

ALTERNATIVE LAND USE FUTURES

METROPOLITAN ATLANTA 2025

CP 6052 - Regional Land Use Studio
City and Regional Planning Program
College of Architecture
Georgia Institute of Technology
Fall 2002

Supported by
Center for Quality Growth and Regional Development

ALTERNATIVE LAND USE FUTURES

METROPOLITAN ATLANTA 2025

CP 6052 - Regional Land Use Studio
City and Regional Planning Program
College of Architecture
Georgia Institute of Technology
Fall 2002

Professor
Dr. Steven P. French, Ph.D., AICP

Teaching Assistant
Sugie Lee

Students
Sandeep Bashyal
Chip Burger
David Cassell
Mausam Duggal
Jamee Holt
Jean Hee Park

Supported by
Center for Quality Growth and Regional Development

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

FIGURES

TABLES

PHOTO CREDITS

Lake Lanier (*Cover* and *Greener Way to Grow*): http://www.martinsweb.com/images/lanier.jpg
MARTA Train (*Cover* and *Concentrating on Corridors*): David L. Cassell
Midtown (*Cover* and *Centered on Centers*): Jan Osburg. http://www.irs.uni-stuttgart.de/JO/site/photos/1995_Piedmont_Park.jpg
Atlanta Skyline (*Introduction*): Kevin C. Rose
Forest (*Greener Way to Grow*): University of Connecticut Department of Natural Resources Management and Engineering. http://www.canr.uconn.edu/nrme/programs/forest/images/forest.jpg
Farmland (*Greener Way to Grow*): Georgia Farm Bureau http://www.gfb.org/legis/farmland.jpg
Lake (*Greener Way to Grow*): Clean Water Initiative http://www.cleanwaterinitiative.com/default.htm
Lindbergh Station (*Concentrating on Corridors*): MARTA http://www.itsmarta.com
Roadway (*Concentrating on Corridors* and *Transportation Impacts*): Northern Sub Area Study Photo Gallery http://www.ga400nsas.com
Lenox Square Mall (*Centered on Centers*): Michael Rose. Atlanta Then and Now. San Diego: Thunder Bay Press. 2001.
King and Queen (*Centered on Centers*): Northern Sub Area Study Photo Gallery http://www.ga400nsas.com
Peachtree & 8th Street (*Centered on Centers*): Photo by Jean Hee Park
People (*Demographic Impacts*): http://www.nylovesbiz.com/Workforce_and_Demographics/default.htm
Centennial Olympic Park (*Demographic Impacts*): Kevin C. Rose (1998)
Chattahoochee River (*Environmental Impacts*): National Park Service http://www.nps.gov/chat/
Forest and House (*Environmental Impacts*): Mountain Visions for the Boise National Forest http://www.mtnvisions.com/TrCrFire/SmStatn.html
Blue Ridge Forest (*Environmental Impacts)*: Blue Ridge Environmental Defense League National Forests http://www.bredl.org/nat_forests/
C-Tran Bus (*Transportation Impacts*): Clayton County Transit-GRTA http://www.grta.org
Skyline (*Conclusion*): Michael Rose. Atlanta Then and Now. San Diego: Thunder Bay Press. 2001.

FOREWARD

The purpose of this graduate planning studio was to inform the ongoing regional discussion of possible land use futures for the Atlanta region. This project is intended to help citizens and decision makers understand the scope and type of the land use changes needed to accommodate likely future growth. This project is designed to reinforce other similar efforts that are looking at regional land use issues, such as the Georgia Regional Transportation Authority's Northern Subarea Study and the Metropolitan Atlanta Chamber of Commerce's Regional Land Use Vision. Hopefully, the Atlanta Regional Commission will be able to draw from all of these efforts as it prepares the 2030 Regional Development Plan and Regional Transportation Plan.

The purpose of this project was not to produce an ideal or optimal plan, but to construct and test a series of distinct alternatives. While the project was careful to use officially prepared population and employment estimates and the best available information on existing land use, students were explicitly instructed not to consider the political feasibility of implementing their alternatives. The alternatives are best thought of as a series of "If… Then" propositions. They are meant to help us understand how an additional 1.1 million residents could be accommodated and what the consequences of the alternative patterns would be.

The students and I would like to thank Dr. Thomas Galloway, Dean of the College of Architecture and Dr. Cheryl Contant, Director of the City and Regional Planning Program and the Center for Quality Growth and Regional Development for their support of this project. Without that support this project would not have been possible. We would also like to thank Dan Reuter of the Atlanta Regional Commission, Kevin Green of the Metropolitan Atlanta Chamber of Commerce and Eric Meyer of the Regional Business Coalition for their helpful comments during the course of the project. The conclusions and any errors or shortcomings of the project remain our own.

Steven P. French, Professor
February 2003

INTRODUCTION

During the 1990's, the Atlanta metropolitan region expanded faster than any other urbanized area in history in terms of geographic growth, even eclipsing the growth of Rome centuries ago. In fact, estimates show that the Atlanta metropolitan region grew from 68 miles north to south in 1990, to 121 miles in 1997. It is this kind of explosive growth that has earned Atlanta's designation as the nation's posterchild for sprawl.

In light of this growth, and anticipated growth in the range of another 1.1 million residents by 2025, there is a recognized need to change the pattern of growth in the metropolitan region. Until the Georgia Regional Transportation Authority (GRTA) was created in 1999, the primary regional body with the most impact on local land use plans was the Atlanta Regional Commission (ARC). While the ARC provides input to local plans on how they can be changed to incorporate regional interests, this input is largely advisory. Not surprisingly, the result has been local land use plans that encourage growth increasing the local tax base and maintaining the low-density character cherished by Atlanta suburban communities. While there is nothing wrong with this type of growth in itself, with low-density development being the focal point of nearly all local plans, the cumulative impacts are a severe reduction in open space, leapfrog development patterns that only accommodate the automobile, and inefficiencies in the provision of infrastructure. Taken on a regional scale, these and other impacts of sprawl result in increased congestion and vehicle miles traveled, degraded air and water quality, and an exacerbated heat island effect.

However, land use planning is beginning to change in the region. The ARC has developed the Livable Centers Initiative (LCI); a program that encourages more compact development, infrastructure investment in defined city and regional centers, and supports alternative modes of transportation. Additionally, the ARC through cooperation with the regional community has developed a Regional Development Plan (RDP) that posits a series of smart growth land use policies for the region.

While there are movements afoot that consider a new regional land use perspective more so than in previous years, the effect of different regional land use patterns are still not well understood. The focus of this graduate planning studio is to come up with scenarios representing different regional growth patterns and understand their effects. This studio does not seek to find which patterns of growth are best, or even preferred, but rather to shed light on alternative growth patterns and their potential effects.

Students in this class developed three alternative scenarios, each with a different guiding theme for growth. One scenario focuses on **environmental protection**, in particular, steering growth away from small water supply watersheds and preserving existing open space. The second scenario constructs a linear development pattern along **transportation corridors** while the

third scenario focuses on nodal development in **activity centers**. Each scenario takes ARC regional population and employment projections for 2025 and apportions the growth according to the criteria set up within that scenario. It is from these types of build-out scenarios that the regional effects of these distinct land use patterns can be understood.

It is important to realize that the students in this studio did not face the political or fiscal constraints that local planners or elected officials experience when making land use decisions. Students were encouraged to explore land use patterns regardless of their political limitations. Thus, these scenarios are not meant to be preferred land use patterns nor recommendations for growth. Rather, they serve as a tool to aid regional land use decision-making.

Just as important as understanding where population and employment will go under each scenario is quantifying the effects of these growth patterns. Several evaluation criteria have been developed addressing environmental performance, transportation equity and land use. In short, the evaluation criteria address the issues embedded in the quality of life. As mentioned earlier, the purpose of these evaluative measures is to help decision makers and planners better understand the effects of these different land use scenarios.

For decades, the Atlanta metropolitan region has initially planned for land use at the local level and then considered the regional effects of land use patterns. This studio seeks to supplement this local planning perspective by providing local planners, the development community, elected officials and citizens a unique perspective on regional growth patterns. What happens when the region focuses on environmental protection, or linear development? Where would people live under these scenarios, where would employment go, and how would watersheds fair? What kind of densities would be required to accommodate growth in activity centers? These are a few of the questions that will be addressed in the following chapters. The lessons learned from this studio will potentially inform the policy debate on land use planning at the local and regional level, and enhance the quality of life throughout metropolitan Atlanta.

Population and Employment

While there are many sources of population and employment data that could be used for this studio, the CP 6052 Planning Studio elected to use the Atlanta Regional Commission (ARC) forecasts. The ARC is the metropolitan planning organization for Atlanta and has been analyzing demographic data in the region for several decades. An important factor in electing to use these estimates over others is that the product of this studio is meant to be used to aid in land use decisions. Therefore, data is needed that is sensitive to the unique conditions and issues of this region. However, the ARC's projections are not void of controversy according to an Atlanta-Journal Constitution article.[1] The article makes the case that these projections may be low, evidenced by discrepancies between ARC 2000 population estimates and Census 2000 results; the ARC projection was lower than the Census result by more than 300,000 people. This introductory section discusses three items that were central to each of the three growth pattern scenarios: population data, employment data and land supply data.

Population: Historic and Current Conditions

In 1970, the Atlanta metropolitan region was home to 1.5 million inhabitants. By 2000, the population had more than doubled to over 3.6 million residents, largely due to a strong economy and a political climate in the region that embraced growth. Growth rates were fairly constant during each decade at 26.3 percent from 1970 to 1980, 23.6 percent from 1980 to 1990 and 39 percent from 1990 to 2000. In the 1990's alone, more than 1 million new residents were added to the region.

Table 1: Census Population by County, 1990 to 2000

County	Year		Absolute Change	Percent Change
	1990	2000	'90 - '00	'90 - '00
Fulton	648,951	816,006	167,055	26%
DeKalb	545,837	665,865	120,028	22%
Gwinnett	352,910	588,448	235,538	67%
Cobb	447,745	607,751	160,006	36%
Clayton	182,052	236,517	54,465	30%
Cherokee	90,204	141,903	51,699	57%
Henry	58,741	119,341	60,600	103%
Douglas	71,120	92,174	21,054	30%
Fayette	62,415	91,263	28,848	46%
Paulding	41,611	81,678	40,067	96%
Rockdale	54,091	70,111	16,020	30%
Forsyth	44,083	98,407	54,324	123%
Coweta	53,853	89,215	35,362	66%
13 Counties	**2,653,613**	**3,698,679**	**1,045,066**	**39%**

Table 1 shows this exceptional growth broken down for each of the 13 counties in the region. The two fastest growing counties were Henry and Forsyth counties which more than doubled. Each of these counties were also among the fastest growing counties in the country. The four largest counties in the region are still Fulton, DeKalb, Cobb and Gwinnett, which combined accounted for 72 percent of the region's population in 2000.

[1] Feagans, Brian. "Gwinnett's gain." Atlanta Journal-Constitution. 11 Oct. 2002: D1.

In total, the 13 county region grew by 39 percent during the 1990's, making it the fastest growing region in the country outpacing metro areas such as Houston at 26 percent and Chicago at 13 percent.

Employment: Historic and Current Conditions

In addition to attracting significant population growth, the Atlanta region has also grown extensively in terms of employment. In the past decade, more than 500,000 jobs were added, an increase of 33 percent. Employment growth is shown by county in **Table 2**. As was the case with population growth in the 1990's, the two counties with the largest increases in employment are also Forsyth County and Henry County. In terms of absolute growth, Fulton and Gwinnett saw the largest increases in employees. As would be expected, Fulton County harbors the most employment; in 2000, Fulton accounted for 35 percent of the region's total employment. Another 46 percent of the region's employment can be found in DeKalb, Gwinnett and Cobb counties. An important reality that **Table 2** shows is that northern counties in the Atlanta metro region account for over ¾ of the region's total employment in 2000.

Table 2: Census Employment by County, 1990 to 2000

County	Year		Absolute Change	Percent Change
	1990	2000	'90 - '00	'90 - '00
Fulton	560,600	731,400	170,800	30%
DeKalb	318,300	346,900	28,600	9%
Gwinnett	152,000	292,250	140,250	92%
Cobb	200,300	313,800	113,500	57%
Clayton	106,600	135,950	29,350	28%
Cherokee	16,000	35,950	19,950	125%
Henry	13,600	32,800	19,200	141%
Douglas	19,800	33,350	13,550	68%
Fayette	16,300	35,000	18,700	115%
Paulding	5,700	12,500	6,800	119%
Rockdale	22,500	34,600	12,100	54%
Forsyth	11,400	35,350	23,950	210%
Coweta	17,800	27,550	9,750	55%
13 Counties	**1,460,900**	**2,067,400**	**606,500**	**42%**

Table 3: ARC Population Forecast by County, 2000 to 2025

County	Year				Absolute Change	Percent Change
	2000	2010	2020	2025	'00 - '25	'00 - '25
Fulton	816,006	873,068	942,276	986,898	170,892	21%
DeKalb	665,865	672,811	734,649	777,383	111,518	17%
Gwinnett	588,448	643,403	710,733	749,254	160,806	27%
Cobb	607,751	612,647	660,603	690,462	82,711	14%
Clayton	236,517	234,829	253,983	263,035	26,518	11%
Cherokee	141,903	176,276	220,495	243,344	101,441	71%
Henry	119,341	191,567	226,870	241,431	122,090	102%
Douglas	92,174	138,542	159,667	166,914	74,740	81%
Fayette	91,263	119,737	141,155	150,936	59,673	65%
Paulding	81,678	111,374	139,815	158,937	77,259	95%
Rockdale	70,111	99,444	120,751	133,277	63,166	90%
Forsyth	98,407	105,107	126,118	133,043	34,636	35%
Coweta	89,215	97,946	112,646	118,686	29,471	33%
13 Counties	3,698,679	4,076,751	4,549,761	4,813,600	**1,114,921**	30%
Growth Rate	**N/A**	**10.2%**	**11.6%**	**5.8%**	**30.1%**	**N/A**

Population Forecast

As stated earlier, this studio has elected to use ARC population and employment forecasts as a basis for allocating future growth in the metro region out to 2025. The ARC forecasts show a significant slowing in growth as can be seen in **Table 3**. This table shows a population growth rate of 30 percent from 2000 to 2025. From 2000 to 2010, the growth rate will be 10.2 percent, while from 2010 to 2020 it will be 11.6 percent. This is a significant decrease from the

1990's when the region's growth rate was 39 percent. **Table 3** also shows how this growth breaks down by county. The highest growth rate percentages, not surprisingly, will be in the outlying counties with Henry, Rockdale and Paulding counties seeing the highest growth rates. Among the top four counties in terms of population, Gwinnett County will see the largest amount of growth at 27 percent making this county as nearly as large as DeKalb. Fulton is still expected to be the most populated county in the region. Interestingly, the big four's (Fulton, DeKalb, Gwinnett and Cobb) share of the region's population is expected to decrease, from 72 percent in 2000, to 66 percent in 2025.

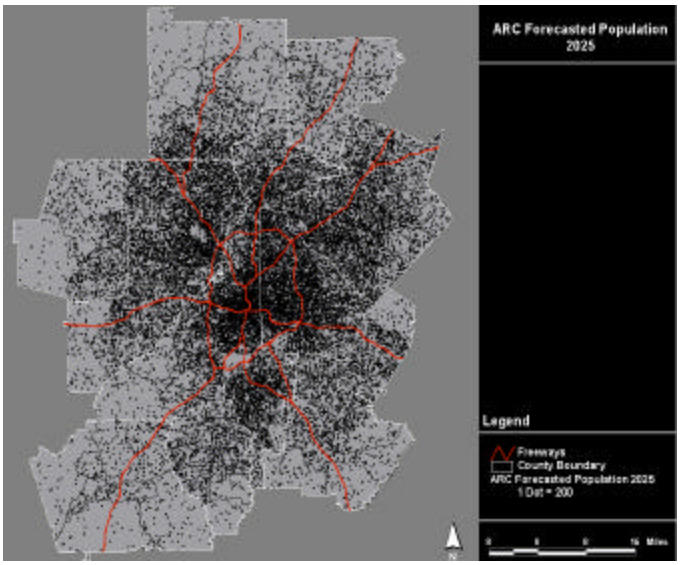
The population distribution is also shown in **Figure I**. Each black dot represents 200 people. The resulting pattern creates an inverse delta in the center of the region. This figure shows that while outlying counties will continue to grow at higher rates than the central counties (Fulton, Cobb, Gwinnett, DeKalb, and Clayton), these outlying counties will not have densities that approach that of central counties.

Employment Forecast

Table 4: ARC Employment Forecast by County, 2000 to 2025

County	Year				Absolute Change	Percent Change
	2000	2010	2020	2025	'00 - '25	'00 - '25
Fulton	731,400	838,067	926,322	967,430	236,030	32%
DeKalb	346,900	370,573	402,782	422,665	75,765	22%
Gwinnett	292,250	344,947	379,610	396,966	104,716	36%
Cobb	313,800	339,216	375,211	397,947	84,147	27%
Clayton	135,950	137,110	155,034	163,246	27,296	20%
Cherokee	35,950	63,268	76,769	84,469	48,519	135%
Henry	32,800	58,960	67,785	71,280	38,480	117%
Douglas	33,350	51,584	56,548	59,182	25,832	77%
Fayette	35,000	49,176	53,964	56,251	21,251	61%
Paulding	12,500	19,296	26,378	30,886	18,386	147%
Rockdale	34,600	51,758	59,632	63,216	28,616	83%
Forsyth	35,350	49,869	54,345	56,692	21,342	60%
Coweta	27,550	36,586	42,037	45,078	17,528	64%
13 Counties	2,067,400	2,410,410	2,676,417	2,815,308	**747,908**	36%
Growth Rate	**N/A**	**16.6%**	**11.0%**	**5.2%**	**36.2%**	**N/A**

Figure I: ARC Population Distribution, 2025

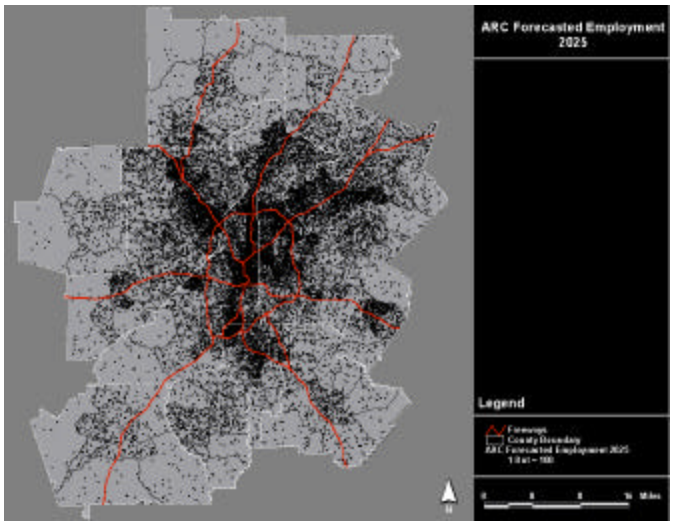


The ARC's employment forecast shown in **Table 4** is quite similar to their population forecast in terms of where growth will occur. The greatest percentage changes are seen in Paulding and Cherokee counties where employment will more than double by 2025. In terms of absolute growth, Fulton will see the largest number of new employees, followed by Gwinnett. Fulton County retains its share of the region's total employment at 34 percent in 2025, compared to 35 percent in 2000. Together, Fulton, DeKalb, Gwinnett and Cobb show a small decline in

employment share, down from 81 percent in 2000 to 78 percent in 2025.

Figure II shows the employment distribution for 2025. Each dot represents 100 employees. Similar to the population distribution, employment is concentrated in central counties in the region. However, this figure shows a significantly denser distribution than does population. Futhermore, this development is concentrated along transportation corridors more so than population, most notably I-75, I-85, GA 400 and Peachtree Road.

Figure II: ARC Employment Distribution, 2025



Land Supply

In order to allocate growth, the students in this studio first had to consider what types of land were available to accommodate future growth. Two types of land were identified: ***vacant land*** and ***redevelopable land***. Summing these two types of land yields the **total developable land** available for each scenario. *Vacant land* can take on one of two forms: (1) *open land*, which is comprised of agricultural and forested lands, or (2) *infill* parcels, which are currently vacant lots within urbanized areas. The way the amount of vacant land was constructed will be explained in further detail below. *Redevelopable land* is any land parcel for which the building on it was built prior to 1960, thus assuming the property may be torn down and redeveloped at the scenario's stated densities. This studio made use of ARC's LandPro 99 dataset to identify vacant land, and used Smartraq parcel-level land use datasets to determine the supply of redevelopable land. Below is a brief discussion of how each scenario considered land supply.

