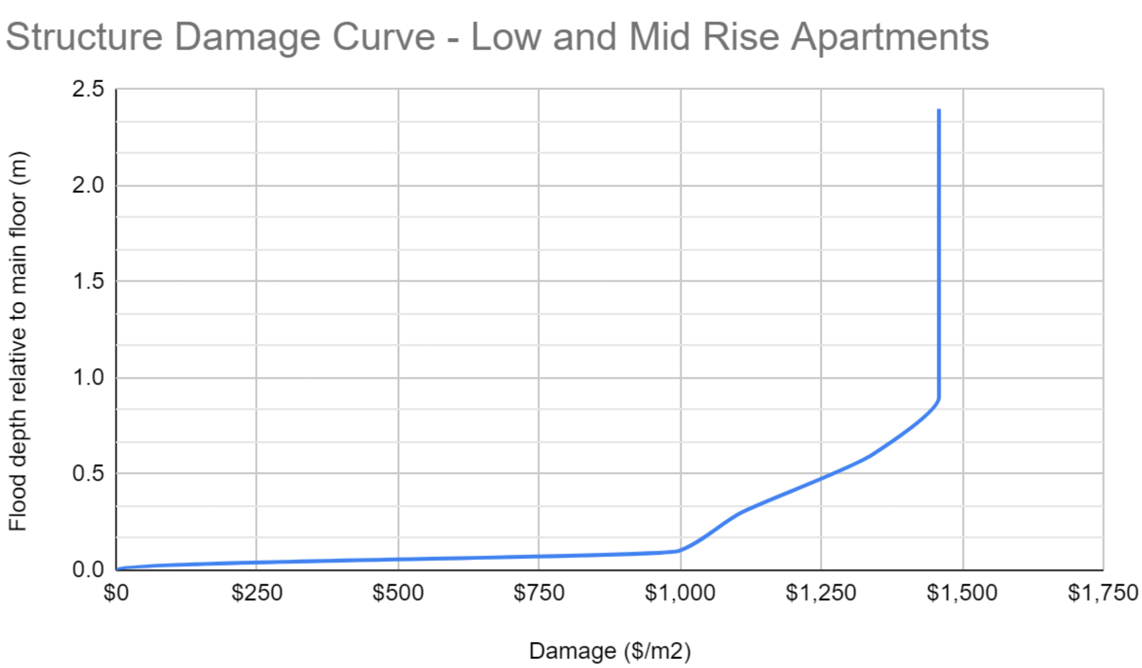

Content Damage Curve - Restaurant
Flood depth relative to main floor (m)
0
1
2
3
4
$0
$250
$500
$750
Damage ($/m2)

