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Compatibility of Freight Transportation and Land Use in Memphis Aerotropolis

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1. INTRODUCTION

1.1 Purpose

This report presents findings from a project investigating compatibility of freight transport and land use in Memphis Aerotropolis. Compatibility of Freight Transport and Land Use is a critical issue in land use planning. There is a growing interest by researchers to study urban freight and urban freight distribution systems. The ability to manage such systems depends upon multiple factors such as location of economic activities, urban land use patterns, types of freight facilities, and types of goods, types of industry, infrastructure and existing regulations. The multiplicity of modes available in Memphis including freight distribution conveys an unclear and complex relationship with land use. This study investigates this complex relationship and takes into consideration the attributes of the transport system as well as the land use factors that are generating and attracting movements of freight. In addition to positive benefits of freight movements including jobs, increased tax revenue and growing consumer markets, this study investigates the potential negative environmental impacts (i.e., including noise and light pollution, traffic congestion and safety concerns) of freight movements and related land uses, if not properly planned.

This report focuses on six specific objectives:

1. Reviewing "best practices" to illustrate how other regional authorities and cities have successfully implemented freight uses into their land use fabric
2. Analyzing spatial organization of the employment and local workforce in terms of race, gender, and earning levels in major employment centers with specialization in freight transport and defining Memphis Aerotropolis boundary

3. Evaluation of existing land use pattern in Memphis Aerotropolis and integrating transportation, economic, census and land use data into Geographic Information Systems and environmental impact of freight transport on adjacent communities such as traffic congestion and noise
4. Recommendation of land use guidelines and regulations

1.2. Memphis Aerotropolis Airport City

Memphis could marshal its resources, design infrastructure and coordinate land use plans to take full economic advantage of Memphis International Airport and its potential to be an Aerotropolis, a large urbanized area growing around an airport and a critical driver of economic development, which jobs and homes are the by-product of airport access and their associated residential complexes largely along or near airport transportation corridors (Kasarda 2008). The Memphis Aerotropolis Region is an "airport-integrated" region extending up to 25 miles outward from the airport, composed of vast industrial districts, major rail and logistic facilities, strings and clusters of airport-linked businesses and the tourist magnet Elvis Presley's Graceland. The blighted areas, economically distressed neighborhoods and retail districts limit the full potential for an Aerotropolis. For example, Memphis Aerotropolis has a reduction in workforce housing in proximity to major employment centers such as the airport, FedEx and UPS hubs, logistics and warehouse facilities and other industrial and commercial businesses; blighted conditions caused by sustained and large-scale vacancies, poor structural maintenance, and neglected exterior repairs and landscaping; crime due to property management issues and apartment vacancies, resulting in reduced property values, and fewer customers for retail businesses.

Despite the critical importance of the Memphis Aerotropolis to the City, to date, development has occurred in a spontaneous, haphazard, and in some areas, unsightly manner, detracting from its economic efficiency, aesthetic appeal and social and environmental sustainability. The Lamar Corridor, which is in the heart of the Aerotropolis, the region's "most congested freight corridor" through which trade flows to the southern portions of the United States, development is showing this strain and represents the lack of coordinated strategic community and transportation planning. The result has been middle-class flight, increased commercial and residential vacancies and an increased concentration of poverty, blight and crime.

With the presence of FedEx, Memphis International Airport will continue to have a tremendous economic impact on the surrounding region, a trend that will be magnified with increasing transfers of freight from air to other modes (air to truck, air to rail, air to warehouse). The Memphis region will need to pay closer attention to how the airport is linked to freight facilities and modes to insure it can adequately support the changing nature of air freight operations.

In Memphis Aerotropolis, there are approximately 60,000,000 square feet of industrial buildings accessed by roadways with congestion at grade intersections and poor traffic movement. Immediate airport area cargo access, including access to nearby warehouses and distribution centers, is mainly along local arterial roads with frequent intersections. Air-ground cargo transfers are often impeded by congested roadways in the airport environs.

This report is an important preparatory work illustrating the structure of employment in Aerotropolis and investigating the land use factors that are generating and attracting movements of freight in the region as well as the potential negative impacts toward a comprehensive strategic redevelopment and transportation plan.

1.3. Best Practices: Successful implementation of freight uses in Land Use planning

Land use planning near freight facilities can minimize potential conflicts between freight transport and nearby land uses while supporting any relevant region-wide freight transport plan. Unfortunately, if not properly planned, freight movements and related land uses also have the potential to produce negative environmental impacts, including noise and light pollution, unwanted odors, vibrations, safety concerns, and impacts to regional air and water quality. These impacts can be mitigated, to a great extent, by careful and smart regional planning, local land use and zoning, site and facility design, and operational considerations. However, these enhancements are only possible if they are implemented as part of a public transportation planning and land use planning, and zoning and permitting processes. If freight planning and land use decision-making activities are well integrated, both the public and private sector may benefit through reduced congestion, improved air quality and safety, enhanced community livability, improved operational efficiency, reduced transportation costs, and greater access to facilities and markets. The freight community can be considered "a good neighbor" when such a balance between economic activity and external impacts is achieved (FHWA Freight and Land Use Handbook). Since land use and zoning rules, and responsibilities of public agencies regarding them vary widely from place to place, "best practices" were drawn from agencies of all sizes, and reflect freight and community needs in urban, rural, and suburban areas alike. A review of each case is provided with a number of "critical success factors" identified in Table 1.1.

Table 1.1. Examples of best practices of appropriate and coordinated Land Use policies

Strategy/Tool	Case Study Example	Goals
Regional visioning and scenario planning	Pittsburg region "Power 32"	Sets regional stakeholder goals and gain common understanding between different levels of government
Incentives to reinvest in existing industrial space-e.g., tax credits	Connecticut urban and industrial reinvestment Tax Credit Program	Offers tax credits as an incentive to (re) develop in urban and industrial areas, provided performance criteria are met
Creating buffers around freight	Vancouver Washington Pedestrian Bridge	Provides safe means for residents to traverse a freight facility
Using zoning tools to preserve industry and limit freight impacts	Baltimore, Maryland Maritime Industrial Zone Overlay District (MIZOD) Layton City, Utah manufacturing (M) zoning code	Provides space for manufacturing where appropriate infrastructure and adjacent land uses exist, and protect industry from pressures to change use M-1 Light Manufacturing/Industrial M-2 Heavy Manufacturing/Industrial
Promote context-sensitive site and building design features	Port of Seattle central Waterfront Project Mitigation	Reduces the noise and vibration, light, aesthetic, and local air quality impacts of freight facilities on neighboring land uses

1.3.1. Pittsburg Region "Power 32":

The "Power of 32" is a regional visioning effort launched in May of 2009. The goal of the process is to allow every resident of the 4-state, 32-county region to participate in creating a shared vision for the region's best future. The Power of 32 effort is a good example of how statewide and regional agencies can work together to address multijurisdictional freight and land use issues. It is also a good example of how private sector freight stakeholders can participate in the process. Tailored to this region's unique sustainability needs and opportunities, it facilitates the collaboration of business and community on a regional level and because of that, it helps build a regional ecosystem that centers on innovation, talent attraction, investment, and healthier people and communities.

Representing the economic region centered on metropolitan Pittsburgh, the process recognizes and communicates the importance of freight land uses such as manufacturing, research and development, and fuel extraction to the region's economy, and has taken steps to include freight-intensive land uses, and the transportation infrastructure supporting them, in the visioning process. The region's vision includes strategies to help businesses find suitable development sites, including those with existing utilities, transportation facilities, and/or in existing industrial or commercial areas.

The effort also includes an extensive outreach and education program to communicate the importance of the region's major industries to its economy, and to receive constructive feedback from stakeholders and the public. In addition, the group's steering committee includes representatives of many of the region's major shippers and receivers.

1.3.2 Connecticut urban and industrial reinvestment Tax Credit Program:

Connecticut urban and industrial reinvestment Tax Credit Program is a powerful economic development tool designed to drive investment to the state's urban centers and other economically distressed communities without depleting valuable state bond dollars. Under the program, the state may provide up to $100 million in tax credits over a ten-year period to support projects that create significant jobs and capital investment in these underserved areas.
There are two types of investment projects under this Program, urban and industrial. An eligible Urban Site Investment Project is defined as an investment that will add significant new economic activity, increase employment in a new facility and generate significant additional tax revenues to the municipality and the state. Communities that may participate in the Urban Site Investment

Tax Credit Program are those that have an enterprise zone, have been designated as a distressed municipality or have a population in excess of one hundred thousand.

An eligible Industrial Site Investment Project is defined as an investment made in real property, or in improvements to real property, located within Connecticut that has been subject to environmental contamination. The investment will return the property to a viable business condition that will add significant new economic activity, increase employment and generate additional tax revenue to the state and the municipality in which the property is located.

1.3.3. Vancouver Washington Pedestrian Bridge

Vancouver Washington Pedestrian Bridge provides safe means for residents to traverse a freight facility. A pedestrian bridge, crossing the highway near Fort Vancouver and the Columbia River provides a safe crossing, integrated with art and local history. Part of the Confluence Project, and designed by architect/artist Maya Lin, the Land Bridge crosses over Highway 14 and railroad tracks, linking together two important historic sites. Along the bridge are places to sit and small kiosks illustrating various aspects of local Native American history.

Confluence Project is a collaborative effort of Pacific Northwest tribes, renowned artist Maya Lin, civic groups from Washington and Oregon and other artists, architects and landscape designers. The project stretches more than 300 miles from where the Columbia River flows into the Pacific Ocean, to Clarkston, WA, with sites in both Oregon and Washington. Each of its seven sites features an art installation by Ms. Lin that interprets the area's ecology and history, encouraging the visitor to reflect on how the surroundings have changed over time. Each references a passage from the Lewis and Clark journals.

Figure 1.1. Vancouver Washington Pedestrian Bridge

1.3.4 Baltimore, Maryland Maritime Industrial Zone Overlay District (MIZOD)

Baltimore, Maryland's port came in danger of withering into obscurity due to practically unrestrained development of the waterfront by commercial and residential developers. The development of Harbor Place on the downtown waterfront in 1980 near the then vacant Inner Harbor steamship docks was the harbinger of commercial and residential waterfront development on industrial lands in Baltimore. The 1990s and 2000s lead to rapid development and reuse of industrial buildings, including Tide Point, the reuse of a soap manufacturer into offices and Silo Point, which converted an unused grain silo into a high rise condominium development. These projects were important in the development of the Marine Industrial Overlay District (MIZOD) in 2004 to limit the use of land in the district to uses served by the deep water ports. This included forbidding Planned Unit Developments (PUD), the reuse of industrial properties to mixed use developments and disallowed office and hotel uses from conditional use in the zoning laws. The Maritime Industrial Overlay District is designed to ensure the

preservation of limited deep water frontage of the Port of Baltimore for maritime use. The intent is to delineate an area where maritime shipping can be conducted without the intrusion of non-industrial uses and where investment in maritime infrastructure is encouraged.

Baltimore had been experiencing rapid growth on the waterfront and planners feared that much of the infrastructure that supported the Port of Baltimore would be removed to allow for further waterfront gentrification. Once this infrastructure was removed it would be either impossible or very expensive to replace including both property with deep water access and railway and truck routes that support them. While MIZOD was created to protect industries around the harbor and port facilities relying on deep water access, the intended effect was to incubate manufacturing growth in the entire city and region. Many manufacturing firms outside of the MIZOD boundaries rely on the proximity to an international and national transportation hub.

1.3.5 Port of Seattle Central Waterfront Project Mitigation

The Central Waterfront of Seattle, in the state of Washington, is the most urbanized portion of the Elliott Bay shore. The Central Waterfront was once the hub of Seattle's maritime activity. Since the construction of a container port to its south in the 1960s, the area has increasingly been converted to recreational and retail uses. As of 2008, several century-old piers are devoted to shops and restaurants. There are several parks, a Ferris wheel, an aquarium, and one over-water hotel. Some docks remain on the Central Waterfront, under the authority of the Port of Seattle, including a cruise ship dock, ferry terminals, and a fireboat dock. There are many architectural vestiges of the area's past status as the heart of a port, and a handful of businesses have remained in operation since that time.

Figure 1.2. Port of Seattle

2. URBAN SPATIAL ORGANIZATION

Understanding urban spatial organization helps explain economic growth, as well as make appropriate land use planning decisions. This section is an overview of the spatial organization of the employment structure of the Shelby County, TN, that contains the city of Memphis. We delineated boundaries of employment centers and analyzed local workforce in terms of race, gender, and earning levels. Most importantly, we delineated the boundaries of Memphis Aerotropolis in Shelby County both as a new urban form, and as an employment center that rivals and surpasses the traditional Central Business District (CBD) in terms of size and total employment. We attempt to find consistent, explicit criteria for the boundary of the Aerotropolis, a type of urban form which may extend up to 25 kilometers outward from the Memphis International Airport (MIA) with specialization in industries supporting air logistics and ground services. We also analyzed effects of Aerotropolis on local economic development in terms of racial, gender, and paying/earning characteristics of job and workforce distribution. This study is an important step towards a more complete understanding of how urban form of current-day metropolis is changing.

The subsequent sections are organized as follows. The following section defines Aerotropolis and reviews research on economic impact of its important element– an airport. The next section reviews methods used to delineate employment centers and identify boundary of Memphis Aerotropolis. It is followed by investigation of employment and labor force structure in major employment centers including Memphis Aerotropolis.

2.1. Aerotropolis, airports and economic development

Aerotropolis can be defined as a new urban form which evolves around the major airport (Kassarda and Lindsay, 2011). Other elements of this urban form include transportation corridors

radiating from the airport, airport-related businesses located within the airport city and along transportation corridors coming from the airports, as well as associated residential clusters. Essentially, aerotropolis is similar in shape to the traditional metropolis (central city and concentric suburbs) and can stretch up to 20 miles (30 km) outward from an airport. Aerotropolis is not a static model, and no aerotropolis is exactly the same with the model suggested by Kassarda, but all include similar features and serve similar purposes. Examples of such modern development within the United States include Chicago O'Hare International Airport, Las Colinas, Texas, and Memphis International Airport (Kassarda, 2011).

Airports are a necessary element of an aerotropolis and are important drivers of economic development (Kasarda and Lindsay, 2011). Business analysts and economic studies scholars note a link between airports and local economic growth because they attract business and trade (Weisbrod et al, 1993; Freidheim and Hansson, 1999). Extensive and frequent airline traffic is crucial factor in the location decision of corporate and regional headquarters, research and development (R&D) facilities and manufacturing sites, while is also a magnet for new firms to the metro area such as distribution facilities, retail, hotel, entertainment, convention, trade complexes, among others (Freidheim and Hansson, 1999; Brueckner, 2003). At the same time, frequent service to multiple destinations also stimulates employment at the established enterprises (Brueckner, 2003). The degree of their effect is compared to that of human capital and greater than the high-tech industries which the literature identifies the key contributors to the regional development.

Essentially, increase in both air passenger and cargo movement has been linked to the improvement in metropolitan economic performance such as economic output per capita

measured as gross regional product per person, a regional equivalent to the national Gross Domestic Product (GDP) (Goetz and Sutton, 1997; Button et al., 1999; Alkaabi an Debbage, 2007; Florida et al, 2012). Service –related employment (such as wholesale and retail trade, services, finance, insurance, and real estate (FIRE), government, transport, and public utilities employment) appears to benefit more from an increase in airline traffic than goods-related jobs such as manufacturing. An increase of 10% in airline traffic might generate a 1% increase in service-related jobs. Expansion of the Chicago's O'Hare airport with the corresponding increase in air traffic by 50% is estimated to raise additional 185,000 jobs in service-related industries in the Chicago metro area.

There were contradictory findings regarding impact of air travel on manufacturing, with some studies stating that such enterprises will not benefit (Brueckner, 2003), and others finding that industrial and commercial development is attracted to locations nearer to an airport (McDonald and McMillen, 2000). Specifically, access to airport measured as a straight-line distance has a prominent effect on employment density within 15 miles of the airport, while extending influence to a larger area over time (McMillen et al, 1998). The size of an airport also impacts high-tech employment (Button et al., 1999). On the other hand, poor air service might inhibit local employment growth by decreasing the attractiveness of the city as a new site for new industries and by reducing the potential of the existing businesses to prosper (Brueckner, 2003). Other studies on the impact of an airport on a city's economy note a connection between base-year airline traffic and population growth in a metro area (Greene, 2002). Still other findings concern association between proximity to the airport and population change with those communities closer to the airport experiencing higher population growth (Lian et al, 2005). A recent study by Halpern and Bråthen (2011) also note importance of local airports for both

resident location and retention. Figure 1 illustrates the location of the Memphis International Airport relative to the downtown area (the CBD), railroad and road network. It occupies a central position within Memphis in Shelby County, TN.

