

FIRE STATION COVERAGE ANALYSIS

CITY OF SAN MARCOS, TEXAS

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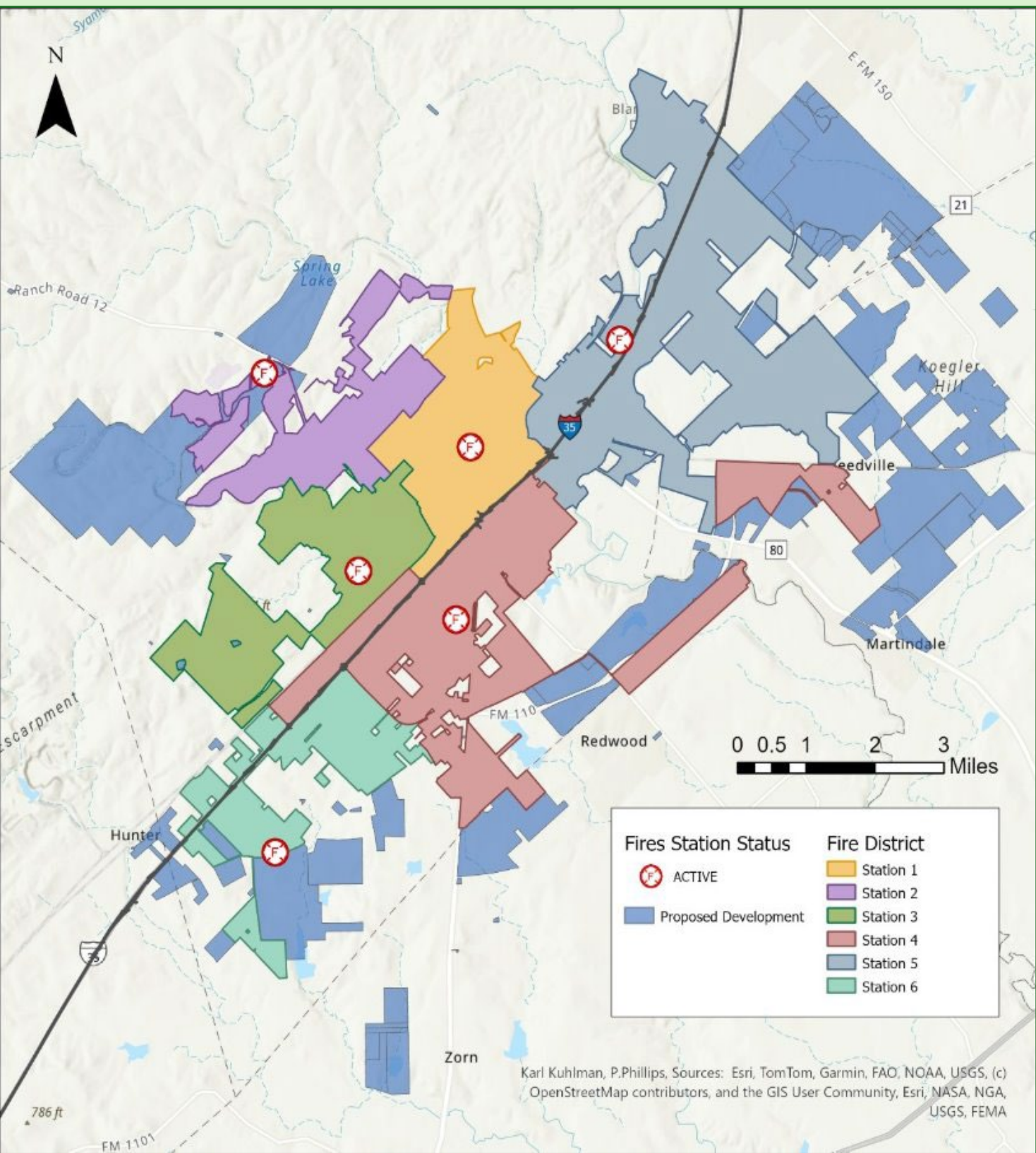
Introduction

