

REVISING BUILDING DESIGN PRACTICES AND POLICIES: a Response to the BC Housing Crisis

Faculty of Engineering and Computer Science - Civil Engineering

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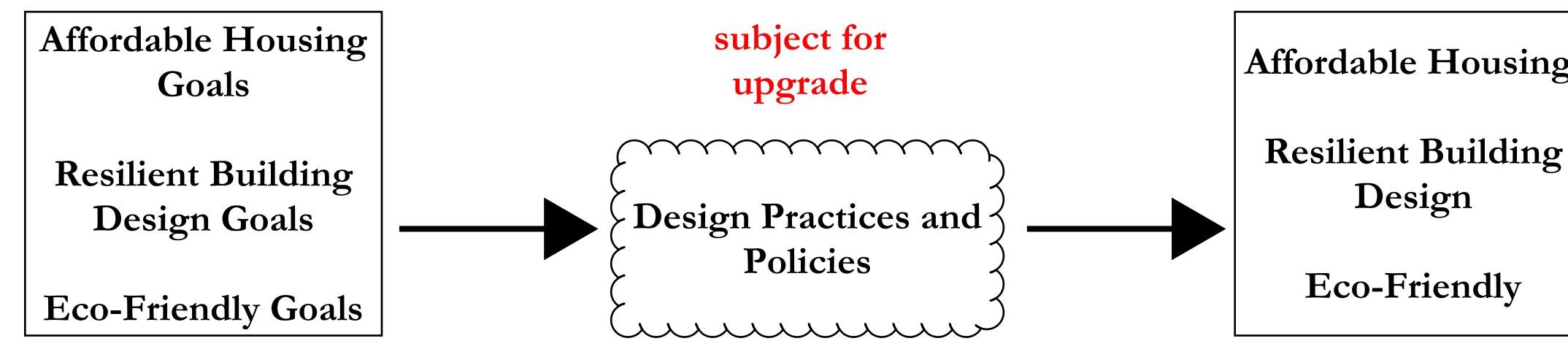


Problem Statement

What would help reliably mandate, design and deliver a home that is: Affordable, Risk Averse (resilient against climatic disasters), and Sustainable, that can be adopted now?

Need

The housing crisis has so many contributing factors; it is difficult to breakdown into a fundamental "issue to resolution". It is therefore more beneficial to target and upgrade the "system" or "process" instead of reducing the effects of each contributing factor. This way all outcomes and goals will benefit.



Proposal

Development of a web-based interactive mapping database (using ArcGIS programs) which contextualizes regional variables pertaining to:

- **Housing Price**
- **Climatic Risk** (to buildings)
- **Site Sustainability Suitability**
- **More?**