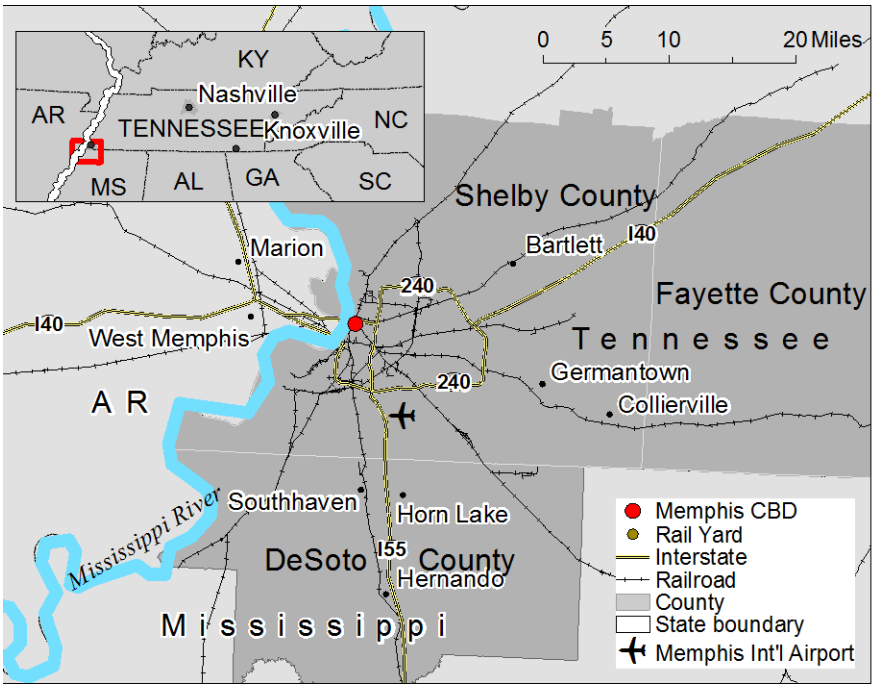

Figure 2.1. Study Area.

2.2. Population and Employment Structure in Shelby County, TN

In 2010, there were 914,342 people of a single race in Shelby County, TN (Tables 1 and 2). There are more African-Americans than the Whites (52.9% vs. 41.1%). Mostly, population is of Non-Hispanic race (94.4%), while Hispanics account for 5.6%.

Table 2.1: Population by ethnicity in Shelby County, TN, 2010 (data are given per Census block):

Variable	Total	Percent	Min	Max	Mean	SD
Population	914,342	100	0	9,685	1,455.96	916.87
White	376,270	41.15	0	8,164	599.16	782.14
AA	483,381	52.87	0	4,296	769.71	606.65
Asian	21,391	2.34	0	1,145	34.06	74.98
Native Hawaiian	441	0.048	0	21	0.7	1.89
Other	30,580	3.34	0	759	48.69	94.13

Table 2.2: Population by race in Shelby County, TN, 2010(data are given per Census block):

Variable	Total	percent	min	max	mean	SD
Population*	927,644	100	0	9886	1477.14	932.97
Hispanic	52,092	5.62	0	1162	82.95	137.57
Not Hispanic	875,552	94.38	0	9612	1394.19	896.87

Population*: Population of 1 or 2 races recorded, as a result 1 person may be counted more than once.

During the past decades employment in Memphis industry has changed. Extensive changes took place in industrial structure and occupational composition. Characteristic for many post-industrial economies, the Memphis regional economy experienced decline in its manufacturing base while services sector has been on the increase. It is interesting to note, that there are similar proportions of male and female employees in the services sector, while sales and office, and management and professional sector are female-dominated, and production and transportation has almost three times as many male employees.

Occupationally, the largest four sectors are represented by management and professional, sales and office, services, and production and transportation (Figure 2.2). There are more females in the labor force (53.09%) than males (46.91%) (Table 2.3).

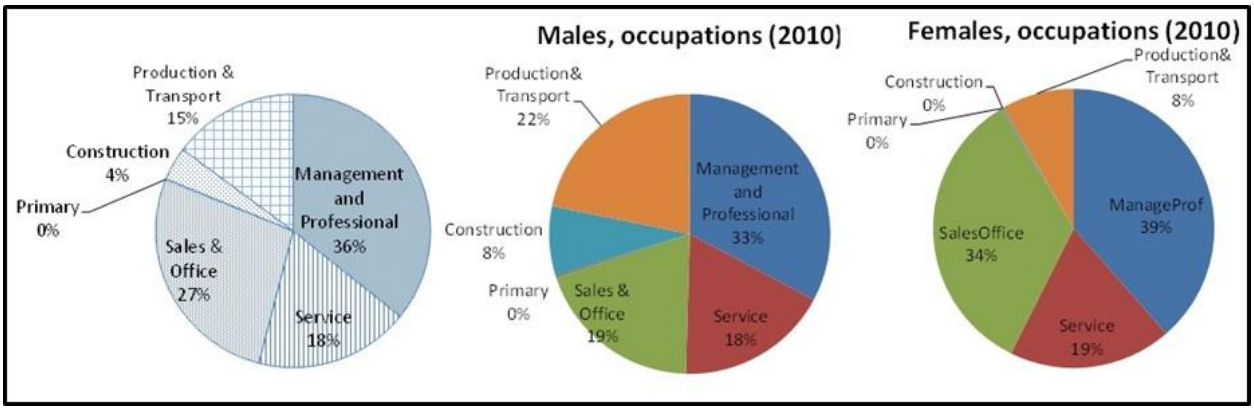

Figure 2.2: Occupations by sector in Shelby County, TN, 2010.

Table 2.3: Employment status by gender, Shelby County, TN, 2010 (US Census, 2010)

Population of 16 years and over	714,412
Male [1]	335,111(46.91%)
Male, In labor force [2]	232,643
Female [1]	379,301(53.09%)
Female, In labor force [2]	234,839
Total in labor force	467,482

[1] Percentage of the population of 16 years and over.
[2] 1 Percentage of the population of 16 years and over for the gender.

Directional distribution of employment and resident workers was measured, and standard deviational ellipse for both features was calculated. Figure 2.3 illustrates the spatial dislocation of the employment from the CBD area. Also on Figure 2.3 is location of the mean centers and distribution of major ethnic groups in Shelby County: African –American (53%) (AA), White (41%) (WH); the mean center of Hispanic population is also shown (almost 6%) (HISP). The ellipses allow to observe the dispersion along major and minor axes, as well as to see the orientation (trend) of the distribution of these segments of Memphis population.

Despite some spatial mismatch between jobs and resident workers, indicated by different locations of the mean geographic centers of employment and worker concentration, there is a general tendency of housing (shown as a white rectangle) to be closer to work places (shown as a red triangle). The Figure shows the tendency for the African American workers to locate closer to the inner area, while the Whites tend to reside in the suburban places. The Hispanic workers generally locate closer to the inner area than do the Whites. They also occupy the most compact territory compared to other racial groups (the spread of the Hispanic working population around its mean is 5.9 miles and 7 miles along the minor and major axes, respectively), while the Whites are the most spread out across the territory (6.9 miles and 8.16 miles) (Figure 2.3).

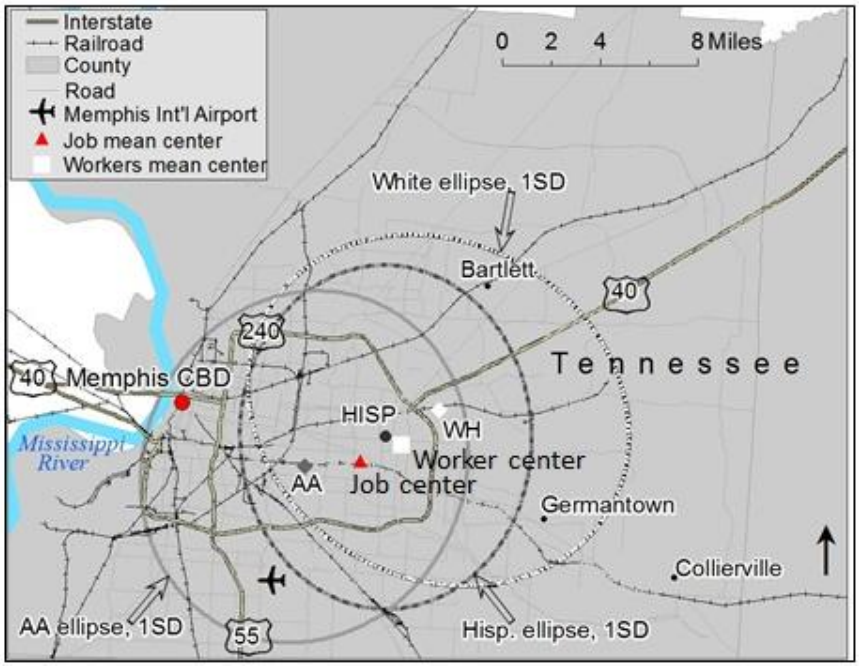

Figure 2.3: mean centers of employment and housing and directional distribution of resident workers by major ethnic groups in the Memphis area, 2011.

In order to map, the travel patterns of workers and identifying small-area workforce characteristics, we used web-based *OnTheMap* tool. This application is based on 2002-2010 federal-state Local Employment Dynamics (LED) worker origin and destination data and the Quarterly Workforce Indicators (QWI) profile data files. The analysis is conducted at the census block level detail, count of Memphis workers working in the each block for the selected year.

Figure 3a shows distribution of the jobs found across the study area. The larger concentrations are located in the CBD area, within the I-240 loop, and to the south of the loop around the Memphis International Airport. The smaller job areas can be seen surrounding transportation corridors and close to the smaller urban places of Germantown and Collierville. Respectively, choosing "home" area, data are generated with count of Memphis workers living in each block within the study area. Figure 3b presents home locations of the workers grouped by census block. Data are further grouped by different demographic and socio-economic worker

characteristics such as age, earnings, race, ethnicity, education, NAICS industry sector, and sex, both at work and home end. By using this dataset one can get answers to the different questions on labor market analysis, workforce development, transportation planning, emergency preparedness, and economic development, among other uses. Additionally, *OnTheMap* contains annual historical data for 2002 through 2010, so that it allows analysis of the temporal dynamics and change.

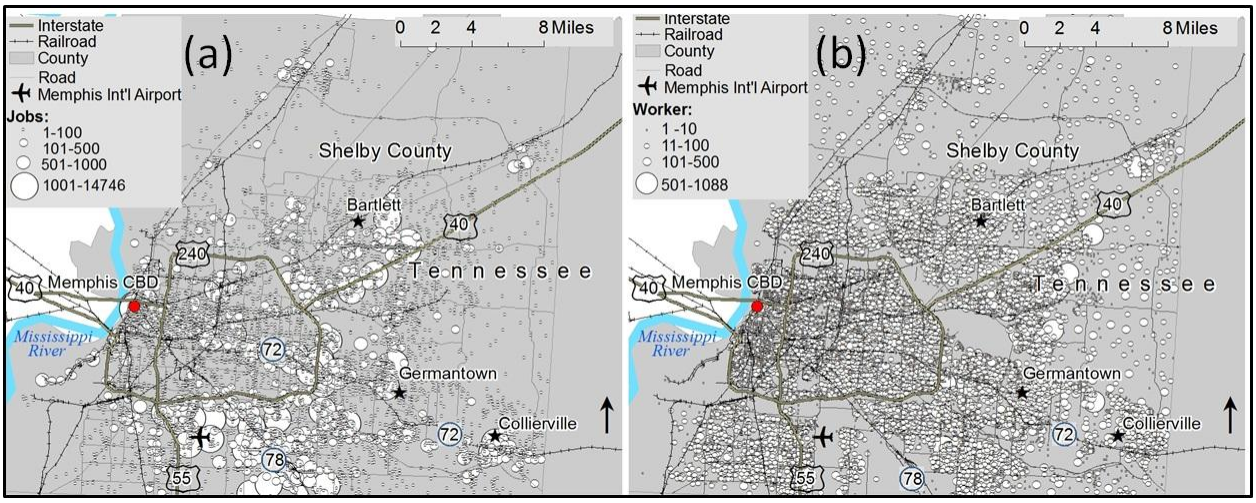

Figure 2.4: (a) job and (b) resident worker distribution in the study area.

2.3. Studies identifying Employment Centers

Numerous studies identify employment concentrations as part of their urban spatial structure analysis (Gordon and Wong, 1985; Gordon et al., 1989a, 1989b; Gordon, et al., 1991; Gordon, and Richardson, 1996; Schwanen, Dieleman and Dijst, 2003; Sultana, 2000; Shearmur, 2006; Shearmur et al., 2007; Horner, 2007).

Empirical clustering studies define a subcenter, also termed *secondary business district*, or SBD, (Cavailhès et al, 2006) as a set of contiguous units of analysis which have employment (job) densities that are significantly higher than the surrounding areas (Forstall and Green, 1997; McMillen, 2001; Baumont et al, 2004; Lee, 2007; Nagle, 2010). Job values vary from 500 to

2000 per center (Zhou and Kockelman, 2006; Cervero, 1989) or 7 to 10 jobs per acre (Cervero and Wu, 1997; Guiliano and Small, 1991). This approach was criticized for its arbitrary nature of the density and employment cut-off definition, as well as for the disregard of the true relationship between job distribution and workers residing in the area (Forstall and Green, 1997; McMillen et al, 1998). Establishment of the cut-off points and the notion of proximity also often require substantial local knowledge (McMillen, 2001). Despite the shortcomings, these studies confirmed increasingly polycentric urban tendency in many metropolitan areas across the Unites States (Wheaton, 2004; Redfearn, 2006).

Other studies apply parametric and non-parametric methods to identify employment subcenters, mostly at the quite aggregate level such as the census tract (McMillen and McDonald, 1997,1998; McMillen, 2001; McMillen, and Smith, 2003; McMillen, 2004; Redfearn, 2006). Nagle (2010) uses a factorial kriging method for aggregated employment data by industrial sector. Among his findings are different-sized clusters, with many clusters forming corridors, and different distribution pattern exhibited by various sectors. Still other studies focus on the gross employment density function to define employment subcenters conditioned on distance to the CBD (Craig and Ng, 2001), or by developing employment density and employment probability models (McMillen and McDonald, 1998).

Our study builds upon the concept of the imbalance between available jobs (supply) and local labor force (demand) measured by jobs-to-resident workers ratio (JWR). The choice of this job concentration criterion was dictated first, by its emphasis on the net in-commuting as the most significant characteristic of a worker concentration (Forstall and Green, 1997). Second, areas such as airports (which are a central element of an Aerotropolis) where most of jobs are located

in a small part might not be recognized as major centers if job density is used as a main criterion to identify job concentrations; such places typically have a much lower job density (Forstall and Green, 1997). However, there is a limitation of this method. An application of the JWR approach toward large areal units such as census tracts can erroneously indicate the entire area as an employment center while in fact most of jobs might be concentrated within a small portion of the entire area. To overcome this limitation, a finer data scale *Census blocks* could be used.

2.4. Delineating Employment centers in Shelby County

We attempted to answer the following questions: (1) where the daytime population is located, that is, where are the workforce destinations for workers in the Memphis area, TN? (2) Where do workers live who are employed in Memphis area? (3) How do the identified employment areas compare in terms of worker race composition, worker ages, monthly earnings, and industry-sector employment? (4) What is the boundary of the Aerotropolis and its impact on the surrounding area?

We aggregated work locations into census blocks . Similarly, home locations of workers employed in Memphis were analyzed. Both work and home locations have additional data of worker age, earnings, 2-digit North American Industrial Classification System (NAICS) industry sector, worker race characteristic groups, ethnicity, educational attainment, and sex. The following criteria have been applied to determine the workforce destinations for workers.

(1) employment-to-resident workers ratio is equal or greater than 1.25. This was used to ensure that; first, there should be enough jobs for the workers residing in the same area. However, it does not mean the realization of the assumption. Second, there should be at least a surplus of 25% jobs more for the workers from a different area. (2) The minimum amount of the jobs

available is at least 100 per block. (3) There should be at least 2 census blocks. (4) The blocks forming the job area need be adjacent, that share either an edge, or a corner.

We were able to identify 463,331 jobs located within the Shelby County, TN in 2010 (there was annual average employment of 464,983 in the Shelby County, TN, according to the U.S. Bureau of Labor Statistics in 2010). Employment in Memphis is concentrated in the central downtown area and stretching east and west along the I-70 corridor.

We identified 40 job-rich areas which we classified into: (1) centers which had at least 10,000 employees in 2010 (7 in total), (2) smaller centers with the overall employment of at least 1,000 defined subcenters (19 in total), and (3) small job clusters which had at least 500 jobs (14 in total).

The largest category, job centers, concentrates almost 63% of all jobs found within Memphis, while occupying as little as 6% of the territory, and accounting for 2.6% of housing and 2.8% of population. The Aerotropolis and the CBD are the largest and second largest job centers in terms of jobs. More than half of all jobs of all age group and earning category are concentrated within the job centers (Tables 2.4 and 2.5). It can be seen that although the third largest job concentration category, job cluster, while occupying the smallest territory (less than a half percent), nevertheless accounts for almost 7% of all manufacturing located in Memphis. Important, the net jobs-to-worker ratio ranges from 2 to 678 within job cluster, in terms of commuting flows being as important as job center and subcenter. Overall, we were able to capture 80.7% of all jobs concentrated on 7.9 square miles within the urban area in Memphis in 2010. Figure 2.5 shows total of 40 delineated employment centers.