The city of San Marcos has a growing population and is proposing development to meet the needs of its new residents. It is the responsibility of the San Marcos Fire Department to ensure that regardless of where someone lives in the city, they can respond to them promptly when there is an emergency. Guidelines for the speed of response and number of responders are set out by the National Fire Protection Association (NFPA). This study aims to examine if current coverage meets NFPA guidelines, update fire station quadrants and district boundaries to best meet these guidelines, analyze the impact of the future planned station on coverage, and suggest alternative locations for the future Station 7.

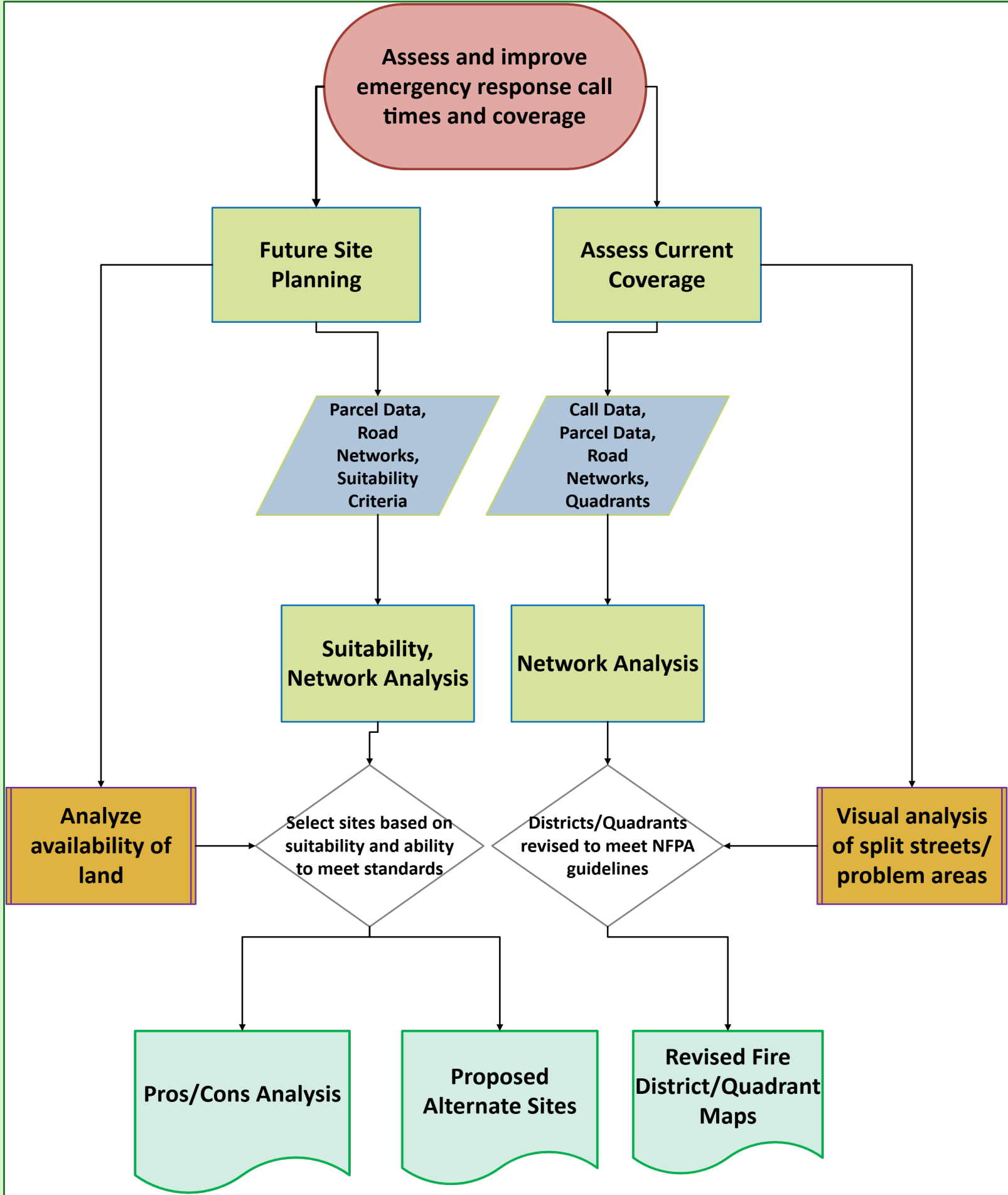
The city of San Marcos currently has six fire stations, and each station has a designated response area. To address the increasing population and projected growth of the city, a seventh station is being built. Before a location is decided for this new station, it is necessary to evaluate the current speed of response for existing boundaries. A GIS-based network analysis will be used to identify stations with service areas that fall outside of the four-minute guideline. Based on these findings, station response areas will be revised to adhere to NFPA guidelines.

