

An Exploratory Framework to Evaluate the City of San Marcos' Commitment to Land Use
Management as a Flood Mitigation Strategy

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Abstract

Purpose: This applied research project has a dual purpose. The first is to explore the different types of land use management practices that reduce flood hazards. Second, the Association of State Floodplain Manager's (ASFPM) No Adverse Impacts (NAI) program is used to assess the City of San Marcos' commitment to floodplain land use management.

Method: This research uses three working hypotheses (floodplain regulations, planning decisions, and elevation standards) that are developed from the ASFPM's No Adverse Impact Toolkit to assess the City of San Marcos' commitment to using land use management to mitigate flood hazards. While initially based on the No Adverse Impact Toolkit, the working hypotheses contain land use management methods and techniques found in the literature that can be applied to mitigate flood hazards. Each working hypothesis contains sub-hypotheses that are used to provide specific criteria to assess the City's Commitment. This study assesses the City of San Marcos through analysis of the City's Ordinances, Land Development Code, Master Plans, Development Agreements, and Conceptual Plans.

Findings: The City of San Marcos exhibits adequate-to-strong commitment in all three working hypotheses. Planning decisions was the only working hypothesis to reveal limited commitment. The City's floodplain regulations exceed the recommendations from the literature in many cases, but there is room for improvement. The primary recommendation is for the City to increase its minimum land dedication regulations to 7 acres per 1,000 residents. The City's greenway and public acquisition plans meet the recommendations from the literature, but capital improvements fall short. This is not a reflection on the City's commitment, however, because this strategy requires an excessive amount of resources. The City is completely committed to base flood elevations and adequately committed to promoting limited enclosures over fill. There are extenuating circumstances when the use of fill in the floodplain is the best option, but it harms other members of the community.

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About the Author

While collecting data for this project, Tyler Blakey served as an intern for the Community Development Block Grant (CDBG) program for the City of San Marcos and assisted in the development of the CDBG – Disaster Recovery (DR) housing rehabilitation program to address the 2015 Memorial Day and All Saints' Day floods. This internship influenced this applied research project and significantly improved its quality. If anyone has questions regarding this applied research project, Tyler Blakey can be reached at trblakey23@gmail.com.

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Chapter I: Introduction

Policy Problem

The hurricanes of 1926 and 1928 should have been wake up calls for the State of Florida. For decades, land developers, engineers, and politicians attempted to drain the Everglades to make the swamp inhabitable, and “after \$13 million of spending and 64 million cubic yards of dredging”, the Everglades proved to be uncontrollable (Grunwald 2006, p. 183). This did not discourage developers from continuing to advertise the Everglades as a reclaimed paradise; “Fort Lauderdale’s population tripled, West Palm Beach’s quadrupled, and Miami’s quintupled” in the first half of the 1920s (Grunwald 2006, p. 176). The settlers in Florida finally understood nature’s fury when the hurricane of 1926 occurred. Miami, Hollywood, Hallandale, and Hialeah experienced significant damage, but Moore Haven suffered some of the worst losses when Lake Okeechobee ripped through its dike. The dike was “designed to imprison Mother Nature so that people could live in her original path”, but when the lake burst through the dike, “the people in the floodplain paid the price: the 1926 hurricane killed nearly 400 and left more than 40,000 homeless” (Grunwald 2006, p. 188).

Despite catastrophic damage, developers and political leaders downplayed the hurricane and continued to argue that Everglades reclamation was possible. To address the dike failure at Lake Okeechobee, leaders proposed a bigger and stronger dike costing \$20 million and passed a \$20 million drainage bond to complete a canal that further controlled Lake Okeechobee’s water levels (Grunwald 2006, p. 190). The projects renewed confidence in Everglades reclamation, and the state enjoyed two extremely profitable years. Then, another hurricane in 1928 washed away that confidence when the storm destroyed the improved dyke

at Lake Okeechobee killing 2,500 people (Grunwald 2006). After seeing the destruction, Florida's political leaders finally acknowledged the gravity of the situation and turned to the Army Corps of Engineers for assistance.

The Army Corps' solution was to replace the existing dike with an even larger \$20 million dike that rose "four stories above sea level from a concrete base more than a football field wide" (Grunwald 2006, p. 199). Named after President Herbert Hoover, this dike effectively kept the lake from overflowing its boundaries, but it also dried up some of the Everglades to the extent that it caused fires. In Florida, there was either too much or too little water at any given moment. In an attempt to evenly distribute the water in South Florida, the Army Corp created the Central and South Florida Plan (C & SF Plan), which led to the construction of 2,000 miles of levees and canals along with hundreds of spillways, floodgates, and pumps (Grunwald 2006). Originally, the C & SF Plan cost \$60 million, but it was expanded to \$208 million (Grunwald 2006). The Army Corps successfully made the Everglades inhabitable at the expense of the American taxpayer.

The network of structural improvements continues to protect much of South Florida, but they require continual maintenance. Since 2001, "the Corps has invested more than \$870 million in rehabilitation" on Herbert Hoover Dike alone (Campbell 2017, p. 1). In addition, there may be a storm that causes Lake Okeechobee to breach Herbert Hoover Dike. If such a storm occurs, there will be tremendous loss of life, property, and a dike that has billions of dollars invested into it. At that point, did the dike really accomplish anything at all?

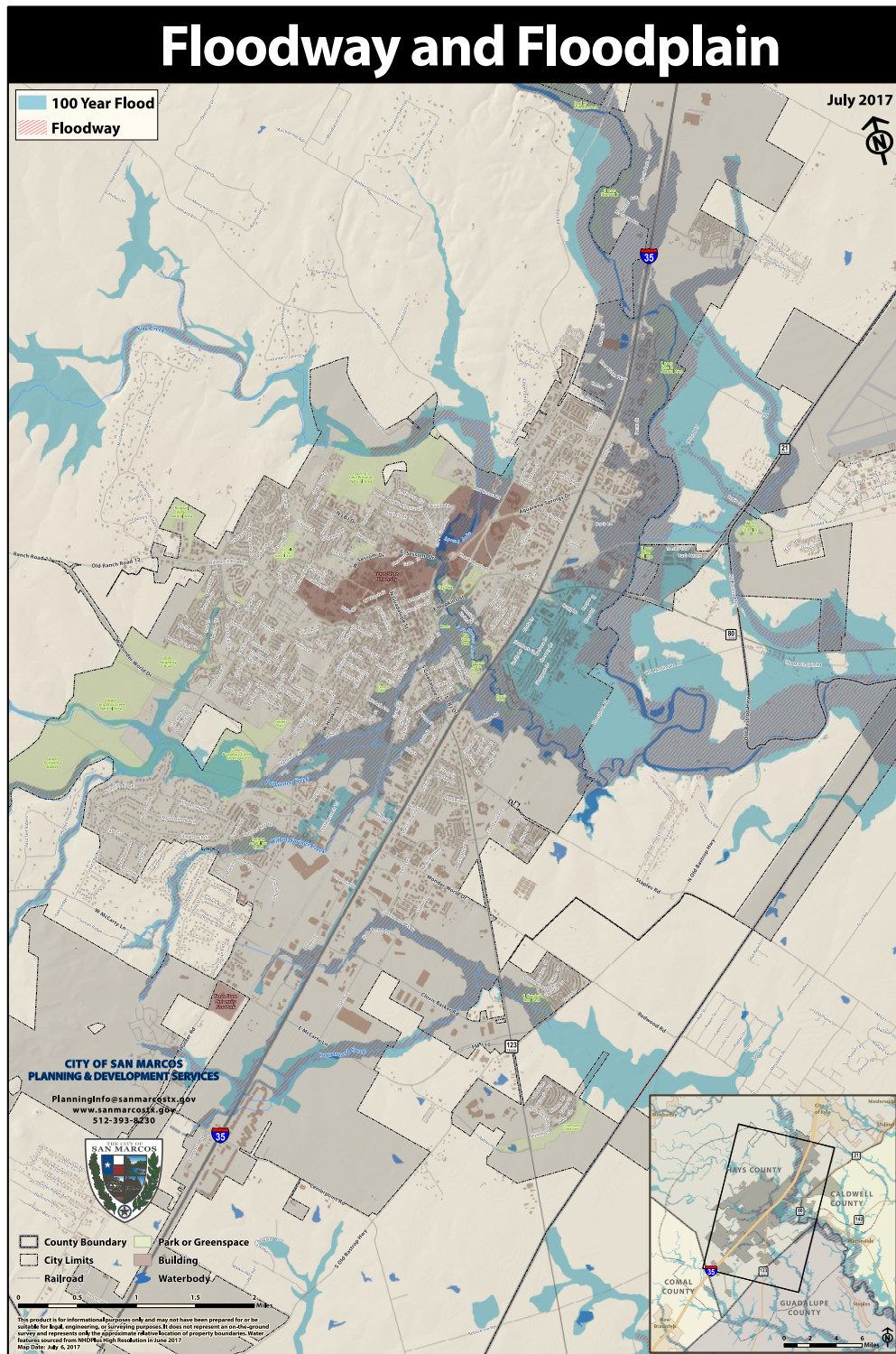
The development of the Everglades should serve as an example for what city planners should not do. Floridian developers and community leaders knew the Everglades experienced

consistent flooding, but they still pushed for structural improvements until entire cities depended on their existence. This is not a sustainable community. Cities that have a significant amount of area in a floodplain must carefully plan the growth of their community, and floodplain land use management provides cities with tools that allow them to effectively manage their growth while ensuring the protection of their citizens and preservation of their floodplains.

Case History

San Marcos, Texas is a growing community of more than 50,000 people lying approximately thirty miles south of Austin. The City of San Marcos experiences floods on a consistent basis because the San Marcos River, Blanco River, and Purgatory Creek run through the middle of the city (City of San Marcos, 2016b). Figure 1.1 on the following page provides a floodplain map of the City of San Marcos.

Figure 1.1: Floodway and Floodplain Map of San Marcos



In the past twenty years alone, San Marcos experienced six significant floods in the past twenty years which are outlined in table 1.1¹.

Table 1.1: San Marcos Floods (1998-2015)

Flood Event	Velocity in cubic feet per second (cfs)	Likelihood of occurrence: shown in years
October 1998	105,000 cfs	26-yr flood
November 2001	87,300 cfs	17-yr flood
November 2004	31,600 cfs	5-yr flood
October 2013	101,000 cfs	24-yr flood
May 2015	180,000 cfs	150-yr flood
October 2015	100,000 cfs	23-yr flood

***City Council CDBG – Flood Workshop 4/25/2016**

In 2015, the Blanco River overflowed twice within six months. On the evening of May 23rd, a thunderstorm produced “12 inches of rain in less than 6 hours” west of San Marcos (City of San Marcos 2017c, p. 1). The majority of the rain from the Memorial Day Floods fell in the upper Blanco River Watershed, which caused the river to rise substantially and devastated several homes within the City of San Marcos. On October 30th, the City of San Marcos again experienced substantial rainfall when nearly 6 inches of rain fell within one hour (City of San Marcos 2017c, p. 1). While this flood was not as intense as the Memorial Day Flood, it still caused significant damage. Many of the same people who were affected by the Memorial Day Floods were hit again during the All Saints’ Day Flood. Combined, these two floods caused damaged to “1,558 homes and 35 businesses” (City of San Marcos 2017c, p. 2).

Immediately after both floods, the City conducted an emergency needs assessment to determine which areas of the town suffered the most. With the help of the Federal Emergency

¹ Blanco River overflows at about 97,000 cubic feet per second.

Management Administration (FEMA), the Small Business Administration (SBA), and the National Flood Insurance Program (NFIP), the City quickly assessed the initial damage and provided aid to victims. The needs assessment determined that the Blanco Gardens neighborhood experienced the most damage and the Total FEMA Verified Loss (FVL) was \$7,093,633 from 1,738 claims (City of San Marcos 2017c, p. 5). Despite relief received from FEMA, SBA, and NFIP, the City calculated that the total unmet need was over \$40 million. Table 1.2 below shows the breakdown of damage types defined by FEMA (none, affected, minor, major, and severe), the estimated cost of repair for each category, the number of units classified under each category, and the total damage estimate. The City's determination of unmet need justified a Congressional Appropriation of \$25,080,000 in Community Development Block Grant – Disaster Recovery (CDBG – DR) funds.

Table 1.2: Disaster Repair Estimate of Unmet Need in Affected Flood Areas

Damage Type	Damage %	Est. Cost to Repair (SBA average)	Area Units #	Total Damage Estimate
None	0%	\$0	136	\$0
Affected	25%	\$20,044.00	506	\$10,142,264.00
Minor	50%	\$40,088.00	315	\$12,627,720.00
Major	75%	\$60,132.00	180	\$10,823,760.00
Severe	100%	\$80,176.00	109	\$8,739,184.00
Total			1,246	\$42,332,928.00

*City of San Marcos 2017c, p. 9

In 2017, the City conducted a needs assessment survey of the most damaged areas from the 2015 floods. The survey assessed the citizens' preferences for how money should be spent for a flood recovery housing rehabilitation program. Using the survey results, the City concluded that the respondents preferred the following in this order: rehabilitation, buyout,

and demolition/reconstruction (City of San Marcos 2017b, p. 2). The City based the housing rehabilitation program off of the results of the survey and will focus its resources on rehabilitation, buyouts, then demolition/reconstruction. Table 1.3 shows the breakdown of funding for owner occupied and rental occupied households. The City will allocate \$7,524,000 for its housing program with \$5,000,000 going toward owner occupied homes and \$2,524,000 going toward rental occupied homes. Tables 1.4 shows each housing activity and maximum cost that activity can be.

Table 1.3: Proposed Breakdown of Funding for Housing Program

Housing Programs Proposed Breakout of Funding	
Single Family Owner Occupied Rehab/Buyout/Recon	\$5,000,000
Single Family 1-4 Unit Rental Rehab/Buyout/Recon	\$2,524,000
Total	\$7,524,000

*City of San Marcos Action Plan, Amended May 1, 2017, p. 29

Table 1.4: Cap for Housing Activities

Housing Activity	Cap
Single Family Owner Occupied Rehabilitation	
No elevation	\$45,000
With elevation	\$60,000
<i>Note: Elevation will be required if rehab costs reach 50% of appraised pre-flood home value</i>	
Single Family Owner Occupied Reconstruction w/ Elevation	\$150,000
Buyout to convert to greenspace or limited use	\$250,000
Acquisition for redevelopment	\$250,000
Elevation Only (with minimal interior rehab)	\$50,000
Single Family Rental Rehabilitation (1-4 Unit)	
No elevation	\$45,000
With elevation	\$60,000
Single Family Rental Reconstruction with elevation (1-4 Unit)	\$150,000

*City of San Marcos Action Plan, Amended May 1, 2017, p. 32

Despite frequent flooding, San Marcos is experiencing substantial population growth because of Texas State University's student enrollment expansion and its proximity to the growing San Antonio and Austin metro areas. This is coupled with the citizens of San Marcos adamant opposition to any development that may increase their flood risks, so the City must plan carefully to accommodate new developments while ensuring that the current residents remain happy. In addition to the City's annual planning budget, the City has released its spending plan for the \$25,080,000 in CDBG – DR funds (City of San Marcos 2017c). The City may use some of the CDBG – DR funds to pursue floodplain land use management strategies. Because of these facts, this is an opportune moment to assess the City of San Marcos' commitment to land use management as a tool for mitigating flood hazards.

Research Purpose

This applied research project has a dual purpose. The first is to explore the different types of land use management practices that reduce flood hazards. Second, the Association of State Floodplain Manager's No Adverse Impacts program is used to assess the City of San Marcos' commitment to floodplain land use management.

Chapter Summaries

Chapter two explores the scholarly literature on floodplain land use management. The first section of the chapter develops the historical context and discusses the need for floodplain land use management. The next section explores ASFPM's No Adverse Impact framework along with NFIP's Community Rating System framework. The third section discusses the use of No Adverse Impacts framework as it applies to floodplain land use management. A summary of the conceptual framework is provided at the end of the chapter.

Chapter three describes the research methodology used to assess the floodplain land use management techniques used by the City of San Marcos. Chapter four provides the results of the City of San Marcos case study. Results with respect to the use of document analysis and structured interview for each working hypothesis are presented in this section. Chapter five provides recommendations and conclusions based on the City of San Marcos case study.

Chapter II: Literature Review

Chapter Purpose

This chapter examines the scholarly literature on the application of land use techniques that mitigate flood hazards. The first part of the chapter develops the historical context and discusses the need for land use management as part of a floodplain management program. Next, the Association of State Floodplain Managers' (ASFPM) No Adverse Impact (NAI) program is defined and develops a series of working hypotheses that assess the City of San Marcos' commitment to land use management as a flood mitigation strategy. Finally, a summary of the conceptual framework is presented.

Historical Context

Flood prone areas are attractive places to live. They provide easy access to water, generally have alluvial soils that are ideal for agriculture, allow for trading between communities, and they are usually aesthetically appealing. People have always risked the occasional flood in exchange for the convenience of living near water, but floods have become exponentially more expensive over the past 150 years (Wright 2000). In 1965, Hurricane Betsy was the first billion-dollar flood disaster ever recorded (Sugg 1966). Since then, billion-dollar floods have become increasingly more common with disasters such as Hurricane Katrina which cost \$153.8 billion and Superstorm Sandy which cost \$68.3 billion (National Centers for Environmental Information 2016). The excessive rise of flood costs occurred because of the United States' floodplain management policies favoring structural improvements and flood insurance. This section discusses the introduction of floodplain management in the federal

government, the structural improvement era, the creation of the National Flood Insurance Program (NFIP), and the promotion of land use management by the federal government.

The first American flood hazard management policy was introduced after settlers along the Lower Mississippi River suffered multiple floods and demanded assistance from the federal government. Instead of relocating away from the hazardous area, settlers demanded that the government make an unsafe location suitable for habitation through structural improvements. The federal government believed that America's mighty rivers could be controlled, so they received Constitutional authority to finance and construct river improvement projects from the Supreme Court case, *Gibbons v Ogden* (1824) (Wright 2000). This ruling allowed the Army Corps of Engineers to remove navigation obstructions and build protective structures such as levees along the Mississippi and Ohio Rivers. Twenty-five years later, Congress appropriated \$50,000 for a "topographical and hydrological survey of the delta of the Mississippi" hoping to find the most effective strategy to manage flood hazards (Wright 2000, p. 5). After a ten year study, Army Corps of Engineers Captain Andrew Humphreys and Lieutenant Henry Abbot submitted a report arguing that levee construction should be the primary tool for managing floods and enhancing navigation (Platt 1998). The "levees-only" policy thus became the Army Corps of Engineers' primary strategy for mitigating flood hazards.

After the implementation of the "levees-only" policy, a pattern persisted in which a devastating flood would occur, then heightened government intervention and structural improvements would follow. Devastating floods partially inspired the creation of the Flood Control Act of 1917, The Flood Control Act of 1928, and the Flood Control Act of 1936 (Platt 1998; Wright 2000). Congress repeatedly passed reactionary legislation to floods and spent

more than “\$11 billion on flood control projects built primarily to store floodwaters and prevent substantial flood damages” (Wright 2000, p. 12). A new approach was necessary because the structural improvements strategy was ineffective and extremely expensive. In 1938, Harlan Barrows introduced a new idea in the Ohio-Lower Mississippi River Regulation Subcommittee when he said that “if it would cost more to build reservoir storage than to prevent floodplain encroachment, the latter procedure would appear to be the best solution” (Wright 2000, p. 14). This idea inspired Barrows’ young assistant, Gilbert White, to develop a national program that incentivized communities to develop away from hazardous areas.

Gilbert White wrote that an effective flood hazard management policy should adjust “human occupancy to the floodplain environment so as to utilize most effectively the natural resources of the floodplain, and at the same time, [apply] feasible and practicable measures for minimizing the detrimental impacts of floods” (White 1945, p. 16). Rather than building structures to make hazardous areas safe, people should choose to not build in hazardous areas. White spent twenty years attempting to create a policy that encouraged communities to not build in hazardous areas. In 1966, White chaired a task force that released “A Unified National Program for Managing Flood Losses” calling for a national flood insurance program that incentivized communities in hazardous areas to take responsibility for their floodplains (Knowles & Kunreuther 2014). This report, along with several other studies, led to the creation of the National Flood Insurance Act of 1968 which created the National Flood Insurance Program. The National Flood Insurance Program (NFIP) gives communities subsidized flood insurance to participating communities in exchange for the adoption of land use regulations and building codes (FEMA 2002).

While the NFIP did force communities to take some responsibility for their land use, development in floodplains and the costs of floods continued to increase. The structural improvement policy and the NFIP give the impression that a hazardous area can be made safe through government intervention. Structural improvements make hazardous areas more suitable to live in, and the NFIP provides a necessary safety net in case of a disaster. However, if a flood occurs that exceeds the capacity of a protective structure, the damage that follows is catastrophic and the American taxpayer pays the price. Since 2015, the NFIP has paid more than \$839 million in flood insurance claims with each claim averaging more than \$46,000 (FEMA 2016). The structural improvement policy and the NFIP are not adequate floodplain management policies because they do not reduce flood damages. A different approach is necessary effectively reduce flood damages.

Floodplain Land Use Management

White argued in his dissertation that “floods are acts of God, but flood losses are largely acts of man” (White 1945, p. 2). A successful floodplain management program requires a strategy that acknowledges that flood losses are man’s responsibility, and floodplain land use management places the responsibility of flood losses on communities. Floodplain land use management revolves around the idea that instead of “keeping the flood out of people’s way, the government works to keep people out of the flood’s way by discouraging development of hazardous areas or where development is warranted... by imposing special building standards that reduce vulnerability” (Burby, ed. 1998, p. 9). Floodplain land use management strategies consist of thorough identification of the community’s flood hazards, decisions based off a comprehensive land use plan, and regulations and standards controlling where development

can be built and in what manner (Burby and French 1985). Land use management costs less money for communities than structural protection and flood alleviation strategies (such as the NFIP), reduces flood damages, and preserves the natural environment (Burby and French 1985).

Communities are hesitant to make a significant commitment to floodplain land use management, however. Structural protection and flood alleviation strategies are preferred over land use management because they give the appearance that a hazardous area is now safe to occupy (Burby and French 1985). Structural improvements can create a market for development in a naturally uninhabitable location. Take the development of the Everglades, for instance. After the Army Corps of Engineers dammed Lake Okeechobee, developments rose overnight in the Everglades (Grunwald 2006). Structural improvements can bring massive amounts of money into communities. Flood alleviation strategies such as flood insurance can also encourage development by diminishing the risk of living in a flood prone area because residents and business owners know insurance will help pay for the costs of flood damage (Burby and French 1985). Structural improvement and flood alleviation strategies provide opportunities for developers while land use management strategies can limit opportunities for developers to make money.

In addition, structural improvement and flood alleviation strategies provide physical and immediate solutions. Once construction of a levee is complete, residents can physically see that their risk levels are reduced. During floods, residents can witness a levee holding back water. Once a resident obtains flood insurance, the resident knows that he will be covered in the case of a flood. On the other hand, land use management does not offer physical and immediate solutions (Burby 2006). Keeping developments out of hazardous areas does not

yield a result that can be witnessed by citizens. Even during a flood, it would be difficult to assess the benefits of land use management because one cannot compare the damage costs of a regulated piece of property with the damage costs of a development that could have existed if the same piece of property was not regulated. For this reason, elected officials are hesitant to enact land use management policies because they do not provide physical results and their benefits may occur after the elected official has been voted out of office (Burby 2006, p. 172)

While it is difficult to prove its effectiveness, land use management strategies are much cheaper and more effective at reducing flood losses than structural improvement and flood alleviation strategies (Burby and French 1985; White 1945). While structural improvements may reduce flood losses of lesser intensity, losses from “rare flood events may be increased, particularly if site design measures, such as elevation of structures and floodproofing, result in greater feelings of safety among hazard zone occupants and greater development of hazard areas than would have otherwise occurred” (Burby and French 1985, p. 21). Ultimately, structural improvement strategies are counterproductive because they can increase flood losses. If a rare flood event occurs and destroys protective structures, the community’s losses will include the cost of the structure and the additional homes the protective structure may have caused to be built. Structural improvement and flood alleviation strategies are temporary solutions, and flood prone communities should seek more permanent solutions, such as land use management.