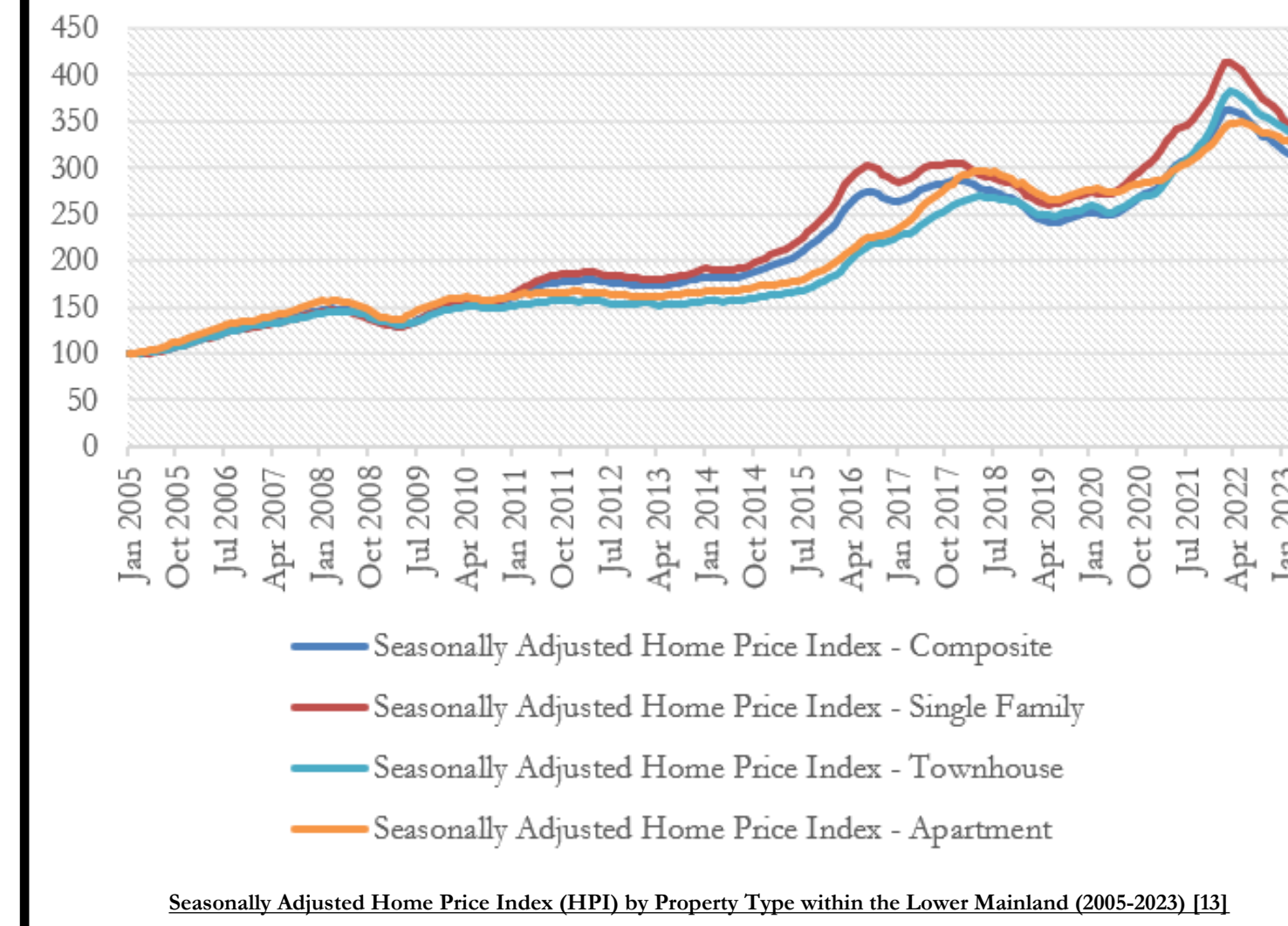
Meant to conceptualize the goals and constraints of new buildings and retrofits

Background

Home Prices

- 3x increase in housing prices since 2005 in the Lower Mainland [1]
- wages have stagnated [2]
- price increases seen on all building types, including rentals [1]

Seasonally Adjusted Home Price Index (HPI) by Property Type within the Lower Mainland - January 2005 to February 2023



Sustainability

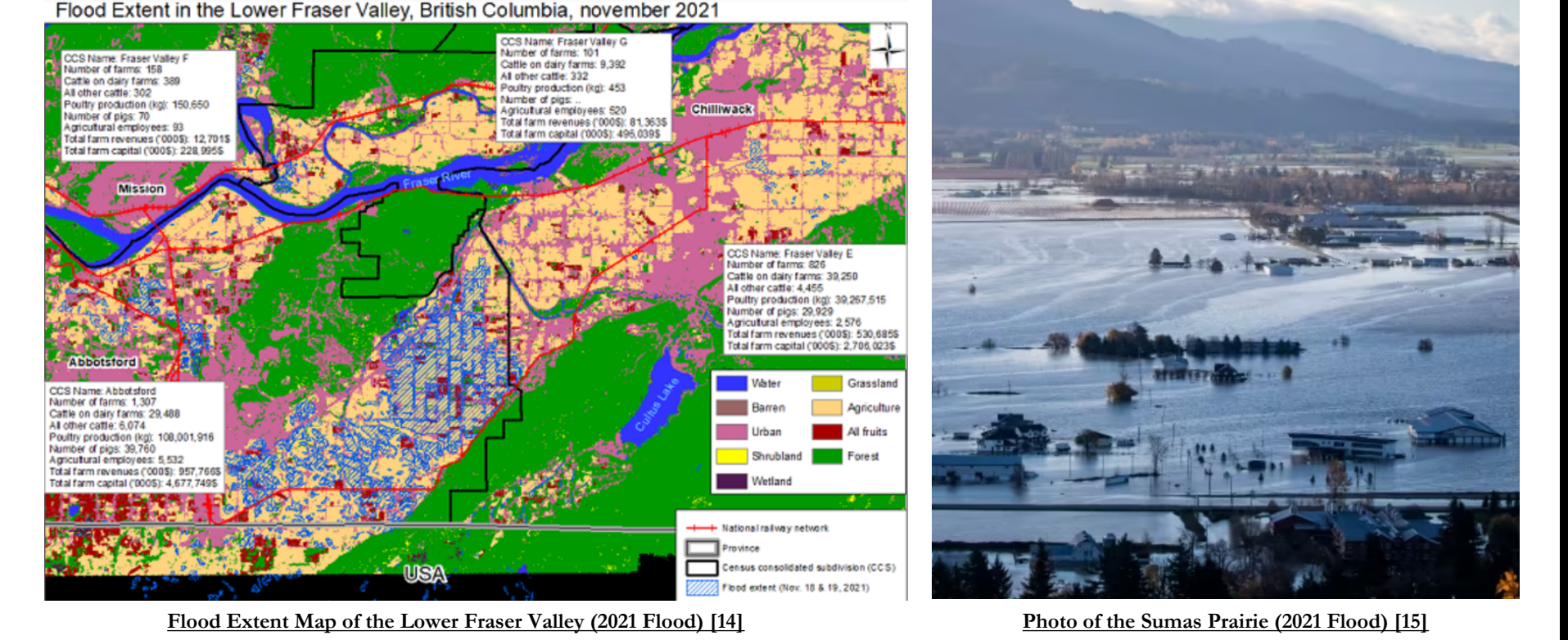
- Goal of reaching "net zero ready" new buildings by 2032 [9]
- As of May 1st, 2023 Step 2 and 3 energy efficiency targets are mandated by the energy step code [9]
- **Operational Carbon:** Carbon Step Code Introduced May 1st, 2023 [10]
- **Embodied Carbon:** New LCA and building material restrictions specifically for Vancouver [11]