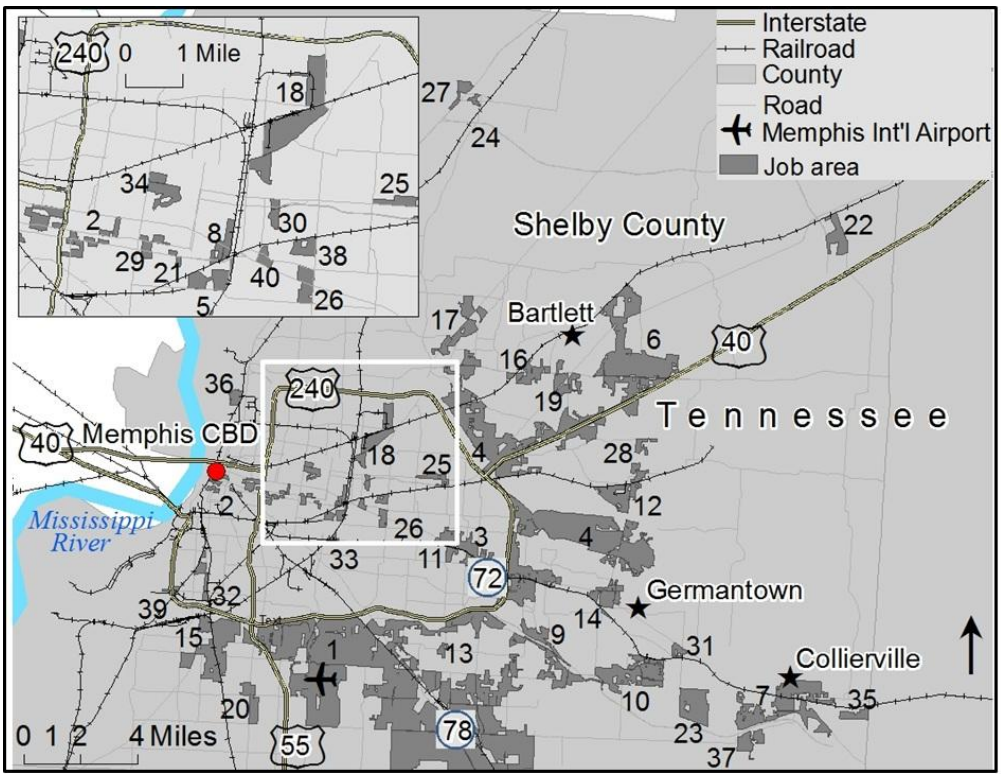

Figure 2.5 Total of 40 delineated employment centers

Table 2.4: Job area classification and socio-economic characteristics.

Job classification	Jobs, at least	N	Area, sq miles	%	Housing	%	Population	%	Jobs	%
1.Center	10,000	7	46.67	5.94	10,411	2.61	25,801	2.78	273,349	62.60
2. Subcenter	1,000	19	13.12	1.67	5,354	1.34	11,599	1.25	69,591	15.94
3. Job cluster	500	14	2.47	0.32	1,504	0.38	2,747	0.30	9,617	2.20
Job center, total		40	62.26	7.93	17,269	4.34	40,147	4.33	352,557	80.74
Study area, total	N/A	N/A	785.04	100	398,274	100	927,644	100	436,633	100

Table 2.5: Jobs by age and earning

	Jobs by age						Jobs by earning					
Job classification	<29y.o.	%	30-54y.o.	%	>55y.o.	%	<=$1,250	%	$1,251-$3,333	%	>$3,333	%
1.Center	55,131	56.83	167,225	65.2	50,993	61.33	51,883	60.84	100,251	59.37	121,215	66.41
2. Subcenter	17,233	17.76	39,132	15.26	13,226	15.91	19,425	22.78	25,440	15.07	24,726	13.55
3. Job area	2,370	2.44	5,625	2.19	1,622	1.95	2,828	3.32	3,558	2.11	3,231	1.77
Job center, total	74,734	77.03	211,982	82.65	65,841	79.19	74,136	86.94	129,249	76.55	149,172	81.73
Study area, total	97,016	100	256,472	100	83,145	100	85,273	100	168,847	100	182,513	100

Figure 2.6 illustrates the structure of the employment within all categories of job concentration by the industry sector. We present those industries that account for at least two-third (70%) within study area. The following 14 NAICS industrial categories were considered: manufacturing, wholesale trade, retail trade, transportation and warehousing, information, finance, real estate, professional and scientific, management, administrative services, educational services, health care, accommodation, and public administration.

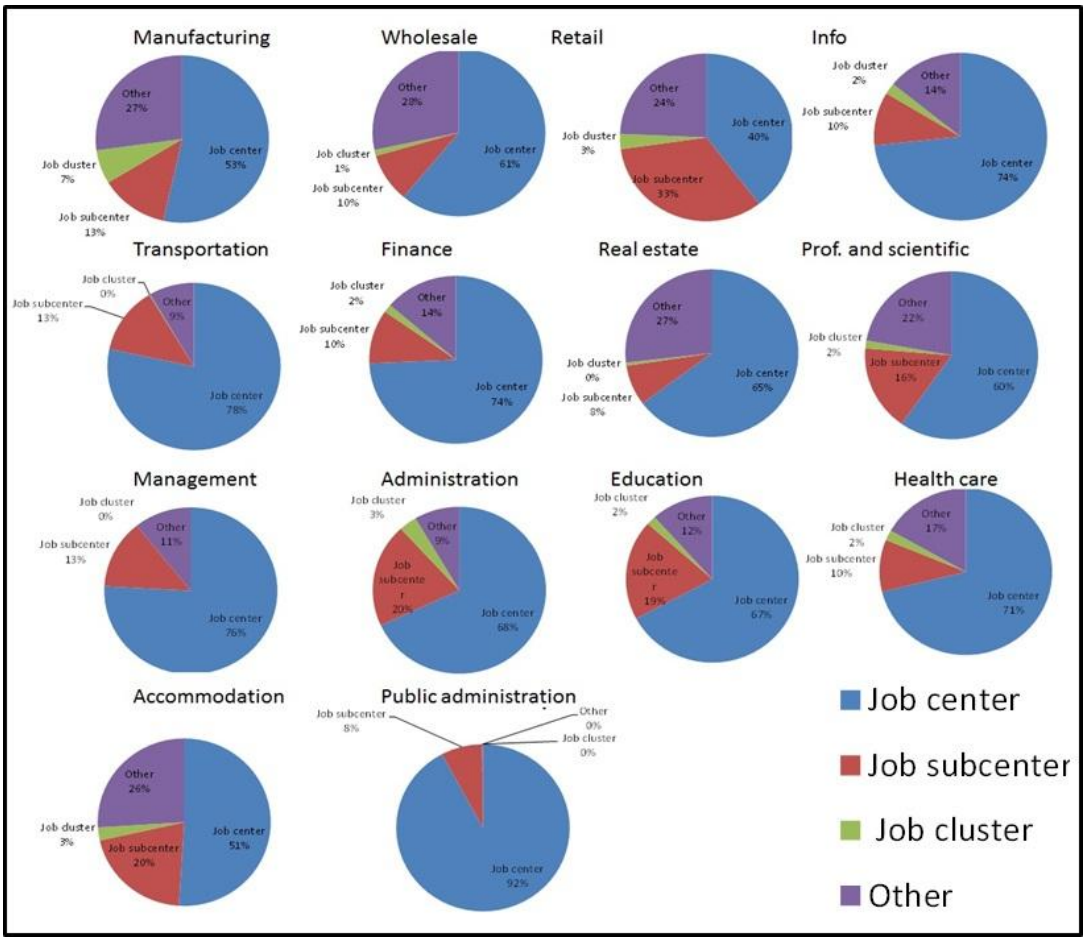

Figure 2.6. The structure of the employment within all categories of job concentration by the industry sector.

The Figure 2.7 demonstrates distribution of jobs from (a) the CBD and from (b) the Aerotopolis (shown in broken black line) with the distribution of the resident workers superimposed (solid blue line) to visualize the spatial alignment of jobs versus workers for all races and ethnic groups. Both (a) and (b) illustrate several peaks in employment (job) distribution. There are important differences between the distributions, though. First, there are more employment peaks identified with the distance from the CBD (the 2nd largest among all job concentrations), at the distance of 5, 8, 10, and 12 miles away from the CBD (and of nearly equal importance in terms of jobs). Other clusters are located at the distance of 15, 21 and 24 miles, respectively. Second, while no relationship between location of resident workers and job location is revealed in (a),

workers do reveal a tendency to cluster around jobs when the starting point for the jobs is chosen at the Aerotropolis as the greatest job concentration.

Generally, workers are more evenly distributed than do the jobs. Directional distribution of employment and resident workers in the Memphis area agrees with the decentralization trend of both population and employment common for many North American metropolitan areas.

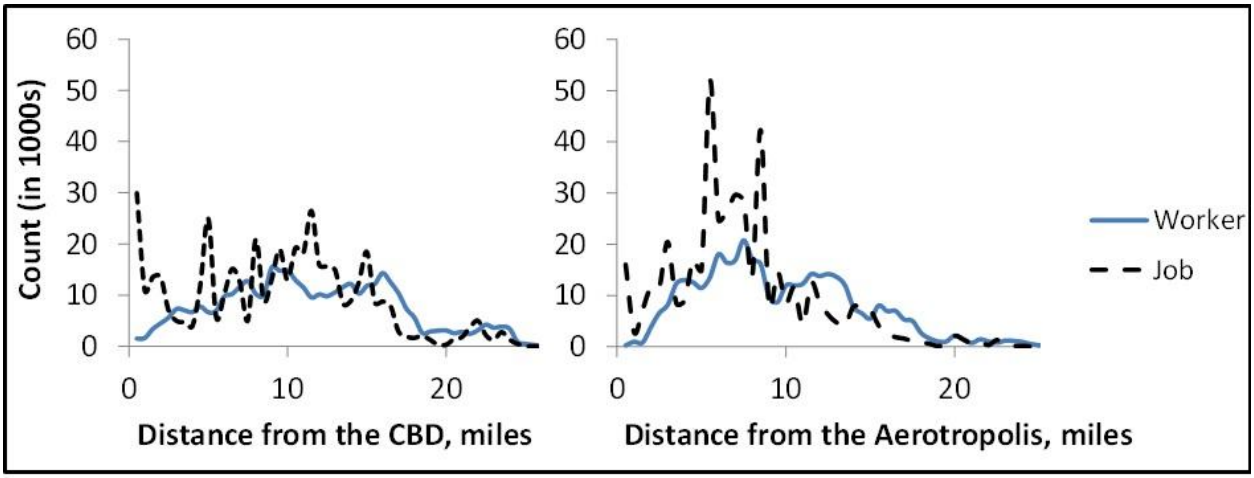

Figure 2.7. Employment (job) and resident worker distribution for all races and ethnic groups with the distance from the: (a) Central Business District (CBD); (b) Aerotropolis.

To further understand urban structure, and spatial alignment of supply (jobs) versus demand (residential workers), an analysis was conducted of the distribution patterns by earning, major racial group, and gender. Regarding distribution of jobs by earnings, it can be seen that around both the CBD and the Aerotropolis area, there are many more higher-paying jobs (more than $1,333 per month) than lower-paying jobs. Several places form an exception to this finding, located at 10 and 15 miles, respectively, from the CBD (a), and about 12 miles away from the Aerotropolis (b), which suggests that the suburbs offer a greater choice of work in terms of the skills level and payment. Workers' residencies in all earning groups can be found farther away from the CBD, which is in agreement with the decentralization trend, while the medium- and high-earning categories cluster around the Aerotropolis, and the second slightly smaller cluster

of the residential workers is seen in the suburbia (Figure 2.8). Middle earners (earning category between $1254 to 1333 per month) account for the largest percentage up to 12 miles from the center, and least earners (less than $1254 per month) and workers earning the highest (more than $1333 per month) total about the same in the inner Memphis. The workers of the highest earning category represent the largest group of the resident workers in the suburbs (12 to 25 miles away from the CBD). Their greatest concentration can be found at 16 miles away from the downtown area, occupying the white suburbs in the study area.

Job and worker distribution across the study area by main racial groups (Whites and Blacks) has been analyzed (Figure). The jobs are equally distributed between the White and the Black employees in the CBD area, however in the inner area, at about 5 miles from the CBD, more jobs are being occupied by the Black employees (Figure a and b). Memphis inner area has also traditionally had a greater share of the black resident workers versus white working residents gradually tapering off as one moves away from the CBD. However, the trend reverses at a distance of about 10 and 12 miles away from the Aerotropolis and the CBD area, respectively (Figure c and d). This finding suggests a preference to have jobs closer to residence for the Black employees.

Resident workers of both racial groups show a spatial tendency to choose houses around the Aerotropolis area. Comparison of jobs versus worker residencies by race lets us conclude that there is some mismatch between the job demand by the Black workers and supply (employment) in the Aerotropolis area where there are more Black workers who reside in the area than the Whites (Figure , d), but the Whites have many more jobs within the Aerotropolis (Figure, b). This finding reflects an association between the increased proportion black and higher earnings in white men and women (Cohen, 1998). The Whites also tend to have more jobs in the suburbs

than do their African American counterparts (Figure b). Hispanics are employed in a greater percentage around the Aerotropolis than they are within the central area. There is a significant concentration of Hispanic employees in the small center (number 13) which has as many as 13% jobs held by this population segment. Hispanic workers' residencies locate in inner Memphis close to places of employment.

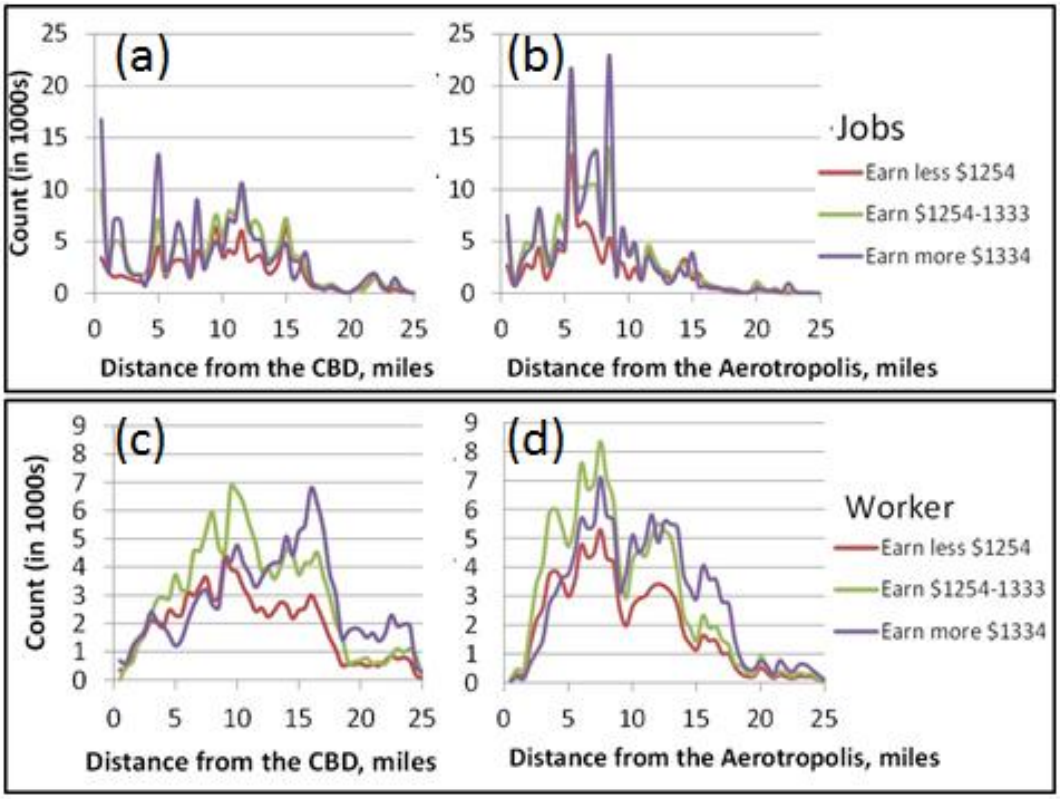

Figure 2.8. Job distribution by earning category across the study area starting from the: (a) Central Business District (CBD); (b) Aerotropolis; and resident worker distribution by earning category starting from the: (c) Central Business District (CBD); (d) Aerotropolis.

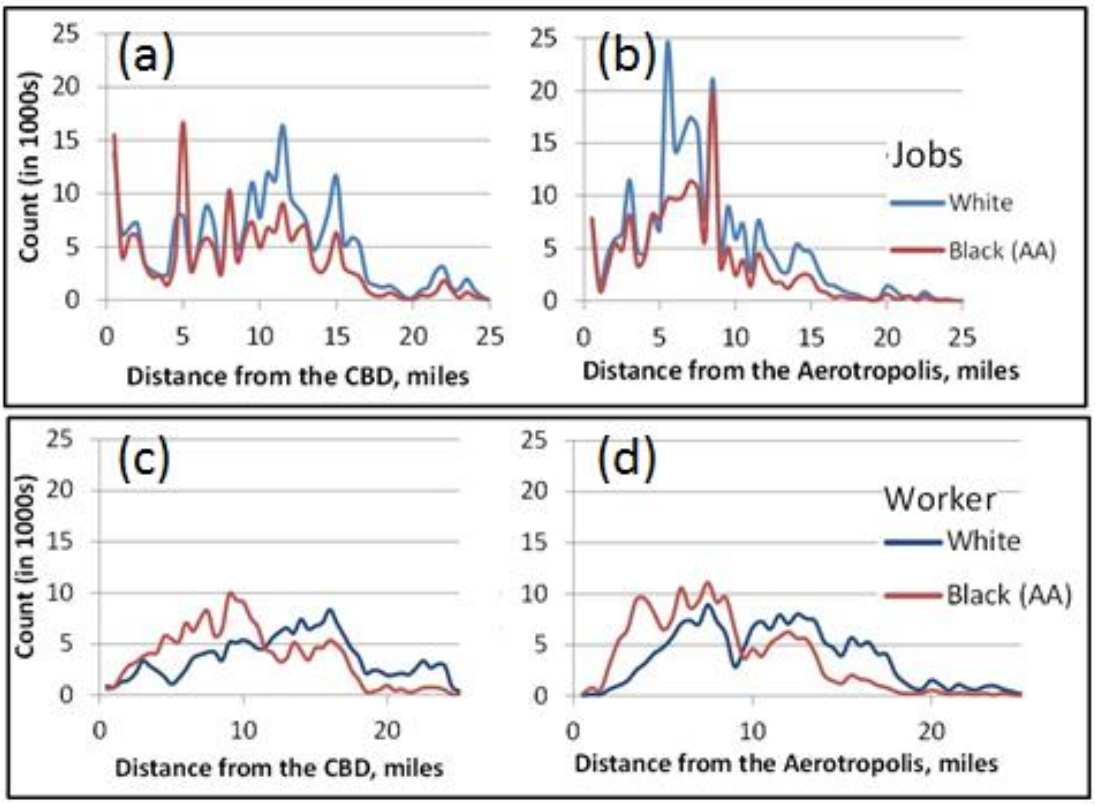

Figure 2.9. Job distribution by racial group across the study area starting from the: (a) Central Business District (CBD); (b) Aerotropolis; and resident worker distribution by racial group starting from the : (c) Central Business District (CBD); (d) Aerotropolis.

