EVALUATING THE IMPACT OF SUSTAINABLE BUILT ENVIRONMENT COMMITMENTS AND OUTCOMES ON RESPIRATORY HEALTH: A LONGITUDINAL CASE STUDY OF TWO TEXAS CITIES

by

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Dedication

This work is dedicated to Homer Lancaster, my grandfather, for his unconditional support and love. Education was so important to him and his strength and dedication to hard work was an inspiration.

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Abstract

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As population continues to grow the need for creating efficient and effective built environments that balance the three pillars of sustainability, environment, economic and equity, becomes even more pertinent. This exploratory research assisted in bridging the gap between understanding sustainable policy development and resulting impact on the corresponding outcomes, including influences from political culture. Followed by an overarching view of the changes in sustainable built environment outcomes over the course of nine years and how these outcomes influenced air quality measurements and inpatient asthma discharges. The case study methodology, established by Yin (2014), was utilized to address the research questions and four research theories, which included: how do select sustainable built environment outcomes impact air quality and respiratory health, and how are these outcomes influenced. Additionally, the four theories analyzed were: (1) The political culture of a city influences sustainable built environment commitments. (2) Cities with greater commitments to sustainable built environment strategies result in larger corresponding outcomes. (3) Cities with more sustainable built environment outcomes have better air quality. (4) Cities with better air quality have lower cases of asthma.

Individual city case studies were conducted followed by a cross case analysis for Fort Worth and Austin. These two cities were selected because of their similarities in size, but significant difference in sustainable reputations and level of conservatism. A review of all city-planning documents for 2005 to 2013 was conducted and scored in order to identify relevant

sustainable built environment policies and level of commitment. Additional variables, identified in the literature to gauge the political culture of a city, were collected in order to address any possible rival explanations. Interviews were also conducted with city representatives from planning and sustainability in order to gain a better understanding of the past, present and future state of sustainability planning in each city. The City of Austin's more progressive political culture, determined by the data and interviews, resulted in a larger number of sustainable built environment policies, than Fort Worth. The claims from the literature that more progressive cities engaged in sustainability planning more often than less progressive cities were corroborated in both city case reports and the cross case report.

Sustainable built environment data, identified to influence air quality, was collected and reviewed to compare to the number of sustainable policies in order to better gauge the level of implementation. In the individual case reports, the yearly fluctuations in policies did not result in corresponding values in the built environment outcomes. However, the cross case analysis did partially support the theory, which was represented by the greater number of policies and the majority of the outcomes existing in the City of Austin over the City of Fort Worth.

Air quality and asthma variables, along with the supportive geographic, climatic, and meteorological elements, were collected for the time series. The inclusion of available regional and national statistics provided a comparative baseline for measuring and interpreting the data within a city. The case study theory that the presence of more select sustainable built environment outcomes resulted in better air quality was not conclusive, given that in the individual case analysis the majority of the sustainable built environment outcomes increased each year despite minor fluctuations in the air quality measurements. The collected annual climatological and geographical variables did not relate to the air quality measurements either in the individual city reports or in the cross case analysis. The data in this research confirmed the importance of the geographical and climatological conditions on dispersion and dilution processes affecting air pollution (Cho & Choi, 2014). Additionally, the individual case studies did not confirm a relationship between air quality and asthma, given the lack of correlation to the annual changes in measurements not coinciding. However, the cross case analysis did support the theory because the better air quality in Austin resulted in lower cases of asthma.

This exploratory case study identified targeted areas for future research. Field studies and targeted experiments would assist in better understanding how the built environment and transportation patterns influence the delicate play between air pollution and weather to result in more effective developments of cities.

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Chapter 1

Introduction

The various forms and transformations sustainability has taken since its first inception in the Brundtland Report in 1987 has provided a need for continuous evaluation and assessment as to the effectiveness. Attempting to validate the claims of the different benefits of sustainability policies, strategies and initiatives implemented by cities present the foundation and support needed for further growth and practice (Lubell, Feiock & Handy, 2009). There are several studies that evaluate city sustainability planning (Berke & Conroy, 2000; Conroy & Iqbal, 2009; Hollman, 2014; Lubell et al., 2009; Portney, 2003; Saha & Paterson, 2008), however one of the major critiques of these studies is that the implementation arm of city commitments is rarely examined (Holman, 2014; Saha, 2009). Therefore, success has been difficult to measure and planning for sustainable development hindered (Cooper & Vargas, 2004). Understanding the relationship between policy and implementation is the basis of my research.

Saha (2009) has been a major proponent for future research in order to identify effective implementation measurement and evaluation methods for sustainability activities. My research addresses these limitations by not only identifying and evaluating select sustainable built environment policies, but to also assess the impact those policies have on the corresponding built environment outcomes and the intended effects on air quality and asthma. Specifically, I evaluate the evolution of sustainable built environment policies indicated in the literature to impact air quality over a 9-year period (2005 to 2013) and determine if there are any relationships to the actual built environment outcomes. Additionally, air quality data and incidences of asthma are examined over the same period to determine if there are any correlations. Theoretically, sustainable built environment solutions are said to positively influence the environment with specific outcomes supposed to impact air quality. Additionally, the asthma literature supports a relationship between air quality and asthma where air pollution triggers asthma attacks. This assessment allows for inspection into these claims in order to better understand the impact at the city level and how future implementation efforts can best be employed.

Research supports the health benefits of being in contact with the natural environment, the use of environmentally conscious building practices, and the overall improvement and design of the built environment (Hutch et al., 2011; Jackson, 2003; Jackson et al., 2013; Srinivasan et al. 2003). The majority of the existing research and literature regarding the built environment and public health examines the connection between the built environment and personal behavior (Frumkin, 2003; Saaloos et al., 2009). Thus, the primary public health concerns addressed are those directly impacted by physical activity, such as obesity (Jackson et al., 2013). Lovasi (2012) points out that there are a number of effects on health, brought about by housing characteristics, pollution sources or other daily stressors that cannot be mediated by behavior, such as respiratory illnesses like asthma. Therefore, it is important to examine impacts to public health from strictly environmental sources and understand how the built environment can influence and improve these health outcomes.

Some of the examples of built environment sources that affect health in a manner not solely addressed by personal behaviors include sprawl, with its land use and transportation patterns, along with the increased use of pesticides in agriculture. These practices and their various unintended consequences have had a debilitating impact on public health, causing greater incidences of asthma and other respiratory problems (Dannenberg et al., 2006; Frumkin, 2003; Jackson, 2003; Srinivasan et al., 2003). However, there appears to be consensus that future research is necessary to better understand the breadth of health consequences, including the economic costs (Remoundou and Koundouri, 2009), and benefits associated with the built environment and various sustainable development practices (Jackson et al., 2013; Srinivasan et al., 2003).

At this point, it is important to review a few key terms vital to my research, including built environment, sustainability and sustainable built environment. The existing literature and definitions of these terms are reviewed in the following section. Additionally, the solidified definitions utilized for the framework in my research are outlined.

Understanding Terms

Sustainability & the Built Environment

There have been many definitions and interpretations of the terms “sustainability” or “sustainable development” over the years (Mebratu, 1998). The term was first coined in the 1987 report, *Our Common Future*, or more commonly known as the *Brundtland Report*, which was published by the World Commission on Environment and Development (WCED) or the Brundtland Commission. This report defined sustainable development as “the kind of development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (World Commission on Environment and Development, 1987, Part 1, Chapter 2, Paragraph 1). In 1993, The President’s Council defined sustainable development as “...an evolving process that improves the economy, the environment, and society for the benefit of current and future generations” (EPA, n.d., n.p.). Sustainable solutions were determined by balancing the three pillars of sustainability: environmental, economic, and social pillars (U.S. Green Building Council, 2009). The environmental pillar includes such topics as air quality, water quality, ecosystem preservation, and resource integrity. Jobs, costs, prices, supply and demand are some of the topics in the economic pillar. The social or equity pillar, which is concerned with topics like public health, education, accessibility, justice, and quality of life, are arguably the most neglected (Saha, 2009).

Fiskel et al. (2012) argued that many individuals found these foundational definitions too theoretical and abstract, thus adopted more functional versions that weighed the three pillars differently and in a manner more in line with their respective missions, values and goals. For example, Holman (2014) utilized the following categories:

- Environmental protection (open space/nature protection, recycling, encouraging alternative transportation)
- Smart Growth (limiting outward expansion, mixed-use development, adaptive reuse, heritage preservation, infill development and encouraging responsible economic development especially around the promotion of green industries)

- Social Justice (affordable housing policies, public participation, and creating community harmony)

The President's Council provides a working definition for sustainable communities as "healthy communities where natural and historic resources are preserved, jobs are available, sprawl is contained, neighborhoods are secure, education is life long, transportation and healthcare are accessible, and all citizens have opportunities to improve the quality of their lives" (Srinivasan et al., 2003, p. 1447). The U.S. Green Building Council (2009) defines sustainability as "creating places that are environmentally responsible, healthful, just, equitable, and profitable" (n.p.).

Many of these definitions emphasize the importance of *place* and how to create places that improve the overall quality of life for all. These places or built environments include, according to Lovasi (2012), "relatively stable aspects of the human-made or modified environment, such as buildings, transportation systems, architectural and urban design features, landscape elements, and green spaces" (p.165). The built environment encompasses all buildings, spaces and products created or modified by people. Therefore, by definition, all physical aspects of cities, both indoors and outdoors, are part of the built environment (Northridge & Sclar, 2003).

Sustainable Built Environment

In order to support quality of life for all, cities must integrate sustainable solutions into the built environment and its various systems (USGBC, 2009). Mohamed and Daliman (2012) outlined five steps for achieving sustainability in the built environment.

> The first step: understand the components and importance of *natural capitals* (natural resources living and non-living and the ecological services). The second step: recognize that many human activities degrade natural capital by using normally renewable resources faster than nature can renew them...The third step: search for solutions to environmental problems…The fourth step: in trying to solve environmental problems there is a need to make trade-offs or compromises. The fifth step: to consider individuals, as each individual matters (p. 1).

Younger et al. (2008) outlined specific sustainable built environment strategies that affect public health. The strategies directly affecting air quality and respiratory health are detailed below in Table 1.1.

Table 1-1 - Relationships between the built environment, air quality, and health

Built Environment Category	Built Environment Strategy	Environmental Impacts	Health Benefit
Transportation	• Increase facilities and opportunities for public transit use, walking, and biking • Decrease distances between destinations (denser and mixed-use development)	• Improved air quality from reduced motor vehicle emissions	• Reduced levels of respiratory illnesses (e.g. asthma) due to improved air quality
Buildings	• Adopt LEED guidelines for energy-efficient buildings • Increase use of sustainable, local, and/or recycled construction materials and reuse of older buildings • Increase heating and cooling efficiency through site orientation, insulated windows, green roofs and natural ventilation	• Improved air quality from reduced coal-generated electricity • Decreased heat island effects	• Reduced levels of respiratory illnesses (e.g. asthma) due to improved air quality
Land Use	• Develop mixed-use communities following smart growth and LEED ND principles • Preserve and expand parks, trails and green space • Coordinate regional planning	• Improved air quality from increased green spaces (Sonuparlak, 2011)	• Reduced levels of respiratory illnesses (e.g. asthma) due to improved air quality

LEED, U.S. Green Building Council's Leadership in Energy and Environmental Design rating systems, LEED-ND, for neighborhood development

Research Overview

Many have noted the research gap between sustainable development planning and implementation (Cooper & Vargas 2004; Holman, 2014; Lubell et al., 2009; Seasons, 2003). The purpose of this case study research is to address the gap and gain a better understanding of the effects the built environment has on air quality and respiratory health. Specifically, as identified from the literature, the influence on air quality and impact on environmentally induced public health concerns from select sustainable built environment outcomes are examined. The respiratory illness, asthma, is a public health concern that is not eliminated by personal behavior and is triggered and exacerbated by environmental causes (Environmental Protection Agency "What is Asthma", 2013). Therefore, evaluating incidences of asthma and the relationship to the built environment is an effective measure for city sustainable built environment commitments, implementation, and resulting impacts. First, an examination of city planning documents is conducted for the cities of Austin and Fort Worth that include a 9-year period (2005 – 2013). This document review identifies and evaluates the city's commitment level to sustainable built environment strategies reported to influence air quality. A breakdown of the related built environment outcomes is outlined in the previous section, *Understanding Terms,* in Table 1.1. This, along with city demographic, socioeconomic, geographic, climatic, and the related built environment outcome data is used to assess any correlations to air quality or the prevalence of asthma in each city.

Utilizing the case study methodology outlined by Yin (2014) provides the framework necessary to thoroughly examine and explain the complex relationships between sustainable built environment strategies and initiatives, air quality and asthma. Although a case study of one city begins to provide insights to how the built environment might influence air quality and respiratory health, evaluating two different cities is more substantial and compelling by allowing for cross-case conclusions (Herriott & Firestone, 1983, as cited in Yin, 2014). The two Texas cities, Austin and Fort Worth, are selected because of their comparable populations and demographics and differences in their climate, political culture, reputation and engagement in sustainability. These conditions provide an excellent environment for drawing conclusions and explanations regarding sustainable built environment planning, outcomes and impacts on air quality and asthma. Additionally, these variations allow the research questions, theories and rival theories to be addressed. The case study theories are utilized in each case study, like research hypothesis, to provide potential explanations for addressing the research questions. Rival theories, much like null hypotheses, indicate the absence of a relationship between the proposed explanations (theories) and the research questions.

My primary **research questions** are:

- How do select sustainable built environment outcomes impact air quality and respiratory health, and
- How are these outcomes influenced?

My case study **theories or hypotheses**, as defined by Yin (2014):

- The political culture of a city influences sustainable built environment commitments.
- Cities with greater commitments to sustainable built environment strategies result in larger corresponding outcomes.
- Cities with more sustainable built environment outcomes have better air quality.
- Cities with better air quality have lower cases of asthma.

My case study **rival theories or null hypotheses,** as defined by Yin (2014):

- Something other than political culture influences a city's commitment level to sustainable built environment strategies.
- A cities' level of commitment to sustainable built environment strategies does not influence or result in larger corresponding outcomes.
- Greater sustainable built environment outcomes do not result in better air quality.
- Better air quality does not result in lower cases of asthma.

The variation of the political culture between the two cities allows for evaluation of its level of influence on sustainability planning strategies by either proving or disproving the theory that cities that are more progressive, like Austin, engage in more sustainability planning than less progressive cities like Fort Worth. Additionally, gauging the significance of having a *green* reputation, like Austin has created, and if that reputation results in more sustainable built environment policies and implementation efforts, is possible because of the vastly different sustainability reputations that exist for these two cities. Variations in climate help to address the possible rival explanations for poor air quality that are discussed and outlined in Chapter 2.

Significance of Research

The significance of this research has both practical and theoretical implications. Better understanding how a cities political culture drives planning and policy development can assist planners with developing better strategies for directing growth and priorities. Research collating the effects of the built environment on public health in regards to non-participatory illnesses, specifically asthma and respiratory diseases, is relatively overlooked by current literature, as demonstrated by the call for additional research "into the substances that are linked to asthma and the efficacy of primary and secondary intervention strategies" by the Global Initiative for Asthma (2010; as citied in Farrah, Glazner, Roose, Syrett & Youssef, 2011, p. 10). Therefore, continuously drilling down on the proven and claimed benefits of various sustainable built environment outcomes provides cities and developers with the necessary tools to make informed, sustainable decisions.

With the current abundance of research focusing on how the built environment can influence personal behaviors, it is essential to continue to examine the strictly environmental factors that might be contributing to the decline of public health and what, if any, role the built environment might play. With growing concerns of global climate change, it is important to continue to examine the extent of the potential impact on public health and quality of life from different perspectives in order to determine more effective planning strategies.

In this dissertation, I examine if asthma has any correlation to the existence of sustainable built environment policies and outcomes, and if these outcomes have any significance to air quality in order to gain a better understanding of the relationships between the built environment, air quality and asthma. The limitations outlined in the existing literature regarding municipal sustainability commitments and the effectiveness of their implementation are addressed by reviewing the cities' commitments to sustainable built environments, as outlined in city planning documents, and then evaluating specific built environment initiatives implemented that effect air quality, which then are utilized to ascertain their significance to the number of asthma cases within each of the respective cities. It is critical to continuously assess municipal planning and implementation strategies, as noted in the literature (Levy, 2013; Saha, 2009). Providing possible evidence that connects select sustainable built environment initiatives, including transportation systems and policies, parks and green spaces, and green building practices, to incidences of asthma allows for more effective planning in the future. The theoretical significance of this research is identified by addressing the larger questions of the true value of sustainable built environment outcomes by evaluating the prevalence of select variables on public health. The results provide evidence to either support or contradict the current literature.

Limitations

As outlined above, sustainability is a broad and complex topic encompassing a variety of environmental, economic, and social issues. My research examines a targeted sustainability tool: the built environment and its impact on one environmental component: air quality, and one social concern: asthma. It is not evaluating how sustainable a city is through the multitude of sustainability criterion or indicators. It is however, evaluating the sustainable built environment commitments affecting air quality made by a city, how these commitments have translated to outcomes, and how these outcomes influence air quality and incidences of asthma.

The literature calls for future research to gain a better understanding of how asthma effects select disadvantaged populations (i.e. elderly, young, poor). My research is limited to evaluating hospitalizations due to asthma related illnesses by zip code only. The existing asthma data is not available by age group and zip code. Additionally, the availability and organization of asthma data limits examination to inpatient discharges only. Therefore, the number of asthma cases could potentially be underestimated given the lack of consideration to emergency room visits or populations who do not seek medical care due to access or economic issues.

The literature calls for future research that examines how the built environment impacts multiple health issues and how to reap multiple health benefits from the built environment. However, my research focuses solely on asthma and the supported built environment outcomes that influence outdoor air quality. It does not include built environment outcomes that affect indoor air quality, other health issues, nor does it examine personal behaviors within the built environment. By focusing on how the built environment influences outdoor air quality and how that air quality impacts asthma, benchmarks for additional research are established to result in more targeted policies and manipulations to the environment for the greatest impact. Additionally, given the emphasis of my research on the passive influence of the built environment on air quality and respiratory health, I am not examining the social equity issues, such as access, living conditions, or support services. Lastly, genetic causes of asthma are not examined.

There are inherent limitations to case study research, including the inability to make statistical generalizations for larger populations. However, following a strict research design that is replicable, provides the framework necessary to better understand empirical concepts, principles, and lesson learned in order to draw analytic generalizations. These generalizations are then utilized to redefine ways for interpreting existing research or identify new areas of research (Yin, 2014). Additionally, both cases selected are cities from the same state; therefore there may be certain unidentifiable variations across places. However, according to Yin (2014), generalizations or lessons learned may still potentially apply to other cases despite a strict cohesion to 'like-cases'.

Assumptions

My research relies on the evidence provided in previous research indicating that the variables examined have an affect on air quality and that air quality has an affect on asthma.

Additionally, I am assuming that the sustainable built environment indicators, identified in existing literature to impact air quality and respiratory health, do actually have an effect.

City staff, official websites, and other government or regulatory agency sources provided the majority of the data for this research. There is an inherent assumption that the data provided is accurate.

In the Following Chapters

In Chapter 2, I expound on the literature regarding air quality, specifically the measurements, influences and how poor air quality triggers and exacerbates asthma. Asthma burdens the health system with annual costs of approximately $19.7 billion in direct and indirect health care costs and accounts for almost 13 million outpatient visits per year (Farrah et al., 2011). The following section reviews how the built environment impacts air quality and asthma, identifying the value of select sustainable built environment strategies. These strategies are utilized in my research to confirm or deny a relationship to incidences of asthma. Lastly, a review of municipal sustainability planning strategies, evaluation studies, and political culture influences provides the framework for my methodology. The identifiable best practices from the literature supplies the structure for assessing and scoring city sustainability commitments, as well as the relevant and measurable indicators necessary for a holistic, comprehensive evaluation of all possible rival explanations for air quality and the prevalence of asthma.

The case study methodology for my research is articulated in Chapter 3, starting with the research design, which outlines the case study questions, units of analysis and methods for interpreting the data. This is followed by design quality measurements and the multiple-case study protocol that defines the case theories for my study, as well as case selection and data collection procedures. A detailed review of the variables and data sources is included. The content analysis framework is outlined for measuring the sustainable built environment commitment level in each city. Followed by the protocol for conducting interviews of city managers and sustainability directors in each city. Finally, a description of procedures is provided to ensure the study is replicable.

The findings from my study are outlined in Chapters 4, 5 and 6 in the individual city case studies and the cross-case analysis. I expected to find from the individual case studies that political culture influenced the level of commitment to sustainable built environment policies and a greater number of policies resulted in more sustainable built environment outcomes. In support of the arguments in the literature that certain sustainable built environment outcomes utilized in this study actually had an affect air quality, more bike lanes, parks, green spaces mixed-use and transit-oriented developments, LEED and Energy Star buildings and higher rates of density should have resulted in better air quality and fewer cases of asthma. Therefore, I expected that the air quality was better when more sustainable built environment outcomes were implemented and that better air quality resulted in lower cases of asthma. However, fluctuations in policy counts and built environment outcomes between 2005 and 2013 did not appear to correlate or impact air quality and asthma at this level. There was however, evidence to support the expectation that political culture influenced sustainable built environment policy commitments.

In the cross-case analysis I expected the City of Austin to have a more progressive political culture, resulting in more sustainable built environment policies than the City of Fort Worth. Additionally, I expected Austin to have implemented more sustainable built environment outcomes, therefore having better air quality and lower incidences of asthma. The evidence collected and analyzed supported each of these expectations for the cross-case analysis.

Possible rival explanations for the evidence not supporting these theories included, specific topographical, geographical, climatological, or other demographic variables. My conclusions and recommendations are summarized in Chapter 7. This includes any identified limitations and areas for future research.

Chapter 2

Literature Review

Air Pollution: Measurement, Causes and Influences

The concern regarding air quality was first initiated by the infamous coal-induced smog events of the late 19th and early 20th century. The deadliest smog occurrence was the *Great Smog of 1952* in London, which killed an estimated 12,000 people and spurred an environmental movement (Bell et al., 2004, Engelke & Frank, 2005). The air quality coupled with the general degenerating urban living conditions in industrialized cities created the foundation for modern day concerns over air quality and the resulting impacts on quality of life. In response to the growing concern regarding pollution, the United States Environmental Protection Agency (EPA) was established in 1970. The EPA's first piece of legislation was the Clean Air Act of 1970, which authorized the EPA to establish standards for air quality, transportation emissions and anti-pollution (EPA History, 2014). The established standards fall under the level "where there will be almost no harmful human health or environmental effects" (WWF Air Quality, n.d., n.p.). In the United States, a few cities and states addressed growing public concerns for air quality by instituting more rigorous standards than those set by the EPA, which according to Sharp Jr. (2005), are insufficient for controlling ozone formation due to increasing urban temperatures.

The quality of air is determined by measuring the quantity of pollutants or greenhouse gases in the atmosphere. These measurements are then compared to the acceptable levels and standards outlined by the EPA for those pollutants (WWF Air Quality, n.d.). High concentrations of these greenhouse gases, or gases that trap heat in the atmosphere, result in poor or unhealthy air. The primary greenhouse gases, as outlined by the EPA, include carbon dioxide (CO2), methane (CH4), nitrous oxide (N20), and a variety of fluorinated gases. There are both indoor and outdoor elements that impact air quality. However, this review only examines the outdoor aspects, both natural and man-made or anthropogenic, which cause and influence air pollution. "Pollutant generation is an inherent by-product of burning petrochemicals, including coal, oil, and natural gas" (Engelke & Frank, 2005, p. 201). People cause most air pollution, whether it is from emissions derived from industry, transportation systems, or aerosol cans (West & Evers, n.d.). A couple of examples of the natural sources of air pollution include smoke from fires or ash from volcanoes.

The Urban Air Quality Management Toolbook (n.d.) categorizes the factors that influence urban air quality into four facets, which are the geographical setting, climatological and meteorological factors, city planning and design, and human activities in urban areas. The geographical setting includes information on the altitude of the city, the presence and location of hills and valleys, plains, bodies of water, mountains, deserts, and other topographic elements. This includes the vegetation and green spaces within the city, including forests and parks. These elements impact the concentration, dispersion and deflection of air pollution. For example, "hills deflect the flow of contaminated air, either vertically or horizontally" (Urban Air Quality Management Toolbook, n.d.). Additionally, wind can carry pollutants throughout valleys where the depths of the valleys actually impact the degree of dispersion. Coastal areas have limited geographical barriers to aid in air pollution dispersion.

The second category that impacts air pollution dispersion is climatological and meteorological factors. Some of the aspects include temperature, turbulence, wind speed and direction, precipitation, and humidity. Air pollutants behave differently in different climates. If there are high winds near the air pollutant discharge location, then the pollutants disperse more rapidly. Climatic conditions can greatly increase air pollution problems. For example, if the temperature in an area increases as the height increases, the turbulence is inhibited, making the air more dense and difficult to integrate or mix with the pollutants. This phenomenon occurs most often in colder climates. If the opposite were to occur, where the temperature decreases with height, the pollutants would rapidly disperse, resulting in an unstable atmosphere (Urban Air Quality Management Toolbook, n.d.). Sharp Jr. (2005) presents empirical evidence linking increased urban temperatures to increased ozone formation.

The third category outlined in the Urban Air Quality Management Toolbook (n.d.) is city planning and design, which includes the structure of settlements and physical development.

Types of buildings, proximity of structure to one another, land uses, and green spaces are all variables to be considered. For example, industrial land designations contain pollution emitting factories, while inner city parks and forests help to filter the air by absorbing CO2 and releasing oxygen. “Open spaces planted with trees, shrubs, and grasses alter the local climate, increasing wind speeds and reducing temperatures, thereby encouraging air circulation and thus increasing the dispersion of pollutants. Even very small areas of open space in an urban area can reduce particulate pollution levels” (Cho & Choi, 2014, p. 5969-70). Stone Jr. (2005) emphasizes the significance of the physical design of cities influence on increasing regional temperatures.

According to the United States Green Building Council (USGBC), the built environment and transportation systems are responsible for more than two-thirds of all greenhouse gas emissions (USGBC, 2009). Urban sprawl and the expansion of highway systems can be attributed to increased amounts of air pollution and negatively impacting air quality (Srinivasan et al., 2003). Decentralizing cities inherently strengthens the reliance of the automobile and without technology advances, regulations, and municipal mitigation strategies, emissions would continue to increase and damage the quality of air.

Several urban development and growth patterns, such as sprawl, impact the movement and dispersion of pollutants. Urban sprawl increases the demand and reliance on the automobile, in addition to generating more traffic, all resulting in greater emissions and pollutants. Additionally, the high-rise buildings in dense, central business districts can cause what is called the “street canyon effect”, which affects temperature, wind speed and direction, and consequently air quality. The exact contribution of urban sprawl on air quality is difficult to ascertain since there is no current standardized system that exclusively measures the effects of sprawl on air quality (Braman, 2006).

The fourth and final category influencing air quality in cities is the human component, which as stated earlier is the primary cause of most air pollution in urban environments (Urban Air Quality Management Toolbook, n.d.; West & Evers, n.d.). Behaviors include energy production and use, waste management, transportation preferences, and development practices. The EPA reported in 2012 that carbon dioxide accounted for 82% of the greenhouse gas emissions in the United States. Together, electricity generation and transportation make up 70% of the carbon dioxide emissions in the United States, generating 38% and 32% respectively. Individual behaviors are impacted and dictated by experience and level of awareness regarding air-polluting activities. The society's wealth and education level have a direct correlation to the level of awareness of polluting behaviors (Urban Air Quality Management Toolbook, n.d.). According to Braman (2006), there are few clear connections between westernization and air quality. However, westernized cities are greater contributors to poor air quality because of their heavy reliance on modern transportation systems and urban development practices.

Poor air quality and pollution are most common in large, metropolitan cities where emissions from a variety of sources are concentrated (West & Evers, n.d.). However, there are many debates as to the location within cities that causes the greatest exposure to air pollution. Frank & Engelke (2005) argue that the greatest exposure is in the urban core due to the high concentrations of emissions caused by increased density. While Brunefreef (2002) states that the concentration of pollutants is greater in suburbs as a result of "scavenging of ozone by nitric oxide originating from traffic" and combustion of fossil fuels from stationary sources (p. 1235). However, Cho & Choi (2014) points out a largely missing attribute from the literature, which is the importance of geographical and topographical conditions, such as wind direction, wind speed, turbulence, and atmospheric stability, in the "dispersion and dilution of air pollutants" (p. 5969). "The dispersion and dilution processes result in ambient air pollution, which shows concentrations of different substances varying in relation to time and space" (Cho & Choi, 2014, p. 5969). A study in Korea demonstrated the importance of these additional variables by the resulting lower concentration of pollutants measured at the point source as opposed to various locations further out from the source (Cho & Choi, 2014).

There are many studies that found a significant association between exposure to pollutants and proximity to major roads and highways (Bernstein, 2004; Jarrett et al., 2005). Therefore, identifying and incorporating proximity and road-type measurements into air quality research is valid and useful, especially when research questions and health effects assessments are at a formative stage (Jerrett, 2005, p. 188). Understanding the nuances of how travel can impact air quality continue to be a source for further examination due to the complexity of the relationship, according to Engelke and Frank (2005). The goal of improving air quality is best achieved by increasing walking and biking trips while reducing vehicular trips or the emissions associated with vehicular travel (Engelke & Frank, 2005).

Future research regarding the different design characteristics of metropolitan areas with measured levels of air pollution associated with lower levels of each type of air pollutant would be beneficial, according to Dannenburg (2003). Including descriptions of the demographic characteristics as well, like age, household structure, income level and race/ethnicity. Given the increased demand for transportation and the assertion in many studies that the demand will exceed advancements in emission reduction technologies (Delucchi, 2000; Faiz, 1993 as citied in Jerrett et al., 2005), exposure to related pollutants may vary more within cities than between cities (Briggs, 2000; Zhu et al., 2002 as cited in Jerrett et al., 2005).

Air Quality and Health

City design and behavioral patterns, such as urban sprawl and transportation practices not only impact air quality and the environment, but also have a significant negative effect to human health (Engelke & Frank, 2005; Srinivasan et al., 2003). Air quality and health have been the source of many governmental regulations, as well as a source of public concern, over the past few decades. It is estimated that thirteen million deaths annually can be attributed to preventable environmental causes (Remoundou & Koundouri, 2009). According to Remoundou and Koundouri (2009), significant health benefits can result from air quality improvements since “air pollution is a major environmental risk to health and is estimated to cause approximately two million premature deaths per year…[and] a reduction in air pollution is expected to reduce the global burden of disease from respiratory infections, heart disease, and lung cancer” (p. 2165). Markandya and Chiabai (2009) discuss the health impacts of climate change, in particular the effect of extreme temperatures on urban air pollution and the resulting aggravation to pre-existing or subsequent respiratory and cardiovascular diseases. Additionally, the increasing reliance of pesticide use and mass-production practices in the agriculture industry has contributed to air pollution, resulting in greater rates of asthma and respiratory issues (Srinivasan et al., 2003).

Lung cancer, asthma and chronic obstructive pulmonary disease (COPD) are the three primary respiratory illnesses (American Lung Association, 2014). Of those three, asthma is the most prolific with 1,846,803 cases in Texas, compared to the 984,708 cases of COPD and 5,089 of Lung Cancer, as reported by the American Lung Association in May 2014. According to the World Health Organization (WHO, 2009), incidences of asthma are rising due in part to environmental factors. There have been several studies conducted with evidence mounting and confirming that high concentrations of greenhouse gases further aggravate asthma symptoms (Engelke & Frank, 2005). One study in Atlanta, Georgia showed that high ozone concentrations, or greenhouse gases, correlated with more emergency room visits for asthma within the region (Tolbert, Mulholland et al., 2000, as citied in Engelke and Frank, 2005). The emergency room visits decreased during the 1996 Summer Olympics due to the measures taken by the city to encourage public transit use over personal automobiles.

High vehicle traffic has been associated with asthma and exacerbating symptoms in people with known allergies (Bernstein, 2004). One study conducted by Jerrett et al. (2002) found that women between the ages of 20 and 44 who lived within 50m of a major road, were associated with a 50% increased risk of reporting asthma symptoms (Jerrett, 2005, p. 187). A significant association was not found for men. Additionally, Bernstein (2004) concluded that exposure to diesel exhaust particulates increased airway inflammation, exacerbating allergies and asthma symptoms.

Some studies reported that asthma symptoms were more prevalent on days with “high aerosolized acid levels” (Bernstein, 2004, p. 1120). According to Brunekreff (2002), “exposure to pollutants such as airborne particulate matter and ozone has been associated with increases in mortality and hospital admissions due to respiratory and cardiovascular disease. These effects have been found in short-term studies, which relate day-to-day variations in air pollution and health, and long-term studies, which have followed cohorts of exposed individuals over time" (p. 1233). Airborne particles have altered in size and composition, which has resulted in a change in their level of toxicity (Brunekreef, 2002). Seaton (1995) references fourteen different studies, from various climatic environments and conditions, linking concentrations of small particles in the air to increased daily mortality rates, as well as acute attacks of asthma. However, some studies regarding exposure to children have indicated that an increase in asthma symptoms or attacks is only greater when those individuals already have asthma (English et al., 1999).

As demonstrated by the interventions implemented by the city of Atlanta, targeted municipal strategies can positively impact public health. Remoundou and Koundouri (2009) argue that since the environment and health are "so intimately linked" so should their policies (p. 2170). Understanding "the linkage between ozone and asthma, a health condition that has been on the rise in the United States and elsewhere for years," as well as how incidences of asthma can be reduced, are vital areas for future research (U.S. Department of Health and Human Services, 2000; as cited in Engelke & Frank, 2005, p. 203). In addition, the growing affects asthma has on the most disadvantaged populations in our society, including those who are poor, young and elderly, should continue to be evaluated (Braman, 2006).

Sustainable Built Environment and Respiratory Health

In the last decade the awareness that land use, transportation systems and community design affect public health has increased (Dannenberg et al., 2006). The number of academic programs concentrated in public health and sustainable development has tripled every five years (Matheson et al., 2014). In an effort to demonstrate the growth in this field, Jackson et al. (2013) reviewed and compared the number of articles written between 2003 and 2013, as well as the previous decade, utilizing the keywords, *built environment* and *health*. There were 675 articles between 2003 and 2013 as compared to the 39 written in the previous decade. Though there are many variables involved that contribute to the overall quality of public health, the built environment has been identified as a "significant potential contributor" (Cerin, 2011, p. 151). Many have identified major health benefits of being in contact with the natural environment, including green spaces and parks (Jackson et al., 2013; Srinivasan et al., 2003). Studies have shown that more compact developments, good public transportation systems and strong connectivity of street networks has decreased emissions and improved air quality (Engelke & Frank, 2005; Hutch et al., 2011). However, implementing additional strategies for reducing the exposure from traffic congestion and pollutants on residents in central cities is essential even with some evidence to support emissions reductions. Evidence is noted in a study by Frank, Stone, and Bachman (2000) that demonstrated an association between street connectivity and density that reduced levels of emissions of all three primary pollutants: nitrogen oxides (NOx), volatile organic compounds (VOCs), carbon monoxide (CO) (Engelke & Frank, 2005).

A variety of chronic health conditions, like asthma, cardiovascular disease, diabetes and cancer, can be alleviated or eradicated by altering the design and select characteristics of the built environment (Hutch et al., 2011; Jackson, 2003). However, Lovasi (2012) argues that there are still questions "as to whether built environments can be effectively designed to cause health improvements" (p.167). Srinivasan (2003) goes on to stress the difficulty of determining causal relationships between specific health issues and the built environment. The National Institute of Environmental Health Sciences established several objectives "to better understand the connection between specific illnesses and health challenges in the built environment" at a conference in July 2002 (Srinivasan et al., 2003, p.1448). Some of these objectives included:

- Develop effective measures and indicators for sustainable communities.
- Conduct multidisciplinary research on the positive health impacts of sustainable and planned communities.
- Assess the environmental health benefits of efficient or alternate energy (for transportation, agriculture, architecture, community design, an so on).
- Create coordinated programs between Federal and nonfederal agencies that address research on the built environment.
- Identify factors and variables that mediate and moderate built environment health effects.

- Study methods and channels to translate research findings into policy and to the community-at-large that improve public health.

In spite of a few coordinated efforts, the United States has been relatively slow to establish a research agenda to better understand the interactivity between the built environment and public health outcomes (Frumkin, Frank & Jackson, 2004, as cited in Engelke & Frank, 2005). Lovasi (2012) emphasizes the significance of future research “to assess how the multiple associations with health are related to each other and whether those associations are causal” (p.167). Taking into account the characteristics of the population and relevant social contexts should be major considerations as well. Frumkin (2003) discusses four areas of the built environment, including nature contact, buildings, public spaces and urban form, which should be researched further to better understand how they can improve health. An examination of how sustainable communities’ impact public health and quality of life is necessary, according to Srinivasan et al. (2003). Jackson et al. (2013) calls for “more research to gain a full understanding of how to reap health benefits from the built environment” (p. 1383). This research should examine all scales, ranges of health outcomes from respiratory health to mental health, and those populations most impacted. One study utilized a framework called RE-AIM which stood for reach, effectiveness, adoption, implementation, maintenance to evaluate the impact of built environment initiatives and projects on health behavior. A major drawback of this model was the difficulty identifying the exact data for the intended target population (King et al., 2010).

Much of the existing research has emphasized how the built environment can encourage physical activity and behavior changes that address obesity and other health issues impacted by weight and exercise (Srinivasan et al., 2003). Transportation, housing and disparities among populations are other primary areas of research regarding the built environment and public health. Though my research focuses on evaluating the impact of specific sustainable development characteristics of the built environment on outdoor air quality and respiratory health, significant studies and findings within these primary areas of research are outlined below in order to identify relevant benchmarks, indicators and research gaps.

Physical Activity and Behavior

The built environment has a role in promoting healthy behaviors and reducing health risks (King et al., 2010). Several government reports acknowledge the role of the built environment on health, especially with regard to obesity (Jackson, et al., 2013). However, it can also impede healthy behaviors by limiting access and failing to provide appropriate solutions for the targeted populations based on individualized social and demographic information (Booth et al., 2005; Lee & Moudon, 2004; Saaloos et al., 2009). Ferdinand et al. (2012) reviewed 169 articles examining the link between the built environment and physical activity with 89.2% of them reporting a beneficial relationship. McCormack and Shiell (2011) discovered that land use, connectivity, population density and overall neighborhood design were important determinants of physical activity. However, Oka (2011) argued that the physical design of environments alone were not enough to promote physical activity; the social component needed to be addressed as well since the relationships people had with their environments were dynamic. Successful behavioral interventions require a multidimensional approach between public health, urban planning and transportation in order to fully understand how and why the built environment influences resident's behaviors (Cerin, 2011).

Saaloos et al. (2009) discussed the influence of built environment programs and strategies on influencing a desired behavior to improve health, in particular how the built environment persuades or dissuades physical activity and how that relates to obesity. Mehta (2007) examined the behavioral responses of people to the environmental qualities of three commercial streets by structured and unstructured observations, finding that the physical design and aspects of a neighborhood do elicit certain types of behaviors from people. Booth et al. (2005) examined the literature regarding the built environment and obesity. A study conducted by Ewing and colleagues in 2003 found that individuals in sprawling counties weighed more, exercised less and had more diagnoses of hypertension. Kelly-Schwartz et al., (2004) examined the influence of sprawl on health, where the results indicated residents with higher accessible and gridded street networks had higher health ratings; residents in more densely populated urban areas had lower rated health; sprawl itself had no significance to the frequency of walking, BMI or diagnosis of various chronic disease. Several studies found that the quality and amenities of an individual's environment directly related to incidences of obesity and overweight tendencies (Booth et al., 2005). Access to public transportation and open spaces, sidewalks, street connectivity, density and mixed land uses were some of the built environment characteristics associated with lower rates of obesity. Even in light of these studies, Ferdinand (2012) calls for more rigorous scientific research to determine whether built environments will result in increased physical activity and decreased obesity rates.

Frank and Engelke (2001) reviewed select evidence identifying the health benefits of engaging in physical activity, specifically walking and biking, along with the environmental influences and barriers to physical activity. Urban design features are more important to pedestrians and cyclists because they experience the streetscape more intimately than motorists (Frank & Engelke, 2001). Therefore, providing bike lanes, sidewalks, and cross walks, as well as thoughtful placement and design of buildings, parking lots and other neighborhood features would be some of the tactics to encourage nonmotorized travel (Owens, 1993; as citied in Frank & Engelke, 2001). Accessibility to recreational facilities has also been a major contributor to physical activity (Lee & Moudon, 2004). A quantitative study conducted in Perth Australia regarding environmental factors that precipitated the engagement in recreational walking confirmed the importance of connectivity, attractiveness and accessibility (Sugiyama et al., 2010). Boarnet et al. (2008) utilized regression analysis and a cost-benefit analysis framework to monetize the estimated health benefits of various urban design characteristics related to walking in Portland, Oregon.

Transportation

Much of the research regarding physical activity interventions intersects with transportation and health research, however, as noted above, there are many other built environment influences on behavior besides transportation, such as design, green spaces, density and connectivity. Therefore, I thought best to separate the literature into two sections.

The following studies provide insight to the intricacies specifically related to the transportation field of the built environment and how it affects public health. According to Hutch et al. (2011), "metropolitan planning organizations have approved plans up to $244 billion in transportation funds that support investments in transportation choices to improve air quality while reducing mobile source pollutions" (p. 592). Engelke and Frank (2005) hypothesized a three-phase process for built environment influences on public health: "first, by its direct effect on motorized travel; second, by the effect produced by the resulting automobile emissions on air quality; and third, by the relationships between air quality and health" (p. 201). Northridge et al. (2003) explains the complication with quantifying the relationship between land-mix and travel behavior, making the connection to public health outcomes difficult.

The process of urban sprawl has allowed development to occupy new green spaces further and further out from the central city. The loss of centrality, rise of agglomeration economies, and overall shaping of development, can also be attributed to automobile dependency resulting in environmental consequences and resource dependence. The land use and transportation patterns associated with urban sprawl have serious health implications. "Heavy use of motor vehicles contributes to air pollution, which increases respiratory and cardiovascular disease as well as overall mortality" (Frumkin, 2003, p. 1454). Jackson (2003) also states that residents in low dense areas are less physically active, resulting in higher propensity for health problems. Stone Jr., Mednick, Hollawoy and Spak (2007) found that a 10% increase in population density would result in a 3.5% reduction in household vehicle travel and emissions. "The Livable Communities Initiative in Atlanta won the EPA's National Smart Growth Award by leveraging transportation funds for improving air quality with private-sector and government sources to transform declining towns and villages into thriving walkable, transit-oriented communities" (Hutch et al., 2011, p. 592). A study in northern Manhattan examined the effects of diesel pollution, which resulted in new idling policies and route changes for buses (Srinivasan et al., 2003).

As previously outlined, there are several built environment strategies for influencing behavior that should also be considered when examining the implications of transportation solutions. The traditional solution for congestion is to build more highways, however increases in transportation supply often leads to increased demand (Noland, 2001, as cited in Engelke & Frank, 2005). "Increasing roadway capacity within these central locations, more often than not, will reduce the likelihood of being physically active or of breathing healthy air" (Engelke & Frank, 2005, p. 212). In a study conducted in Tarrant County by Li and Newcomb (2009), they found a slight significance in the proximity to roadways and traffic density to increased cases of asthma.

Housing

Research regarding housing and public health has been extensive, but surprisingly the majority of the evidence linking housing directly to health issues is limited (Shaw, 2004). Respiratory health is the primary health outcome related to housing due to poor indoor air quality (Shaw, 2004). The cold, damp conditions of poor, substandard housing, along with insufficient ventilation, are associated with greater incidences of chronic respiratory disease (Hernandez, 2013; Krieger & Higgens, 2002; Shaw, 2004). Additionally, exposure to pollutants, like lead or carbon monoxide, results in poor indoor air quality within the home and can cause a variety of health issues, including asthma. The importance of these improvements are validated by an Environmental Protection Agency (EPA) study stating that people spend approximately 90% of their time indoors (USGBC, 2009).

Thomson et al. (2003) reviewed several studies that attempted to connect housing improvements to improved respiratory health, primarily in children. Of the thirteen studies reviewed, ten showed some health improvements, five showed no difference in some of the measures and some found mixed results. "One study found children's respiratory symptoms improved and fewer days were missed from school due to asthma three months after installation of central heating" (Northridge et al., 2003, p. 562).

Sustainable building practices provide a method for ensuring safe, healthy housing. The EPA states "green buildings are designed to reduce the overall impact of the built environment on human health and the natural environment” (EPA Green Building, 2014, p.1). Sustainable or green building practices specifically related to respiratory health and the quality of air, primarily indoor, include the minimal use of pollutants that generate fewer emissions. Green buildings emit less greenhouse gases, use less energy, and produce less construction waste, which potentially results in less methane production in landfills (EPA Green Building, 2014). Based on study by the New Buildings Institute, green buildings average approximately 24% less energy than conventional buildings, result in higher levels of occupant satisfaction, lower maintenance costs, carbon dioxide emissions, water usage, and indoor air pollutants (USGBC, 2009). There are two primary green building certification bodies, the EPA’s Energy Star program and U.S. Green Building Council’s Leadership in Energy and Environmental design (LEED) program. However, certification is not required and many builders and developers utilize sustainable construction practices without submitting for certification. This is primarily due to the high costs and labor-intensive process of documentation and reporting.

Social Equity

My research is focused on determining if select sustainable features of the built environment affect the air quality or number of asthma cases in a city, in order to provide evidence to support future sustainable strategies. It is important that actual outcomes match with the promoted or assumed outcomes. Although my research is not examining the interaction between people and the built environment, nor the equity issues associated, I thought it was important to briefly review the significant literature and evidence regarding some of the disparities that exist within the built environment. Lovasi (2012) stresses the importance of examining and understanding how different populations engage and interact to the built environment. In 2006, the Federal Collaboration on Health Disparities Research identified the built environment as one of the top approaches for eliminating health disparities (Hutch et al., 2011). Hutch et al. (2011) reviews the literature outlining the clear association between health and socioeconomic status, and discusses strategies for eliminating health disparities among disadvantaged populations through the built environment. Some of these strategies included, preserving open spaces;

utilizing green building practices; encouraging compact growth, and the development of transit-oriented and walkable communities.

The results of a study conducted by McCormack and Shiell (2011) concluded that lower socio-economic and minority groups had fewer opportunities for physical activity and higher odds of obesity. Gordon-Larsen et al. (2006) conducted a study that looked at the locations of physical activity facilities and the disparity of access that led to increased prevalence of overweight adolescents in the United States. Minority communities are more affected by poor air quality (Hutch et al., 2011). Hernandez (2013) argues "economically disadvantaged populations disproportionately occupy housing units with poor air quality and harmful temperature and humidity conditions, resulting in excess moisture, dampness, and mold, conditions that can trigger respiratory illnesses such as asthma" (p. e1). In a study conducted in Tarrant County by Li and Newcomb (2009), they found that children with asthma were concentrated in "census block groups with high percentages of non-white population and poverty rates" (p. 321). The *Southern California Environmental Health Project* was able to prevent oil refineries from reopening in low-income, minority neighborhoods based on evidence provided to city planners regarding the negative effects of air pollution on the children within the neighborhoods (Srinivasan et al., 2003).

The Built Environment Workgroup Economist (D.J.H.) formulated a financial health benefits model for calculating the national 30-year projected savings from smart growth developments on mitigating cardiovascular disease, cancer, and asthma within minority populations. According to that model, the cumulative benefits were up to $228 billion over 30 years (Hutch et al., 2011). As the growing consequences of global climate change become more prevalent within the intersection of the built environment and health, additional research and innovative solutions that help guide policy and increase awareness of the inequalities of vulnerable populations, primarily regarding comparable housing conditions, will be necessary.

Municipal Planning: Sustainability and Public Health

My research evaluates the level of commitment to sustainable built environment strategies demonstrated by cities in their comprehensive plans and other policy documents, then evaluates how these commitments or policies and the related built environment outcomes correlate to air quality and incidences of asthma within the respective cities. Therefore, it is important to understand the influences and benefits of sustainability planning and how it can impact the health and quality of life of citizens. The role that political culture plays in a city's engagement in sustainability planning and implementation is discussed. Additionally, sustainability planning assessment methodologies established in practice and research is reviewed. Historically, planning and public health have worked hand in hand, however with the onset of increased legislation, professionalization and specialization the fields have become isolated (Jackson, et al., 2013).

Markandya and Chiabi (2009) identify urban planning as a means for anticipating and responding to the environmental needs brought about by climate change. Even though planners still may not fully understand the health consequences of environmental factors (Srinivasan et al., 2003). Over the last decade, there has been a greater understanding of how planning of cities can affect a range of health impacts, from obesity and asthma to cardiovascular disease and cancer, by implementing various sustainable built environment features, such as "green space provision, traffic management, urban climate control, air quality management and building standards" (Rydin, 2012, p.xiii). Northridge and Sclar (2003) outline the need of a joint public health and urban planning framework in an effort to continue to bridge the gap between planning and environment. Characteristics of this framework are "to move toward mixed land use (vs segregated land use), long-term sustainability (vs. short term expediency), mass transportation and walking (vs. automobile dependency), urban redevelopment (vs. urban renewal), and a viable, functioning public sector (vs an unregulated market and vested interests)" (p.558).

According to Northridge and Sclar (2003), as stated by Stephen Wheeler,

> In this age of entrenched economical and political forces opposing sustainability, no single planning effort is going to set cities on a path towards a healthy long-term future. Rather, the need is for a long-term strategy emphasizing consensus processes, public education, political organizing, policy tools such as indicators and performance standards, development of vision documents and "best practice" examples, and the creation of institutions that can more effectively address physical planning and equity issues. Together, such efforts can develop the knowledge, political will, and institutional capacity to bring about change (p.120).

Influence of Political Culture

The study of political culture has evolved over the years and has been the source of much debate and interpretation (Branson, Schecter & Vontz, 2009; Elazar, 1970; 1994; Silver & Dowley, 2000). This is due in large part to the broad definitions of political culture, which involve complex social systems that are difficult to quantify. Additionally, the lack of a standardized method for assessment and unit of analysis only add to the variance of interpretations. Sharp (2005a) attributes the unit of analysis issue of defining culture to the absence of established, specific boundaries. The International Encyclopedia of the Social Sciences (1968) defines political culture as "the set of attitudes, beliefs and sentiments which give order and meaning to a political process and which provide the underlying assumptions and rules that govern behavior in the political system. It encompasses both the political ideals and operating norms of a polity. Political culture is thus the manifestation in aggregate form of the psychological and subjective dimensions of politics. A political culture is the product of both the collective history of a political system and the life histories of the members of the system and thus it is rooted equally in public events and private experience" (n.p.). Many of the other various definitions are merely variations of the above, however the differences emerge in the manner in which scholars attempt to measure and categorize political culture.

In 1963, Almond and Verba wrote the book, *The Civic Culture: Political Attitudes and Democracy in Five Nations,* based on their research evaluating the political and social attitudes attributed to democracy at the national level. Almond and Verba (1963) identify five important dimensions of political culture, which are resonant to previous definitions of political culture.

These dimensions include, a sense of national identity, attitudes towards one's self as a participant in political life, attitudes toward one's fellow citizens, attitudes and expectations regarding governmental output and performance, and attitudes toward and knowledge about the political process of decision-making. Their study categorized each of the national cultures they examined into three categories: parochial, subject or citizen, based on the highest percentage of the population exhibiting corresponding characteristics. A 'parochial' designation indicated that the population was dimly aware and paid little attention to polity. The level of awareness and attitudes towards the individual's role in government increased slightly with the 'subject' designation and greatly with the 'citizen' label. Nations with more stable democracies consisted of a greater mix of citizens in their populations.

Elazar (1970; 1994) developed the first examination of political culture within a state and local context and his work provided the baseline for the growth and development of a 'new political culture' paradigm. Before this new paradigm is examined, it is important to first understand what existed before. Political culture, according to Elazar (1970; 1994), is related to the general culture of a particular society, but not identical to it, and is measured by race, ethnicity, religion, language and life experiences. Elazar (1970; 1994) identified three different categories of political culture, including *Individualistic*, *Moralistic*, and *Traditionalistic*. A breakdown of the characteristics of each culture type is described in the table below. Populations can be classified in more than one of the cultural types, however one type is identified as being predominant.

Table 2-1 - Characteristics of Elazar's Three Political Cultures

Characteristics of Elazar’s Three Political Cultures				
Culture Type	**Government**	**Economics**	**Politics**	**Initiative**
Individualistic	Viewed as utilitarian, a marketplace Limited intervention, at any level, into personal matters	Strong commitment to commercialism Treated like a business	Rooted in relationships (political parties) Not concerned about issues of a ‘good society’	Not likely to engage in new activities unless there is an overwhelming desire from the public, will be based on quid pro quo
Moralistic	Serve the commonwealth Committed to advancing the public interest and balancing the need for large-scale bureaucratic efficiency Little tolerance for corruption	Encourages local intervention & involvement	Strict adherence to political party is not important High calling, not for economic gain In search for a ‘good society’	Will initiate new programs without public demands
Traditionalistic	Maintain the social order of things No interference in interpersonal relationships Acceptable and expected to gain, indirectly, from participating in government	Ambivalent attitude toward the marketplace	Political parties not important – tied to strong familial and social connections Accepts hierarchal society – office is a privilege Power given to small group of select elite	If it serves the needs of the governing elite

Elazar (1970; 1994) attributes the shaping of cities to four “decisive” forces, which are the frontier, migration, sectionalism, and federalism. According to Elazar (1994), “the ‘geological’ base of location and its influence on political culture provides the context the political system will operate in, the broad limits of its discretion, structuring of its political concerns, and the continuing character of the political interaction within it” (p. 16). The geological base is only defined by the inclusion of governmental institutions, which demonstrates the unit of analysis issue outlined previously (Sharp, 2005a). The fundamental emphasis on geography is one of the major critiques of Elazar's work (Webster, 1996), along with the inability to allow for localized subcultures or deal with cultural changes in a community (Sharp, 2005a).

New Political Culture

In response to the decline of class-based conflicts and a rise of new social movements, many researchers have noted the ongoing evolution of culture and the emergence of a 'new political culture' thesis (Gromala, Hoffmann-Martinot & Clark, 1998; Sharp, 2005ab). Increasing levels of education, geographic mobility, and technological and economic changes are also important trends responsible for the gradual changing of political culture (Ronald Inglehart, 1977; as cited by Sharp, 2005b). Soha (2000; as cited in DeLeon & Naff, 2004) references the measured shift from "politics of equality" traditionally defined in economic terms to a "specifically cultural politics" aimed at understanding "how differences between people are intrinsically created, externally imposed, and culturally represented through a politically charged process of identity formation" (p. 691). In an effort to begin understanding these differences, Sharp (2005a) identified several additional trends for consideration, including changes in women's roles and growing numbers of nontraditional households.

Daniel Rosdil (1998, as cited by Sharp, 1995) argued that large subcultures that challenge traditional values have emerged in cities where these trends have developed the most. The subcultures create an unconventional social culture in the city. "Cities having such unconventional cultures are depicted as being dominated by a set of political values that include radicalization (in the sense of antisystem beliefs and values), a propensity to support new social movements, and a left-liberal predisposition" (Sharp, 1995, p. 23). Sharp (2005a) discusses the growing cultural divide between the 'culturally conservative impulses' and 'culturally progressive impulses' and credits Hunter (1991) as the notable authority of this "culture wars thesis" (pp. 6-7). Characteristics of some of these impulses are similar to those identified in the literature as 'new political culture'. Though there are ongoing debates on how to measure political culture and its impact on various social phenomena, there are general consensuses as to the broad characteristics of the ‘new political culture’, which are summarized in Table 2-2.

Table 2-2 – Characteristics of the New Political Culture

Characteristics of the New Political Culture			
Structure	**Party Affiliation & Platform**	**Issues**	**Citizens**
Transforming the classic left-right designation to a more neutral position	Decline of partisan loyalty	Increasing emphasis on social issues	Younger, better educated, higher paid citizens in high-tech occupations
Decline of hierarchal political organizations and class-based politics[1]	Focus on Issues	Shift from home/work issues to lifestyle concerns	Growing market individualism and social individualism
Increased citizen participation		Explicitly distinguishing between social and economic issues	Questioning the welfare state

Sources: Clark, 2000; DeLeon & Naff, 2004; Gromala et al., 1998; Sharp 2005ab

[1]An important consideration regarding the decline in class-based politics, attributed in the literature to be a trend responsible for the change in political culture, is the argument by some that new political culture populations would be considered a class in itself (Ansell, 2000; as cited by Gromala et al., 1998).

Political Culture: Policy Influence

The relationship between political culture, policy and implementation, according to scholars ascribing to the ‘new political culture’ thesis, is complex, dynamic and particular to the cultural system being examined. According to Elazar (1970; 1994), political culture influences national, state and local political systems by molding the political communities perceptions of the nature and purpose of politics, influencing the recruitment of special kinds of people to become active in government and politics, and by subtly directing politicians and public officials. Heck et al. (2014) defined state and local political culture “as the collective beliefs and values of citizens and policymakers about how political institutions and policy processes work, the role of each institution in the policy process, the proper rules of the game, and expectations about the feasibility of different policy options” (p. 9). Long-term core values of a community that are engrained, but challengeable, need to be widely shared by those in the community in order to represent political culture, not just political opinion (Silver & Dowley, 2000).

Public officials reflect the sub-cultural environment, “either because, as products of that subculture, they share its values and preferences or because reelection (or reappointment) imperatives force them to be sensitive to those values and preferences” (Sharp, 2005a, p. 14). The ability for policymakers to attribute quick policy changes to cultural differences is difficult given the long lasting characteristics of political culture (Sharp, 2005a). Additionally, city leaders are responsible for developing the image of the city, outlining what the city could or should become, which is utilized as a competitive advantage for economic development (Pagano & Bowman, 1997, as cited by Sharp, 2005a). Putnam, Leonardi and Nanetti (1993; Putnam, 2000) argued that social capital and the factors associated with it were essential for fostering economic prosperity and functional democratic processes.

The changing political cultures and growing cultural divide (Hunter, 1991; as cited by Sharp 2005b) have provided the setting for many scholars to examine the different characteristics associated with more progressive cities. Sharp (2005a) uses the term reformed to identify these more progressive cities. In her research she concludes that reformed cities generally have city governments with city managers, instead of mayors, elected city councils, and utilize nonpartisan ballots. Additionally, it is important to gauge the reformation of cities accurately and on issues to which they have the authority to address. Existing federal and state laws and regulations may impede a local community from responding to moral issues or policies in a manner that is truly representative of their political culture (Sharp 2005a). Taking into account variations in local political culture helps to understand why some social movements succeed and others fail (DeLeon & Naff, 2004, p. 694)

The influence of political culture was increasingly complex due in large part to the growing social nuances, choices, and issues prevalent in many urban societies, resulted in a need for additional indicators of measurement that were not considered before the ‘new political culture’ emerged. ‘New political culture’ researchers have included supplementary characteristics for consideration, in addition to race, ethnicity, and religion, such as, social diversity, nontraditional family structure and gender roles, the presence and acceptance of gays and lesbians, a low level of religious traditionalism and high levels of income and education (DeLeon & Naff, 2004, Sharp, 2005b).

Most analyses of political culture have assumed an existence of a national, universal political culture, thus asserting that the entire society shares a set of common values and beliefs (Silver & Dowley, 2000). However, DeLeon and Naff (2004) point out the complexity of political identity where individuals have a collection of possible alternate self-identities, such as race or gender, they can utilize in various different arenas. Bailey (1991) calls this “identity multiplexing” (as cited in DeLeon & Naff, 2004, p. 691). Other studies have attempted to evaluate these other possible self-identities in an effort to identify those that significantly impact political culture. Silver and Dowley (2000), supported by their research, argue that ethnic groups are more likely to share common values than all those in the total population. Paterson and Saha (2010) noted Sharp’s (2005a) findings that “sub-cultural and economic factors are most useful in understanding local government actions in regard to morality public policies” (p. 13). Ongoing research is necessary to further validate and identify a set of indicators and standards of measurement.

Political Culture: Influence on Sustainability Engagement

In an article discussing the politics of sustainability, Freidman (2012) called for a review of America’s foundational values to better understand why sustainability, which is very much inline with American values, is such a politicized hot topic. Packaging sustainability initiatives and platforms into strategically labeled boxes, such as ‘energy independence’ or ‘energy-efficiency’, are just a few methods for navigating the controversial topic. However, there are some cities and communities that have openly embraced sustainability and do not deter from using the term or engaging in a variety of sustainability-branded initiatives. These cities, according to Sharp (2005ab) are most likely reformed, progressive societies with high levels of income and education, low levels of religious traditionalism, with a greater acceptance and presence of nontraditional families, gays and lesbians (DeLeon & Naff, 2004, Sharp, 2005ab). “While it [new political culture] embraces environmental conservation, tolerance of diverse lifestyles, and liberal ethical standards, it is socially individualistic and fiscally conservative" (Paterson & Saha, 2010, p. 13).

Competing versions of political culture have different impacts on the environment, economy and equity dimensions of local sustainability efforts (Paterson & Saha, 2010). In an effort to begin to identify these impacts, Paterson and Saha (2010) conducted a study where they evaluated the influence of political culture on the implementation effectiveness of 36 local government sustainability initiatives using the old political culture framework (religion, race, ethnicity-based) and the new political culture framework. Their work is groundbreaking in that it begins to identify and standardize the political culture indicators that significantly effect the implementation of sustainability. Paterson and Saha (2010) found that the additional indicators identified in the 'new political culture' research provided a better explanation for city sustainability efforts. However, it is important to note the limitation of their study to infer causal relationships due to the use of cross-sectional data.

Outside of the political culture indicators, Paterson and Saha (2010) identified other factors that may influence sustainability implementation efforts in order to provide reliable potential rival explanations (Yin, 2014). These factors included city economic conditions, like population growth, unemployment level, poverty rate and revenue base, the state's influence on planning, and the government structure of either council-manager or mayor-council. The study found city revenue base significant to explaining implementation effectiveness, which was anticipated given the expectation that available city resources determine project investments. Many times sustainability initiatives are considered a luxury and are bypassed for more mainstream, traditional programs (Paterson & Saha, 2010). However, in accordance to new political culture literature, I would suspect that this belief would only ring true in more conventional, less-tolerant cities. They found that governments with a council-manager form of government were more likely to have better implementation records of environmental initiatives than mayor-council. Limiting my research to Texas controls for this phenomenon.

Engaging in sustainability planning, policy development and implementation efforts can be highly political depending on the political culture of the community involved, as outlined earlier by Freidman (2012). And though not specifically addressed in Sharp's (2005ab) work regarding morality politics, which is typically concerned with controversial issues, like abortion, drugs, gambling, gay rights and sexual-related activities, sustainability can easily align itself in the growing cultural divide between conservative and progressive impulses of a city. Aspects of sustainability would be considered moral in nature, especially in terms of social sustainability, which is concerned about equity and accessibility issues.

Evaluation of Planning Sustainability Efforts

There have been several studies with various methodologies developed to begin to measure sustainability within the planning field. A chronological account of the relevant studies is provided in Table 2.3.

Table 2-3 – Sustainability Planning Evaluation Studies

Author(s)	Research Methodology	Outcomes
Berke and Conroy (2000)	Examined comprehensive plans for certain keywords and policies representing six sustainable development principles.	In a review of 30 plans, 10 of which utilized sustainable development as an overarching organizing framework, they discovered that there was not a significant difference in the integration or implementation of sustainability policies and initiatives between the plans.
Portney (2003)	Created a Sustainability Index that consisted of 34 sustainability and demographic measurements grouped into seven clusters that were utilized to evaluate and score 24 cities reporting to be pursuing sustainability, on how seriously they took sustainability based on policies.	Evaluation provided a full matrix of the scores given to the 24 cities based on the 34 measurements. Research identified policies present in the majority of the cities and policies that were innovative and rarely adopted.
Jepson (2004a)	Surveyed 390 communities regarding 39 sustainable development policies, the extent to which action had	Received a 26.4% response rate, found that policies and initiatives were broad, however, the majority of the emphasis was on land

Table 2.3 - Continued

	been taken relative to these policies, and any barriers preventing action to be taken	development and use planning. Additionally, found that the major impediments to taking action were not related to politics, but to motivation and knowledge.
Saha and Paterson (2008)	Conducted a survey of medium to large U.S. cities to determine if cities were adopting sustainable development as an overarching framework or if policies and initiatives were adopted on a more piecemeal basis. Additionally, the types of initiatives and frequency of adoption were examined.	Concluded that most cities were adopting sustainable development policies on an ad hoc basis and these initiatives were rarely connected to equity and social justice issues.
Conroy and Iqbal (2009)	Conducted a survey of planning directors in Indiana, Kentucky and Ohio to ascertain their respective levels of support and activity towards sustainability. A sustainability activity index, consisting of 16 initiatives, was created based on the survey information. This information, along with demographic data, was utilized to perform several statistical models to help determine the variables that accounted for greater engagement in sustainability-related activities.	Received a 45% response rate, found that though planning directors were aware of the concept of sustainable development, it had not been translated or embedded into organizational use or acceptance. The sustainable practices utilized in the 3 states were ones that had been part of planning for years – not uniquely identified as 'sustainability'
Lubell et al. (2009)	Developed an environmental policy sustainability index for 100 incorporated cities in California's Central Valley using survey and archival data. Regression and cluster analysis was utilized to help explain why communities adopt environmental sustainable policies.	"The results suggest that the sustainable policies are more likely to occur in cities with better fiscal health and whose residents are of higher socioeconomic status" (p. 306). Additionally, they found a benefit in studying entire regions because it allows predicting the adoption of sustainability policies at varied stages of development.
Holman (2014)	Conducted an analysis of current planning	The act of planning and developing plans provided the two cities with

Table 2.3 - Continued

	documents, local ordinances and key planning and zoning committee meeting minutes of two East Texas cities, in hopes to understand how integrated sustainable development was in the planning documents, how they were implemented, and ultimately how sustainability was translated in rural, small, “hard-to-reach” cities (p. 1).	the ability to begin incorporating various “sustainability” initiatives and policies even if they were not known or catalogued as sustainability.

Understanding the environment of sustainability planning in a city, including motivations, barriers and strategies, allowed for a more thorough grasp on how planning influences the related outcomes. Evaluating the intended results and impacts of these outcomes provided the validation for pursuing or not pursuing select sustainability planning initiatives. The content analysis framework in the Berke and Conroy (2000) study provided the best structure for identifying and evaluating the sustainable built environment policies and commitments that are essential for my research. Their objective is closely aligned with mine. However, instead of examining all components of sustainability, including the environmental, economic and social, I am only looking at the cities’ commitment to sustainable built environment policies and initiatives that have been identified to impact air quality. A complete breakdown of the modified content analysis framework utilized in my study is outlined in Chapter 3.

Holman (2014) was primarily concerned with examining the level of integration sustainability had within city planning documents. I am less concerned with cities utilizing sustainability as an overarching framework, as I am with the actual policy intentions and outcomes, especially given the results of several studies indicating the irrelevance of claiming sustainability on the impact of implementation (Berke & Conroy, 2000; Conroy & Iqbal, 2009; Hollman, 2014; Saha & Paterson, 2008). Although, the political culture literature suggested a correlation between embracing sustainability, the moniker and planning structure, with measuring the progressiveness of a city (DeLeon & Naff, 2004, Sharp, 2005ab). Portney (2003) examined policies only and did not evaluate implementation measures of outcomes. This research provided information regarding the most prevalent sustainability policies within city planning documents, which is not directly relevant to my research. The studies conducted by Jepson (2004a), Saha and Paterson (2008), Conroy and Iqbal (2009), and Lubell et al. (2009) utilized survey techniques to gauge the characteristics and challenges for adopting sustainability policies. These studies did not provide a replicable methodology that was useful for my research, however they did provide some valuable survey questions for gauging the motivations, barriers, and status of sustainability within a city. Additionally, these studies did not review the comprehensive plans, which would "undoubtedly provide a more complete understanding of community efforts" (Conroy & Iqbal, 2009, p. 124).

Saha (2009) warned that the mere adoption of sustainability policies or activities is not a holistic indicator of the city's level of commitment towards sustainable development. Additionally, it is not a gauge on how effective the measures are either. The absence of effective implementation does little for the city's sustainability efforts. Rydin (2012) emphasized "implementation rather than strategy development" since experimentation and trial and error are needed to address complex issues, like sustainability and urban health (p. xvi). Many have noted the research gap between sustainable development planning and implementation (Cooper & Vargas 2004; Holman, 2014; Lubell et al., 2009; Seasons, 2003). Additionally, Lubell et al. (2009) notes the limitation of evaluating sustainability policies alone and that validating if the corresponding outcomes are actually improved is essential to assess the effectiveness of the sustainability policies. Continued research is necessary in order to identify effective implementation assessments and measurements based on best practices and lessons learned (Saha, 2009). However, understanding what constitutes 'success' is difficult due to the scarcity of data and proven methodologies (Brody & Highfield, 2005). The evaluation of sustainability planning initiatives needs to include not only the environmental impacts, but the social and economic impacts as well (Saha, 2009).

The majority of the research conducted that evaluates sustainability planning that is outlined above utilizes large-scale surveys, which can provide causal relationships. However, my research is focused on providing an in-depth, thorough and holistic examination of one segment of sustainability: the built environment. This is achieved by identifying and measuring select sustainable built environment policies, their influences and related outcomes in order to gain a better understanding of how the outcomes actually impact the environment and public health areas intended. This is best achieved by utilizing a case study methodology, which is delineated in Chapter 3.

Summary

The air pollution literature, primarily the Urban Air Quality Toolkit (n.d.), provided the various elements that impact air quality to identify and evaluate in my research. These elements include geography, climate and select city planning and design elements and human activities that intersect with the built environment indicators identified by Younger in Table 1.1, including types of buildings, land uses, green spaces, and transportation preferences. Additionally, education level and income are two measurements that help to identify the level of community awareness regarding sustainability, which provides the benchmark for understanding individual sustainability preferences and behaviors. Research supports the evaluation of air quality within a city, however city-level air quality data is not available at more localized levels.

The air quality and health literature called for more research in order to gain a better understanding of the implications of ozone and other pollutants on asthma (Engelke & Frank, 2005). My research addresses this call by evaluating the measurements of the different greenhouse gases and asthma hospitalizations within a particular city over a given period of time in order to identify any correlations.

The built environment significantly impacts public health as demonstrated in the literature above. However, more research is needed to evaluate specifically how the various facets of the built environment, like density, transportation systems, buildings, and contact with nature influence public health. The majority of the existing literature regarding the built environment and public health focused on how the built environment influenced physical activity and the resultant health effects from that activity. My research provides evidence on the passive influence that select built environment outcomes have on respiratory health, which provides municipalities with key strategic areas to emphasize in future planning. The literature did provide a breakdown of important and relevant indicators based on previous studies and established best practices. Indicators such as vehicle miles traveled, public transit options and ridership, available parks and trails, number of transit-oriented developments and green buildings.

