Appendix D: Bivariate Maps

New Westminster Climate Change Adaptation and Resilience Plan

A bivariate map displays two independent variables simultaneously, using a two-colour scheme on a single map, revealing shared patterns of overlap. In the case of the Climate Change Adaptation and Resilience Plan, the two mapped variables are hazard exposure and overall neighbourhood social vulnerability. Two bivariate maps were created as part of the analysis for the Plan:

- Social Vulnerability vs. Freshet Flood Exposure, c. 2050 (1-in-100-year flood event with 0.5 m of sea-level rise)
- Social Vulnerability vs. Extreme Heat Exposure

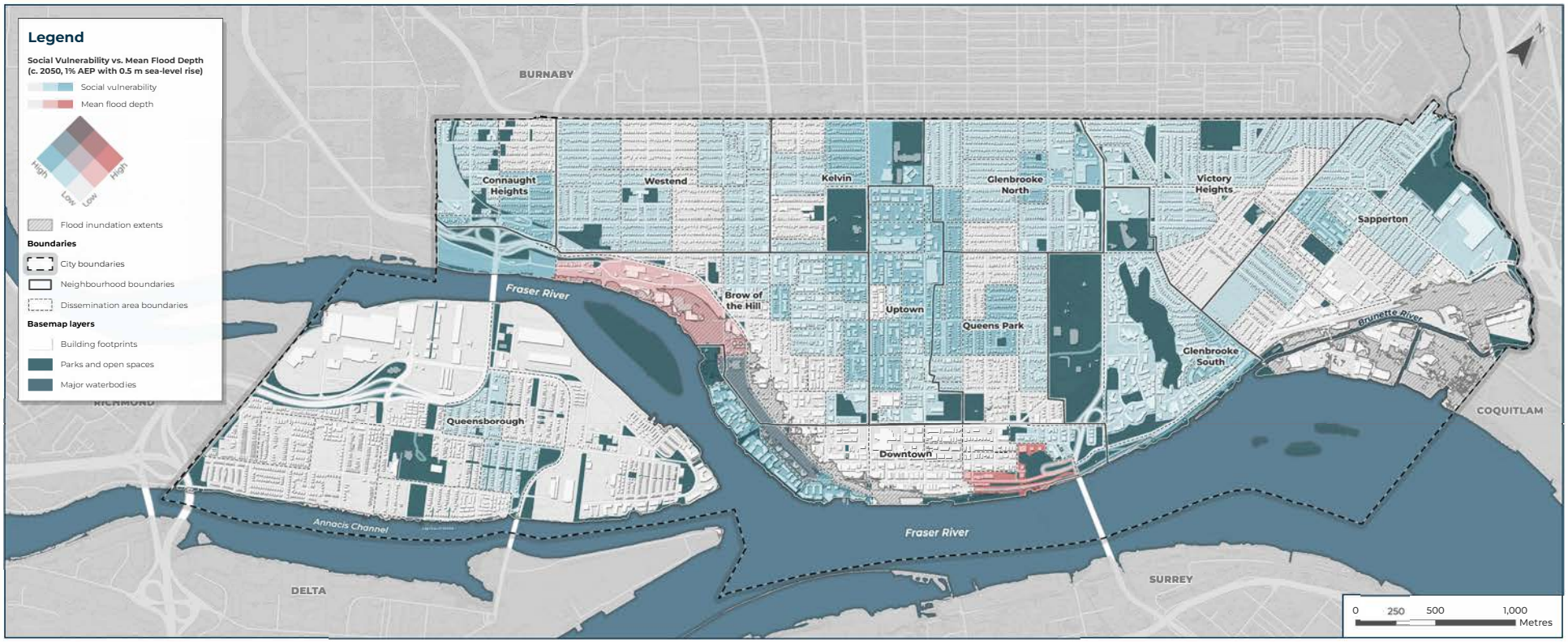
Social vulnerability refers to the social, economic, and demographic characteristics that affect a community's ability to prepare for, respond to, and recover from natural and climate-related hazard events. It is not simply a measure of poverty or age; instead, vulnerability reflects the full range of systemic conditions that shape whether community members have the resources, information, capacity, and social connections needed to stay safe and recover effectively when these events occur. Social vulnerability was measured at the census dissemination area (DA) scale, which acts as a proxy for neighbourhoods. Vulnerability scores indicate, in standard deviations (σ), how far a given neighbourhood is above or below the community average. Neighbourhoods that have 'Above average' ($0.5 \leq \sigma \leq 1.5$) or 'Very high' ($\sigma > 1.5$) overall vulnerability scores tend to have multiple overlapping vulnerabilities.

Limitations of Vulnerability Scores

There are inherent constraints with all census-based vulnerability assessments, including the overall vulnerability scores used in the bivariate maps. Unhoused populations are systematically undercounted in census data and, as a result, virtually invisible in such assessments. Detailed health and disability data are not available in public census profiles, and some groups known to face elevated vulnerability, including members of the 2SLGBTQ+ community, are also not identified. Existing social networks, community cohesion, and informal support systems are important factors of community resilience, yet they are not captured by census data alone. For these reasons, the neighbourhood vulnerability scores are not comprehensive and are not a true reflection of the vulnerability felt or experienced by each community member living in each neighbourhood.