Policy

- **Review Cycles:** Takes a long time for change to occur, and further reach market penetration. May not represent current market interests.
- **Subject to Change:** Multi-year plans and priorities on a municipal level can change when different administrations take power
- **Complexity of Delivery:** The amount of restrictions, requirements, etc from a policy perspective make it incredibly difficult to meet fundamental objectives

Extreme Weather and Climatic Events

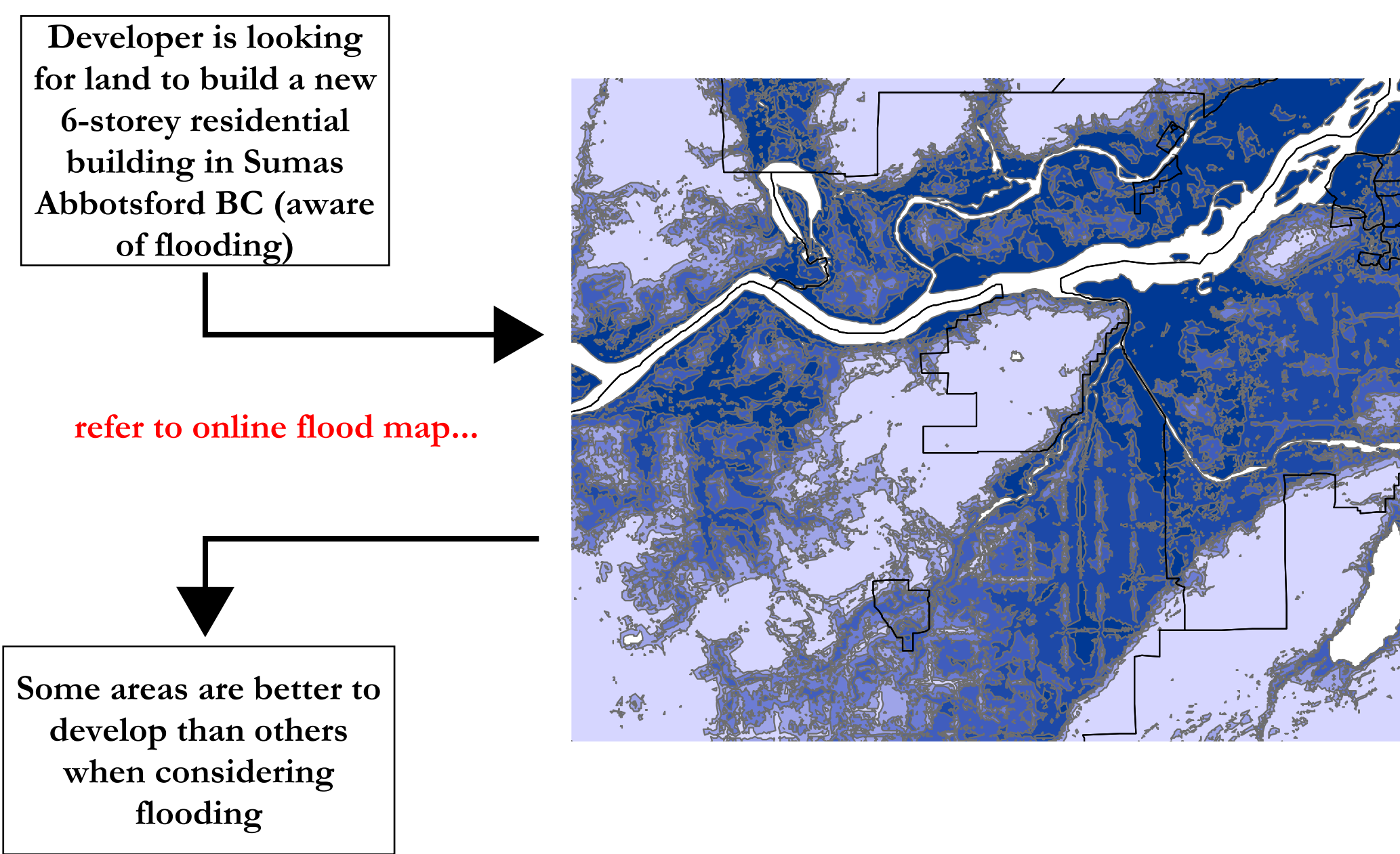
- **Earthquakes:** The "big one" - current low rise residential building stock ill equipped to resist [3]
- **Flooding:** 2021 Flood - destruction of homes and property in the fraser valley [4]
- **Fires:** 2023 was the most destructive wildfire year reported in BC (yearly Ha burned increased by >5x since 2010) [5]
- **Extreme Heat:** 2021 Heat dome killed 619 people (in 7 days) with blame pointed at unconditioned homes [6]
- **Extreme Cold:** 2022 winter storm and cold snap established 41 cold temperature records across BC [7]
- **Slides, Wind, Moisture, Precipitation, Snowfall:** BC Climatic variables expected to change due to climate change (increases in precipitation), etc [8]