After gaps in desired travel time to the scene of emergencies are identified, a site analysis for potential station seven locations will be conducted. This step is necessary to ensure that a station could realistically be constructed, and will encompass criteria such as vacancy of parcels, slope of the land, distance to roadways, and other spatial considerations.

Project Scope Map



Methodology Flow Chart



Data

Most of the data used in this project was provided by the City of San Marcos (CoSM) and the San Marcos Fire Department (SMFD), with some supplemental information the team acquired for analysis coming from TxDOT, USGS, and the US census. NFPA standards were necessary as those were the guidelines that determined the required response time for the network analysis. The spatial data for this project mostly used already existing data layers that are publicly available on the CoSM website. Since the spatial data we acquired is highly specific and designed for our area of study no data cleaning or adaptation was needed; it was ready

District and Quadrant Remapping

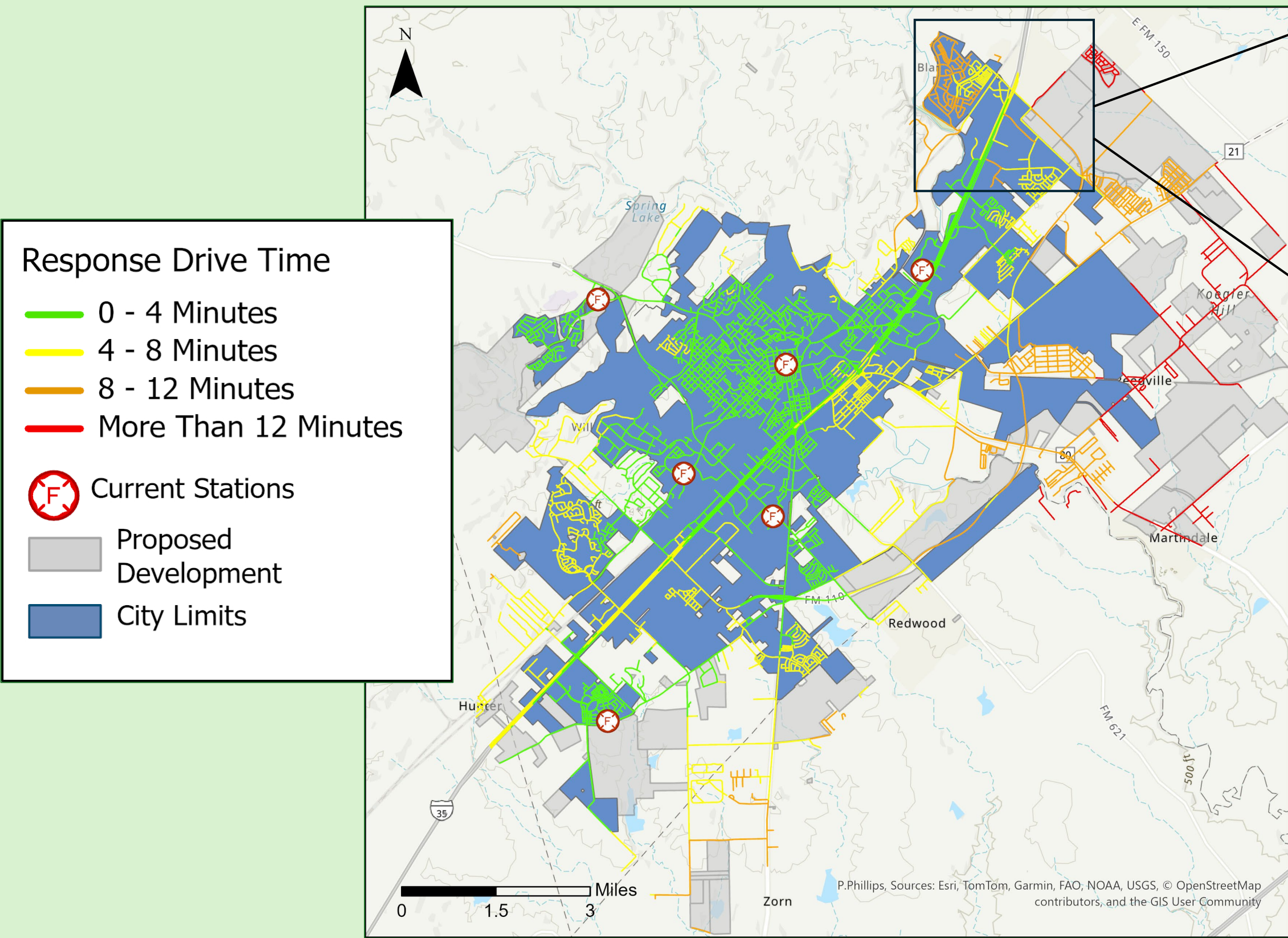
For the district and quadrant remapping portion of this project we used the travel times generated by the road network analysis to determine if the stations were responding to appropriate areas of San Marcos. The majority of the districts were accurate and fit the NFPA standard times or used the best station for the areas that did not meet NFPA times from any station. The main areas of change were in the downtown area for Station 1. Figure () below shows the light-yellow areas that were annexed into Station 1 area from station 2's area. There were also areas that were taken away from Station 1 and given to Station 3, 4 and 5 respectively to maximize efficiency. We recognize that the reason why the station 1 district did not originally include these areas is based on the high call volume that downtown experiences and the fact that the other stations may have more availability to respond. However, these changes and analysis are solely based on the data of travel times.

Current Coverage Analysis

To analyze the current fire station coverage, we made a 4-minute service area network for each existing station individually and all together. We also considered the many railroad crossings in San Marcos and as per our client's request adding a 30 second added time cost to those crossing to account for trains blocking those paths.