In an effort to address the concerns illustrated in the literature regarding the possible discrepancies between sustainability planning, policy development and implementation effectiveness, an analysis is conducted of one element of city sustainability planning, measurements are identified, and outcomes and impacts evaluated. The targeted city-planning element examined is sustainable built environment strategies and policies that are outlined in the literature to impact air quality and respiratory health. City commitments to a sustainable built environment are collated and scored, using a modified content analysis framework established by Berke and Conroy (2000), and then the corresponding outcome measurements are identified and studied to assess their impact on air quality and asthma.

The political culture of the city is examined in an effort to gain a holistic view of the climate in which policies are discussed, developed and implemented. Based on my analysis of the multiple studies (DeLeon & Naff, 2004; Paterson & Saha, 2010; Sharp, 2005a; Silver & Dowley, 2000) evaluating the influence of political culture within the 'new political culture' framework, including the critiques and lessons learned, a select group of indicators have been identified that best capture the relationship between local political culture, policy and implementation in the areas of sustainability. Population growth, unemployment rate, poverty rate and revenue base provides insight to the economic condition of the city (Paterson & Saha, 2010). The city revenue base outlines the resources available to the city to potentially commit and implement various sustainability efforts (Paterson & Saha, 2010). The structure of the city government can influence the vision and outputs of a city. Both city revenue base and government structure have proven significant in a previous study by Paterson and Saha (2010).

According to Paterson and Saha (2010), “cities with higher levels of education and income and with more people engaged in professional occupations are more likely to be at the forefront of environmental initiatives” (p. 28). The indicators identified to directly quantify political culture and are significant to influencing sustainability implementation efforts, include nontraditional lifestyles and gender roles, religious affiliations, level of conservatism, and same-sex households (Paterson & Saha, 2010). Although, DeLeon and Naff (2004) included racial diversity and tolerance measurements in their study, Sharp’s (2005a) research indicated a lack of significance to influencing political culture; therefore I elected to omit these measurements from my study. Silver and Dowley (2000) encouraged researchers to consider the importance of ethnicity in evaluating local political culture. The remaining descriptive variables include gender, age and marital status, of which provide the means to affirm other studies findings that single, young females are more prevalent in progressive cities. In the following section, I provide a detailed outline of the scope and methodology utilized in this study.

Chapter 3

Methodology

The ultimate objective of my research is to better understand the relationships between sustainability planning and the corresponding built environment outcomes, and how these outcomes impact air quality and respiratory health. The literature emphasizes the need for assessing the effectiveness of sustainability planning and commitments, as well as gaining a better understanding of how built environments influence public health. These gaps in the literature begin to be examined by targeting select sustainable built environment strategies and evaluating air quality and asthma data, along with other identified influential indicators on policy development and air quality. Given the complexity and multiple nuances impacting sustainability planning, built environment implementation, and air quality, I have elected to employ a case study methodology, which allows for greater exploration and descriptive analysis.

The first phase of my research is a review and assessment of city sustainable built environment commitments between 2005 and 2013. This is done by utilizing a modified content analysis framework from the typology developed by Berke and Conroy (2000), where I examine and measure sustainable built environment commitments from each city identified from policies within their comprehensive plans and other relevant planning documents. City managers and sustainability directors are interviewed in an effort to gain a more comprehensive view of sustainability planning in each city, as well as ensure that a complete account of sustainable built environment policies and commitments are identified between 2005 and 2013. My research then links specific sustainable built environment commitments identified in phase one to outcomes or indicators strictly reported to affect air quality, and ultimately to incidences of asthma. Additionally, data is identified and collected on various indicators noted to influence policy development, implementation, and air quality. Comparing these commitments to the actual effectiveness of implementation measurements address the limitations discussed in previous typologies, which is the lack of evaluation on implementation. Understanding the connection between commitment and outcomes provides important information for future policy development.

This Chapter includes the scope of my research, the case study methodology and case selection process, interview protocol, content analysis framework and assessment methods for determining relationships and correlations.

Case Study Methodology

Case study research arises out of a desire to understand complex social issues and occurrences (Yin, 2014). "A case study is an empirical inquiry that investigates a contemporary phenomenon (the "case") in depth and within its real-world context, especially when the boundaries between phenomenon and context may not be clearly evident" (Yin, 2014, location 951). Case study research is preferred when the research questions are "how" or "why" questions (Yin, 2014). Attempting to understand how select sustainable built environment outcomes impact respiratory health, including the political and cultural influences on the establishment of related policies and commitments, the complexity of air pollution production and dispersion, and the uncertainty of how other demographic factors play a role are the motivations and justifications for selecting a case study framework.

A benefit of case study research is that it allows for an intense and thorough analysis, unlike larger, more superficial statistical studies. Surveys and experimental methods are not suitable for my study, given the complexity of the subject matter and relatively new area of research (Yin, 2014). Many social scientists, as cited by Yin (2014), believe that case-study research is only appropriate for the exploratory phase of an investigation. However, there are many valid examples of explanatory and descriptive case studies that prove otherwise (Allison & Zelikow, 1999; Whyte, 1943, 1993; as cited by Yin, 2014). Case studies can explain causal links, describe the real-world context of an intervention, illustrate certain topics within an evaluation, or provide insight to situations that have no clear outcomes (Yin, 2014). The data collection and analysis methodologies can be both qualitative and quantitative. A case study framework deals with "technically distinctive" situations where there are more variables of interest than data points or cases (Yin, 2014). Another major strength of case studies is the ability to examine changes over periods of time (Yin, 2014).

One of the critiques of case study research is that it is not rigorous enough; however Yin (2014) argues that this is due in large part to the lack of a standardized research design. Implementing a standardized, replicable research design that does not allow the evidence to influence the results is essential for addressing some of the shortfalls of previous case studies (Yin, 2014). Another frequent concern of case study research is that the work is too long and results in large quantities of unreadable reports. Yin (2014) counters this by providing methods for writing and organizing the large amounts of data and analysis. Many confuse case study research with intensive, ethnographic studies (Yin, 2014). However, a valid, high-quality case study can be produced solely by the use of the telephone or Internet (Yin, 2014). Another one of the major critiques of case study research is that generalizations cannot be made from the findings (Yin, 2014). Case studies can provide analytic generalizations, not statistical generalizations, by using descriptive theory, rival hypotheses and additional cases (Yin, 2014). Describing the purpose, full range of issues of what is to be studied, along with corresponding rationales help to provide the theoretical structure necessary for extrapolating generalizations (Flyvbjerg, 2006; Yin, 2014).

Another important feature of the case study method that makes it a valid framework for my study is that it can fit both single-case studies and multiple-case studies (Yin, 2014). There have been other disciplines that have coined other terms for a multiple-case study protocol, like 'comparative method', but, according to Yin (2014), single- and multiple-case studies are just variants of the case study design. Multiple-case studies allow for cross-case conclusions and are often considered more substantial and compelling (Herriott & Firestone, 1983, as cited in Yin, 2014). Yin (2014) states that, "although single-case studies can yield invaluable insights, most multiple-case study designs are likely to be stronger than single-case study designs. Trying to use even a "two-case design is therefore a worthy objective, compared to a single-case study." (Yin, 2014, Chapter 2, Abstract, Paragraph 3).

Case Study Research Design

Unlike other research methods, a standard, comprehensive catalog of research design has not been established for case study research. However, effective protocols and best practices continue to be discussed and outlined in the literature. According to Yin (2014), “a research design is the logic that links the data to be collected (and the conclusions to be drawn) to the initial questions of the study” (Yin, 2014, Chapter 2, Abstract, Paragraph 1). Given the lack of standardized methods, it is essential for the researcher to establish replicable protocols for good quality design. Yin (2014) outlines five important components of case study research design that should be addressed. These include: (1) the case study questions (typically consist of ‘how’ and ‘why’ questions), (2) propositions, if any, that outline topics that should be examined within the scope of the study, (3) unit(s) of analysis that defines and bounds the case and assists with case selection and scope for data collection, (4) logic linking the data to the propositions, (5) criteria for interpreting the findings. These critical components are depicted in Figure 3.1.

Figure 3-1 Five Components for Quality Case Study Research Design

Case Study Questions

The two overarching questions of my case study research design are:

1. How do select sustainable built environment outcomes impact air quality and respiratory health, and
2. How are these outcomes influenced?

Propositions

When evaluating the main case study questions, other propositions or potential areas of influence were identified for consideration. Case study propositions are not the same as case study theories. Case study theories are similar to research hypotheses, which provide proposed explanations for addressing the case study questions. Propositions are new areas of interest that may be tangentially related to the research questions and the inclusion of these topics could enhance the overall research. Given the setting in which built environment initiatives are developed and implemented, it was apparent that sustainable built environment planning and policies should be included in the scope of my research in order to better understand the process and evaluate the resulting outcomes. Additionally, evaluating the influence of political culture on sustainable built environment policy development provides a holistic perspective on city planning motivations, which help explain the built environment outcome data, while also adding another layer for comparison.

Units of Analysis

The examination of other studies and research regarding the built environment, air pollution and public health, including their resulting best practices, limitations and lessons learned, along with available data, have provided the structure and scale necessary for my study. Primarily, since planning and implementation of sustainable built environment policies and outcomes occur at the city-level, my research is best conducted at this level as well. However, more localized areas within the city are examined in order to provide a more comprehensive review of the data. Specifically, data at the zip code level is utilized for evaluating asthma cases, land uses, age of building stock, density of buildings and census blocks. A complete list of Austin and Fort Worth zip codes is available in Appendix B. Additionally, air quality measurements, climatological data, and pollen counts are collected at specific monitoring and collection sites within the city. Bounding the case to a nine-year period allows for a greater examination to the environment before and after the development of policies and the evolution of the corresponding outcomes, as well as the impact on air quality and the prevalence of asthma.

The global analysis of city air pollution conducted by Sarzynski (2012), suggested that urban pollution is likely to increase as populations increase and “that policy-makers must focus on reducing the emissions intensity of production activities within cities, specially from energy sector, if they are to avoid rapid growth in urban air pollution in coming decades” (p. 3121). A city level scale deems most appropriate given the importance of city planning and policy development on air pollution reduction. Evaluating how sustainable built environment policies and outcomes impact or influence air quality and respiratory health is a multifaceted issue, requiring a holistic and thorough examination. Conducting my research at the city-level allows for this extensive review (Druckman, 2005).

As stated, sustainable development planning and policies are conducted at the city level (Dixon et al., 2014), which is at the root of my research question. However, a closer examination at locations and features within the city that possibly influence air quality and respiratory health provide a more comprehensive representation. Especially given the complexities of air pollution dispersion and dilution qualities. Evaluating the variables influencing air pollution and exposure within a city may be as or more important than examining between cities due to the increasing variance inside cities (Briggs, 2000; Zhu et al., 2002 as cited in Jerrett et al., 2005). Additionally, analyzing available asthma data by zip code allows for the potential connection to specific city geographical, topographical elements, or built environment features identified to influence air quality. One of the limitations of the proximity studies outlined previously was that many just utilized the place of residence, instead of looking at elements within a city that influence air quality, which is more representative of transient travel and the potential exposure to traffic exhaust. The specific units of analysis for the data include archival records, documentation and interviews (semi-structured or vie email responses).

Linking and Interpreting the Data

The ‘logic linking data to propositions’ and ‘criteria for interpreting the findings’ are the categories directly concerned with data analysis. According to Yin (2014), “data analysis consists of examining, categorizing, tabulating, testing or otherwise recombining evidence, to produce empirically based findings” (Chapter 5, Abstract, Paragraph 1). The large amounts of longitudinal data collected is organized in a variety of matrices and graphical displays in an effort to identify patterns to assist in building explanations and addressing possible rival explanations within each case and for cross-case synthesis. Identifying more potential rival explanations provides a stronger case for the findings. Therefore, looking into other possible impacts to air quality than the built environment is essential to ensure a comprehensive, reliable and valid study. The other air quality influencers were determined from the literature and are outlined in the Variables section later in this chapter.

Table 3-1 – Sustainable Built Environment Case Study Design Protocol

Case Study Question(s)	Propositions	Unit of Analysis	Logic Linking Data to Propositions	Criteria for Interpreting the Findings
How do select sustainable built environment outcomes impact air quality and respiratory health and how are these outcomes influenced?	(1) Influence of Political Culture (2) Sustainable Development Planning & Commitments	City-level: Fort Worth & Austin Time span: 2005 - 2013	Means: pattern matching, explanation building, time-series analysis, logic models, cross-case synthesis	Address rival explanations for findings Identify and select variables representing these rivals • Geography • Topography • Climate • Demographics • Structure/Funding

Measuring Design Quality

Quantitative research relies on large amounts of data to measure and analyze causal relationships and test hypothetical generalizations (Denzin & Lincoln 1998; Hoepfl, 1997, as cited in Golafshani, 2003). While qualitative research "seeks to understand phenomena in context-specific settings" (Golafshani, 2003, p. 600). "Unlike quantitative researchers who seek causal determination, prediction, and generalization of findings, qualitative researchers seek instead illumination, understanding, and extrapolation to similar situations" (Hoepfl, 1997, as cited in Golafshani, 2003, p. 600). Reliability and validity work differently in qualitative research than in quantitative research. There are conflicting studies that dispute the use of reliability in qualitative studies. Golafshani (2003) says that even discussing reliability in a qualitative study is misleading because the quality of the study is either good or bad. Continuously reviewing the quality of research in terms of consistency, credibility, and dependability is a way to address reliability in qualitative studies (Golafshani, 2003).

The same discrepancies regarding reliability exist regarding the concept of validity in qualitative studies. Though many agree that validity is addressed by the same quality concepts described with reliability (Golafshani, 2003). According to Yin (2014), the quality of the research design can actually be evaluated by using the four common tests typically utilized in social science research. These tests are construct validity, internal validity, external validity, and reliability.

Construct validity is concerned with identifying the correct operational measures for the concepts being studied and can be accomplished by using multiple sources of evidence (triangulation), proper measurements and establishing a chain of evidence. The use of triangulation in qualitative studies is a tool for controlling bias and assuring the validity of research (Yin, 2014). The process of triangulation is the means of utilizing more than one method to collect data. It is intended to capture different aspects of the same phenomenon, not cross-validate the data (Golafshani, 2003; Ghrayeb, Damodaran & Vohra, 2011). My study includes data sources from archival records, documentation and interviews. All the data collected on the dependent, independent and control variables, as well as the descriptive factors, are collected at the city-level and areas within the city, thus maintaining the proper unit of measurement throughout the study. Interviewees and my dissertation committee serve as the chain of evidence, or third-party reviewers.

Internal validity is only used in explanatory studies, not descriptive or exploratory, and seeks to establish causal relationships. By utilizing tools of pattern matching, explanation building, and addressing rival explanations, causal relationships can be described (Yin, 2014). Identifying variables and collecting data regarding other possible explanations for better air quality and reduced incidences of asthma provides the means necessary for inferring causation. External validity defines the domain to which a study's findings can be generalized which is achieved in multiple-case study research by using replication logic (Yin, 2014). This is possible by developing and following the established research design for the study.

The final test for evaluating the effectiveness of the research design is reliability. Reliability, much like the replication logic discussed previously in relation to multiple-case study research, demonstrates that the procedures of the study can be repeated with consistent results (Yin, 2014). Instituting and following the case study protocol of theory development, case selection and definition of specific measures are the best ways to ensure reliability in case study research (Yin, 2014). Additionally, properly documenting and maintaining case study data, separately from the report, in a case study database helps increase the reliability of the case study. The case study database includes narrative, numeric and other documentation collected from the study (Yin, 2014).

Multiple-Case Study Protocol

As stated previously, establishing a systemic research design that ensures literal replication for a multiple-case study review of 2-3 cases is necessary for quality design and for the researcher to be able to develop analytic generalizations. Yin (2014) provides a procedure for conducting multiple-case study research. It is broken down into three phases, which are 'Define and Design', 'Prepare, Collect and Analyze', and 'Analyze and Conclude'. Defining the theory, selecting the cases, and designing the data collection protocol are the three functions of the ‘Define and Design’ phase. The second phase, ‘Prepare, Collect and Analyze’, consists of conducting and writing each individual case study and report. Followed by the ‘Analyze and Conclude’ phase that entails drawing cross-case conclusions, modifying the theory, developing policy implications and writing the cross-case report. These steps are represented in Figure 3.2.

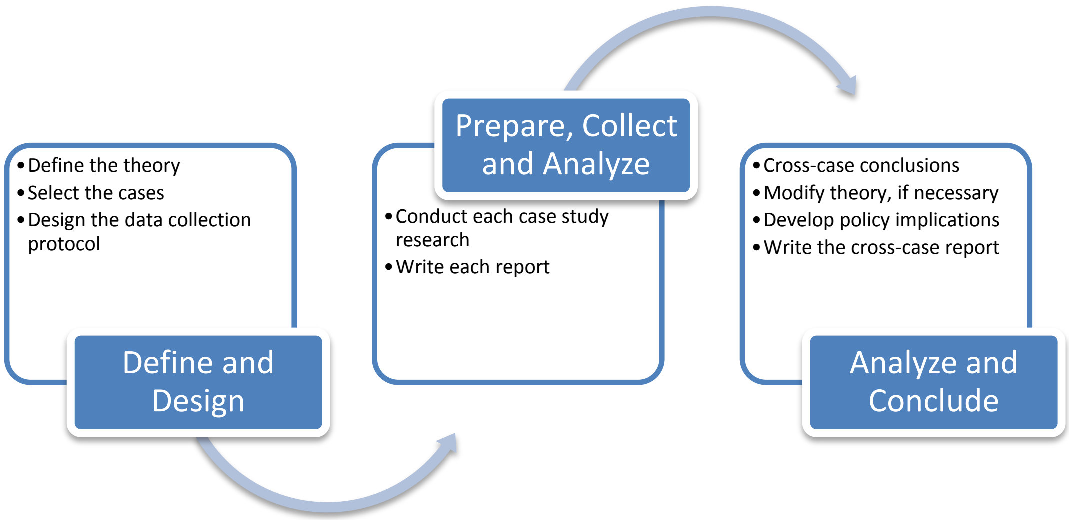

Figure 3-2 Three Phases of Multiple-Case Study Design (Yin, 2014)

Defining the Theory

The term theory in case study research is used to describe, “a hypothetical story about why acts, events, structure, and thoughts occur” (Sutton & Staw, 1995, p. 378; as cited by Yin, 2014, Chapter 2, Section 2, Sub-heading 1, Paragraph 4). My primary case study research questions are, how do select sustainable built environment outcomes impact air quality and respiratory health and how are these outcomes influenced? The theories or hypothetical story to address the primary research questions above are that progressive or reformed (Sharp, 2005ab) cities engage in more sustainability planning that results in greater corresponding built environment outcomes, which positively influence air quality and asthma. The rival theory for my study is that something other than the political culture of a city influences sustainability planning and the level of commitment to sustainable built environment strategies does not influence or result in larger corresponding outcomes. Additionally, the presences of more sustainable built environment outcomes does not result in better air quality or reduced cases of asthma.

Case Selection

The next phase of the case study protocol is case selection. The selection of the cases to be studied should be done carefully and with consideration to the availability and accessibility of data, as well as to those that will provide the most insight to the outlined research questions (Yin, 2014). Cases are selected that either (a) predict similar results, or (b) predict contrasting results but for anticipatable reasons. The former is literal replication structure, while the latter is a theoretical replication. The protocol outlined by Yin (2014) suggests that a multiple-case study analysis of 2-3 cases should be a literal replication and the cases selected should predict similar results and follow replication logic, as opposed to sampling logic. Therefore, the cases selected in my study should result in lower incidences of asthma hospitalizations and better air quality when higher sustainable built environment commitments and outcomes exist, if the theory is proven true.

Dannenberg et al. (2003) argues that communities can benefit from case studies that evaluate the processes and impacts of various community design choices and policy interventions. Cities with larger populations are expected to have higher emissions (Sarzynski, 2012). Thus cities with comparable populations should have similar emissions. The two urban Texas cities that have the most similar populations are Austin and Fort Worth, with 842,750 and 767,560 respectively. These cites also have comparable median ages of 31.6 in Fort Worth and 32 in Austin, as well as similar median income of $52,430 in Fort Worth and $56,351 in Austin. Additionally, the most common ethnicity in both cities is Caucasian, with 77.7% in Austin and 62.1% in Fort Worth (U.S. Census Bureau, American Community Survey, 2013).

However, these two cities are very different culturally and in regards to their sustainability efforts, whether it is by reputation or outcomes. This is demonstrated by the difference between the percentage of the population that affiliates with a particular religion in each city, with 55.21% in Fort Worth and 46.22% in Austin, as compared to the national average of 48.78% (Sperling's

Best Places, 2014). In a study conducted by Tausanovitch and Warshaw (2014) that scored 67 U.S. cities with a population of 250,000 or more on their level of conservatism, with 1 being the most conservative and 67 being the most liberal. The City of Fort Worth ranked 12 out of 67 for most conservative. The City of Austin ranked 54 out of 67 most conservative (or 14th most liberal). The culture of sustainability in each city differs greatly. Every other year, The American Council for an Energy-Efficient Economy (ACEEE), a nonprofit, 501(c)(3) organization, ranks the largest U.S. cities on their energy efficiency policy and program efforts. The 2013 City Energy Efficiency Scorecard serves as a benchmark for city efforts, encouraging cities to continue strengthening their efficiency commitments. Fort Worth scored 33 out of 100 possible points and ranked 26 out of 34 cities, while Austin scored 62 out of 100 points and ranked 6th out of 34 cities. A study by Saha (2009) identified political culture as one of the most significant predictors of local government sustainability performance, so the link between religiousness and conservatism is not surprising (Paterson & Saha, 2010). These differences provide an opportunity to evaluate this case study theory that greater commitments to sustainable built environment outcomes result in better air quality and reduced incidences of asthma by evaluating and controlling for other topographical or climatologic factors. Additionally, the levels of influence from political culture and city sustainability cultures are reviewed.

Data Collection Protocol

The sustainability planning environment and policy commitments are reviewed in order to evaluate how sustainable built environment commitments, identified by the literature to influence air quality (Table 1.1), actually result in implementation, impact air quality, and affect the prevalence of asthma in Austin and Fort Worth. The political culture is examined in each city case study due to its influence on the planning process and policy development and implementation. Additionally, key variables noted to influence air quality are collected and reviewed in order to capture other possible rival explanations for the results. Archival research, from archival records and documentation, is a major component of my study. One distinction in archival research is that researchers are collecting data that already exists; not creating or generating it themselves by conducting interviews or surveys (Vogt, Gardner & Haeffele, 2012). However, this existing data is not without flaws and according to Vogt et al. (2012), there are no data collections that are completely neutral because they are subject to the original compilers' interpretation. What to count, what to include or discard, are all considerations.

Data is collected between 2005 and 2013 for each case study, Austin and Fort Worth. The categories of the data collected are 'Sustainable Built Environment Policies and Commitments', 'Sustainable Built Environment Outcomes', 'City Demographic and Socioeconomic Variables', 'Political Culture', 'Air Quality', and 'Asthma'. The data collection methods for each city case study, Austin and Fort Worth, vary based on the availability and location of data. The specific variables and data sources are described in the Variables section below. Primarily the data in each category is located from existing literature and governmental and organizational tools, websites and datasets. However, city personnel are also contacted for specific city policy, demographic and built environment outcome data for each year between 2005 and 2013 that is not readily available by other means. Additionally, the city manager and sustainability director in each city is contacted and interviewed regarding sustainability planning engagement over the specified time period (2005-2013). A comprehensive interview protocol is outlined later in this chapter.

All data collected, except the policy data and interview results[1], are quantitative based. The numerical values are collated in a master spreadsheet for each city, organized by variable category, variable, and year. Additionally, geographical mapping tools are used to display the data, important city landmarks, and structures throughout the city in order to demonstrate possible explanations. Organization of data in this manner allows for easier evaluation of changes in outcomes related to the year's policies were enacted and for the cross-case assessment. The sustainable built environment policy data is the only data requiring coding. The content analysis framework utilized to review and score the identified policy data is outlined later

[1] According to IRB, the interviews with city personnel did not require approval since individual views were not assessed and the interview questions were strictly regarding city planning efforts and motivations.

in this chapter. The sustainability interview results are described in the narrative of each city case study and utilized to further explain the research questions. The case study methodology and qualitative emphasis of this research gives the flexibility for addressing the variance of data availability over the nine-year review period by adding to the dynamics of the narrative. The use of dynamic data in longitudinal studies is the "necessary empirical basis for a new type of dynamic thinking about the processes of social change" (Gershuny, 1998; as citied by Ruspini, 1999, p. 220).

Variables and Data Sources

Sustainable Built Environment Planning and Policies

Identifying and collecting all of the existing policies and commitments relating to sustainable built environment initiatives supported by the literature to impact air quality and respiratory health (Table 1.1) between 2005 and 2013 for each city study, is fundamental to my research objective and questions. These initiatives include policies and ordinances pertaining to select land use, buildings and transportation strategies identified within each city's comprehensive plans and other relevant planning documents. Understanding the influence of the level of commitment to sustainable built environments on the corresponding outcomes can demonstrate the importance of planning and assist in prioritizing future policy strategies and development.

The City of Fort Worth developed their comprehensive plan in 2000 with mandated annual updates. According to the City Planning Department, no changes were made from the 2010 comprehensive plan to the 2011 plan. Additionally, the 2013 plan was unavailable at the time of my request, due to staff turnover during that time and not archiving the plan as directed. Comprehensive plans from 2005, 2006, 2007, 2008, and 2009 were located and scanned at the Fort Worth Central Library. Plans from 2010 and 2012 were emailed directly from the Fort Worth Planning Department.

The planning process in Austin is more decentralized. Phone and email conversations with the City of Austin Planning and Zoning Department, specifically the Development Services

Process Coordinator, the Planning Manager of the Comprehensive Division, and the Corporate Marketing Communications Consultant, were conducted in order to understand the planning process and locate the necessary documents. Prior to the 2012 Imagine Austin comprehensive plan, the city had not had a comprehensive plan since the 1979 Austin Tomorrow plan. The City attempted to adopt a new comprehensive plan in the 1980's, however the plan failed on its third attempt to be voted in by City Council. In response to this, Austin began instituting more localized neighborhood, master, and transit-oriented plans in lieu of citywide comprehensive plans. A complete list of the planning documents developed within the 2005 and 2013 time period of this study are listed in Table 3.2. All of these plans are available on the official city website. The plans are reviewed and relevant sustainability policies, ordinances and initiatives that impact the built environment and air quality, either directly or indirectly, are organized and scored according to the content analysis framework detailed later in this chapter. The complete list of the selected policies and scorings are provided in Appendix D and summarized in each city case study.

Table 3-2 – City of Austin Planning Documents, 2005-2013

Year	Planning Documents
2005	South Congress Combined Neighborhood Plan
2005	Greater South River City Combined Neighborhood Plan
2007	Martin Luther King (MLK) Boulevard TOD Station Area Plan
2007	Plaza Saltillo TOD Station Area Plan
2007	University Hills/Windsor Park Neighborhood Plan
2008	Lamar Blvd/Justin Lane TOD Station Area Plan and Regulating Plan
2008	Plaza Saltillo TOD Station Regulating Plan
2009	North Burnet Gateway Regulatory Plan
2009	Martin Luther King (MLK) Boulevard TOD Station Area - Regulating Plan
2010	East Riverside Corridor Regulatory and Master Plans
2010	Waller Creek District Master Plan
2010	Parks & Recreation Long Range Plan for Land, Facilities and Programs (LRP)
2012	Imagine Austin Comprehensive Plan
2012	Downtown Austin Plan
2012	Sustainability Action Agenda
2013	The Imagine Austin: The Way Forward Annual Report

In an effort to gain a better, more thorough view of the past, present and future of sustainability planning in each city for the period between 2005 and 2013, interviews are conducted with the city manager and sustainability director, or their designees. The sustainability offices in each city, specifically Amy Petri, the Communications Manager in Austin, and Samuel Steele, the Sustainability Administrator in Fort Worth, replied to the request for interviews with written responses to the interview questions. A face-to-face interview was conducted with Dana Burghdoff, the Assistant Director for Planning in Fort Worth, as designated by the city manager's office. The city manager's office in Austin did not respond to several attempts to schedule an interview, nor were responses provided in writing. The detailed interview protocol, including the specific interview questions, is described later in this chapter. The content of the interviews and responses were utilized in the case analysis in Chapter's 4 and 5.

Sustainable Built Environment Outcomes

Citywide Data

The sustainable built environment variables that correlate with those outlined in Table 1.1 and with the policies and commitments identified in each city to impact air quality and respiratory health are collected for 2005 to 2013. The data are collected from city, government and local non-profit websites, documents or personnel. Specifically, annual population density is calculated by dividing the total population by the land area in square miles. The City of Fort Worth Planning and Development Department and the City of Austin Planning and Zoning Department provided the land area of each city and year between 2005 and 2013. Annual, cumulative totals for acres of green spaces, number of parks, and miles of city-managed trails in Fort Worth was provided by the Capital Projects/Infrastructure Manager in the Parks and Community Services Department. The Tarrant Regional Water District provided additional mileage data for Fort Worth pedestrian and bike trails, however data was only available from 2007 to 2013. The City of Austin Parks and Recreation Department provided an Access database and additional information necessary to ascertain the cumulative number of parks and acreage for each year in Austin. Cumulative, annual pedestrian and bike trail data for the City of Austin was provided from 2008 to 2013 by the city's Transportation Department. Data prior to 2008 was not available. Cumulative bike lane data for 2005 to 2013 was also provided. A transportation planner at the City of Fort Worth provided annual, cumulative bike lane numbers for 2005 to 2013.

The number and locations of LEED and Energy-Star certified buildings for each city were identified via the third-party organizational websites. Capital Metro, the Austin-area transportation authority, provided annual bus and rail ridership data for Austin. Austin did not have rail opportunities until 2010. The T and the Trinity Railway Express (TRE) provided the annual bus and rail ridership data for Fort Worth. The Texas Department of Transportation (TxDOT) provided annual vehicle miles traveled (VMT) counts for each city. The TOD Program Manager at the City of Austin provided details via email regarding the transit-oriented development environment in Austin between 2005 and 2013. A meeting with a Planning Manager in the Comprehensive Planning Section of the City of Fort Worth provided information regarding transit-oriented developments in Fort Worth for 2005 to 2013.

Zip Code Level Data

Land uses, categorized as single-family, multi-family, vacant platted lots, acreage, farm/ranch, commercial/industrial, oil/gas/mineral reserves, utilities, business personal property, mobiles homes, and residential inventory, along with annual average age of building stock, percentage of built-out parcels, and density of buildings, represented by the floor to area ratio (FAR), are calculated from appraisal district GIS data and organized by zip codes within each city boundary (see Appendix B for a full list of zip codes in each city). Each county appraisal district provided GIS parcel shapefiles and corresponding appraisal data, however data was only available for years 2009 to 2013 from all counties except Hays, which only retained shapefiles since 2012. All but one of the zip codes in Fort Worth is in Tarrant County. Part of zip code 76177 also falls within Denton County. All but four zip codes in Austin are solely located in Travis County and three zip codes within the city boundary actually reside in other counties. Appraisal data for zip codes 78717 and 78729 were provided by Williamson County, zip code 78737 from

Hays County, and zip codes 78727, 78728, 78750, 78759 have data from both Travis and Williamson Counties.

Data Transformation Process

Utilizing ArcGIS, the parcel shapefiles for each county and year are intersected with the respective zip code layers in order to identify the parcels within each zip code. The new parcel layers are then linked to the corresponding appraisal data by specific unique identifiers, such as GIS Link or Parcel ID Number, and the following fields are extracted: year built, living area, land square footage, and state land use code. Averages are calculated to determine average age of building stock for each zip code for each year. The FAR is calculated by summing the total living area for each built parcel within a zip code and dividing it by the total land area of those built parcels for each year between 2009 and 2013 (Forsyth, 2003). FAR is calculated only for parcels that had both living area data and total land square footage or acreage data.

The land uses are summed for each category: single-family, multi-family, vacant platted lots, acreage, farm/ranch, commercial/industrial, oil/gas/mineral reserves, utilities, business personal property, mobiles homes, and residential inventory for each zip code within the Fort Worth and Austin city boundaries for each year. However, the Travis County appraisal data only included real property, or parcel data with land and buildings. Therefore, the land use data for the vacant platted lots, oil/gas/mineral reserves, business personal property, and mobiles homes categories were not included for the Austin zip codes in Travis County. The average percentage of parcels with buildings in relation to the total number of parcels within each zip code was also calculated for each year in order to ascertain the level of development in each zip code. The GIS parcel shapefiles were used to identify the data for vacant lots in Austin since Travis County did not provide it in the appraisal data. Specifically, the vacant parcels were identified as the parcels with no corresponding appraisal data once the appraisal data was joined with the shapefiles.

In order to gain a better understanding of the level of street connectivity within each zip code, the census block density was calculated. A study conducted by Frank et al. (2000) supported the use of census block density as a means for accounting for the level of street connectivity, which is believed to directly relate to the level of vehicle emissions. According to Frank and Engelke (2005), “if a district has many street intersections, the odds are better that someone will be able to travel in a fairly direct line between any two points in the district", therefore resulting in potentially less vehicle emissions. Census block density is the measure of the mean number of census blocks found per square mile within a specified area, which in this case is zip code (Frank et al., 2000). Census block maps are provided electronically on the U.S. Census Bureau website. These maps are layered on top of zip code boundary maps in ArcGIS for each city for each year between 2009 and 2013. The census block density calculation is then determined by dividing the number of census blocks within each zip code by the total area of that respective zip code.

Relationship to Research Questions

These independent variables within the land use, buildings, and transportation categories are the presumed causes of the dependent variables in my study, which are air quality and asthma. The increase or decrease of the values of these variables along with the corresponding policies and resultant air quality and asthma data for the same time period provide the information needed to develop explanations that address the case study questions. Table 3.3 details the specific sustainable built environment variables, data sources, purpose, and unit of analysis. In addition to these variables, locations of major roads and highways are identified and graphically displayed via mapping tools. This information helps to explain the possible variance in air quality and incidences of asthma throughout the city.

City Demographic and Socioeconomic Data

The literature identified several demographic and socioeconomic indicators that potentially influence the political culture and air quality of a city. In order to ensure a quality research design, according to Yin (2014), it is essential to identify as many rival explanations for the case study results as possible. Therefore, annual average data is collected for each of the identified variables, detailed in Table 3.3 below, for the nine-year period between 2005 and 2013. This data is utilized to gain a better understanding of each city and as a control for political culture and air quality. Annual city population data for 2005 to 2013 is located on the official website for each city. Median household income, unemployment rate, median age, sex ratio, race, level of education, marital status and poverty rate for each city and year are provided by the U.S. Census Bureau's American Community Survey[2]. The data is located on the following tables: S2302, S0101, S1903, S2301, B02001, S1501, S1201, S1701, B12006, S2403, B11009. Manual calculations are necessary to determine the value for race (percentage of the population identifying as Caucasian) and level of education (percentage of the population age 25 and older with a bachelor's degree or higher). The value for race is determined by dividing the total number of 'white only' population by the total population. The percentage of the population who has a bachelors, masters, professional or doctoral degree is tallied to get the values for the level of education variable.

Political Culture

The literature evaluating the influence of political culture, especially in the area of sustainability planning, on policy development and implementation identified a select group of indicators to evaluate. These independent variables describing the overall political culture of a city are the presumed cause for the pervasiveness of sustainable built environment policies and commitments. Collecting and analyzing this data adds to the narrative of the case study and provides the means for addressing any rival explanations for the level of commitment to sustainable built environment initiatives. The selected indicators include nontraditional lifestyles (percentage of the population 35 and older that never married); nontraditional gender roles (percentage of women in the labor force that never married); percentage of the population in professional, scientific and technical fields; percentage of unmarried same-sex partner

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[2] The American Community Survey (ACS) is conducted by the U.S. Census Bureau to establish annually updated estimates by utilizing a series of monthly samples. The resulting data are estimates and the associated margin of error for each value utilized in this research is not displayed, given the more exploratory nature of the research design. Therefore, there are potential errors with this data source. Additional information regarding the ACS methodology can be found at https://www.census.gov/programs-surveys/acs/.

households; city revenue base (total revenues per 100,000 population); and the structure of the local government (council-manager or mayor-council).

The U.S. Census Bureau's American Community Survey (ACS) [1] is the source for all the variables, except city revenues and government structure, and are calculated for each year between 2005 and 2013. The nontraditional lifestyle variable is calculated by multiplying the percentage of each age group over 35 (groups 34-44, 45-54, 55-64, and over 65) that never married with the total population of that age group, add the resulting numbers, and then divide that sum by the total population over 15 years of age. Values are provided for both males and females. The nontraditional gender role variable is calculated by dividing the total number of women in the labor force by the total population 16 years and older. The percentage of the population in professional, scientific and technical fields is calculated by dividing the number of people in a professional, scientific and technical industry by the total number of the civilian employed population over 16. The number of same-sex unmarried households are tallied then divided by the total number of households to give the overall percentage of same-sex partner households. Each city's Comprehensive Annual Financial Report (CAFR), available on the official city website, provides the city revenue base for each year between 2005 and 2013. The values are calculated by dividing the annual city revenue by the resulting value of dividing the total population by 100,000. The government structure is located on the official city websites.

In addition to the variables outlined above, the two studies discussed previously in the case selection section of this chapter regarding the level conservatism and religiousness, also help explain the political culture of each city. The City of Fort Worth has a higher percentage of its population affiliating with a religion than the City of Austin (Sperling's Best Places, 2014). Additionally, Austin was ranked three times more liberal than Fort Worth (Tausanovitch & Warshaw, 2014). Details of each variable, including data sources, are detailed in Table 3.3.

Air Quality

The air quality in each city serves as one of the dependent variables in this case study research. The dependent variable is the presumed effect, whereas the independent variables are the presumed causes. The specific air quality variables include the number of days when the U.S. Environmental Protection Agency (EPA) qualifies the air GOOD; annual average of compliance with the 8hr EPA Ozone standard; annual average and max measurement of carbon monoxide; and the three-year average (design value) of PM-2.5. The EPA Air Quality Index Report is utilized to obtain the 'days air quality is GOOD' variable for each year by CBSA (Dallas-FT-Arlington and Austin-Round Rock). The remaining air quality variables are obtained through the Texas Commission on Environmental Quality (TCEQ) for each year between 2005 and 2013. Data is available from specific monitoring sites within each city boundary.

Compliance with 8-hour ozone standard is met when the three-year average of the annual fourth highest daily maximum eight-hour ozone concentration measured is less than 76 parts per billion (ppb). According to the North Central Texas Council of Governments (NCTCOG), utilizing the EPA's 8-hour ozone attainment measurements provides a more accurate reading of the actual ozone levels. Annual averages from the Texas Commission on Environmental Quality (TCEQ) can be misleading since the ozone season is March 1st - October 31st (J. Loza, personal communication, May 11, 2015). Carbon monoxide cannot exceed 35ppm more than once per year, according to the EPA standards. Utilizing the 3-year average, or design value, of annual PM-2.5 follows the EPA methodology for measuring compliance, which is less than 12 micrograms per cubic meter for sensitive populations, like asthmatics, children, and the elderly.

Data is also collected and analyzed regarding other identified influences on air quality, including geographic and climatological indicators noted in the literature to influence air quality and dispersion. The geographical elements include city elevation and topography, which are available in graphical maps from geological organizations. These elements are still taken under consideration when evaluating results and addressing the case study questions, although Texas does not receive any exceptions on air quality standards for topography like other states with more mountainous regions (J. Loza, personal communication, May 11, 2015). Additionally, climatological and meteorological variables collected from TCEQ and analyzed for each monitoring site and year between 2005 and 2013, included annual averages of the dew point temperature, temperature, precipitation, and wind speed. Collecting and reviewing average dew point temperatures instead of average relative humidity is recommended because the dew point measures the actual moisture in the air without the influence of outside temperatures since warmer temperatures hold more moisture (S. Stevenson, personal communication, May 15, 2015). Dew points greater than 72-74% can be observed and physically felt in the environment. There could be an association between more moisture in the air (higher dew point) and higher ozone days (S. Stevenson, personal communication, May 15, 2015). Annual precipitation data for each city is collected from the National Weather Service. Increased precipitation and accompanying cloud cover reduce temperatures, which impacts dew point and other potential elements that influence air quality and dispersion. Additionally, wind speed data helps to understand the dispersion effect of high winds that help diffuse ozone. However, annual averages may not account for the nuances, such as daily cold or warm fronts, which affect the daily averages (S. Stevenson, personal communication, May 15, 2015).

There are two monitoring sites within the City of Fort Worth, identified as CAMS 310 and CAMS 13, which were active during the timespan of this research (2005-2013). Of these two sites, only one had all of the available data, which is CAMS 13 or Fort Worth Northwest. The other site only measured limited PM-2.5 data. Therefore, the data from the CAMS 13/FW Northwest monitoring site was utilized for all of the Fort Worth air quality and climate variables for each year between 2005 and 2013. The City of Austin had five active monitoring sites during the specified period of this research, including CAMS 0038, 0003, 5003, 0171, and 5001/5002. CAMS 0171 and 5001/5002 monitored certain weather statistics irrelevant to this research. CAMS 0038/Audubon and CAMS 0003/Austin Northwest monitoring sites collected data on ozone, PM-2.5, wind speed and temperature. Only the CAMS 0003/Austin Northwest monitoring site offered carbon monoxide measurements and CAMS 5003/Bergstrom offered dew point temperature data. The resulting measurements represent the area at the monitoring site(s) and provide generalizations for the overall air quality of each city and may not account for specific environmental events or land uses. Texas Commission on Environmental Quality (TCEQ) maintains, reports and reviews the monitoring network in Texas to ensure compliance with federal regulations. TCEQ conducts an assessment every five years to “evaluate any changes in population, emissions sources, and monitored concentrations to determine whether individual monitors within the network should be added, moved, or decommissioned to best understand and evaluate air quality” (TCEQ Monitoring Network Plan, n.d., n.p.). A complete listing of variables, sources and units of measurement are outlined in Table 3.3.

Asthma Data

The Texas Health Care Information Collection Center for Health Statistics collects data on discharges from Texas hospitals by diagnosis. Hospitalization data are based on inpatient hospitalization and do not include emergency department visits. The State of Texas only requires hospitals to report outpatient or emergency department discharges for surgical and radiological procedures, not for asthma or any other diagnosis. The Texas Department of State Health Services’ Office of Surveillance, Evaluation and Research provided the annual inpatient discharge data that had a diagnosis of asthma for each year between 2005 and 2013 via locked, password-protected spreadsheets. The data is organized by zip code and year. Limitations of this data include:

- Data is only available in each zip code where there were at least 12 reportable cases.
- Data does not include HIV and drug/alcohol use patients.
- Data cannot determine the duration of a diagnosis (i.e. if a hospitalization served as an initial diagnosis of asthma)

The collected asthma data serves as the other dependent variable in this case study research, which has a goal to understand how the built environment influences air quality and asthma.

Pollen count data is also collected for each city for each year between 2005 and 2013 in order to address potential rival explanations for the reported incidences of asthma. The official North Texas Pollen Station responsible for reporting data to the National Allergy Bureau (NAB) is located in the City of Flowermound, which is adjacent to the Fort Worth city boundary. The station provided the official NAB counts, which started on October 21, 2007. Pollen counts for each year were tallied and divided by the total number of counts to give the annual average count. Unofficial monthly reports were provided for 2005 and averaged to obtain the overall 2005 pollen count. 2006 monthly reports were provided for January, July, August, September, October, November and December. Pollen counts were tallied and averaged for each month, then divided by 7 months to give the 2006 average. Daily count reports were provided for January 1st through October 20th, 2007. The daily pollen counts were tallied for each month and divided by the number of total counts in order to get the monthly average count. Then the sum of all monthly averages were divided by 12, which gives the annual 2007 pollen count average. The official pollen-monitoring site for the Austin area is located in the City of Georgetown. Official counts were provided for each year between 2005 and 2013. Annual counts were summed for each year then divided by the total number of counts in order to get the average annual count for each year.

Comprehensive List of Variables, Presumed Relationships & Data Sources

Figure 3.3 demonstrates the presumed relationships between the variable categories. The arrows indicate the categories presumed influence on the other category. A comprehensive list of all variables from each category, along with data sources and unit of analysis are outlined in Table 3.3. Additionally, the role of the variable within the overall case study research design is identified as either independent, dependent, control and/or descriptive.

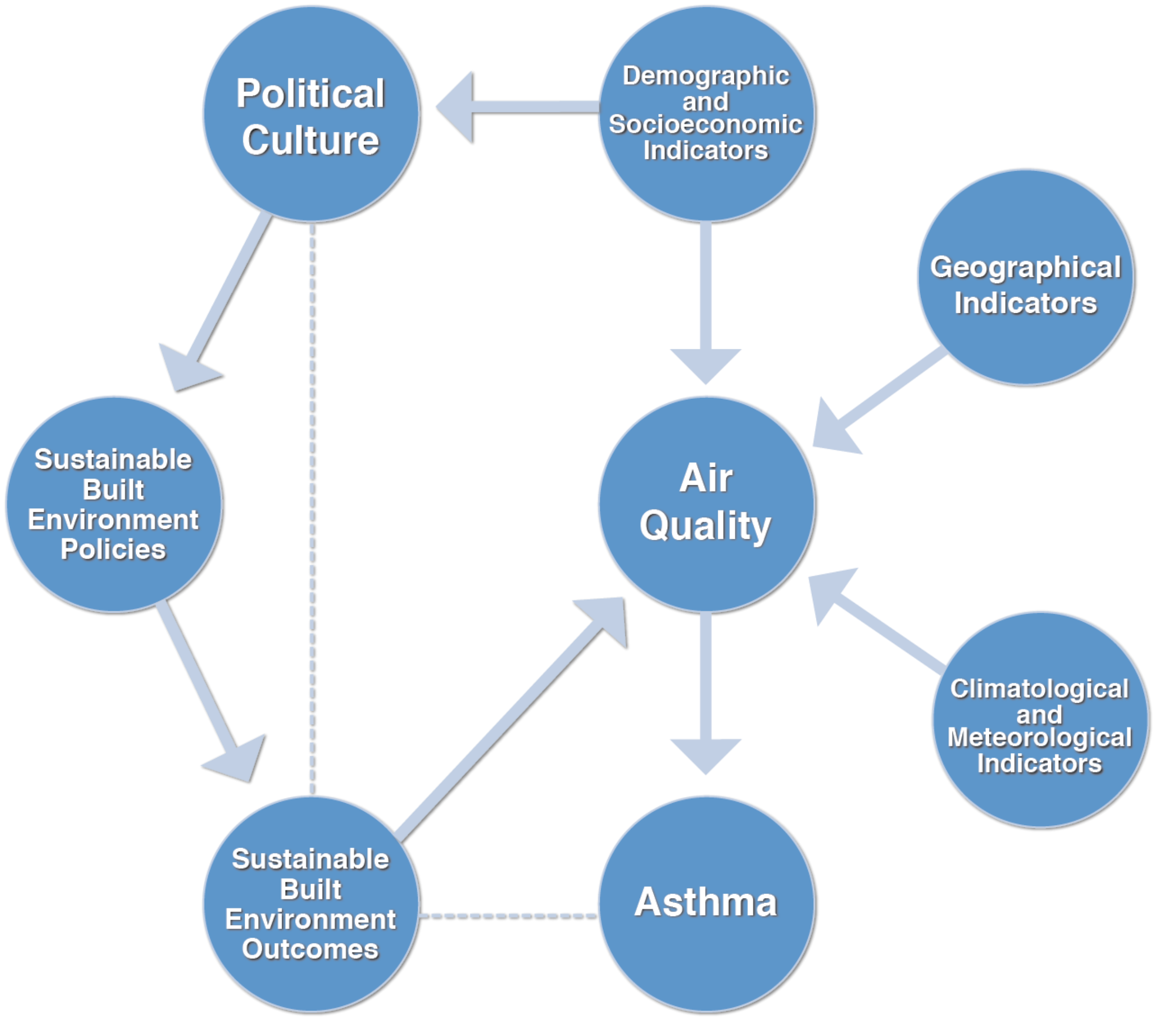

Figure 3-3 Diagram of Relationships Between Variable Categories

Table 3-3 – Variables and Data Sources

SUSTAINABLE BUILT ENVIRONMENT COMMITMENT VARIABLES			
Variable	**Variable Type**	**Unit(s) of Analysis/Formats Available**	**Data Sources**
Sustainable Commitment Score	Independent	City-level, between the years 2005-2013	City websites, policy documents, ordinances
Sustainability Interview Results	Descriptive	City-level	Planning Manager and Sustainability Director

Table 3.3 - Continued

SUSTAINABLE BUILT ENVIRONMENT OUTCOME VARIABLES			
Variable	**Variable Type**	**Unit(s) of Analysis/Formats Available**	**Data Sources**
Land Uses			
Acres of Green Space (city-owned park land)	Independent	City-level, cumulative annual totals reported for each year 2005 to 2013	City Parks and Recreation personnel and documents
Census Block Density	Independent	Zip codes within city boundaries, 2009-2013	Tax Appraisal Districts: GIS Shapefiles and Appraisal Data
Population Density (Total Population /Land Area)	Independent	City-level, annual totals for each year 2005 to 2013	City documents and personnel
Land Uses (Residential, Commercial)	Independent	Zip codes within city boundaries, 2009-2013	Tax Appraisal Districts: GIS Shapefiles and Appraisal Data
Number of Parks	Independent	City-level, cumulative annual totals reported for each year 2005 to 2013	City Parks and Recreation personnel and documents
Transportation			
Bike Lanes (miles)	Independent	City-level, cumulative annual totals reported for each year 2005 to 2013	City documents and personnel
Bus Ridership	Independent	City-level, annual totals for each year 2005 to 2013	Local Transit Authorities (The T and Capital Metro)
Location of Major Roadways	Descriptive	City-level	TXDOT GIS Maps
Pedestrian & Bike Trails (miles)	Independent	City-level, cumulative annual totals reported for each year 2005 to 2013	City and Public Water District personnel and documents
Rail Ridership	Independent	Annual totals for each year 2005 to 2013, travel from FTW to Dallas and Austin to Leander	Local Transit Authorities (TRE and Capital Metro)
Annual Vehicle Miles Traveled (TxDOT-Maintained Roads)	Independent	City-level totals for 2005 – 2013	Texas Department of Transportation

Table 3.3 - Continued

Transit-Oriented Developments	Independent	City-level, annual totals for each year 2005 to 2013	City websites, documents, personnel
Buildings			
Age of Building Stock	Independent	Zip codes within city boundaries, 2009-2013	Tax Appraisal Districts: GIS Shapefiles and Appraisal Data
Density of Buildings (Floor to Area Ratio)	Independent	Zip codes within city boundaries, 2009-2013	Tax Appraisal Districts: GIS Shapefiles and Appraisal Data
# of Energy Star-rated Buildings	Independent	City-level, annual totals for each year 2005 to 2013	Energy Star website
# of LEED certified Buildings	Independent	City-level, annual totals for each year 2005 to 2013	USGBC/LEED website
DEMOGRAPHIC & SOCIOECONOMIC VARIABLES			
Variable	**Variable Type**	**Unit(s) of Analysis/Formats Available**	**Data Sources**
Level of Education *(% of population age 25 and older with a bachelor's degree or higher)*	Descriptive/Control for air pollution & political culture	City-level, annual estimates for each year 2005 to 2013	U.S. Census American Community Survey
Marital Status *(% of the population aged 15 and older never married)*	Descriptive/Control for political culture	City-level, annual estimates for each year 2005 to 2013	U.S. Census American Community Survey
Median Age	Descriptive/Control for political culture	City-level, annual estimates for each year 2005 to 2013	U.S. Census American Community Survey
Median Household Income	Descriptive/Control for political culture	City-level, annual estimates for each year 2005 to 2013	U.S. Census American Community Survey
Population	Descriptive/Control for political culture & air pollution (Cho & Choi, 2014)	City-level, annual estimates for each year 2005 to 2013	City Website (Austin and Fort Worth)

Table 3.3 - Continued

Poverty Rate *(% of persons below poverty level)*	Descriptive/Control for political culture	City-level, annual estimates for each year 2005 to 2013	U.S. Census American Community Survey
Race *(% of population white only)*	Descriptive/Control for political culture	City-level, annual estimates for each year 2005 to 2013	U.S. Census American Community Survey
Sex Ratio *(# of males/100 females)*	Descriptive/Control for political culture	City-level, annual estimates for each year 2005 to 2013	U.S. Census American Community Survey
Unemployment Rate *(population 16 years and older)*	Descriptive/Control for political culture	City-level, annual estimates for each year 2005 to 2013	U.S. Census American Community Survey
POLITICAL CULTURE VARIABLES			
Variable	**Variable Type**	**Unit(s) of Analysis/Formats Available**	**Data Sources**
Nontraditional Lifestyle *(% of the population 35 and older never married - Male/Female)*	Independent	City-level, annual estimates for each year 2005 to 2013	U.S. Census American Community Survey
Nontraditional Gender Roles *(% of women never married in the labor force)*	Independent	City-level, annual estimates for each year 2005 to 2013	U.S. Census American Community Survey
% of the population that affiliates with a religion	Independent, utilized for case selection	City-level, an annual percentage	Sperling's Best Places (2014)
Level of conservatism of the population	Independent, utilized for case selection	City-level, an annual ranking	Study conducted by Tausanovitch & Warshaw (2014)
% of unmarried same-sex partner households	Independent	City-level, annual estimates for each year 2005 to 2013	U.S. Census American Community Survey

Table 3.3 - Continued

% of workforce in professional, scientific, technical category	Independent	City-level, annual estimates for each year 2005 to 2013	U.S. Census American Community Survey
*City Revenue Base *(total revenues per 100,000 population)*	Descriptive/Control for sustainability efforts	City-level, annual totals for each year 2005 to 2013	City Comprehensive Annual Financial Reports
*Government Structure *(council-manager or mayor-council)*	Descriptive/Control for sustainability efforts	City-level	Official City Website
**Identified by Paterson & Saha (2010) to significantly impact city sustainability implementation efforts*			
AIR QUALITY VARIABLES			
Variable	**Variable Type**	**Unit(s) of Analysis/Formats Available**	**Data Sources**
Geographical			
City Elevation	Descriptive/Control	City-level map and value	U.S. Geological Survey
Topography	Descriptive/Control	City-level map	Topographical GIS maps
Climatological and Meteorological			
Dew Point Temperature (degrees Fahrenheit)	Descriptive/Control	Annual averages measured at monitoring site(s) within each city boundary, 2005-2013	Texas Commission on Environmental Quality (TCEQ)
Precipitation (inches)	Descriptive/Control	City-level, annual totals for each year 2005 to 2013	National Weather Service
Temperature (degrees Fahrenheit)	Descriptive/Control	Annual averages measured at monitoring site(s) within each city boundary, 2005-2013	Texas Commission on Environmental Quality (TCEQ)
Wind Speed	Descriptive/Control	Annual averages measured at monitoring site(s) within each city boundary, 2005-2013	Texas Commission on Environmental Quality (TCEQ)

Table 3.3 - Continued

Air Quality			
# of Days when Air Quality was GOOD	Dependent	Number of days per year by city/CBSA, 2005-2013	U.S. Environmental Protection Agency AQI Report
Compliance with 8hr EPA Ozone Standard (parts per billion)	Dependent	Annual averages measured at monitoring site(s) within each city boundary, 2005-2013	Texas Commission on Environmental Quality (TCEQ)
Carbon Monoxide (part per million)	Dependent	Annual averages and max measured at monitoring site(s) within each city boundary, 2005-2013	Texas Commission on Environmental Quality (TCEQ)
PM-2.5 (micrograms per cubic meter)	Dependent	Design value (3 year average) measured at monitoring site(s) within each city boundary, 2005-2013	Texas Commission on Environmental Quality (TCEQ)
ASTHMA VARIABLES			
Variable	**Variable Type**	**Unit(s) of Analysis/Formats Available**	**Data Sources**
Inpatient Hospital Discharge Data	Dependent	Zip Code-level, annual counts for each year, 2005-2013	Texas Health Care Information Collection, Texas Department of State Health Services
*Pollen Count	Control	Annual averages measured at designated monitoring site for each city, 2005-2013	National Allergy Bureau designated monitoring site in each city
** In an attempt to address the limitation of epidemiologic asthma data, Bernstein (2004) suggests examining or controlling for the other factors that may exacerbate asthma, like, allergens (pollen and fungal spores).*			

Content Analysis Framework

A modified content analysis framework is utilized to evaluate city built environment plans and policies outlined by Younger et al. (2008) in Table 1.1 to influence air quality and respiratory health between the years 2005 and 2013. City sustainable strategies and plans regarding transportation, buildings and land use are identified and scored based on the level of commitment. Transportation plans, commitments and policies are identified by their relationship to reducing motor vehicle emissions. Some examples include increased bike lanes, sidewalks, and public transit opportunities and facilities, including transit-oriented developments. The policies relating to buildings include green building practices, the use of LEED or Energy Star frameworks, or those utilizing keywords like ‘local’, ‘recycled’, ‘sustainable’, or ‘energy efficient’. Additionally, adaptive reuse commitments encouraging the preservation of existing building infrastructure are identified and scored. Policies relating to land uses include those that allow for mixed uses, increased density, preservation of parks, trails and green spaces, and other smart growth principles.

City comprehensive plans and planning documents are the primary units of analysis for the collection of policy data. Additionally, key city personnel are identified and contacted to assist with locating the related policies for the specified time period. Evaluating policies for this time period provides benchmarks for determining any significant affect on the corresponding built environment outcomes, and subsequently air quality and asthma. It is safe to assume that policy data for each sustainable built environment category, Land Use, Buildings and Transportation, may not exist for every year between 2005-2013. These occurrences actually create another layer for comparison and interpretation and aids in my ability to analyze any potential causal significance by evaluating fluctuations in outcomes before and after policies were enacted.

Berke and Conroy (2000) developed the commitment scoring methodology utilized in my research in their evaluation of thirty different city comprehensive plans. The objective of their study was to ascertain if utilizing ‘sustainability’ as a framework actually influenced the level of commitment to sustainable practices. The authors discovered that understanding and utilizing the term ‘sustainability’ as an overarching framework for planning made no difference on instituting commitments and policies related to sustainability. My research takes Berke and Conroy’s (2000) a step further by examining the impact of select sustainable built environment policies and commitments on the corresponding built environment outcomes and analyzing the relationships between these outcomes, air quality and asthma.

The following steps of the content analysis framework are utilized to evaluate and measure the level of commitment to sustainable built environments as identified from the city planning documents for Austin and Fort Worth between 2005 and 2013. First, each of the policies is scored based on if the policy is a suggestion or a requirement. A suggested policy is determined by the utilization of keywords like, *encourage*, *consider*, *intend* or *should*, and is given a score of 1. If the policy used keywords such as *shall*, *will*, *require* or *must*, then it is given a score of 2. Each city case study is therefore given an overall sustainability commitment score. Higher summed scores indicate either the existence of more sustainable built environment policies, or a greater commitment to implementing sustainable built environment policies.

Interview Protocol

Semi-structured interviews with the city manager and sustainability director (or their designees) are conducted in each city case study in an effort to describe the philosophy and history of sustainability planning and engagement over the specified time period. City managers are responsible for implementing policies and offer a needed perspective between council or public concerns and city government plans and strategies. Interviewing the sustainability director of each city provides the focused perspective on sustainability-related planning and priorities. Semi-structured interviews consist of a formal interview with an established list of questions. Although semi-structured interviews allow for questions to be prepared ahead of time, both the interviewee and respondent also have the freedom to deviate and follow other trajectories that may surface throughout the conversation (Cohen & Crabtree, 2006). The interviewees are contacted via email to schedule a face-to-face or phone interview. Each interview is to last no longer than one hour and consists of open-ended questions regarding the past, present and future state of sustainability in each city. These questions only serve to provide additional context to the policy and outcome data collected and analyzed within my case study framework and designated unit of analysis (Yin, 2014). Given the unknown tenure at the city of each interviewee and the possibility for a historical recall bias in interview responses, collected policy data will be used to confirm or triangulate the responses. Additionally, questions are sent to the interviewee prior to the scheduled interview so they may collect and review any necessary meeting notes or other historical data sources to assist with responding accurately to the questions. In the case when an in-person or phone interview is unable to be scheduled, respondents are able to provide written responses to the interview questions.

The interview questions include:

1. When did the city first engage in sustainability or sustainable development practices? What was the nature of this engagement?
2. What was the motivation for engaging in sustainable development?
3. Are there any barriers to sustainable development planning and implementation? If so, what are they?
4. Is sustainability currently a priority for the city? If so, how does it rank with other priorities?
5. What will sustainability/sustainable development look like in the city 5 years from now? 10 years from now?

The interview results are shared with the interviewee as part of the chain of evidence process to ensure construct validity of my case study research design. This research is exempt from Institutional Review Board (IRB) approval because the interviewees are public officials and the questions pertain to the city, its policies and priorities, not the views or opinions of the interviewee or any other human subject.

Description of Procedures

The elements of the 'Define and Design' phase of the multiple-case study protocol (Figure 3.2) developed by Yin (2014) were outlined previously in this chapter. The two remaining phases of the protocol, which are 'Prepare, Collect and Analyze' and 'Analyze and Conclude', are described below.

Prepare, Collect and Analyze

STEP 1: Data Collection

City sustainable built environment policy data for 2005 to 2013 are identified from official city websites, data sources, and personnel. The year, policy category (Land Use, Buildings, Transportation), and policy verbiage are recorded in the policy database. Each policy is then scored based on the content analysis framework outlined earlier in this chapter. The score for each policy and the summed scores for each year and city are recorded in the database. See Appendix A to view the complete variables database.

City sustainable built environment outcomes, demographic and socioeconomic, air quality, asthma, and political culture data for 2005 to 2013 are identified and collected from governmental websites and data sources, including federal, state, local and non-profit regulatory agencies. Data is organized and recorded in the master variables database (see Appendix A). Annual city total counts or averages are collected for each variable except for asthma, land uses, age of building stock, building and census block density, and percentage of built-out parcels, which are organized and recorded by zip code. Annual vehicle miles traveled for each year and city are provided and recorded in the master variables database as well.

City managers and sustainability directors are contacted via phone and/or email to schedule interviews. One-hour phone or face-to-face interviews are conducted and, if authorized by interviewee, recorded. Interviews are transcribed and provided to the interviewee for verification and review. If necessary, respondents are permitted to submit written responses to the interview questions. Pertinent and specific responses are reported in the city case study results and final report.

STEP 2: Data Analysis Procedures

The first three of the five components of a quality case study research design (Yin, 2014), which entail identifying the case study questions, propositions (other areas to be examined within the score of the study), and units of analysis, were addressed and outlined earlier in this chapter. The two remaining phases of the case study research design addressing the research questions and theories (hypotheses) are developing the logic linking the data to the propositions and the criteria for interpreting the findings.

As stated earlier the logic linking the data to the propositions, which are the influence of political culture on sustainability planning and policy development and the prevalence of sustainable built environment policies, and to the overarching research questions as to how these propositions relate to the implementation of sustainable built environment outcomes and the impact of these outcomes on air quality and the prevalence of asthma, include such methods as pattern matching, explanation building, time-series analysis, logic models, and cross-case synthesis. All of the data for the variables collected over the nine year time period are recorded in the master variables database (see Appendix A) for each city case study. Additionally, visual representations of the data are created utilizing ArcGIS and graphics software. The *Asthma and Air Quality Map* for each city is organized by zip code and includes the demographics data said to influence air quality specifically, Level of Education and Population, the climatological variables, air quality variables, asthma data, elevation, and the monitoring sites. A *Built Environment Map* is created for each year and city and is organized by zip code. It includes all of the sustainable built environment variables, major roads and highways, rail lines, green spaces, location of green buildings and transit-oriented developments. Austin and Fort Worth *Compilation Maps* are created for 2005, 2009 and 2013, which include all of the mapped variables from the *Asthma and Air Quality Map* and *Built Environment Map*. All of these maps serve to aid in identifying relationships and developing explanations for the data.

The chronological and organized displays of data provide the ability to identify and evaluate patterns and develop explanations. This review and analysis is conducted independently for each case study. The explanations developed thoroughly answer the case study research questions and proposed theories by also addressing any rival explanations that may have appeared significant through data analysis.

STEP 3: Write Individual Case Studies

According to Yin (2014), a compelling case study can "raise awareness, provide insight, or even suggest solutions to a given situation" (Chapter 6, Section1, Subsection 3, Paragraph 1). Each case study report is a narrative, written separately, and includes both textual and nontextual elements, including graphs, maps, and other elements to assist in illustrating the results and explanations.

Analyze and Conclude

The final stage of the multiple-case study protocol outlined by Yin (2014) is the analyze and conclude phase, which includes evaluating and drawing cross-case conclusions, developing policy implications (if any), and writing the cross-case report. The same pattern matching, time-series analysis, and explanation building processes conducted for the single case studies (Austin and Fort Worth) are performed for the cross-case analysis. The multiple-case theories and rival theories are addressed and reported. Any other unidentified rival explanations for the final cross-case results are recognized as resulting limitations of this study, thus identifying future areas of research. Additionally, policy implications or recommendations identified in the cross-case analysis are reported.

Introduction to Individual City Case Reports

The case study research design outlined by Yin (2014) and detailed earlier in Chapter 3, consisted of five components: (1) the case study questions, (2) propositions, (3) unit(s) of analysis, (4) logic linking data to propositions, and (5) criteria for interpreting the findings. Additionally, Yin (2014) provided the framework for multiple case study designs, which consisted of the (1) define and design phase, (2) prepare, collect and analyze phase, and (3) the analyze and conclude phase. The following two individual case study reports for the city's of Austin and Fort Worth addressed the data analysis phase of the case study research design, specifically the logic linking data to propositions and criteria for interpreting the findings, in addition to finalizing the prepare, collect and analyze phase of the multiple case study protocol.

In reviewing and analyzing the data collected, it was essential to ensure a firm connection to the research questions and theories (hypotheses). In an effort to certify a valid research design and to provide a framework for analysis, the structure of these case studies followed a hierarchal flow addressing each case theory or hypothesis developed as part of the multiple case study protocol and based on existing literature. The case study theories for this research were:

1. The political culture of a city influences sustainable built environment commitments.
2. Cities with greater commitments to sustainable built environment strategies result in larger corresponding outcomes.
3. Cities with more sustainable built environment outcomes have better air quality.
4. Cities with better air quality have lower cases of asthma.

These theories serve as my research predictions, as to which methods, like pattern matching, were utilized for evaluation and comparison. Additionally, data collected for rival explanations were reviewed to assist in interpreting the results.

Chapter 4

Fort Worth Case Report

Case Study Theory #1

Does the political culture of a city influence a city's commitment to sustainable built environment policies? The literature stated that more progressive cities engaged in more sustainability planning than less progressive cities. Although the structure of city government in Fort Worth was council-manager and not mayor-council, which according to Sharp (2005a) should indicate a more reformed or progressive city, Fort Worth had a reputation for being more conservative and less focused on sustainability. This reputation was corroborated by existing evidence indicating that almost 6.5% more of the Fort Worth population was religious over the national average and ranked 12th out 67 as most conservative (Sperling's Best Places, 2014; Tausanovitch & Warshaw, 2014). Additionally, cities that had openly embraced sustainability and adopted the moniker were more likely to be progressive societies with high levels of income, education, and nontraditional households (DeLeon & Naff, 2004, Sharp, 2005ab).

Interview Insights: Sustainability Planning

According to Dana Burghdoff (personal communication, September 30, 2015), an Assistant Director in the Planning Department, Fort Worth had not blatantly focused on sustainability or greenhouse gas emissions reductions, instead they had targeted goals regarding efficiencies and energy consumption reduction. The widespread acceptance from the city's leaders to improve air quality, while addressing a growing population and mobility improvements, served as the motivation for engaging in sustainability planning and programming, despite the lack of sustainability branding. Central city revitalization and establishing mixed-use growth centers were other emphasis areas. However, these initiatives were widely accepted because of their inherent efficiencies, not as a broader acceptance of sustainability planning and initiatives. The pattern of engaging in traditionally organized sustainability efforts without the need for the associated marketing was prevalent in the city's philosophy and actions regarding green-building practices as well. Although the city encouraged energy reduction and other green-building practices, they had not found it necessary to certify through U.S. Green Building Council's LEED program or any other organization.

> According to Ms. Burghdoff (personal communication, September 30, 2015), the city "will measure and achieve the targets, but we don't need to spend the time or resources to get the certification and put the label on it. There has not been any demand from our leadership to report specifically what are green buildings and what are not, other than just showing that we are saving taxpayers' dollars. It is back to efficiency and air quality".

The City of Fort Worth was very cautious regarding instituting regulations that may impede economic development. This includes extra costs to the city or developers. There is a desire for Fort Worth to be perceived as a developer friendly community. To date, the Fort Worth City Council had not actively emphasized green building, however the concern regarding efficiencies and projects making good business sense with achievable and reasonable return on investments were what drove the decisions of city leadership (D. Burghdoff, personal communication, September 30, 2015). A complete transcript of the interview conducted with Ms. Burghdoff and the written responses provided by Samuel Steele, the Sustainability Administrator with the City of Fort Worth are available in Appendix C.

Demographics and Political Culture Indicators

While the interview with the city planning office provided the benchmark for evaluation and insight regarding the planning priorities in Fort Worth from 2005 to 2013, the new political culture literature identified several other demographic and lifestyle indicators said to influence the political culture of a city, either directly or indirectly. All of these demographic and political culture variables, along with the data collected for the City of Fort Worth are detailed in Table 4.1. The sustainability commitment scores established through the policy review process and city revenue base for each year were also provided.