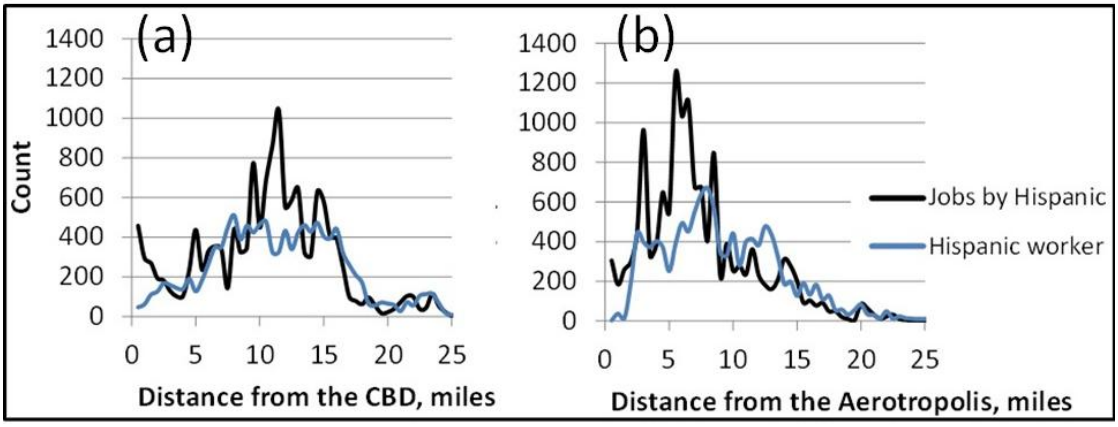

Figure 2.10: Employment (job) Hispanics and Hispanics resident worker distribution with the distance from the: (a) Central Business District (CBD); (b) Aerotropolis.

Women account for the larger share in Memphis labor force by 6% (Table 3). Figure (2.11) illustrates job and worker distribution across the study area by workers' gender. Geographically, at every distance there is at least the same number of female working residents as male, and in

the inner Memphis area there are consistently more female resident workers (Figure, c and d). Respectively, it can be seen that in downtown area there are more pink-collar jobs (a). However, the opposite is true for the areas located at 6.5 and 8 miles away from the CBD (where the Aerotropolis is located) which have more male dominated jobs.

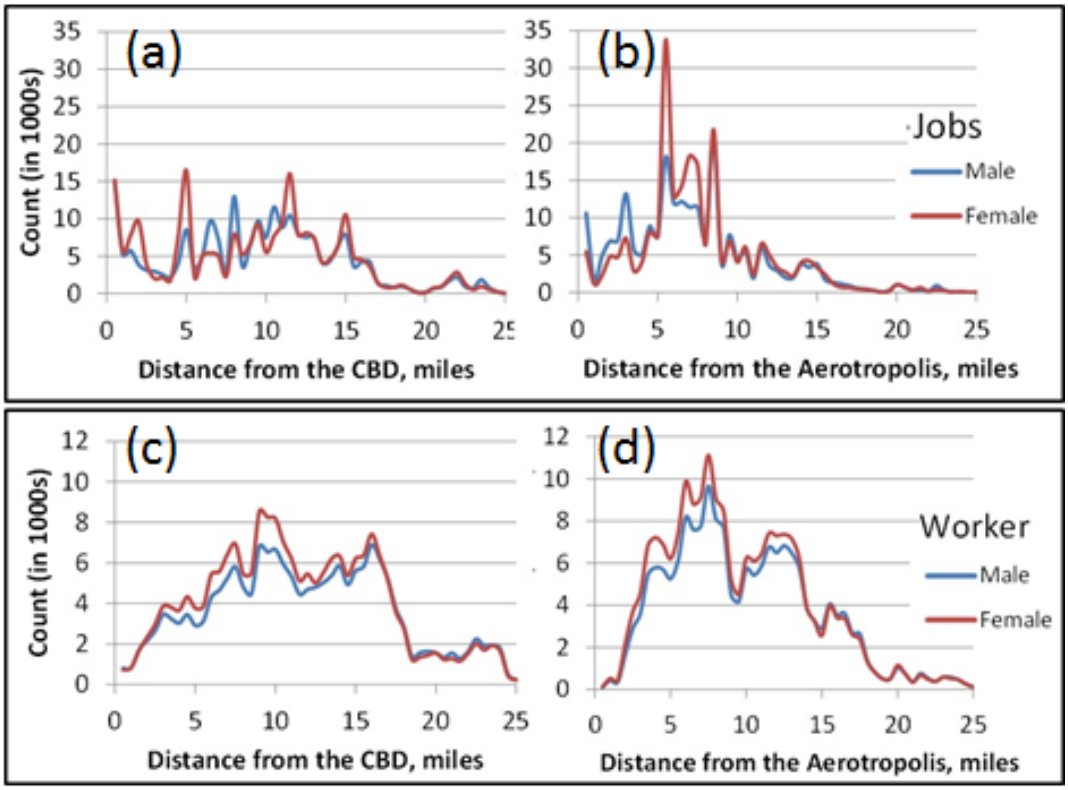

Figure 2.11: job distribution by gender across the study area starting from the: (a) Central Business District (CBD); (b) Aerotropolis; and resident worker distribution by gender starting from the: (c) Central Business District (CBD); (d) Aerotropolis.

2.5 The Aerotropolis and the CBD: two giants in the urban hierarchy.

To understand the urban hierarchy, we compared two largest job concentrations, the Aerotropolis and the CBD, by age, gender, racial composition, job earning, and industrial structure. Interesting to note that more jobs (62.2%) are accounted for by males vs 38% by females inside the Aerotropolis. We observed the opposite situation within the CBD center with many more "pink-collar" jobs held by females than by males (59% vs 41%).

Resident workers who are black are a majority in the Aerotropolis (71%), vs 25% of the workers living within the center who are White. However, more than half of all jobs are also held by the Whites (51%), vs 45% by the Blacks.

In the CBD job center more than a half of all workers who live there are the Whites (53%), vs just 41% who is Black. The Whites also account for half of all jobs (50%) in the CBD, while the Blacks account for the 47%.

Generally, the largest job concentrations such as the CBD and Aerotropolis have a small percentage of jobs by the Hispanic population. Jobs by the Hispanic employees account for just 4% and 2% in the Aerotropolis and the CBD centers, respectively. Nor, they are attracted to live within the largest job centers. For example, the Aerotropolis and the CBD have respectively just 6 and 3% of the resident workers who are Hispanic.

2.6. Functional structure of the identified job areas

Examination of the employment pattern revealed multiple nuclei structure consisting of the several major employment areas, grouped into concentrations, centers, and subcenters. 8 job concentrations with total jobs at least of 10,000; 13 job centers with total jobs at least of 1,000; and 9 job subcenters with total jobs at least of 500 (earlier Figure 2.5). Job areas were ranked according to the total amount of jobs found across the areas and the rank number was assigned to the job areas. The identified job areas account for 73.04% of all jobs found in Shelby County, but occupy less than 8 % of all territory (Table 2.6).

Among major centers there are the Central Business District (CBD), the government district, the University of Memphis, and the Aerotropolis (the airport and the surrounding businesses). Aerotropolis defined as an economic hub extending out from the Memphis International Airport into a surrounding area consists mostly of manufacturing firms, distribution centers, office

buildings, wholesale facilities, and other firms and businesses supporting air logistics and ground services.

Distribution of the centers was measured to determine the extent of concentration or dispersal of the centers, both across the space and relative of the population centers. The location of the major centers is highly industry-specific, while local centers take advantage of the nearby concentration of population.

To help determine the functional specialization, location quotient measure was applied. Although data on 20 NAICS industry sectors was used for the analysis, only 18 sectors are reported in the Table (2.7), since none of the areas specialized either in agriculture or mining industries. The following 18 NAICS industrial categories were considered: utilities (NACS22), construction (NACS23), manufacturing(NACS31-33), wholesale(NACS42), retail(NACS44-45), transportation (NACS48-49), information (NACS51), finance (NACS52), real estate and (NACS53), professional (NACS54), management (NACS55), administrative sevices (NACS56), educational services (NACS61), health care (NACS62), arts and entertainment (NACS71), accommodation (NACS72), other (NACS81), and public administration (NACS92). We have also analyzed functional structure of the identified job areas by allying location quotient method. Table reports detailed description of the function, total jobs, and workers of each job area.

Table 2.6: Comparison of the characteristics of the identified job area vs. Shelby County

area	blocks	area, Sq miles	jobs	workers
Job areas	535	58.52	318,927	13,912
Shelby County, total	17275	758.04	436,633	382,527

Table 2.7: Description of the job areas.

Ranking	designation	Job	%Memphis	Res. Worker	%Memphis	JTW
1	center	92798	21.25	3325	0.87	27.90
2	center	61515	14.09	564	0.15	108.88
3	center	41625	9.53	1945	0.51	21.39
4	center	32936	7.54	1852	0.48	17.77
5	center	18994	4.35	62	0.02	301.49
6	center	15078	3.45	879	0.23	17.13
7	center	10403	2.38	687	0.18	15.12
8	subcenter	9155	2.10	72	0.02	125.41
9	subcenter	8084	1.85	634	0.17	12.73
10	subcenter	8011	1.83	811	0.21	9.87
11	subcenter	5702	1.31	291	0.08	19.53
12	subcenter	5020	1.15	290	0.08	17.25
13	subcenter	4391	1.01	75	0.02	57.78
14	subcenter	4275	0.98	310	0.08	13.75
15	subcenter	4119	0.94	311	0.08	13.20
16	subcenter	3830	0.88	427	0.11	8.95
17	subcenter	2397	0.55	350	0.09	6.83
18	subcenter	2279	0.52	41	0.01	54.26
19	subcenter	2228	0.51	613	0.16	3.63
20	subcenter	1876	0.43	218	0.06	8.57
21	subcenter	1614	0.37	65	0.02	24.45
22	subcenter	1415	0.32	201	0.05	7.00
23	subcenter	1380	0.32	0	0.00	1380.00
24	subcenter	1337	0.31	156	0.04	8.52
25	subcenter	1243	0.28	154	0.04	8.02
26	subcenter	1235	0.28	161	0.04	7.62
27	cluster	966	0.22	26	0.01	35.78
28	cluster	839	0.19	270	0.07	3.10
29	cluster	795	0.18	157	0.04	5.03
30	cluster	778	0.18	81	0.02	9.49
31	cluster	709	0.16	26	0.01	26.26
32	cluster	687	0.16	25	0.01	26.42
33	cluster	678	0.16	0	0.00	678.00
34	cluster	676	0.15	324	0.08	2.08
35	cluster	671	0.15	2	0.00	223.67
36	cluster	662	0.15	18	0.00	34.84
37	cluster	583	0.13	91	0.02	6.34
38	cluster	544	0.12	160	0.04	3.38
39	cluster	515	0.12	4	0.00	103.00
40	cluster	514	0.12	112	0.03	4.55
Shelby		436633	100.00	382527	100.00	1.14

As can be seen from above Table 2.7, all but 3 job areas (number 5,11, and 28) specialize in more than 1 function. A total of almost 20% (19.49%) of all Shelby County jobs are concentrated within the Memphis Aerotropolis (94,404 out of all 484, 403, as of 2006). This includes 30% of all manufacturing, 60.5% of all wholesale industry, and 13.9% of all offices found across the Shelby County. These three industrial sectors support air logistics and ground services. Application of the method described above let us delineate Aerotropolis boundary. Figure 3.1. shows the location of Aerotropolis boundary in relation to other employment centers.

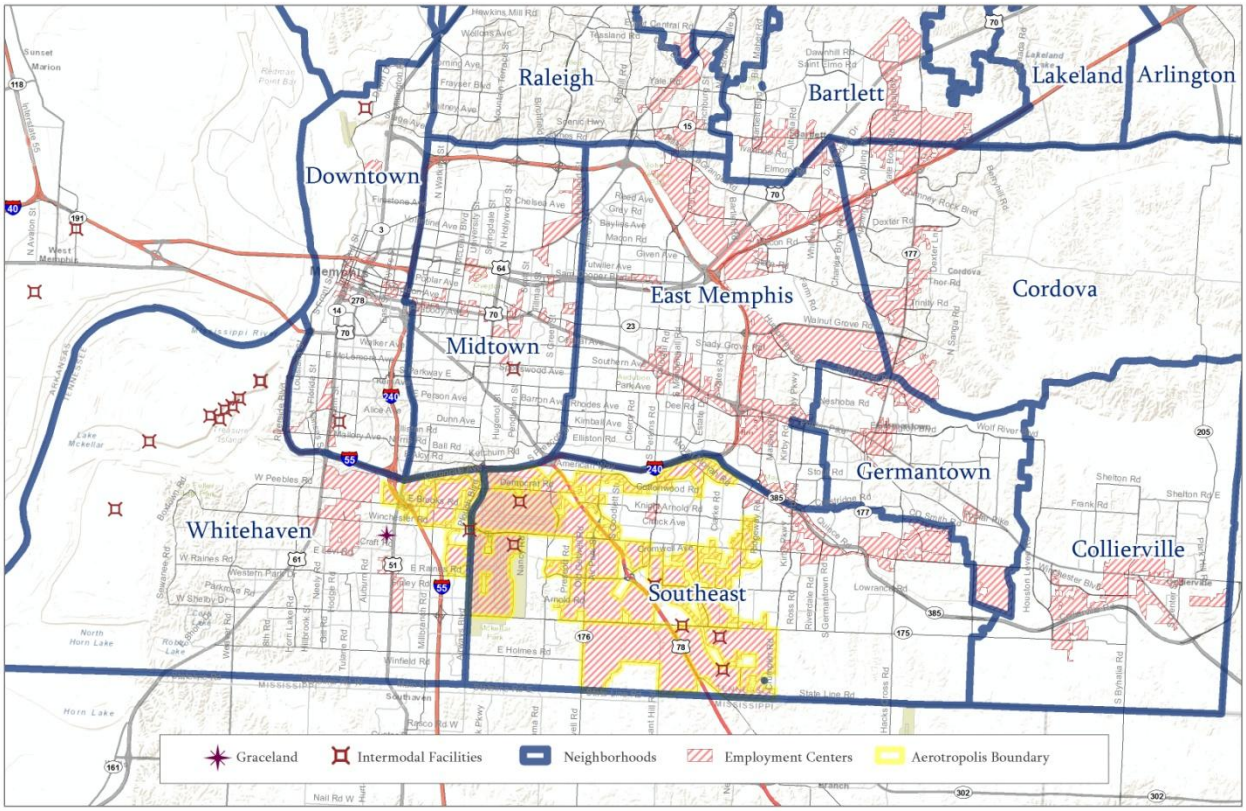

Figure 3.1. Aerotropolis boundary in relation to other employment centers.

3. LANDUSE

3.1 Purpose

The Memphis International Airport is in the heart of Aerotropolis as is the tourist magnet Graceland, vast industrial districts and major rail and intermodal facilities. Existing land uses in the Memphis Aerotropolis follow patterns of freight activity. Lamar Corridor (Hwy 78) functions as the spine to the overall land use pattern within Aerotropolis and runs north/south along SL SF Railway (St. Louis-san Francisco Railway). Industrial and ware house uses are predominant land use pattern south of Interstate 240 along Lamar Corridor. Aerotropolis is also distinguished by its north/south and east/west roadway network. Interstate 55 forms the western boundary, while Highway 78 (Lamar Ave) traverses the area. The northern boundary of the study area is Interstate 240 and the southern boundary is Holmes Rd. The eastern boundary extends till Kirby Pkwy.

Intermodal facility, light manufacturing and warehouse uses are concentrated on Lamar Corridor between Winchester and Holmes. Supply and Distribution Facilities are located along major arterials such as Shelby Drive and minor collectors with low traffic volume and shorter trip lengths to and from major arterials. Figure 3.2 shows location and boundary of Aerotropolis and its north/south and east/west road network.