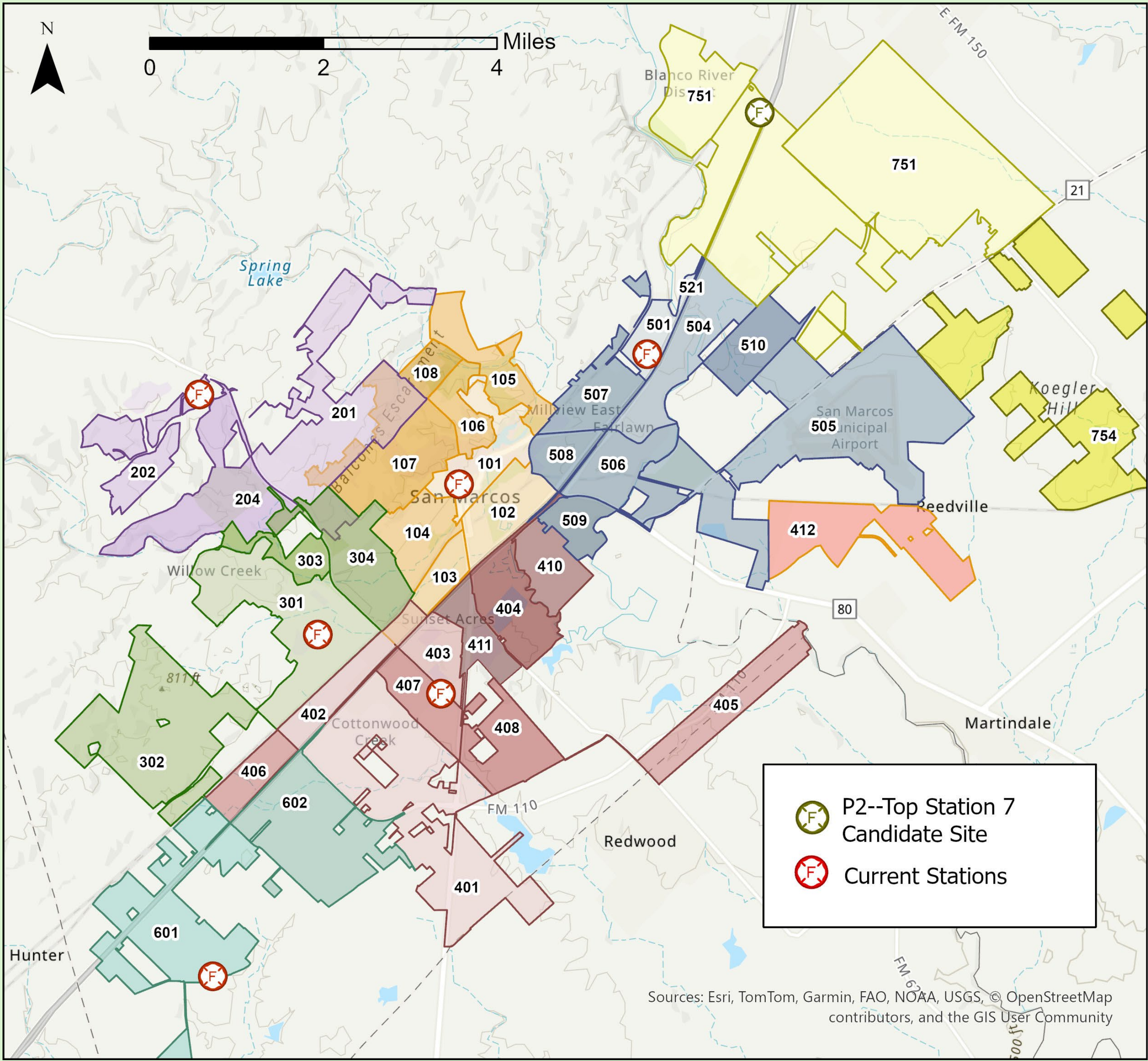
After determining our current coverage areas, we made a service area for our 5 selected parcels as well as the fire department's current proposed station 7. Using these service areas, we took the total number of miles covered within the 4-minute NFPA guidelines and used that to further determine the best site.

