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ON THE RIGHT TRACK?

ASSESSING LAND USE CHANGE ALONG TRANSIT LINES USING EXISTING RAIL CORRIDORS

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Executive Summary

This research looks at the development of transit service using preexisting railroad corridors in North American cities. Many cities have taken this approach, often citing cost and ability to reuse existing corridors and not having to create new ones as justification for doing so. However, the land use that exists along existing railroad corridors is typically assumed to not be conducive to transit service due to the fact that freight rail corridors generally serve industrial areas. Often, it is assumed, existing land use along what are typically freight railroad corridors is generally industrial in nature and does not offer significant residential or employment density to generate transit ridership. In such areas, brownfield sites may require remediation for transit conducive development.

The goals of this research were to: identify how cities reuse existing rail corridors for transit service, assess preexisting land use in station areas along the corridors and changes that occurred after the opening of transit service, and to identify planning policies cities used to guide land use change in station areas along the corridors.

This research considers three case cities, Dallas, Texas, Charlotte, North Carolina, and Austin, Texas, each of which have developed rail transit services using existing railroad corridors. In assessing the three cities, the research begins by identifying how each city developed transit service along the corridors chosen for the study by analyzing documents which laid out the plans for developing the transit service.

After identifying how the case cities reused rail corridors, an analysis of land use in station areas along the corridors was conducted. This analysis used publicly available spatial data inputted into ArcGIS Pro to identify what land use types existed in station areas prior to the opening of the transit service, and how land uses changed over time following its opening. Finally, planning policy documents were analyzed to determine what policies were put in place to guide land use change along those corridors.

The research revealed the three case cities had somewhat different approaches to using existing corridors for transit service. Additionally, the research revealed preexisting land uses were not always industrial in nature, but there were trends towards homogeneity in the types of preexisting land use. As land use changed, most areas tended to see a decrease in industrial land use accompanied by an increase in land use diversity. With regard to planning policy, there is little consistency in how policies are applied across the three cities. In Charlotte, all station areas were given dedicated land use plans to help guide land use change. Meanwhile, in Dallas and Austin, the use of dedicated station area plans was more limited.

The results between Charlotte and the two Texas cities differed. While all station areas in Charlotte had dedicated land use plans overall land use change along the corridor was quite limited. Meanwhile, in Dallas and Austin, those station areas with dedicated station area plans or more specific policies for the local area around the station saw somewhat more land use change than other station areas.

Overall, this study highlights how the relationship between transit and land use is complex. While the two are inextricably linked in that land use constitutes the origins and destinations for people who are using transit, the ability of transit and associated land use planning policies to guide land use change is limited. Cities contemplating using existing railroad corridors to develop transit service should consider existing land use along the corridor and the planning policies necessary to guide land use change to instigate development that is more conducive to transit service should be taken.

At the time of this research, there were discussions in Winnipeg about relocating freight railroad corridors out of the city. The potential to reuse these corridors for transit may present opportunities that could both provide justification to relocate freight rail and improve transportation options.

1.0 - Introduction

1.1 - Research Overview

In 2024, the Province of Manitoba announced a study that will analyze rail infrastructure in the Winnipeg area to determine if it should be relocated (Province of Manitoba, 2024). Rail corridors that are currently used for freight service may present opportunities to be repurposed for other uses. One of these potential uses is transit service. The potential opportunities presented by a corridor if freight service were relocated may play a role in determining if the relocation should occur in the first place.

Because of the aforementioned interest in rail relocation in Winnipeg, this study analyzes the potential for existing freight rail corridors to be reused for transit service and intends to draw lessons that Winnipeg and other cities could learn from when reusing rail corridors for transit service. The analysis studies corridors that have been redeveloped in North America, the land use implications of reusing these corridors, and associated planning policy Findings are based on approaches taken in other cities and the resulting land use changes.

This report serves to compile information regarding approaches that various cities throughout North America have taken to repurpose freight rail corridors for transit service, assess data on the land use implications of these redevelopments, and review the policies that guided land use change. While previous studies have looked at land use implications with regard to North American transit systems more broadly, there has been limited research specifically regarding repurposed freight rail corridors. It is intended that the findings of this study may contribute to the recently announced rail relocation study for the Winnipeg region. Analysis and findings of this research are intended to be presented in a way that is accessible to industry members, policy makers, and the general public.

Research Questions

- What approaches have North American transit agencies taken to reuse freight rail corridors for transit service?
- How has land use changed along rail corridors following redevelopment for transit?
- How did planning policy guide these land use changes?

1.2 - Document Overview

This report begins by discussing the methods used to conduct the analysis. This includes a discussion of how cases were selected. The methodology section is followed by a literature review which provides an overview of previous research on reusing railroad corridors for transit service and the relationship between transit and land use. After the literature review, a brief overview of the context of the chosen case cities is provided.

After establishing the case context, the findings arising from the analysis are discussed. These findings are divided into three key sections which each address on of the above research questions: an overview of the details of how each case city developed transit using existing rail corridors, the spatial analysis of land use along these corridors, and the policies that guided land use change in these areas. After laying out the findings, a further discussion and analysis of the findings is included. This leads to a series of recommendations that come from the research, limitations associated with the research and potential future research arising.

2.0 - Methods

This section provides an overview of the methods of analysis used to assess land use change along transit corridors developed using existing freight rail corridors and the planning policies that guided these land use changes. The primary method of analysis used to assess land use change was spatial analysis. To analyze planning policies, coding of the relevant policy documents was used. Additionally, this section details the methodology of case selection, which involved identifying potential cases, reviewing the extent of their use of railroad corridors for transit service, and then selecting cases for analysis based on data availability..

2.1 - Case Selection

The scope of this study was limited to North America. This limitation on the scope reflects the similarities between the regulatory regimes which govern rail corridors and their uses in Canada and the United States. This scope also helps to ensure that the results of the analysis would be relevant to the regulatory and development contexts in the Winnipeg region.

The case selection was also limited to those cities and regions which developed transit service using freight rail corridors after the year 1990. This limitation was intended to ensure that data regarding specific aspects of land use along redeveloped corridors would be available. More specifically, it was required that data be available for cases both prior to and after the development of a transit system using a freight rail corridor. Having data from before and after the development of the transit corridor ensured that the analysis was able to accurately capture land use changes and compare what existed before with what has developed since.

To identify potential cases, a database which compiles information regarding transit systems was consulted. The database used was the Rapid Transit Database published by the Institute for Transportation and Development Policy (Institute for Transportation and Development Policy, 2022). This database compiles information regarding transit lines from around the world, including the name of the corridor, the type of transit (LRT, BRT, Regional Rail, or Metro), the length and number of stations, and the year it opened. The characteristics of length, number of stations, and year opened were essential to determining the suitability of cases for analysis. As previously mentioned, the year opened was a key criterion to ensure the availability of data for analysis. Additionally, the length and number of stations characteristics helped to ensure that the line is substantial enough in length to warrant analysis for land use change.

The database was filtered to identify just those corridors in North America which are rail based (LRT, Regional Rail, and Metro) and those which occurred during the study period. The study focuses on rail-based transit systems due to the potential to reuse existing infrastructure. Internet searches were then performed to identify whether existing rail corridor alignments were used to develop the transit corridor. Internet searches generally identified varying sources such as policy documents, plans, academic articles, industry publications, and news articles which discussed the nature of the development of the transit system and whether it used a preexisting railroad corridor. From this a separate list of potential cases was generated. See *Table 1: Identified Potential Cases* below for the initial list of identified potential cases.

Table 1: Identified Potential Cases

City	State / Province	Type	System	Line	Year Opened	Source
Charlotte	NC	LRT	LYNX	Blue	2007	(Charlotte Department of Transportation, 1989)
Dallas	TX	LRT	DART	Red	1996-2002	(Dallas Area Rapid Transit, 1983)
Dallas	TX	LRT	DART	Blue	1996-2016	(Dallas Area Rapid Transit, 1983)
Dallas	TX	LRT	DART	Orange	2010-2014	(Dallas Area Rapid Transit, 1983)
Austin	TX	Hybrid	CapMetro	Red	2010	(Clark-Madison, 2004)

Albuquerque	NM	Commuter	NMDOT	Rail Runner Express	2006	(New Mexico Department of Transportation, 2015)
Ottawa	ON	LRT	OC Transpo	Trillium	2001	(Leclair, 2002)
Portland	OR	LRT	Tri-Met	Blue	1998	(Trimet, 2016b)
Portland	OR	Hybrid	Tri-Met	WES Commuter Rail	2009	(Trimet, 2016a)
Los Angeles	CA	LRT	Metro Rail	Blue (Long Beach)	1990	(Loukaitou-Sideris & Banerjee, 2000)
Los Angeles	CA	LRT	Metro Rail	Blue (Pasadena)	2003	(Transportation Department & Surface Transportation Board, 2003)
St. Louis	MO	LRT	MetroLink	Red	1994-2003	(Allen, 2001)
St. Louis	MO	LRT	MetroLink	Blue	1994-2006	(Allen, 2001)
Salt Lake City	NM	LRT	TRAX	Blue	1999	(Allegra, 1996)
Salt Lake City	NM	LRT	TRAX	Red	2001	(Allegra, 1996)
Salt Lake City	NM	Commuter	Utah Transit Authority	Frontrunner	2008	(Utah Transit Authority, n.d.)
Baltimore	MD	LRT		Light RailLink	1992-1997	(Maryland Transit Administration, 2002, p. 17)
Denver	CO	LRT	RTD	D	1994-2000	(Ratner & Goetz, 2013)
Denver	CO	LRT	RTD	E	2002	(Ratner & Goetz, 2013)
Hudson-Bergen	NJ	LRT	NJTransit	Hudson-Bergen Light Rail	2000-2011	(Federal Transit Administration, 1999)
Oceanside	CA	Hybrid	North County Transit District	Sprinter	2008	(San Diego Union-Tribune, 2008)
Santa Clara	CA	LRT	VTA Light Rail	Vascona Extension	2005	(Clark, 2008)

The resulting list of potential cases was then used to perform internet searches to identify whether the required data to perform spatial analysis on the land use adjacent to the corridor existed for both before and after the development of the rail corridor. Keywords used for searches looked for land use datasets along with the case city name and the oldest year of data required based on the opening date.

Searches led to various GIS databases and data websites for local, county, state, and regional level governments. The searches revealed sufficient publicly available data existed to perform a spatial analysis for three case cities: Charlotte, North Carolina; Dallas, Texas; and Austin, Texas. For a fourth case city (Ottawa, Ontario) data was identified on the Carleton University Library website but was not publicly accessible. For all other cases, available data did not cover a sufficient time period prior to and following the development of the transit corridor.

2.2 - Spatial Analysis

Spatial analysis is used to relate transportation and land use, plan infrastructure, and inform policy decisions; in doing so, helping to develop transportation systems that meet current and future needs and are efficient, resilient, sustainable, and equitable (Panchal & Debbarma, 2017; Zhang, 2023, p. 4). While common in practical professional applications, as highlighted above, using GIS for spatial analysis of land use change has also been used across academic disciplines (Bielecka, 2020). Spatial analysis was conducted to both identify characteristics of each case and relate them with land use. ArcGIS Pro software was be used to conduct the analysis.

Data was retrieved from government sources, including the North Central Texas Council of Governments, Mecklenburg County, the City of Dallas, the City of Charlotte, and the City of Austin, and categorized into two distinct areas: Land Use Data and Routes / Station Data. Land Use Data includes datasets that identify specific characteristics of land use such as land use type and intensity. Route / Station Data provide the locations of the transit routes and station being analyzed.

Timeframes

Studies point to a ten-year timeframe as being the minimum for analyzing land use changes in conjunction with transit, with longer time frames also being used. In a 1993 study on the relationship between transit investments and real estate, Cervero and Landis note it takes about a decade from the opening of a transit service to be able to measure its land use impacts. This timeframe is also used by Hurst and West 2014) and Dong (2016). Further research using a 20-year time frame of the Bay Area Rapid Transit system in California indicates that development was largely localized to San Francisco and Oakland's downtowns and some suburban stations (Cervero and Landis, 1997).

Gathering the Data

Conducting spatial analysis using ArcGIS Pro requires data to be in a compatible format, such as shapefiles. Much of the required data was identified as part of the case selection process. For the case of Dallas, Texas, all data was publicly available and published by the North Central Texas Council of Governments dating back to 1990. This data consists of regional-scale shapefiles created in five-year intervals which identify 20+ types of land use throughout the region. For the case of Charlotte, North Carolina, data was published by Mecklenburg County. The datasets consist of individual parcel level tax data dating back to 2001, which includes the land use of each parcel.

For Austin, Texas, data was published by the City of Austin and includes much of the surrounding Travis County. This data consists of parcel level land use datasets, which cover the years 2006, 2010, and 2021. The dataset for 2021 also identifies the previous land use in 2018. For all cases, datasets indicating the routes of transit lines and the locations of their stations were also identified.

For Ottawa, the required data was identified as existing on the Carleton University Library website. However, this data was only accessible to Carleton students. In attempting to acquire this data, a request was made to the City of Ottawa which went unanswered. Subsequently, a request was made to the Carleton

University Library directly. This resulted in a connection between Carleton's Library and the University of Manitoba's Library. However, this failed to result in the successful acquisition of the data in time for this study. See *Table 2: Years of Analysis for Case Cities* below for an overview of the case cities and years of data used. See *Appendix A: Land Use Datasets Used for Spatial Analysis* for an overview of the specific datasets used.

Table 2: Years of Analysis for Case Cities

Case	Year of Construction	Years of Data Analysed
Dallas	1996	1995, 2000, 2005, 2010, 2015, 2020
Charlotte	2007	2005, 2010, 2015, 2020
Austin	2010	2006, 2010, 2018, 2021

Preparing the Data

This study primarily uses spatial analysis to identify areas of land use change within the station areas of the transit corridors being studied. The data was manipulated to ensure that it reflected a series of general land use categories to ensure cross-comparability and standardization between cases. For example, if a case contained multiple designations which might generally be considered a single detached home, such as "Single-Family," "Mobile Home" and "Large Lot Single Family," these were all considered to fit into the more general category of "Single Family" for the purposes of this analysis. See *Appendix B: Dallas Land Use Classifications*, *Appendix C: Charlotte Land Use Classifications*, and *Appendix D: Austin Land Use Classifications* for an overview of the land use classifications generated for each case.

Once the land use data was manipulated to create consistent land use classifications, datasets for the routes and stations of each transit line were imported into ArcGIS and prepared for analysis. See *Appendix E: Route and Station Datasets*

Used for Spatial Analysis for an overview of the datasets used for routes and station areas. Including the station locations allowed ArcGIS network functions to identify station areas within 800 meters walking distance of the station to focus the analysis. 800 meters was chosen to define the station areas as the distance is considered a standard walkshed for assessing transit-oriented development (Dittmar & Ohland, 2004, p.20).

Analyzing the Data

Once all the data was added to the ArcGIS Pro project for a respective case, station areas were established using the Network function in ArcGIS pro. This resulted in the ArcGIS Pro establishing an 800-metre walkshed from each station location and creating a feature outlining this walkshed that could be used for analysis. Following the creation of these walkshed areas, maps were created for relevant station areas to visually represent the land use that existed in each year of analysis. Maps were created for each year of data that was identified to allow for a visual assessment of change over time.

The Summarize Within function of ArcGIS Pro was used to calculate the total area of a given land use that existed within the defined station area walkshed for a given year. The Summarize Within function generated tables which indicated the total land use of each type for each station area in a given year. The raw data tables were converted into Microsoft Excel compatible files. Once in Excel, they were altered to remove station areas that were not included as part of the analysis.

Only those station areas which were along existing railroad corridors and part of the initial starter line(s) for each case were included as part of the analysis. For example, the Charlotte station area dataset included stations on the Blue Line that were constructed as part of an expansion that occurred too recently to be included in the analysis, and these were therefore removed from the data in Excel. Land use types not included in the analysis, such as bodies of water, were also removed. The raw data was then transformed using Pivot Tables to present the data for each year in a more easily digestible format.

After data tables were created for each year of the study, additional tables were created to compare study year to study year land use changes. For example, for Charlotte, tables were created which identified changes in land use type from 2005 to 2010, 2005 to 2015, 2005 to 2020, 2010 to 2015, 2010 to 2020, and 2015 to 2020. Additional tables were also created for each station area indicating the land use for that station area for each study year of the study timeframe. From these tables, charts were created for each station area to visually represent the land use changes which occurred over the course of the entire study timeframe. All tables and charts are included in Appendices G through L.

For Dallas, the dataset used for 1995 differed from the rest. The land use parcels shown in this dataset included adjacent roads and other areas that were not included in land use parcels for datasets from other years. To remedy this issue, road areas were extracted from the 2000 dataset, placed in a separate layer, and then used to remove road areas from the 1995 dataset using the Pairwise Clip function of ArcGIS Pro. This resulted in a 1995 dataset which excluded roadways from land use parcels and therefore would be more directly comparable with land use datasets from other years.

Additionally, for Charlotte, using the analysis functions of ArcGIS Pro to extract the total area of land use types yielded inaccurate results. The areas for certain land use types were significantly overestimated, in some cases stating that a particular land use type covered more area than the entire station area. Attempts were made to remedy this error using ArcGIS Pro's Summarize Within function as had been done for other case cities. However, using this function was of no avail. Alternatively, various functions of ArcGIS Pro were used to extract all land use data outside of the station areas, then attach a value to each land use parcel within a station area identifying it as part of that station area.

After completing these steps, it was realized that the error was resulting from many land use parcels containing several overlapping parcels. The Delete Identical function of ArcGIS Pro was used to eliminate these overlapping parcels. After deleting these parcels, the datasets were then inputted into Excel and the Pivot

Table function used to summarize the total areas for parcels which a given land use types and station area code. Using this method, the raw data inputted into excel contained the area for individual land use parcels which were then summarized to provide on the total land use of that type for the station area in which they were located.

2.3 - Coding and Document Review

Reviewing documents can be complementary to quantitative analyses by helping to provide background, context, insight, and supplementary data that may not be identified in raw data analysis (Bowen, 2009, p. 30). To supplement the spatial analysis of land use change in the case cities, planning policy documents were also reviewed. The purpose of this analysis was to identify links between the development of the transit corridors, the land use change that occurred or lack thereof, and the policies that guide land use and development in the case cities.

To identify relevant documents, internet searches were used with key words such as "(city name) Transit Oriented Development Plan," "(city name) Land Use Plan (year)," "Station Area Plan," and "(city name) Transit Network Plan." Internet searches led to webpages for the various case cities or for local libraries and institutions where more relevant documents were identified.

To analyze documents, deductive coding was used, with codes generated prior to the documents being reviewed. Codes were broken down into two broad categories of "Approach," which details elements of the approach taken to redevelopment, and "Land Use," which details the relationship between the development and land use. Analyses of documents which detailed the approach taken to develop the rail corridor, such as a Transit System Plan, were conducted prior to spatial analysis for each case to build context, help identify additional data for spatial analysis and identify areas of interest that may benefit from special attention during the spatial analysis.

Policy documents and government reports which specifically relate land use with the development of transit, such as "Transit-Oriented Development Strategies, Policies, etc.," for specific cases were analyzed in greater detail after the spatial analysis was conducted. This helped to identify how policy was used in the specific case to guide land use in relation with reuse of rail corridors for transit, after an understanding of the land use changes that occurred was developed. A specific set of deductive codes was generated for these documents. Codes for transit plans included “Land Use,” “Development,” “Density,” and “Transit-Oriented Development.” Codes for land use planning documents included “Transit,” “Transit-Oriented Development,” “LRT,” “Light Rail,” “Station,” “Station Area,” and “Integrated.”

Once coding and review of the documents was complete, analysis concluded by generating findings through identification of common themes that exist between cases and specific or unique characteristics that arise within specific cases. This included identifying the types of plans that each case had in place, how connections between land use and transit were discussed in each case, and the types of policies that were used. Planning policies analyzed have been categorized as either a Transit Plan which is primarily focused on planning for the transit system, a Comprehensive Plan planning for an entire city or region, an Area Plan which looks at a specific area of district of a city, or a Station Area Plan which looks at a station area specifically. The findings of the spatial analysis were also related to the findings of the document analysis to identify potential links between land use changes that occurred and the policies that were in place.

3.0 - Literature Review

3.1 - Introduction

Transportation corridors, such as railroad corridors, form a key element of the structure of a city. According to Lynch (1960, p. 49) the paths that connect our city, such as railroad corridors, form the predominant element through which we experience out cities. Modern cities face many challenges, including ensuring there is space for people to live and work the means of transportation exist for people to get around. This literature review delves into the connections between land use and transit, with a particular focus on transit lines along reused railroad corridors. The literature review begins with a discussion around the reuse of rail corridors, further analyzes the links between transit lines and land use with specific attention given to transit lines using freight rail corridors. A discussion regarding the use of policy to guide land use along transit corridors is also included. The literature review compiles existing knowledge regarding these topics and identifies ways in which future work can build upon the existing understanding.

3.2 - Reuse of Rail Corridors

Rail corridors can be redeveloped for various uses including recreation, transportation, utility, or other uses such as public open space (Morgan et al., 2012). Given the importance of linear corridors within cities, policies may exist to ensure preservation of the right of way in the event that it becomes unused (Morgan et al., 2012). One common example is rails-to-trails conversions. In these cases, rail corridor rights of way are converted to recreational multi-use trails as a method of both increasing active transportation options and preserving the linear right of way (Ferster, 2006).

This literature review focuses on the reuse of rail corridors for transit service. In discussing the potential to use rail corridors for transit service, Allen (2001) posits that, while opportunities for reuse are not widespread, rail corridors can serve as effective and affordable transit corridors when they link major activity centers. Light rail has been used as a less costly rail-based transit alternative, and cities often chose to use freight rail corridors for transit lines to save on cost (Cervero, 1984). In some cases, transit lines may share tracks with freight rail. Allen and Newmark (2020), Lytton (2022), and Resor and Hickey (2005) discuss the regulatory issues that exist when doing so and the specific strategies that are used to facilitate these shared uses. These findings indicate that reuse of rail corridors for transit is a not-uncommon scenario that is often chosen for the potential cost savings. In some cases, despite regulatory hurdles, freight operations will continue to share tracks with the new transit lines.

3.3 - The Transit – Land Use Connection

Transit Influences Land Use

Knight and Trygg (1977) were among the first to discuss the relationship between land use, development, and transit. Rail transit may have a significant impact on land use if other factors align. These factors include the alignment of land use policy with transit development, the availability of land for development, the attractiveness of the surrounding area, and the existence of demand within the larger economy (Knight & Trygg, 1977). Gomez- Ibanez (1985) further discussed how regional growth, supportive zoning, and the level of the improvement in transportation quality all play a role as conditions for development adjacent to rapid transit station areas. The basis of the modern understanding of how transit can influence land use is built upon these collective early findings.

An analysis of San Diego, Sacramento, and Portland found that regional scale policy coordination is key to effectively integrating land use with transit development (Glick, 1992).

Another study of the California Bay Area's BART system revealed that vacant and developable land was an important predictor in land use change; additionally, the system was a contributor in some cases to large scale land use changes despite not necessarily instigating them (Cervero & Landis, 1997).

The collective findings of research regarding the transit land use connection are perhaps best summarized by Higgins et al. (2014), who identified six relevant factors. The most important factors identified were the level of improvement to transit accessibility, the growth and development demand that exists in the region, and the existence public policies that support development (Higgins et al., 2014). They also note that various studies mentioned the social and physical conditions adjacent to the corridor and the local availability of land were also mentioned as factors (Higgins et al., 2014).

Research shows that strong policies that guide development help to realizing land use change along transit corridors. Therefore, many cities use policy tools to guide development along transit corridors. There are many examples of policies that have been used to guide transit supportive or transit-oriented development. Lewis and Auzenne (2014) explored these policies more in-depth with reference to Houston, Portland, and Phoenix. They found various methods used by cities to guide development along transit lines. These methods included providing incentives to developers, altering zoning policies, and establishing development authorities for stations areas (Lewis & Auzenne, 2014).

Land Use Influences Transit

These findings only discuss one side of the equation. Transit can potentially influence land use, but this relationship is not-one sided. Land use can also influence transit outcomes in that:

a. The characteristics of land use, whether they exist before or after transit, play a role in determining whether transit actually gets used, and
b. Therefore, existing land uses play a role in determining where transit gets built if they offer the potential to support people using transit.

Three characteristics of land use, Density, Diversity, and Design were identified by Cervero and Kockelman (1997) as influencing transit, and subsequently called the 3Ds. This concept has since been expanded upon to include three more Ds: Destination, Distance, and Demand Management (Ogra & Ndebele, 2014). This concept is used by cities, such as Vancouver, in the practical application of policies that relate transportation and land use (Translink, 2012). There are conflicting opinions as to whether compact forms of development actually lead to people driving less, with some such as Stevens (2016) arguing that encouraging compact development should not be the sole method used by planners to alter transportation behaviour. Others such as Handy (2017) and Ewing and Cervero (2017) argue that altering transportation behaviour is not possible without encouraging alternative forms of development.

Transit Oriented vs. Transit Adjacent

Various studies have discussed the differences between Transit Oriented Development (TOD) and Transit Adjacent Development. These studies argued that the development that occurs near transit stations is not usually well-suited to get people to use transit (Renne & Ewing, 2013; Belzer & Autler, 2002; Dittmar & Ohland, 2004; Renne, 2008; Cervero et al., 2002). Therefore, this development is simply transit adjacent and not transit oriented. Belzer and Autler (2002) state that TOD lacks a true definition; it often struggles to balance the node aspect of the transit with the place aspect of the development, strives to achieve a balance that is difficult to obtain between various uses and functions, and lacks clear and consistent policy or even general guiding principles in its development.

