BSAN 710
BUSINESS ANALYTICS
CAPSTONE PROJECT

Final Presentation

Capstone Group 2
November 19, 2024

precisely

DREXEL UNIVERSITY
LeBow
College of Business

OUR TEAM

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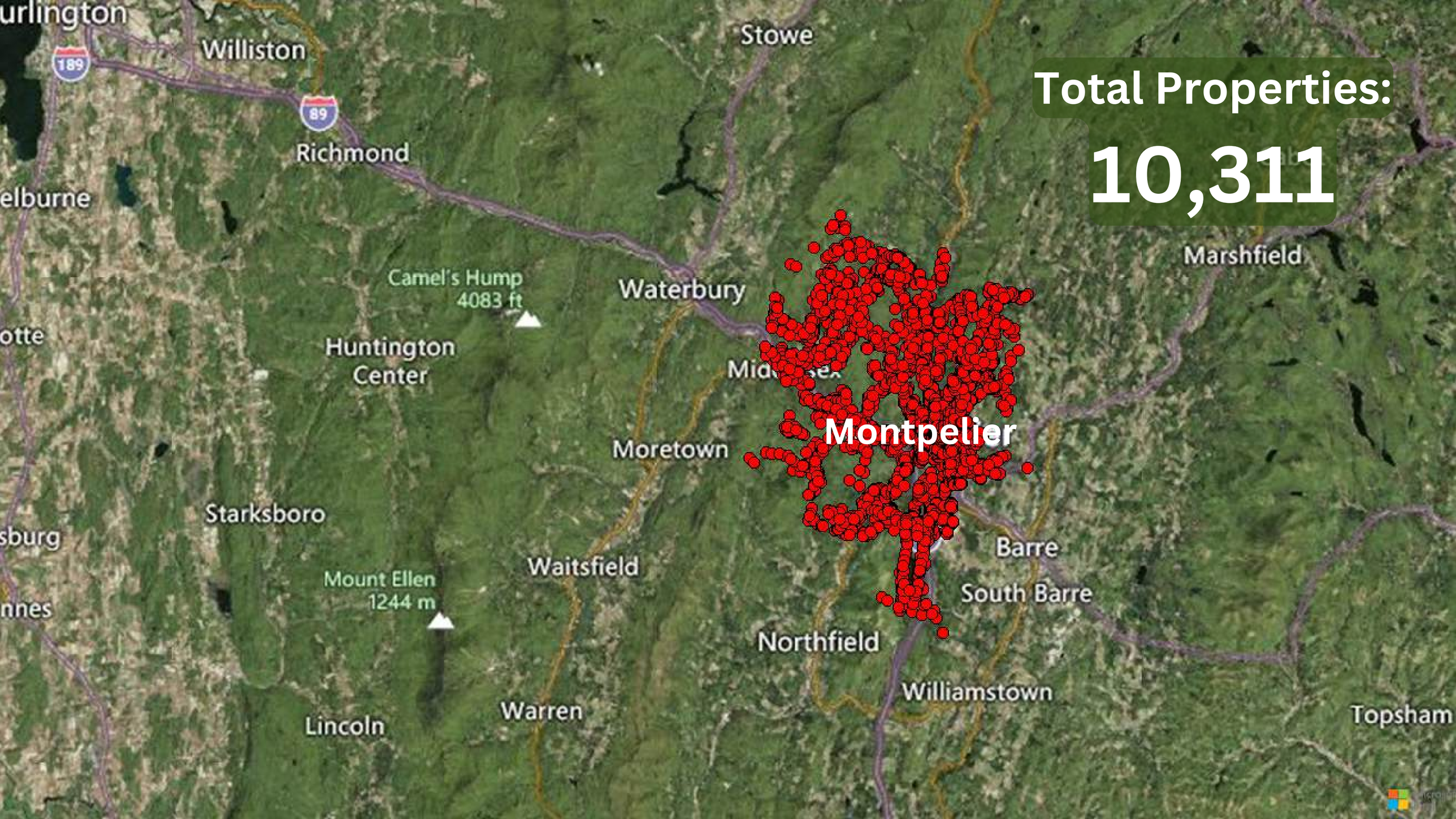
"The historic flooding last month has had a deep impact on our state. In my travels to Hardwick, Montpelier, Ludlow and many areas in between, it has been heartbreaking to see the damage inflicted on people's homes, businesses, and to our natural landscape."

– VERMONT SECRETARY OF STATE

Reference: https://www.montpelier-vt.org/610/Flood-Guide


Total Properties:
10,311
Montpelier
Stowe
Williston
Richmond
Waterbury
Camel's Hump
4083 ft
Huntington
Center
Moretown
Marshfield
Barre
South Barre
Waitsfield
Mount Ellen
1244 m
Starksboro
Northfield
Williamstown
Warren
Lincoln
Topsham

90%

of natural disasters within the United States involve flooding.

Floods cause more economic damage, loss of life, and property than any other natural hazard.

Reference: https://www.montpelier-vt.org/610/Flood-Guide

Reference: https://www.dhs.gov/natural-disasters

MONTPELIER, VT

HISTORICAL REFERENCE

JULY FLOOD, 2023

Downtown Montpelier local roads submerged by floodwaters

Transportation Disruptions

Extensive flooding throughout the Winooski River valley

FEMA 1 Percent Annual Chance Flood

SUMMARY STATISTICS

Making a Comprehensive Dataset

1

DATA FILTRATION

Focused dataset on Montpelier, VT.

Address Fabric:

10,311 properties

Unique Columns: 16

Unique Property ID	City	ZIP Code	Latitude
Street Number	State	ZIP+4	Longitude
Street Name	Unit Designator	Location Code	FIPS Code
Parent Property ID	Unit Number	Geographic ID	Property Type

2

DATA CLEANING

Data Standarization and consistency checks

Unique **Property Types**:
['R' 'X' 'B' 'M']

R	Residential	6935
X	Exempt	2522
B	Business	590
M	Mixed-Use	264

Number of Invalid ZIP Codes	0
Number of Records with Incorrect State	0
Total Number of Duplicate Rows based on PBKEY	0
Number of Unique ZIPCODEs	6

No Missing Values in the most critical fields:

- Unique Property ID
- Address Details: City, State, ZIP Code
- Geographic Information: Latitude, Longitude, Location Code

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SUMMARY STATISTICS

Making a Comprehensive Dataset

Data Preprocessing

Unique **Property Types**:
['R' 'X' 'B' 'M']

R	Residential	6935
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10,311 properties

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No Missing Values in the most critical fields:

- Unique Property ID
- Address Details: City, State, ZIP Code
- Geographic Information: Latitude, Longitude, Location Code

A mere 23% of organizations use geospacial and location intelligence (GLI) capabilities within their business intelligence (BI) and analytic platforms, according to Gartner research.

https://www.gartner.com/smarterwithgartner/add-location-to-your-analytics

3

ADDRESS FORMATTING & GEOCODING

Standardized addresses and geocoded using

Precisely's Geoaddressing - Geocode API

ENRICHMENT

Fetched flood risk data using

Precisely's GraphQL - Floodrisk API

4

5

MERGING

Combined enriched datasets into a comprehensive data source.

Total unique records:

10,170

Key Insights for Insurance Companies - Flood Risk

- **High Flood Risk:** 238 Goodnow Rd, Montpelier, VT, is in an AE flood zone.
- **Proximity to Winooski River:** Increases flood vulnerability.
- **Flood History:** FIRM data shows past flooding.
- **Mitigation Strategies:** Elevate building, install flood barriers.
- **Tailored Insurance:** Offer customized coverage and risk management.

Flood Risk Output

Parameters	Values
PreciselyID	P0000N0KH4MW
Address	238 GOODNOW RD, MONTPELIER, VT 05602
FloodID	2343500
FemaMapPanelIdentifier	50023C0431E
FloodZoneMapType	P2P
StateFIPS	50
FloodZoneBaseFloodElevationFeet	AE0545
FloodZone	AE
BaseFloodElevationFeet	0545
CommunityNumber	500106
CommunityStatus	R
MapEffectiveDate	2013-03-19
FloodHazardBoundaryMapInitialDate	1974-02-15
FloodInsuranceRateMapInitialDate	1984-08-15
AddressLocationElevationFeet	533
Year100FloodZoneDistanceFeet	0
Year500FloodZoneDistanceFeet	515
ElevationProfileToClosestWaterbodyFeet	533.77298
DistanceToNearestWaterbodyFeet	193
NameOfNearestWaterbody	Winooski River

FLOOD RISK MODELING SOLUTIONS FOR PROPERTY INSURANCE

Custering based Risk Assessment

Categorizes properties by flood risk

Underinsurance Prediction

Identifies underinsured properties

CLUSTERING-BASED RISK ASSESSMENT

for Insurance

Insurance companies need a more accurate and data-driven way to categorize risk levels for different properties.

Better risk categorization can improve pricing strategies, enhance customer satisfaction, and reduce losses.