Table 4-1 – Relationship between City of Fort Worth demographics, political culture and policy commitments, 2005 – 2013

		2005	2006	2007	2008	2009	2010	2011	2012	2013
Demographic and Socioeconomic Variables	**Population**	624,850	664,100	686,850	702,850	720,250	741,206	748,450	757,810	767,560
	Median Household Income	$40,663	$45,276	$47,104	$48,870	$47,634	$48,224	$47,399	$50,750	$52,430
	Unemployment Rate *(population 16 years and older)*	7.70%	7.70%	6.00%	6.60%	9.70%	10.70%	10.80%	7.90%	7.50%
	Median Age	30.9	32.3	31.7	31.6	30.8	31.5	31.4	31.9	31.6
	Sex ratio *(males per 100 females)*	100	101.9	98.3	100.4	96.4	97.5	91.6	95.3	96.4
	Race *(% of the population white alone)*	60.78%	60.76%	63.09%	65.33%	62.44%	62.66%	70.25%	67.96%	62.07%
	Level of Education *(% of population age 25 and older with a bachelor's degree of higher)*	25.10%	24.40%	24.80%	24.60%	24.90%	26.10%	26.10%	25.80%	28.20%
	Marital Status *(% of the population aged 15 and over never married)*	29.60%	31.80%	31.30%	31.30%	32.00%	33.10%	33.50%	33.50%	34.00%
	Poverty Rate *(% of population below poverty level)*	18.80%	16.60%	16.20%	16.60%	19.00%	17.90%	21.80%	18.60%	20.10%
Political Culture Variables	**Nontraditional Lifestyle** *(% of the population 35 and older never married - MALE/FEMALE)*	3.06%	4.04%	3.76%	4.19%	3.69%	4.31%	3.96%	3.71%	3.51%
		2.29%	3.24%	3.30%	2.86%	3.17%	3.33%	3.87%	3.35%	4.00%
	Nonntraditional Gender Roles *(% of women never married in labor force)*	8.89%	9.01%	8.91%	8.31%	9.48%	8.93%	10.90%	9.93%	11.53%
	% of workforce in professional, scientific, technical	4.65%	4.22%	4.44%	4.65%	4.66%	5.37%	5.53%	5.37%	4.81%
	% of unmarried same-sex partner households	0.90%	1.00%	0.59%	0.36%	0.51%	0.46%	0.30%	0.26%	0.39%
Sustainability Commitment Score		84	2	10	7	14	16	0	45	NA
City Revenue Base *(total revenues per 100,000 population)*		$161,241	$174,718	$171,594	$172,064	$166,457	$165,215	$171,867	$170,196	$175,342

The population in Fort Worth steadily increased over the nine-year period, demonstrated by the increase of 142,710 from 2005 to 2013. The largest increase of 39,250 occurred between 2005 and 2006. The biggest gain in median household income also occurred from 2005 to 2006, with a gain of $4,613. Income remained relatively consistent between 2007 and 2011, and increased by $2,600 and $1,680, respectively, in 2012 and 2013. The unemployment rate in 2013 is 0.2% lower than the rate in 2005. Unemployment was at its highest between 2009 and 2011, during the period of the global financial crisis, peaking at 10.8% in 2011. The median age increased over the 9-year period, however it remained consistent between 31 and 32 years. The ratio of men to women declined by 3.6 fewer men for every 100 women from 2005 to 2013. Additionally, the diversity in Fort Worth declined over the time span of this research, which was indicated by the increase of white only population from 60.78% to 62.07%. However, this was an improvement from the percentage in 2011 of 70.25%. The percentage of the population at least 25 years old with a college degree fluctuated slightly over nine years, but between 2012 and 2013 there was an impressive 9.3% change year over year, ending at 28.2%, an increase of 2.4% from 2012. A larger percentage of the 2013 population were single than in any of the previous years, peaking at 34%. The poverty rate hit the lowest point in 2007 at 16.2% and the highest point in 2011 at 21.8%. The rate declined in 2012, but grew to the second highest level over the nine-year period in 2013 to 20.1%.

The lifestyle variables identified in the literature to influence political culture included, the prevalence of nontraditional lifestyles, represented by individuals over the age of 35 that never married; nontraditional gender roles, represented by the percentage of women whom have never married in the labor force; percentage of the population in professional, scientific or technical fields; and the percentage of unmarried, same-sex partner households. The percentage of nontraditional males exceeded females in every year since 2005 except for the most recent, 2013, when the percentage of nontraditional females hit 4%. This could be an indication that more women were choosing to focus on a career instead of getting married and having children. The percentage of women in the labor force that never married had not exceeded 9.5% between 2005 and 2010. In 2013, the percentage hit a nine-year high of 11.53%. This also supported the theory that more women were electing to emphasize their careers. The percentages of the workforce in a professional, scientific or technical field were the greatest in 2010 at 5.37%, 2011 at 5.53% and 2012 at 5.37%. The percentage declined in 2013 to 4.81%. The percentage of unmarried, same-sex partner households was around 1% in 2005 and 2006. However, since then the percentage had decreased substantially, indicated by a 0.4% average for 2007 to 2013. This could be an indication that Fort Worth had a growing reputation for being intolerant, less progressive or reformed.

Overall, the percentage change from 2005 to 2013 of all the political culture variables, except for same-sex households, increased. The largest increase exhibited by unmarried women over the age of 35 and unmarried women in the labor force, represented by a percentage change of nearly 75% and 30%, respectively. This increase was significantly greater than the national percentage change between 2005 and 2013, which was 18% in unmarried women over the age of 35 and nearly 16% in women in the labor force whom have never married. Although the increase in Fort Worth was greater, the percentage of the population of these two variables were considerably lower than the national average in 2005, with 30% and 60% differences, respectively. The percentage of women in the labor force who had never married continued to be substantially lower in Fort Worth than the national percentage through 2013 with a near 50% difference. However, the percentage of unmarried women over the age of 35 in Fort Worth had surpassed the national average by 8.6% in 2013. Unmarried men over the age of 35 increased almost 15% from 2005 to 2013, though the 2005 and 2013 percentages in Fort Worth were 12% and 21% lower than the overall national percentage. The percentage increase of the population in professional, scientific, and technical professions from 2005 to 2013 was nominal at 3.4%. Additionally, both the 2005 and 2013 percentages in Fort Worth were lower than the national numbers by nearly 36% and 23%, respectively. As mentioned previously, the percentage of unmarried same-sex partner households decreased drastically in Fort Worth between 2005 and 2013 by almost 57%, which was at a much greater rate than the national decline in this population of 29% from 2005 to 2013.

Connecting the changing percentages of these measurements in Fort Worth to the actual political culture would indicate a slight shift towards a more progressive society, however, the over 50% decrease in the number of same-sex couples and minimal increase in the technical population would appear to contradict any substantial reformation. Additionally, the difference in the Fort Worth percentages as compared to the national percentages were significantly lower for Fort Worth in 2005 and 2013, except for the growth of the percentage of unmarried women over the age of 35. These results were in line with the original expectations and assumptions that the political culture in Fort Worth was more conservative and less progressive. Additionally, the corroboration from the interview with city personnel that the leadership in Fort Worth, driven by this political culture, had not emphasized sustainability planning or embraced sustainability as a policy framework.

Policy Review and Commitment Score

A review of the City of Fort Worth comprehensive plans from 2005 to 2013 was conducted utilizing the content analysis framework outlined in Chapter 3 in order to address the question if a city's political culture influences its engagement in sustainable development planning. Tables 4.2 and 4.3 provide a breakdown of the number of sustainable built environment policies that influence air quality from each sustainable built environment category for each year, along with the number of those policies that were suggestions versus commitments (see Appendix D for a complete list of identified policies and scores). The City of Fort Worth conducted their baseline comprehensive plan in 2000 with annual updates mandated by city council. Therefore, the majority of the scores were allocated in 2005. Recurring and ongoing policies were only scored in the first year identified, not for subsequent years. Additionally, the 2013 comprehensive plan was not available for public review, according to city staff.

2005 and 2012 were the two years with the greatest number of sustainable built environment policies with 57 and 25. However, only 47% of the 2005 policies were commitments versus suggestions, as compared to 80% in 2012. Ten new policies were generated in both 2009 and 2010 with 40% and 60% correspondingly identified as commitments. Although 2006, 2007 and 2008 resulted in the fewest number of policies, the majority of these policies were commitments. No new policies were identified in 2011. Of the four sustainable built environment categories, transportation and land use, contained the most policies and attention from the city, with 46 and 43 respectively from 2005 to 2013. A total of nine policies were identified in the buildings category and 14 in the general sustainable development category for 2005 to 2013.

Table 4-2 – Fort Worth sustainable built environment policy counts by year, 2005 – 2013

Policy Category	Area of Focus	2005			2006			2007			2008			2009			2010			2011			2012			2013	
Buildings	Development Practices	5	3	2	0	0	0	1	0	1	0	0	0	1	1	1	1	1	1	0	0	0	1	0	1	NA	NA
Land Use	Infill/Brownfields	10	7	3	0	0	0	1	0	1	1	0		0	0	0	0	0	0	0	0	0	1	0	1	NA	NA
Land Use	Mixed-Use Development	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	NA	NA
Land Use	Parks, Trails and Green Space	7	1	6	0	0	0	0	0	0	0	0		0	0	0	4	2	2	0	0	0	3	0	3	NA	NA
Land Use	Reuse	3	3	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	NA	NA
Land Use	Zoning	4	1	3	1	0	1	1	0	1	0	0		0	0	0	0	0	0	0	0	0	4	0	4	NA	NA
Sustainable Development		6	5	1	0	0	0	1	0	1	0	0		4	3	1	1	0	1	0	0	0	2	0	2	NA	NA
Transportation	Accessibility	8	3	5	0	0	0	0	0	0	0	0		2	1	1	1	1	0	0	0	0	1	0	1	NA	NA
Transportation	Increase Bike & Pedestrian Opportunities	1	1	0	0	0	0	1	0	1	2	1		2	0	2	2	0	2	0	0	0	4	0	4	NA	NA
Transportation	Reduce VMT/Improve Air Quality	7	4	3	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	3	0	3	NA	NA
Transportation	Transit-Oriented Development	5	1	4	0	0	0	0	0	0	1	0		1	1	0	1	0	1	0	0	0	4	0	4	NA	NA
	Total Number of Policies	**57**			**1**			**5**			**4**			**10**			**10**			**0**			**25**			**NA**	
	Number of Policy Suggestions	**30**			**0**			**0**			**1**			**6**			**4**			**0**			**5**			**NA**	
	Number of Policy Commitments	**27**			**1**			**5**			**3**			**4**			**6**			**0**			**20**			**NA**	

Table 4-3 – Fort Worth policy classifications by focus area, 2005-2013

Policy Category	Area of Focus	Total Number of Policies	Number of Policy Suggestions	Number of Policy Commitments
Buildings	Development Practices	9	5	4
Land Use	Infill/Brownfields	13	7	6
Land Use	Mixed-Use Development	3	1	2
Land Use	Parks, Trails and Green Space	14	5	9
Land Use	Reuse	3	3	0
Land Use	Zoning	10	2	8
Sustainable Development		14	8	6
Transportation	Accessibility	12	6	6
Transportation	Increase Bike & Pedestrian Opportunities	12	2	10
Transportation	Reduce VMT/Improve Air Quality	10	5	5
Transportation	Transit-Oriented Development	12	2	10

All three of the reuse policies were suggestions and only mentioned in 2005. Mixed-use development and reduce VMT/improve air quality were only addressed in 2005 and 2012, however the reduce VMT/improve air quality category had substantially more total policies, less of which were commitments, than those in the mixed-use development category. The sustainable development and the parks, trails and green space focus areas contained the majority of the total policies with 14 each, but not the majority of the higher-valued commitment policies. Over 80% of the policies identified in each of the transit-oriented development, bike and pedestrian opportunities, and zoning categories were commitment policies instead of suggested policies, signifying a larger focus on implementing means for alternative transportation and supportive development. Additionally, policies within these categories were mentioned 5, 6, and 4 years respectively out of the 9-year period. Infill/brownfield development and access issues in transportation categories contained the second and third highest numbers of total policies with approximately 50% being commitments and mentioned in four out of the nine years. Although development practices were mentioned five out of the nine years, it had one of the fewest numbers of total and commitment policies.

Discussion and Conclusions

Additional indicators were identified in the study conducted by Paterson and Saha (2010) for their potential influence on the economic and social wellbeing of a city, with the argument that cities with fewer economic and social issues and greater resources were more inclined to emphasize sustainability. These factors included population growth, unemployment rate, poverty rate, and revenue base. Fort Worth was ranked the sixth fastest growing city since the recession by Forbes Magazine (2013), which was evidenced by the near 23% population increase from 2005 to 2013, as compared to the 9.6% increase nationally. Although the 2013 unemployment rate of 7.5% was lower than the 2005 rate, 21% lower than the national rate, and declined from record highs in 2009 to 2011, the poverty rate increased from 18.6% in 2012 to 20.1% in 2013. Additionally, the poverty rate in Fort Worth was over 26% higher than the national rate. The increase in the poverty rate could be a result of the population growth, which may have potentially influenced sustainability planning and implementation. However, Fort Worth developed new sustainable built environment policies in 2009 and 2010, when unemployment and poverty rates were high. Fifty percent of these policies were commitments rather than suggestions, indicating a level of acceptance as to the potential efficiencies of sustainable built environment initiatives. In 2012 and 2013, as city revenues increased, an influx of policies were developed, 62% of which were identified as commitments. This level of commitment to implementing sustainable built environment policies rather than solely encouraging sustainable behaviors supported the Paterson and Saha (2010) study finding city revenues significant to subsequent sustainability implementation efforts.

Given that Fort Worth had chosen not to embrace the moniker of sustainability and its higher levels of religious traditionalism, it would suggest that the city was less progressive and generally had lower levels of income, education and nontraditional households (DeLeon & Naff, 2004, Sharp, 2005b). Although income and education levels, as well as the presence of nontraditional households and gender roles had increased in Fort Worth from 2005 to 2013, the 2005 and 2013 percentages were well below the national level for each indicator except for nontraditional females, which was nearly 9% higher in 2013, and median income, which was less than 1% higher. The higher percentage of nontraditional females in Fort Worth could be a result of the population in Fort Worth consisting of approximately 51.4% females as compared to 50.8% nationally. The percentage of professional and technical population in Fort Worth was significantly lower than the national averages in 2005 and 2013. The difference between the median income in Fort Worth and the national average was nominal, making its potential significance difficult to interpret. The percentage of same-sex partner households decreased nationally and in Fort Worth, however the decrease of this population from 2005 to 2013 in Fort Worth was nearly double the rate of decline nationally. Also, when comparing the level of controversy surrounding each of these indicators or populations, one could argue that the percentage of same-sex households in a city would be the most contentious and best measure as to the level of progressiveness of that city. These results validated that the political culture in Fort Worth produced a less progressive or reformed city.

A couple of key identifiers from the policy review and interviews with the city that support this case study theory, included the desire for Fort Worth to be perceived as developer friendly and the lack of emphasis on sustainability planning or the acceptance of sustainability as a policy framework by city leadership. This was corroborated by the small percentage of commitment policies in the buildings development practices category, as compared to the ratio in the other categories. This motivation and resulting lack of strict development policies were additional indicators that the less progressive political culture in Fort Worth influenced the city's commitment to sustainable built environment policies.

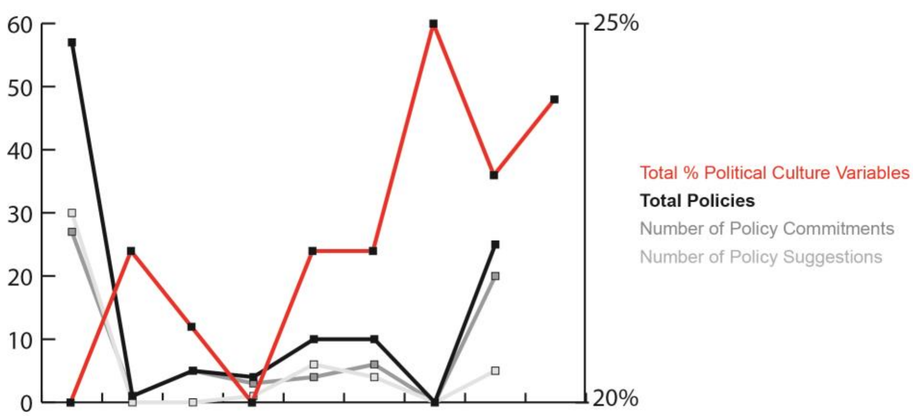

Figure 4-1 Relationship between Fort Worth political culture and policies, 2005 - 2013

Case Study Theory #2

Do cities with a greater commitment to sustainable built environment policies result in more abundant sustainable built environments? Several sustainable built environment variables were identified in the literature to influence air quality and respiratory health (Table 1.1). These indictors, collected and analyzed over the nine-year period, along with the sustainability policy review and scoring detailed in the above section (Case Study Theory #1), served as the means for addressing the second case study theory that cities with greater commitments to sustainable built environment strategies resulted in larger corresponding outcomes. Table 4.4 provides a complete list of the citywide sustainable built environment variables collected for 2005 to 2013, along with the city revenue base and sustainability policy commitment score. A few of the built environment variables were only logical at a smaller unit of analysis within the city. Zip codes were the smallest and most appropriate unit of analysis for this case study as identified by the scale of the available asthma data provided. The sustainable built environment variables collected at the zip code level are summarized in Table 4.5 with a complete detailing in Appendix E. The land and building zip code data was only available for 2009 to 2013 as explained in the Methods section in Chapter 3. Additionally, maps of all the collected sustainable built environment data, including land uses by zip code, are provided for each year between 2009 and 2013 in an effort to assist with analysis and drawing potential explanations (see Figures 4.2 – 4.6).

Citywide Built Environment Data

The population density of Fort Worth steadily increased each year from 2005 to 2013, ending with an increase of 371.7 more people per square mile. The city grew in number of parks and acreage over the nine-year period, but saw the biggest increases in 2009 and 2011 with 8 and 6 additional parks and 275.06 and 328.8 acres, respectively. Overall, this represented a 15% growth in the number of parks and an 8% increase in park acreage from 2005 to 2013. According to the data, it appeared the city began to aggressively commit to increasing bike lanes in 2011, especially since they had not installed any lanes until 2006. There was an 80% increase in lanes from 2011 to 2012 and nearly a 50% increase from 2012 to 2013, which can most likely be attributed to Mayor Betsy Price, an avid supporter of cycling, and who was elected in 2011. Neither the City of Fort Worth nor the Trinity River Vision maintained trail data for 2005 and 2006. 2008 had the biggest increase in trail mileage with a 17% growth over 2007 and the second largest influx of trails was in 2013 with a 10% increase from 2012.

In reviewing the transit ridership data, there was a surprising 2.9% decrease in rail ridership from 2005 to 2013, however a dramatic 30% increase in bus ridership. Rail ridership did peak in 2008 and 2009, coinciding with the financial crisis, at close to 2.8 million then steadily declined. Annual vehicle miles traveled also increased from 2005 to 2013 by 5.6%, which was nominal considering the near 23% increase in population during this same period. The development of passenger rail and the push for transit-oriented developments (TOD) started pretty early in Fort Worth with the three TOD stations opening in 2000 and 2001. There had been no additional TOD locations designated since that time. However, there are future plans to implement a new passenger line, called Tex Rail, with two already approved and funded stations due to open in 2018 (Eric Fladager, personal communication, September 22, 2015).

Certifying buildings with the U.S. Green Building Council's LEED certification had picked up popularity in Fort Worth since 2009 and peaked in 2013 with 64 certified buildings. It is important to note that the majority of the 64 buildings were part of a volume registration by one developer. There does not appear to be a pattern to the locations of LEED certified buildings over the period of 2005 to 2013. This is demonstrated by the wide dispersion of certified buildings throughout the city. Utilizing Energy-star certifications occurred in Fort Worth first in 2005 and averaged about 4 rated buildings per year through 2012, except for 2006, which did not have any certifications. Energy-star certifications peaked in 2013 with 10 buildings. The majority of the Energy-star rated buildings occurred in or near the central city and designated TOD stations.

Table 4-4 – Relationship between City of Fort Worth policy commitments and sustainable built environment outcomes, 2005-2013

			2005	2006	2007	2008	2009	2010	2011	2012	2013
City Revenue Base *(total revenues per 100,000 population)*			$161,241	$174,718	$171,594	$172,064	$166,457	$165,215	$171,867	$170,196	$175,342
Sustainability Commitment Score			84	2	10	7	14	16	0	45	NA
Sustainable Built Environment Variables	**Land Uses**	**Population Density per Square Mile**	1800.2	1909.4	1972.6	2011.0	2057.9	2112.9	2130.5	2152.3	2171.9
		Acres of Green Space	10,851.69	10,898.62	10,956.78	11,056.67	11,331.73	11,372.13	11,700.94	11,719.67	11,733.12
		# of Parks	226	229	234	241	249	252	258	260	261
	Transportation	**Bus Ridership**	399,057	437,475	440,786	449,989	439,253	461,558	485,072	543,357	522,829
		Rail Ridership	2,154,400	2,409,851	2,507,705	2,746,992	2,789,030	2,469,215	2,425,335	2,252,140	2,092,782
		Miles of Bike Lanes	0	9.3	9.3	9.3	11.38	11.38	18.16	32.71	48.62
		Pedestrian & Bike Trails (miles)	no data	no data	49.67	58.1	60.44	61.11	64.4	64.93	71.33
		Annual Vehichle Miles Traveled	19,140,833	18,034,950	18,705,720	19,391,361	19,858,367	19,550,769	19,900,434	20,213,977	20,220,922
		# of Transit-oriented Developments	3	3	3	3	3	3	3	3	3
	Buildings	**# of LEED certified buildings**	0	0	1	0	3	9	7	10	64
		# of Energy Star rated Buildings	2	0	4	4	5	2	6	4	10

Table 4-5 – Fort Worth land and building data averages by zip code, 2009-2013

Fort Worth Zip Codes	Average Age of Building Stock (2009-2013)	Average Floor to Area Ratio (2009 - 2013)	Average Census Block Density (2009-2013)	Census Block Density (% change: 2009 to 2013)	Average % of Parcels with Buildings (2009 - 2013)
76102	1966	1.07	148.02	16%	57%
76103	1951	0.14	55.94	8%	89%
76104	1948	0.37	164.83	-1%	59%
76105	1947	0.15	101.85	9%	75%
76106	1955	0.18	64.63	17%	79%
76107	1955	0.24	96.55	9%	85%
76108	1982	0.13	18.61	16%	83%
76109	1959	0.22	75.03	21%	95%
76110	1942	0.24	137.07	-2%	89%
76111	1949	0.17	81.00	12%	87%
76112	1967	0.17	72.97	16%	92%
76114	1956	0.13	77.23	7%	89%
76115	1954	0.20	95.28	11%	87%
76116	1965	0.22	86.85	14%	91%
76118	1974	0.16	40.28	24%	92%
76119	1964	0.13	58.72	12%	83%
76120	1994	0.15	36.92	55%	83%
76123	1999	0.25	31.30	19%	86%
76126	1984	0.09	10.04	11%	70%
76131	2000	0.19	25.61	70%	85%
76132	1989	0.26	69.35	13%	89%
76133	1972	0.21	94.63	11%	99%
76134	1978	0.21	58.39	20%	87%
76135	1979	0.07	22.34	10%	81%
76137	1993	0.29	62.32	20%	95%
76140	1983	0.11	23.39	10%	76%
76148	1980	0.18	82.77	11%	98%
76155	1994	0.22	23.23	41%	25%
76164	1936	0.23	122.57	20%	84%
76179	1995	0.13	13.83	30%	80%
76177 (Denton Co)	2006	0.24	23.77	25%	55%
76177 (Tarrant Co)	2006	0.26		25%	74%
	2009	2010	2011	2012	2013
Average Age of Building Stock	1973	1973	1972	1972	1972
% of Parcels with Buildings	80%	80%	82%	82%	82%
Average Floor to Area Ratio	0.22	0.22	0.22	0.22	0.22
Average Census Block Density	58.28	65.63	65.63	65.66	65.69

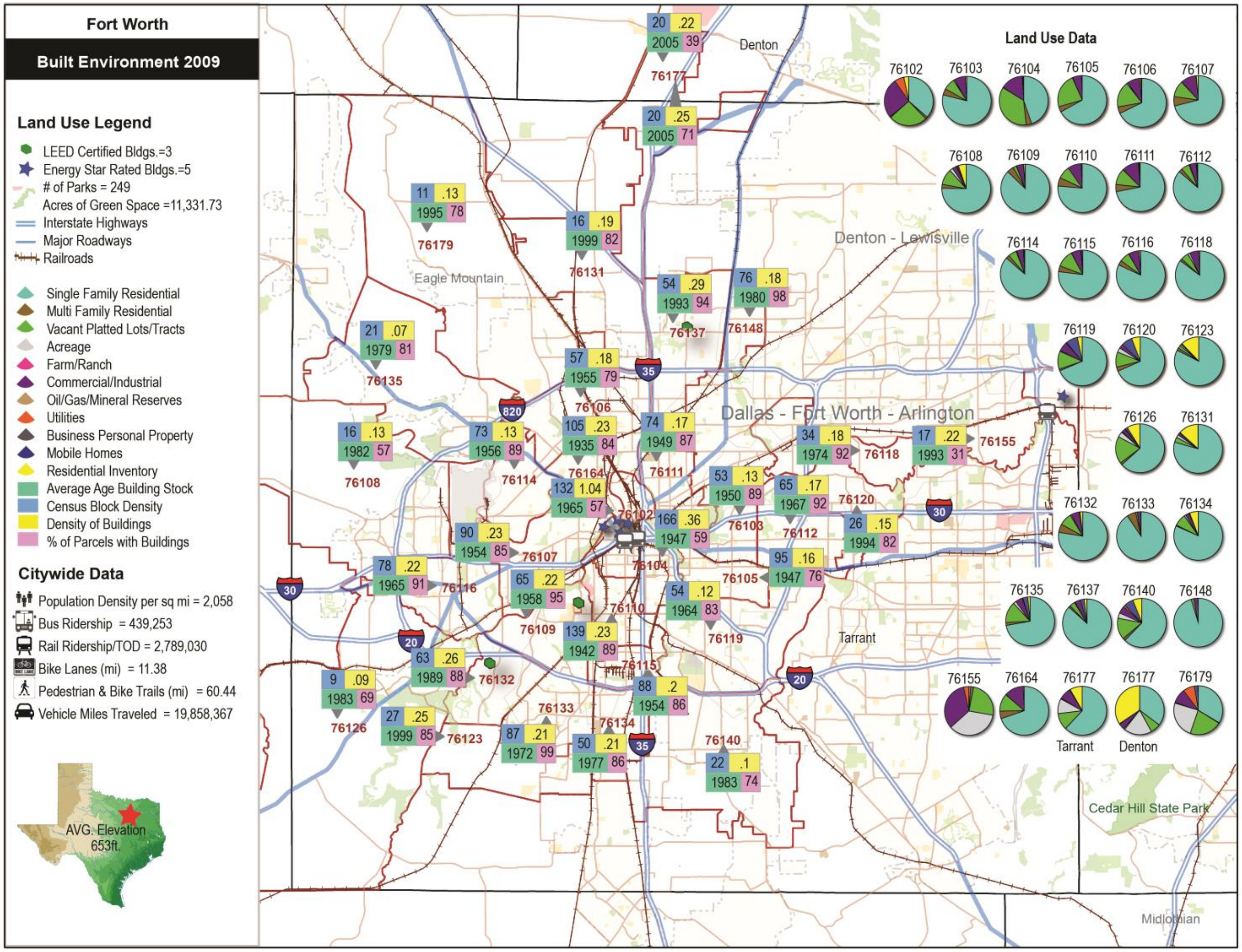

Figure 4-2 Fort Worth Built Environment Map - 2009

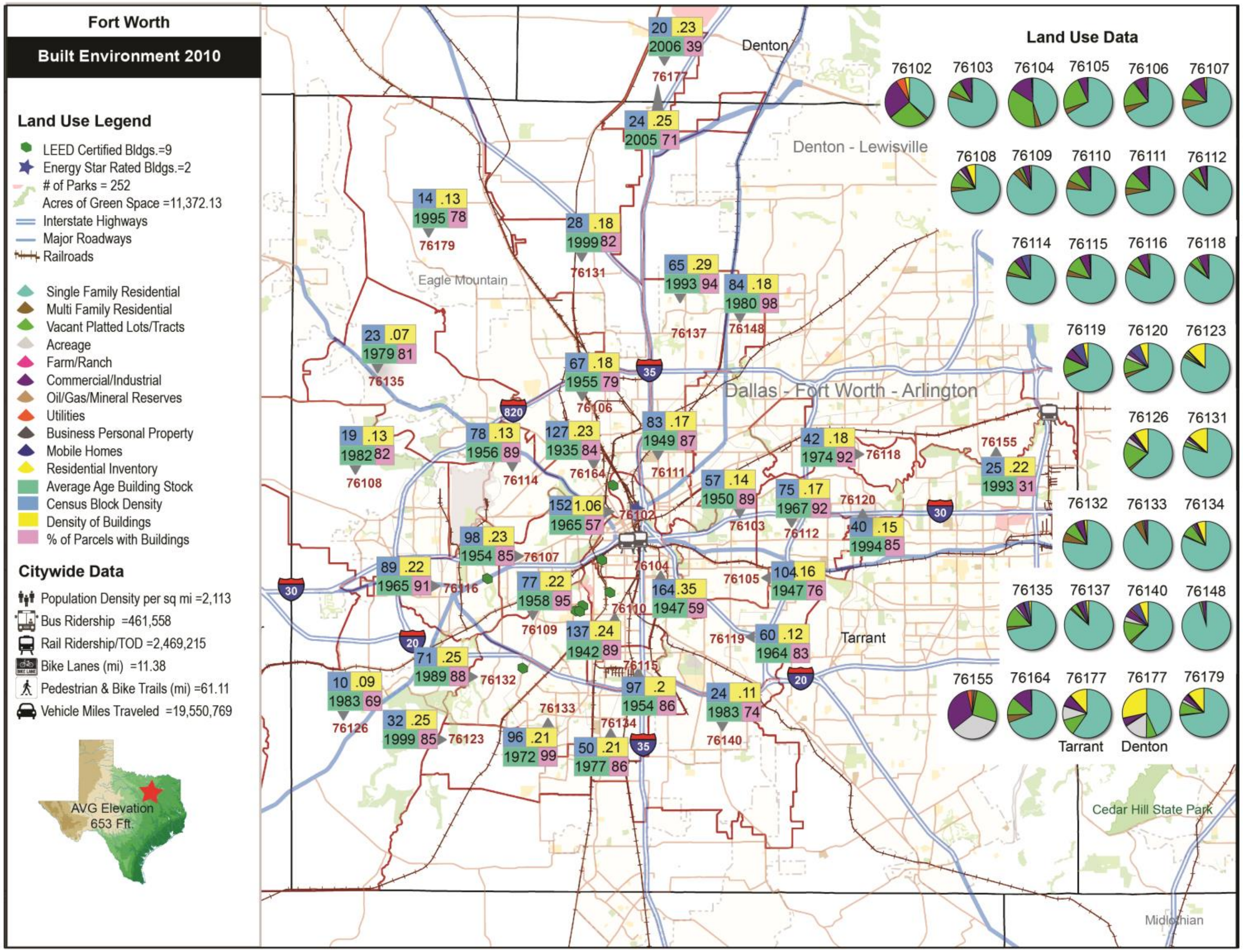

Figure 4-3 Fort Worth Built Environment Map – 2010

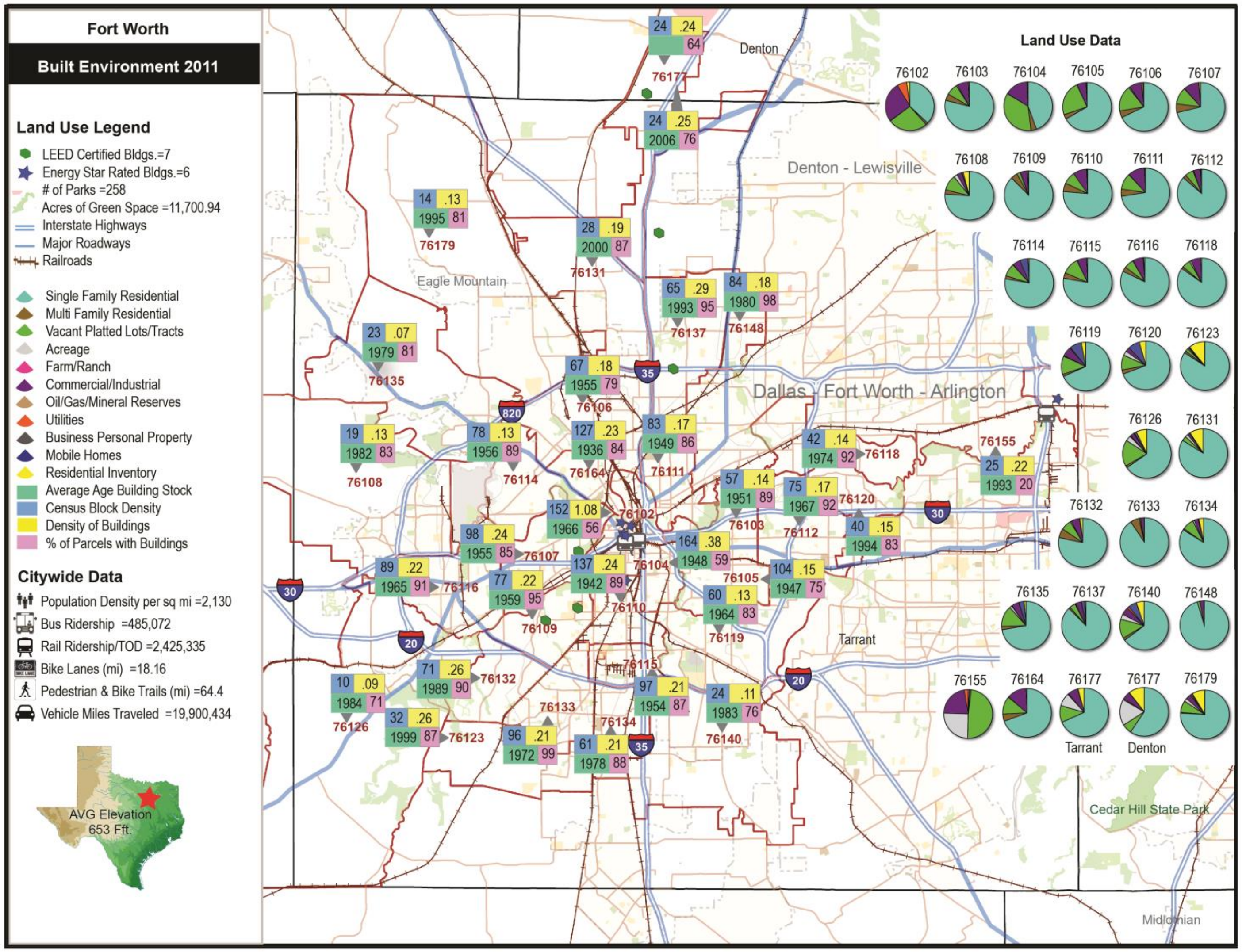

Figure 4-4 Fort Worth Built Environment Map – 2011

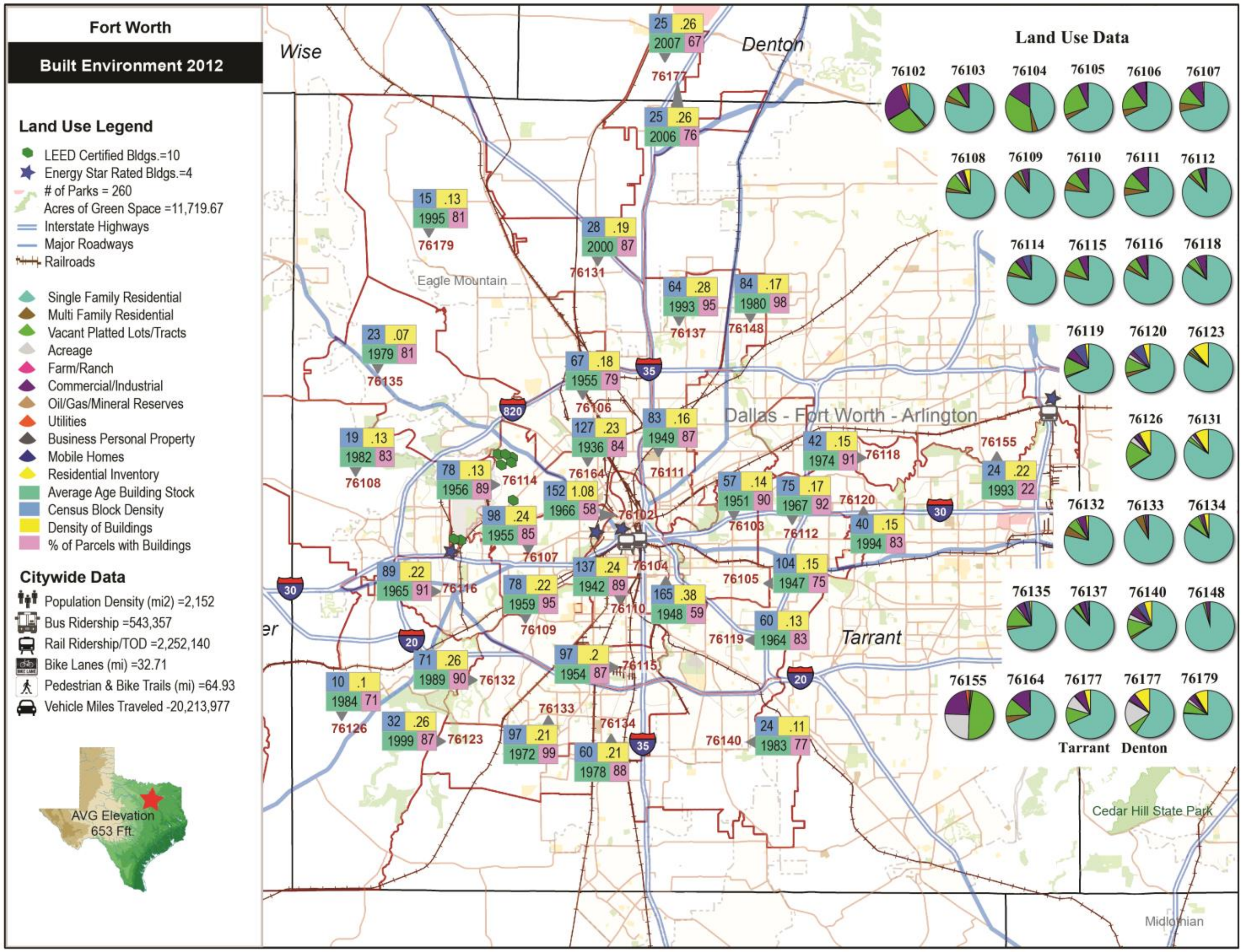

Figure 4-5 Fort Worth Built Environment Map – 2012

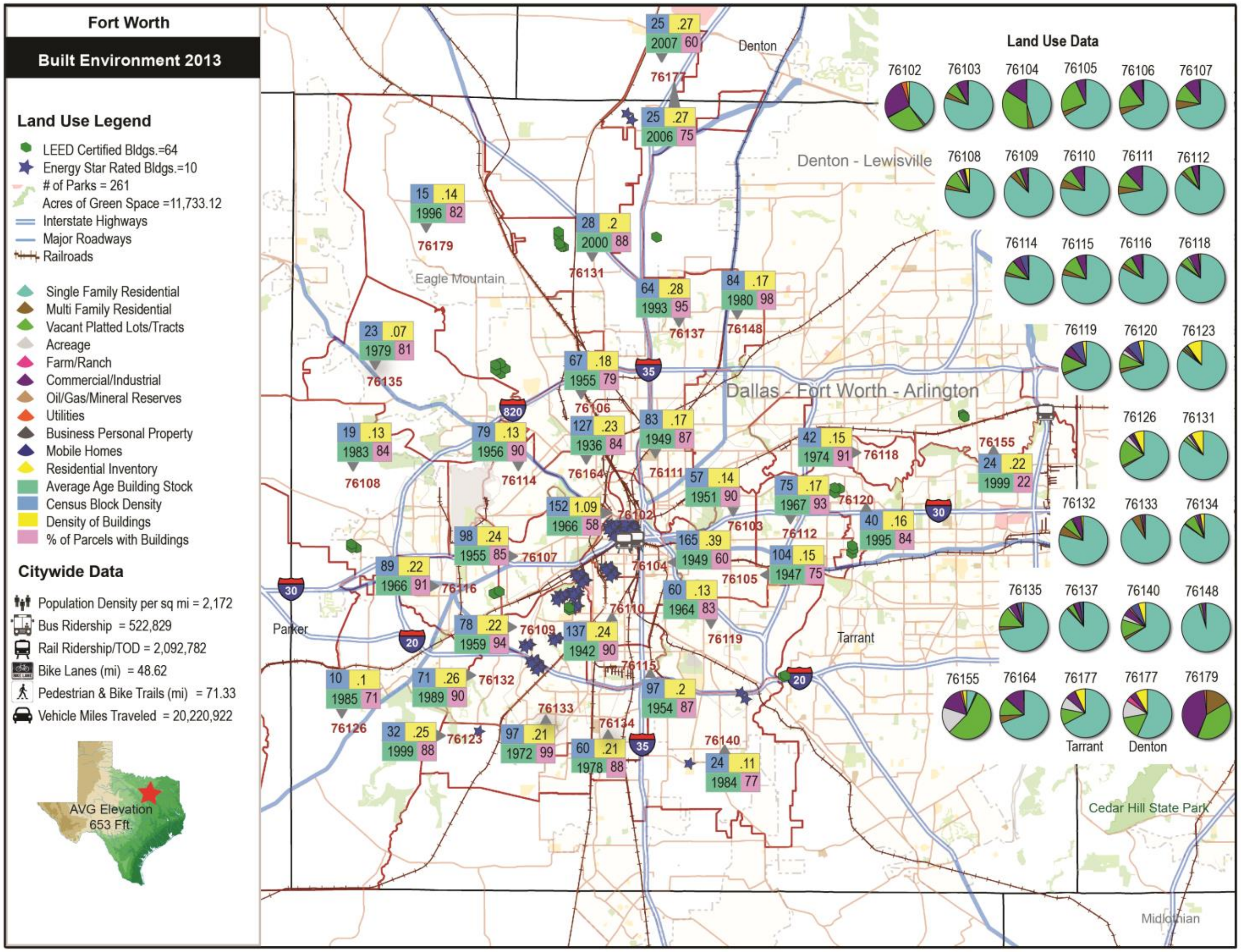

Figure 4-6 Fort Worth Built Environment Map - 2013

Built Environment Data: Zip Code-Level

The citywide sustainable built environment data detailed in Table 4.4 and summarized above provided a holistic perspective to Fort Worth's implementation strategies and transit preferences. However, examining specific land use and building data by zip code provided a better understanding of city development patterns with a greater potential for identifying connections between policies and outcomes (see Table 4.5 and Figures 4.2 to 4.6). Additionally, according to the literature, analyzing elements within a city can potentially result in more accurate assumptions and explanations regarding air quality measurements, which was discussed in the case study theory #3 section of this chapter (Briggs, 2000; Zhu et al., 2002 as cited in Jerrett et al., 2005). There are 31 zip codes with corresponding appraisal and land use data in the City of Fort Worth. The 76177 zip code is in Tarrant and Denton County, so data was provided for both counties. Zip codes 76122 and 76129 only contained one parcel and were omitted from the tables and analysis. 76129 was a vacant parcel and the data provided for 76122 was inconsistent, due most likely to input error, according to the Tarrant County Appraisal District GIS Administrator.

The average age of building stock in Fort Worth ranged from 1936 in the 76164 zip code to 2006 in zip code 76177, for both Tarrant and Denton County. Zip code 76164 is adjacent to the downtown zip code, 76102, and 76177 is on the outskirts of the city boundary. These results corresponded with traditional development patterns where existing, older structures were closer to the central city and newer developments occurred further and further out from the city core. The remainder of the zip codes followed this same pattern. The five-year (2009-2013) citywide average age of building stock was 1972 and the overall average of parcels with buildings was 81%. In addition to having the most recent development, Zip code 76177/Denton County also had a 21% increase of the number of parcels with buildings from 2009 to 2013. However, it remained the second least built-out zip code with an average of 55%. According to the land use maps in Figures 4.2 – 4.6, the land use classifications in 76177/Denton were primarily residential with a mix of commercial/industrial, business personal property, acreage and vacant lots. Single-family residential increased significantly between 2010 and 2011, diminishing the residential inventory category. In 2013, this zip code increased in vacant lots and farm/ranch land designations, and decreased in acreage. An average of 25% of the parcels in zip code 76155 were built, which was the least of all zip codes. Additionally, this zip code lost approximately 9% of its built parcels between 2009 and 2013, which was also demonstrated by an increase in the number of vacant lot land use designations in 2011 and 2013. The loss of built parcels and demolition of buildings in zip code 76155 could have been preparation for future development given the location of the CentrePort rail station and its designation as a TOD. Zip code 76131 had a 6% increase in built parcels over the five-year period with a 50% increase in multi-family and 13% increase in single-family residential from 2009 to 2013, followed by 76177/Tarrant and 76179, both with a 4% increase in built parcels. Parcels with the single-family and mobile homes land use designations in zip code 76177/Tarrant increased over 30% and 25%, respectively, from 2009 to 2013. Single-family residential and commercial/industrial classifications exploded in 76179 with almost 16,000 and 569 parcels added, respectively, in 2013 from 2009. All three of these zip codes border each other and fall within the northern edge of the city. Zip codes 76123 and 76140, which border the southern edge of the city, had a 3% increase in development. 28% of all the zip codes exhibited no change in built parcels, 25% had a 1 % increase, 12.5% had a 2% increase, and slightly less than 1% had a 1% decrease in built parcels between 2009 and 2013. Zip codes 76133 and 76109, located at the southwest corner of the city boundary, were 99% and 95% built-out, respectively. Correspondingly, zip codes 76148 and 76137 at the northeast corner of the city were 98% and 95% built. The city had the most opportunities for new development in the central city zip code 76102 and the adjacent zip code 76104, with just over 40% vacant parcels available in each. In 2013 from 2009, the utilities land use designation did not vary in zip codes 76108, 76120, and 76177/Denton; however it increased in zip codes 76105, 76116, and 76118; and decreased in every other zip code.

Average floor to area ratio (FAR) of the building in each zip code for 2009 to 2013 was utilized to gauge the density of buildings. A higher FAR tends to indicate more dense construction. The buildings in the downtown zip code, 76102, had the greatest density with an average floor to area ratio of 1.07. FARs decreased greatly outside of the central city. The adjacent zip code 76104 had the second largest average FAR of 0.37, followed by 76137 at 0.29. Zip codes that bordered the city had the smallest FAR at 0.07 in 76135, 0.09 in 76126, and 0.11 in 76140. The 2009 to 2013 average census block density was calculated for each zip code to further explain the level of connectivity within the city by providing the mean number of census blocks per square mile in each zip code (yearly calculations are available in Appendix E). Zip codes 76104, 76102, 76110, 76164, and 76105, located in the city core, all had over 100 census blocks per square mile, with corresponding density averages of 164.8, 148, 137, 122.6, and 101.9. Conversely, zip codes 76126, 76179, and 76108 on the western boundary of the city had less than 20 census blocks per square mile, with corresponding density averages of 10, 13.8, and 18.6. Zip code 76131 had the largest percentage difference in census block density between 2009 and 2013, represented by a 70% change. This corresponded with the 6% increase of built parcels occurring during this time period. The northern and easternmost zip codes had the next greatest change in census block density with a range of 24-55% increases. Zip codes 76110 and 76104 deceased in density from 2009 to 2013.

Discussion and Conclusions

In order to analyze any potential explanations for the representative sustainable built environment outcomes over the nine-year review period and address the research theory that the presence of more sustainable policies resulted in greater corresponding outcomes, the policy categories were aligned with the related built environment outcomes in Tables 4.6, 4.7 and 4.8. Each table represents the sustainable built environment categories: land use, buildings, and transportation. As discussed in the previous section, the majority of the City of Fort Worth sustainable built environment policies were allocated in 2005, the base year of this research. For this reason, and given that the majority of the related built environment outcomes increased year over year, the ability to address the research theory that more policies resulted in more outcomes was hindered. One could argue that the sustainable built environment outcomes increased because the city made the majority of the corresponding policy suggestions and commitments at the beginning of the established research period. Given the evidence, however, there did not appear to be an immediate connection between the times a policy was generated to the corresponding built environment outcomes. This may be due to a delay between policy adoption and implementation. Although, the evidence did not support the case study theory that more sustainable built environment policies resulted in greater outcomes, it did validate and correspond with the existing literature noting the inconsistencies between sustainability policy development and implementation (Cooper & Vargas 2004; Holman, 2014; Lubell et al., 2009; Saha, 2009; Seasons, 2003).

Table 4-6 - Fort Worth sustainable land use outcomes and related policies, 2005-2013

YEAR	Population Density per Square Mile	Related Policy Land Use: Infill/ Brownfields	Related Policy Land Use: Zoning	Acres of Green Space	# of Parks	Related Policy Land Use: Parks, Trails & Greenspace
2005	1800.2	10	4	10,851.69	226	7
2006	1909.4	0	1	10,898.62	229	0
2007	1972.6	1	1	10,956.78	234	0
2008	2011.0	1	0	11,056.67	241	0
2009	2057.9	0	0	11,331.73	249	0
2010	2112.9	0	0	11,372.13	252	4
2011	2130.5	0	0	11,700.94	258	0
2012	2152.3	1	4	11,719.67	260	3
2013	2171.9	NA	NA	11,733.12	261	NA

Table 4-7 - Fort Worth sustainable buildings outcomes and related policies, 2005-2013

YEAR	# of LEED certified Buildings	# of Energy Star rated Buildings	Related Policy Buildings: Development Practices
2005	0	2	5
2006	0	0	0
2007	1	4	1
2008	0	4	0
2009	3	5	1
2010	9	2	1
2011	7	6	0
2012	10	4	1
2013	64	10	NA

Table 4-8 - Fort Worth sustainable transportation outcomes and related policies, 2005-2013

YEAR	Bus Ridership	Rail Ridership	Annual Vehichle Miles Traveled	Related Policy Transportation: Reduce VMT/Improve Air Quality	Related Policy Transportation: Accessibility	Miles of Bike Lanes	Pedestrian & Bike Trails (miles)	Related Policy Transportation: Increase Bike & Pedestrian Opportunities	# of Transit-oriented Developments	Related Policy Transportation: Transit-Oriented Development
2005	399,057	2,154,400	19,140,833	7	8	0	no data	1	3	5
2006	437,475	2,409,851	18,034,950	0	0	9.3	no data	0	3	0
2007	440,786	2,507,705	18,705,720	0	0	9.3	49.67	1	3	0
2008	449,989	2,746,992	19,391,361	0	0	9.3	58.1	2	3	1
2009	439,253	2,789,030	19,858,367	0	2	11.38	60.44	2	3	1
2010	461,558	2,469,215	19,550,769	0	1	11.38	61.11	2	3	1
2011	485,072	2,425,335	19,900,434	0	0	18.16	64.4	0	3	0
2012	543,357	2,252,140	20,213,977	3	1	32.71	64.93	4	3	4
2013	522,829	2,092,782	20,220,922	NA	NA	48.62	71.33	NA	3	NA

Case Study Theory #3

Do cities with more abundant select sustainable built environment outcomes have better air quality? The measurements for the identified land use, buildings, and transportation outcomes, determined by the literature to impact air quality, were analyzed from 2005 to 2013 for the City of Fort Worth in the section above. These outcomes along with the air quality statistics, including relevant climatological and meteorological influences noted in the literature, were utilized to examine the third research theory that cities with more sustainable built environment outcomes had better air quality. Before an analysis of the impact the built environment outcomes had on air quality could be conducted effectively, a review of the air quality measurements and the potential environmental influences was necessary. Data collected from the one monitoring site in Fort Worth for 2005 to 2013 is provided in Table 4.9.

Table 4-9 - Fort Worth air quality, 2005-2013

			2005	2006	2007	2008	2009	2010	2011	2012	2013
Air Quality Variables	Climatological & Meteorological	**Yearly Average: Dew Point Temperature** *(degrees Fahrenheit)*	50.2	48.3	51.3	48.2	50.2	50.3	49.3	51.6	48.8
		Annual Precipitation *(inches)*	15.97	32.95	51.29	28.04	45.28	37.55	24.74	28.33	31.01
		Yearly Average: Temperature *(degrees Fahrenheit)*	67.5	68.8	65.7	66.7	66.2	66.5	68.8	68.8	66
		Yearly Average: Wind Speed *(mph)*	7.4	8.1	7.3	8.5	8.1	7.8	8.5	7.9	8
	Air Quality	**# of Days when Air Quality was GOOD**	107	118	144	150	171	186	146	146	156
		Yearly Average: Compliance w/ 8hr EPA Ozone standard *(parts per billion)*	95	94	91	83	79	78	81	79	81
		Yearly Average: Carbon Monoxide *(parts per million)*	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.3	0.2
		Yearly Max: Carbon Monoxide *(parts per million)*	2.6	2.4	2.5	1.7	1.6	2	1.5	1.5	2.2
		Design Value (3yr average): PM-2.5 *(micrograms per cubic meter)*	11.8184	11.2453	11.2386	10.7004	10.3759	Invalid Data	10.1788	10.2445	10.5086

Air Quality Analysis

The number of good days of air quality continuously increased from 2005 to 2010 when it peaked at 186 days. Good air quality days decreased in 2011, maintained in 2012, and increased in 2013. Compliance with the EPA 8-hour ozone standard is achieved when the three-year average of the annual fourth highest daily maximum eight-hour ozone concentration measured is less than 76 parts per billion (ppb). Utilizing this measurement instead of annual averages provided a more accurate account since it provided consideration for higher readings during the ozone season of March 1st - October 31st. Similarly to the numbers of good air quality days, ozone was highest in 2005, improving through 2010 when it began to decline, ending at 81 in 2013. At no point in the nine-year period was Fort Worth in compliance with the 8-hour ozone standard. The yearly average and max of carbon monoxide were provided to gauge compliance with the EPA standards stating that carbon monoxide cannot exceed 35ppm more than once per year. The Fort Worth yearly max measurements and annual averages fall well below these standards for each year. EPA primary standards for PM-2.5 allow up to 12 micrograms per cubic meter for sensitive populations, like asthmatics, children, and the elderly. Like the other air quality measurements, PM-2.5 improved from 2005, with a nine-year low in 2011 at 10.18 micrograms per cubic meter. Slight increases occurred in 2012 and 2013, however at no point did measurements surpass the EPA standard of 12 micrograms per cubic meter.

According to NCTCOG, there could be an association of high dew point temperatures and ozone days (S. Stevenson, personal communication, May 15, 2015). However, examining the annual averages limited the accountability for daily high and low temperatures. This was illustrated by the average dew point upholding around 50 degrees Fahrenheit for each year and the number good air quality days increasing when the dew point temperatures increased instead of decreased. Verifying a correlation between increased precipitation and reduced temperatures was not feasible utilizing annual averages, since the daily rainfall measurements could not be directly associated to actual daily temperatures. However, utilizing this same logic, it would suggest that more precipitation would result in more good air quality days. This holds true for every year except for 2008 and 2010, when precipitation decreased and good air quality days increased. Wind assists in air pollution dispersion. So, increased wind speeds should be indicative of more good air quality days and reduced pollutant measurements. However, the annual data did not support this assumption, most likely due the use of averages and the inability to associate individual wind events to specific air pollution statistics. Examining the influence of climate and meteorological elements on air pollution over the course of a year did not appear to capture the hourly or daily events that immediately influence air quality and dispersion, instead the weather measurements equalized when utilizing annual averages.

Comparing the Fort Worth annual averages for the three measured pollutants: ozone, carbon monoxide, and PM-2.5, with the regional and national averages provided additional benchmarks for comparison and analysis. Texas belongs to the southern region, along with Oklahoma, Kansas, Arkansas, Louisiana, and Mississippi. The annual regional and national ozone measurement provided by the EPA was the 4^{th} maximum of daily max 8-hour average. Fort Worth exceeded the regional and national average for every year between 2005 and 2013 with an average percentage difference of 10.4% and 12.8% respectively. The years 2005, 2006, 2009, and 2013 measured between 14% and 20% higher ozone levels in Fort Worth than the region and between 19% and 23% higher than the national average. The measurement for the carbon monoxide regional and national comparison was the annual 2^{nd} maximum 8-hour average. The carbon monoxide values in Fort Worth were well below the regional and national averages every year between 2005 and 2013, demonstrated by nine-year average differences of 42% and 45%. The EPA utilized seasonally weighted annual averages of PM-2.5 for the regional and national totals. Fort Worth PM-2.5 measurements were an average of 4.8% and 5.3% less than the regional and national averages from 2005 to 2010. However, starting in 2011, PM-2.5 in Fort Worth exceeded the regional and national averages, hitting a peak in 2013 with percentage differences of 13% over the regional average and 16% more than the national average. Lastly, to gain additional perspective, the annual average temperatures and precipitation in Fort Worth was compared to national averages for 2012 and 2013. The temperature in Fort Worth was approximately 13.5 degrees warmer that the national average for both years. Precipitation in Fort Worth for 2012 was 0.16 inches less than the national average and 1.66 inches more than the national average in 2013.

Air Quality and the Built Environment

A review of the percentage change from year to year between 2005 and 2013 for each sustainable built environment and air quality variable, detailed in Table 4.10, aided in the ability to address the case study theory that the presence of more select sustainable built environment outcomes resulted in better air quality. In order to evaluate this theory, good air quality days needed to stay consistent or increase, measurements of each pollutant needed to maintain or decrease, while all sustainable built environment variables increased or remained consistent, except for vehicle miles traveled (VMT), which needed to stay constant or decrease. The change in values between 2005 and 2006 met these requirements, except for the number of Energy-star rated buildings, which decreased. Requirements were met between 2006 and 2007, except for increases in VMT and the yearly max measurement for carbon monoxide, which actually could support the research theory since carbon monoxide is a byproduct of vehicle exhaust. However, VMT also increased from 2007 to 2008 and 2008 to 2009 without an increase in the carbon monoxide yearly max measurement. Therefore, the relationship was inconclusive. Air quality measurements did not increase when bus ridership decreased from 2008 to 2009, although rail ridership started to decline in 2010 when air quality measurements increased, which could indicate a correlation. The presence of LEED and Energy-star certified buildings did not appear to influence air quality measurements since the locations and numbers varied over the nine-year period with no apparent pattern. It is possible that the changes in the values of the outcomes impacted air quality over the period of time, however the evidence did not indicate an influential relationship within each year.

Table 4-10 – Percentage change year over year of Fort Worth sustainable built environment and air quality indicators, 2005-2013

			% change 2005 to 2006	% change 2006 to 2007	% change 2007 to 2008	% change 2008 to 2009	% change 2009 to 2010	% change 2010 to 2011	% change 2011 to 2012	% change 2012 to 2013
Air Quality Variables	Air Quality	# of Days when Air Quality was GOOD	10.28%	22.03%	4.17%	14.00%	8.77%	-21.51%	0.00%	6.85%
		Yearly Average: Compliance w/ 8hr EPA Ozone standard *(parts per billion)*	-1.05%	-3.19%	-8.79%	-4.82%	-1.27%	3.85%	-2.47%	2.53%
		Yearly Average: Carbon Monoxide *(parts per million)*	0.00%	0.00%	0.00%	-33.33%	0.00%	0.00%	50.00%	-33.33%
		Yearly Max: Carbon Monoxide *(parts per million)*	-7.69%	4.17%	-32.00%	-5.88%	25.00%	-25.00%	0.00%	46.67%
		Design Value (3yr average): PM-2.5 *(micrograms per cubic meter)*	-4.85%	-0.06%	-4.79%	-3.03%	NA	NA	0.65%	2.58%
Sustainable Built Environment Variables	Land Uses	Population Density per Square Mile	6.07%	3.31%	1.95%	2.33%	2.67%	0.83%	1.02%	0.91%
		Acres of Green Space	0.43%	0.53%	0.91%	2.49%	0.36%	2.89%	0.16%	0.11%
		# of Parks	1.33%	2.18%	2.99%	3.32%	1.20%	2.38%	0.78%	0.38%
	Transportation	Bus Ridership	9.63%	0.76%	2.09%	-2.39%	5.08%	5.09%	12.02%	-3.78%
		Rail Ridership	11.86%	4.06%	9.54%	1.53%	-11.47%	-1.78%	-7.14%	-7.08%
		Miles of Bike Lanes	100.00%	0.00%	0.00%	22.37%	0.00%	59.58%	80.12%	48.64%
		Pedestrian & Bike Trails *(miles)*	NA	NA	16.97%	4.03%	1.11%	5.38%	0.82%	9.86%
		Annual Vehichle Miles Traveled	-5.78%	3.72%	3.67%	2.41%	-1.55%	1.79%	1.58%	0.03%
		# of Transit-oriented Developments	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Buildings	# of LEED certified buildings	0.00%	100.00%	-100.00%	300.00%	200.00%	-22.22%	42.86%	540.00%
		# of Energy Star rated Buildings	-100.00%	400.00%	0.00%	25.00%	-60.00%	200.00%	-33.33%	150.00%

** Highlighted values indicate a negative result (i.e. decrease in air quality days, increase in pollutant measurements, increase in VMT, decrease in all other buitl environment outcomes.*

Discussion and Conclusions

Although the measurements for each pollutant decreased from 2005 to 2013 in Fort Worth, ozone levels were never in compliance with EPA standards and were significantly higher than the regional and national averages. Emissions from industrial facilities, electric utilities, vehicle exhaust, and gasoline and chemical vapors are some of the major sources of ozone. Fort

Worth was compliant with carbon monoxide standards every year and averaged over 40% fewer parts per million than the regional and national averages. Carbon monoxide gas is primarily emitted from transportation sources. Fort Worth was also compliant with the PM-2.5 standards for sensitive populations in every year between 2005 and 2013. However, the measurements in Fort Worth surpassed the regional and national averages in 2011, 2012 and 2013, despite the minor fluctuations in the actual Fort Worth annual averages. Secondary or fine particles (PM-2.5) are derived from power plants, industries and automobiles. Though the annual vehicle miles traveled increased in Fort Worth for the majority of the years between 2005 and 2013, the miles traveled per capita decreased by nearly 14%. Additionally, the number of parcels with a utilities land use designation decreased by 33% between 2011 and 2012, while the number of commercial and industrial classifications remained consistent. Therefore, indicating that portions of ozone and PM-2.5 emissions in Fort Worth were most likely derived from other unidentified sources; or that dispersion was obstructed by other weather occurrences or built environment characteristics. One possible assumption for the higher ozone levels in Fort Worth could be that the average temperatures run approximately 13 degrees higher than the national averages and ozone forms more aggressively on warm, sunny days.

Case Study Theory #4

Do cities with better air quality have lower cases of asthma? The research regarding the impact of air quality on respiratory health, specifically asthma is extensive and was thoroughly outlined in the literature review. Evaluating hospital discharge data for patients with a diagnosis of asthma with the air quality measurements provided the framework necessary to address the fourth research theory that cities with better air quality had a lower number of asthma inpatient cases. Additionally, pollen counts were examined in order to understand any other potential explanations for the corresponding asthma numbers. The data for the air quality variables, annual asthma hospital counts, and pollen counts are provided in Table 4.11. Additionally, Figure 4.6 graphically displays the asthma data by zip code, along with the air quality measurements.

Table 4-11 - Relationship between Fort Worth air quality and incidences of asthma

		2005	2006	2007	2008	2009	2010	2011	2012	2013
Air Quality	**# of Days when Air Quality was GOOD**	107	118	144	150	171	186	146	146	156
	Yearly Average: Compliance w/ 8hr EPA Ozone standard *(parts per billion)*	95	94	91	83	79	78	81	79	81
	Yearly Average: Carbon Monoxide *(parts per million)*	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.3	0.2
	Yearly Max: Carbon Monoxide *(parts per million)*	2.6	2.4	2.5	1.7	1.6	2	1.5	1.5	2.2
	Design Value (3yr average): PM-2.5 *(micrograms per cubic meter)*	11.8184	11.2453	11.2386	10.7004	10.3759	Invalid Data	10.1788	10.2445	10.5086
Asthma Variables	**Annual # of Inpatient Hospital Discharges**	835	860	915	837	969	797	796	840	819
	Annual Average Pollen Count	151	*134	176	184	205	201	183	235	279

**Data only available for 7 months, therefore average could be skewed either to high or too low.*

Citywide Data

The pollen counts for Fort Worth increased in 2005 to 2009, except for 2006, which was an average of seven months instead of twelve. Counts declined slightly in 2010 and 2011, then increased in 2012 and 2013. The inpatient asthma discharge numbers decreased from 2007 to 2008 and 2009 to 2010. There did not appear to be a direct connection between pollen counts and incidences of asthma, given that asthma discharges decreased when pollen counts increased in 2008 and 2013. The City of Fort Worth had 7,668 asthma discharge cases from 2005 to 2013, which represented 3% of the total reported cases in Texas. The 2010 number of discharges with asthma nationally was 439,000; 797 of which were from Fort Worth (CDC, 2010). The assumption was also that when air quality declined, the number of asthma cases increased. When examining the citywide asthma numbers for each year and the corresponding air quality statistics, there did not appear to be a connection, when asthma numbers increased, air quality numbers decreased and vice-versa, except in 2008 and 2013. Additionally, changes in population could result in an influx of people with asthma moving into the city, thus potentially impacting the number of hospital discharges. However, the population in Fort Worth increased each year while asthma discharges fluctuated. Though a portion of the asthma discharges could potentially be accounted for by changes in population.

Zip Code-Level Data

Reviewing the asthma cases by zip code, represented in Figure 4.7, allowed for a more thorough examination for analyzing the research question by identifying relevant patterns between the air quality data and asthma cases (see Appendix F to view the asthma discharge data by zip code and year). Individuals who received inpatient hospital care for asthma between 2005 and 2013 were represented from an average of 80% of Fort Worth zip codes. Zip codes 76112, 76119, and 76133, located in the south and southeast edge of the city, averaged the most cases from 2005 to 2013, with 66, 82, and 55 cases respectively. Followed by zip codes 76106, 76105, 76116, and 76108, which were located in all areas of the city and averaged over 40

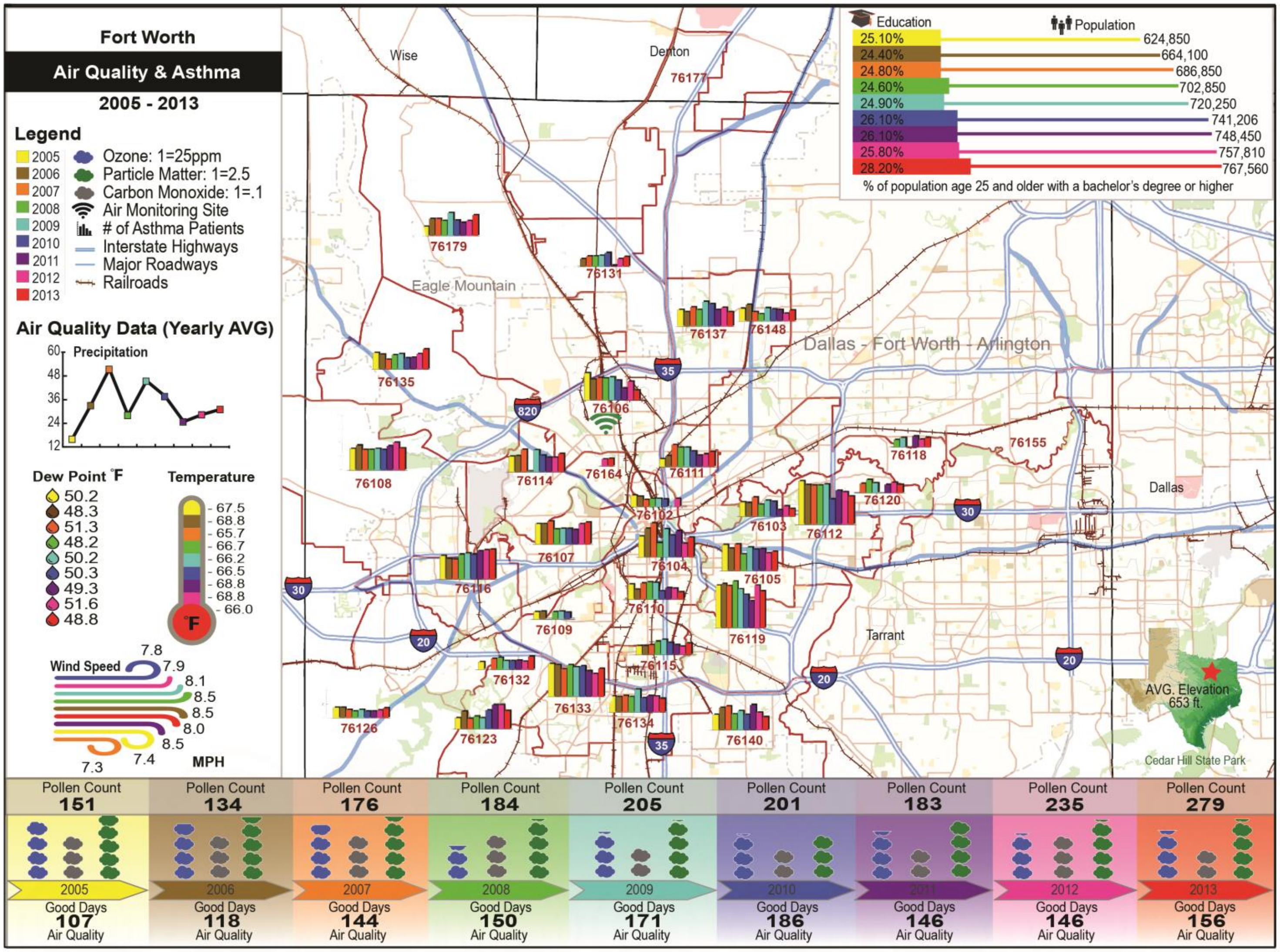

Figure 4-7 Fort Worth Air Quality & Asthma Map, 2005-2013

annual cases each. Demographics for the three zip codes with the highest average asthma cases were not available, however data was available by census tract. There were eleven census tracts in zip code 76112, seven in zip code 76119, and nine in zip code 76133 with demographic data. The 2013 demographics, including median income, race, and housing costs, of the census tracts in each zip code ranged drastically. For example, median income in 76112 ranged from $21,783 to $50,664 and average monthly housing costs ranged in zip code 76133 from $860 to $1,131. The pattern was the same for all the demographics. Therefore, averages were calculated across all census tracts in each zip code. 76112 resulted in a median income of $39,661, monthly housing costs of $841, and an average of 43% white population. Zip code 76119 had an average median income across the seven census tracts of $28,226, $664 average monthly housing costs, and 48% white population. Lastly, the average of the demographics among the nine census tracts in zip code 76133 resulted in a median income of $53,575, monthly housings costs of $978, and a 71% white population. There does not appear to be an obvious connection between any of the demographic statistics and the prevalence of asthma. Because of the wide dispersion of asthma cases across the majority of the zip codes in Fort Worth, a pattern connecting air quality with the prevalence or asthma discharges was undetected within this individual city analysis.

Discussion and Conclusions

Although there did not appear to be a connection between the number of yearly asthma hospital discharges and corresponding annual air quality measurements, it could have been due in part to the air quality in Fort Worth not improving significantly enough, or in some cases complying with the EPA standards, year over year to realize equivalent, supportive results. Also, the lack of direct evidence linking annual air quality measurements to the number of asthma cases could indicate the significance of daily weather conditions influencing the dispersion and flow of air pollution, individual exposure to bad air quality days, or the potential for personal health and genetics being more influential. It could also be indicative of missing explanatory variables, such as specific structural elements of the built environment, or a greater influence from indoor air quality versus outdoor air quality. Therefore, future research would be necessary in order to identify the significance of specific living conditions and housing structures on indoor air quality and asthma.