Measuring Impacts

Austin et al. (2010) developed performance-based criteria to determine if a development is Transit Adjacent, Transit Oriented, or a hybrid of the two. They developed these criteria based off a combination of factors such as density, land use diversity, and walkable design (Austin et al., 2010). Their work defining TOD helps differentiate between developments that may lead to real changes in transportation behaviour and developments that simply exist near transit stations. Cervero and Guerra (2011) found a population density of 30 people per gross acre (74.13 people / gross hectare) near stations placed transit systems in the top 25% most cost-effective systems in the United States.

Renne and Ewing (2013) later aimed to build upon this work and categorize station areas of all fixed transit systems across the United States as TOD or not using the criteria of:

- 30 jobs or residents per gross acre (74.13 / hectare),
- Use that is neither 100% commercial nor residential, and
- Average block size of less than 6.5 acres (2.63 hectares).

Renne and Ewing (2013) found that these land use characteristics have a significant impact on local residents' transportation choices. Those living in true TODs were more likely to use active transportation or transit and showed lower rates of car ownership (Renne & Ewing, 2013). These findings indicate that true TOD has a measurable impact on transportation behaviour and can also help to provide a framework for analyzing development adjacent to transit.

Hurst and West (2014) conducted an analysis of land use change along a rapid transit corridor in Minneapolis. To conduct this study, Hurst and West (2014) assembled parcel level land use data for areas near rail stations throughout the Minneapolis region and conducted analyses on land use before and after the introduction of rail service at various intervals which they indicate as the pre-construction, construction, and operation periods. Their findings showed that land use change did not significantly occur during construction or after operation of the line began; there were only limited changes in land use on single family and industrial properties, and no change on vacant, commercial, or multi-family properties (Hurst and West, 2014). Additionally, Hurst and West (2014) discussed the policy that was implemented in conjunction with the transit development and compared their results to broader land use changes throughout the metro region.

The findings of these studies indicate that land use, and land use changes along corridors can be studied. The examples highlight methods for analyzing land use including using data regarding density, use types, and urban form. Despite this, Renne and Ewing (2013) did not determine if significant land use changes occurred as a result of transit as it did not analyze land use over different time periods. Hurst and West (2014) identified methods to measure land use change over time.

Transit, Development, & Freight Rail Corridors

Cervero (1984) posited that developing transit along freight rail corridors, which are often built to service industrial areas, may ignore potential land use opportunities and negate transit's ability to reshape cities. Allen (2001) built on this discussion by stating that railroad alignments are not intrinsically inferior, but they have attracted industrial land uses over time. Despite this, railroad alignments may still connect major activity centres and offer the potential to focus residential and commercial development should market conditions exist (Allen, 2001).

Allen (2001) discusses transit systems that use rail corridors and connect downtowns with outlying centres of regional importance, only analyzing the portions of transit lines that use redeveloped rail corridors. To identify centres of regional importance, Allen (2001) borrowed a definition from Schumann (1997), which includes uses such as universities, cultural and sports facilities, intercity transportation terminals, airports, and regional shopping centres. Evidently, there is some debate as to whether freight rail corridors can serve as effective transit lines if reused. Further analysis of constraints and land use outcomes can help build a better understanding.

Development Constraints

Various studies have discussed the development constraints that exist when redeveloping rail corridors for transit. A 1999 study by Boarnet and Compin looked at San Diego's experience with the development of its trolley system, in which portions of existing rail corridors were reused. This placed constraints on development adjacent to the corridor as areas were already developed, and this development was auto centric and not conducive to redevelopment for residential use (Boarnet & Compin, 1999). They highlighted that pre-existing land uses are a contributor redevelopment along new transit corridors and the importance of policy and aligning development along transit corridors with broader planning objectives (Boarnet & Compin, 1999).

Loukaitou-Sideris and Banerjee (2000) analyzed the Blue Line Light Rail project in Los Angeles between downtown Los Angeles and Long Beach. They sought to identify barriers to development along the line which was redeveloped from a freight rail corridor. Four broad areas of constraints which inhibited development along the Blue Line corridor are discussed. These include planning problems, physical / environmental problems, social / structural problems, and economic problems (Loukaitou-Sideris & Banerjee, 2000). To counter these problems a more regional approach to the project is proposed.

Additionally, along the Red Line corridor in St. Louis, which was developed along a below grade rail corridor, some stations areas have seen little redevelopment from preexisting industrial use to commercial or residential (Allen, 2001). This may be attributed to its lack of planning policy for these areas (Baker & Lee, 2017). Collectively, these studies point to preexisting land use being a consistent constraint when it comes to reusing rail corridors for transit. A lack of planning policy can also contribute to a lack of land use change.

3.4 - Analyzing Land Use and its Change

Dong (2016) discusses residential development along suburban transit corridors in Portland, Oregon. One of the corridors, the Westside corridor, is notable in that it is a specific example of the conversion of a freight rail right of way for transit use. Dong (2016) found that, along the corridors analyzed, housing units increased 15% between 2004 and 2014, noting that this primarily occurred along established corridors, which included the Westside corridor. Dong (2016) goes on to argue that the purpose of his study was to conduct an analysis on a best-case example, one in which there were significant changes in land use. This helps make the argument that strong transit-oriented development policies can play a role in encouraging transit-oriented land use even along former freight rail corridors.

Bhattacharjee & Goetz (2016) analyzed land use change adjacent to rail corridors in the Denver metro region. They highlight that spurring redevelopment was a specific goal of developing the system and that land use growth has occurred along proposed rail lines despite the fact that they are existing freight corridors with industrial land uses. The Southwest corridor, which was developed along a former freight rail right of way through a more established neighborhood, has exceeded ridership expectations and required expansion of park-and-ride facilities (Ratner & Goetz, 2013). There has been some new development but significantly less than corridors running through more centrally located areas (Ratner & Goetz, 2013).

Collectively, these examples highlight how land use change along transit lines using rail corridors have been analyzed. They find that, despite being located along rail corridors where uses may not be conducive to redevelopment, redevelopment and land use change does indeed occur along these transit lines. In particular, setting land use change as a goal from the outset and enacting policy associated with development along transit corridors may lead to potential success.

3.5 - Summary

From this literature review, it is evident that transit can influence land use and land use can influence transit outcomes. There are various ways in which these phenomena occur. Transit may influence land use when the service improves accessibility, there is regional demand for growth and development, and there is supportive policy. The land use conditions to support transit use may exist prior to the development of transit, or they may occur over time as a result of the existence of transit. Development, therefore, may simply be adjacent to transit or it may be transit oriented if it meets certain criteria. Policy plays a key role in influencing development adjacent to transit, and cities often use multiple policy tools to influence land use adjacent to transit.

Reusing railroad corridors has been identified as a cost-effective method to develop transit systems. Railroad corridors can be viable for transit, particularly if they connect major regional destinations, but not all are. Often, pre-existing land uses along railroad corridors are not supportive of transit, as railroads were built to service industrial areas. Despite this, some cities have seen success in redeveloping land use along railroad corridors to be more supportive of transit.

There has been significant research into transit lines and their relationships with cities. Many have looked at development adjacent to transit lines. However, few studies have looked specifically at transit lines developed using railroad corridors. The research that has been conducted with regard to land use along these transit lines is often in the broader context of land use along transit lines more generally. Little research has been conducted taking the specific approach to identify relationships between land use and transit along transit lines developed using railroad corridor rights of way. This presents an opportunity to dive deeper into this topic and investigate land use changes along transit lines that use freight rail corridors and the policies that may have been used to influence these changes.

The findings of this literature review also indicate that the density of residential and commercial uses, the diversity of these use types, and the design of station areas are important considerations when analyzing development along transit lines. Additionally, connections to major destinations were identified as a key consideration with regard to the reuse of railroad corridors for transit. Previous studies have analyzed only portions of lines that were redeveloped from former railroads, excluding portions of a line that didn't use freight railroad corridors. A timeframe of at least 10 years post-opening of the transit line was identified as ideal for analyzing land use change, and specific examples with potential for further analysis identified based on those discussed in the literature.

4.0 - Context

4.1 - Case Profiles

Case profiles highlight relevant features of each case being discussed in the analysis. Each profile provides an overview of the general context of the case, including the population, area, and regional structure of the area under consideration. This is followed by a discussion of the transit system that is being analyzed and broader transportation considerations for the case. A brief history of the transit network serves as an introduction to the case, with further discussion of system development to follow as part of more in-depth analysis. Relevant considerations, such as the length and lines of the rail-based transit system, other types of transportation, and the transportation mode share are identified. Key indicators from case profiles are summarized below in *Table 3: Relevant Indicators for Cases*.

Table 3: Relevant Indicators for Cases

Case City	Metro Population	Metro Area (km²)	Urban Population	Urban Area (km²)	Transit System	System Length
Dallas	8,100,037	22,468	5,843,632	4524	DART	150 km LRT
Charlotte	2,805,115	8,280 km²	1,436,613	1703	LYNX	31.1 km
Austin	2,473,275	10,929 km²	1,915,031	1604	CapMetro	51.5 km

4.2 - Dallas – Ft. Worth

Figure 1: Stations Analyzed in Dallas, Texas.

Overview

Located in the State of Texas, the Dallas-Fort Worth metroplex is the most populous metropolitan region in Texas and the fourth largest in the United States with a population of over 8 million (United States Census Bureau, 2024). The region has a large and diversified economy, with key sectors including finance, technology, and transportation (The Editors of Encyclopaedia Britannica, 2024). Other key cities that make up the region include Arlington, Denton, and Irving. This population occupies a land area of 22,468 km², with 4,524 km² of that being urbanized (US Census Bureau, 2023a; U.S. Census Bureau, 2023b). The above map, *Figure 1: Stations Analyzed in Dallas, Texas*, highlights the stations analyzed in Dallas.

Transit

The beginnings of Dallas's current rapid transit system originated in 1983, when voters in the 15 municipalities that make up Dallas County approved of the creation of a special tax to help fund regional transportation (Dallas Area Rapid Transit, 2024). This resulted in the replacement of the Dallas Transit System (DTS), the City of Dallas's transit provider, with Dallas Area Rapid Transit (DART) (Dallas Area Rapid Transit, n.d.). In 1996, 13 years after initial conception, the DART light rail system began operation. Initially, DART consisted of two lines, the Red and Blue. The initial system was approximately 18 kilometres in length. Subsequently, two additional lines, the Green and Orange were added to the system in 2009 and 2010 respectively. Today, DART operates in 13 cities, with 86 bus and shuttle routes, 31 on demand zones, a streetcar line, nearly 150 kilometers of light rail, and over 50 kilometers of commuter rail (Dallas Aera Rapid Transit, 2024). The total length of its light rail system makes it the longest in the United States (Dallas Area Rapid Transit, n.d.).

4.3 - Charlotte, North Carolina

Figure 2: Stations Analyzed in Charlotte, North Carolina.

Overview

Charlotte is the most populous city in North Carolina and the county seat of Mecklenburg County. The metropolitan area of Charlotte is the 22nd largest in the United States, with a population of over 2.8 million (United States Census Bureau, 2024). The metropolitan region stretches across state borders to include parts of South Carolina (UNC Charlotte Urban Institute, 2013). For decades, Charlotte has been one of the fastest growing metropolitan regions in the country. It has a diversified economy and is one of the largest banking centres in the United States (The Editors of Encyclopaedia Britannica, 2025). The metropolitan region occupies an area of 8,280 km^2, giving it a population density of approximately 318.2 people / km^2 (U.S. Census Bureau, 2023c). The urban area has a population of just under 1.5 million in an area of approximately 1,700 km^2 (U.S. Census Bureau, 2023d). The above map, *Figure 2: Stations Analyzed in Charlotte, North Carolina*, highlights the stations analyzed in Charlotte.

Transportation

Public transit in Charlotte began in 1976 and would eventually come to be known as the Charlotte Area Transit System (CATS) (Allen, 2023). Studies in the 1980s proposed the development of a light rail rapid transit system for the area. After years of delays, the first line of this system, the Lynx Blue Line, opened in 2007 (Harrison, 2007). An extension to the Blue Line opened in 2018 (The Associated Press, 2018). The Blue Line now totals 31.1 km in length (Metro Report International, 2018). Over the past decade, Charlotte has been plagued by a significant decrease in ridership on its public transit system (Allen, 2023). CATS is now working on development of its next light rail line, the Silver Line (Charlotte Area Transit System, n.d.).

4.4 - Austin, Texas

Figure 3: Stations Analyzed in Austin, Texas.

Overview

Austin is the capital of the State of Texas and is located in Travis County. It is a rapidly growing metropolitan region home to nearly 2.5 million people (United States Census Bureau, 2024). In addition to being the centre of governance for the State of Texas, Austin has seen an influx of investment in the technology sector, reflected in its nickname Silicon Hills (Schroer, 2025). The metropolitan region occupies a total area of over 10,000 km² (U.S. Census Bureau, 2023d). The urban area has a population of nearly 2 million in an area of approximately 1,600 km². The above map, *Figure 2: Stations Analyzed in Austin, Texas*, highlights the stations analyzed in Austin.

Transportation

Austin's rapid growth has necessitated significant investments in its transportation network. The regional transit system, Cap Metro, was established in 1985 by voter referendum (Cap Metro, n.d.). Today, Cap Metro operates 71 bus routes, including two Bus Rapid Transit routes, as well as its over 50 kilometer long Red Line rail service, and owns 260 kilometers of freight railroad between Giddings and Llano (Cap Metro, n.d.). The first significant investment is the city's Red Line rail line which opened in 2010 (Freemark, 2010). This transit line has been described as a Hybrid system, with elements of light rail and commuter rail (Capital Metropolitan Transportation Authority, 2025). Currently, CapMetro is working to upgrade the Red Line with new stations, more frequent service, and electrification, as well as to develop additional light rail lines (Cap Metro, 2024).

5.0 - Findings

The following section covers the use of the aforementioned research methods to identify the necessary information that will contribute to answering the research question. Findings are divided into three subsections, Corridor Development, Land Use Change, Planning Policies. The first subsection corresponds to the first research question, the following subsection to the second, and the final subsection to the third. The collective findings are built upon further in the subsequent Discussion section of this report.

5.1 - Corridor Development

This section explores how the case cities being studied have reutilized existing freight railroad corridors for transit service. A combination of mapping and spatial analysis, as well as plans, reports, and policy documents from the development of the transit services are used to identify how each case developed its transit system. This section aims to address the first research question and identify how case cities redeveloped railroad corridors for transit service. It sets the stage for further analysis into land use along the redeveloped corridors and the policies that guided land use change.

5.1.1 - Dallas, Texas

Dallas first began exploring regional scale transit in the early 1980s as part of the Dallas Area Rapid Transit (DART) Final Service Plan and Supporting Documentation. This document outlined vision for a proposed regional transit system, including the plan criteria, policy, and performance. As part of the general system criteria for fixed guideways, it states "Relocation of residences and businesses is always disruptive; therefore, the fixed guideway system should, to the extent possible, use existing linear right-of-way" (Dallas Area Rapid Transit, 1983, p. II-5). Further, to realize this vision of developing regional scale transit with little disruption to local residences and business, the document goes on to state:

> *"As a part of the cost effectiveness evaluation, the Board determined it will be most advantageous if the fixed guideway system is constructed within existing railroad rights-of-way. The DART Board evaluated costs, accessibility and environmental concerns in reaching its decision. The decision does not preclude the use of highway rights-of-way but rather states a preference to use railroad property. Only existing rights-of-way were considered by the Board, reflecting a goal of avoiding the disruption of forging new rights-of-way" (Dallas Area Rapid Transit, 1983, p. II-7).*

This section highlights how, from the very beginning, utilizing existing railroad rights of way achieved the goals of cost effectiveness and disruption minimization set out in its plan criteria. This original plan would have seen development primarily along existing railroad corridors outside of the Central Business District and called for a subway to be constructed within the CBD. In total, this system would have consisted of a variety of lines sprawling in all directions into Dallas's suburbs, with a total system length of 257 kilometers (160 miles). See *Figure 4: The original DART Service Plan from the 1983* proposal below for an overview of the system proposed in the 1983 Service Plan.

Figure 4. The original DART Service Plan from the 1983 proposal. Source: Dallas Area Rapid Transit (1983).

These initial plans, however, did not come to fruition. In 1988, a referendum on financing for the initial proposal was defeated, resulting in a revisitation of the plans for rail-based transit in the Dallas region (Dallas Area Rapid Transit, 1989, p. 5). The 1989 Transit System Plan was the result of this review. The resulting plan continued with the initial proposal's focus on utilizing existing railroad rights of way, as shown in *Figure 2* below, where railway corridor owners such as Santa Fe Railroad (SF RR) are indicated along proposed corridors. The LRT portion of the newly proposed system would be approximately 106 kilometres (66 miles) in length, a significant reduction from the initial proposal (Dallas Area Rapid Transit, 1989, P. 13). See *Figure 5: Map of the updated DART Plan from the 1989 system plan* below for an overview of the system proposed in the 1989 Transit System Plan.

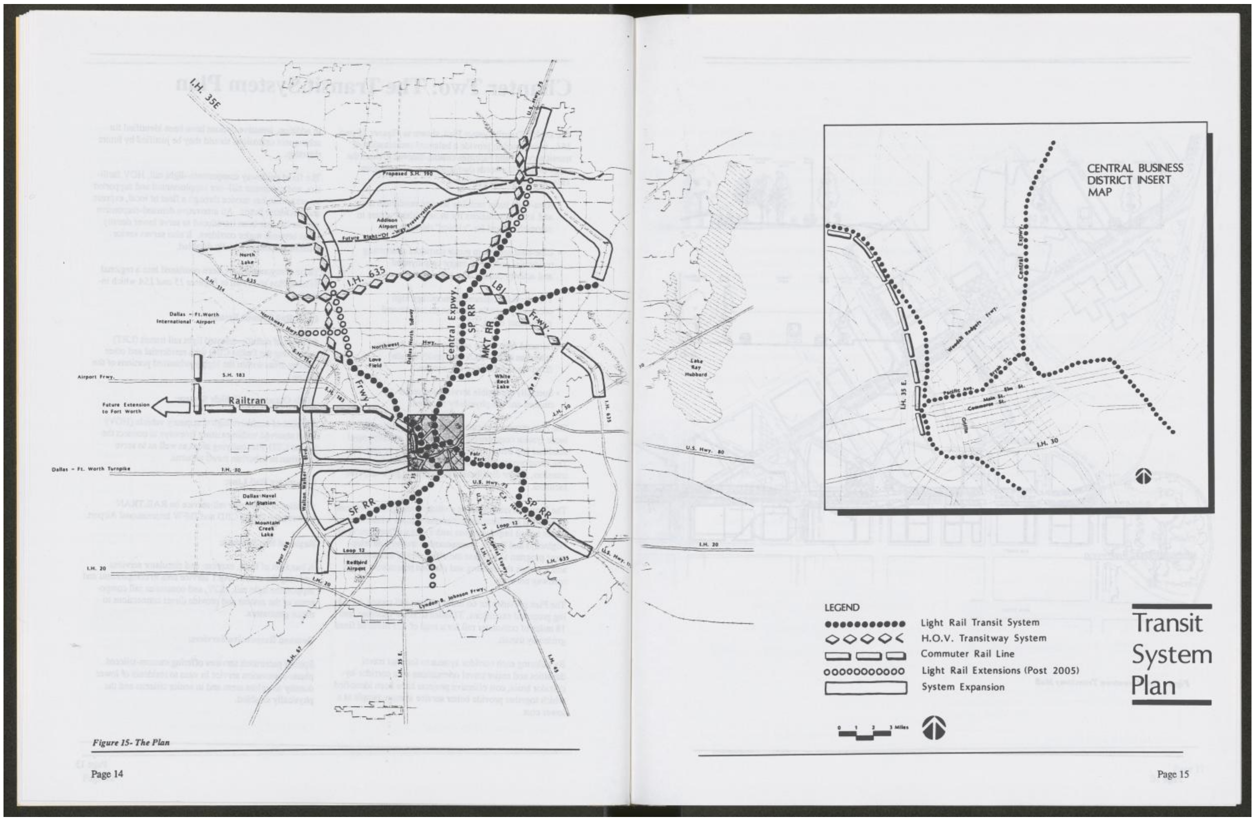


Figure 5. The updated DART Plan from the 1989 system plan. Source: Dallas Area Rapid Transit (1989).

In 1995, after the 1989 Plan had already begun implementation, Dallas once again adapted the DART plan. The 1995 Transit System Plan highlights the 32 km (20 mile) starter system that was under construction at the time and planned for opening in 1996, as well as the development of commuter rail (Dallas Area Rapid Transit, 1995, p.4). The 1995 Plan also discusses elements of its Intermediate Capacity Light Rail Transit proposal for areas outside of the initial starter system (Dallas Area Rapid Transit, 1995, p.4). These elements, intended to reduce costs, focus on reutilizing existing infrastructure to the greatest extent possible, reducing the need to construct new infrastructure. See *Figure 6: Map of the updated DART Service Plan indicating proposed service by 2010* below for an overview of the updates in the 1995 plan.

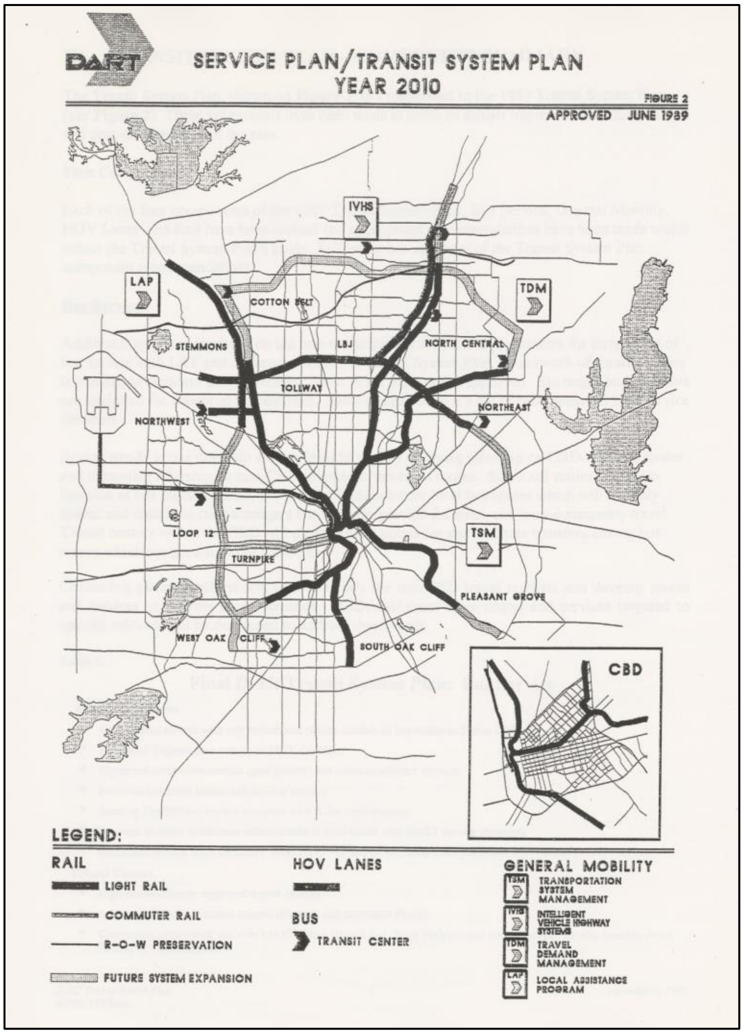


Figure 6: The 1995 DART Service Plan indicating proposed service by 2010.
Source: Dallas Area Rapid Transit (1995).

In 1996, Dallas's initial started system opened for operation 13 years after it was initially conceived. This starter system consisted of two lines, the Red Line and the Blue Line which run concurrently through the Dallas Central Business District (CBD) and branch from one another to the north and south of the CBD. Subsequent additions to the network have included the Green and Orange lines which also share concurrency with the Red and Blue lines through the CBD and have independent branches which head northwest and southwest from the CBD. Through the Dallas CBD, the transit system used newly constructed rights of way including a transitway along Main Street, with eventual plans for the construction of a subway in the CBD area.

The 1983 Service Plan detailed the specific existing railroad corridor alignments chosen to build out the light rail system. The following alignments were determined based on cross referencing the corridors proposed in the 1983 Service Plan, indicators of previous alignments on ArcGIS Pro maps, and the lines that were later developed. The south concurrent section of the Red and Blue lines leave the CBD via Santa Fe railway right of way before crossing the Trinity River (Dallas Area Rapid Transit, 1983, P. III-23). From this concurrency the Red line continues along Santa Fe railway right of way, while the Blue line heads south utilizing DP&L Transmission Line Right of Way right of way (Dallas Area Rapid Transit, 1983, p. III-24; Dallas Area Rapid Transit, 1983, p. III-28).

The Northeast Section of the Blue and Red lines, which now also includes the Orange line, begins by utilizing the US75 highway right of way (Dallas Area Rapid Transit, 1983, p. III-21). After departing from US75, the lines pass through Mockingbird Lane Station the Red and Orange lines continue along Southern Pacific Railway right of way for the remainder of this corridor and the Blue line diverts to MKT Railroad right of way for the remainder of its northern alignment (Dallas Area Rapid Transit, 1983, p. III-21; Dallas Area Rapid Transit, 1983, p. III-27). These rights of way were the primary ones utilized by the starter system and extensions of the Red and Blue lines have continued along the rights of way listed above.