A Greener Way to Grow

Only the portion of vacant land less than 2,000 acres in size and not in a small area watershed or other environmentally sensitive area (to be described in this scenario's section later) was used to allocate growth. This scenario made use of *open space* vacant land, not infill. Only one-half of redevelopable land was used for development. As stated above, these two categories together (vacant + redevelopable land) accounted for total developable land. Population growth was allocated to 70 percent of this total developable land; while the remaining 30 percent was used to accommodate employment growth.

Concentrating on Corridors

The corridor scenario allocated growth differently depending on location.

Inside of I-285, 100 percent of both vacant and redevelopable land was utilized. Outside of I-285, 60% of vacant and 40% of redevelopable land were used. As is the case with the other two scenarios, 70 percent of total developable land was used to accommodate population growth, but only 20 percent was used for employment growth. The other 10 percent of developable land was allocated to open space.

Centered on Centers

Since this scenario concentrates growth in activity centers, this is the only scenario of the three that used *infill* vacant land. This was due to the fact that very few open space lands (agriculture and forest lands) can be found within current and emerging activity centers. Unlike the *Greener Way to Grow* scenario which used 50 percent of redevelopable land, this scenario uses 75 percent of redevelopable land, while 100 percent of vacant (infill) land was used. As is the case with the two previous scenarios, 70 percent of the total developable land was used for population growth while 30 percent was used for employment growth.

A GREENER WAY TO GROW

Atlanta's growth and the resultant pattern of sprawl have placed significant pressure on the natural environment of the region. To protect the natural environment, this scenario presents a future growth pattern for the Atlanta metro region preserving its important environmental features to maintain existing quality of life for current and future residents. Natural resources are often taken for granted in the day-to-day working of government and development. These resources provide important services. Riparian areas around streams naturally treat water in a manner that is cleaner requiring less treatment. Forested areas help cool the environment through transpiration, a plant's process of "breathing". They take in heat from the sun and release water, effectively cooling the ambient environment around them. Forests and open spaces provide habitat for a variety of valuable species.

Defining the Need for Environmental Protection

Urban development, along with economic growth, can bring about a host of environmental problems. Among these problems are increased impervious surface cover, erosion and sedimentation, and increased effluent output from publicly owned treatment works (POTW's).

Impervious surfaces such as parking lots and rooftops, replace open spaces and forest areas. This type of surface keeps rain from flowing into the ground and being filtered naturally by the soil before flowing into tributaries and ultimately a drinking water source. Impervious surfaces also act as a "holding area" for pollutants from automobiles and other pollutant sources that are immediately washed into tributaries after rainfall. This accumulation pattern on impervious surfaces increases the pollutant load in nearby water bodies which spikes immediately after rainfall and affects the overall health of the water body. Specific pollutants harmful to aquatic ecosystems that are introduced through impervious surfaces include chemicals such as ethylene glycol (primary chemical component in anti-freeze) and acetylcholine (a widely used pesticide). In small doses these chemicals can kill small mammals such as dogs and cats. Suspended in water in large quantities, it can have a similar impact on aquatic populations.

Development patterns can increase sedimentation loads in tributaries, rivers, and watersheds. Erosion caused by land clearing is a major source of turbidity within these water bodies. This increase in sedimentation increases the amount of matter on the floor of the body as well as suspended in water impairing the ecosystem. Bottom-dwelling species that rely on materials found on the floor for sustenance may disappear as sediment covers their food source. Chemical pollutants can adhere themselves to these suspended solids and increase their dispersion throughout the strata of the lake.

Water Supply Issues in Atlanta

Development and growth also places a strain on the quantity of water available to residents of the region. The expected increase in population of 1.4 million people equates to an additional 17.1 million gallons a day (MGD). This water has to be supplied from a source and the river basins in Georgia are beginning to become restricted. Drought conditions have decreased stream and lake holdings and flow, and thus, have decreased the amount of water that can be removed per day. Conservation practices such as limiting the watering of lawns to specific times and using water conserving appliances can help, but are not enough to offset the effects of continued population growth.

Inter-Basin Transfers (ITB) have been used in the past to make up for shortcomings in water supply. An ITB occurs when water is removed from one basin and moved to another. This can have detrimental effects on the sending river. Most water that is removed (and not transferred) is returned to the body of water at some point. This helps to maintain a relatively stable water level throughout the system. When water is removed in large quantities and not replaced, the water level drops and reduces the amount of water available within that basin for drinking water and aquatic habitat.

Water supply is the basis of the Apalachicola-Chattahoochee-Flint (ACF) Basin water "war" between Alabama, Florida, and Georgia. Georgia requested that the Atlanta region increase their use from the basin by 125 MGD during times of peak demand. Alabama wants adequate water to support its own growth and protect its environment that may not be possible with a decrease in water levels. Florida wants to be guaranteed of enough water passing through the system to protect its oyster industry at the terminus of the ACF basin. The three states continue to negotiate on an equitable division of water rights, but no settlement has been reached.

Water Quality and Aquatic Life

Habitat degradation is also an important factor to consider when planning for future growth. Many species require a large area of land for their habitat while some (edge species) only require small tracts of land. When development breaks up existing habitats, species either relocate or die out. Relocation is especially difficult for larger species and human populations may be unwelcoming. The Endangered Species Act applies to several species of flora and fauna in Georgia. The ESA places endangered and threatened species on a public register and provides for the protection of critical habitat for the species. This designated critical habitat area has limitations on development that can occur and human activities that can alter the behavioral patterns of the species, including reproductive activities.

Conclusions on Development and Water Quality and Supply

Is urban development "bad"? It doesn't have to be. Proper regulations can protect natural resources and limit the impact development will have on environmental features. This scenario identifies four types of environmental areas that are in need of protection: **small water supply watersheds**, **streams and rivers**, **wetlands**, and **forest and agricultural areas**.

All four of these protection areas address the prevalent issue of degraded water quality. This scenario places ***100-foot buffers*** around streams, wetlands and watersheds ***while maintaining forests and other vegetative cover*** that serve to capture potential pollutants. Development is also limited in small water supply watersheds such as the Big Creek Watershed.

A growth pattern that follows these guidelines for development will provide protection for the region's drinking water, recreational areas and wildlife habitat. For the most part, this scenario places future development in currently developed areas, providing an unanticipated benefit of infrastructural efficiency. However, this same benefit provides a possible barrier to implementation as outlying counties may oppose land use restrictions that reduce the amount of growth and development that can take place in their jurisdictions.

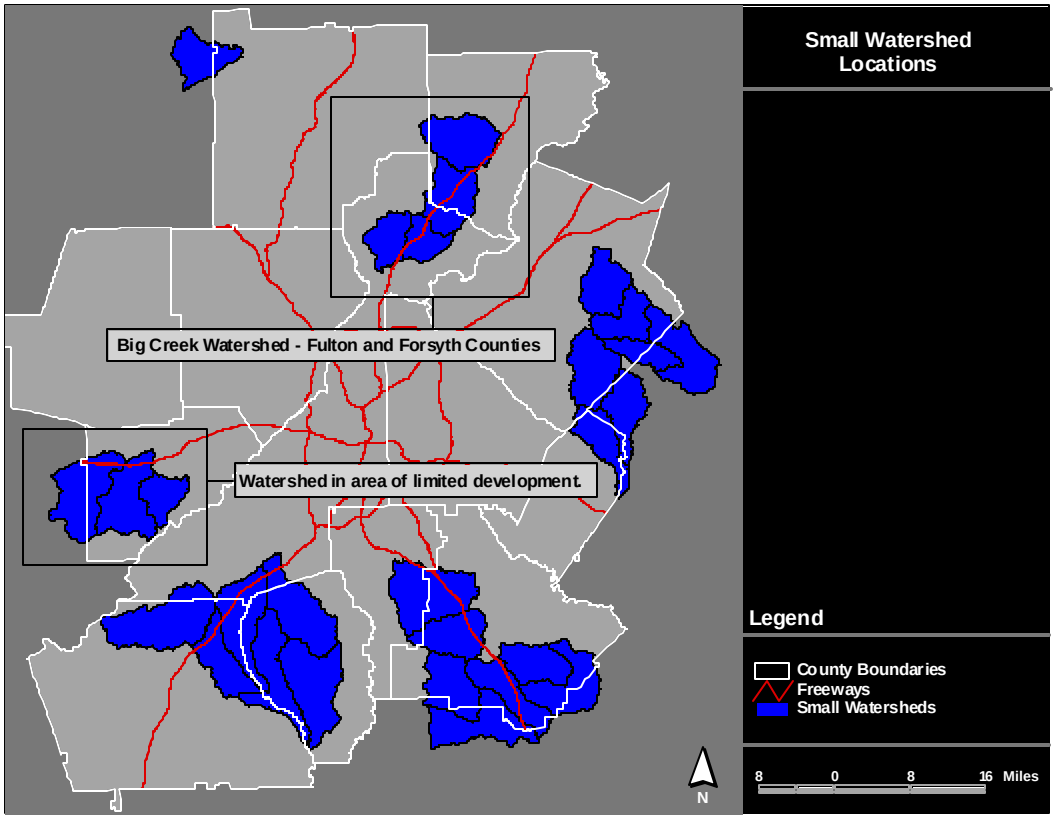
Defining Environmentally Sensitive Areas in the Atlanta Region

In this scenario, several environmental features of the Atlanta region are considered to be sensitive to development patterns and population growth. These areas are small area water supply watersheds, streams and rivers, wetlands, and forested areas. Large amounts of growth in these areas or the elimination of these environmental features can lead to environmental degradation throughout the entire ecosystem of the region. For example, pollution created by construction in the northern area of the region can degrade the water supply of downstream southern communities, while deforestation decreases the amount of vegetation that serves as a filter for rainwater and urban runoff.

Small Water Supply Watersheds

Watersheds are also known as drainage basins and are areas where tributaries (streams or creeks) collect the water that will flow into a given stream or river. There are numerous small water supply watersheds in the Atlanta region. Several of these watersheds are located in areas of current intense development (Big Creek Watershed). In all, six small area watersheds were identified within the metro area. They are all located on the periphery of the Atlanta region but have experienced large amounts of development in and around their vicinity in the past decade. **Figure III** on the following page shows these areas and their locations within the region.

Figure III: Small Water Supply Watersheds



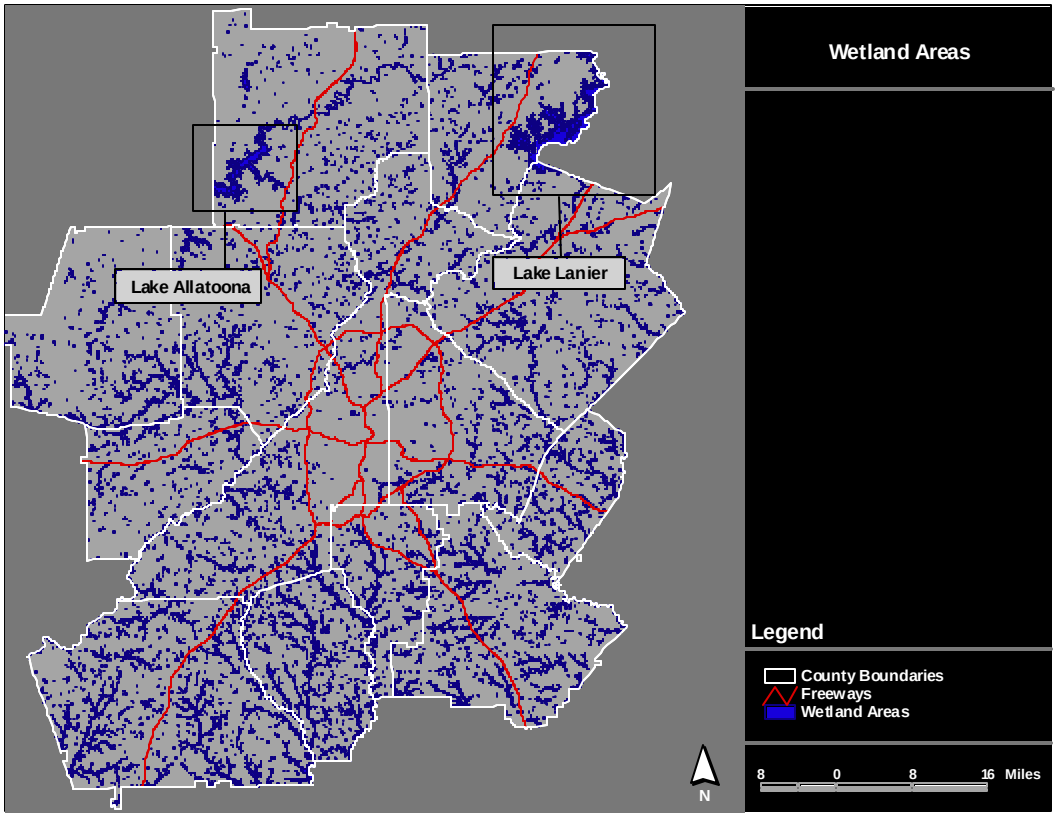
Rivers and Streams

The Chattahoochee River is the primary source of water for the Atlanta region. This river is currently under protection from development through the Metropolitan River Protection Act (Georgia Code 12-5-440 et seq.) passed in 1970 by the Georgia General Assembly. This Act includes a 50-foot undisturbed, natural vegetative buffer along the river and 150-foot impervious surface setback along the river, among other restrictions. This act has prevented development within specified areas and limits the amount of unfiltered runoff that reaches the Chattahoochee River and its tributaries. *For this scenario we selected only major rivers and streams that are defined as having a flow greater than 100 cubic feet per second*. A 100-foot buffer has been created along each major stream or river where no future development will be allowed.

Wetlands

There are numerous small wetlands distributed throughout the Atlanta metropolitan area. Areas designated as wetlands include lakes, wetlands, and other types of water bodies. The two major bodies of water in this category are Lake Lanier and Lake Alatoona, which provide surface water to the region. Although covered in wetlands,

Figure IV: Wetland Areas



many of the region's wet areas are quite small. The analysis section that follows describes how a Geographic Information System (GIS) was used to create 100-foot buffers around major rivers, streams and wetlands. Wetlands larger than one acre were used to avoid the many small wetlands. Wetlands located in the Atlanta region are shown in **Figure IV**.

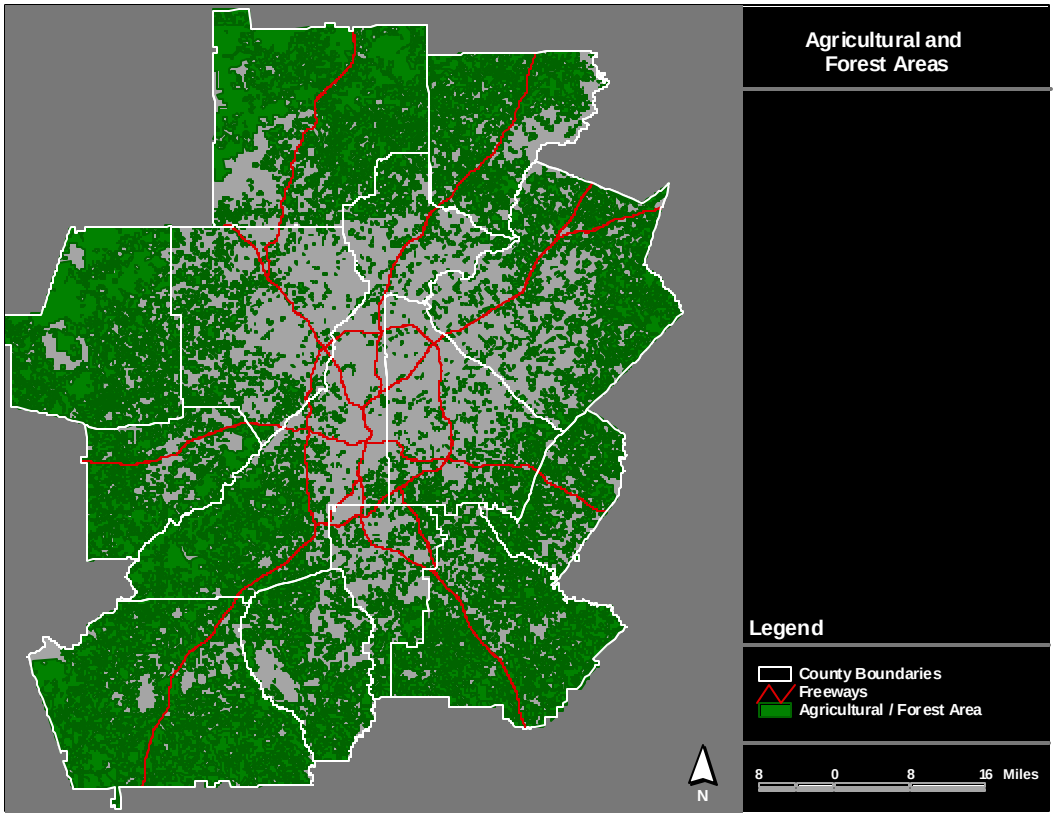
Forest and Agricultural Areas

Forest and agricultural lands are the predominant land use types on the periphery of the Atlanta region. Forested land accounts for roughly 926,344 acres of land and agricultural uses are found on over 345,722 acres.

The majority of forested land within the central portion of the region are areas on private property or found within parks. It is possible to see the relation of the lack of forested space with current dense development patterns that have occurred within the core of the region.

The forest and agricultural land forms a visible greenbelt around the city and includes many of the previously mentioned environmentally sensitive areas. Through implementing preservation measures to protect this "greenbelt" and concentrating development within the already developed areas, it would be possible to

Figure V: Agricultural and Forested Areas



protect a large amount of open space without limiting the total amount of growth possible in the region.

Using the ARC's Landpro 99 photo-interpreted level cover data, tracts that contained greater than 2,000 acres of forested and agricultural land were selected from the region for exclusion from population and employment allocation. While the data does not suggest that this land is contiguous, the mass of land covered by this land use can provide important environmental services. These tracts potentially could be important for future use as a greenbelt, for their aesthetic value, to protect water quality and create a dense urban core for the region. The result of the selection of these tracts led to the creation of a "Delta" or an inner core for future growth and an outer ring for preservation. This studio refers to this area as the "Delta" due to its upside down triangular shape. These agricultural and forest lands can be seen in **Figure V** above.

Allocating Future Population and Employment

The Atlanta region study area contains approximately 2.6 million acres. The

most environmentally sensitive areas of the region were removed from areas appropriate for development using GIS.

The analytical process entailed the creation of 100-foot buffers around environmentally sensitive areas. These buffers were then extracted from the available developable land. Census tracts with more than 2,000 acres of forested and agricultural land were then identified and removed. Since it is unlikely all the redevelopable land would turn over, only 50 percent of the redevelopable land was used to allocate population and employment. This reduction was also driven by historic preservation and affordable housing concerns.

In summary, taking the total acreage of the study area, removing the environmentally sensitive areas and half of the redevelopable land yielded the total net acreage available for future development. These land types and the delta they form are shown in **Figure VI** below.