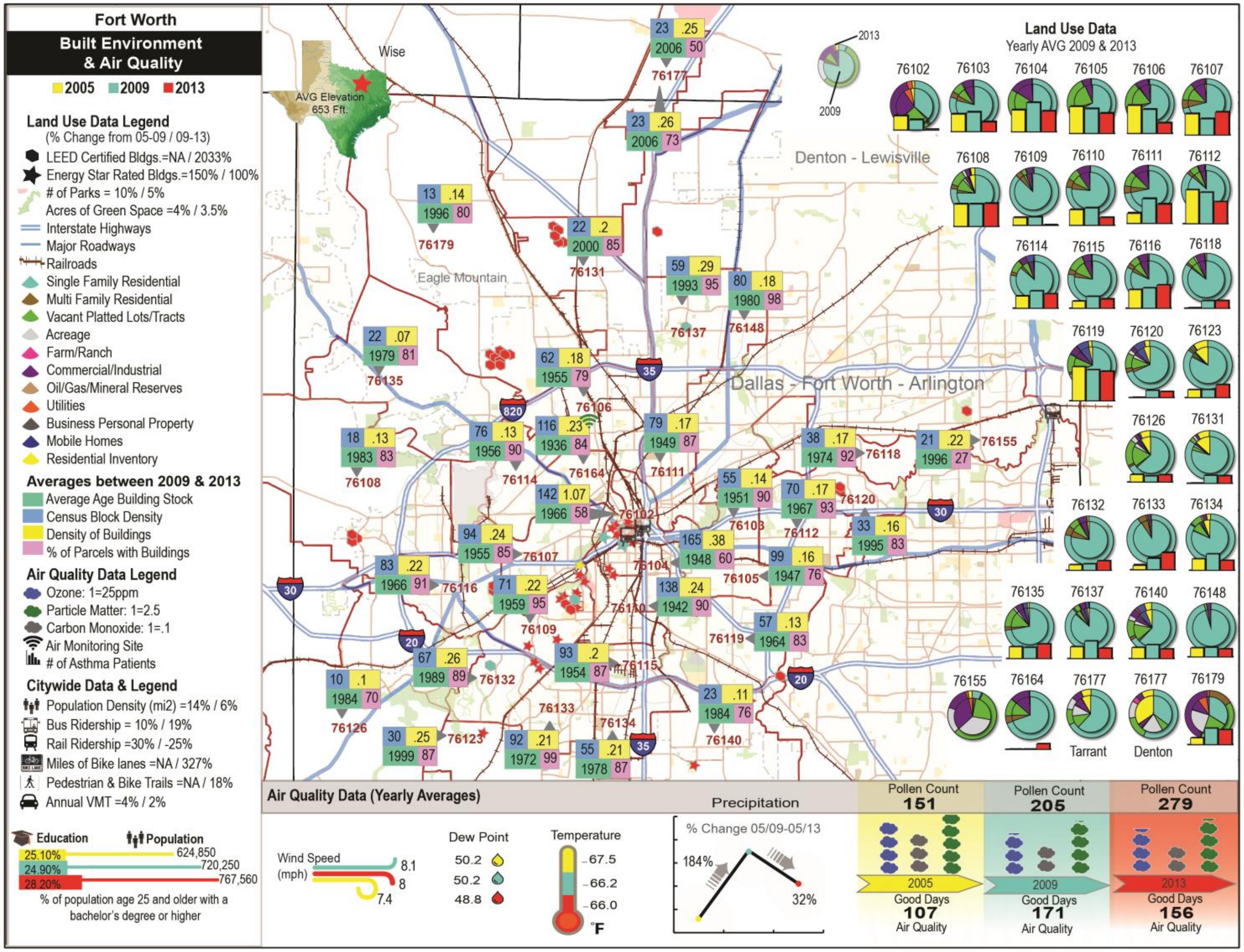

Figure 4-8 Fort Worth Built Environment, Air Quality & Asthma (2005/2009/2013)

Summary and Case Conclusions

The purpose of this case study research was to examine the impact political culture has on sustainable built environment policy development and how the level of commitment established in those policies influenced the implementation of the corresponding outcomes in order to determine if the evidence supported the literature stating that select sustainable built environment outcomes influenced air quality and thus the number of asthma cases. Although the political culture of Fort Worth resulted in the city electing not to organize and brand initiatives under the sustainability umbrella, many of the established suggestions and policy commitments were inherently sustainable in nature. Instead of requiring green certifications and strict development guidelines, the city emphasized resource efficiencies above anything else, wanting to maintain a developer-friendly environment that encouraged economic development. City planning priorities and policy development processes were guided by City Council, which to date had not indicated the need to engage in more sustainability planning. This, along with the higher levels of religious traditionalism, and the city's rejection of the sustainability moniker, supported the theory identified in the literature that more progressive cities engaged in more sustainability planning than less progressive cities. Additionally, the literature suggested that less reformed cities had lower levels of income, education, and nontraditional households than more progressive cities. Though Fort Worth had increased in all areas between 2005 and 2013, except in the percentage of same-sex households, the averages for majority of the indicators were lower than the national averages (American FactFinder, n.d.; DeLeon & Naff, 2004, Sharp, 2005b).

The planning structure in Fort Worth was extremely centralized and systematic with a baseline city comprehensive plan established in 2000 and annual mandated updates every year. The review of the 2005 to 2013 planning documents identified 112 sustainable built environment policies meeting the criteria outlined in the literature to influence air quality (see Table 1.1). 66 of the 112 policies were scored as commitments and 46 as suggestions, which gave Fort Worth an overall sustainability commitment score of 178 based on the content analysis methodology established in Chapter 3. The transportation and land use categories contained the most policies, as well as the highest percentage of commitment-level policies in the transit-oriented development, bike and pedestrian opportunities, and zoning sub-categories. Overall, the evidence identified through the policy analysis across the nine-year period supported the literature regarding the significance of city revenues on sustainability implementation efforts (Paterson & Saha, 2010). However, Fort Worth did develop new sustainable built environment policies in 2009 and 2010, when unemployment and poverty rates were high, which supported the city's commitment to resource efficiency. It was clear through the interviews with city personnel, specifically the desire for Fort Worth to be perceived as developer friendly and the lack of prioritization from city leadership for sustainability planning and implementation, as well as by the resulting sustainable built environment policy structures, that the more conservative political culture of Fort Worth influenced its commitment to sustainable built environment policies.

A correlation between the sustainable built environment policies and the collected sustainable built environment data from 2005 to 2013 was not identified due to the allocation of the majority of the policies existing in the base year and that most of the outcomes increased year over year, despite fluctuations in the corresponding policies. One could argue that the sustainable built environment outcomes increased steadily over time because the city made an early commitment. Although there may not be a direct connection between the times a policy was generated to an increase in the matching built environment outcome, there may be a connection to the overall pervasiveness of sustainability planning and policies with the existence and prevalence of sustainable built environment outcomes within a city. The evidence did support the existing literature regarding the discrepancies between sustainability policy development and implementation efforts (Cooper & Vargas 2004; Holman, 2014; Lubell et al., 2009; Saha, 2009; Seasons, 2003).

The third case study research theory argued that cities with more sustainable built environment outcomes resulted in better air quality. Of the three major air pollutants examined in this study, Fort Worth was never in compliance with the EPA ozone standards and measurements exceeded both regional and national averages. Additionally, even though the PM-

2.5 levels were under the standards set for sensitive populations each year between 2005 and 2013, they surpassed the regional and national averages in 2011, 2012 and 2013, ending with a 16% and 13% higher average, respectively. The primary sources of the pollutants include transportation emissions, industrial facilities, and utilities. The annual vehicle miles traveled in Fort Worth increased each year, however the per capita vehicle miles traveled decreased. Rail ridership decreased and bus ridership increased, but how this affects the number of annual routes was unclear. The number of land parcels in Fort Worth classified with a utilities land use code decreased by 33% between 2011 and 2012, while the number of commercial and industrial classifications remained consistent. Therefore, indicating that portions of ozone and PM-2.5 emissions in Fort Worth were most likely derived from other unidentified sources; or that dispersion was obstructed by other weather occurrences or built environment characteristics. Examining averaged annual climate and meteorological data was problematic because it did not account for daily weather events, which then could not be directly associated with the corresponding air quality measurements. One possible assumption for the higher ozone levels in Fort Worth could be that the average temperatures run approximately 13 degrees higher than the national averages and ozone forms more aggressively on warm, sunny days. Lastly, the majority of the sustainable built environment outcomes increased each year, which had no apparent connections to the fluctuations in air quality. Although, there was no identifiable pattern between outcomes and air quality from year to year, there may be collective differences between cities. Given the apparent intricate relationship between air quality and the built environment, field studies would be recommended for future research.

The final case study research theory assessed was the connection between poor air quality and asthma. As with the other case study theories, there was not a direct correlation between the changes in the number of asthma hospital discharges and corresponding air quality measurements year over year between 2005 and 2013. Given the vast quantities of existing research connecting air quality and asthma, the lack of identified linkages between the corresponding data in Fort Worth indicated the presence of additional influencers. The fact that

Fort Worth was never in compliance with the EPA 8-hour ozone standard and only an average of 40% of the days in a year between 2005 and 2013 were classified as good could indicate that annual variances in air quality were not significant enough to influence the number of asthma cases. Also, daily weather conditions and events could impact air quality and asthma in a more targeted and localized manner, personal health and genetics could be more influential to the prevalence of asthma, or more explanatory variables were necessary, like an analysis of the structural elements of the built environment. Indoor air quality may also be the cause of more asthma episodes. Fort Worth averaged 852 asthma inpatient cases per year with national numbers consistently ranging from roughly 430,000 to 500,000 between 2001 and 2010 (CDC, 2012).

Each of the above sections examined the research questions independently, however in order to identify any potential influencers all of the available data needed to be analyzed holistically. In an effort to identify any potential patterns and variations over time the percentage change was calculated for 2005 to 2009 and 2009 to 2013 and displayed graphically on a map of Fort Worth with roads, rail lines, and green space (see Figure 4.7). The three zip codes with the largest number of inpatient asthma cases were 76119, 76112, and 76133, which were also three of the six zip codes with the largest quantity of zoned residential land uses. Of the 29 zip codes with asthma cases between 2005 and 2013, zip code 76119 ranked 11th for having the highest percentage of built parcels, and zip codes 76112 and 76133 were subsequently ranked 25th and 29th. Therefore, there may be a connection between the residential population in the zip code and the number of asthma cases, despite the highest number of cases coming from 76119, which was only 83% built out compared to 92% and 99% in 76112 and 76133. Additionally, the review of the demographics of the census tracts within these three zip codes did not result in identifying a pattern or connection explaining the high number of asthma discharges. The three other zip codes with the largest quantity of zoned residential parcels had similar built percentages as the other three zip codes and ranked 4th, 6th, and 11th for most reported asthma cases out of the 29 zip codes. There was no apparent pattern between the number of asthma cases and the age of building stock, census block density, or floor to area ratio of buildings within the zip codes. Additionally, the number of asthma cases each year did not coincide with increases or decreases in the sustainable built environment or demographic variables.

In summary, the evidence indicating that the political culture of a city influenced sustainable built environment policies and commitments supported the first case study theory. Additionally, key indicators identified in the literature and supported by this study can be utilized to gauge the level of progressiveness of a city and the resulting engagement in sustainability planning efforts. The remaining case study theories stating that greater sustainable built environment policy commitments resulted in larger corresponding outcomes and more outcomes resulted in better air quality, and better air quality resulted in fewer cases of asthma, were not fully supported by the data. Additional research, preferably field studies, would be necessary in order to gain a better understanding of the intricate relationships between the built environment, air quality, and asthma.

Chapter 5

Austin Case Report

Case Study Theory #1

Does the political culture of a city influence a city's commitment to sustainable built environment policies? The literature stated that more progressive cities engaged in more sustainability planning than less progressive cities. Given the progressive reputation of Austin, the council-manger structure of its city government, which according to Sharp (2005a) indicated a more reformed or progressive city, policies regarding sustainability and sustainable built environments in Austin should be abundant. This reputation was corroborated by existing evidence indicating that the national average of religiousness is over 2.5% more than the percentage of the religious population in Austin and was ranked 14^{th} out 67 as most liberal (Sperling's Best Places, 2014; Tausanovitch & Warshaw, 2014). Additionally, cities that have openly embraced sustainability and adopted the moniker were more likely to be progressive societies with high levels of income, education, and nontraditional households (DeLeon & Naff, 2004, Sharp, 2005ab).

Interview Insights: Sustainability Planning

According to Amy Petri (personal communication, September 29, 2015), the Communications Manager in the City of Austin's Sustainability Office, "Austin's long-standing green leadership is one of our distinguishing characteristics as a municipality. Austin consistently leads national rankings as a smarter, greener city because of our investments in green power, energy efficiency, and conservation". Austin first engaged in sustainability planning and policy development in 1986 when they established the Comprehensive Watershed Protection Ordinance, followed by the Austin Energy Green Building Program in 1990. "The City of Austin's identity and pride of place are intimately tied to environmental protection and sustainability" (A. Petri, personal communication, September 29, 2015). Austin proudly promoted itself as a green city, confirmed by sustainability being listed as a key principle in the 2012 Imagine Austin Comprehensive Plan and identified as a core value by the City Manager (A. Petri, personal communication, September 29, 2015). Additionally, the city committed resources to the establishment of the Office of Sustainability with a Chief Sustainability Officer. According to the official website, the goals of the Office of Sustainability included, achieving net-zero community-wide greenhouse gas emissions by 2050, a healthy and just local food system, resource efficient strategies for municipal operations, tangible projects that demonstrate sustainability, and a resilient and adaptive city.

There was widespread acceptance and support from the city's leaders and citizens for sustainable development as a means to "preserving the great quality of life that has made Austin so attractive to so many" (A. Petri, personal communication, September 29, 2015). Austin had been aggressive about instituting green building practices in not only municipally owned and operated facilities, but in all residential and commercial developments. Austin developed its own green building standards, through the municipally owned utility, Austin Energy, ten years before the U.S. Green Building Council launched LEED. Further demonstrating that Austin wanted to be recognized as a leader in sustainability. However, one barrier to implementing innovative sustainable development ideas in Austin, as noted by Ms. Petri, was the current Land Development Code. The City was engaged in a collaborative initiative, called CodeNEXT, with the business community, residents, and civic organizations to revise the current Land Development Code to better integrate sustainability and align land use standards and regulations with community priorities. CodeNEXT will determine "how land can be used throughout the city – including what can be built, where it can be built, and how much can (and cannot) be built" while addressing issues like diminishing natural resources, household affordability, and access to healthy lifestyles (A. Petri, personal communication, September 29, 2015). The complete written responses to the interview questions from Amy Petri are available in Appendix C. An interview with the City Manager of the City of Austin could not be scheduled; therefore the perspective regarding the history, current state and future priorities of sustainability planning in Austin were limited.

Demographics and Political Culture Indicators

While the interview responses provided the benchmark for evaluation and insight regarding the planning priorities in Austin from 2005 to 2013, the new political culture literature identified several other demographic and lifestyle indicators said to influence the political culture of a city, either directly or indirectly. All of these demographic and political culture variables and data collected for the City of Austin are detailed in Table 5.1, along with the sustainability commitment score established through the policy review.

The population in Austin steadily increased over the nine-year period, demonstrated by the increase in population by 142,343 from 2005 to 2013. The largest percentage increase of 3.1% or 23,512 people occurred between 2008 and 2009. The largest percentage increases in median household income occurred between 2005 and 2006, with an 8% increase and gain of $3,481, and between 2012 and 2013, with a 7.4% increase and a $3,898 gain, which resulted in the highest median income average for the nine-year period of $56,351. Income remained relatively consistent between 2006 and 2007, and 2010 and 2011. The unemployment rate in 2013 was 1.1% lower than the rate in 2005. Unemployment was at its highest between 2010 and 2011, during the period of the global financial crisis, peaking at 8.4% in 2010. The median age increased over the 9-year period, however it remained consistent between 31 and 32 years. The ratio of men to women declined by 4.2 fewer men for every 100 women from 2005 to 2013. Additionally, the diversity in Fort Worth declined over the nine-year span of this research, indicated by the percentage increase of the white only population from 69.21% in 2005 to 77.74% in 2013. The percentage of the population at least 25 years old with a college degree fluctuated slightly over nine years, with the biggest gain happening between 2008 and 2009. The level of education percentage hit the nine-year high in 2013 at 46.7%. Additionally, a larger percentage of the 2013 population were single than in any of the previous years, peaking at 44.2%. The poverty rate hit the lowest point in 2008 at 17% and the highest point in 2010 at 20.8%. The rate began to decline in 2011, remained consistent in 2012, and fell 2.5% to 17.8% in 2013.

Table 5-1 - Relationship between City of Austin demographics, political culture and policy commitments, 2005-2013

		2005	2006	2007	2008	2009	2010	2011	2012	2013
Demographic and Socioeconomic Variables	**Population**	700,407	718,912	735,088	750,525	774,037	790,390	812,025	824,205	842,750
	Median Household Income	$43,731	$47,212	$48,966	$51,372	$50,132	$47,434	$49,987	$52,453	$56,351
	Unemployment Rate *(population 16 years and older)*	7.00%	6.10%	5.10%	5.10%	7.50%	8.40%	8.30%	7.10%	5.90%
	Median Age	31.4	31.2	31.4	31.7	31.2	30.9	31.3	31.7	32
	Sex ratio *(males per 100 females)*	105.2	108.9	110.1	108.9	109.1	102.5	101.9	101.6	101
	Race *(% of the population white alone)*	69.21%	59.09%	62.87%	68.17%	69.09%	71.31%	70.20%	76.89%	77.74%
	Level of Education *(% of population age 25 and older with a bachelor's degree of higher)*	44.00%	42.90%	42.50%	42.10%	43.90%	43.70%	44.50%	45.40%	46.70%
	Marital Status *(% of the population aged 15 and over never married)*	39.10%	40.80%	41.40%	41.50%	41.90%	44.10%	43.80%	44.00%	44.20%
	Poverty Rate *(% of population below poverty level)*	18.10%	17.70%	17.50%	17.00%	18.40%	20.80%	20.30%	20.30%	17.80%
Political Culture Variables	**Nontraditional Lifestyle** *(% of the population 35 and older never married - MALE/FEMALE)*	5.21%	5.74%	6.20%	5.52%	5.81%	5.87%	5.44%	5.87%	6.18%
		3.54%	3.61%	3.61%	3.99%	3.68%	3.79%	4.26%	4.02%	4.47%
	Nonntraditional Gender Roles *(% of women never married in labor force)*	12.07%	12.27%	12.32%	12.50%	12.49%	13.81%	13.82%	14.59%	14.40%
	% of workforce in professional, scientific, technical	10.10%	9.71%	10.42%	11.35%	10.32%	10.20%	10.49%	11.03%	12.21%
	% of unmarried same-sex partner households	0.82%	0.96%	1.00%	1.20%	1.10%	0.99%	0.62%	1.20%	0.99%
Sustainability Commitment Score		10	2	30	29	7	27	7	58	28
City Revenue Base *(total revenues per 100,000 population)*		$323,986	$351,579	$343,788	$376,625	$357,787	$340,786	$359,451	$351,972	$376,469

The lifestyle variables indicated in the literature to influence political culture included, the prevalence of nontraditional lifestyles, represented by individuals over the age of 35 that never married; nontraditional gender roles, represented by the percentage of women whom have never married in the labor force; percentage of the population in professional, scientific or technical fields; and the percentage of unmarried, same-sex partner households. The percentage of nontraditional males exceeded females in every year since 2005. However, the nine-year average rate for the percentage change year over year was greater for females than males, at 3.2% versus 2.4%. Additionally, 2013 percentages were the highest over the nine years for nontraditional females and tied with 2007 for the highest percentage of nontraditional males. This could be an indication that more men and women were electing to forgo marriage and traditional family structures to focus on a career or other aspects of their lives. The percentage of women in the labor force that never married either increased or remained constant between 2005 and 2012, but declined slightly in 2013 by nearly 0.2%. The percentages of the workforce in a professional, scientific or technical field were the greatest in 2013 at 12.21%, 2008 at 11.35% and 2012 at 11.03%. The nine-year average percentage increase was 10.65%. The percentage of unmarried, same-sex partner households peaked at 1.2% in 2008 and 2012 and averaged nearly 1% over the nine years. The lowest percentage of 0.62% occurred in 2011, which could coincide with the economic crisis and need for many people to relocate for work.

Overall, the percentages change from 2005 to 2013 of all the political culture variables increased. The largest increase exhibited was by unmarried women over the age of 35, represented by a percentage change of nearly 26%. This increase was greater than the national percentage change between 2005 and 2013, which was 18%. The percentage increase in Austin was not only greater than the national average, but the overall percentage of the population was considerably higher in 2005 and 2013, with 13% and 20% differences, respectively. Additionally, the percentages of all the other political culture variables in Austin were greater than the national averages, except for women in the labor force who have never married, which was less by 31% in 2005 and 28% in 2013. Unmarried men over the age of 35 increased almost 20% from 2005 to

2013 and the 2005 and 2013 percentages in Austin were 41% and 36% higher than the overall national percentages. The percentage increase of the population in professional, scientific, and technical professions from 2005 to 2013 was significant at 21%. Additionally, both the 2005 and 2013 percentages in Austin were considerably higher than the national averages by nearly 41% and 68%, respectively. The percentage of unmarried same-sex partner households fluctuated minimally between 2005 and 2013, but did see an overall 21% increase over the nine years. In 2005 and 2013, Austin had a difference of over 16% and 66% more same-sex partner households than the national averages.

The increase of each of these indicators from 2005 to 2013 in Austin and the fact that all but one, percentage of women never married in the labor force, were greater than the national averages validated the initial assumption that Austin was a more progressive, reformed city. Additionally, this was corroborated from the interview with city personnel that sustainability had been embedded into the culture of Austin, not only by city leadership but the community as well. The dedicated sustainability department and officer, sustainability emphasized throughout city plans, goals and objectives, and the historical demonstration of innovative programming, like the Austin Energy Green Building certification program, were all examples that supported a progressive political culture in Austin.

Policy Review and Commitment Score

Despite the perceived commitment of the City of Austin to organize sustainability efforts through a centralized office, many of the initiatives and programs were developed, measured and managed through the 40 individual city departments. Unlike many large corporations, municipalities had not instituted a comparable document like the corporate sustainability report to collect, organize, and report on all sustainability efforts. This and the fact that Austin's historic planning structure and related documents had been extremely decentralized by the use of neighborhood and site-specific master plans in lieu of citywide comprehensive plans, until the 2012 Imagine Austin plan was adopted, made identifying relevant sustainability policy commitments difficult. However, in an effort to address the question if a city's political culture influenced its engagement in sustainable development planning, a thorough analysis of all Austin planning and regulatory documents from 2005 to 2013 was conducted utilizing the content analysis framework outlined in Chapter 3 (see Table 3.2 for complete list of plans).

Tables 5.2 and 5.3 provided a breakdown of the number of sustainable built environment policies that influence air quality from each sustainable built environment category for each year, along with the number of those policies that were suggestions versus commitments (see Appendix D for a complete list of identified policies and scores). Due to the decentralized nature of planning in Austin, many of the planning documents referenced redundant or similar policies and regulations. Therefore, scores were allocated only once for a given policy and in the first year identified. A policy was considered new if it was not mentioned previously or if there was a substantive change to a previous policy.

Table 5-2 – Austin sustainable built environment policy counts by year, 2005-2013

Policy Category	Area of Focus	2005			2006			2007			2008			2009			2010			2011			2012			2013		
Buildings	Development Practices	0	0	0	0	0	0	3	2	1	5	4	1	2	1	1	5	3	2	0	0	0	9	6	3	3	1	2
Land Use	Infill/Brownfields	0	0	0	0	0	0	1	0	1	2	2	0	0	0	0	1	1	0	1	0	1	6	5	1	1	0	1
Land Use	Mixed-Use Development	1	1	0	1	0	1	1	1	0	2	2	0	0	0	0	0	0	0	1	1	0	1	0	1	1	0	1
Land Use	Parks, Trails and Green Space	0	0	0	0	0	0	4	1	3	1	1	0	0	0	0	4	0	4	1	1	0	4	1	3	2	0	2
Land Use	Reuse	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Land Use	Zoning	2	0	2	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	4	1	3	0	0	0
Sustainable Development		0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Transportation	Accessibility	1	1	0	0	0	0	1	0	1	3	2	1	0	0	0	4	2	2	1	0	1	2	0	2	3	0	3
Transportation	Increase Bike & Pedestrian Opportunities	1	1	0	0	0	0	2	0	2	7	5	2	2	2	0	2	1	1	0	0	0	7	1	6	2	1	1
Transportation	Reduce VMT/Improve Air Quality	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	1	0	1	1	0	4	3	1	0	0	0
Transportation	Transit-Oriented Development	2	1	1	0	0	0	3	0	3	3	2	1	1	1	0	1	1	0	0	0	0	1	1	0	2	0	2
	Total Number of Policies	**7**			**1**			**17**			**24**			**6**			**18**			**5**			**38**			**15**		
	Number of Policy Suggestions	**4**			**0**			**4**			**19**			**5**			**9**			**3**			**18**			**2**		
	Number of Policy Commitments	**3**			**1**			**13**			**5**			**1**			**9**			**2**			**20**			**13**		

Table 5-3 – Austin policy classifications by focus area, 2005-2013

Policy Category	Area of Focus	Total Number of Policies	Number of Policy Suggestions	Number of Policy Commitments
Buildings	Development Practices	27	17	10
Land Use	Infill/Brownfields	12	8	4
Land Use	Mixed-Use Development	8	5	3
Land Use	Parks, Trails and Green Space	16	4	12
Land Use	Reuse	1	1	0
Land Use	Zoning	7	1	6
Sustainable Development		2	1	1
Transportation	Accessibility	15	5	10
Transportation	Increase Bike & Pedestrian Opportunities	23	11	12
Transportation	Reduce VMT/Improve Air Quality	7	5	2
Transportation	Transit-Oriented Development	13	6	7

The City of Austin had at least one new relevant sustainable built environment policy each year between 2005 and 2013 with a total of 131 policies. 2008 and 2012 were the two years with the greatest number of sustainable built environment policies with 24 and 38. However, only 21% of the 2008 policies were commitments versus suggestions, as compared to 53% in 2012. Additionally, both of these years had the highest percentage of sex-sex couples in Austin over the nine-year period of 1.2%. 2008 and 2012 also were two of the three years with the highest percentages of the professional, scientific and technical population with 11.35% and 11.03%, respectively. The policies in 2007 and 2013 had the highest percentage of commitments, with 76% and 87% respectively. Of the four sustainable built environment categories: buildings, land use, sustainable development, and transportation; the policies in the transportation category made up 44% of the total policies. Thirty-four percent were land use policies, followed by buildings at 21% and sustainable development at 2%.

Out of all of the identified policies, only one suggested policy from 2009 was in the reuse focus area of the land use category. The two general sustainable development policies were only mentioned in 2008 and 2013, with one policy commitment and one policy suggestion. Zoning and reduce VMT/improve air quality focus areas were mentioned 3 and 4 times, respectively, out of the 9 years. Both had a total of seven policies, however 86% of the zoning policies were commitments as opposed to the 29% in the reduce VMT/improve air quality category. All of the remaining categories had policies in either six or seven of the nine years. Development practices had the greatest number of policies, however only 37% were commitment policies. This is followed by, in order of the greatest number of total policies: increase bike and pedestrian opportunities; parks, trails and green space; accessibility; and transit-oriented development. All of these categories had over 50% commitment policies with the highest at 75% for parks, trails and green space. Lastly, seven and eight policies were identified, respectively, in the infill/brownfields and mixed-use development categories with 33% and 38% resulting in commitment policies.

Discussion and Conclusions

Additional indicators were identified in the study conducted by Paterson and Saha (2010) for their potential influence on the economic and social wellbeing of a city, with the argument that cities with fewer economic and social issues and greater resources were more inclined to emphasize sustainability. These factors included population growth, unemployment level, poverty rate, and revenue base. Austin was ranked the eleventh fastest growing city since the recession by Forbes Magazine (2013), which was evidenced by the over 20% population increase from 2005 to 2013, as compared to the 9.6% overall increase nationally. The percentage difference between the 2013 unemployment rate in Austin and the national rate was 45% lower in Austin, but the poverty rate was about 15% higher. However, both the unemployment and poverty rates decreased in Austin every year except 2009 and 2010. According to the literature, this should indicate that the economic and social environments in Austin were positioned for greater engagement in sustainability planning and implementation efforts. However, the numbers of new policies were minimal (less than 10) in 2006 and 2011 when both the unemployment and poverty rates decreased, and in 2009 when both rates increased. This could indicate that either the unemployment and poverty rates had no influence on sustainability planning efforts, or that there was a direct relationship between rates and policies. A decrease or improvement in the unemployment and poverty rates could signify available funds for the city to allocate towards sustainability. On the other hand, an increase in the unemployment and poverty rates could inspire a city to implement new sustainability policies in an effort to establish resource efficiencies. The revenue base, or total revenues for every 100,000 people, for Austin peaked in 2008 at $376,625. Revenues increased in 2011, decreased in 2012, then shot back up nearly to the 2008 level. There did not appear to be a connection between Austin's revenue base and the percentage of commitment policies versus suggested policies.

Given that Austin utilized the moniker of sustainability, its lower levels of religious traditionalism, and liberal rankings suggested that the city was more progressive and possessed higher levels of income, education and nontraditional households than less progressive cities (DeLeon & Naff, 2004, Sharp, 2005b). Income, education levels, nontraditional lifestyle and gender roles, same-sex households, and percentage of workforce in professional, scientific, and technical professions increased in Austin from 2005 to 2013. Additionally, all of the indicators were greater in Austin than the 2005 and 2013 national averages, except for nontraditional gender roles, identified my women in the labor force whom have never married, which was 31% and 28% different, respectively. The lower percentage of nontraditional gender roles in Austin could be a result of the population in Austin consisting of approximately 49.5% females as compared to 50.8% nationally. Despite the decrease in the percentage of same-sex partner households nationally from 2005 to 2013, this population increased in Austin. The percentage of individuals with a college degree in 2013 was significantly higher in Austin than the national average, represented by a difference of 47%. Additionally, there was an 8% greater difference in the 2013 median income in Austin than the national average.

In support of this case study theory, the more progressive political culture in Austin influenced the city's commitment to sustainable built environment policies, which was evidenced by the presence of new sustainable built environment policies generated every year between 2005 and 2013, with 51% categorized as commitments.

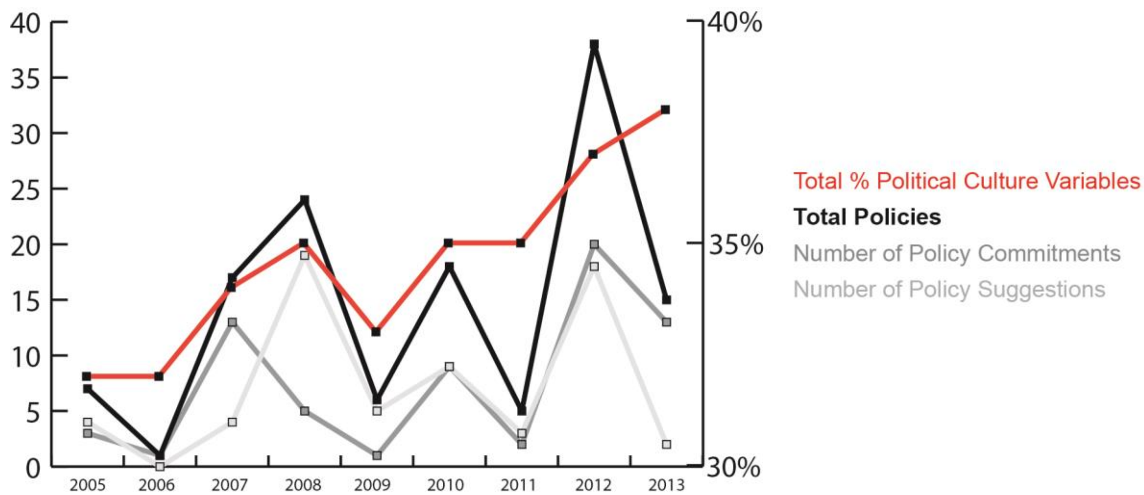

Figure 5-1 Relationship between Austin political culture and policies, 2005- 2013

Case Study Theory #2

Do cities with a greater commitment to sustainable built environment policies result in more abundant sustainable built environments? Several sustainable built environment variables were identified in the literature to influence air quality and respiratory health (Table 1.1). These indictors, collected and analyzed over the nine-year period, along with the sustainability policy review and scoring detailed in the above section (Case Study Theory #1), served as the means for addressing the second case study theory that cities with greater commitments to sustainable built environment strategies resulted in larger corresponding outcomes. Table 5.5 provides a complete list of the citywide sustainable built environment variables collected for 2005 to 2013, along with the city revenue base and sustainability policy commitment score. A few of the built environment variables were only logical at a smaller unit of analysis within the city. Zip codes were the smallest and most appropriate unit of analysis for this case study as identified by the scale of the available asthma data provided. The sustainable built environment variables collected at the zip code level were summarized in Table 5.6 with a complete detailing in

Appendix E. The land and building zip code level data was only available for 2009 to 2013 as explained in the Methods section in Chapter 3. Additionally, maps of all the collected sustainable built environment data, including land uses by zip code, are provided for each year between 2009 and 2013 in an effort to assist with analysis and drawing potential explanations (see Figures 5.2 – 5.6).

Citywide Built Environment Data

The population density of Austin steadily increased from 2005 to 2011, then decreased in 2012, and increased again in 2013 with a nine-year high of 2625.8 persons per square mile. Overall the population density increased 10.5% from 2005 to 2013. The city grew in parks and green space acreage over the nine-year period, however the biggest increase was in 2005 with an addition of three parks and 231.7 acres. This was followed by 2008 with a growth of six parks and 194.76 acres. Overall, this represented almost an 11% growth in the number of parks and 5.6% increase in park acreage from 2005 to 2013. According to the data, it appeared the city committed to installing substantial miles of bike lanes prior to 2005. There was a 90% increase in lanes from 2005 to 2013, which appeared to start in 2008 with nearly a 14% increase in 2009. These results coincided with the large number of identified bike policies in 2008, representing the assertive commitment made by the city. Austin did not maintain or retain trail data for 2005, 2006, or 2007. 2012 showed the biggest increase in trail mileage with a 3.8% increase from 2011, however the increase was miniscule at 1.9 miles.

The City of Austin did not institute rail until 2010, with inaugural ridership of 176,433. There was nearly a 150% increase in ridership in 2011, 50% in 2012, and 18% in 2013, which could indicate a possible equilibrium. However, Austin's bus program appeared to be established and integrated in the community as a valid means of travel, demonstrated by the over 34 million riders in 2005. It is interesting, given the economic climate, that bus ridership declined by nearly 8% in 2009, before rail was available, and increased in 2011 and 2012, after rail was established. Annual vehicle miles traveled also increased from 2005 to 2013 by over 10%, which is a large percentage even given the 20% increase in population during this same period. The development of passenger rail and the push for transit-oriented developments (TOD) started later in Austin than in other cities. However, they made an aggressive commitment to rail and the accompanying development by establishing nine designated TOD locations at the same time the rail lines opened in 2010. The TOD designations accompanied plans, ordinances, and development regulations.

Certifying buildings with the U.S. Green Building Council's LEED rating system existed in Austin since 2005 with an average of 12 certifications per year for 2005 to 2013. However, given that Austin Energy, a municipal utility, established a green building certification program in 1990 that many Austin developers could have opted to utilize. Although LEED buildings were distributed throughout the city, there was a heavy concentration around the downtown area. There were four more Energy-star certifications in 2005 than LEED and over 2.5 times more average certifications per year from 2005 to 2013. The average percent change over the nine years was less than 1%. The majority of the Energy-star rated buildings occurred near the central city and major roadways, with clusters scattered throughout the periphery of the city.

Built Environment Data: Zip Code-Level

The citywide sustainable built environment data detailed in Table 5.4 and summarized above provided a holistic perspective to Austin's implementation strategies and transit preferences. However, examining specific land use and building data by zip code provided a better understanding of city development patterns (see Table 5.5 and Figures 5.2 to 5.6). Additionally, according to the literature, analyzing elements within a city can potentially result in more accurate assumptions and explanations regarding air quality measurements, which was discussed in the case study theory #3 section of this chapter (Briggs, 2000; Zhu et al., 2002 as cited in Jerrett et al., 2005). There are 36 zip codes with corresponding appraisal and land use data in the City of Austin. Austin zip codes 78717, 78727, 78728, 78750, and 78759 fall in Travis and Williamson Counties, so data is provided for both counties. Zip codes 78717 and 78729 are solely in Williamson County and zip code 78737 is in Hays County. The data from Hays County was only available for 2012 and 2103, so averages represent those two years. The land use data

Table 5-4 – Relationship between City of Austin policy commitments and sustainable built environment outcomes, 2005-2013

			2005	2006	2007	2008	2009	2010	2011	2012	2013
City Revenue Base *(total revenues per 100,000 population)*			$323,986	$351,579	$343,788	$376,625	$357,787	$340,786	$359,451	$351,972	$376,469
Sustainability Commitment Score			10	2	30	29	7	27	7	58	28
Sustainable Built Environment Variables	**Land Uses**	**Population Density per Square Mile** *(Total Population/Land Area)*	2376.0	2426.3	2465.3	2498.0	2559.3	2565.4	2633.2	2587.3	2625.8
		Acres of Green Space *(City-owned Park Land)*	14,806.08	15,037.78	15,043.94	15,238.70	15,309.60	15,435.25	15,473.02	15,547.23	15,630.87
		# of Parks	255	258	259	265	268	272	276	279	283
	Transportation	**Bus Ridership**	34,002,836	34,253,479	33,133,394	34,258,400	31,594,628	30,748,887	31,688,766	33,058,122	32,735,981
		Rail Ridership *(between Austin and Leander)*	no rail	no rail	no rail	no rail	no rail	176,433	439,294	650,923	769,264
		Miles of Bike Lanes	108.6	111.6	114.6	117.6	133.9	146.3	165.1	189	206.5
		Pedestrian & Bike Trails (miles)	no data	no data	no data	49.2	49.5	49.5	50	51.9	52.8
		Annual Vehichle Miles Traveled	18,382,951	18,751,992	19,670,072	19,792,745	19,663,904	19,838,530	19,653,383	20,029,585	20,440,893
		# of Transit-oriented Developments	0	0	0	0	0	9	9	9	9
	Buildings	**# of LEED certified buildings**	1	7	2	6	15	11	20	23	25
		# of Energy Star rated Buildings	5	0	32	45	32	53	27	38	47

Table 5-5 – Austin land and building data averages by zip code, 2009-2013

Austin Zip Codes	Average Age of Building Stock (2009-2013)	Average Floor to Area Ratio (2009 - 2013)	Average Census Block Density (2009-2013)	Census Block Density (% change: 2009 to 2013)	Average % of Parcels with Buildings (2009 - 2013)
78701	1944	1.43	189.40	-1%	71%
78702	1952	0.20	119.05	1%	81%
78703	1954	0.25	96.96	12%	92%
78704	1960	0.24	66.26	9%	92%
78705	1946	0.61	143.60	-1%	85%
78717 (Williamson Co)	2000	0.12	27.16	37%	88%
78719	1980	0.01	5.73	-13%	60%
78721	1968	0.14	44.92	8%	82%
78722	1951	0.20	148.20	0%	90%
78723	1969	0.19	49.07	26%	93%
78724	1990	0.06	14.85	21%	69%
78725	1994	0.03	8.93	30%	75%
78726	1995	0.10	15.56	-14%	89%
78727 (Travis Co)	1986	0.20	46.80	11%	94%
78727 (Williamson Co)	1981	0.21			70%
78728 (Travis Co)	1990	0.22	34.27	1%	88%
78728 (Williamson Co)	1985	0.35			74%
78729 (Williamson Co)	1987	0.24	33.11	15%	96%
78730	1995	0.09	12.26	3%	85%
78731	1973	0.20	40.12	16%	94%
78732	2000	0.09	14.44	16%	80%
78733	1990	0.03	16.79	3%	84%
78734	1990	0.06	21.76	13%	68%
78735	1992	0.03	11.54	31%	83%
78736	1984	0.01	6.81	3%	84%
78737 (Hays Co)	2004	0.03	5.07	31%	72%
78738	1999	0.02	7.93	5%	67%
78739	1998	0.10	16.79	20%	87%
78741	1975	0.23	40.14	28%	84%
78742	1970	0.01	13.77	6%	55%
78744	1985	0.13	22.32	20%	89%
78745	1975	0.16	57.91	9%	95%
78746	1984	0.11	23.73	10%	89%
78747	1997	0.03	9.07	24%	82%
78748	1993	0.17	42.96	26%	92%
78749	1991	0.18	44.00	15%	95%
78750 (Travis Co)	1986	0.10	25.63	-9%	61%
78750 (Williamson Co)	1979	0.26			97%
78751	1949	0.24	126.33	2%	93%
78752	1965	0.27	85.22	25%	92%
78753	1978	0.20	46.39	17%	93%
78754	1997	0.10	21.23	2%	77%
78756	1955	0.23	96.80	-2%	94%
78757	1960	0.21	75.66	4%	98%
78758	1976	0.25	50.79	16%	96%
78759 (Travis Co)	1982	0.19	46.92	18%	94%
78759 (Williamson Co)	1979	0.24			99%

	2009	2010	2011	2012	2013
Average Age of Building Stock	1980	1980	1980	1980	1980
% of Parcels with Buildings	85%	86%	86%	85%	85%
Average Floor to Area Ratio	0.19	0.18	0.19	0.19	0.19
Average Census Block Density	44.51	47.72	47.72	47.80	47.85

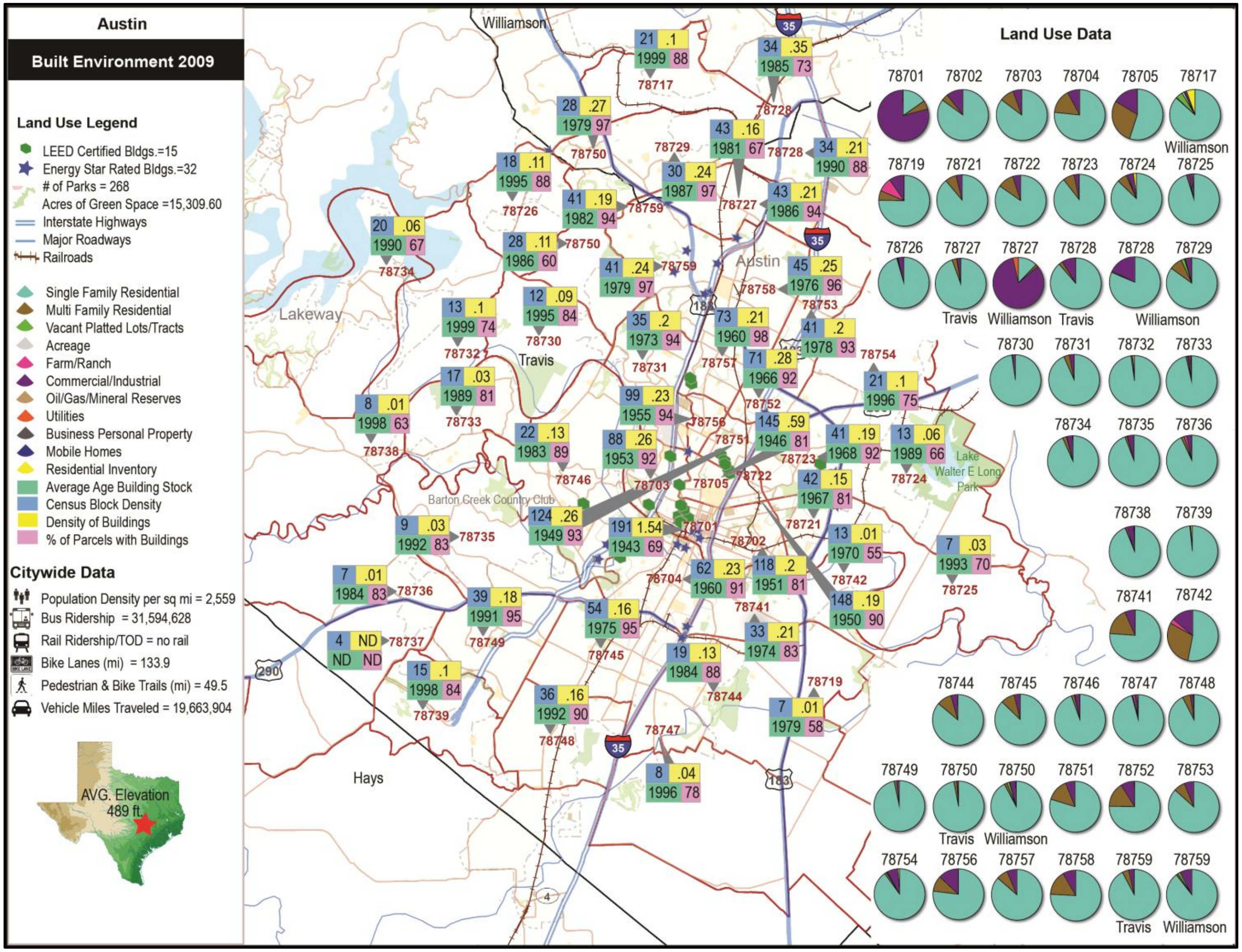

Figure 5-2 Austin Built Environment Map – 2009

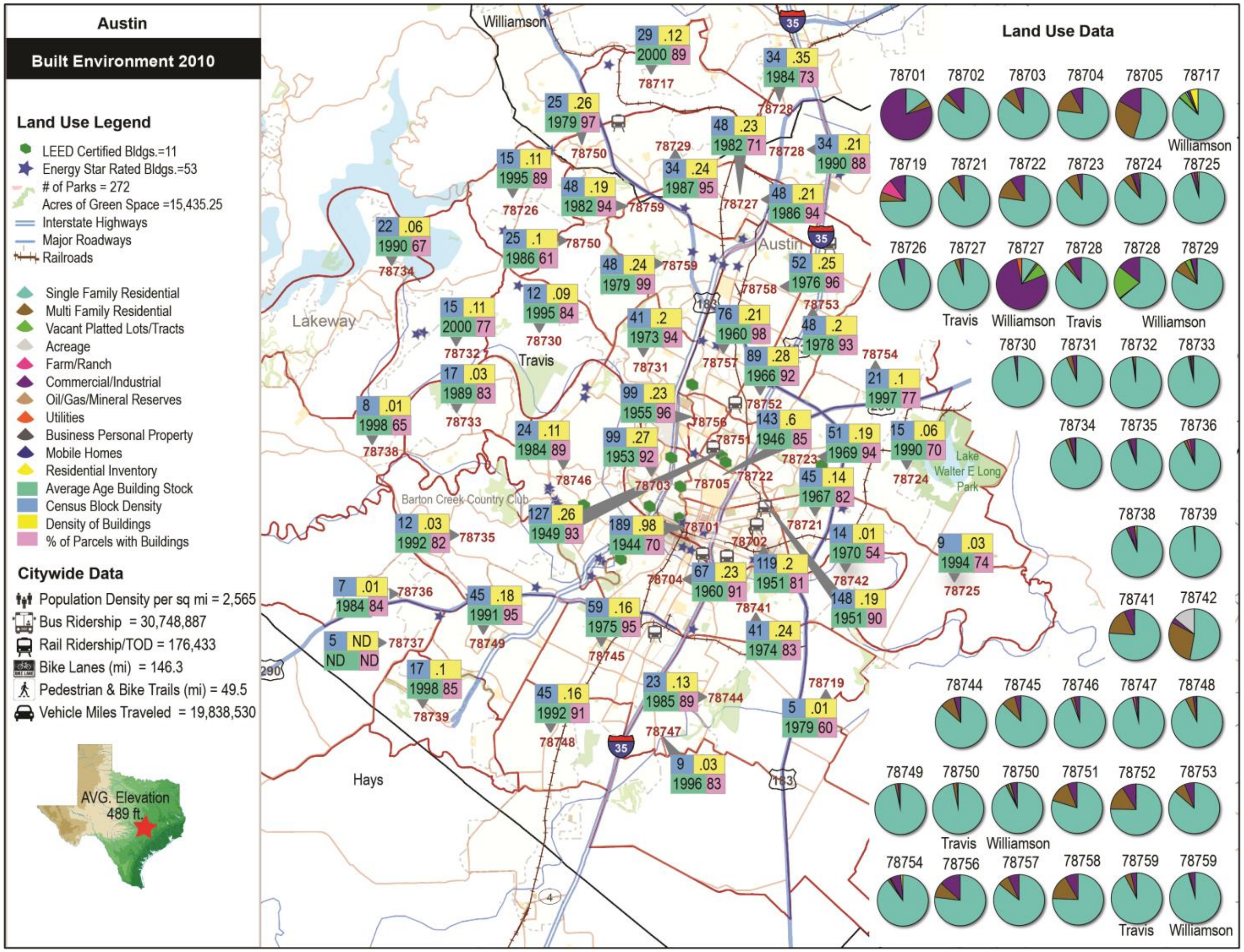

Figure 5-3 Austin Built Environment Map - 2010

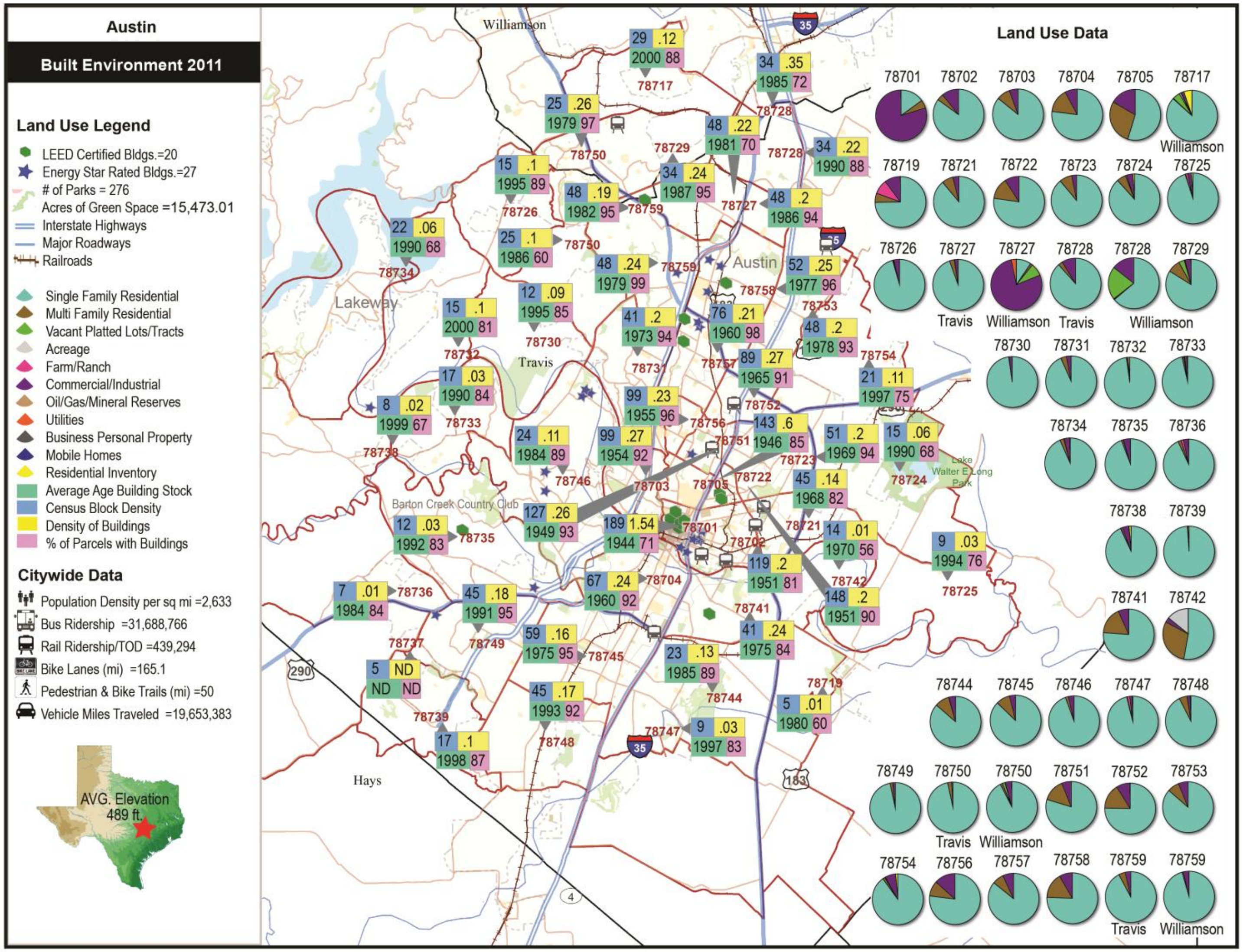

Figure 5-4 Austin Built Environment Map – 2011

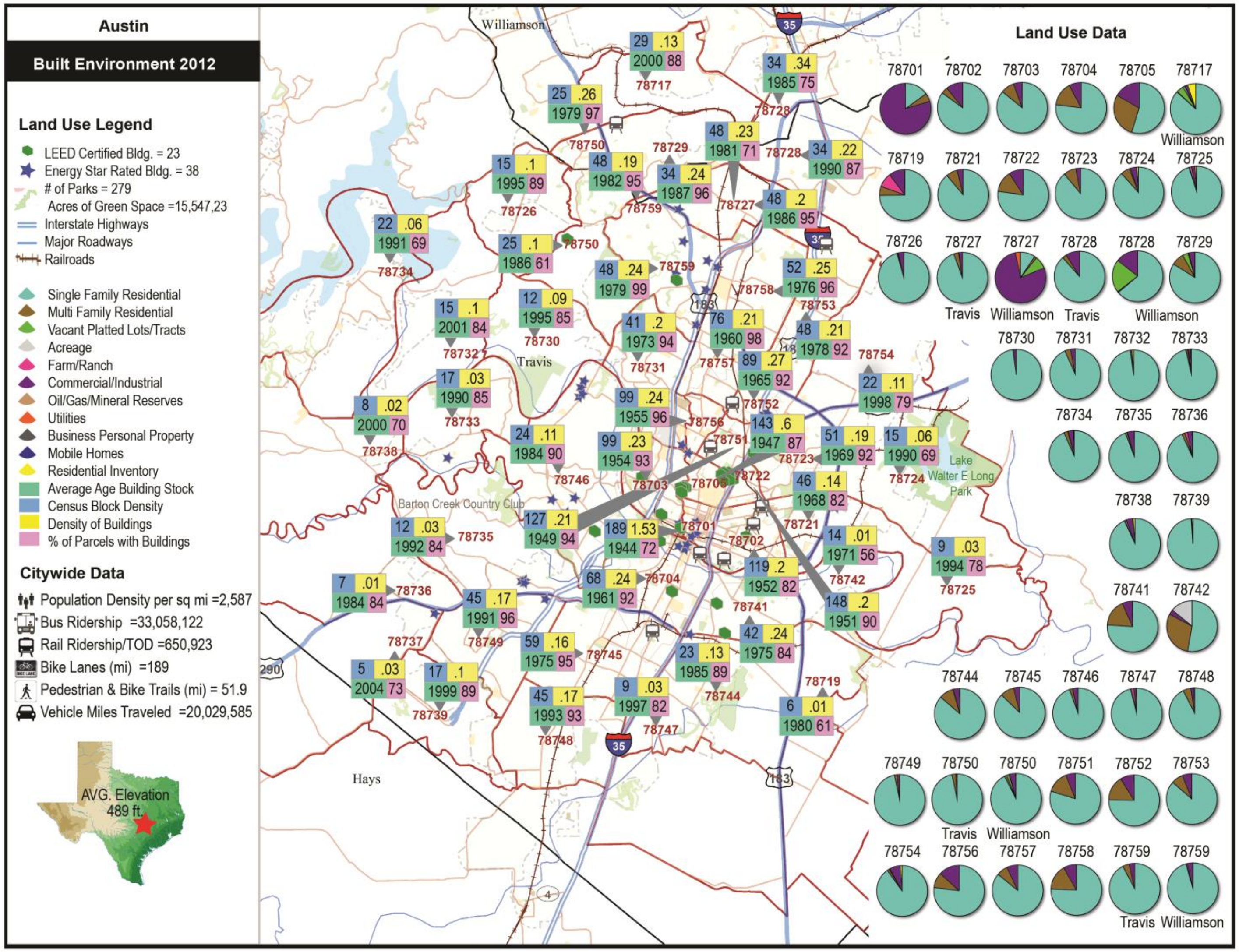

Figure 5-5 Austin Built Environment Map - 2012

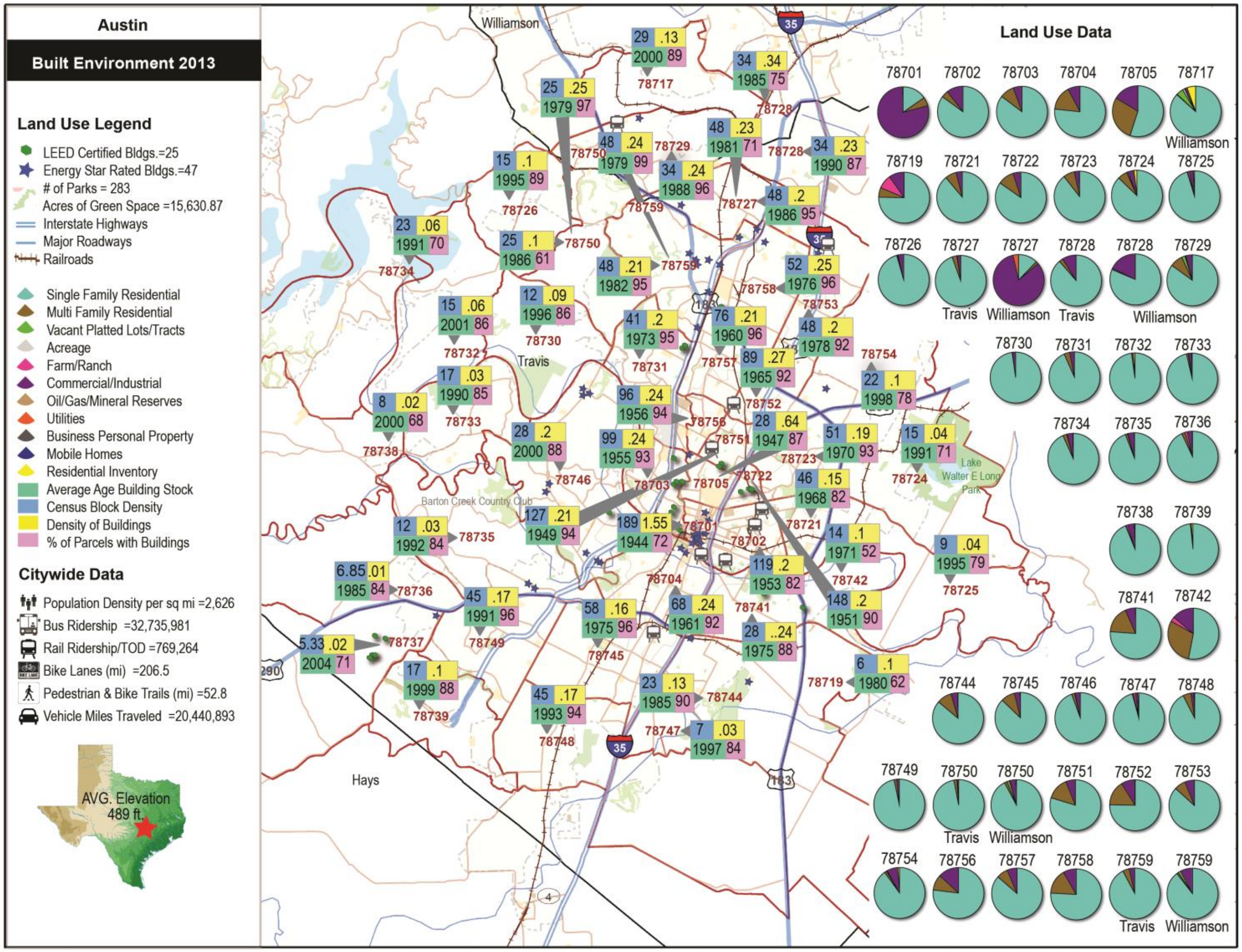

Figure 5-6 Austin Built Environment Map- 2013

from Travis County only included ‘real’ property or immovable property. Therefore, the following land use classifications were not reported: vacant platted lots, acreage, oil/gas/mineral rights, business personal property, and mobile homes.

The average age of building stock in Austin ranged from 1944 in 78701 to 2004 in zip code 78737/Hays County. Downtown Austin was located in zip code 78701 and 78737/Hays bordered the southwest boundary of the city. These results corresponded with traditional development patterns where existing, older structures were closer to the central city and newer developments occurred further and further out from the city core. The remainder of the zip codes followed this same pattern. The five-year citywide average age of building stock was 1980 and the overall average of parcels with buildings was 85%. Zip code 78732, located on the northwest border of the city, had a 16% increase of the number of parcels with buildings from 2009 to 2013 and was among 1/3 of the Austin zip codes with the least built-out parcels. Next was zip code 78725 with a 13% increase and an 8% increase in 78724, 78747, and 78738. 78724 and 78725 are located at the east border of the city, while zip code 78738 border the west and 78747 borders the south. All of these zip codes except 78747 were also in the 1/3 least built zip codes. 78747 had an average of 2% more growth than 78732 with a five-year average of 82%. According to the land use maps in Figures 5.2 – 5.6, the land use breakdown in 78732 was primarily single-family residential with a smaller percentages of commercial/industrial, residential inventory, multi-family residential, and farm/ranch. Single-family residential increased 17% from 2009 to 2013, diminishing the residential inventory category by 8%. There was a 21% increase in commercial/industrial and two new multi-family classifications between 2009 and 2013. Similar land uses and growth patterns occurred in 78724, 78725, 78747, and 78738 where single-and multi-family residential, commercial/industrial, and farm/ranch classifications increased. The residential inventory classification remained consistent or decreased in each of those zip codes between 2009 and 2013, except 78738, which had more than a 5% increase. 78738 also had the largest percentage increase in single-family of 26.4%.

Zip codes 78742 and 78737/Hays had a negative percentage change in built parcels between 2009 and 2013, with a -5% in 78742 and -3% in 78737/Hays. In addition to the loss of built parcels between 2009 and 2013 in 78742, it also had the least percentage of built parcels than any other zip code at 55%. The loss of built parcels could coincide with the change in land use classifications. Zip code 78742 lost all 85 multi-family classifications over the five years, 81 of which occurred in 2013. This zip code also gained 31 commercial/industrial designations in 2011. The land use transitions in this zip code could be a response to the growth in the adjacent zip codes, 78724 and 78725. Single-family residential parcels made up approximately 80% of zip code 78737/Hays, followed by vacant lots and residential inventory at around 10% each. 14% of all the zip codes showed no change in built parcels, 47% had a 1 % increase, 11% had a 2% increase, and about 8% had a 1% decrease in built parcels between 2009 and 2013.

Average floor to area ratio (FAR) of buildings in each zip code for 2009 to 2013 were utilized to gauge the density of buildings. A higher FAR tends to indicate more dense construction. The buildings in the downtown zip code 78701 had the greatest density with a five-year average floor to area ratio of 1.43. FARs decreased greatly outside of the central city. The adjacent zip code 78705 had the second largest average FAR of 0.61, followed by 78728/Williamson at 0.35, located in the northern part of the city. Border zip codes, 78719, 78736, and 78742 had the smallest average FAR at 0.01. The 2009 to 2013 average census block density was calculated for each zip code to further explain the level of connectivity by providing the mean number of census blocks per square mile in each zip code (yearly calculations are available to view in Appendix E). Zip codes 78701, 78722, 78705, 78751, and 78702, located in the city core, all had over 100 census blocks per square mile, with corresponding five-year density averages of 189.4, 148.2, 143.6, 126.3, and 119.1. Conversely, city border zip codes 78737/Hays, 78719, 78736, 78738, 78725, and 78747 all had less than 10 census blocks per square mile, with corresponding density averages of 5.1, 5.7, 6.8, 8.9, 7.9, and 9.1. Zip code 78717/Williamson had the biggest percentage difference in census block density between 2009 and 2013, represented by a 37% change. Zip codes 78744, 78747, 78748, bordering Interstate 35 on the southern part of the city, and zip codes 78723 and 78752 on the northern part of I-35, had over 20% changes in census block density from 2009 to 2013. Adjacent zip codes 78724 and 78739 also had over 20% increases in census block density from 2009 and 2013. 78726, located on the northwest periphery of the city, had a 15% loss in density from 2009 to 2013, followed by a 13% loss in 78719, which is located at the southern periphery. 78750, located adjacently to 78726, had a 9% loss, and three zip codes in the central city, including 78701, had 1-2% losses from 2009 to 2013.

Discussion and Conclusions

In order to analyze any potential explanations for the representative sustainable built environment outcomes over the nine-year review period and address the research theory that sustainable policies resulted in greater corresponding outcomes, the policy categories were aligned with the related built environment outcomes in Tables 5.6, 5.7 and 5.8. Each table represents the sustainable built environment categories: land use, buildings, and transportation. There did not appear to be a connection between the sustainable built environment policies and outcomes, given that many of the sustainable built environment outcomes increased year over year despite the fluctuations in policies. Additionally, in the few occasions where the outcomes decreased, the number of policies decreased as well, instead of increasing. Although, the evidence does not support the case study theory that more sustainable built environment policies resulted in greater outcomes, it does validate and correspond with the existing literature noting the inconsistencies between sustainability policy development and implementation (Cooper & Vargas 2004; Holman, 2014; Lubell et al., 2009; Saha, 2009; Seasons, 2003).

Table 5-6 – Austin sustainable land use outcomes and related policies

YEAR	Population Density per Square Mile	Related Policy Land Use: Infill/ Brownfields	Related Policy Land Use: Zoning	Acres of Green Space	# of Parks	Related Policy Land Use: Parks, Trails & Greenspace
2005	2376.0	0	2	14,806.08	255	0
2006	2426.3	0	0	15,037.78	258	0
2007	2465.3	1	1	15,043.94	259	4
2008	2498.0	2	0	15,238.70	265	1
2009	2559.3	0	0	15,309.60	268	0
2010	2565.4	1	0	15,435.25	272	4
2011	2633.2	1	0	15,473.02	276	1
2012	2587.3	6	4	15,547.23	279	4
2013	2625.8	1	0	15,630.87	283	2

Table 5-7 – Austin sustainable buildings outcomes and related policies, 2005-2013

YEAR	# of LEED certified Buildings	# of Energy Star rated Buildings	Related Policy Buildings: Development Practices
2005	1	5	0
2006	7	0	0
2007	2	32	3
2008	6	45	5
2009	15	32	2
2010	11	53	5
2011	20	27	0
2012	23	38	9
2013	25	47	3

Table 5-8 – Austin sustainable transportation outcomes and related policies, 2005-2013

YEAR	Bus Ridership	Rail Ridership	Annual Vehichle Miles Traveled	Related Policy Transportation: Reduce VMT/Improve Air Quality	Related Policy Transportation: Accessibility	Miles of Bike Lanes	Pedestrian & Bike Trails (miles)	Related Policy Transportation: Increase Bike & Pedestrian Opportunities	# of Transit-oriented Developments	Related Policy Transportation: Transit-Oriented Development
2005	34,002,836	no rail	18,382,951	0	1	108.6	no data	1	0	2
2006	34,253,479	no rail	18,751,992	0	0	111.6	no data	0	0	0
2007	33,133,394	no rail	19,670,072	1	1	114.6	no data	2	0	3
2008	34,258,400	no rail	19,792,745	0	3	117.6	49.2	7	0	3
2009	31,594,628	no rail	19,663,904	0	0	133.9	49.5	2	0	1
2010	30,748,887	176,433	19,838,530	1	4	146.3	49.5	2	9	1
2011	31,688,766	439,294	19,653,383	1	1	165.1	50	0	9	0
2012	33,058,122	650,923	20,029,585	4	2	189	51.9	7	9	1
2013	32,735,981	769,264	20,440,893	0	3	206.5	52.8	2	9	2

Case Study Theory #3

Do cities with more abundant sustainable built environments have better air quality? The measurements for the identified land use, buildings, and transportation outcomes, determined by the literature to impact air quality, were analyzed from 2005 to 2013 for the City of Austin in the section above. These outcomes along with the air quality statistics, including relevant climatological and meteorological influences noted in the literature, are utilized to examine the third research theory that cities with more sustainable built environment outcomes have better air quality. Before an analysis of the impact the built environment outcomes had on air quality could be conducted effectively, a review of the air quality measurements and the potential environmental influences was necessary. Data collected for 2005 to 2013 is provided in Table 5.9. There were three air-monitoring stations responsible for reporting air quality and meteorological measurements for the City of Austin, representing the northern, central and southern quadrants of the city (see Figure 5.7). Combinations of two of the three air-monitoring stations in Austin reported on four of the air quality and meteorological measurements.

Air Quality Analysis

The number of good days of air quality continuously increased from 2005 to 2010 when it peaked at 279 days. Good air quality days decreased in 2011 by almost 15%, but increased by 10.5% in 2012, and a little over 2% in 2013. Compliance with the EPA 8-hour ozone standard is met when the three-year average of the annual fourth highest daily maximum eight-hour ozone concentration measured is less than 76 parts per billion (ppb). Utilizing this measurement instead of annual averages provides a more accurate measurement since it accounts for higher measurements during the ozone season of March 1st - October 31st. Similarly to the good air days measurement, ozone was highest in 2005 and 2006, as reported by both the Audubon and Northwest monitoring stations. Ozone measurements, reported by the Audubon station, decreased in 2007 through 2009, maintained in 2010, increased in 2011 and 2012, and reported no change in 2013. The measurements from the Northwest station exhibited a similar pattern, however amounts continued to decline through 2010, then again in 2012 and 2013.

Table 5-9 – Austin air quality, 2005-2013

			2005	2006	2007	2008	2009	2010	2011	2012	2013
Air Quality Variables	Climatological & Meteorological	**Yearly Average: Dew Point Temperature** *(degrees Fahrenheit) Bergstrom Site*	56.8	52.3	56.6	52.8	54.1	55.1	53.6	57.0	54.8
		Annual Precipitation *(inches)*	21.45	27.23	45.91	15.98	34.11	28.42	16.9	35.14	37.04
		Yearly Average: Temperature *(degrees Fahrenheit) Audoban / Northwest Sites*	67.6 / 69.1	68.9 / 70	65.9 / 68.8	68.1 / 68.9	67.9 / 68.6	66.8 / 68	69.6 / 70.4	69.5 / 70	66.6 / 67.7
		Yearly Average: Wind Speed *(mph) Audobon / Northwest Sites*	5.7 / 6.0	6.2 / 6.4	5.6 / 5.8	6.4 / 6.7	6.2 / 6.5	5.6 / 5.9	6.0 / 6.4	5.8 / 5.8	6.1 / 6.2
	Air Quality	**# of Days when Air Quality was GOOD**	227	241	256	261	261	279	238	263	269
		Yearly Average: Compliance w/ 8hr EPA Ozone standard *(ppb) Audobon /Northwest Sites*	80 / 82	81 / 82	77 / 80	74 / 77	69 / 75	69 / 74	70 / 75	73 / 74	73 / 72
		Yearly Average: Carbon Monoxide *(parts per million) Northwest Site*	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
		Yearly Max: Carbon Monoxide *(ppm) Northwest Site*	1	0.9	0.9	0.7	0.7	2.2	0.7	0.8	0.6
		Design Value (3yr average): PM-2.5 *(micrograms per cubic meter) Audoban / Northwest*	8.13 / 9.17	8.37 / 9.53	9.13 / 10.03	8.93 / 9.73	8.77 / 9.43	8.30 / 9.13	8.07 / 9.07	7.87 / 8.93	7.83 / 8.63

Austin was in compliance with the 8-hour ozone standard in 2008, but only with the measurement reported by the Audubon station. However, both stations reported measurements under the 76 ppb threshold from 2009 to 2013. The yearly average and max of carbon monoxide were provided in order to gauge compliance with the EPA standards that carbon monoxide cannot exceed 35ppm more than once per year. The yearly average and max measurements in Austin were well below these standards for each year and averaged 0.1 and 0.9, respectively, for 2005 to 2013. The EPA primary standards for PM-2.5 allow up to 12 micrograms per cubic meter for sensitive populations, like asthmatics, children, and the elderly. Unlike the other air quality measurements, PM-2.5 increased between 2005, 2006 and 2007, then consistently declined since 2008, resulting in an overall reduction of 3.7% from the Audubon station and 5.9% from the Northwest station. At no point did the measurements surpass the EPA standard of 12 micrograms per cubic meter from either reporting stations.