Why Would this be Useful?

Ease of Understanding

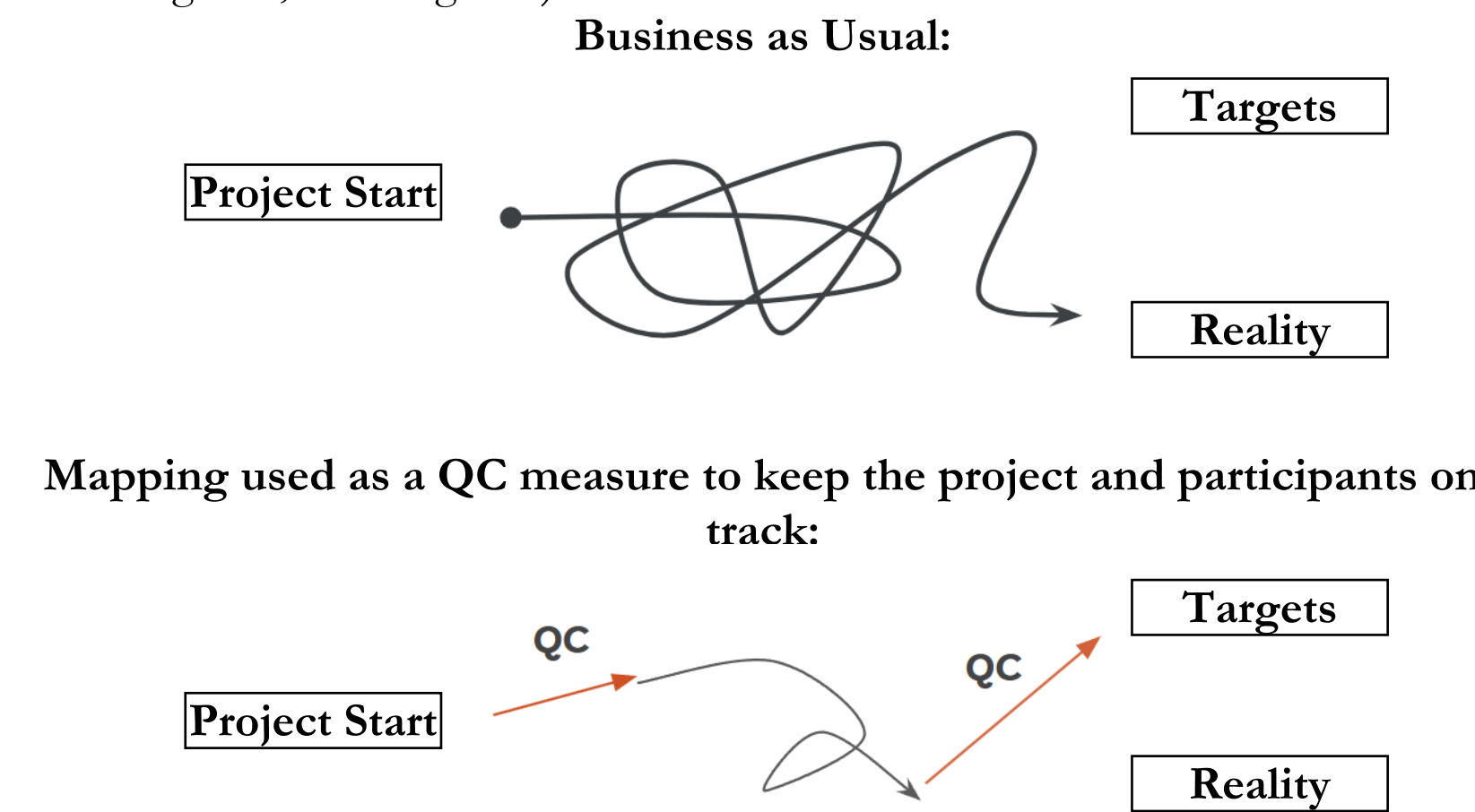
A user can immediately explain a site constraint or goal in a visual way to someone who may or may not have a technical background.