Current Coverage Network Analysis Results



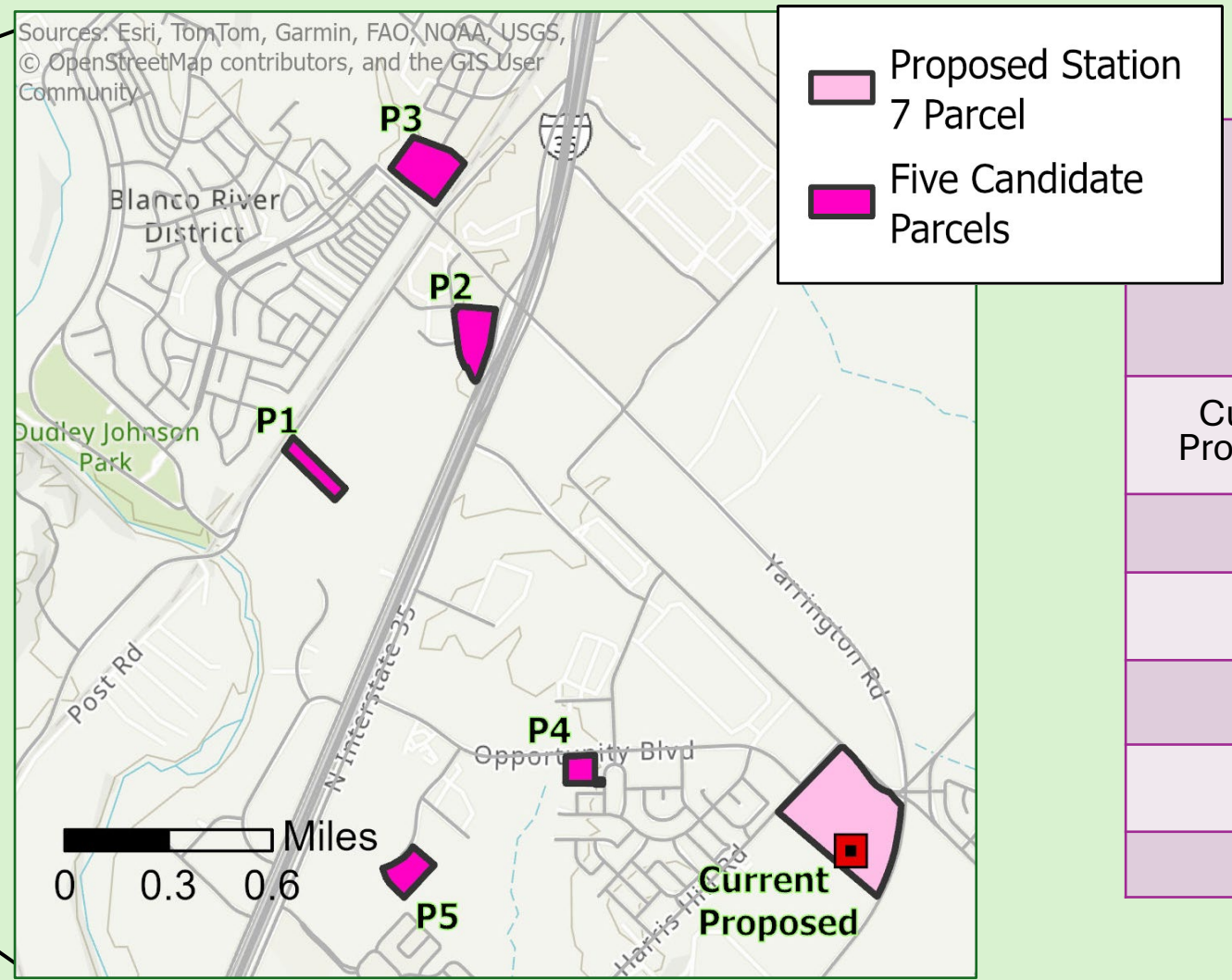
Hypothetical Station District Map

We created a map showing likely Station 7 districts and quadrants using our results from proposed site coverage and current coverage network analysis, while also accounting for the incorporation of proposed development areas into city limits.