According to NCTCOG, there could be an association of high dew point temperatures and ozone days. Examining annual averages, however, limits accountability for individual high or low days. This is illustrated by the average annual dew point only fluctuating at most by 4.5°F and averaging under 55°F for 2005 to 2013. Also increases or decreases in the number of good air quality days did not result in the corresponding decreases and increases in the average dew point temperatures. Verifying a distinctive correlation between increased precipitation and reduced temperatures was not feasible utilizing annual averages, since the daily rainfall measurements could not be tied to actual daily temperatures. However, it would suggest that more precipitation would result in more good air quality days, or an inverse relationship between the two variables. The inverse relationship held true for every year except for 2007, 2008 and 2010. Wind assists in air pollution dispersion and increased wind speeds should be indicative of more good air quality days and reduced pollutant measurements. However, examining the influence of climate and meteorological elements on air pollution over the course of a year did not appear to capture the hourly or daily events that immediately influence air quality and dispersion, instead the weather measurements equalized when utilizing annual averages.

Comparing the Austin annual averages for the three measured pollutants: ozone, carbon monoxide, and PM-2.5, with the regional and national averages provided additional benchmarks for comparison and analysis. Texas belongs to the southern region, along with Oklahoma, Kansas, Arkansas, Louisiana, and Mississippi. The annual regional and national ozone measurement provided by the EPA was the 4th maximum of daily max 8-hour average. The annual average measurements in Austin were relatively comparable to the regional and national averages for every year between 2005 and 2013, with nine-year average differences of 0.6% and 2.7% respectively. Four out of the nine year, the ozone levels in Austin were the same regionally. Measurements in 2008 and 2009 were 4.1% and 5.4% greater in Austin than the region and 2009 resulted in the highest percentage difference nationally as well at 9.7%. The measurement for the carbon monoxide regional and national comparison was the annual 2nd maximum 8-hour average. The carbon monoxide values in Austin were significantly less than the regional and national averages every year between 2005 and 2013, demonstrated by nine-year average differences of 124% and 125%. The EPA utilized seasonally weighted annual averages of PM-2.5 for the regional and national totals. The data for Austin was only available for 2008 to 2012. Austin PM-2.5 measurements were an average of 6% and 8% less than the regional and national averages in 2008, but then in 2009 the difference in the levels were 4% and 3% higher in Austin. PM-2.5 in Austin exceeded the regional and national averages in 2011 and 2012 as well, hitting a peak in 2012 with percentage differences of 4.9% over the regional average and 10.5% more than the national average. Lastly, to gain additional perspective, the annual average temperatures and precipitation in Austin were compared to national averages for 2012 and 2013. The temperature in Austin was approximately 14.6 degrees warmer than the national average for both years. Precipitation in Austin for 2012 was 8.5 inches less than the national average and 5.9 inches more than the national average in 2013.

Table 5-10 – Percentage change year over year of Austin sustainable built environment outcomes and air quality indicators, 2005-2013

		% change 2005 to 2006	% change 2006 to 2007	% change 2007 to 2008	% change 2008 to 2009	% change 2009 to 2010	% change 2010 to 2011	% change 2011 to 2012	% change 2012 to 2013
Air Quality	**# of Days when Air Quality was GOOD**	6.17%	6.22%	1.95%	0.00%	6.90%	-14.70%	10.50%	2.28%
	Yearly Average: Compliance w/ 8hr EPA Ozone standard *(parts per billion) Audobon /Northwest Sites*	1.25% / 0.00%	-4.94% / -2.44%	-3.90% / -3.75%	-6.76% / -2.60%	0.00% / -1.33%	1.45% / 1.35%	4.29% / -1.33%	0.00% / -2.70%
	Yearly Average: Carbon Monoxide *(parts per million) Northwest Site*	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Yearly Max: Carbon Monoxide *(ppm) Northwest Site*	-10.00%	0.00%	-22.22%	0.00%	214.29%	-68.18%	14.29%	-25.00%
	Design Value (3yr average): PM-2.5 *(micrograms per cubic meter) Audoban / Northwest Sites*	2.95% / 3.93%	9.08% / 5.25%	-2.19% / -2.99%	-1.79% / -3.08%	-5.36% / -3.18%	-2.77% / -0.66%	-2.48% / -1.54%	-0.51% / -3.36%
Land Uses	**Population Density per Square Mile**	2.12%	1.61%	1.33%	2.45%	0.24%	2.64%	-1.74%	1.49%
	Acres of Green Space	1.56%	0.04%	1.29%	0.47%	0.82%	0.24%	0.48%	0.54%
	# of Parks	1.18%	0.39%	2.32%	1.13%	1.49%	1.47%	1.09%	1.43%
Transportation	**Bus Ridership**	0.74%	-3.27%	3.40%	-7.78%	-2.68%	3.06%	4.32%	-0.97%
	Rail Ridership	NA	NA	NA	NA	NA	148.99%	48.17%	18.18%
	Miles of Bike Lanes	2.76%	2.69%	2.62%	13.86%	9.26%	12.85%	14.48%	9.26%
	Pedestrian & Bike Trails (miles)	NA	NA	NA	0.61%	0.00%	1.01%	3.80%	1.73%
	Annual Vehichle Miles Traveled	2.01%	4.90%	0.62%	-0.65%	0.89%	-0.93%	1.91%	2.05%
	# of Transit-oriented Developments	NA	NA	NA	NA	900.00%	0.00%	0.00%	0.00%
Buildings	**# of LEED certified Buildings**	600.00%	-71.43%	200.00%	150.00%	-26.67%	81.82%	15.00%	8.70%
	# of Energy Star rated Buildings	-100.00%	3200.00%	40.63%	-28.89%	65.63%	-49.06%	40.74%	23.68%

** Highlighted values indicate a negative result (i.e. decrease in air quality days, increase in pollutant measurements, increase in VMT, decrease in all other built environment outcomes.*

Air Quality and the Built Environment

A review of the percentage change from year to year for each variable, detailed in Table 5.10, aided in the ability to address the case study theory that the presence of more select sustainable built environment outcomes resulted in better air quality. In order to prove this theory, good air quality days needed to maintain or increase and measurements of each pollutant needed to maintain or decrease, while all sustainable built environment variables increased or maintained and vehicle miles traveled (VMT) decreased or remained the same. There was not a year in Austin between 2005 and 2013 that met all of these requirements. The measurements for ozone and PM-2.5 were provided from the Audubon and Northwest monitoring stations. Although both of the measurements followed the same pattern of improvement or decline, there were notable fluctuations from the measurements recorded at these different locations in the city. The variation in the percentage change in ozone measurements year over year ranged from -2.5% to 5.6% and averaged 0.5% over the nine years. The percentage change in PM-2.5 fluctuated between the two stations as well, ranging from -2.2% to 3.8, and averaging 0.3% from 2005 to 2013. Between 2005 and 2007, ozone and PM-2.5 increased even when the reported number of good air quality days increased. Conversely, in 2011, good air quality days decreased, while ozone improved at both monitoring sites. Over the course of the nine years, decreased bus ridership and increased VMT did not appear to impact the air quality measurements. The presence of LEED and Energy-star certified buildings did not appear to influence air quality measurements either. These results may indicate that there are additional variables that when in concert with select sustainable built environment outcomes influence air quality.

Discussion and Conclusions

The measurements for each pollutant decreased from 2005 to 2013 in Austin and were in compliance with the EPA standards, except for the ozone measurements in 2005, 2006 and 2007, despite the measurements being equivalent to the regional averages for the same years. Emissions from industrial facilities, electric utilities, vehicle exhaust, and gasoline and chemical vapors are some of the major sources of ozone. Austin was compliant with carbon monoxide standards every year and averaged over 124% fewer parts per million than the regional and national averages. Carbon monoxide gas is primarily emitted from transportation sources. Austin was also compliant with the PM-2.5 standards for sensitive populations in every year between 2005 and 2013, with measurements decreasing since 2008. However, the measurements in Austin surpassed the regional and national averages in 2009, 2011 and 2012, despite the minor fluctuations in the actual annual Austin averages. Secondary or fine particles (PM-2.5) are derived from power plants, industries and automobiles. Though the annual vehicle miles traveled increased in Austin for the majority of the years between 2005 and 2013, the miles traveled per capita decreased by 7.6% from 2005 to 2013. Examining the changes in land use designations in Austin between 2009 and 2013 provided additional areas for comparison and pattern matching. Ozone levels increased between 2010 and 2011 from both monitoring sites and between 2011 and 2012 from the Audubon site. In 2011 from 2010, the commercial/industrial land use designation decreased by 5.4%, while land with a designation of utilities increased slightly by 3%. Between 2011 and 2012, both the utilities and commercial/industrial land use designations increased by approximately 9%. Ozone levels in Austin decreased between 2009 and 2010 and 2012 and 2013. The only major land use change during these years was a near 31% loss in the utilities category between 2012 and 2013. The yearly max measurement for carbon monoxide increased in 2010 and 2012. The number of land parcels coded as a utility increased in 2011 and 2012 when the ozone levels increased and in 2013 when ozone levels decreased parcels with the utility land use code decreased. However, it appeared that there was possibly a different primary source for the yearly max carbon monoxide measurement, which could potentially be captured by analyzing daily weather influencers instead of annual averages. Additionally, PM-2.5 increased in 2006 and 2007 when VMT also had the highest percentages increases over the nine-year period. The absences of direct connections between the sustainable built environment outcomes and air quality, and between weather and air quality indicated that the dispersion of air pollution was not captured by the data collected and analyzed. The use of field studies in future research may provide better explanations regarding the impact of the built environment on air quality.

Case Study Theory #4

Do cities with better air quality have lower cases of asthma? The research regarding the impact of air quality on respiratory health, specifically asthma was extensive and was thoroughly outlined in the literature review. Evaluating hospital discharge data for patients with a diagnosis of asthma with the air quality measurements provides the framework necessary to address the fourth research theory that cities with better air quality have lower cases of asthma. Additionally, pollen counts are examined in order to understand any other potential explanations for the corresponding asthma data. The data for the air quality variables, annual asthma hospital discharge counts, and pollen counts are provided in Table 5.11. Additionally, Figure 5.7 graphically displays the asthma data by zip code, along with the air quality measurements.

Citywide Data

The pollen counts for Austin doubled in 2006 with a record nine-year high of 749, and then dropped under the 2005 level in 2007. The counts increased in 2008 and 2009, followed by declining counts through 2012 when they hit the nine-year low of 99. Counts increased in 2013, however to the second lowest amount between 2005 and 2013. There did not appear to be a direct connection between pollen counts and incidences of asthma, given that asthma discharges increased when pollen counts decreased in 2007, 2010, 2011, and 2012. Conversely, asthma discharges decreased in 2013 when pollen counts increased. The data only indicated a relationship in 2006, 2008, and 2009 when both measurements increased. The assumption was also that a decline in air quality resulted in an increase in the number of asthma cases. The City of Austin had 5,546 asthma discharge cases from 2005 to 2013, which represented 2% of the total reported cases in Texas. The 2010 number of discharges with asthma nationally was 439,000; 649 of which were from Austin (CDC, 2010). When examining the citywide asthma numbers for each year and the corresponding air quality statistics, there did not appear to be a connection, represented by an increase in asthma cases when air quality numbers decreased and vice-versa, except in 2013, when asthma numbers decreased while air quality declined.

Table 5-11 – Relationship between Austin air quality and incidences of asthma

		2005	2006	2007	2008	2009	2010	2011	2012	2013
Air Quality	**# of Days when Air Quality was GOOD**	227	241	256	261	261	279	238	263	269
	Yearly Average: Compliance w/ 8hr EPA Ozone standard *(parts per billion) Audobon /Northwest Sites*	80 / 82	81 / 82	77 / 80	74 / 77	69 / 75	69 / 74	70 / 75	73 / 74	73 / 72
	Yearly Average: Carbon Monoxide *(parts per million) Northwest Site*	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	Yearly Max: Carbon Monoxide *(ppm) Northwest Site*	1	0.9	0.9	0.7	0.7	2.2	0.7	0.8	0.6
	Design Value (3yr average): PM-2.5 *(micrograms per cubic meter) Audoban / Northwest Sites*	8.13 / 9.17	8.37 / 9.53	9.13 / 10.03	8.93 / 9.73	8.77 / 9.43	8.30 / 9.13	8.07 / 9.07	7.87 / 8.93	7.83 / 8.63
Asthma Variables	**Annual # of Inpatient Hospital Discharges**	410	493	584	635	642	649	706	801	626
	Annual Average Pollen Count	369	749	303	489	529	329	285	99	231

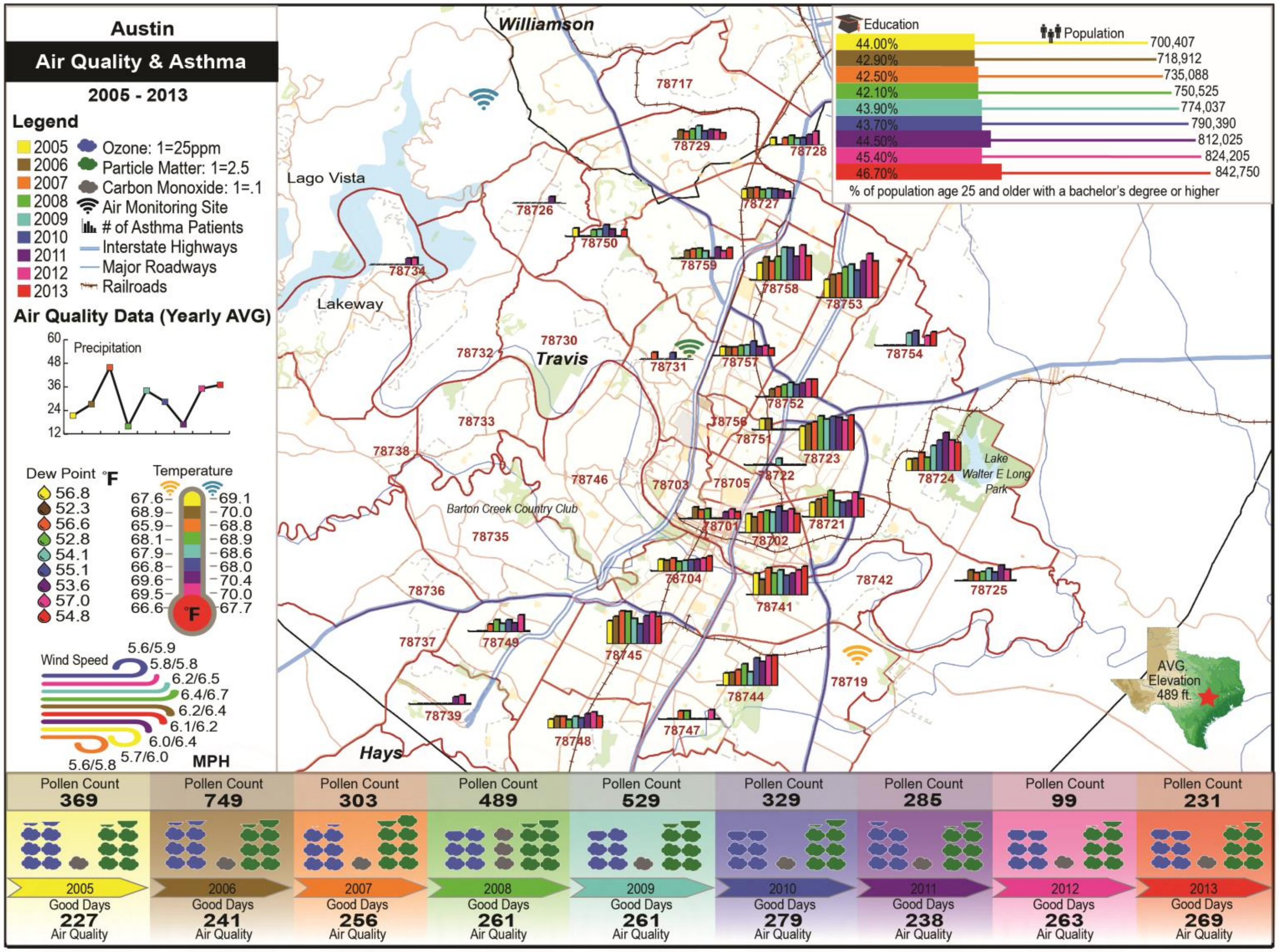

Figure 5-7 Austin Air Quality & Asthma Map, 2005-2013

Additionally, changes in population could result in an influx of people with asthma moving into the city, thus potentially impacting the number of hospital discharges. The population in Austin increased each year between 2005 and 2013, while asthma discharges also increased every year, except 2013. A portion of asthma discharges could potentially be accounted for by changes in population, however identifying this population was not possible

Zip Code-Level Data

Reviewing the asthma cases by zip code, represented in Figure 5.7, allowed for a more thorough examination for analyzing the research question by identifying relevant patterns between the air quality data and asthma cases (see Appendix F to view the asthma discharge data by zip code and year). An average of 58% of Austin zip codes reported cases of asthma between 2005 and 2013. Zip codes 78723, 78753, and 78745 averaged the most cases from 2005 to 2013, with 56, 56, and 50 cases respectively. Nearly 40% of the zip codes with asthma cases reported over 40 discharges in 2005. The number of zip codes with over 40 incidences consistently declined through 2013, with a record low of 12.5%. In addition to the three zip codes listed above, zip codes 78702, 78721, 78724, 78741, 78744, and 78758 all had nine-year average discharges over 40. Out of these zip codes, only 78723 reported over 40 cases in every year between 2005 and 2013, followed by zip codes 78745 and 78753, which reported in eight out of the nine years. Several of the zip codes in the western part of the city had no cases of asthma discharges from 2005 to 2013.

The three zip codes with the highest asthma discharges were located in the central and eastern part of the city, adjacent to the Interstate 35 highway and rail line. This could validate the resultant impact of transportation emissions on air quality. Demographics for these zip codes were not available, however data was available by census tract. There were nine census tracts in zip code 78723, twelve in zip code 78745, and nine in zip code 78753 with demographic data. The 2013 demographics, including median income, race, and housing costs, of the census tracts in each zip code ranged drastically. For example, median income in 78723 ranged from $28,333 to $64,974 and average monthly housing costs ranged from $739 to $1,618. Similar ranges were exhibited in the other zip codes across the captured demographics. Therefore, averages were calculated across all census tracts in each zip code for 2013. 78723 resulted in an average median income of $45,899, monthly housing costs of $994, and an average of 64% white population. Zip code 78745 had an average median income across the twelve census tracts of $52,107; $1,074 average monthly housing costs; and 86% white population. Lastly, the average of the demographics among the nine census tracts in zip code 78753 resulted in an average median income of $43,532, monthly housings costs of $937, and a 60% white population. The demographics of each of these zip codes fell below the city averages, which could be an indication of various other potential affects on the number of asthma discharges, such as quality of housing, access to health care and potential greater exposure to environmental triggers.

Discussion and Conclusions

Although there did not appear to be a connection between the number of yearly asthma hospital discharges and corresponding annual air quality measurements, the evidence did support an influence from population changes and proximity to major roads and rail lines. The lack of identifiable influence from air quality on asthma could be an indication of the significance of daily weather conditions influencing the dispersion and flow of air pollution, the individual exposure to bad air quality days, or the potential for personal health and genetics being more influential. It could also be indicative of missing explanatory variables, such as specific structural elements of the built environment, or a greater influence from indoor air quality versus outdoor air quality. Therefore, future research would be necessary in order to identify the significance of specific living conditions and housing structures on indoor air quality and asthma.

Summary and Case Conclusions

The purpose of this case study research was to examine the impact political culture has on sustainable built environment policy development and how the level of commitment established in those policies influenced the implementation of the corresponding outcomes in order to determine if the evidence supported the literature stating that select sustainable built environment outcomes influenced air quality and thus the number of asthma cases. The political culture of Austin allowed the city to embrace sustainability very early on, which was now engrained in the city's identity and core principles. Austin's reputation as a sustainability trailblazer was corroborated in a written interview with Amy Petri from the City of Austin's Office of Sustainability and represented by the development of the Austin Energy Green Building Program ten years before LEED was launched. Austin embraced the sustainability moniker and proudly promoted itself as a green city. The city planning priorities and policy development processes were guided by city leadership, whom accepted and supported sustainable development practices as a means for preserving the quality of life in Austin (A. Petri, personal communication, September 29, 2015). This widespread acceptance and culture of sustainability in Austin and the lower levels of religious traditionalism, supported the theory identified in the literature that more progressive cities engaged in more sustainability planning than less progressive cities. The literature also suggested that more progressive cities had higher levels of income, education, and nontraditional households than less progressive cities. Austin had increased in all areas between 2005 and 2013 and the percentages were significantly higher than the national averages in 2005 and 2013,except for the percentage of women in the labor force who never married (American FactFinder, n.d.; DeLeon & Naff, 2004, Sharp, 2005b).

Despite Austin's leadership and commitment to sustainability, its planning structure was extremely redundant and decentralized with the use of individualized neighborhood and master plans. This was due in large part to the inability to garner a consensus across the board. However, in 2012, Imagine Austin, the city's first comprehensive plan in nearly 20 years was adopted. The review of the 2005 to 2013 planning documents identified 17 plans and 131 sustainable built environment policies meeting the criteria outlined in the literature to influence air quality (see Table 1.1). 67 of the 131 policies were scored as commitments and 64 as suggestions, which gave Austin an overall sustainability commitment score of 198 based on the content analysis methodology established in Chapter 3. The transportation and land use categories contained the most policies, as well as the highest percentage of commitment-level policies in transportation accessibility, parks, trails and green space, and zoning sub-categories. The evidence identified through the policy analysis across the nine-year period did not correlate with the literature regarding the significance of city revenues on sustainability implementation efforts, given the lack of apparent pattern to policy development (Paterson & Saha, 2010). Additionally, the unemployment and poverty rates decreased every year except 2009 and 2010, which should provide for greater engagement in sustainability planning and implementation efforts. However, the numbers of new policies were minimal. The evaluation of the select demographic indicators supported the theory that Austin had a progressive political culture. It was clear through the interview with city personnel and allocated sustainability commitment score that the more liberal political culture of Austin influenced its commitment to sustainable built environment policies.

A correlation between the sustainable built environment policies and the collected sustainable built environment data from 2005 to 2013 was not identified due in most part to the outcomes increasing year over year, despite fluctuations in the corresponding policies. Although there may not be a direct connection between the times a policy was generated to an increase in the matching built environment outcome, there may be a connection to the overall pervasiveness of sustainability planning and policies with the existence and prevalence of sustainable built environment outcomes within a city. The evidence did support the existing literature regarding the discrepancies between sustainability policy development and implementation efforts (Cooper & Vargas 2004; Holman, 2014; Lubell et al., 2009; Saha, 2009; Seasons, 2003).

The third case study research theory argued that cities with more sustainable built environment outcomes resulted in better air quality. As stated previously, the majority of the sustainable built environment outcomes increased each year, which had no apparent connections to the fluctuations in air quality. Austin was in compliance with the EPA standards for all three pollutants, except for ozone in 2005 and 2006. Additionally, the measurements in Austin averaged a 0.46 percent greater difference in PM-2.5 regionally and 3.1% nationally. The percentage difference was similar for ozone measurements, represented by an average difference of 0.63% regionally and 2.7% nationally. Carbon monoxide measurements in Austin were substantially lower than both the regional and national averages, demonstrated by an average percentage difference between 2005 and 2013 of 124% and 125%, respectively. The primary sources of the pollutants include transportation emissions, industrial facilities, and utilities. The annual vehicle miles traveled in Austin increased over the years, however the per capita vehicle miles traveled decreased. Rail was only initiated in 2010 and increased aggressively year over year. Bus ridership decreased from 2005 to 2013, but did not appear to impact the measurements of the pollutants. There did appear to be a pattern between the changes in the number of utility-coded land use parcels and ozone. However, a connection was not observed with carbon monoxide. It became clear from the data that examining the influence of climate and meteorological elements on air pollution was problematic with annual averages because the daily weather events and measurements appeared to equalize over the course of the year. Given the lack of direct connections between the sustainable built environment outcomes and air quality, and between weather and air quality, future field studies are recommended in order to better understand and explain these intricate relationships.

The final case study research theory assessed was the connection between poor air quality and asthma. As with the other case study theories, there was not a direct correlation between the changes in the number of asthma hospital discharges and corresponding air quality measurements year over year between 2005 and 2013. However, when the asthma data was examined at the zip code level it was clear that the zip codes with the greatest number of asthma cases were located near or adjacent to a major highway or rail line, which supported the research regarding the impact of transportation emissions on air quality and air quality on asthma. Austin's compliance with the EPA 8-hour ozone standard and the average of 70% of good air quality days in a year between 2005 and 2013 could indicate that any annual variations in air quality were not significant enough to influence the number of asthma cases. Also, daily weather conditions and events could impact air quality and asthma in a more targeted and localized manner, personal health and genetics could be more influential to the prevalence of asthma, or more explanatory variables were necessary, like an analysis of the structural elements of the built environment. Indoor air quality may also be the cause of more asthma episodes. Austin averaged 616 asthma cases per year, with national cases consistently ranging from roughly 430,000 to 500,000 between 2001 and 2010 (CDC, 2012).

Each of the above sections examined the research questions independently, however in order to identify any potential influencers all of the available data needed to be analyzed holistically. In an effort to identify any potential patterns and variations over time the percentage change was calculated for 2005 to 2009 and 2009 to 2013 and displayed graphically on a map of Austin with roads, rail lines, and green space (see Figure 5.8). The three zip codes with the largest number of inpatient asthma cases were 78723, 78753, and 78745. Zip code 78745 also had the largest quantity of zoned residential land uses and the 5th most commercial and industrial uses. Of the 29 zip codes with asthma cases between 2005 and 2013, zip code 78745 ranked 4th for having the highest percentage of built parcels, and zip codes 78753 and 78723 were ranked 10th and 11th respectively. Therefore, there may be a connection between the residential population in the zip code and the number of asthma cases, although given the proximity of these zip codes to each other, a major highway, and rail lines, it was more likely that the impact on air quality in that area was from transportation emissions and production. Additionally, the review of the demographics of the census tracts within these three zip codes were lower than the city averages, which could point to additional possible influencers to the number of asthma discharges. There was no apparent connection between the number of asthma cases and the age of building stock, census block density, or floor to area ratio of buildings within the zip codes.

Additionally, the number of asthma cases each year did not coincide with increases or decreases in the sustainable built environment or demographic variables.

In summary, the evidence indicating that the political culture of a city influenced sustainable built environment policies and commitments supported the first case study theory. Additionally, key indicators identified in the literature and reinforced by this study were utilized to gauge the level of progressiveness of a city and the resulting influence on sustainable built environment policy development. The remaining case study theories stating that greater sustainable built environment policy commitments resulted in larger corresponding outcomes, more outcomes resulted in better air quality, and better air quality resulted in fewer cases of asthma, were not fully supported by the data. Additional research in the form of field studies would be necessary in order to gain a better understanding of the complex relationships between the built environment, air quality, and asthma.

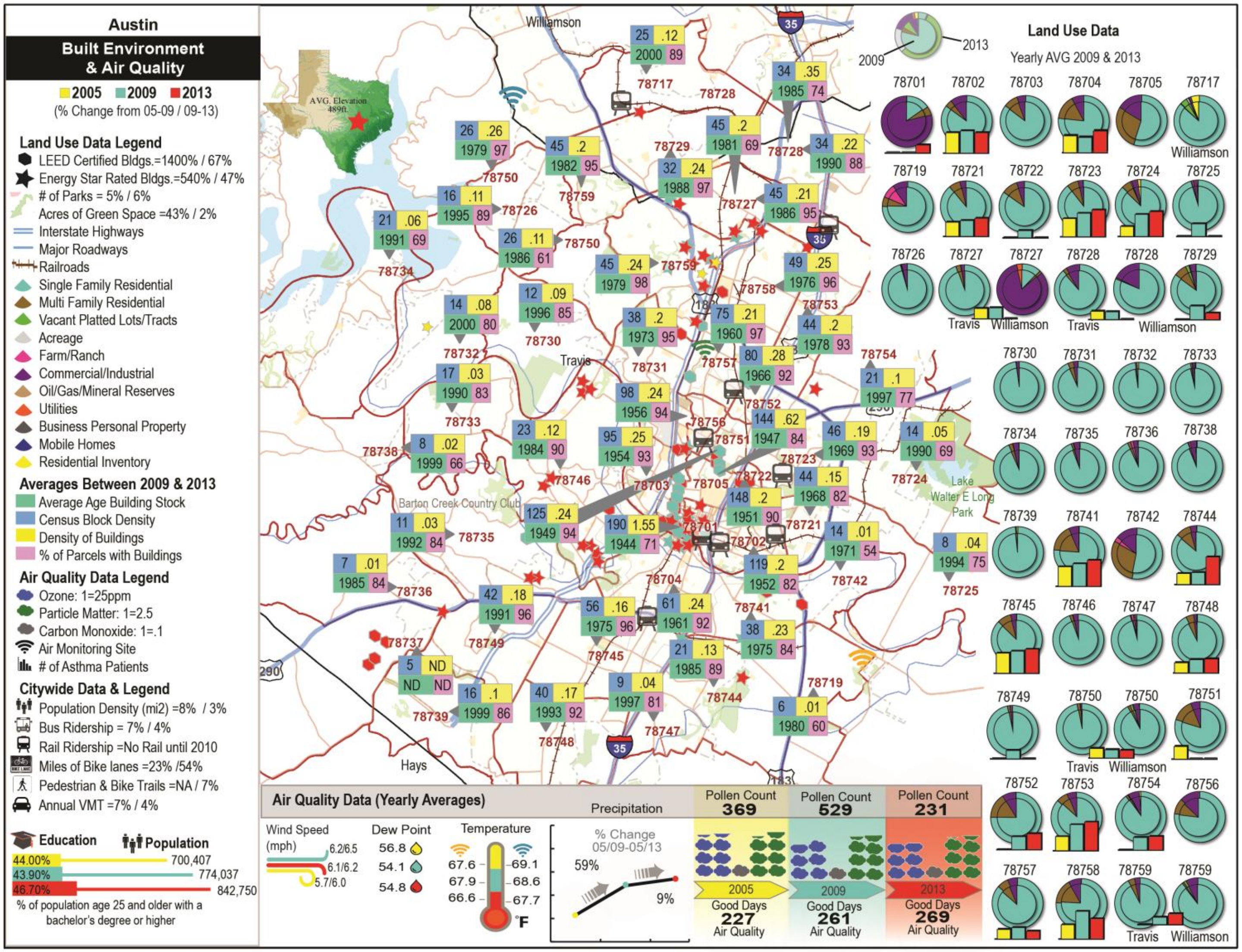

Figure 5-8 Austin Built Environment, Air Quality & Asthma (2005/2009/2013)

Chapter 6

Cross Case Report

The independent city studies for Fort Worth and Austin were conducted in Chapters 4 and 5. These longitudinal studies followed the established case study research design where each case study theory was analyzed based on the collected data for 2005 to 2013. The progression of the analysis involved a review of the demographic and political culture data, including relevant interview results, and the resultant sustainable built environment policy assessment to demonstrate the influence form political culture on the city's level of commitment. This was followed by a thorough evaluation of the citywide and zip code level sustainable built environment data in order to identify potential patterns and connections to the corresponding policies. Air quality measurements and select climate and weather variables were then analyzed for relationships and identifiable patterns to the built environment outcomes. The last case study theory followed where asthma data at the city and zip code levels were analyzed in conjunction with the air quality results to ascertain any potential explanations for the prevalence of asthma. Each city case report concluded with a summary and a holistic review of the potential influences of the built environment outcomes and demographics on cases of asthma.

This chapter consists of the cross case analysis between Fort Worth and Austin as part of the 'Analyze and Conclude' phase of the multiple case study protocol, developed to ensure a quality research design (Yin, 2014). As stated in the case selection section in Chapter 3, these two cities were identified for their contrasting reputations and perceived political cultures in order to better analyze the case study theories. The framework of this cross case analysis follows the same outline of the individual city reports.

Case Study Theory #1

Does the political culture of a city influence a city's commitment to sustainable built environment policies? The literature stated that more progressive cities engaged in more sustainability planning than less progressive cities. Given the liberal reputation of the City of Austin, policies regarding sustainable built environments should be abundant. Conversely, the

City of Fort Worth had a reputation for being more conservative and less concerned with sustainability. Evidence supported these reputations, which was demonstrated by the percentage of the populations identifying as religious with 6.5% more than the national average in Fort Worth and 2.5% less in Austin (Tausanovitch & Warshaw, 2014). Additionally, Austin was ranked 54th out 67 and Fort Worth 12th out of 67 most conservative cities (Sperling's Best Places, 2014). According to previous studies, cities that had openly embraced sustainability and adopted the moniker were more likely to be progressive societies with higher levels of income, education, and nontraditional households (DeLeon & Naff, 2004, Sharp, 2005ab). A comparative analysis of the results from the individual case studies evaluating the influence of city demographics and political culture on sustainable built environment policy commitments between Fort Worth and Austin follows.

Interview Insights: Sustainability Planning

The interviews, either in person or via written responses, with the sustainability administrators from both cities and the representative from the Fort Worth City Managers Office provided a better understanding of the past, present, and future state of sustainability planning in each city (see Appendix C for interview transcriptions and full written responses). The position on branding sustainability and embracing the moniker to categorize and promote related policies and initiatives vary greatly between the two cities. Austin first engaged in sustainability planning and policy development in 1986 when they established the Comprehensive Watershed Protection Ordinance, followed by the Austin Energy Green Building Program in 1990. "The City of Austin's identity and pride of place are intimately tied to environmental protection and sustainability" (A. Petri, personal communication, September 29, 2015). Austin proudly promoted itself as a green city, confirmed by sustainability listed as a key principle in the 2012 Imagine Austin Comprehensive Plan and identified as a core value by the City Manager (A. Petri, personal communication, September 29, 2015). Additionally, the city committed resources to establish the Office of Sustainability with a Chief of Sustainability Officer. There was widespread acceptance and support from city's leaders and citizens for sustainable development as a means to “preserving the great quality of life that has made Austin so attractive to so many” (A. Petri, personal communication, September 29, 2015).

On the other hand, Fort Worth had not blatantly focused on sustainability or greenhouse gas emissions reductions. Instead, the city focused on targeted goals regarding efficiencies and energy consumption reduction. The widespread acceptance from the city’s leaders to improve air quality, while addressing a growing population and mobility improvements, served as the motivation for engaging in sustainability planning and programming, despite that lack of sustainability branding (Dana Burghdoff, personal communication, September 30, 2015). The pattern of engaging in traditionally organized sustainability efforts without the need for the associated marketing was prevalent in the city’s philosophy and actions regarding green-building practices as well. Although the city encouraged energy reduction and other green-building practices, they had not found it necessary to certify through U.S. Green Building Council’s LEED program or any other organization. The City of Fort Worth was very cautious regarding instituting regulations that may impede economic development and desired for Fort Worth to be perceived as a developer friendly community (D. Burghdoff, personal communication, September 30, 2015).

Demographics and Political Culture Indicators

While the interview responses provided a benchmark for evaluation and insight regarding the planning priorities in Fort Worth and Austin from 2005 to 2013, the new political culture literature identified several other demographic and lifestyle indicators said to influence the political culture of a city, either directly or indirectly. All of these demographic and political culture variables and data collected for each city are detailed in Table 6.1 below, along with the sustainability commitment scores allocated to each city through the policy review and content analysis procedure.

The population growth of both cities from 2005 to 2013 was comparable, demonstrated by the increase in population of 142,710 in Fort Worth and 142,343 in Austin. Fort Worth saw its biggest increase in 2006, while the largest growth in Austin occurred in 2009. Over the nine years, the population is Austin was an average of 8% greater than the population of Fort Worth.

Table 6-1 – Fort Worth and Austin: Relationship between demographics, political culture and policy commitments, 2005-2013

		2005		2006		2007		2008		2009		2010		2011		2012		2013	
		Fort Worth	Austin	Fort Worth	Austin	Fort Worth	Austin	Fort Worth	Austin	Fort Worth	Austin	Fort Worth	Austin	Fort Worth	Austin	Fort Worth	Austin	Fort Worth	Austin
Demographic and Socioeconomic Variables	**Population**	624,850	700,407	664,100	718,912	686,850	735,088	702,850	750,525	720,250	774,037	741,206	790,390	748,450	812,025	757,810	824,205	767,560	842,750
	Median Household Income	$40,663	$43,731	$45,276	$47,212	$47,104	$48,966	$48,870	$51,372	$47,634	$50,132	$48,224	$47,434	$47,399	$49,987	$50,750	$52,453	$52,430	$56,351
	Unemployment Rate *(population 16+ years)*	7.70%	7.00%	7.70%	6.10%	6.00%	5.10%	6.60%	5.10%	9.70%	7.50%	10.70%	8.40%	10.80%	8.30%	7.90%	7.10%	7.50%	5.90%
	Median Age	30.9	31.4	32.3	31.2	31.7	31.4	31.6	31.7	30.8	31.2	31.5	30.9	31.4	31.3	31.9	31.7	31.6	32
	Sex ratio *(males per 100 females)*	100	105.2	101.9	108.9	98.3	110.1	100.4	108.9	96.4	109.1	97.5	102.5	91.6	101.9	95.3	101.6	96.4	101
	Race *(white alone population)*	60.78%	69.21%	60.76%	59.09%	63.09%	62.87%	65.33%	68.17%	62.44%	69.09%	62.66%	71.31%	70.25%	70.20%	67.96%	76.89%	62.07%	77.74%
	Level of Education *(population age 25 and older with a bachelor's degree of higher)*	25.10%	44.00%	24.40%	42.90%	24.80%	42.50%	24.60%	42.10%	24.90%	43.90%	26.10%	43.70%	26.10%	44.50%	25.80%	45.40%	28.20%	46.70%
	Marital Status *(population aged 15 and over never married)*	29.60%	39.10%	31.80%	40.80%	31.30%	41.40%	31.30%	41.50%	32.00%	41.90%	33.10%	44.10%	33.50%	43.80%	33.50%	44.00%	34.00%	44.20%
	Poverty Rate *(population below poverty level)*	18.80%	18.10%	16.60%	17.70%	16.20%	17.50%	16.60%	17.00%	19.00%	18.40%	17.90%	20.80%	21.80%	20.30%	18.60%	20.30%	20.10%	17.80%
Political Culture Variables	**Nontraditional Lifestyle** *(% of the population 35 and older never married - MALE/FEMALE)*	3.06%	5.21%	4.04%	5.74%	3.76%	6.20%	4.19%	5.52%	3.69%	5.81%	4.31%	5.87%	3.96%	5.44%	3.71%	5.87%	3.51%	6.18%
		2.29%	3.54%	3.24%	3.61%	3.30%	3.61%	2.86%	3.99%	3.17%	3.68%	3.33%	3.79%	3.87%	4.26%	3.35%	4.02%	4.00%	4.47%
	Nonntraditional Gender Roles *(women never married in labor force)*	8.89%	12.07%	9.01%	12.27%	8.91%	12.32%	8.31%	12.50%	9.48%	12.49%	8.93%	13.81%	10.90%	13.82%	9.93%	14.59%	11.53%	14.40%
	% of workforce in professional, scientific, technical	4.65%	10.10%	4.22%	9.71%	4.44%	10.42%	4.65%	11.35%	4.66%	10.32%	5.37%	10.20%	5.53%	10.49%	5.37%	11.03%	4.81%	12.21%
	% of unmarried same-sex partner households	0.90%	0.82%	1.00%	0.96%	0.59%	1.00%	0.36%	1.20%	0.51%	1.10%	0.46%	0.99%	0.30%	0.62%	0.26%	1.20%	0.39%	0.99%
Sustainability Commitment Score		84	10	2	2	10	30	7	29	14	7	16	27	0	7	45	58	0	28
City Revenue Base *(total revenues per 100,000 population)*		$161,241	$323,986	$174,718	$351,579	$171,594	$343,788	$172,064	$376,625	$166,457	$357,787	$165,215	$340,786	$171,867	$359,451	$170,196	$351,972	$175,342	$376,469

The largest percentage increases in median household income occurred between 2005 and 2006 in both cities, with an 11% increase in Fort Worth and an 8% increase in Austin. The median income averaged 5.2% more in Austin than Fort Worth in every year except 2010 when the median income in Fort Worth exceeded Austin by $790. The unemployment rate improved at a greater rate in Austin than Fort Worth, represented by the 1.1% decrease in 2013 from 2005, as opposed to the 0.2% decrease in Fort Worth. Unemployment peaked in both cities during the period of the global financial crisis, with a high of 10.8% in Fort Worth and 8.4% in Austin. The median age of both cities has increased over the 9-year period, however has maintained between 31 and 32 years. The ratio of men to women has declined in Fort Worth and Austin, by 3.6 and 4.2 fewer men for every 100 women, respectively, from 2005 to 2013. However, Austin still had more men than women with a ratio of 101/100 in 2013, as compared to 96.4/100 in Fort Worth. Additionally, the diversity in both cities has declined over the nine-year period, which is indicated by the 1.3% increase of white only population in Fort Worth and 8.5% increase in Austin from 2005 to 2013. 2006, 2007 and 2011 were the only years the white only population in Fort Worth exceeded Austin, however marginally. The largest difference in the percentages of white only population in Austin and Fort Worth was in 2013 when the percentage in Austin surpassed Fort Worth by 22%. The percentage of the population at least 25 years old with a college degree has fluctuated slightly over nine years in Fort Worth and Austin. Fort Worth saw the biggest growth in 2013, with a 9.3% change from 2012. The biggest gain in Austin happened between 2008 and 2009 at 4.3%. Although Fort Worth has seen some gains in its college-degreed population, Austin maintained an average of 53% more with a college degree. Additionally, a larger percentage of the 2013 population in both cities were never married, than in any of the previous years, peaking at 34% in Fort Worth and 44.2% in Austin. The percentage of the population over the age of 15 that never married averaged over 27% more in Austin than Fort Worth between 2005 and 2013. The poverty rate hit the lowest point between 2005 and 2013 for Fort Worth in 2007 at 16.2% and in 2008 for Austin at 17%. However, only two years later in 2010, the poverty rate in Austin peaked at 20.8%. Fort Worth's poverty rate did not peak until 2011, four years after the record low, at 21.8%. The average difference between the poverty rates in the two cities was less than 1.6% over the nine years.

The lifestyle variables indicated in the literature to influence political culture included, the prevalence of nontraditional lifestyles, represented by individuals over the age of 35 that never married; nontraditional gender roles, represented by the percentage of women whom have never married in the labor force; percentage of the population in professional, scientific or technical fields; and the percentage of unmarried, same-sex partner households. The percentage of nontraditional males exceeded females in every year since 2005 in both cities, except 2013 in Fort Worth when the percentage of nontraditional females hit 4%. There was an 18% average difference between nontraditional females in Fort Worth and Austin and over a 41% average difference in nontraditional males, with more percentages of both populations occurring in Austin. However, Fort Worth had a 75% increase from 2005 to 2013 in nontraditional females, compared to the 26% increase in Austin. Austin had a greater percentage change of nontraditional males between 2005 and 2013 with a growth of nearly 19%, compared to the near 15% in Fort Worth. These statistics could be an indication that more men and women were electing to forgo marriage and traditional family structures to focus on a career or other aspects of their lives. The large increase in nontraditional females in Fort Worth over the years could have signified a growing progressiveness of the city. For each year between 2005 and 2013, Austin had a higher percentage of women in the labor force whom have never married than Fort Worth, with an average percentage difference of almost 32%. Additionally, the percentages of this population in both cities increased from 2005 to 2013, by 30% in Fort Worth and 19% in Austin. This also supported the theory that more women were electing to focus on careers in lieu of marriage and family. Austin also had a significantly higher percentage of its workforce in professional, scientific or technical fields than Fort Worth, with nearly a 75% average difference over the nine years. The nine-year average percentage increase in Austin was 10.65% and 4.86% in Fort Worth. The percentage of unmarried, same-sex partner households peaked at 1.2% in Austin and 1% in Fort Worth. However, the percentage of this population declined substantially in Fort Worth, which was indicated by the overall nine-year average of 0.5% and the 57% negative change from 2005 to 2013. This could be an indication that Fort Worth had a growing reputation for being intolerant, or less progressive and reformed. The unmarried, same-sex population in Austin remained relatively consistent over the nine years and resulted in an average difference of less than 0.08% and an overall average of nearly 1%.

Overall, the percentages change from 2005 to 2013 of all the political culture variables increased in Austin and all but the same-sex household population increased in Fort Worth. The largest increase exhibited by both cities was in the women over the age of 35 whom never married population, represented by a percentage change between 2005 and 2013 of nearly 26% in Austin and 75% in Fort Worth. Although the 2005 percentage of this population in Fort Worth was below the national average, the increase through 2013 surpassed the national average with a difference of 8.6%. The percentage of this population in Austin was higher than the national averages in both years by 13% and 20%, respectively. The percentages of all the other political culture variables in Austin were greater than the national averages, except for women in the labor force whom never married, which had a negative percentage difference of 31% in 2005 and 28% in 2013. Similarly, this population in Fort Worth was lower the national averages by 60% in 2005 and 49% in 2013; even with a 30% increase form 2005 to 2013.

Unmarried men over the age of 35 increased almost 15% in Fort Worth and 20% in Austin from 2005 to 2013. However, the 2005 and 2013 percentages in Austin were 41% and 36% higher than the national percentages, while the percentages in Fort Worth were 12% and 21% lower. The percentage increase of the population in professional, scientific, and technical professions from 2005 to 2013 was significant at 21% in Austin and nominal in Fort Worth at 3.4%. Additionally, both the 2005 and 2013 percentages in Austin were considerably higher than the national averages by nearly 41% and 68%, respectively, and significantly lower in Fort Worth by nearly 36% in 2005 and 23% in 2013. The percentage of unmarried same-sex partner households fluctuated minimally between 2005 and 2013 in Austin, although there was an overall 21% increase over the nine years. In 2005 and 2013, Austin had a difference of over 16% and

66% more same-sex partner households than the national averages. Conversely, this population Fort Worth decreased drastically in Fort Worth between 2005 and 2013 by almost 57%, which was at a much greater rate than the national decline of 29% from 2005 to 2013.

The assumption that Austin had a more liberal, progressive political culture than Fort Worth was further corroborated by the interviews conducted in each city. The disclosure in the interview with the City of Austin Sustainability Office that sustainability had been embedded into the culture of Austin, not only by city leadership but the community as well, demonstrated by the inclusion of sustainability throughout city plans, goals and objectives, was a major characteristic that supported the existing political culture literature regarding city sustainability engagement. Additionally, the city's commitment to a dedicated sustainability department and officer and the historical demonstration of innovative programming, like the Austin Energy Green Building certification program, were also examples that supported a progressive political culture in Austin. On the other hand, the interview with the City Managers Office in Fort Worth revealed that the leadership in Fort Worth had not emphasized sustainability planning or embraced sustainability as a policy framework. Instead the city was primarily concerned about being perceived as developer friendly, even though resource efficiency was a priority and the city engaged in activities that could be categorized under sustainability.

Policy Review and Commitment Score

A review of each city's planning documents between 2005 and 2013 was conducted utilizing the content analysis framework outlined in Chapter 3 in order to address the question if a city's political culture influenced its engagement in sustainable policy development. Unlike many large corporations, municipalities had not instituted a standard, comparable document like the corporate sustainability report (CSR) to collect, organize, and report on all sustainability efforts. Also, despite the perceived commitment of the City of Austin to organize sustainability efforts through a centralized office, many of the initiatives and programs were actually developed, measured and managed by one of the other 40 individual city departments. This and the fact that Austin's historic planning structure and related documents had been extremely decentralized by the use of neighborhood and site-specific master plans in lieu of citywide comprehensive plans, until the 2012 Imagine Austin plan was adopted, had made identifying relevant sustainability policy commitments difficult. However, after a thorough analysis of all identified Austin planning and regulatory documents between 2005 and 2013, 17 were recognized with relevant sustainable built environment policies (see Table 3.2 in Chapter 3 for a complete list). Inversely, and despite the lack of a centralized sustainability office, the City of Fort Worth adopted and standardized the citywide comprehensive planning model back in 2000. Additionally, in order to stay viable and relevant, the Fort Worth City Council mandated annual updates. Therefore, comprehensive plans were available and reviewed for every year between 2005 and 2012, with the majority of the policies existing in 2005, the baseline year. The comprehensive plan for 2013 was not available for public review at the time of this analysis, according to City of Fort Worth staff. Recurring and ongoing policies were only scored in the first year identified, not for subsequent years. A policy was considered new if it was not mentioned previously or if there was a substantive change to a previous policy. Tables 6.2 and 6.3 provide a comparison between the number of sustainable built environment policies, identified in the literature to influence air quality (Tables 1.1 and 3.3) and categorized by the sustainable built environment group (Buildings, Land Use, Transportation, and Sustainable Development) for every year in Fort Worth and Austin, along with the number of policies that were suggestions versus commitments (see Appendix D for a complete list of identified policies and scores for Fort Worth and Austin).

The City of Austin had at least one new relevant sustainable built environment policy each year between 2005 and 2013 with a total of 131 policies, 51% of which were scored as a commitment, rather than suggestion. 112 policies were identified in Fort Worth, which was nearly a 16% difference from Austin. However, 59% of the Fort Worth policies were commitments, suggesting greater implementation results in Fort Worth, which should be represented by greater sustainable built environment outcomes. 2005 and 2012 in Fort Worth and 2008 and 2012 in Austin were the two years with the greatest number of identified sustainable built environment policies. The year 2012 in both cities encompassed higher percentages of commitment policies than the other high policy-producing years, which was 80% in Fort Worth and 53% in Austin. Of the four sustainable built environment categories, transportation and land use contained the most policies in both cities, accounting for almost 80% in Fort Worth and 78% in the Austin, indicating a complimentary planning focus. However, the biggest difference between the policy focal areas of Fort Worth and Austin were in the number of policies in the development practices category. Austin had 27 policies compared to the 9 in Fort Worth, although 44% of the Fort Worth policies, compared to 37% in Austin, were commitments. The overall sustainability commitment scores for Austin and Fort Worth, based on the total number of commitment and suggested policies, was 198 and 178, respectively.

The reuse focus area of the land use category contained the least amount of policies in both cities and none of which were commitment policies. Out of the five land use focus areas, the parks, trails and green space category had the most policies in Fort Worth and Austin, with 64% and 75% identified as commitments, respectively. This is followed by the infill/brownfields category in both cities, further solidifying the cities' corresponding planning agendas. 80% and 86% of the corresponding Fort Worth and Austin zoning policies were commitments. The biggest difference with the number of policies identified in the land use category between these two cities was in the mixed-use development focus area. Austin had five more policies than Fort Worth, representing a 91% difference. The four focus areas in the transportation category ranked the same in each city with the number of policies, three of which though had the same amount in Fort Worth. Increase bike and pedestrian opportunities had the most, followed by accessibility, transit-oriented development, and reduce VMT/improve air quality. Although Austin had 11 more bike and pedestrian policies than Fort Worth, only 52% of them were commitments, as opposed to 83% in Fort Worth. The same was true for the transit-oriented development policies where 54% in Austin were commitment policies, while 83% in Fort Worth were classified commitments. Lastly, the sustainable development policies varied greatly between the two cities. Two were identified in Austin, one of which was a commitment policy, and 14 in Fort Worth with nearly 43% scored as commitments. Overall, the rankings of policy categories, from least to most, were.

Table 6-2 - Fort Worth and Austin: Sustainable built environment policy counts by year, 2005-2013

		2005		2006		2007		2008		2009		2010		2011		2012		2013	
Policy Category	**Area of Focus**	**Fort Worth**	**Austin**	**Fort Worth**	**Austin**	**Fort Worth**	**Austin**	**Fort Worth**	**Austin**	**Fort Worth**	**Austin**	**Fort Worth**	**Austin**	**Fort Worth**	**Austin**	**Fort Worth**	**Austin**	**Fort Worth**	**Austin**
Buildings	Development Practices	5	0	0	0	1	3	0	5	1	2	1	5	0	0	1	9	NA	3
Land Use	Infill/Brownfields	10	0	0	0	1	1	1	2	0	0	0	1	0	1	1	6	NA	1
Land Use	Mixed-Use Development	1	1	0	1	0	1	0	2	0	0	0	0	0	1	2	1	NA	1
Land Use	Parks, Trails and Green Space	7	0	0	0	0	4	0	1	0	0	4	4	0	1	3	4	NA	2
Land Use	Reuse	3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	NA	0
Land Use	Zoning	4	2	1	0	1	1	0	0	0	0	0	0	0	0	4	4	NA	0
Sustainable Development		6	0	0	0	1	0	0	1	4	0	1	0	0	0	2	0	NA	1
Transportation	Accessibility	8	1	0	0	0	1	0	3	2	0	1	4	0	1	1	2	NA	3
Transportation	Increase Bike & Pedestrian Opportunities	1	1	0	0	1	2	2	7	2	2	2	2	0	0	4	7	NA	2
Transportation	Reduce VMT/Improve Air Quality	7	0	0	0	0	1	0	0	0	0	0	1	0	1	3	4	NA	0
Transportation	Transit-Oriented Development	5	2	0	0	0	3	1	3	1	1	1	1	0	0	4	1	NA	2
	Total Number of Policies	**57**	**7**	**1**	**1**	**5**	**17**	**4**	**24**	**10**	**6**	**10**	**18**	**0**	**5**	**25**	**38**	**NA**	**15**
	Number of Policy Suggestions	**30**	**4**	**0**	**0**	**0**	**4**	**1**	**19**	**6**	**5**	**4**	**9**	**0**	**3**	**5**	**18**	**NA**	**2**
	Number of Policy Commitments	**27**	**3**	**1**	**1**	**5**	**13**	**3**	**5**	**4**	**1**	**6**	**9**	**0**	**2**	**20**	**20**	**NA**	**13**

Table 6-3 – Fort Worth and Austin: Policy classifications by focus area, 2005-2013

Policy Category	Area of Focus	Total Number of Policies		Number of Policy Suggestions		Number of Policy Commitments	
		Fort Worth	Austin	Fort Worth	Austin	Fort Worth	Austin
Buildings	Development Practices	9	27	5	17	4	10
Land Use	Infill/Brownfields	13	12	7	8	6	4
Land Use	Mixed-Use Development	3	8	1	5	2	3
Land Use	Parks, Trails and Green Space	14	16	5	4	9	12
Land Use	Reuse	3	1	3	1	0	0
Land Use	Zoning	10	7	2	1	8	6
Sustainable Development		14	2	8	1	6	1
Transportation	Accessibility	12	15	6	5	6	10
Transportation	Increase Bike & Pedestrian Opportunities	12	23	2	11	10	12
Transportation	Reduce VMT/Improve Air Quality	10	7	5	5	5	2
Transportation	Transit-Oriented Development	12	13	2	6	10	7

aligned in four out of the 10 focus areas for both cities. The four areas included reuse, zoning, reduce VMT/improve air quality, and infill/brownfields. The focus area rankings that aligned the least between Fort Worth and Austin were sustainable development and mixed-use development

Discussion and Conclusions

Additional indicators were identified in the study conducted by Paterson and Saha (2010) for their potential influence on the economic and social wellbeing of a city, with the argument that cities with fewer economic and social issues and greater resources were more inclined to emphasize sustainability. These factors included population growth, unemployment level, poverty rate, and revenue base. Fort Worth and Austin were ranked the sixth and eleventh fastest growing city since the recession by Forbes Magazine (2013), which was substantiated by the near 23% population increase in Fort Worth and over 20% increase in Austin from 2005 to 2013, compared to the 9.6% increase nationally. Although the 2013 unemployment rate of 7.5% in Fort Worth was lower than the 2005 rate and was lower than the national rate with a 21% difference, the poverty rate increased from 18.6% in 2012 to 20.1% in 2013. Additionally, the poverty rate in Fort Worth was over 26% higher than the national rate. The percentage difference between the 2013 unemployment rate in Austin and the national rate was 45% represented by a lower rate in Austin of 5.5% versus a 9.3% average national rate. However, like Fort Worth, the poverty rate in Austin was higher than the national average with a percentage difference of 15%, even though the rate decreased between 2012 and 2013 from 20.3% to 17.8%. According to the literature, a decrease or improvement in the unemployment and poverty rates could signify available funds for the city to allocate towards sustainability. On the other hand, an increase in the unemployment and poverty rates could inspire a city to implement new sustainability policies in an effort to establish resource efficiencies. The numbers of new policies in Austin were minimal (less than 10) in 2006 and 2011 when both the unemployment and poverty rates decreased, and in 2009 when both rates increased. Additionally, Fort Worth developed new sustainable built environment policies in 2009 and 2010, when unemployment and poverty rates were high. Given the inconsistencies between the timing of instituting sustainable built environment policies and the fluctuations of unemployment and poverty rates in Fort Worth and Austin, there was no evidence to support an influential relationship within each year. Although, there was a direct relationship between unemployment and poverty rates, where an increase or decrease in one resulted in the same in the other. However, holistically Austin had a greater number of policies, resulting in a higher sustainability commitment score, than Fort Worth and lower unemployment and poverty rates.

The revenue base, or total revenues for every 100,000 people, for Austin peaked in 2008 at $376,625 and averaged $353,604 over the nine years. There was a 70% average difference between the revenue base in Fort Worth and Austin. The revenue base in Fort Worth peaked in 2013 at $175,342 and averaged $169,855 between 2005 and 2013. The fluctuations in revenues matched in each city, decreasing and increasing in the same years. However, there was not an apparent connection between the annual city revenue base and presence of more than ten new sustainable built environment policies. The three years in Fort Worth that generated more than ten new policies were years when revenues decreased. Similarly, only two out of the five years with at least 10 new policies in Austin coincided with revenue increases. Again though, Austin had significantly greater revenues and greater numbers of identified sustainable built environment policies.

The fact that Austin embraced the moniker of sustainability, had lower levels of religious traditionalism, and ranked more liberal than Fort Worth, which also elected not to utilize sustainability branding, suggested that Austin was more progressive and should have lower levels of income, education and nontraditional households (DeLeon & Naff, 2004, Sharp, 2005b). This assumption was confirmed by comparing the data within each city, as well as between each city and against national averages. Income, education levels, nontraditional lifestyle and gender roles, same-sex households, and percentage of workforce in professional, scientific, and technical professions increased in Austin from 2005 to 2013. Additionally, all of the indicators were greater in Austin than the 2005 and 2013 national averages, except for nontraditional gender roles, identified by women in the labor force whom never married, which had a percentage difference of 31% and 28%, respectively. The lower percentage of nontraditional gender roles in Austin could be a result of the population in Austin consisting of approximately 49.5% females as compared to 50.8% nationally. Although income and education levels, as well as the presence of nontraditional households and gender roles increased in Fort Worth from 2005 to 2013, the 2005 and 2013 percentages were well below the national level for each indicator except for nontraditional females, which was nearly 9% higher, and median income, which was less than 1% higher. The higher percentage of nontraditional females in Fort Worth could be a result of the population in Fort Worth consisting of approximately 51.4% females as compared to 50.8% nationally. The difference between the median income in Fort Worth and the national average was nominal, making its potential significance difficult to interpret. Despite the decrease in the percentage of same-sex partner households nationally from 2005 to 2013, this population increased in Austin and not in Fort Worth. Additionally, the decrease of this population from 2005 to 2013 in Fort Worth was nearly double the rate of decline nationally.

In summary, the income levels were comparable for Fort Worth and Austin from 2005 to 2013, demonstrated by a 4.4% average difference between the 2 cities. However, there was a 53% average difference between Fort Worth and Austin education levels, represented by 26% of the population in Fort Worth possessing a bachelor's degree or higher, compared to 44% in Austin. The percentage difference between the average percentage of nontraditional males in Fort Worth and Austin was 41% and 17% for nontraditional females, with Austin having more in both categories than Fort Worth. Additionally, the prevalence of the nontraditional gender role indicator was greater in Austin and exhibited a 32% average difference between the two cities. An average of 75% more of the population in Austin worked in a professional, scientific or technical field than the population of Fort Worth. Lastly, the percentage difference in unmarried same-sex households was 60% more in Austin than Fort Worth.

Based on this analysis, the following indicators appeared to be significant for predicting the level of progressiveness of a city: nontraditional lifestyle and gender roles; percentage of workforce in professional, scientific, and technical fields; percentage of unmarried same-sex households, and level of education. Income level, city revenue base, unemployment rate, and poverty rate did not appear to influence the level of sustainability commitment or implementation within each city. Although, given that Austin had a greater number of policies and higher income, education, and revenue levels, as well as lower poverty and unemployment rates than Fort Worth, there could be an indication of possible tangential relationships with other unidentified influencers. This evidence supported the claim that Austin was more progressive than Fort Worth, which resulted in a greater prevalence of sustainable built environment planning and policy development. Given that Austin's allocated total sustainability commitment score, determined by the identified relevant policies between 2005 and 2013, of 198 exceeded the allocated score for Fort Worth by 20 points, representing a 10.6% difference, then a more progressive political culture would result in more substantial sustainable built environment policy commitments. However, fluctuations in the annual values did not appear to be influenced by the number of policies generated in the corresponding year.

Case Study Theory #2

Do cities with a greater commitment to sustainable built environment policies result in more abundant sustainable built environments? Several sustainable built environment variables were identified in the literature to influence air quality and respiratory health (Table 1.1). These indictors, collected and analyzed over the nine-year period, along with the sustainability policy review and scoring detailed in the above section (Case Study Theory #1), serve as the means for addressing the second case study theory that cities with greater commitments to sustainable built environment strategies result in larger corresponding outcomes. Table 6.4 provides the citywide sustainable built environment variables collected for 2005 to 2013, along with the city revenue base and sustainability policy commitment score for Fort Worth and Austin. A few of the built environment variables were only logical at a smaller unit of analysis within the city. Zip codes were the smallest and most appropriate unit of analysis for this case study as identified by the scale of the available asthma data provided. The sustainable built environment variables collected at the zip code level for each city are summarized in Tables 4.5 and 5.5 with a complete detailing in Appendix E. The land and building zip code data was only available for 2009 to 2013 as explained in the Methods section in Chapter 3. Additionally, maps of all the collected sustainable built environment data, including land uses by zip code, are provided for each year between 2009 and 2013 in the individual city case studies (see Figures 4.2 – 4.6, 5.2 – 5.6).

Citywide Built Environment Data

The population density in Fort Worth and Austin steadily increased from 2005 to 2013, except for a slight decrease in Austin in 2012. The difference in the population density was nearly 22% greater in Austin than Fort Worth for 2005 to 2013. Both cities grew in parks and green space acreage over the nine-year period. Overall, in Austin, this represents an 11% growth in the number of parks and a 5.6% increase in park acreage. Fort Worth had a 15% growth in the number of parks and an 8% increase in park acreage. The City of Austin had an average of 30% more acres of green space and 9% more parks than the City of Fort Worth. The commitment to providing cycling facilities and opportunities commenced in Austin several years before Fort Worth, demonstrated by the existence of 108.6 miles of bike lanes in 2005 when Fort Worth had zero. Additionally, Austin averaged over 163% more miles of bike lanes between 2005 and 2013 than Fort Worth. Although the miles of bike lanes in Fort Worth were substantially lower than Austin, the city had aggressively added more lanes since 2011, validated by the 80% increase in miles of lanes from 2011 to 2012 and nearly 50% increase from 2012 to 2013. This commitment can most likely be attributed to Mayor Betsy Price who was elected in 2011 and an avid supporter of cycling. Pedestrian and bike trail data was not available for 2005, 2006, or 2007 in Austin, nor 2005 and 2006 in Fort Worth. Unlike the huge percentage of bike lanes in Austin compared to Fort Worth, the miles of trails in Fort Worth exceeded those in Austin by an average of 10.9 miles.

Table 6-4 – Fort Worth and Austin: Relationship between policy commitments and sustainable built environment outcomes

		2005		2006		2007		2008		2009		2010		2011		2012		2013	
		Fort Worth	Austin	Fort Worth	Austin	Fort Worth	Austin	Fort Worth	Austin	Fort Worth	Austin	Fort Worth	Austin	Fort Worth	Austin	Fort Worth	Austin	Fort Worth	Austin
City Revenue Base *(total revenues per 100,000 population)*		$161,241	$323,986	$174,718	$351,579	$171,594	$343,788	$172,064	$376,625	$166,457	$357,787	$165,215	$340,786	$171,867	$359,451	$170,196	$351,972	$175,342	$376,469
Sustainability Commitment Score		84	10	2	2	10	30	7	29	14	7	16	27	0	7	45	58	0	28
Land Uses	**Population Density per Square Mile**	1800.2	2376.0	1909.4	2426.3	1972.6	2465.3	2011.0	2498.0	2057.9	2559.3	2112.9	2565.4	2130.5	2633.2	2152.3	2587.3	2171.9	2625.8
	Acres of Green Space	10,851.69	14,806.08	10,898.62	15,037.78	10,956.78	15,043.94	11,056.67	15,238.70	11,331.73	15,309.60	11,372.13	15,435.25	11,700.94	15,473.02	11,719.67	15,547.23	11,733.12	15,630.87
	# of Parks	226	255	229	258	234	259	241	265	249	268	252	272	258	276	260	279	261	283
Transportation	**Bus Ridership**	399,057	34,002,836	437,475	34,253,479	440,786	33,133,394	449,989	34,258,400	439,253	31,594,628	461,558	30,748,887	485,072	31,688,766	543,357	33,058,122	522,829	32,735,981
	Rail Ridership	2,154,400	no rail	2,409,851	no rail	2,507,705	no rail	2,746,992	no rail	2,789,030	no rail	2,469,215	176,433	2,425,335	439,294	2,252,140	650,923	2,092,782	769,264
	Miles of Bike Lanes	0	108.6	9.3	111.6	9.3	114.6	9.3	117.6	11.38	133.9	11.38	146.3	18.16	165.1	32.71	189	48.62	206.5
	Pedestrian & Bike Trails (miles)	no data	no data	no data	no data	49.67	no data	58.1	49.2	60.44	49.5	61.11	49.5	64.4	50	64.93	51.9	71.33	52.8
	Annual Vehicle Miles Traveled	19,140,833	18,382,951	18,034,950	18,751,992	18,705,720	19,670,072	19,391,361	19,792,745	19,858,367	19,663,904	19,550,769	19,838,530	19,900,434	19,653,383	20,213,977	20,029,585	20,220,922	20,440,893
	# of Transit-oriented Developments	3	0	3	0	3	0	3	0	3	0	3	9	3	9	3	9	3	9
Buildings	**# of LEED certified Buildings**	0	1	0	7	1	2	0	6	3	15	9	11	7	20	10	23	64	25
	# of Energy Star rated Buildings	2	5	0	0	4	32	4	45	5	32	2	53	6	27	4	38	10	47

Also, contrary to Austin's early commitment to bike lanes, rail was not instituted until nine years after Fort Worth in 2010. Fort Worth averaged 2,427,494 individual trips per year for 2005 to 2013, while Austin averaged 508,979 for 2010 to 2013. However, rail ridership in Austin did increase over 336% from 2010 to 2013, unlike the 3% loss in Fort Worth from 2005 to 2013. Austin's bus program appeared to be established and integrated in the community as a valid means of travel, demonstrated by the near 33 million average annual riders between 2005 and 2013, as compared to the 464,375 in Fort Worth for the same period. The annual VMT was comparable in both cities, signified by an average difference of 2.2%. The development of passenger rail and the push for transit-oriented developments (TOD) started later in Austin than in Fort Worth. However, they made an aggressive commitment to rail and the accompanying development by establishing nine designated TOD locations at the same time the rail lines opened in 2010. Austin's TOD designations accompanied plans, ordinances, and development regulations.

Certifying buildings with the U.S. Green Building Council's LEED rating system existed in Austin since 2005 with an average of 12 certifications per year through 2013. However, given that Austin Energy, a municipal utility, established a green building certification program in 1990 that many Austin developers could have opted to utilize instead of LEED. LEED picked up in popularity in Fort Worth in 2009, but still had far less certified buildings than Austin, which averaged 101% more than Fort Worth over the nine years. There did not appear to be a pattern to the locations of LEED certified buildings over the period of 2005 to 2013 in Fort Worth, however Austin had a heavy concentration around the downtown area. There were over 2.5 times more average Energy-star certifications per year in Austin than LEED certifications. Also, Fort Worth averaged 4 Energy-star certifications per year, compared to the 31 in Austin. The majority of the Energy-star rated buildings were located in or near the central city in both cities. However, Fort Worth also had clusters near designated TOD stations and Austin near major roadways, with clusters scattered throughout the periphery of the city. The greater prevalence of green buildings within a city could be indicative of a greater acceptance of sustainability from not only city leadership but, throughout the development community.

Built Environment Data: Zip Code-Level

The citywide sustainable built environment data detailed in Table 6.4 and summarized above provided a holistic perspective to the implementation strategies and transit choices in Fort Worth and Austin. However, examining specific land use and building data provided a better understanding of city development patterns. County parcel and appraisal data was used to determine the average age of building stock, floor to area ratio (FAR) of buildings, percentage of built parcels, land use classifications, and census block density for each city. This data, provided by the county appraisal districts, was only available for 2009 to 2013, as explained in the Methods section in Chapter 3. The land use data from Travis County only included 'real' property or immovable property. Therefore, the following land use classifications were not reported: vacant platted lots, acreage, oil/gas/mineral rights, business personal property, and mobile homes.