Versatility in Application

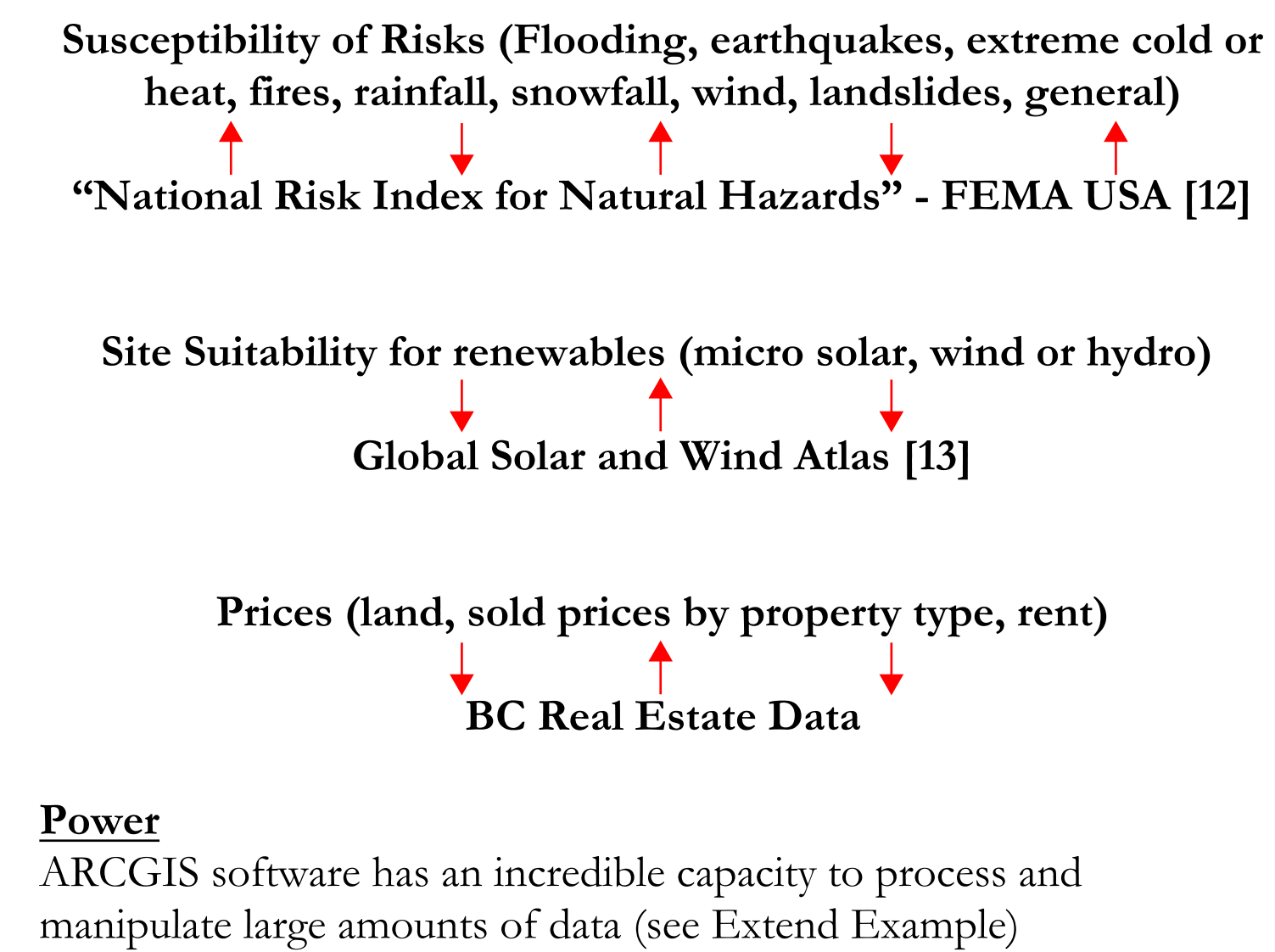
Useful for multiple professions, at different stages of a buildings construction timeline.

