Ambulance Response Times in the Greater Vancouver Regional District

A GIS Network Analysis

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Abstract

This analysis evaluates ambulance response times across the Greater Vancouver Regional District (GVRD) using GIS network analysis techniques. By modeling service areas from BC Emergency Health Services (BCEHS) station locations and intersecting these with census population data, this study quantifies the proportion of the regional population within critical response time thresholds. Results indicate that only 39% of GVRD residents fall within the provincial 9-minute benchmark, with over 900,000 people beyond the 12-minute threshold where cardiac arrest survivability diminishes significantly.

Introduction

Emergency medical response time is a critical determinant of patient outcomes, particularly for time-sensitive conditions such as cardiac arrest. Research demonstrates that survival rates decrease by approximately 10% for each minute that defibrillation is delayed, with minimal chance of survival beyond 10–12 minutes without intervention (American Heart Association, 2024). Given these stakes, understanding the spatial distribution of emergency medical services coverage is essential for public health planning.

BC Emergency Health Services maintains a benchmark of 9 minutes for emergency response times. However, achieving this target depends on station placement, road network characteristics, and geographic constraints. This analysis employs GIS network analysis to model ambulance coverage across the Greater Vancouver Regional District, quantifying population exposure across different response time thresholds.

The objectives of this analysis are to: (1) model service areas for existing BCEHS ambulance stations based on road network travel times, (2) quantify the population served within critical response time thresholds, and (3) identify geographic gaps in coverage that may warrant additional resources or station placement.

Methods

Study Area

The study area encompasses the Greater Vancouver Regional District, including the municipalities of Vancouver, Burnaby, Richmond, Delta, Surrey, Langley, White Rock, New Westminster, Port Coquitlam, Coquitlam, North Vancouver, and West Vancouver. This multi-jurisdictional approach reflects the operational reality that ambulance units frequently provide cross-coverage between municipalities.

Data Sources

The following datasets were used in this analysis: Ambulance Station Locations (addresses for 20 BCEHS stations compiled manually and geocoded to point features), Road Network (BC Digital Road Atlas from GeoBC), Administrative Boundaries (Greater Vancouver Regional District boundaries from Metabolism of Cities), Population Data (Statistics Canada 2021 Census dissemination areas with population counts), and Water Features (GeoBC Freshwater Atlas for cartographic context).

Response Time Thresholds

Response time thresholds were established based on clinical evidence and operational standards. A 2-minute crew deployment time (chute time) was added to all travel time calculations to account for the time between dispatch notification and unit departure from station. The resulting thresholds are: Under 6 minutes (4 minutes travel + 2 minutes deployment) representing optimal coverage with highest cardiac arrest survivability; 6–9 minutes (7 minutes travel + 2 minutes deployment) meeting the BCEHS provincial benchmark; 9–12 minutes (10 minutes travel + 2 minutes deployment) representing below target with reduced survivability for time-sensitive emergencies; and Over 12 minutes representing critical gaps with minimal cardiac arrest survivability without bystander intervention.

GIS Processing Steps

Station Geocoding: Station addresses were compiled in a CSV file containing station ID, street address, city, and province fields. The Geocode Addresses tool in ArcGIS Pro was used with the ArcGIS World Geocoding Service to convert addresses to point features. Geocoding results were reviewed for accuracy, and stations with failed matches were identified and corrected manually using the Locate pane to verify addresses and digitize points at correct locations.

Network Analysis Configuration: Service area analysis was performed using the Network Analyst extension in ArcGIS Pro. The ArcGIS Online network dataset was selected as the routing source, which incorporates road classification, speed limits, and connectivity rules. A new Service Area analysis layer was created with facilities set to the geocoded ambulance station points, cutoff values of 4, 7, and 10 minutes (travel time only, excluding deployment time), travel mode set to driving time under free-flow conditions, and direction set to away from facility. The analysis was executed using the Solve function, generating non-overlapping service area polygons as rings representing areas reachable within each time threshold from any station.