The five-year citywide average age of building stock in Austin was 1980 and ranged from 1944 to 2004, with older buildings located closer to the central city. The five-year average age of building stock in Fort Worth was 1972 and ranged from 1936 to 2006, following the same pattern as Austin with older buildings located closer to the center of the city. An average of 85% of the parcels in Austin contained buildings, compared to an 81% average in Fort Worth for 2009 to 2013. The 2009 to 2013 average floor to area ratio (FAR) of buildings was calculated for each city by dividing the total square footage of buildings by the total square footage of parcels with buildings. A higher FAR tends to indicate more dense construction. The five-year average floor to area ratio of Austin was 0.19 and 0.22 in Fort Worth, indicating the presence of more densely built lots in Fort Worth. The buildings in the downtown area of both cities had the greatest density with an FAR of 1.43 in Austin and 1.07 in Fort Worth. The FARs in both cities decreased greatly outside of the central city. The 2009 to 2013 average census block density was calculated to further demonstrate the level of connectivity in each city by providing the mean number of census blocks per square mile (yearly calculations by zip code are available in Appendix E). The five-year average census block was 47.12 in Austin and 66.94 in Fort Worth, indicating a greater potential for shorter blocks and better connectivity throughout the City of Fort Worth. Land use classifications for the provided parcel data were tallied for all the zip codes in each city for every year between 2009 and 2013, and then averaged in order to get the five-year average of citywide land uses. Totals and percentages were only calculated for the classifications with available data since the land use records from Travis County were limited to 6 of the 11 land use categories. An average of 90.2% of the land in Austin was designated single-family residential between 2009 and 2013, compared to the 86.6% in Fort Worth. 5.3% were designated multi-family residential in Austin and 3.1% in Fort Worth, followed by 4% in Austin designated commercial/industrial, compared to 6.5% in Fort Worth.

Discussion and Conclusions

In order to evaluate the research theory that more sustainable built environment commitment policies resulted in greater corresponding outcomes, the nine-year annual average of each sustainable built environment outcome, sustainable policy commitment score, and revenue base for each city, along with the percentage difference between Fort Worth and Austin were provided in Table 6.5. As noted in the individual city case reports, there did not appear to be a specific connection between the years sustainable built environment policies were enacted and the corresponding outcomes in that same year. This could have resulted from a delay between when a policy was adopted and when it was implemented, which could be caused by a variety of factors, like funding and community support. However, it could also have indicated that policies, regardless of the level of commitment emphasized, did not actually translate to implementation. However, when examining and comparing the differences in the nine-year averages between Fort Worth and Austin in Table 6.5, the majority of the results supported the research theory that more sustainable built environment policies resulted in greater outcomes. All of the built environment outcomes, except miles of pedestrian and bike trails and rail ridership, were more prevalent in the City of Austin than the City of Fort Worth. The data for rail ridership may not provide the most accurate interpretations, given that rail was initiated in Austin in 2010, unlike Fort Worth where rail was established in 1997. Also, the percentage difference in the miles of pedestrian and bike trails between Fort Worth and Austin may not provide the best comparison since the differences in total land area of each city was not considered. The land area (square miles) in Fort Worth was significantly larger than Austin, with a nine-year average difference of 13.6%. These factors, along with the larger sustainability commitment score in Austin supported, at least in part, the case theory that more sustainable built environment policies resulted in greater outcomes. The theory was partially supported since an influential relationship was only detected when evaluated over a nine-year period of time, not year over year. These results also supported the previous explanation regarding the lack of correlation between policy years and corresponding built environment outcomes resulting from a delay in implementation. Future longitudinal research would be necessary to validate this theory.

Table 6-5 – Fort Worth and Austin: 9-year annual average comparison of sustainable built environment policies and outcomes, 2005-2013

		Annual Average (2005 - 2013)		% Difference (FTW-AUS)
		Fort Worth	Austin	
City Revenue Base *(total revenues per 100,000 population)*		$169,855	$353,605	-70.21%
Sustainability Commitment Score		20	22	-10.64%
Land Uses	**Population Density per Square Mile**	2035.4	2526.3	-21.52%
	Acres of Green Space	11,291.26	15,280.27	-30.02%
	# of Parks	246	268	-8.86%
Transportation	**Bus Ridership**	464,375	32,830,499	-194.42%
	Rail Ridership	2,427,494	508,979	130.67%
	Miles of Bike Lanes	16.7	143.7	-158.39%
	Pedestrian & Bike Trails (miles)	61.4	50.5	19.56%
	Annual Vehicle Miles Traveled	19,446,370	19,580,451	-0.69%
	# of Transit-oriented Developments	3	4	-28.57%
Buildings	**# of LEED certified Buildings**	10	12	-15.69%
	# of Energy Star rated Buildings	4	31	-153.16%

Case Study Theory #3

Do cities with more abundant sustainable built environments have better air quality? The measurements for the identified land use, buildings, and transportation outcomes, determined by the literature to impact air quality, were reviewed from 2005 to 2013 for the cities of Fort Worth and Austin in the section above. These outcomes along with the air quality statistics, including relevant climatological and meteorological influences noted in the literature, were utilized to evaluate the third research theory that cities with more sustainable built environment outcomes had better air quality. Before an analysis of the resultant built environment outcomes could be conducted effectively, a review was required of the air quality measurements and the potential environmental influences. The air quality data was collected for 2005 to 2013 from each available monitoring station in Fort Worth and Austin (see Table 6.6). There were three air-monitoring stations responsible for reporting air quality and meteorological measurements for the City of Austin, representing the northern, central and southern quadrants of the city (see Figure 5.7). Combinations of two of the three stations in Austin reported on four of the air quality and meteorological measurements. The City of Fort Worth had one monitoring station.

Air Quality Analysis

The number of good days of air quality continuously increased in both cities from 2005 to 2010 when it peaked at 279 days in Austin and 186 days in Fort Worth. Austin averaged 108 more good air quality days in a year than Fort Worth from 2005 to 2013. Compliance with the EPA 8-hour ozone standard was met when the three-year average of the annual fourth highest daily maximum eight-hour ozone concentration measured was less than 76 parts per billion (ppb). Utilizing this measurement instead of annual averages provided a more accurate measurement since it accounted for higher measurements during the ozone season of March 1st - October 31st. Austin was in compliance with the 8-hour ozone standard in 2008, but only with the measurements taken at the Audubon station, not the Northwest station. However, both stations reported measurements under the 76ppb threshold since 2009. Although ozone improved in Fort Worth from 2005 to 2013, compliance with the 8-hour ozone standard was never met. Fort Worth

Table 6-6 – Fort Worth and Austin: Air quality comparison, 2005-2013

	2005		2006		2007		2008		2009		2010		2011		2012		2013	
	Fort Worth	Austin	Fort Worth	Austin	Fort Worth	Austin	Fort Worth	Austin	Fort Worth	Austin	Fort Worth	Austin	Fort Worth	Austin	Fort Worth	Austin	Fort Worth	Austin
Yearly Average: Dew Point Temperature *(degrees Fahrenheit)*	50.2	56.8	48.3	52.3	51.3	56.6	48.2	52.8	50.2	54.1	50.3	55.1	49.3	53.6	51.6	57.0	48.8	54.8
Annual Precipitation *(inches)*	15.97	21.45	32.95	27.23	51.29	45.91	28.04	15.98	45.28	34.11	37.55	28.42	24.74	16.9	28.33	35.14	31.01	37.04
Yearly Average: Temperature *(degrees Fahrenheit)*	67.5	67.6 / 69.1	68.8	68.9 / 70	65.7	65.9 / 68.8	66.7	68.1 / 68.9	66.2	67.9 / 68.6	66.5	66.8 / 68	68.8	69.6 / 70.4	68.8	69.5 / 70	66	66.6 / 67.7
Yearly Average: Wind Speed *(mph)*	7.4	5.7 / 6.0	8.1	6.2 / 6.4	7.3	5.6 / 5.8	8.5	6.4 / 6.7	8.1	6.2 / 6.5	7.8	5.6 / 5.9	8.5	6.0 / 6.4	7.9	5.8 / 5.8	8	6.1 / 6.2
# of Days when Air Quality was GOOD	107	227	118	241	144	256	150	261	171	261	186	279	146	238	146	263	156	269
Yearly Average: Compliance w/ 8hr EPA Ozone standard *(parts per billion)*	95	80 / 82	94	81 / 82	91	77 / 80	83	74 / 77	79	69 / 75	78	69 / 74	81	70 / 75	79	73 / 74	81	73 / 72
Yearly Average: Carbon Monoxide *(parts per million)*	0.3	0.1	0.3	0.1	0.3	0.1	0.3	0.1	0.2	0.1	0.2	0.1	0.2	0.1	0.3	0.1	0.2	0.1
Yearly Max: Carbon Monoxide *(parts per million)*	2.6	1	2.4	0.9	2.5	0.9	1.7	0.7	1.6	0.7	2	2.2	1.5	0.7	1.5	0.8	2.2	0.6
Design Value (3yr average): PM-2.5 *(micrograms per cubic meter)*	11.82	8.13 / 9.17	11.2453	8.37 / 9.53	11.24	9.13 / 10.03	10.70	8.93 / 9.73	10.38	8.77 / 9.43	Invalid Data	8.30 / 9.13	10.18	8.07 / 9.07	10.24	7.87 / 8.93	10.51	7.83 / 8.63

averaged 10.5ppb more than the measurements from Austin's Audubon station and 7.7ppb more than the Northwest station. The yearly average and max of carbon monoxide were provided in order to gauge compliance with the EPA standards, which stated that carbon monoxide could not exceed 35ppm more than once per year. The yearly average and max measurements in Fort Worth and Austin were well below these standards for each year, which averaged 0.26ppm and 2.0ppm in Fort Worth and 0.1ppm and 0.9ppm in Austin. The EPA primary standards for PM-2.5 allowed up to 12 micrograms per cubic meter (µg/m³) for sensitive populations, like asthmatics, children, and the elderly. At no point did the measurements surpass the EPA standard of 12 micrograms per cubic meter for Fort Worth or Austin. However, Fort Worth averaged higher measurements of approximately 1.2µg/m³ than the Audubon station in Austin and 0.3µg/m³ than the Northwest station.

According to NCTCOG, there could be an association of high dew point temperatures and ozone days. Examining annual averages, however, limited the accountability for individual high or low temperature days. This was illustrated in the individual city case reports by the annual fluctuations in average dew point temperatures not corresponding with the number of good air quality days. Additionally, the dew point in Austin averaged 5 degrees higher than Fort Worth. This should have indicated higher ozone levels and fewer good air quality days in Austin than Fort Worth, which the data did not support. Verifying a distinctive correlation between increased precipitation and reduced temperatures was not feasible in the individual city case studies utilizing annual averages because daily rainfall measurements could not be connected to the corresponding daily temperatures. Additionally, the assumption that larger quantities of precipitation would result in more good air quality days was not supported by the annual averages from both cities. Fort Worth had a nine-year average of 3.7 more inches of annual rainfall and 1.2 degrees cooler temperatures than Austin, and an overall average of 108 fewer GOOD air quality days. Wind assists in air pollution dispersion. So, increased wind speeds should have indicated more good air quality days and reduced pollutant measurements. The 2005 to 2013 average wind speeds in Fort Worth were 1.8 to 2 mph more than Austin, yet all of the air quality measurements in Austin were better than Fort Worth. This suggested that the dispersion benefits of increased wind speeds may have influenced daily air quality, however these benefits were not substantial enough to impact air quality measurements over longer periods of time.

Comparing the Fort Worth Austin annual averages for the three measured pollutants: ozone, carbon monoxide, and PM-2.5, with the regional and national averages provided additional benchmarks for comparison and analysis. Texas belongs to the southern region, along with Oklahoma, Kansas, Arkansas, Louisiana, and Mississippi. The annual regional and national ozone measurement provided by the EPA was the 4th maximum of daily max 8-hour average. Fort Worth exceeded the regional and national average for every year between 2005 and 2013 with an average percentage difference of 10.4% and 12.8% respectively. The percentage differences were much less between Austin, the region, and nation than the Fort Worth differences, at 0.6% and 2.7%, respectively. The measurement for the carbon monoxide regional and national comparison was the annual 2nd maximum 8-hour average. The carbon monoxide values in Fort Worth were well below the regional and national averages every year between 2005 and 2013, demonstrated by nine-year average differences of 42% and 45%. However, the average measurements in Austin were drastically lower than the regional and national averages, with differences of 124% and 125%. The EPA utilized seasonally weighted annual averages of PM-2.5 for the regional and national totals. Fort Worth PM-2.5 measurements were an average of 4.8% and 5.3% less than the regional and national averages from 2005 to 2010. However, starting in 2011, PM-2.5 in Fort Worth exceeded both of the regional and national averages, hitting a peak in 2013 with percentage differences of 13% over the regional average and 16% more than the national average. The data for Austin was only available for 2008 to 2012. Austin PM-2.5 measurements were an average of 6% and 8% less than the regional and national averages in 2008, but then in 2009 the difference in the levels were 4% and 3% higher in Austin. PM-2.5 in Austin exceeded the regional and national averages in 2011 and 2012 as well, hitting a peak in 2012 with percentage differences of 4.9% over the regional average and 10.5% more than the national average. Lastly, to gain additional perspective, the annual average temperatures and precipitation in Fort Worth and Austin were compared to national averages for 2012 and 2013. The average temperatures in Fort Worth and Austin were approximately 13.5 and 14.6 degrees, respectively, higher than the national averages for both years. 2012 precipitation levels in Fort Worth and Austin were lower than the national average by 0.16 and 8.5 inches, respectively. The averages in both cities surpassed the national average in 2013 by 1.66 inches in Fort Worth and 5.9 inches in Austin.

Air Quality and the Built Environment

A review of the percentage differences between Fort Worth and Austin for the nine-year averages of each variable, detailed in Table 6.7, aided in the ability to address the case study theory that the presence of more select sustainable built environment outcomes resulted in better air quality. In order to prove this theory there would be more good air quality days and fewer pollutants, while all sustainable built environment variables increased or maintained and vehicle miles traveled (VMT) decreased or remained the same. According to the data, the 2005 to 2013 average air quality in Austin was better than Fort Worth. Additionally, the values of all the sustainable built environment variables, except rail ridership and pedestrian and bike trails were more prevalent in Austin. The VMT was 0.7% greater in Austin, even though the average population difference was also greater in Austin by 8%. These results indicated that there were potentially additional variables that influenced the impact of these select transportation indicators on air quality. Potential influences to the miles of pedestrian and bike lanes could be adjusting for the total land area of a city and identifying the actual usage for commuting. Also, given that rail was established in Austin more than ten years after Fort Worth, it was difficult to determine how this particular indicator would influence air quality over the long term.

Discussion and Conclusions

Although the measurements for each pollutant decreased from 2005 to 2013 in Fort Worth, ozone levels were never in compliance with EPA standards and were significantly higher than the regional and national averages. Each pollutant also decreased in Austin every year between 2005 and 2013, however Austin was in compliance with all of the EPA standards, except for the ozone measurements in 2005, 2006 and 2007. Emissions from industrial facilities, electric utilities, vehicle exhaust, and gasoline and chemical vapors were some of the major sources of ozone. Both Fort Worth and Austin were compliant with carbon monoxide standards every year and averaged over 40% and 124% fewer parts per million than the regional and national averages, respectively. Carbon monoxide gas is primarily emitted from transportation sources. Fort Worth and Austin were also compliant with the PM-2.5 standards for sensitive populations in every year between 2005 and 2013. However, the 2011, 2012 and 2013 measurements in Fort Worth surpassed the regional and national averages, as did Austin in 2009, 2011 and 2012, despite minor fluctuations in the actual annual averages in each city. Secondary or fine particles (PM-2.5) are derived from power plants, industries and automobiles. Though the annual vehicle miles traveled increased in both cities for the majority of the years between 2005 and 2013, the miles traveled per capita also decreased in both cities by nearly 14% in Fort Worth and 7.6% in Austin.

Examining the changes in land use designations for 2009 to 2013 provided additional areas for comparison and pattern matching between the annual variations in pollution and types of land use. The number of parcels with a utilities land use designation in Fort Worth decreased by 33% between 2011 and 2012, while the number of commercial and industrial classifications remained consistent. No other major changes in the land use designations in Fort Worth were identified. Therefore, indicating that portions of ozone and PM-2.5 emissions in Fort Worth were most likely derived from other unidentified sources; or that dispersion was obstructed by other weather occurrences or built environment characteristics. One possible assumption for the higher ozone levels in Fort Worth could be that the average temperatures run approximately 13 degrees higher than the national averages and ozone forms more aggressively on warm, sunny days.

Ozone levels in Austin increased in 2011 from both monitoring sites and in 2012 from the Audubon site. In 2011, the commercial/industrial land use designation decreased by 5.4%, while utilities designations increased slightly by 3%. In 2012, both the utilities and commercial/industrial land use designations increased by approximately 9%. Ozone levels in Austin decreased in 2010 and 2013. The only major land use change during these years was a near 31% loss in the utilities category in 2013. The only other increase in pollutant measurements during this period was in 2010 and 2012 for the carbon monoxide yearly max measurement. In summary, the number of land parcels coded as a utility increased in 2011 and 2012 when the ozone levels increased and in 2013 when ozone levels decreased parcels with the utility land use code decreased, indicating a potential influential relationship between ozone and utility land uses. However, it appeared that there was possibly a different primary source for carbon monoxide emissions. Overall, Austin had a smaller percentage of commercial/industrial and utilities land use designations than Fort Worth, which could possibly explain in part why Austin had better air quality.

The absences of direct connections between the sustainable built environment outcomes and air quality within cities, and between weather and air quality within and between cities, indicated that the dispersion of air pollution was not captured by the data collected and analyzed. However, there was a greater presence of sustainable built environment outcomes and better air quality in Austin than Fort Worth. The use of field studies in future research may provide better explanations regarding the impact of the built environment on air quality within cities, as well as what other variables may be attributed to the possible correlation when comparing cities.

Table 6-7 – Fort Worth and Austin: 9-year annual average comparison of sustainable built environment outcomes and air quality, 2005-2013

		Annual Average (2005 - 2013)		% Difference (FTW-AUS)
		Fort Worth	Austin	
Air Quality	# of Days when Air Quality was GOOD	147	255	-53.73%
	Yearly Average: Compliance w/ 8hr EPA Ozone standard *(parts per billion)*	85	74	13.84%
			77	9.88%
	Yearly Average: Carbon Monoxide *(parts per million)*	0.26	0.10	88.89%
	Yearly Max: Carbon Monoxide *(parts per million)*	2.0	0.9	71.70%
	Design Value (3yr average): PM-2.5 *(micrograms per cubic meter)*	9.59	8.38	13.47%
			8.29	14.54%
Land Uses	Population Density per Square Mile	2035.4	2526.3	-21.52%
	Acres of Green Space	11,291.26	15,280.27	-30.02%
	Average Census Block Density	66.94	47.12	34.75%
	# of Parks	246	268	-8.86%
Transportation	Bus Ridership	464,375	32,830,499	-194.42%
	Rail Ridership	2,427,494	508,979	130.67%
	Miles of Bike Lanes	16.7	143.7	-158.39%
	Pedestrian & Bike Trails (miles)	61.4	50.5	19.56%
	Annual Vehicle Miles Traveled	19,446,370	19,580,451	-0.69%
	# of Transit-oriented Developments	3	4	-28.57%
Buildings	# of LEED certified Buildings	10	12	-15.69%
	Average Age of Building Stock	1972	1980	-0.39%
	% of Parcels with Buildings	82%	85%	-3.61%
	Average Floor to Area Ratio	0.22	0.19	15.88%
	# of Energy Star rated Buildings	4	31	-153.16%

Case Study Theory #4

Do cities with better air quality have lower cases of asthma? The research regarding the impact of air quality on respiratory health, specifically asthma was extensive and was thoroughly outlined in the literature review. Evaluating hospital discharge data for patients with a diagnosis of asthma along with the air quality measurements provided the framework necessary to address the fourth research theory that cities with better air quality had lower cases of asthma. Additionally, pollen counts were examined in order to understand additional potential explanations for the corresponding asthma data. The annual percentage differences between the air quality variables, annual asthma hospital discharges, and pollen counts in Fort Worth and Austin for 2005 to 2013 were provided in Table 6.8, in an effort to easily identify the relationships between the variables.

Citywide Data

Pollen counts in each city fluctuated year over year with ranges from 99 to 749 in Austin and 134 to 279 in Fort Worth. The overall nine-year average pollen counts in each city were 194 in Fort Worth and 350 in Austin. Annual asthma inpatient discharges ranged from 796 to 969 in Fort Worth and 410 to 801 in Austin. Averages of the 2005 to 2013 discharges resulted in an average of 852 cases in Fort Worth and 616 in Austin. Fort Worth had a nine-year average of 33% more asthma cases and 50% less pollen counts than Austin. Given that Fort Worth had more cases of asthma each year and lower pollen counts in every year except 2012 and 2013 than Austin, a direct connection between annual pollen counts and incidences of asthma was not identified. Additionally, the analysis of the annual data within each city case report did not identify an influential relationship between pollen count and asthma discharges. An important note for consideration regarding a possible cause for variations in annual asthma discharges included changes in population where influxes of people, potentially with asthma, move into the city. The evidence for this assumption was inconclusive. The population in Fort Worth increased each year while asthma discharges fluctuated. However, both population and asthma discharges increased in Austin every year except for 2013. A portion of asthma discharges could potentially be accounted for by changes in population, however identifying this populace was not possible within the scope of this study.

Zip Code-Level Data

Reviewing the asthma cases by zip code, represented in Figures 4.7 and 5.7, allowed for a more thorough examination for analyzing the research question by identifying potential patterns between the air quality data and asthma cases (see Appendix F to view the asthma discharge data by zip code and year). An average of 58% of Austin zip codes and 80% of Fort Worth zip codes reported cases of asthma between 2005 and 2013, indicating a greater distribution of cases in Fort Worth. The highest averages of asthma discharges in Fort Worth were 82, 66, and 55, represented by three zip codes with no identifiable geographic connections. The highest averages in Austin were 56 and 50, represented by three zip codes. Additionally, the locations of the zip codes in Austin with the highest reported asthma cases clearly indicated a relationship to transportation-related emissions given their proximity to a major highway and rail lines. Demographics for these six zip codes with the highest average asthma cases in Fort Worth and Austin were not available at the zip code level, however data was available by census tract. The demographics, including median income, race, and housing costs, of the census tracts in each zip code ranged drastically. Two out of the three highest asthma-producing zip codes in Fort Worth had lower average incomes and higher minority populations than the city average. The median income and percentage of white population was lower than the overall city average in Austin for all of the three zip codes reporting the greatest number of asthma discharges. This could indicate a connection between issues or poverty, social equality and increased prevalence of asthma.

Discussion and Conclusions

Although there did not appear to be a connection between the number of yearly asthma hospital discharges and corresponding changes in annual air quality measurements in the Fort Worth case report, the evidence identified in the Austin case study did support a potential influence from population changes and proximity to major roads and rail lines. The lack of a connection identified in Fort Worth could have been due in part to the air quality in Fort Worth not improving significantly enough to impact asthma. The lack of identifiable influence from air quality on asthma within each city could be an indication of the significance of daily weather conditions influencing the dispersion and flow of air pollution, the individual exposure to bad air quality days, or the potential for personal health and genetics being more influential. It could also be indicative of missing explanatory variables, such as specific structural elements of the built environment, or a greater influence from indoor air quality versus outdoor air quality. Therefore, future research would be necessary in order to identify the significance of specific living conditions and housing structures on indoor air quality and asthma.

When comparing the two cities, there did appear to be a direct relationship between the annual fluctuations in air quality and resultant numbers of asthma cases. In every year between 2005 and 2013 Austin had superior air quality to Fort Worth and fewer cases of asthma. This occurrence could possibly support the case study theory that better air quality resulted in fewer cases of asthma. However, this was only true when comparing cases, not within each city report. A few possible explanations for this occurrence include, that cases of asthma were not responsive to minor changes in air quality, patterns were unidentifiable through the use of annualized data, or there were other influential variables unaccounted for that were more prevalent in Austin than Fort Worth. Additional research is necessary in order to validate these results or identify other influencers.

Table 6-8 – Percentage difference between Fort Worth and Austin air quality and incidences of asthma, 2005-2013

		2005 % Difference (FTW-AUS)	2006 % Difference (FTW-AUS)	2007 % Difference (FTW-AUS)	2008 % Difference (FTW-AUS)	2009 % Difference (FTW-AUS)	2010 % Difference (FTW-AUS)	2011 % Difference (FTW-AUS)	2012 % Difference (FTW-AUS)	2013 % Difference (FTW-AUS)
Air Quality	**# of Days when Air Quality was GOOD**	-71.86%	-68.52%	-56.00%	-54.01%	-41.67%	-40.00%	-47.92%	-57.21%	-53.18%
	Yearly Average: Compliance w/ 8hr EPA Ozone standard *(parts per billion)*	17.14%	14.86%	16.67%	11.46%	13.51%	12.24%	14.57%	7.89%	10.39%
		14.69%	13.64%	12.87%	7.50%	5.19%	5.26%	7.69%	6.54%	11.76%
	Yearly Average: Carbon Monoxide *(parts per million)*	100.00%	100.00%	100.00%	100.00%	66.67%	66.67%	66.67%	100.00%	66.67%
	Yearly Max: Carbon Monoxide *(parts per million)*	88.89%	90.91%	94.12%	83.33%	78.26%	-9.52%	72.73%	60.87%	114.29%
	Design Value (3yr average): PM-2.5 *(micrograms per cubic meter)*	36.98%	29.32%	20.70%	18.04%	16.78%	NA	23.11%	26.22%	29.21%
		25.24%	16.51%	11.37%	9.50%	9.55%	NA	11.52%	13.71%	19.63%
Asthma Variables	**Annual # of Inpatient Hospital Discharges**	68.27%	54.25%	44.16%	27.45%	40.60%	20.47%	11.98%	4.75%	26.71%
	Annual Average Pollen Count	-83.85%	-139.30%	-53.03%	-90.64%	-88.28%	-48.30%	-43.59%	81.44%	18.82%

Summary and Conclusions

The purpose of this case study research was to examine the impact political culture had on sustainable built environment policy development and how the level of commitment established in those policies influenced the implementation of the corresponding outcomes in order to determine if the evidence supported the literature stating that select sustainable built environment outcomes influenced air quality and thus the number of asthma cases. Unlike Austin, the political culture of Fort Worth resulted in the city electing not to organize and brand initiatives under the sustainability umbrella. Instead of requiring green certifications and strict development guidelines, Fort Worth emphasized resource efficiencies above anything else, wanting to maintain a developer-friendly environment that encouraged economic development. Austin on the other hand had been branded a leader in sustainability throughout national rankings and through internal marketing and branding efforts. The political culture in Austin embraced sustainability, which was now engrained in the city's identity and core principles. City leadership guided the planning priorities and policy development processes in both cities. However, the leadership in Fort Worth had not indicated the need to engage in more sustainability planning or reporting, as opposed to the leadership in Austin whom accepted and supported sustainable development practices as a means for preserving the quality of life in Austin (A. Petri, personal communication, September 29, 2015). The contrasting levels of religiousness and utilization of the sustainability moniker to organize and engage in relevant policy development and implementation between Austin and Fort Worth supported the theory identified in the literature that more progressive cities engaged in more sustainability planning than less progressive cities. The literature also suggested that more progressive cities had higher levels of income, education, and nontraditional households than less progressive cities (DeLeon & Naff, 2004, Sharp, 2005b). The percentages of each of the indicators were greater in Austin than Fort Worth for every year between 2005 and 2013.

Despite Austin's leadership and commitment to sustainability, its planning structure was extremely redundant and decentralized with the exclusive use of individualized neighborhood and master plans, until the 2012 Imagine Austin comprehensive plan was adopted. Conversely, the planning structure in Fort Worth was extremely centralized and systematic with a baseline city comprehensive plan established in 2000 and annual mandated updates every year. The review of the 2005 to 2013 planning documents identified 17 plans and 131 relevant sustainable built environment policies in Austin and 112 policies in Fort Worth. 66 of the 112 policies, or 59%, were scored as commitments in Fort Worth compared to the 64 out of 131, or 49%, in Austin. The overall sustainability commitment score, based on the content analysis methodology established in Chapter 3, in Fort Worth was 178 and 198 in Austin, representing nearly an 11% difference.

The transportation and land use categories contained the most policies in both cities. The highest percentages of commitment-level policies in Fort Worth were in the transit-oriented development, bike and pedestrian opportunities, and zoning sub-categories; compared to transportation accessibility, parks, trails and green space, and zoning sub-categories in Austin. The evidence identified through the policy analysis across the nine-year period had conflicting results in each city. The increases and decreases in city revenues year over year between 2005 and 2013 coincided with policy development, unlike Austin where there was no apparent pattern linking fluctuations in revenues with new policies (Paterson & Saha, 2010). Also, a connection between annual unemployment and poverty rates with the development of sustainable built environment policies within those same years was not identified. The poverty rate was lower in Fort Worth than Austin five out of the nine years, however Austin had a larger number of sustainable built environment policies. Conversely, the unemployment rate in Austin was significantly lower than Fort Worth each year between 2005 and 2013. Based on the analysis, the following indicators appeared to be significant for predicting the level of progressiveness of a city and the impact on sustainable policy development: nontraditional lifestyle and gender roles; percentage of workforce in professional, scientific, and technical fields; percentage of unmarried same-sex households, and level of education. Income level, city revenue base, unemployment rate, and poverty rate did not appear to contribute to understanding the progressiveness of a city and its political culture. Through the interviews and results of the policy analysis, the evidence supported the research theory that political culture influenced the development of sustainable built environment policies.

As noted in the individual city case reports, there did not appear to be a specific connection between the years sustainable built environment policies were developed and the corresponding outcomes for that same year. This could be due to a delay between policy adoption and implementation. When examining and comparing the differences in the averages between Fort Worth and Austin in Table 6.5, the majority of the results supported the research theory. All of the built environment outcomes, except miles of pedestrian and bike trails and rail ridership, were more prevalent in the City of Austin than the City of Fort Worth. Given that Austin also had a larger total sustainability commitment score over the nine years than Fort Worth, the theory that more sustainable built environment commitment policies resulted in greater outcomes was supported.

The third case study research theory argued that cities with more sustainable built environment outcomes resulted in better air quality. It became clear from the data that examining the influence of climate and meteorological elements on air pollution was problematic with annual averages because the daily weather events and measurements appeared to equalize over the course of the year. As stated previously, the majority of the sustainable built environment outcomes increased each year, which had no apparent connections to the fluctuations in air quality with each city. Although, there was no identifiable pattern between outcomes and air quality from year to year, there were collective differences between the two cities. According to the data, the 2005 to 2013 average air quality in Austin was better than Fort Worth and the majority of the regional and national averages. Additionally, the values of all the sustainable built environment variables, except rail ridership and pedestrian and bike trails were more prevalent in Austin. These anomalies cold be the result of the newness of rail opportunities in Austin and the lack of consideration given to the total land area of the city in relation to the miles of trails. Another potential consideration to the miles of pedestrian and bike lanes could be adjusting for the actual usage for commuting. Also, given that rail was established in Austin ten years after Fort Worth, it was difficult to determine how this particular indicator would influence air quality over the long term. The nine-year average difference in VMT between Fort Worth and Austin was 0.7%, with an average of 134,080 more annual miles in Austin. However, the higher numbers in Austin could have been due to a larger population than Fort Worth.

The final case study research theory assessed was the connection between poor air quality and asthma. The same was true for this case theory as with the other case study theories that there was not a direct correlation within each year. The changes in the number of asthma hospital discharges did not relate to the corresponding air quality measurements year over year between 2005 and 2013. However, when the asthma data was examined at the zip code level in Austin it was clear that the zip codes with the greatest number of asthma cases were located near or adjacent to a major highway or rail line, which supported the research regarding the impact of transportation emissions on air quality. Given the vast quantities of existing research connecting air quality and asthma, the lack of identified linkages between the corresponding data in Fort Worth indicated the potential presence of additional influencers. Unlike Austin, Fort Worth was never in compliance with the EPA 8-hour ozone standard and only had an average of 40% of good air quality days in a year between 2005 and 2013, compared to the 70% in Austin. The annual variances in air quality may not have been significant enough to influence the number of asthma cases. Also, daily weather conditions and events could impact air quality and asthma in a more targeted and localized manner, personal health and genetics could be more influential to the prevalence of asthma, or more explanatory variables were necessary, like an analysis of the structural elements of the built environment. Indoor air quality may also be the cause of more asthma episodes. Fort Worth averaged 852 asthma cases per year, compared to the 616 average asthma cases in Austin. Although there did not appear to be a relationship between the annual fluctuations in air quality and resultant numbers of asthma cases within an individual city, there did appear to be a direct relationship between cities. In every year between 2005 and 2013 In every year between 2005 and 2013 Austin had superior air quality to Fort Worth and fewer cases of asthma. This occurrence could possibly support the case study theory that better air quality resulted in fewer cases of asthma. However, this was only true when comparing cases, not within each city report. A few possible explanations for this occurrence include, that cases of asthma were not responsive to minor changes in air quality, patterns were unidentifiable through the use of annualized data, or there were other influential variables unaccounted for that were more prevalent in Austin than Fort Worth. Additional research is necessary in order to validate these results or identify other influencers.

Each of the above sections examined the research questions independently, however in order to identify any potential connections all of the available data needed to be analyzed holistically. In an effort to identify any potential patterns and variations over time the percentage change was calculated for 2005 to 2009 and 2009 to 2013 and displayed graphically on maps of Fort Worth and Austin with roads, rail lines, and green space (see Figures 4.8 and 5.8). The three zip codes in Fort Worth with the largest number of inpatient asthma cases were 76119, 76112, and 76133, which also had large quantities of zoned residential land uses. Austin zip codes 78723, 78753, and 78745 had the most reported asthma cases. Zip code 78745 also had the largest quantity of zoned residential land uses and the 5th most commercial and industrial uses. Therefore, there may be a connection between the residential and commercial populations in the zip code and the number of asthma cases, although given the proximity of the zip codes in Austin reporting the most asthma cases to a major highway and rail lines, it was more likely that the impact on air quality in that area was from transportation emissions and production. Both cities had a total of 29 zip codes that reported asthma cases between 2005 and 2013. There was no apparent pattern between the number of asthma cases and the age of building stock, census block density, or floor to area ratio of buildings within the zip codes. Additionally, the number of asthma cases each year did not coincide with increases or decreases in the sustainable built environment variables within each city. However, Austin did have greater sustainable built environment outcomes and fewer cases of asthma from 2005 to 2013.

Chapter 7

Recommendations and Conclusions

The overriding purpose of this research was to determine the influence of political culture on policy development and how policies translated to sustainable built environment outcomes, which have been identified in the literature to have an influence on air quality. Thus, further testing those claims to determine if the built environment actually effected air quality and how air quality impacted asthma. The case study framework developed by Yin (2014), provided the necessary leverage to evaluate the potential connections between the variables, as did the selection to conduct a multiple case study protocol between two Texas cities, Austin and Fort Worth. These cities were selected because of their similar demographics, including population size and median age, and because of their differences in political culture and sustainability reputation. The variation of the political culture between the two cities provided more depth to the research by testing the claims in the literature that more progressive cities engaged in sustainability planning more often than less progressive cities. Additionally, gauging the significance of a *green* reputation and determining if a reputation translated into more policies and outcomes.

The research design of the individual case studies included, the case study questions, propositions, unit of analysis, logic linking the data to propositions, and the criteria for interpreting the findings. The case study questions were:

1. How do select sustainable built environment outcomes impact air quality and respiratory health, and
2. How are these outcomes influenced?

In an effort to better explain and evaluate the case study questions additional propositions were identified to review, including the planning environment and policy development processes, along with the influence from political culture. All of the data was collected from 2005 to 2013, unless otherwise unavailable, and was either organized at the city or zip code level, depending on the availability of the data and preferred level of analysis. A review of all city-planning documents for 2005 to 2013 was conducted in order to identify relevant sustainable built environment policies. These policies were then scored, in accordance with the content analysis methodology outlined in Chapter 3, to evaluate the city's commitment level to planning and implementing sustainable built environment initiatives. Policy suggestions were given a score of 1, while commitment policies received a score of 2. Indicators aligned with the sustainable built environment policy categories; land use, buildings, and transportation, were collected for the same time span from various municipal and third party sources. Additionally, potentially influential variables, identified in the literature to gauge the political culture of a city, were collected in order to address any possible rival explanations for the results of the data analysis. Air quality and asthma variables, along with the supportive geographic, climatic, and meteorological elements, were collected for the time series. Interviews were also conducted with city representatives from planning and sustainability in order to gain a better understanding of the past, present and future state of sustainability planning in each city.

In addition to the research design protocol for the individual city case studies, Yin (2014) developed criteria for conducting multiple case studies, which included the following phases: (1) define and design phase, (2) prepare, collect and analyze phase, and (3) the analyze and conclude phase. In order to ensure consistency and replicable results, case study theories, much like research hypotheses, were established to provide potential explanations for the case study questions. The case study theories for Austin and Fort Worth were:

1. The political culture of a city influences sustainable built environment commitments.
2. Cities with greater commitments to sustainable built environment strategies result in larger corresponding outcomes.
3. Cities with more sustainable built environment outcomes have better air quality.
4. Cities with better air quality have lower cases of asthma.

These four theories were addressed in the individual case reports and the cross case report by organizing and analyzing the numerous data points for each city in order to either prove or disprove the theories. The inclusion of available regional and national statistics provided a comparative baseline for measuring and interpreting the data within a city. Additionally, the time series analysis, consisting of reviewing and attempting to connect the variations in the data year to year with the changes in the corresponding values of the indicators identified in the literature to have an impact, did not identify relationships for most of the theories within each city case report. Only with the comparative report between Fort Worth and Austin were the majority of the theories supported. In the cross-case analysis I expected that the City of Austin's sustainable built environment commitment score would be higher than the City of Fort Worth because the evidence supported a more liberal political culture in Austin. Additionally, I expected Austin to implement more sustainable built environment outcomes and in return have better air quality and lower incidences of asthma.

I expected to find that political culture influenced the level of commitment to sustainable built environment policies with higher levels of commitments resulting in more sustainable built environment outcomes in the city. This was true in the cross case report, evidenced by the higher percentages of nontraditional households and gender roles, same-sex partner households, level of education, and percentage of workforce in professional, scientific, and technical fields in Austin than Fort Worth. Additionally, Austin had almost 11% more policies than Fort Worth. Supporting the literature that select sustainable built environment strategies utilized in this study actually do affect air quality (Table 1.1.), I expected that cities with more bike lanes, parks, green spaces mixed-use and transit-oriented developments, LEED and Energy Star buildings and higher rates of density would have better air quality and fewer cases of asthma than cities with fewer of these select sustainable built environment outcomes. The individual city case reports did not indicate a relationship between the years sustainable built environment policies were enacted and the corresponding outcomes in that same year. However, all of the built environment outcomes, except miles of pedestrian and bike trails and rail ridership, were more prevalent in the City of Austin than the City of Fort Worth. Given that Austin also had a larger sustainability commitment score, the theory that more sustainable built environment commitment policies resulted in greater outcomes was supported, at least in the cross-case analysis.

The case study theory that the presence of more select sustainable built environment outcomes resulted in better air quality was not conclusive, given that in the individual case analysis the majority of the sustainable built environment outcomes increased each year despite minor fluctuations in the air quality measurements. Also, in the cross case analysis three out of the eleven citywide sustainable built environment variables were more prevalent in Fort Worth between 2005 and 2013 than Austin, while the air quality in Austin exceeded Fort Worth each year. These results indicated that there might be additional variables that influenced the impact of these select transportation indicators on air quality. One potential modification to the miles of pedestrian and bike trails could be adjusting for the actual usage for commuting and measuring in relation to the total land area of the city. Another, possible explanation for rail ridership being lower in Austin could be due to its relative infancy as compared to rail in Fort Worth. The variables identified in the air quality literature that could potentially influence pollutant measurements, included annual average precipitation, annual average temperature, annual average dew point and annual average wind speed, were collected for my research to address any possible rival explanations. However, no identifiable patterns or connections were detected in the analysis of the impact these variables had on the air quality measurements either in the individual city reports or in the cross case analysis. A possible explanation for the lack or correlation, especially given the extensive literature confirming their influence, could be the use of annual averages and the subsequent inability to capture the daily weather events that would appear to be essential to fully evaluating air quality within a city. Field studies and targeted experiments would assist in better understanding how the built environment and transportation patterns influence the delicate play between air pollution and weather to result in more effective developments of cities.

The last case study theory that better air quality resulted in fewer cases of asthma discharges, was again validated in the cross case report but not in the analysis within each city case reports. The changes in the number of asthma cases each year did not coincide with the changes in air quality, which could indicate that the fluctuations were not significant enough to result in an impact. Pollen counts were collected in order to address any possible rival explanations. However, there did not appear to be a direct connection between pollen counts and incidences of asthma within each city or between cities, represented by an average of 33% more asthma cases and 50% fewer pollen counts in Fort Worth than Austin. The lack of apparent influence between total pollen counts and asthma could be the difference in the amount of a specific tree, grass, or weed in one city over another, which could be responsible for triggering asthma symptoms. Although the changes in air quality and asthma were seemingly unconnected in the individual city analysis, the overall air quality in Austin was better and the number of asthma cases were fewer than in Fort Worth, demonstrated by an average percentage difference of 54% in the number of good air quality days and 32% in the number of asthma discharges. Both temperatures and dew point temperatures were lower in Fort Worth every year with an average percentage difference of 9.5% and 1.8%, respectively. Fort Worth had more precipitation than Austin in six out of the nine years and higher average wind speeds each year, represented by an average percentage difference in both measurements of 27%. According to this data, the air quality should be poorer in Austin than Fort Worth. These contradictory results could be the result of utilizing annual weather averages, as discussed in the previous section.

Sustainable built environment policies were more abundant in Austin than Fort Worth, which could indicate a potential correlation. However, there was not an apparent pattern between the number of asthma cases and the proportion of policy commitments versus suggestions. In addition to the overall larger occurrences of the majority of the citywide sustainable built environment outcomes existing in Austin, specific building, transportation and land use indicators could play a more significant role in explaining the lower number of asthma cases in Austin than Fort Worth. The per capita VMT was lower in Austin each year with an average percentage difference of 7%. An average of 7.7% of the land area in Austin was designated green space, compared to the 5% average in Fort Worth. The analysis of state land use code designations for each city identified a couple of key differences that could possibly explain the disparity in asthma cases between Fort Worth and Austin. Overall, 0.56% of the land uses in Fort Worth were designated utilities, compared to the 0.02% in Austin. Additionally, 0.24% of the designations in Austin were farm/ranch land, compared to the 0.06% in Fort Worth. Fort Worth also had a higher percentage of commercial/industrial designations than Austin, represented by 6.46% in Fort Worth and 3.95% in Austin. In the air quality analysis for Austin, there was a potential connection between ozone and utilities land use designations.

The average age of building stock between 2009 and 2013 in Fort Worth was eight years older than in Austin. Three percent more of the land parcels in Austin had buildings than the land parcels in Fort Worth. However, the average density of buildings was greater in Fort Worth, demonstrated by average floor to area ratios (FAR) of 0.22 in Fort Worth and 0.19 in Austin. The average census block density was also greater in Fort Worth with an average of 64.18 census blocks per zip code, compared to the 47.12 average in Austin. Greater census block density should result in greater connectivity, which could positively impact vehicle emissions and air quality (Frank, Stone & Bachman, 2000, as cited in Engelke & Frank, 2005; Hutch et al., 2011). Austin may have had a greater population density and slightly higher percentage of built land, however the actual development in Fort Worth was denser. The influence on how density impacts the number of asthma cases was inconclusive, given the conflicting relationship between sustainability and exposure to transportation emissions. This would be an area for future research, along with further examination as to variations of density within cities, influences from political culture, and the corresponding impact on asthma.

Though not in scope of this study, select demographics may also influence the number of asthma cases in a city from disparities in housing and other social sustainability issues. Given that the average income, unemployment rate, education level, ratio of males to females, and white population were all higher in Austin than Fort Worth, further research could assist in identifying direct correlations to asthma. In addition to the potential pattern of income and race within zip codes influencing the prevalence of asthma.

Conclusion

The results of this study corroborated the political culture literature claiming a correlation between embracing the sustainability moniker and the presence of select indicators with measuring the progressiveness of a city (DeLeon & Naff, 2004, Sharp, 2005ab). Although the connection between the political culture and resulting sustainable built environment policies was recognized in the individual case studies through the policy review and interviews, the relationship was more apparent in the cross-case analysis between Fort Worth and Austin.

The theory that more sustainability policy commitments would result in greater corresponding outcomes was partially supported by the evidence since a relationship was only detected when comparing cities over a collective period of time. However, the evidence did support the claims in literature that the adoption of sustainability policies was not indicative of implementation (Cooper & Vargas 2004; Holman, 2014; Lubell et al., 2009; Saha, 2009; Seasons, 2003). Given the inconclusive results, additional research would help to determine if the outcomes could be attributed to a delay between policy adoption and implementation.

The data in this research confirmed the importance of the geographical and climatological conditions on dispersion and dilution processes affecting air pollution (Cho & Choi, 2014). However, the use of annual data did not allow for proper analysis and development of explanations for the corresponding air quality measurements. Future air quality research should accommodate for daily weather occurrences. Additionally, the connection between air quality and land uses should be further explored, given that a connection was identified in the City of Austin case report and not in the City of Fort Worth report. Field studies examining the specific influences from the built environment on exposure to air pollution could better identify the significant sustainable development variables. Field studies would be most appropriate because of the polarizing views within the existing research regarding the locations within a city that resulted in the greatest exposure to air pollution (Frank & Engelke, 2005; Brunefreef, 2002).

Although there did not appear to be a connection between the number of yearly asthma hospital discharges and corresponding annual air quality measurements, the evidence did support an influence from population changes and proximity to major roads and rail lines. The lack of identifiable influence from air quality on asthma could be an indication of the significance of daily weather conditions influencing the dispersion and flow of air pollution, the individual exposure to bad air quality days, or the potential for personal health and genetics being more influential. It could also be indicative of missing explanatory variables, such as specific structural elements of the built environment, or a greater influence from indoor air quality versus outdoor air quality. Therefore, future research would be necessary in order to identify the significance of specific living conditions and housing structures on indoor air quality and asthma.

This exploratory case study identified targeted areas for future research. Gaining a better understanding of the influential relationships between these variables, not only has future policy and planning implications, but theoretical significance by challenging the beliefs regarding the environmental, economic and social benefits of sustainable built environment policies and practices. Further evaluation and expansion of the political culture research is necessary in order to better understand if and how the culture of a city can change or evolve. The literature regarding political change is minimal and has primarily focused on evaluating historical changes in select regimes and economic structures (Back, Keith, Khan, Shukra & Solomos, 2009; Brown & Gray, 1977; 1979; Girvin, 1993; Ishomuddin, 2014; Kristiansen, 2007; Mertes, 1994; Tosi & Vitale, 2009). It has also not included the new political culture indicators utilized to measure the progressiveness of the culture of today's societies (Gromala, Hoffmann-Martinot & Clark, 1998; Paterson & Saha, 2010; Sharp, 2005ab). However, the literature does note that the process is lengthy and arduous, requiring the modification of individual opinions and attitudes (Fulga, 2005). Better identifying processes that allow cities to actively engage in social or political change rather than political change being an involuntary result of something, would not only significantly contribute theoretically, but practically by improving efficiencies and allow for more effective city planning.

The relationship between policy development and implementation needs to be examined in order to identify more effective measurements and tools for improving outcomes and to better understand the gap between policy development and implementation, which could potentially elicit greater accountability from cities (Levy, 2013; Saha, 2009). Additionally, this case study research provided a more precise list of variables that can be used to conduct larger statistical studies for many cities in an effort to better target the specific sustainable built environment outcomes that impact air quality and asthma, which would ultimately improve resource efficiencies and significantly contribute to the theoretical basis for engaging and implementing sustainability within the built environment.

Given the apparent association between political culture, sustainable built environment policies and outcomes, cities, like Fort Worth, that have a less progressive culture would benefit from developing and implementing long-term strategies to change culture. Some of these strategies, identified and corroborated by the results of this study, could include recruitment of more professional and technical firms to the city; providing more educational opportunities and support; promoting work daycare programs; and ensuring nondiscrimination and equal opportunities regardless of sexual orientation among all local businesses. In cities like Austin that have a progressive political culture and have embraced sustainability as a core value, are challenged to make more substantial and transformative changes, not only in their city, but regionally (James, 2015). Austin should be a leader and an advocate for change in other cities, by providing important lessons learned and best practices. Austin needs to fully understand the various benefits and values, as well as consequences, of the sustainable built environment policies and outcomes. Therefore, instituting methodical assessments with the implementation strategies could provide the much-needed data to support or abandon particular initiatives in the future. The incorporation of implementation measurements and assessments within policies would ensure a more efficient and effective utilization of resources. Additionally, it is important for cities to fully understand the weather and climate characteristics of their city and how the built environment influences it. Future built environment developments should take into consideration the potential impacts to wind and temperatures before permits are issued.

Overall, understanding the affects of built environments and sustainable strategies on the environment and public health, as well as the nuances that influence outcomes within cities and between cities, adds to the theory of urban sustainability in a time when the concepts of sustainability are being called into question (James, 2015). Adapting and remodeling sustainability in lieu of adopting just another term appears to be the direction of the current urban sustainability literature (James, 2015). James (2015) states on the challenge to move beyond the triple-bottom line:

> Market-based sustainability practices continue to proclaim their own practical enlightenment while, in most cases, changing relatively little except the language of development. This false promise does all active institutions a disservice from municipalities and community-based organizations to ethically motivated corporations seeking to act differently. Unfortunately, the concept of resilience is fast entering the same well-lit narrow space. By contrast, the Circles of Sustainability approach takes the positive intention of the 'three pillars' phrase and for the first time locates that well-intentioned spirit in an integrated and generalizing framework that provides more than high-sounding words.

Therefore, evaluating the level of sustainability commitment and resulting outcomes is beneficial for the transparency and accountability of cities. Examining the influence from the political culture on sustainable policy development and implementation supports the new *Circles of Sustainability* methodology where "sustainability intersects with other social conditions" and the social context is at the forefront of all initiatives (James, 2015, p. xiv). This framework could be applied in future research evaluating city sustainability efforts and commitments. Additionally, examining the differences and evolutions of sustainability policy development and engagement between cities contribute to the theory and framework of urban sustainability transitions, which attempts to better explain and understand transformative changes to sustainability (Childers et al., 2014).

Appendix A

Database of Variables and Data: Fort Worth and Austin

CITY OF AUSTIN

Year	Demographic and Socioeconomic Variables									Political Culture Variables								
	Population	**Median Household Income**	**Unemployment Rate** *(population 16 years and older)*	**Median Age**	**Sex ratio** *(males per 100 females)*	***Race*** *(% of the population white alone)*	**Level of Education** *(% of population age 25 and older with a bachelor's degree of higher)*	**Marital Status** *(% of the population aged 15 and over never married)*	**Poverty Rate** *(% of population below poverty level)*	**Nontraditional Lifestyle** *(% of the population 35 and older never married - MALE/FEMALE)*		**Nonntraditional Gender Roles** *(% of women never married in labor force)*	**% of the population that affiliates with a religion**	**Level of conservatism of the population**	**% of workforce in professional, scientific, technical**	**% of unmarried same-sex partner households**	**City Revenue Base** *(total revenues per 100,000 population)*	**Government Structure** *(council-manager or mayor-council)*
2005	700,407	$43,731	7.00%	31.4	105.2	69.21%	44.00%	39.10%	18.10%	5.21%	3.54%	12.07%			10.10%	0.82%	$323,986	
2006	718,912	$47,212	6.10%	31.2	108.9	59.09%	42.90%	40.80%	17.70%	5.74%	3.61%	12.27%			9.71%	0.96%	$351,579	
2007	735,088	$48,966	5.10%	31.4	110.1	62.87%	42.50%	41.40%	17.50%	6.20%	3.61%	12.32%			10.42%	1.00%	$343,788	
2008	750,525	$51,372	5.10%	31.7	108.9	68.17%	42.10%	41.50%	17.00%	5.52%	3.99%	12.50%			11.35%	1.20%	$376,625	
2009	774,037	$50,132	7.50%	31.2	109.1	69.09%	43.90%	41.90%	18.40%	5.81%	3.68%	12.49%	Study used for case selection	Study used for case selection	10.32%	1.10%	$357,787	Council-Manager
2010	790,390	$47,434	8.40%	30.9	102.5	71.31%	43.70%	44.10%	20.80%	5.87%	3.79%	13.81%			10.20%	0.99%	$340,786	
2011	812,025	$49,987	8.30%	31.3	101.9	70.20%	44.50%	43.80%	20.30%	5.44%	4.26%	13.82%			10.49%	0.62%	$359,451	
2012	824,205	$52,453	7.10%	31.7	101.6	76.89%	45.40%	44.00%	20.30%	5.87%	4.02%	14.59%			11.03%	1.20%	$351,972	
2013	842,750	$56,351	5.90%	32	101	77.74%	46.70%	44.20%	17.80%	6.18%	4.47%	14.40%			12.21%	0.99%	$376,469	

Sustainable Built Environment Variables

Year	Land Uses					Transportation						Buildings			
	Population Density per Square Mile *(Total Population/Land Area)*	**Land Uses (State Land Use Codes)**	**Acres of Green Space** *(City-owned Park Land)*	**Census Block Density**	**# of Parks**	**Bus Ridership**	**Rail Ridership** (between Austin and Leander)	**Miles of Bike Lanes**	**Pedestrian & Bike Trails (miles)**	**Annual Vehichle Miles Traveled**	**# of Transit-oriented Developments**	**Age of Building Stock**	**Density of Buildings (Floor to Area Ratio)**	**# of LEED certified Buildings**	**# of Energy Star rated Buildings**
2005	2376.0	Zip Code	14,806.0826	Zip Code	255	34,002,836	no rail	108.6	no data	18,382,951	0	Zip Code	Zip Code	1	5
2006	2426.3	Level Data	15,037.7814	Level Data	258	34,253,479	no rail	111.6	no data	18,751,992	0	Level Data	Level Data	7	0
2007	2465.3		15,043.9377		259	33,133,394	no rail	114.6	no data	19,670,072	0			2	32
2008	2498.0		15,238.6969		265	34,258,400	no rail	117.6	49.2	19,792,745	0			6	45
2009	2559.3		15,309.6010		268	31,594,628	no rail	133.9	49.5	19,663,904	0			15	32
2010	2565.4		15,435.2485		272	30,748,887	176,433	146.3	49.5	19,838,530	9			11	53
2011	2633.2		15,473.0175		276	31,688,766	439,294	165.1	50	19,653,383	9			20	27
2012	2587.3		15,547.2294		279	33,058,122	650,923	189	51.9	20,029,585	9			23	38
2013	2625.8		15,630.8710		283	32,735,981	769,264	206.5	52.8	20,440,893	9			25	47

Air Quality Variables

Year	Geographical		Climatological & Meteorological				Air Quality				Asthma Variables		
	City Elevation	**Topography**	**Yearly Average: Dew Point Temperature** (degrees Fahrenheit) Bergstrom Site	**Annual Precipitation** (inches)	**Yearly Average: Temperature** (degrees Fahrenheit) Audoban / Northwest Sites	**Yearly Average: Wind Speed** (mph) Audobon / Northwest Sites	**# of Days when Air Quality was GOOD**	**Yearly Average: Compliance w/ 8hr EPA Ozone standard** (parts per billion) Audobon /Northwest Sites	**Yearly Average: Carbon Monoxide** (parts per million) Northwest Site	**Design Value (3yr average): PM-2.5** (micrograms per cubic meter) Audoban / Northwest Sites	**Annual # of Inpatient Hospital Discharges**	**Annual Average Pollen Count**	**Sustainability Commitment Score**
2005			56.8	21.45	67.6 / 69.1	5.7 / 6.0	227	80 / 82	0.1	8.13 / 9.17	410	369	10
2006			52.3	27.23	68.9 / 70	6.2 / 6.4	241	81 / 82	0.1	8.37 / 9.53	493	749	2
2007			56.6	45.91	65.9 / 68.8	5.6 / 5.8	256	77 / 80	0.1	9.13 / 10.03	584	303	30
2008			52.8	15.98	68.1 / 68.9	6.4 / 6.7	261	74 / 77	0.1	8.93 / 9.73	635	489	29
2009	489 Feet	GIS MAPS	54.1	34.11	67.9 / 68.6	6.2 / 6.5	261	69 / 75	0.1	8.77 / 9.43	642	529	7
2010			55.1	28.42	66.8 / 68	5.6 / 5.9	279	69 / 74	0.1	8.30 / 9.13	649	329	27
2011			53.6	16.9	69.6 / 70.4	6.0 / 6.4	238	70 / 75	0.1	8.07 / 9.07	706	285	7
2012			57.0	35.14	69.5 / 70	5.8 / 5.8	263	73 / 74	0.1	7.87 / 8.93	801	99	58
2013			54.8	37.04	66.6 / 67.7	6.1 / 6.2	269	73 / 72	0.1	7.83 / 8.63	626	231	28

CITY OF FORT WORTH

Demographic and Socioeconomic Variables

Year	Population	Median Household Income	Unemployment Rate *(population 16 years and older)*	Median Age	Sex ratio *(males per 100 females)*	Race *(% of the population white alone)*	Level of Education *(% of population age 25 and older with a bachelor's degree of higher)*	Marital Status *(% of the population aged 15 and over never married)*	Poverty Rate *(% of population below poverty level)*
2005	624,850	$40,663	7.70%	30.9	100	60.78%	25.10%	29.60%	18.80%
2006	664,100	$45,276	7.70%	32.3	101.9	60.76%	24.40%	31.80%	16.60%
2007	686,850	$47,104	6.00%	31.7	98.3	63.09%	24.80%	31.30%	16.20%
2008	702,850	$48,870	6.60%	31.6	100.4	65.33%	24.60%	31.30%	16.60%
2009	720,250	$47,634	9.70%	30.8	96.4	62.44%	24.90%	32.00%	19.00%
2010	741,206	$48,224	10.70%	31.5	97.5	62.66%	26.10%	33.10%	17.90%
2011	748,450	$47,399	10.80%	31.4	91.6	70.25%	26.10%	33.50%	21.80%
2012	757,810	$50,750	7.90%	31.9	95.3	67.96%	25.80%	33.50%	18.60%
2013	767,560	$52,430	7.50%	31.6	96.4	62.07%	28.20%	34.00%	20.10%

Sustainable Built Environment Variables

Year	Land Uses					Transportation						Buildings			
	Population Density per Square Mile *(Total Population/Land Area)*	Land Uses (State Land Use Codes)	Acres of Green Space *(City-owned Park Land)*	Census Block Density	# of Parks	Bus Ridership	Rail Ridership (between FTW and Dallas)	Miles of Bike Lanes	Pedestrian & Bike Trails (miles)	Annual Vehichle Miles Traveled	# of Transit-oriented Developments	Age of Building Stock	Density of Buildings (Floor to Area Ratio)	# of LEED certified Buildings	# of Energy Star rated Buildings
2005	1800.2	Zip Code	10,851.6903	Zip Code	226	399,057	2,154,400	0	no data	19,140,833	3	Zip Code	Zip Code	0	2
2006	1909.4	Level Data	10,898.6153	Level Data	229	437,475	2,409,851	9.3	no data	18,034,950	3	Level Data	Level Data	0	0
2007	1972.6		10,956.7840		234	440,786	2,507,705	9.3	49.67	18,705,720	3			1	4
2008	2011.0		11,056.6684		241	449,989	2,746,992	9.3	58.1	19,391,361	3			0	4
2009	2057.9		11,331.7289		249	439,253	2,789,030	11.38	60.44	19,858,367	3			3	5
2010	2112.9		11,372.1342		252	461,558	2,469,215	11.38	61.11	19,550,769	3			9	2
2011	2130.5		11,700.9391		258	485,072	2,425,335	18.16	64.4	19,900,434	3			7	6
2012	2152.3		11,719.6682		260	543,357	2,252,140	32.71	64.93	20,213,977	3			10	4
2013	2171.9		11,733.1195		261	522,829	2,092,782	48.62	71.33	20,220,922	3			64	10

Political Culture Variables

Year	Nontraditional Lifestyle *(% of the population 35 and older never married - MALE/FEMALE)*		Nonntraditional Gender Roles *(% of women never married in labor force)*	% of the population that affiliates with a religion	Level of conservatism of the population	% of workforce in professional, scientific, technical	% of unmarried same-sex partner households	City Revenue Base *(total revenues per 100,000 population)*	Government Structure *(council-manager or mayor-council)*
2005	3.06%	2.29%	8.89%			4.65%	0.90%	$161,241	
2006	4.04%	3.24%	9.01%			4.22%	1.00%	$174,718	
2007	3.76%	3.30%	8.91%			4.44%	0.59%	$171,594	
2008	4.19%	2.86%	8.31%			4.65%	0.36%	$172,064	
2009	3.69%	3.17%	9.48%	Study used for case selection	Study used for case selection	4.66%	0.51%	$166,457	Council-Manager
2010	4.31%	3.33%	8.93%			5.37%	0.46%	$165,215	
2011	3.96%	3.87%	10.90%			5.53%	0.30%	$171,867	
2012	3.71%	3.35%	9.93%			5.37%	0.26%	$170,196	
2013	3.51%	4.00%	11.53%			4.81%	0.39%	$175,342	

Air Quality Variables / Asthma Variables

Year	Geographical		Climatological & Meteorological				Air Quality				Asthma Variables		
	City Elevation	Topography	Yearly Average: Dew Point Temperature (degrees Fahrenheit)	Annual Precipitation (inches)	Yearly Average: Temperature (degrees Fahrenheit)	Yearly Average: Wind Speed (mph)	# of Days when Air Quality was GOOD	Yearly Average: Compliance w/ 8hr EPA Ozone standard (parts per billion)	Yearly Average: Carbon Monoxide (parts per million)	Design Value (3yr average): PM-2.5 (micrograms per cubic meter)	Annual # of Inpatient Hospital Discharges	Annual Average Pollen Count	Sustainability Commitment Score
2005			50.2	15.97	67.5	7.4	107	95	0.3	11.8184	835	151	84
2006			48.3	32.95	68.8	8.1	118	94	0.3	11.2453	860	*134	2
2007			51.3	51.29	65.7	7.3	144	91	0.3	11.2386	915	176	10
2008			48.2	28.04	66.7	8.5	150	83	0.3	10.7004	837	184	7
2009	653 Feet	GIS MAPS	50.2	45.28	66.2	8.1	171	79	0.2	10.3759	969	205	14
2010			50.3	37.55	66.5	7.8	186	78	0.2	Invalid Data	797	201	16
2011			49.3	24.74	68.8	8.5	146	81	0.2	10.1788	796	183	0
2012			51.6	28.33	68.8	7.9	146	79	0.3	10.2445	840	235	45
2013			48.8	31.01	66	8	156	81	0.2	10.5086	819	279	0

Appendix B

Austin and Fort Worth Zip Codes

City of Fort Worth

76102	76111	76123	76140
76103	76112	76126	76148
76104	76114	76129	76155
76105	76115	76131	76164
76106	76116	76132	76177 *(Tarrant County)*
76107	76118	76133	76177 *(Denton County)*
76108	76119	76134	76179
76109	76120	76135	
76110	76122	76137	

City of Austin

78701	78726	78736	78750 *(Travis County)*
78702	78727 *(Travis County)*	78737 *(Hays County)*	78750 *(Williamson County)*
78703	78727 *(Williamson County)*	78738	78751
78704	78728 *(Travis County)*	78739 *(Travis County)*	78752
78705	78728 *(Williamson County)*	78741	78753
78717 *(Williamson County)*	78729 *(Williamson County)*	78742	78754
78719	78730	78744	78756
78721	78731	78745	78757
78722	78732	78746	78758
78723	78733	78747	78759 *(Travis County)*
78724	78734	78748	78759 *(Williamson County)*
78725	78735	78749	

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Appendix C

Interview transcripts and written responses (Fort Worth & Austin)

Dana Burghdoff, City of Fort Worth

DB: Me your background so I have a sense of-

MT: Sure.

DB: Your lens of where you come from in terms of Bachelor's or under ... Or [crosstalk 00:00:05] or anything like that.

MT: Well my undergrad was in ... I had a BBA in Management. Then my Master's is in Information Systems Management.

DB: Oh, wow!

MT: I know. Then I'm like ... But I'm the director of operations of the UTA Fort Worth campus here in downtown.

DB: Okay.

MT: My experience and interests lie within sustainability, operations, you know, all that. I'm like, okay, when I'm looking at a PhD, let me actually kind of hone in on something that I'm passionate about.

DB: Yeah.

MT: That's what brought me to the Urban Planning and the Focus on Sustainability.

DB: Cool.

MT: Yeah.

DB: Are you familiar with ... I'm going to mess it up because I haven't been that ... Associated with it for that long. But is it CDP which is the international organization that collects data on climate change and sustainability efforts for cities around the country or around the [crosstalk 00:00:56]

MT: No.

DB: If you don't mind, I want to look that up while we're talking.

MT: Yeah, please.

DB: Because when you mentioned information systems, I thought, "Ooh, she might, you know ... This might be an interesting ... Organization."

MT: Yeah.

DB: CDP ... It's one of those you know, it's like chaos theory.

MT: Yeah.

DB: Okay. ... I think this is it. Yeah.

MT: Okay.

DB: CDP.net will get you there.

MT: Okay.

DB: Driving sustainable economies. It's free for cities, at least so far it had been, for us to join. We don't have a lot to report, because unlike some of the other more progressive cities in the country and in the world, we don't have a, and have not had a specific focus on greenhouse gas emission reductions, per se.

MT: Right.

DB: We've had some energy consumption reduction goals, but we've not done anything that was ...

MT: Targeted.

DB: Targeted even overtly or covertly.

MT: Mm-hmm (affirmative)

DB: Worded this way in terms of specific climate goals. However, we did submit information just so that they could have their data base. But let me come to the ... I just wanted you to be aware of it because-

MT: Yeah.

DB: It looks like it could be an interesting resource. What I don't know is if they share-

MT: Share.

DB: Their services, or if they're, you know.

MT: Yeah.

DB: I didn't get that sense that it was really as a for-profit kind of enterprise.

MT: Mm-hmm (affirmative)

DB: Anyway, there's information in here about who they are-

MT: I appreciate that.

DB: And what they do. It just occurred to me as ...

MT: Yeah.

DB: There might be some interesting ideas here in terms of what-

MT: How to look at the different ...

DB: Yeah, how to look at the different-

MT: See what's on there.

DB: Comparative analysis among communities.

MT: Sure.

DB: Okay.

MT: When you said that there's overtly, you know, policies or anything that's driving you know, the climate issue or the greenhouse gas ...

DB: We still have a lot of policies that get us towards that goal, but it's-

MT: But what's the motivation behind those policies. Like why does it ... Why does the city involve in energy reduction, then?

DB: Sure. I would say that there's wide spread acceptance of the need to improve air quality. That's been an issue for the region, the COG that our central Texas region, the Council of Governments has been a, I'd say very active in educating its member cities and counties about the air quality issues. They've been tracking it, and having to submit the implementation plans to the state for years. There's, you know, I would say much more acceptance about that issue, and about understanding that, okay, it comes from transportation, it comes from buildings, it comes from, you know, non-point sources. It comes from construction equipment, whatever. I'm not familiar with all the factors.

MT: Right.

DB: But that has been discussed for a long time. I think that's one, that there's a broad understanding of the need to improve air quality while improving, or keeping up with population growth to improve mobility. We've had as a city strategic goal for a long time, to improve mobility and air quality, kind of combined. Improve mobility and air quality, with congestion being, you know, another source of air quality issues. Improving air quality is certainly a sustainability issue and a climate change issue, but it's just always been worded-

MT: Packaged differently.

DB: As air quality. Yeah. It's always been labeled as air quality improvement.

MT: Well, it's less ...

DB: Yes.

MT: More people can swallow that though.

DB: Yes. It doesn't bring to mind ...

MT: To [inaudible 00:04:47]

DB: Any controversy.

MT: Right.

DB: There's been so much air quality testing. There's been so much modeling for so many years.

MT: No one's going to say, "No, I want bad air quality."

DB: Yeah. Exactly. "I want children and elderly to suffer."

MT: Yeah.

DB: That's just, yeah, the frail and yeah. There's been broad acceptance of that. I think that's one, is air quality improvement has been an important driver. Then, the other piece has been the argument ... It hasn't been used as much in terms of common language around the community, but there's also a broad acceptance of the idea of being efficient and using government resources efficiently. That's the other piece that we can ... That we talk about quite a bit is that it's more efficient for us to have development in places where we already have infrastructure. Rather than having to extend infrastructure to new, you know, new locations, particularly those that are well beyond our current infrastructure limits.

MT: Gotcha.

DB: So that's the idea of an efficiency and improving air quality are probably two that are strong. The other one that's very strong for us ... Although it hasn't, in my observations, hasn't led to any actions, yet, although I think it can. There hasn't been a problem, I guess, is water quality. Water quality is also another item that resonates with our residents and with everybody. Since our, you know, our lakes are our water supply-

MT: It's going to be an issue for everybody.

DB: Then that's also broadly accepted that we need to make sure we have good quality water. We don't tend to, in my experience, and this is somewhat new for us. We have focused primarily on our water treatment plants, making sure they're the best they can be. They really are. They're really wonderful.

MT: Yeah.

DB: If a treatment plant can be wonderful.

MT: Yeah.

DB: They're really very progressive and very thorough, I guess, I don't know if that is the right way to describe it. We have wonderful water quality in Fort Worth. It's only been in recent years where the Council of Governments has engaged with communities to think about water quality and how it's affected from the entire watershed through runoff-

MT: Right.

DB: Primarily. We did our first, for the city of Fort Worth specifically, did our first what we call the ... Well, we didn't come up with the term, but the Green Print which was for the Lake Worth watershed, which is the body of water that we control with the Tarrant Regional Water District. The Green Print includes ... The watershed extends well into Parker County. It's northwest Fort Worth and well into Parker County. We just briefed the city council on that, those final results, final action plan, yesterday. It was pretty well received. Obviously, there's always worry about if you're trying to come up with any methods that would infringe on a property owner's rights, and how they use their land. It's focused on voluntary efforts, of course. But just raising that issue is something that we've focused quite a lot in our history with water quantity and just having a water supply-

MT: Right.

DB: For our growing population. Then we've looked at water quality again, from a treatment standpoint. But we really haven't talked much about whether it's erodable soils, you know, just filling the lakes or whatever chemicals or other items I'm ignorant about all that.

MT: Got you. No. I'm no different.

DB: Our water department's very well versed on the different phosphorous or something. I don't know. Other, you know-

MT: Yeah. That sounded good.

DB: Yeah. Yeah. Whatever.

MT: When did the city first engage in sustainability, even if it wasn't really, truly called sustainability?

DB: Well, I don't know that I would be able to say for sure, the first. I started with the city in 1999, so my sense is of course based on the time that I've been here. Fernando Costa, who is now our assistant city manager, when he was hired the year before, 1998, he worked with the community leaders to recognize that we needed a comprehensive plan. The Comprehensive Plan is full of policies that relate to sustainability.

MT: Right.

DB: But we didn't always use that word or terms. It was very much about revitalizing our central city and ensuring that we're taking advantage of existing infrastructure, you know, getting return on investment. That was one big theme, was central city revitalization. Another was the concept of growth centers, which we have mixed use, and industrial. Areas where we wanted to concentrate development in a way that both accounted to growth, but also protected single family neighborhoods from encroachment and provided for more efficient delivery of services, whether it was transportation or other infrastructure.

MT: Okay.