Population and Employment Allocations

For the future population distribution and density, the estimated population increase of 1.1 million people was

Figure VI: Developable Land, The "Delta"

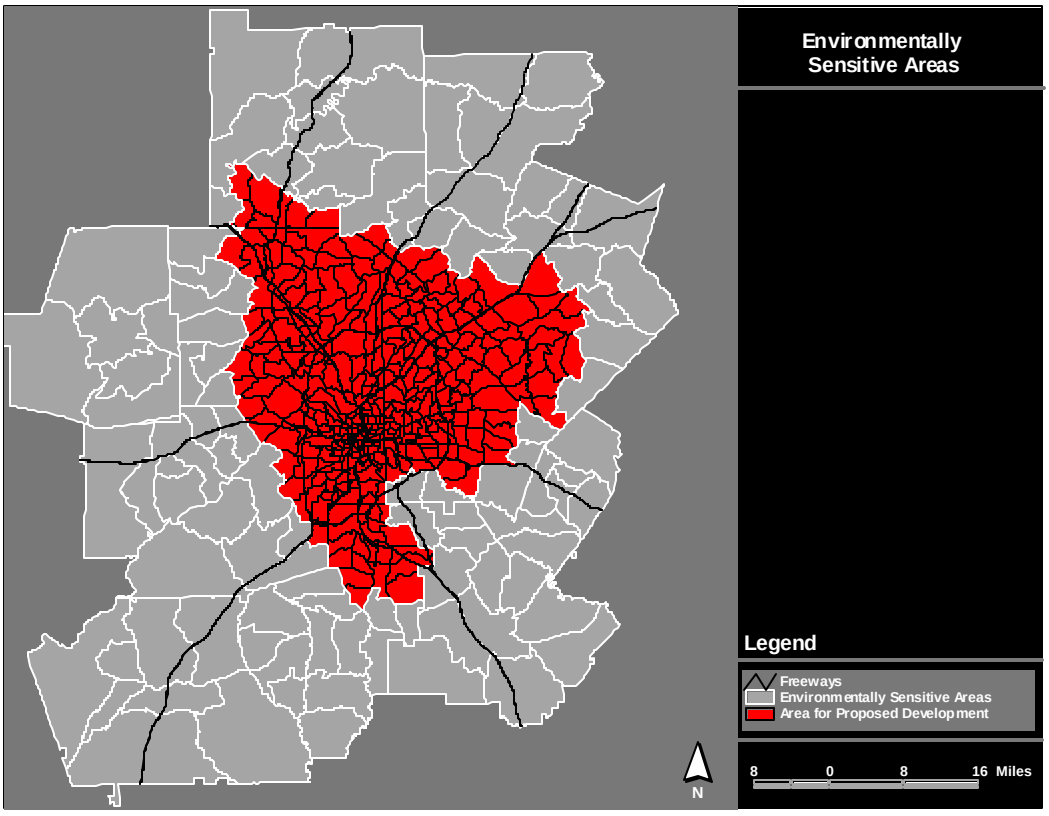


Figure VII: Population Distribution After Allocation

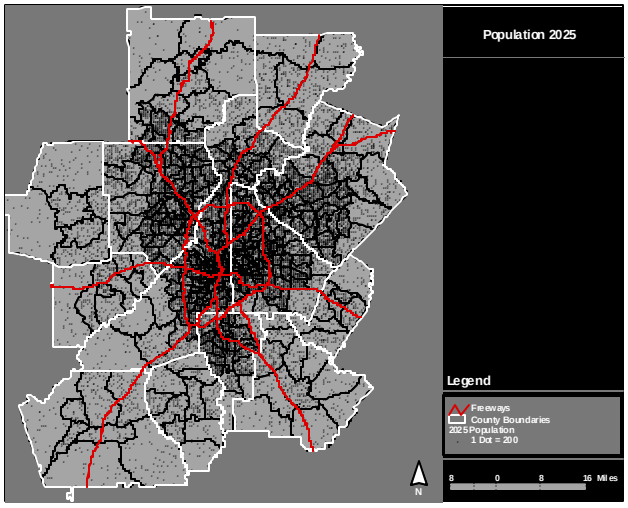
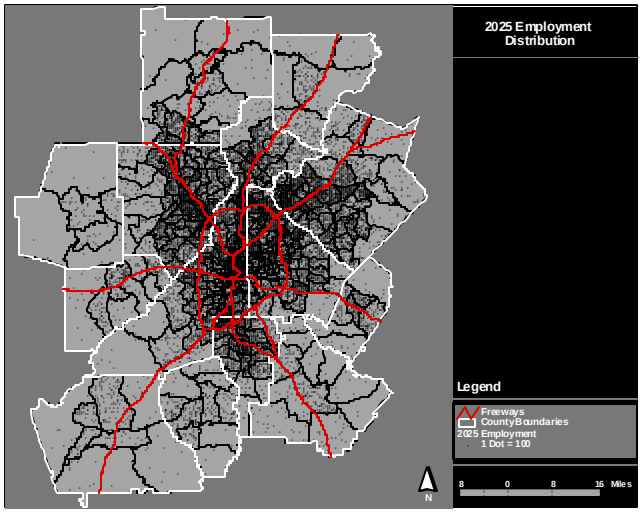


Figure VIII: Employment Distribution After Allocation



allocated evenly over 70 percent of the total developable acres. This was done in order to allow 30 percent of the land for employment. After allocating population within the inverse delta shown in **Figure VI**, the population density of the future growth was 3.37 people per acre which was derived from the existing population over total land area. The population of each census tract was determined by multiplying the net available acres for population by 3.37 and adding in the existing population of each tract. The future employment growth for 2025 was estimated by taking one half the population; this total is 741,000 jobs. The future employment dispersion and density was determined by dividing 741,000 jobs by the net available acres for employment. This yielded an estimate of 4.16 jobs per acre. Multiplying the acres in each census tract available for employment by 4.16 and adding the existing employment figures yielded the number of jobs in each census tract. The results of these applications can be seen above in **Figure VII** and **Figure VIII**. Each figure shows a very predictable result, both employment and population are concentrated at similar densities within the inverse delta. Jobs and residents outside the delta already existed prior to allocation. No new population or employment was allocated to these areas.

Conclusions: The Atlanta Metropolitan Region Before and After Allocations

This scenario has concentrated on providing environmental protection by identifying valuable environmental resources, and directing growth away from them. From small water supply watersheds to wetlands and open space areas, the environment particularly on the edge of the region has largely been preserved. With such protection, it may

Table 5: Population and Employment Distribution by County, 2025

County	Population Census 2000	Population 2025	Absolute Change	Percentage Change	Employment 2000	Employment 2025	Absolute Change	Percentage Change
Cherokee	141,903	190,002	48,099	34%	35,950	68,216	32,266	90%
Clayton	236,517	328,571	92,054	39%	135,950	197,702	61,752	45%
Cobb	607,751	857,165	249,414	41%	313,800	481,106	167,306	53%
Coweta	89,215	89,215	0	**0%**	27,550	27,550	0	**0%**
DeKalb	665,865	901,039	235,174	35%	346,900	504,660	157,760	45%
Douglas	92,174	92,174	0	**0%**	33,350	33,350	0	**0%**
Fayette	91,263	91,263	0	**0%**	35,000	35,000	0	**0%**
Forsyth	98,407	98,407	0	**0%**	35,350	35,350	0	**0%**
Fulton	816,006	1,097,215	281,209	34%	731,400	920,045	188,645	26%
Gwinnett	588,448	797,419	208,971	36%	292,250	432,429	140,179	48%
Henry	119,341	119,341	0	**0%**	32,800	32,800	0	**0%**
Paulding	81,678	81,678	0	**0%**	12,500	12,500	0	**0%**
Rockdale	70,111	70,111	0	**0%**	34,600	34,600	0	**0%**
Total	**3,698,679**	**4,813,600**	**1,114,921**	**N/A**	**2,067,400**	**2,815,308**	**747,908**	**N/A**

be possible to see slight reductions in future ambient temperatures versus normal development patterns due to increased vegetative coverage. Additionally, water quality will be significantly improved as water bodies both large and small will have 100-foot development free buffers around them.

In addition to environmental considerations, this scenario will also serve to increase infrastructure efficiency. Rather than building roads in outlying areas, current roads would be used for the majority of incoming residents by 2025. However, while infrastructure costs would likely decrease, traffic congestion would almost certainly increase. Thus, while this scenario adequately addresses environmental issues, it raises issues of traffic congestion and political feasibility.

This scenario does not consider the political effects this type of growth pattern at all, nor was it the point of this studio to do so. Nonetheless, addressing this issue briefly sheds additional light on the validity of such a growth pattern. The principal political problem with this growth pattern can be seen in **Table 5**. As this table shows, some counties experience no growth whatsoever. These counties include Coweta, Douglas, Fayette, Forsyth, Henry, Paulding and Rockdale. All of these counties are presently growing at a fast rate, but due to the constraints in this scenario (principally the amount of open space in each county), these counties would receive virtually no new growth. While it may be politically infeasible, this scenario demonstrates that Atlanta's existing urbanized area could accommodate all the future growth expected for the next 20 years.

CONCENTRATING ON CORRIDORS

The ability to find efficient means of accessibility through transportation investments needs to be emphasized further in the Atlanta metro region to prepare for future growth. Those living in metro Atlanta rely on various transportation modes for their trips. However, many face lengthy commute times and serious congestion on the region's roadways due to their residential location and the automobile mode choice.

The environmental protection and activity center scenarios produced through this studio examine regional development patterns focused on nodal development and environmental protection. While there are many other growth patterns that could be examined, a linear type of development pattern represents a distinctly different type of urban form. This scenario will concentrate incoming population and employment in areas that are currently, or will soon be served by some form of transportation; whether by road or transit. However, this scenario was not done in the same manner as the other scenarios. In the environmental scenario, conservation lands were delineated and removed from development. In the activity center scenario, centers were delineated and growth was concentrated in them. This scenario shows that a model resembling DRAM/EMPAL and two accessibility indices were used to take into account a series of variables that affect residential and employment location. Although these variables were meant to focus development along corridors, they were not able to direct all future growth along corridors. Because linear development is the desired output for this scenario, it was necessary to further constrain population growth to these corridors after the model was run.

A clear advantage of linear development is that it coordinates land use with transportation investments. This can reduce travel times as fewer connector and collector roads are necessary in comparison to typical sprawl development. Perhaps more importantly, it keeps development more tightly packed along these corridors, reducing impacts on greenspace consumption. Lastly, it serves to provide greater fiscal efficiency constructing roads to where people are living; in this case people go where roads and transit corridors already, or soon will, exist. However, there are disadvantages as development will not be as compact as nodal development, and no account is given to the environmental or social ramifications of these growth patterns. For example, if a future road runs through the Lake Alatoona watershed, it may be preferable to keep development within a close distance of the road, but it may be more beneficial to prevent any development from occurring in the first place due to the impact of impervious surfaces within the watershed. Thus, while land use and transportation are well coordinated, additional growth factors like environmental constraints are not addressed.

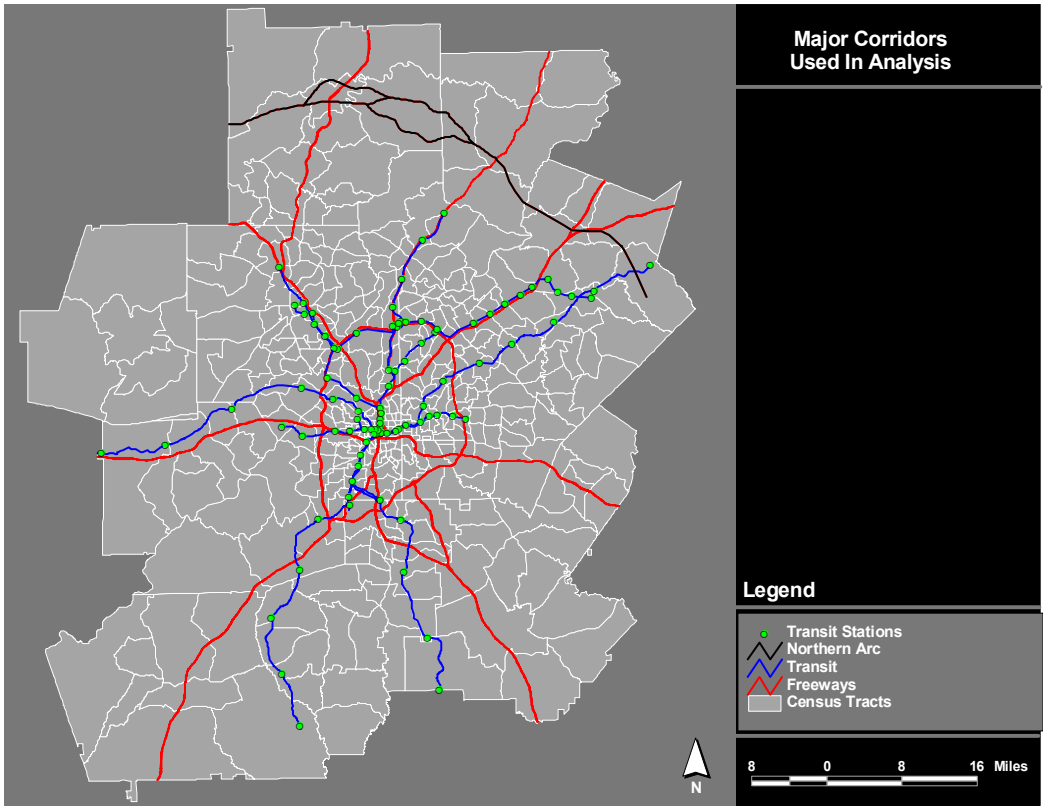
Defining the Scenario Process

This section provides an overview of how this scenario was constructed. First, the transportation corridors that are considered in the model are discussed. Next, the overall modeling approach is described, including an overview of the three models used. Finally, each of these three models are discussed in detail, including the variables involved and the allocation of growth within the corridors.

Defining Transportation Corridors

The process of allocating population began with the assessment of existing and future transportation systems considered important to the region. The transportation network used for the analysis is shown in **Figure IX** where freeways are shown in ***red***, transit lines are shown in ***blue*** and the Northern Arc is shown in ***black***. In the case of transit lines and freeways, both current and future infrastructure are included. Population and employment will be directed. to the corridors shown in **Figure IX**. In addition to considering new infrastructure systems, improvements within the current system, such as the widening of I-285 and transit improvements along major highways,

Figure IX: Major Transportation Corridors

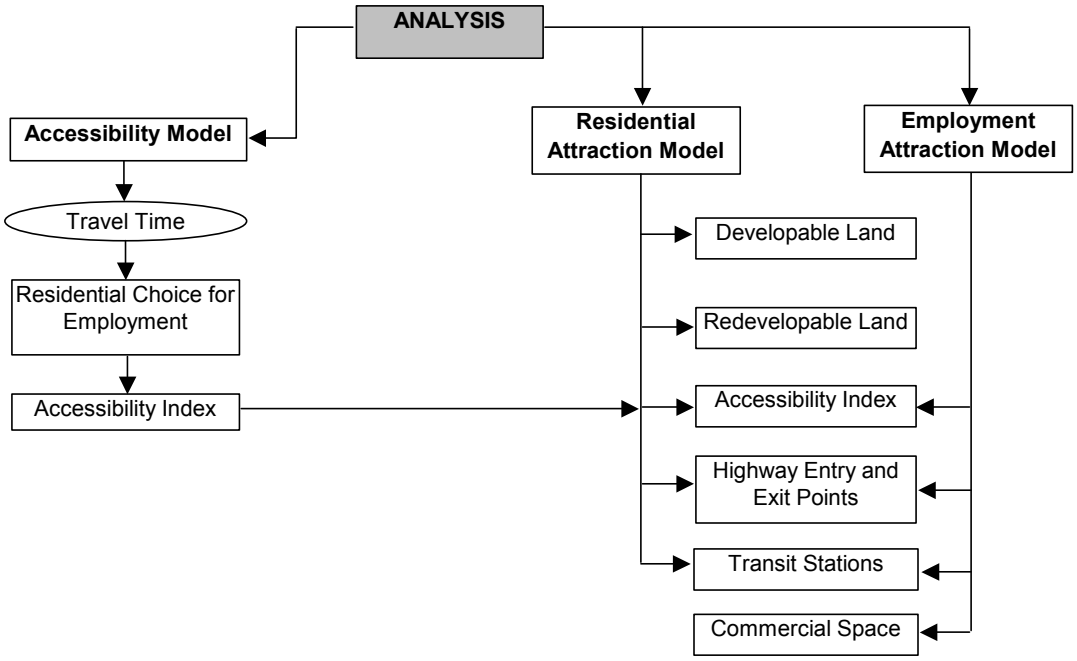


are included in the modeling process. These improvements are part of the 2025 Regional Transportation Plan (RTP) and also include major projects along I-75, I-85, I-20 and GA 400. It is important to consider the effects of these projects through the modeling process as they could significantly alter commute patterns throughout the region and thus, will impact growth patterns. Although put on hold, the Northern Arc was also considered and included as a potential future roadway within the next 25 years. Various commuter rail lines extending outside the Atlanta Metro Region were integrated into the transit network for their potential impact on regional transportation.

Defining the Modeling Approach

Two attractiveness models and one model resembling DRAM/EMPAL were created and utilized to determine which areas would be most attractive for new growth. These three models are shown in **Figure X**, along with the variables that are considered within them. The accessibility model focused primarily on travel-time to determine census tracts where the workforce would prefer to live. For example, a census tract with a low travel-time to all the other tracts would be more attractive as it would reduce the cost of travel for the home based work (HBW) trip.

Figure X: Modeling Flow Chart



The two attractiveness models focused on specific variables essential to population and employment attractiveness. The variables that were generated for the modeling process such as type of land, availability of land, and accessibility index (generated from an accessibility model) provided a comprehensive understanding of the forces that interact to influence growth and development patterns. The modeling flow chart (**Figure X**) outlines the structure and interaction of the accessibility model.

The residential attractiveness model focuses on five variables: developable and redevelopable land availability, highway entry and exit points, transit stations and the accessibility index. The employment model focuses on four variables: the accessibility index, highway entry and exit points, transit stations and commercial space. Thus, the biggest difference between the two attractiveness models is in the consideration of developable and redevelopable land. The residential attractiveness model considers both of these as important variables whereas the employment attractiveness model disregards the availability of land in favor of the presence of prior commercial development. Both of these models strongly consider accessibility and travel time.

Accessibility Model and Calculation of Accessibility Index

To initiate the modeling process, an accessibility model was created with an origin-destination matrix for 440 census tracts factoring in future highway and transit improvements. The speed on all surface roads and transit lines were assumed to be 35 mph, while highway speeds were assumed to be 45 mph. The impeding cost, or travel-time, was calculated for each tract against each of the remaining 439 tracts through the following calculation for travel time:

C = speed/length of road

This was then inversed and squared as cost (in terms travel-time) is inversely proportional to location choice, C_{ij}^{-2}, where:

i = origin tract
j = destination tract

The following equation yielded the number of employees that would live in each tract based upon the cost of travel:

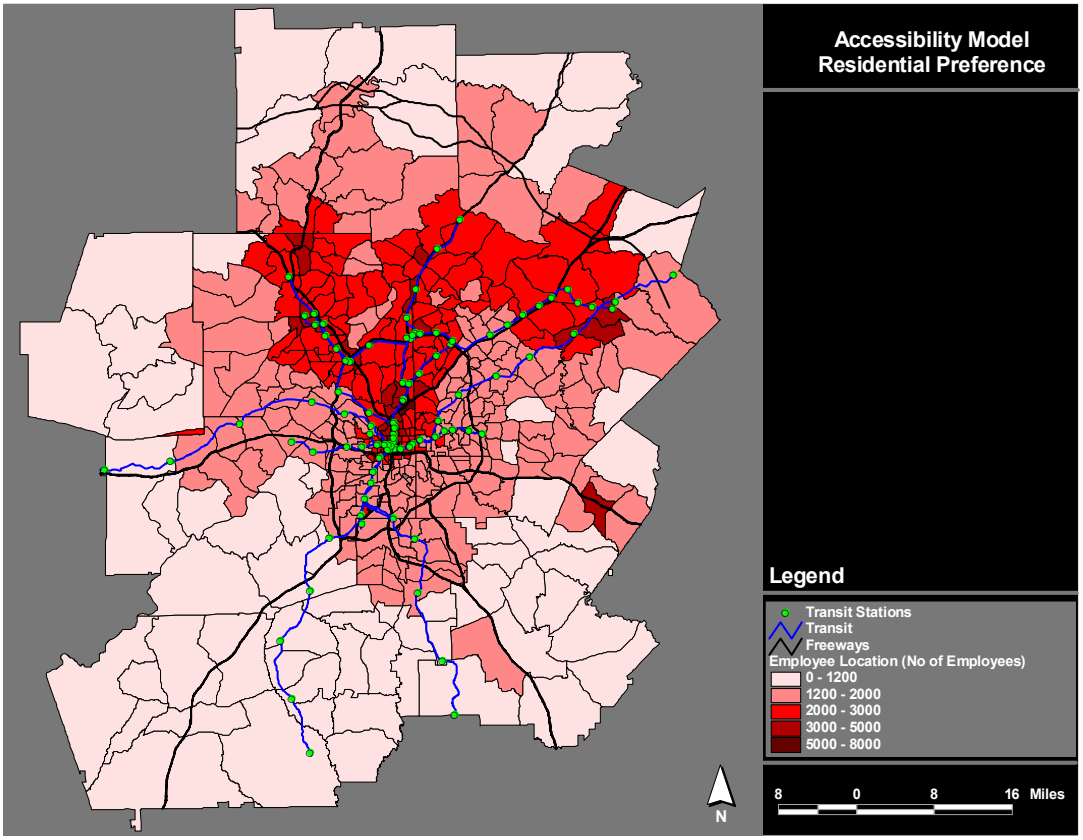
$$E_i = E_n(C_{ij})^{-2} / \sum(C_{i\text{-}n})^{-2}$$

where,

E_n = Total Growth in Employment
C_{ij} = Travel Time Between tracts *i* and *j*
n = Total tracts

With the number of employees residing in each tract identified, the accessibility index was calculated as a proportion of the number of employees per tract to the total number of employees. The accessibility index provides an idea of which tracts are more preferred as a residential location by employees; these can be seen in **Figure XI**.

Figure XI: Residential Preference



Attractiveness Models

While the accessibility model generated *preference of employee residence* through calculating travel costs and travel times, the residential and employment attractiveness models indicate where residential and employment population are most likely to be attracted to by combining the accessibility index with up to four other variables.