In the context of climate risk assessment, bivariate maps move the analysis from exposure towards consequence. A neighbourhood with high hazard exposure but low

vulnerability (or strong adaptive capacity) faces a different challenge than one with the same physical exposure and high vulnerability (or fewer resources and capacity to respond). The bivariate maps show this distinction using darker shades of cyan to indicate higher social vulnerability, while darker shades of red indicate greater hazard exposure. Where the two colours blend into dark brown, both conditions are present together. The 3x3 matrix included with each map provides a guide to reading the colour combinations across the full range of both dimensions.



Neighbourhood Social Vulnerability vs. Freshet Flood Exposure (1-in-100-year, c.2050)

for the City of New Westminster

This map shows how neighbourhood social vulnerability and flood exposure overlap across New Westminster for a 1% annual exceedance probability (AEP)—or 1-in-100-year—freshet flood scenario that accounts for climate change effects on ocean water levels (0.5 m) and mid-century (c. 2050) peak river flows. A freshet refers to the seasonal rise in river levels caused by spring snowmelt and rainfall, and represents the primary flood risk along the Fraser River. Darker shades of cyan indicate higher social vulnerability scores, while darker shades of red show greater flood exposure. Where these colours blend into dark brown, both challenges are present in the same area.

Social vulnerability refers to the social, economic, and demographic characteristics that affect a community's ability to prepare for, respond to, and recover from hazards and stressors. Social vulnerability was assessed as a component of New Westminster's Climate Change Adaptation and Resilience Plan, with scores classified so that the central class falls within a half-standard deviation of the community average. Flood threat was assessed using mean maximum flood depths per census dissemination area from the City's 2022 Flood Plain Management Strategy Update (NHC, 2022), with depths classified as low threat (up to 0.3 m), moderate (up to 0.6 m), or high (above 0.6 m).

Neighbourhoods in darker cyan tend to have higher social vulnerability but are less likely to face significant flood inundation, and may benefit most from social support programming, including education about flood resilience and programs to strengthen local social networks. Areas in darker red tend to have greater flood exposure but generally have lower social vulnerability scores; flood extents are superimposed on the map to highlight those areas most likely to be inundated in this scenario. These are where flood mitigation efforts are most likely to increase local resilience.

Where both colours overlap into dark brown, neighbourhoods face elevated social vulnerability alongside significant flood exposure, and should be prioritized for both mitigation and enhanced social support. While no areas in New Westminster show a high-high overlap for this scenario, several areas of moderate overlap (medium brown) warrant attention. The tall residential towers along Downtown's Quayside Drive face moderate social vulnerability along with a moderate flood threat due to their low-lying waterfront location. The section of Brow of the Hill south of Stewardson Way will also experience moderate flooding, and portions of Downtown along Front Street adjacent to the Fraser River face moderate to high flood inundation.

It is important to note that this bivariate map is part of a larger analytical puzzle and should be considered in the context of the broader Climate Change Adaptation and Resilience Plan.

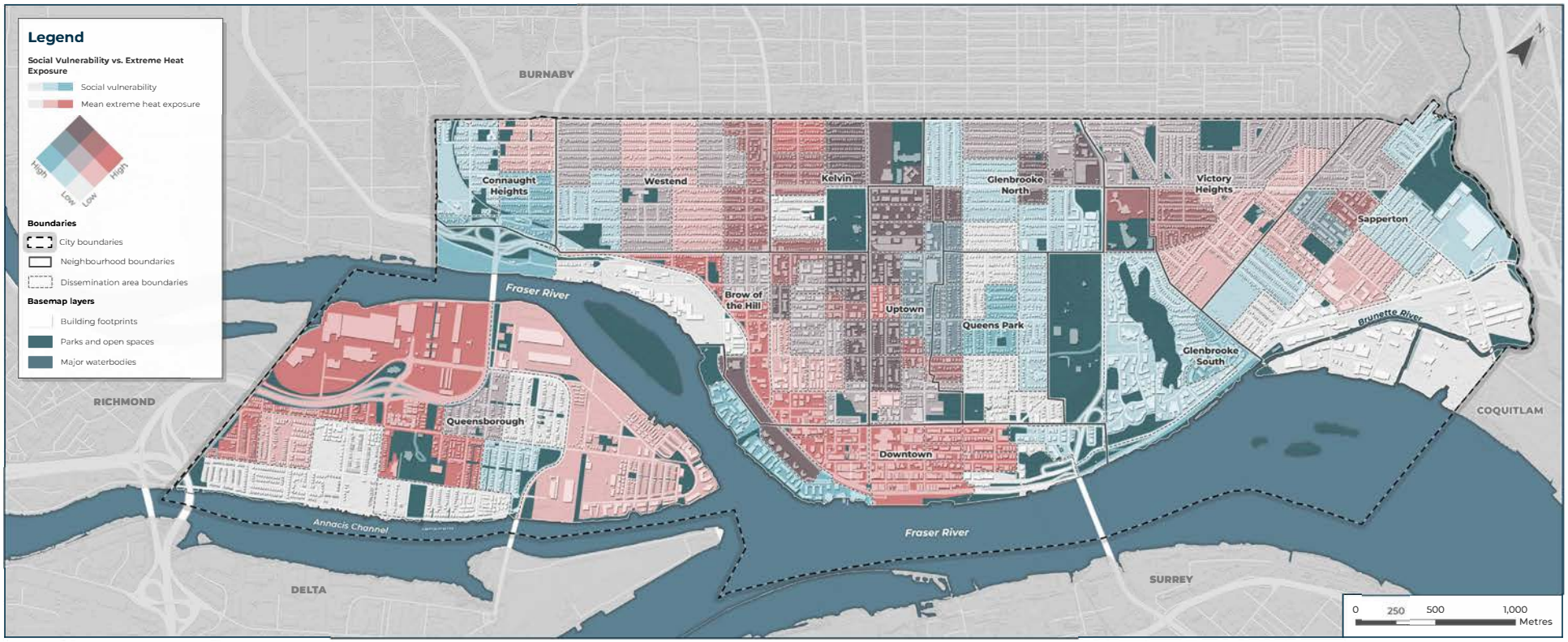
Map Series:
New Westminster Climate Change Adaptation and Resilience Plan

