Andrea Nieto, Project Manager/GIS Analyst

Bryan Heisinger, Assistant Manager/GIS Analyst

Matthew Mitchell, GIS Analyst

Nadine Oliver, GIS Analyst

Spatial Analysis for Construction of a San Marcos Fire Station

Prepared for:

Final Report

Prepared by: CenTex 360°

February 12, 201

TABLE OF CONTENTS

Introduction

San Marcos, Texas is located along the I-35 corridor between San Antonio and Austin. With a population of more than 45,000 people, the city is home to Texas State University and the Tanger Outlet Mall. According to the United States Census Bureau, in 2011 San Marcos experienced a 4% increase in population. To meet the demands of this growth trend, the City of San Marcos is proactively developing a plan to construct a new fire station. The City of San Marcos has approached CenTex 360◦ to analyze factors based on a previous study published in Fire Chief Magazine, *An Equation for Station Location* (2004). Emulating this article, the City of San Marcos divided the study area into 16 grid cells for comparative analysis. Our group is going to use these grid cells to determine where the social and economic conditions of the city justify the construction of a new fire station. Currently there are only 5 existing fire stations serving the area and as the city grows, these fire stations may not provide the optimal service equally throughout the city. The results of our GIS implementation will highlight areas across 16 city grid cells that display values of parcels that potentially need a fire station. This information will enable the San Marcos Fire Department to provide an even distribution of fire services throughout the city.

Scope

San Marcos, Texas is approximately 30 square miles and contains about 1500 people per square mile (United States Census Bureau). We will calculate and analyze data based on parcels found in grid cells that have been predetermined by the City of San Marcos. The shape of these cells is similar to the diamond shaped cells used in the study, *An Equation for Station Location*. There are 16 grid cells total and 11 of these do not contain a fire station. We will perform

calculations on all of the grid cells. This will allow us to compare the values of parcels that have fire stations to the values of the parcels that do not. The results of this analysis will enable the San Marcos Fire Department to better serve San Marcos.

Data

The data used for this project was provided by the City of San Marcos. We obtained the San Marcos population block data for 2010 from the US Census Bureau website, to help better allocate a true Night time population. The shapefiles are as follows:

- San Marcos Parcels
- San Marcos Buildings
- San Marcos Existing Fire Stations
- Texas State University San Marcos
- San Marcos City Limits
- San Marcos Railroads
- San Marcos Street Centerlines
- San Marcos ETJ *(Extra-Jurisdictional Territory)*
- San Marcos Park Boundaries
- San Marcos City Grid Cells
- San Marcos Block Population for 2010

The data was definitely a major portion of the project. This project focused more on data analysis, as opposed to geodatabase design. We did take the data provided with a grain of salt however and edited and corrected a good amount of layers. The data did allow us to identify

various attribute fields, which were relevant in creating and accurate portrayal of the City of San Marcos.

Methodology

For this analysis the City of San Marcos asked us to calculate the following: parcel area (developed/vacant), parcel value (developed/vacant/multi-family), (daytime/nighttime), square footage of buildings, value of improvements, conflagration (fire damage) potential, and wildlife/urban interface. These above values all required a large amount data condensing. Therefore, in order to avoid mistakes and to keep our data organized, *CenTex360* decided to use Microsoft Excel when calculating these values.

Initial problems – Population & Developed Parcel Data

We first tested our proposed methodology on grid cell 8 — the largest of the 16 grid cells covering the city of San Marcos. This initial trial run was going to tell us what worked and what we needed to change in our project proposal's methodology section. The first major problem that we encountered was the population data. The city had asked us to find the day and nighttime population. These population values were determined by looking at the parcels zoning code. If a parcel inside of the grid cell was labeled as being commercial/industrial we recorded its population value as being a daytime population. Parcels zoned as residential were recorded as having a nighttime population. A majority of the population values were missing from the parcel layers attribute table, making it difficult to provide the city with an accurate estimate of the two populations. One solution to this problem was for us to add a 2010 census block population layer to our analysis. This layer would give us a better estimate of the nighttime population,

because its data projected residential population values. To find the daytime population, we used the day-pop field in the parcels attribute table.

The second problem that we encountered was how to decide if a parcel was developed or not. Each parcel in the parcels layer was labeled as being vacant or non-vacant, but not all of the non-vacant parcels were developed. We identified if a parcel was developed by adding the buildings layer to our analysis. If the parcel was projected as having significant development i.e. if the buildings sq. footage took up more than 25 % of the parcel, we labeled it as being developed.

Parcel Value, Value of Improvements, & Parcel Area

With the exception of these two problems, calculating the remaining values for grid cell 8 went smoothly. To find the total parcel value (TPV), we first had to find the percentage of the parcels shape area that was intersected by the grid cell boundary. We multiplied this shape area percentage by the total assets data we were given and divided by 100 to find the parcel for the intersecting parcels. We then added the intersected parcels value to the contained parcels value to find the grid cell's Total Parcel Value. To find the vacant parcel value, we selected the parcels that were indicated as being vacant and added together their total parcel values. The same method was applied to find the developed parcel value. Last, we determined if a parcel was multifamily by looking at the building layer's zoning codes. These multifamily parcel values for were also summated and recorded in our spreadsheet.