Affected jobs include: Consultants (Engineers, Architects), Clients (Municipalities, Developers, Private Corporations), Real Estate Agents, Home Owners, Insurance Providers). **Stages of Building Development include:** Proposal (RFP), Schematic Design, Final Closeout, Building Sale, Building Life).



Precedent

Maps like this have been used for other applications, but not specifically in this context. Desired mapping data has either not been conducted in Canada, not publicly available, and/or not on a singular database. Examples of this include:



Who Would Deliver?

Since this is a proof-of-concept for a new design process, there are many ways to deliver this service. Three categories jump out:

- private (service and business oriented)
- non-profit (funded by grants)
- government (part of the government) - **Recommended**

Ultimately this should be in the hands of the government for a couple of reasons:

- ability to provide widespread open access service
- access to resources the public does not
- infrastructure for GIS programs present

Liability: This mapping database will be created from the co-operation of different technical professions. For legal purposes, proper use of these maps must be outlined. In the event that any legal action is pursued against the misuse of the program; first determine if the error was in the source data, or in the processing. Then, determine if proper procedure was followed.

How Should it be Delivered?

Research

Comprehensive literature review into the housing crisis to determine actionable steps to settle this issue.

Mapping

Of the actionable steps, determine what is site specific, and what is regionally applicable, then map.

Site Specific Design

Design buildings using the project constraints and goals determined from the research and mapping portions.

To give context in how this new system will work, the following appendices of this research project are an in-depth example of this proposed methodology:

- SECTION 2.0: BACKGROUND RESEARCH - CONTEXTUALIZING BC HOUSING
- SECTION 3.0: MAPPING REGIONAL DESIGN CONSIDERATIONS - MAPPING
- SECTION 4.0: SITE SPECIFIC DESIGN CONSIDERATIONS - HOUSING DESIGN

Extended Example

Case

A young family from out of town are looking to move to the Lower Mainland (Climate Zone 4 for the purposes of this investigation). The parents are both working class and are considering jobs in the downtown core of Vancouver. They know southwestern BC's climate is tame compared to most other parts of Canada but are unaware of the local intricacies relating to risk. The family is looking for something affordable but also something that will last. They want to establish their roots in one place and still have room for more kids and (maybe) grandkids. Depending on the size of the building, they are open to share some of this space with other families or individuals who are also looking for more affordable options. Finally, they care for the environment, so something that is eco-friendly is preferred. They are open to purchasing an existing home or building a new home.

Summary

Based on the wants of the case study family, they are looking for:

- A detached single-family house with auxiliary dwelling units/basement separation, or a duplex/triplex unit.
- The dwelling should be in the City of Vancouver.
- They are looking for an affordable, risk adverse, sustainable piece of land that has an existing building onsite or a site that could be redeveloped.

Regional Considerations

SECTION 2.0: BACKGROUND RESEARCH - CONTEXTUALIZING BC HOUSING, and other requests from the client, the following regional design considerations are applicable:

1. target single family zoning lots, redevelop into middle size housing types.
2. If designing for buildings along major transportation lines, consider higher density projects.
3. Optimize building location, orientation and exposure for interior sunlight penetration, natural cooling (wind), and onsite renewable energy generation if applicable.
4. Limit search to areas that have the least susceptibility to risk.
5. Should be in one of the more affordable Vancouver neighbourhoods.

