

Improving Fire Station Coverage and Response Times Across San Marcos with Network Analysis

Progress Report

In conjunction with City of San Marcos and San Marcos Fire Department represented by Emilee Freeman and Karl Kuhlman

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Introduction

Summary

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.

Our study considers 56,844 address points in the city limits of San Marcos, not yet including future developments, with the goal of ensuring adequate emergency service coverage for all residents.

Purpose Statement

Using GIS tools and network analysis of the roads in the city, combined with spatial reference to current stations, areas that have response times that fall outside NFPA guidelines will be identified. Based on these findings, station response areas will be revised to adhere to NFPA guidelines. After gaps in travel time to the scene of emergencies are identified, a site analysis for potential station seven locations will be performed to filter locations that will best fill the gaps. This step is necessary to ensure that the station can realistically be built - e.g. is on already reserved land, the construction site is level, there is enough space, etc.

Scope

The scope of the project is still the San Marcos City limits and the proposed developments for the city. For some of the calculations we are running for travel time, unincorporated roads are needed for the completeness of the network.

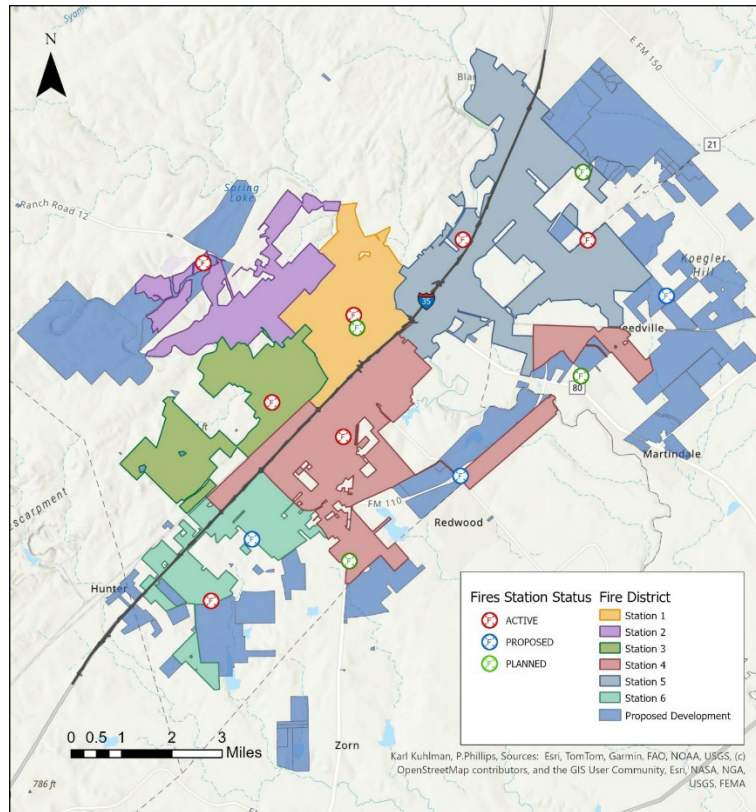


Figure 1- Scope Map

Work Completed

Network Coverage Analysis:

A network for the four-minute response of each existing station has been created. Additionally, points where there are railway crossings have been added in order to implement a time buffer. This simulates the possibility of being delayed by a train crossing. In a similar fashion, low water crossings points have been identified to also add time buffers in the event that inclement weather floods roads.