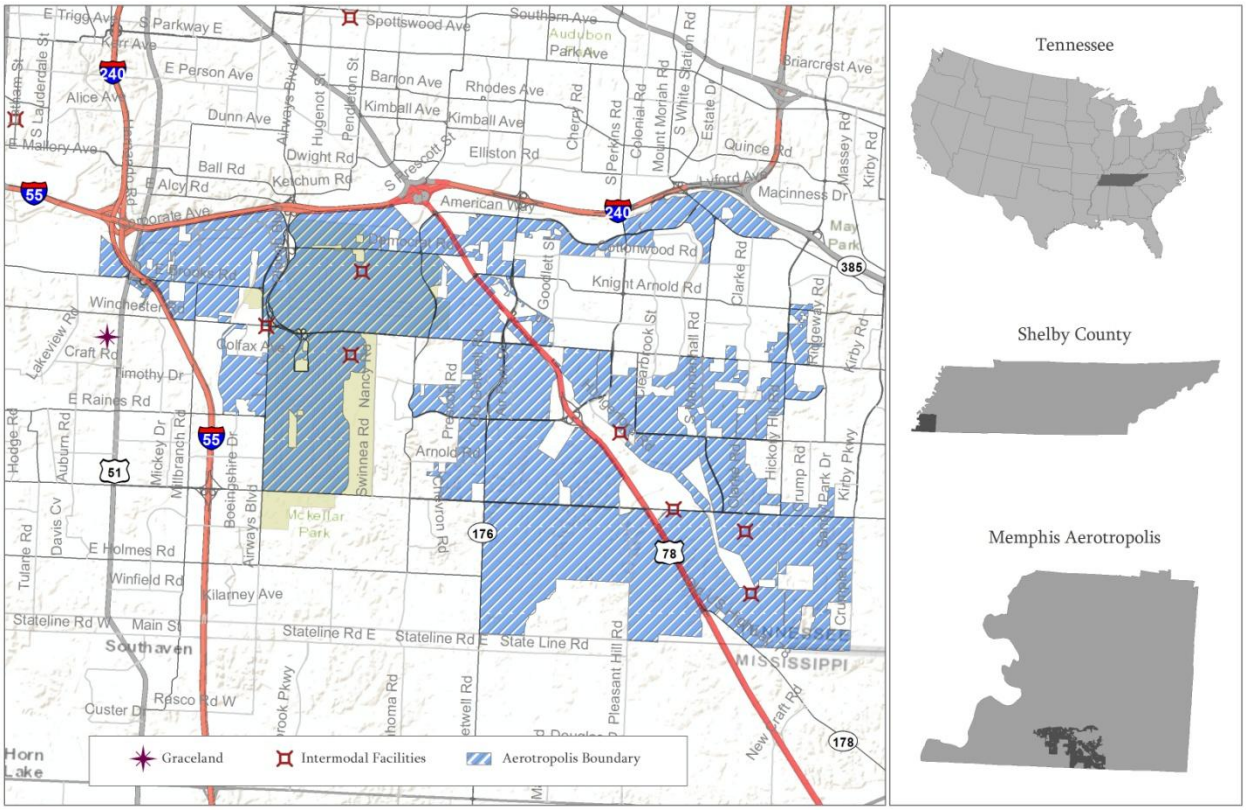

Figure 3.2 Aerotropolis and its north/south and east/west road network

Winding in and around those powerful engines of commerce in Aerotropolis are many economically distressed neighborhoods with households 29.2 % having incomes below $25,000 and 42.6% below $35,000. 82.5% of the households are black in comparison to 62.5% citywide. These neighborhoods struggle against the effects of concentrated poverty. The impacts are observable in unemployment and crime data, median incomes, health status, and educational attainment rates. As an example, Whitehaven, Parkway Village, Hickory Hill neighborhoods have among the County's highest concentrations of adverse pregnancy outcomes and risk factors including births to teen mothers, births to mothers with incomes less than $10,000 per year, low-birth weight and pre-term births (Ozdenerol et. al. 2005).

Whitehaven is the largest neighborhood in South Memphis and is roughly bounded by Brooks Road on the north and the Mississippi state line on the south, with the Illinois Central Railroad

on the west and Airways Boulevard on the east. The major traffic artery of the community is U.S. Route 51, later known as Elvis Presley Boulevard. Graceland mansion attracts many thousands to Whitehaven neighborhood. Elvis Presley bought his famous home in 1957; soon afterward the farmland surrounding the estate was subdivided into home sites. Travelers and people of means and influence often may choose to steer clear of economically distressed neighborhoods, when they visit Graceland but they have no choice when driving to and from Memphis International Airport.

Southeast Memphis neighborhood includes Hickory Hill community defined with major commercial arterial Winchester Road, lined with shopping centers, restaurants and offices. Figure 3.3 shows the neighborhood boundaries in relation to Aerotropolis boundary.

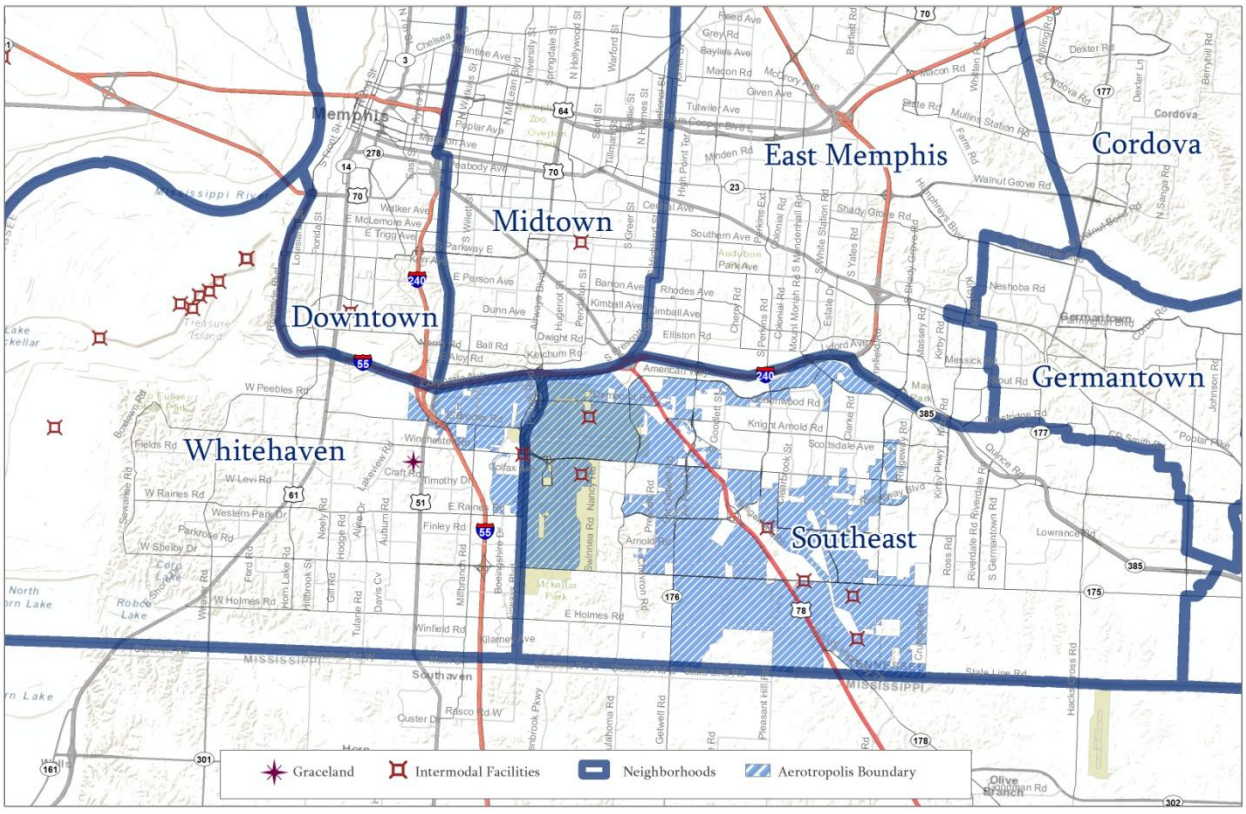

Figure 3.3. Aerotropolis and its surrounding neighborhoods

3.2. Strategies and tools for region wide policies and approaches.

Land use is generally planned and implemented at the local agency level, using the comprehensive plan, zoning code, and permitting system. However, many regional agencies, such as Metropolitan Planning Organizations (MPO) or Downtown Memphis Commission are recognizing the importance of linking freight transportation and land use planning, and are learning to find ways to guide or educate local jurisdictions without infringing on their sovereignty. As such, strategies and tools at the regional level involve guidance in locating major freight-generating uses (such as manufacturing centers, distribution centers, etc.) within the region, as well as gaining regional planning consensus, and suggesting region wide policies and approaches.

3.3. Recommendations for creating an authority overseeing redevelopment efforts:

Strategies and tools implemented by regional agencies include scenario planning, preferential zoning and tax relief programs that we will further discuss and recommend per Land Use category in this report. But First and Foremost in order t. gain regional planning consensus, we recommend creating an authority overseeing redevelopment efforts in Memphis Aerotropolis. We also recommend below chart for regional visioning and phases of implementation for both land use and freight transportation pieces.

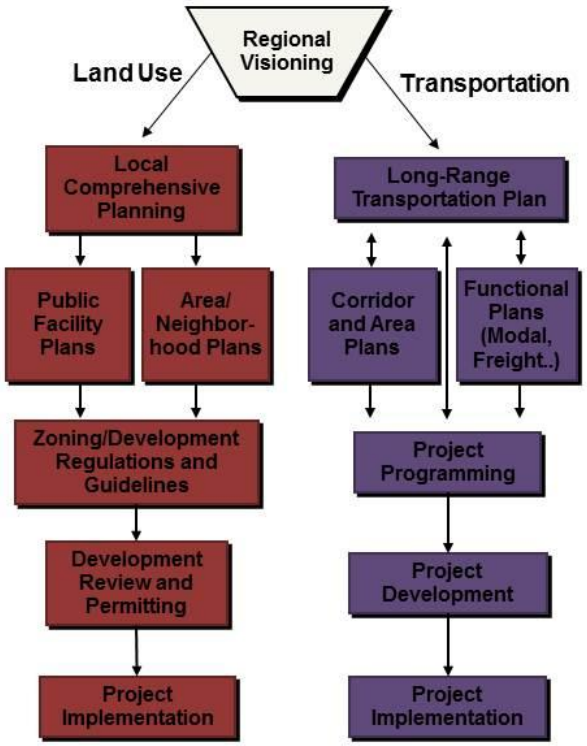

Figure 3.4. Regional visioning for Land Use and freight transportation

3.4. Aerotropolis Existing Land Use

There are 4408 parcels within the Aerotropolis boundary. Table 3.1 shows the Land Use categories. Commercial areas, classified real and personal property utilized as business the primary nature of which is the exchange of goods and services at either the wholesale or retail level constitute of 19.96 % of Aerotropolis parcels, approximately 2187.7602 acres. Properties exempted from taxation, including tax-exempt industrial properties, non-profit homes for the aged, places of religious worship, property used for charitable purposes, places of religious burial, charity hospitals, educational institutions, etc. constitute 16.47 % of Aerotropolis parcels, approximately 8825.5707 acres of land. Industrial lands, utilized as a business unit the primary nature of which is the manufacture or processing of goods destined for wholesale or retail sale constitute 25.79% of Aerotropolis parcels, approximately 5864.53 acres. Forested parcels mostly woody vegetation for such indirect benefits as protection of catchment areas or recreation constitutes 0.24 % of Aerotropolis parcels, approximately 127.533 acres.

Table 3.1 Aerotropolis Land Use Categories

Commercial	880 out of 4408	19.96%	2187.7602 acres
Exempt	726 out of 4408	16.47%	8825.5707 acres
Industrial	1137 out of 4408	25.79%	5864.5318 acres
Residential	1654 out of 4408	37.52%	889.5612 acres
Forest	11 out of 4408	0.24%	127.533 acres

Major categories of Land Use based on Class code from County Assessor's data are presented in Figure 3.5. Memphis International Airport, intermodal facilities, light manufacturing and warehouse uses are among the essential Land Uses of Aerotropolis Industrial district. Industrial uses are found primarily in the Southeast Memphis, on either side of Lamar Avenue and on the northern and western part of Whitehaven neighborhood at the intersection of Interstates 55, and 240.

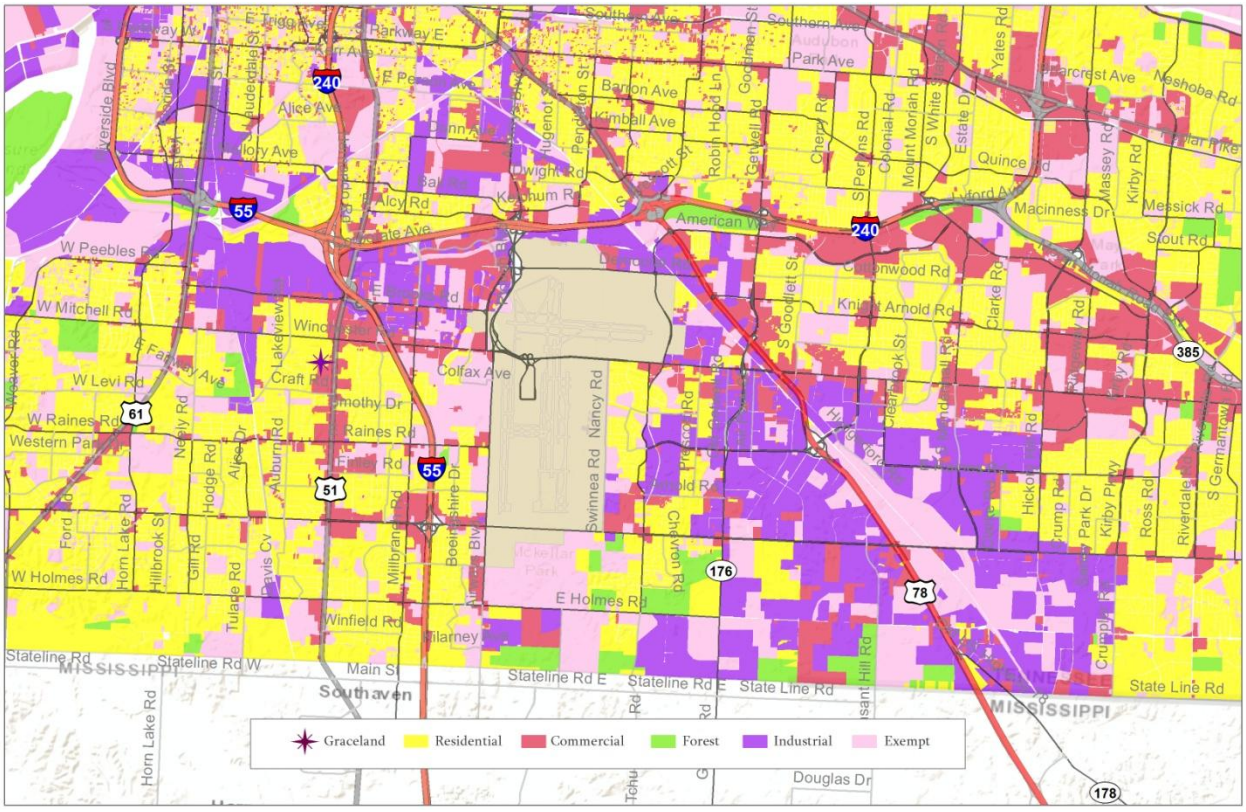

Figure 3.5. Aerotropolis Land Use

3.5 Industrial Lands

In order to measure the level of industrial development, we identified industrial lands in our delineated Aerotropolis boundary (Figure 3.1) . Figure 3.6 shows inventory of industrial lands in Memphis Aerotropolis. Parcels utilized for industrial purposes were extracted using “MSG” code from 2012 Shelby County Assessor’s data (Warehouse office, warehouse storage, service garage, truck terminal, manufacturing mill, manufacturing facility, pud-detached, RR station, utility/RR, cold storage, parking garage, pud-common, pud-attached, truck terminal, trucking company, flex storage, mini-warehouse, warehouse office).

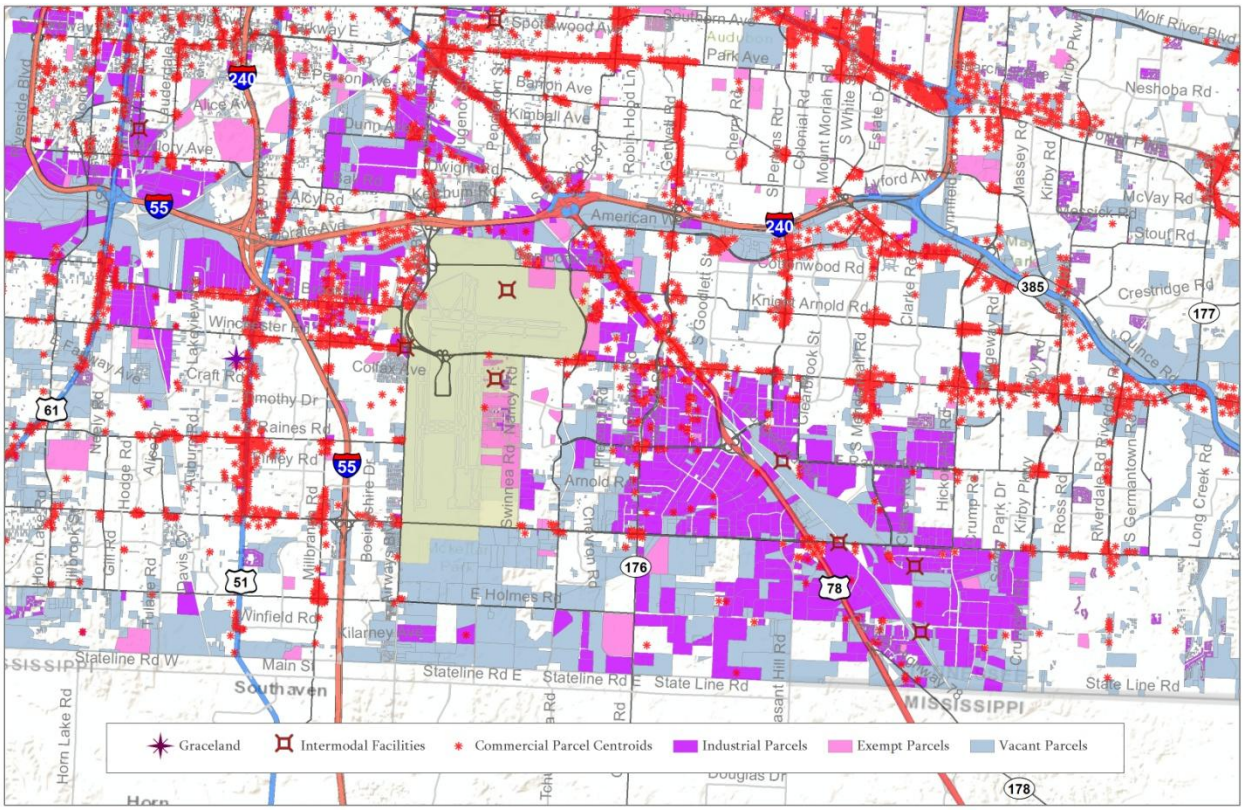

Figure 3.6. Aerotropolis Industrial Lands

Memphis Aerotropolis contains approximately 5865 acres of land zoned for industrial uses (%32) out of total land (17895 acres). On these properties there are some 100 million square feet (2295 acres) of building floor space supporting more than 9,000 jobs Aerotropolis generates (Antipova and Ozdenerol et al. 2012). The appraised land value for industrial land in the Aerotropolis is maximum $5.87 per square foot and average value is $1.75 per square foot.