No Adverse Impact Framework

In the early 1970s, the NFIP experienced a rough transition partially because the national floodplain policy overruled local floodplain policies (ASFPM 2003a). The NFIP’s rigid

standards did not initially consider the localized situations communities faced therefore limiting local floodplain management programs. A few frustrated floodplain managers began meeting in Madison, Wisconsin to discuss possible solutions to address the NFIP problem and formed the Association of State Floodplain Managers (ASFPM) in 1977 (ASFPM 2003a). Today, ASFPM has “17,000 national and chapter members [representing] local, state and federal government agencies, citizen groups, private consulting firms, academia, insurance industry and lenders” (ASFPM 2017, p. 1). ASFPM’s goals consist of reducing loss of life and property from flooding, preserving floodplains, and promoting the wise use of land (ASFPM 2017). To achieve its goals, ASFPM members present their ideas to legislatures which has resulted in the creation of beneficial floodplain management regulations such as the Community Ratings System (CRS). Because of ASFPM’s significant impact on floodplain management policy and its devotion to wise land use practices, this study utilizes ideas created by the ASFPM.

In addition to making policy recommendations to legislatures, the ASFPM also provides communities with tools and programs that improve floodplain management programs. One of their programs, the No Adverse Impact (NAI), is “an approach that ensures the action of any community or property owner, public or private, does not adversely impact the property and rights of others” (ASFPM 2003b, p. 8). The NAI helps communities design programs to meet their own needs, allowing communities to “incorporate the approaches into [their] community plans, adopt specific regulatory or policy language, initiate individual projects, start or revise entire programs or prepare a master plan that addresses all activities that impact flooding” (ASFPM 2003b, p. 9). The NAI program is organized under seven building blocks:

1. Hazard identification and floodplain mapping
2. Education and outreach

3. Planning
4. Regulations and development standards
5. Mitigation
6. Infrastructure
7. Emergency Services

The NAI's framework is modeled after the organization of the Community Rating System (CRS) (ASFPM 2003b). The CRS is an addition to the NFIP's minimum standards which encourages communities to exceed the minimum criteria by "scoring the community's activities according to formulas that measure their impact on flood losses and flood insurance rating" (ASFPM 2003b, p. 11). The CRS provides a list of floodplain management strategies award points to communities based on the number of strategies they implement in their floodplain management program. A community can receive a discount of up to 45% on flood insurance premiums based on the number of CRS points a community receives. CRS communities are placed into ten categories; Category 1 receives the highest discount and category 10 receives the lowest discount. Appendix E provides a tables that show each CRS activity and the maximum number of points communities can earn as well as the discount percentages and the points required for each rate class. The NAI is a legitimate program because of the credibility of the ASFPM and because its similarity to the CRS. Because of the program's legitimacy, this study bases its conceptual framework on Chapters 3 and 4 which cover: planning, regulations, and development standards.

A Framework to Assess the City of San Marcos

This study uses an exploration – working hypothesis conceptual framework to assess the City of San Marcos' commitment to land use management as a flood mitigation strategy. Exploration is the appropriate organizational tool because it "generally occurs within the

context of a case... and the goal is to collect evidence, which would support (or fail to support) certain expectations about the case. These preliminary or not quite formal expectations are called working hypotheses” (Shields and Rangarajan 2013, p. 110). Three chapters in the NAI Program Toolkit develop three working hypotheses that assess the City of San Marcos’ commitment to floodplain land use management. In addition, the sub-working hypotheses define the rating criteria that provide an accurate depiction of the City of San Marcos’ commitment to floodplain land use management. Similar to the metaphor used to explain the policy logic model which says, “the team expects that if they get the right coach, recruit the right players, train the players correctly, they will win more games”, this study expects that if the City of San Marcos uses floodplain regulations, considers floodplains in policy decisions, and exceeds the NFIP minimum development standards, the City will be committed to floodplain land use management (Shields and Rangarajan 2013, p. 167). A table summarizing the conceptual framework of the research is provided at the end of the chapter.

Regulations (WH1)

Regulations “define how a community should be developed” through an established set of rules (ASFPM 2003b, p. 31). Regulations are police powers that are “inherent in the sovereign power of the state to regulate private conduct to protect and further the public welfare” (Lawton 1894). Cities have the right to regulate development in their communities to protect the public welfare, therefore floodplain regulations fall under this category. Thus, this study expects the following if the City of San Marcos is committed to floodplain land use management:

WH1: The City of San Marcos demonstrates commitment to floodplain land use management through floodplain regulations

This section develops regulatory sub-hypotheses about exactions, zoning regulations, and residential cluster regulations.

Exactions (WH1a)²

Exactions, a common land use technique used since the 1970s, “impose on subdivision developers or builders [requirements] that they dedicate park land or specified amenities, or pay a fee to be used by the government entity to acquire and develop park and recreation facilities” (Crompton 1997, p. 16). Exactions require developers to pay for facilities that they created the demand for (Crompton 1997). For example, Exactions can take the form of physical land donations or monetary payments, and communities have flexibility in how and when they can be applied. They typically occur in rapidly growing suburban communities similar to San Marcos (Crompton 1997, p. 20). Courts generally uphold the legality of an exaction as long as the city can prove the exaction will address the harm the development will create and the cost is “roughly proportional” to the degree of harm threatened by the development (Byrne and Zyla 2016, p. 765). This subsection discusses the legal justifications for imposing an exaction, multiple methods of implementation, and using exaction as a means for controlling flood hazards.

Developers despise exactions, and they have fought against them in court arguing that they violate the 5th amendment of the Constitution. The 5th amendment of the Constitution

² This section draws from the following sources: Crompton 1997; Adams County Planning Commission 2015.

states that private property shall not be seized for public use. Despite these claims made by developers, exactions have been upheld in multiple cases as a police power of local governments. In one case decided at the Florida Supreme Court, *Hollywood Inc. v. Broward County*, exactions were upheld as constitutional. The court stated: “open space, green parks and adequate recreational areas are vital to a community’s mental and physical well-being”, therefore, communities have the power to require developers to dedicate land (Crompton 1997, p. 19). In *Nollan v. California Coastal Commission*, the Supreme Court affected exactions by creating the “essential nexus” test which requires communities to prove that the concessions address the negative impact made by the development. (Nollan 1985; Byrne and Zyla 2016, p. 768-69). In 1994, exactions were the subject of another Supreme Court case, *Dolan v. City of Tigard*. This case added on to the “essential nexus” by introducing the “rough proportionality” standard which required communities to establish that the exaction must be roughly equal to the impacts of the proposed development (Dolan 1994). These two tests “taken together approved the use of exactions to address the impairment of public viewsheds, increased vehicular traffic, and additional runoff into a stream from paving adjacent land” (Koontz 2013; Byrne and Zyla 2016, 765).

Exactions reappeared again at the Supreme Court in the 2013 case, *Koontz v. St. Johns River Water Management District*. This case addressed the question of whether monetary exactions are held to the same standards as land exactions. The court ruled that the general constitutional tests, “essential nexus” and “rough proportionality” apply to monetary exactions. In *Koontz*, Justice Alito said in his opinion, “Insisting that landowners internalize the negative externalities of their conduct is a hallmark of responsible land-use policy, and we have long

sustained such regulations against constitutional attack” (Byrne and Zyla 2016, p. 767). In addition to applying the general standards to monetary exactions, Justice Alito solidified the opinion that landowners must help offset the negative consequences of their developments. Understanding the legal justifications of exactions allow communities to implement them legally in their own policies.

There have been many methods used to implement exactions in communities. Some communities do not have set exaction policies and instead use flexible negotiation to offset a developments harmful effects. Other communities give zoning incentives to developers in exchange for land or fees (Crompton 1997, p. 21). These methods are not recommended, therefore this study focuses on mandatory land dedication and monetary fees as viable forms of exaction used by local government.

Mandatory land dedication requires a developer “to deed a portion of the land to a local authority for recreation purposes as a condition of the approval of a permit to build” (Crompton 1997, p. 25). To satisfy the “essential nexus” and “rough proportionality” tests, the donated land would be used to offset the harm caused by the development. For instance, a new apartment complex would increase the demand of a public park. To alleviate that demand, the developer would donate a portion of the land to be used to meet the demand for the public park. The amount of land that developers donate is either calculated through the population density formula or is set at a fixed percentage. The population density formula “requires developers to deed a specific acreage per 1,000 residents” (Crompton 1997, p. 25). In Littleton, Colorado, developers dedicated “10.5 acres for every 1,000 residents in a proposed subdivision” (Burby and French 1985, p. 198). The fixed percentage method requires that “a

minimum of five percent of the gross land area of subdivisions of more than 50 lots or 25 acres, shall be dedicated for parks” (Crompton 1997, p. 25). The percentage of gross land area donated can be as high as 10%, but it is not guaranteed that courts will uphold that percentage (Crompton 1997). Although the fixed percentage offers consistency, it does not adjust for large subdivisions. A larger subdivision should donate a larger tract of land, so the population density formula is more suitable when using mandatory land dedication. There are, however, some problems with mandatory land dedication.

Two significant issues with mandatory land dedication are that the city cannot control the location of the donated parcel and that the size of the donated parcel is typically too small to do anything with (Byrne and Zyla 2016). Instead of requiring developers to donate land, the city can require developers to donate money to the government (Byrne and Zyla 2016; Gowder Jr. 2016; Crompton 1997; Burby and French 1985). In order to satisfy the “essential nexus” test, exaction money the city receives from developers must be used to address the negative consequences of the development. In addition, the money must be proportional to the cost of the damage from the development. Littleton, Colorado and Adams County, Pennsylvania used monetary exaction to address harmful consequences of developments. In Littleton, developers had to “pay \$505 for every single family unit and \$350 for every multi-family unit” (Burby and French 1985, p. 198). In Adams County, Pennsylvania, the developer must donate a percentage of the total cost of the non-residential development if the size of the project exceeds two acres (Adams County Planning Commission 2015, 610.02). The figures in these examples would have to be adjusted to comply with the “rough proportionality” standard. The funds collected from the developer could then go toward city needs caused by the development.

Byrne and Zyla (2016) argue that harm caused by climate change justifies the use of exaction. For instance, if a developer builds a subdivision far from the city center, people will drive longer distances. Essentially, the developer causes harm to the community through the additional use of fossil fuels and should pay for their negative impact on the environment (Byrne and Zyla 2016). Similarly, if a developer proposes a project in a floodplain, the developer is increasing the number of citizens who will be vulnerable to floods and should pay to ensure that hazards are mitigated through either mandatory land dedication or monetary exaction. The essential nexus and rough proportionality standards justify the use of exactions to mitigate flood hazards. Mandatory land dedication and monetary exactions ensure that developers are held accountable to the people who occupy their homes and can discourage development away from hazardous areas.

Exaction methods such as mandatory dedication of land and monetary fees are tools that force developers to claim responsibility for the negative consequences of their projects. Although exactions are typically used to address the public's physical needs such as parks and public facilities, exactions can be used to offset a flood hazard. Thus, this study expects to find the following if the City of San Marcos is committed to floodplain land use management.

WH1a: The City of San Marcos manages flood hazards through exactions.

Hazard Zoning Regulations (WH1b)³

Zoning is the practice of dividing a city into districts with “regulations for each on having to do with the architectural design of structures, the area to be occupied by them, and the use to which the property may be devoted” (Welch 2009, p. 1). Zoning regulations have historically

³ This section draws from the following sources: Welch 2009; ASFPM 2013.

been used to separate incompatible land uses by dividing a community into commercial, residential, industrial, or retail districts (Platt 1998, p. 42). They create quieter residential areas, encourage communities to develop plans for their land use, and decrease hazards. In addition to manipulating development into specific districts, zoning regulations can be used to keep structures from being built in hazardous areas, such as floodplains (Barua, Akhter, Ansary 2016). This sub-section discusses the development of zoning regulations in the United States and Texas, introduce the idea of managing flood hazards through zoning regulations, and identify hazard zoning practices suggested in the literature.

In colonial America, many cities were clusters of mixed uses which were prone to fires and disease (Welch 2009, p. 1). Property owners chose how to use their tract of land, so a home could be next door to a lumber factory or steel mill. American communities began to realize the merit of separating certain land uses, or zoning, prior to 1800 when laws were enacted in Boston, Salem, and Charleston that regulated the “location of slaughterhouses and distilleries as well as the business premises of chandlers and couriers, and the location of potters’ kilns” (Welch 2009, p.1). Public officials recognized that controlling what could be developed where was in the interest of the public, but there were many who considered zoning a violation of property rights. Most state courts ruled that zoning was a legitimate police power of a municipality because it prevented congestion, secured quiet residential districts, and organized the distribution of industrial, commercial, and residential areas (Welch 2009, p. 2). In 1924, the Supreme Court upheld the constitutionality of zoning regulations in *Village of Euclid, Ohio v. Ambler Realty Corp* arguing that “the question whether the power exists to forbid the

erection of a building of a particular kind or for a particular use... [is determined by] considering it in connection with the circumstances and the locality” (Village of Euclid, Ohio 1924).

Three years after the *Village of Euclid, Ohio v. Ambler Realty Corp* ruling, Texas adopted a version of the Standard Zoning Enabling Act (SZA) which provided model zoning regulations to states who then delegated zoning power to the local governments (Welch 2009, p. 3). The Texas Supreme Court upheld the legality of zoning in *Lombardo v. City of Dallas*. Chapter 211 of the Texas Local Government Code authorizes municipalities to divide areas into zoning districts and create requirements for each of those districts. The zoning regulations must be adopted in accordance with a comprehensive land use plan and be designed to reduce traffic, promote health and general welfare, avoid overcrowding, provide adequate light and air, facilitate transportation, and security from hazards (Texas Local Government Code Sec. 211.004 [a] [1-7]).

The Massachusetts Supreme Judicial Court upheld the first floodplain zoning regulations in *Turnpike Realty Co v. Town of Dedham* in 1972. Hazard zoning regulations became a widespread tool after this ruling, and communities saw that floodplain zoning was an effective method to reduce flood damages. According to Chapter 211 of the Texas Local Government Code 211.004 (a)(2), a community’s zoning regulations must assist in the reduction of “fire, panic, and other dangers”, and floods can reasonably be considered other dangers or panic. Therefore, floodplain zoning regulations are justified for use in Texas communities.

Hazard zoning regulations consider geographic features when dividing communities into districts. The uses for a parcel of land are established according to its neighboring districts and the hazards exposed to it. If a parcel is located in the 100-year floodplain, it should be assigned

to a district with limited uses. An ideal district for a parcel located in the 100-year floodplain would have strict impervious cover limitations encouraging the use preservation of open space. Districts that are located adjacent to the 100-year floodplain should have provisions that decrease vulnerability to floods. A setback is an example of a flood mitigation zoning regulation, and they keep proposed developments that are adjacent to floodways 50, 100, or 200 feet from the floodway boundary (ASFPM 2013, p. 12). Setbacks ensure that no development will be constructed too close to a defined floodway. The buffer zone between the floodway boundary and the development increases the likelihood that structures will be protected from floods that are more intense than the 100-year flood. Zoning regulations can also prohibit any construction activity in the floodway, other than water-dependent uses or stream bank stabilization activity (ASFPM 2013, p. 15). Because zoning regulations can reduce the number of developments that are built in hazardous areas, this study, therefore, expects to find the following if the City of San Marcos is committed to floodplain land use management.

WH1b: The City of San Marcos manages flood hazards through zoning regulations.

Residential Cluster Regulations (WH1c)⁴

Residential Cluster regulations allow developers to build houses on smaller plats to increase the amount of open space in a subdivision (Sykes 1998; Olshansky and Kartaz 1998; Lindell, Prater, Perry 2006). In a clustered subdivision, lot sizes are reduced causing the subdivision to occupy less space, and developers leave the open space in its natural state. Because homes are built on smaller lots, the developer makes just as much money through a normally platted subdivision. Clustering is a beneficial practice for communities because it saves money by not

⁴ This section draws from the following sources: Sykes 1998; Mega et al 1998.

requiring as much infrastructure and maintenance, reduces travel times, can encourage physical activity, and ensures flood drainage patterns are left in a natural state (American Planning Association 2012). The open space become a natural stormwater management system that maximizes overland flow and combines “the use of plants and landforms to slow, hold, and treat runoff from new development” (Mega et al 1998, p. 3). Cities can effectively mitigate flood losses through the use of residential clustering regulations.

The Woodlands’ New Community outside of Houston, Texas is a well-known example of a clustered subdivision (Sykes 1998). The community’s comprehensive plan clustered residential developments in suitable areas and “[preserved] the site’s natural drainage system, [avoided] environmentally-critical areas, [worked] with existing topography, and [maintained] prevailing hydrological conditions” (Sykes 1998, p. 16). Engineers estimated that the capital expense of the natural system cost about “\$14 million” less than the conventional system (Sykes 1998, p. 16). In addition, the community has experienced minimal impacts from many floods that devastated neighboring communities (Sykes 1998). The Woodlands effectively planned their community to work with the existing topography. The community understood the importance of natural drainage patterns and planned subdivisions accordingly. The Woodlands’ clustering strategies can be applied to flood prone communities nationwide.

Clustering does not need to be used for every subdivision though. When the topography does not require special accommodations, normal subdivision development practices can be applied. When a proposed subdivision includes an environmentally sensitive area, communities must be prepared with clustering regulations. To incentivize developers to use clustering, cities should offer density bonuses of up to 25% (American Planning Association

2012). Density bonuses are useful in convincing developers that clustering is in their best interest. If a developer chooses to cluster to create additional open space, “not less than 25 percent of the site shall be conveyed as common open space” (American Planning Association 2012, p. 5). If the site includes a floodplain and/or wetland, “not less than 50 percent of such floodplains and/or wetlands shall be included in calculating the common open space” (American Planning Association 2012, p. 5). This ensures that the majority of the floodplain is included in the undevelopable portion of the site. Clustering provisions such as those described assist in the mitigation of flood hazards. Therefore, this study expects to find the following if the City of San Marcos is committed to floodplain land use management.

WH1c: The City of San Marcos manages flood hazards through residential cluster regulations.

Planning Decisions (WH2)

Despite hazard regulations being codified and enforced, city planners still have a significant amount of discretion in how a community will be developed. Effective planning can keep developments out of hazardous areas and prevent future flood problems, so it is imperative that communities carefully consider flood hazards when deciding how and where a community will grow. According to the No Adverse Impact Toolkit, “plans should relate the use of the land to the land’s hazards, typically by reserving hazardous areas for parks, greenways, golf courses, wildlife refuges, natural areas, or similar open space compatible uses” (ASFPM 2003b, p. 31). Because city planners have discretion in the development of their community, a commitment to preserving hazardous areas in a reasonably natural state is necessary. Therefore, this study expects to find the following if the City of San Marcos is committed to floodplain land use management:

WH2: The City of San Marcos demonstrates commitment to floodplain land use management through planning decisions

Communities can show commitment through planning decisions in a variety of ways, and this study focuses on the following decision city planners can make to preserve hazardous areas: capital improvements, public acquisition, and the creation of greenways.

Capital Improvements (WH2a)⁵

A capital improvement is the planned construction of a public facility or infrastructure. Commitment to floodplain land use management can be measured by a city's planned sites for capital improvements (Burby & French 1985; Wright 2007). In *Floodplain Land Use Management: A National Assessment*, Burby and French (1985) interviewed business owners who risked building in a floodplain. Some respondents believed that the costs that could occur because of flooding did not outweigh the advantages of the business opportunities of that location. Business owners built in hazardous locations because that was where they could make the most money. The center of the community is often near public facilities, and the most advantageous location for businesses is located near the center of the community. Localities can take advantage of developers' desire to build in attractive locations by locating public facilities outside of hazardous areas (Lindell, Prater, Perry 2006). Constructing roads off of the floodplain also forces private developers to build off the floodplain because a business cannot succeed without access to a road. Building public facilities such as roads, hospitals, and schools out of the floodplain provides private developments to build outside of the floodplain.

⁵ This section draws from the following sources: Burby and French 1985; ASFPM 2013.

The strategy of building public facilities out of hazardous areas has been used for decades. In response to a major earthquake in Alaska in 1964 and Hurricane Betsy in 1965, President Johnson signed Executive Order 11296 which directed federal agencies to evaluate and take action on flood hazards on properties they oversaw (Knowles & Kunreuther 2014). The acknowledgement that federal properties should be built outside of hazardous areas helped influenced state agencies and localities to do the same. President Jimmy Carter's Executive Order 11988 replaced EO 11296 which required federal agencies to avoid direct and indirect support of floodplain development (Burby & French 1985). Executive Order 11988 also defined critical public facilities and required that they could not be built in the 500-year floodplain (ASFPM 2013). Critical public facilities are places that are depended upon during hazardous events and some examples are "jails, hospitals, schools, daycares, public and private utilities, fire stations, emergency operation centers, police stations, nursing homes, wastewater treatment facilities, water plants, gas/oil/propane facilities, hazardous waste" (ASFPM 2013, p. 7). This Executive Order further elevated the idea that government should be an example for private businesses to avoid developing in hazardous areas.

The ASFPM (2013) provides three options for model language for locating critical public facilities. In all three options, critical facilities are prohibited in the 100-year floodplain. One option says, "where critical developments are located adjacent to 1%-chance flood areas, flood protection evaluation shall be two feet above .2% flood elevation" (ASFPM 2013, p. 7). The next option says that any critical facility must be built "one-foot above the .2% floodplain" (ASFPM 2013, p. 7). The final option says that localities can prohibit critical public facilities from being built in the 100 and 500-year floodplain. The final option is recommended because it

solidifies the community's position on building in hazardous areas. The center of the community will be located outside of the hazardous area because of the location of its public facilities. Communities will set an example by building outside of the floodplain which will influence private developers to build near the community's center outside of the floodplain.

Building public facilities and infrastructure can move development away from hazardous areas. Floodplain land use management therefore contains planning capital improvements outside of hazardous areas. This study thus expects to find the following if the City of San Marcos is committed to floodplain land use management:

WH2a: The City of San Marcos manages flood hazards through capital improvements

Public Acquisition (WH2b)⁶

Acquisition is the most effective way to reduce flood hazards (Burby & French 1985; Wright 2007). Acquisition is "an action by which a state or local government obtains an interest in land, either by full ownership through purchase, donation or land exchange; or a less interest such as an easement or leasehold" (Wright 2007, 15-11). The most common form of acquisition, fee simple, involves the full purchase of land at fair market value (Wright 2007). Parks and other public uses with low flood-damage potential are typically built on fee simple acquisition properties (Burby & French 1985). The other form of acquisition, less-than-fee simple, occurs when the community does not purchase the full title. The city can either lease the property for a specified time or acquire an easement which is the right to use land for a particular purpose (Wright 2007). Easements are typically used for utility right-of-way

⁶ This section draws from the following sources: Burby and French 1985; Lindell, Prater, Perry 2006.

(telephone poles, sewer lines) or for railroads (Wright 2007). The city should use the less-than-fee simple form of acquisition when only a section of property needs to be preserved or when a property owner refuses to sell. Less-than-fee simple also allows land owners the continued use of their property as long as it does not interfere with the city's uses (Lindell, Prater, Perry 2006). Cities can use acquired property for the construction of roads, public facilities, drainage improvements, or any other public endeavor. In addition, communities should consider acquiring property for the purpose of keeping it in its natural state.

Keeping land in its natural state increases flood storage area which results in reduced downstream flood peaks (Wright 2007). This reduces the cost of floodplain management because there is not a need for additional protective measures or development standards. Leaving land in its natural state is the most effective way to improve drainage, reduce downstream flooding, and increase groundwater recharge (Wright 2007). Acquisition accomplishes many other community objectives such as "increasing open space, active or passive recreation, urban or waterfront revitalization, and establishment of greenways" (Wright 2007, p. 15-12).