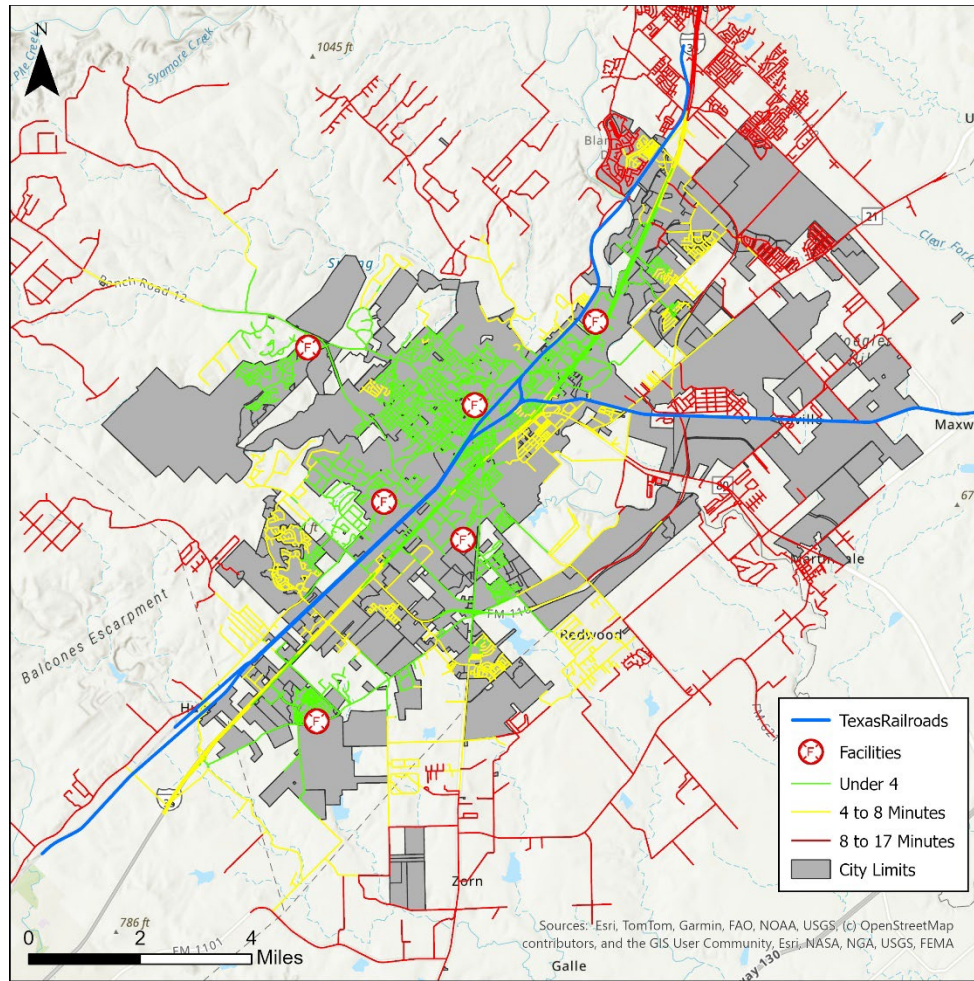


Figure 2- Service Area Network Analysis With Railroad Crossings

Site Suitability:

Initial filtering of parcels narrowed down to 289 parcels in the city limits was performed on the City of San Marcos Parcel Data through ArcGIS Pro “Select by Attributes” tool. Parcels that were vacant, greater than 3 acres, within city limits, and outside of the immediate floodplain were exported into a new layer. We completed additional filtering of parcels manually based upon factors such as obstructions, no access to roads, incompatible shape, high proximity to already existing stations, etc. After these considerations, we now have 77 candidate parcels left (Figure 2) and will continue to refine after further analysis of our finalized weighted overlay raster output.



Figure 3- The 77 candidate parcels that remain after filtering

Present Work

Network Coverage Analysis:

We are also working on refining our low water crossing time considerations. Our current thinking regarding low water crossings is to create a map with three different permutations- no water crossing issues, some standing water, and completely impassable or flooded. This will allow for decision making based on possibilities of extreme conditions that can occur during emergency response. Additionally, another next step is refining our work on the service area tool to find travel times from existing and new stations. Specifically, we need to look at generalized areas for new station potentials identified by the suitability analysis in tandem with the service area data to start picking out new station locations. This will be the last phase of the project, where we will look to implement our findings from the coverage analysis to run location-allocation and make final decisions regarding site selection.

Site Suitability:

Currently we are working to make minor revisions to our suitability model so that it creates a more refined visual representation of most suitable parcels to aid in our parcel selection process. We currently have a weighted surface raster created that ranks suitability of each pixel on a scale from 1-10. Our current criteria is distance to major roads, distance to new development, and

slope. We configured our model through ArcGIS Pro's model builder tool (figure 3). We ran the "Euclidean Distance" tool for distance to major roads and new development and then used the reclassified tool to set the value that would correlate with each "distance from" value range. For the classification of both, we used 1/8-mile (660 ft.) increments. 0-660 was assigned a score of 10; 660-1,320 was assigned a weight of 7; 1,320-1,980- was assigned a score of 5; 1,980-2,640 was assigned a score of 3; 2,640-3,300 was assigned a score of 1; and any values beyond 3,300 feet away were given a score of 0.