DB: Or just city facilities, what have you. That concept, you know, mixed use growth centers, central city revitalization. Then, another one that's ... I think it's a sustainability measure, was trying to focus more directly on ... In fact, the words we used were "Celebrating the Trinity River." That has a lot to do with indirectly thinking about water quality for the river. But also, thinking of it as an existing amenity that we need to take advantage of. Because so much of the river, and the interesting parts of the river are in the central city, it feeds into supporting central city revitalization.

MT: Preserving as natural resources.

DB: Preserving the natural resources as an amenity. Then also encouraging appropriate development as opposed to just having parking lots or auto salvage yards.

MT: I mean that's one thing ... Yeah.

DB: Backing up to the river. Which we still have quite a bit of, but it's getting better.

MT: That's one thing I've noticed while looking through the comp plans, is that, you know, there's a lot of focus on revitalization and the growth and how it ... Infill and that kind of thing. But not a lot talking about the actual 'how to build,' the buildings themselves, like whether it's green building or ... That's seems barely I touched on.

DB: Yeah. I agree. There, the ... Let me think. In terms of the city, we've been ... It's only been in the last probably five years or so, where we've looked at encouraging building efficiency for buildings beyond what the city owns. We've, luckily, for many years ... I don't remember the first year there was state legislation that required that we reduce energy consumption by, I think it was 5% per year. I mean, not per year, but there was some goal. Sam Steele ... I don't know if you've met him or know Sam ...

MT: Mm-hmm (affirmative)

DB: He's another wealth of-

MT: Yeah. He sent me a-

DB: Knowledge and wealth of ...

MT: Pretty substantial email.

DB: Okay. Yeah.

MT: Yeah.

DB: Sam has worked for years on energy conservation initiatives for existing buildings and for new construction. The other interesting this is that, philosophically, there's been ... I don't know. Let me think how to put it. That there's been a philosophy of wanting to encourage energy reduction, but not necessarily any desire to certify, through LEED, you know, the U.S. Building Council, or any other organizations to necessarily put the label on it. It's been a very much a functional approach of you know, we'll measure and we'll achieve the targets, but we don't need to go you know, spend the time and or resources to get the certification and put the label on it. Part of that is just staff, you know, just focusing on what they need to do-

MT: For sure.

DB: And not go and needing to go get the accolade, if you will. Then also, there hadn't been any ... It also comes from [error 00:14:00] in council, of course. If they're interested and want a report on, "Oh, hey we'd like to have green buildings, and be able to tout that we have green buildings in Fort Worth. Give us a report." You know, that you are what you measure.

MT: Right.

DB: There's not been any demand from our leadership to-

MT: Report any of that.

DB: Report on specifically what are green buildings and what are not, other than just showing that we're saving tax payers' dollars. Very much back to the-

MT: But it's all focused ...

DB: It's back to the efficiency, you know, air quality and efficiency, not things that might sound flowery or you know ...

MT: But it all really focuses on energy.

DB: Yes.

MT: Not necessarily ... Like does it translate to waste and all these other aspects of like, construction waste?

DB: Yes. Yes.

MT: You know, all the other things that like LEED-

DB: Right.

MT: Would actually kind of regulate?

DB: Would get into. Right. I don't know as much, again for city buildings. I don't know as much about what all they've done.

MT: Right.

DB: I know very much it's been systems. I don't know enough about the operational side.

MT: Got you.

DB: I don't about the construction side. My guess is, probably not, since I haven't heard much about it.

MT: Yeah.

DB: But then, similarly, there's really not been, up until probably five years ago, any, other than just allowing it ... You know, we allow, of course, green buildings, and we're happy to have them come in. But we haven't done anything to incentivize it or educate folks about it until the last five years. That was through, again, through Sam Steele and Sam Gunderson doing the Better Buildings Challenge.

MT: Right.

DB: They can tell you more about that. I understand that's through the Department of Energy. There's some different partners that partner organizations, you know, the utility companies as well as other major campus folks to have some commitments to ... But again, that's you know, related to energy consumption.

MT: Got you.

DB: And I don't know, I'm not as familiar with it to know if it gets into the full spectrum-

MT: The full range-

DB: Yeah. The full life cycle of the building in terms of construction through-

MT: Got you.

DB: Through demolition. Well, hopefully not demolition, but ...

MT: Yeah. It happens sometimes as a measure. Yeah.

DB: I know ... You may know Brandy O'Quinn.

MT: Mm-hmm (affirmative)

DB: I know Brandy has brought up, just because of her going through the UTA program-

MT: Right.

DB: A number of different ideas and initiatives that I think she's talked about with some of the other city departments, and or the mayor and council. Ideas that, you know, she's suggested we look into. One of those is building and construction waste. To my knowledge, there hasn't been any traction on that. That doesn't mean that-

MT: There won't be.

DB: There couldn't or wouldn't or ... Yeah. But she would be able to tell you a little bit more about, you know, that specific idea.

MT: Okay.

DB: Of what she's heard, or what she was hearing. Now, that may have been she, because she's working so heavily now with the Blue Zones Initiative, the Blue Zones Project, as the policy manager, I don't know if she's even been able to think-

MT: That again.

DB: About anything else, because that's not, as far as I know, one of the strategies that we're working on for the different committees-

MT: Right. Okay.

DB: Different policy committees.

MT: Are there any barriers that you can think of that the city has experienced with sustainable development or pursuing sustainability, or anything like that? Whether in the planning stage or implementation.

DB: Sure. The only barriers are typical. The barriers would be if it's something that's going to cost us more ... If it's just going to cost us more, period, then that's a challenge.

MT: Right.

DB: If it's going to cost us more up front, but then we can recoup our costs you know, as with green buildings ... It may cost a little more to build, but we should recoup it over 10 years or 20 years of operations. Usually the city council's been supportive of those kinds of things. They haven't ... Again, I don't know that it's even presented to them in a way of, "Okay, we're going to build this library, but we're going to make it green. Therefore, it's 15% more to construct-

MT: Right.

DB: "But here's the ..." It's really just, "Here's the cost estimate for the library. "We're going to make it green because ..." You know, the architects that are working on it-

MT: It makes sense. Right.

DB: Just do it. I don't know that there's been any actual ...

MT: Well, sometimes, it's easier not to wave the green flag.

DB: Right. Right. I don't know that it's necessarily because they're afraid of, you know, that the staff is worried about push back. It's just I don't know that they've needed to, that the council hasn't been looking into it or asking some of those detail questions.

MT: Got you.

DB: Again, either not necessarily wanting to know if it's green, or not necessarily caring whether it is. I'm not saying they don't care. It hasn't risen to the level of "We want to showcase this,

MT: Got you.

DB: "and therefore we want to ..."

MT: Why do you think that is? Is it just the culture, you think, of Fort Worth?

DB: Yeah. I think it's the culture of Fort Worth. I do think there are individual members who are interested in that. I think for some of the council members who might be arguably more progressive about policy, they also have challenges with low income residents and other things where a green building for a new office ... You know, a new office building that's green building isn't as important as trying to serve ...

MT: Yeah.

DB: You know, just that sometimes the ... Or transportation, or just police, and crime, and safety, those kinds of things, that I think priorities may be, you know, part of that. That it's great that it's happening, but it's not the main messages.

MT: Okay. Got you.

DB: It hasn't risen to that level.

MT: Do you think it's an economic development issue, like with bringing in new ... Like when the city, you know ... When you're describing what you're going to allow for development, do you think there's a hindrance for doing that, and having stronger regulations for green buildings, because you're ... The fear of impeding economic development, or ...

DB: Mmm. I see what you mean. I'm sure that could be part of it. Going back to, you asked me about impediment. One is cost. But related to that is either cost to the city or extra cost to the private sector. Or just extra hoops to jump through. They're very cautious. That is cultural. They're very cautious about adding regulations to property owners and developers. ... Very much, there's a desire for Fort Worth to be perceived as a developer friendly community. ... There's certainly not a barrier in terms of particularly any of the national companies that come in with ... GE was coming in to do their plant.

MT: Right.

DB: They can make it as green as they want and we'll just get out of the way.

MT: But they could make it not as green as they want it, and it would be ...

DB: Right. We would be just be happy that the job's done.

MT: Got you.

DB: Yeah.

MT: Would you say that sustainability is a priority at all for the city, or do you think that ...

DB: Well, it is one of the ... Let's see if I can pull that out if I need to read it. I can pull it out if we need to read it.

MT: Okay.

DB: But there are five strategic goals that the city council has. They've had them for a number of years. I believe it's the fifth one, not in any priority order necessarily. But the fifth one is to promote orderly and sustainable development. It is at least recognized as, you know, on of the five elements for the city.

MT: Yeah. Okay. What will sustainability or sustainable development look like, in the city, 5 years from now, do you think? And then 10 years from now? ... I mean, we've kind of seen this wave, you know, like when this first came out several years, "Oh ..." Then most people, some, you know, people jumped on the band wagon, but then it was all just kind of-

DB: Yeah. Well, I would say ... We've done some dabbling in it in a few projects, right now. But I think we'll have a bigger focus, or bigger not focus, be more common is low impact development. Because of our storm water and flooding challenges, that it was the flooding challenges that ... I'm trying to remember what year it was, maybe eight, was it eight years ago? I don't remember when we first created the Storm Water Utility. Because of the flooding challenges, that got the political support to create a Storm Water Utility. You have a monthly bill, you know, you pay with your water bill based on, roughly, particularly for commercial and industrial, based on your pervious cover for your property. That is what determines the amount that you pay on your bill. Then, for residential, there's sort of an average that's worked out unless you have a larger property.

MT: Right.

DB: But the storm water and flooding issues that we've had created the impetus to have the utility created. That added a funding stream that hadn't existed before to make storm water improvements. Our storm water division has been very, I think, very open to using more green options, rather than just concrete channels. They also, you know, they give credits for creating-

MT: Improving. Yeah.

DB: best practice, pervious surfaces. We participated in and helped to host the Low Impact Development Competition a few years ago. There's consulting firms that are, you know, like Freese and Nichols, for example-

MT: Yeah.

DB: That are becoming more astute and helpful in, whether it's with the city or with other developers, in thinking about how they can do low impact development. That's a few ... Going back to the Lake Worth example, and even Lake Arlington, even though Lake Arlington is Arlington's water source, we drain into it from the west side. Say for Lake Worth and Lake Arlington, the idea of promoting low impact development treatments for any of our city infrastructure and drainage improvements is something that's really catching on.

Then, there had been an economic development project called ... Well, it was at a location that exists, called Casino Beach. But we refer to the development as Casino Beach, also, which is off Jacksboro Highway. It's a city park. Well, there's city owned land that's controlled by the water department, and then there's city park land. Next to the park land, we were going to sell them some of the city property so that they could bring in waterfront development. You know, not huge, but you know, some restaurants and maybe a little marina.

MT: Right.

DB: A swimming area, what have you. There, we had low impact development as part of our development agreement. That they would have, you know, pervious parking surfaces, and other treatments for their landscape areas to-

MT: You'd definitely have to control run-off there.

DB: Yeah. Yeah. Making that nexus, so that for the city council, that's not seen as an economic development impediment, they're seeing it as, "Oh, of course. That's right on the water, we really should do that."

MT: Yeah.

DB: As opposed to city-wide, where it wouldn't resonate as well.

MT: Got you.

DB: Low impact development is one. The other is ... I joke because it comes up every five to ten years all on its own, is the idea of more local rail, rather than just the regional rail. We looked at it in 2001-2002. We looked at it again in 2008-2009.

MT: Right.

DB: I know that it will come back up again. Looking at transit that's more local rather than the regional rail service.

The other piece that has been happening, but I see it coming more is, our housing authority's been very progressive about creating mixed income communities. They're going to be continuing that trend. They sold, years ago, what was called the Ripley-Arnold Complex. It was, probably you know, 250 roughly units on the river, which is where the Radio Shack TCC Campus is today.

MT: Got you.

DB: That initiated for them ... And again, that's probably been almost 15 years ago. That initiated for them a new program of rehousing the residents in mixed income developments. They were actually acquiring multifamily ... Market multifamily developments and then integrating them so that they were mixed income, by design.

MT: Are those subsidized? Or how does that-

DB: Mm-hmm (affirmative)

MT: Okay.

DB: Well, the market rate's not, but yeah, the -

MT: But the rent. Okay.

DB: Rather than using their federal dollars to have a concentrated project that they administer, they now have ... You know, instead of that one ... I think they have ... Let me think. They had four, I believe it was. They had four project sites. Maybe I'm missing one in my head. But there were at least four project sites that were for all low-income families, and one that was specifically for seniors. They had those four sites originally. They sold the one and rehoused everybody in probably like ten mixed income multifamily complexes, some that were new construction and then some that were existing, like Stone Gate down on Hulen was one of the ones that-

MT: But it wasn't necessarily a mixed income development, they just-

DB: No, they made it mixed income-

MT: Made it mixed income because they're subsidizing several of the residents.

DB: Right.

MT: Got you.

DB: That was, you know, quite controversial at the time. I mean, it was really divided the community, particularly Stone Gate at Hulen. It was just "oh, oh, oh."

MT: Yeah.

DB: But since that time, you know, they've quietly acquired more and more, and then have created a revenue source for themselves so they can keep providing more affordable housing. It's been really good. The piece that I see coming in the next five years is a more focused effort to have mixed income housing at our rail stations, down town. At the ITC, and at the TMP terminal. To have focused mixed income development at those ... At and around those stations. The Housing Authority is working with the T now on a ... The T owns a parking lot just behind the TMP terminal, at Vickory and Main Street, where you go for to Park and Ride for TRE, or they've got the bus, several bus stops there. There's a surface parking lot that they would probably lease to the Housing Authority that they'd probably lease to the Housing Authority so they could build a mid-rise or high-rise structure on it to have mixed income housing and structured parking.

MT: It would be interesting to know like how success ... I mean, do they just continue to subsidize these ... You know, like it's just an on-going thing? Like if you get ... Say I need to be rehoused and I need assistance, and they don't have ... That's like-

DB: Yes. Well, that's ... I don't know enough about their statistics, but I do know that there are folks, you know, particularly the elderly, that they'll be in, you know, in public housing for the rest of their lives, because they're not making anymore income.

MT: Right.

DB: They're all on fixed income. I know, for the elderly, that it's rare that they move out of the assistance, needing the assistance.

MT: Got you.

DB: For some of the families, you know, there's more turn over, because as they get jobs and no longer qualify, then ...

MT: Got you.

DB: The go through different programs. But my sense is, for a certain sector of the population, disabled and elderly-

MT: That's an ongoing.

DB: Yeah. That's a permanent condition.

MT: You know, one thing that I've noticed about Fort Worth, too, is that you know, again, not packaging it under the sustainability umbrella, but everything is kind of like, okay, we have ... When you're looking at the organizational chart, and like the hierarchy, it's like, okay, energy's here, and then waste is here, and then it's like all these elements are all over.

DB: Yeah.

MT: But there doesn't seem to be like an overarching-

DB: Right, there's not. Right.

MT: You know, like sustainability-

DB: Czar. Yeah, no. There's not.

MT: Yeah. Do you think that-

DB: And Sam would really, you know, at least at one point, really wanted to be that.

MT: Yeah.

DB: And have that role. Or at least have the role in the city. If he wasn't it, then at least have that role-

MT: Right. It exists.

DB: I think Brandy O'Quinn would love to you know, have that role and be that role. But again, that goes to whatever or whoever the mayor and the city manager is.

MT: What they're passionate about.

DB: Yup. It all comes down to that. They've definitely heard about those ideas and those concepts, because it's come to them as suggestions or ideas.

MT: It's just mainly, like I don't know if it necessarily has to be called sustainability. I think it's just a word now, that everybody kind of knows what you're talking about. But I think it's valuable to have some sort of consistency through-

DB: Yeah.

MT: All of these efforts. You guys are doing so much and they're doing a lot, But then, maybe, when you're talking about efficiency, things could be-

DB: Yes. Yes.

MT: More efficient if there's some sort of cohesiveness. But-

DB: There have been some minor efforts, at least to improve communication and sharing of information across the department. Two things, several years ago ... To be honest, I don't even know that it's still up on our website. Let me just do a search because I-

MT: Sure.

DB: Our web master for our communications office just redid our website not too long ago.

MT: I did notice that. [crosstalk 00:33:20]

DB: Yeah, it's like totally different look. Let me just look up sustainability and see what comes up. We created ... Pretty much just a page. There had been more to it than this. But-

MT: Okay.

DB: In 2009, there was this Sustainability Task Force. It was a three phase plan. One phase had to do with how we operate as a city. The other had to do with, you know, private development. Let's see if this will even come up. It's thinking. ... Yeah. Let me actually ... This won't take too long. Let me see if I have, on the server ... Yeah. Phase One was private development. Phase Two was city operations, and Phase Three were individual actions. There had been a little bit of a push. This was under Mayor Moncrief. You can see him right there.

MT: Yeah.

DB: Let me pull up the presentation and see if this gives us some oversight. ... Yeah. We had this Sustainability Action Plan, and we had ... Minor success, I would say in ... Here's part of what was going on. We had a ... In fact, I think we had a resolution adopted, but I don't know if we actually had any kind of signed agreement. But with the Fort Worth Museum of Science and History, and the TCU Energy Institute ... The city, the TCU Energy Institute, and the-

MT: Museum.

DB: The Museum of Science and History came together to talk about sustainability. As we were working on this action plan, there were some really cool ideas about having each of those entities help the city, both with ideas, but also to help get the word out and educate folks about this. Right as we were finishing up and getting the adoption and talking about implementation ... One of our implementation ideas was to bring folks together, to learn about sustainable activities. About a few times during the year, we met once at TCU to learn what TCU was doing for their campus for sustainability. We met once at Lockheed to learn what Lockheed was doing about sustainability. We met once at DFW International Airport to learn what they were doing with sustainability, to just educate all these different folks about what you could do.

MT: Got you.

DB: Because of the facilities I've described, it was very much large campus operators who had, you know, buildings and other big assets.

MT: Right.

DB: It didn't necessarily appeal to individuals or you know, small business or small building owners or other small property owners. But at least it was a good information sharing. GSA, the General Services Administration, was interested in you know, supporting sustainability within federal properties, and so they participated. One of the neat ideas had been for the museum to support the individual actions and the ... Let me see if I can remember his name. I don't know if I'm going to have it. It was Charlie something, or Charles something. But basically, the VP of programming for the museum, he left and relocated to like Albuquerque or something to go run their museums. He had really been the individual passionate driving force talking through-

MT: Which is needed.

DB: Yeah. Which is really needed to help create these and sustain these partnerships. That pretty well phased out. I know that Allison Gray, right now she's acting as the Neighborhood Services Director, but she's my counterpart here in the department, she's Assistant Director over the Development Division for our department. She was a manager at the time, but she had been the lead staff person on the Sustainability Action Plan. She's be another person who might be good to talk with if you wanted some more assessment of sort of the barriers or what helped or what didn't help. A few of these things were implemented, but a lot weren't. Again, the sustainability issue of planning.

MT: Yeah.

DB: Implementing your plans.

MT: It all sounds great, but it all costs money and ...

DB: Yeah. Yeah. This has happened. This is something that we actually did. These are examples, but this is now in place. We do have grading permits now. We did not reduce permit fees for these items, in part because our fees were so low.

MT: Is this available on the website?

DB: I can just email it to you.

MT: Oh, that would be great.

DB: I can just email it to you. These two operations. ... Yeah, like providing pay stubs electronically or email. That's in place now, but that was just inevitable. Yeah. Low flow plumbing. I think that's generally been in place. Here, we did say, "Obtain LEEDS Silver or better for new facilities and major renovation," but again, there was that little bit of a push back from the facility folks saying, "We don't really ... We know-

MT: Yeah. "As long as we build to LEEDS Silver, we don't need to-

DB: "We don't have to get the certification. Yeah. No one was asking us to prove it.

MT: Right.

DB: Then, these ideas of things you can do in your home, for the individual, the education and outreach piece. That had some limited ... Then this piece was the other one. Allison really struggled to get some buy-in across the departments, but also with our city web master. She was trying to create a website where you could go and check and see, "How are we doing on these efforts?"

The other thing that happened ... This was in I think I said 2009 is when it got adopted.

I'll look for that, for sure, to give to you. But as the recession hit, we lost 25% of our staff. That immediately nixed any of the nice to have functions. It cut a lot of our planning staff. Anyway ...

MT: Was that in the end of 2009? When was the layoff?

DB: It was in that time period. It was layoffs for FY09, you know, big layoffs for FY09, and then just losing positions. You know, if we had turnover, we would have higher increases and would have to then lose that position.

MT: Right. Yeah.

DB: Yeah. That was the big-

MT: Was the task-

DB: The big barrier to implementing our action plan.

MT: I mean, that's understandable. You just kind of get back to bare necessities.

DB: Yup.

MT: Is the Sustainability Task Force still in existence?

DB: No. It was just put together-

MT: Just for 2009.

DB: Well, just to create that plan. It was just an action planning task force.

MT: Okay.

DB: Let me see if I can find for you ... Got you. Okay. ...

MT: What does the city do now, to kind of help with those communications between the units and ...

DB: It's limited. What I'm aware of, and we're not directly involved in making it happen, but Michelle Gutt, who is the city's communications and public engagement director basically, she was hired just a few years ago. She had a woman who worked with her ... [Bagely 00:41:57] ... Bill ... It was funny because she and her husband both worked for the city. Becky, I think, Becky Bagely. Becky was very interested in green and sustainability. Becky had pulled together green teams across the city departments to look at, you know, different ... Probably to highlight what are we doing as a city that's green, and putting it into the employee newsletter. Pretty much every employee newsletter would have a green tip, or a green highlight of some kind. Becky and her husband relocated to Houston. I don't know if Michelle has anyone, you know, who's picked up that ball and run with it. ...

MT: But would you say that most of the departments are individually communicating with and collaborating amongst themselves, there's just no ...

DB: Yeah, well ...

MT: There's just no like ... Do you think that a centralized sustainability unit would mainly just be a communications arm, or do you think it would actually facilitate some more cohesiveness in the implementation of things.

DB: I think it could be both. I definitely think it could be both.

MT: Okay.

DB: The departments ... This is something that our city manager is really trying to push, which is more corporate thinking and policy making and decision making. I don't know yet how all of that's shaping up. One example is our finance department is trying to create a five year funded capital improvement program that rolls in all the different funding resources that all of the different department have and create a transparent document where it lays out, you know, everything for the next five years. Pretty much that's been a much more siloed activity with each ...

MT: Budget.

DB: The Water Department has its water and sewer fund, so it does its planning. The Storm Water does its planning, Aviation does its planning, Parks does its planning. Library, similar. You know, every department does their own planning. Then, really the only time there's collaboration, it's sort of just forced collaboration, is when we're talking about the general fund. Because the general fund touches so many different departments, that as you're trying to prioritize dollars for the next bond program, then the departments come together to-

MT: Wheel and deal.

DB: You know, Police and Firemen and yeah. Wheel and deal about whose projects get, and what percentage of funding gets to be in the bond program. In my tenure here, the capital planning has been again, very siloed, and when it's come together it's only been about the general fund and the bond program. This effort was really to at least create a document that brought everything together and laid it out in a way that ... That's a sign of things to come-

MT: Yeah.

DB: You know, that there's going to be more of that thinking-

MT: Well, you can only be more efficient when you have things like that.

DB: Yes. Yes.

MT: I can't imagine ... It would drive me crazy to have like all of these-

DB: There had been, procedurally, basic things worked out so that transportation wasn't going to touch a street without consulting with Storm Water, Water, and Sewer so that they're coordinating.

MT: Right.

DB: You know, that's enough of a routine exercise that you didn't necessarily have to have a five year CIP for those operational kinds of coordination elements to happen. It was just best, you know, just [crosstalk 00:46:02]

MT: Standard practice. Yeah. Yeah.

DB: To a limited extent, there was a coordination thing happening. But to me, not from a planning, capital planning standpoint, just from an operational implementation stand point.

MT: Got you.

DB: ... Oop. That didn't work. I was trying to send you attachments, but it was cutting and pasting. It didn't ... Let me try that again.

MT: Is there anything else that you think would be helpful for me to know?

DB: Well, I imagine you're familiar with the Blue Zone's project. Related to that ... There's some overlap among three initiatives that are all happening right now, which is good. Good overlap because it means that it will happen. There's enough umpf from different sources. One is the update of the Master Thoroughfare Plan. That's a major update. The last one was 2009, so a major update of the Master Thoroughfare Plan. The reason that's important is because we're designing, or we're totally starting over with all of the street cross-sections, and creating new cross-sections. The premise behind all of the cross-sections is the Complete Streets Policy. That's a big paradigm shift in transportation for us. The Master Thoroughfare Program incorporating complete streets and the design of the cross-sections for all of the different street types.

Then, the Blue Zones Project, one element of that is the Built Up Environment. I co-chair the Built Up Environment committee. Four of our nine initiatives for the nine strategies relate to Complete Streets, both to adopting policy, updating all of our design manuals, training city staff and consultants, and then having an implementation plan for Complete Streets. There's a big push there for Complete Streets.

Then, third is AARP. We've joined the Network of Age Friendly Communities. They've got a focus on two ... They've got eight domains that they look at within that network. One of the domains is public spaces and public buildings, and the other is transportation. They're ... In fact, I think they're founding members of the Complete Streets Coalition nationally. But they're pushing for Complete Streets and making sure that communities are walkable and accessible for people of all ages.

The main overlap area among those three initiatives is Complete Streets and putting that thinking into you know, retrofits as well as new construction. Up to this point, it's really just been planning and development I would say, with grant projects or grant dollars that we get for transportation through COG, typically.

MT: It's just kind of piece-meal.

DB: Yeah. It's in designated areas, within our designated urban villages as we redesign the streets to make them more pedestrian friendly, and transit friendly, and bike friendly and all those things. We haven't always used the language of Complete Streets, but that's really where it fits in. Also contact sensitive in Complete Streets. That's exciting. Hopefully there'll be a big push to-

MT: Is the Master Thoroughfare Plan, basically is it an implementation plan, of phasing in the concept of the Complete Streets through out the city?

DB: Yep. Yep. The Master Thoroughfare Plan itself is a planning document. It's part of the Comprehensive Plan. The Master Thoroughfare Plan's part of the Comprehensive Plan, but as the implementing ordinance is the Subdivision Ordinance. The Subdivision Ordinance requires that you dedicate right-of-way, and then design your streets in accordance with the Master Thoroughfare Plan. By updating that-

MT: It's the Subdivision Ordinance, is that what you said?

DB: Yeah. The Subdivision Ordinance is truly the implementation tool. Master Thoroughfare Plan would be just a plan, but for the Subdivision Ordinance, which legally requires that you-

MT: Do these things.

DB: Do these things. Yeah. That you put your roads where we show them roughly and design them-

MT: Okay.

DB: The Subdivision Ordinance is really the implementing document. A lot of people think of it as, "Well, the MTP requires ..." Well, yes-

MT: Right.

DB: But if you're going to you know. We develop legalese about, yeah, which is the control document.

MT: Well, I mean if you don't work in the city, it's hard to know how all-

DB: Yeah, it doesn't really matter.

MT: These pieces work together. I'm like regulation, ordinance, policy ... What?

DB: The Comprehensive Plan is just a plan. You know, it's not a regulatory document. The Master Thoroughfare Plan becomes a regulatory document because of the Subdivision Ordinance. The Comprehensive Plan does not become a regulatory document because it's prohibited by state law. You know, you can't use it as, particularly for land use, you can't use it as a zoning ordinance. It's forbidden, so it has to remain as a guide.

MT: Got you.

DB: You can use your zoning ordinance and your subdivision ordinances to try to get at what-

MT: Translate what you've put in there. Yeah.

DB: You put in a plan.

MT: Got you. Okay. Well, I think that that answers all my questions.

DB: Okay.

MT: I appreciate it.

DB: Sure. Sure.

MT: That was very informative. It helps me get a lot better, bigger picture about the environment

DB: Yeah. The other thing I'll mention, just as a ... I don't know enough about Austin or any of the other cities to compare, but I will say that Fort Worth is very good at partnerships. Both with other agencies, you know, whether it's other nonprofits, or governmental entities, or with the private sector. There's a lot that we, I think, can do and get done because folks are very open, and very willing to you know, bring together community-

MT: Collaborate.

DB: Leaders to collaborate. Just as a quick example, this is actually through the leadership of Fernando Costa. I mentioned that the Housing Authority, they've been trying to convert, over time, think about converting some of their project based housing to more dispersed mixed income housing. Butler Place is the complex that's just east of I-35, north of I-30. It's basically bounded by highways. It's I-35, 287, and I-30. It's in this triangle. It's-

MT: Is it right behind my building, probably? Over on Jones?

DB: It's east of I-35. Jones is right here. This is I-35, so it's right in this triangle.

MT: Got you.

DB: If you were driving along Lancaster Avenue, at Pine Street, that's where the T's headquarters are. But if you were to go north on Pine, that would be how you'd get into Butler housing. Oop, excuse me. There's a neat collaboration happening because the Fort Worth ISD has the I.M. Terrell Elementary school that's over there. They're also requiring property to have the Performing Arts School be there.

MT: That's great.

DB: Yeah. You've got ... Now the Housing Authority, and ISD, and Downtown Fort Worth Inc., and the city are partnering to bring in the Urban Land Institute for the first week of December to talk about how do we plan for this area, because there are some neat things that are happening from the school district. The Housing Authority would really like to potentially sell some or all of their property, and either do mixed income housing on that site with a developer, or do something else. But just exploring all of the possibilities, both for the school district and for the Housing Authority and private developers. That's a neat opportunity. It was just within a few days that all the entities have contributed. I think they've raised about $100,000.

MT: Wow.

DB: Which, you know, off budget and just for the planning exercises is pretty impressive, so-

MT: That is impressive.

DB: Now that doesn't happen all the time, but every few years, there's the umpf to work on a really special site or a special project that will come together. The same thing happened years ago with the Trinity River and just, "We really need to think about how we approach the Trinity River," and come together [crosstalk 00:55:16]

MT: Well, and that area definitely needs some attention, so I think it's great that the ISD is committed to actually developing over there.

DB: Right. I think those partnerships are key to us in, first of all, making sure there's continued action, and continued support for different concepts. We try to align our interests where we can, you know, again to be efficient.

MT: Right.

DB: But also central city revitalization, and mixed income housing, and supporting transit, because the T's headquarters are right there, education. Okay. Just [inaudible 00:55:55]

MT: No, it's great. I appreciate it.

DB: Okay. Before let me make sure I get to you these items I wanted to ...

Samuel Steele, City of Fort Worth

The interview questions include:

1. When did the city first engage in sustainability or sustainable development practices? What was the nature of this engagement? Please see list below and attached public documents. Also note that, prior to City establishment of the Administrator of Sustainability Programs title, I served as a Conservation Specialist within the Facilities Management Division of the Transportation & Public Works Department. In that role my supervisor, Glenn Balog, Facilities Manager, and I served on the original Sustainability & Green Building Task Force, as facilitated by the then Environmental Management Department from 2007 to 2009. For the follow-on Sustainable Development Task Force established in January of 2009 and the Sustainability Task Force established in June of 2009, I served on the supporting Technical Committee.

Resolution No. 3501-07-2007	…Assigning Membership to the City of Fort Worth's Sustainability & Green Building Task Force
M&C Communication C-23122	Authorize… the American Institute of Architects to Conduct a Sustainable Design Assessment Team Program…
Resolution No. 3705-01-2009	…Creating & Appointing Members to the Sustainable Development Task Force (Phase 1)
Resolution No. 3744-06-2009	Creating & Appointing Members to the Sustainability Task Force (Phase 2)
Resolution No. 3789-09-2009	Adopting a Master Plan for the Texas Motor Speedway and Amending the Comprehensive Plan…
Resolution No. 3860-02-2010	Appointing Members to the Sustainability Task Force (Phase 3)
Resolution No. 3895-06-2010	…Establishing a Tax Abatement Policy…
Resolution No. 3924-10-2010	Adopting the Recommendations of the Sustainability Task Force & Entering into a Partnership for Education…
Resolution No. 3966-02-2011	Adopting the City of Fort Worth's 2011 Federal Legislative Program
Ordinance No. 19569-03-2011	Approving Adoption of the City of Fort Worth 2011 Comprehensive Plan (Appendix A-only, see Page A-5)
M&C Communication P-11215	Authorize…(the)…Design, Preparation and Implementation of a Sustainability Education & Outreach Plan (Contract

	No.41736, 03-22-2011)
Resolution No. 4071-03-2012	Designating Saturday, March 31, 2012, from 830-930p as Earth Hour in Fort Worth
Resolution No. 4080-04-2012	Authorizing Closure of Z. Boaz Golf Course and Re-Purposing of the Property as a Community Park
Resolution No. 4089-05-2012	Authorizing… a Community Partnership Agreement with the U.S. DOE for their Better Buildings Challenge
Resolution No. 4130-09-2012	Establishing an Energy Conservation Goal in Compliance with State of Texas Legislative Action
Resolution No. 4184-03-2013	Designating Saturday, March 23, 2013, from 830-930p as Earth Hour 2013 in the City of Fort Worth, Texas
Resolution No. 4282-02-2014	Designating Saturday, March 29, 2014, from 830-930p as Earth Hour 2014 in the City of Fort Worth, Texas
Resolution No. 4333-07-2014	Approving the Cavile Place/Historic Stop Six Neighborhood Transformation Plan
Resolution No. 4370-10-2014	…Establishing a Moratorium… Pending Consideration of the Adoption of the TCU Residential Overlay District
Resolution No. 4399-01-2015	Adopting the 2015 Park, Recreation and Open Space Master Plan for the City…
Resolution No. 4428-03-2015	Designating Saturday, March 28, 2015, from 830-930p as Earth Hour 2015 in the City of Fort Worth, Texas

2. What was the motivation for engaging in sustainable development?

Your work should reference the above documents and the language contained therein, as well as in the second file of a few Informal Reports (IRs) to our City Council. Most of these are relative to sustainability, several include efforts more specific to the improvement of our environmental air quality – the City has 1) an Energy Savings Performance Contracting effort dating back to 2001 with 8-phases completed, 1-phase in construction, and 4-phases varying forms of development (note the availability of public records for each individual project), 2) fully participated in a stimulus-related Energy Efficiency & Conservation Block Grant funding multiple sustainability- & air quality-focused projects, 3) a more transportation-related Mobility & Air Quality Plan (http://fortworthtexas.gov/planninganddevelopment/maq/) and 4) various associated cooperative work-relations with the programming of our region's Council of Governments (http://www.nctcog.org/trans/air/.)

3. Are there any barriers to sustainable development planning and implementation? If so, what are they?

The chief barrier to sustainability development planning & implementation continues to involve issues of awareness, education, and outreach. In reviewing the attachments provided, I trust that you'll see that this work reflects the City's recognition of sustainability issue interdependence – further, please consider that this recognition has resulted in a shift in City management and staff views that better integrate these issues for the betterment of our community.

4. Is sustainability currently a priority for the city? If so, how does it rank with other priorities?

Yes, as listed in the City's current Comprehensive Plan posted on the City's website (http://fortworthtexas.gov/comprehensiveplan/current/.) Please note that questions regarding the City's comprehensive planning process may be best addressed to Dana Burghdoff, Deputy Director, Planning & Development Department. Questions regarding the ranking of City priorities would be best addressed by David Cooke, City Manager, City of Fort Worth – please note that he began working in that capacity in 2014 as new to the City and, as such, was not part of the local discussions through the period of most of the above documents' consideration & approval.

5. What will sustainability/sustainable development look like in the city 5 years from now? 10 years from now?

Again, with special consideration to more recent changes in the City Manager's Office and with elected officials, it would be best to address these questions to City Manager Cooke, or first to Deputy Director Burghdoff's consideration.

Amy Petri, City of Austin

1. When did the city first engage in sustainability or sustainable development practices? What was the nature of this engagement?

Austin's long-standing green leadership is one of our distinguishing characteristics as a municipality. Austin consistently leads national rankings as a smarter, greener city because of our investments in green power, energy efficiency, and conservation. The following timeline highlights some of Austin's sustainable development efforts:

1986: Comprehensive Watershed Protection Ordinance passed (provided requirements through the City of Austin's planning area such as stream setbacks, water quality controls, and impervious cover limits, as well as net site area and critical environmental feature protection)

1990: Austin Energy Green Building Program established (the City of Austin created the nation's first green building program, which continues to use an Austin-specific rating system to help in meeting our aggressive climate protection goals)

1992: Save Our Springs Initiative and Ordinance passed (addressed development in the Barton Springs Zone, which includes Barton Creek and the other creeks draining to, or crossing, the Edwards Aquifer recharge zone, requiring non- degradation based on total average annual loading and lowered impervious cover)

1998: Water Quality Protection Land bonds approved (used to purchase and manage 30,000 acres of land in fee title and conservation easement in the Barton Springs recharge zone to protect the quality of the City's water supply)

2000: Mueller Redevelopment Master Plan adopted (public-private partnership between the City of Austin and Catellus Development Group to redevelop the former Robert Mueller Municipal Airport as a mixed-use community that is compact and pedestrian-scaled, supportive of transit, energy efficient, and that protects and preserves water quality and green spaces)

2012: Imagine Austin Comprehensive Plan adopted (30-year comprehensive plan that sets priorities for a compact and connected city; an integrated, expanded and affordable transportation system to reduce sprawl, congestion, and travel times; safe bicycle and pedestrian facilities with well-designed routes that promote connectivity)

2013: Seaholm EcoDistrict planning and implementation (using the EcoDistrict framework, involves ongoing collaboration with neighborhood developers and property owners to address community engagement and sustainability education within the 85-acre Seaholm Redevelopment area, as well as identify neighborhood-wide goals for energy, water, ecosystems, and food)

Sustainability will also be a development priority for several major master plan efforts that are currently underway for the South Central Waterfront, Colony Park, and Central Health / University of Texas / Seton Medical Campus.

2. What was the motivation for engaging in sustainable development?

The City of Austin's identity and pride of place are intimately tied to environmental protection and sustainability, so there is broad support for sustainable development throughout the community. Because we are also one of the fastest growing cities in America, thoughtful development strategies with a view to long-term success will be critical in helping us respond to the physical, economic, and social impacts resulting from rapid population growth. Sustainable development will help us to preserve the great quality of life that has made Austin so attractive to so many.

3. Are there any barriers to sustainable development planning and implementation? If so, what are they?

The current Land Development Code for the City of Austin is overly complex and cumbersome, making it difficult to implement innovative ideas for sustainable development.

CodeNEXT is the initiative to revise the Land Development Code, which will determine how land can be used throughout the city – including **what** can be built, **where** it can be built, and **how much** can (and cannot) be built. The City's Land Development Code needs to be changed to help us create the kinds of places we want, and to address critical issues such as diminishing natural resources, household affordability, and access to healthy lifestyles – to name a few. The process is a collaboration between Austin's residents, business community, and civic institutions to align our land use standards and regulations with what is important to the community – and sustainability is an important priority that will be incorporated into CodeNEXT.

4. Is sustainability currently a priority for the city? If so, how does it rank with other priorities?

Sustainability is a core value, specifically identified by the City Manager for the City of Austin and applied to programs and initiatives in every department, as well as day-to-day municipal operations. We have about 40 departments city-wide that include the Water Utility, Austin Energy, Watershed Protection, Parks and Recreation, and Resource Recovery (to name a few).

Efforts that currently underway to make Austin the greenest, most livable city in the country include:

Built Environment:

- Imagine Austin Comprehensive Plan (https://austintexas.gov/imagineaustin)
- Austin Energy Green Building (http://greenbuilding.austinenergy.com/)
- Capital Improvement Projects (http://austintexas.gov/page/green-capital-improvement-projects)

Energy:

- Power Saver Program (http://powersaver.austinenergy.com/)
- GreenChoice (http://austinenergy.com/wps/portal/ae/programs/greenchoice/)
- Solar Solutions (http://austinenergy.com/wps/portal/ae/programs/solar-solutions/)
- LED Streetlights (http://www.austinenergy.com/wps/portal/ae/about/environment/energy-saving-streetlights/)

Ecosystems and Environmental Quality:

- Water Quality Protection Land (http://www.austintexas.gov/department/water-quality-protection-land)
- Nature Preserves (http://austintexas.gov/department/nature-preserves-0)
- Nature-Based Programs (http://www.austintexas.gov/department/nature-based-programs)
- Wildlife Austin (http://www.austintexas.gov/wildlifeatx)
- Urban Forestry (http://www.austintexas.gov/department/austins-urban-forest)
- Watershed Protection (http://www.austintexas.gov/department/watershed-protection/programs)

Zero Waste

- Composting (http://www.austintexas.gov/department/composting)
- Recycled Reads (http://library.austintexas.gov/recycled-reads)
- Austin ReBlend Paint (http://www.austintexas.gov/department/austin-reblend)
- Household Hazardous Waste (http://www.austintexas.gov/hhw)
- Resource Recovery Center (http://www.austintexas.gov/department/resource-recovery-center)

Equity and Livability:

- Neighborhood Housing and Community Development Programs (http://www.austintexas.gov/department/housing/programs)
- Neighborhood Partnering Programs (http://www.austintexas.gov/neighborhoodpartnering)
- Women, Infants & Children Programs (http://www.austintexas.gov/wic)
- Youth & Family Services (http://austintexas.gov/kids)
- Afterschool Programs (http://www.austintexas.gov/department/afterschool-programs)
- Senior Programs and Services (http://austintexas.gov/department/seniors-programs-and-services)

Economy & Innovation:

- Smart Grid (http://austinenergy.com/wps/portal/ae/about/environment/integrated-smart-grid/)
- Electric Vehicle Charging Stations (https://na.chargepoint.com/charge_point)

Food & Health:

- Community Gardens (http://www.austintexas.gov/department/sustainable-urban-agriculture)
- Active Austin (http://www.austintexas.gov/department/walk-texas-active-austin-10-week-challenge)
- Healthy Places Healthy People (http://www.austintexas.gov/department/healthy-eating-and-active-living-promotion)
- Tobacco Cessation (http://www.austintexas.gov/department/tobaccosmoking-cessation-and-prevention)
- Diabetes Prevention & Management (http://www.austintexas.gov/department/central-texas-diabetes-coalition)

Mobility:

- Plug-In Austin (http://austinenergy.com/wps/portal/ae/programs/plug-in-austin)
- Bicycle and Pedestrian Programs (http://www.austintexas.gov/department/bicycle-program-0)
- Urban Trails (http://www.austintexas.gov/urbantrails)
- Air Quality (http://www.austintexas.gov/airquality)

Water Conservation:

- Water Conservation Initiatives and Rebates (http://www.austintexas.gov/department/water-conservation)

5. What will sustainability/sustainable development look like in the city 5 years from now? 10 years from now?

The Imagine Austin Comprehensive Plan sets a road map for sustainable development in Austin over the next 30 years. Key principles from the plan include:

- ***Austin is Livable:***

One of Austin's foundations is its safe, well-maintained, stable, and attractive neighborhoods and places whose character and history are preserved. Economically mixed and diverse neighborhoods across all parts of the city have a range of affordable housing options. All residents have a variety of urban, suburban, and semi-rural lifestyle choices with access to quality schools, libraries, parks and recreation, health and human services, and other outstanding public facilities and services.

- Development occurs in connected and pedestrian-friendly patterns supporting transit and urban lifestyles and reducing sprawl, while protecting and enhancing neighborhoods.
- Downtown offers a safe, vibrant, day and night time urban lifestyle for residents, workers, and visitors.
- Development occurs across the city in a manner friendly to families with children, seniors, and individuals with disabilities.
- Austin's unique character and local businesses are recognized as a vital part of our community.
- Clear guidelines support both quality development and preservation that sustain and improve Austin's character and provide certainty for residents and the business community.
- Austin's diverse population is active and healthy, with access to locally-grown, nourishing foods, and affordable healthcare.
- ***Austin is Natural and Sustainable:***

Austin is a green city. We are environmentally aware and ensure the long-term health and quality of our community through responsible resource use as citizens at the local, regional, and global level. Growth and infrastructure systems are well-managed to respect the limitations of our natural resources.

- We enjoy an accessible, well-maintained network of parks throughout our city.
- We protect the beauty of the Colorado River watershed, Hill Country and Blackland Prairie and value our farmland that nurtures local food production.
- Our open spaces and preserves shape city planning, reduce infrastructure costs, and provide us with recreation, clean air and water, local food, cooler temperatures, and biodiversity.
- We conserve water, energy, and other valuable resources.
- Austin is a leader in reducing greenhouse gas emissions.
- We use and inspire new technologies that create more sustainable communities while reducing our dependence on environmentally costly practices.
- ***Austin is Mobile and Interconnected:***

Austin is accessible. Our transportation network provides a wide variety of options that are efficient, reliable, and cost-effective to serve the diverse needs and capabilities of our citizens. Public and private sectors work together to improve our air quality and reduce congestion in a collaborative and creative manner.

- Interconnected development patterns support public transit and a variety of transportation choices, while reducing sprawl, congestion, travel times, and negative impacts on existing neighborhoods.
- Our integrated transportation system is well-maintained, minimizes negative impacts on natural resources, and remains affordable for all users.

- Austin promotes safe bicycle and pedestrian access with well-designed routes that provide connectivity throughout the greater Austin area. These routes are part of our comprehensive regional transportation network.
- ***Austin is Prosperous:***

Austin's prosperity exists because of the overall health, vitality, and sustainability of the city as a whole-including the skills, hard work, and qualities of our citizens, the stewardship of our natural resources, and developing conditions that foster both local businesses and large institutions. Development carefully balances the needs of differing land uses with improved transportation to ensure that growth is both fiscally sound and environmentally sustainable.

- Our economy is resilient and responsive to global trends thanks to its diverse and thriving mix of local entrepreneurs, large and small businesses, educational institutions, government, and industry.
- Innovation and creativity are the engines of Austin's economy in the arts, research and development, and technology.
- Our ecology is integrated with our economy-the preservation of the environment and natural resources contribute to our prosperity.
- Equitable opportunities are accessible to all through quality education, training, and good jobs.
- ***Austin Values and Respects its People:***

Austin is its people. Our city is home to engaged, compassionate, creative, and independent thinking people, where diversity is a source of strength and where we have the opportunity to fully participate and fulfill our potential.

- Austin government is transparent and accountable.
- People across all parts of the city and of all ages and income levels live in safe, stable neighborhoods with a variety of affordable and accessible homes, healthy food, economic opportunity, healthcare, education, and transportation.

- We stand together for equal rights for all persons, especially acknowledging those who have been denied full participation in the opportunities offered by our community in the past.
- The history of the people of the Austin area is preserved and protected for future generations.
- ***Austin is Creative:***

Creativity is the engine of Austin's prosperity. Arts, culture, and creativity are essential keys to the city's unique and distinctive identity and are valued as vital contributors to our community's character, quality of life and economy.

- As a community that continues to stimulate innovation, Austin is a magnet that draws and retains talented and creative individuals.
- Our creative efforts reflect, engage with and appeal to the ethnic, gender and age diversity of Austin and to all socioeconomic levels.
- Residents and visitors participate fully in arts and cultural activities because the opportunities are valued, visible, and accessible.
- Our buildings and places reflect the inspirational and creative spirit of who we are as Austinites, through design excellence, public art and beautiful, accessible public spaces.
- ***Austin is Educated:***

Education is the hope for Austin's future. Austin provides everyone with an equal opportunity for the highest quality of education that allows them to fully develop their potential. Networks of community partnerships support our schools and ensure that our children receive the resources and services they need to thrive and learn.

- Our school campuses provide safe and stable environments enabling future success.
- Neighborhood schools and libraries serve as centers for community collaboration, recreational, and social events, as well as learning opportunities.

- In partnership with private entities and the broader community, institutions of higher education continue to be incubators for innovation in the cultural arts, medicine, industry, business, and technology.
- Every child in Austin has the chance to engage with other cultures, communities, and languages, providing pathways for healthy development, and the critical thinking skills students need as future citizens of Austin and the world

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Appendix D

Sustainable Built Environment Polices & Commitment Scores (Fort Worth & Austin)

CITY OF FORT WORTH					
Sustainable Built Environment Polices & Commitment Scores					
Year	**Policy Category**	**Area of Focus**	**Policy Description**	**Commitment Score**	**TOTAL SCORE**
2005 - 2012	Buildings	Development Practices	Encourage building practices that reduce environmental impacts.	1	
2005 - 2012	Buildings	Development Practices	Encourage development practices that help reduce the higher temperatures in urban areas that accelerate ground-level ozone formation (the urban heat island effect), such as planting shade trees and using appropriate highly reflective (high albedo) paving surfaces and roofing materials. Use City projects to demonstrate the effectiveness of these development practices.	1	
2005 - 2012	Buildings	Development Practices	Research options to increase the reflectivity of City roofs and paved surfaces to reflect more solar radiation, thereby reducing air conditioning loads and urban heat island effects.	2	
2005 - 2012	Buildings	Development Practices	Encourage planting and maintenance of native vegetation near buildings and along paved surfaces to directly shield them from the sun's rays, reducing urban heat island effects.	1	
2005 - 2012	Buildings	Development Practices	Create and implement an online information system about sustainable development to further the networking of builders, developers, and material providers, as well as educate the public.	2	
2005 - 2012	Land Use	Infill/Brownfields	Encourage redevelopment and infill in order to reduce the amount of new impervious surfaces	1	
2005 - 2012	Land Use	Infill/Brownfields	Encourage new development adjacent and connected to previously developed or platted areas in order to utilize existing utility and road infrastructure	1	
2005 - 2012	Land Use	Infill/Brownfields	Promote appropriate infill development of vacant lots, old commercial centers (greyfields), and contaminated sites (brownfields) within developed areas, particularly in the central city.	1	

2005 - 2012	Land Use	Infill/Brownfields	Encourage high quality infill and mixed-income housing development, both single-family and multifamily, within the central city.	1	
2005 - 2012	Land Use	Infill/Brownfields	Redevelop abandoned industrial and commercial sites, or brownfields, to help reuse land in the central city.	2	
2005 - 2012	Land Use	Infill/Brownfields	Promote and facilitate the redevelopment of brownfields	1	
2005 - 2012	Land Use	Infill/Brownfields	If a private developer is redeveloping a brownfields site, the City can potentially assist in securing site-specific assessment funding or a cleanup loan.	1	
2005 - 2012	Land Use	Infill/Brownfields	Continue identification of potential brownfields redevelopment candidates, focusing on the central city.	2	
2005 - 2012	Land Use	Infill/Brownfields	Encourage the use of federal brownfields programs to assist in central city revitalization	1	
2005 - 2012	Land Use	Infill/Brownfields	Aggressively expand land assembly for infill housing, [*particularly in designated urban villages, mixed-use growth centers, rail station areas that support Transit-Oriented Development, and Neighborhood Empowerment Zones]. (*added in 2009)	2	
2005 - 2012	Land Use	Mixed-Use Development	Encourage higher intensity residential and commercial uses within mixed-use growth centers, and higher intensity industrial and commercial uses within industrial growth centers.	1	
2005 - 2012	Land Use	Parks, Trails and Green Space	In order to maintain standards for meeting park and recreation needs, *8,727 acres of parkland will need to be acquired by 2025 to meet the 21.25 acres of parkland per 1,000 population standard, based on projected population. (*2006: 5,968; 2008: 5,834; 2009: 5,773;2010: 5,773; 2012: 5,773)	2	
2005 - 2012	Land Use	Parks, Trails and Green Space	Encourage the provision of open space within new developments, with the goal of linking open spaces within adjoining subdivisions.	1	
2005 - 2012	Land Use	Parks, Trails and Green Space	Renovate or replace existing trails	2	

2005 - 2012	Land Use	Parks, Trails and Green Space	Increase park acreage from *18.05 acres per 1,000 persons to 21.25 acres per 1,000 by 2025 by expanding close-to-home and regional park space, concentrating on under-served areas in the central city. (*2006:17.29; 2007: 16.22; 2008:16.9; 2009: 15.52; 2010/12: 5.11 acres per 1,000 persons to 6.25 acres per 1,000 by 2025)	2	
2005 - 2012	Land Use	Parks, Trails and Green Space	Seek the means to develop and support a system of urban parks and open space that link neighborhoods to growth centers, as well as other park, recreation, and community facilities.	2	
2005 - 2012	Land Use	Parks, Trails and Green Space	Seek grants and other non-City funding resources for riparian buffer conservation, park development,[*including bike trail linkages], and other projects. (*added in 2010)	2	
2005 - 2012	Land Use	Parks, Trails and Green Space	Provide new parkland and facilities to meet park, recreation, and open space needs in developing areas of the City.	2	
2005 - 2012	Land Use	Reuse	Encourage renovation and reuse of existing commercial structures throughout commercial districts, where feasible.	1	
2005 - 2012	Land Use	Reuse	Establish and use appropriate incentives to promote development of vacant land and redevelopment or reuse of deteriorated properties within designated commercial districts.	1	
2005 - 2012	Land Use	Reuse	Wherever possible, the City should set an example for private sector developers and builders by developing facilities that demonstrate the most effective technologies and techniques available to ensure public facilities are environmentally responsible, highly energy efficient, and take the most advantage of opportunities to co-locate activities and re-use land and structures.	1	
2005 - 2012	Land Use	Zoning	City staff to continue reviewing the Zoning Ordinance and Subdivision Ordinance, in	2	

			consultation with the City Council, City Plan Commission, Zoning Commission, developers, and community leaders, to identify regulatory impediments to appropriate development, address the impacts of development on traffic and the natural environment, and address technical and administrative issues.		
2005 - 2012	Land Use	Zoning	City to provide preference for projects in targeted areas (e.g., growth centers, urban villages, neighborhood empowerment zones, Community Development Block Grant eligible areas, etc.).	2	
2005 - 2012	Land Use	Zoning	The purpose of the Mixed-Use Zoning Assistance incentive is to assist individual property owners and interested community groups in rezoning to mixed-use in designated mixed-use growth centers, urban villages, and transit-oriented development areas. In using a petition process or Council-initiated process, the City initiates the rezoning at no cost to the property owners.	2	
2005 - 2012	Land Use	Zoning	Support zoning changes that reduce the amount of vacant land zoned for multifamily residential development outside of designated growth centers, urban villages, and transit-oriented developments (TOD).	1	
2005 - 2012	Sustainable Development		Adopt a sustainable development policy that promotes the following: 1) Land use and transportation practices that promote economic development while using limited resources in an efficient manner; 2) Transportation decision-making based on land use, traffic congestion concerns, vehicle miles traveled, and the viability of alternative transportation modes; and 3) Balance among accessibility affordability, mobility, community cohesion, and environmental quality.	1	
2005-2012	Sustainable Development		Implement a sustainable development online forum — an	2	

			educational and networking resource that will inform the public about local opportunities and the benefits of sustainable development while increasing builder and developer participation.		
2005-2012	Sustainable Development		Encourage the development of industries with minimal air emissions, which will allow continued economic growth while the Metroplex is under strict federal emissions standards.	1	
2005-2012	Sustainable Development		Promote traditional neighborhood and other pedestrian-oriented developments, which encourage human interaction, walking, bicycling, mixed uses, slower traffic, public places, and attractive streetscapes.	1	
2005-2012	Sustainable Development		Encourage and provide support for higher density, mixed-use, mixed-income developments in mixed-use growth centers, and urban villages.	1	
2005-2012	Sustainable Development		Promote sustainable development patterns that include greater density at appropriate locations, mixed-use development, public transit, park-and-ride facilities, and access management (e.g. encouraging shared driveways and limiting the number of curb cuts) to reduce vehicle trips.	1	
2005 - 2012	Transportation	Accessibility	Encourage regional public transportation by working with other cities in the Metroplex to create efficient commuter rail, modern streetcar, light rail, bus service, and other types of mass transit.	1	
2005 - 2010	Transportation	Accessibility	Conduct corridor studies to evaluate pedestrian and vehicle movements and their impacts on retail, residential, and historic areas.	2	
2005 - 2012	Transportation	Accessibility	Facilitate travel between growth centers and urban villages through thoroughfare improvements and public transportation opportunities.	2	
2005 - 2010	Transportation	Accessibility	Participate with The T and NCTCOG on passenger rail and bicycle route studies.	2	
2005	Transportation	Accessibility	Continue to work with The T to	2	

- 2012			expand and integrate public transit into the City's transportation system.		
2005 - 2012	Transportation	Accessibility	Identify and promote potential locations for the expansion of rail transit. (2012 -Promote the expansion of rail)	1	
2005 - 2012	Transportation	Accessibility	Promote park-and-ride facilities to encourage the use of public transit.	1	
2005 - 2012	Transportation	Accessibility	Evaluate traffic, [*cyclist], and pedestrian safety near shopping, schools, and other pedestrian-oriented areas on a continuous basis.(*added in 2009)	2	
2005 - 2012	Transportation	Increase Bike & Pedestrian Opportunities	Emphasize public transportation, bicycle, and pedestrian improvements in designated growth centers	1	
2005 -2012	Transportation	Reduce VMT/Improve Air Quality	Encourage development that reduces daily vehicle miles traveled for commuters through the creation of urban villages, transit-oriented development, and mixed use growth centers	1	
2005 - 2012	Transportation	Reduce VMT/Improve Air Quality	Promote location of multifamily units within walking distance of public transportation, employment, and/or shopping to increase accessibility and decrease vehicular traffic generation	1	
2005 - 2012	Transportation	Reduce VMT/Improve Air Quality	Link growth centers with major thoroughfares, public transportation, trails and linear parks	2	
2005 - 2012	Transportation	Reduce VMT/Improve Air Quality	Provide for [*and maintain] interconnectivity of streets and trails, especially within residential subdivisions, to reduce vehicle trips on arterial streets, increase efficiency, reduce air pollution, distribute traffic, improve access to public places, improve efficiency in providing services and deliveries, and ensure access for emergency services.(*added in 2010)	2	
2005 - 2010	Transportation	Reduce VMT/Improve Air Quality	Lessen the transportation system's negative impacts on air quality, the environment, and neighborhood quality of life.	1	
2005 - 2010	Transportation	Reduce VMT/Improve Air Quality	Continue to implement transportation control measures that reduce vehicle use, improve traffic flow, and reduce	2	

			congestion conditions.		
2005 - 2012	Transportation	Reduce VMT/Improve Air Quality	Encourage linkages between neighborhoods and integrate land uses to decrease vehicle miles traveled. **(In 2012 'Encourage' is replaced with 'Improve')**	1	
2005 - 2012	Transportation	Transit-Oriented Development	Promote transit-oriented development, which encourages compact urban development adjacent to transit stops and interchanges. Mixed uses in a single building, minimal setbacks, and taller structures help achieve the higher densities necessary to support transit. Parking facilities, retail businesses, and services for commuters should be located close to transit stops.	1	
2005 - 2012	Transportation	Transit-Oriented Development	Include projects in future Capital Improvement Programs that support the growth center concept, [*transit-oriented development, and urban villages]. (*added in 2009)	2	
2005 - 2012	Transportation	Transit-Oriented Development	Use the City's interim land banking policy to expedite redevelopment and reuse of underutilized property [*and to support the creation of successful transit-oriented developments (TOD)]. (*added in 2009)	2	
2005 - 2012	Transportation	Transit-Oriented Development	Improve mobility and air quality by providing a multimodal transportation system that is effectively coordinated with existing and planned adjacent land uses.	2	
2005 - 2009	Transportation	Transit-Oriented Development	Work with The T to create Station Area Plans and to identify potential locations for transit-oriented developments (TOD).	2	**84**
2006 - 2012	Land Use	Zoning	The City Council has adopted four mixed-use zoning classifications, MU-1, MU-1G, MU-2, and MU-2G to promote desirable development in designated mixed-use growth centers and urban villages, but property owners must still seek a zoning change to utilize them.	2	**2**
2007 - 2012	Buildings	Development Practices	Design Guidelines for New & Existing Facilities – The City has recently published major guideline revisions to more	2	

			accurately communicate City efficiency and sustainability concerns to project architects, engineers and contractors. In addition, specific sustainability guidelines referencing the United States Green Building Council's Leadership in Energy & Environmental Design (USGBC/LEED) program have been added.		
2007	Land Use	Infill/Brownfields	Create a Brownfields Redevelopment Guidebook in 2007 to help educate potential developers on the City's brownfields program, the process needed to redevelop a site, and any funding or other incentives available.	2	
2007 - 2012	Land Use	Zoning	Pursue greater statutory authority to effectively manage growth and discourage suburban sprawl.	2	
2007 - 2009	Sustainable Development		Established the original Sustainability & Green Building Task Force, followed by the Sustainable Development Task Force established in January of 2009 and the Sustainability Task Force established in June of 2009.	2	
2007 - 2009	Transportation	Increase Bike & Pedestrian Opportunities	A neighborhood trail connection study is currently underway that will identify potential connection between neighborhoods and the Trinity River trail system.	2	**10**
2008 - 2009	Land Use	Infill/Brownfields	Require infill development to adhere to the design guidelines for new construction within historic districts	2	
2008 - 2012	Transportation	Increase Bike & Pedestrian Opportunities	Promote and participate in local and regional activities that encourage bicycling and walking as a means of transportation	1	
2008	Transportation	Increase Bike & Pedestrian Opportunities	Complete the bicycle transportation plan in 2008	2	
2008 - 2012	Transportation	Transit-Oriented Development	Incorporate the needs of pedestrians, bicyclists, transit riders, and persons of all ages and abilities when planning and designing transportation projects	2	**7**
2009 - 2012	Buildings	Development Practices	Where appropriate, preserve mature trees and plant additional trees to help the air filtering process and to reduce	1	

			the ambient outdoor temperature.		
2009 - 2012	Sustainable Development		Promote sustainable development practices within the public and private sectors.	1	
2009	Sustainable Development		Prepare a Sustainability Action Plan in 2009	2	
2009 - 2012	Sustainable Development		Improve sustainability of public and private development activities within Fort Worth and the Metroplex.	1	
2009 - 2012	Sustainable Development		Promote orderly and sustainable development in growing areas.	1	
2009 - 2012	Transportation	Accessibility	Promote street system patterns that provide greater connectivity between streets and between developments to reduce traffic demands on arterial streets, improve emergency access, and make bicycling and walking more attractive transportation options	1	
2009 - 2012	Transportation	Accessibility	Develop a Complete Streets policy that requires streets to be designed to accommodate all likely users	2	
2009 - 2010	Transportation	Increase Bike & Pedestrian Opportunities	Implement bicycle transportation improvements identified in the Bike Fort Worth Plan.	2	
2009 - 2010	Transportation	Increase Bike & Pedestrian Opportunities	Provide new and enhanced access to existing bicycling and walking facilities	2	
2009 - 2012	Transportation	Transit-Oriented Development	Support the expansion of rail transit and associated transit-oriented developments (TOD) as a means to efficiently connect workers and employers.	1	**14**
2010 - 2012	Buildings	Development Practices	The City encourages new buildings to meet Leadership in Energy and Environmental Design (LEED) certification or comparable green-building standards.	1	
2010 - 2012	Land Use	Parks, Trails and Green Space	Review the effectiveness of, and seek amendments to, policies and procedures in the acquisition, development, and management of parkland and community facilities in 2010/2012.	2	
2010 - 2012	Land Use	Parks, Trails and Green Space	Support implementation of the park, trail, and open space recommendations of the Lake Worth Vision Plan.	1	
2010	Land Use	Parks, Trails	Support innovative development	1	

- 2012		and Green Space	projects that showcase low-impact development practices, conserve riparian buffers, and extend greenway networks with hike/bike trails.		
2010 - 2012	Land Use	Parks, Trails and Green Space	Improve land use efficiency, mobility, and air quality by developing a network of interconnected local streets and trails that facilitate more direct vehicle and pedestrian access between adjacent uses	2	
2010 - 2012	Sustainable Development		Develop and implement a Sustainability Action Plan for the City including action items that affect private development, City operations, and individual efforts	2	
2010 - 2012	Transportation	Accessibility	Encourage new development in character with the existing neighborhood scale, architecture, and platting pattern, while working to improve pedestrian, bicycle, and transit access between adjacent neighborhoods and nearby destinations.	1	
2010 - 2012	Transportation	Increase Bike & Pedestrian Opportunities	Through implementation of the 2010 Bike Fort Worth Plan, the City is providing a higher level of bicycling accommodation, including the provision of dedicated bicycle lanes on arterial streets designated as bike routes; better connections between the on-street and off-street bicycling networks and between facilities in Fort Worth and those in neighboring communities; additional bicycle parking and end-of-trip facilities for bicyclists; and work with partner agencies to provide public safety, education, and promotional programs.	2	
2010	Transportation	Increase Bike & Pedestrian Opportunities	City Council unanimously passed the first Fort Worth bike parking zoning ordinance in November 2010. This ordinance now requires installation of bike racks for most new nonresidential and multifamily developments. The presence of well-designed and positioned bike racks has been shown to increase bicycle trips.	2	
2010	Transportation	Transit-Oriented Development	Work with The T to plan for transit-oriented development	2	**16**

			(TOD) in 2010 as part of the Southwest-to-Northeast Rail Corridor Environmental Impact Statement and Preliminary Engineering		
2012	Buildings	Development Practices	Obtain LEED Silver certification or better for newcity-owned facilities and major renovations.	2	
2012	Land Use	Infill/Brownfields	Reduce the amount of vacant developable land in the central city from 12,800 acres to 11,300 acres.	2	
2012	Land Use	Mixed-Use Development	Identify and designate on future land use maps mixed-use neighborhood centers and/or new mixed-use growth centers in rapidly developing areas, based on proximity to future rail transit and key transportation intersections.	2	
2012	Land Use	Mixed-Use Development	Increase new residential units in mixed-use growth centers, urban villages, and transit-oriented development areas so that one third of new residential development occurs in these locations. It is estimated that this would equal approximately 30,000 units over a 20-year period.	2	
2012	Land Use	Parks, Trails and Green Space	To protect water quality and provide for connected green spaces, encourage parks, bike trails, and open space within floodplains and adjacent water bodies.	1	
2012	Land Use	Parks, Trails and Green Space	Review the effectiveness of, and seek amendments to, policies and procedures in the acquisition, development, and management of parkland and community facilities in 2012.	2	
2012	Land Use	Parks, Trails and Green Space	Recognize the importance of urban parks and plazas to the success of central city redevelopment efforts, and to the creation of attractive and vibrant transit-oriented development areas, and support development of urban parks and plazas in these areas.	1	
2012	Land Use	Zoning	Establish mixed-use design districts– whether as a combination of MU and UR zoning, or as independent form-based zoning districts– in all areas of the city where higher	2	

			density mixed-use districts are appropriate.		
2012	Land Use	Zoning	Coordinate future land uses with the Master Thoroughfare Plan, Bike Fort Worth Plan, and Transit-Oriented Development (TOD) Plans.	2	
2012	Land Use	Zoning	Increase the total land area zoned for mixed-use or urban residential development in designated mixed-use growth centers, urban villages, and proposed transit-oriented developments (TODs) from 5,000 to 7,500 acres by 2014.	2	
2012	Land Use	Zoning	Support community efforts to create form-based zoning districts that reflect the aspirations of stakeholders to foster the development of attractive and vibrant walkable urban neighborhoods	1	
2012	Sustainable Development		Integrate practices aimed at improving environmental quality with innovative urban design approaches.	2	
2012	Sustainable Development		Implement at least three initiatives identified in the Sustainability Action Plan in 2012.	2	
2012	Transportation	Accessibility	Encourage and facilitate the location and design both urban and suburban of schools to maximize walkable, bikeable, and transit connectivity with all surrounding residential areas.	1	
2012	Transportation	Increase Bike & Pedestrian Opportunities	Increase the number of marked bike lanes on City streets from 7.5 miles to 15 miles.	2	
2012	Transportation	Increase Bike & Pedestrian Opportunities	Increase the miles of bikeways from 104 miles to 150 miles in 2013.	2	
2012	Transportation	Increase Bike & Pedestrian Opportunities	In 2012, secure annual funding for a bicycle rack request program and annual funding for installation of on-street bicycle facilities.	2	
2012	Transportation	Increase Bike & Pedestrian Opportunities	Adopt the Walk Fort Worth Pedestrian Master Plan in 2012	2	
2012	Transportation	Reduce VMT/Improve Air Quality	Support community efforts to create form-based zoning districts that reflect the aspirations of stakeholders to foster the development of attractive and vibrant walkable urban neighborhoods.	1	
2012	Transportation	Reduce	Reduce vehicle-miles traveled	2	

		VMT/Improve Air Quality	per capita from 25.3 to 24.5.		
2012	Transportation	Reduce VMT/Improve Air Quality	Increase The T's average weekday bus ridership at a rate of 2% annually.	2	
2012	Transportation	Transit-Oriented Development	Starting in 2012, the City will begin developing and implementing Transit-Oriented Development plans with a strong emphasis on providing housing choices with access to rail transit and other transportation options.	2	
2012	Transportation	Transit-Oriented Development	Plan for and begin implementing Transit-Oriented Development adjacent to regional rail stations in 2015.	2	
2012	Transportation	Transit-Oriented Development	Create a Transit-Oriented Development Plan and implementing Form-Based Code for the TCU/Berry rail station area in 2013.	2	
	Transportation	Transit-Oriented Development	Design and construct streetscape improvements in selected urban villages and transit-oriented development (TOD) locations by 2016.	2	**45**
				TOTAL SCORE FOR 2005-2013	**178**

CITY OF AUSTIN					
Sustainable Built Environment Polices & Commitment Scores					
Year	**Policy Category**	**Area of Focus**	**Policy Description**	**Commitment Score**	**TOTAL SCORE**
2005	Land Use	Zoning	Apply the mixed-use future land use designation to commercial properties on arterial roads to encourage combined residential and commercial projects, resulting in increased housing options and more housing units.	2	
2005	Land Use	Mixed-Use Development	The local commercial corridors should become higher-intensity, mixed-use, pedestrian-oriented places.	1	
2005	Land Use	Zoning	Identify areas where mixed use would enhance the livability of the neighborhoods and rezone accordingly.	2	
2005	Transportation	Accessibility	Promote multi-modal approaches to improve mobility.	1	
2005	Transportation	Transit-Oriented Development	Investigate the creation of programs or incentive packages to promote new pedestrian-oriented development or redevelopment. These may include public/private partnerships and/or changes to the land development code.	1	
2005	Transportation	Transit-Oriented Development	TOD Ordinance, establishing denser development surrounding commuter rail stops, improved connectivity betweent the surrounding community and the TOD district, and seeks to establish housing affordability goals for new development.	2	
2005	Transportation	Increase Bike & Pedestrian Opportunities	Improve the regional and local bicycle network throughout the	1	**10**

			area.		
2006	Land Use	Mixed-Use Development	Austin City Council amended the City's Land Development Code in 2006 to add Subchapter E: Design Standards and Mixed Use to improve the quality of commercial development.	2	**2**
2007	Buildings	Development Practices	In 2007, the City of Austin passed the Austin Climate Protection Plan resolution.	2	
2007	Land Use	Infill/Brownfields	Adopt the Neighborhood Urban Center infill option on the Capital Plaza site (5300 North IH-35), Springdale Shopping Center site, and Windsor Village Shopping Center.	2	
2007	Land Use	Mixed-Use Development	Promote a mix of land uses that respect and enhance the existing neighborhood and address compatibility between residential, commercial, and industrial uses.	1	
2007	Land Use	Parks, Trails and Green Space	Achieve and maintain a healthy, sustainable, robust, functional, and aesthetically beautiful parks and green space system that provides active and passive recreational opportunities for all residents.	2	
2007	Land Use	Parks, Trails and Green Space	Acquire parkland to serve the residents living in the area between IH-35, Hwy 290 and Cameron Road.	2	
2007	Land Use	Parks, Trails and Green Space	Because open space is such an important element of compact, high density development areas, on-site open space provision generally in the form of pocket and/or linear parks, trails, and plazas are	2	

			recommended. If it is either impossible on unrealistic that parkland be provided on-site, parkland dedication fees generated in a TOD are recommended to be spent within the TOD or in the immediate vicinity with the Open Space Concept used as a guide.		
2007	Land Use	Parks, Trails and Green Space	Create more public open space, including parks and green spaces, improve existing parks and increase recreational amenities	1	
2007	Land Use	Zoning	The City Council has adopted a Vertical Mixed Use (VMU) density bonus with affordability requirements, as part of the Design Standards and Mixed Use ordinance.	2	
2007	Transportation	Accessibility	Achieve maximum connectivity between greenbelts/trails in the Mueller redevelopment and trails in the surrounding neighborhoods.	2	
2007	Transportation	Transit-Oriented Development	The City of Austin Neighborhood Planning and Zoning Department prepared a TOD Guidebook to create a shared understanding of TOD and also to identify the major design principles and factors for success	2	
2007	Transportation	Increase Bike & Pedestrian Opportunities	As part of the evaluation the Austin Traffic Impact Analysis (TIA) program, an amendment of Section 2.3.5 of the Transportation Criteria Manual, “Recommendation on Roadway Improvements and	2	