There are a few problems with acquisition though. Acquisition is very expensive and most communities do not have the funds to buy the hazard prone land in their community (Wright 2007). FEMA does have an acquisition program that it utilizes after a Presidential Disaster Declaration (Wright 2007). Under the Stafford Act, the Hazard Mitigation Grant Program provides up to "15 percent of the total estimated federal assistance for mitigation projects. This is the principle mechanism for acquiring severely damaged property" (Wright 2007, p. 20-22). Funds allocated to communities after a devastating flood can then be used by

the community to acquire the property. Acquisition is typically used after a flood event which is another significant disadvantage to acquisition. Acquisition is rarely used as a proactive flood hazard management strategy. It also carries the risk of strong opposition that occurs if the city has to use its eminent domain to buy land from somebody who refuses to sell (Wright 2007). Tax dollars are also no longer received from the acquired land, and the city must maintain the property (Wright 2007). However, the costs of a catastrophic flood are far greater than the tax dollars lost and maintenance required. Acquisition may be the most effective strategy to prevent developments from being built on floodplains, but it should not be the number one strategy for reducing flood hazards because of the issues associated it.

Purchasing hazardous land keeps developments out of hazardous areas. Floodplain land use management therefore includes acquisition of hazardous property. Thus, this study expects to find the following if the City of San Marcos is committed to floodplain land use management:

WH2b: The City of San Marcos manages flood hazards through public acquisition/relocation.

Greenways (WH2c)⁷

If a community acquires property in the floodplain, it can be maintained as a greenway. Greenways are defined as “networks of land that are planned, designed and managed for multiple purposes including ecological, recreational, cultural, aesthetic, or other purposes compatible with the concept of sustainable land use” (Ahearn 2003, p. 35). Greenways are widely used across the United States and are becoming more prevalent in urban areas that do not have access to natural environments (Ahearn 2003). If a community makes a strong

⁷ This section draws from the following sources: Ahearn 2003; Fields et al 2016.

commitment toward public acquisition, cities can use the acquired land to create greenways. This subsection discusses the benefits of greenways and the case of the Lafitte Greenway in New Orleans.

Greenways and green infrastructure have been used since the 1800s as a tool to enhance a city's resiliency by creating open space and storm buffers while maintaining natural ecosystems (Fields et al 2016). Undeveloped land drains runoff much more effectively than developed land. When land is developed, runoff can increase from "two to six times as absorbent vegetation is replaced by impervious cover" (Burby & French 1985, p. 14). Greenways allow for natural drainage patterns to continue, absorb a significant amount of runoff, and they add amenity value to communities.

Furthermore, greenways reduce maintenance costs, control sprawl, enhance environmental quality, and attract tourists and businesses. Greenways in a floodplain ultimately cost less than structural mitigation projects because they require little maintenance (Ahearn 2003). In addition to the initial cost of construction, structural improvements become damaged over time and require consistent maintenance. Greenways, on the other hand, do not require significant maintenance expenditures because the land remains in its natural state. Greenways can also promote "more concentrated development patterns, thereby reducing the costs of providing infrastructure for low-density or sprawl-type development" (Ahearn 2003, p. 46). The continuous network of parks and open space also "attract business and residents to communities, stimulating commercial growth, tax revenues and tourism" (Ahearn 2003, p.46). Purchasing enough hazard prone land to create a greenway is a substantial investment, but the additional parks bring money into the community. Finally, greenways provide environmental

benefits such as: “flood protection, water storage and purification, air cleaning, degradation of organic wastes, and reducing of urban heat island effects” (Ahearn 2003, p. 46-47). Converting acquired land into a greenway requires little maintenance, reduces sprawl, attracts businesses and tourists, and provides flood protection.

New Orleans converted underused space into a greenway. After Hurricane Katrina, there were many initiatives proposed to improve the city’s protection from floods. These initiatives moved away from the structural improvement approach and focused on improving the city’s green infrastructure. The Lafitte Corridor was a “three-mile corridor of marginal land and underutilized industrial properties [which] divided several neighborhoods from the back of the French Quarter to the Lakeview neighborhood” (Fields et al 2016, p. 6). Prior to construction of the greenway, the corridor was an unsightly buried canal from the 1700s (Fields et al 2016). After Hurricane Katrina, city official quickly approved the plan to convert the Lafitte Corridor into the Lafitte Greenway. Once constructed, the greenway expanded open space, revitalized the surrounding neighborhoods, and provided flood protection from future disasters.

The multiple benefits greenways provide to communities combined with the increased flood protection make greenway an effective floodplain land use management tool. Thus, this study expects to find the following if the City of San Marcos is committed to floodplain land use management.

WH2c: The City of San Marcos reduces flood hazards through greenways.

Elevation Standards (WH3)

An element of floodplain land use management acknowledges that development in the floodplain cannot be entirely avoided. When this is the case, it is necessary to have development “standards that can fully protect it from flood damage and help reduce the impact of that development on others” (ASFPM 2003b, p. 39). Communities protect new buildings in the floodplain by elevating structures at or above the base flood elevation (BFE). The National Flood Insurance Program (NFIP) requires new residential and non-residential structures in the floodplain to be built at the BFE, and it is “calculated that buildings built to the standards suffer 70% less damage than unprotected buildings, saving over \$1 billion per year in flood damage” (ASFPM 2003, p. 40). Additionally, the No Adverse Impact Toolkit suggests that the lowest floor of all new developments in the 100-year floodplain “be elevated to or above the base flood elevation (BFE)” (ASFPM 2003b, p. 40). A community’s elevation requirements can be used to gauge their commitment to floodplain land use management. For this reason, the quality of a floodplain development standard is determined by comparing it with the NFIP’s standard. Therefore, one would expect the following:

WH3: The City of San Marcos demonstrates commitment to floodplain land use management through elevation standards

In addition to BFE requirements, the NFIP provides standards on how to elevate structures. Structures can be elevated with limited enclosures or with fill, but the literature prefers the limited enclosure method. This section discusses Base Flood Elevation requirements and methods to elevate properties.

Base Flood Elevations (WH3a)⁸

FEMA defines the Base Flood Elevation (BFE) as “the computed elevation to which floodwater is expected to rise during the base flood (100-year flood)” (FEMA 2015a, p. 1). The NFIP requires “all new construction and substantial improvements of residential structures within Zones A1-30, AE and AH zones⁹ on the community’s FIRM to have the lowest floor (including basement) elevated to or above the base flood level” (44 CFR 60.3(c)(2)). The NFIP’s minimum standard only requires structures to be elevated to what experts expect a 100-year flood to look like. If a 100-year flood exceeds experts’ expectations, then the NFIP’s minimum BFE will be insufficient. Moreover, the NFIP’s minimum BFE will be ineffective against any flood that is greater than a 100-year flood. Therefore, communities should require that developments in the 100-year floodplain be elevated higher than the BFE.

Structures can be raised above the BFE through freeboarding, which is “an additional height requirement above the base flood elevation” (ASFPM 2003b, p. 41). Communities should require that the lowest level of structures in the 100-year floodplain be elevated as high as “1,2,3 feet above the base flood elevation” (ASFPM 2013, p. 4). Additions to existing structures that increase the building’s original floor area by 25% should also be held to the same elevation standard (ASFPM 2013). This standard has the potential to provide significantly more protection than the NFIP’s minimum standard. Thus, this study expects the following if the City of San Marcos is committed to floodplain land use management:

⁸ This section draws from the following sources: FEMA 2015a; ASFPM 2013.

⁹ See Appendix D for description of flood zones.

WH3a: The City of San Marcos manages flood hazards by exceeding the NFIP’s minimum Base
Flood Elevation standards

Elevation Methods (WH3b)¹⁰

There are three methods that elevate structures to or above the BFE: “Elevation on fill; elevation on piles, posts, piers, or columns; and elevation on walls or crawlspace (FEMA 2017c, 5-27). These methods can be further simplified into elevating with solid material (fill) or with material that does not inhibit the flow of flood waters (piles, posts, piers, columns, walls, and crawlspace). Communities utilize both methods to elevate structures, but the Community Ratings System (CRS) strongly prefers methods that do not inhibit the flow of floodwaters. This sub-section describes both methods and explains while un-inhibiting elevation methods are preferred over elevating with solid material.

Fill elevates structures through the use of solid, impervious materials such as concrete. Some communities “require or encourage the use of fill to elevate residential buildings because they consider fill a safer construction method since the building itself is not in contact with floodwaters” (FEMA 2017c, p. 5-28). When fill is utilized, it is imperative for communities to alleviate the possibility of erosion. This can be accomplished by extending the fill “10-15 feet beyond the walls of the building before it drops below the BFE” (FEMA 2017c, p. 5-28). Fill, on the other hand, “reduces floodplain storage capacity, can deflect waves onto neighboring property, and it has an adverse impact on native vegetation, wetlands, drainage, and water

¹⁰ This section draws from the following sources: FEMA 2017c; FEMA 2017b.

quality” FEMA 2017b, p. 430-6). The CRS awards zero points (credited under DL1a¹¹) to communities who do not prohibit fill (FEMA 2017b, p. 430-2).

To attenuate the reduction in floodplain storage capacity, some communities require compensatory storage which is created by “excavating an additional floodable area to replace the lost flood storage area” (FEMA 2017d, p. 6-23). Compensatory storage offsets the negative impacts that fill may have on the floodplain, but it is worth half of what totally prohibiting fill is worth (FEMA 2017b, p. 430-2). Fill benefits the developer and the property owner but causes harm to neighbors and the environment. Fill is contradictory to the purpose of the No Adverse Impact program. Therefore, this method is not recommended.

The ASFPM and the NFIP instead suggest to use a method that does not inhibit the passage of stormwater through either posts, piers, walls, or crawlspace (FEMA 2017c; ASFPM 2003b). Piles, piers, posts, or columns are appropriate foundations where there is deeper flooding or “flooding is likely to have high velocities” (FEMA 2017c, p. 5-28). These foundations do not inhibit the passage of stormwater and therefore do not cause flood heights to increase.

Walls are another option to use as the elevating foundation. The area of the foundation can be small enough to only be considered a crawlspace or it can be large enough to park vehicles. Communities must regulate this method if walls are to be used as the elevating foundation. First, it must be recognized that the space created by the elevating foundation can only be used for “building access, vehicle parking, and storage” (FEMA 2017c, p. 5-33). It must be made clear that the space created by the elevating foundation cannot be finished or

¹¹ See Appendix E for list of CRS activities and maximum points for completion.

converted into a living space. Second, there must be regulations to ensure that the walls are constructed in the correct manner. There are two design methods for wall construction:

- “Stem walls can be used on two sides parallel to the flow of water. The two other sides are kept open” (FEMA 2017c, p. 5-29).
- “The walls can be built with openings large enough to allow floodwaters to flow in and out” (FEMA 2017c, p. 5-29)¹².

The second option requires further regulations for the openings. To ensure that flood waters can pass through, the openings must meet or exceed the following criteria:

1. The bottom of the openings must be no higher than one foot above grade (see Figure 5-12).
2. The openings shall be installed on at least two walls of the enclosure to ensure that at least one will work if others get blocked or plugged.
3. Provide a minimum of two openings having a net area of not less than one square inch for every square foot of enclosed area that is subject to flooding. If the area of the enclosure is 1,000 square feet, the area of the openings combined must total at least 1,000 square inches.

For example, removing a concrete block from a block wall results in an 8” x 16” or 128 square inches opening (see Figure 5-12). To determine how many openings would be needed, divide the square footage of the floor area by 128.

Example 1: 1,280 square foot house/128 square inches/opening = 10 openings will be needed

Example 2: 2,000 square foot house/128 square inches/opening = 15.62, 16 openings will be needed

If the opening is covered by a standard crawlspace vent cover or grate, the net area of the opening must be used and the number of openings increased accordingly. Net areas can be found on manufacturers specifications or estimated if specifications are not available. (FEMA 2017c, p. 5-34)

¹² Refer to Appendix F for examples of these methods.

There are several methods communities can use to elevate properties. Fill effectively raises structures above the BFE, but this method has adverse effects on flood heights, flood storage, and the environment. Compensatory storage can mitigate some of these adverse effects, but it is recommended to pursue other elevating methods. Elevating methods that do not inhibit floodwater flow are the preferred options. These methods include elevating with piles, piers, post, columns, and walls which do not increase flood heights. Because these methods sufficiently raise structures above the BFE while not affecting the carrying capacity of the floodplain, this study expects to find the following if the City of San Marcos is committed to floodplain land use management:

WH3b: The City of San Marcos manages flood hazards by encouraging limited enclosure elevation methods over fill

Chapter Summary

This chapter summarized the relevant literature regarding floodplain land use management and developed three working hypotheses to assess the City of San Marcos' commitment to floodplain land use management. Two chapters in the ASFPM's No Adverse Impact program provided the basis to create the working hypotheses. Table 2.1 summarizes the conceptual framework.

Table 2.1

Conceptual Framework	
Working Hypotheses	Source
WH1: The City of San Marcos demonstrates commitment to floodplain land use management through floodplain regulations	
WH1a: The City manages flood hazards through exactions	Crompton 1997; Byrne and Zyla 2016; Nollan 1985; Hollywood Inc. 1956; Dolan 1994; Koontz 2013; Burby and French 1985; Gowder Jr. 2016; Adams County Planning Commission 2015
WH1b: The City manages flood hazards through zoning regulations	Welch 2009; Platt 1998; Barua, Akhter, Ansary 2016; Village of Euclid, Ohio 1924; Lombardo 1934; Texas Local Government Code Sec. 211; ASFPM 2013
WH1c: The City manages flood hazards through residential cluster regulations	Sykes 1998; Olshansky and Kartaz 1998; Lindell, Prater, Perry 2006; American Planning Association 2012; Mega et al 1998
WH2: The City of San Marcos demonstrates commitment to floodplain land use management through planning decisions	
WH2a: The City manages flood hazards through capital improvements	Burby and French 1985; Wright 2007; Lindell, Prater, Perry 2006; Knowles and Kunreuther 2014; ASFPM 2013
WH2b: The City manages flood hazards through public acquisition/ relocation	Burby and French 1985; Wright 2007; Lindell, Prater, Perry 2006
WH2c: The City manages flood hazards through greenways	Ahearn 2003; Burby and French 1985; Fields et al 2016
WH3: The City of San Marcos demonstrates commitment to floodplain land use management through elevation standards	
WH3a: The City manages flood hazards by exceeding the NFIP's minimum Base Flood Elevation standards	FEMA 2015; 44 CFR 60.3; ASFPM 2003b; ASFPM 2013
WH3b: The City manages flood hazards by encouraging limited enclosure elevation methods over fill	FEMA 2017 Unit 5; ASFPM 2003b; FEMA 2017 Unit 6; FEMA 2017 CRS

Chapter III: Research Methodology

Chapter Purpose

This chapter describes the assessment of the City of San Marcos' commitment to land use management as a strategy for mitigating flood hazards. First, the conceptual framework is operationalized, which provides a data collection plan. Second, the criteria for support table defines how commitment to land use management is rated in an objective manner. Third, the chapter identifies advantages and disadvantages of case-study research. Fourth, it describes the conceptual plans of four residential projects located in San Marcos, and, finally, discusses the use of document analysis and direct observation to measure the City of San Marcos' commitment to land use management.

Operationalization Table

While the conceptual framework organizes research logically, it does not provide a design for collecting data. The operationalization of the conceptual framework provides “the case with a data collection plan that specifies what evidence to look for and how to interpret it. This plan is directed by the working hypothesis which specify the evidence needed to support the expectations posited beforehand” (Shields and Rangarajan 2013, 114). Additionally, the operationalization table is an organizational device that requires “far less mental effort” for planning decisions in hazardous areas (Shields and Whetsell 2017, 79). Table 3.1 summarizes the operationalization of the conceptual framework. The first column provides the sub-hypotheses that are linked to an overarching working hypothesis. The second column identifies the evaluated source. Column three identifies the type of evidence the study is searching for.

The fourth column displays the criteria used to assess the City’s commitment to land use management. For instance, the statement, “the City requires land donations of 10.5 acres for every 1,000 residents” partially assesses the City of San Marcos’ commitment to floodplain land use management under WH1.

Table 3.1: Operationalization Table

Operationalization of the Conceptual Framework			
Working Hypotheses	Source	Evidence	Rating Criteria
WH1: The City of San Marcos demonstrates commitment to floodplain land use management through floodplain regulations			
WH1a: The City manages flood hazards through exactions	Land Development Code, development agreements and conceptual plans	Verification of the City’s commitment through exactions	<ul style="list-style-type: none"> •The City requires land donations of 10.5 acres for every 1,000 residents. •The City requires donations of 5% for subdivisions larger than 50 lots or 25 acres. •The City requires developers to pay \$505 for every single family unit and \$350 for every multi-family unit. •The City requires developers to donate a percentage of the total cost of the non-residential development if the project exceeds 2 acres
WH1b: The City manages flood hazards through zoning regulations	Code of Ordinances, Land Development Code, development agreements and conceptual plans	Verification of the City’s commitment through zoning regulations	<ul style="list-style-type: none"> •The City utilizes setback requirements exceeding 50 feet from the 100-year floodplain. •The City has floodplain zoning districts •The City prohibits development in the floodway
WH1c: The City manages flood hazards through residential cluster regulations	Land Development Code, development agreements and conceptual plans	Verification of the City’s commitment through residential cluster regulations	<ul style="list-style-type: none"> •The City incentivizes developers by offering density bonuses of up to 25% •The City requires at least 25% of a site to be open space •If site contains floodplains, the City requires that at least 50% of such floodplains be included in calculating open space
WH2: The City of San Marcos demonstrates commitment to floodplain land use management through planning decisions			

<p>WH2a: The City manages flood hazards through capital improvements</p>	<p>Code of Ordinances, Recommended Capital Improvements Plan, development agreements and conceptual plans</p>	<p>Verification of the City's commitment through capital improvements plan</p>	<ul style="list-style-type: none"> •The City does not have any plans to construct infrastructure or a public facility in a hazardous area. •The City requires critical facilities to be built one-foot above the .2% floodplain. •The City limits the construction of public facilities in the 100-year and 500-year floodplain. •The City limits the construction of infrastructure in the 100-year and 500-year floodplain.
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WH2b: The City manages flood hazards through public acquisition/relocation	CDBG – DR Action Plan, CDBG – DR Workshops, Recommended Capital Improvements Plan	Verification of the City’s commitment through public acquisition options	<ul style="list-style-type: none"> •The City plans to purchase fee-simple property in the 100-year or 500-year floodplain for the purpose of mitigating flood hazards. •The City plans to purchase less-than-fee-simple property in the 100-year or 500-year floodplain for the purpose of mitigating flood hazards.
WH2c: The City manages flood hazards through greenways	Recommended Capital Improvements Plan, Parks Master Plan, San Marcos Greenbelt Alliance	Verification of the City’s commitment through planned greenways	<ul style="list-style-type: none"> •The City plans to convert any portion of the 100-year or 500-year floodplain into a greenway.
WH3: The City of San Marcos demonstrates commitment to floodplain land use management through elevation standards			
WH3a: The City manages flood hazards by exceeding the NFIP’s minimum Base Flood Elevation standards	Code of Ordinances	Verification of the City’s BFEs exceeding the NFIP’s minimum standards through documents	<ul style="list-style-type: none"> •The City requires developments in the 100-year floodplain to be elevated above the BFE. •The City requires additions to structures in the floodplain that increase the building’s original floor area by 25% be held to the same elevation standard.
WH3b: The City manages flood hazards by encouraging limited enclosure elevation methods over fill	Code of Ordinances	Verification of the City’s commitment through the use of limited enclosures	<ul style="list-style-type: none"> •The encourages limited enclosures over fill. •If fill is used, the City requires compensatory storage to be created. •The City requires openings to be no higher than one foot above the BFE. •The City requires openings on at least two walls of the enclosure. •The City requires that the area of the openings cannot be lower than one square inch for every square foot of enclosed area.

Criteria for Support

In order to assess the strength of the evidence, a four-level scale of commitment adapted by Carvell (2016) was developed. The scale determines the level of support between the collected evidence and the working hypotheses. For instance, strong, supportive evidence for a sub-hypothesis yields stronger commitment between the sub-hypothesis and the case study. Similarly, weaker support yields less commitment. The assessment scale is divided into four levels of commitment – No, Limited, Adequate, and Complete.

An assessment score of No Commitment occurs when there is no evidence to support the sub-hypothesis, or the evidence found does not align with the component. A score of Limited Commitment occurs when documents and observations suggest little-to-no evidence supporting the sub-hypothesis. A sub-hypothesis would receive this score if there is some alignment in the City’s policies but the City’s practices reveal results that are contradictory to the City’s policies. A sub-hypothesis could also receive this score if the evidence fails to meet the standards defined in the literature. When evidence mostly supports the sub-hypothesis, a score of Adequate Commitment is awarded. “Evidence mostly supports the sub-hypothesis” means that there are multiple sources that consistently meet the literature’s standards. If there are multiple examples of evidence that support the sub-hypothesis, a score of Complete Commitment is awarded. All of the evidence must exceed the criteria in order for Complete Commitment to be awarded. Table 3.2 summarizes the assessment scale and provides definitions for each possible score.

Table 3.2: Levels of Commitment (Carvell, 2016)

Levels of Commitment	Document Analysis
No Commitment	No documents found, or documents provide no proof of support for sub-hypothesis
Limited Commitment	Documents contain minimal written evidence supporting sub-hypothesis, or do not meet standards defined in literature
Adequate Commitment	Documents contain some written evidence supporting sub-hypothesis, or meet standards defined in literature
Complete Commitment	Documents contain multiple written examples of support sub-hypothesis, or exceed standards defined in literature

Case Study

The most appropriate data collection method for exploration “generally occurs within the context of a case... and the goal is to collect evidence, which would support (or fail to

support) certain expectations about the case” (Shields and Rangarajan 2013, p. 110). By using the case study method, a researcher has the ability to narrow his/her focus which allows for a thorough investigation of the subject. The advantages of the case study are that it emphasizes the use of a variety of evidence (archives, interviews, direct observation, or surveys) and develops a thorough analysis of the subject (Shields and Rangarajan 2013; Yin 2007; Eisenhardt, 1989, p. 534). Typically, case studies provide little scientific generalization and fail to establish causal relationships that are possible through controlled experiments (Yin 2009, p. 14-16). Where this would normally be considered a weakness, the lack of generalization strengthens this study because it is only evaluating San Marcos. This study’s purpose is not to generalize floodplain land use management, only to assess San Marcos’ commitment to certain land use management strategies. The exploratory research methodology is “expressly purposive”, therefore the use of the case study fulfills the purpose of this applied research project (Shields and Rangarajan 2013, p. 114).

The City of San Marcos has been selected as the case because of its recent flooding history, its CDBG – DR award allocation, and its projected future growth. The City is in the unique position of knowing they will experience substantial growth, that the City will suffer flooding again, and that they have additional resources that may allow them to increase their commitment to land use management. Because of these three factors, this study has the potential to significantly impact the floodplain policy choices of the City of San Marcos, which may increase the City’s resiliency and sustainability.

Document Analysis

This study collects data primarily through document analysis. Case studies use “multiple sources of evidence... [such as] interviews, document analysis, archival investigations, client surveys, direct observation, and focus groups” (Shields and Rangarajan 2013, p. 115). A wide range of data collection methods ensure that the study comprehensively and thoroughly reviews all relevant information. Document analysis other advantages include having the capacity to support the working hypotheses on their own and the ability to analyze the sources repeatedly (Ruiz 2010). However, bias selectivity can occur if the analysis of documents is not exhaustive (Ruiz 2010). In addition, a supportive finding in an official city document does not guarantee that the city actually follows their policy. For instance, a city’s code of ordinances may restrict development in a floodplain, but that is meaningless if that policy is not actively pursued and enforced. This study attenuates this weakness by reviewing conceptual plans of four residential developments located near floodplains.