Zoning

To ensure compliance with (1), the parcel must be within an adequate residential area. The best zoning district which matches the families' interests is "Residential Inclusive" or "RS1-1" [50]. This zoning stipulation allows a variety of small-scale housing options including detached single-family homes, duplexes, triplexes etc. [50]. The City of Vancouver offers this zoning area as a shapefile on their open data portal [51]. The extent of this zoning area is depicted in **MA-4.1 SITE SELECTION - ZONING (RS1-1)**.

Proximity to Transportation Lines

To ensure compliance with (2), the building location should be near transportation lines, and if so, should be of higher density. The City of Vancouver has multiple datasets in relation to transportation routes. For this example, the following routes and proximity (in meters) were Bus lines (400m away) [52], and Bike routes (300m away) [53]. To find these regions, the CoV layers were buffered by 400m and 300m for bus lines and bike routes respectively, then dissolved and clipped to the CoV boundary. Areas within transportation limits are depicted in **MA-4.2 SITE SELECTION - PROXIMITY TO TRANSPORTATION**.

South Facing

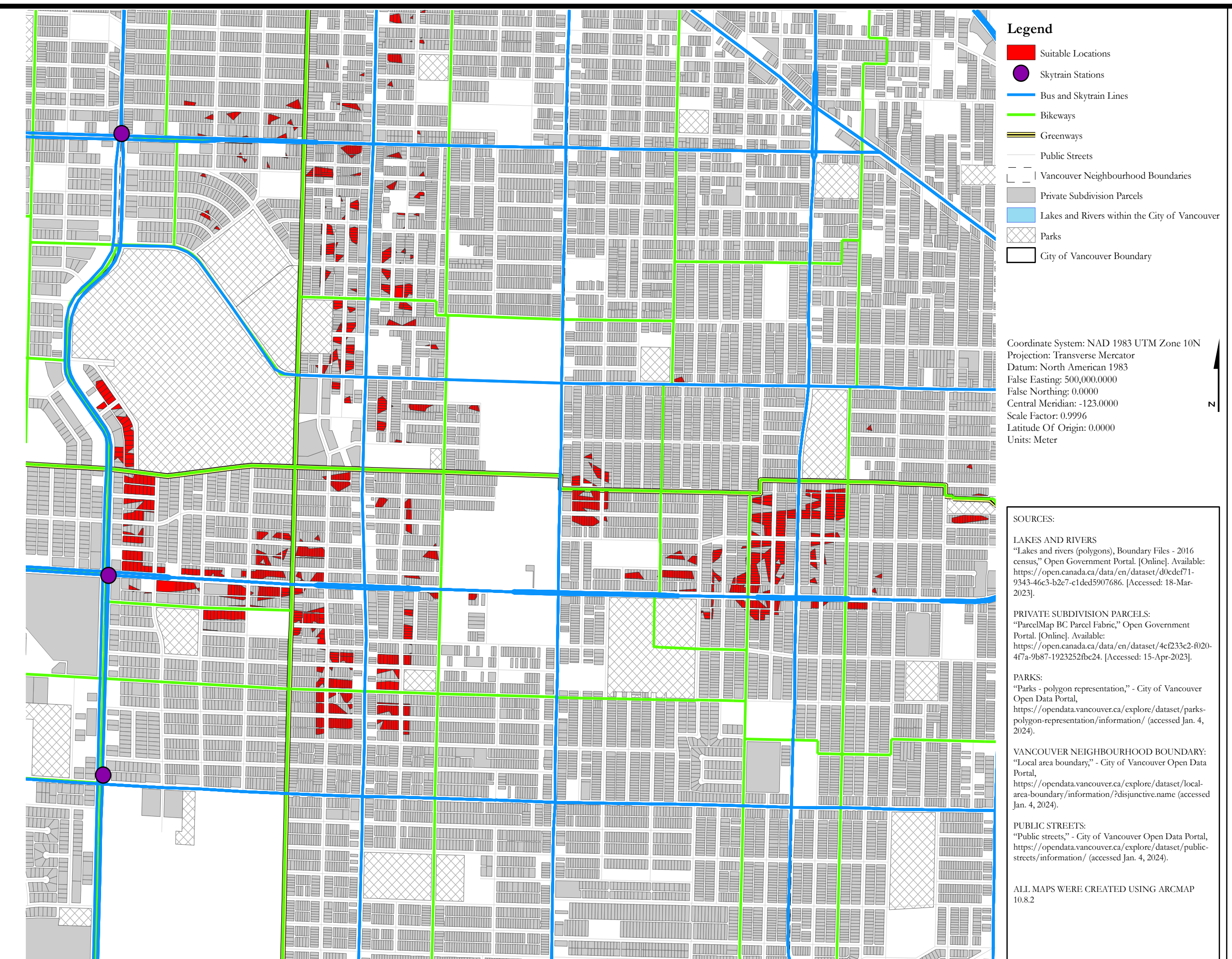
To ensure compliance with (3), the building should be uniquely positioned to optimize solar exposure. This is in case a future occupant wants to take advantage of on-site renewable energy generation or wants to offset internal heating with direct sunlight. To accomplish this, areas that are south facing and less than 30 degrees in slope were extracted from an open-source Canadian Digital Elevation Models ("CDEM") to represent optimal sunlight exposure areas in Vancouver [25]. These areas are depicted in **MA-4.3 SITE SELECTION - SUNLIGHT EXPOSURE**.