Residential Attractiveness

After an assessment of which variables best suited this model, a weighted ranking approach was utilized. Initially each variable was ranked from 1-9 with a higher rank indicating more desirability and then weighted based on its ability to influence growth. For

Table 6: Residential Attractiveness Model, Variables and Weights

Residential Attractiveness Variables	Weight
Developable Land	10%
Redevelopable Land	20%
Accessibility Index	30%
High entry/exit points, Access to transit stations	40%

example, highway entry and exit points are considered twice as important (40 percent) as the presence of redevelopable land (20 percent) in terms of attracting growth, hence the highway entry and exit points variable is multiplied by 0.4, while redevelopable land is multiplied by 0.2. These weights are shown in **Table 6.**

These scores were then summed across each tract providing a total measure to indicate the attractiveness of each tract. The higher the total weighted score, the more attractive the tract is for residential development. Residential attractiveness is shown for each census tract in **Figure XI**.

Employment Attractiveness

Similar to the residential attractiveness model, the employment attractiveness model was also calculated on a weighted ranking approach. Many of the same variables were used here as in the residential attractiveness model. **Table 7** shows these variables and their weights.

Table 7: Employment Attractiveness Model, Variables and Weights

Employment Attractiveness Variables	Weight
Accessibility Index	30%
Commercial Space	30%
Highway entry/exit points, Access to transit stations	40%

Employment allocation is primarily driven by transportation and proximity to existing commercial space. The developable and redevelopable land variables were deleted in the model and commercial space was added. The aggregate weights for developable and redevelopable land (20% and 10% respectively) were combined into a weight of 30% and used to weigh the commercial space variable. As in the residential attractiveness model, the sum of the total weight across each tract resulted in determining which tracts have the potential to attract employment. Tracts with higher values were considered more attractive for employment as shown in **Figure XI**.

Allocating Growth Along Corridors

Prior to implementing the scenario the accessibility and attractiveness models showed that the tracts under consideration for the corridors scenario would account for 65 percent of the population and employment growth envisioned by 2025. Thus, 35 percent of the region's growth by 2025 is not allocated along corridors through the modeling process. As mentioned in the introduction, the remaining 35 percent was forced into the corridors after the modeling process.

Buffering the Corridors

The initial step in the allocation process was to select census tracts that had 50% or more of their area within **1 ½-miles** of the major transportation corridors. These tracts are shown in **Figure IX**. Therefore, *all population and*

employment growth that is concentrated along corridors falls within this 1½-mile buffer.

Population and Employment Allocation Densities

The second step was to allocate growth based on a reasonable density within each census tract. To gain an idea of reasonable density for each census tract, two criteria were used; attractiveness driven density calculated through the attractiveness models, and a transit oriented development (TOD) density concept. First, total regional population growth is multiplied by the proportion of the tract's attractiveness factor to that of the entire region. This yields the amount of population that *could* be assigned to each census tract, but first, the density that this would produce in each tract must be considered.

A maximum acceptable density was established as 24 du/acre for population growth and 200 employees per acre for employment growth. This 24 du/acre density threshold has been used as a maximum recommended density for TOD by experts like Peter Calthorpe. Two hundred employees per acre is also a maximum recommended employment density in TOD developments, and thus, becomes a reasonable upper threshold for allocating employment growth within census tracts. All tracts above these acceptable limits were labeled as "high density" tracts for which any density above the 24 du/acre and 200 employees was reallocated to surrounding tracts. Thus, no tract was assigned more than 200 employees per acre or 24 du/acre. If a census tract is not a high density tract, and it does not fall within a TOD area, the census tract received 4 du/acre and 25 employees per acre.

The TOD concept is used to concentrate growth around transit stations at appropriate densities. The TOD area consists of buffers of ¼-mile, ½-mile, ¾-mile, and 1½-miles around all transit stations. The idea of these buffers is to allocate population at the highest density within the closest buffer, and to scale densities down within each additional buffer. If a tract is a high density tract,

Table 8: TOD Population and Employment Allocation Hierarchy

Assigned Density		TOD Buffer				Location of High Density Tracts	
Residential (du/acre)	Employees (per acre)	1/4 mile	1/2 mile	3/4 mile	1-1/2 mile	High Density Tract Inside TOD	High Density Tract Outside TOD
24	200	yes				yes	no
18	150	yes				no	yes
15	125	yes				no	no
12	100		yes			no	no
9	75			yes		no	no
6	50				yes	no	no
4	25	All other tracts outside TOD				no	no

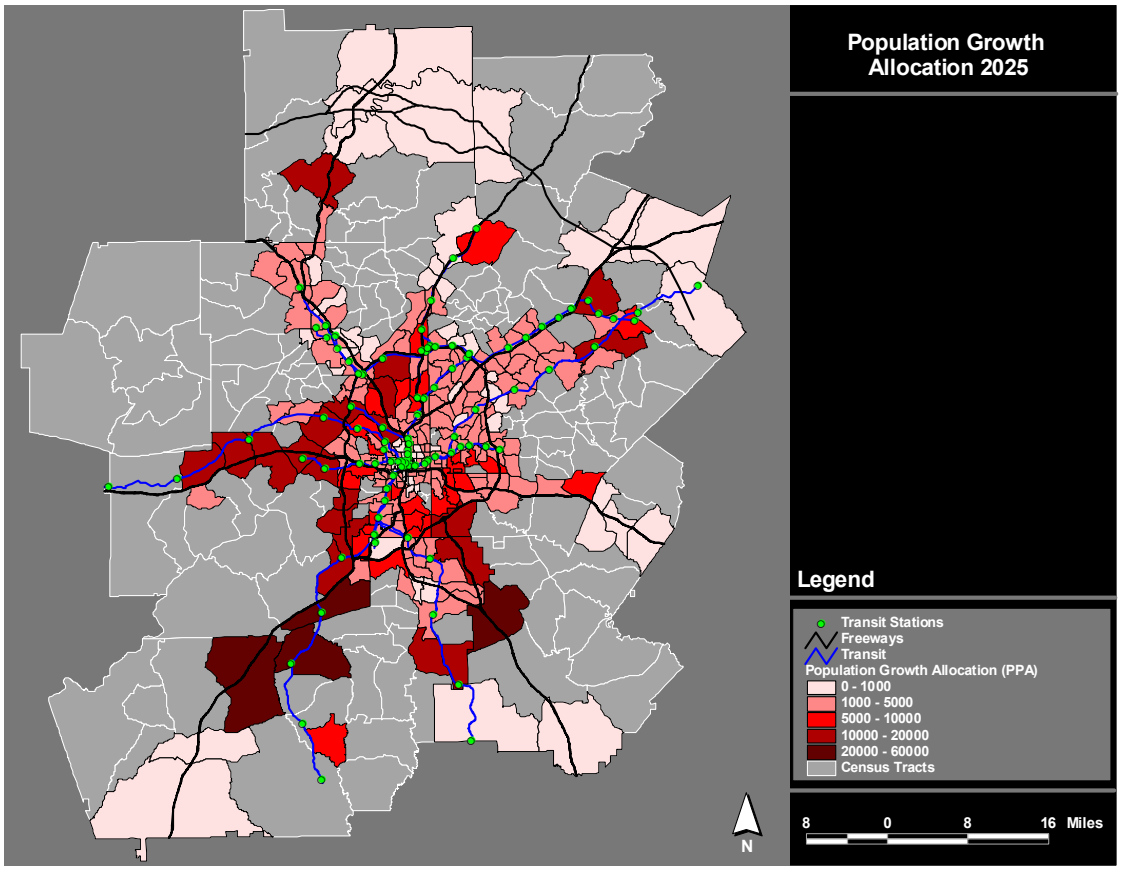
and it falls within the ¼-mile buffer, then it receives 24 du/acre. However, if the tract is within the ¼-mile buffer and not a high density tract, then the tract receives 15 du/acre. As you move to each additional buffer, densities are scaled down, eventually reaching 6 du/acre within the 1½- mile buffer. This density allocation can be seen in **Table 8**.

The approach to allocate employment densities is similar to that of population in that it uses the same hierarchical approach as the population allocation. Once again, as the distance of a tract increases from the transit station its potential to support higher employment densities decreases. For example tracts only in the ¼ mile buffer can support 125 emp/acre whereas those in the ½ mile buffer support 100 emp/acre and so on. As was the case with the population allocation table, 150 employees per acre are only allocated when a tract qualifies as a high density tract, but does not fall within the 1½-mile buffer.

Population Allocation Results

Figure XII shows the final population

Figure XII: Population Allocation Results

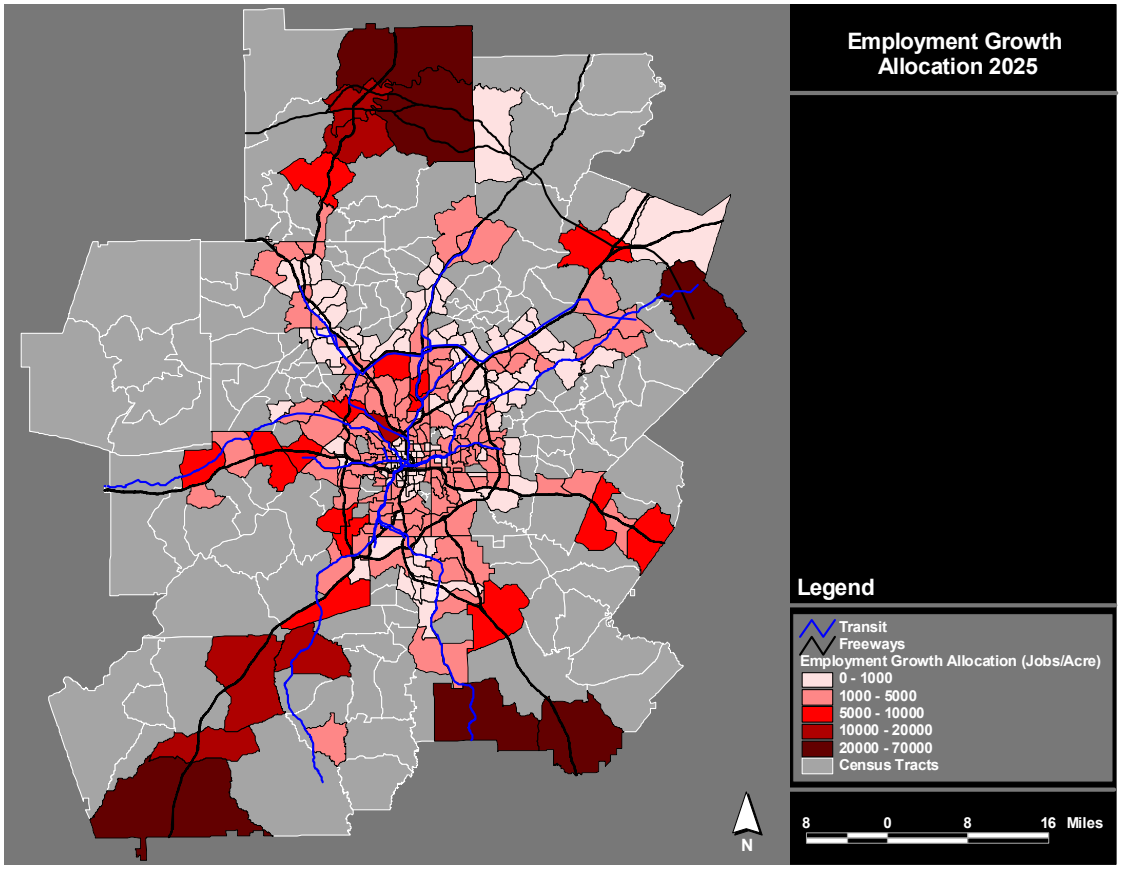


allocation after the models were run. In this graphic, freeways are represented in *black* and transit lines are shown in *blue*. Population allocation is expressed in terms of people per acre, with the smallest allocation seen in outlying counties. Although growth was explained in the model as being allocated within a 1½-mile buffer of corridors, this map does not give this impression. This is due to the fact that census tracts with more than 50 percent of their area located within the buffer are included in this analysis. Thus, parts of some tracts will fall well outside of this buffer, especially in outlying counties where census tracts are larger. In this map, population growth is shown by census tract, therefore the buffer may appear larger in some areas.

As expected the census tracts showing the most growth are those with the greatest amount of accessibility, especially those at the junction of I-285 and transit lines. This is to be expected since the model allocated higher densities within transit station buffers and these census tracts offer multi-modal accessibility.

The smallest amount of population growth is seen within outlying counties, primarily due to a lack of accessibility.

Figure XIII: Employment Allocation Results



This is in part due to fewer roads and in part due to a lack of transit service.

Employment Allocation Results

The employment allocation results are shown in **Figure XIII**. These results are very similar to the results seen previously in the population allocation figure; the majority of the employment growth is seen within I-285, especially where transit lines intersect I-285. Together, the population and employment allocations produce an asterisk-like growth pattern that follows freeways and transit routes.

Conclusions

Several observations come from this analysis. First, as will be seen with the activity center scenario, this scenario requires that densities increase significantly in census tracts around transportation corridors. In some cases, 24 du/acre may be too dense to be accepted. Examining **Figure XII** however, shows that the majority of these census tracts are located inside I-285 in Fulton, Cobb, Gwinnett and DeKalb counties. Although these counties may oppose such densities, they are more likely to accept of them than outlying counties.

A second important observation is that this scenario is more likely to be politically feasible than any other scenario. This is because it balances growth between the north and south more than the other scenarios. **Figures XII** and **XIII** show that growth has been allocated throughout the region, with few counties seeing little to no growth. The impact section will further discuss the impacts this scenario will have, and one might expect this scenario to perform well in terms of economic justice.

A third observation relates to transportation performance. At its root, this type of development is similar to sprawl development in that it skips along transportation corridors that radiate from the region's epicenter. **Figure XII** shows a fair share of growth going into Coweta, Cherokee and upper Gwinnett, just to name a few. The question is whether this will have an impact on VMT. One reason it may not have a large impact is due to the concentration of employment along with population in these corridors. This will to some extent reduce the potential mileage driven from one tract to the next as jobs are located nearby. Nonetheless, with higher amounts of growth in the outlying parts of the region than the environmental scenario, one would wonder whether VMT will be more or less.

CENTERED ON CENTERS

Activity centers are typically characterized by large concentrations of employment. Activity centers can be defined as small neighborhood centers, but for the purposes of this scenario, we will focus on centers of regional importance. Rather than growing outward in a haphazard manner, creating activity centers concentrates growth in areas where jobs, infrastructure and services already exist.

In light of policies like the Livable Centers Initiative, that seek to develop current activity and town centers, and regional development policies that stress infill development, this type of regional growth pattern has some fiscal and political support. By concentrating development where it already exists, less land will be consumed compared to greenfield development, housing can be brought closer to employment reducing vehicle miles traveled, and mass transit becomes more viable while infrastructure costs are reduced. However, traffic congestion within these centers, rising housing costs and the difficulty in providing affordable housing constitute barriers that must be addressed if such a regional growth policy were to be adopted.

Defining Activity Centers

For this scenario, both population and employment growth are allocated throughout the Atlanta 13-county region. This scenario's first goal was to identify existing and emerging activity centers, delineate them, and find out how many people could reasonably be placed within them. Thus, the primary question this scenario will answer is whether there is enough vacant and redevelopable land in current and emerging activity centers to reasonably accommodate growth projected through 2025. However, before doing so, the process used in this scenario must be explained. First, there will be an explanation of the delineation of activity centers, both existing and emerging. Second, population allocation among the centers will be discussed including the percentage of land dedicated to population growth in each center and their subsequent assumed densities, assumed vacancy rates and persons per household. Employment allocation is explained last, and will also be addressed in terms of the percentage of land dedicated to employment growth and assumed employee densities.

Defining Existing Activity Centers

An activity center can be defined simply as a concentration of employment activity. To identify areas of employment activity, two useful sources of data are commercial and office square footages. To find office and commercial employment densities, 1-km grid cells were combined using GIS, then mapped according to square footage per acre. **Figure XIV** shows this grid density map which is broken down into four density thresholds; areas above 1,800 square feet of commercial and office space per acre, areas between 1,250 and 1,800 square feet, 700 to 1,250 square feet, and 130 to 700 square feet.[2] This map produced

[2] Totals may appear low for they represent the average over an entire square kilometer.

some very predictable results as established employment centers such as Downtown, Midtown, Perimeter, Buckhead and Cumberland showed the highest employment density levels.

These thresholds were used to determine major and minor centers. Those centers that fell above 1,800 square feet of office and commercial space per acre were deemed major activity centers, while centers falling between 1,250 and 1,800 square feet per acre were labeled minor activity centers.

However, as can be seen from **Figure XIV**, the commercial and office density grid has the tendency to produce large, general areas of activity. Thus, there was a need for another form of analysis to complement the initial assessment of current activity centers. To cross check the commercial and office grid, an employment dot density map was developed, which showed employment concentration. While most of the activity centers found using the commercial-office grid were determined to be legitimate, the employment density map showed that a minor activity center west of the Stone Mountain area should be eliminated. This area is shown in **Figure XV**.

Figure XIV: Commercial/Office Square Footage Per Acre

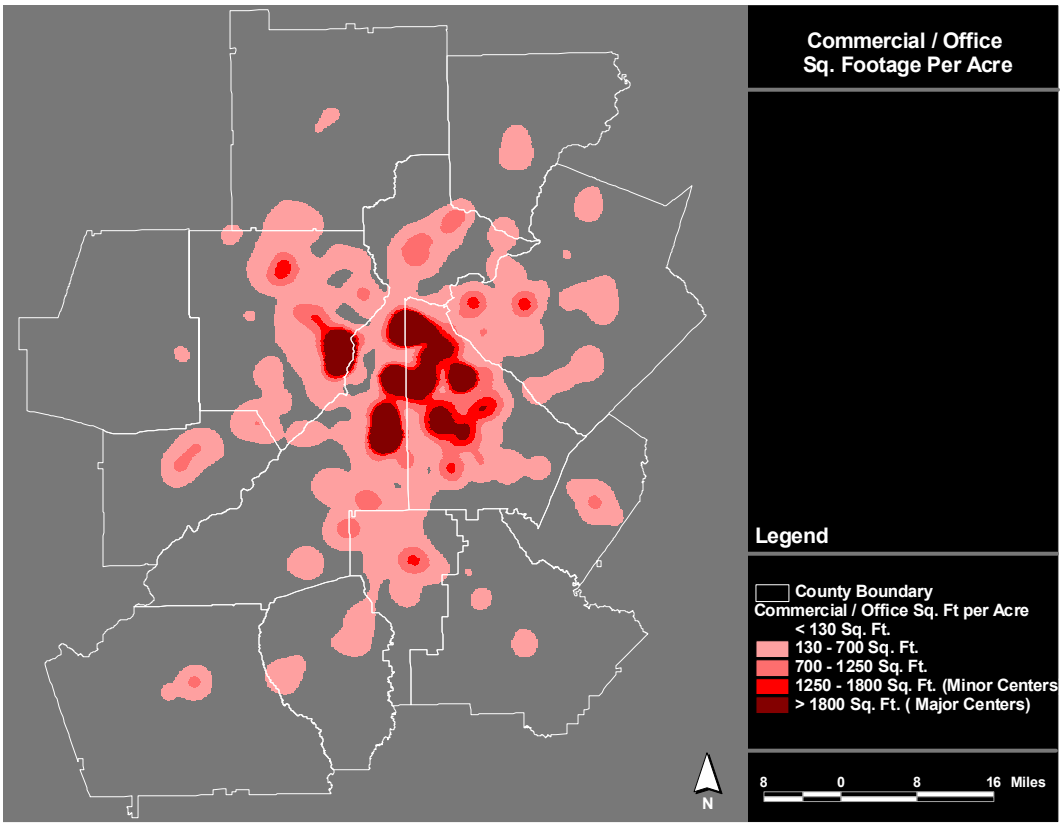
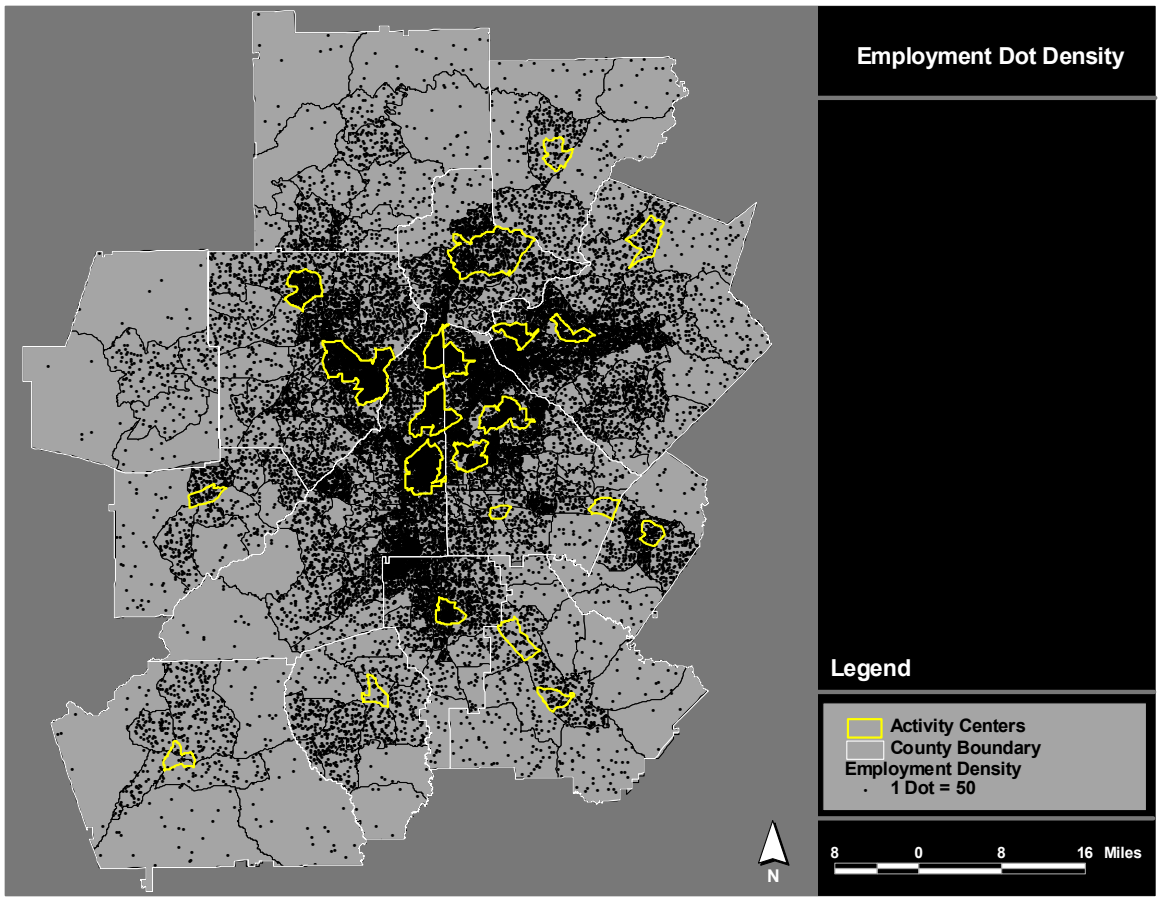