All working hypotheses are tested using evidence from documents. The documents show the City of San Marcos’ formal commitment to using land use management to mitigate flood hazards. The documents used to complete this assessment include the City of San Marcos floodplain regulations, zoning regulations, master plans, CDBG Action Plans, and four conceptual plans of residential developments. All of these documents are available to the public, and the conceptual plans were provided after an open records request was submitted. The documents reviewed in this study are listed and connected to their corresponding working hypotheses in Table 3.3:

Table 3.3: Documents Reviewed

San Marcos Document List	Supported Working Hypotheses
City of San Marcos 2017-2027 Recommended Capital Improvements Plan	2a, 2b, 2c
City of San Marcos CDBG – DR Action Plan	2b
City of San Marcos CDBG – DR Infrastructure Workshop (4/27/17)	2b
City of San Marcos Code of Ordinances Section 39	1b, 2a, 3a, 3b
City of San Marcos Land Development Code Chapter 4	1c
City of San Marcos Land Development Code Chapter 5	1b,1c
City of San Marcos Land Development Code Chapter 7	1a
City of San Marcos Parks, Recreation & Open Space Master Plan	2c
Capstone Collegiate Communities Planned Development District Standards	1a, 1c, 2a
Cottonwood Creek Planned Development District Standards	1a, 2a
San Marcos Greenbelt Alliance’s Website	2c
The Retreat at Willow Creek Planned Development District Standards	1a, 1b, 2c
The Woodlands Planned Development Standards	1a

Description of Projects

To reduce the disconnect that exists between policies defined in official city documents and the actions a city pursues, this study analyzes four conceptual plans and development agreements of residential developments in San Marcos. While official documents define a city’s stance on a policy issue, conceptual plans and development agreements explicitly reveal a city’s commitment to their own policies. The four residential developments analyzed are The Woods Apartments, the Retreat at Willow Creek, Cottonwood Creek, and Capstone Collegiate

Communities. This subsection provides a brief description of each development including the location, the size of the development, and the conceptual plans.

The Woods Apartments

The Woods Apartments, referred to as the “The Woodlands of San Marcos” in the Planned Development District Standards”, resides on an approximately “44.67-acre tract of land” known as “Capes Camp” and “Thompson’s Island” (Ordinance No. 2013.03, The Woods PDD, p. 1). The Project Site is located on “the east side of IH-35, south of River Road, west of Cape Road and north of the San Marcos River” (The Woods PDD 2013, p. 41). The location is significant because it is located on the border of the San Marcos River Corridor within the 100-year floodplain (Source). The Project consists of “multiple-story, multifamily attached residential dwellings”, is restricted to “306 units and 1,000 bedrooms”, and is restricted to “one person per lease per bedroom” (The Woods PDD 2013, p. 41). Figure 3.1 provides the conceptual plan of the Woods Apartments, Figure 3.2 provides the aerial view of the project site, and Figure 3.3 provides the illustrative conceptual plan of the Woods Apartments on the following three pages.

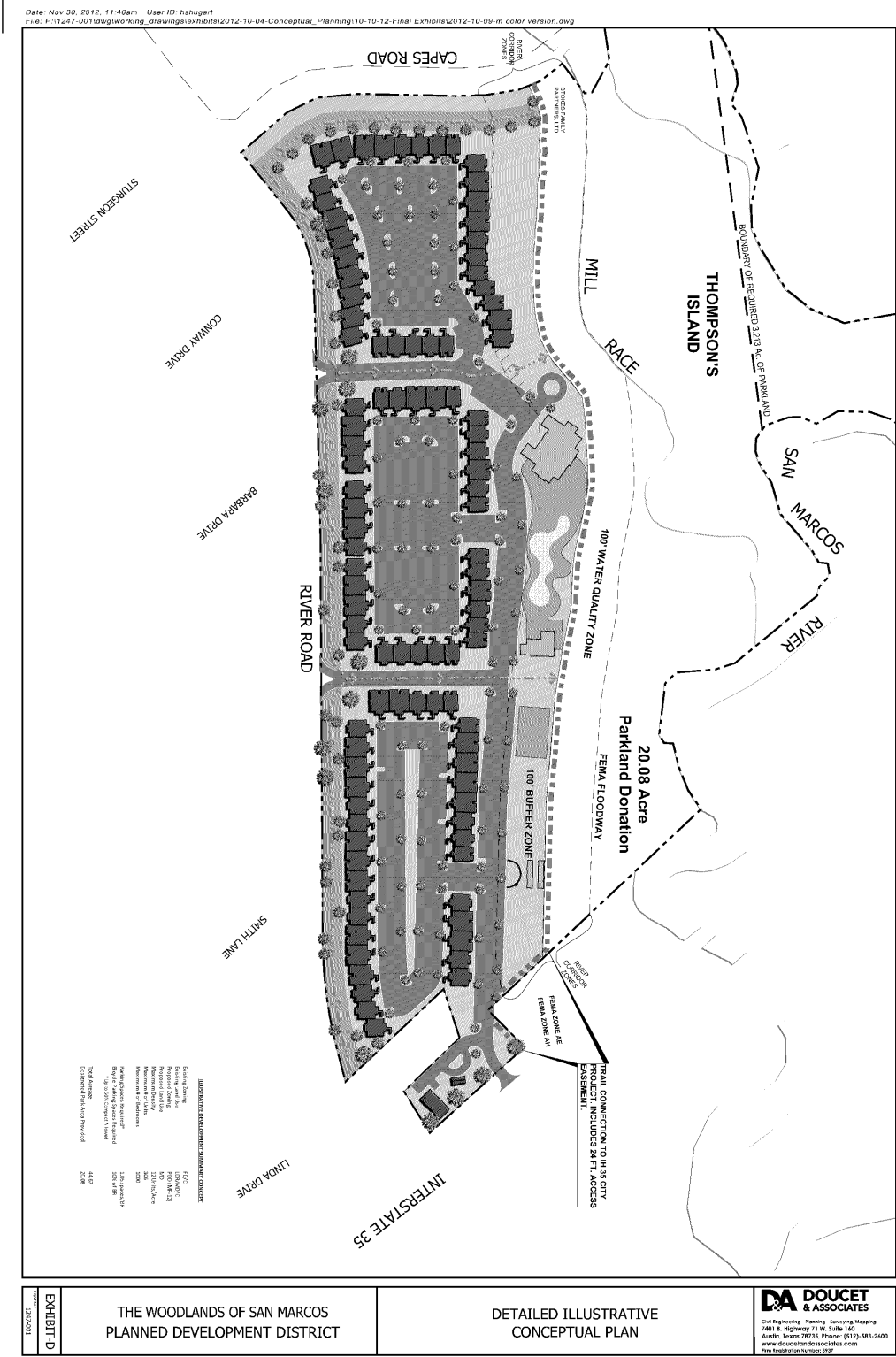
Date: Nov 30, 2012, 11:45am User ID: hshugart
File: P:\1247-001\dwg\working_drawings\exhibits\11-30-2012 PDD MARKUPS\WPP AND PDD 10-03-12.dwg



Figure 3.2: Aerial View of the Woods



Figure 3.3: Woods Illustrative Conceptual Plan



The Retreat at Willow Creek

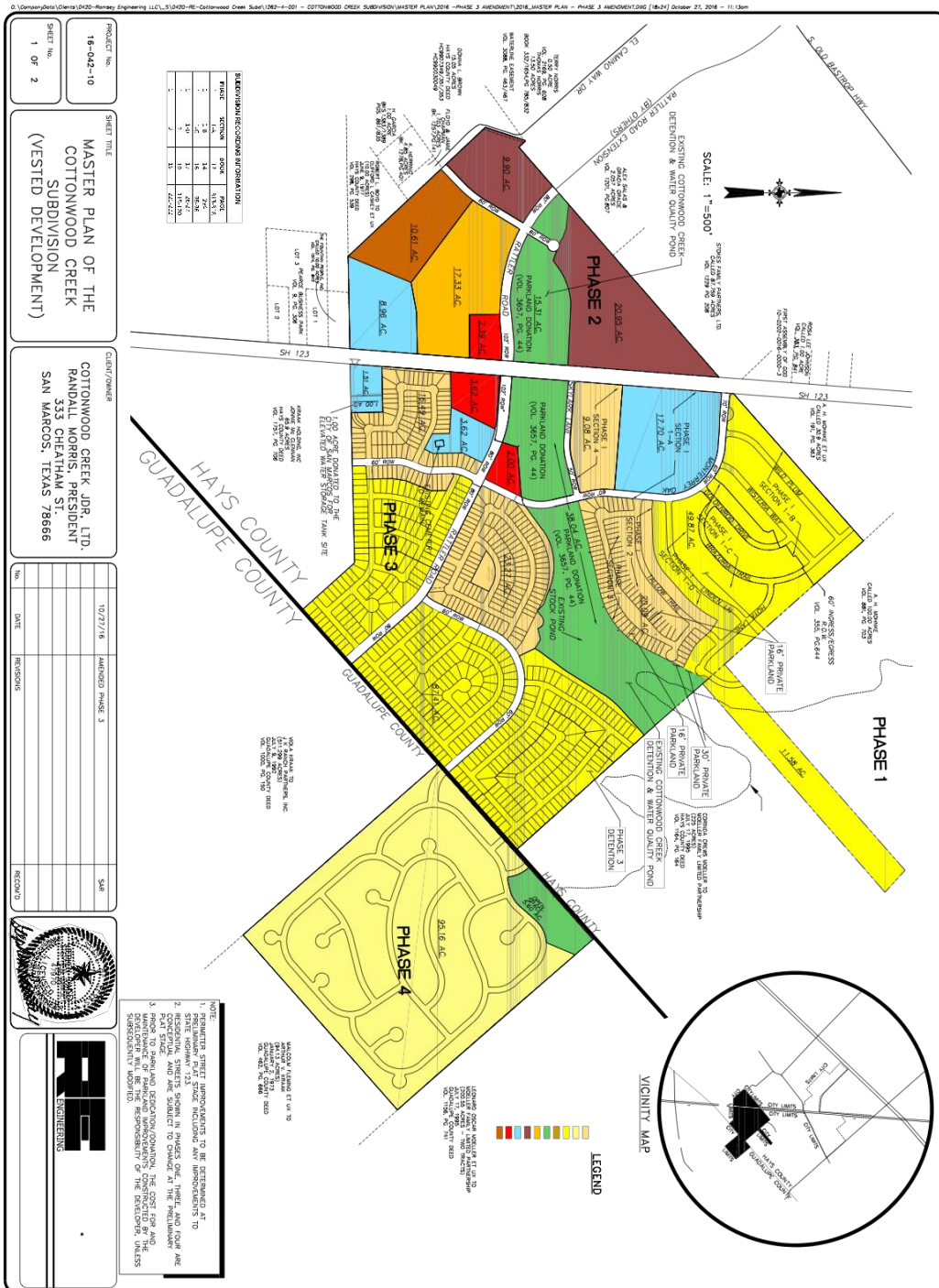
The Retreat on Willow Creek is a primarily single-family residential development on “approximately 101.40 acres of land” located “on the west side of Hunter Road south of Stagecoach Trail and at the terminus of Hunters Hill Drive and Foxtail Run” (Retreat at Willow Creek PDD 2012, p. 13). The subdivision is divided into two phases with a floodplain separating the areas. Figure 3.4 on the following page provides the Revised Conceptual Plan of the Retreat at Willow Creek.

[illegible]

Cottonwood Creek

Cottonwood Creek is a single-family subdivision that was proposed to be developed “over a period of 15 years, through a series of subdivision plats” (Cottonwood Creek PDD 2004, p. 1). The subdivision is located on the eastern side of IH-35 along State Highway 123. The subdivision is divided into three tracts: tract I is “272.24 acres”, tract II is “85.44 acres”, and tract III is “100.71 acres”. Figure 3.5 on the following page provides the conceptual plan for the Cottonwood Creek subdivision.

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Capstone Collegiate Communities

The Capstone Cottages is a student living community developed on “the Buie Tract Property, a 148.774-acre tract of land located along the Craddock Road extension and the confluence of the Wonder World Drive extension” (Capstone DA 2012, p. 2). The property is divided into “459 Lots/Units (based on an overall Project Density of 3 Lots/Units per Acre)” (Capstone DA 2012, p. 2). Figure 3.6 on the following page provides the conceptual plan for Capstone Cottages.

[illegible]

Chapter Summary

This chapter discussed the research methodology used in this study. The operationalization of the conceptual framework was summarized which is the plan the study follows when assessing the City of San Marcos. This chapter then identified the advantages and disadvantages of case studies and completing the assessment through document analysis. Next, the chapter defined the documents that would be used to assess the City of San Marcos' commitment to floodplain land use management. Finally, four development projects called the Woods, the Retreat at Cottonwood Creek, Cottonwood Creek, and Capstone Collegiate Communities were described.

Chapter IV: Results

Chapter Purpose

This applied research project has a dual purpose. The first is to explore the different types of land use management practices that reduce flood hazards. Second, the Association of State Floodplain Manager's (ASFPM) No Adverse Impacts (NAI) program is used to assess the City of San Marcos' commitment to floodplain land use management. This chapter summarizes the results collected from the City of San Marcos case study.

WH1: The City of San Marcos demonstrates commitment to floodplain land use management through floodplain regulations

This study has three sub-hypotheses to assess the City of San Marcos' commitment to floodplain regulations. The first sub-hypothesis assesses the City's commitment to exactions, zoning regulations are analyzed next, and residential cluster regulations are last. Eight out of fourteen documents reviewed include references to exactions, zoning, and residential cluster regulations (see Table 4.2).

Exactions (WH1A)

The City of San Marcos' Land Development Code (LDC) article 7 defines dedication requirements. The City defines dedication requirements for capital improvements, easements, drainage improvements, public facilities, and parkland. City of San Marcos LDC Section 7.6.1.2 (a) states:

"The City of San Marcos has determined that recreational areas in the form of public parks and open spaces are necessary for the well being of the residents of the City. The City has further determined that a reasonable connection exists between the subdivision of residential property and the need for additional parkland to serve new residents of the community. It is the intent of this Section,

therefore, to require a reasonable method for the dedication of public parkland, or the payment of a fee in lieu of property dedication, that is directly related to the need for high quality park land and open space sites for the use and enjoyment of the citizens of San Marcos.”

This clearly defines the City’s intention to require developments of a certain size to dedicate parkland. The code then provides the criteria for how much open land developers are required to donate. All residential subdivisions "shall be required to dedicate suitable land for park or open space development in the amount of five acres per 1,000 ultimate residents of the subdivision” (LDC Section 7.6.1.2(b) provides the following definitions:

- 1) 2.7 residents per single-family dwelling;
- 2) 2.5 residents per townhouse, duplex or condominium unit; and
- 3) 2.1 residents per multifamily residential unit

In order to calculate how much a residential development should dedicate, the LDC Section 7.6.1.2(c) provides the following formula: “5-acres (multiplied by) #units (multiplied by) residents per unit (divided by) 1,000”. For instance, a 500-unit multifamily residential unit would calculate the amount of land they must dedicate with this formula: 5 (multiplied by) 500 (multiplied by) 2.1 (divided by) 1,000 = 5.25-acres of dedicated open space. Additionally, the LDC describes which land is acceptable to be donated as open space. The following criteria applies to land proposed to be dedicated as parkland or open space:

- 1) “At least 50% of the parkland that is required to be dedicated (based on the previously described calculation) shall be acceptable in terms of design, location, etc., for use as an area of active recreation.
- 2) Drainage ditches, detention ponds, power line easements, steep slopes and similar sites shall not be accepted for parkland dedication, unless the Commission finds, after consultation with the Director of Community Services, that the land has exceptional recreational value that warrants its acceptance as parkland or open space.
- 3) The dedication of land within the 100-year floodplain is acceptable, provided the land consists of the native floodplain that is unaltered by channelization or other man-made stormwater control facilities.

- 4) All parkland and open space dedication shall be consistent with the goals, objectives and policies of the City's adopted Park Plan (as amended)."
(LDC 7.6.1.2 [e])

The City allows for a fee in lieu of dedication under certain conditions if a developer is unable to donate property. The LDC Section 7.6.1.2 (f) states: "a cash fee for the purchase of offsite parkland may be paid in lieu of all or part of the dedication of onsite parkland". Fees in lieu of dedication may be accepted if either of the following conditions apply:

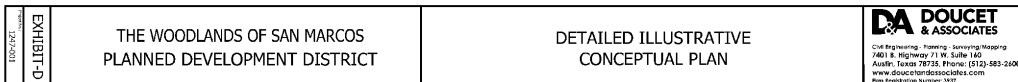
- 1) "If requested by the subdivider, and reviewed by the Director of Community Services, the Planning and Zoning Commission may allow the option of the payment of a fee over the dedication of land within the subdivision; or
- 2) If the Director of Community Services recommends to the Planning and Zoning Commission that land proposed for dedication by the subdivider is either unsuitable for parkland due to its size or general physical characteristics, or the proposed dedication is not consistent with the goals, policies and objectives of the City's adopted Parks Plan, as amended."
(LDC 7.6.1.2 [f])

The City then places the fee in "a separate parkland and open space account. The funds in the account [are] earmarked solely for the acquisition and development of parkland either in the same park benefits area in which the subdivision is located, or for regional parks and open space that will benefit all of the citizens of San Marcos" (LDC 7.6.1.2 [g]). Parkland dedication is defined entirely in the LDC Section 7.6.1.2, but an analysis of the City's subdivision development agreements reveals further information regarding parkland dedication.

The Woodlands of San Marcos (The Woods Apartments) Planned Development District Standards include parkland dedication provisions. Dovetail Developments proposed to build a student living community with a "maximum 306 units and 1,000 bedrooms" in the San Marcos River Corridor along IH-35 and River Road (The Woods PDD 2013, p. 42). Because of the increased need for a public park and its location in the 100-year floodplain, Dovetail

Developments dedicated “approximately 20 acres of land including approximately 10 acres known as Thompson’s Island, all of the area contained within the floodplain as well as the land contained within the Water Quality Zone in accordance with the Watershed Protection Plan” (The Woods PDD 2013, p. 41). Figure 4.1 on the following page provides the conceptual plan for the Woods. The dedicated land is depicted vertically on the right side of the property.

Date: Nov 30, 2012, 11:46am User ID: hshugart
File: P:\1247-001\dwg\working_drawings\exhibits\2012-10-04-Conceptual_Planning\10-10-12-Final Exhibits\2012-10-09-m color version.dwg



The developer also dedicated land for “direct connectivity between the existing Stokes Park City Park on Cape Road and existing City Owned parkland on the west side of IH-35” (The Woods PDD 2013, p. 41). If Dovetail had simply used the City’s parkland dedication formula, the developer would have been required to donate “3.21-acres” of parkland¹³ (The Woods PDD 2013, p. 43). In addition, Dovetail dedicated the following parkland improvements:

- Construction of a pedestrian trail located within the 100-foot Water Quality Zone from the property boundary adjacent to IH 35 east to cape Road.
- Payment of a parkland development fee of a maximum of \$75,000 as contribution for the construction of off-site parking facilities
- Dedication of up to 35 feet of ROW along Cape Road, as necessary, to provide for adequate space for on-street parking
- Construction of 12 spaces of on-street parking located on Cape Road adjacent to the project site
- Striping of a pedestrian crossing across Cape Road to provide a connection from Stokes Park to the above referenced trail
- Installation of a security gate and bollards at trail end on Cape Road to provide for emergency access to dedicated parkland area (The Woods PDD 2013, p. 46).

Dovetail Developments dramatically exceeded the City’s minimum park dedication requirements by 16.79 acres and paid fees of more than \$75,000 for park improvements.

The Retreat at Willow Creek Planned Development District Standards also include parkland dedication provisions. There are three areas within the 101.399-acre tract of land: two areas are developable and the third is “approximately 29.39 acres of” parkland located in the floodplain (The Retreat at Willow Creek PDD 2012, p. 17). Figure 4.2 is provided again to show the conceptual plan of the Retreat at Willow Creek.

¹³ The City’s parkland dedication formula for The Woods: 5 acres (multiplied by) 306 units (multiplied by) 2.1 residents per unit (divided by) 1,000 = 3.21 acres.

[illegible]

If the developer dedicated the minimum parkland acreage, the City would have only received 4.1-acres of parkland¹⁴. The developer dramatically exceeded the minimum dedication requirement by more than twenty-five acres. Further, the developer donated additional “private open space and amenities within the Project Site, construction of a park and emergency access road, a minimum of ten dedicated parking spaces, and a payment of \$23,000 in parkland development funds for the construction of a trail system and playground” (The Retreat at Willow Creek PDD 2012, p. 18).

The City of San Marcos’ land dedication regulations require significantly less land to be dedicated than what is recommended in the literature. Burby’s fixed land donation percentage of 5% is irrelevant to this study because the City bases its land dedication formula off of the number of residents a subdivision will house. Burby 1985 recommends that communities require subdivisions to donate *10.5-acres* for every 1,000 residents which doubles the City of San Marcos’ land dedication requirements. The “fee in lieu of dedication” requirements differ from Burby’s recommended methods because the required fee depends on a “resolution of the City Council” (LDC Section 7.6.1.2 [f]). While the City’s ordinances do not meet the literature’s recommended exaction standards, the City’s practices significantly exceed the literature’s recommended standards. The City required the developers of the Woods Apartments and the Retreat at Willow Creek to donate approximately 16 and 25 more acres than the minimum dedication rate along with thousands of dollars of parkland development fees.

¹⁴ The City’s parkland dedication formula for the Retreat at Willow Creek: 5 acres (multiplied by) 250 units (multiplied by) maximum of 2.7 residents per unit (divided by) 1000 = 4.1 acres.

The substantial parkland dedications do not prove strong commitment because the motive for the dedication is unclear. It cannot be determined through this analysis whether the City's commitment to floodplain land use management caused the large dedication or the developer attempted to sweeten the deal. While the parkland dedications from these two developments are substantial, the motive for the dedication cannot be determined and the City's minimum parkland dedication requirements are significantly less stringent than what is recommended in the literature. Therefore; the City of San Marcos displays **adequate commitment** to exactions as a floodplain land use management strategy.

Zoning Regulations (WH1b)

There are several city documents that assess the City of San Marcos' commitment to mitigating flood hazards through zoning regulations. The City of San Marcos defines their zoning regulations in chapter four of the LDC¹⁵, and environmental zoning provisions are then defined in the following chapter. Section 39 of the City Ordinances discusses flood hazard mitigation strategies through zoning practices. Finally, this study assesses the City's commitment to zoning regulations as a flood mitigation strategy through the analysis of the Retreat at Willow Creek Planned Development District Standards.

The City utilizes flood buffer zones and water quality zones to limit development in the floodplain. Water quality zones are areas immediately surrounding a waterway. For FEMA defined floodways, "a water quality zone shall be established 100 feet in width, measured from the boundary of the defined floodway on each side on the water, but shall not exceed the

¹⁵ Summary of zoning districts is provided in Appendix B.

width of the 100-year floodplain” (LDC Section 5.1.2.2 [a][1]). If the waterway is not defined by FEMA, the water quality zone is either:

- a. 50 feet extending out on each side of the centerline of a minor waterway, 100 feet extending out on each side of the centerline of an intermediate waterway, and 200 feet extending out on each side of the centerline of a major waterway; or
- b. The area of the 100-year floodplain resulting from fully developed conditions in the watershed as calculated and determined by a Texas-licensed engineer, at the developer's option and expense, in accordance with engineering standards acceptable to the Engineering Director.
(LDC Section 5.1.2.2 [a][2])

In water quality zones, “no impervious cover shall be allowed in or transferred to a water quality zone” (LDC Section 5.1.2.4 [a]). Water quality zones keep developments as much as 100 feet away from the floodway, and the City adds an additional buffer to add further protection.