The North West section which forms the northwest beginning of the Green and Orange lines, as well as the Trinity Railway Express (TRE) commuter line to Fort Worth using what was originally Chicago, Rock Island and Pacific Railroad (CRIP) right of way (Dallas Area Rapid Transit, 1983, P. III-22). The TRE line continues along this right of way while the Orange and Green lines turn toward the north and utilizing MKT Railway right of way (Dallas Area Rapid Transit, 1983, p. III-22). The Green line continues along this right of way while the Orange line turns to cross the river and head to Dallas Fort Worth International Airport, leaving preexisting railroad right of way in the process (Dallas Area Rapid Transit, 1983, P. III-21). Heading southeast from the city, the Green Line primarily uses former rights of way of the Santa Fe Railway and Southern Pacific Railroad rights of way (Dallas Area Rapid Transit, 1983, p. III-24-III-25). Overall system costs for the initial starter system were estimated to be approximately $880 million, or $26 million / kilometer (Salin & Allen, 1995).

Sections which do not use preexisting railroad corridors are not considered in the land use analysis. These sections include the CBD sections of the network, which primarily utilize newly constructed dedicated rights of way, as well as the Orange Line connection to DFW airport. Included in the analysis will be the components of the network which were part of the original starter system. See *Table 4: Corridors Included in Analysis of Dallas* below for a description of the corridors which were considered for potential analysis, and the stations which were included in the scope. Stations opened less than 10 years ago were not considered for analysis to ensure sufficient time has passed since opening for land use change to occur.

Table 4: Corridors Included in Analysis of Dallas

Line	Stations	Former Owner	Year Opened
Red / Blue Line	Cedars	Santa Fe Railway (Dallas Area Rapid Transit, 1983)	1996
	8th and Corinth		
	SMU / Mockingbird		
Red Line	Westmoreland	Santa Fe Railway (Dallas Area Rapid Transit, 1983)	1996
	Hampton		
	Tyler Vernon		
	Zoo		
	Lover's Lane		
	Park Lane		

5.1.2 - Charlotte, North Carolina

Planning for a rail-based transit system for Charlotte and Mecklenburg County began in the 1980s with proposals for various lines which were supported by preliminary studies into their potential ridership and alignment with land use and development goals. The 2005 Generalized Land Use Plan, released in 1985, recommended a rail transit system be established in Mecklenberg County. The 1989 Charlotte Transit Corridors Study identified 8 potential rail corridors which for transit system development using 7 existing railroad corridors totalling 124 kilometers in length (Charlotte Department of Transportation, 1989, p. 8). This was proposed to include 70 kilometers in branch lines which could support dual transit and freight use, and 48 kilometers where additional track would have to be constructed alongside mainline freight operations (Charlotte Department of Transportation, 1989, p. 8).

Table 5: Proposed LRT System for Charlotte. Adapted from Charlotte Transit Corridors Study Table 18. LRT System Description. (Charlotte Department of Transportation. 1989. p. 90)

Route Segment	Description	Operational Characteristics
Albemarle (10.1 miles / 16.25 km)	Norfolk Southern Rwy. — From 30th St. to Wilgrove	Secondary
Downtown I (1.1 miles / 1.77 km)	Norfolk Southern Rwy. - From 30th St. to Brookshire Freeway	Mainline (Classified as such because it will require the total reconstruction of a double track along Brevard St.)
Downtown II (1.8 miles / 2.9 km)	Norfolk Southern Rwy. - From Brookshire Freeway to Park Ave.	Secondary (Trackage presently unused)
Pineville I (4.4 miles / 7.1 km)	Norfolk Southern Rwy. - From Park Ave. to Griffith Junction	Secondary
Pineville II (5.2 miles / 8.37 km)	From Griffith Junction to Pineville	Mainline
Airport (8.2 miles / 13.2 km)	Norfolk Southern Rwy. — 2nd Street/Uptown to Sam Wilson Road	Mainline (Except for one mile of Uptown street operation)

UN CC (8.0 miles / 12.9 km)	Norfolk Southern Rwy. — 30th Street to near L85	Mainline (Except for 1.7 miles of new track at outer end)
Matthews (10.5 miles / 16.9 km)	CSX Transportation R.R. From NS R.R. to Trade St. in Matthew	Mainline
Northwest (7.6 miles / 12.23 km)	CSX Transportation R.R. - (Former Piedmont & Northern Rwy.) From Airport line, vicinity So. Cedar St., to City limit	Secondary
Davidson (20.2 miles / 32.5 km)	Norfolk Southern Rwy. - From 30th Street to Griffith St. in Davidson	Secondary

The studies conducted considered the ridership potential of identified corridors. It also comparatively analyzed them relative to those of transit systems found in other cities. For example, the South District Plan noted the Matthews corridor had the highest ridership potential but it was still less than those of comparable systems in Sacramento and San Jose, whose ridership levels were marginal at best (Charlotte-Mecklenburg Planning Commission, 1992). Further studies looked into the potential for other corridors as alternatives to using existing rail corridors. Eight corridors were chosen for a more intensive study which would go on to be used to make recommendations for the development of LRT in Charlotte Mecklenburg County.

Early policy regarding the development of transit using railroad right of way in Charlotte focused on preserving rights of way for future transit use. Charlotte also began working together with the North Carolina Department of Transportation to plan for acquisition of the railway corridors necessary for the development of its transit vision. An analysis by Floyd et. al. (1992) discussing the creation of a regional transportation planning organization for Charlotte-Mecklenburg County highlights how Charlotte wished to work with the State Department of Transportation to both fund the acquisition of the corridors, as well as to take advantage of the greater power the State has at its disposal to legally acquire the corridors. Floyd et. al. (1992)

also highlight the inability of the City of Charlotte to acquire or protect the necessary corridors outside of its city limits, where its power was limited to lobbying for the protection of said corridors. See *Table 6 – Corridor for Analysis in Charlotte* for an overview of the line being analyzed an overview of the stations which exist on this portion of the line.

Table 6: Corridor for Analysis in Charlotte

Line	Stations	Former Owner	Year Opened
Blue Line	East/West Boulevard	Norfolk Southern Railway (Charlotte Department of Transportation. 1989. p. 90)	2007
	New Bern		
	Scaley Bank		
	Woodlawn		
	Tyvola		
	Archdale		
	Arrowwood		
	Sharon Road West		
	I-485		

5.1.3 - Austin, Texas

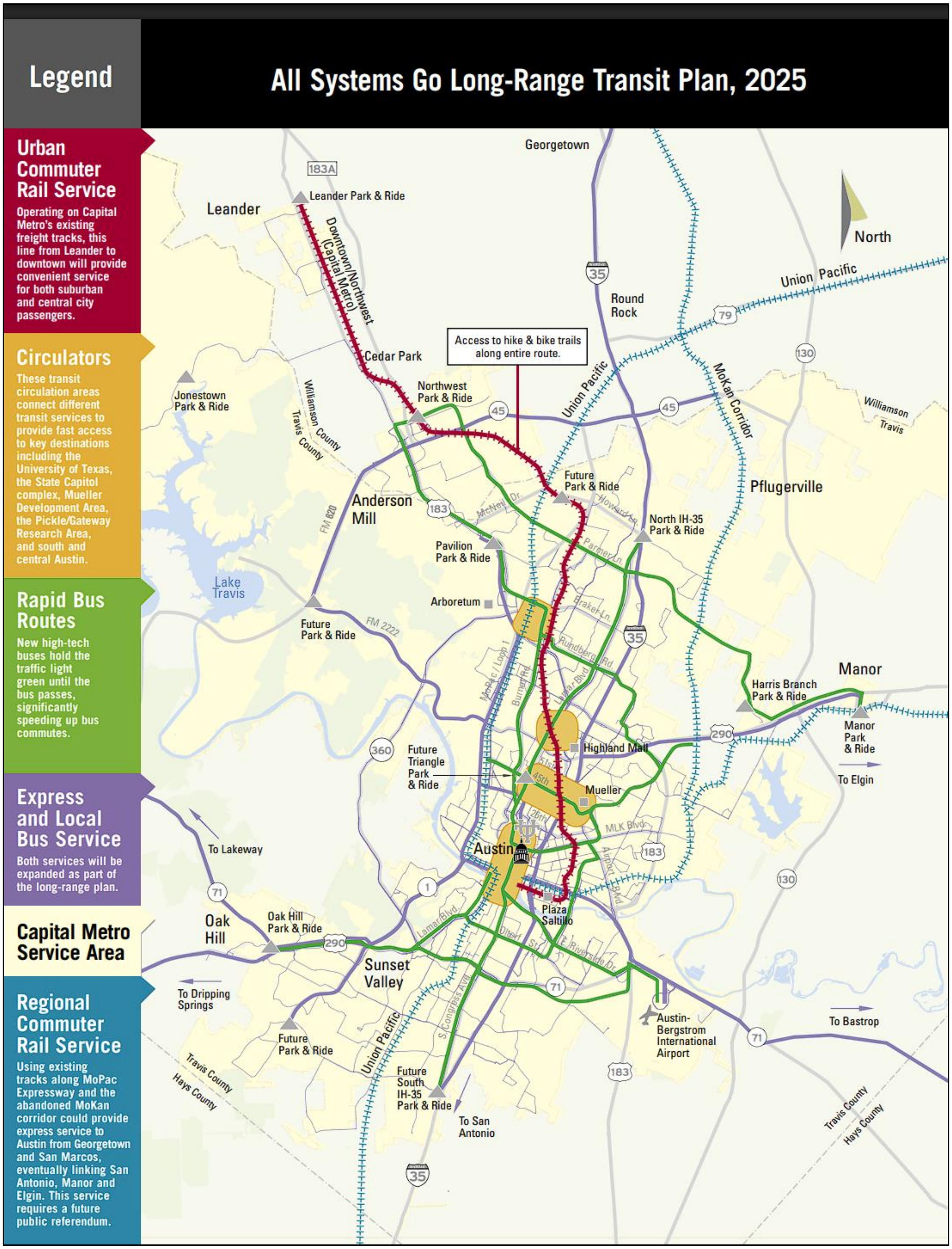
Preparations for the development of rail-based transit service in Austin began with the purchase of nearly 250 kilometers of freight railway by Cap Metro, the regional transit board, and the City of Austin (Werner, 1994). Despite purchasing the right of way in the early 1990s, the development of transit service using the right of way did not occur until the 21st century. As with other cases, plans for transit along existing corridors in Austin involved multiple iterations. Throughout the 1990s, Austin bounced between various proposals for transit using the purchased right of way, and others not using the right of way (Clark-Madison, 2000). In 2000, following the removal of the Cap Metro board in 1997, a referendum was held on approving a sales tax to finance transit construction (Clark-Madison, 2000). This proposal was narrowly defeated (Robinson, 2007).

Eventually, Cap Metro developed the All Systems Go plan, which was released in 2004. This plan identified the first transit line which would be developed using the purchased right of way, the Red Line (Clark-Madison, 2004). This line would run from Downtown Austin heading east before turning in a generally northwesterly direction to serve the city's suburbs. The plan referred to the proposed service as an Urban Commuter Rail Service and aimed to have the line completed and operational by 2008 (Cap Metro, 2004). See *Figure 7: All Systems Go Long Range Transit Plan* for an overview of the plan released in 2004. See *Table 7: Corridor for Analysis in Austin* for an overview of the corridor and station area to be analyzed.

Table 7: Corridor for Analysis in Austin

Line	Stations	Former Owner	Year Opened
Red Line	Plaza Saltillo	Southern Pacific (Werner, 1994)	2010
	MLK Jr.		
	Highland		
	Crestview		
	Howard		
	Lakeline		

Figure 7: All Systems Go Long Range Transit Plan. Source: CapMetro (2004).



5.2 - Land Use Change

This section draws on spatial analysis to identify changes in land use patterns along corridors in the selected case cities. In all instances, an 800-metre walkshed is used as the spatial limitation for assessing land use change. This aligns with best practice in transit planning. The geospatial analysis looks primarily at land use types and is supplemented using census data to identify other relevant changes, such as in population density. The findings will discuss the preexisting land uses along a particular corridor, how they have changed. Subsequent discussion will include the relationship between the planning policies that were in place to guide land use change and the actual changes that occurred.

5.2.1 - Dallas, Texas

Land-use analysis for Dallas began with confirmation that all sections of the original starter system opened in 1996 were constructed using existing freight railroad corridors. This process resulted in the elimination of the south portion of the Blue line, south of 8th and Corinth Station, as well as the downtown portion of the Red and Blue lines, from the scope of the analysis. Land use datasets for 1995, 2000, 2005, 2010, 2015, and 2020 covering the entire North Central Texas region were inputted into ArcGIS Pro and formatted to ensure consistent colors were used for similar land use types. Land use type categories differed from year to year, so a series of general land use classifications were established. For land use charts and tables for Dallas see *Appendix F: Dallas Land Use Tables* and *Appendix G: Dallas Land Use Charts*.

Looking at the land use charts for Dallas, a few key takeaways become apparent. First of all, many station areas have a disproportionate amount of one particular land use type, particularly towards the beginning of the study timeframe. For stations such as Hampton, Tyler Vernon, and 8th and Corinth the predominant type is Single Family. Meanwhile, around Cedars Station, it is industrial. Other station areas, such as Lovers Lane, Park Lane, Westmoreland, and SMU / Mockingbird exhibit a diverse mix of land use types throughout the study period.

Generally, across station areas, Single Family land uses remain consistent throughout the study timeframe. Across stations which are located on the north and south branches of the Red Line, Single Family land uses were both more predominant, which is to be expected in less urbanized areas, and saw a general decrease of 13% or about 30 hectares from 1995 to 2020. Station areas located along the co-running sections of the Red and Blue lines had less preexisting single family land use but saw a more significant reduction of 35% over the course of the study period, losing over 21 hectares of single family land use across these station areas.

Meanwhile, the land use type which saw the greatest percent decrease over the course of the study period was Industrial. Along the north and south branches of the Red Line, there was a 44% decrease in industrial land use between 1995 and 2020. This was equivalent to 23 hectares of industrial land. Additionally, over the same period station areas along the co-running Red and Blue lines saw an even more significant 65% decrease in industrial land use over the entire timeframe. SMU / Mockingbird and Cedars station areas saw decreases in industrial land use of 70% and 66% respectively. For Cedars station alone, this was equivalent to over 40 hectares of industrial lands.

While some of this loss of industrial land use may be attributable to specific uses being placed in different categories based on the 2010 land use codes, other use types which they could be categorized as, such as Commercial, also saw significant reductions over the course of the study timeframe. Reductions were 10% and 16% for Red line and Red and Blue Line station areas respectively.

Other land use types, such as Office, also saw consistent trends across Red Line and Red and Blue Line station areas. Red Line areas saw a modest 10% increase in Office land use, while Red and Blue Line areas saw a more significant 64% increase between 1995 and 2020. Institutional land uses also increased across the board. However, as with Offices, these land use types were not significant to begin with.

Meanwhile, land use types such as Multi Family and Vacant land were more of a mixed bag. Both land uses saw significant increases in Red and Blue station areas. There was a 421% increase in multi family land use, and a 76% increase in vacant land. Both equivalent to approximately 25 hectares of total land areas. These increases were driven by Cedars station which saw a nearly 15000% increase in Multi Family and a 319% increase in Vacant land. Red line station areas saw a more modest 4% increase in Multi Family and a 14% decrease in Vacant land.

Collectively, it can be said that the station areas studied, which cover different parts of the DART Light Rail starter system, each saw differing levels of land use change over time following the opening of the transit service. Initially, many areas were quite homogenous in their land use. Station areas such as Park Lake, Tyler Vernon, and Cedars had over 50 % of their preexisting land use of a single type, whether that be Industrial, Commercial, or Single Family Residential. One common trend among most areas is that they became much more heterogenous in their land use types over time. Areas with industrial uses saw a decline in those land use types and their replacement with other commercial and residential uses. Areas of predominantly single family homes, in more recent years, saw the addition of multi family and commercial uses mixed in with these single family homes.

While some areas saw more change than others, all areas saw land use changes from the opening of the light rail in 1996 to 2020. There are plenty of factors that could influence these land use changes. It is impossible to say from this analysis how significant a role the addition of the transit service played in these changes. Other market factors could have significant impacts on how these areas developed over time. It is interesting to note areas with significant preexisting industrial uses, as one would associate with a freight rail corridor, saw a significant reduction in the amount of industrial land use adjacent to the transit corridor over time. The next section of this analysis will look into the planning policies which have been put in place since the opening of the system to identify whether they may have played a role in guiding how developed occurred in these station areas.

Overall, some station areas experienced significant land use change over the study timeframe while others did not. Cedars Station saw significant land use changes with decreases in industrial and commercial uses alongside simultaneous increases in vacant and multi family uses. Other station areas experienced much less significant land use changes. Further analysis of planning policies that existed during the study timeframe will help to understand whether policy played a role in shaping these land use changes.

5.2.2 - Charlotte, North Carolina

Land-use analysis for Charlotte began by identifying the data necessary for conducting the analysis. Land use datasets dating back to 2001 were identified covering the City of Charlotte and areas of surrounding Mecklenburg County. Datasets for 2005, 2010, 2015, and 2020 were downloaded to ensure the period of analysis captured a sufficient timeframe prior to and following the opening of the Blue Line LRT. Datasets were inputted into ArcGIS Pro and formatted to ensure consistent colors were used for similar land use types. Land use type categories for the data for Charlotte were generally consistent from year to year. A series of general land use classifications were established for the analysis of all cases, and land use categories for Charlotte were grouped into these classifications. For land use charts and tables for Charlotte see *Appendix H: Charlotte Land Use Tables* and *Appendix I: Charlotte Land Use Charts*.

Station areas in Charlote also produced inconsistent results. Preexisting land uses in most station areas were generally diverse. Typically, this consisted of larger amounts of industrial land use alongside a mix of various other land use types. Station areas, such as Arrowood, Archdale, and East-West also had significant amounts of Single Family land use which predated the opening of the Blue Line. Preexisting land use around the I-485 station area was predominantly Commercial. Other station areas, such as Woodlawn, Tyvola, East-West, and Arrowood also had significant amounts of Commercial and Office uses. New Bern, Sharon Road, and Bland Street also had significant amounts of pre-existing Multi Family residential land uses.

After the line opened in 2007, station areas saw varying degrees of land use change. In many cases, Single Family Residential uses remained consistent throughout the study timeframe. The most significant changes in Single Family residential land use occurred in the Woodlawn and Sharon Road station areas which saw 20% and 30% reductions in this land use type over the study period. However, these changes occurred from a starting point of very little land use of this type to begin with. The East-West station area saw the most significant actual reduction, which itself was a loss of just 1.74 hectares of Single Family land use. New Bern also saw a 1.42 hectare increase.

For industrial land use, results were much more varied. Some station areas, such as East-West, New Bern, Scaleybark, and Sharon Road saw significant reductions in Industrial land use ranging from 21% to 41% over the course of the study timeframe. In total area, the most significant changes occurred in New Bern and Scaleybark station areas, which saw 14.48 and 16.84 hectare reductions in Industrial land use. Other station areas, in particular I-485, saw significant increases in Industrial land use over the same time period. The total increase in Industrial land use around I-485 totaled 11.63 hectares, representing an increase of 116%.

For Commercial and Office land use types, changes were also varied. Bland Street, East-West, New Bern, and Sharon Road saw significant percentage increases in Commercial land use. However, the actual area of these land use changes was relatively small ranging from just three to six hectares in total increase. Other areas, such as Arrowood, Tyvola, and Woodlawn saw modest decreases ranging between 2.5 and 5 total hectares. Office land use saw similarly modest increases in total land use area. These ranged from a four hectare decrease in Archdale station area to a five hectare increase in Sharon Road station area. In some areas, these changes represented significant increases from preexisting conditions, with Arrowood and Sharon Road seeing increases over 200% from what existed previously.

Multi Family residential land use change was the greatest in Scaleybark and New Bern station areas. Scaleybark saw a 6.44 hectare decrease in this land use type, while New Bern saw an 8.62 hectare increase. Generally, outside of Scaleybark station area, the area of Multi Family residential land use remained relatively stagnant or saw modest increases over the course of the study timeframe. Vacant land also saw similarly modest changes outside of the Scaleybark station area, which saw a 15.48 hectare increase in Vacant land over the course of the study timeframe.

Overall, land use changes during the study timeframe in Charlotte's station areas were not overly significant. Generally, there was a reduction in Industrial land use to the tune of over 42 hectares, which represented a 7% decrease from preexisting conditions. This was accompanied by increases to most other land use types. However, net increases across all station areas were modest with approximately 15 hectares of Office land use and 7 hectares of Multi Family residential added. Vacant land use also increase by a total of 12.75 hectares, representing a 7% increase from what existed previously.

5.2.3 - Austin, Texas

Land-use analysis for Austin began by identifying the data necessary for conducting the analysis. Land use datasets for 2006, 2010, and 2021 covering the City of Austin and areas of surrounding Travis County were inputted into ArcGIS Pro and formatted to ensure consistent colors were used for similar land use types. The dataset for 2021 also included previous land use of the parcel for 2018, so 2018 was also included in the analysis. Land use type categories for the data for Austin were generally consistent from year to year. A series of general land use classifications were established for the analysis of all cases, and land use categories for Austin were groups into these classifications. See *Appendix D: Austin Land Use Classifications* for an overview of the land use categories and codes from the raw data, and the classifications they were given. See *Appendix J: Austin Land Use Tables* and *Appendix K: Austin Land Use Charts* for all tables and charts produced for Austin.

The land use data for Austin shows differing trends over time for different station areas. More urban station areas, such as Plaza Saltillo, MLK Jr, and Crestview had diverse pre-existing land uses. Other station areas, such as Lakeline, Howard, and Highland had less diverse pre-existing land uses. Lakeline is unique in that preexisting land use in the station area was predominantly vacant lands and much of the used land development in this station area occurred over the course of the study timeframe. The land use that did exist prior to the opening of the station in 2010 was single family residential, and over time the land use that has developed includes commercial, industrial, and multi family residential uses, while single family use has remained relatively constant.

Land use around the Howard station area remained generally consistent over the course of the study timeframe. Preexisting use was predominantly industrial, and this remains the same for the duration of the study. The most significant change to the Howard station area was one additional hectare of multi family residential, coupled with an equivalent decrease in single family residential. This is also the case for Highland station, where land use types remain generally consistent over time. The most significant change in this area is from Commercial to Industrial.

For Crestview Station, land use remains relatively mixed over the course of the study timeframe, however some preexisting industrial uses are replaced with other use types including an increase in single family, mixed use, multi family, and commercial land use areas. A decrease of 15 hectares in industrial land use resulted in an increase of 6 hectares in single family, and a combined seven hectares of multi family and mixed use development. MLK Jr Station area has a significant amount of preexisting vacant land in addition to significant single family residential land use.

Over time, while residential remains generally consistent vacant land decreases and is replaced by other use types such as multi family residential and mixed use. Increases to these land use types totaled approximately 7 and 5 hectares respectively, while vacant land decreased by approximately 22 hectares. Land use for Plaza Saltillo station also remains generally consistent over time, with a small amount of industrial land use changing to other use types. The most significant change is an increase of 6 hectares in mixed use development.

The various station areas analyzed in Austin do not present consistent results with regard to land use change overtime. Key takeaways from the analysis of this case include that vacant lands were generally replaced over time, single family land uses typically remained consistent over time, industrial uses tended to be reduced over time, and small amounts of multi family and mixed-use development generally occurred in their place. Land use in all station areas generally became more diverse over time. However, in urbanized areas preexisting land use was typically diverse to begin with while less urban areas became more diverse over the course of the study period. Overall, Austin saw increases in multi family and mixed use land use types across station areas and accompanied decreases in industrial and vacant lands.

5.3 - Planning Policies

This section builds upon the previous to identify the policies the case cities had in place to guide land use change along their transit corridors. These findings are intended to identify associations between particular planning policies and the land use that resulted from their implementation. The section primarily draws from planning policies to identify which policies were used in a particular case, with further discussion on the topic in the subsequent Discussion section of this report linking them to the realized land use changes, or lack thereof.

Table 7: Planning Policies Analyzed

City	Name	Year	Plan Type
Dallas	Transit Service Plan	1983	Transit Plan
	New Directions: Transit System Plan	1989	Transit Plan
	Transit System Plan	1995	Transit Plan
	Comprehensive Plan	1998	Comprehensive Plan
	Cedars Area Plan	2002	Area Plan
	Vickery Meadow Station Area Plan	2013	Station Area Plan
Charlotte	General District Plan	1990	Comprehensive Plan
	Northwest District Plan	1990	Local Area Plan
	South District Plan	1992	Local Area Plan
	Corridor System Plan	2001	Transit Plan
	General Development Policies	2001	Comprehensive Plan

	Scaleybark Station Area Plan	2008	Station Area Plan
	Tyvola Archdale Station Area Plan	2008	Station Area Plan
Austin	Comprehensive Plan	2012	Comprehensive Plan
	Plaza Saltillo Station Area Plan	2008	Station Area Plan
	MLK Jr Station Area Plan	2008	Station Area Plan
	Lamar-Justin Plan	2008	Station Area Plan

5.3.1 - Dallas, Texas

Dallas's original transit service plan, published in 1983 in association with a referendum to implement a tax to fund regional transportation upgrades, including transit, highlighted the desired relationship between proposed transit service and land use. As part of the general system criteria for fixed guideways, it states "The fixed guideway system should fit the existing land uses in the areas it serves and be a catalyst for desired land use" (Dallas Area Rapid Transit, 1983, p. II-5). The Alignment Criteria for Fixed Guideways states that "Fixed guideway alignments should be compatible with and encourage local development plans" (Dallas Area Rapid Transit, 1983, p. II-6). The original plan also highlighted that the DART Board included the following criteria in selecting station locations:

- "It will comply with existing community plans and development policies and encourage, to the extent feasible, the concentration of appropriate development adjacent to the station," and
- "It will provide for physical integration of station facilities into the existing development fabric of the communities, especially in major activity centers." (Dallas Area Rapid Transit, 1983, p. II-30)

After the initial plan was shelved following a referendum on its funding, an updated plan was produced. This new plan again proposed LRT utilizing existing rail corridors, albeit a significantly smaller system. Again, the plan took into account the land use implications of rail based transit stating:

"The concentration of accessibility in high-demand travel corridors and regional centers provided by transit can have a very real effect on the urban form and support more efficient land use and development patterns. These benefits already have been recognized by the Dallas business community in key locations. Developments can reduce the amount of land and structures dedicated to auto parking and roadways, thus providing the opportunity for urban design and other economies which can improve the region's competitiveness" (Dallas Area Rapid Transit, 1989, p. 24).