Population Analysis: Statistics Canada 2021 Census dissemination areas were clipped to the study area extent and joined with population data. To calculate population within each service tier, the following process was employed: A field was added to the dissemination area layer to calculate original polygon area. The Intersect tool was used to overlay dissemination areas with the non-overlapping service tier polygons. A field was added to calculate the area of each resulting polygon fragment. Proportional population was calculated using the formula: (SplitArea / OriginalArea) × Pop2021. The Summarize Statistics tool was used to sum proportional population by service tier. This area-weighted allocation method accounts for dissemination areas that span multiple service tiers, distributing population proportionally based on the geographic area within each tier.

Limitations

This analysis has several limitations that should be acknowledged: Travel times are modeled using free-flow traffic conditions; actual response times vary with time of day, congestion, weather, and traffic incidents. The analysis assumes units respond directly from stations, which is often not the case as units may be mobile or staged at alternate locations. Population distribution within dissemination areas is assumed to be uniform for the area-weighted allocation. Bystander CPR, which significantly affects cardiac arrest outcomes, is not accounted for in this model. The analysis does not account for unit availability or simultaneous call volumes.

Results

The network analysis produced service area polygons covering the urbanized portions of the Greater Vancouver Regional District. Table 1 presents the population served within each response time threshold.

Table 1: Population Served by Response Time Threshold

Response Time	Population Served	% of Total
Under 6 minutes	326,587	12%
6 to 9 minutes	708,623	27%
9–12 minutes	691,057	26%
Over 12 minutes	919,716	35%
Total	**2,645,983**	**100%**

The results indicate that only 39% of the GVRD population (approximately 1,035,210 residents) falls within the 9-minute BCEHS benchmark. Notably, 35% of the population—over 919,000 people—resides in areas where modeled response times exceed 12 minutes, the threshold beyond which cardiac arrest survivability diminishes dramatically.

Geographic analysis reveals that coverage gaps are concentrated in several areas: Southern Surrey and Langley, where station density is lower relative to the expanding suburban population; parts of the North Shore, where topographic constraints and limited road network connectivity affect travel times; and eastern portions of the study area including Pitt Meadows and Maple Ridge fringes. The urban core areas of Vancouver, Burnaby, and central Richmond demonstrate the highest coverage levels, with most residents within the 6-minute optimal threshold.

A cartographic representation of this analysis is viewable in appendix 1

Discussion

This analysis demonstrates the application of GIS network analysis to evaluate emergency medical services coverage at a regional scale. The finding that only 39% of the GVRD population falls within the provincial response time benchmark, even under idealized free-flow conditions, suggests significant opportunities for service improvement.

Implications for Station Placement

The spatial distribution of coverage gaps identified in this analysis can inform strategic decisions regarding new station placement. Areas with high population and response times exceeding 12 minutes represent priority candidates for additional resources. Specifically, southern Surrey and Langley show a combination of growing population and limited station coverage, suggesting these areas may benefit from additional station infrastructure. The geographic clustering of stations in the urban core results in overlapping coverage, while peripheral areas experience gaps.

Funding Justification

This analysis provides quantitative evidence to support funding requests for emergency medical services expansion. The population exposure statistics—particularly the 919,716 residents beyond the 12-minute threshold—represent a measurable service gap that can be communicated to policymakers and budget authorities. Future analyses could incorporate demographic factors such as age distribution to further prioritize areas with populations at higher risk for cardiac events.

Future Work

Several extensions of this analysis could provide additional planning value: incorporating time-of-day traffic patterns to model peak-hour response times, location-allocation analysis to identify optimal placement for new stations, integration of historical call volume data to weight service areas by demand, and sensitivity analysis varying the deployment time assumption.

Conclusion

This GIS network analysis quantifies ambulance response coverage across the Greater Vancouver Regional District, revealing that a substantial portion of the population resides beyond critical response time thresholds. The methodology demonstrated here—combining network-based service area analysis with area-weighted population allocation—provides a replicable framework for evaluating emergency services coverage. The results can inform evidence-based decisions regarding station placement and resource allocation to improve emergency response outcomes across the region.

References

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