The City defines flood buffer as “the designated area beyond the base flood limits where structures will be subject to elevation requirements to provide the same level of protection as those within the base floodplain” (San Marcos Code of Ordinances Section 39.015). Flood buffer zones exist at any waterway with a FEMA defined floodway and are “100 feet in width, measured from the outer boundary of the water quality zone... on each side of the waterway” (LDC Section 5.1.2.3). If the waterway is within the San Marcos River Corridor, the buffer zone is defined “as all land within a distance of 200 feet from a bank of the river” (LDC Section 5.3.2.2 [b]). Developments in buffer zones are permitted, but there are restrictions on impervious cover such as:

- 1) 30 percent on areas having a slope with a gradient of less than 15 percent;
 - 2) 20 percent on areas having a slope with a gradient of between 15 and 25 percent; or
 - 3) Ten percent on areas having a slope with a gradient greater than 25 percent.
- (LDC Section 5.1.2.4 [a])

In addition, the City requires developments in buffer zones to elevate to the freeboard¹⁶ of “two feet” and “submit an elevation certificate to the city prior to the issuance of a certificate of occupancy” (San Marcos Code of Ordinances Section 39.046.4). These provisions ensure that developments do not encroach too closely to the floodplain and provide limitations on what can be built in the buffer zone.

The City utilized setback requirements for the Retreat on Willow Creek. In single-family subdivisions, setbacks typically create the minimum yard size. Chapter four of the LDC provides minimum requirements for setbacks¹⁷, but there are also minimum setback requirements included in the Planned Development District Standards for the Retreat on Willow Creek such as:

- Minimum Front Yard Setback: 20 feet
- Minimum Side Yard Setback: 5 feet
- Minimum Rear Yard Setback: 20 feet for all lots with the exception of those adjoining the South and West property lines
(Retreat on Willow Creek PDD 2012, p. 16)

There are additional setback requirements for the south and west property lines that border the floodplain. Those provisions include “a 25-foot greenbelt area and a 25-foot building setback from the Greenbelt boundary resulting in an overall building setback of 50 feet from the South and West boundary of the property” (Retreat on Willow Creek PDD 2012, p. 16).

The City uses zoning regulations extensively to mitigate flood hazards through water quality zones, buffer zones, and setbacks. While the City practices many of the same zoning methods defined in the literature, the City determines its buffer zones through a different

¹⁶ Freeboard is a factor of safety usually expressed in feet above a flood level (FEMA 2017b).

¹⁷ Summary of setbacks included in Appendix B.

method. The literature recommends a fixed setback of 50 feet from the *floodplain*, but the City has a fixed setback from the *waterway*. This causes the City's setback requirements to be less stringent than what the literature recommends. On the other hand, the City did show complete commitment with the setback requirements in the Retreat on Willow Creek with a 50-foot setback. Even though the City's zoning regulations are less strict than the literature's recommendations, the City showed strong commitment to zoning regulations as a flood mitigation strategy in the Retreat at Willow Creek PDD. Therefore; the City of San Marcos displays **adequate commitment** to zoning regulations as a floodplain land use management strategy.

Residential Cluster Regulations (WH1c)

There are several provisions defining residential cluster regulations throughout the Land Development Code. The City establishes the importance of clustering by saying, "Clustering of residential density shall be allowed... and transfer of impervious cover for nonresidential uses shall be allowed" (LDC Section 5.1.2.5 [a][1]). The LDC strongly outlines the City's commitment to using clustering regulations to mitigate flood hazards. Environmental concerns are the primary reasons the City provides for justifying the use of clustering regulations. The major clustering provisions in the LDC are summarized.

To make sure that development is being transferred to appropriate locations, the City created the Development Transfer (DT) District which allows:

"the transfer of residential density or impervious cover from a site that is to be in whole or in part restricted to permanent open space (granting site) to a different site on which the density or impervious cover can be utilized pursuant to an

integrated development design (receiving site)” (LDC Section 4.2.7.1 [a]).

There are two districts that make up DTs: Development Transfer Granting (DTG) Districts and Development Transfer Receiving (DTR) Districts. DTG’s are the districts that donate density or impervious cover due to a need to keep that area preserved because the land is “in a natural state, part of which is located over the Edwards Aquifer or contains watershed protection zones, buffer zones, floodplain or other environmentally significant natural features” (LDC 4.2.7.1 [b]). DTR’s do not contain environmentally significant resources and are thus allowed to receive land from DTG’s. However, “no DTG district may be established without a corresponding receiving site, and no DTR district may be established without a corresponding granting site” (LDC 4.2.7.2 [a]). The two Development Transfer districts ensure the transfer of density or impervious cover is occurring in appropriate areas.

The City employs limitations on the number of dwelling units that may be transferred from a granting site to a receiving site. The City calculates the maximum number of dwelling units which may transferred from the granting site by “multiplying the density associated with the base zoning district by the number of gross acres in the DTG district” (LDC Section 4.2.7.3 [b]). Table 4.1 provides each base zoning district and the density that can be transferred.

Table 4.1: Allowable Density Transfers

Base Zoning District	Density Transferred (units per acre)
MF-24	24
MF-18	18
MF-12	12
TH	12
D and DR	6
SF-4.5	7.5
SF-6	5.5
SF-11	3
SF-R	0.8

(LDC 4.2.7.3 [b])

Similarly, the City limits the number of dwelling units that may be developed on the receiving site to “50% of the residential density associated with the base zoning district multiplied by the number of gross acres included in the DTR district” (LDC 4.2.7.3[c]). An example of this would be: [12 units per acre] + [12 units per acre X 50%] = 18 units per acre. Additionally, the City provides the following formula to calculate the maximum number of residential units that can be attained:

$$\begin{aligned}
 & \text{[Gross non-restricted site area]} \\
 & \quad \text{multiplied by} \\
 & \quad \{ \text{The number of units allowed under the applicable zoning district in accordance with Table} \\
 & \quad \quad \text{4.1.6.1}^{18} \} \\
 & \quad \text{multiplied by} \\
 & \quad \{ 1.25 \}
 \end{aligned}$$

(LDC Section 5.1.2.5 [a][2])

This formula represents a density bonus to incentivize developers to utilize clustering. The formula multiplies the site area by the number units by 1.25 which creates a 25% increase in the number of units that can be developed. LDC Sections 4.2.7.3(b-c) and 5.1.2.5(a)(2) control

¹⁸ Dimensional and Development Standards Table provided in Appendix B.

the number of units that can be transferred.

The City provides additional clustering incentives when a site is located in a floodplain or other environmentally sensitive area. To further incentivize developers to move units out of the floodplains, the City offers an “allowance for impervious cover... for a site located in the recharge zone [which] may be transferred in the form of a residential unit bonus to a receiving site inside the City Limits” (LDC 5.2.8.2 [a][1]). Developers may construct two single family homes, duplexes, or townhouses, or three apartment units “for each 5,000 square feet of impervious cover that could be legally constructed in the sending site” (LDC Section 5.2.8.2 [a][1]). The City’s cluster regulations exceed the recommendations in the literature. Therefore; the City of San Marcos displays **complete commitment** to residential cluster regulations as a floodplain land use management strategy.

Summary of Findings (WH1)

The analysis of documents reveals that the City of San Marcos displays adequate to complete commitment to floodplain land use management through floodplain regulations. The analysis of exactions and zoning regulations demonstrated adequate commitment, residential cluster regulations exhibited complete commitment. Table 4.2 summarizes the findings for working hypothesis 1.

Table 4.2: Results for WH1

WH1: San Marcos demonstrates commitment through floodplain regulations	
Finding	Level of Commitment
WH1a: Exactions	
Case study revealed the City’s development agreements significantly exceed the recommendations in the literature, but the City’s policies fail to meet those same standards.	Adequate Commitment
WH1b: Zoning Regulations	
Case study showed the City’s development agreements meet the recommendations in the literature, but the City’s policies fail to meet those same standards.	Adequate Commitment
WH1c: Residential Cluster Regulations	
Case study displayed the City’s development agreements and policies significantly and consistently exceed the recommendations in the literature.	Complete Commitment

WH2: The City of San Marcos demonstrates commitment to floodplain land use management through planning decisions

This study has three sub-hypotheses to assess the City of San Marcos’ commitment to floodplain land use management through planning decisions. The first sub-hypothesis assesses the City’s commitment to building capital improvements outside of the floodplain, public acquisition/relocation is analyzed next, and greenways are last. Ten out of fourteen documents reviewed include references to capital improvements, public acquisition/relocation/ and greenways (see Table 4.3).

Capital Improvements (WH2a)

The City’s planned capital improvements are listed in the 2017-2026 Recommended Capital Improvements Plan and in Chapter 39 of the Code of Ordinances. The City requires construction of new critical facilities to be:

“located outside the limits of the SFHA, preferably outside the 0.2% annual chance floodplain. Construction of new critical facilities may be permissible within the SFHA if feasible alternative sites are unavailable. Critical facilities constructed within the

SFHA shall have the lowest floor elevated 3.0 feet above the base flood elevation at the site. Flood proofing and sealing measures must be taken to ensure that toxic substances will not be displaced by or released into floodwaters. Access routes elevated to or above the level of the base flood elevation shall be provided to all critical facilities to the maximum extent possible” (Code of Ordinances Section 39.047).

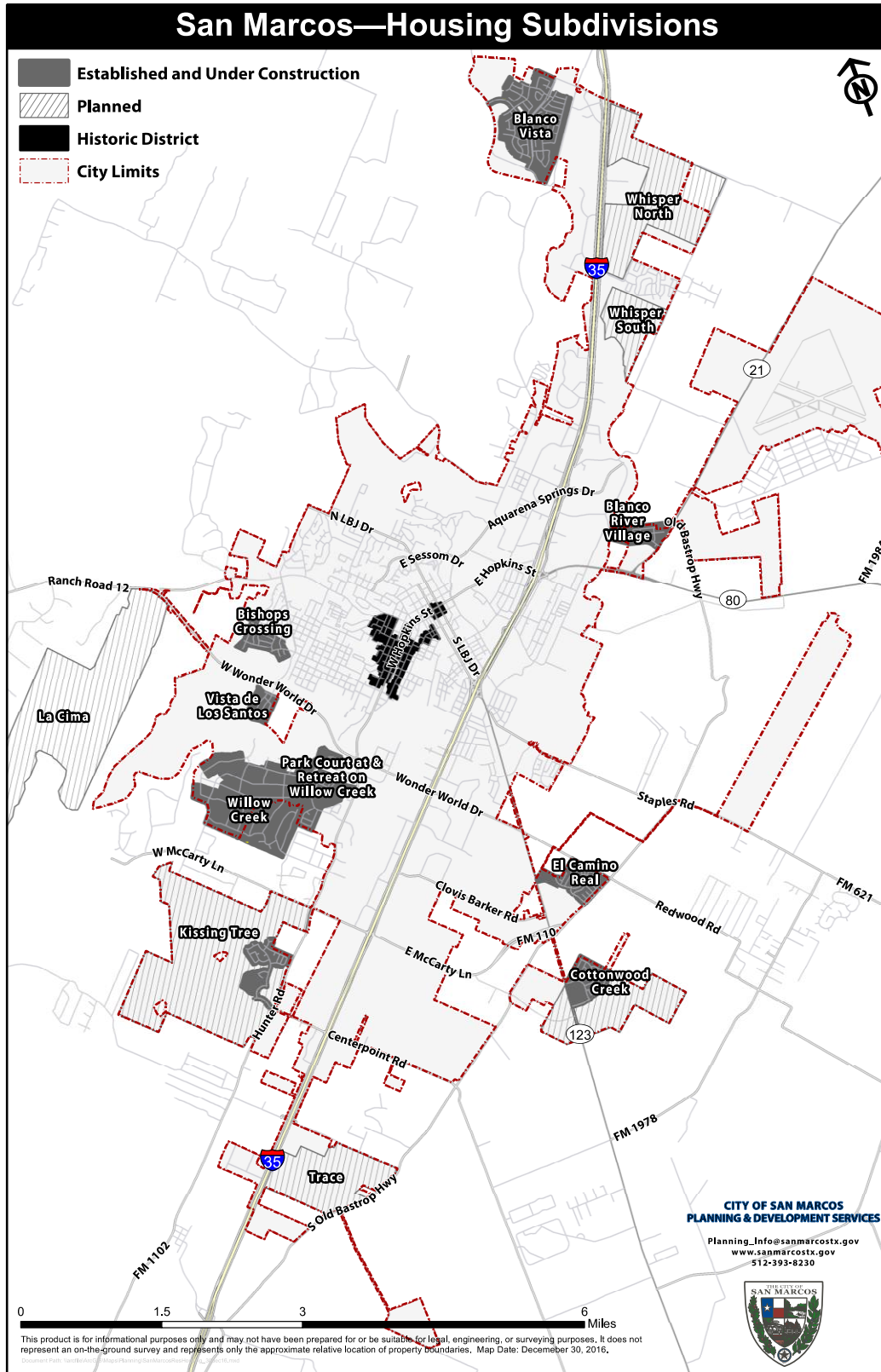
Although the City states that new critical facilities should be constructed outside of the floodplain, it creates a loophole that allows development of critical facilities to occur within the 100-year floodplain. In addition, the City is weakly committed to constructing critical facilities outside of the 500-year floodplain because the only reference in that ordinance reads that new critical facilities be constructed “preferably outside of the .2% annual chance floodplain” (Code of Ordinances Section 39.047). This ordinance fails to meet the recommendations in the literature of prohibiting capital improvements in the 100-year floodplain. The literature suggests that critical facilities be limited in the 500-year floodplain, so the City meets that standard.

The City’s 2017-2026 Recommended Capital Improvements Plan lists all of the City’s proposed capital improvement proposals for the next ten years. The proposals include routine maintenance, drainage projects, maintenance of critical facilities, and new construction. Most of the proposed projects simply maintain existing infrastructure, but the City does propose to expand and relocate Municipal Services Complexes¹⁹. This plan includes an expansion of current facilities at City Hall and relocates all public services (SMEU, PS, Fleet, Parks) to a new location. This plan could represent an important step for the City in beginning to move development away from floodplains.

¹⁹ Picture provided in Appendix C.

While the City may not have proposed capital improvement projects outside of the floodplain, the City does have multiple subdivisions that will be built outside of the floodplain. The City proposes to build the subdivision Trace completely outside of the floodplain, and the subdivisions La Cima, Kissing Tree, and Cottonwood Creek will have very little land located in the floodplain. On the other hand, the subdivisions Whisper North and Whisper South will be located almost entirely within the floodplain. The locations of the City's proposed subdivisions demonstrate some commitment to moving developments away from floodplains, but the locations of Whisper North and Whisper South damage the City's commitment. Figure 4.3 provides a map of the existing and proposed subdivisions in San Marcos.

Figure 4.3: San Marcos Housing Subdivisions Map



The literature discusses how capital improvements to mitigate flood hazards are ineffective in some communities, and this is certainly the case for San Marcos. Capital improvements could be utilized as a flood mitigation method for newer communities which are planning their development, but San Marcos is deeply established in their location and moving the focal point of the city away from floodplains would be astronomically expensive. Therefore, the City does not show strong commitment to capital improvements as a strategy for mitigating flood hazards. This is understandable and should not be interpreted as a weak commitment to floodplain land use management because relocating public facilities is not a practical strategy for the City to pursue. The City's Code of Ordinances do not prohibit capital improvements to be constructed in the 100-year floodplain, but the City may move some of their public facilities to a location that is outside of the floodplain. Additionally, the City has subdivision proposals that are located outside of the floodplain. Therefore, the City of San Marcos displays **limited commitment** to capital improvements as a floodplain land use management strategy.

Public Acquisition/Relocation (WH2b)

Public Acquisition/Relocation is another method not heavily used by the City of San Marcos because the City received large amounts of parkland from developments such as the Woods (20 acres), the Retreat at Willow Creek (29.39 acres), Capstone Cottages (94 acres), and Cottonwood Creek (67 acres). The City does not need to purchase additional land to use as open space because land has been dedicated from subdivisions. Even with the dedicated parkland, the 2016-2027 Recommended Capital Improvements Plan lists projects that require the acquisition of property and the City may buyout properties near the Blanco River using CDBG – DR funds.

While there are projects listed in the 2016-2027 Recommended Capital Improvements Plan that require acquisition, the City does not intend to maintain any of the acquired land as open space. For instance, the City proposes to acquire property near downtown San Marcos to construct additional parking. Downtown San Marcos has a shortage of parking spots, so the City will spend \$750,000 to acquire property for additional parking²⁰. This project appears to go in the opposite direction recommended by the literature. The City plans to acquire property near a floodplain and convert it into a parking lot which will likely be impervious cover. This will increase the speed of runoff and decrease the area's natural storage abilities. The City must carefully consider the location of this parking lot due to its proximity to a floodplain.

The City may acquire flood damaged property near the Blanco River using CDBG – DR funds. The Action Plan for Disaster Recovery states:

“The City has done an initial buyout assessment considering properties that had repetitive flooding along with substantial damage assessments. There are LMI [Low-Moderate Income] areas that are adjacent to the Blanco River and existing parkland that may be pursued for buyouts with these HUD funds and Hazard Mitigation Grant sources” (City of San Marcos 2017c, p. 24).

There are two sides of the CDBG – DR rehabilitation program: housing and infrastructure. Originally, housing was responsible for purchasing flood damaged property to be converted to greenspace. This was problematic because housing could only purchase properties if the owners indicated they wanted their home to be bought out. This would have caused the City to own single plots located sporadically throughout San Marcos, and the plots would not have been large enough to be converted to greenspace. Because of this, housing transferred the buyout responsibilities to infrastructure. The infrastructure

²⁰ Summary of proposal provided in Appendix C.

side acquires property through eminent domain and justifies the purchase because of necessary flood protection projects. The properties the City may purchase are located on the east side of Blanco Gardens at Harper Drive and River Road. The City plans to demolish the homes on those properties to construct a dyke to mitigate the 25-year flood. The City will build the dyke close to the Blanco River and leave the rest of the acquired property in its natural state²¹. In addition, the City plans to construct a paved trail on the dyke²².

Public acquisition/relocation is not utilized extensively as a flood mitigation strategy in San Marcos. This is partially due to the City obtaining dedicated land from developments such as the Woods, the Retreat at Willow Creek, Capstone Cottages, and Cottonwood Creek. Land dedication mostly eliminates the need to acquire additional land. The acquisition of property to be used as a parking lot is concerning because it is likely to increase runoff. This proposal suggests that the City is less committed to floodplain land use management than the literature recommends. However, the City's plan to acquire property for dyke construction and to maintain as open space represents a strong commitment to floodplain land use management. Therefore, the City of San Marcos displays **adequate commitment** to public acquisition/ relocation as a floodplain land use management strategy.

²¹ Disclaimer: The infrastructure project is still in its planning phase meaning that the acquisition plan may change.

²² Slides for proposal are provided in Appendix C.

Greenways (WH2c)

The City of San Marcos has a reputation for its expansive park system which is documented in detail in the *Parks, Recreation & Open Space Master Plan*, the San Marcos Greenbelt Alliance's (SMGA) website, and 2016-2017 Recommended Capital Improvements Plan. In addition, the City shows clear commitment in utilizing greenways in subdivisions such as the Retreat at Willow Creek. There is extensive evidence of the City's commitment to use greenways to enrich San Marcos as well as mitigate flood hazards.

The City of San Marcos' Parks and Recreation Department describes the park system in the *Recreation & Open Space Master Plan*. The City classifies its parks as neighborhood, regional, and as greenspace. Greenspace should be provided "at an average of 5-10 acres per 1,000 people served" (SM Parks and Rec 2010, p. 65). The City of San Marcos significantly exceeds this average with "approximately 26 acres per 1,000 people" with over 1,420 acres of greenspace (SM Parks and Rec 2010, p. 65). In addition, the City is "continually obtaining natural area, and also maintains property along existing portions of the San Marcos and Blanco Rivers" (SM Parks and Rec 2010, p. 67). The City utilizes greenways to connect the greenspaces, and the City classifies greenways into two groups: "those that follow waterways, and those that serve as connective corridors" (SM Parks and Rec 2010, p. 67). Waterway greenbelts are constructed along the City's rivers and in the floodplain, and they occupy the most acreage out of the City's greenspaces (SM Parks and Rec 2010)²³.

The San Marcos Greenbelt Alliance (SMGA) is a 501(c)(3) and partner of the City of San Marcos that works to "protect the quality of life for the people of San Marcos through the

²³ Maps of the City's greenspaces and greenways are provided in Appendix A.

creation of interconnected parks and natural areas (SM Greenbelt Alliance 2017, p. 1). The SMGA works to protect greenspaces through conservation, stewardship, and outreach/education, and envisions San Marcos with a “network of greenways and trails” to reduce “the impact of severe flooding” (SM Greenbelt Alliance 2017, p. 2). SMGA also created the ideal greenway vision for the City of San Marcos called the Loop and Check²⁴.

On a more localized scale, the developers of the Retreat at Willow Creek created a waterway greenway in their subdivision. The developers conserved space in the dedicated 29.39-acre tract of land located in the floodplain for a greenway. This area included “preserved trees, mitigated trees, and stormwater management features... with a goal to preserve the greenbelt as a mostly natural vegetative area” (Retreat at Willow Creek PDD 2012, p. 16). The preserved land provides protection from floods by keeping development away from the floodplain and by increasing the storage the floodplain’s storage capacity.

The City of San Marcos is committed to greenways for many reasons. They are a tourist attraction, increase the aesthetic value of the City, preserve natural ecosystems, and provide flood protection. *The Parks, Recreation & Open Space Master Plan* describes the City’s intentions for the growth of its park system, and it is clear that further development of greenways is a priority. In addition, the City partners with non-profits such as the San Marcos Greenbelt Alliance to provide further protection to greenways. The City demonstrates significant commitment to greenways by working with a non-profit that focuses on greenway development and preservation. Greenways are also being utilized in subdivisions such as the Retreat at Willow Creek. There is strong commitment to greenways in each of these sources.

²⁴ Loop and Check map located in Appendix A.

Therefore, the City of San Marcos displays **complete commitment** to greenways as a floodplain land use management strategy.

Summary of Findings (WH2)

The analysis of documents reveals that the City of San Marcos displays limited to complete commitment to floodplain land use management through planning decisions. The analysis of capital improvements yielded limited commitment, public acquisition/relocation established adequate commitment, and greenways exhibited complete commitment. Table 4.3 summarizes the findings for working hypothesis 2.

Table 4.3: Results for WH2

WH2: San Marcos demonstrates commitment through planning decisions	
Finding	Level of Commitment
WH2a: Capital Improvements	
Case study revealed the City's Recommended Capital Improvements Plan does not include major improvements located outside of the floodplain, but the City has shown some commitment by locating subdivisions outside of the floodplain.	Limited Commitment
WH2b: Public Acquisition/Relocation	
Case study showed the City's acquisition proposal for a parking lot is contradictory to the literature's recommendations, but the CDBG – DR acquisition proposal for a trail meets the literature's recommendations.	Adequate Commitment
WH2c: Greenways	
Case study of the City's Parks Master Plan, partnerships with non-profits, and development agreements significantly and consistently exceed the recommendations in the literature.	Complete Commitment

WH3: The City of San Marcos demonstrates commitment to floodplain land use management through development standards

This study has three sub-hypotheses to assess the City of San Marcos' commitment to floodplain floodplain land use management through planning decisions. The first sub-hypothesis assesses the City's commitment to building capital improvements outside of the

floodplain, public acquisition/relocation is analyzed next, and greenways are last. One out of fourteen documents reviewed include references to capital improvements, public acquisition/relocation/ and greenways (see Table 4.4).

Base Flood Elevations (WH3a)

Chapter 39 of the San Marcos City Code of Ordinances defines elevation requirements for structures in and near the floodplain. For structures built in AE and AH zones²⁵, all new construction of residential structures must “have the lowest floor (including basement) elevated to two-feet above the base flood elevation” (Code of Ordinances Section 39.043 [2][a]). For structures located in AO zones, the lowest floor must be “elevated above the highest adjacent grade at least as high as the depth number specified in feet on the FIRM (at least two feet if no depth number is specified)” (Code of Ordinances Section 39.043 [2][b]). For residential structures built in approximate A zones, the lowest floor must be elevated “to three feet above the highest adjacent grade²⁶, (or two feet above the highest crown of the adjacent roadway)” (Code of Ordinances Section 39.042 [1]). Additionally, the City requires additions to existing structures in the floodplain to be held to full compliance with the BFE requirements in chapter 39. The City exceeds the NFIP’s minimum standard of elevating structures in the floodplain to the BFE. Therefore, the City of San Marcos displays **complete commitment** to base flood elevations as a floodplain land use management strategy.