The updated plan also discusses the cost-effectiveness of constructing LRT given the land use context of the reason, noting that the updated plan will cost less and thus be more economically justifiable in a sprawling low-density region.

The 1995 Transit System Plan highlights the relationship between transit development and land use is also acknowledged. This plan states:

"The reduced dependency on the single occupant automobile which will permit the development of more livable communities. Residential and commercial development can have higher densities with less land and structures needed for roadways and parking. As a result, residential and commercial areas will become more pedestrian and transit oriented" (Dallas Area Rapid Transit, 1995, p.26).

Collectively, throughout the initial planning phases of its transit network, DART acknowledges the links between the development of its transit system and impacts on land use, development, and urban form.

As part of an Impact Study conducted prior to construction of the initial starter system, recommendations were developed based on case studies as to how DART might wish to assess the land use impacts of its system as it develops, and what to consider when planning for "Transit Sensitive Development." The study states that a Transit Sensitive Development should include the following considerations:

"(1) a location within an existing developed area;

(2) medium-to-high-intensity site use;

(3) proximity to a transit station (ideally within 1/4 mile [400 metres]);

(4) the ability to generate off-peak (other than midday and evening) ridership, if possible

(a shopping center is an example);

(5) the ability to generate transit trips (e.g., through office buildings, high-intensity

commercial uses, and medium-to-high-density residential uses);

(6) integration into the transit route (Le., street, rail line); and

(7) minimum parking (within local requirements)" (Coleman et al., 1993).

The study further highlights how joint development – incorporating coordination between public and private entities – can be achieved for transit supportive developments through policies such as land use plans and zoning.

In its 1998 Comprehensive Plan, the Policy 5.1.10 states "The City will develop and use land use and land division regulations that set standards for needed transportation facilities and improvements and direct development patterns that enhance opportunities for pedestrian, bicycle and transit travel" (City of Dallas, 1998, p. 20), Additionally, in the Background Documents section of the plan, 2.6.1 states "Commercial land should also be located near higher density housing, to minimize travel distance and to encourage use of alternative modes (walking, bicycling, transit) of transportation" (City of Dallas, 1998, P. 26). This policy also notes that the city's existing commercial corridors are located along major transportation corridors and have adjacent multi-family land.

While the city of Dallas itself lacked significant land use policies that directed transit oriented development in the early stages of developing its transit network, other regional cities embraced the concept in planning policy (Ohland, 2004). After the turn of the century, Dallas began looking toward more localized planning initiatives to guide land use. In 2002, the City adopted the Cedars Area Plan. This plan stated that existing zoning in the Cedars area did not support mixed-use development around the light rail station (City of Dallas, 2002, p.14). The area had previously predominant industrial land use, but was now in transition with vacant areas, and so the Cedars area plan called for the creation of a Mixed-Use Transit-Oriented sub district (City of Dallas, 2002, p. 5,19).

This sub-district was intended to "promote high density, transit oriented mixed-use development around the DART light roil station by providing incentives to encourage a mix of multifamily residential, office, and retail commercial uses on the same site" (City of Dallas, 2002, p.19). The City of Dallas also had in place PD. 317, the Cedars Special Purpose District, which encourage zero setback high density development in the area (City of Dallas, 2002, p.21). However, the Cedars Area Plan called for amendments to this Special Purpose District to encourage creative development plans, adaptive reuse of existing structures, transit-oriented development, reduced parking requirements, and improved pedestrian facilities in the sub district (City of Dallas, 2002, p.21).

In the early 2010s, Dallas set out to enhance its Transit Oriented Development and began creation of five station area plans encompassing seven different DART Stations (City of Dallas, 2013, p. 2). One of these station area plans, Vickery Meadow, included provisions for the station area around Park Lane station; the only station area of the seven that were analyzed as part of this study. The Station Area Plan focuses on three key land use types, Urban Mixed-Use, Urban Neighbourhood, and Campus District (City of Dallas, 2013, p. 27). The Urban-Mixed Use type is to be located directly adjacent to the station area, while the Campus District surrounds a major healthcare facility and the Urban Neighbourhood incorporates surrounding residential areas (City of Dallas, 2013, p. 27).

The plan highlights immediate zoning changes to incentive a catalyst project, a mixed-use development with a new City library on a vacant site (City of Dallas, 2013, p. 37). The Plan states that this project is "one that is expected to create the greatest level of strategic, positive change, spurring on additional development" (City of Dallas, 2013, p. 37). The Plan identifies a design plan for the site and highlights the necessary zoning changes required to make this development feasible (City of Dallas, 2013, p. 38-41).

Overall, it is clear that Dallas used multiple strategies when planning for development in station areas. From the outset, initial planning documents for the transit system acknowledge the connection between land use and transit, including the ability for transit to allow for alternative forms of development. It appears from this analysis, however, the Dallas's incorporation of transit-oriented development planning policies into its planning documents has been lackluster. There were cursory mentions in planning policy only after the opening of the initial starter system in 1996. Later policies have developed area specific development policies for station areas, but these are limited to select station areas and are not comprehensive.

5.3.2 - Charlotte, North Carolina

In the case of Charlotte, decades of work that went into creating a vision for a regional transit network incorporated land use as one of its key considerations. District Plans for regions of Charlotte Mecklenburg County from the early 1990s highlight the proposed light rail network and discuss land use as an important consideration in developing such a network. The 1990 Northwest District Plan states that "rail lines identified as candidates for service should be protected and higher density development planned around them to support LRT service in the future" (Charlotte Mecklenburg Planning Commission, 1990, p. 22).

Planning policy in Charlotte began considering development adjacent to proposed rail corridors right from their conception, with such policies incorporated into planning documents. The Northwest District Plan does this without identifying stations areas, as they hadn't been identified in preliminary studies, but by discussing how the existing land use patterns along the proposed corridor are primarily industrial and identifying large tracts of vacant land and potential station areas which might be considered for development to support future LRT (Charlotte Mecklenburg Planning Commission, 1990).

The 1990 General District Plan highlights how the 1989 Charlotte Transit Corridors Study warns that land uses throughout the region as proposed in the 2005 General Land Use Plan would not be sufficient to support higher order transit. The

General District Plan notes that higher density development will be required, particularly along identified corridors, in order to support a future transit network. It explicitly states that "decision makers must recognise the density/transit relationship and base land use decisions upon it" (Charlotte-Mecklenburg Planning Commission, 1990, p. 30) Further, the General District Plan states that Charlotte Mecklenburg County should actively pursue a transit rail and expanded bus systems for the community and support the rail concept by encouraging higher density development (Charlotte-Mecklenburg Planning Commission, 1990).

As sub-policies to this, it also states that planners should explore the corridors, potential stations, and the land uses around them (Charlotte-Mecklenburg Planning Commission, 1990). Then recommending that they should focus on one or two corridors as prototypes for transit development, and that vacant land should be identified along them and its feasibility for development assessed (Charlotte-Mecklenburg Planning Commission, 1990). It also recommends analyzing the employment potential of the Uptown area and its relationship with future density along the transit system, update individual district plans once corridor planning is completed, and consider the density/transit relationship in rezoning decisions with a goal of 8-10 dwelling units per acre (19.76 – 24.71 units / hectare) within 800 metres (1/2 mile) of the corridors (Charlotte-Mecklenburg Planning Commission, 1990).

Other early policy documents, such as the South District Plan discuss the ridership potential of identified lines. It warns that ridership potential based on existing land use patterns were mixed, with even the best lines unlikely to reach the marginal ridership numbers found on comparable systems such as those in Sacramento and San Jose (Charlotte-Mecklenburg Planning Commission, 1992, P. 43). This plan highlights the links between ridership and land use and acknowledges that to overcome this hurdle higher density would have to be developed along the proposed corridors. It also acknowledges the need to balance these higher density developments with the desire to retain existing single family neighbourhoods. It goes on to recommend that future planning consider the locations of transit stations for areas of intensification, highlighting that compact pedestrian-oriented development would be required to support LRT in a cost-effective manner Charlotte-Mecklenburg Planning Commission, 1992, p. 45).

The 1994 Centres and Corridors vision was founded on the idea of guiding future development in the region along major transportation corridors. Subsequently, the release of the 2025 Integrated Transit/Land-Use Plan for Charlotte / Mecklenburg County in 1998 further solidified the vision for transit development in the region to occur in conjunction with land use redevelopment. This plan outlined various goals for the region as a whole to achieve from integrated transit and land use planning. This further translated into the 2001 Corridor System Plan, with a focus on planning for the development of the corridors that would come to comprise Charlotte's transit system, with land use being a key consideration for the transit network plan.

The Corridor Systems Plan states:

> *"The primary purpose of the public transit system is to support the region's land use vision. Making Charlotte-Mecklenburg's future transit system successful will require developing land uses in a manner that enables decisions that encourage residents to use transit as an alternative for their daily and occasional travel. Transit Oriented Development (TOD) around transit stations will help sustain economic growth and vitality within close proximity to the stations while contributing to the enrichment of the Center City and key activity centers" (Charlotte Area Rapid Transit, 2002).*

Including the above as the first principle informing the system plan for Charlotte's transit network highlights how, in the case of Charlotte, the idea of transit being integrated with land use is not accessory to the development of the transit system, but an integral component.

In 2001, Charlotte updated its General Development Policies to include a new policy area, Transit Station Area Principles. Albeit not part of the policy area, but included as part of separate amendments, the General Development Policies also state that one of the overall goals of the policy framework is to "integrate land use and transportation" (Charlotte-Mecklenburg Planning Department, 2007, p. 6). The introduction of this policy area highlights the incorporation of the ideals set out in the 2025 Integrated Transit/Land-Use Plan for Charlotte / Mecklenburg County, stating:

> *"Building an integrated land use and transit system is key to managing the rapid growth occurring in the Charlotte-Mecklenburg area and to invigorating existing communities and making them better places to live and work" (Charlotte-Mecklenburg Planning Department, 2007, p. 20)*

The policy area is intended to apply within a half mile (800 metre) distance of transit station areas. Additionally, it calls for the development of specific land use and urban design policies for each of the station areas. Key policy considerations incorporated in this addition to the General Development Policies include:

- "Mixing transit supportive uses;
- Increasing Land-use Intensity;
- Provisions for pedestrians, cyclists, street network upgrades, and parking;
- Building design, site design, and streetscaping; and
- Open Spaces." (Charlotte-Mecklenburg Planning Department, 2007, pp. 12-16)

Charlotte has also adopted area specific plans for all station areas along the initial corridor of the Blue Line. Generally, these Station Area Plans include provisions for rezoning of particular portions of the station area to a Transit Oriented Development zone while also highlighting specific land use types appropriate for different station areas. For example, the Scaleybark Station Area Plan encourages the development of duplexes, while the Tyvola and Archdale Station Area Plan encourages provisions to allow for pedestrianization of auto oriented office and business areas (City of Charlotte, 2008a, City of Charlotte, 2008b).

Charlotte began working to include considerations for transit in land use planning policies early on, when development of its transit system was just conceptual. This included everything from broader regional land use considerations, to discussions around dwelling unit density in potential transit station area walksheds. Charlotte followed this up with the incorporation of these policies into its higher level land use planning policies, as well as through the adoption of station area plans for all station areas along the corridor studied. Overall, Charlotte's planning policies with regard to transit and land use appear to be strong, with considerations in higher level policy and tailored planning policies for station areas.

5.3.3 - Austin, Texas

In Austin, planning policy appears to be a bit of a mixed bag when it comes to development in transit station areas. Austin's comprehensive plan, Imagine Austin, makes only cursory mention of the concept of transit-oriented development. Adopted in 2012, this document states "The absence of a strong transit system makes it more difficult for Austin to encourage efficient land use patterns" (City of Austin, 2012, p.44). It also acknowledges many of the city's residents live in areas where the density is too low to support regular transit service (City of Austin, 2012, p.75). In envisioning the city's future, this document states the city desires that future "Development occurs in connected and pedestrian-friendly patterns supporting transit and urban lifestyles and reducing sprawl, while protecting and enhancing neighborhoods (City of Austin, 2012, p. 84). Additionally, it highlights a desire for development patterns to support transit and transportation choice while reducing sprawl (City of Austin, 2012,p. 86).

The growth concept included in the plan is intended to focus development along activity corridors and centres that support transit use (City of Austin, 2012, p. 96). Austin acknowledges the role of its transit network in altering development patterns by promoting infill and redevelopment. (City of Austin, 2012, p.98). Activity centres, a key development area policy in this plan, are intended to be centred around major transit stops (City of Austin, 2012, p.104).

Broadly speaking, Imagine Austin's Land Use and Transportation policies include provisions necessary to achieve these goals. They discuss promoting compact development in centres served by transit, providing for a mix of uses and housing types in these areas, and encouraging infill and redevelopment of these areas (City of Austin, 2012, p.118). The housing policy section discusses connecting the places people live with the places they need to go by directing housing and employment growth to Transit Oriented Development sites (City of Austin, 2012, p.137).

When discussing indicators for measuring success, the Plan highlights population and employment density within ½ mile (800 metres) of transit stops as a way to measure its goal of increasing access to transit (City of Austin, 2012, p.188). In measuring success toward its goal of making Austin a more connected city, the number of units within ½ mile (800 metres) of transit and development within activity centres and along corridors as discussed as metrics (City of Austin, 2012, p. 208).

Looking toward developing more detailed policy, the plan discusses using more detailed area plans for transit station areas (City of Austin, 2012, p.217) Prior to the development of its Comprehensive Plan and the opening of the Red Line, Austin had already put in place three Transit Oriented Development Station Areas Plans. These plans correspond to Plaza Saltillo, MLK Jr., and Crestview Stations.

Common across all plans is a desire to develop Transit Oriented mixed-use development in station areas. For example, the Lamar-Justin Plan for Crestview Station highlights how mixed use land use types should be build closest to the station area, and these areas should be surrounded by smaller mixed use, and high and medium density residential development (City of Austin, 2008a, p.9). The plan highlights a focus on development directly adjacent to the station where the highest densities are intended to be located (City of Austin, 2008a, p.34). This plan is also unique in the emphasis it places on policies for corridor mixed use and Live/Work Flex land use types (City of Austin, 2008a, p. 34).

The MLK Jr plan takes a similar but differing approach. The core of the plan for MLK Jr. Station is focused on mixed use development, with some additional low density residential development (City of Austin, 2008c, p.33). Corridor mixed use and Live/Work Flex are present but much less significant in this plan. The focus of the plan for this station area is again on developing the greatest densities closest to the station area (City of Austin, 2008c). The plan sets out minimum building heights and residential density requirements for future development in the station area (City of Austin, 2008c, p.38).

Located in a more urbanized area, the plan for Plaza Saltillo Station again puts the focus on mixed use development. As with the other plans, it discusses developing higher densities and taller building heights closer to the transit station (City of Austin, 2008b, p. 38). It also discusses provisions for density and height bonusing in the station area in order to incentivize affordable housing development (City of Austin, 2008b, p.40).

Across all plans, there are also provisions for green infrastructure, green spaces and buildings, and improving connectivity and urban design. The plans discuss how they are to be implemented including the development potential and constraints that exist for the particular station area, as well as action items which are required to implement the plan. The plan provides timelines to achieve these action items, which include amending other planning policies, dedicating staff and prioritising projects, and working to ensure the development of catalyst projects in the areas.

Overall, Austin does have some elements of transit-oriented development policies which should guide development in station areas. The city's comprehensive plan incorporates goals and policies for transit-oriented development. There is also a provision in the City's land use code for the creation of station area plans. This has resulted in the three-station area plans which exist for stations along the Red Line. However, these station area plans were developed prior to the city's most recent comprehensive plan, which intended to encourage transit-oriented development. In the discussion section, the relationship between these policies and the land use changes that occurred following the opening of the Red Line are addressed.

6.0 - Discussion

This section builds upon the findings from the previous section, adding a comparative lens between cases, and highlighting common themes to help answer the research questions that lay the foundation for this study. This section begins with a discussion of how the case cities developed rail-based transit systems utilizing existing railroad infrastructure. It then dives into the land use changes that occurred as the railroad infrastructure was reutilized for transit. This is followed by a broad discussion about the policy context in each case jurisdiction, including the local transit and land use planning documents and policies that guided the development of the transit service and associated land use in station areas and the broader jurisdiction.

6.1 - How Systems Developed

In each case studied, the initial concept for the network involved reutilizing existing freight rail corridors for transit service. Findings from the literature review highlight how cost is often a factor at play in developing transit using freight rail corridors. Reusing existing infrastructure can help to reduce costs and speed up development timelines. In the case of Dallas, where the network plan was revised multiple times before implementation, retaining elements of the existing freight rail infrastructure rather than building new infrastructure along the existing corridor was noted as a cost saving measure. The case of Dallas also highlighted in its conceptual documents the desire to reduce impacts to existing neighbourhoods, and utilizing existing corridors would help with that.

Early planning documents for the system in Charlotte also highlight a focus on using existing railroad corridors for transit. In Charlotte, it was acknowledged that land use along existing corridors may not be suitable to encourage transit use. Therefore, integrating provisions for land use was a key consideration for network planning in Charlotte. Charlotte, however, saw less success in the development of its system than Dallas. To date, Dallas has built over 150 kilometers of light rail transit, much of it using preexisting railroad corridors. Meanwhile, Charlotte has built just over 30 kilometers of light rail transit with system planning starting much the same time in the 1980s.

Meanwhile, in Austin, the rail corridor was purchased well before transit was developed along it, with CapMetro and the City of Austin purchasing the corridor in the 1980s and transit service only opening in 2010. This was partially a result of difficulty getting the project off the ground with funding. Austin was unique in developing a hybrid system, with elements of both light rail and commuter rail. At 50 kilometers, the Red Line is longer than the Blue Line in Charlotte but has significantly fewer stations. The tracks owned by CapMetro also continue to be used for freight rail service.

Overall, each case took a different direction with regard to developing transit service using existing rail corridors. Dallas has developed a comprehensive system, the largest LRT system in the United States. Charlotte set out a vision for a significant system but to date has only developed a single line. Austin created a hybrid system using tracks that the transit authority has owned for decades and struggled to use for transit service.

6.2 - What Land Use Changes Occurred?

In all cases, there were common trends in land use change following the opening of transit service. Existing land use in many areas tended to be homogeneous, with large areas of a particular land use type clustered along the corridor. One notable consideration for transit station areas from this analysis was the walkshed area. For station areas in more urbanized parts of the case cities, street patterns resulted in larger walkshed areas. Consequently, areas that were less urbanized and further from the central city had smaller walkshed areas due to street patterns that were less conducive to walking.

The literature review noted that existing land use types along freight rail corridors may not be conducive to transit. Homogenous areas of industrial and commercial use may not generate the ridership necessary to support transit development in a cost-effective manner. Often, these areas were built to be car dependent and did not encourage walkability, or using alternative modes of transportation such as active transportation or transit. The literature review also noted how mixed use, walkable, and compact development is generally more conducive to transit use.

Looking at the land use changes that occurred, in some areas it was clear that changes trended in the direction of incorporating a larger variety of uses. In Dallas, it was noted that areas which had significant amounts of a single type of land use changed to incorporate other uses over time. This was particularly notable in the Cedars Station area, which began as predominantly industrial and over time came to include a mix of different uses. Today, industrial uses are much more limited in this area while there are greater numbers of multi family residential, commercial, and office uses.

In Charlotte, trends were different for different station areas. Those closer to the Uptown area tended to exhibit greater land use diversity and increased land use change over time. There were significant differences in the land use changes observed for I-485 Station, the terminus station furthest from Uptown, when compared to East-West station located just outside Uptown. Other areas along the Blue Line corridor highlighted reductions in industrial land use and increases in multi family residential land use. This aligns with the idea of creating transit-oriented development. Overall, land use patterns in station areas in Charlotte evolved to include

In Austin, similar patterns were observed with generally more homogenous land use patterns prior to the opening of the Red Line. Station areas such as MLK Jr., Crestview, and Plaza Saltillo exhibited the greatest land use changes over time, including an increase in multi family residential and mixed use land use types, and a reduction in industrial land use. Other land use types remained generally consistent over time. Overall, this trend was also observed, however the changes that occurred in the three station areas mentioned were more significant than the changes that occurred in other station areas.

Overall, the three cases examined highlighted a trend in which land use patterns became more diverse over time. Generally, there was a reduction in industrial land use accompanied by an increase in multi family residential and mixed use land use types over time. The significance of these changes, however, varied. A common trend with regard to the significance of the changes appears to be proximity to the urban centre or the existing level of urbanization in the station areas. The following section of this discussion provides an overview of the planning policies that may have influenced the resulting land use changes overtime.

6.3 - How did Policy Guide Land Use Change?

Dallas, while acknowledging the connection between land use and transit in early planning documents for its transit network, appears to not have incorporated such provisions into its land use planning policies. Despite this, other municipalities in the Dallas region which were not included in the land use aspect of this analysis did incorporate provisions for transit oriented development into their land use planning documents. This, however, does not mean that station areas in Dallas did not realize land use change. Certain station areas in Dallas saw significant land use change over the years. And, over time, Dallas has come to incorporate provisions for land use planning in station areas into its policies.

In Charlotte, the connection between land use planning and transit network development was a key consideration from the outset. Initial plans for the transit network highlighted how development patterns throughout the city were not conducive to transit use, this was observed in area plans for various areas of the city through which transit was proposed at the time. In the early 1990s, when Charlotte was beginning planning for its transit network, higher level planning documents reflected these attitudes.

There are various examples of planning policies addressing the transit-land use connection, and discussing how planning policies would have to be implemented that would create the development patterns necessary to make transit service viable and cost effective. Charlotte, unlike other case cities, is also an example where every station area along the initial system of the Blue Line had dedicated station area plans in place to guide development. This is interesting given that land use changes observed were not consistent across station areas.

Austin is a notable example in this regard. When observing land use changes, it was noted that the most significant changes occurred in the Plaza Saltillo, MLK Jr., and Crestview Station Areas. Consequently, these station areas were also the three in Austin with Transit Oriented Development Station Area Plans in place. These plans were intended to guide development in transit station areas and were highlighted in the city's comprehensive plan as a tool to achieve its goals of encouraging transit use and creating alternative development patterns in order to do so. The Station Area Plans were in effect prior to both the opening of the Red Line in 2010 and the adoption of the Imagine Autin Comprehensive Plan in 2012. No other Station area plans have been adopted since.

Additionally, it was notable that there were few mentions in planning policies as to the necessary steps that would have to be taken to develop potential brownfield sites along these corridors. Many previously industrial areas would likely have been brownfields that may require significant remediation to redevelop. Planning policies did not appear to address this potential barrier to development, with limited reference to financial incentives to guide redevelopment as well.

This points to a correlation between the development of specific area planning policies and changes in land use within station areas. While land use changes occurred in other station areas, they were not as significant as in those with Station Area Plans in place. This points to the idea that, while broader policies such as Comprehensive Plans may set out goals and objectives to realize land use changes in station areas, having dedicated area planning policies is likely a more effective and strategic tool to help realize these land use changes.

7.0 – Conclusion

This section discusses several recommendations that were drawn from the findings of the study. These recommendations are intended to be broadly applied to cities which are considering using existing railroad corridors for transit service. Additionally, the limitations of the study are discussed in conjunction with the potential future research opportunities they present. Finally, to conclude, final thoughts on the outcomes of this study are presented.

7.1 - Recommendations

The primary purpose of this study was to draw lessons from the studied case cities as to how they developed transit using existing railroad rights of way, the land use implications of doing so, and the policy context that guided it. This study is being undertaken in the context of a broader regional rail relocation study ordered by the Government of Manitoba for the Winnipeg Region. The purpose of the government of Manitoba's study is to identify the potential for railways in the Winnipeg region to be relocated to mitigate the negative impacts of urban freight rail while maintaining the transportation benefits freight rail provides.

This study aims to inform this rail relocation study, and other cities who may potentially wish to use existing railroad corridors for transit service, by looking at potential reuse scenarios for rail corridors should freight service be relocated, as the potential to use them for transit service could provide justification for their relocation and further amplify the potential benefits that could be realized from relocation.

Cities should consider the potential for transit use when looking at the potential for freight railroad corridors to be relocated. In the case examples analyzed, it is clear that using existing railroad corridors for transit use was a strategic policy choice. This includes using the lower develop costs associated with using existing railroad corridors for transit service as a justification. However, cases such as Dallas highlight the fact that this also allows the development of transit service while reducing potential impacts on existing communities.

The cases analyzed planned to use existing railroad corridors from the start. However, given the limited potential to influence land use change, the results of this study can only lead to a recommendation that they be considered as a potential option for redevelopment among other options. Cities intending to do so should consider the existing land uses along the corridor, the potential to alter these land uses to make them more transit supportive both in terms of residential and employment uses, and the policies necessary to guide land use change.

Overall, this could be a cost-effective way to quickly build out a higher order transit system. Potential opportunities for reusing these corridors could also provide justification for relocating the freight rail in the first place and provide communities with improved transportation options while reducing the negative impacts of urban freight rail. However, reusing existing railroad corridors is not a be-all end-all solution and should come with careful considerations for land use implications.