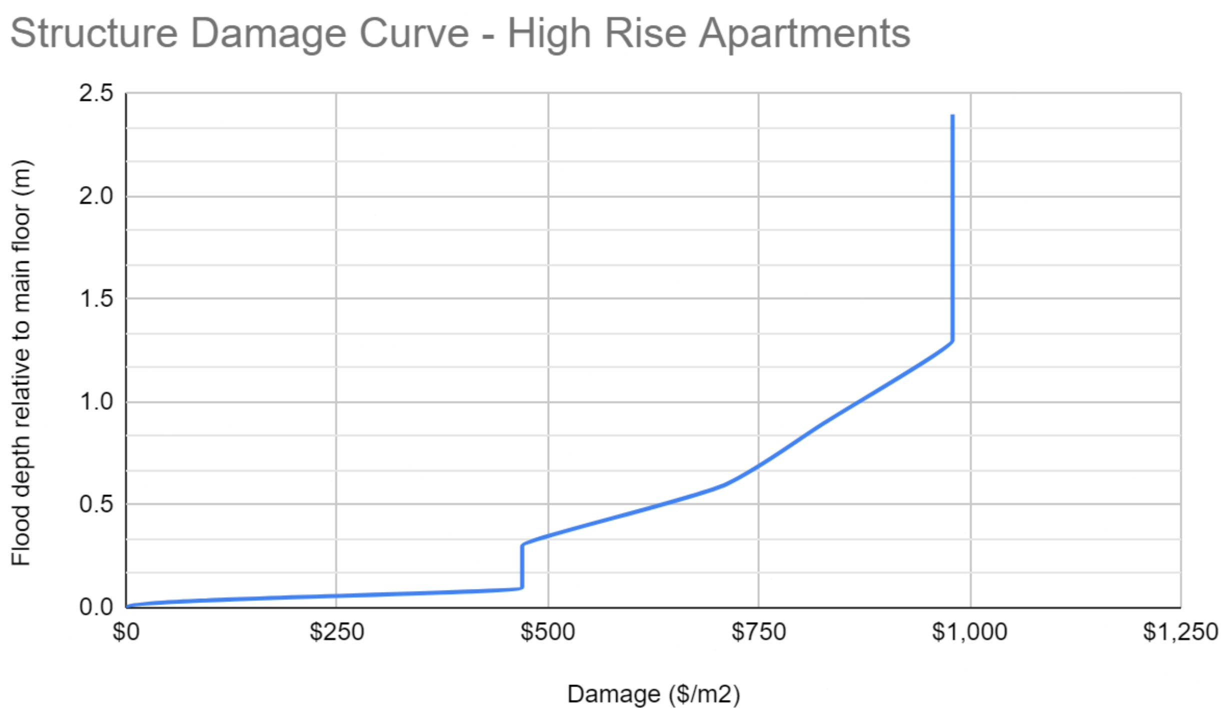

Content Damage Curve - Institutional
Flood depth relative to main floor (m)
0
1
2
3
4
$0
$250
$500
$750
$1,000
Damage ($/m2)


Content Damage Curve - Warehouse
Flood depth relative to main floor (m)
0
1
2
3
4
$0
$250
$500
$750
$1,000
$1,250
$1,500
$1,750
Damage ($/m2)