To find the value of improvements (VOI) we also had to find the percentage of the parcels shape area that was intersected by the grid cell boundary. We multiplied this shape area percentage by the value of improvements data that was given to us and divided by 100 to find the

value of improvements for the intersecting parcels. We then added the intersected parcels VOI to the contained parcels VOI to find the grid cell's Total Value of Improvements.

We determined the total parcel area of grid cell 8 by separating the parcels that were completely contained in the grid cell from those that overlapped onto another grid cell. Using the calculate geometry tool, we are able to accurately determine the area of the parcels within each cell. Once we had done this separately for the contained and intersected parcels, we added them together to get the total parcel area of grid cell 8. To find the vacant parcel area, we selected the parcels that were indicated as being vacant and added their values together. To find the developed parcel area we applied the buildings layer to the parcels to determine if they were developed or not. Last, we added these developed parcels together to find the developed parcel area

Conflagration Index & Wildlife Urban Interface

For the conflagration index, we decided on a weighted sum model with three factors. The first factor, conflagration area, was derived from creating a 20' buffer around the buildings layer. We then intersected the output of this process to determine where the buffer overlapped. This overlap calculated the relative proximity of two structures to each other. The closer the structures, the larger the overlap and furthermore, the more likely a fire was to spread from structure A to B.

In addition to the area between the buildings, the second factor took into quantity of buildings that were vulnerable to a fire spreading. This is the quantity of buildings that had their buffer intersect with another building's buffer. Since the buildings layer had multiple entries for

buildings more than one story, we also proportionally factored into account the vertical contribution of a building during the event of a fire.

The third factor, wildlife-urban interface was the total length of developed parcels that were adjacent or within 10' of an undeveloped parcel. We clipped the parcel layer for each grid cell and then coded all parcels as either being developed (1) or undeveloped (2). From here, we selected parcels by attribute and created independent layers for both factors. We took both layers, which were originally polygons, and converted them to polylines. From this output, we ran multipart to singlepart to convert the polylines into line segments. I recalculated the geometry of the length and selected by location to determine the total length in a grid

Spreadsheet of Values

Following the completion of grid cell 8, our team applied the above methodology on the remaining 15 grid cells. After each individual value was calculated, we recorded our results in a master spread sheet. This master spreadsheet helped us in determining which city grid cells met the criteria for a future fire station services.

As predicted, the five grid cells currently containing a fire station consistently scored high values in all factors. However, the results of our analysis indicated that, of the cells not currently containing a fire station, grid cell 11 received the highest values for the following 11 factors: nighttime population, daytime population, building acreage, value of improvements, wildland-urban interface, percent developed, total developed acreage, developed parcel value, total parcel value, total multifamily value, and conflagration rate. Because grid cell 11 scored such high values for these factors, it's economic and social conditions resemble the cells with a fire station more so than the grid cells without one.

Discussion

Our data indicates that grid cell 11 is the most suitable area for the construction of a new fire station. This grid cell contains a high value for both daytime (1,993) and nighttime (6,374) population. It is also the most developed grid cell outside of the areas currently containing a fire station and features 99.95 acres of building footprints. Besides being the most developed of grid cells, out of grid cells 6-16, it is also the most valuable grid cell, with a total parcel value of $192,613,618, almost $105 million greater than the next largest value. Also, the results of the conflagration index concluded that, of grid cells under consideration for a new fire station, this grid cell has the highest likelihood of a fire spreading between structures. This area features relatively dense development, a high population rate, expensive parcel values, and a high conflagration potential. Our team recommends that this grid cell be considered for the construction of a new fire station.

Conclusion

We have successfully identified the city grid cell that indicates a need for future firefighting services considering all of the following factors: parcel area, parcel value, day/night time population, square footage of buildings, value of improvements, conflagration potential and wildlife urban interfaces. Our team created a map book of the all grid cells displaying each variable. We have created a master spreadsheet showing the values of each grid outlining all statistics that were calculated by our analysis, resulting in the potential areas in San Marcos that justify the construction of a fire station. This can be used by the City of San Marcos to identify future fire station issues, as well as giving the city an efficient way to keep records, and plan for future fire stations accordingly.

Participation

Andrea Nieto Project Manager GIS Analyst	• Authored *Introduction and Scope* • Organized documents final draft of the Proposal
Bryan Heisinger Project Assistant Manager GIS Analyst	• Authored *Methodology* section of Final Report • Prepared final draft of PowerPoint presentation
Matthew Mitchell GIS Analyst	• Authored the *Data* and *Conclusion* sections • Prepared final draft of PowerPoint presentation
Nadine Oliver GIS Analyst	• Authored *Discussion* and *Results*

References

United States Census Bureau. "San Marcos (city) QuickFacts from the US Census Bureau." *San Marcos (city) QuickFacts from the US Census Bureau*. N.p., 10 Jan. 2013. Web. 12 Feb. 2013.