Station 7 Candidate Site Selection

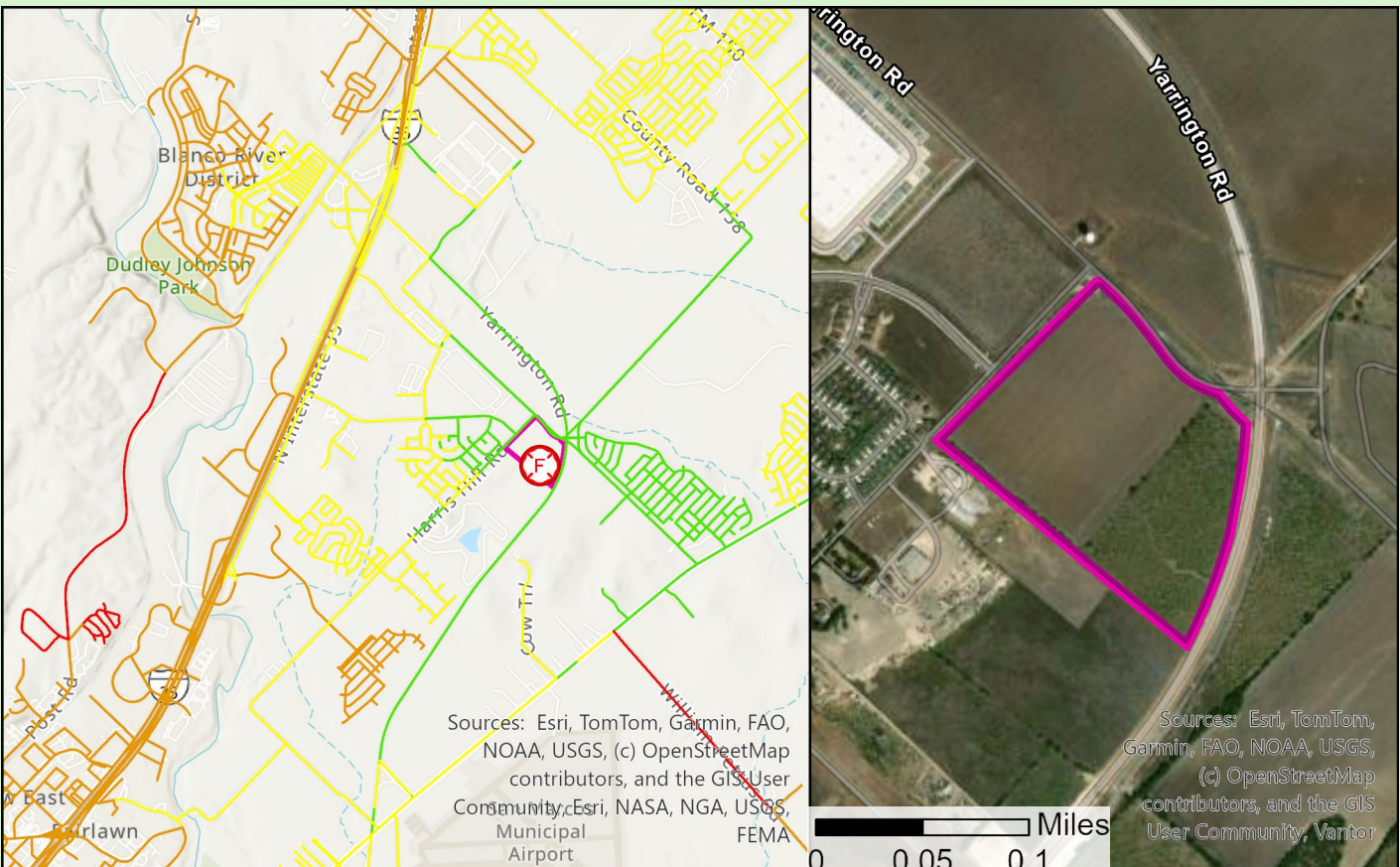
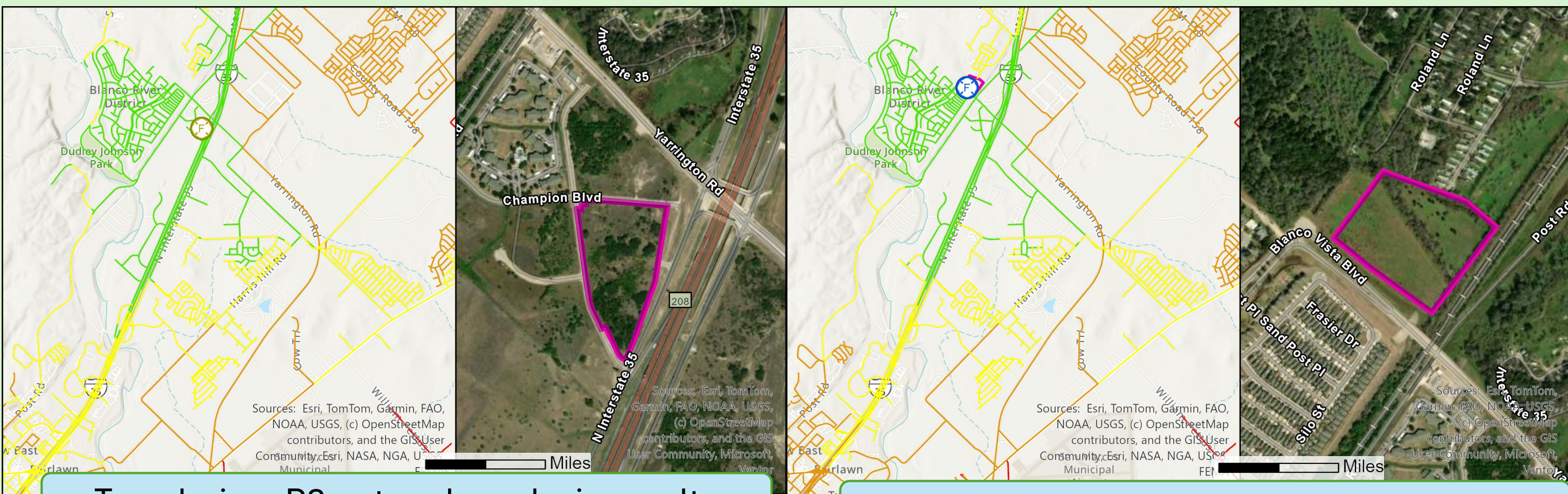
Parcels were selected in ArcGIS Pro based on vacancy, size, location within city limits, and exclusion from the floodplain, then exported for further analysis. Unsuitable parcels were removed due to development constraints such as access, shape, obstructions, and proximity to existing stations. A response time network identified a coverage gap in North San Marcos, where parcels were further refined by feasibility and development potential. Final candidates were selected based on call volume, address points, and suitability factors including slope, proximity to major roads, and distance to new development. The location-allocation was used to summarize key coverage statistics, which included call points and population covered within 4 minutes. Miles of road network covered within 4 minutes was also calculated.