Precisely APIs

propertyAttributesByAddress

floodrisk data

(Using Address details from Address Fabric)

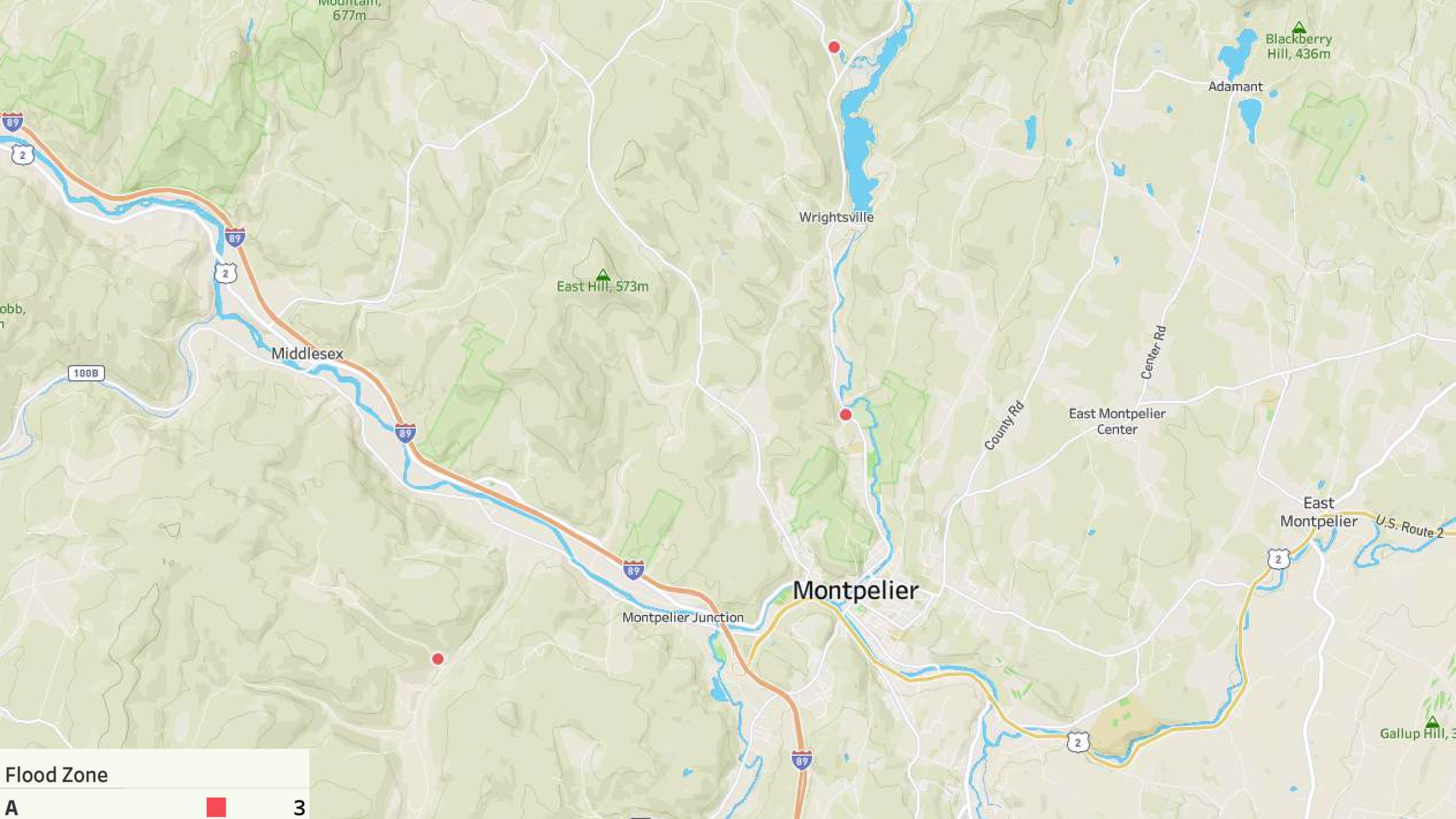
Total addresses:

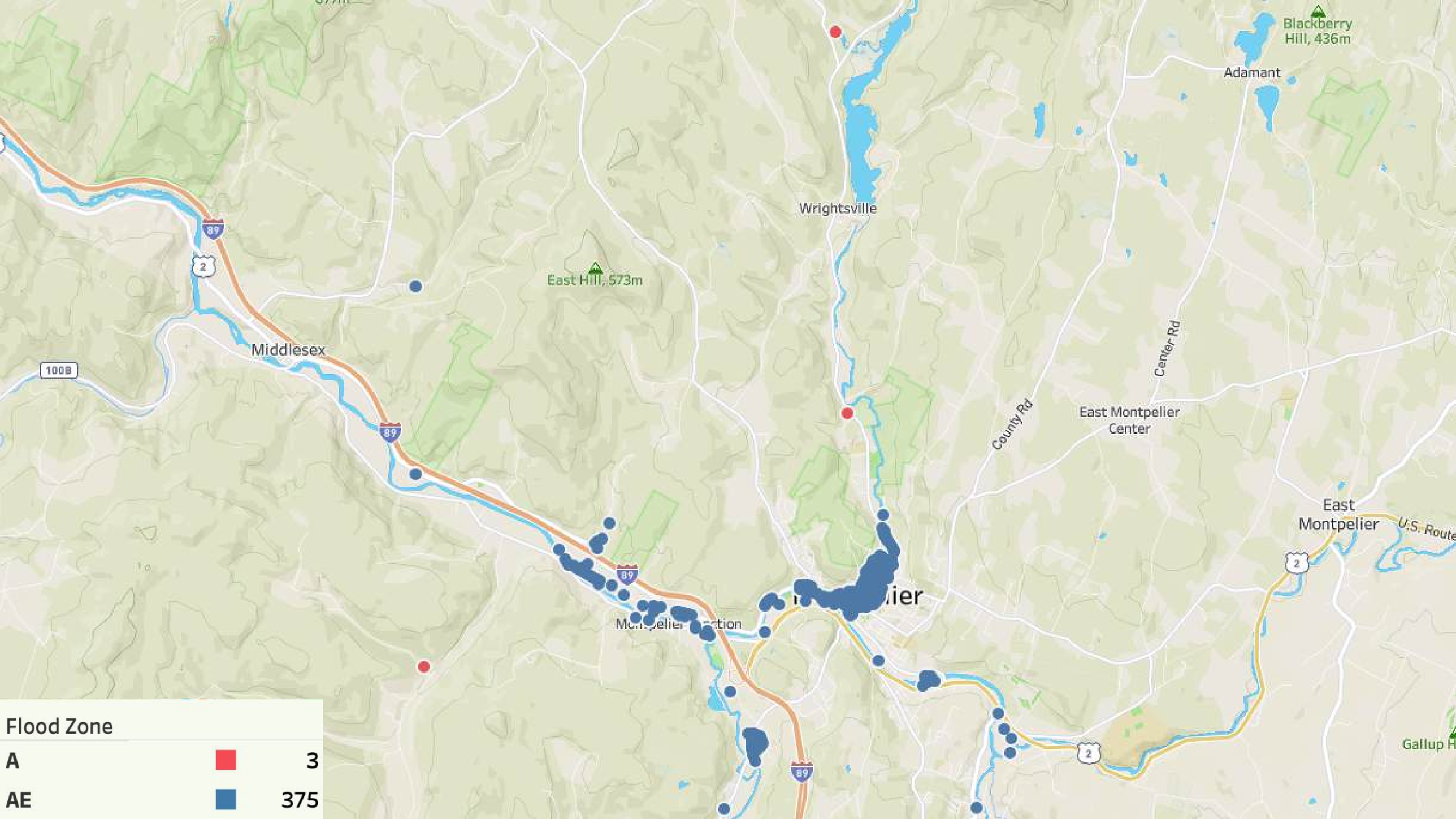
4184

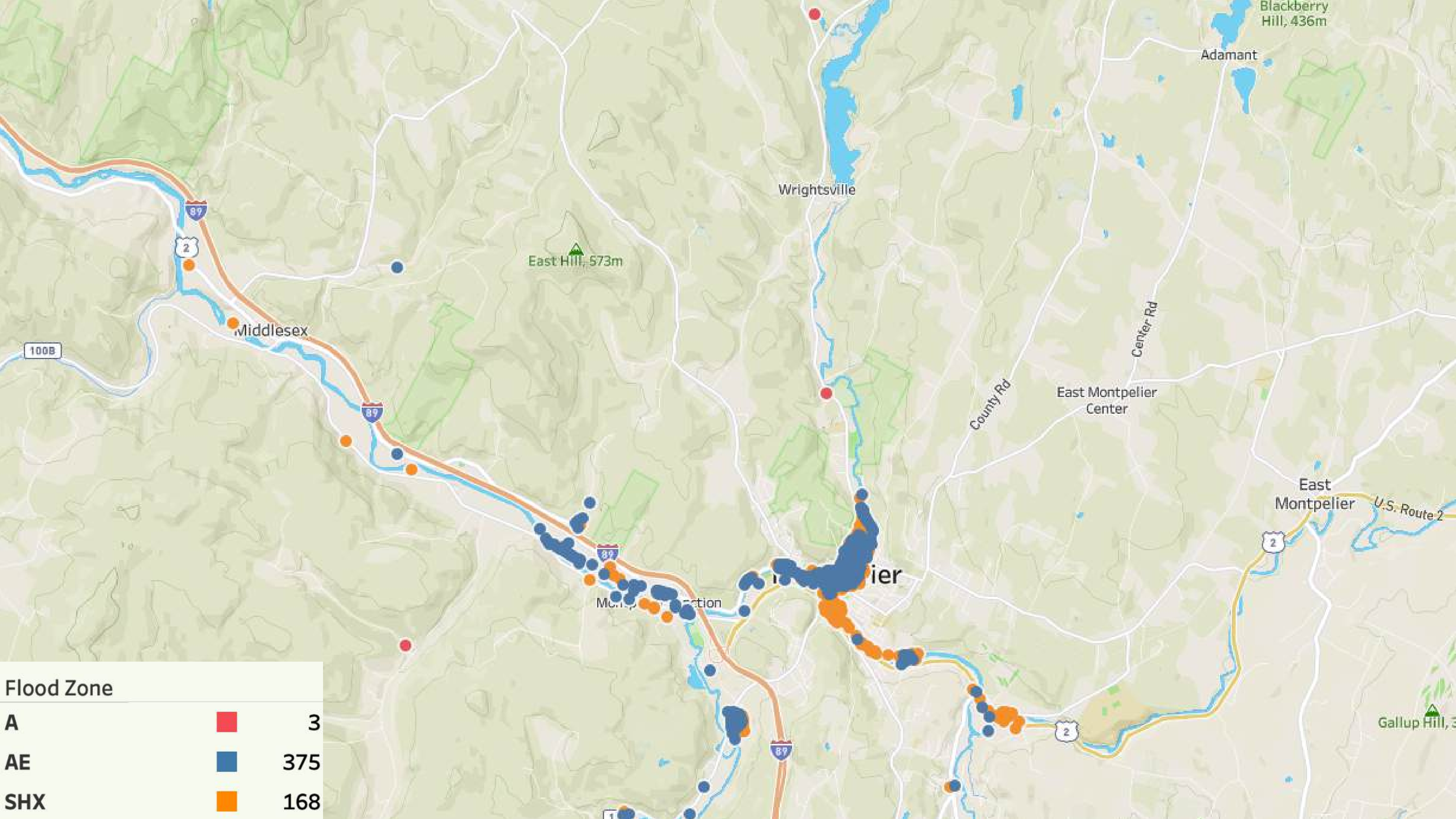
Which customers are at the highest risk of flood damage *based on their location*?

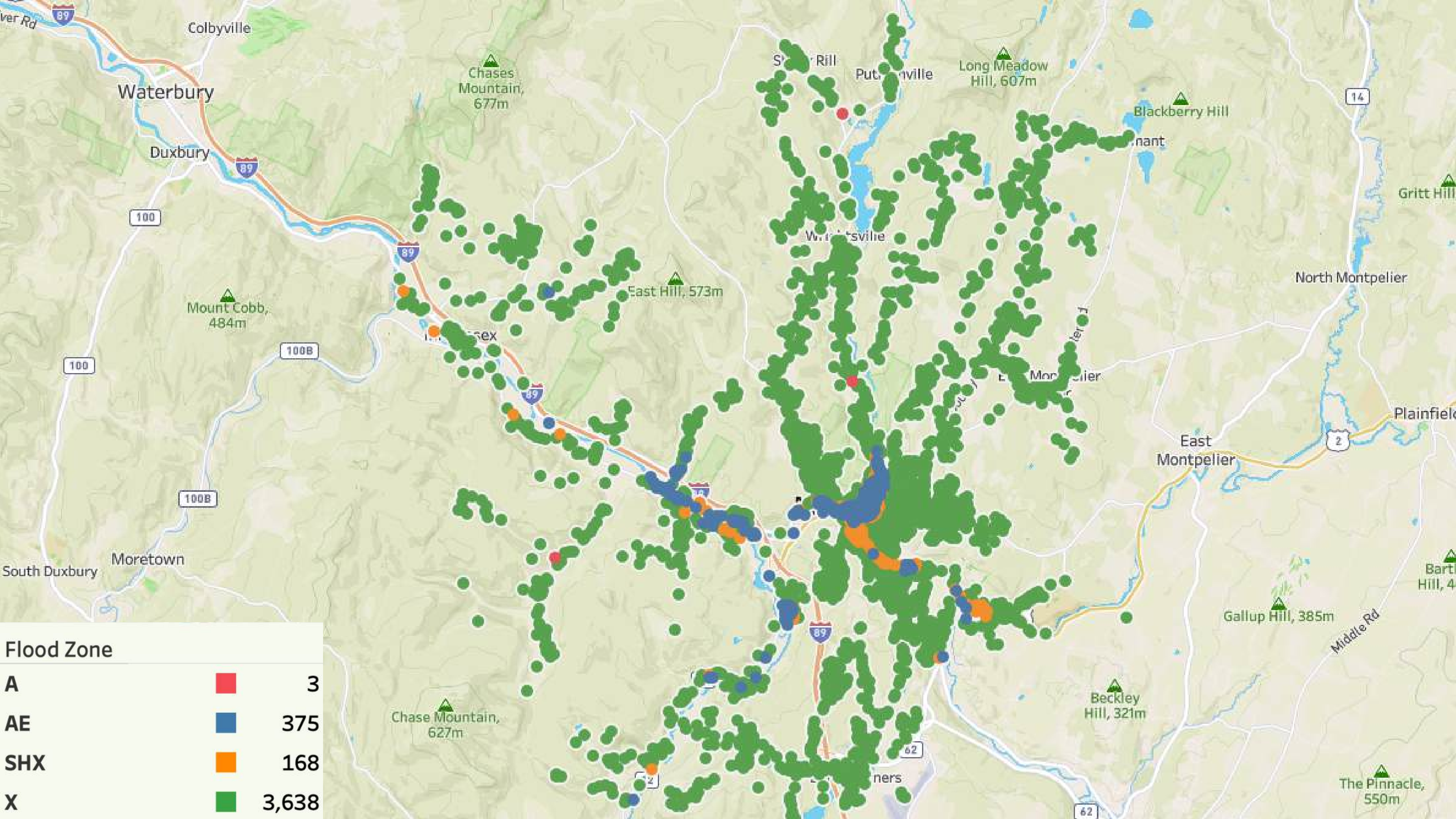
"**40%** of all flood claims occur in low- to moderate-risk areas. Flood insurance is an important safeguard, even for those in areas of low risk."

Reference: https://www.floodsmart.gov/flood-risk


Flood Zone
A
3
Middlesex
Montpelier
Montpelier Junction
Wrightsville
East Hill, 573m
Blackberry Hill, 436m
Adamant
East Montpelier Center
East Montpelier
U.S. Route 2
County Rd
Center Rd
Gallup Hill
89
2
100B


Blackberry Hill, 436m
Adamant
Wrightsville
East Hill, 573m
Middlesex
100B
89
2
County Rd
Center Rd
East Montpelier Center
East Montpelier
U.S. Route
Gallup
Flood Zone
A 3
AE 375


Blackberry Hill, 436m
Adamant
Wrightsville
East Hill, 573m
Middlesex
100B
89
2
Center Rd
County Rd
East Montpelier Center
East Montpelier
U.S. Route 2
Gallup Hill,
Flood Zone
A 3
AE 375
SHX 168


Colbyville
Waterbury
Duxbury
Chases Mountain, 677m
Long Meadow Hill, 607m
Blackberry Hill
Gritt Hill
North Montpelier
East Hill, 573m
Mount Cobb, 484m
East Montpelier
Plainfield
Moretown
South Duxbury
Gallup Hill, 385m
Middle Rd
Beckley Hill, 321m
Chase Mountain, 627m
The Pinnacle, 550m
89
100
100B
14
2
62
Flood Zone
A 3
AE 375
SHX 168
X 3,638

DATA AND IT'S BUSINESS RELEVANCE

Distance-related features

(proximity to flood zones and elevation)

Distance Factor:

'Year100FloodZoneDistanceFeet'
'DistanceToNearestWaterbodyFeet'
'AddressLocationElevationFeet'

Evaluate environmental hazard exposure affecting property risk.

Property characteristics and value

Building Construction Type (Frame, Concrete)
Exterior Walls (Wood Siding, etc.)
Roof Cover
Total Market Value
Living Square Footage

Determine structural vulnerability for accurate risk evaluation.

Geographic and Flood risk data

Flood Zone (AE, SHX, A, X)
Nearest Waterbody (Winooski River)

Assess likelihood of hazards impacting properties for better underwriting.