7.2 - Limitations and Future Work

Overall, there were various limitations due to the limited scope of this study. While these limited the findings of the study, they also present opportunities for future research to consider land use change along railroad corridors. Due to several limitations, this study was not able to dive deep into a number of considerations with regard to using existing railroad corridors for transit service. The study used publicly available land use data, which limited the analysis to only those cases for which data was able to be identified. A more comprehensive analysis may consider other cities which were identified as having used existing railroad corridors, but for which data was not publicly available.

Additionally, the study did not consider the relationship between land use change and transit ridership on similar corridors. The study did not look specifically at the success of the individual transit systems beyond land use changes that occurred and associated policies. Cases such as Austin mentioned the inclusion of metrics to gauge transit ridership in planning policies. Future studies may wish to consider the links between land use change along such corridors and the transit ridership generated.

The study specifically looked at higher order planning policies, specifically those which were publicly available. Other policies not included in this study, such as zoning bylaws, could also have significant influence on land use change. Generally, these policies were not easily identifiable over the timeframe of the study and were therefore not included. Future research may wish to consider the implications of these other forms of planning policy on land use change.

7.3 – Final Thoughts

Overall, this research has demonstrated that other jurisdictions have used existing freight railroad corridors to develop their transit networks, and that land use changes have occurred in station areas along these corridors. Each of the cases analyzed has had a different experience with developing its transit system. Dallas has used freight railroad corridors to develop the longest light rail system in the United States. Meanwhile, Charlotte and Austin have used freight rail corridors to develop much less comprehensive systems. In all cases, the cost savings associated with using existing railroad corridors for transit were viewed as a justification for using these corridors.

With regard to land use change, all of the cases studied have seen varied results. Literature highlights this fact, as well as the fact that land use along freight railroad corridors is not entirely conducive to transit service. Typically, industrial and commercial land uses are associated with freight rail. However, this research showed that, while generally land use along corridors is more homogenous and lacks diversity, preexisting uses are not always commercial and industrial.

The analysis of land use changes highlighted how, over time, many station areas saw much more diverse land uses develop over time. Generally, mixed use and multi family residential uses increased over time. Some station areas saw significant changes in their land use over time while others saw less significant changes. Some trends identified relate to areas that experienced more significant land use change. These included the proximity of stations to urban cores, the pre-existing urban form in new station areas, and the policies put in place to guide land use change.

When looking at policy, trends were observed with regard to the existence of particular types of land use policies and land use change. Some cases, such as Charlotte, recognized the connections between transit and land use as part of the planning process for their transit network. In all cases, transit-oriented development became incorporated into general land use planning policy, though not always in advance of the opening of the transit station. There was a noticeable correlation between the existence of station area planning policies, such as those for select station areas in Dallas and Austin, and land use change. Areas in these cities with station area plans saw more significant change than other station areas.

Given that the Government of Manitoba is currently exploring the idea of relocating freight railroad corridors in the Winnipeg region, there are a few takeaways from this analysis that could be valuable to consider. The government should consider the potential for transit use when looking at the potential for freight railroad corridors to be relocated. This should include a more stringent analysis of the existing land uses along corridors, as well as identifying the potential for land use change to make corridors more suitable for transit use.

Additionally, this research has identified opportunities for future research. This report has provided a high-level overview of land use change along transit corridors. There are opportunities to explore land use change in a more in depth manner, looking at other factors that may have been involved outside of planning policy. Overall, the findings of this research show that when corridors are reused for transit service the land uses do tend to change over time. In some cases, these changes are more significant than others. Planning policy may play a role in this change, particularly when strong station area plans are in place to guide land use in station areas.

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Appendix A: Land Use Datasets Used for Spatial Analysis

Case City	Dataset	Source	Link
Dallas	1995 Land Use	North Central Texas Council of Governments	https://hub.arcgis.com/datasets/NCTCOGGIS::1995-land-use/about?uiVersion=content-views
Dallas	2000 Land Use	North Central Texas Council of Governments	https://arc-gis-hub-home-arcgishub.hub.arcgis.com/datasets/4940d3c0ef334677a664a1ae1425b5b3/about
Dallas	2005 Land Use	North Central Texas Council of Governments	https://hub.arcgis.com/datasets/7af1c1dfecbf4706bf8e53186492c740_3
Dallas	2010 Land Use	North Central Texas Council of Governments	https://hub.arcgis.com/datasets/NCTCOGGIS::2010-land-use/about?uiVersion=content-views
Dallas	2015 Land Use	North Central Texas Council of Governments	https://hub.arcgis.com/datasets/NCTCOGGIS::2015-land-use/about?uiVersion=content-views
Dallas	2020 Land Use	North Central Texas Council of Governments	https://hub.arcgis.com/datasets/NCTCOGGIS::2020-land-use/about
Charlotte	Tax Data 2005	Mecklenburg County	https://mecklenburgcounty.hosted-by-files.com/OpenMapping/Parcel%20Data%20Archive/
Charlotte	Tax Data 2010	Mecklenburg County	https://mecklenburgcounty.hosted-by-files.com/OpenMapping/Parcel%20Data%20Archive/
Charlotte	Tax Data 2015	Mecklenburg County	https://mecklenburgcounty.hosted-by-files.com/OpenMapping/Parcel%20Data%20Archive/
Charlotte	Tax Data 2020	Mecklenburg County	https://mecklenburgcounty.hosted-by-files.com/OpenMapping/Parcel%20Data%20Archive/

Austin	Austin Land Use Year 2006	City of Austin	https://austin.hub.arcgis.com/datasets/austin::austin-land-use-year-2006/about
Austin	Austin Land Use Year 2010	City of Austin	https://austin.hub.arcgis.com/datasets/4d6818029d0c48bf9ae705e333ff5702/about
Austin	Land Database 2021	City of Austin	https://data.austintexas.gov/Housing-and-Real-Estate/Land-Database-2021/kk8y-6cmt/about_data

Appendix B: Dallas Land Use Classifications

Land Use Code	Category	Classification	1995	2000	2005	2010	2015	2020
111	Single Family	Single Family						
112	Multi Family	Multi Family						
113	Mobile home	Single Family						
114	Group Quarters	Multi Family						
120	Commercial	Commercial	N/A	N/A	N/A			N/A
121	Office	Office						
122	Retail	Commercial						
123	Institutional	Institutional				N/A	N/A	N/A
124	Hotel/motel	Hotel / Motel						
125	Institutional/semi-public	Institutional	N/A	N/A	N/A			
126	Education	Institutional	N/A	N/A	N/A			
131	Industrial	Industrial						
141	Transportation	Not Included				N/A	N/A	N/A
142	Roadway	Not Included					N/A	N/A
143	Utilities	Not Included						
144	Airport	Not Included						
145	Parking Garage	Not Included	N/A			N/A	N/A	N/A
146	Runway	Not Included	N/A					
147	Venue	Not Included	N/A					
148	Railroad	Not Included	N/A	N/A	N/A			
149	Communication	Not Included	N/A	N/A	N/A			
151	Transit	Not Included	N/A	N/A	N/A			
160	Mixed Use	Mixed Use	N/A	N/A				N/A
170	Parks / recreation	Open / Green Space	N/A	N/A	N/A			
171	Parks / recreation	Green / Open Space				N/A	N/A	N/A
172	Landfill	Not Included						
173	Under Construction	Vacant						N/A
174	Cemeteries	Not Included	N/A	N/A	N/A			
175	Flood Control	Not Included						
300	Vacant	Vacant				N/A	N/A	
301	Vacant	Vacant	N/A	N/A	N/A			
302	Residential Acreage	Single Family	N/A	N/A	N/A			
303	Ranch Land	Not Included	N/A	N/A	N/A			

304	Timberland	Not Included	N/A	N/A	N/A			
305	Farmland	Not Included	N/A	N/A	N/A			
306	Parking CBD	Not Included				N/A	N/A	N/A
308	Expanded Parking	Not Included	N/A					
309	Improved Acreage	Not Included	N/A	N/A	N/A			
401	Parking	Not Included	N/A	N/A	N/A			
500	Water	Not Included						
501	Water	Not Included	N/A	N/A	N/A			
502	Small Water Bodies	Not Included	N/A	N/A	N/A			

Adapted from: North Central Texas Council of Governments. (n.d.).

Appendix C: Charlotte Land Use Classifications for Charlotte

Land Use Description	Classification	2005	2010	2015	2020
Single Fam	Single Family				
Multi Fam	Multi Family				
Condominium	Multi Family			N/A	
Attached Res	Multi Family	N/A	N/A		N/A
Warehouse	Industrial				
Warehouse Lg	Industrial				
Commercial	Commercial				
Hotel / Motel	Hotel/Motel				
Office	Office				
Govt-Inst	Institutional				
Vacant	Vacant				

Appendix D: Austin Land Use Classifications

Land Use Description	Code #	Classification
Single Fam	100	Single Family
Mobile Homes	113	Single Family
Large Lot Single Family	160	Single Family
Multi Family	200	Multi Family
Commercial	300	Commercial
Mixed Use	330	Mixed Use
Office	400	Office
Industrial	500	Industrial
Civic	600	Institutional
Green / Open Space	700	Green / Open Space
Undeveloped	800	Vacant

Appendix E: Route and Station Datasets Used for Spatial Analysis

Case City	Dataset	Source	Link
Dallas	DART Rail	City of Dallas GIS Services	https://gisservices-dallasgis.opendata.arcgis.com/maps/0fb5273f30be4fe0b2459760481bcaf0/about
Charlotte	LYNX Blue Line Route	City of Charlotte	https://data.charlottenc.gov/datasets/ba37d75c37034c53abeb5f4cbc502e63_0/about
Charlotte	LYNX Blue Line Stations	City of Charlotte	https://www.arcgis.com/home/item.html?id=ab575dca86334eb69ffc8e6b88554ec7
Austin	Capital Metro Shapefiles - AUGUST 2022	City of Austin	https://catalog.data.gov/dataset/capital-metro-shapefiles-august-2022

Appendix F: Dallas Land Use Tables

Land Use by Red Line Station Area – 1995

Land Use	Park Lane	Lovers Lane	Tyler Vernon	Westmoreland	Zoo	Hampton	Total
Commercial	60.05	20.22	1.18	8.56	6.40	5.85	102.26
Hotel / Motel							0.00
Industrial		2.71	2.43	39.38	7.40		51.92
Institutional	0.91	1.56	1.33	5.71	2.41	4.11	16.03
Multi Family	27.57	22.85		5.39	4.05		59.87
Office	11.95	8.65	1.39	0.89			22.89
Parks / Open Space							
Single Family	1.51	15.48	93.24	29.83	22.02	73.59	235.68
Vacant	12.37	3.59	2.20	4.08	8.39	7.89	38.52

Land Use area in Hectares.

Land Use by Red + Blue Line Station Area – 1995

Land Use	8th and Corinth	Cedars	SMU/Mockingbird	Total
Commercial	3.08	2.49	16.46	22.02
Hotel / Motel		1.69	4.16	5.85
Industrial	8.94	60.96	26.16	96.06
Institutional	0.65	3.61	5.38	9.64
Multi Family	2.69	0.08	3.24	6.01
Office	0.94		8.82	9.76
Parks / Open Space				
Single Family	37.35		23.33	60.68
Vacant	20.66	4.91	7.12	32.69

Land Use area in Hectares.

Land Use by Red Line Station Area – 2000

Land Use	Park Lane	Lovers Lane	Tyler Vernon	Westmoreland	Zoo	Hampton	Total
Commercial	40.17	22.58	1.18	8.00	6.48	4.91	83.34
Hotel / Motel							0.00
Industrial		3.52	3.08	33.52	7.20		47.33
Institutional	5.51	0.93	2.27	5.92	4.54	7.87	27.04
Multi Family	27.56	22.77		5.39	3.95		59.67
Office	9.94	8.26		2.14		4.51	24.85
Parks / Open Space							
Single Family	3.09	14.54	92.24	29.38	23.14	72.85	235.24
Vacant	2.44	1.87	5.18	3.98	5.35	1.30	20.12

Land Use area in Hectares.

Land Use by Red + Blue Line Station Area – 2000

Land Use	8th and Corinth	Cedars	SMU/Mockingbird	Total
Commercial	6.28	2.91	11.89	21.08
Hotel / Motel		1.62	3.46	5.08
Industrial	10.60	65.13	22.49	98.22
Institutional	0.63	3.59	4.50	8.73
Multi Family	2.70	0.08	3.32	6.09
Office	1.26		6.51	7.78
Parks / Open Space				
Single Family	37.42		23.41	60.83
Vacant	15.24	0.32	0.57	16.13

Land Use area in Hectares.

Land Use by Red Line Station Area – 2005

Land Use	Park Lane	Lovers Lane	Tyler Vernon	Westmoreland	Zoo	Hampton	Total
Commercial	47.23	18.18	1.06	4.88	3.18	6.46	80.99
Hotel / Motel							0.00
Industrial		3.21	1.94	34.27	6.66		46.09
Institutional	6.63	2.50	3.46	6.14	0.33	6.23	25.29
Multi Family	27.99	22.95	0.34	5.55	6.21	0.03	63.07
Office	22.35	6.97		1.00	2.05		32.37
Parks / Open Space							
Single Family	0.50	14.58	86.72	25.55	17.76	65.51	210.63
Vacant	2.72	1.20	4.58	2.90	6.65	1.51	19.57

Land Use area in Hectares.

Land Use by Red + Blue Line Station Area – 2005

Land Use	8th and Corinth	Cedars	SMU/Mockingbird	Total
Commercial	1.89	2.13	15.63	19.65
Hotel / Motel		1.74	2.01	3.75
Industrial	9.67	33.57	11.19	54.43
Institutional	1.54	3.91	4.39	9.84
Multi Family	3.29	3.89	5.00	12.19
Office	1.38	3.22	10.01	14.61
Parks / Open Space				
Single Family	20.12	1.45	22.88	44.45
Vacant	30.78	22.05	1.14	53.98

Land Use area in Hectares.

Land Use by Red Line Station Area – 2010

Land Use	Park Lane	Lovers Lane	Tyler Vernon	Westmoreland	Zoo	Hampton	Total
Commercial	64.46	29.88	3.53	25.21	19.81	8.66	151.56
Hotel / Motel							
Industrial			1.75	11.39			13.14
Institutional	20.26	0.70	1.71	6.17	1.22	3.23	33.29
Multi Family	21.34	22.75	0.32	5.76	5.16	0.03	55.36
Office					2.70		2.70
Parks / Open Space			3.45	0.47	14.11	0.90	18.93
Single Family	0.24	14.08	84.34	28.07	14.92	67.68	209.34
Vacant	1.47	0.43	6.03	6.21	9.58	2.46	26.19

Land Use area in Hectares.

Land Use by Red + Blue Line Station Area – 2010

Land Use	8th and Corinth	Cedars	SMU/Mockingbird	Total
Commercial	8.57	33.09	23.44	65.09
Hotel / Motel				
Industrial	0.01	14.84	2.36	17.21
Institutional	1.22	8.94	9.24	19.41
Multi Family	6.51	4.61	8.60	19.72
Office				0.00
Parks / Open Space	4.58		7.25	11.82
Single Family	18.28	1.74	21.84	41.87
Vacant	31.93	13.19	8.74	53.86

Land Use area in Hectares.

Land Use by Red Line Station Area – 2015

Land Use	Park Lane	Lovers Lane	Tyler Vernon	Westmoreland	Zoo	Hampton	Total
Commercial	49.12	27.67	1.73	25.42	7.24	7.09	118.27
Hotel / Motel	13.05				0.25		13.30
Industrial			1.74	11.39	1.28		14.42
Institutional	21.08	0.38	2.79	6.87	0.50	6.10	37.71
Multi Family	19.65	21.55	0.29	5.61	5.42	0.03	52.56
Office	0.29			1.34	1.18	0.25	3.06
Parks / Open Space		0.39	7.39	1.52	25.18		34.48
Single Family	0.26	13.93	83.86	28.01	14.21	68.07	208.34
Vacant	4.08	5.63	5.99	3.60	12.67	1.73	33.70

Land Use area in Hectares.

Land Use by Red + Blue Line Station Area – 2015

Land Use	8th and Corinth	Cedars	SMU/Mockingbird	Total
Commercial	7.18	25.16	21.78	54.12
Hotel / Motel		2.08	1.25	3.33
Industrial	0.01	9.69		9.70
Institutional	2.06	4.52	14.91	21.49
Multi Family	6.28	7.54	9.41	23.23
Office				0.00
Parks / Open Space	4.64	3.40	6.26	14.31
Single Family	17.01	1.80	21.61	40.42
Vacant	35.66	23.87	5.12	64.64

Land Use area in Hectares.

Land Use by Red Line Station Area – 2020

Land Use	8th and Corinth	Cedars	SMU/Mockingbird	Total
Commercial	2.14	5.26	11.15	18.55
Hotel / Motel		1.16	1.63	2.80
Industrial	5.44	20.60	7.76	33.79
Institutional	2.34	7.66	7.43	17.43
Multi Family	7.93	11.62	11.76	31.31
Office		5.22	10.73	15.95
Parks / Open Space	15.34	3.30	5.84	24.48
Single Family	16.72	2.10	20.49	39.30
Vacant	30.62	20.54	6.46	57.62

Land Use area in Hectares.

Land Use by Red + Blue Line Station Area – 2020

Land Use	Park Lane	Lovers Lane	Tyler Vernon	Westmoreland	Zoo	Hampton	Total
Commercial	48.44	20.47	0.91	13.49	2.90	5.35	91.55
Hotel / Motel					0.49		0.49
Industrial	2.61	2.77	0.35	17.40	5.71		28.83
Institutional	20.68	1.87	4.26	8.41	4.07	8.10	47.39
Multi Family	23.24	22.05	3.35	8.23	5.61	0.03	62.51
Office	9.75	7.47	2.33	4.94	0.33	0.25	25.07
Parks / Open Space	0.41	1.53	4.10	1.55	22.62		30.22
Single Family	0.16	14.04	82.88	25.80	14.92	68.22	206.01
Vacant	5.40	0.89	4.21	9.74	11.24	1.53	33.01

Land Use area in Hectares.

Land Use Change by Red Line Station Area and Land Use Type – 1995 to 2020

Land Use	Column1	Commercial	Hotel / Motel	Industrial	Institutional	Multi Family	Office	Parks / Open Space	Single Family	Vacant
Park Lane	Area Change	-11.61	0.00	2.61	19.77	-4.33	-2.20	0.41	-1.35	-6.97
	% Change	-19%			2176%	-16%	-18%		-90%	-56%
Lovers Lane	Area Change	0.25	0.00	0.06	0.30	-0.80	-1.18	1.53	-1.44	-2.70
	% Change	1%		2%	19%	-4%	-14%		-9%	-75%
Tyler Vernon	Area Change	-0.27	0.00	-2.08	2.93	3.35	0.94	4.10	-10.36	2.01
	% Change	-23%		-86%	219%		67%		-11%	91%
Westmoreland	Area Change	4.93	0.00	-21.98	2.70	2.83	4.05	1.55	-4.04	5.66
	% Change	58%		-56%	47%	53%	454%		-14%	139%
Zoo	Area Change	-3.50	0.49	-1.69	1.67	1.56	0.33	22.62	-7.10	2.85
	% Change	-55%		-23%	69%	38%			-32%	34%
Hampton	Area Change	-0.50	0.00	0.00	3.99	0.03	0.25	0.00	-5.38	-6.36
	% Change	-9%			97%				-7%	-81%
Total	Area Change	-10.71	0.49	-23.09	31.36	2.64	2.18	30.22	-29.67	-5.51
	% Change	-10%		-44%	196%	4%	10%		-13%	-14%

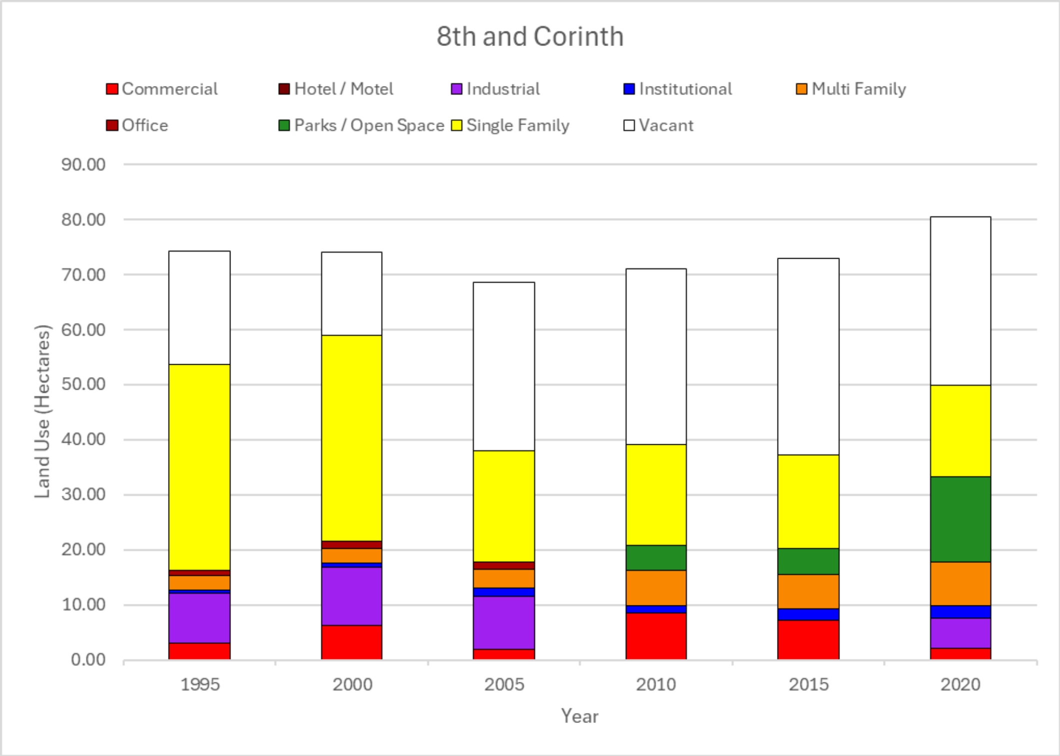
Land Use area change in Hectares.