	Miles of Road Network (4 minutes)	Call Points (4 minutes)	Population (4 minutes)
Current Proposed	23.75	51	468
P1	41.03	438	4246
P2	50.90	557	4686
P3	45.45	476	4142
P4	27.72	323	2101
P5	10.55	130	375

Proposal of 2 Alternate Sites

Based on these coverage statistics, we proposed P2 and P3 as our top candidate sites for Station 7. When compared to the current proposed location, these sites provide more adequate coverage and may better meet the NFPA 1710 response time standards.



Conclusion

We selected P2, as our first choice for the station 7 candidate site. This proposed station site had the highest overall coverage, reaching about 50.90 miles of road network, 557 call points, and a population of 4,686 within 4 minutes. The pros of this parcel are its immediate highway access and excellent coverage within 4 minutes. The cons of this site are that it appears to have high tree cover, which could have minor impacts on buildability. Furthermore, it is currently owned by a development company, and we have limited knowledge on the ability of the City of San Marcos to acquire this parcel.

Based on these hypothetical districts and quadrants, we can conclude that implementing station 7 at any of these candidate sites would help improve current coverage, as well as effectively account for future growth. While the current proposed location 7 offers decent coverage, it may not be most optimal in terms of meeting the NFPA 1710 response time standards. It may be beneficial to inquire further into building Station 7 at one of these proposed candidate sites.

Resources