Feature Selection:

Principal Component Analysis (PCA)

Feature Variance Analysis

Selected Features:

Building Construction Type (Frame)
Exterior Walls (Wood Siding)

} **vulnerability to damage**

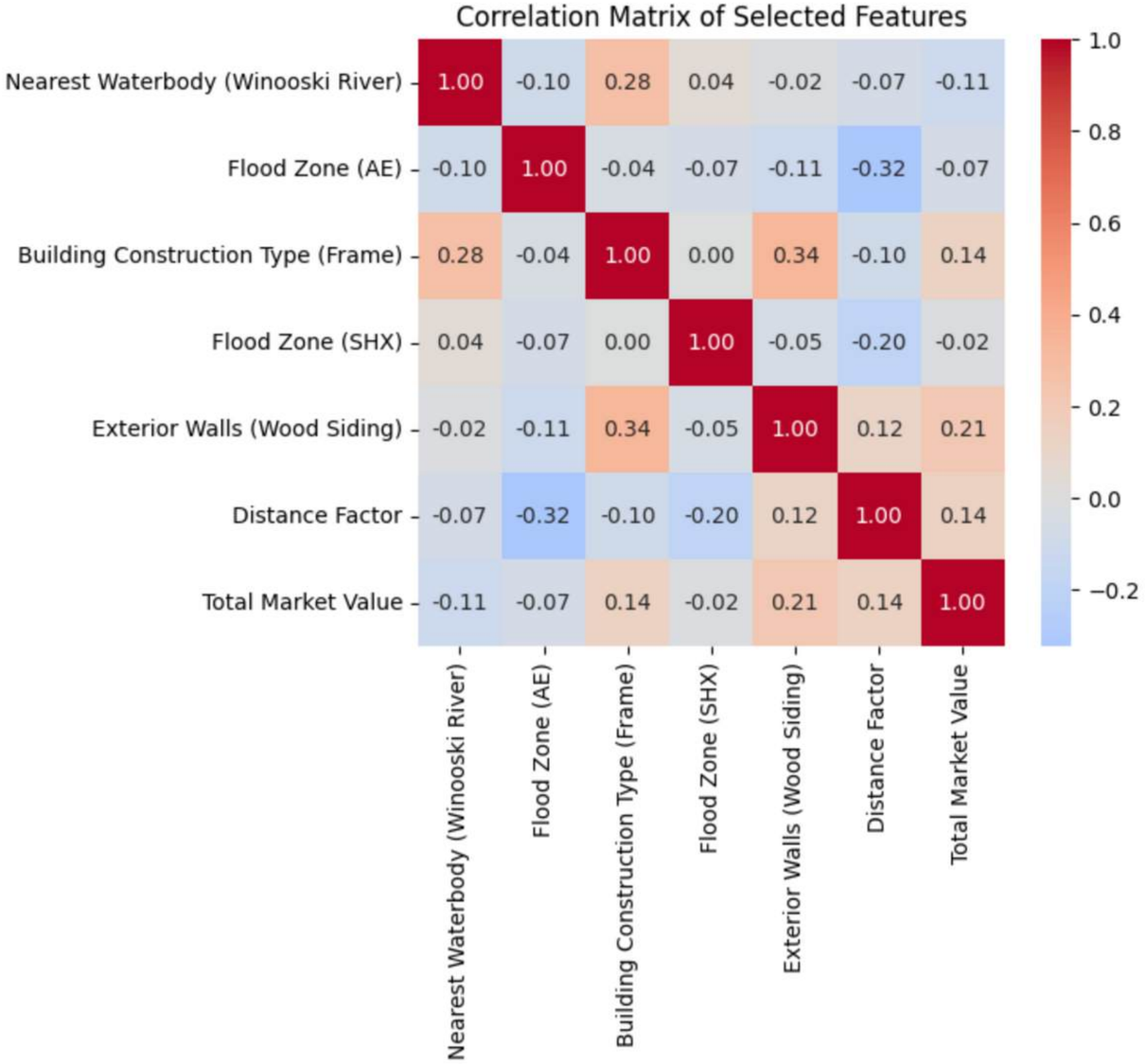
Flood Zone (AE)
Flood Zone (SHX)
Total Market Value
Nearest Waterbody (Winooski River)

} **exposure to natural hazards**

Distance Factor:

Proximity to 100-Year Flood Zone
Nearest Waterbody Distance
Elevation Above Sea Level

} **risk from nearby water bodies and elevation differences**

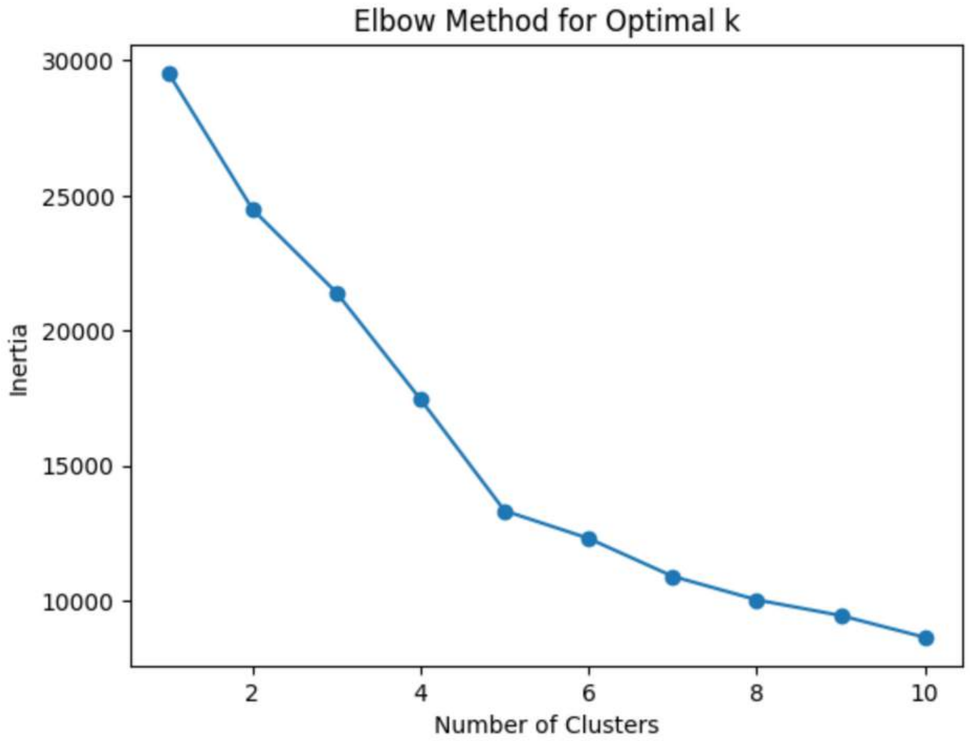


Defining Clusters:

K-means Clustering: **segmented properties based on selected features.**

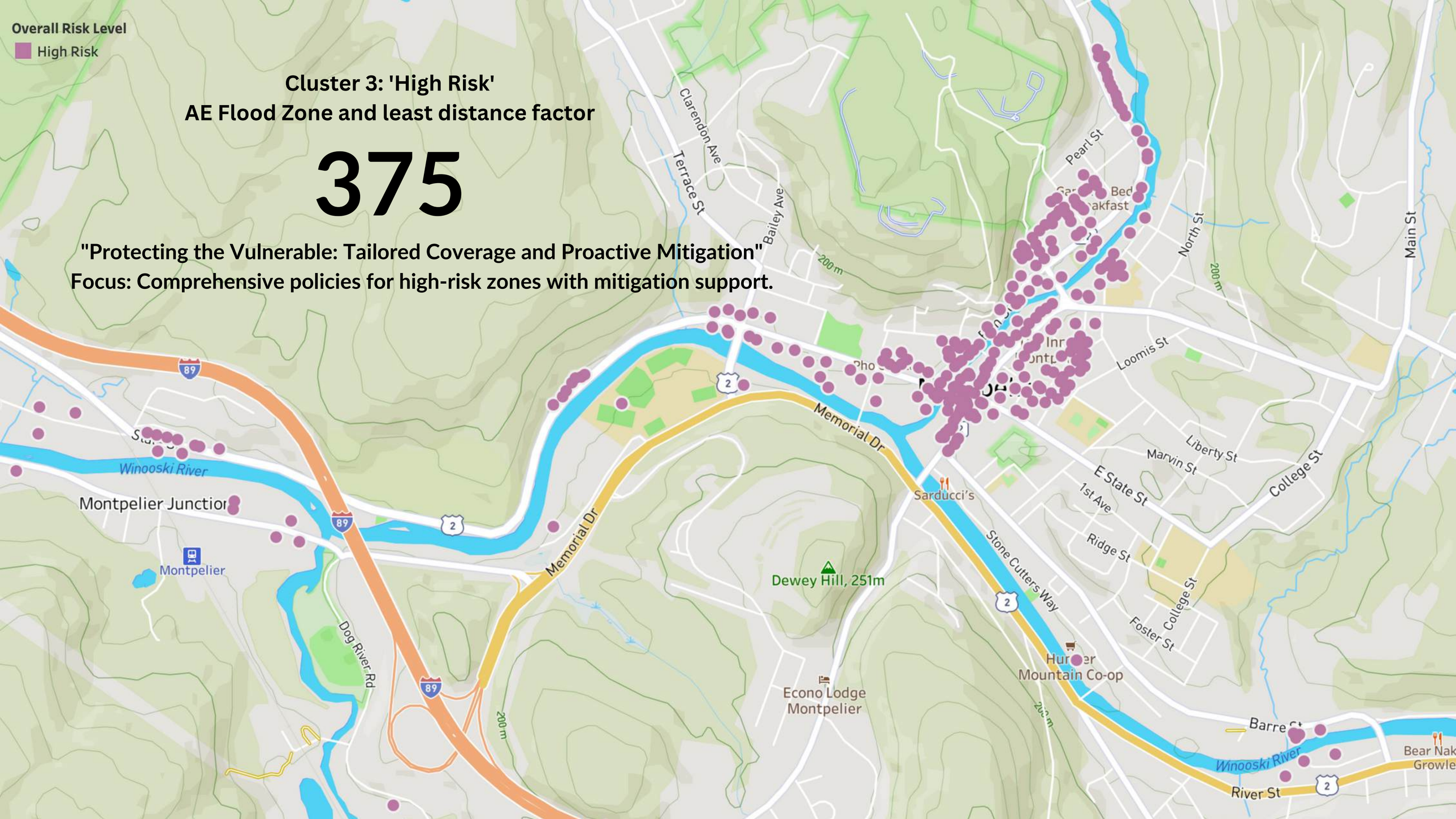
Clusters: Grouped properties with shared risk factors, allowing for differentiated risk levels.