Figure XV: Employment Dot Density and Activity Centers

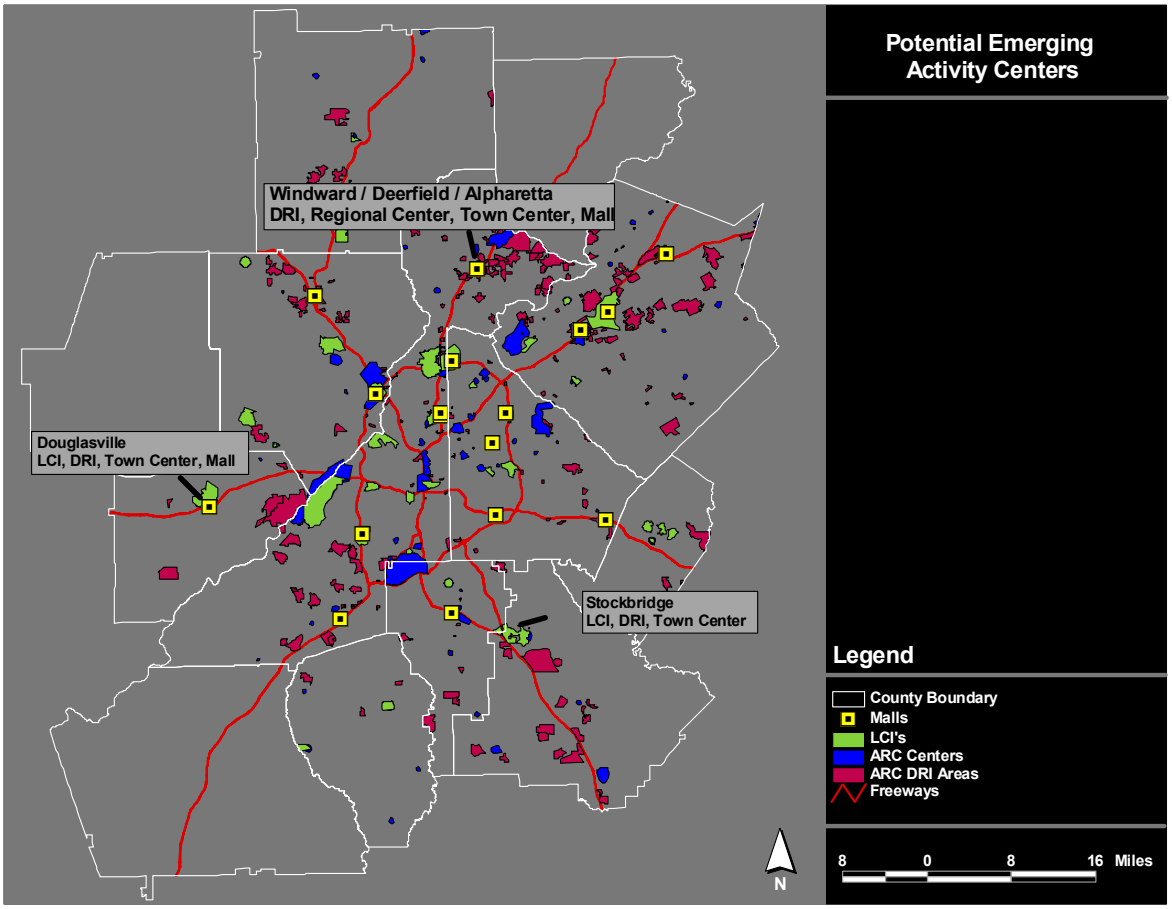


Upon finding the areas within the region that have heavy concentrations of employment activity, the next step is to delineate specific activity centers. To find the focal points of these activity centers, the activity centers from the Atlanta Regional Commission's (ARC) Regional Development Plan were used. These centers were outlined using aerial photography and attempted to capture the core of each employment district. Due to the fact that the ARC centers were quite small, these centers alone were not used to outline the activity centers for this scenario. Rather, for this scenario those census tracts were selected that most closely matched ARC centers and were within the commercial and office space density grid. In other words, the ARC centers served as focal points and the commercial and office density grid shown earlier was used to define the boundary.

Defining Emerging Activity Centers

The determination of emerging centers was a more difficult process due to the inherent uncertainty in forecasting where future employment is likely to go. To

Figure XVI: Potential Emerging Activity Centers



find potential emerging centers, five key variables were considered:

- Existing Commercial and office space density;
- Developments of Regional Impact (DRI);
- Livable Centers Initiative (LCI) projects;
- Regional malls and,
- ARC center designation (regional center, town center, city center)

Commericial and office space density, DRI's and regional malls are all indicators of employment growth while being designated as an ARC center or an LCI shows that needed infrastructure, population or employment already exist or likely will in the future. Each of these five themes were displayed using GIS; where any two variables were found in close proximity, the area was noted as a possible emerging center. **Figure XVI** shows the activity center factors considered along with a few samples of areas chosen as potential emerging centers.

In order to choose the strongest of the emerging activity centers, there was a need to rank the potential centers. Office space was scored on a 1-4 scale, with four representing greater than 1,800 square feet of commercial and office space per acre and 1 showing areas of greater than 130 yet less than 700 square feet. One point was given for a small DRI, while medium and large DRI's were given 2 and 3 points, respectively. Shopping malls were valued at 3 points as was designation as a regional center. Town centers and LCI's were each assigned one point. These variables were summarized to see which had the greatest potential to be an activity center. These centers and their components are shown below in **Table 9**. However, this was only the first step in the process of determining emerging activity centers. To find which potential centers were most likely to thrive in the future, employment change from 1990 to 2000 was mapped by census tract. Each potential center was then analyzed to see how the tracts in and around them were growing over the past decade.

Table 9: Determining Emerging Activity Centers

	Indicators of Activity			Recognized Center				
Area	**Comm /Office**	**DRI**	**Shopping Mall**	**ARC Center**	**LCI**	**Sum**	**Employment Change**	**End Result**
Lockhead Dobbins	4			RC		Current	High	**Current**
Marrietta	4			TC	Yes	7	Low	**Not**
Douglasville		Small	Arbor Place	TC	Yes	6	High	**Emerging**
Union City			Shannon Mall	TC		4	High	**Not**
McDonough	1	Medium		TC		4	Very High	**Emerging**
Locust Grove		Small		TC		2	Very High	**Not**
Hampton		Small		TC		2	High	**Not**
Stockbridge	1	Large		TC	Yes	6	HIgh	**Emerging**
Jonesboro	2			TC		3	Low	**Not**
Stonecrest		Medium	Stonecrest	RC		8	High	**Emerging**
Conyers	2			TC	Yes	4	High	**Emerging**
Canton		Medium		TC		3	High	**Not**
Discover Mills		Medium	Discover Mills		Yes	6	Very High	**Not**
Alpharetta	1	Large	Northpoint	TC		8	Very High	**Emerging**
Mall of Georgia		Medium				2	Very High	**Emerging**
Windward/Deerfield	3	Large		RC		10	Very High	**Emerging**
Hapeville	1	Small		TC	Yes	4	Low	**Not**
Powder Springs		Medium		TC	Yes	4	High	**Not**
North Point		Small	Northpoint	RC		7	Very High	**Emerging**
Newnan	added after analysis: equity							**Emerging**
Peachtree City	added after analysis: equity							**Emerging**
Cumming	added after analysis: equity							**Emerging**

Each tract was classified according to its employee growth per acre. The four classifications are: 0-65 employees per acre, 65-200 employees, 200-400 employees and 400 or more new employees per acre. This was essentially the deciding factor in the determination of emerging activity centers. Most areas that saw high or very high amounts of employment change from 1990 to 2000 were listed as emerging centers. **Figure XVII** shows this correlation as the majority of the chosen emerging centers also fall within tracts with greater employment growth. The exceptions to this include Union City, Locust Grove, Canton, Hampton, Discover Mills and Powder Springs. In each of these cases, discussions with class members and the professor eliminated these as possible emerging centers.

Table 9 also shows three centers that were added after the analysis. These centers were added for equity reasons, both in terms of attempting to establish

Figure XVII: Emerging Activity Centers and Employment Growth

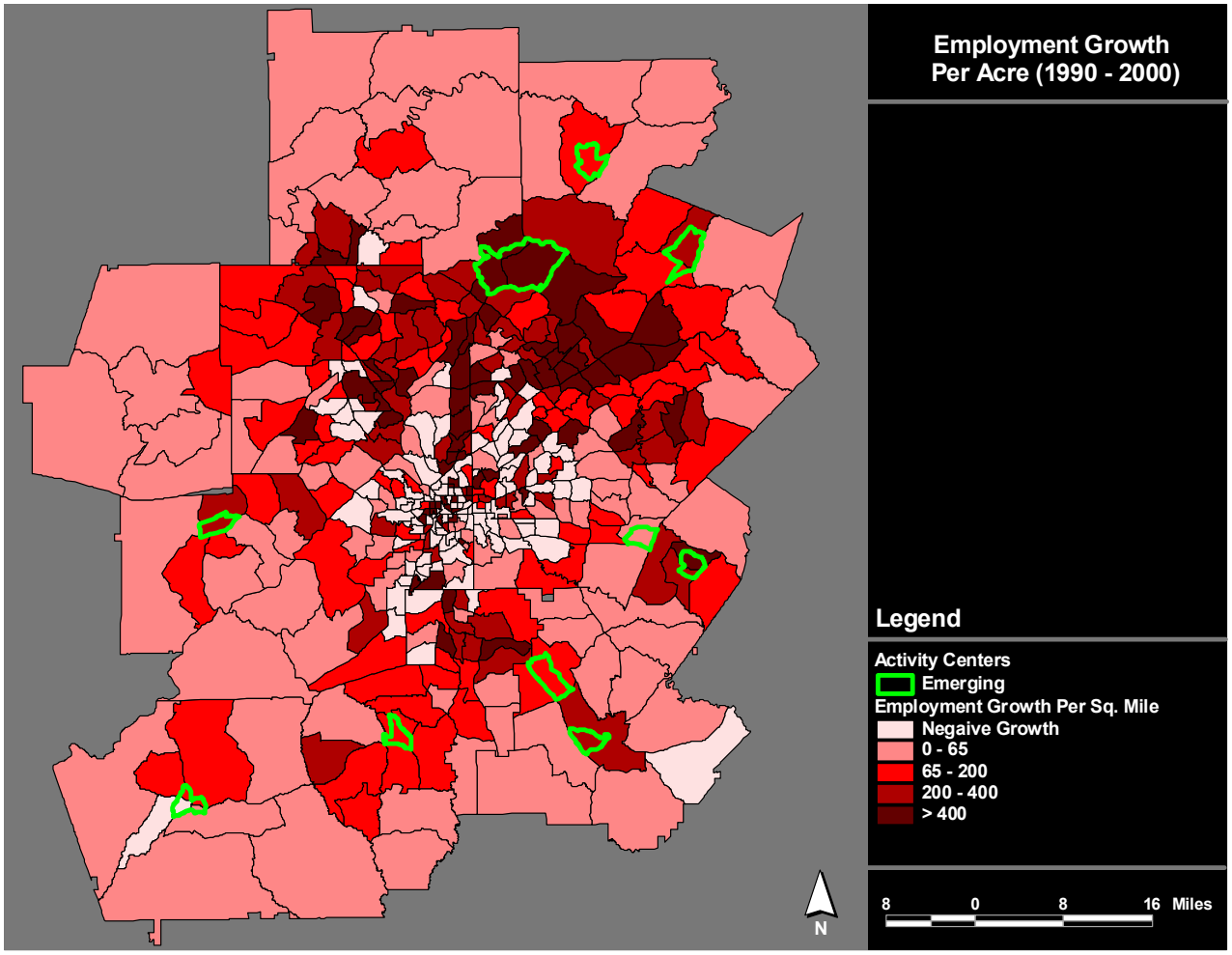
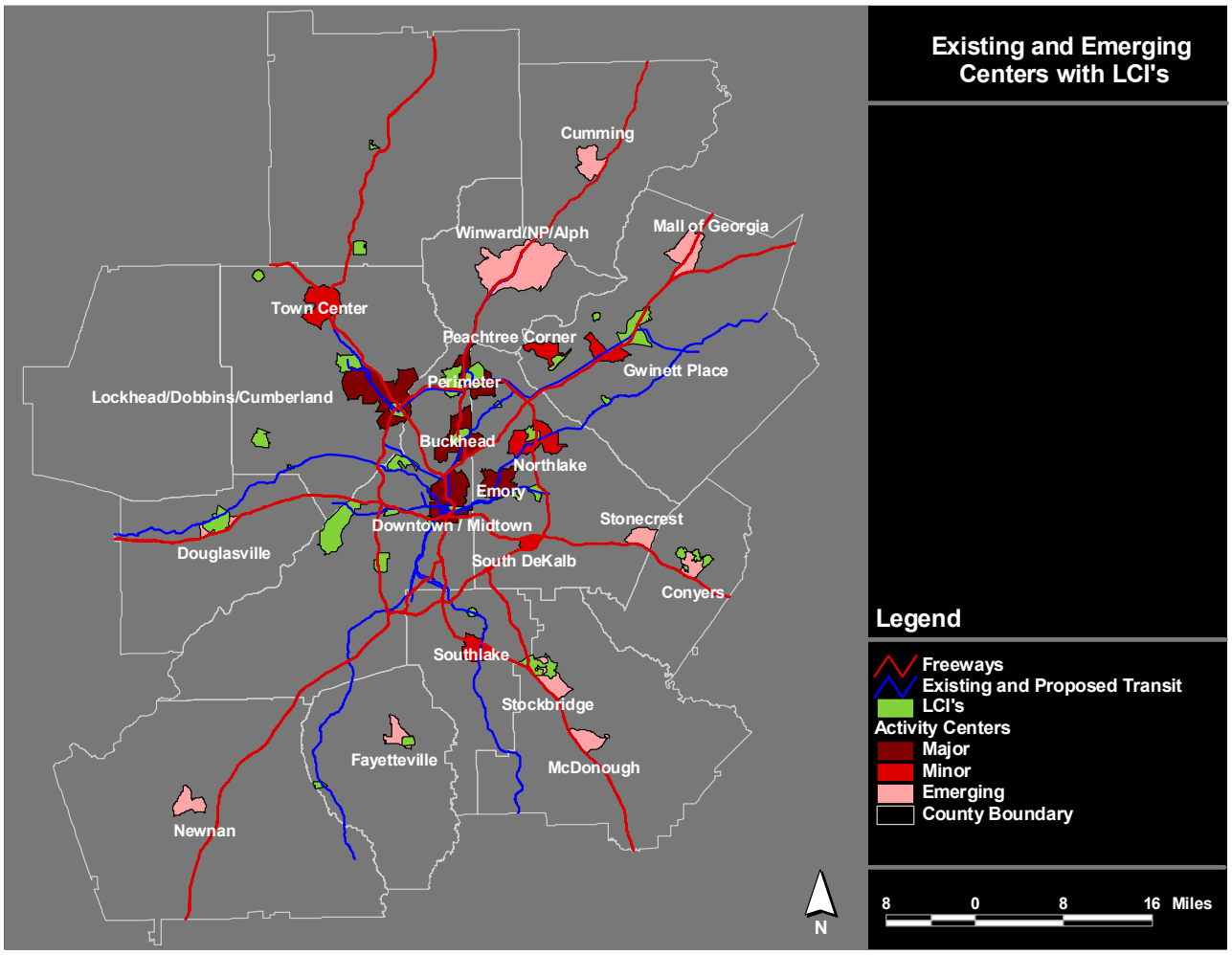


Figure XVIII: Existing and Emerging Centers and LCI Projects



centers in each county, and providing for a better balance of centers in the northern and southern portions of the region. In each case, these centers also had the largest concentration of office and commercial space in their respective counties (refer to **Figure XIV**).

After all of this analysis, it is possible to map existing and emerging activity centers. This scenario identifies 21 activity centers in the region; five major, six minor and ten emerging. These centers are shown in **Figure XVIII** which also shows Livable Centers Initiative (LCI) projects that are efforts by local governments in coordination with regional government to provide the transportation infrastructure necessary to accommodate additional population and employment growth. While the provision of this infrastructure is preferable in all activity centers, they are especially beneficial in outlying, emerging centers where such infrastructure is generally lacking.

Allocating Population and Employment Growth

After delineating existing and emerging activity centers, it was necessary to find the amount of developable land in each that can accommodate population and employment growth. To determine this, two types of land were used: vacant and redevelopable land. Vacant land takes on one of two forms; it is either agricultural or forest land (*open space*: this is the vacant land used in the other two scenarios) or land that is currently undeveloped (*infill*). The need to use two different types of vacant land comes from the fact that many existing activity centers lack any open space while outlying emerging centers often lack infill acreage. Both of these vacant acreages were calculated for each activity center, and the larger of the two was selected. Potential redevelopable land was identified as land parcels with structures built before 1960. This suggests these structures will be taken down and replaced with a new structure. For this scenario, 75 percent of the total redevelopable land was used to accommodate development, not the entire available stock.

Allocating Population

Once the amount of vacant and redevelopable land was calculated, population growth was allocated to each center. In each center, 70 percent of all available vacant and redevelopable land was allocated to residential development while the remaining 30 percent was used for employment growth. These proportions are equal to those in the City of Decatur. Decatur is widely recognized in the Atlanta metro region as a good example of a mixed use community. Their land use mix is approximately 70 percent residential, 10 percent commercial and 8 percent industrial. However, because the focus of an activity center is on employment concentration, dedicating only 18 percent of available land to employment seemed low. Taking the 70 percent residential space, the remaining 30 percent was allocated for employment growth.

To determine the residential densities in each activity center, current densities were calculated and summed by the type of center. Rather than taking these actual numbers, which were typically in the neighborhood of 1 to 4 dwelling units per acre, these numbers were used to scale higher densities. To do this, a reasonable density had to be determined for each type of center (major, minor, emerging). For Downtown and Midtown, 35 du/acre were assumed. Using the scale found earlier from existing densities, 35 dwelling units was scaled down for each additional type of center. It is important to note that even though Downtown/Midtown is a major center, other major centers were not assigned 35 du/acre because they lack the high density seen in the Downtown area. The result was 25 du/acre for all other major activity centers, 20 du/acre in minor activity centers and 15 du/acre for emerging activity centers. *These densities pertain to densities for each new development on the vacant or redevelopable land parcel, they are not*

the overall densities for the entire center.