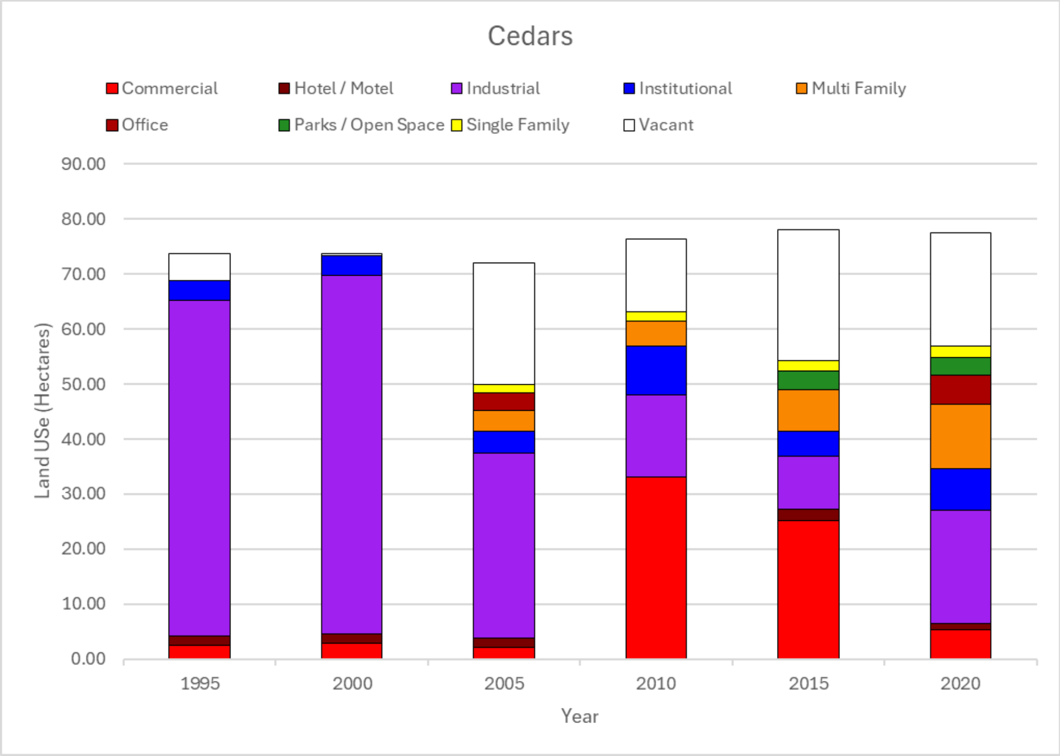
Land Use Change by Red + Blue Line Station Area and Land Use Type – 1995 to 2020

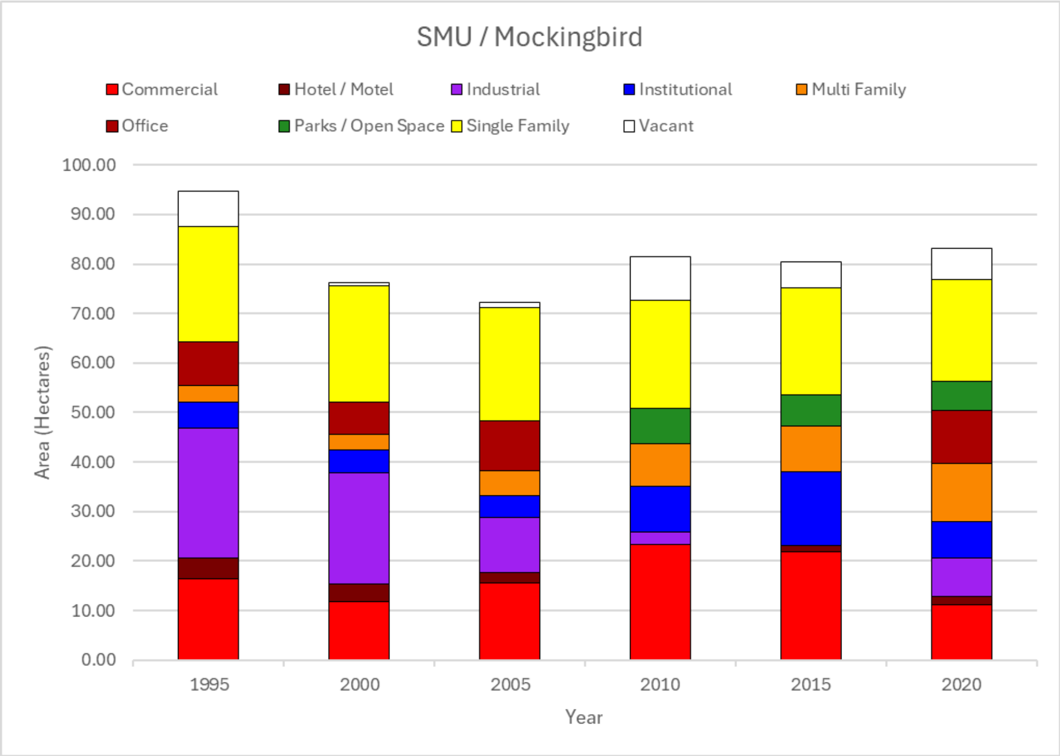
Station Area	Land Use	Commercial	Hotel / Motel	Industrial	Institutional	Multi Family	Office	Parks / Open Space	Single Family	Vacant
8th and Corinth	Area Change	-0.94	0.00	-3.50	1.69	5.24	-0.94	15.34	-20.64	9.95
	% Change	-31%		-39%	260%	195%	-100%		-55%	48%
Cedars	Area Change	2.78	-0.53	-40.36	4.05	11.55	5.22	3.30	2.10	15.63
	% Change	112%	-31%	-66%	112%	14772%				319%
SMU/Mockingbird	Area Change	-5.31	-2.52	-18.41	2.05	8.51	1.91	5.84	-2.84	-0.65
	% Change	-32%	-61%	-70%	38%	263%	22%		-12%	-9%
Total	Area	-3.47	-3.05	-62.27	7.79	25.30	6.20	24.48	-21.38	24.94
	% Change	-16%	-52%	-65%	81%	421%	64%		-35%	76%

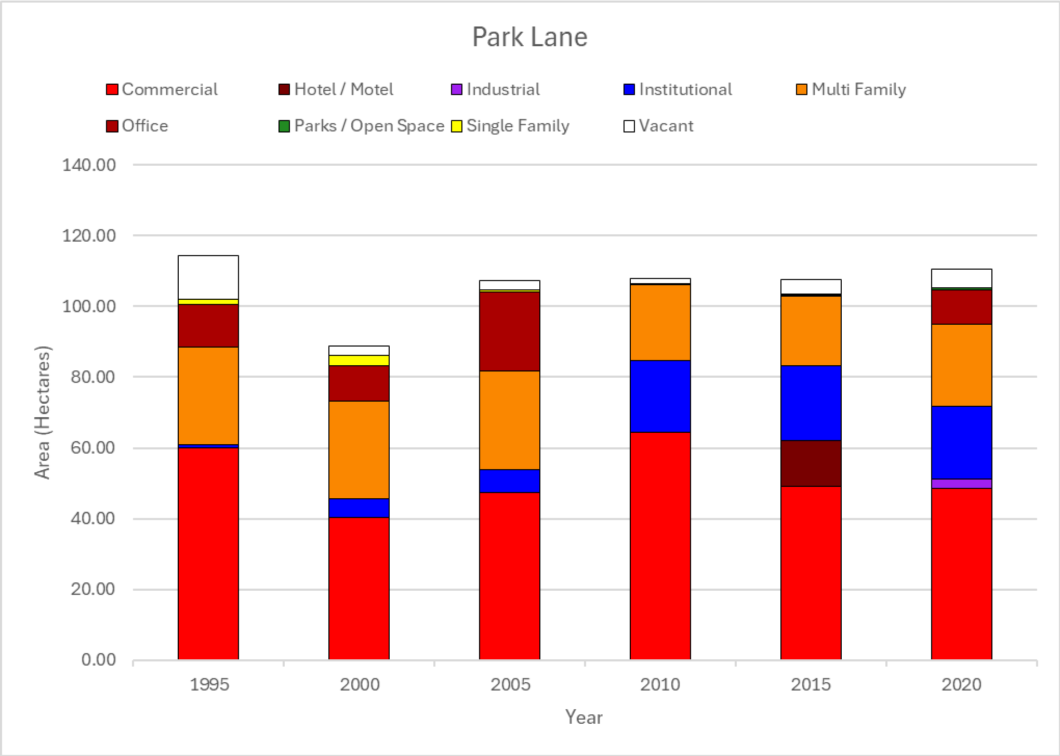
Land Use area change in Hectares.

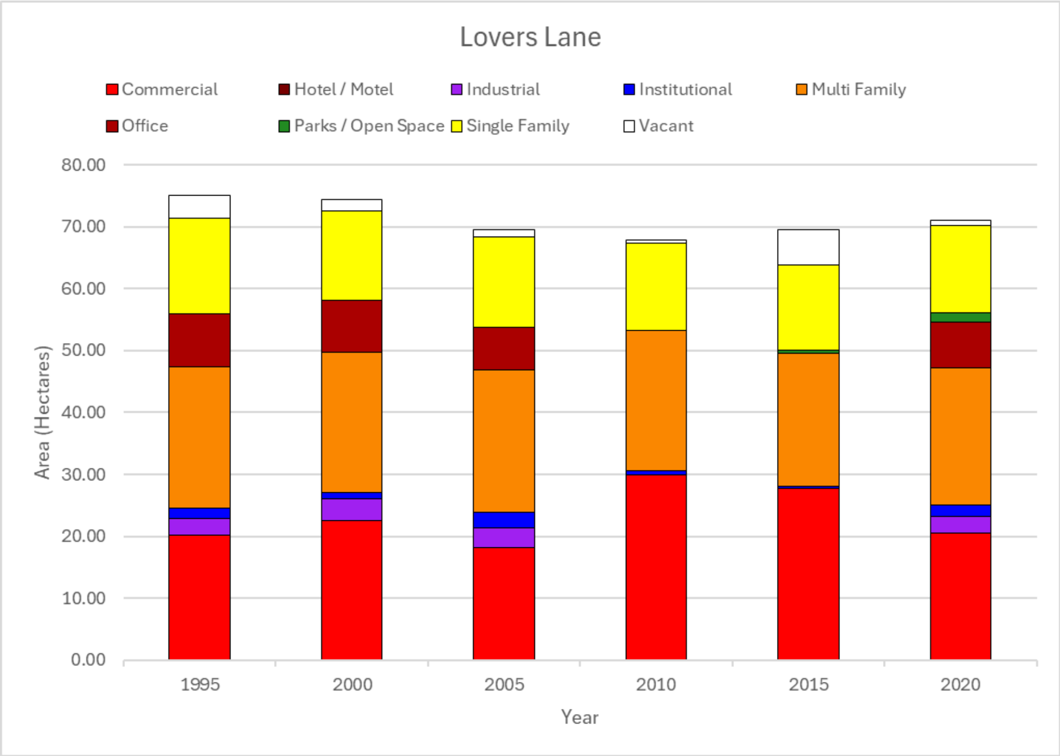
Appendix G: Dallas Land Use Charts

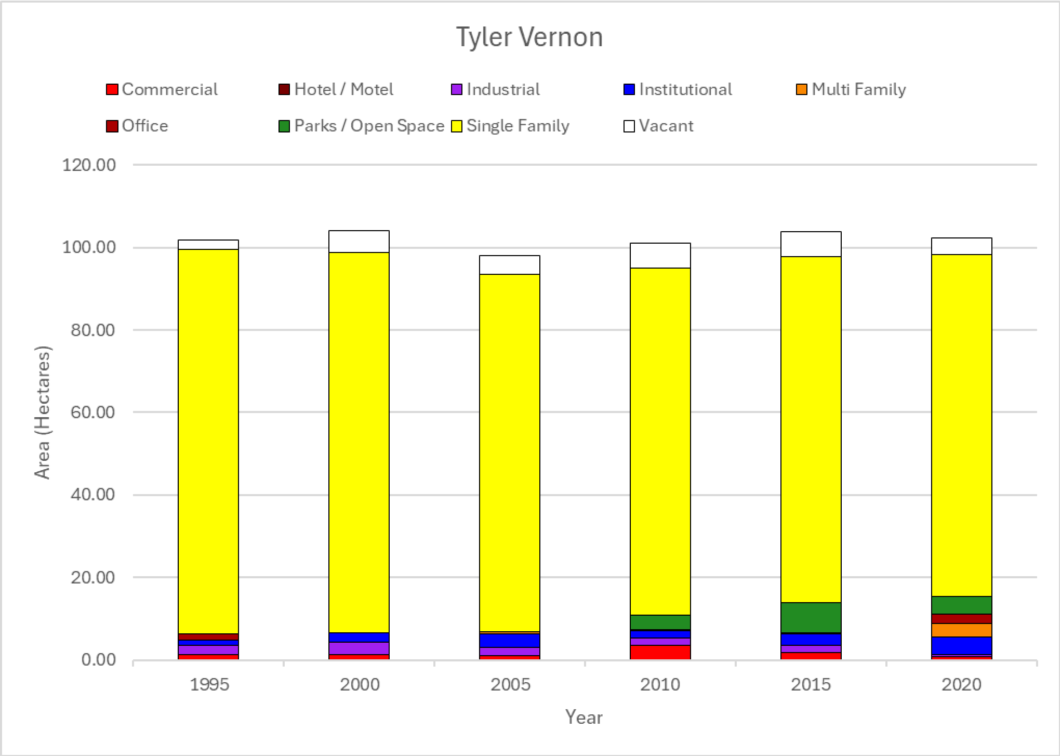


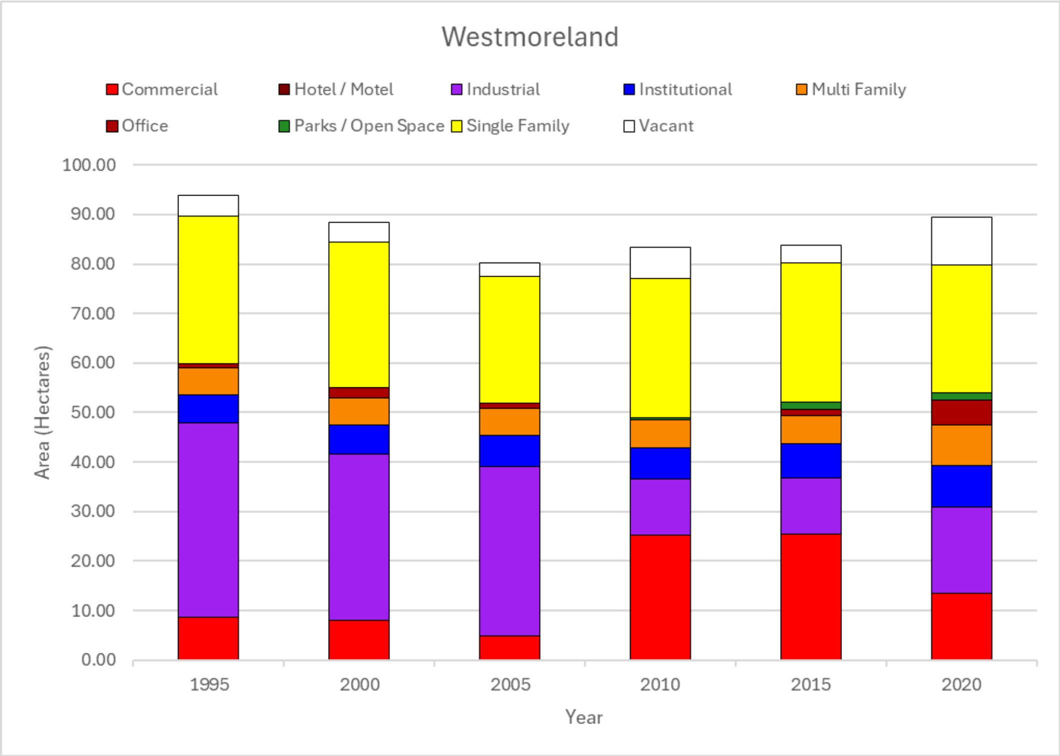



SMU / Mockingbird
Commercial
Hotel / Motel
Industrial
Institutional
Multi Family
Office
Parks / Open Space
Single Family
Vacant
Area (Hectares)
Year
1995
2000
2005
2010
2015
2020


Park Lane
Commercial
Hotel / Motel
Industrial
Institutional
Multi Family
Office
Parks / Open Space
Single Family
Vacant
Area (Hectares)
Year
1995
2000
2005
2010
2015
2020


Lovers Lane
Commercial
Hotel / Motel
Industrial
Institutional
Multi Family
Office
Parks / Open Space
Single Family
Vacant
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Area (Hectares)
1995
2000
2005
2010
2015
2020
Year


Tyler Vernon
Commercial
Hotel / Motel
Industrial
Institutional
Multi Family
Office
Parks / Open Space
Single Family
Vacant
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Area (Hectares)
1995
2000
2005
2010
2015
2020
Year


Westmoreland
Commercial
Hotel / Motel
Industrial
Institutional
Multi Family
Office
Parks / Open Space
Single Family
Vacant
Area (Hectares)
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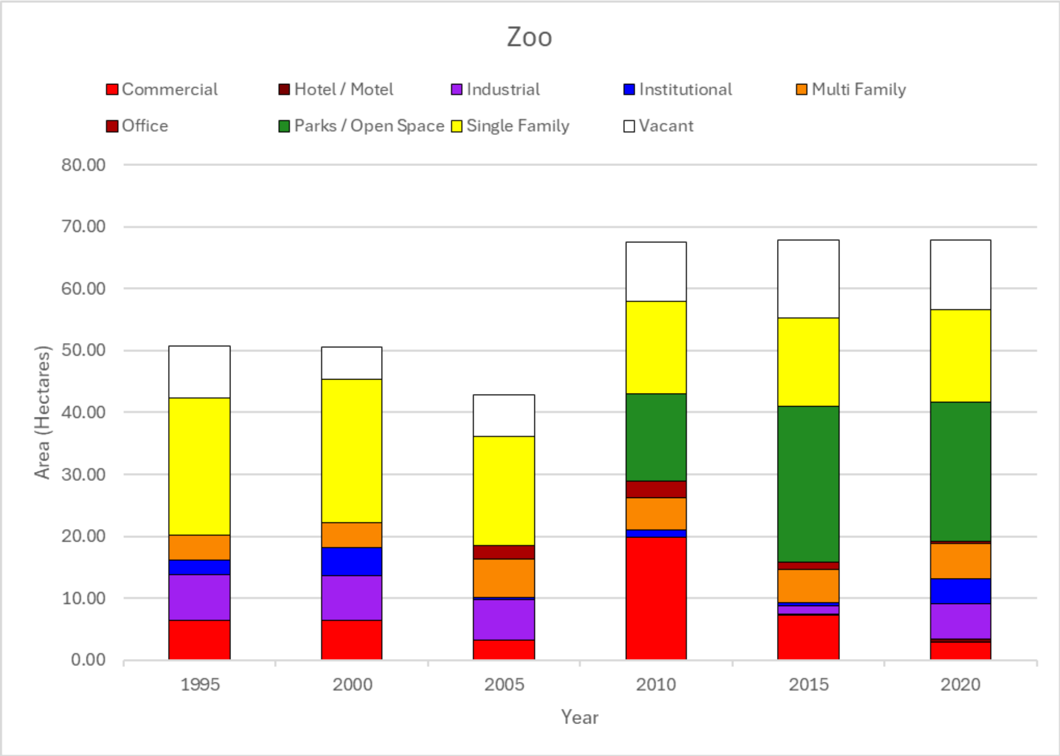
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
1995
2000
2005
2010
2015
2020
Year


Zoo
Commercial
Hotel / Motel
Industrial
Institutional
Multi Family
Office
Parks / Open Space
Single Family
Vacant
Area (Hectares)
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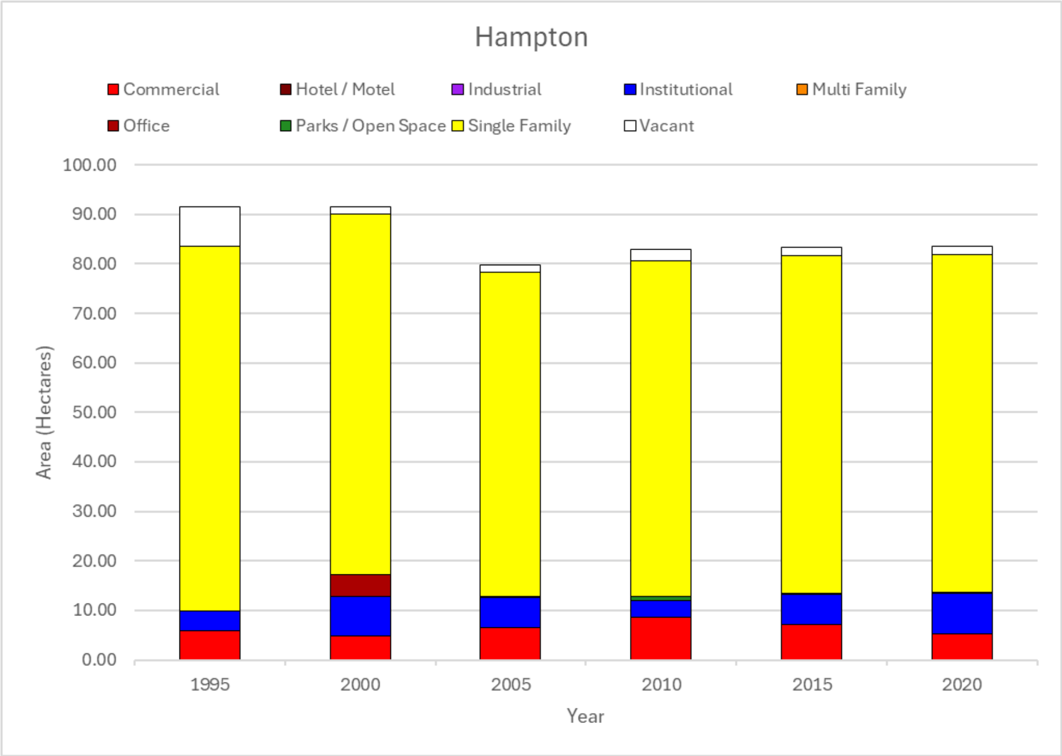
60.00
50.00
40.00
30.00
20.00
10.00
0.00
1995
2000
2005
2010
2015
2020
Year


Hampton
Commercial
Hotel / Motel
Industrial
Institutional
Multi Family
Office
Parks / Open Space
Single Family
Vacant
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Area (Hectares)
1995
2000
2005
2010
2015
2020
Year

Appendix H: Charlotte Land Use Tables

Land Use by Station Area – 2005

Land Use	Archdale	Arrowood	Bland St	East/West	I-485	New Bern	Scaleybark	Sharon Rd	Tyvola	Woodlawn	Total
Commercial	15.55	19.59	4.23	10.69	34.77	8.15	11.44	0.93	21.91	25.25	152.52
Hotel / Motel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.62	3.62
Industrial	9.65	16.57	16.34	23.52	9.99	35.32	55.36	47.92	26.58	29.04	270.28
Institutional	3.94	5.11	1.10	4.23	13.03	3.78	1.98	0.01	1.51	6.97	41.65
Multi Family	14.10	4.95	11.52	4.43	0.00	18.42	10.06	12.73	9.22	0.00	85.43
Office	6.03	1.95	6.86	12.90	2.78	6.21	3.71	1.80	17.87	16.01	76.12
Single Family	56.65	23.02	12.17	20.07	10.89	20.52	23.94	4.64	4.96	2.76	179.62
Vacant	12.26	22.78	13.13	8.97	13.89	9.16	9.87	10.10	15.83	15.60	131.59

Land Use area in Hectares.

Land Use by Station Area – 2010

Land Use	Archdale	Arrowood	Bland St	East/West	I-485	New Bern	Scaleybark	Sharon Rd	Tyvola	Woodlawn	Total
Commercial	18.09	18.96	4.54	14.61	36.02	7.97	7.99	0.93	23.41	21.25	153.77
Hotel / Motel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.50	3.50
Industrial	10.50	16.49	12.91	16.32	11.88	28.23	48.74	28.57	30.64	28.63	232.92
Institutional	3.48	8.13	1.69	3.59	14.93	4.38	4.99	1.80	3.63	7.21	53.83
Multi Family	11.18	6.13	16.25	7.03	0.00	19.13	10.00	12.94	9.18	0.00	91.82
Office	4.97	1.95	7.36	15.44	0.82	2.53	6.32	18.82	13.93	18.32	90.46
Single Family	59.72	23.02	12.13	19.47	10.86	20.56	23.76	3.89	4.96	3.17	181.55
Vacant	10.21	18.80	10.74	8.63	10.73	18.62	13.26	10.72	11.77	16.81	130.30

Land Use area in Hectares.

Land Use by Station Area – 2015

Land Use	Archdale	Arrowood	Bland St	East/West	I-485	New Bern	Scaleybark	Sharon Rd	Tyvola	Woodlawn	Total
Commercial	24.43	20.34	5.69	13.93	34.59	9.50	10.01	4.71	22.73	23.86	169.78
Hotel / Motel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.60	4.60
Industrial	9.61	10.71	9.88	14.25	11.88	25.24	37.24	45.90	26.63	27.57	218.91
Institutional	3.48	8.98	1.61	3.59	14.93	3.35	9.79	1.86	3.63	6.91	58.14
Multi Family	8.45	6.13	18.47	9.74	0.00	24.38	7.05	9.91	9.18	0.00	93.32
Office	1.69	3.49	6.70	12.64	0.82	3.66	7.82	2.07	18.21	10.03	67.12
Single Family	59.56	21.26	11.79	19.22	11.11	19.87	22.41	3.53	4.96	2.89	176.60
Vacant	10.93	21.87	10.95	9.80	11.92	13.31	20.54	9.68	12.18	23.02	144.18

Land Use area in Hectares.

Land Use by Station Area – 2020

Land Use	Archdale	Arrowood	Bland St	East/West	I-485	New Bern	Scaleybark	Sharon Rd	Tyvola	Woodlawn	Total
Commercial	16.37	14.85	7.79	16.40	33.20	11.39	12.42	4.03	19.40	22.63	158.48
Hotel / Motel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.16	4.16
Industrial	11.17	15.49	11.36	14.28	21.62	20.90	38.52	37.85	26.42	29.86	227.47
Institutional	3.99	8.94	0.44	3.80	5.89	3.34	2.50	1.79	3.33	5.84	39.85
Multi Family	14.42	6.15	10.78	7.71	0.00	27.03	3.62	13.80	9.18	0.00	92.69
Office	2.03	5.94	9.96	13.98	1.39	5.12	7.18	6.87	21.26	17.13	90.85
Single Family	56.37	22.31	12.41	18.33	11.15	21.94	23.61	3.24	4.96	2.21	176.53
Vacant	13.78	18.38	14.41	9.96	11.50	10.84	25.35	10.13	13.01	16.98	144.34

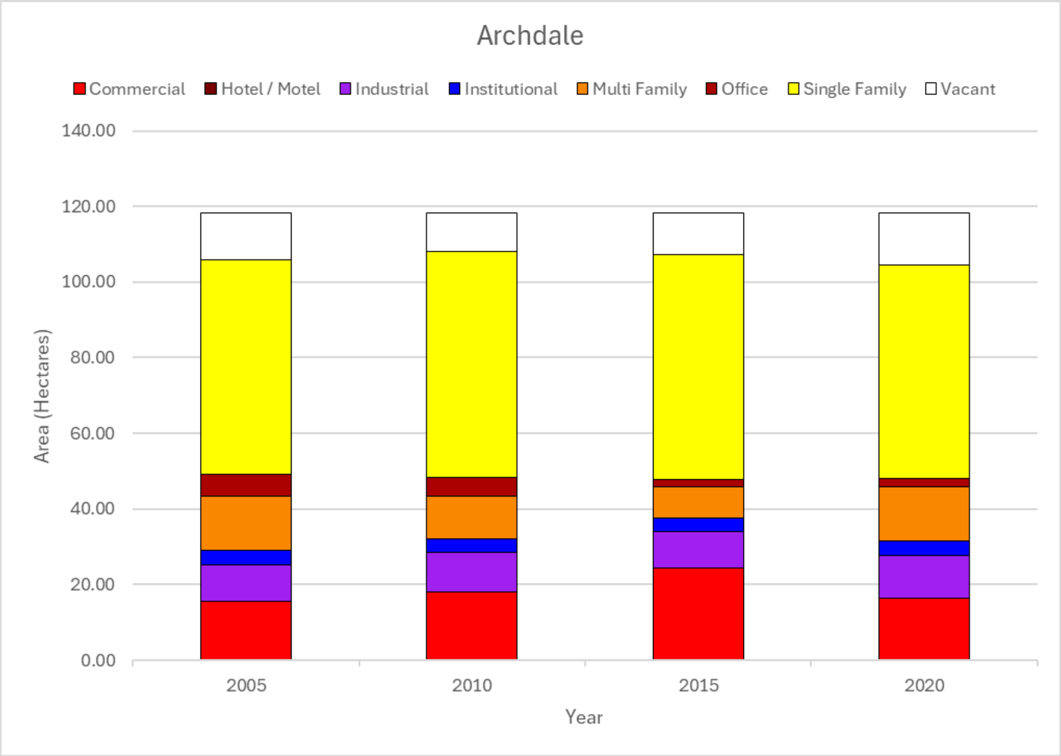
Land Use area in Hectares.