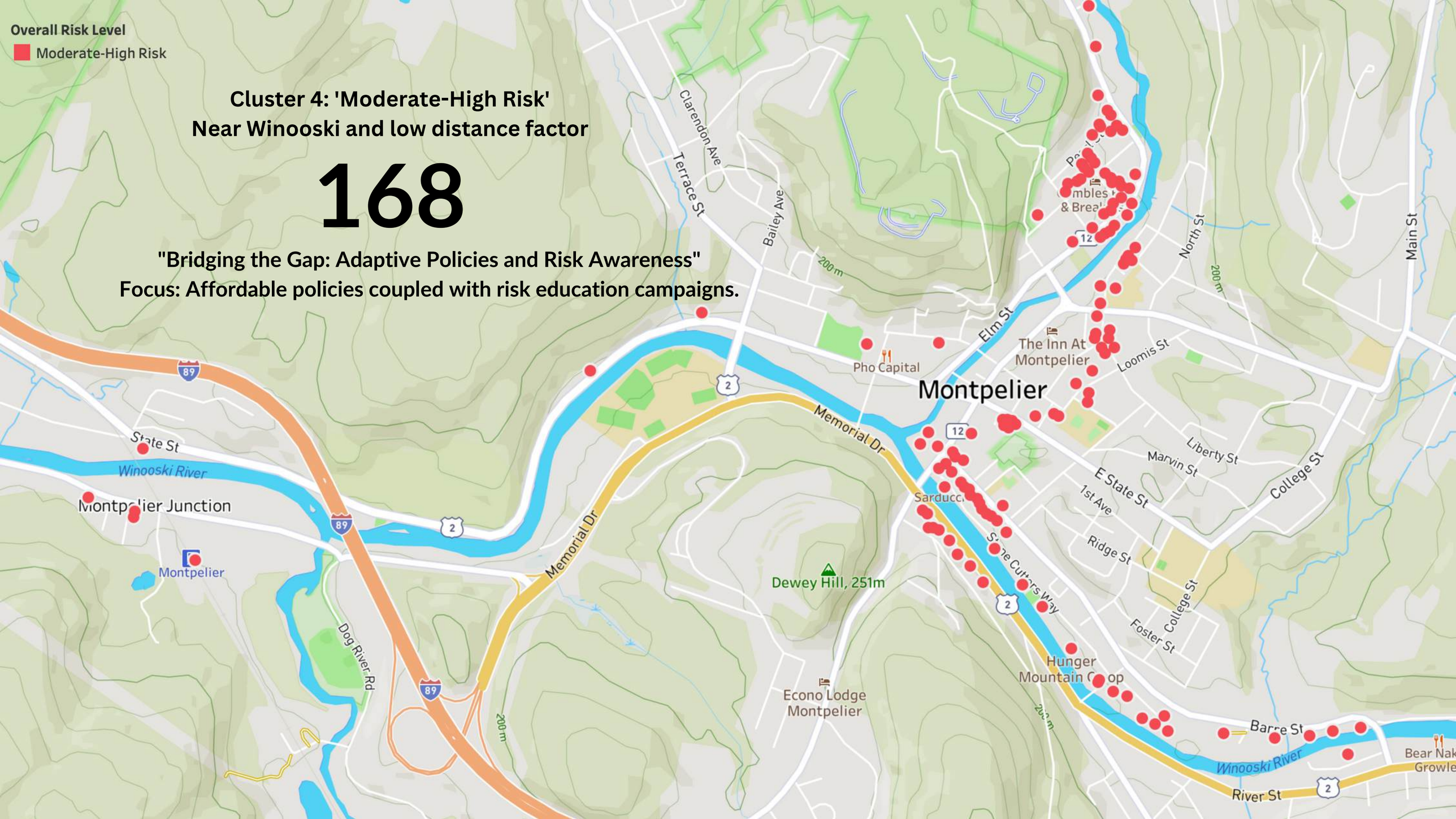
Cluster	Proximity to Winooski River	Flood Zone (AE/SHX)	Frame Construction	Exterior Wall: Wood	Distance Factor (ft)	Total Market Value (USD)
Cluster 0	0.51% properties close	AE (0%)	63.7%	99.1%	4115.4	398,256
Cluster 1	16.5% properties close	AE (0%)	24.5%	0.1%	3783.9	323,386
Cluster 2	100% properties close	AE (0%)	97.9%	58.1%	3796.0	332,214
Cluster 3	21.5% properties close	AE (100%)	52.7%	29.6%	871.3	317,906
Cluster 4	44.8% properties close	SHX (100%)	59.8%	35.1%	1016.5	336,554