²⁵ See Appendix E for descriptions of each flood zone.

²⁶ Highest Adjacent Grade: “The highest natural elevation of the ground surface prior to construction next to the proposed walls of a structure” (FEMA 2017a).

Elevation Methods (WH3b)

The methods for elevating structures above the BFE are also outlined in chapter 39 of the San Marcos City Code of Ordinances. The City provides fill standards and regulations to control filling or other earthwork “which may increase stormwater runoff, change drainage patterns, or otherwise increase flood hazards” (Code of Ordinances Section 39.048 [9]). In addition, the use of fill within the floodplain is “prohibited unless it has been demonstrated through hydrologic and hydraulic analyses performed in accordance with standard engineering practice that the proposed encroachment would not result in any increase in flood levels” (Code of Ordinances Section 39.043 [b][9]). The ordinance continues by saying that fill would be permitted when if it would cause an increase in water surface elevation if:

- a) The property owner owns both sides of the floodplain to the extent of the increase in water surface elevation; and
 - b) The increase in the regulatory floodplain is contained in a dedicated drainage easement or right-of-way; and
 - c) The increase in water surface elevation for the 1% annual chance flood does not exceed six inches
- (Code of Ordinances Section 39.043 [b] [9] [a-c]).

The City clearly discourages the use of fill in the 100-year floodplain but provides loop holes that permit its use. In order to alleviate the adverse effects of filling in the floodplain, the City requires the following:

The volume of the loss of floodwater storage due to filling in the special flood hazard area shall be offset by providing an equal volume of flood storage by excavation or other compensatory measures at or adjacent to the development site. (Code of Ordinances Section 39.049.2)

While the City limits the use of fill and requires natural floodplain storage to be replaced, the City’s ordinances have provisions that allow for fill to occur in the floodplain.

Despite this fact, the City shows stronger commitment to encouraging limited enclosure methods beginning with their definition of an elevated building which is “a non-basement building built to have the lowest floor elevated above the ground level by foundation walls, shear walls, posts, piers, pilings, or columns” (Code of Ordinances Section 39.015). The City’s regulations on limited enclosures are nearly identical to the NFIP’s minimum standards. For all new construction or substantial improvements:

- 4) Fully enclosed areas below the lowest floor elevation may be usable solely for parking of **vehicles, building access, or storage**. These enclosed areas must be designed and constructed to allow for the entry and exit of floodwaters to automatically equalize hydrostatic flood forces on exterior walls.
 - a) Designs for meeting this requirement must be certified by a professional engineer or architect, to meet or exceed the following minimum criteria:
 - i. A minimum of two openings having a total net area of not less than one square inch for every square foot of enclosed area subject to flooding must be provided;
 - ii. The bottom of all openings must be no higher than one foot above grade; and
 - iii. Openings may be equipped with screens, louvers, valves, or other coverings or devices provided they provide the required net area of the openings and permit the automatic entry and exit of floodwaters.
 - b) Access to the enclosed area must be the minimum necessary to allow for parking of vehicles (garage door) or limited storage of maintenance equipment used in connection with the premises (standard exterior door) or entry to the living area (stairway or elevator); and
 - c) The interior portion of the enclosed areas may not be partitioned, temperature-controlled, or finished into separate rooms.(Code of Ordinances Section 39.043 [a][a-c])

The City meets the NFIP’s requirement that the enclosures can only be used for parking of vehicles, building access, or storage. The City also matches the NFIP on opening standards in enclosures by requiring a minimum of two openings with a net area of not less than one square inch for every square foot of enclosed area, by requiring the bottoms of openings to be no higher than one foot above grade, and by allowing the openings to be equipped with screens.

The City encourages citizens to utilize limited enclosure methods over fill and requires compensatory storage when fill is used. The City prohibits fill from being used in the floodplain but provides some exceptions for when it could be acceptable. The City's limited enclosure policy is identical to the NFIP's. Because of these findings, this study finds that the City of San Marcos displays **adequate commitment** to use encouraging limited enclosures over fill.

Summary of Findings (WH3)

The analysis of documents reveals that the City of San Marcos displays adequate to complete commitment to floodplain land use management through elevation standards. The analysis of Base Flood Elevations revealed complete commitment, and elevation methods exhibited adequate commitment. Table 4.4 summarizes the findings for working hypothesis 3.

Table 4.4: Results for WH3

WH1: San Marcos demonstrates commitment through elevation standards	
Finding	Level of Commitment
WH3a: Base Flood Elevation	
Case study revealed the City's Code of Ordinances significantly and consistently exceed the recommendations in the literature.	Complete Commitment
WH3b: Elevation Methods	
Case study showed the City's Code of Ordinances encourage the use of limited enclosures over fill, but the City allows the use of fill in the floodplain in certain situations.	Adequate Commitment

Chapter Summary

This chapter provided the results of the case study of the City of San Marcos, Texas. The study's primary source of evidence was the analysis of documents. The overall results ranged from limited-to-complete levels of commitment for all three floodplain land use management strategies. WH1 received scores of adequate-to-complete commitment, WH2 revealed limited,

adequate, and complete commitment, and WH3 demonstrated adequate and complete commitment. The following chapter provides recommendations and conclusions based on these results.

Chapter V: Recommendations and Conclusions

Chapter Purpose

This applied research project had a dual purpose. The first purpose explored the different types of land use management practices that reduce flood hazards. Then, the Association of State Floodplain Manager's No Adverse Impacts program assessed the City of San Marcos' commitment to floodplain land use management. This chapter provides recommendations and conclusions based on the case study of the City of San Marcos.

Recommendations

A case study assessed the City of San Marcos' commitment to floodplain regulations, planning decisions, and elevation regulations. Table 5.1 summarizes the results and provides recommendations.

Floodplain regulations

The City of San Marcos demonstrates adequate-to-complete commitment to floodplain land use management through floodplain regulations. Regulations on exactions, zoning, and residential clusters verify the City's commitment to floodplain land use management. The City's floodplain regulations exceed the recommendations from the literature in many cases, but there is room for improvement. The primary recommendation is for the City to increase its minimum land dedication regulations to 7 acres per 1,000 residents. The City attracts developers and therefore has the ability to ask for a little more from them. This also is a compromise between the current policy of 5 acres per 1,000 residents and the literature's recommended policy of 10.5 acres per 1,000 residents. Additionally, the City should push developers to donate land located in the floodplain.

Planning Decisions

The City of San Marcos displays limited, adequate, and complete commitment to floodplain land use management through planning decisions. Decisions on capital improvements, public acquisition, and greenways reveal the City's Commitment to floodplain land use management. The City's greenway and public acquisition plans meet the recommendations from the literature, but capital improvements fall short. This is not a reflection on the City's commitment, however, because this strategy requires an excessive amount of resources. Even if the City dedicated the infinite sums of money required to pursue this strategy, the City would essentially have to relocate itself because there are three streams surrounding the City. This strategy would be better suited for younger communities that are not completely established in a floodplain. Using capital improvements to mitigate flood hazards is not practical for the City of San Marcos, therefore this study recommends the City continue its current decision making practices.

Elevation Regulations

The City of San Marcos exemplified adequate and complete commitment to floodplain land use management through elevation standards. Standards on base flood elevations and the preference for limited enclosures over fill show the City's commitment to floodplain land use management. The City is completely committed to base flood elevations and adequately committed to promoting limited enclosures over fill. There are extenuating circumstances when the use of fill in the floodplain is the best option, but it harms other members of the community. This study recommends that the City update its ordinances to emphasize how

extreme the situation must be in order for the City to consider allowing fill to be used in the floodplain.

Table 5.1: Findings and Recommendations

City of San Marcos Case Study Summary		
Working Hypotheses	Evidence	Findings/Recommendations
WH1: The City of San Marcos demonstrates commitment through floodplain regulations		
WH1a: The City demonstrates commitment through exactions	Adequate Commitment	Findings: The City of San Marcos demonstrates adequate commitment to floodplain land use management through exactions. The City's minimum dedication requirements are less than the literature's recommendation, but the City has received substantial dedications from developers.
		Recommendation: The primary recommendation is for the City to increase its minimum land dedication regulation to at 7 acres per 1,000 residents. Additionally, the City should push developers to donate land that is located in the floodplain.
WH1b: The City demonstrates commitment through zoning regulations	Adequate Commitment	Findings: The City of San Marcos demonstrates adequate commitment to floodplain land use management through zoning regulations. The City's floodplain setback requirements are less stringent than the literature's recommendations, but floodplain setbacks are used in the residential developments such as the Retreat at Willow Creek
		Recommendation: Institute fixed floodplain setbacks that are 50 feet from the floodplain rather than the waterway.
WH1c: The City demonstrates commitment through residential cluster regulations	Complete Commitment	Findings: The San Marcos case study offers a substantial commitment to residential cluster regulations
		Recommendation: Continue the City's current residential cluster policy.

WH2: The City of San Marcos demonstrates commitment through planning decisions		
WH2a: The City demonstrates commitment through capital improvements	Limited Commitment	Findings: The San Marcos case study reveals limited commitment to capital improvements. The City shows some support by planning to move public facilities to a new location.
		Recommendation: Manipulating development out of the floodplain through capital improvements is not a practical strategy for San Marcos. When new capital improvements are proposed, the City should consider locating them outside of the 100 and 500-year floodplain.
WH2b: The City demonstrates commitment through public acquisition/relocation	Adequate Commitment	Findings: The San Marcos case study reveals adequate commitment to public acquisition/relocation. The CDBG – DR infrastructure plan exhibits commitment through the proposed acquisition of property in the floodplain. However, there is also a proposal to acquire land near the floodplain to be used as a parking lot.
		Recommendation: The City should consider acquiring property for parking facilities in a location that will not have adverse flood impacts.
WH2c: The City demonstrates commitment through greenways	Complete Commitment	Findings: The San Marcos case study shows complete commitment to greenways as a flood mitigation strategy. The Parks and Rec Master Plan, the City’s partnership with the non-profit SMGA, and the implementation of greenways in subdivisions represent complete commitment.
		Recommendation: Continue current greenway policy

WH3: The City of San Marcos demonstrates commitment through elevation standards		
WH3a: The City demonstrates commitment through Base Flood Elevations	Complete Commitment	Findings: The City is completely committed to base flood elevations by requiring structures in the floodplain to be elevated two feet above the base flood elevation.
		Recommendation: Continue current base flood elevation policy.
WH3b: The City demonstrates commitment by encouraging limited enclosures to fill	Adequate Commitment	Findings: The City is adequately committed to encouraging limited enclosures to fill by matching the NFIP's standards. The City's commitment is diminished because there are loopholes that allow fill to be used in the floodplain
		Recommendation: Emphasize in the City Ordinances that fill is used in the 100-year floodplain is the City's last resort

Limitations

There are three primary limitations to this study: the documents analyzed in this study are susceptible to selectivity bias, San Marcos does not use some of the assessment criteria because some of the criteria does not fit the City's needs, and this study does not fully address the disconnect that exists between city policies defined in documents and actual city practices. These limitations must be carefully considered when analyzing the results of this study.

The documents are susceptible to selectivity bias because this study did not exhaust all of the possible relevant documents. The City continually updates its policies, and some of the conceptual plans and development agreements of proposed developments were unavailable. Additionally, the City changed various aspects of the CDBG – DR housing rehabilitation program throughout this study, so the sections that discuss the CDBG – DR program may be out of date. The results of this study should be considered with caution partially because additional documents may exist that should have been used.

Some of the criteria used to assess San Marcos revealed limited commitment because it did not fit the needs of the City. For example, the case study of San Marcos showed that the City displayed limited commitment to capital improvements as a flood mitigation strategy. Using capital improvements to move development out of the floodplain is better suited for younger communities who are not quite established. The City of San Marcos is certainly established, and most of the surrounding area is in at least the 500-year floodplain. This is not a practical option for the City to pursue and is therefore not utilized by the City. The lack of commitment to capital improvements does not reflect the City's commitment to floodplain land use management. This study should have first identified the City's primary floodplain land use management strategies and then created the criteria to assess its commitment.

This study does not fully address the disconnect between the City's policies and its practices because only documents are analyzed. While the City's policies exhibit fairly strong commitment to floodplain land use management, the City's actions may reveal something different. The study does not fully capture the City's commitment because only documents are analyzed. That being said, the disconnect was partially attenuated through the analysis of local development agreements and conceptual plans. Conducting interviews and physically visiting sites would have more effectively addressed the disconnect. Because of these limitations, the results should be considered with caution.

Future Research

Suggestions for future research include assessing the effectiveness of the land use management strategies identified in mitigating flood hazards. For instance, the City of San Marcos exhibited complete commitment in residential cluster regulations, greenways, and base

flood elevations. An analysis of these strategies in San Marcos may reveal which are the most effective at mitigating flood hazards. Specifically, the development of the Woods Apartments was an extremely controversial planning decision because it was built in the floodplain, but the Woods significantly exceeded the recommendations for exactions and impervious cover clustering. Future research on these strategies may reveal their effectiveness. Another suggestion gauges the flood mitigation abilities of floodplain regulations, planning decisions, and elevation standards. This study provided the methods and assessed the City's commitment to using them but did not identify which of the methods would be the most effective at reducing flood hazards.

Other research includes an assessment of state and regional entities' (such as river authorities) commitment to floodplain land use management. A comparison of the commitment of state, regional, and local governments may reveal different levels of commitment. In addition, another study could be conducted identifying which government entity has the largest effect on land use practices based on their commitment to floodplain management. Varying levels of commitment may be identified in communities who are more likely to be affected by the impacts of climate change.

Conclusion

The results strongly support the City's commitment to floodplain regulations, planning decisions (with the exception of capital improvements), and elevation standards. The original purpose of this research was to make the case for completely eliminating development in floodplains, but this is clearly not possible. It must be acknowledged that people settled in floodplains because of their proximity to water. San Marcos in particular has been consistently

inhabited by humans for thousands of years specifically because of its access to water, and settlers gladly accepted the risk of periodic floods in exchange for water. Substantial flood damage has recently evolved into a significant policy problem because technology has advanced substantially over the last 200 years. The costs of floods began to rise as communities became more established in the floodplain. In the United States, structural improvements were the first solution to address the cost of flood damages. Structural improvements represent an extremely flawed policy solution because not only have flood damages increased over time, but communities must now constantly maintain the structures meant to protect them. Structural improvements require a vast amount of resources but have proven to be ineffective at reducing the cost of floods.

Gilbert White was among the first to argue that floods could be mitigated through land use management. Land use management is the most effective way to reduce the cost of flood damages, but it is difficult to enact such policies because flood prone communities are already established in hazardous locations. This study contributes by offering methods to begin the process of moving communities out of flood prone locations. Through floodplain regulations, planning decisions, and elevation standards, communities can plan for a resilient and sustainable future.

Chapter Summary

This chapter provided recommendations and conclusions based on the case study of the City of San Marcos. The results indicate that the City of San Marcos is committed to floodplain land use management in varying degrees through floodplain regulations, planning decisions,

and elevation standards. This chapter also provided limitations, suggestions for future research, and concluding thoughts.

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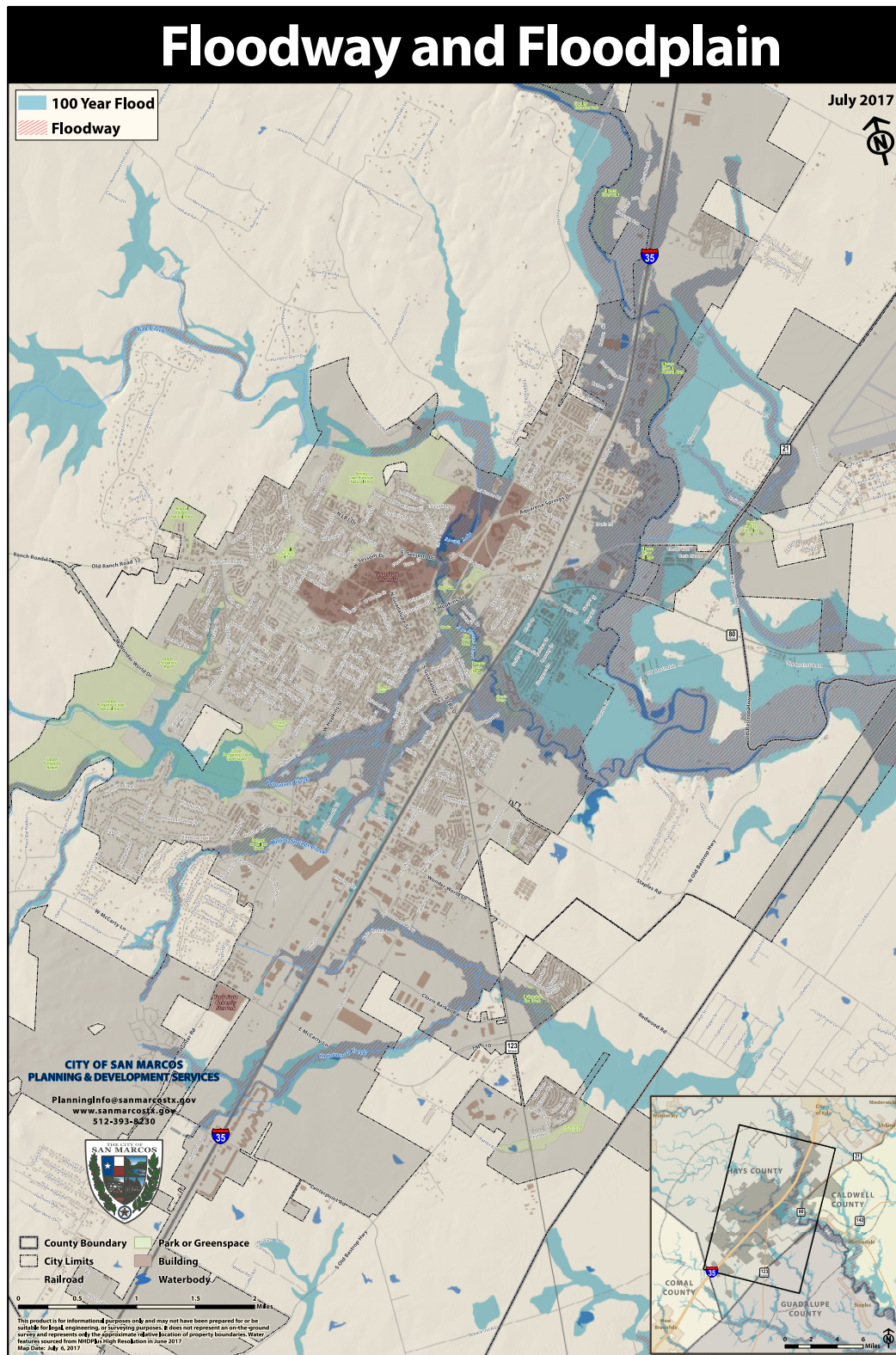
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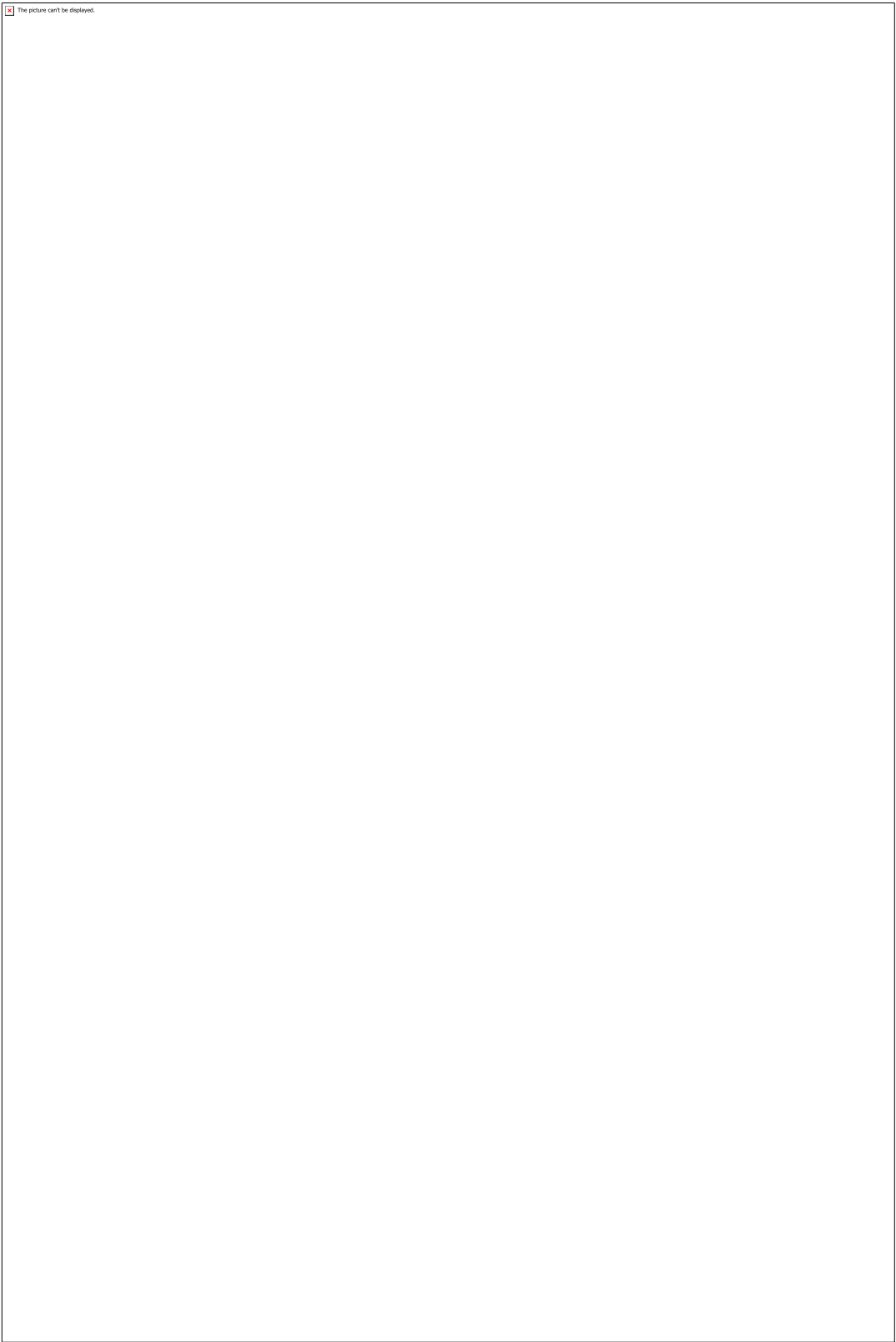
Appendix