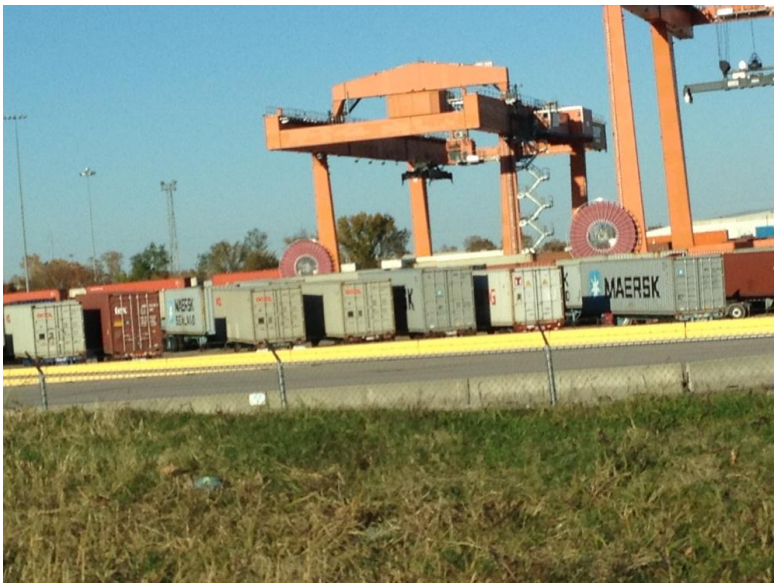

Figure 3.7. Intermodal Facility along Lamar Ave.

Intermodal terminals with transportation modes are given at below table and their locations are shown in Figure 3.8.

Table 3.2. Intermodal Facilities with their transportation modes

Intermodal facility	**Mode Type**
BNSF-Memphis-TN	Rail & Truck
CN/Memphis Gateway terminal	Port-Rail-Truck
FedEX EXPRESS	Air & Truck
Intermodal Cartage Company	Rail & Truck
Mallory Distribution Center	Rail & Truck
Memphis International Airport	Air & Truck
Transload of TN	Rail & Truck
UPS	Air & Truck

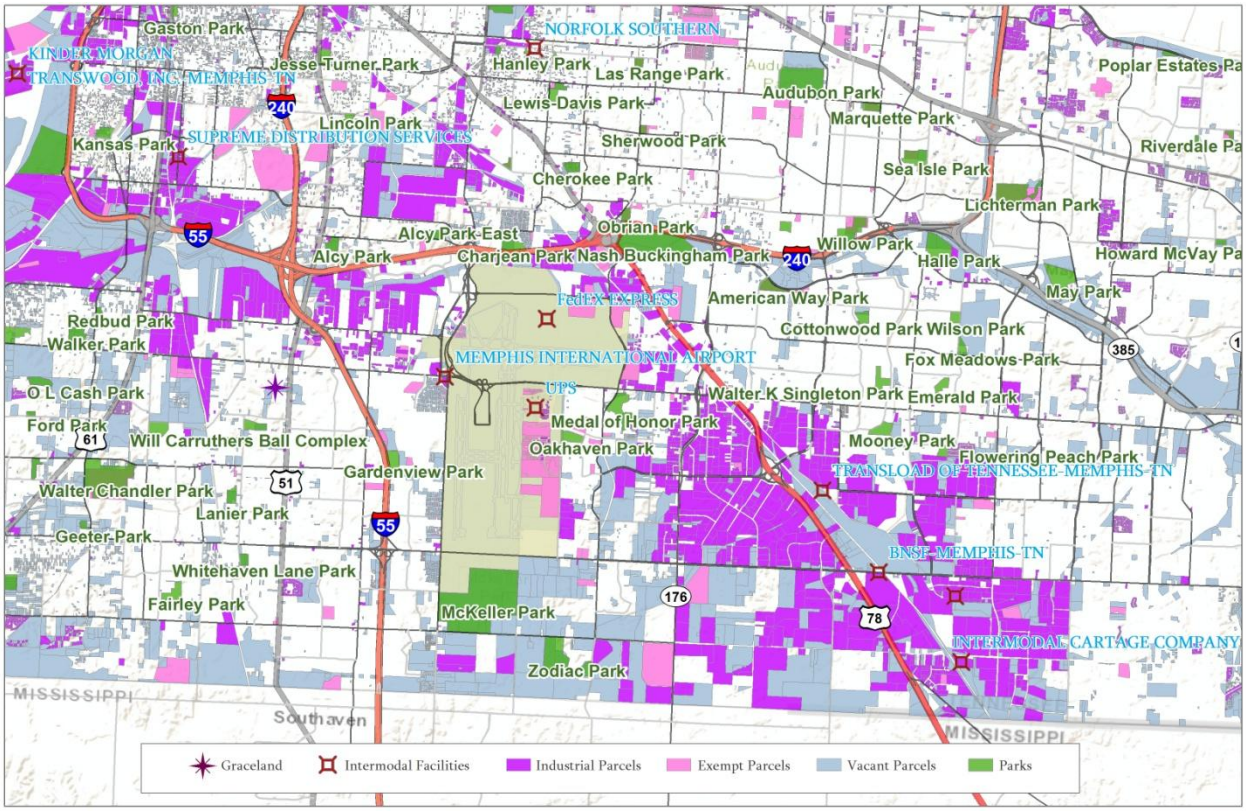

Figure 3.8. Intermodal facility locations in Aerotropolis

The statistical table below (Table 3.3) shows the uses permitted in the industrial district in Aerotropolis. The zoning shows 3506 acres of industrial land supporting employment. 964 acres is used for heavy industry. The lowest amount of industrial land used for other use in Aerotropolis is commercial mixed use development and office space.

Table 3.3 Uses permitted in industrial lands in Aerotropolis

ZONING	Designation	Area(acres)	Appraised Land(Ave)	Appraised Land(Sum)
CA	Conservation Agriculture	424.40	$884,564.28	$24,767,800
CA(FP)	Conservation Agriculture(FP)	25.2676	$278,300	$834,900
CMU-1	Commercial Mixed Used-1	14.9014	$193,157.14	$1,352,100
CMU-2	Commercial Mixed Used-2	18.6577	$935,550	$1,871,100
CMU-3	Commercial Mixed Used-3	37.474	$158,329.41	$2,691,600
EMP	Employment	3506.1623	$291,023.79	$205,462,800
EMP(FP)	Floodplain (FP) Overlay	448.4268	$320,033.75	$25,602,700
FW	Floodway	77.6409	$68,169.56	$1,567,900
IH	Heavy Industrial	964.2078	$242,757.01	$53,649,300
IH(FP)	Heavy Industrial(FP Overlay)	161.604	$190,126.31	$3,612,400
OG	Office general	9.64	$152,400	$225,400
R-6	Residential Single-Family-6	50.7767	$208,641.66	$2,503,700
R-8	Residential Single-Family-8	85.2251	$368,672.72	$4,055,400
RU-2	Residential Urban-2	14.577	$268,100	$536,200
RU-3	Residential Urban-3	25.5696	$275,900	$1,379,500

Industrial protection is needed both out of necessity to protect industries from encroaching non-compatible uses and to preserve high-wage, low education jobs. The encroachment of commercial and residential uses on industrial land makes banks very cautious about lending money to industrial companies in areas where non-compatible uses are developed in the surrounding areas. The traffic and noise created by early morning and late night shifts and shipping lead to complaints to the city and eventually the lobbying efforts by residents lead to restrictions on industrial properties and activities which puts the productivity, profit and viability of an industrial company in jeopardy.

In Aerotropolis there is one hospital, Delta Medical center on Getwell Road and three elementary schools(Getwell, Cromwell, Gardenview), one middle school(American way), and one vocational school(Shelby Training Center). None of these are located on land designated as

industrial. However, there are eight daycare centers, located in industrial district and 6 of them zoned as EMP (industry supporting employment), one in Residential-Urban zone (R-ML) and one in commercial mixed use zone (C-L). They are located on Democrat, Millbranch, Cromwell, Mendenhall, Holmes and Cazassa streets. There are twenty churches in Aerotropolis. Three of them are located in areas zoned as EMP in industrial district under commercial and exempt Land use class categories. There are day care centers very close proximity to Memphis International Airport in residential areas adjacent to the industrial district. Figure 3.9 shows non-compatible land uses in Aerotropolis boundary.

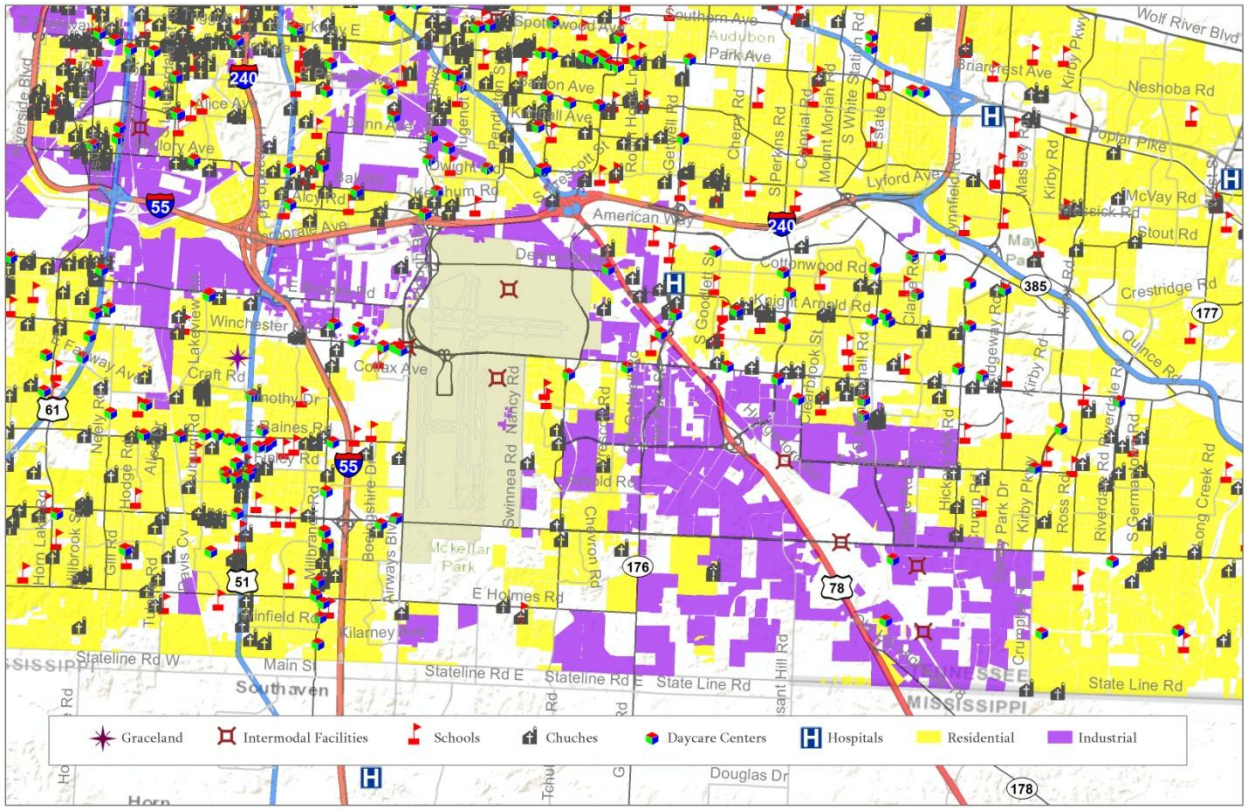

Figure 3.9. Non-compatible Land Uses with industry in Aerotropolis

3.5.1. Recommendations for Industrial Development

- Allow conversion of approximately 10% of industrial land for residential purposes such as live/work units in light industrial areas may be permitted through zoning where compatible with onsite and adjacent land uses.
- Encourage industries supporting high employment and tax base benefits through intensification of uses and development
- Add land available for “Business Centres” that incorporate research, light manufacturing and business office uses
- Identify businesses that benefit from being close to the airport, like bioscience firms that ship time-sensitive samples around the nation
- Encourage land use intensification, employment to meet contemporary needs such as housing and high tech industries
- Provide the land base for industrial, business park and office activities
- Ensure lands are served through an effective transportation network
- Identify and manage present and future utility servicing needs
- Investigate and respond to opportunities for reuse and intensification of underutilized sites
- Acknowledge overlap between technology and knowledge-based business, business parks and offices
- Refine industrial and business park land use designations and zoning
- Continue to accommodate heavy and service industrial uses while minimizing their impact on newer industrial forms and business parks

- Develop local area plans for selected industrial lands should they become available for redevelopment
- Avoid industrial displacement by locating non-compatible uses and forcing industry out of areas, especially those around the central core of Aerotropolis industrial district
- Land uses such as manufacturing, fabricating and assembly shall be encouraged;
- Land uses shall consider the effect of noise, vibration and other potential nuisances on adjacent land uses; and complementary land uses, such as related office space and coffee shops, shall be permitted through zoning;
- Encourage regular traffic to use the smaller, underused roads while leaving Lamar for the big trucks going back and forth from the area's many logistics enterprises or increase Lamar's capacity by widening it to six or eight lanes
- Industrial developments shall consider the compatibility of building design with the surrounding land uses, buildings and physical environment. Roof lines, height, building mass, form, architectural character and outdoor spaces should complement adjacent commercial and other buildings.
- The design of parking areas should be attractive and screened from streets with substantial landscaping;
- Trees shall comply with the City of Memphis Street Tree Master Plan or a master Plan should be developed if non-existed.

Future employment needs can be met by a number of strategies such as:

- Maintaining and supporting existing industries
- Building upon the existing employment base by high tech and bioscience industries
- Encouraging the redevelopment of some underutilized general industrial lands for hybrid

industrial/business and high technology businesses

- Encourage clean, light industrial uses, with special emphasis on high technology (bio-tech) and information based industry
- All new industrial development shall be evaluated and developed consistent with Development Permit Area guidelines

3.6. Commercial Land Use

As air passenger and cargo traffic has increased and as Memphis has continued to expand outward towards, and around Memphis International airport, Memphis Aerotropolis operates as multimodal commercial nexus offering a variety of specialized goods and services. Existing commercial environment around the Memphis International Airport does not provide urban functions such as affordable hotels and exhibition complexes, retail and other amenities for business travelers. As aviation-linked businesses, warehouses and light manufacturing, supply and distribution businesses cluster further outward, primarily along connecting transportation corridors such as Interstates and Lamar Corridor, a more expansive Aerotropolis (airport-integrated urban economic region) takes shape. Redevelopment plans and a Master Plan along with local plans can provide the structure Memphis Aerotropolis needs.

Commercial and retail use within the Aerotropolis are primarily located along major and minor arterials, including Democrat, American Way, Knight Arnold, Winchester, Shelby Drive, and Elvis Presley Boulevard. Figure # shows commercial development in Aerotropolis.

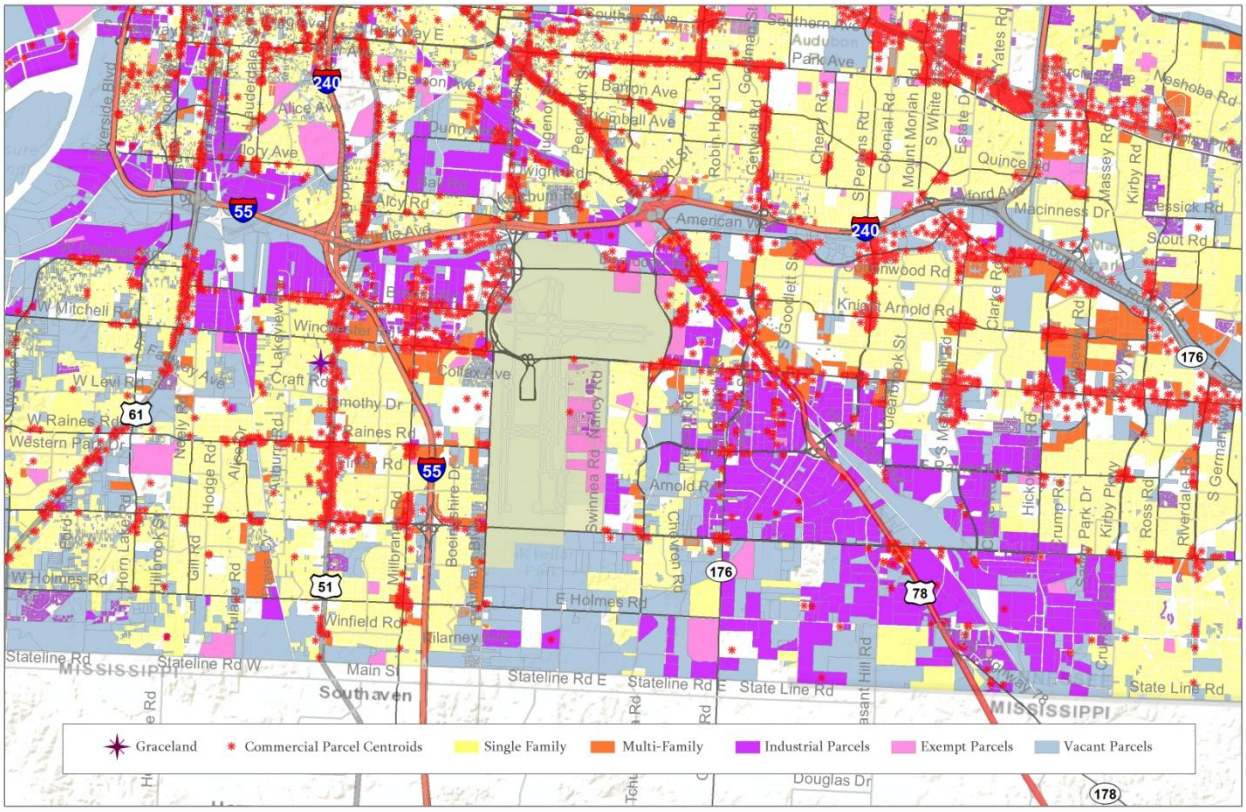

Figure 3.10. Commercial areas in comparison to other Land Use patterns

Most of the commercial corridors within Aerotropolis lack cohesiveness and are substantially underdeveloped and visually unappealing. This lack of cohesion and physical blight extends into many blocks and side streets, for example, Winchester/Lamar intersection is a blighted spot with closed businesses and abandoned buildings that need to be redeveloped to gain its economic competitiveness in the corridor.