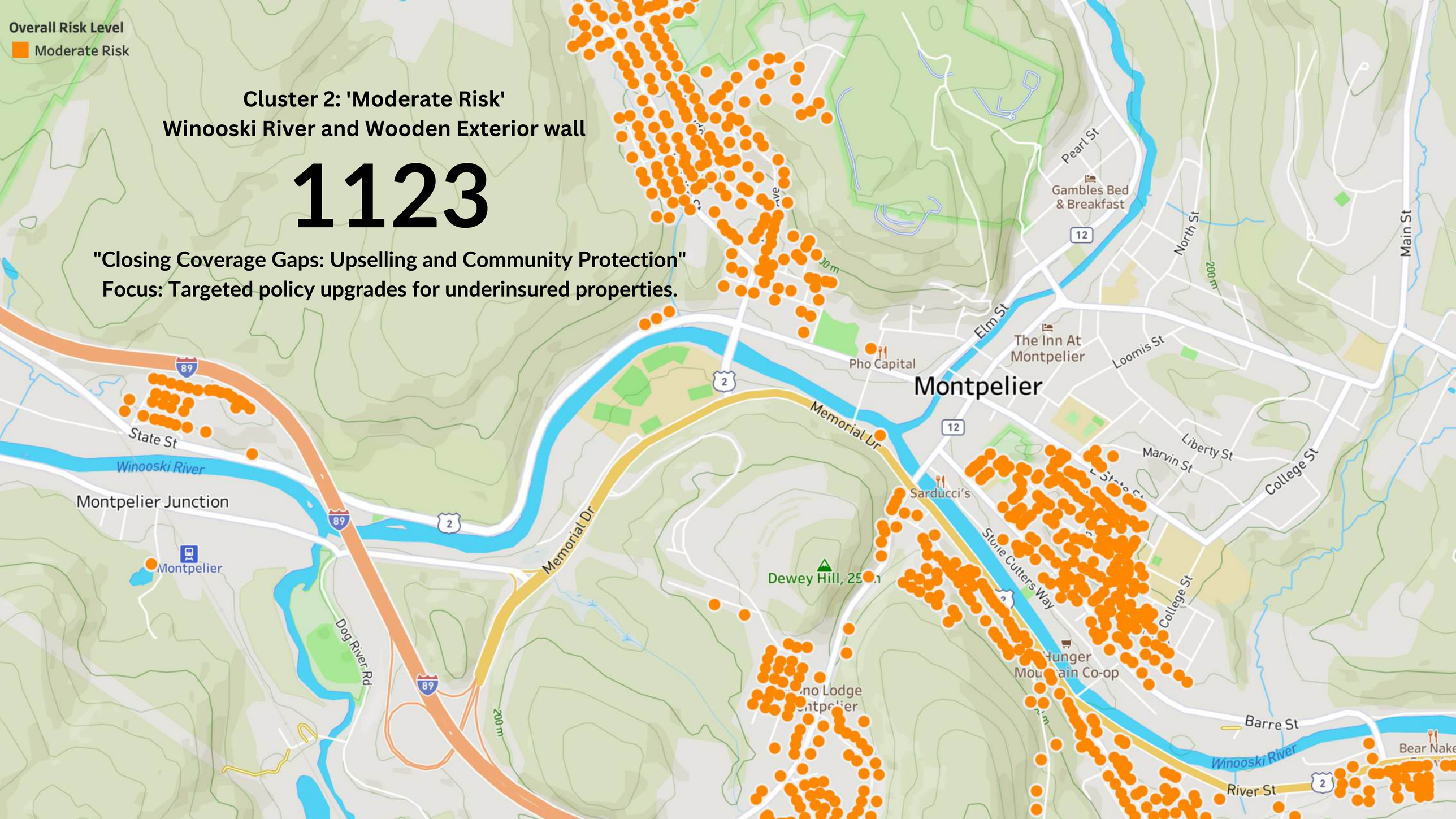


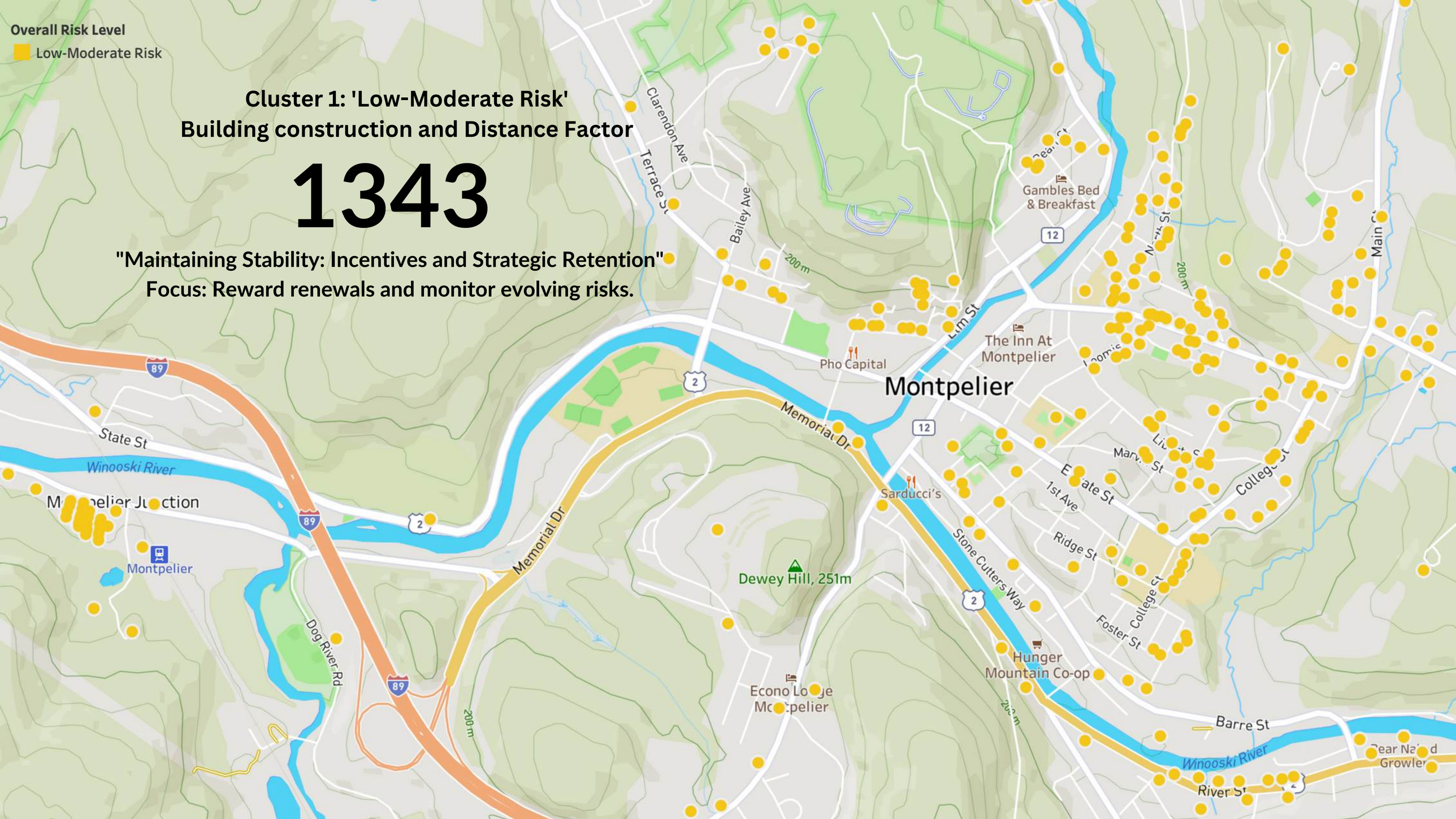
Number of clusters = 5

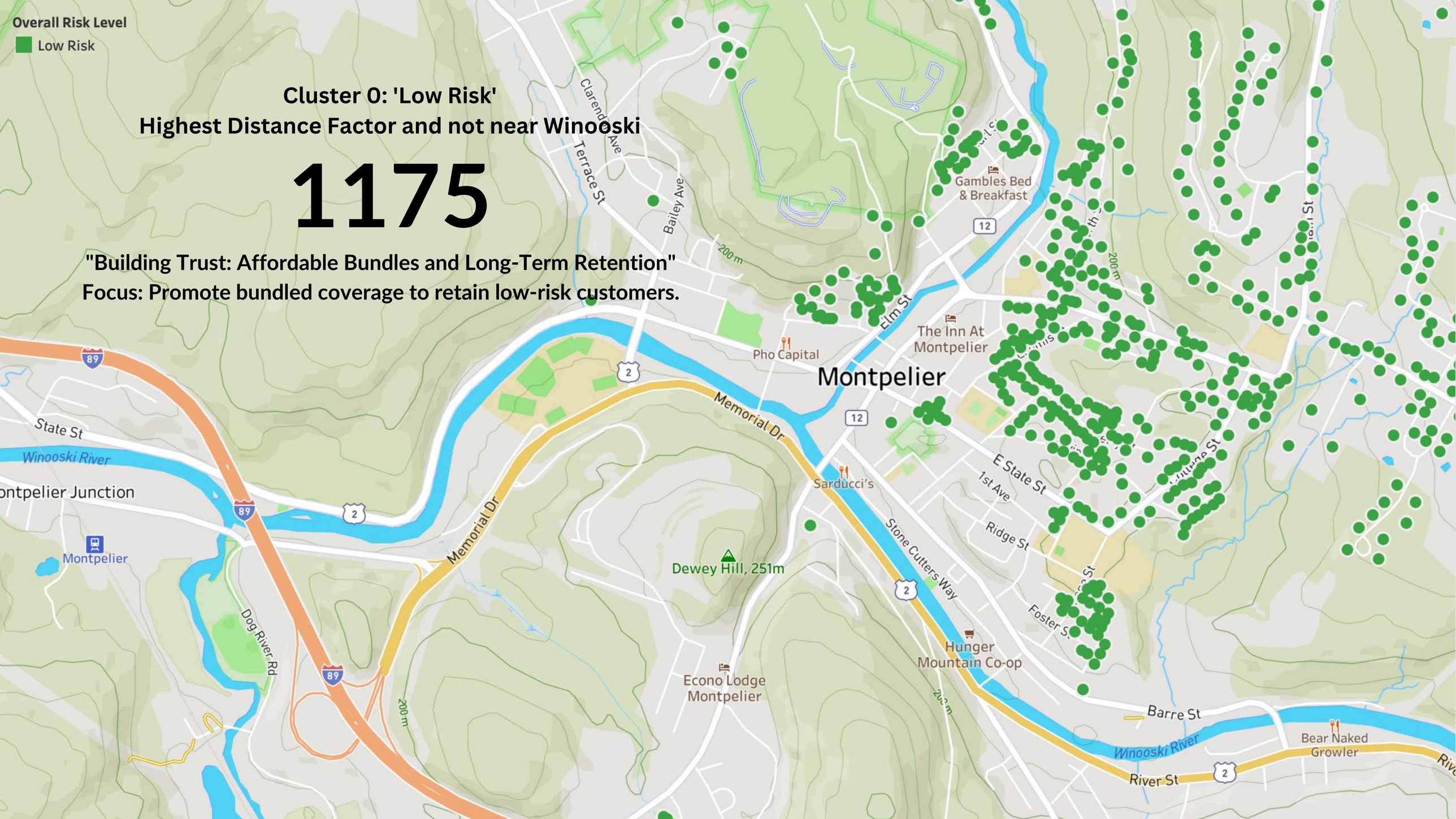
Identified using the Elbow method

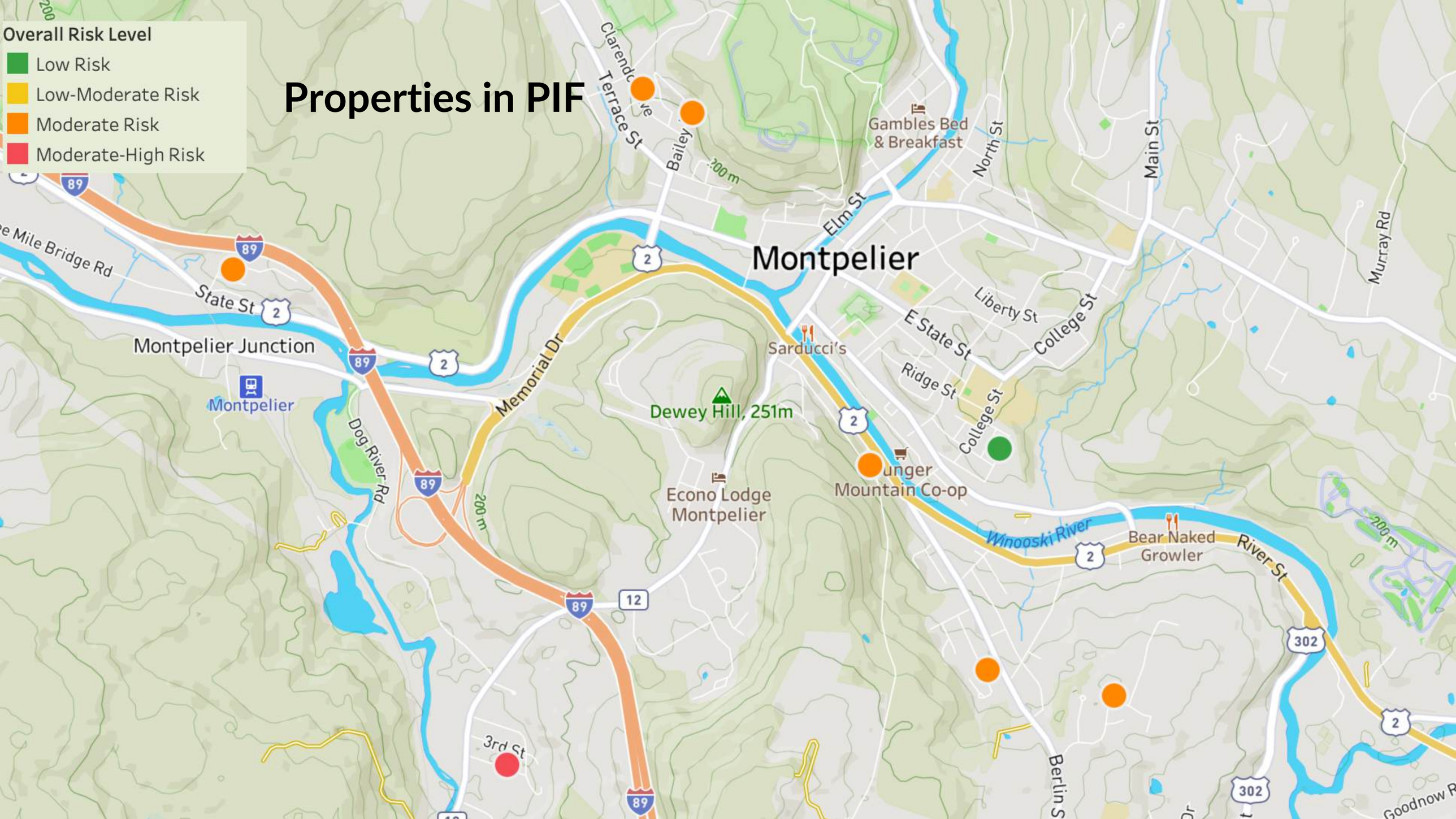

Overall Risk Level
High Risk
Cluster 3: 'High Risk'
AE Flood Zone and least distance factor
375
"Protecting the Vulnerable: Tailored Coverage and Proactive Mitigation"
Focus: Comprehensive policies for high-risk zones with mitigation support.
Clarendon Ave
Terrace St
Bailey Ave
200 m
Pearl St
North St
Main St
Loomis St
Liberty St
Marvin St
E State St
1st Ave
College St
Ridge St
Foster St
Stone Cutters Way
Memorial Dr
Winooski River
Montpelier Junctior
Montpelier
Dog River Rd
Dewey Hill, 251m
Econo Lodge
Montpelier
Sarducci's
Mountain Co-op
River St
89
2


Overall Risk Level
Moderate-High Risk
Cluster 4: 'Moderate-High Risk'
Near Winooski and low distance factor
168
"Bridging the Gap: Adaptive Policies and Risk Awareness"
Focus: Affordable policies coupled with risk education campaigns.
Montpelier
Pho Capital
The Inn At Montpelier
Sarducci
Dewey Hill, 251m
Econo Lodge Montpelier
Hunger Mountain Co-op
Montpelier Junction
Memorial Dr
Winooski River
Elm St
Main St
North St
Loomis St
Liberty St
Marvin St
E State St
College St
1st Ave
Ridge St
Foster St
Stone Cutters Way
Barre St
River St
Terrace St
Clarendon Ave
Bailey Ave
Dog River Rd
State St
200 m
89
2
12


Overall Risk Level
Moderate Risk
Cluster 2: 'Moderate Risk'
Winooski River and Wooden Exterior wall
1123
"Closing Coverage Gaps: Upselling and Community Protection"
Focus: Targeted policy upgrades for underinsured properties.
Montpelier
Montpelier Junction
Pho Capital
The Inn At Montpelier
Gambles Bed & Breakfast
Sarducci's
Dewey Hill, 25
Hunger Mountain Co-op
State St
Winooski River
Memorial Dr
Elm St
Pearl St
North St
Main St
Loomis St
Liberty St
Marvin St
College St
Stone Cutters Way
Barre St
River St
Dog River Rd
89
2
12
200 m


Overall Risk Level
Low-Moderate Risk
Cluster 1: 'Low-Moderate Risk'
Building construction and Distance Factor
1343
"Maintaining Stability: Incentives and Strategic Retention"
Focus: Reward renewals and monitor evolving risks.
Montpelier
Pho Capital
The Inn At Montpelier
Gambles Bed & Breakfast
Sarducci's
Dewey Hill, 251m
Hunger Mountain Co-op
Econo Lodge Montpelier
Montpelier
Memorial Dr
State St
Winooski River
Dog River Rd
Stone Cutters Way
1st Ave
Ridge St
Foster St
College St
Barre St
River St
Clarendon Ave
Terrace St
Bailey Ave
200 m
89
2
12


Overall Risk Level
Low Risk
Cluster 0: 'Low Risk'
Highest Distance Factor and not near Winooski
1175
"Building Trust: Affordable Bundles and Long-Term Retention"
Focus: Promote bundled coverage to retain low-risk customers.
Clarendon Ave
Terrace St
Bailey Ave
200 m
Gambles Bed & Breakfast
12
Elm St
The Inn At Montpelier