Figure 4- ArcGIS Pro Suitability Analysis Model Interface

This weighted overlay raster output (Figure 5) serves as a supplemental baseline in our site selection. We are continually working to improve this output by adding and reweighting suitability factors. Furthermore, we would like to include Manhattan distance modeling technique because it may be able to better capture how distance factors influence the suitability of a potential fire station by incorporating road networks into the calculation. Additionally, we are working to configure the most effective way to incorporate call volume as a factor in suitability. This is to ensure that we are proposing locations that are able to effectively cover population, rather than just looking at geographic area covered.

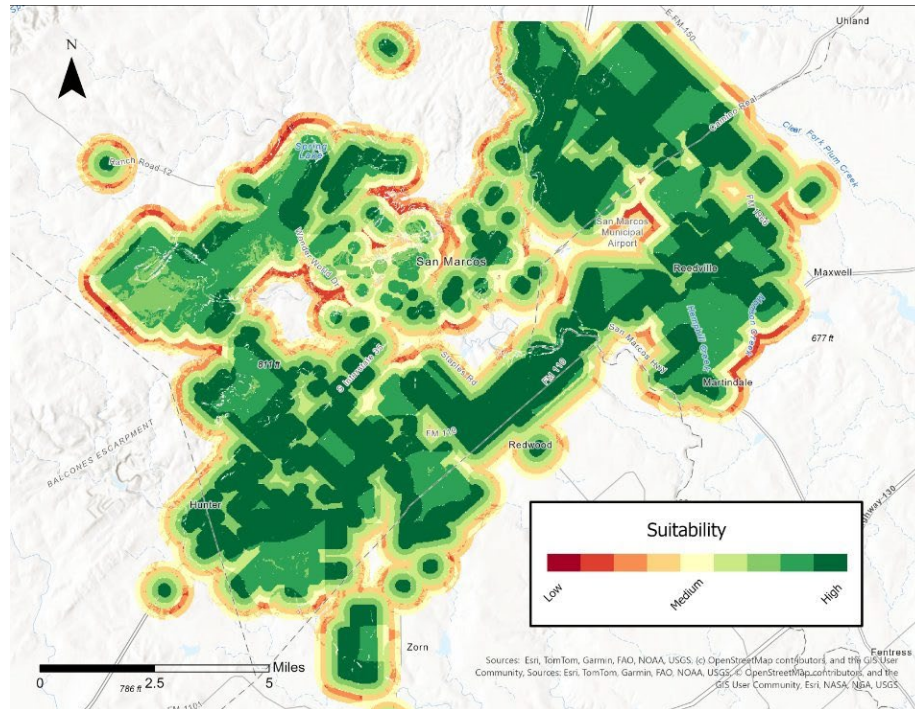


Figure 5- Result of weighted overlay suitability model

Work Scheduled

Phase	Dates
Proposal Writing and First Client Meeting	January 21 st – February 24 th
Data Analysis and Progress Report	February 25 th - March 29 th
Final Project and Poster Creation	March 30 th – April 29 th

This is a general outline of our work schedule. Specifics and details may change within the time blocks, but our project is currently progressing as expected.

Problems

One problem area is the need to find support for how much time is allotted for a low water crossing time buffer. Lack of literature for similar scenarios is leading us to improvise a little bit and be creative. Next steps will be consulting with our clients and subject matter experts to see if they agree with our current approach or if they have alternative suggestions. Additionally, we need to reconsider how we calculated distance for the creation of our weighted overlay suitability model, as Euclidian might not be the most ideal for this scenario. Due to the nature of emergency response, it may be more appropriate to use Manhattan Distance since this model is able to take into account road networks and show distance as it relates to actual routes traveled.

Conclusion

Overall, our project is moving along well and we are staying on track with upcoming deadlines. We have built a strong foundation for the remainder of our project by completing key components of network coverage analysis, as well as our site suitability analysis. The development of our 4-minute service area network sets us up to accurately identify gaps in coverage. Additionally, our filtering down of parcels and creation of a ranked suitability surfaces will guide us towards selecting the most effective locations for the new station. Our main focus now is to continue to clean up and refine the data so that our final results are as accurate as possible.

Deliverables will be completed by the end of April and will include 2 proposed fire station locations, along with a comparison and contrast of those locations and station 7. Additionally, an updated service area and districts map to best fit the growing needs of San Marcos will be created, as well as a network analysis based on which areas in the city limits are outside response times set out by NFPA guidelines.