Additionally, a regional vacancy of 8 percent was assumed throughout as was the regional average of 2.73 persons per household. The regional vacancy rate was assumed to impart a dose of reality in this scenario. The fact is that these densities may not be met in all new developments.

Population Allocation

Table 10 shows that **1,073,819** incoming residents can be accommodated within all 21 activity centers using the above stated assumptions. This represents **96 percent** of the projected population growth by 2025. The remaining 4 percent is dispersed evenly throughout the region. The top three activity centers for population growth are Downtown/Midtown, Windward, and Buckhead, respectively.

This is primarily due to the extensive amount of developable land found in each of these centers. An additional factor are the assumed densities; if the Mall of Georgia or Windward were at similar densities as major employment

Table 10: Population Allocation Results

Name	Type	Total Acerage	Total Developable Land	70% for Res. Use	Assumed Res. Density (DU/ Acre)	Additional DU	Assumed Vacancy	Additional Population
Downtown / Midtown	Major	8,535	2,286	1,600	35	56,000	4,474	152,881
Lockhead/Dobbins/Cumberland	Major	14,601	1,204	843	25	21,075	1,684	57,534
Perimeter	Major	6,882	946	662	25	16,554	1,323	45,193
Buckhead	Major	7,753	2,603	1,822	25	45,555	3,640	124,364
Emory	Major	4,536	1,226	858	25	21,448	1,714	58,552
Town Center	Minor	5,684	796	557	20	11,145	891	30,427
Gwinett Place	Minor	2,792	804	563	20	11,262	900	30,746
Peachtree Corner	Minor	3,070	587	411	20	8,212	656	22,419
Northlake	Minor	6,295	930	651	20	13,015	1,040	35,530
South DeKalb	Minor	1,178	204	143	20	2,863	229	7,815
Southlake	Minor	3,081	469	328	20	6,564	524	17,920
Douglasville	Emerging	2,588	972	680	15	10,207	816	27,866
Stockbridge	Emerging	4,433	1,589	1,113	15	16,689	1,333	45,561
Windward/NP/Alph	Emerging	16,766	4,759	3,331	15	49,970	3,993	136,419
Mall of Georgia	Emerging	5,177	2,732	1,913	15	28,690	2,292	78,324
Conyers	Emerging	2,403	772	540	15	8,102	647	22,118
Stonecrest	Emerging	2,384	1,324	927	15	13,903	1,111	37,954
Newnan	Emerging	2,864	757	530	15	7,946	635	21,694
McDonough	Emerging	2,703	1,714	1,200	15	17,994	1,438	49,125
Cumming	Emerging	3,540	1,754	1,228	15	18,417	1,471	50,277
Fayetteville	Emerging	2,335	736	515	15	7,729	618	21,099
Total		109,601	29,164	20,415		**393,340**	**31,428**	**1,073,819**

Table 11: Employment Allocation Results

Name	Type	Total Acerage	Total Developable Land	30% for Employment	Assumed Employment Density	Additional Employment
Downtown / Midtown	City Center	8535	2286	686	150	102,858
Lockhead/Dobbins/Cumberland	Major	14601	1204	361	125	45,160
Perimeter	Major	6882	946	284	125	35,473
Buckhead	Major	7753	2603	781	125	97,617
Emory	Major	4536	1226	368	125	45,959
Town Center	Minor	5684	796	239	75	17,912
Gwinett Place	Minor	2792	804	241	75	18,100
Peachtree Corner	Minor	3070	587	176	75	13,198
Northlake	Minor	6295	930	279	75	20,916
South DeKalb	Minor	1178	204	61	75	4,601
Southlake	Minor	3081	469	141	75	10,549
Douglasville	Emerging	2588	972	292	50	14,582
Stockbridge	Emerging	4433	1589	477	50	23,842
Windward/NP/Alph	Emerging	16766	4759	1428	50	71,386
Mall of Georgia	Emerging	5177	2732	820	50	40,986
Conyers	Emerging	2403	772	231	50	11,574
Stonecrest	Emerging	2384	1324	397	50	19,861
Newnan	Emerging	2864	757	227	50	11,352
McDonough	Emerging	2703	1714	514	50	25,706
Cumming	Emerging	3540	1754	526	50	26,309
Fayetteville	Emerging	2335	736	221	50	11,041
Total		**109601**	**29164**	**8749**		**668,984**

centers, these centers would see the largest growth under this analysis. Given that Windward is considered by the ARC as a regional center, this suggests that Windward might become one of the more prominent centers in the future.

Allocating Employment

To apportion employment, the same vacant and redevelopable acreages were used as discussed earlier in the Population section. Thirty percent of the vacant and redevelopable land was used for employment. After research on typical employees per acre was conducted, 150 employees per acre was used for the city center, 125 employees per acre for major activity centers, 75 employees per acre for minor centers and 50 employees per acre for emerging centers. These numbers are used by New Jersey as guidelines for transit oriented development (TOD) in heavy rail and rapid bus service environments. The reason for assuming the existence of TOD development is that many centers are currently served by transit, and emerging centers are proposed to be served by transit over the next 5 years in the Atlanta region through the regional express bus program. It seems appropriate to assume densities that will support these investments in transit.

Employment Results

At the assumed densities, a total of **668,984** employees can be placed into current activity centers. This represents **89 percent** of employment projected for

2025. The remaining 11 percent is dispersed evenly throughout the region. Similar to the population allocation, Downtown/Midtown, Buckhead and Windward absorb the largest portions of this employment growth. These results can be seen in **Table 11**.

Conclusions: Activity Centers Before and After Allocations

An important aspect of this analysis is determining the legitimacy of the assumed densities. To determine this it is useful to examine densities before and after the population and employment allocations. **Table 12** on the following page shows the household, population and employment densities before and after allocation. One key aspect is the resulting household densities in the activity centers. The highest density in any tract is 12.54 du/acre in Downtown and Midtown, while no emerging center indicates a density above 7.09 du/acre. Given that the typical 3-story garden style apartment is about 25 du/acre, this shows that the average densities throughout the selected activity centers are reasonable. For example, 12 du/acre is typical of two story apartments and 7 du/acre can be achieved in row housing.

In contrast, many of the resulting densities remain too low to support heavy rail transit (according to Peter Calthorpe, 12 du/acre are necessary) and generally too low for bus (around 7 to 8 du/acre). Of course, the major reason for this is that the activity centers are far too large to be analyzed on this level. TOD areas generally have a radii of one-

Table 12: Densities Before and After Allocations

Name	Type	Year 2000			Year 2025			Percentage Change In Density		
		HU Density	Pop Density	Emp Density	HU Density	Pop Density	Emp Density	HU	Pop	Emp
Downtown / Midtown	City Center	4.4	9.3	25.2	10.9	27.3	37.3	151%	192%	48%
Lockhead/Dobbins/Cumberland	Major	2.1	4.2	7.8	3.5	8.2	10.9	69%	93%	40%
Perimeter	Major	2.2	3.9	12.8	4.6	10.5	18.0	111%	169%	40%
Buckhead	Major	3.3	6.2	9.9	9.2	22.2	22.5	178%	260%	127%
Emory	Major	2.4	5.3	7.8	7.2	18.2	18.0	193%	243%	129%
Town Center	Minor	0.8	1.7	4.0	2.8	7.1	7.1	242%	307%	79%
Gwinett Place	Minor	2.5	5.8	3.2	6.5	16.8	9.7	162%	191%	203%
Peachtree Corner	Minor	1.0	2.2	8.0	3.7	9.5	12.3	264%	327%	54%
Northlake	Minor	1.4	3.2	5.0	3.4	8.9	8.3	151%	176%	67%
South DeKalb	Minor	1.6	4.1	0.9	4.0	10.8	4.9	152%	161%	412%
Southlake	Minor	1.3	3.5	3.4	3.4	9.3	6.9	165%	167%	100%
Douglasville	Emerging	0.7	1.9	1.1	4.7	12.6	6.7	536%	580%	521%
Stockbridge	Emerging	1.0	2.4	0.6	4.7	12.7	6.0	384%	429%	858%
Winward/NP/Alph	Emerging	1.0	2.5	1.5	4.0	10.7	5.8	287%	320%	279%
Mall of Georgia	Emerging	0.3	0.9	0.9	5.9	16.1	8.8	1592%	1608%	868%
Conyers	Emerging	1.4	3.5	0.6	4.8	12.7	5.4	243%	261%	803%
Stonecrest	Emerging	0.4	1.0	0.6	6.2	16.9	8.9	1453%	1673%	1426%
Newnan	Emerging	1.3	3.4	0.3	4.1	11.0	4.2	215%	221%	1450%
McDonough	Emerging	1.0	2.5	0.5	7.7	20.7	10.0	654%	715%	1763%
Cumming	Emerging	0.5	1.3	0.6	5.7	15.5	8.1	1104%	1065%	1186%
Fayetteville	Emerging	0.5	1.2	0.4	3.8	10.2	5.1	681%	745%	1183%
Average		**1.7**	**3.7**	**6.1**	**5.3**	**13.5**	**12.2**	**210%**	**264%**	**99%**

half mile, far smaller than these activity centers which on the low end are upwards of 1 to 2 miles in diameter. This suggests that a concerted effort must be given to placing these densities in the correct nodal locations, especially around current and potential transit stations. This is of greater importance in the largest centers such as Cumberland/Dobbins/Lockhead and Windward/North Point/Alpharetta.

However, an area of concern is the political feasibility of such a growth pattern. Will outlying counties without centers like Cherokee and Paulding support such a regional growth strategy? Furthermore, will these types of densities be embraced by local governments? This issue will be particularly important in outlying counties where exceptions to denser development patterns are often the norm. Lastly, while the densities used in this analysis are debatable, the proposition that 75% of all buildings built before 1960 in activity centers (redevelopable land) will be replaced by 2025 may not be. If redevelopable land is ignored and **only vacant land is used**, 652,065 residents and 380,850 employees can be accommodated in the 21 centers. This represents **58.5** percent of the projected population and **50.9** percent of projected employment. These results indicate that a substantial amount of growth can be absorbed by activity centers if efforts are made to increase infill development and encourage higher densities within centers throughout the region.

DEMOGRAPHIC IMPACTS

While the three previous sections concentrated on the scenarios and their population and employment allocations, this section considers the impacts these land use patterns will have. The three scenarios developed through this studio will be assessed and will be compared with the ARC's 2025 RDP/RTP and the current land use pattern termed Census 2000. Comparisons to Census 2000 assesses whether the scenario's land use patterns leave us better off, worse off, or about the same as today. The ARC's 2025 population and employment projections provide a baseline future land use pattern incorporating concepts seen in each scenario, but is held in check by political constraints and feasibility. This is the first of three impact sections which seek to quantify the effects of these land use patterns. In this section, demographic-related impacts will be considered including population densities, jobs-housing balance and economic justice. The following two sections will evaluate environmental and transportation impacts, respectively.

Population Density

Population density was calculated to determine how dense the metro region will become under each scenario. There are two primary reasons for this analysis. The first is to understand which areas of the region become more dense under each scenario. The second is to take a more holistic view and evaluate the density distribution of each scenario. For this distribution, classification ranges were created to represent the number of persons per acre within each census tract. **Table 13** on the following page gives an overview of the population density distribution in the region. For this distribution, four density classes have been used: 0-4, 4-10, 10-20 and more than 20 people per acre

The centers scenario has the highest percentage of the three studio scenarios in the highest (10 to 20 persons per acre) range. This is largely due to the fact that population and employment were concentrated into relatively small areas at higher densities in this scenario. Even considering this high-density allocation technique, the 0-4 density distribution contains the proportion of population with 65.4 percent. This is true of all the scenarios, in effect demonstrating an "inertia" effect; even extreme land use scenarios are limited by what is on the ground today. The 1.1 million new residents predicted for 2025 is only about one-quarter of the existing population in the region.

Census 2000 has 30.7 percent of its population in the 4 to 10 persons per acre category. The centers scenario having the smallest percentage at 29.7 percent. The environmental and corridors scenarios both provided an increase in this category over the Census 2000 scenario. However, there is a noticeable difference at the highest density range of 20 or more persons per acre. The centers scenario shows the largest percentage living at this density range indicating a significant increase from the current pattern. The environmental and corridors scenarios also saw a slight increase in the 20 or

Table 13: Population Density Distribution

Persons per Acre	Census 2000	% of Total	ARC 2025	% of Total	Environmental 2025	% of Total	Corridors 2025	% of Total	Centers 2025	% of Total
0 to 4	2,411,038	65.2%	3,453,021	71.7%	3,123,984	64.9%	3,076,612	63.9%	3,150,318	65.4%
4 to 10	1,136,982	30.7%	1,210,356	25.1%	1,516,739	31.5%	1,554,728	32.3%	1,428,276	29.7%
10 to 20	144,399	3.9%	142,648	3.0%	166,178	3.5%	175,207	3.6%	224,586	4.7%
20+	6,260	0.2%	7,575	0.2%	6,699	0.1%	7,053	0.1%	10,420	0.2%

more persons per acre category over Census 2000.

As seen in the corridors scenario map shown in **Figure XX** on the following page, density follows along the lines of transportation networks as opposed to the environmental scenario which focuses population density in developable areas protecting precious resources. The centers scenario situates density in existing and emerging centers explaining its scattered pattern of low and high densities. **Figure XIX** shows the Census 2000 distribution.

Figure XIX: Census 2000 Population Distribution

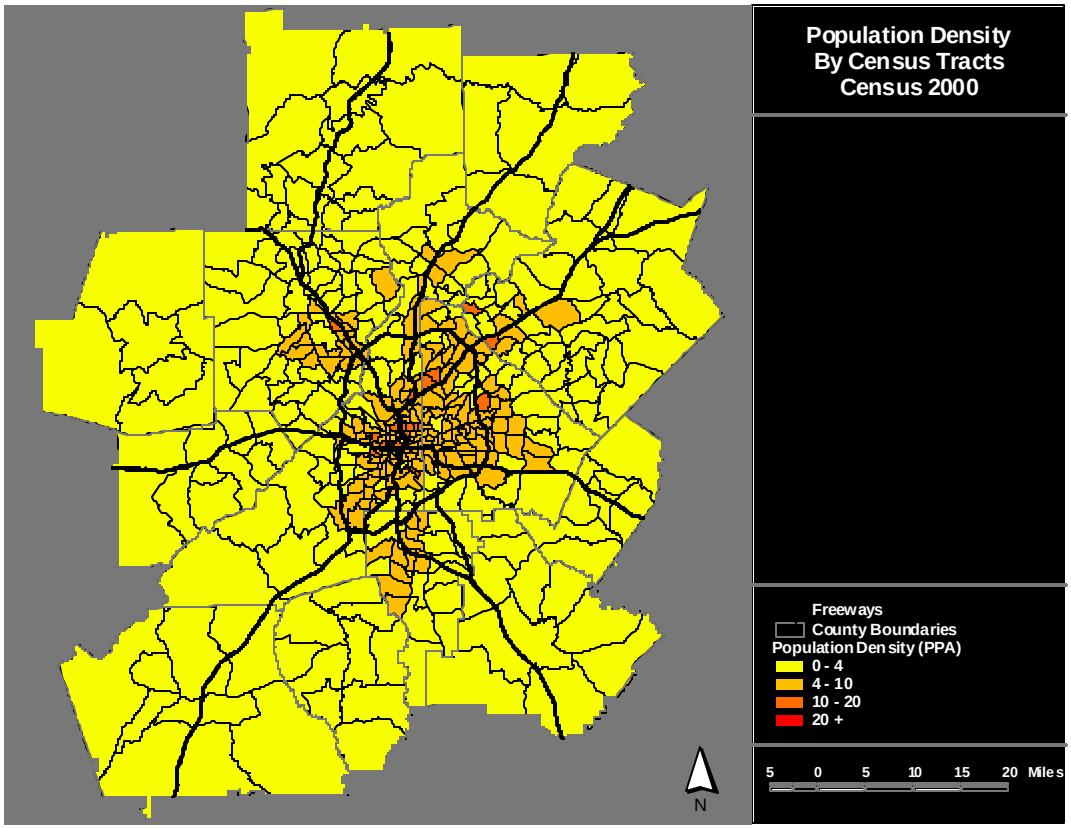


Figure XX: Population Density, Future Scenarios

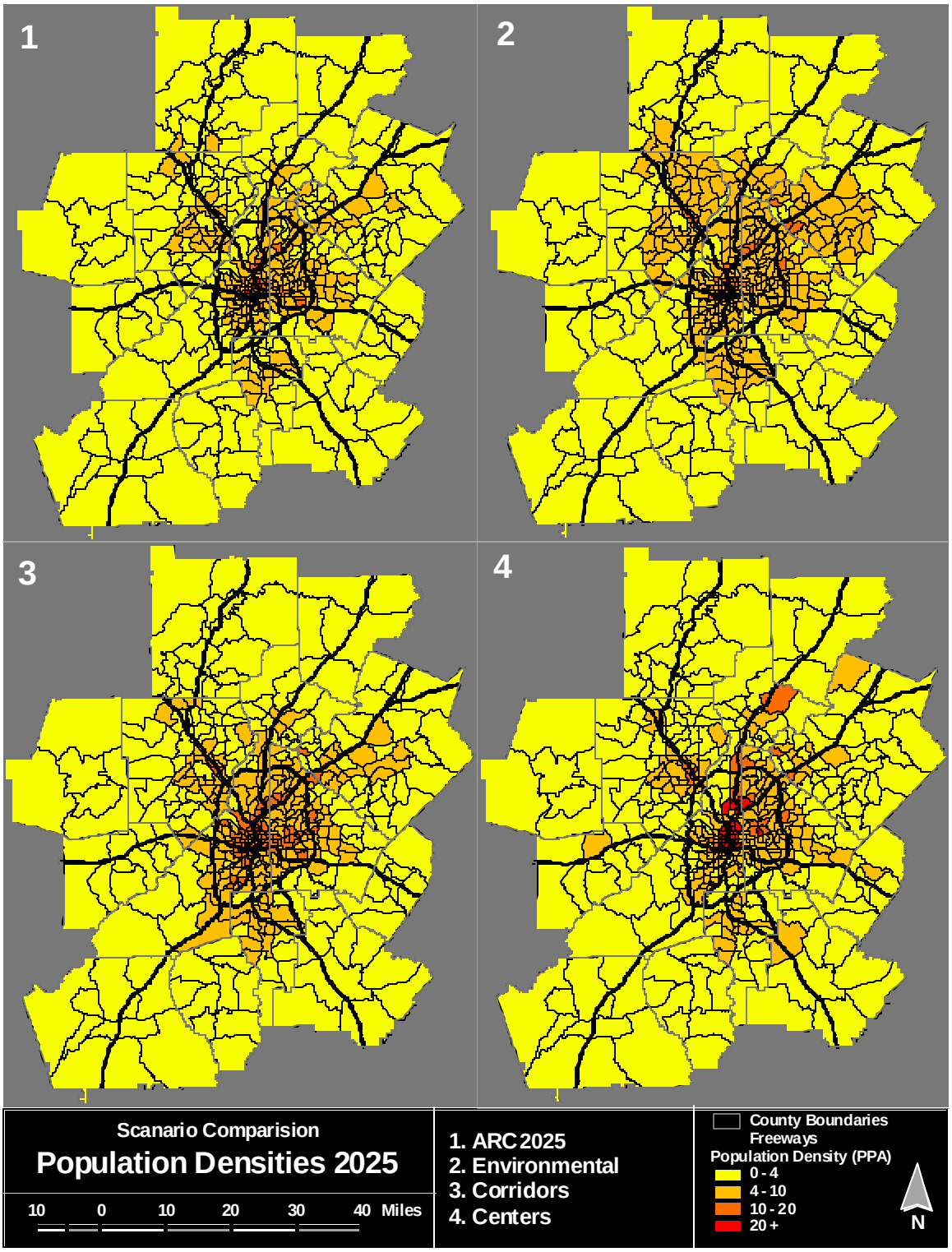


Table 14: Jobs-Housing Balance, All Scenarios

Jobs Housing Balance	Census 2000 % of Total Population	ARC 2025 % of Total Population	Environmental 2025 % of Total Population	Corridors 2025 % of Total Population	Centers 2025 % of Total Population
0 - 0.80 (Housing-Rich)	32.70%	26.10%	13.20%	22.30%	22.60%
0.80 - 1.50 (Balanced)	34.90%	43.50%	48.00%	40.80%	39.60%
1.50+ (Jobs-Rich)	32.40%	30.40%	38.80%	36.90%	37.80%

Jobs-Housing Balance

Similar to other metropolitan regions in the country, much of the Atlanta region has an imbalance between the number of jobs available and the number of housing units nearby. More jobs tend to be situated in areas where there is a large housing shortage and less jobs tend to be situated in areas with a large number of housing units.[3] Areas with a housing surplus are considered suburban, low-density areas while areas consisting of a job surplus are normally in downtown areas or major activity centers. One beneficial aspect of striking a balance between the two is that in theory, a good jobs-housing balance will reduce the distance a resident would have to drive to his or her job. However, the matter of "fit" is also important; in other words do the jobs fit the people who live near them? While this is an important question to answer, it falls beyond the scope of this impact analysis, which strictly concentrates on a simple ratio of jobs to housing.