Pho Capital
Montpelier
2
Memorial Dr
89
State St
Winooski River
ontpelier Junction
Montpelier
Dog River Rd
Dewey Hill, 251m
Sardúcci's
Stone Cutters Way
E State St
1st Ave
Ridge St
Foster St
Hunger Mountain Co-op
Econo Lodge Montpelier
Barre St
Bear Naked Growler
River St


Overall Risk Level
Low Risk
Low-Moderate Risk
Moderate Risk
Moderate-High Risk
Properties in PIF
Montpelier
Montpelier Junction
State St
Elm St
Main St
North St
Gambles Bed & Breakfast
Terrace St
Bailey
Memorial Dr
Dog River Rd
Dewey Hill, 251m
Sarducci's
Econo Lodge Montpelier
Mountain Co-op
Liberty St
E State St
College St
Ridge St
Winooski River
Bear Naked Growler
River St
Murray Rd
Berlin St
3rd St
200 m
89
2
12
302

THE KEY BUSINESS IMPLICATIONS:

CLUSTER 3: HIGH RISK SHOULD BE TARGETTED BY THE INSURANCE COMPANIES FOR HIGH-MARGIN POLICIES TO OFFSET POTENTIAL LOSSES.

Cluster 4: Moderate-High Risk acts as

- Why Target? Acts as a transition buffer, strategically positioned for risk mitigation efforts.
- Strategy: Implement risk-sharing partnerships (e.g., co-insurance models with reinsurers).

3. Cluster 2: Moderate Risk

- Why Target? Largest cluster = biggest upselling opportunity.
- Strategy: Develop customized policy bundles that emphasize flood add-ons.

4. Cluster 1: Low-Moderate Risk

- Why Target? Key for ensuring steady premium revenue.
- Strategy: Provide low-premium loyalty programs to increase retention.

5. Cluster 0: Low Risk

- Why Target? Minimal claims = reliable profit margins.
- Strategy: Upsell multi-policy packages with flood coverage as a value-add.

UPSELLING OPPORTUNITIES FOR UNDERINSURED PROPERTIES

Are these customers *underinsured* based on their assessed property value versus policy value?

Flood insurance requirement in Montpelier:
"The coverage should be at least the lesser of the loan amount or the maximum amount available ($250k for single-family homes)"

Insights for the Insurance Companies:
Advise these policyholders to increase/decrease their coverage to comply with requirements or to mitigate risk

Reference: https://www.montpelier-vt.org/611/Flood-Insurance-Information

Adequacy of Policy Coverage

UNDERINSURANCE PREDICTION

Predicting if the properties
are potentially ***underinsured***

Based on:

Policy Value
Property Assessed Value
Living Area (Sq Ft)
Insurance Premium
Construction Type
Property Style: Mobile Home
Deductible Amount

(Identified using PCA feature selection)

Our Dataset: Vermont
(Policies in Force)

Total Properties: 555

UNDERINSURANCE PREDICTION

Predicting if the properties
are potentially ***underinsured***

Based on:

Policy Value
Property Assessed Value
Living Area (Sq Ft)
Insurance Premium
Construction Type
Property Style: Mobile Home
Deductible Amount

(Identified using PCA feature selection)

Our Dataset: Vermont
(Policies in Force)