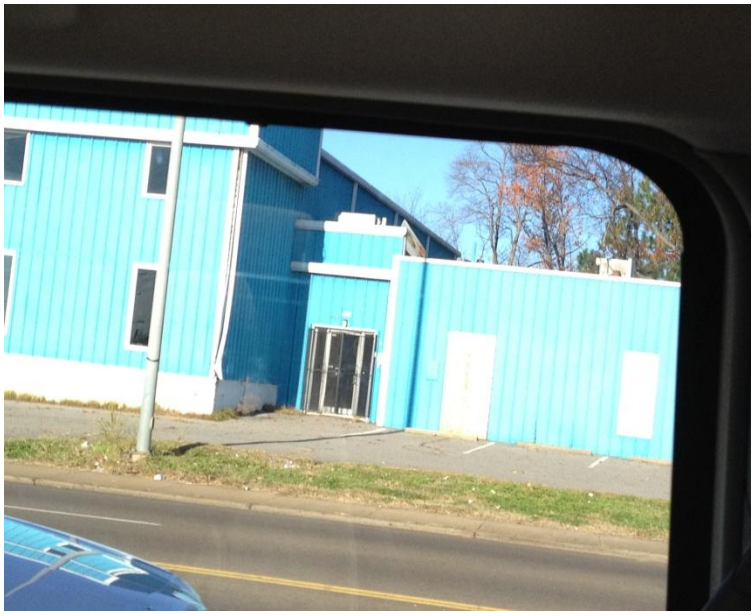

Figure 3.11. Closed businesses at the intersection of Winchester/Lamar

The appraised land value for commercial land in the Aerotropolis is maximum $27 per square foot and average value is $3.36 per square foot. For sale signs also show the potential of commercial development in the area.

Figure 3.12. Commercial Properties for Sale and Lease

3.6.1. Recommendations for Commercial Development:

- Provide a commercial environment in Aerotropolis that does more branding and markets Memphis's strengths in food, live music, cultural attractions such as Graceland, and high-tech workforce
- Conduct an inventory of blighted areas for a potential redevelopment
- Redevelop blighted spots with closed businesses and abandoned buildings to gain its economic competitiveness in the corridor.
- Provide better transportation for redeveloped areas
- Provide a better mix of businesses (activities) in neighborhoods, from restaurants to vocational training
- Create opportunity to develop a relationship between the paving patterns and outdoor uses by commercial establishments rather than just asphalt pavement.
- By expanding the sidewalk, commercial use of zoning spaces becomes viable and will allow commerce, such as restaurants, cafes and the like, to use the sidewalks for a variety of activities.
- Characterize Commercial districts by continuous rows of mixed use buildings constructed at the front property line. This development pattern creates a distinctive "streetwall" effect that adds visual interest, enhances the pedestrian environment, and establishes a "human" scale within the area.

3.7. Transit-oriented neighborhoods

Memphis Aerotropolis lacks infrastructure for transit-oriented neighborhood and employment centers. General lack of pedestrian pathways to bus stops reduces the accessibility by residents and workers to local businesses or commercial office/retail services. Traffic congestion occurs because 80 percent of the traffic is carried on just 20 percent of the roads. And half the traffic in the district is commuter traffic.

- Encouraging regular traffic to use the smaller, underused roads while leaving Lamar corridor for the big trucks going back and forth from the area's many logistics enterprises.
- Widen Lamar Corridor to six or eight lanes
- Connect rail, roads, river and airport for improved transportation
- A public transit development could create accessibility to the proposed greenway and be combined with other pedestrian oriented improvements

Figure 3.13. MATA bus stops by a local business along Lamar Avenue

3.8. Residential Land Use

Residential uses are primarily located within interior blocks from the commercial and retail corridors and industrial/warehouse districts. Concentrations of single family uses are located in the west of Lamar Corridor between American Way and Winchester and west of the airport between Brooks and Holmes Road. Multi-family residential uses are scattered throughout the area, but are mainly concentrated along American way /Lamar, American Way/Get well, Winchester/Lamar, Winchester/Oakside Drive, Winchester/Goodlett, Winchester/Knight Road, Winchester/ Outland, Knight Arnold/Mendenhall, Mendenhall/Flowering Peach in the east and west of Winchester, Winchester/Mill Branch, Winchester/Cazassa St, Raines/Interstate 55, Raines/Boingshire Drive, Raines/Elvis Presley Blvd, Shelby Dr/Boingshire, Shelby Dr/Airways, and Holmes/Tulane in the southwest. Multi-family housing includes apartment complexes, high rise apartments, town houses and condos.

The appraised land value for residential land in the Aerotropolis is maximum $8.66 per square foot and average value is $2.20 per square foot. Residential areas comprise of 889.56 acres. Maximum value, residential land appraised is $343, 200. Average building value is $54,104. Maximum value, a residential building appraised is $254,000. Figure 3.14 shows the residential land use pattern.

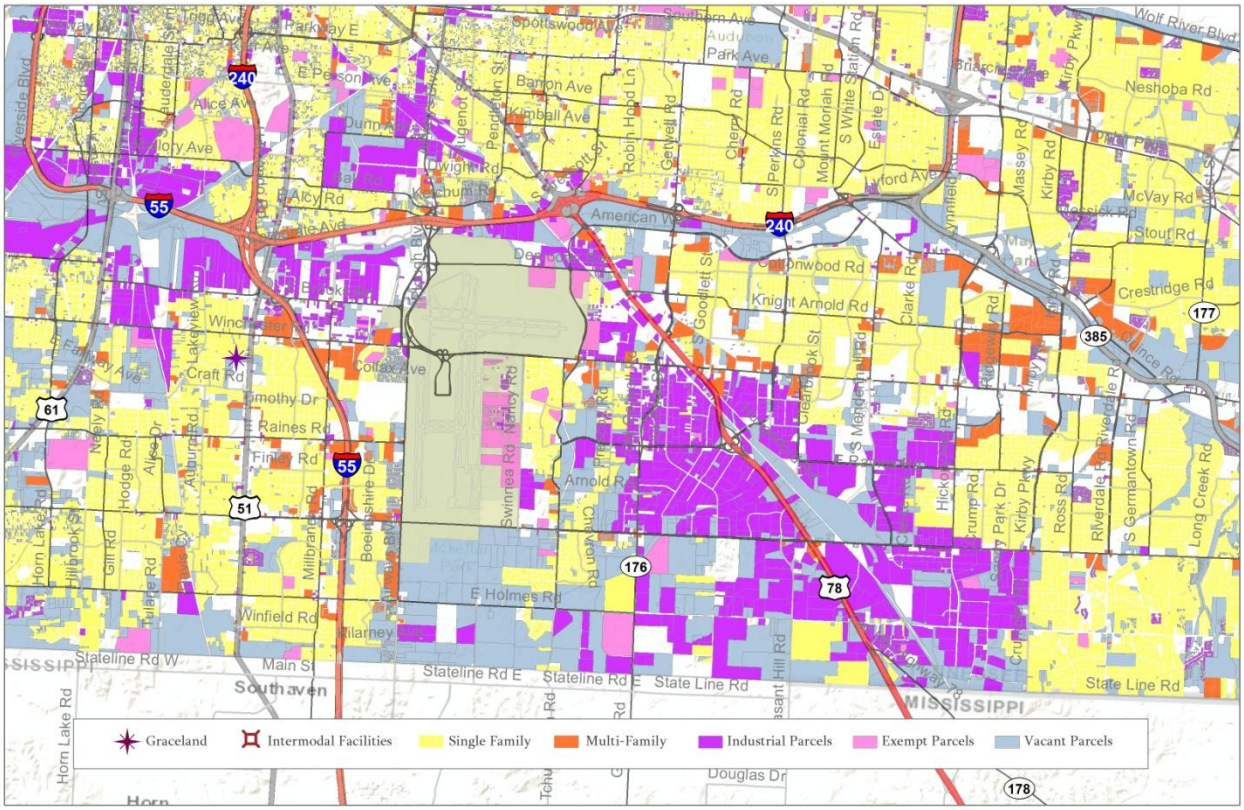

Figure 3.14. Residential Land Use Pattern

The most common measure of overcrowding is persons-per-room in a dwelling unit. The areas with households with more than two people-per-bedroom are shown with blue outline in Figure 3.15. Overcrowded environments increase the prevalence of communicable diseases and have effect on child growth and development. The effects of second-hand smoke and household hazards in overcrowded homes merit attention as well. Over-crowded housing units indicate less affordable housing in the area. Number of dwellings in multi-family housing in Aerotropolis needs to be examined. A rise in overcrowding, both in relative and in absolute terms, is evident among the Hispanic, Black households. Overcrowding indicate a lack of financial means for the populations with the greatest economic need (i.e., households with negative income or without income, and the households earning less than $25,000/year) in the Memphis Aerotropolis.

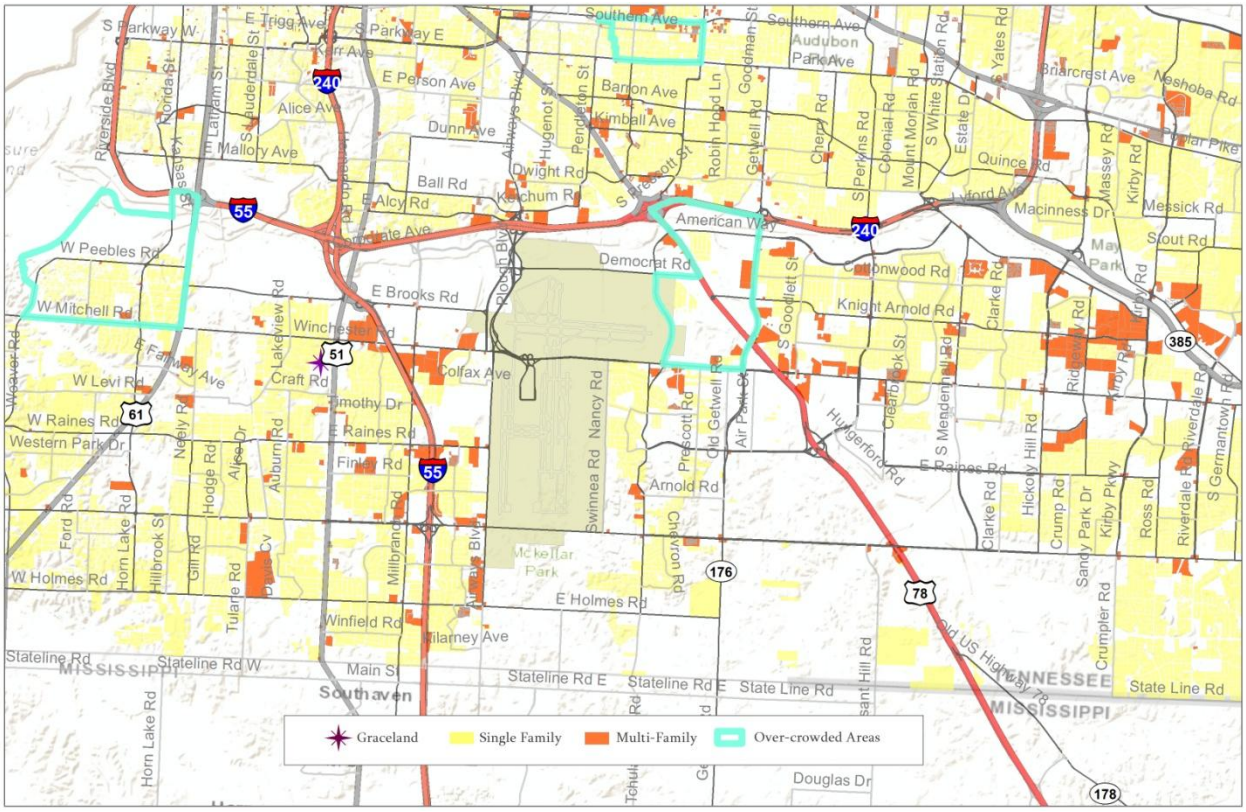

Figure 3.15 Over-crowded Areas

3.8.1. Recommendation for Residential Development

- Provide more affordable housing
- Provide access to retail and amenities for all the local residents
- Reduce higher incidence of overcrowding in multi-family housing by exploring demographic variables such as ethnicity and race, income, tenure, region, metropolitan status, and citizenship status.

3.9 Existing Open Space and Recreation

Public open space and recreation is scattered throughout the Memphis Aerotropolis. Figure 3.16 below shows the existing parks, planned greenways and bikeways, within single and multi-family housing. Open Space and recreation uses within the Memphis Aerotropolis are minimal, and with few exceptions, pedestrian connectivity non-existent.

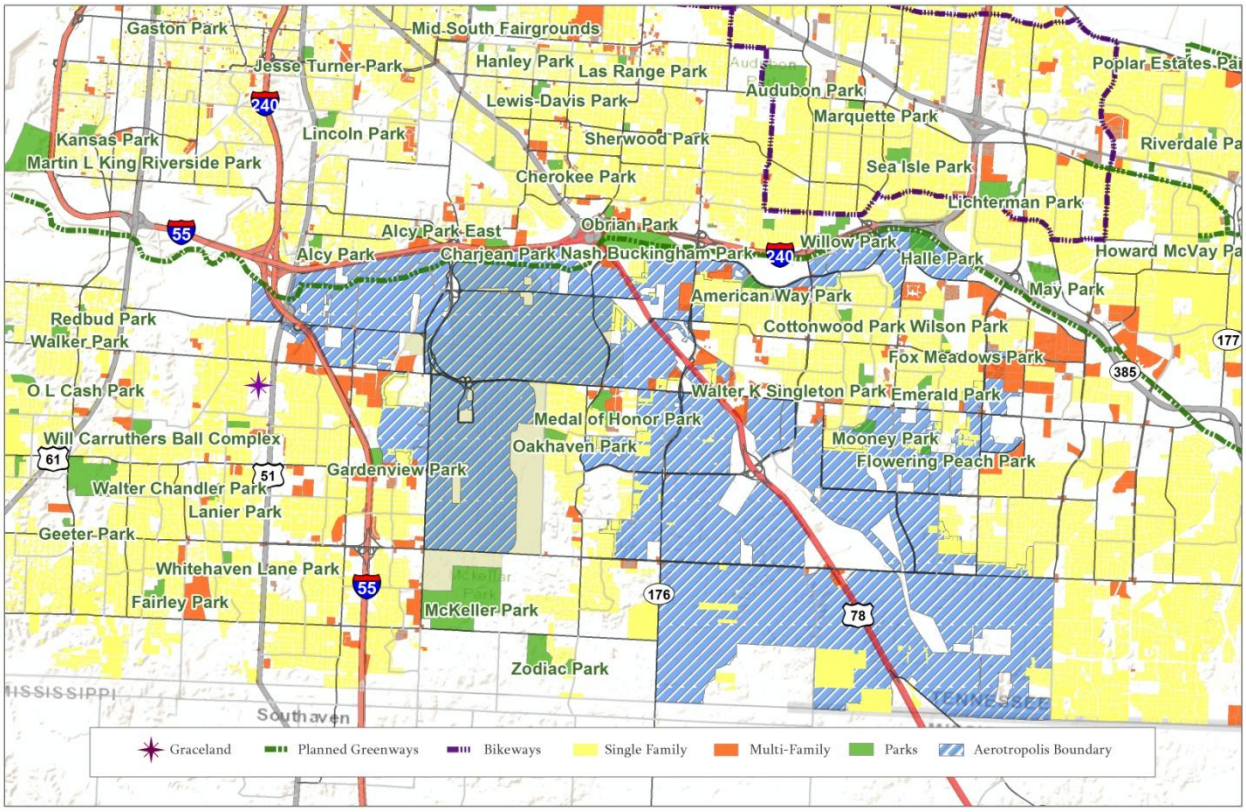

Figure 3.16. Aerotropolis Parks

The overall aesthetic conditions of the area vary. Blighted, deserted areas with overgrown yards, no trees, clutter and trash characterize the areas closer to Lamar corridor. The Aerotropolis, in general, has no predominant character that helps to create and define neighborhoods and a sense of place. Visual clutter is a major problem for the Aerotropolis open space and recreation areas. Billboards and above ground utilities clutter are prominent. The most abundant type of clutter is the fencing that surrounds the parks and the playgrounds, which create a perception of danger by virtue of the very measures taken to guard these properties. Fences destroy the normal sense of openness and approachability of a park and give the area a character of defense and anonymity despite the large areas of lawns interspersed with shade trees. Trash receptacles are present in the park system, but the few that exist are neither well maintained nor used properly. Changes are needed in the way the public currently interacts with the area's parks. In order to provide visitors

with a sense of safety, proper lighting, maintenance, and design solutions are needed to create pedestrian access, a unique identity, and a sense of place.