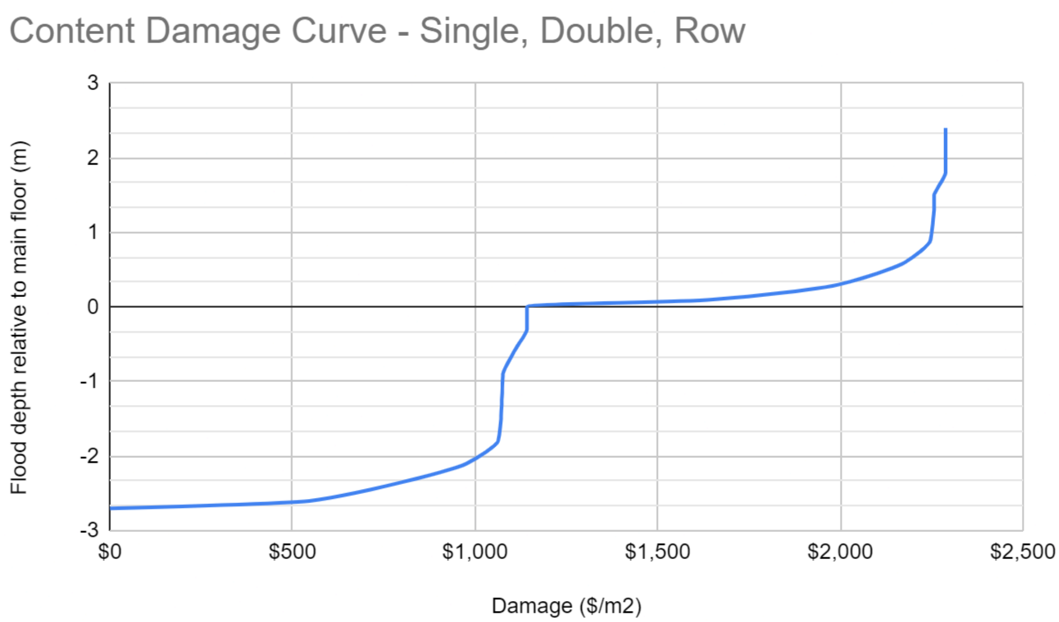
Residential Structure

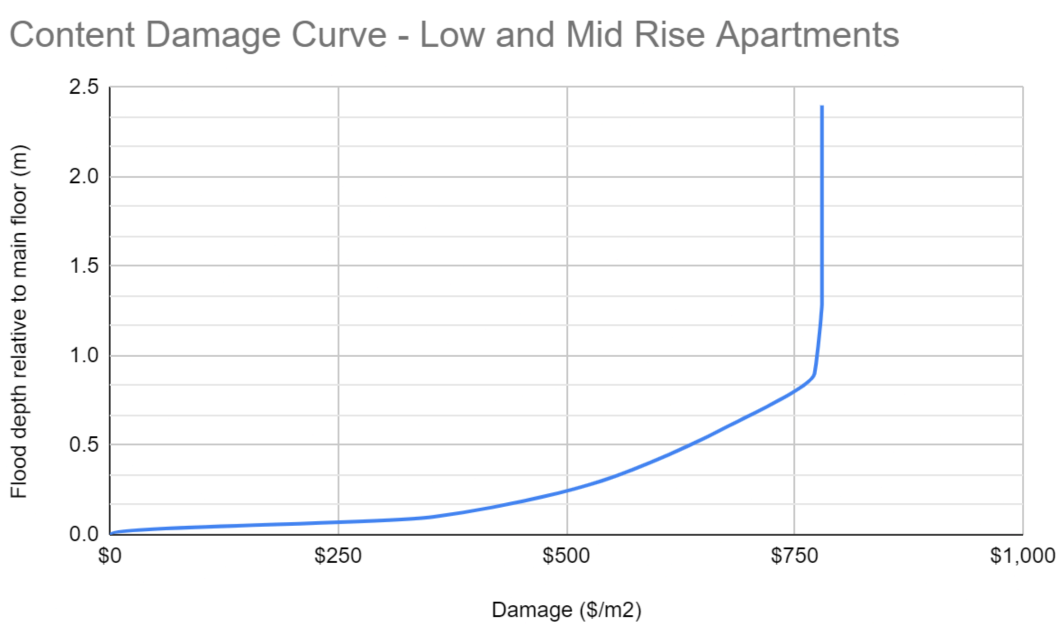


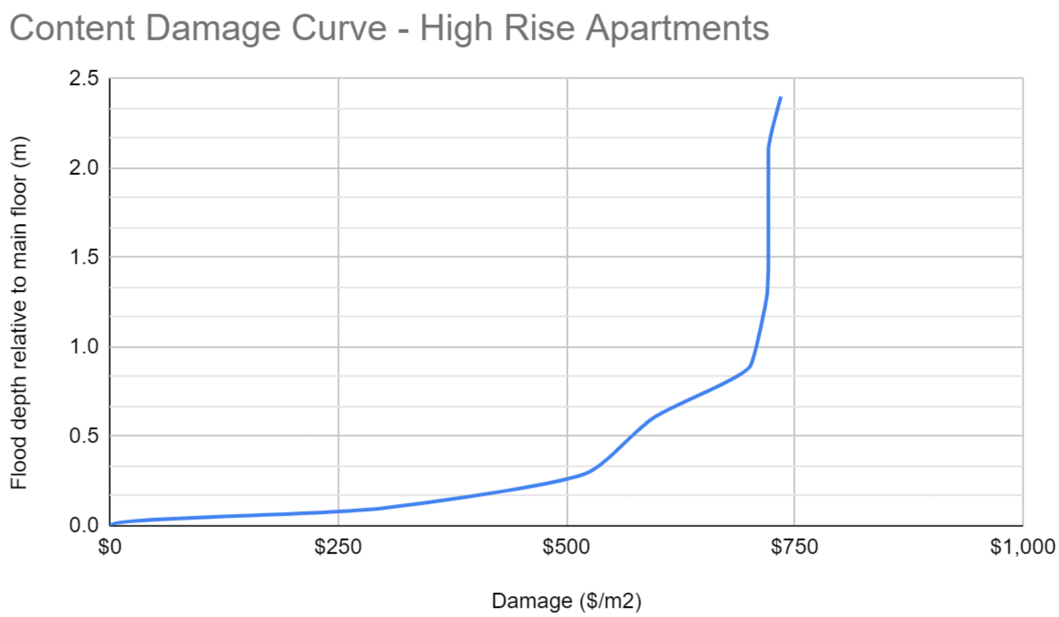



Structure Damage Curve - High Rise Apartments
2.5
2.0
1.5
1.0
0.5
0.0
Flood depth relative to main floor (m)
$0
$250
$500
$750
$1,000
$1,250
Damage ($/m2)

Residential Content






Content Damage Curve - High Rise Apartments
Flood depth relative to main floor (m)
2.5
2.0
1.5
1.0
0.5
0.0
$0
$250
$500
$750
$1,000
Damage ($/m2)

Town of
CANMORE