Appendix A: Maps

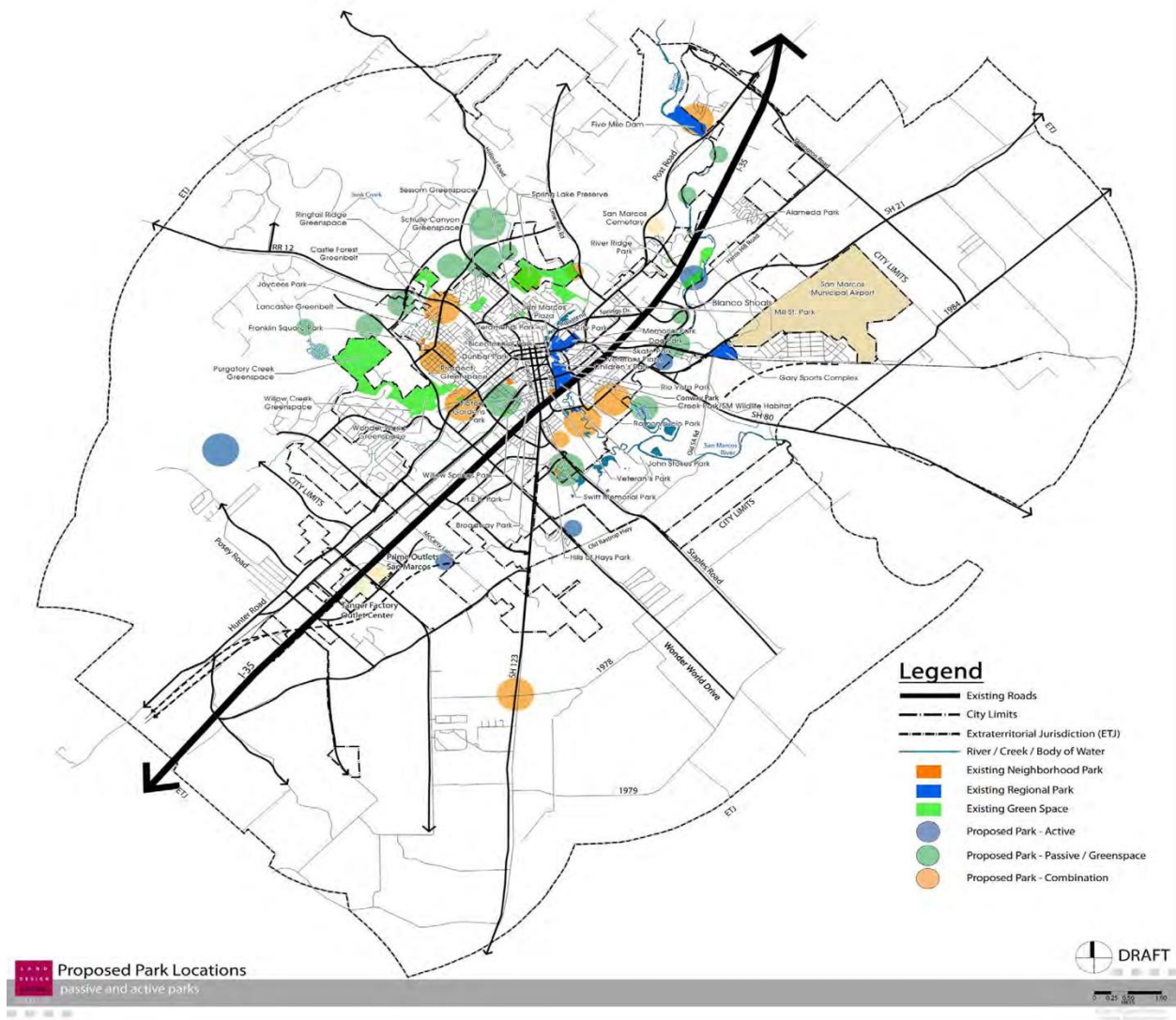
San Marcos Floodway and Floodplain Map



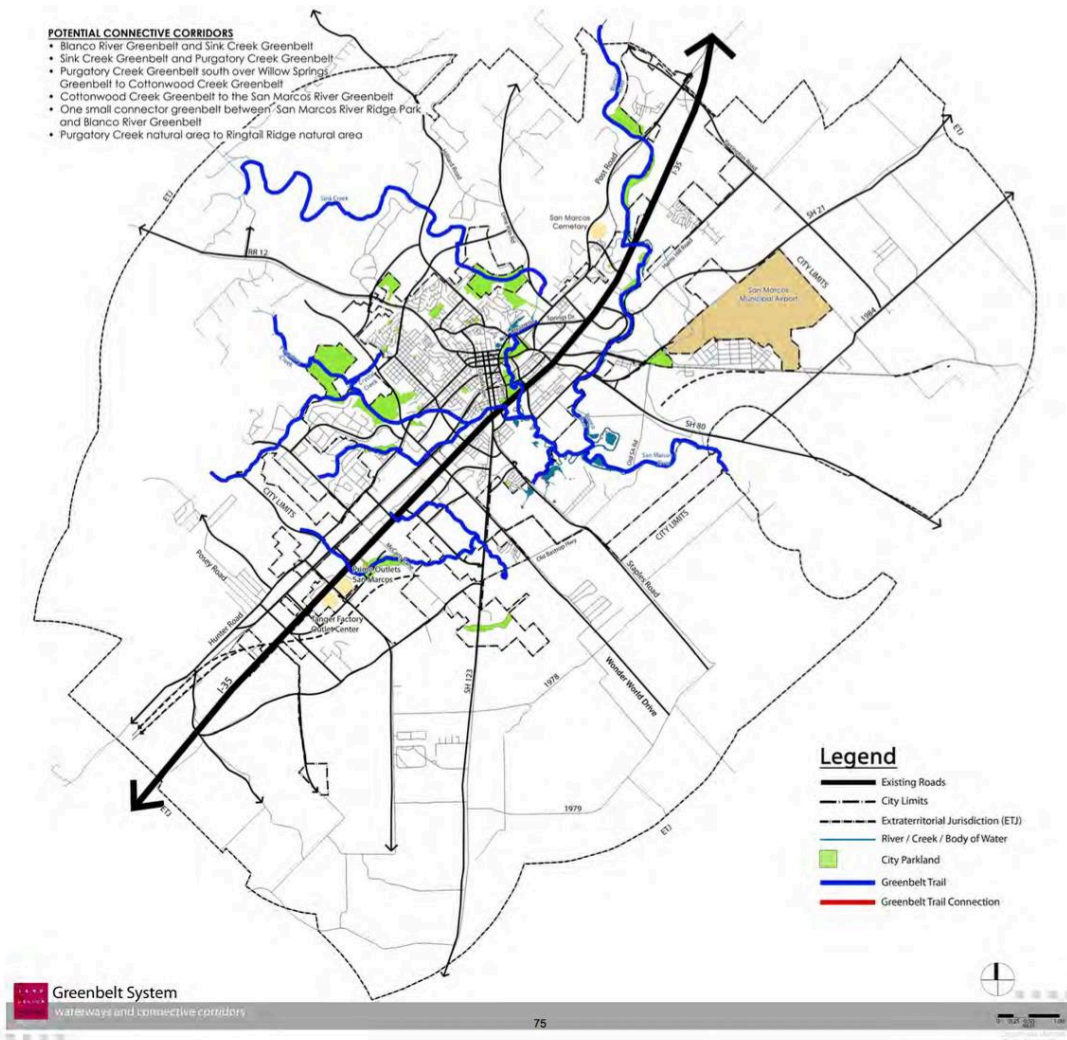
San Marcos Preferred Scenario Map




San Marcos Current and Proposed Park Locations



San Marcos Potential Greenbelt Corridors

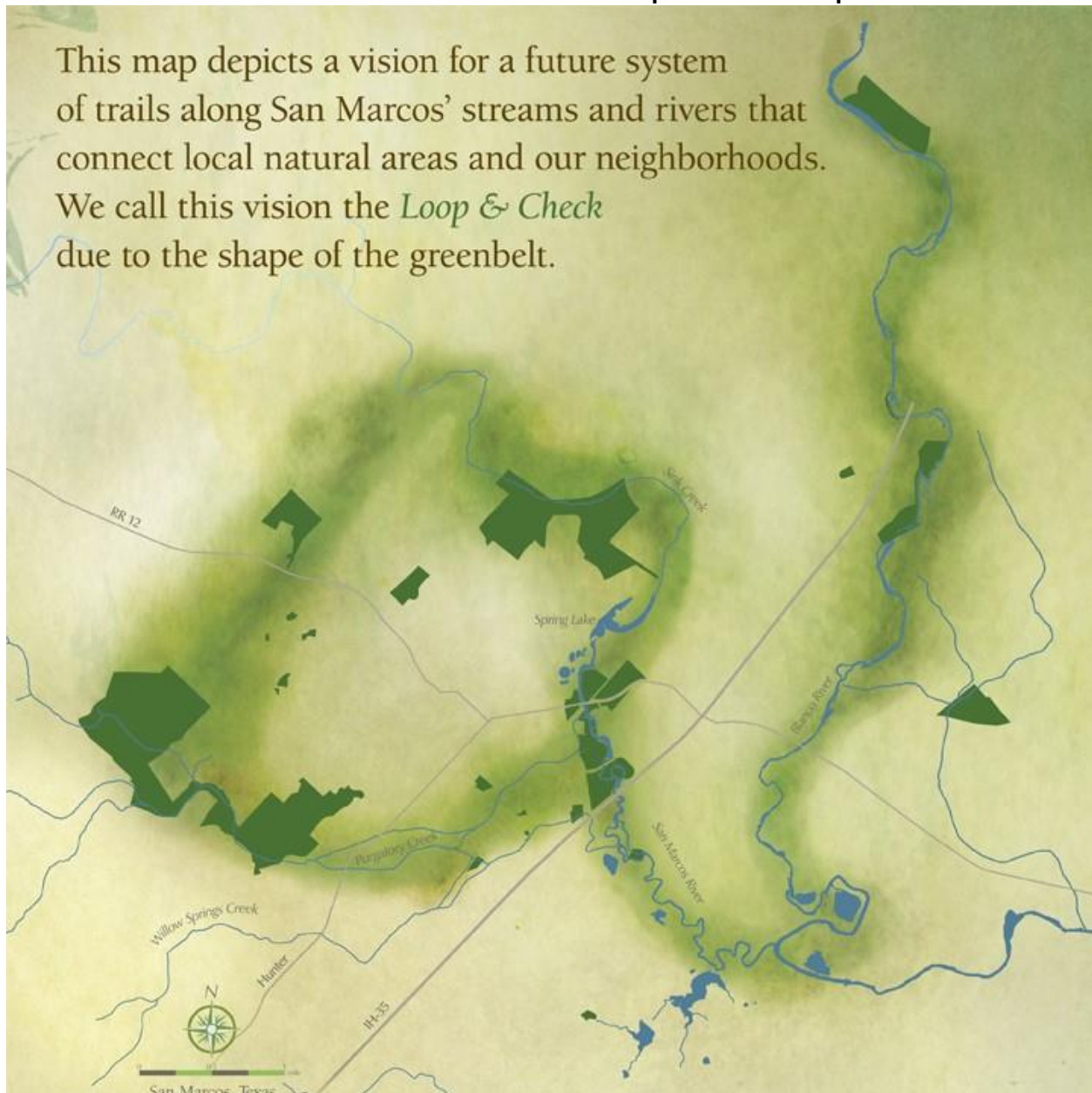


San Marcos Parks Map

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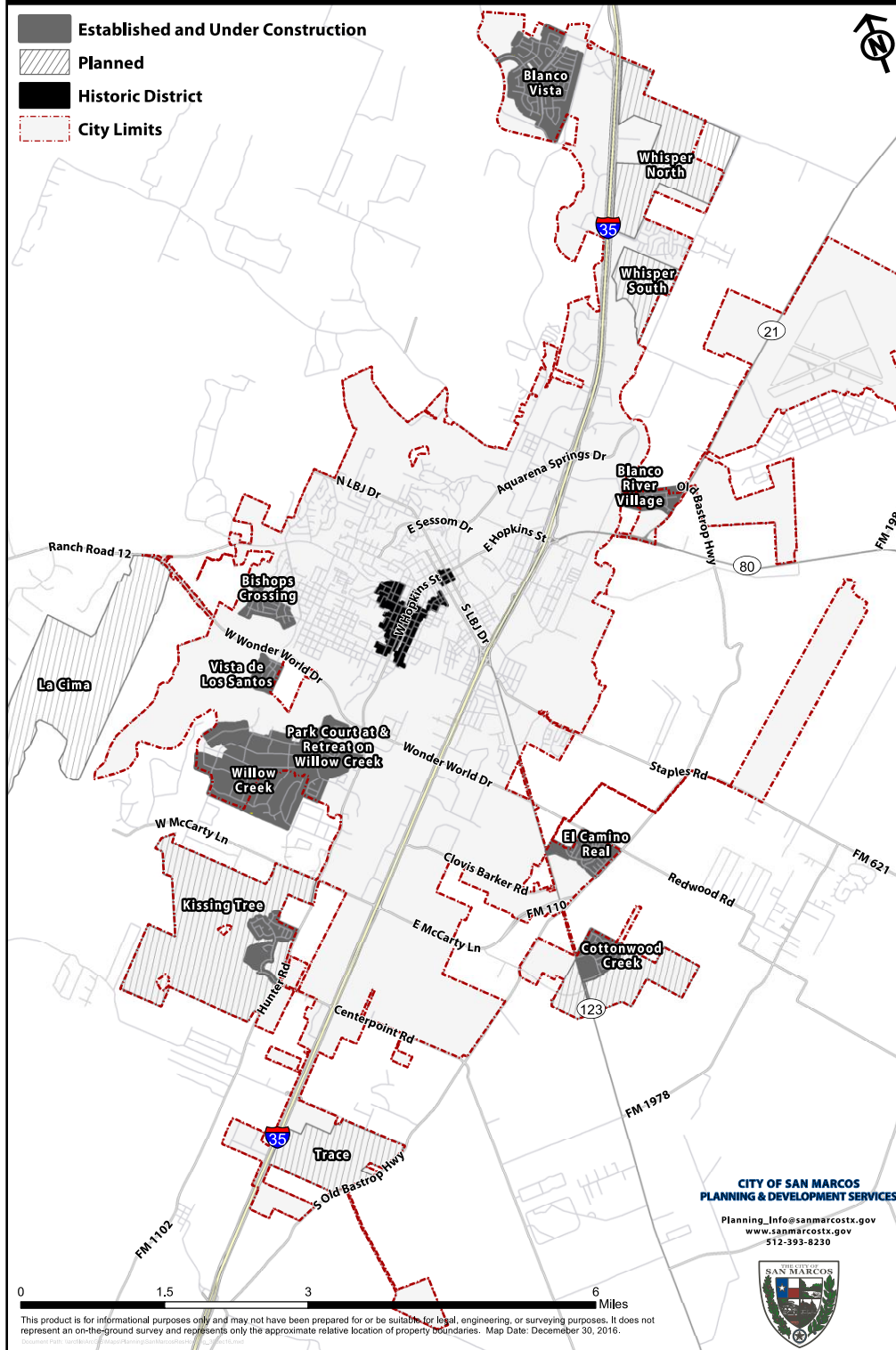
San Marcos Greenbelt Alliance Loop and Check Map

This map depicts a vision for a future system of trails along San Marcos' streams and rivers that connect local natural areas and our neighborhoods. We call this vision the *Loop & Check* due to the shape of the greenbelt.



San Marcos Housing Subdivisions

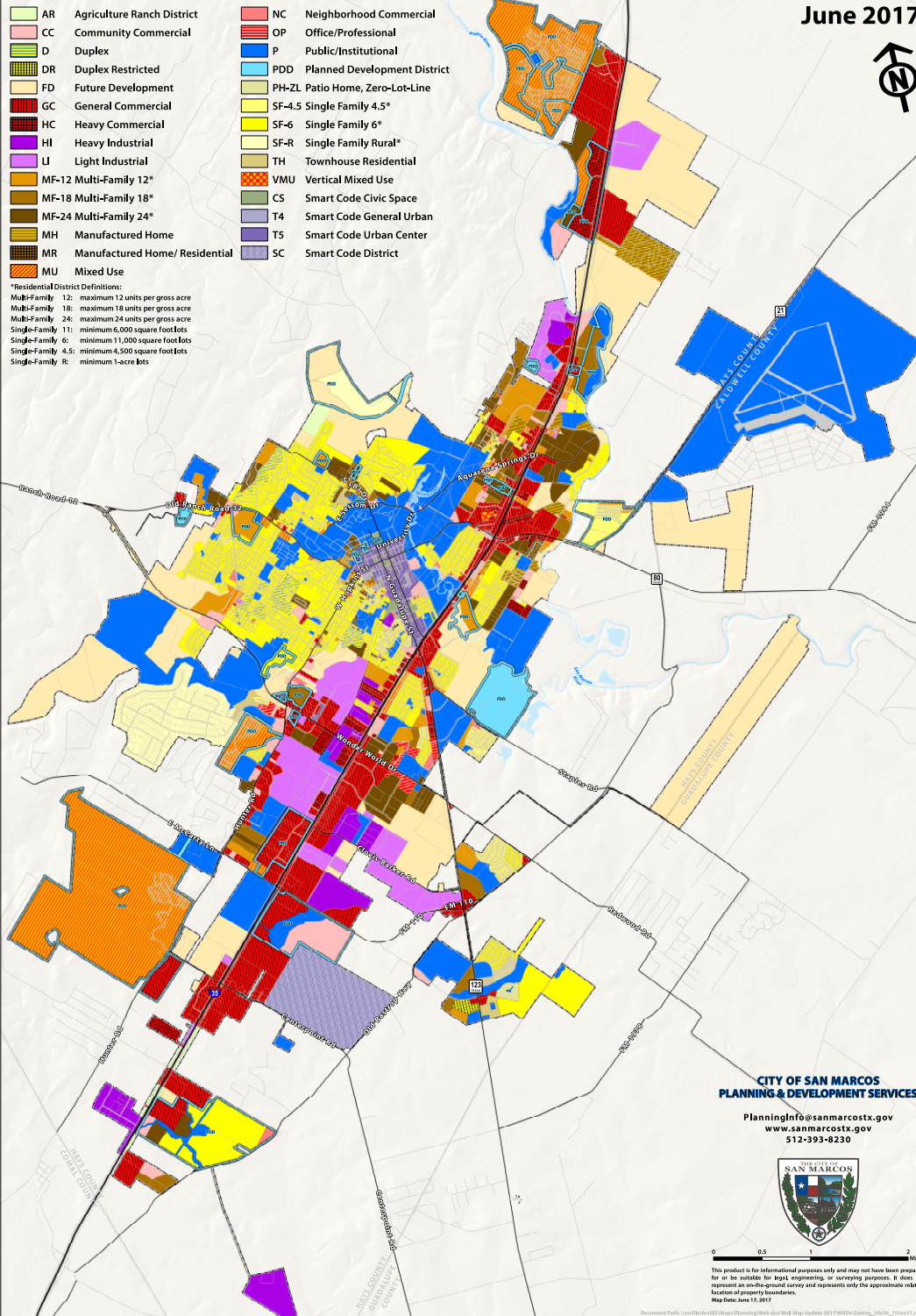
San Marcos—Housing Subdivisions



Zoning Districts

Zoning Districts

June 2017



Appendix B: City of San Marcos Zoning Districts

Section 4.2.1.1: FD, Future Development District

- a) Purpose. The Future Development (FD) District is intended to provide areas for land that is relatively undeveloped and/or agricultural in nature. The FD district is also a default district for newly annexed land that is not yet ready to be zoned for a particular intended use.
- b) Authorized Uses. The following are authorized uses under the regulations established in this Chapter:
 - 1) Permitted and conditional uses, as authorized in the Land Use Matrix in Article 3, Division 1 of this Chapter 4.
 - 2) Accessory uses as authorized in Article 3, Division 2 of this Chapter 4.
- c) Additional Development Standards. See Table 4.1.6.1.
- d) Additional Area, Building, and Height Requirements:
 - 1) The minimum rear yard shall be 20 per cent of the total lot depth measured at the point of the lots greatest depth.
- e) Additional Requirements. See Chapter 6 for additional development requirements and standards.

Section 4.2.1.2: AR, Agricultural Ranch District

- a) Purpose. The AR Agricultural Ranch District is intended to preserve agricultural usage of land, to offer protection to agricultural land from the effects of objectionable, hazardous, or environmentally disruptive uses, and to discourage untimely scattering of more dense urban development.
- b) Authorized Uses. Permitted and conditional uses, as authorized in the Land Use Matrix in Article 3, Division 1 of this Chapter 4. Accessory uses as authorized in Article 3, Division 2 of this Chapter 4.
- c) Additional Development Standards. See Table 4.1.6.1.
- d) Additional Area, Building and Height Requirements:
 - 1) The minimum rear yard shall be 20 per cent of the total lot depth measured at the point of the lots greatest depth.
- e) Additional Requirements. See Chapter 6 for additional requirements and standards.

Section 4.2.1.3: SF-R, Single-Family Rural Residential District

- a) Purpose. The SF-R Rural Residential District is intended for the development of single-family uses in larger lot subdivisions in a more rural setting.
- b) Authorized Uses. Permitted and conditional uses, as authorized in the Land Use Matrix in Article 3, Division 1 of this Chapter 4. Accessory uses as authorized in Article 3, Division 2 of this Chapter 4.
- c) Additional Development Standards. See Table 4.1.6.1.
 - 1) For lots in the SF-R district, consisting of at least one acre but with a lot width less than 150 feet, the side setbacks may be reduced proportionally to the percent difference between the lot width and 150 feet.
- d) Additional Area, Building and Height Requirements:
 - 1) The minimum rear yard shall be 20 per cent of the total lot depth measured at the point of the lots greatest depth.

- e) Additional Requirements. See Chapter 6 for additional requirements and standards.
- f) Occupancy Restrictions. See Section 4.3.4.5.

Section 4.2.1.4: SF-11, Single-Family District

- a) Purpose. The SF-11 Single Family District is intended for development of primarily low-density detached, single-family residences and customary accessory uses on lots of at least 11,000 square feet in size.
- b) Authorized Uses. Permitted and conditional uses, as authorized in the Land Use Matrix in Article 3, Division 1 of this Chapter 4. Accessory uses as authorized in Article 3, Division 2 of this Chapter 4.
- c) Additional Development Standards. See Table 4.1.6.1.
- d) Additional Area, Building and Height Requirements:
 - 1) The minimum rear yard shall be 20 per cent of the total lot depth measured at the point of the lots greatest depth.
- e) Additional Requirements. See Chapter 6 for additional requirements and standards.
- f) Occupancy Restrictions. See Section 4.3.4.5.

Section 4.2.1.5: SF-6, Single-Family District

- a) Purpose. The SF-6 Single Family District is intended for development of primarily detached, single-family residences and customary accessory uses on lots of at least 6,000 square feet in size.
- b) Authorized Uses. Permitted and conditional uses, as authorized in the Land Use Matrix in Article 3, Division 1 of this Chapter 4. Accessory uses as authorized in Article 3, Division 2 of this Chapter 4.
- c) Additional Development Standards. See Table 4.1.6.1.
- d) Additional Area, Building and Height Requirements:
 - 1) Minimum Lot Area:
 - i. Internal: 6,000 square feet
 - ii. b.Corner: 6,900 square feet
 - 2) Minimum Lot Width:
 - i. Internal: 50 feet
 - ii. Corner: 60 feet
- e) Additional Requirements. See Chapter 6 for additional requirements and standards.
- f) Occupancy Restrictions. See Section 4. 3.4.5.

Section 4.2.1.6: SF-4.5, Single-Family District

- a) Purpose. The SF-4.5 Single Family District is intended for development of primarily detached, single-family residences and customary accessory uses on lots of at least 4,500 square feet in size.
- b) Authorized Uses. Permitted and conditional uses, as authorized in the Land Use Matrix in Article 3, Division 1 of this Chapter 4. Accessory uses as authorized in Article 3, Division 2 of this Chapter 4.
- c) Additional Development Standards. See Table 4.1.6.1.
- d) Additional Area, Building and Height Requirements:

- 1) Minimum Lot Area:
 - i. Internal: 4,500 square feet
 - ii. Corner: 5,400 square feet
- 2) Minimum Lot Width:
 - i. Internal: 50 feet
 - ii. Corner: 60 feet
- e) Additional Requirements. See Chapter 6 for additional requirements and standards.
- f) Occupancy Restrictions. See Section 4. 3.4.5.

Section 4.2.1.7: D, Duplex Residential District (Low Density)

- a) Purpose. The D Duplex Residential District is intended for development of single-family residences and associated uses as well as for development on larger parcels of land of low density two-family duplex units. The D Duplex Residential District is intended to replace existing DP zoned areas. D zoning is not to be applied to properties for new duplex development.
- b) Authorized Uses. Permitted and conditional uses, as authorized in the Land Use Matrix in Article 3, Division 1 of this Chapter 4. Accessory uses as authorized in Article 3, Division 2 of this Chapter 4.
- c) Additional Development Standards. See Table 4.1.6.1.
- d) Additional Area, Building and Height Requirements:
 - 1) Minimum Lot Area:
 - i. Duplex, duplex condominium: 11,000 square feet
 - ii. All other uses: 6,000 square feet
 - 2) Minimum Lot Width:
 - i. Single-family dwelling, group 50 feet per lot home, two-unit townhouse:
 - ii. All other uses: 90 feet per lot
 - 3) Minimum Lot Frontage:
 - i. Single-family dwelling, group 35 feet per lot home, two-unit townhouse:
 - ii. All other uses: 60 feet per lot
 - 4) Minimum Side Yard, Interior:
 - i. Single-family dwelling, group five feet home, two-unit townhouse:
 - ii. All other uses: Ten feet
 - iii. No side setback required for the common wall side of two-unit townhouses
- e) For the purpose of determining if an area is predominantly single-family or Mixed Residential Area when interpreting the Land Use Intensity Matrix in the Comprehensive Plan, Duplex Residential (D) is considered a mixed residential zoning district (see Section 1.4.1.3)
- f) Additional Requirements. See Chapter 6 for additional requirements and standards.