			Traffic Control Modifications", to allow for infrastructure projects (including bicycle, trail, pedestrian, and street/intersection improvements) is recommended to allow an adopted station area plan to qualify for required improvements through the TIA process.		
2007	Transportation	Increase Bike & Pedestrian Opportunities	Install bicycle racks at all area shopping centers.	2	
2007	Transportation	Reduce VMT/Improve Air Quality	Improve air quality and public health by providing alternative transportation choices. Provide clear alternatives to auto-centric development patterns by providing an environment that is pedestrian, bicycle, and transit-friendly.	2	
2007 - 2008	Buildings	Development Practices	Encourage roofing and paving design and materials that reduce the urban heat island effect (the tendency of urban areas to be several degrees warmer than the surrounding countryside). This includes using light colored roofing, siding and paving materials to reflect, rather than absorb the sun's heat and by maximizing planted areas and shading paved areas and dark surfaces. Green roofs (planted vegetation on roofs) are a good option to help reduce the heat island effect and also provide air quality benefits.	1	
2007 - 2008	Buildings	Development Practices	Promote the use of environmentally compatible building materials by selecting	1	

			regional materials that are non-toxic, recycled and harvested in a sustainable manner.		
2007 - 2008	Transportation	Transit-Oriented Development	Created four TOD types and designated a TOD type for each of the stations	2	
2007 - 2008	Transportation	Transit-Oriented Development	Developed TOD districts around the stations to delineate between areas appropriate for redevelopment and established neighborhoods that would be protected;	2	**30**
2008	Buildings	Development Practices	Builders should use the Green Building Standards in their projects whenever possible: Using local materials, considering water needs for landscaping, and installing efficient heating and cooling systems are all steps to building greener homes.	1	
2008	Buildings	Development Practices	Consider design and application of sustainable roof such as vegetated roofs and/or rainwater collection systems.	1	
2008	Buildings	Development Practices	Encourage all new buildings to meet the goals of the Austin Climate Protection Plan in effect at the time they begin the permit process. Current goals are to make all new single-family homes zero net energy capable by 2015 and increase energy efficiency in all other new construction by 75% by 2015.	1	
2008	Buildings	Development Practices	Integrate green building practices such as solar power panels, solar hot water heating, wind power, rainwater collection systems, green roofs	2	

			and water quality controls as necessary. If possible, projects should strive to achieve one star or higher rating under the City of Austin Green Building Program or other environmental programs.		
2008	Buildings	Development Practices	Preserve character of old while incorporating sustainable green building practices.	1	
2008	Land Use	Infill/Brownfields	Cluster higher density development in appropriate areas, striving to balance the interests of stakeholders while taking into consideration environmental concerns.	1	
2008	Land Use	Infill/Brownfields	Encourage developers to explore clustered development as an option, since it provides sufficient housing units while maintaining and preserving considerable amounts of open space.	1	
2008	Land Use	Parks, Trails and Green Space	Provide, protect, and preserve open spaces and environmental features by encouraging cluster developments.	1	
2008	Sustainable Development		Balance development and environmental protection by maintaining a vibrant residential and commercial community that demonstrates caring stewardship of the environment.	1	
2008	Transportation	Accessibility	Establish a network of greenspaces and trails connecting neighborhoods and other destinations.	2	
2008	Transportation	Transit-Oriented Development	Prioritization of TOD Projects.	2	
2008	Transportation	Increase Bike & Pedestrian	All new residential development and	1	

		Opportunities	redevelopment projects should incorporate select design elements to increase walk-ability throughout the Oak Hill area.		
2008	Transportation	Increase Bike & Pedestrian Opportunities	Builders should explore the option of including a trail through their project site or dedicating an easement near water quality features.	1	
2008	Transportation	Increase Bike & Pedestrian Opportunities	Encourage pedestrian mobility by additional (separated) sidewalks and bicycle paths along major roadways.	1	
2008	Transportation	Increase Bike & Pedestrian Opportunities	Provide clear alternatives to auto-centric development patterns by providing an environment that is pedestrian, bicycle, and transit-friendly.	2	
2008 - 2009	Land Use	Mixed-Use Development	Create opportunities for shorter, multi-purpose trips by encouraging a mix of uses	1	
2008 - 2009	Transportation	Accessibility	Ensure that site design promotes efficient pedestrian and vehicle circulation patterns	1	
2008 - 2009	Transportation	Transit-Oriented Development	Encourage transit-supportive land uses, which generally have higher densities near transit stops, thereby promoting greater transit ridership	1	
2008 - 2009	Transportation	Transit-Oriented Development	To promote TOD principles intended to successfully integrate land use and transit by providing greater density than the community average, a mix of uses, and a quality pedestrian environment around a defined center	1	
2008 - 2009	Transportation	Increase Bike & Pedestrian Opportunities	Austin’s climate requires shade and shelter amenities in order to accommodate and promote	1	

			pedestrian activity. These amenities will provide greater connectivity between sites and allow for a more continuous and walkable network of buildings.		
2008 - 2010	Land Use	Mixed-Use Development	Provide for and encourage development and redevelopment that contains a compatible mix of residential, commercial services, and employment within close proximity to each other and to transit.	1	
2008 - 2010	Transportation	Accessibility	Ensure that sites are developed in a manner that supports and encourages connectivity for all modes of travel and that new and existing development, pedestrian and bicycle paths, and open spaces complement and link to one another.	1	
2008 - 2010	Transportation	Increase Bike & Pedestrian Opportunities	Ensure the creation of a high-quality street and sidewalk environment that is supportive of pedestrian and transit mobility and that is appropriate to the roadway context	1	
2008 - 2010	Transportation	Increase Bike & Pedestrian Opportunities	Provide adequate, secure, and convenient bicycle parking to meet the needs of the users of a development and to encourage cycling activity	2	**29**
2009	Buildings	Development Practices	All buildings must achieve a minimum One Star rating from Austin Energy Green Building using the rating system version in use at the time of application for building permit.(North Burnet Gateway)	2	

2009	Buildings	Development Practices	Ensure green building techniques are considered in building design and decisions are made with health, energyefficiency, long-term maintenance and the environment in mind.(North Burnet Gateway)	1	
2009	Transportation	Increase Bike & Pedestrian Opportunities	To improve the area's access to high quality transit services and create an environment that promotes walking and cycling (North Burnet Gateway)	1	
2009 - 2010	Land Use	Reuse	Enable redevelopment and adaptive reuse while accommodating existing uses.	1	
2009 - 2010	Transportation	Transit-Oriented Development	Enable opportunities for transit-oriented development around the rail transit stations.	1	
2009 - 2010	Transportation	Increase Bike & Pedestrian Opportunities	Encourage a greater percentage of travel accomplished by walking, biking, and transit	1	**7**
2010	Buildings	Development Practices	Create an incentive program for Green Building and LEED - All buildings should strive to meet either 1) Austin's Green Building Program or 2) be LEED Certified as defined by the US Green Building council or other nationally recognized green building certification system. A development green bonus program could include the inclusion of sustainable green building design and practices as a potential way for developers to be granted additional height or density for a project.(East Riverside Cooridor)	2	
2010	Buildings	Development Practices	New development should be designed and constructed using	1	

			the latest green technologies and principles embodied in Austin Energy's Green Building program to help reduce energy consumption. Historic buildings should be preserved.		
2010	Buildings	Development Practices	PARD equipment selection criteria encourages the purchase of equipment with a large percentage of post consumer recycled building materials	1	
2010	Buildings	Development Practices	All new development (mixed use, commercial, or multi-family) must be pedestrian-friendly and oriented towards the street with parking located to the rear of the building(s).	2	
2010	Buildings	Development Practices	Provide property owners with information to encourage green practices in private development (East Riverside Cooridor)	1	
2010	Land Use	Infill/Brownfields	Promote transit-supportive development and redevelopment within the ERC Hubs in order to successfully integrate land use and transit by providing greater density than the City of Austin average, a mix of uses, and a quality pedestrian environment around defi ned centers (East Riverside Cooridor)	1	
2010	Land Use	Parks, Trails and Green Space	Design and maintain parks and facilities to achieve sustainability	2	
2010	Land Use	Parks, Trails and Green Space	Develop neighborhood pocket parks and greenways	2	
2010	Land Use	Parks, Trails and Green Space	Incorporate a range of types and sizes of open space within the	2	

			area. Different types of open space such as plazas, squares, and streetscapes in the Huns, pocket parks in residential areas, and greenways along the creeks and trails. (East Riverside Cooridor)		
2010	Land Use	Parks, Trails and Green Space	Parkland Dedication Ordinance – The Ordinance requires that any new residential development contribute land or fees to offset the impact of new demands on the park system due to increase residential density. Land is dedicated at a rate of 5 acres per 1000 new residents, or a fee is paid based on $650 per living unit.	2	
2010	Transportation	Accessibility	Coordinate with the Neighborhood Connectivity Division and other relevant agencies to increase trail connectivity (by means of sidewalks, recreation easements or land acquisition) between parks, neighborhoods, community facilities, and the urban core	2	
2010	Transportation	Accessibility	Improve the area's access to transit services and create an environment that promotes walking and cycling (East Riverside Cooridor)	1	
2010	Transportation	Accessibility	Increase connectivity from neighborhoods to parks, greenways and trails	1	
2010	Transportation	Accessibility	Introduce streetcar/light rail service on East Riverside Dr.	2	
2010	Transportation	Transit-Oriented Development	Enabling transit-supportive redevelopment that supports higher levels	1	

			of development around primary transit stops (East Riverside Cooridor)		
2010	Transportation	Increase Bike & Pedestrian Opportunities	Allow for creation of dense and vibrant Hubs, or areas where the most intensive development within the corridor is encouraged, with urban form and uses that require less reliance on the automobile and are more accommodating of pedestrian, transit, and bicycle transportation.(East Riverside Cooridor)	1	
2010	Transportation	Increase Bike & Pedestrian Opportunities	Include a mix of striped bicycle lanes and off-street bicycle paths to serve multiple needs and levels of cycling experience.(East Riverside Cooridor)	2	
2010	Transportation	Reduce VMT/Improve Air Quality	The design of any redevelopment should be compact, mixed use, and walkable so that automobile trips are minimized.	1	**27**
2011	Land Use	Infill/Brownfields	Adopt 'Cottage Lot and Urban Home', 'Small Lot Amnesty', 'Residential Infill', or 'Neighborhood Urban Center' infill option within the subdistrict specified.	2	
2011	Land Use	Mixed-Use Development	Support commercial or mixed use developments that are neighborhood serving and neighborhood-friendly (which do not emit noise, pollution, or light, and, do not have a lot of truck traffic/deliveries, or have extended hours of operation), especially when they abut single family subdivisions.	1	
2011	Land Use	Parks, Trails and Green Space	Support the expansion of public parkland and greenspace	1	

2011	Transportation	Accessibility	Expand and improve bicycle/pedestrian network to encourage greater non-automotive transportation and connectivity.	2	
2011	Transportation	Reduce VMT/Improve Air Quality	Encourage greater public transit service and increased ridership	1	**7**
2012	Buildings	Development Practices	Assess options to coordinate and expand incentives for residential and commercial property owners to install green infrastructure elements, such as green roofs, rainwater harvesting, pervious pavement, and rain gardens.	2	
2012	Buildings	Development Practices	Develop and implement City of Austin 2012 Energy Code for commercial construction to achieve energy improvement goals established in the Climate Protection Plan Homes and Buildings section.	2	
2012	Buildings	Development Practices	Develop local amendments to 2012 Energy Code for residential construction to achieve 50% below 2000 IECC target in accordance with the 2015 goals of the Zero Energy Capable Homes plan	2	
2012	Buildings	Development Practices	Encourage green practices in housing construction and rehabilitation that support durable, healthy, and energy-efficient homes.	1	
2012	Buildings	Development Practices	Promote the highest levels of sustainable design and green construction.	1	
2012	Buildings	Development Practices	The "Sustainability" component of Downtown Density Bonus Program should	1	

			be modified to move 2-Star Austin Energy Green Building (AEGB) rating from the list of Sustainability options to a “Gatekeeper” requirement. In other words, a 2-Star rating would be required for all projects that seek to participate in the Density Bonus Program.		
2012	Buildings	Development Practices	The City should also allow developers to employ the Leadership in Energy and Environmental Design (LEED) rating system as an alternative to the AEGB, since this rating system has become a nationally-recognized standard.	1	
2012	Buildings	Development Practices	The City should develop Downtown standards for green building, based on the goals and policies established city-wide by the Comprehensive Plan, to ensure that Downtown plays an appropriate and equitable role in meeting local and regional sustainability targets	1	
2012	Buildings	Development Practices	The City should evaluate other accepted green building rating tools in addition to AEGB. One such rating tool is the Leadership in Energy and Environmental Design (LEED) rating system, which has become a nationally recognized benchmark. Some developers, especially those with a presence outside of Austin, may desire the option to use such tools. Further analysis is needed to	1	

			develop specific recommendations, including determining an appropriate process and level of certification that would provide equivalency to AEGB ratings. If LEED, or another rating tool, is included as an option, processes should be put in place that will ensure an equivalent level of verification and reporting.		
2012	Land Use	Infill/Brownfields	Dense development that respects the context of Downtown's diverse districts should be encouraged.	1	
2012	Land Use	Infill/Brownfields	Encourage infill and redevelopment opportunities that place residential, work, and retail land uses in proximity to each other to maximize walking, bicycling, and transit opportunities.	1	
2012	Land Use	Infill/Brownfields	Ensure that Downtown can evolve into a compact and dense urban district.	1	
2012	Land Use	Infill/Brownfields	Promote infill residential development with a high degree of livability.	1	
2012	Land Use	Infill/Brownfields	Reuse former brownfields, grayfields and vacant building sites to reduce negative impacts of vacancy and provide new mixed use and/or housing options.	2	
2012	Land Use	Infill/Brownfields	Support up-to-date infrastructure, flexible policies and programs, and adaptive reuse of buildings, so local, small, and creative businesses thrive and innovate.	1	
2012	Land Use	Mixed-Use Development	Integrate public buildings and facilities into active, walkable,	2	

			mixed use neighborhoods and complete, healthy communities.		
2012	Land Use	Parks, Trails and Green Space	Extend existing trail and greenway projects to create an interconnected green infrastructure network that includes such elements as preserves and parks, trails, stream corridors, green streets, greenways, agricultural lands linking all parts of Austin and connecting Austin to nearby cities.	2	
2012	Land Use	Parks, Trails and Green Space	Protect Austin's natural resources and environmental systems by limiting land use and transportation development in sensitive environmental areas and preserving areas of open space.	2	
2012	Land Use	Parks, Trails and Green Space	Provide incentives and design criteria that promote high quality open space within private developments. Special incentives including density bonuses and/or Floor Area Ratio exemptions should be offered to developments which provide publicly-accessible open space in compliance with established design criteria.	2	
2012	Land Use	Parks, Trails and Green Space	The 'Publicly Accessible Open Space' component of the Downtown Density Bonus Program should be modified so that a participant in the Program can achieve bonus square footage either by providing on-site open space that is publicly accessible and that meets well-defined	1	

			criteria or by paying a fee-in-lieu that could be used to improve Downtown parkland In developing the code amendments that put in place the proposed Downtown Density Bonus Program, City staff should modify the structure		
2012	Land Use	Zoning	Align land use and transportation planning and decision-making to achieve a compact and connected city in line with the Growth Concept Map	2	
2012	Land Use	Zoning	Amend the Land Development Code. Revise regulations for the downtown area to promote a mix of uses, incentivize well-designed dense development, preserve unique districts and destinations and result in buildings that contribute to a vibrant public realm.	2	
2012	Land Use	Zoning	Replace single-use zoning districts with downtown mixed-use zoning designations.	2	
2012	Land Use	Zoning	The City should establish two new downtown mixed-use zoning districts, “DMU-40” and “DMU-60”, to replace these single-purpose zoning districts and provide for a broader mix of residential and commercial uses.	1	
2012	Transportation	Accessibility	Develop a multi-modal transportation system that improves access to and mobility within Downtown.	2	
2012	Transportation	Accessibility	Increase connectivity between neighborhoods and from neighborhoods to parks and greenways through the use of sidewalks, bicycle	2	

			lanes, multi-use paths, and trails.		
2012	Transportation	Transit-Oriented Development	Promote development in compact centers, communities, or along corridors that are connected by roads and transit, are designed to encourage walking and bicycling, and reduce healthcare, housing and transportation costs.	1	
2012	Transportation	Increase Bike & Pedestrian Opportunities	Assure that new development is walkable and bikable and preserves the positive characteristics of existing pedestrian friendly environments.	2	
2012	Transportation	Increase Bike & Pedestrian Opportunities	Create a more continuous system of off -street bikeways and multi -use trails.	2	
2012	Transportation	Increase Bike & Pedestrian Opportunities	Encourage more active lifestyles through new and redevelopment that supports walking and bicycling.	1	
2012	Transportation	Increase Bike & Pedestrian Opportunities	Establish bicycle priority streets that provide facilities for all levels of bicyclists along key northsouth and east-west corridors. The City should augment the existing bicycle network by implementing the recommended facilities for the bicycle priority streets, as identified in the Austin Bicycle Plan Update and the DAP Transportation Framework Plan, thereby providing a clear and safe network for bicyclists of all experience levels.	2	
2012	Transportation	Increase Bike & Pedestrian Opportunities	Implement 5 miles of new sidewalk per year, both 2012 and 2013 to support transit and encourage walking as a mode of transportation, as per	2	

			the Sidewalk Master Plan		
2012	Transportation	Increase Bike & Pedestrian Opportunities	Improve the Austin Bicycle Route Network by 35 miles each year 2012/2013, as per the Bicycle Master Plan	2	
2012	Transportation	Increase Bike & Pedestrian Opportunities	Improve the pedestrian infrastructure by providing urban trails for recreational and commuting purposes.	2	
2012	Transportation	Reduce VMT/Improve Air Quality	Apply high standards of urban design to ensure that "complete streets" are safe and accessible for all users. Encourage people to use alternative forms of transportation that are sensitive to the demands of the Central Texas climate.	1	
2012	Transportation	Reduce VMT/Improve Air Quality	Continue efforts to implement future intercity rail and High Speed Rail in the Austin region.	1	
2012	Transportation	Reduce VMT/Improve Air Quality	Establish an urban rail system to connect Downtown with other Central Austin destinations and the existing and passenger rail system.	2	
2012	Transportation	Reduce VMT/Improve Air Quality	Public transit should be enhanced as a high-quality mode of choice.	1	**58**
2013	Buildings	Development Practices	Create regulations and incentives for developers and builders to use green development techniques for buildings, streets, and open spaces with a focus on conservation, longevity, and sustainability.	2	
2013	Buildings	Development Practices	Encourage designs and building practices that reduce the environmental impact of development and that result in accessible green	1	

			space.		
2013	Buildings	Development Practices	Expand informational programs that educate homeowners and builders about sustainable building practices.	2	
2013	Land Use	Infill/Brownfields	Create a regulatory environment to promote the redevelopment of brownfields and greyfields into compact, walkable places.	2	
2013	Land Use	Mixed-Use Development	Adopt policies and establish a regulatory environment that promotes the development of compact, mixed-use places that provide great public spaces accessible to people of all ages.	2	
2013	Land Use	Parks, Trails and Green Space	Establish pocket parks, smaller undeveloped preserves, and passive recreational spaces in areas with little open space.	2	
2013	Land Use	Parks, Trails and Green Space	Identify existing areas with limited access to parks, open space, and trails and create mechanisms to address these gaps.	2	
2013	Sustainable Development		Review and change building and zoning codes and incorporate best practices to promote green building and sustainable development.	2	
2013	Transportation	Accessibility	Create a trails master plan to ensure connectivity and provide consistency with regional, city, and neighborhood – level trail and transportation goals to provide pedestrian and bicycle connections between neighborhoods and destinations; incorporate trails throughout the city and	2	

			region; encourage developers to connect to or complete the trail system; and use protected land along creeks and floodplains in an environmentally sustainable way.		
2013	Transportation	Accessibility	Develop standards to connect all new neighborhoods to adjacent neighborhoods and commercial areas by streets, sidewalks, and bicycle lanes and/or paths.	2	
2013	Transportation	Accessibility	Enhance crosstown transit options to better connect people to the places where they live, work, play, shop, and access services.	2	
2013	Transportation	Transit-Oriented Development	Create a system of high-capacity transit, including elements such as urban rail and bus rapid transit corresponding to land-use mix and intensity.	2	
2013	Transportation	Transit-Oriented Development	Give priority to City of Austin investments to support mixed use, transit, and the creation of compact walkable and bikeable places.	2	
2013	Transportation	Increase Bike & Pedestrian Opportunities	Create a network of on –and off-street physically separated bicycle and walking routes or trails linking all parts of Austin and the region.	2	
2013	Transportation	Increase Bike & Pedestrian Opportunities	Promote increased bicycling and walking through traffic enforcement, program evaluation, and developing and integrating web-based tools, mobile applications and other educational materials.	1	**28**
				TOTAL SCORE FOR 2005-2013	**198**

Appendix E

Land and Building Data by Zip Code for 2009 - 2013: Fort Worth & Austin

Fort Worth Zip Codes	Avg Age Building Stock					Density of Building (FAR = living area/total land area)					Census Block Density (Mean Number of Census Blocks per Square Mile)					% of Parcels with Buildings				
	2009	2010	2011	2012	2013	2009	2010	2011	2012	2013	2009	2010	2011	2012	2013	2009	2010	2011	2012	2013
76102	1965	1965	1966	1966	1966	1.04	1.06	1.08	1.08	1.09	131.05	152.04	152.04	152.47	152.47	57%	57%	56%	58%	58%
76103	1950	1950	1951	1951	1951	0.13	0.14	0.14	0.14	0.14	52.66	56.76	56.76	56.76	56.76	89%	89%	89%	90%	90%
76104	1947	1947	1948	1948	1949	0.36	0.35	0.38	0.38	0.39	165.82	164.45	164.45	164.62	164.79	59%	59%	59%	59%	60%
76105	1947	1947	1947	1947	1947	0.16	0.16	0.15	0.15	0.15	95.01	103.56	103.56	103.56	103.56	76%	75%	75%	75%	75%
76106	1955	1955	1955	1955	1955	0.18	0.18	0.18	0.18	0.18	56.84	66.64	66.64	66.51	66.51	79%	79%	79%	79%	79%
76107	1954	1954	1955	1955	1955	0.23	0.23	0.24	0.24	0.24	89.94	97.99	97.99	98.40	98.40	85%	85%	85%	85%	85%
76108	1982	1982	1982	1982	1983	0.13	0.13	0.13	0.13	0.13	16.48	19.17	19.17	19.12	19.12	82%	81%	83%	83%	84%
76109	1958	1958	1959	1959	1959	0.22	0.22	0.22	0.22	0.22	64.50	77.45	77.45	77.86	77.86	95%	95%	95%	95%	94%
76110	1942	1942	1942	1942	1942	0.23	0.24	0.24	0.24	0.24	138.93	136.56	136.56	136.56	136.73	89%	89%	89%	89%	90%
76111	1949	1949	1949	1949	1949	0.17	0.17	0.17	0.16	0.17	74.21	82.50	82.50	82.90	82.90	87%	86%	86%	87%	87%
76112	1967	1967	1967	1967	1967	0.17	0.17	0.17	0.17	0.17	64.61	75.10	75.10	75.01	75.01	92%	92%	92%	92%	93%
76114	1956	1956	1956	1956	1956	0.13	0.13	0.13	0.13	0.13	73.10	78.15	78.15	78.27	78.50	89%	89%	89%	89%	90%
76115	1954	1954	1954	1954	1954	0.2	0.2	0.21	0.2	0.2	87.91	96.79	96.79	97.45	97.45	86%	86%	87%	87%	87%
76116	1965	1965	1965	1965	1966	0.22	0.22	0.22	0.22	0.22	77.78	89.20	89.20	89.03	89.03	91%	91%	91%	91%	91%
76118	1974	1974	1974	1974	1974	0.18	0.18	0.14	0.15	0.15	33.90	41.69	41.69	42.00	42.11	92%	92%	92%	91%	91%
76119	1964	1964	1964	1964	1964	0.12	0.12	0.13	0.13	0.13	53.52	60.01	60.01	60.01	60.01	83%	83%	83%	83%	83%
76120	1994	1994	1994	1994	1995	0.15	0.15	0.15	0.15	0.16	25.67	39.79	39.79	39.67	39.67	82%	82%	83%	83%	84%
*76122	1992	1992	1950	1950	1950	0	0	0.23	0.23	0.23	19.93	19.93	19.93	19.93	19.93	0%	0%	100%	100%	100%
76123	1999	1999	1999	1999	1999	0.25	0.25	0.26	0.26	0.25	27.19	32.29	32.29	32.37	32.37	85%	85%	87%	87%	88%
76126	1983	1983	1984	1984	1985	0.09	0.09	0.09	0.1	0.1	9.26	10.23	10.23	10.23	10.23	69%	68%	71%	71%	71%
*76129	0	0	0	0	0	0	0	0	0	0	22.66	22.66	22.66	22.66	22.66	0%	0%	0%	0%	0%
76131	1999	1999	2000	2000	2000	0.19	0.18	0.19	0.19	0.2	16.41	27.85	27.85	27.96	27.96	82%	82%	87%	87%	88%
76132	1989	1989	1989	1989	1989	0.26	0.25	0.26	0.26	0.26	62.77	70.93	70.93	71.06	71.06	88%	88%	90%	90%	90%
76133	1972	1972	1972	1972	1972	0.21	0.21	0.21	0.21	0.21	86.92	96.40	96.40	96.72	96.72	99%	99%	99%	99%	99%
76134	1977	1977	1978	1978	1978	0.21	0.21	0.21	0.21	0.21	50.06	60.95	60.95	60.00	60.00	86%	86%	88%	88%	88%
76135	1979	1979	1979	1979	1979	0.07	0.07	0.07	0.07	0.07	20.73	22.72	22.72	22.75	22.75	81%	81%	81%	81%	81%
76137	1993	1993	1993	1993	1993	0.29	0.29	0.29	0.28	0.28	53.73	64.54	64.54	64.39	64.39	94%	94%	95%	95%	95%
76140	1983	1983	1983	1983	1984	0.1	0.11	0.11	0.11	0.11	21.51	24.09	24.09	23.64	23.64	74%	74%	76%	77%	77%
76148	1980	1980	1980	1980	1980	0.18	0.18	0.18	0.17	0.17	76.23	84.40	84.40	84.40	84.40	98%	98%	98%	98%	98%
76155	1993	1993	1993	1993	1999	0.22	0.22	0.22	0.22	0.22	17.33	25.02	25.02	24.37	24.37	31%	30%	20%	22%	22%
76164	1935	1935	1936	1936	1936	0.23	0.23	0.23	0.23	0.23	105.40	126.99	126.99	126.73	126.73	84%	84%	84%	84%	84%
76177 (Tarrant Co)	2005	2005	2006	2006	2006	0.25	0.25	0.25	0.26	0.27	20.01	24.38	24.38	24.97	25.10	71%	71%	76%	76%	75%
76177 (Denton Co)	2005	2006	2007	2007	2007	0.22	0.23	0.24	0.26	0.27						39%	47%	64%	67%	60%
76179	1995	1995	1995	1995	1996	0.13	0.13	0.13	0.13	0.14	11.19	14.46	14.46	14.51	14.51	78%	78%	81%	81%	82%

**Zip Codes 76122 and 76129 were ommited in the average calculations and analysis because they only contained one parcel. The parcel in 76129 contained no buildings. 76122 contained inconsistent data from clerk input error, according to the Tarrant County Appraisal District GIS Administrator.*

Austin Zip Codes	Avg Age Building Stock					Density of Building (FAR = living area/total land area)					Census Block Density (Mean Number of Census Blocks per Square Mile)					% of Parcels with Buildings				
	2009	2010	2011	2012	2013	2009	2010	2011	2012	2013	2009	2010	2011	2012	2013	2009	2010	2011	2012	2013
78701	1943	1944	1944	1944	1944	1.54	0.98	1.54	1.53	1.55	191.30	188.93	188.93	188.93	188.93	69%	70%	71%	72%	72%
78702	1951	1951	1951	1952	1953	0.2	0.2	0.2	0.2	0.2	118.42	119.20	119.20	119.20	119.20	81%	81%	81%	82%	82%
78703	1953	1953	1954	1954	1955	0.26	0.27	0.27	0.23	0.24	88.21	99.15	99.15	99.15	99.15	92%	92%	92%	93%	93%
78704	1960	1960	1960	1961	1961	0.23	0.23	0.24	0.24	0.24	62.05	67.08	67.08	67.54	67.54	91%	91%	92%	92%	92%
78705	1946	1946	1946	1947	1947	0.59	0.6	0.6	0.6	0.64	145.31	143.17	143.17	143.17	143.17	81%	85%	85%	87%	87%
78717 (Williamson Co)	1999	2000	2000	2000	2000	0.1	0.12	0.12	0.13	0.13	21.03	28.57	28.57	28.82	28.82	88%	89%	88%	88%	89%
78719	1979	1979	1980	1980	1980	0.01	0.01	0.01	0.01	0.01	6.58	5.40	5.40	5.55	5.71	58%	60%	60%	61%	62%
78721	1967	1967	1968	1968	1968	0.15	0.14	0.14	0.14	0.15	42.39	45.42	45.42	45.69	45.69	81%	82%	82%	82%	82%
78722	1950	1951	1951	1951	1951	0.19	0.19	0.2	0.2	0.2	148.20	148.20	148.20	148.20	148.20	90%	90%	90%	90%	90%
78723	1968	1969	1969	1969	1970	0.19	0.19	0.2	0.19	0.19	40.56	51.27	51.27	51.12	51.12	92%	94%	94%	92%	93%
78724	1989	1990	1990	1990	1991	0.06	0.06	0.06	0.06	0.04	12.85	15.23	15.23	15.48	15.48	66%	70%	68%	69%	71%
78725	1993	1994	1994	1994	1995	0.03	0.03	0.03	0.03	0.04	7.22	9.36	9.36	9.36	9.36	70%	74%	76%	78%	79%
78726	1995	1995	1995	1995	1995	0.11	0.11	0.1	0.1	0.1	17.73	14.93	14.93	15.02	15.20	88%	89%	89%	89%	89%
78727 (Travis Co)	1986	1986	1986	1986	1986	0.21	0.21	0.2	0.2	0.2	43.05	47.73	47.73	47.73	47.73	94%	94%	94%	95%	95%
78727 (Williamson Co)	1981	1982	1981	1981	1981	0.16	0.23	0.22	0.23	0.23						67%	71%	70%	71%	71%
78728 (Travis Co)	1990	1990	1990	1990	1990	0.21	0.21	0.22	0.22	0.23	34.11	34.24	34.24	34.37	34.37	88%	88%	88%	87%	87%
78728 (Williamson Co)	1985	1984	1985	1985	1985	0.35	0.35	0.35	0.34	0.34						73%	73%	72%	75%	75%
78729 (Williamson Co)	1987	1987	1987	1987	1988	0.24	0.24	0.24	0.24	0.24	29.65	33.87	33.87	34.08	34.08	97%	95%	95%	96%	96%
78730	1995	1995	1995	1995	1996	0.09	0.09	0.09	0.09	0.09	12.01	12.32	12.32	12.32	12.32	84%	84%	85%	85%	86%
78731	1973	1973	1973	1973	1973	0.2	0.2	0.2	0.2	0.2	35.61	41.24	41.24	41.24	41.24	94%	94%	94%	94%	95%
78732	1999	2000	2000	2001	2001	0.1	0.11	0.1	0.1	0.06	12.76	14.85	14.85	14.85	14.85	74%	77%	81%	84%	86%
78733	1989	1989	1990	1990	1990	0.03	0.03	0.03	0.03	0.03	16.46	16.87	16.87	16.87	16.87	81%	83%	84%	85%	85%
78734	1990	1990	1990	1991	1991	0.06	0.06	0.06	0.06	0.06	20.05	22.01	22.01	22.01	22.75	67%	67%	68%	69%	70%
78735	1992	1992	1992	1992	1992	0.03	0.03	0.03	0.03	0.03	9.28	12.06	12.06	12.15	12.15	83%	82%	83%	84%	84%
78736	1984	1984	1984	1984	1985	0.01	0.01	0.01	0.01	0.01	6.67	6.85	6.85	6.85	6.85	83%	84%	84%	84%	84%
78737 (Hays Co)	ND	ND	ND	2004	2004	ND	ND	ND	0.03	0.02	4.07	5.30	5.30	5.33	5.33	ND	ND	ND	73%	71%
78738	1998	1998	1999	2000	2000	0.01	0.01	0.02	0.02	0.02	7.73	7.92	7.92	7.95	8.11	63%	65%	67%	70%	68%
78739	1998	1998	1998	1999	1999	0.1	0.1	0.1	0.1	0.1	14.50	17.32	17.32	17.40	17.40	84%	85%	87%	89%	88%
78741	1974	1974	1975	1975	1975	0.21	0.24	0.24	0.24	0.24	33.06	41.39	41.39	42.43	42.43	83%	83%	84%	84%	84%
78742	1970	1970	1970	1971	1971	0.01	0.01	0.01	0.01	0.01	13.14	13.93	13.93	13.93	13.93	55%	54%	56%	56%	52%
78744	1984	1985	1985	1985	1985	0.13	0.13	0.13	0.13	0.13	19.30	23.14	23.14	22.94	23.09	88%	89%	89%	89%	90%
78745	1975	1975	1975	1975	1975	0.16	0.16	0.16	0.16	0.16	53.94	59.17	59.17	58.64	58.64	95%	95%	95%	95%	96%
78746	1983	1984	1984	1984	1984	0.13	0.11	0.11	0.11	0.11	21.95	24.16	24.16	24.20	24.20	89%	89%	89%	90%	90%
78747	1996	1996	1997	1997	1997	0.04	0.03	0.03	0.03	0.03	7.79	9.31	9.31	9.31	9.63	78%	83%	83%	82%	84%
78748	1992	1992	1993	1993	1993	0.16	0.16	0.17	0.17	0.17	35.74	44.72	44.72	44.72	44.88	90%	91%	92%	93%	94%
78749	1991	1991	1991	1991	1991	0.18	0.18	0.18	0.17	0.17	39.44	45.05	45.05	45.23	45.23	95%	95%	95%	96%	96%
78750 (Travis Co)	1986	1986	1986	1986	1986	0.11	0.1	0.1	0.1	0.1	27.61	25.07	25.07	25.21	25.21	60%	61%	60%	61%	61%
78750 (Williamson Co)	1979	1979	1979	1979	1979	0.27	0.26	0.27	0.27	0.25						97%	97%	97%	97%	97%
78751	1949	1949	1949	1949	1949	0.26	0.26	0.26	0.21	0.21	123.86	126.95	126.95	126.95	126.95	93%	93%	93%	94%	94%
78752	1966	1966	1965	1965	1965	0.28	0.28	0.27	0.27	0.27	70.91	88.64	88.64	88.96	88.96	92%	92%	91%	92%	92%
78753	1978	1978	1978	1978	1978	0.2	0.2	0.2	0.21	0.2	40.70	47.81	47.81	47.81	47.81	93%	93%	93%	92%	92%
78754	1996	1997	1997	1998	1998	0.1	0.1	0.11	0.1	0.1	21.15	21.00	21.00	21.52	21.52	75%	77%	75%	79%	78%
78756	1955	1955	1955	1955	1956	0.23	0.23	0.23	0.24	0.24	98.67	96.34	96.34	96.34	96.34	94%	94%	94%	94%	94%
78757	1960	1960	1960	1960	1960	0.21	0.21	0.21	0.21	0.21	73.17	76.29	76.29	76.29	76.29	98%	98%	98%	98%	96%
78758	1976	1976	1977	1976	1976	0.25	0.25	0.25	0.25	0.25	44.88	52.27	52.27	52.27	52.27	96%	96%	96%	96%	96%
78759 (Travis Co)	1982	1982	1982	1982	1982	0.19	0.19	0.19	0.19	0.21	40.94	48.41	48.41	48.41	48.41	94%	94%	95%	94%	95%
78759 (Williamson Co)	1979	1979	1979	1979	1979	0.24	0.24	0.24	0.24	0.24						97%	99%	99%	99%	99%

Land Uses

2009

Fort Worth Zip Codes	A	B	C	D	E	F	G	J	L	M	O
76102	1191	46	840	13	1	864	0	209	0	0	103
76103	4233	230	417	44	1	391	0	30	0	0	0
76104	4604	390	3658	8	0	1538	0	65	0	0	34
76105	6331	320	2173	14	0	571	0	23	0	2	5
76106	7564	487	1937	74	3	919	0	95	0	3	54
76107	9571	823	1464	31	0	1351	0	53	0	0	156
76108	10927	397	1503	326	25	406	0	61	0	120	748
76109	6483	321	179	22	0	330	0	14	0	0	73
76110	8241	618	877	4	0	972	0	61	0	0	9
76111	5975	402	876	24	1	902	0	38	0	62	7
76112	10643	270	684	66	1	506	0	61	0	14	56
76114	7483	212	812	31	3	467	0	10	0	529	82
76115	4401	214	649	11	0	359	0	35	0	37	0
76116	10293	377	819	44	7	818	0	51	0	0	113
76118	4547	71	287	70	1	317	0	38	0	1	0
76119	10109	179	1753	82	7	913	0	59	0	1162	461
76120	2996	122	435	128	2	124	0	7	0	317	245
76122	0	0	0	0	0	1	0	0	0	0	0
76123	9002	177	228	113	2	42	0	20	0	0	1310
76126	6849	165	1929	413	48	260	0	51	0	143	952
76129	0	0	0	0	0	1	0	0	0	0	0
76131	8657	2	342	215	6	157	0	57	0	4	1438
76132	4240	318	450	50	0	290	0	21	0	0	103
76133	14440	919	136	9	0	360	0	23	0	1	0
76134	6911	64	664	100	2	199	0	32	0	20	477
76135	6235	188	1187	156	15	385	0	35	0	292	130
76137	14284	179	629	99	0	576	0	23	0	415	279
76140	7592	199	1744	413	30	558	0	176	0	749	716
76148	8450	0	149	14	0	235	0	12	0	0	4
76155	5	7	97	138	0	128	0	14	0	0	0
76164	3872	277	654	9	0	694	0	41	0	1	0
76177 (Tarrant Co)	1165	2	209	186	14	141	0	9	0	2	153
76177 (Denton Co)	234	0	44	122	5	26	0	1	0	0	227
76179	634	5	402	463	8	178	0	148	0	42	1

2010

Fort Worth Zip Codes	A	B	C	D	E	F	G	J	L	M	O
76102	1199	46	850	13	1	869	0	207	0	0	92
76103	4243	230	431	46	1	394	0	32	0	0	0
76104	4605	391	3673	9	0	1548	0	68	0	0	34
76105	6355	320	2209	15	0	581	0	27	0	2	5
76106	7567	491	1957	77	3	925	0	100	0	3	54
76107	9580	826	1488	36	0	1361	0	57	0	0	186
76108	9933	389	1492	332	25	387	0	60	0	120	795
76109	6501	322	184	21	0	332	0	15	0	0	80
76110	8264	620	880	5	0	974	0	66	0	0	9
76111	5984	402	890	25	1	905	0	39	0	59	7
76112	10626	271	687	67	1	500	0	61	0	14	56
76114	7489	212	821	31	3	470	0	10	0	530	82
76115	4409	215	653	13	0	356	0	35	0	37	0
76116	10295	380	829	43	7	831	0	52	0	0	114
76118	4546	74	293	71	1	323	0	39	0	1	0
76119	10141	179	1770	81	7	925	0	61	0	1161	461
76120	3006	124	448	131	1	125	0	7	0	317	245
76122	0	0	0	0	0	1	0	0	0	0	0
76123	9007	177	232	114	2	42	0	20	0	0	1309
76126	6851	164	1930	415	49	260	0	54	0	143	998
76129	0	0	0	0	0	1	0	0	0	0	0
76131	8657	2	343	217	6	163	0	59	0	4	1449
76132	4248	326	465	51	0	294	0	21	0	0	104
76133	14448	920	142	10	0	369	0	23	0	1	0
76134	6920	65	668	102	2	199	0	32	0	20	478
76135	6258	188	1218	156	15	392	0	34	0	291	131
76137	14289	180	639	101	0	580	0	24	0	415	279
76140	7595	199	1739	417	28	566	0	178	0	747	723
76148	8458	0	151	14	0	237	0	13	0	0	4
76155	5	7	107	139	0	127	0	14	0	0	0
76164	3879	276	661	9	0	704	0	44	0	1	0
76177 (Tarrant Co)	1195	2	215	190	14	142	0	9	0	2	233
76177 (Denton Co)	280	0	43	100	6	31	0	1	0	0	181
76179	15412	147	1783	473	11	717	0	173	0	116	2304

2011

Fort Worth Zip Codes	A	B	C	D	E	F	G	J	L	M	O
76102	1216	45	868	15	1	862	0	213	0	0	68
76103	4238	228	426	45	1	391	0	34	0	0	0
76104	4547	381	3636	9	0	1555	0	67	0	0	22
76105	6336	308	2209	14	0	574	0	47	0	2	5
76106	7582	484	1925	76	2	927	0	100	0	3	51
76107	9615	802	1534	32	0	1357	0	59	0	0	118
76108	11186	394	1534	335	25	422	0	61	0	110	604
76109	6506	316	179	18	0	335	0	16	0	0	53
76110	8256	604	895	5	0	968	0	69	0	0	6
76111	5968	401	882	25	1	901	0	38	0	6	4
76112	10496	269	690	70	1	504	0	66	0	14	41
76114	7465	213	828	30	3	464	0	9	0	516	75
76115	4394	207	640	11	0	349	0	35	0	0	0
76116	10340	381	801	43	7	837	0	62	0	0	93
76118	4545	74	292	71	1	330	0	41	0	1	0
76119	10147	179	1807	87	5	911	0	56	0	1190	407
76120	3111	126	452	124	1	125	0	10	0	343	199
76122	0	0	0	0	0	1	0	0	0	0	0
76123	9182	179	180	123	1	43	0	24	0	0	1177
76126	7061	164	1875	404	49	273	0	54	0	138	782
76129	0	0	0	0	1	0	0	0	0	0	0
76131	9352	2	329	207	4	174	0	59	0	5	1001
76132	4304	331	381	51	0	300	0	22	0	0	95
76133	14446	918	140	11	0	372	0	25	0	1	0
76134	7130	66	663	100	2	208	0	33	0	20	270
76135	6258	188	1199	153	14	406	0	34	0	280	111
76137	14464	180	636	98	0	588	0	24	0	401	105
76140	7842	199	1569	406	22	589	0	178	0	647	623
76148	8457	0	148	13	0	241	0	13	0	0	3
76155	6	7	295	153	0	132	0	16	0	0	0
76164	3866	275	665	9	0	707	0	42	0	1	0
76177 (Tarrant Co)	1438	2	234	187	9	144	0	7	0	2	82
76177 (Denton Co)	384	0	42	112	5	33	0	1	0	0	67
76179	16100	146	1664	472	10	730	0	177	0	117	1825

2012

Fort Worth Zip Codes	A	B	C	D	E	F	G	J	L	M	O
76102	1215	45	870	15	1	863	0	121	0	0	66
76103	4238	225	416	43	1	387	0	25	0	0	0
76104	4548	377	3614	9	0	1537	0	26	0	0	22
76105	6331	305	2203	14	0	574	0	38	0	2	5
76106	7581	484	1929	78	2	927	0	51	0	2	51
76107	9615	798	1531	32	0	1352	0	27	0	0	119
76108	11185	390	1537	335	25	421	0	61	0	109	603
76109	6504	315	176	18	0	334	0	8	0	0	53
76110	8256	600	885	5	0	962	0	28	0	0	6
76111	5968	401	883	25	1	895	0	31	0	6	4
76112	10491	268	691	70	1	502	0	56	0	14	41
76114	7466	212	825	30	3	465	0	9	0	516	74
76115	4391	207	641	11	0	351	0	17	0	0	0
76116	10333	379	806	43	7	837	0	53	0	0	94
76118	4544	74	295	71	1	329	0	40	0	1	0
76119	10144	179	1842	87	5	911	0	36	0	1191	365
76120	3108	126	455	124	1	123	0	7	0	342	199
76122	0	0	0	0	0	1	0	0	0	0	0
76123	9184	179	177	121	1	43	0	15	0	0	1176
76126	7059	164	1881	404	48	273	0	36	0	139	814
76129	0	0	0	0	0	1	0	0	0	0	0
76131	9354	2	327	207	4	175	0	28	0	5	999
76132	4304	327	382	51	0	301	0	17	0	0	95
76133	14443	913	141	11	0	370	0	8	0	1	0
76134	7127	66	664	100	2	206	0	11	0	20	270
76135	6249	188	1195	151	12	408	0	34	0	281	111
76137	14466	180	634	97	0	588	0	15	0	401	105
76140	7835	200	1476	409	21	588	0	158	0	646	621
76148	8460	0	148	13	0	241	0	6	0	0	3
76155	6	8	295	152	0	132	0	15	0	0	0
76164	3862	276	666	9	0	706	0	28	0	1	0
76177 (Tarrant Co)	1440	2	233	190	9	143	0	5	0	2	82
76177 (Denton Co)	404	0	44	113	5	32	0	1	0	0	48
76179	16092	146	1665	471	10	731	0	124	0	117	1822

2013

Fort Worth Zip Codes	A	B	C	D	E	F	G	J	L	M	O
76102	1235	46	854	15	0	855	0	121	0	0	53
76103	4244	220	406	44	0	384	0	24	0	0	0
76104	4591	374	3535	9	0	1505	0	26	0	0	22
76105	6333	301	2222	15	0	574	0	37	0	2	5
76106	7559	480	1925	77	0	934	0	48	0	2	51
76107	9631	786	1562	31	0	1354	0	27	0	0	100
76108	11389	391	1536	332	0	422	0	61	0	88	431
76109	6492	306	243	17	0	350	0	8	0	0	49
76110	8265	601	869	5	0	962	0	28	0	0	4
76111	5961	400	877	25	0	896	0	31	0	5	0
76112	10515	264	687	69	0	503	0	56	0	14	23
76114	7470	213	814	31	0	469	0	9	0	510	68
76115	4389	205	647	10	0	351	0	17	0	0	0
76116	10360	380	804	39	0	841	0	53	0	0	79
76118	4555	75	294	67	0	331	0	40	0	0	51
76119	10170	178	1838	84	0	913	0	35	0	1191	347
76120	3144	126	460	122	0	125	0	7	0	351	163
76122	0	0	0	0	0	1	0	0	0	0	0
76123	9303	179	173	117	0	47	0	15	0	0	1072
76126	7247	164	1925	398	0	283	0	36	0	120	748
76129	0	0	0	0	0	1	0	0	0	0	0
76131	9785	3	345	209	0	180	0	27	0	5	931
76132	4336	333	382	49	0	302	0	17	0	0	69
76133	14442	914	143	11	0	370	0	8	0	1	0
76134	7180	67	659	99	0	210	0	11	0	20	220
76135	6278	188	1170	151	0	416	0	34	0	273	103
76137	14524	180	647	97	0	592	0	15	0	392	47
76140	7909	200	1457	395	0	588	0	158	0	679	576
76148	8462	0	147	13	0	241	0	6	0	0	2
76155	55	8	473	149	0	134	0	13	0	0	23
76164	3860	280	666	9	0	707	0	26	0	0	0
76177 (Tarrant Co)	1520	2	243	186	0	146	0	5	0	2	157
76177 (Denton Co)	448	0	122	93	29	32	0	1	0	0	64
76179	16490	147	1613	471	0	747	0	114	0	117	1710

Austin Zip Codes	Land Uses 2009											2010											2011										
	A	B	C	D	E	F	G	J	L	M	O	A	B	C	D	E	F	G	J	L	M	O	A	B	C	D	E	F	G	J	L	M	O
78701	149	54	0	0	0	757	0	1	0	0	0	148	52	0	0	0	772	0	1	0	0	0	144	50	0	0	0	774	0	1	0	0	0
78702	5337	268	0	0	1	659	0	2	0	0	0	5337	263	1	0	1	664	0	2	0	0	0	5348	259	1	0	1	670	0	2	0	0	0
78703	5015	532	0	0	0	314	0	1	0	0	0	5043	517	0	0	0	311	0	1	0	0	0	5042	517	0	0	0	311	0	1	0	0	0
78704	7041	1418	0	0	0	694	0	3	0	0	2	7062	1403	0	0	0	692	0	3	0	0	2	7085	1402	0	0	0	706	0	3	0	0	0
78705	1188	617	0	0	0	352	0	0	0	0	0	1182	617	0	0	0	357	0	0	0	0	0	1184	616	0	0	0	357	0	0	0	0	0
78717 (Williamson Co)	6082	15	326	93	14	108	0	1	0	0	381	6164	16	331	84	13	117	0	2	0	0	371	6303	16	592	100	13	119	0	2	0	0	143
78719	387	31	0	0	45	49	0	0	0	0	0	397	31	0	0	48	53	0	1	0	0	0	401	31	0	0	51	52	0	1	0	0	0
78721	2749	224	0	0	2	115	0	0	0	0	0	2761	228	0	0	2	115	0	0	0	0	0	2765	228	0	0	2	116	0	0	0	0	0
78722	1695	204	0	0	0	100	0	0	0	0	0	95	17	0	0	0	11	0	0	0	0	0	1695	202	0	0	0	101	0	0	0	0	0
78723	6443	527	0	0	1	218	0	1	0	0	17	4888	446	0	0	1	161	0	1	0	0	0	6623	528	1	0	1	222	0	1	0	0	1
78724	3243	221	0	0	35	149	0	0	0	0	63	3407	225	0	0	39	147	0	0	0	0	37	3459	227	0	0	39	143	0	0	0	0	29
78725	1696	3	0	0	20	43	0	0	0	0	15	1796	3	0	0	24	44	0	0	0	0	19	1867	3	0	0	24	47	0	0	0	0	8
78726	2061	11	0	0	6	75	0	1	0	0	0	2061	10	0	0	7	77	0	1	0	0	0	2068	10	0	0	7	77	0	1	0	0	0
78727 (Travis Co)	6553	211	0	0	5	153	0	0	0	0	2	6577	213	0	0	5	151	0	0	0	0	0	6588	213	0	0	6	154	0	0	0	0	0
78727 (Williamson Co)	7	1	0	0	0	47	0	2	0	0	0	6	1	5	0	0	49	0	2	0	0	0	6	1	6	0	0	49	0	2	0	0	0
78728 (Travis Co)	3356	99	0	0	2	328	0	0	0	0	0	3352	100	0	0	3	328	0	0	0	0	0	3353	104	0	0	3	329	0	0	0	0	0
78728 (Williamson Co)	102	1	0	0	0	22	0	0	0	0	0	103	1	34	0	0	23	0	0	0	0	0	103	1	35	0	0	23	0	0	0	0	0
78729 (Williamson Co)	5213	508	136	32	1	241	0	5	0	0	0	5214	506	230	31	1	225	0	4	0	0	0	5212	513	141	31	1	227	0	4	0	0	91
78730	2108	3	0	0	7	39	0	0	0	0	0	2121	3	0	0	7	39	0	0	0	0	0	2132	3	0	0	7	40	0	0	0	0	0
78731	7281	290	0	0	1	228	0	0	0	0	0	7290	291	0	0	1	222	0	0	0	0	0	7212	289	0	0	1	227	0	0	0	0	0
78732	4086	6	0	0	3	43	0	0	0	0	40	4275	6	0	0	3	43	0	0	0	0	41	4481	7	0	0	3	49	0	0	0	0	26
78733	2877	36	0	0	11	45	0	0	0	0	14	2955	36	0	0	11	46	0	0	0	0	13	7185	199	0	0	7	276	0	4	0	0	15
78734	7048	202	0	0	7	268	0	4	0	0	8	7125	201	0	0	7	264	0	4	0	0	18	3324	47	0	0	12	143	0	1	0	0	0
78735	3261	46	0	0	10	136	0	1	0	0	4	3295	46	0	0	11	143	0	1	0	0	2	3324	47	0	0	12	143	0	1	0	0	0
78736	2420	52	0	0	40	84	0	2	0	0	0	2431	53	0	0	41	83	0	2	0	0	0	2436	53	0	0	40	88	0	2	0	0	0
78737 (Hays Co)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
78738	3374	9	0	0	44	142	0	2	0	0	13	3523	9	0	0	49	148	0	2	0	0	48	3742	9	0	0	44	154	0	2	0	0	24
78739	5381	0	0	0	10	10	0	0	0	0	55	5555	0	0	0	10	11	0	0	0	0	36	5723	0	0	0	9	12	0	0	0	0	30
78741	2695	613	0	0	1	227	0	2	0	0	0	2698	611	0	0	1	229	0	2	0	0	0	2692	615	0	0	1	235	0	2	0	0	0
78742	151	85	0	0	9	39	0	0	0	0	0	151	85	0	0		9	40	0	0	0	0	153	82	0	0	10	40	0	0	0	0	2
78744	7222	778	0	0	18	333	0	1	0	0	15	7276	781	1	0	21	328	0	1	0	1	6	7333	781	1	0	21	341	0	1	0	0	4
78745	13331	1346	0	0	6	572	0	0	0	0	14	13369	1354	0	0	6	575	0	0	0	0	6	1354	0	0	6	577	0	0	0	0	0	5
78746	7733	171	0	0	7	273	0	1	0	0	0	7745	168	0	0	7	276	0	1	0	0	0	7764	166	0	0	7	263	0	1	0	0	0
78747	3604	10	0	0	60	49	0	0	0	0	25	3840	14	0	0	66	53	0	0	0	0	15	3958	15	0	0	68	54	0	0	0	0	21
78748	11299	613	0	0	6	246	0	0	0	0	43	11530	613	0	0	7	259	0	0	0	0	41	11700	624	0	0	7	265	0	0	0	0	36
78749	10075	156	0	0	7	156	0	0	0	0	0	10073	158	1	0	7	160	0	0	0	0	0	10074	159	1	0	7	160	0	0	0	0	0
78750 (Travis Co)	4596	93	0	0	5	37	0	2	0	0	0	4585	107	0	0	6	34	0	2	0	0	0	4550	104	0	0	6	32	0	2	0	0	0
78750 (Williamson Co)	2630	44	52	5	0	110	0	4	0	0	0	2632	43	51	5	0	111	0	4	0	0	0	2630	43	47	5	0	113	0	4	0	0	0
78751	2932	515	0	0	0	220	0	1	0	0	0	2924	518	0	0	0	223	0	1	0	0	0	2919	524	0	0	0	233	0	1	0	0	0
78752	2154	448	0	0	0	247	0	2	0	0	0	2151	448	0	0	0	249	0	2	0	0	0	1903	451	0	0	0	252	0	2	0	0	0
78753	6771	579	0	0	2	462	0	2	0	0	0	6773	582	0	0	2	472	0	2	0	0	0	6699	582	0	0	2	476	0	2	0	0	0
78754	2649	46	0	0	16	199	0	0	0	0	31	2778	46	0	0	17	203	0	0	0	0	36	2868	46	0	0	17	211	0	0	0	0	21
78756	1955	258	0	0	0	328	0	1	0	0	0	1959	253	0	0	0	333	0	1	0	0	0	1955	256	0	0	0	333	0	1	0	0	0
78757	6515	535	0	0	0	477	0	0	0	0	0	6215	528	0	0	0	487	0	0	0	0	0	6514	529	0	0	0	485	0	0	0	0	0
78758	5934	1230	0	0	1	649	0	1	0	0	0	5927	1241	1	0	1	645	0	1	0	0	0	5756	1243	1	0	1	644	0	1	0	0	0
78759 (Travis Co)	8693	387	0	0	4	341	0	0	0	0	0	8702	387	0	0	3	335	0	0	0	0	0	8708	387	0	0	3	339	0	0	0	0	0
78759 (Williamson Co)	95	1	2	0	0	8	0	0	0	0	0	114	1	0	0	0	4	0	0	0	0	0	114	1	0	0	0	4	0	0	0	0	0

2012											2013										
A	B	C	D	E	F	G	J	L	M	O	A	B	C	D	E	F	G	J	L	M	O
141	53	0	0	0	785	0	1	0	0	0	121	48	0	0	0	803	0	1	0	0	0
5369	264	1	0	1	674	0	2	0	0	0	5383	271	1	0	1	672	0	2	0	0	1
5064	515	0	0	0	314	0	1	0	0	0	5066	507	0	0	0	322	0	1	0	0	0
7088	1443	0	0	0	717	0	3	0	0	0	7133	1412	0	0	0	709	0	3	0	0	0
1188	632	0	0	0	362	0	0	0	0	0	1179	634	0	0	0	378	0	0	0	0	0
6411	16	586	94	14	128	0	3	0	0	186	6524	18	298	83	14	106	2	2	0	0	389
407	31	0	0	53	51	0	1	0	0	0	411	31	0	4	49	52	0	1	0	0	0
2770	230	0	0	2	117	0	0	0	0	2	2783	229	0	0	2	118	0	0	0	0	0
1694	205	0	0	0	102	0	0	0	0	0	1689	206	0	0	0	106	0	0	0	0	0
6673	533	1	0	1	230	0	1	0	0	6	6715	533	1	1	0	243	0	1	0	0	32
3550	229	1	0	37	149	0	0	0	0	23	3612	230	0	4	42	162	0	0	0	0	24
1918	3	0	0	23	48	0	0	0	0	0	1995	3	0	2	33	53	0	0	0	0	0
2070	10	0	0	7	78	0	1	0	0	0	2069	10	0	1	8	83	0	1	0	0	0
6589	216	0	0	5	154	0	0	0	0	0	6588	219	0	2	3	155	0	0	0	0	0
6	1	5	0	0	49	0	2	0	0	0	7	1	5	0	0	44	0	1	0	0	0
3359	103	0	0	3	332	0	0	0	0	11	3400	103	0	1	1	334	0	0	0	0	8
104	1	32	0	0	25	0	0	0	0	0	105	1	31	0	0	25	0	0	0	0	0
5246	515	142	31	1	226	0	5	0	0	54	5270	515	100	31	1	207	2	2	0	0	21
2147	3	0	0	6	41	0	0	0	0	0	2162	3	0	2	6	44	0	0	0	0	3
7219	293	0	0	1	228	0	0	0	0	0	7248	264	0	2	0	233	0	0	0	0	2
4660	7	0	0	4	50	0	0	0	0	13	4793	8	0	1	3	52	0	0	0	0	7
3033	35	0	0	11	46	0	0	0	0	2	3051	36	0	6	8	48	0	0	0	0	0
7308	203	0	0	8	285	0	4	0	0	7	7430	204	0	0	7	310	0	4	0	0	22
3365	46	0	0	10	145	0	1	0	0	1	3377	47	0	2	9	140	0	1	0	0	1
2434	53	0	0	40	90	0	2	0	0	0	2457	53	0	6	45	95	0	1	0	0	1
2563	3	490	125	36	31	0	2	0	0	312	2811	5	496	154	37	38	0	1	0	0	345
3958	9	0	0	46	157	0	2	0	0	37	4264	10	0	7	51	168	0	2	0	0	80
5866	0	0	0	10	13	0	0	0	0	25	6026	0	0	3	7	14	0	0	0	0	27
2697	614	0	0	2	239	0	2	0	0	0	2706	618	0	0	2	241	0	2	0	0	0
154	83	0	0	10	40	0	0	0	0	0	141	81	0	0	11	40	0	0	0	0	0
7380	783	1	0	18	344	0	1	0	0	4	7426	783	0	5	17	350	0	1	0	0	2
13429	1361	0	0	6	587	0	0	0	0	6	13463	1359	0	0	6	598	0	0	0	0	6
7795	170	0	0	7	267	0	1	0	0	0	7811	169	0	1	6	273	0	1	0	0	0
4094	16	0	0	76	53	0	0	0	0	14	4246	16	0	14	62	60	0	0	0	0	25
11843	620	0	0	6	266	0	0	0	0	34	12067	619	0	2	4	272	0	0	0	0	17
10077	162	1	0	7	169	0	0	0	0	0	10080	162	1	1	7	174	0	0	0	0	0
4554	106	0	0	6	33	0	2	0	0	0	4554	106	0	3	5	34	0	2	0	0	0
2664	47	47	5	0	123	0	5	0	0	0	2627	44	32	5	0	98	0	0	0	0	0
2920	526	0	0	0	238	0	1	0	0	0	2917	530	0	0	0	240	0	1	0	0	0
1901	456	0	0	0	252	0	2	0	0	0	1902	454	0	0	0	254	0	2	0	0	0
6705	590	0	0	2	486	0	2	0	0	4	6734	593	0	0	2	508	0	2	0	0	5
2994	47	0	0	6	211	0	0	0	0	37	3134	47	0	8	12	220	0	0	0	0	37
1951	257	0	0	0	334	0	1	0	0	0	1974	29	0	0	0	330	0	1	0	0	1
6517	534	0	0	0	485	0	0	0	0	1	6516	527	0	0	0	483	0	0	0	0	0
5761	1259	1	0	0	644	0	1	0	0	0	5761	1261	1	0	0	654	0	1	0	0	0
8716	397	0	0	3	340	0	0	0	0	0	8740	396	0	1	4	340	0	0	0	0	14
114	1	0	0	0	4	0	0	0	0	0	114	1	0	0	0	4	0	0	0	0	0

Appendix F

Asthma Inpatient Discharge Data by zip code 2005-2013: Fort Worth and Austin

Number of Hospital Discharges for Asthma Among All Ages By ZIP Code of Residence, Texas

Patient ZIP Code	Asthma Hospital Discharges - 2013	Asthma Hospital Discharges - 2012	Asthma Hospital Discharges - 2011	Asthma Hospital Discharges - 2010	Asthma Hospital Discharges - 2009	Asthma Hospital Discharges - 2008	Asthma Hospital Discharges - 2007	Asthma Hospital Discharges - 2006	Asthma Hospital Discharges - 2005
Texas Total	21,326	24,731	23,988	25,167	27,612	25,649	26,323	26,119	25,568
Fort Worth Total	819	840	796	797	969	837	915	860	835
76101	0	0	0	0	0	0	0	0	0
76102	0	15	0	14	15	15	13	19	21
76103	14	19	12	27	29	22	35	25	26
76104	36	25	48	40	51	26	62	52	38
76105	35	32	40	39	43	30	48	41	47
76106	18	34	22	36	42	40	41	38	49
76107	40	37	26	28	28	27	42	37	37
76108	40	50	44	37	39	37	37	45	39
76109	0	0	0	12	14	13	0	14	13
76110	13	20	21	15	30	31	29	18	27
76111	27	23	21	28	35	35	40	20	14
76112	51	59	62	46	73	71	71	72	79
76113	0	0	0	0	0	0	0	0	0
76114	33	26	26	30	40	1	41	29	28
76115	21	15	18	22	27	24	18	16	16
76116	54	53	51	45	47	45	36	37	43
76118	17	14	20	0	17	13	0	0	0
76119	76	88	56	69	80	96	87	91	88
76120	15	19	15	0	18	24	17	0	0
76121	0	0	0	0	0	0	0	0	0
76122	0	0	0	0	0	0	0	0	0
76123	33	44	44	34	20	23	19	32	20
76124	0	0	0	0	0	0	0	0	0
76126	18	14	12	12	15	12	15	19	19
76129	0	0	0	0	0	0	0	0	0
76130	0	0	0	0	0	0	0	0	0
76131	19	19	21	25	20	19	19	14	0
76132	24	15	17	16	16	22	20	0	14
76133	51	42	47	56	54	58	50	58	60
76134	25	29	30	26	42	28	30	28	29
76135	37	28	22	21	28	26	18	27	30
76136	0	0	0	0	0	0	0	0	0
76137	26	34	30	41	45	30	35	26	30
76140	24	32	46	28	35	29	44	41	28
76147	0	0	0	0	0	0	0	0	0
76148	20	14	21	22	24	13	17	30	23
76150	0	0	0	0	0	0	0	0	0
76155	0	0	0	0	0	0	0	0	0
76161	0	0	0	0	0	0	0	0	0
76162	0	0	0	0	0	0	0	0	0
76163	0	0	0	0	0	0	0	0	0
76164	14	13	0	0	0	0	0	0	0
76166	0	0	0	0	0	0	0	0	0
76177	0	0	0	0	0	0	0	0	0
76179	38	27	24	28	42	27	31	31	17
76181	0	0	0	0	0	0	0	0	0
76185	0	0	0	0	0	0	0	0	0
76191	0	0	0	0	0	0	0	0	0
76192	0	0	0	0	0	0	0	0	0
76193	0	0	0	0	0	0	0	0	0
76195	0	0	0	0	0	0	0	0	0
76196	0	0	0	0	0	0	0	0	0
76197	0	0	0	0	0	0	0	0	0
76198	0	0	0	0	0	0	0	0	0
76199	0	0	0	0	0	0	0	0	0

(shaded) zip codes are points - not whole areas

Number of Hospital Discharges for Asthma Among All Ages By ZIP Code of Residence, Texas

Patient ZIP Code	Asthma Hospital Discharges - 2013	Asthma Hospital Discharges - 2012	Asthma Hospital Discharges - 2011	Asthma Hospital Discharges - 2010	Asthma Hospital Discharges - 2009	Asthma Hospital Discharges - 2008	Asthma Hospital Discharges - 2007	Asthma Hospital Discharges - 2006	Asthma Hospital Discharges - 2005
Texas Total	21,326	24,731	23,988	25,167	27,612	25,649	26,323	26,119	25,568
Austin Total	626	801	706	649	642	635	584	493	410
73301	0	0	0	0	0	0	0	0	0
73344	0	0	0	0	0	0	0	0	0
78701	12	17	12	0	0	18	16	21	0
78702	34	43	39	48	37	40	37	28	34
78703	0	0	0	0	0	0	0	0	0
78704	27	23	21	20	19	17	23	19	21
78705	0	0	0	0	0	0	0	0	0
78708	0	0	0	0	0	0	0	0	0
78709	0	0	0	0	0	0	0	0	0
78710	0	0	0	0	0	0	0	0	0
78711	0	0	0	0	0	0	0	0	0
78712	0	0	0	0	0	0	0	0	0
78713	0	0	0	0	0	0	0	0	0
78714	0	0	0	0	0	0	0	0	0
78715	0	0	0	0	0	0	0	0	0
78716	0	0	0	0	0	0	0	0	0
78717	0	0	0	0	0	0	0	0	0
78718	0	0	0	0	0	0	0	0	0
78719	0	0	0	0	0	0	0	0	0
78720	0	0	0	0	0	0	0	0	0
78721	33	45	29	26	29	48	35	32	26
78722	0	0	0	0	12	0	0	0	0
78723	65	55	60	62	57	63	52	48	44
78724	52	56	70	56	46	24	33	22	21
78725	0	20	28	15	22	16	14	19	0
78726	0	0	12	0	0	0	0	0	0
78727	0	12	15	17	18	16	20	19	17
78728	0	25	19	13	12	17	13	0	13
78729	12	17	18	15	25	19	14	17	0
78730	0	0	0	0	0	0	0	0	0
78731	0	0	0	12	0	0	13	0	0
78732	0	0	0	0	0	0	0	0	0
78733	0	0	0	0	0	0	0	0	0
78734	0	13	12	0	0	0	0	0	0
78735	0	0	0	0	0	0	0	0	0
78736	0	0	0	0	0	0	0	0	0
78737	0	0	0	0	0	0	0	0	0
78738	0	0	0	0	0	0	0	0	0
78739	0	16	13	0	0	0	0	0	0
78741	52	45	39	35	45	39	49	27	39
78742	0	0	0	0	0	0	0	0	0
78744	55	54	43	50	24	39	28	23	22
78745	50	58	51	36	46	59	60	50	42
78746	0	0	0	0	0	0	0	0	0
78747	0	17	0	0	0	15	15	0	0
78748	22	29	26	18	21	15	21	21	16
78749	0	30	15	21	14	21	13	0	0
78750	12	0	13	21	13	12	0	0	15
78751	0	0	0	0	0	0	0	20	20
78752	32	32	25	22	26	22	18	14	0
78753	67	81	67	50	61	56	44	42	33
78754	25	18	0	27	23	0	0	0	0
78755	0	0	0	0	0	0	0	0	0
78756	0	0	0	0	0	0	0	0	0
78757	13	18	16	26	19	18	15	15	16
78758	44	64	43	59	60	43	34	42	31
78759	19	13	20	0	13	18	17	14	0
78760	0	0	0	0	0	0	0	0	0
78761	0	0	0	0	0	0	0	0	0
78762	0	0	0	0	0	0	0	0	0
78763	0	0	0	0	0	0	0	0	0
78764	0	0	0	0	0	0	0	0	0
78765	0	0	0	0	0	0	0	0	0
78766	0	0	0	0	0	0	0	0	0
78767	0	0	0	0	0	0	0	0	0
78768	0	0	0	0	0	0	0	0	0
78769	0	0	0	0	0	0	0	0	0
78772	0	0	0	0	0	0	0	0	0
78773	0	0	0	0	0	0	0	0	0
78774	0	0	0	0	0	0	0	0	0
78778	0	0	0	0	0	0	0	0	0
78779	0	0	0	0	0	0	0	0	0
78780	0	0	0	0	0	0	0	0	0
78781	0	0	0	0	0	0	0	0	0
78783	0	0	0	0	0	0	0	0	0
78785	0	0	0	0	0	0	0	0	0
78786	0	0	0	0	0	0	0	0	0
78788	0	0	0	0	0	0	0	0	0
78789	0	0	0	0	0	0	0	0	0
78798	0	0	0	0	0	0	0	0	0
78799	0	0	0	0	0	0	0	0	0

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