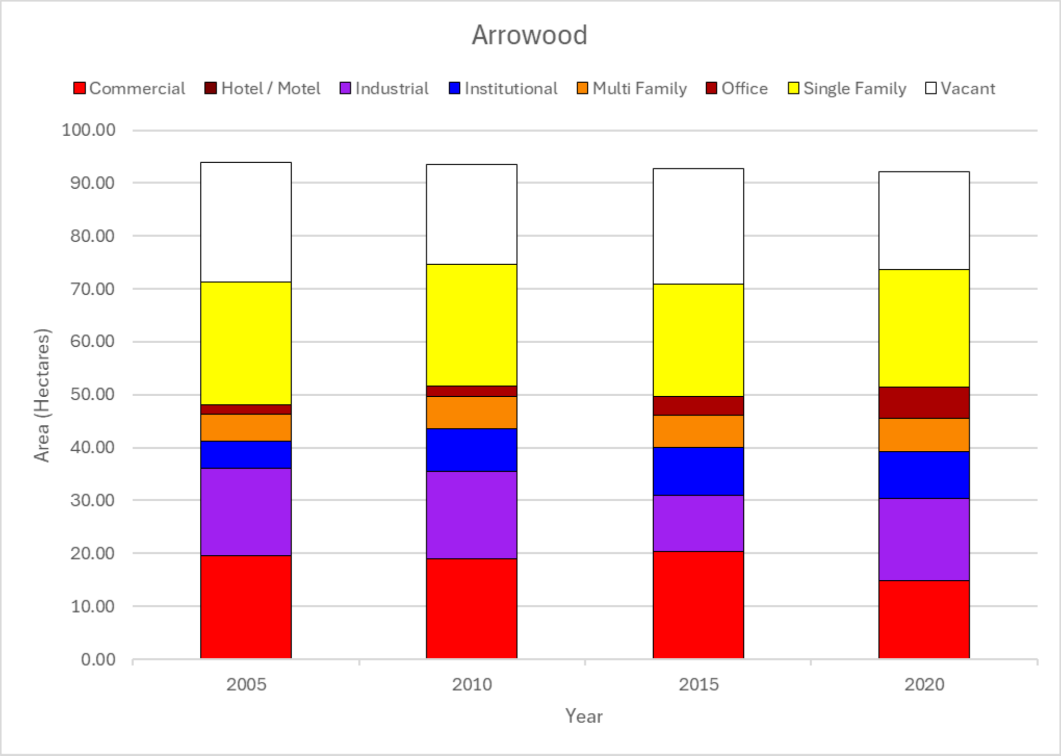
Land Use Change by Station Area and Land Use Type – 2005 to 2020

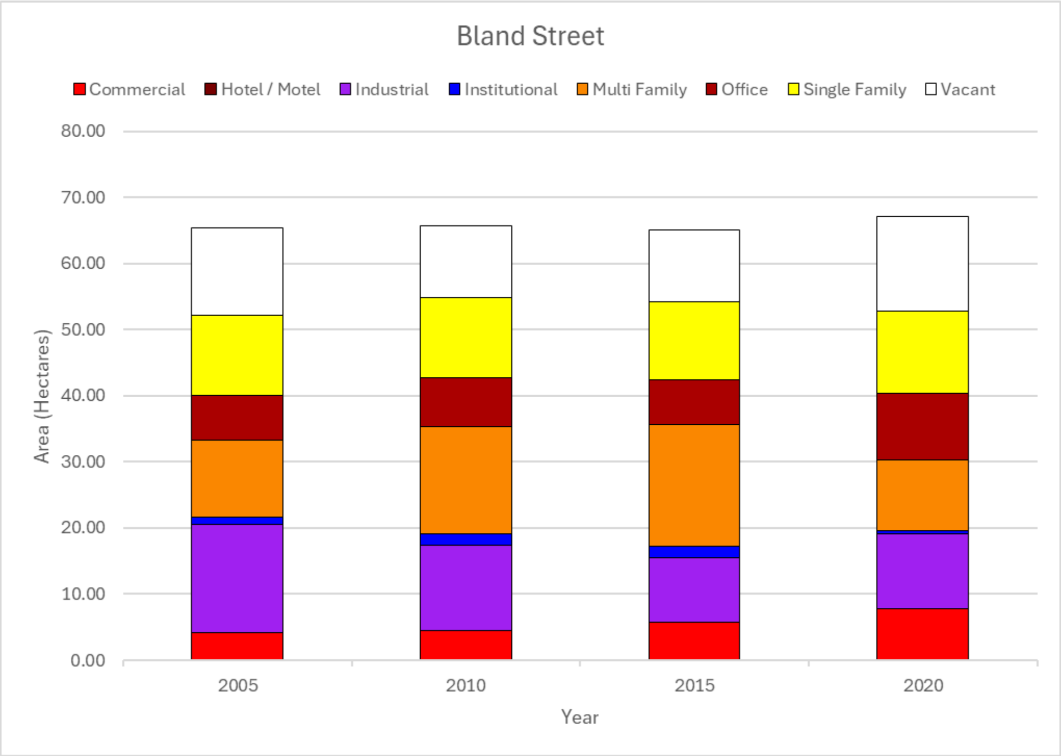
Station Area	Land Use	Commercial	Hotel / Motel	Industrial	Institutional	Multi Family	Office	Single Family	Vacant
Archdale	Area Change	0.82	0.00	1.52	0.05	0.32	-4.00	-0.28	1.52
	% Change	5%		16%	1%	2%	-66%	0%	12%
Arrowood	Area Change	-4.74	0.00	-1.08	3.82	1.20	3.99	-0.71	-4.40
	% Change	-24%		-7%	75%	24%	204%	-3%	-19%
Bland St	Area Change	3.55	0.00	-4.98	-0.67	-0.74	3.10	0.24	1.27
	% Change	84%		-30%	-60%	-6%	45%	2%	10%
East/West	Area Change	5.72	0.00	-9.24	-0.43	3.28	1.07	-1.74	0.99
	% Change	53%		-39%	-10%	74%	8%	-9%	11%
I-485	Area Change	-1.57	0.00	11.63	-7.14	0.00	-1.39	0.26	-2.38
	% Change	-5%		116%	-55%		-50%	2%	-17%
New Bern	Area Change	3.23	0.00	-14.42	-0.44	8.62	-1.09	1.42	1.68
	% Change	40%		-41%	-12%	47%	-18%	7%	18%
Scaleybark	Area Change	0.97	0.00	-16.84	0.52	-6.44	3.47	-0.33	15.48
	% Change	9%		-30%	27%	-64%	94%	-1%	157%
Sharon Rd	Area Change	3.11	0.00	-10.07	1.78	1.07	5.07	-1.40	0.04
	% Change	335%		-21%	18677%	8%	282%	-30%	0%
Tyvola	Area Change	-2.50	0.00	-0.15	1.82	-0.05	3.39	0.00	-2.82
	% Change	-11%		-1%	121%	0%	19%	0%	-18%
Woodlawn	Area Change	-2.63	0.54	0.82	-1.13	0.00	1.12	-0.56	1.37
	% Change	-10%	15%	3%	-16%		7%	-20%	9%
Total	Area Change	5.96	0.54	-42.81	-1.80	7.26	14.72	-3.09	12.75
	% Change	1%	6%	-7%	-1%	0%	4%	-1%	7%

Land Use area change in Hectares.

Appendix I: Charlotte Land Use Charts






Bland Street
Commercial
Hotel / Motel
Industrial
Institutional
Multi Family
Office
Single Family
Vacant
80.00
70.00
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50.00
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20.00
10.00
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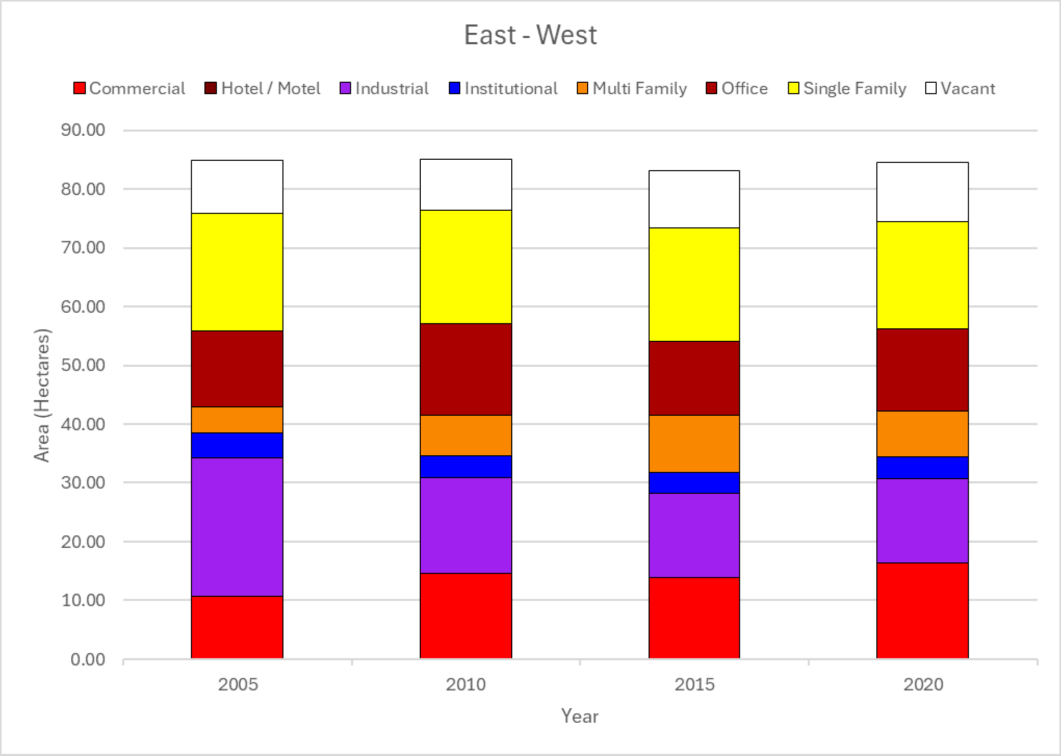
Area (Hectares)
2005
2010
2015
2020
Year


East - West
Commercial
Hotel / Motel
Industrial
Institutional
Multi Family
Office
Single Family
Vacant
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80.00
70.00
60.00
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30.00
20.00
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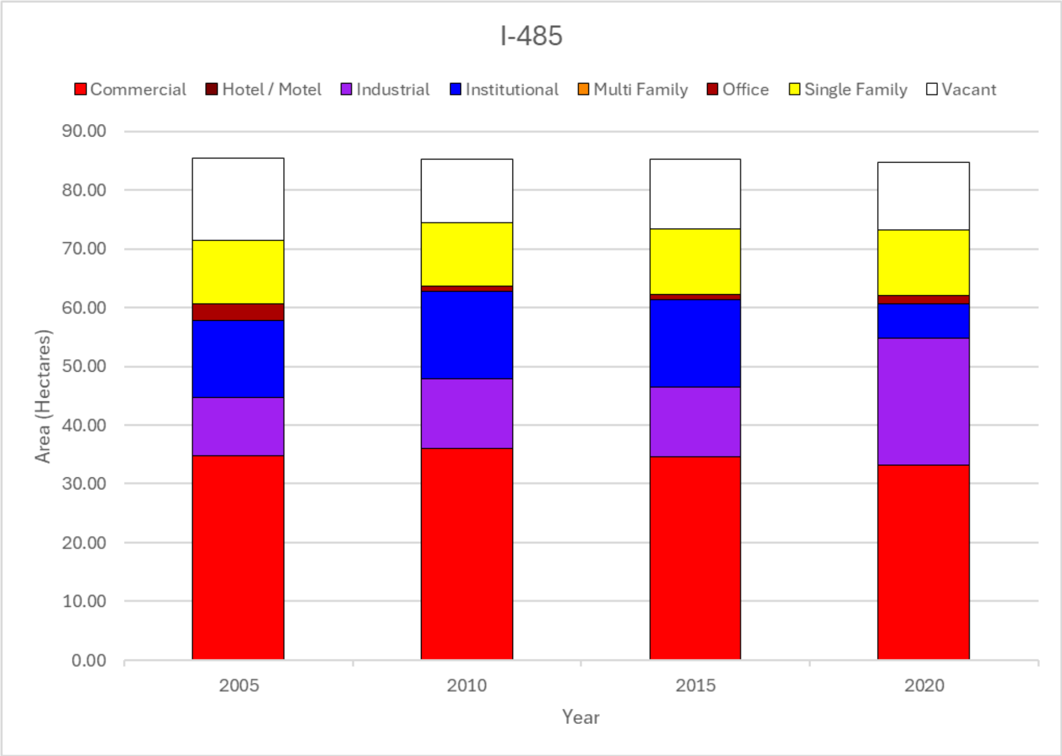
Area (Hectares)
2005
2010
2015
2020
Year


I-485
Commercial
Hotel / Motel
Industrial
Institutional
Multi Family
Office
Single Family
Vacant
90.00
80.00
70.00
60.00
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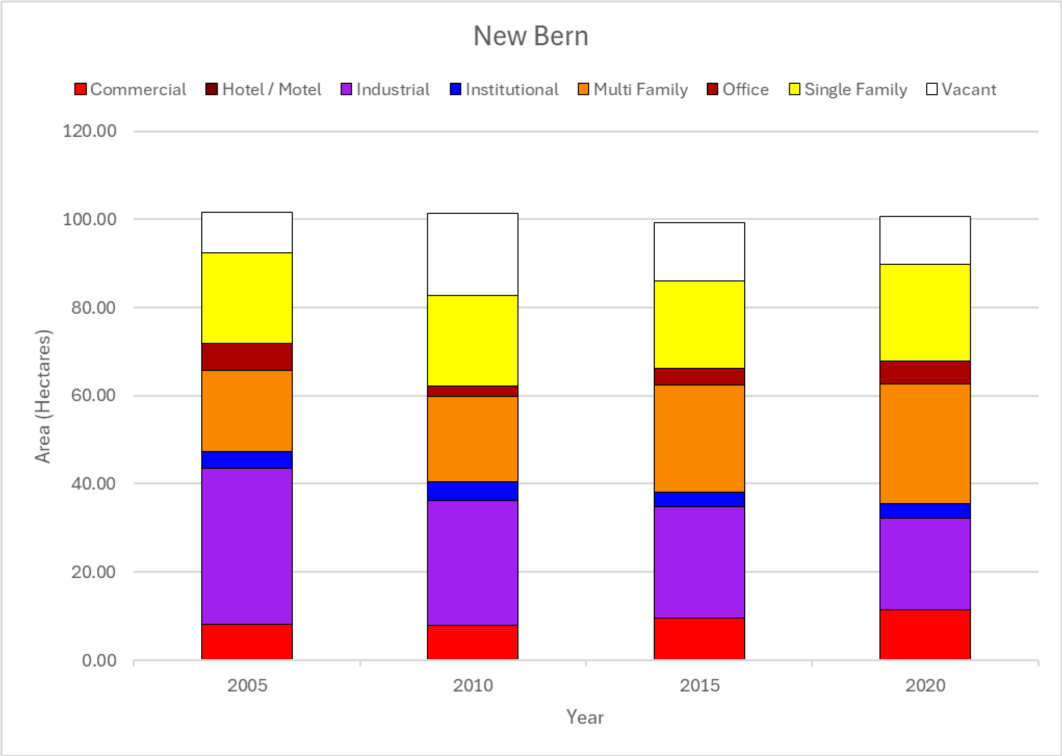
Area (Hectares)
2005
2010
2015
2020
Year


New Bern
Commercial
Hotel / Motel
Industrial
Institutional
Multi Family
Office
Single Family
Vacant
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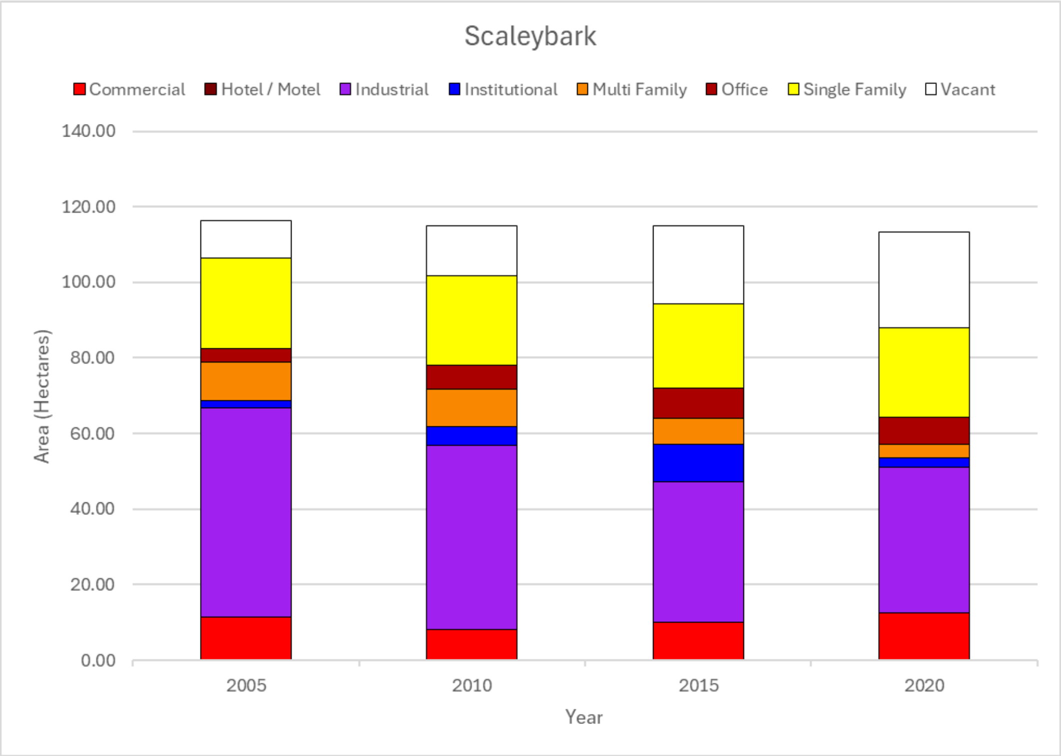
80.00
60.00
40.00
20.00
0.00
Area (Hectares)
2005
2010
2015
2020
Year


Scaleybark
Commercial
Hotel / Motel
Industrial
Institutional
Multi Family
Office
Single Family
Vacant
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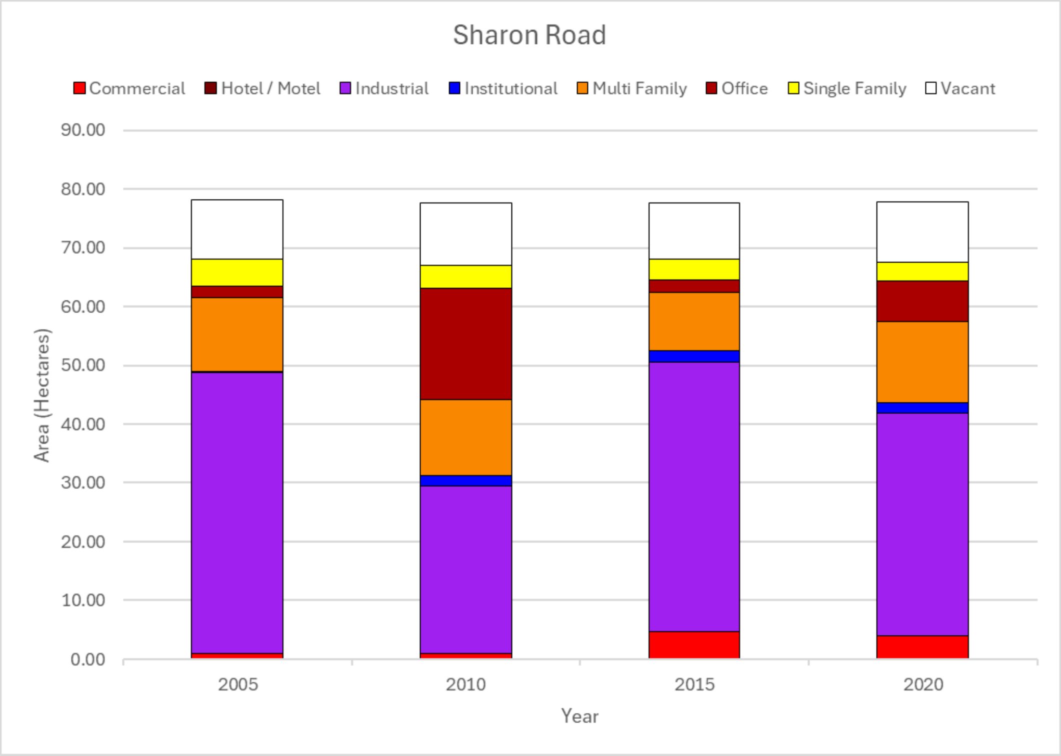
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Area (Hectares)
2005
2010
2015
2020
Year


Sharon Road
Commercial
Hotel / Motel
Industrial
Institutional
Multi Family
Office
Single Family
Vacant
90.00
80.00
70.00
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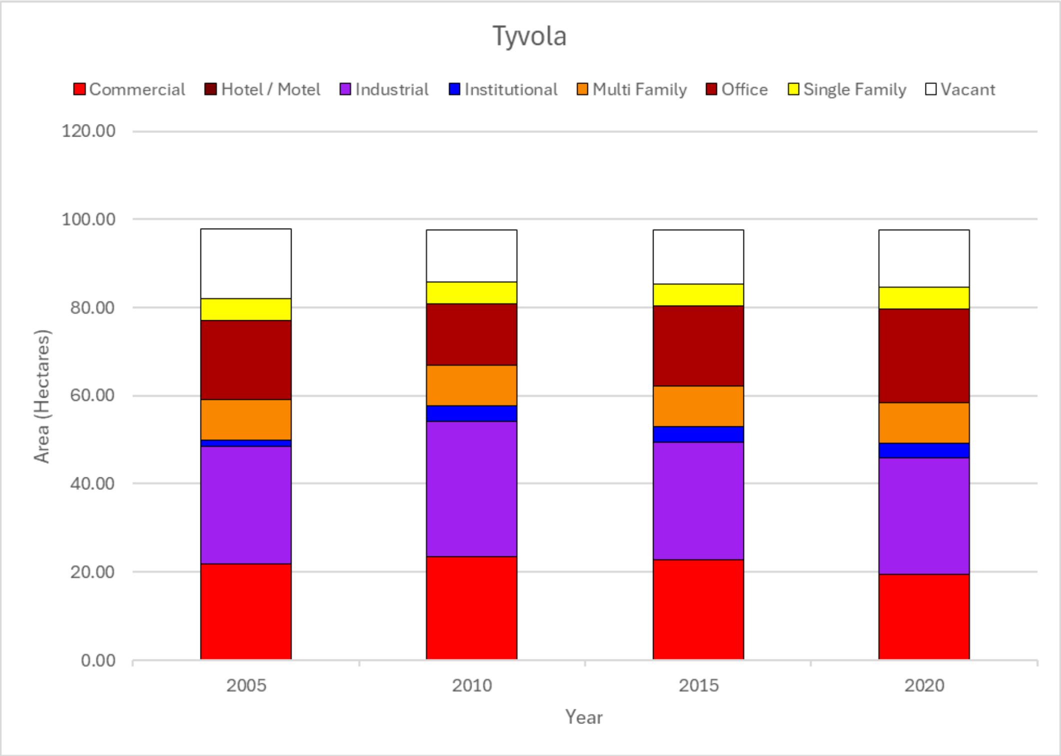
50.00
40.00
30.00
20.00
10.00
0.00
Area (Hectares)
2005
2010
2015
2020
Year



Tyvola
Commercial
Hotel / Motel
Industrial
Institutional
Multi Family
Office
Single Family
Vacant
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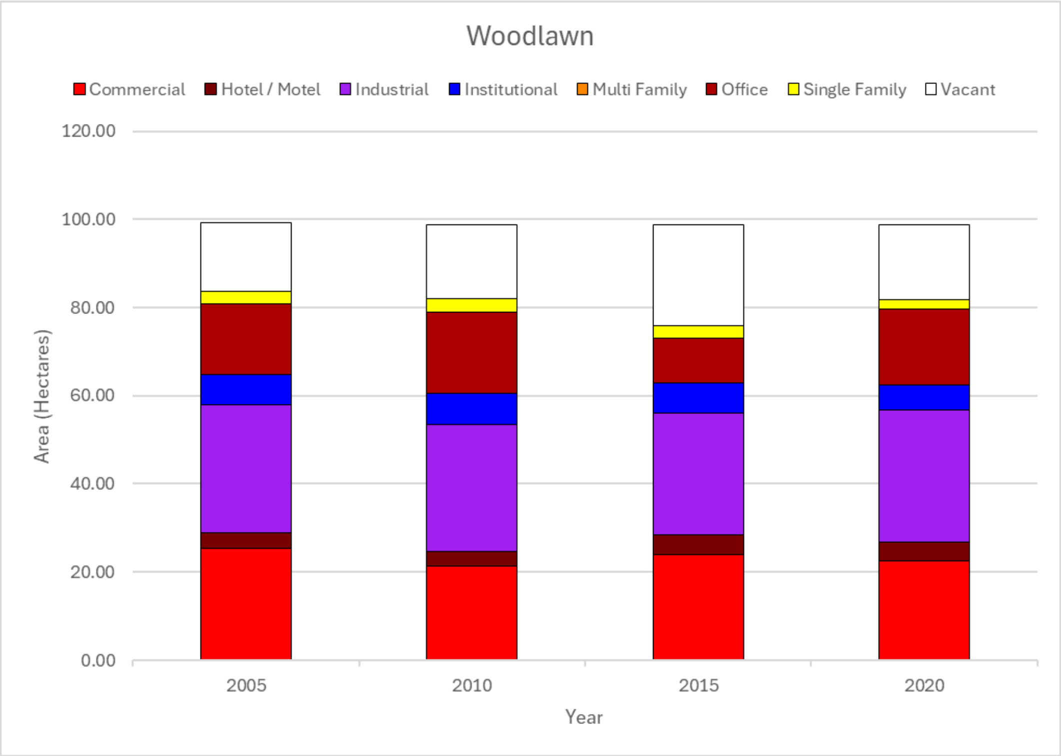
80.00
60.00
40.00
20.00
0.00
Area (Hectares)
2005
2010
2015
2020
Year



Woodlawn
Commercial
Hotel / Motel
Industrial
Institutional
Multi Family
Office
Single Family
Vacant
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Area (Hectares)
2005
2010
2015
2020
Year

Appendix J: Austin Land Use Tables

Land Use by Station Area – 2006

Land Use	Crestview	Highland	Howard	Kramer	Lakeline	MLK Jr	Plaza Saltillo	Total
Commercial	22.04	39.23	6.02	14.52	0.00	4.69	8.98	113.70
Mixed Use	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.16
Industrial	24.62	5.94	32.70	48.72	0.00	4.14	16.66	139.56
Institutional	0.08	6.60	0.00	0.53	0.00	4.50	19.26	43.55
Multi Family	9.36	1.01	2.90	0.00	0.00	1.47	6.33	24.40
Office	2.29	11.99	1.59	4.39	0.00	1.37	7.65	49.39
Parks	6.75	6.38	0.00	3.53	0.00	1.34	2.17	27.84
Single Family	34.59	25.03	0.14	0.00	1.81	38.13	34.03	139.70
Vacant	2.46	2.34	11.30	18.57	12.66	22.98	8.84	83.88

Land Use area in Hectares.