Section 4.2.1.8: DR, Duplex Restricted Residential District (Medium Density)

- a) Purpose. The DR Duplex Restricted Residential District is intended for development of single-family residences and associated uses as well as for development on larger parcels of land of medium density two-family duplex units.

- b) Authorized Uses. Permitted and conditional uses, as authorized in the Land Use Matrix in Article 3, Division 1 of this Chapter 4. Accessory uses as authorized in Article 3, Division 2 of this Chapter 4.
- c) Additional Development Standards. See Table 4.1.6.1.
- d) Additional Area, Building and Height Requirements:
 - 1) Minimum Lot Area:
 - i. Duplex, duplex condominium: 5,400 square feet
 - ii. All other uses: 4,500 square feet
 - 2) Minimum Lot Width:
 - i. Single-family dwelling, group 50 feet per lot home, two-unit townhouse, patio home, industrialized home:
 - ii. All other uses: 60 feet per lot
 - 3) Minimum Lot Frontage:
 - i. Single-family dwelling, group 35 feet per lot home, two-unit townhouse, patio home, industrialized home:
 - ii. All other uses: 40 feet per lot
 - 4) Minimum Side Yard, Interior:
 - i. Single-family dwelling, group five feet home, two-unit townhouse, patio home, industrialized home:
 - ii. All other uses: Ten feet
 - iii. No side setback required for the common wall side of two-unit townhouse
- e) Additional Requirements. See Chapter 6 for additional requirements and standards.
- f) For the purpose of determining if an area is predominantly single-family or Mixed Residential Area when interpreting the Land Use Intensity Matrix in the Comprehensive Plan, Duplex Restricted Residential (DR) is considered a mixed residential zoning district (see Section 1.4.1.3)
- g) Occupancy Restrictions. See Section 4.3.4.5.

Section 4.2.1.9: TH, Townhouse Residential District

- a) Purpose. The TH Townhouse Residential District is intended for development of single-family residences and associated uses as well as for development on larger parcels of land of two-family townhouse units.
- b) Authorized Uses. Permitted and conditional uses, as authorized in the Land Use Matrix in Article 3, Division 1 of this Chapter 4. Accessory uses as authorized in Article 3, Division 2 of this Chapter 4.
- c) Additional Development Standards. See Table 4.1.6.1.
- d) Additional Area, Building and Height Requirements:
 - 1) Minimum Lot Area:
 - i. Internal: 2,500 square feet
 - ii. Corner: 4,000 square feet
 - 2) Minimum Lot Width:
 - i. Internal: 25 feet
 - ii. All other uses: 36 feet

- 3) Minimum Lot Frontage:
 - i. Internal: 25 feet
 - ii. All other uses: 36 feet
- 4) Minimum Rear Yard: Zero feet when abutting townhouses on the rear: Ten feet when abutting an alley or service drive, or property not zoned for townhouse usage
- 5) Minimum Side Yard, Interior:
 - i. Corner. Common Wall. Zero feet
 - ii. District Boundary. Exterior Wall: five feet
- e) Additional Requirements. See Chapter 6 for additional requirements and standards.
- f) For the purpose of determining if an area is predominantly single-family or Mixed Residential Area when interpreting the Land Use Intensity Matrix in the Comprehensive Plan, Townhouse Residential (TH) is considered a mixed residential zoning district (see Section 1.4.1.3)
- g) Occupancy Restrictions. See Section 4.3.4.5.

Section 4.2.1.10: PH-ZL, Patio Home, Zero-Lot-Line Residential District

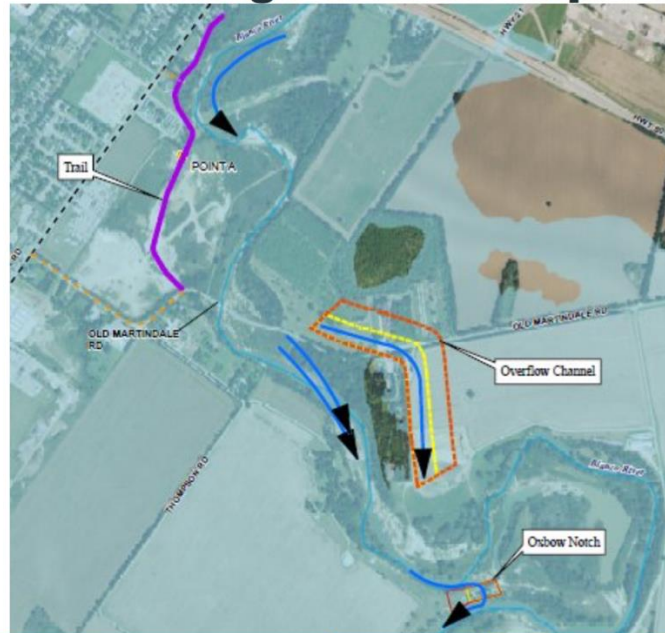
- a) Purpose. The PH-ZL Patio Home, Zero-Lot-Line Residential District is intended for development of primarily detached single-family residences on compact lots having one side yard reduced to zero feet, also commonly referred to as "zero-lot-line", and having a minimum of 4,000 square feet.
- b) Authorized Uses. Permitted and conditional uses, as authorized in the Land Use Matrix in Article 3, Division 1 of this Chapter 4. Accessory uses as authorized in Article 3, Division 2 of this Chapter 4.
- c) Additional Development Standards. See Table 4.1.6.1.
- d) Additional Area, Building and Height Requirements:
 - 1) Minimum Side Yard: The dwelling may be constructed with a zero side yard on one side, and a side yard of not less than nine feet extending the full depth of the lot on the other side. On the "zero" side, the structure may be set back a maximum of one foot. A five-foot wide maintenance, drainage, and roof overhang easement extending the full depth of the lot shall be designated along the side property line which abuts the zero side yard on an adjacent lot, and which shall be indicated on the Final Subdivision Plat. In all cases, there shall be at least a ten-foot side yard on corner lots where adjacent to a street right-of-way or alley. Under no circumstances shall the separation between two zero lot line dwellings, or between a zero lot line dwelling and any other type of principal building on an adjacent lot, be less than ten feet wall-to-wall.
- e) Additional Requirements. See Chapter 6 for additional requirements and standards.
- f) Parking. A 20-foot paved alley must be provided for ingress and egress to all rear garages.
- g) Accessory buildings. No accessory building shall occupy more than 40 per cent of the required rear yard. Accessory buildings shall be set back a minimum of three feet from the rear property line; provided, however, that where the rear lot line is the line of an alley 20 feet or more in width, no setback shall be required. No accessory building may

be closer than ten feet to the main building in the rear yard. Accessory buildings, except garages, shall not be allowed in front or side yards.

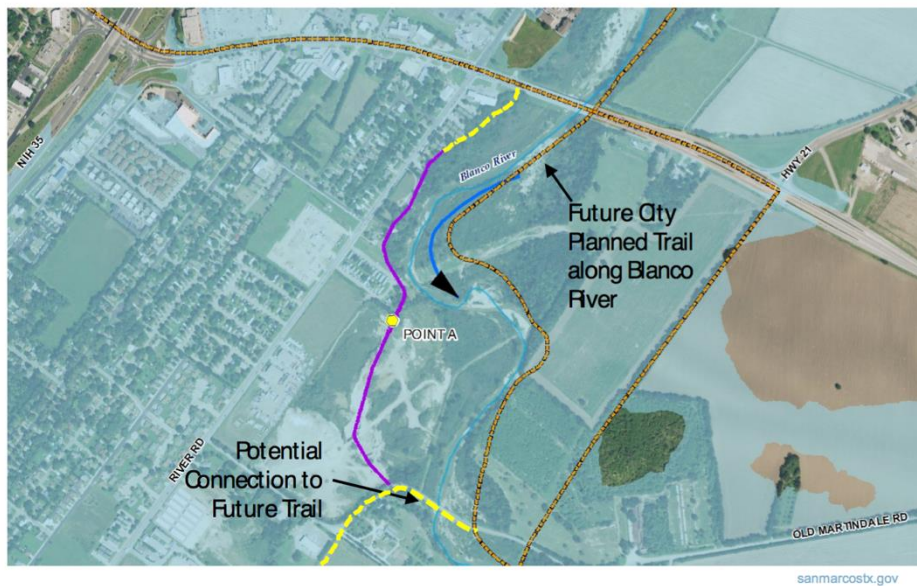
- h) Plat Requirements. The plat of the requested area for a PH-ZL zero lot line dwelling district shall incorporate the requirements for a PH-ZL zero lot line dwelling as follows:
 - 1) Zero lot line dwellings can be constructed in an area requested and approved for designation as PH-ZL.
 - 2) Zero lot line dwellings will be uniformly located on the same side of the lot within a street block.
 - 3) Zero lot line dwellings shall have no windows on the side of the house which abuts the property line.
 - 4) No area shall be designated PH-ZL that contains less than five adjoining lots on each street.
 - 5) The entire frontage on the street side under review must be included in the PH-ZL designation. An exception may be made where an alley breaks the block on the side of the street.
- i) Occupancy Restrictions. See Section 4.3.4.5.
- j) For the purpose of determining if an area is predominantly single-family or Mixed Residential Area when interpreting the Land Use Intensity Matrix in the Comprehensive Plan, Patio Home, Zero-Lot-Line Residential (PH-ZL) is considered a mixed residential zoning district (see Section 1.4.1.3)

Appendix C: Examples of documents used in case study

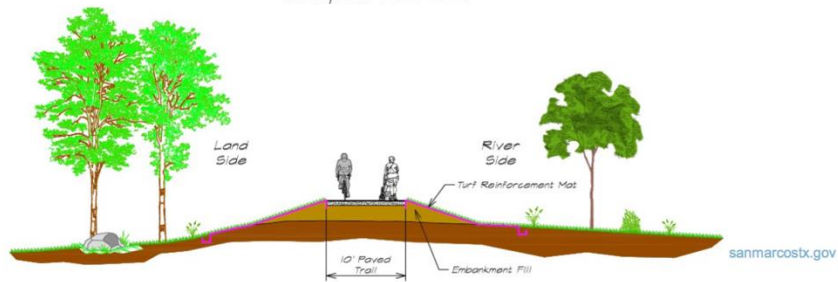
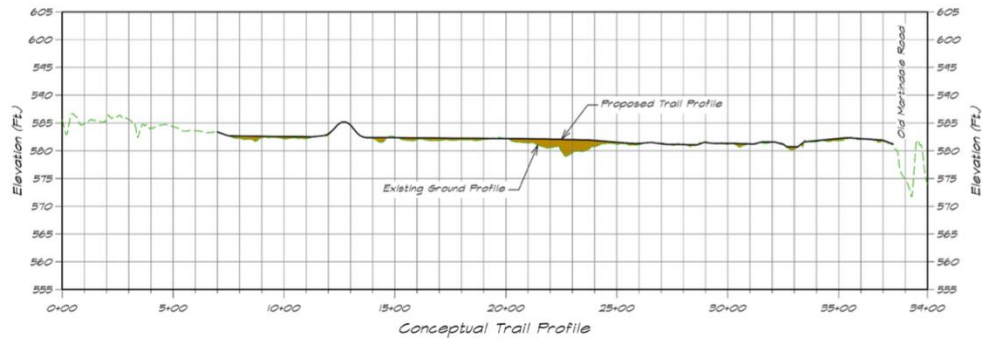
SAN MARCOS Drainage & Bank Improvements



SAN MARCOS Bank Improvement Trail

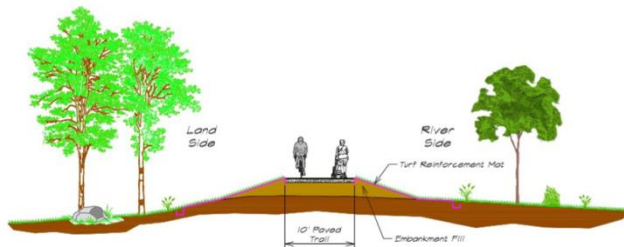


SAN MARCOS Cross Section and Profile

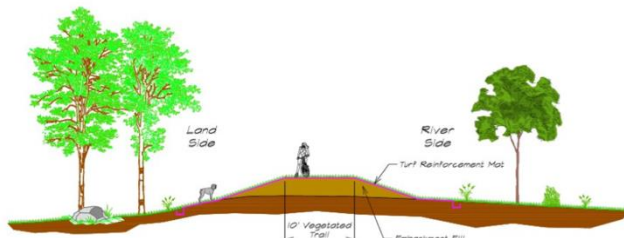


SAN MARCOS

Cross Section of Trail Options



Blanco River Bike Trail with Paved Surface



Blanco River Bike Trail with Vegetated Surface

sanmarcostx.gov

2017-2026 RCIP: Downtown Property Acquisition



10 Year Capital Improvement Program Projects

General

Downtown Property Acquisition

Project ID 614

Acquire future site downtown for potential parking areas as recommended in Downtown parking implementation plan. Acquiring a site now will ensure future location.

Department Responsible for project Engineering-CIP

Estimated Project Cost \$750,000.00

Comp Plan Goals

Year	General	Water	WW	Drainage	Electric	Total for FY
2017	\$750,000					\$750,000
Total	\$750,000					\$750,000

PROJECT RISK FACTORS



Schedule Constrained	<input type="text" value="0"/>
Acquisition Required	<input type="text" value="5"/>
Engineering Challenges	<input type="text" value="0"/>
Construction Challenges	<input type="text" value="0"/>
Project Phase	<input type="text" value="5"/>
Permitting Required	<input type="text" value="0"/>
Public Influence	<input type="text" value="4"/>
PM/City Expertise	<input type="text" value="2"/>
Sensitive Location	<input type="text" value="4"/>
Utility Coordination/Relocation	<input type="text" value="0"/>
Developed Area	<input type="text" value="5"/>
Construction Area Limited	<input type="text" value="0"/>
Total Risk	<input type="text" value="25"/>

Thursday, September 29, 2016

Recommended Projects

2017-2026 RCIP: Municipal Services Complex Expansion/Relocation



10 Year Capital Improvement Program Projects

General

Municipal Services Complex Expansion/Relocation

Project ID 132

Relocate and consolidate city facilities; With the FY15 first year funds of \$150k, conduct an assesment to expand City Facilities at the current City Hall location, relocate all Public Services (SMEU, PS, Fleet, Parks) to a new combined location, and make necessary repairs to the current fleet maintenance area. The second year of funds approved in FY 16, \$1.8M - will begin the concept and design phase for the improvements. The third year of funds in 2017 \$4M - will provide funding for land. The final year of funding in 2018, \$12M - will be for construction.

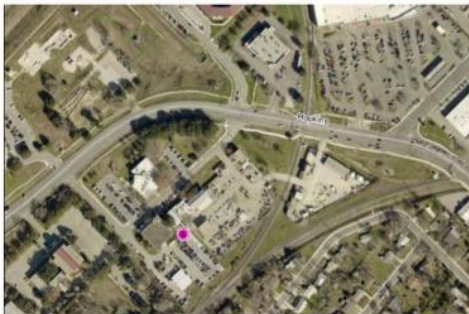
Department Responsible for project CS - Facilities

Estimated Project Cost \$17,950,000.00

Comp Plan Goals PPSFG101

Year	General	Water	WW	Drainage	Electric	Total for FY
2015	\$150,000					\$150,000
2016	\$600,000	\$300,000	\$300,000		\$600,000	\$1,800,000
2017	\$1,300,000	\$700,000	\$700,000		\$1,300,000	\$4,000,000
2018	\$4,000,000	\$2,000,000	\$2,000,000		\$4,000,000	\$12,000,000
Total	\$6,050,000	\$3,000,000	\$3,000,000		\$5,900,000	\$17,950,000

PROJECT RISK FACTORS



Schedule Constrained	1
Acquisition Required	0
Engineering Challenges	2
Construction Challenges	2
Project Phase	4
Permitting Required	2
Public Influence	4
PM/City Expertise	1
Sensitive Location	1
Utility Coordination/Relocation	2
Developed Area	0
Construction Area Limited	0
Total Risk	19

Thursday, September 29, 2016

Recommended Projects

Appendix D: Classification of FEMA flood zones

Hazard Mapping

Hazard identification is the calculation of a community's hazards "along with their intensity and potential damage levels" (Barua, Akhter, Ansary 2016, p. 1897). In order to have a successful floodplain land use management program, communities must identify at risk areas (Barua, Akhter, Ansary 2016). Identifying hazards allows communities to "guide development, prepare plans for community economic growth and infrastructure, utilize the natural and beneficial function of floodplains, and protect private and public investments" (ASFPM 2003b, p. 13). There are many methods communities can use to identify hazards, but one of the most popular methods is developing hazard maps. According to ASFPM, floodplain management "depends on good floodplain mapping and related flood hazard data" (ASFPM 2003b, p. 13). If a community has access to an accurate floodplain map, city officials can know exactly which members of their community are at risk and which areas should remain in the natural state. Developing floodplain maps is expensive and difficult, so many communities rely on the federal government to provide maps.

The NFIP develops Flood Insurance Rate Maps (FIRM) which assess the communities that are eligible to receive national flood insurance. Flood Insurance Rate Maps (FIRM) "delineate the flooding and floodplain for 100-year and 500-year floods and provide contours that depict flood elevations within the 100-year floodplain" (Deyle et al 1998, p. 125). FIRMs divide communities into different zones that define the hazard each section of the community is exposed to. In riverine communities, "the floodplain is comprised of the floodway and the flood fringe" (ASFPM 2003b, p. 13). The floodway represents the land that is at the highest risk, and the flood fringe represents the land that will be inundated by a 100-year flood event. Areas

that are outside the floodplain or within the .2% chance (500-year) floodplain are “shown as B, C, D, or X zones”, and FIRMs have little information on them other than what area is within the .2% chance floodplain (ASFPM 2003b, p. 16). Special Flood Hazard Areas (SFHA) are areas within the 100-year floodplain or floodway and are “designated by the letter ‘A’ or ‘V’ on FIRMs” (ASFPM 2003b, p. 14). Table 2.3 defines FEMA’s riverine flood zone designations.

Table 2.3: FEMA Flood Zone Designations and Definitions

Moderate to Low Risk Areas	
Zone	Description
B and X (Shaded)	Area of moderate flood hazard, usually the area between the limits of the 100-year and 500-year floods. B Zones are also used to designate base floodplains of lesser hazards, such as areas protected by levees from 100-year flood, or shallow flooding areas with average depths of less than one foot or drainage areas less than one square mile.
C and X (Unshaded)	Area of minimal flood hazard, usually depicted on FIRMs as above the 500-year flood level. Zone C may have ponding and local drainage problems that don't warrant a detailed study or designation as base floodplain. Zone X is the area determined to be outside the 500-year flood and protected by levee from 100-year flood.
High Risk Areas	
Zone	Description
A	Areas with a 1% chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. Because detailed analyses are not performed for such areas; no depths or base flood elevations are shown within these zones
AE	The base floodplain where base flood elevations are provided. AE Zones are now used on new format FIRMs instead of A1-A30 Zones.
A1-30	These are known as numbered A Zones. This is the base floodplain where the FIRM shows a BFE (old format)
AH	Areas with a 1% annual chance of shallow flooding, usually in the form of a pond, with an average depth ranging from 1 to 3 feet. These areas have a 26% chance of flooding over the life of a 30-year mortgage. Average flood depths derived from detailed analyses are shown within these zones.
AO	River or stream flood hazard areas, and areas with a 1% or greater chance of shallow flooding each year, usually in the form of sheet flow, with an average depth ranging from 1 to 3 feet. These areas have a 26% chance of flooding over the life of a 30-year mortgage. Average flood depths derived from detailed analyses are shown within these zones.
AR	Areas with a temporarily increased flood risk due to the building or restoration of a flood control system. Mandatory flood insurance purchase requirements will apply, but rates will not exceed the rates for unnumbered A zones if the structure is built or restored in compliance with Zone AR floodplain management regulations.
A99	Areas with a 1% annual chance of flooding that will be protected by a Federal flood control system where construction has reached specified legal requirements. No depths or base flood elevations are shown within these zones.

*(FEMA 2017, p. 1)

While FIRMs provide a solid assessment of the flood hazards within a community, there are a few shortfalls. FIRMs do not provide “flood elevations, do not map small watersheds, may not map localized drainage problems, and may not provide floodway boundaries” (ASFPM 2003b, p. 16). In addition, FIRMs do not take into account areas that flood outside of the identified floodways and flood fringes. FIRMs are also not updated enough to remain up-to-date at all times, so the information a FIRM provides may be inaccurate (ASFPM 2003b, p. 20).

There are measures communities can take to offset FIRM’s shortfalls. The Denver Urban Drainage and Flood Control District “assumes complete development of each watershed for its models. As a result, its estimates of flood depth and geographic extent of its floodplains are greater than what is indicated on the FIRM” (Deyle et al 1998, p. 149-150). Using the worst-case scenario allows communities to see what could happen if they allowed development to continue in hazardous areas. In order to have a complete understanding of a community’s flood risk, communities should also use “historical data in preparation of hazard-specific” maps (Barua, Akhter, Ansary 2016, p. 1897). Looking at past flood events will allow communities to know exactly which areas are at risk. Communities can also require developers to provide detailed flood data in all surrounding areas of the proposed development (ASFPM 2003b). In addition to removing the cost from the city, it forces the developer to look at the risk he may cause if he builds in that location. Communities can develop their floodplain land use programs once hazardous areas have been identified. The following working hypotheses occur after the identification of hazardous areas.

**Appendix E: Community Rating System Activity Description and Discount
Information**

Table 2.1: CRS Insurance Discounts

Rate Class	SFHA	Non-SFHA	Credit Points Required
1	45%	10%	4,500 +
2	40%	10%	4,000 – 4,499
3	35%	10%	3,500 – 3,999
4	30%	10%	3,000 – 3,499
5	25%	10%	2,500 – 2,999
6	20%	10%	2,000 – 2,499
7	15%	5%	1,500 – 1,999
8	10%	5%	1,000 – 1,499
9	5%	5%	500 – 999
10	0%	0%	0 – 499

*(FEMA 2015, p. 2)

Table 2.2: CRS Activities and Maximum Points for Completion

Series Number	Activity	Maximum Points Allotted
Series 300	Public Information	Total: 981
310	Elevation Certificates	116
320	Map Information Service	90
330	Outreach Projects	350
340	Hazard Disclosure	80
350	Flood Protection Information	125
360	Flood Protection Assistance	110
370	Flood Insurance Promotion	110
Series 400	Mapping and Regulations	Total: 5,841
410	Floodplain Mapping	802
420	Open Space Preservation	2,020
430	Higher Regulatory Standards	2,042
440	Flood Data Maintenance	222
450	Stormwater Management	755
Series 500	Flood Damage Reduction	Total: 4,692
510	Floodplain Management Planning	622

520	Acquisition and Relocation	1,900
530	Flood Protection	1,600
540	Drainage System Maintenance	570
Series 600	Flood Preparedness	Total: 730
610	Flood Warning and Response	395
620	Levee Safety	235
630	Dam Safety	160

*(FEMA 2015, p. 3-6)

Appendix F: NFIP examples of limited enclosures

Examples of Limited Enclosures



Figure 5-9: Building elevated on parallel stem walls.



Figure 5-10: Building elevated on crawlspace with openings.