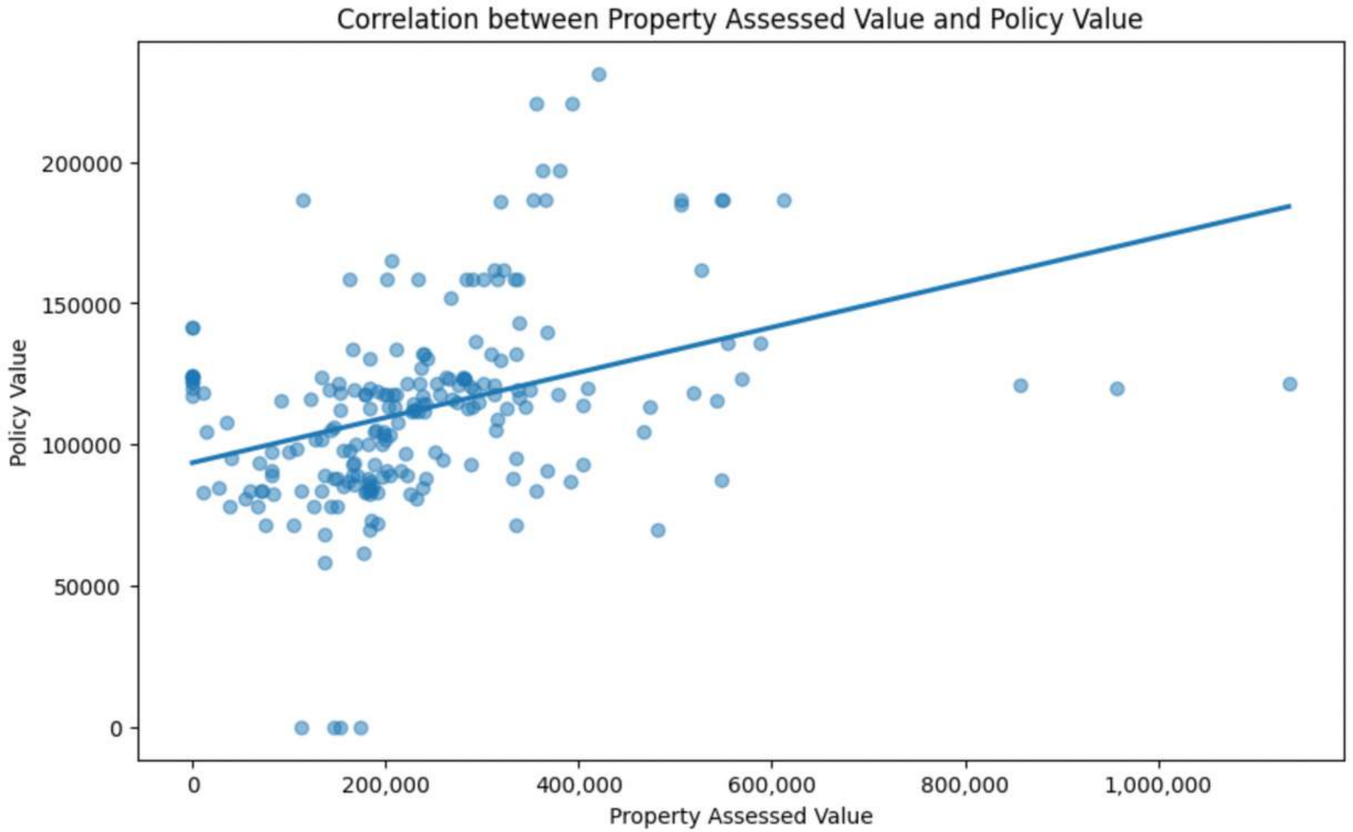
Total Properties: 555

Selected records: 216

ITV Ratio:
Policy Value / Property's assessed value

flagged properties that might be inadequately insured using

ITV Threshold = **80%**



https://davies-group.com/northamerica/knowledge/understanding-insurance-to-value-challenges/

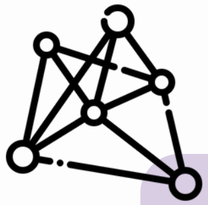
https://www.libertyhomeguard.com/glossary/insurance-to-value/

BUILDING THE MODEL

Target variable:

‘Underinsured’

Binary variable (Underinsured = 1; Adequately insured = 0)



Model Selection

Random Forest Classifier

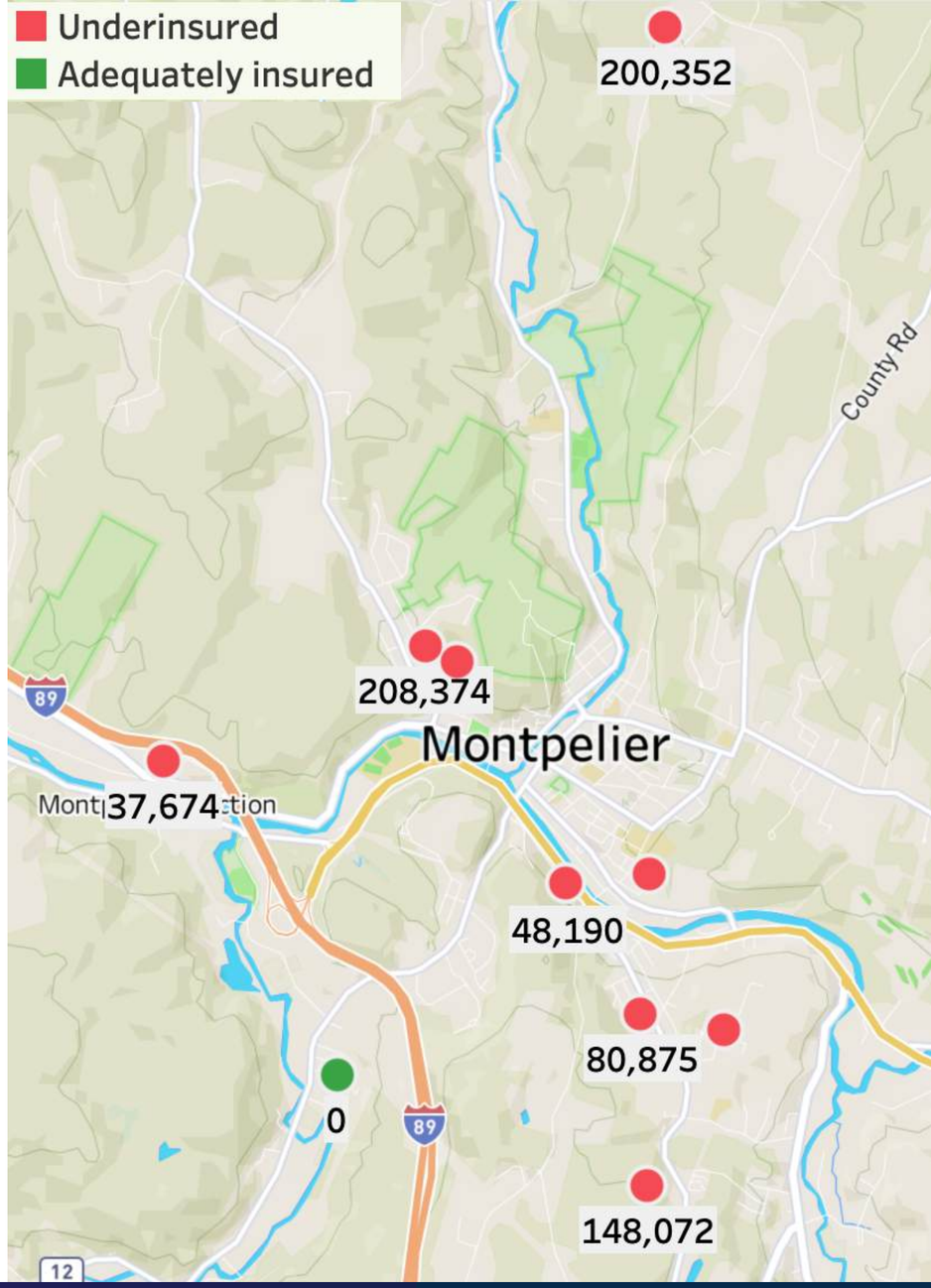
Accuracy	0.932
Precision	0.971
Recall	0.944
F1 Score	0.957

Testing our underinsurance prediction model on PIF data for Montpelier

pbKey	PolicyNo	PolicyValue	Premium	Deductable	Predicted_Underinsured	Underinsured_Amount
P0000N0KCJ3T	479399	89010	2885	890	1	48190
P0000N0KCH6S	267803	105026	10578	7351	1	84174
P0000N0KCH7Q	267804	105026	2885	1050	1	208374
P0000N0KCMA1	267816	105026	13463	4201	1	37674
P0000N0KCKSK	267815	86025	14425	860	1	95375
P0000N0KCLOH	498222	95269	10578	9526	0	0
P0000N0KCJQT	267800	139642	7693	13964	1	227658
P0000N0KCLZB	464303	105548	13463	6332	1	200352
P0000N0KCKTJ	443488	113928	5770	10253	1	148072
P0000N0KCJBY	267818	86025	6731	7742	1	80875

Average underinsurance amount for underinsured properties in Vermont:

$147689



precisely

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BUSINESS OUTCOME OF THE MODEL

Targeted Upselling Opportunities

Identifies underinsured properties.

Increase premiums on underinsured policies to enhance coverage adequacy and generate additional revenue.

Enhanced Underwriting Decisions

Highlights underinsured properties for precise policy adjustments.

Montpelier's Rising Flood Risks

80% increase in the likelihood of flooding threatening homes, businesses, infrastructure, communication and transportation systems.

Increased Flood Frequency:

- Flood frequency has risen significantly with major events in 2023, and 2024 (source: Vermont Climate Assessment).
- Climate change is exacerbating flood risk, requiring an adaptive response from insurers.

Our Analysis:

- Clustering based risk assessment
- Underinsured properties prediction

Reference: https://climatechange.vermont.gov/sites/climatecouncilsandbox/files/2021-12/VT%20CAP%20Summary_Final_0.pdf

BARRE STREET FLOOD IMPACT

- July 2024 floods severely affected Barre Street.
- Multiple residential properties flooded.

BERLIN MOBILE HOMES

- 28 mobile homes condemned after flooding.
- $500,000 in road damage recorded.

MONTPELIER COMMERCIAL PROPERTIES

- Major flooding in Barre-Montpelier commercial area.
- Businesses experienced up to 4 feet of water.

https://www.vermontpublic.org/local-news/2024-07-11/a-kick-in-the-stomach-barre-city-floods-on-anniversary-of-last-years-destruction

Leveraging Reinsurance
for Flood Risk Management

Reinsurance as a Risk Management Tool

Ensuring Financial Stability

Applicability for Flood Risks

Q&A