The Atlanta metro on the whole has a job-housing balance of 1.5 jobs per housing unit.[4] The ideal jobs-housing balance is defined differently by experts, but this analysis will consider the range of 0.8 to 1.5 jobs per housing unit to be in balance. Superdistricts were used instead of census tracts for this measure because they represent an appropriate size area to measure this phenomenon. After all, one cannot expect a neighborhood to have a jobs-housing balance, but balance within a county could still produce long commutes. Superdistricts are larger than census tracts yet smaller than counties. While this may not be the perfect geographic unit to consider jobs-housing balance, there is little research available to define the appropriate scale. **Table 14** outlines the total population that falls within each jobs-housing category ranges. The range from 0 to 0.8 indicates a housing-rich area, 0.8 to 1.5 shows a balance between jobs and housing and 1.5 and above shows that the area is job-rich.[5]

[3] Downs, Anthony. Stuck in Traffic: Coping With Peak-Hour Traffic Congestion. Brookings Institution: Washington, DC. 1992: 98.

[4] French, Steven P. "Optimizing the Land Use Mix: Which Uses, What Techniques?" ACSP Annual Conference: Chicago. October 21, 1999.

[5] Cervero, Robert. "Jobs-Housing Balance Revisited: Trends and Impacts in the San Francisco Bay Area." Journal of the American Planning Association. 62 (1996): 499.

The number of housing units was estimated by dividing total population by 2.6, the average number of persons per household in the region. **Table 14** shows the total population of the region that is situated in each jobs-housing range. Examining across all three scenarios and the ARC in comparison to Census 2000, it can be concluded that all of the future scenarios are more balanced than the current pattern. The environmental scenario shows the greatest percentage of population situated in areas with a jobs-housing balance. The centers scenario appears to have a somewhat even distribution between being balanced and jobs-rich. All three scenarios and the ARC 2025 show increases in population situated in balanced areas as well as jobs-rich areas.

Figure XXI shows the jobs-housing balance in 2000, while **Figure XXII** shows jobs-housing for the other four evaluative scenarios. Generally, about 17 superdistricts have a jobs-housing balance of 1.5 or more concentrated in areas mainly in the northern sections of Fulton and DeKalb counties. This holds true throughout all three scenarios for 2025 as well as what ARC has projected for 2025. However, the ARC and the

Figure XXI: Census 2000 Jobs -Housing Balance

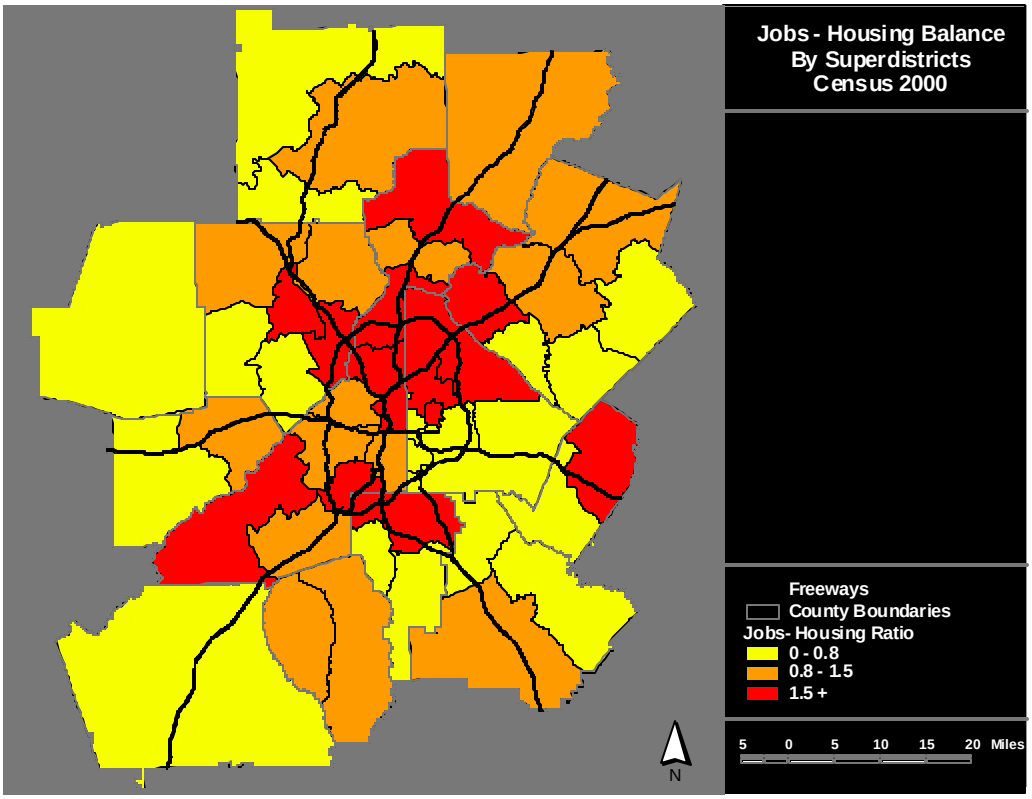
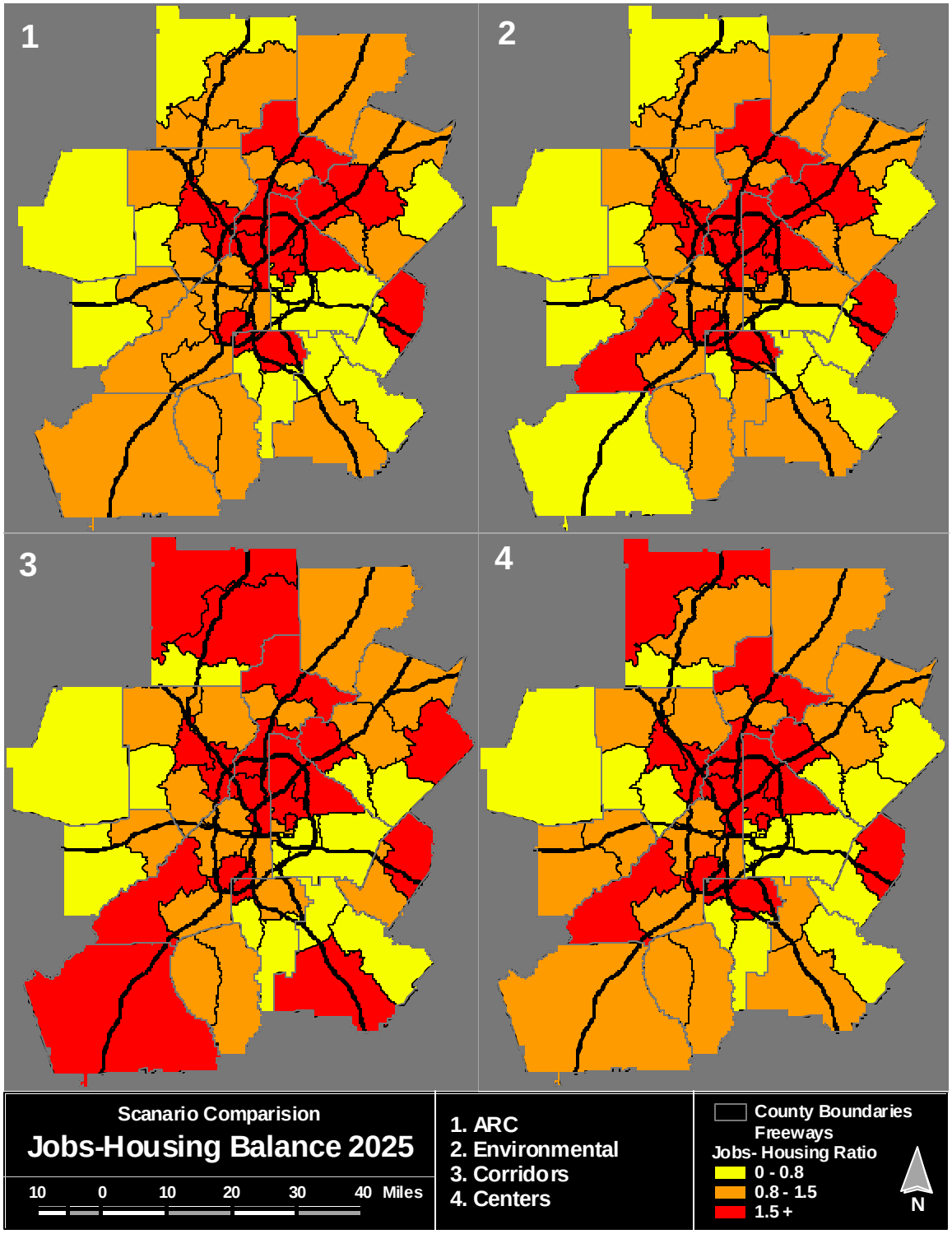


Figure XXII: Jobs Housing Balance, Future Scenarios



environmental scenarios are very similar and do not change much from the 2000 pattern. What does show a dramatic change is the corridors scenario where population and employment growth were concentrated along major transportation networks. This allowed for the high jobs-housing balance in certain areas such as Coweta County to the south and Cherokee County to the north. This balance occurs in Coweta county primarily because of the growth that was placed along the future commuter transit line while in Cherokee County, growth was allocated along the proposed Northern Arc.

Jobs and Housing Within ½-mile of Transit Stations

Traditionally in the Atlanta metro region, transit use has been associated with low-income groups prompting many middle class citizens to view the MARTA system as unsafe and inefficient. However, with the recent trend of concentrating jobs and housing near transit stations, there is potential to increase transit use providing improved accessibility across the region. The degree to which each scenario provides access to transit locations provides a measure of how well the region can support alternatives to the automobile. It must be noted that existing and future transit stations were considered and the evaluation of the number of jobs and housing within a ½-mile of a transit station will be impacted by the station locations. As with the calculation of jobs-housing balance, housing was calculated by dividing population by 2.6 that is considered to be a reasonable average household size.

Currently, there is more employment within close proximity to transit stations than housing as seen throughout all four 2025 scenarios. This is shown below in **Table 15**. The ARC scenario has the most jobs and least housing near transit. The Centers scenario has nearly as many jobs, and more housing units. The environmental scenario, which did not focus on transportation issues, has the smallest number of jobs or housing near transit.

Jobs North and South of I-20

Historically, Interstate 20 has been the socioeconomic divide for the Atlanta region. In recent years, growth in development predominantly occurred in the northern part of the region. "There is not only a north-south divide in the

Table 15: Census 2000, Jobs and Housing Within ½ Mile of Transit Stations

Category	Census 2000	ARC 2025	Environmental 2025	Corridors 2025	Centers 2025
Housing	72,915	91,119	97,307	118,893	125,946
Jobs	328,358	428,424	370,907	390,592	427,553

number of jobs, but also in the kind of jobs." [6] More focus is based on leveraging employment in the north primarily due to the influence of employers choosing, "wealthier suburban locations because of the 'pull' of residential suburbanization and the 'push' of high taxes, regulatory constraints, and public service inefficiencies in the city and aging suburbs." [7] However, if jobs were to be situated in the south, it would reduce commute time as well as address the issue of economic justice. The placement of jobs south of I-20, especially in fast growing counties to the south such as Henry County, would also allow for easier commute times. Despite being a major provider of jobs to the Atlanta Metro region, the location of Hartsfield below I-20 does not make up for the number of jobs located in the northern part of the region.

Table 16 indicates differences between scenarios for jobs north and south of I-20. Across each scenario, a greater number of jobs are situated in the north than in the south with an average range of about 77%. As for the southern part of the region, it appears to be fairly consistent throughout each scenario at about 23% of the region's employment. The Corridors scenario placed the smallest percentage of jobs north of I-20 and the largest number of jobs south of I-20. This is because employment was concentrated along corridors south of I-20 also with little difference from the existing employment distribution.

Table 16: Jobs North and South of I-20

Geographic Region	Census 2000	% of Total Jobs	ARC 2025	% of Total Jobs	Environmental 2025	% of Total Jobs	Corridors 2025	% of Total Jobs	Centers 2025	% of Total Jobs
North	1,596,884	77.2%	2,158,514	76.7%	2,191,690	77.8%	2,019,066	71.7%	2,177,351	77.3%
South	470,516	22.8%	656,794	23.3%	623,618	22.2%	796,242	28.3%	637,957	22.7%

[6] Center on Urban and Metropolitan Policy. Moving Beyond Sprawl: The Challenge for Metropolitan Atlanta. Brookings Institution: Washington, DC. 2000: 19.
[7] Center on Urban and Metropolitan Policy. p. 19.

ENVIRONMENTAL IMPACTS

Environmental factors and natural resources are important to the overall health of the Atlanta region. Not only do natural resources effect the overall health of an ecosystem, they can also be strong determinants in economic growth and development. This is especially true in the Atlanta region, where poor air quality resulted in a temporary loss of hundreds of millions of federal transportation dollars in 1999, and where degraded water quality may lead to further action by the EPA in the future. For this reason, the students in this studio have undertaken a comparison of each of the potential scenarios with respect to four of the region's most important environmental factors. These measures are[8]:

- Amount of **open space** consumed (including forested and agricultural areas);
- Population and employment located within **Small Water Supply Watersheds**;
- **Public Wastewater Treatment** (Sewer) availability; and
- Population and employment inside and outside of the urbanized **"Delta"** (shown in "A Greener Way to Grow", pg 14).

Each scenario distributes population and employment differently throughout the region. The goal of these comparisons is to evaluate each scenario based their impacts upon the natural resources of the region.

[8] We assume that the population and employment for each scenario is uniformly spread within each census tract.

Open Space

Population and employment growth can consume large amounts of agricultural land, forest habitat and scenic land. In recent years, no region in the country has seen such a loss in open space as metro Atlanta.

This measure focuses on census tracts within the region that currently have a large percentage of agricultural and forested land. Tracts with less than 20 percent open space are considered urbanized, with open space relegated to parks and recreational areas. Areas with 20 to 60 percent of open space are generally found in moderately developed suburban areas like portions of Cobb County. Those tracts that have greater than 60 percent of their total area in open space are typically rural and are located closer to the periphery of the region.

Table 17 shows census tracts grouped by the amount of open space they contain. The most important row is the bottom one which shows how each scenario allocates population to "rural" census tracts. The higher the percentage of growth in the census tracts, the more likely it is that the scenario is consuming significant amounts of open space. The ARC 2025 scenario consumes the most open space with 16 percent of its population allocated to these outlying census tracts. The Corridor and Environmental scenarios are the two top performers and are the only two scenarios that have a smaller proportion of the region's population in rural tracts than is seen today.

Table 17: Population Allocation and Open Space by Census Tract

% Open Space	Census 2000	ARC 2025	Environmental 2025	Corridors 2025	Centers 2025
0%-10%	1,046,897 (28%)	1,113,184 (23%)	1,349,086 (28%)	1,486,888 (31%)	1,503,371 (31%)
10%-20%	562,100 (15%)	624,516 (13%)	838,700 (17%)	803,315 (17%)	594,746 (12%)
20%-40%	1,061,564 (29%)	1,357,589 (28%)	1,312,402 (27%)	1,445,518 (30%)	1,309,735 (27%)
40%-60%	614,326 (17%)	952,963 (20%)	818,333 (17%)	664,087 (14%)	848,446 (18%)
60%-80%	413,792 **(11%)**	765,348 **(16%)**	495,079 **(10%)**	413,792 **(9%)**	557,302 **(12%)**
Total	3,698,679	4,813,600	4,813,600	4,813,600	4,813,600

Small Water Supply Watersheds

Small water supply watersheds surround the periphery of the region as seen in **Figure III**. Limiting development inside small water supply watersheds will serve to protect public drinking waters. It also helps to reduce costs for local governments by reducing the amount of treatment needed before the water is consumed by residents. Channeling future population and employment growth outside of these watersheds is the best method to ensure that the quality of drinking water is maintained or improves.

To address this measure, population and employment was divided into two parts: areas within the small water supply watershed and areas not within the watershed. The Environmental scenario has the smallest percentage of its population within the small water supply watersheds because they were explicity excluded from future allocation within that scenario. The ARC 2025 scenario shows the smallest growth in population within the watersheds and appears to be the best alternative after the Environmental scenario. These two scenarios also perform the best in terms of employment allocation within the watersheds. The Corridors and Centers scenarios allocate a greater percentage of employment in these watersheds. However, one very important observation comes from this table; the difference between the Census 2000 scenario and the future scenarios is very small, suggesting that an additional 1.1 million people is not enough growth to sway the proportion of the region's population or employment that is located in watersheds in any direction. This becomes especially obvious when looking at the Environmental scenario for which small water supply watersheds received no new growth. In this scenario the share of residents and employees in these watersheds changes by 1 percent and 2 percent, respectively from where it

Table 18: Population and Employment in Small Supply Watersheds

Population (Percent of Total Population)	Census 2000	ARC 2025	Environmental 2025	Corridors 2025	Centers 2025
Inside Watersheds	389,803 (11%)	551,019 (11%)	435,611 (9%)	553,739 (12%)	593,470 (12%)
Outside Watersheds	3,308,876 (89%)	4,262,581 (89%)	4,377,989 (91%)	4,259,861 (88%)	4,220,130 (88%)
	3,698,679	4,813,600	4,813,600	4,813,600	4,813,600
Employment (Percent of Total Population)	**Census 2000**	**ARC 2025**	**Environmental 2025**	**Corridors 2025**	**Centers 2025**
Inside Watersheds	169,869 (8%)	243,138 (9%)	200,598 (7%)	281,957 (10%)	284,526 (10%)
Outside Watersheds	1,897,531 (92%)	2,572,170 (91%)	2,614,710 (93%)	2,533,351 (90%)	2,530,782 (90%)
	2,067,400	2,815,308	2,815,308	2,815,308	2,815,308

stands today. These percentages can be seen in **Table 18**.

Public Wastewater Treatment (Sewer)

The cost of additional infrastructure to local governments is always an important fiscal issue and when inefficient, reduces the amount of growth a county or municipality can accomodate. Growth may also overwhelm existing facilities and cause effluent to be released into streams untreated. As seen with the City of Atlanta's Combined Sewer System, overflows of this type can be harmful to stream and river health adding fecal coliform bacteria into surface water supply as well as other substances harmful to human health.

While the total usage will rise, additional capacity could be added at lower costs to both taxpayers and the environment. Increasing population and employment in unsewered areas can intrinsically lead to spread out development patterns. This is due to the large lot size needed per unit for septic systems. This pattern of development can deplete forested areas as well as create fragmentation in wildlife habitats.

Table 19 shows the figures for population and employment within sewered and unsewered areas. The 2000 Census scenario shows that only 20 percent of the total population of the region currently lives in areas that are unsewered. The ARC 2025 projection places 26 percent of the total future population within areas that are currently unsewered, increasing the number of additional residents by almost 500,000. Each of the three scenarios developed in this studio place the same proportion of the population or less within unsewered areas with the Environmental scenario showing the smallest share. While little changes in terms of population, the employment allocation in the ARC, Corridor and Center scenarios all show

Table 19: Population and Employment in Sewered and Unsewered Areas

Population (Percent of Total Population)	Census 2000	ARC 2025	Environmental 2025	Corridors 2025	Centers 2025
Unsewered Area	755,731 (20%)	1,253,384 (26%)	824,647 (17%)	949,928 (20%)	946,832 (20%)
Sewered Area	2,942,948 (80%)	3,560,216 (74%)	3,988,953 (83%)	3,863,672 (80%)	3,866,768 (80%)
Total	3,698,679	4,813,600	4,813,600	4,813,600	4,813,600
Employment (Percent of Total Population)	**Census 2000**	**ARC 2025**	**Environmental 2025**	**Corridors 2025**	**Centers 2025**
Unsewered Area	232,677 (11%)	406,896 (14%)	278,906 (10%)	539,410 (19%)	370,050 (13%)
Sewered Area	1,834,723 (89%)	2,408,412 (86%)	2,536,402 (90%)	2,275,898 (81%)	2,445,258 (87%)
Total	2,067,400	2,815,308	2,815,308	2,815,308	2,815,308

small increases in the proportion of employment outside of sewered areas. The environmental scenario places more employment in sewered areas than the current 89 percent.

The "Delta"

This measure is a different way of analyzing open space consumption. While the first open space measure considered all census tracts, this measure only looks at the agricultural, forest and open space lands that line the periphery of the region. The delta was originally discussed and shown in the "Greener Way to Grow" scenario.