Risk

To ensure compliance with (4), the home should be located in a lower risk susceptible area. We can determine this by reviewing **MA-2.0 RISK INDEX BY SQUARE KILOMETER GRID AREA**. Areas with a risk index lower than 1.825 (which roughly equates to the lowest 10%) were selected as acceptable areas. These areas are depicted in **MA-4.4 SITE SELECTION - RISK**.

Price

To ensure compliance with (5), this parcel should be located in one of the more affordable neighborhoods of Vancouver. As mentioned in section 3.0 **AFFORDABILITY MAPPING**, up to date housing data on a neighborhood level is not publicly available. That said, the same procedure conducted in **MA-3.0 HOUSING AFFORDABILITY BY REGION** could be done on a neighborhood level once that information is open to the public. Based on **MA-3.0 HOUSING AFFORDABILITY BY REGION**, the average yearly sold price for a detached single-family home is \$3.4 million (~\$1168/sq ft, westside), and \$1.93 million (~\$852/ sq ft - eastside) [54]. Eastside is preferred.



Sources

- [1] "The MLR HPI index" CREA, <https://www.crea.ca/en/news-releases/mlr-hpi-index/> (accessed Jan 16, 2024)
- [2] "Wages have stagnated" CREA, <https://www.crea.ca/en/news-releases/wages-have-stagnated/> (accessed Jan 16, 2024)
- [3] "The big one" CREA, <https://www.crea.ca/en/news-releases/the-big-one/> (accessed Jan 16, 2024)
- [4] "2021 Flood" CREA, <https://www.crea.ca/en/news-releases/2021-flood/> (accessed Jan 16, 2024)
- [5] "2023 was the most destructive wildfire year reported in BC" CREA, <https://www.crea.ca/en/news-releases/2023-was-the-most-destructive-wildfire-year-reported-in-bc/> (accessed Jan 16, 2024)
- [6] "Heat dome" CREA, <https://www.crea.ca/en/news-releases/heat-dome/> (accessed Jan 16, 2024)
- [7] "Winter storm" CREA, <https://www.crea.ca/en/news-releases/winter-storm/> (accessed Jan 16, 2024)
- [8] "Climate change" CREA, <https://www.crea.ca/en/news-releases/climate-change/> (accessed Jan 16, 2024)
- [9] "Net zero ready" CREA, <https://www.crea.ca/en/news-releases/net-zero-ready/> (accessed Jan 16, 2024)
- [10] "Carbon Step Code" CREA, <https://www.crea.ca/en/news-releases/carbon-step-code/> (accessed Jan 16, 2024)
- [11] "Embodied Carbon" CREA, <https://www.crea.ca/en/news-releases/embodied-carbon/> (accessed Jan 16, 2024)
- [12] "National Risk Index for Natural Hazards" FEMA USA, <https://www.fema.gov/national-risk-index> (accessed Jan 16, 2024)
- [13] "Global Solar and Wind Atlas" NREL, <https://www.nrel.gov/global-atlas/> (accessed Jan 16, 2024)
- [14] "BC Real Estate Data" CREA, <https://www.crea.ca/en/news-releases/bc-real-estate-data/> (accessed Jan 16, 2024)

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