Source Data:
City of New Westminster flood plain management strategy update (NHC, 2022); Census dissemination area profiles (Statistics Canada, 2023); Census dissemination area boundary layers (Statistics Canada, 2022); Waterbodies (Metro Vancouver, 2023); Lidar elevation data (GeoBC, 2017); Digital Road Atlas (GeoBC, 2025); all other data from the City of New Westminster.

Map Details:
Datum: NAD83
Projection: UTM Zone 10N
Scale: 1:24,000
Author: R.P. Reynolds
Date: 2026-03-19

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Neighbourhood Social Vulnerability vs. Extreme Heat Exposure

for the City of New Westminster

This map shows how neighbourhood social vulnerability and extreme heat exposure overlap across New Westminster using a two-colour scheme. Darker shades of cyan indicate higher social vulnerability scores, while darker shades of red show greater extreme heat exposure. Where these colours blend into dark brown, both challenges are present in the same area. Together, these patterns reveal which neighbourhoods are both more likely to be home to vulnerable residents and to experience the worst heat during extreme heat events.

Social vulnerability refers to the social, economic, and demographic characteristics that affect a community's ability to prepare for, respond to, and recover from hazards and stressors. Extreme heat was measured using neighbourhood mean temperature difference values from the extreme heat exposure dataset developed at Université Laval (2023). Social vulnerability was assessed as a component of New Westminster's Climate Change Adaptation and Resilience Plan. Both parameters were classified so that the central class falls within a half-standard deviation of the community average.

Neighbourhoods in darker cyan tend to have higher social vulnerability but are less likely to face peak extreme temperatures. These areas often benefit most from social support programming, including education about extreme heat resilience and programs to strengthen local social networks. Areas in darker red tend to have greater exposure to extreme heat but generally have lower social vulnerability scores. These are areas where enhancing community green spaces and other efforts to reduce local temperatures can help build resilience.

Neighbourhoods marked in dark brown face both high social vulnerability and extreme heat exposure, and should be prioritized for environmental cooling and enhanced social support interventions. Three areas warrant particular attention. The 8th Street corridor—running southeast from Burnaby through Kelvin, Uptown, and Brow of the Hill towards Queens Avenue—combines medium-to-higher-density residential and commercial structures, high pavement cover, and limited tree canopy, resulting in higher local temperatures that coincide with concentrations of single-resident and low-income households. Glenbrooke North, particularly along 8th Avenue, shows elevated vulnerability across three of the four social vulnerability themes, compounded by sparse tree canopy and high pavement cover. The tall residential towers along Quayside Drive in Downtown face unique challenges: despite roadside tree-planting efforts, these high-density structures sit near railway lines with significant concrete and pavement cover, and are set back from the cooling influence of the Fraser River.

It is important to note that this bivariate map is part of a larger analytical puzzle and should be considered in the context of the broader Climate Change Adaptation and Resilience Plan.

Map Series:
New Westminster Climate Change Adaptation and Resilience Plan

Source Data:
Vulnerability and exposure to extreme heat waves (Université Laval, 2023); Census dissemination area profiles (Statistics Canada, 2023); Census dissemination area boundary layers (Statistics Canada, 2022); Waterbodies (Metro Vancouver, 2023); Lidar elevation data (GeoBC, 2017); Digital Road Atlas (GeoBC, 2025); all other data from the City of New Westminster.

Map Details:
Datum: NAD83
Projection: UTM Zone 10N
Scale: 1:24,000
Author: R.P. Reynolds
Date: 2026-05-04

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