Land outside the Delta region is composed primarily of forested lands, very little of which is used for forestry practice. Primarily these forest lands serve as wildlife habitat and scenic views. Agricultural lands compose about one third this land and serve as food sources for the region and parts of north Georgia. Perhaps more importantly than these uses, these open space lands in the Delta serve to cool ambient air temperatures and reduce runoff. A key goal of any growth scenario in this region would be to limit the amount of development that takes place on these lands.

Table 20 shows the distribution of population and employment inside and outside of the Delta. Currently, 65 percent of the population of the region resides inside the Delta (Census 2000). The ARC 2025 scenario comes closest to emulating this pattern with 66 percent of its population within the Delta. The Environmental scenario places the majority of its population 84 percent inside the Delta, far more than any other scenario present or future. The Centers scenario is the least effective of the scenarios for limiting development to areas within the Delta with just over half of the region's population inside. However, the Centers scenario does

Table 20: Population and Employment Inside and Outside the Delta

Population (Percent of Total Population)	Census 2000	ARC 2025	Environmental 2025	Corridors 2025	Centers 2025
Inside Delta	2,393,190 (65%)	3,182,532 (66%)	3,508,111 (73%)	2,963,469 (62%)	2,660,755 (55%)
Outside Delta	1,305,489 (35%)	1,631,068 (34%)	1,305,489 (27%)	1,850,131 (38%)	2,152,845 (45%)
	3,698,679	4,813,600	4,813,600	4,813,600	4,813,600
Employment (Percent of Total Population)	**Census 2000**	**ARC 2025**	**Environmental 2025**	**Corridors 2025**	**Centers 2025**
Inside Delta	1,626,315 (79%)	1,975,657 (70%)	2,374,223 (84%)	2,032,736 (72%)	2,053,004 (73%)
Outside Delta	441,085 (21%)	839,651 (30%)	441,085 (16%)	782,572 (28%)	762,304 (27%)
	2,067,400	2,815,308	2,815,308	2,815,308	2,815,308

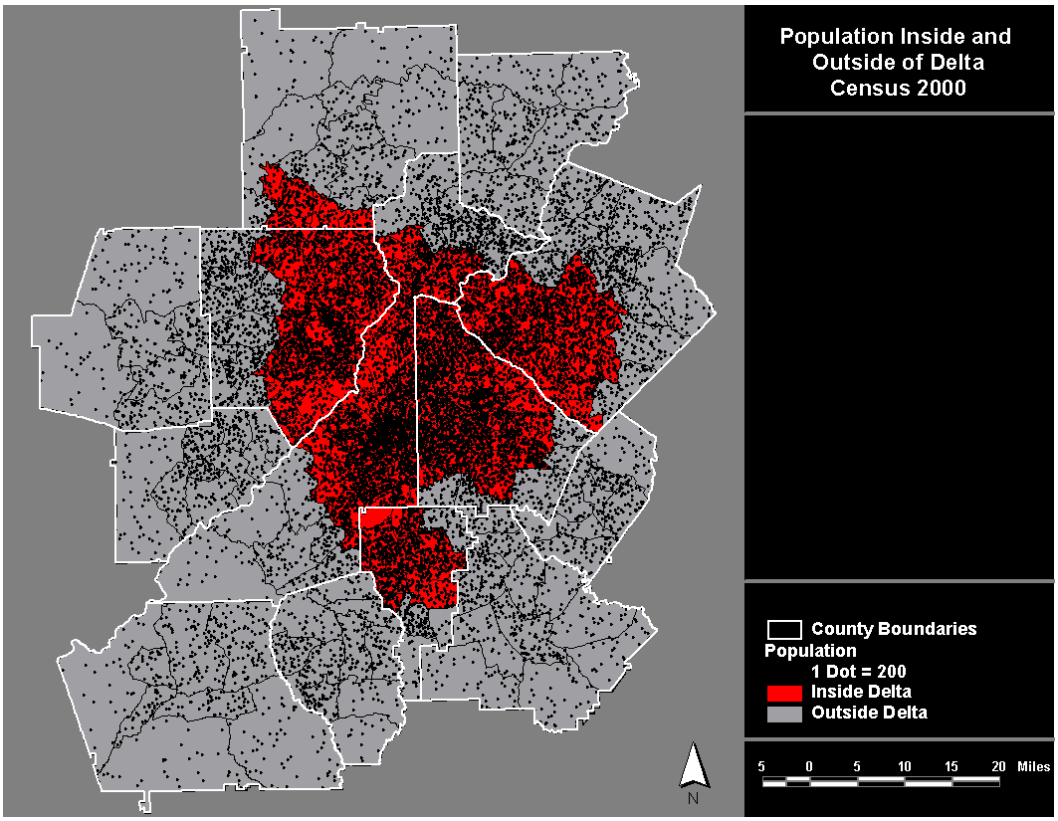
attempt to create dense conglomerations of population and employment that may reduce its impact on the environment in the periphery of the region. The corridor scenario falls in the middle of the three studio scenarios placing 62 percent of its growth in the delta, and much like the center scenario allocates population outside of the Delta in relatively dense linear patterns along corridors.

The employment allocation shows a similar but different situation. The environmental scenario places the most employment inside the Delta and Census 2000 shows the second largest share within the urbanized area. The ARC places the least employment within the Delta, an unexpected result considering that population share increased from 2000. The centers and corridors scenarios show very similar shares of employment within the Delta, even though they had a relatively large difference in the share of population.

Figure XXIII on the following page shows this tabular data in graphic form for the Census 2000 scenario. In this and the graphics in the future scenarios, the Delta is highlighted in red. The current development pattern shows large concentrations of population in Fulton and DeKalb counties, with the densest areas existing in Downtown and Midtown. Gwinnett and Cobb also show relatively dense development patterns.

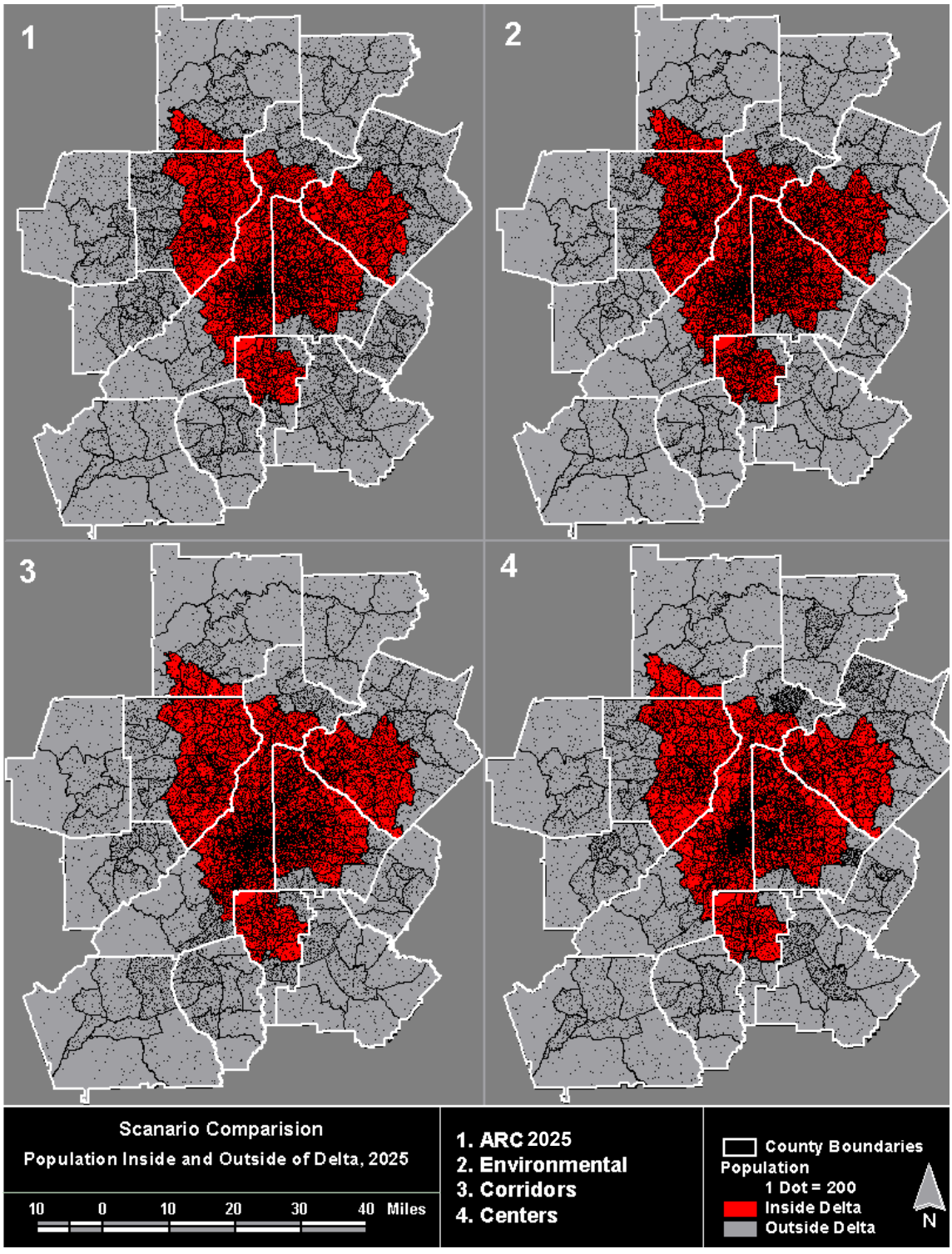
Figure XXIV shows all four future scenarios side by side. The ARC and environmental scenarios both show a fairly even distribution throughout the delta, despite the environmental scenario clearly having more residents inside than

Figure XXIII: Population Distribution Inside the Delta



outside. The corridor and center scenarios show exactly what the numbers above suggest. Although they place fewer residents inside the delta, those that are allocated outside of it were densely placed linearly or in nodes. This effectively reduces the impacts of these scenarios on the open spaces at the edge of the region. In the corridor scenario, it is difficult to see these denser development patterns. The centers scenario, by contrast, clearly show the densely populated centers both inside and outside of the Delta.

Figure XXIV: Population Allocation Inside the Delta, Future Scenarios



TRANSPORTATION IMPACTS

Transportation is arguably one of the most important issues facing Atlanta residents today. Estimates show key issues such as congestion and vehicle miles traveled (VMT) will continue to increase into the forseable future. This section looks at two important transportation issues, VMT and employment accessibility, and compares them across the five scenarios. However, these measures do more than evaluate transportation issues; they also contribute to environmental and equity issues which will be discussed below.

Vehicle Miles Travel (VMT)

In 1990, with the passage of the Clean Air Act, 13 counties in and around the City of Atlanta were designated as non-attainment zones. This meant that the Atlanta region did not meet the National Ambient Air Quality Standards (NAAQS) for ground level ozone. But, over the years the number of days that the region has violated the one-hour standard of ground level ozone has progressively decreased from 22 days in 1998 to 11 days in 2001. This decrease has been attributed to better weather conditions, cleaner fuels and cleaner-burning engines. Mobile source emissions from cars and trucks contribute about 56 percent of Nitrous Oxides (NOx) and 58 percent of Volatile Organic Compounds (VOC's), two of the key elements that make up ground level ozone. Since the emissions generated by cars and trucks are directly related to the number of vehicle miles they traveled (VMT), analyzing the scenarios based upon the VMT each one generates becomes a critical environmental measure. It helps in understanding whether a particular scenario will help the region attain its goal of achieving better air quality.

The four step urban transportation modeling system (trip generation, trip distribution, modal split, and trip assignment) typically used to calculate the VMT generated was difficult to duplicate for the purposes of this study. However, adopting a simpler technique approximated this process to give us a proxy measure of VMT for each scenario. Its assumptions and approach are listed below:

1. It was assumed that every resident in the metro region by 2025 would also make 3.3 person trips per day on an average, which is the current number of trips being made by every person as mentioned in ARC's Travel Demand Computer Modeling Data. [9] This number when multiplied by the population assigned to each tract resulted in the number of trips generated by each census tract.
2. To calculate the number of vehicle hours of travel (VHT) the number of trips generated by each tract was multiplied by the average travel time of each tract. The average travel time data was produced by our model after factoring in the transportation improvements as well as the Northern Arc.

[9] Atlanta Regional Commission. Atlanta Region Transportation Planning Fact Book. 2001.

3. Assuming the average speed in 2025 of 30 miles/hour, an approximate figure for the VMT generated by each tract was calculated and the summation of all the tracts produced the total VMT.

VMT (Distance) = Speed x Time (VHT)

4. The above assumptions were constant across each scenario.

Table 21 shows the VMT calculated for each scenario. Not surprisingly the corridors scenario generated the least VMT at 283 million miles per year as it concentrated growth only along major transportation corridors. It is closely followed by the environmental scenario at 283.3 million miles per year, which directed this future growth within the existing urbanized area and thus this limited the VMT that would have been generated if the population were more dispersed out. Even though the centers scenario allocated its growth in a smaller area as compared to the previous two scenarios, it generated a significantly greater amount of VMT. This can be attributed to the fact that activity centers are spread all over the region and not necessarily close to one another. Also, the residual population that was not assigned to the centers was distributed to the census tracts at the edge of the region. Finally, the ARC scenario due to its widespread distribution of population in the region, produced the highest VMT at 304 million miles per year.

The above methodology used to carry out the VMT calculations is obviously not as accurate as a travel demand model. This approach tends to overestimate VMT. To correct this, VMT calculated for the four scenarios was calibrated to the existing VMT of 112 million miles per day and the final result was the normalized VMT for each scenario as can be seen on the second line in **Table 17**. These numbers are more realistic estimates for 2025 but the relative performance of the four scenarios remained the same. The Corridors scenario generated the least VMT followed by the Environmental, the Centers, and finally the ARC 2025 scenario.

Table 21: Vehicle Miles Traveled (VMT), All Scenarios

VMT type in millions of miles	Census 2000	ARC 2025	Environmental 2025	Corridors 2025	Centers 2025
VMT	112	304	283	282	291
Normalized VMT	112	152	142	141	145

Employment Accessibility

Accessibility to employment opportunities is one of the key factors that help people make residential choices. It can be understood as the number of employment opportunities available to the population within a certain travel time from their home. Accessibility could be chosen using any one of a number of possible travel times. For this analysis, 15 minutes was chosen to evaluate the four scenarios.

A scenario that has good employment accessibility will make employment opportunities available to a larger portion of the population within a 15 minute travel time. This will be achieved by clustering population and employment growth in the region and creating the base for activity centers and mixed-use development. Additionally, under ideal conditions, scenarios with greater accessibility will be better suited to addressing environmental justice issues.

This analysis used a 15-minute travel time buffer from the center of every census tract to measure the employment accessibility of each scenario. The initial step was to sum up the number of employment opportunities captured within the travel time buffer created from the center of every tract. Next, this number was scaled down by dividing it by a million to get an accessibility index. These absolute numbers have little meaning, but when compared to each other *the scenario with a higher index is drawn to better employment opportunities* available for its population within 15 minutes of travel. **Table 22** shows these indices for all with the exception of the Census 2000 evaluative scenario.

The Centers scenario provides the best accessibility to employment opportunities. This is because as the Centers are spread throughout the region they make employment opportunities accessible to populations in outlying counties. Next is the Environmental scenario. Once again the distribution of its development pattern (inside the Delta) makes access to employment opportunities possible for much of the population. The Corridors and the ARC 2025 scenario have roughly the same level of accessibility. The Corridors scenario was a concentrated development pattern along major transportation links reducing the accessibility of the population in the surrounding counties to employment opportunities. Ironically, even though

Table 22: Employment Accessibility, Future Scenarios

Measure	ARC 2025	Environmental 2025	Corridors 2025	Centers 2025
Accessibility Value	20.6	21.3	20.6	21.4

the ARC 2025 scenario has more dispersed population and employment than the Environmental scenario, which ideally should have increased its accessibility value, this is not the case. This is mainly attributed to the analytical technique that is used to calculate the value. For example, the ARC scenario has allocated growth to counties like Coweta, Forsyth, and Paulding that have large census tracts. Thus, the 15-minute travel time buffer established from the center of these census tracts is well within the tracts or does not enclose the centroid of surrounding tracts. This reduces the index value as the employment opportunities have been attached to the centroid of each tract. Buffers not encompassing the centroid sees a drop in the index value. Hence, it would be fair to assume that the ARC 2025 scenario will exhibit an equal if not higher accessibility index value in comparison to the Centers and Environmental scenario.

CONCLUSION

The creation and analysis of these scenarios demonstrate there are a number of alternative ways the Atlanta region can accommodate the growth that is expected in the next 25 years. This project shows that growth can be accommodated in several different land use patterns that are more efficient and produce fewer environmental impacts than the type of low-density sprawl that characterized the growth patterns of the 1990's.

Table 23 shows how each scenario scored across all of the impact measures. The Corridors and Environmental scenarios performed well across most measures. While the ARC 2025 scenario spread population and employment more widely across the region than any of the studio scenarios, it still performed reasonably well, especially on the demographic measures.

The Environmental scenario demonstrates that all of the population expected for the next 25 years could be accommodated within the existing urbanized portion of the region while maintaining reasonably low residential densities. This suggests that the urbanized "Delta" would be a good candidate for an urban growth boundary should the region decide to implement this type of growth management strategy. This scenario performed well across most measures and, as might be expected, was the strongest on the environmental measures. In addition to political feasibility, the adequacy of existing infrastructure capacity and the cost of required improvements to handle this amount of growth within the Delta would need to be more carefully investigated before pursuing this approach.

The Corridors scenario also performed well across the entire range of impact measures. Rather than concentrating development in the center of the region as in the Environmental scenario, it follows a linear pattern along the major highway and transit lines. However, since many of the transportation corridors converge in the center of the region, this scenario also places a significant amount of growth within I-285. This scenario would be the most conducive to transit-oriented

Table 23: Scenario Evaluation Cateories

SCENARIO	EVALUATION CATEGORY									TOTAL
	Demographic				Environmental			Transportation		
	Popualation Densities	Jobs Housing Balance	Households Within 1/4 mile of Transit	Jobs South of I-20	Development in Small Water Supply Watersheds	Development in Sewered Areas	Open Space Consumed	VMT	Employment Accessibility	
Environmental	N/A	1	3	5	1	1	2	2	2	**17**
Corridors	N/A	3	2	1	4	2	1	1	3	**17**
Centers	Most Dense	4	1	2	4	2	4	3	1	**21**
Census 2000	N/A	5	5	2	2	2	3	N/A	5	**24**
ARC 2025	Least Dense	2	4	2	2	5	5	4	3	**27**

development. It would also minimize the investment in arterials to convert dispersed population to the backbone of the transportation system. By placing more jobs south of I-20 this scenario was the most effective in addressing economic justice issues.

The Centers scenario demonstrated that a surprisingly large amount of growth could be accommodated within existing and emerging centers at true urban densities. This scenario was able to accommodate 96% of the expected population and 89% of the expected population on just 5% of the region's land. Even without significant amounts of redevelopment, this scenario found that approximately half of the new population and employment could be accommodated in the identified centers. This scenario also identified 21 existing and emerging centers that should be the focus of policies to concentrate growth. This scenario scored lower than expected on the environmental and transportation measures at least in part because the growth that was not accommodated within the centers was located at the edge of the region. This scenario warrants additional development and analysis. This scenario suggests that ARC's Livable Centers Initiative (LCI) may produce significant results if it is successful in attracting growth into a limited number of centers.

This report reflects the result of a student project with limited time and resources. It shows that there are real alternatives available to the Atlanta region. It has not answered the question "How should the region continue to grow?" We hope that it serves to stimulate citizens and decision makers to examine that question and to undertake additional research to inform the region as it confronts its future.

REFERENCES

REFERENCES

Literature

Atlanta Regional Commission. Atlanta Region Transportation Planning Fact Book. 2001.

Center on Urban and Metropolitan Policy. Moving Beyond Sprawl: The Challenge for Metorpolitan Atlanta. Brookings Institution: Washington, DC. 2000: 19.

Cervero, Robert. "Jobs-Housing Balance Revisited: Trends and Impacts in the San Francisco Bay Area." Journal of the American Planning Association. 62 (1996): 499.

Downs, Anthony. Stuck in Traffic: Coping With Peak-Hour Traffic Congestion. Brookings Institution: Washington, DC. 1992: 98.

Feagans, Brian. "Gwinnett's gain." Atlanta Journal-Constitution. 11 Oct. 2002: D1.

French, Steven P. "Optimizing Land Use Mix: Which Uses, What Techniques?" ACSP Annual Conference: Chicago. October 21, 1999.

Data

Atlanta Regional Commission, *Land Use 99 Data*; *Future Land Use Data; ARIS V1b Data 2002*

Georgia GIS Data Clearinghouse, United States Census Bureau, *Census 2000 Data*

The Center for GIS/Georgia Institute of Technology, *SMARTRAQ 1.4 Data*

Metropolitan North Georgia Water Planning District, *Wastewater Data*