Land Use by Station Area - 2010

Land Use	Crestview	Highland	Howard	Kramer	Lakeline	MLK Jr	Plaza Saltillo	Total
Commercial	20.81	38.04	6.02	8.19	3.42	4.73	9.07	106.83
Mixed Use	0.00	0.00	0.00	0.00	0.00	0.00	2.20	6.56
Industrial	30.12	7.16	32.70	48.85	0.00	4.15	17.06	145.77
Institutional	0.08	6.61	0.71	0.53	0.00	4.50	19.25	43.87
Multi Family	9.30	1.00	2.90	0.00	0.00	4.61	4.55	25.83
Office	2.22	11.97	1.60	9.95	0.00	1.37	7.83	54.35
Parks	4.89	5.35	0.00	4.44	0.00	6.48	2.17	30.85
Single Family	34.38	25.04	0.14	0.00	2.11	41.08	34.30	143.12
Vacant	1.53	1.76	14.11	16.04	9.32	10.82	7.52	64.90

Land Use area in Hectares.

Land Use by Station Area – 2018

Land Use	Crestview	Highland	Howard	Kramer	Lakeline	MLK Jr	Plaza Saltillo	Total
Commercial	21.41	38.01	6.08	14.97	4.04	2.58	10.68	116.30
Mixed Use	3.39	0.00	0.00	0.00	0.00	7.58	2.19	17.87
Industrial	9.36	7.51	32.76	48.84	0.89	4.15	16.12	125.11
Institutional	0.42	6.62	0.84	3.47	0.00	4.50	18.89	45.01
Multi Family	11.03	1.19	5.89	0.00	1.59	6.84	5.87	36.52
Office	2.00	11.99	1.59	13.16	0.16	1.50	8.51	57.66
Parks	6.52	6.21	0.00	4.64	0.45	5.85	2.16	33.35
Single Family	40.80	25.02	0.00	0.00	1.98	40.83	34.22	148.05
Vacant	4.67	0.81	7.25	4.11	4.63	3.58	5.57	32.81

Land Use area in Hectares.

Land Use by Station Area – 2021

Land Use	Crestview	Highland	Howard	Kramer	Lakeline	MLK Jr	Plaza Saltillo	Total
Commercial	21.50	38.01	6.08	14.97	4.04	2.58	10.47	116.89
Mixed Use	3.39	0.00	0.00	0.00	0.00	5.88	6.31	21.05
Industrial	9.25	7.18	32.76	48.84	0.89	4.15	13.54	122.22
Institutional	0.42	6.62	0.84	3.47	0.00	4.50	18.89	46.93
Multi Family	12.93	1.10	5.89	0.00	1.59	8.54	5.12	38.52
Office	2.18	11.99	1.59	13.61	0.16	1.50	8.53	58.15
Parks / Open Space	7.26	5.30	0.00	5.01	0.45	7.80	2.17	35.49
Single Family	40.70	24.98	0.00	0.00	1.98	41.22	33.61	147.70
Vacant	1.91	1.80	7.25	3.29	4.63	1.25	5.25	27.60

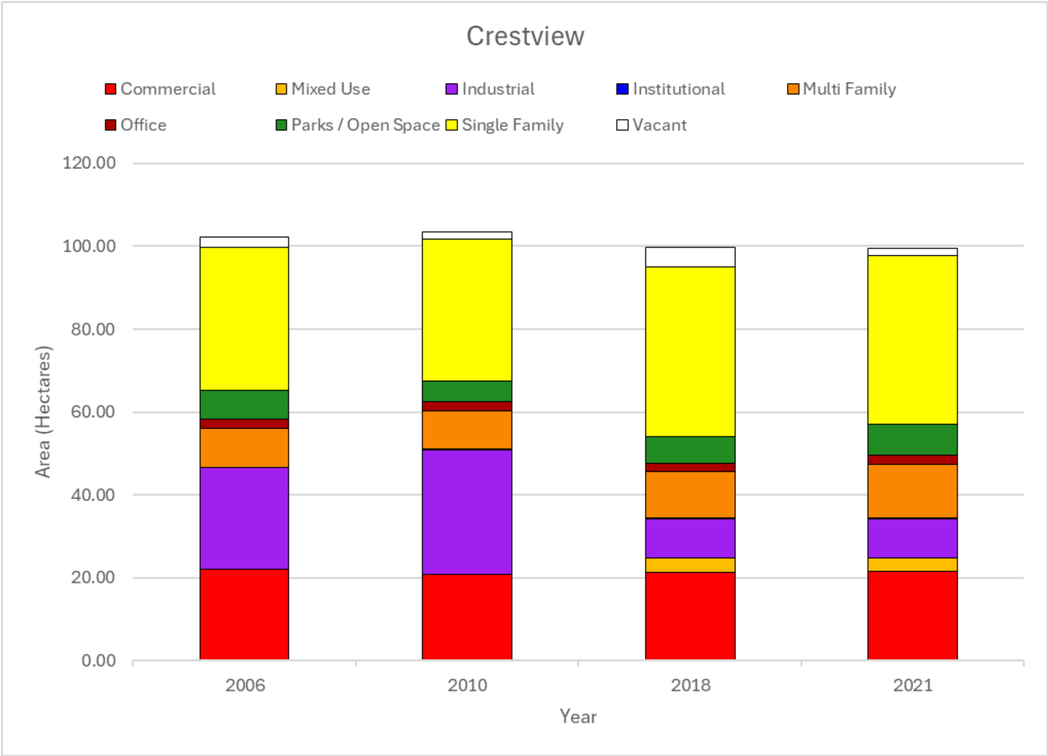
Land Use area in Hectares.

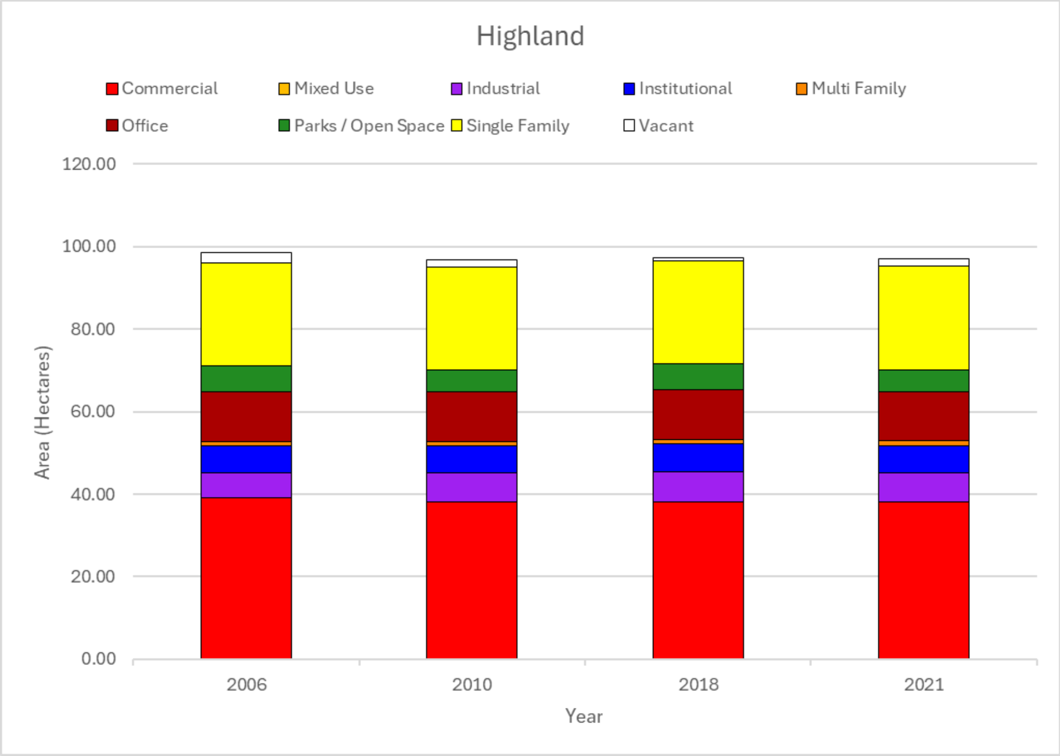
Land Use Change by Station Area and Land Use Type – 2006 to 2021

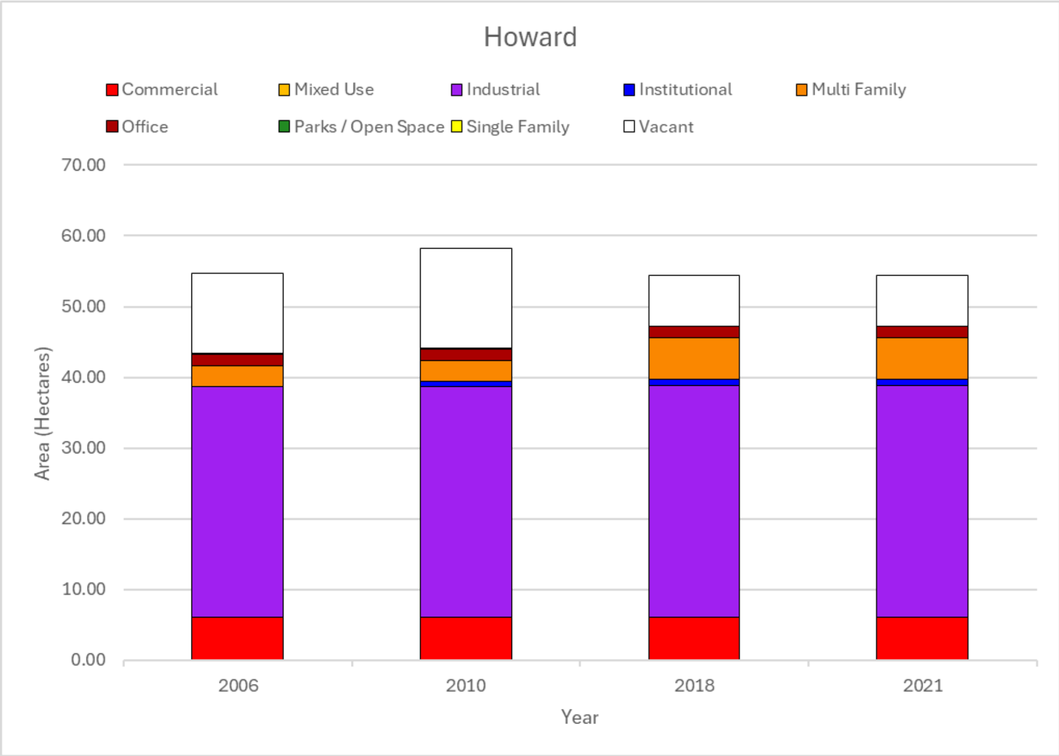
Station	Land Use	Commercial	Mixed Use	Industrial	Institutional	Multi Family	Office	Parks	Single Family	Vacant
Crestview	Area Change	-0.55	3.39	-15.37	0.34	3.57	-0.11	0.51	6.11	-0.55
	% Change	-2%		-62%	437%	38%	-5%	8%	18%	-22%
Highland	Area Change	-1.23	0.00	1.24	0.02	0.10	0.00	-1.08	-0.05	-0.54
	% Change	-3%		21%	0%	9%	0%	-17%	0%	-23%
Howard	Area Change	0.07	0.00	0.06	0.84	2.99	0.00	0.00	-0.14	-4.05
	% Change	1%		0%		103%	0%		-100%	-36%
Kramer	Area Change	0.45	0.00	0.13	2.95	0.00	9.21	1.48	0.00	-15.28
	% Change	3%		0%	559%		210%	42%		-82%
Lakeline	Area Change	4.04	0.00	0.89	0.00	1.59	0.16	0.45	0.17	-8.03
	% Change								9%	-63%
MLK Jr	Area Change	-2.11	5.72	0.01	0.01	7.06	0.13	6.46	3.09	-21.74
	% Change	-45%	3498%	0%	0%	479%	9%	483%	8%	-95%
Plaza Saltillo	Area Change	1.49	6.31	-3.12	-0.37	-1.21	0.88	0.00	-0.42	-3.59
	% Change	1%	3862%	-2%	-1%	-5%	2%	0%	0%	-4%
Total	Area Change	2.17	15.42	-16.16	3.78	14.10	10.27	7.82	8.76	-53.78
	% Change	2%	9433%	-12%	9%	58%	21%	28%	6%	-64%

Land Use area change in Hectares.

Appendix K: Austin Land Use Charts






Howard
Commercial
Mixed Use
Industrial
Institutional
Multi Family
Office
Parks / Open Space
Single Family
Vacant
70.00
60.00
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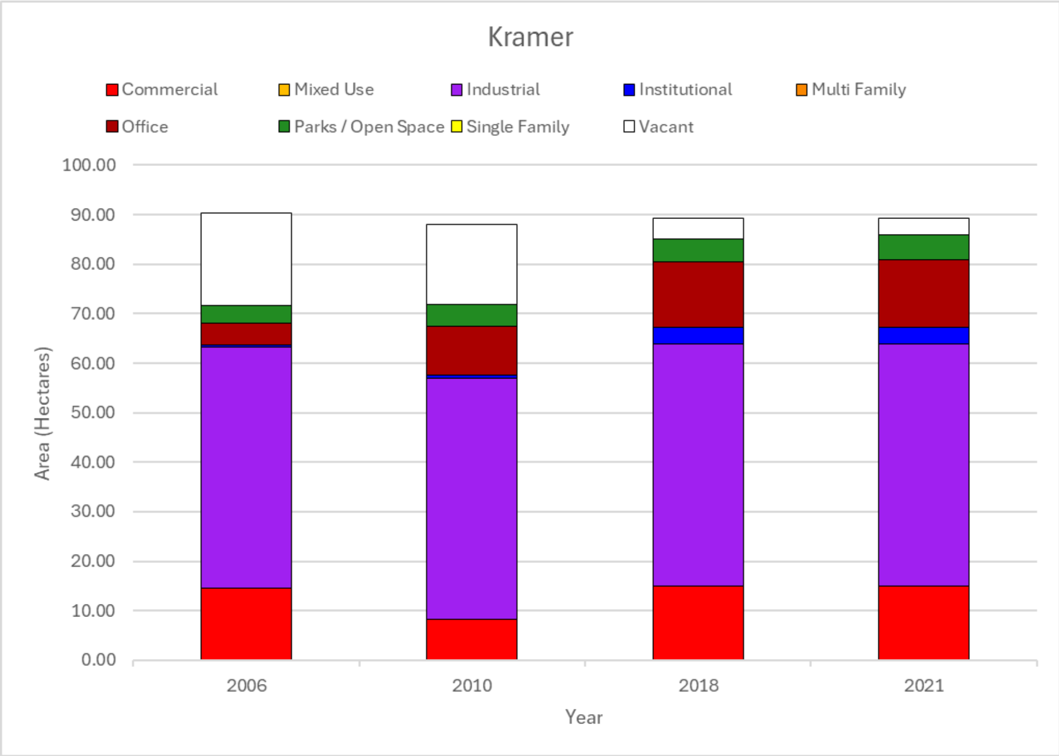
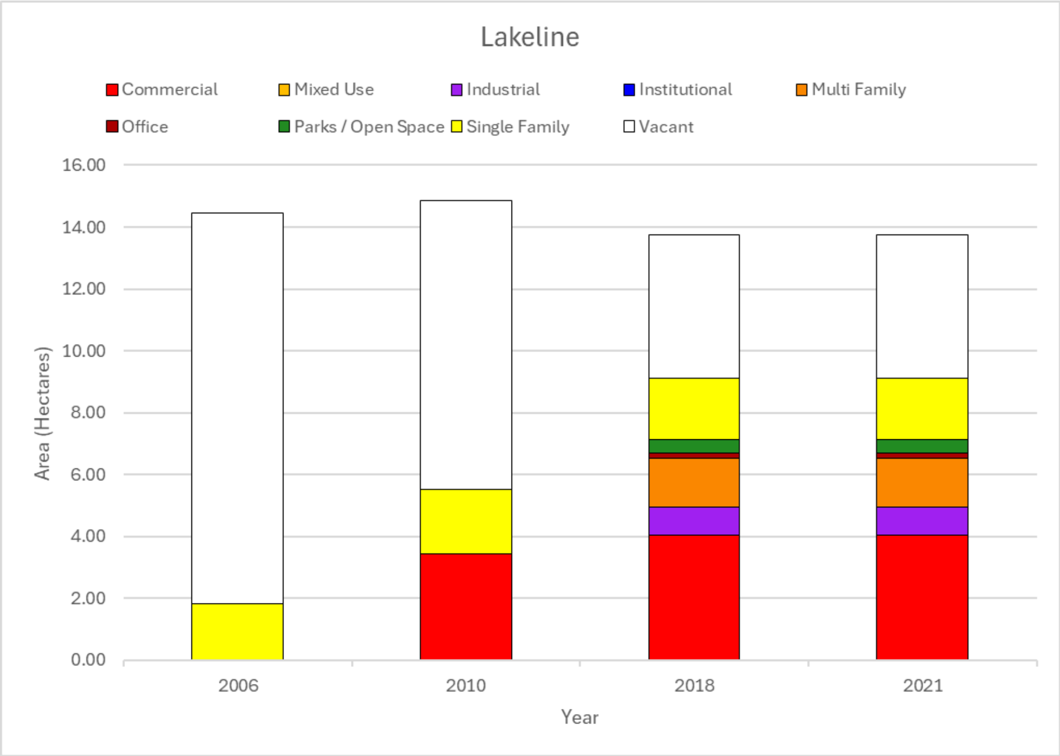
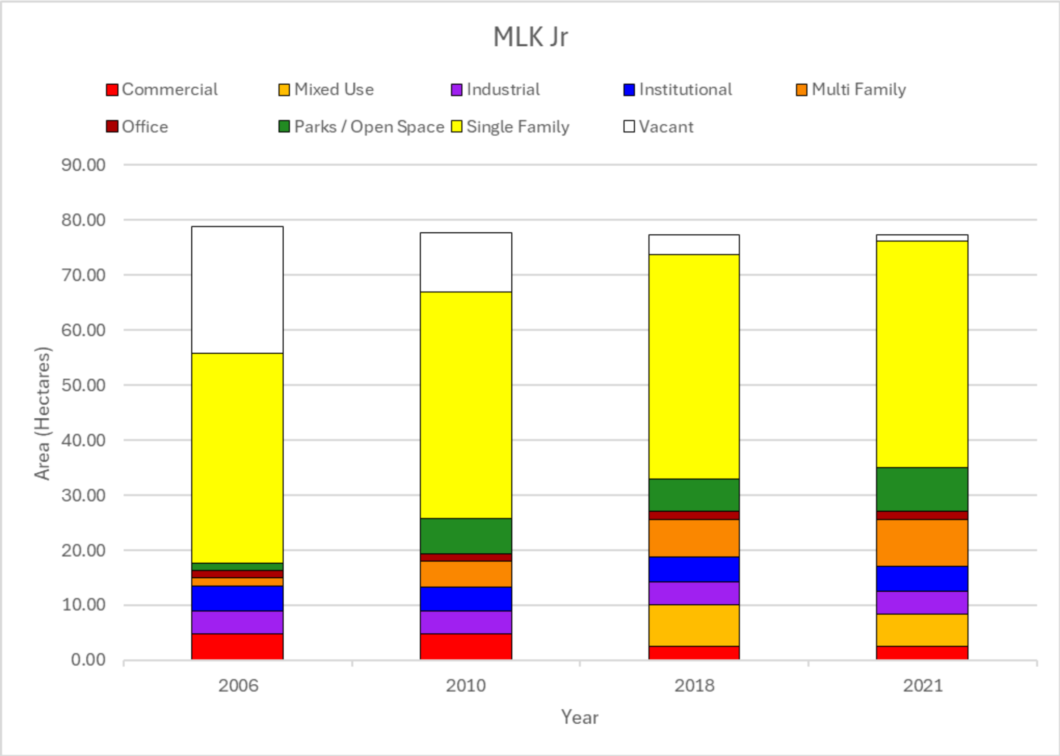
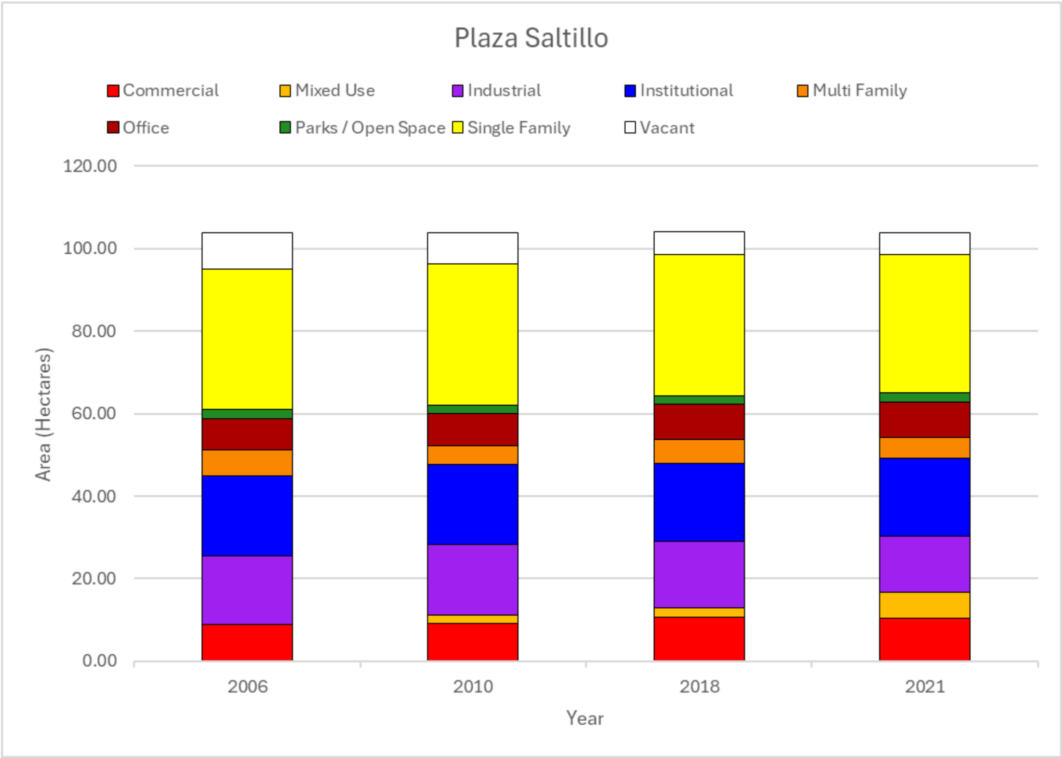
40.00
30.00
20.00
10.00
0.00
Area (Hectares)
2006
2010
2018
2021
Year


Kramer
Commercial
Mixed Use
Industrial
Institutional
Multi Family
Office
Parks / Open Space
Single Family
Vacant
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Area (Hectares)
2006
2010
2018
2021
Year


Lakeline
Commercial
Mixed Use
Industrial
Institutional
Multi Family
Office
Parks / Open Space
Single Family
Vacant
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Area (Hectares)
2006
2010
2018
2021
Year


MLK Jr
Commercial
Mixed Use
Industrial
Institutional
Multi Family
Office
Parks / Open Space
Single Family
Vacant
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Area (Hectares)
2006
2010
2018
2021
Year


Plaza Saltillo
Commercial
Mixed Use
Industrial
Institutional
Multi Family
Office
Parks / Open Space
Single Family
Vacant
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Area (Hectares)
2006
2010
2018
2021
Year