3.9.1.Recommendations for Open Space and Recreation:

- Create hiking and biking trails along streams such as Nonconnah Creek
- The scenic quality of Nonconnah Creek should be emulated in restoration efforts. Its vegetated banks may serve as models for passive recreation areas such as pocket parks in the neighborhoods situated along the banks of the creek
- A thorough streetscape assessment needs to be conducted for the area and recommendation should be proposed for better streetscape conditions in terms of safety, aesthetics, and recreation facilities. There is no predominant evidence of the demographic, cultural presence of the various ethnic groups within the elements that comprise the streetscapes.
- Expand and plan new greenways and bike ways south of interstate 240 in Whitehaven and southeast Memphis neighborhoods
- The areas in close proximity to warehouses that result in narrow-width corridor segments disadvantages to trail development, can utilize alternate local roads in the vicinity to accommodate the recommended greenway
- A linear greenway can bring nature to the Lamar corridor residents and enhance recreation opportunities within short distances from living and working environments
- A greenway can also provide access and linkage among parks, cultural and historic sites such as Graceland.
- A public transit development could create accessibility to the proposed greenway and be combined with other pedestrian oriented improvements

3.10 Vacant Lands

A distinguished characteristic of the area is the inordinate amount of vacant and underdeveloped land, located primarily south of the Memphis Airport and ware house districts. Vacant land and underutilized land and buildings at key intersections create a blighted overall appearance. This condition is exacerbated by barren streetscapes, decaying public infrastructure, abandoned businesses and a general lack of green space throughout the area. Figure 3.17 shows vacant lands in relation to industrial lands and parks.

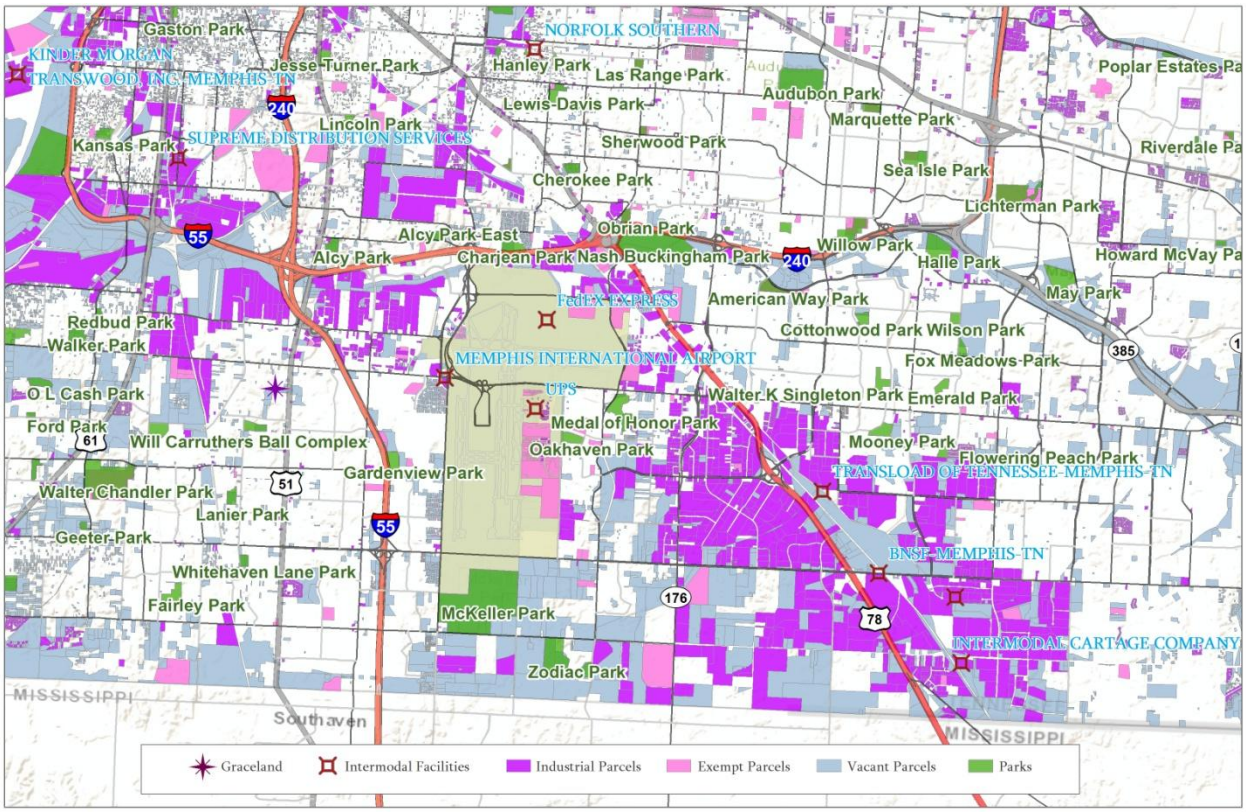

Figure 3.17. Vacant Lands in relation to industrial lands and parks

3.11. Recommendations for Development of Vacant Lands

- The undeveloped vacant lots are clearly conducive to open space and recreation development
- make productive some of the unused land with agriculture, at least for the short-term uses;
- acquire land and provide incentives for redevelopment;
- Provide opportunities for building secure parking garages with controlled entry to reduce the impact of parking vehicles along the streets
- Vacant lots offer unique but challenging opportunities for infill housing, especially more affordable housing that has interesting design qualities and is in harmony with the long standing character of old south Memphis neighborhoods

3.11. Graceland's role in Memphis Aerotropolis

Graceland is a large white-columned mansion and 13.8-acre (5.6 ha) estate that was home to Elvis Presley in Memphis, Tennessee. It is located at 3764 Elvis Presley Boulevard in the vast Whitehaven community about 9 miles (14.5 km) from Downtown and less than four miles (6 km) north of the Mississippi border. Graceland is a major tourist attraction for Memphis visitors and a major redevelopment potential in Memphis Aerotropolis. The 13.5 acre estate which served as the primary residence of Elvis Presley from 1957 until his passing in 1977 was first opened to public tours in 1982. Over the past five years, Graceland has averaged approximately 564,000 visitors per year. The focal point of the Graceland business is a guided mansion tour, which includes a walk through the historic residence as well as an extensive display of Elvis' gold records and awards, career mementos, stage costumes, jewelry, photographs and more. The tour also includes a visit to the Meditation Garden, where Elvis and

members of his family have been laid to rest. In addition to the mansion, the Graceland include access to an automobile museum featuring vehicles owned and used by Elvis, the "Sincerely Elvis" and "Elvis After Dark" museums, which feature changing exhibits of Elvis Presley memorabilia, an aviation exhibition featuring the airplanes on which Elvis traveled while on tour, restaurants, a wedding chapel, ticketing and parking. Retail stores at Graceland offer Elvis Presley-themed merchandise and produce exclusive licensed merchandise for visitors to Graceland. Adjacent to the Graceland real property is the Meadow Oaks Apartments, a 270-unit apartment complex. Located directly across from the mansion, the Graceland RV Park and Campground, an 18.9 acre site expands the Graceland experience.

3.11.1 **Recommendations for Graceland:**

- Incorporate Graceland in planned greenways providing access and linkage among parks, and other cultural and historic sites.
- Make it more appealing by the addition of restaurants in walkable distance, retail opportunities, goods, services and amenities
- Design an entrance or sense of place to the Graceland experience
- Provide easy access for business travelers to tourist attractions through a good transit system
- Make the neighborhood around Graceland more transit-oriented neighborhood

3.12. Environmental Noise Analysis

The aim of this section of the report is to map unwanted or harmful outdoor sound generated from road, rail, and airport in Memphis Aerotropolis, where multiple modes of transportation exist. In order to inform policy and to develop freight-supportive land use guidelines, local governments need to understand and consider this new evidence on the health impacts of environmental noise. This is not a risk assessment study. We mapped traffic noise levels, rail and airport noise with geographic information systems (GIS) datasets.

3.12.1. Existing Traffic Congestion

Memphis Aerotropolis is characterized by Memphis Airport, large concrete intermodal facilities, supply and distribution centers, multi-tenant office buildings and Elvis Presley's Graceland. Intermodal facility and larger industrial operations on Lamar Corridor between commercial uses of Lamar/Winchester and the Lamar/Shelby Drive generates significant amount of truck traffic, which contributes to congestion on roadways. Congestion during weekday peak hours threatens the environment; roadways become more congested and less efficient. The commercial and industrial developments in the area of Airport West as well as the expanding residential development towards Mississippi seriously strain the existing highway system. Figure 3.18 shows congestion on Lamar Avenue. While the highways are congested, roadways inside Aerotropolis still have additional capacity to allow growth in employment and traffic in the area.

Figure 3.18. Congestion on Lamar Corridor

3.12.2. Definitions and Standards

Noise is unwelcome sound. Sound is made up of pressure variations detected by the ear which have been transmitted in longitudinal waves (WHO, 1995) The loudness or intensity of sound is measured in Pascal (Pa). Because the Pascal scale is so large it is more useful to express the loudness of sound on a logarithmic scale as decibels (dB) (WHO, 1999a). Sounds which are audible to people range from the threshold of hearing at 0 dB to the threshold of pain at levels over 130 dB 0)

Figure shows the intensity of sound in dB scale at a reference distance from noise emitters. Noise above 65 dBA is highly undesirable. More specifically, the World Health Organization recommends maximum noise levels of ≤ 30 dBA in sleeping areas. For outdoor living areas, in residential areas, exposure levels should not exceed 50 – 55 dBA. Some local planning authorities include design levels and performance standards in local plans but considerable variation exists (McCallum-Clark, et al. 2006). The EPA indicated that maximum acceptable

levels of 55 dBA for external noise and 45 dBA for internal noise were adequate (US EPA 1981) (McCallum-Clark, et al. 2006). For outdoor living areas in residential areas exposure levels should not exceed 50 – 55 dBA Leq (WHO, 1999a).

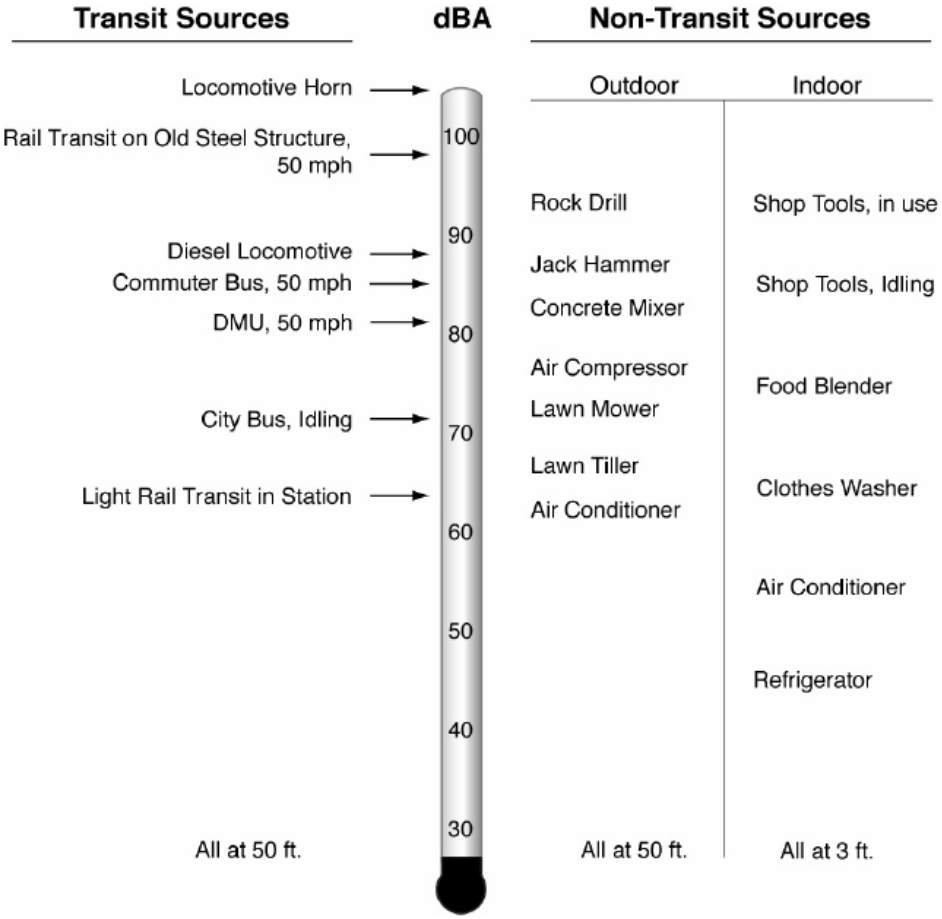

Figure 3.19 Intensity of sound from different noise emitters

3.12.3 Noise Maps

Road traffic noise maps have been modeled in several places including Chittenden County, Vermont (Chittenden, 2005), Fort Riley, Kansas (Fort, 2006), and San Francisco, California (San Francisco in California, 2008), Fulton County Georgia (Seong 2011). Noise mapping is the presentation of data on an existing or predicted noise situation in terms of a noise indicator. Two approaches are frequently used in developing traffic noise maps. One is to make direct

measurements of numerous points and create a map by interpolating values over space. The other is to model traffic noise levels with geographic information systems (GIS) datasets and traffic information (Jeong C. Seong 2011).

3.12.3.1. Traffic Noise Maps

There are many noise prediction models. Some early models used simple variables such as traffic volume, distance from traffic lanes, mean vehicle speed, and percentage of heavy trucks. Recent models are more sophisticated, incorporating various attributes such as empirical measurement data, sound propagation and linear sources (Steele C.A. 2001).

Probably the earliest road traffic noise model was that given in the 1952 Handbook of Acoustic Noise Control. It was offered for speeds of 35±45 mph and distances greater than 20 feet. The 50 percentile was there given as 0:

$$L_{50} = 68 + 8.5 \log(V) - 20 \log(D),$$

where

V . Traffic volume in vehicles per hour,

D . Distance from the traffic lane, in feet.

We obtained traffic history data from the Tennessee Department of Transportation (TDOT) in 2010. Traffic History reflects the Annual Average Daily Traffic (AADT) count along specific locations on Tennessee's road network. To generate the noise prediction maps, point features of traffic history data were spatially joined to Shelby County streets features in the GIS environment. To achieve this goal, the closest line segment was joined to each point feature of traffic history data. Then the attributes of traffic history feature were transferred to the closest road segment, discrete line segments, located close to the traffic observation stations that have Average Daily traffic data. Predicting noise pollution around corridors requires hourly traffic

volume in vehicles per hour for all road segments. To achieve this, a statistical summary was extracted based on the Feature Class Codes (FCC). Then the summary was generalized to all streets based on their FCC. Table 3.4 is the classification of roads based on FCC, and Table 3.5 shows the approach used to calculate traffic data for all road segments. Figure 3.20 shows transportation noise from traffic.

Table 3.4 . Detailed information on the classification of the line segment based on feature class codes

FCC	Description
A15	Primary road with limited access or interstate hwy, separated
A21	Primary Highways without limited access, unseparated
A25	Primary Highways without limited access, separated
A30	Secondary state and county highways, major category
A31	Secondary state and county highways, unseparated
A35	Secondary state and county highways, separated
A40	Local, neighborhood, rural road, city street, major category
A41	Local, neighborhood, rural road, city street, unseparated
A45	Local, neighborhood, rural road, city street, separated
A60	At-grade ramp or connecting road not associated with a limited access highway
A63	Access Ramp, the portion of a road that forms a cloverleaf or limited access interchange
A75	Road, parking area

Table 3.5. Reclassification of Shelby County road segments based on their FCC and A

1. **FCC**	**2. Road Segments (All)**	**3. Road Segments (with AADT)**	**4. Average AADT**	**5. Re-class.**	**6. PHV (veh/h)**	**7. Req. Dist for 65 dB (ft)**	**8. Req. Dist for 55 dB (ft)**	**9. Req. Dist for 45 dB (ft)**
A40	41471	422	5641	5674	681	23	71	226
A41	6773	31	6128					
A45	1329	32	10948	11521	1383	31	97	305
A75	159	1	11053					
A30	4672	197	11617					
A60	1167	6	17553	21025	2523	39	125	394
A31	1341	48	18627					
A35	2468	51	21547					
A21	1241	56	22978					
A25	981	21	28106	28106	3373	45	141	446
A63	1657	11	48570	48570	5829	56	178	563
A15	2371	52	78773	78773	9453	69	219	691
Other	511	0	NA	NA	NA	NA	NA	NA

∑ =66141 ∑ =928

Column 1 is Feature Class Codes
Column 2 is the number of roads for different feature class codes in Shelby County
Column 3 is the number of road with AADT data in FCC classes
Column 4 is the average AADT for measured road segments
Column 5 is reclassification of road segments with close average ADDT
Column 6 is pick hour volume (veh/h). For urban area PHV is 7-12% of AADT 0.
Column 7, 8 and 9, calculated by Anon noise prediction model, are required distance to reach desired noise intensity of 45, 55 and 65 dB.

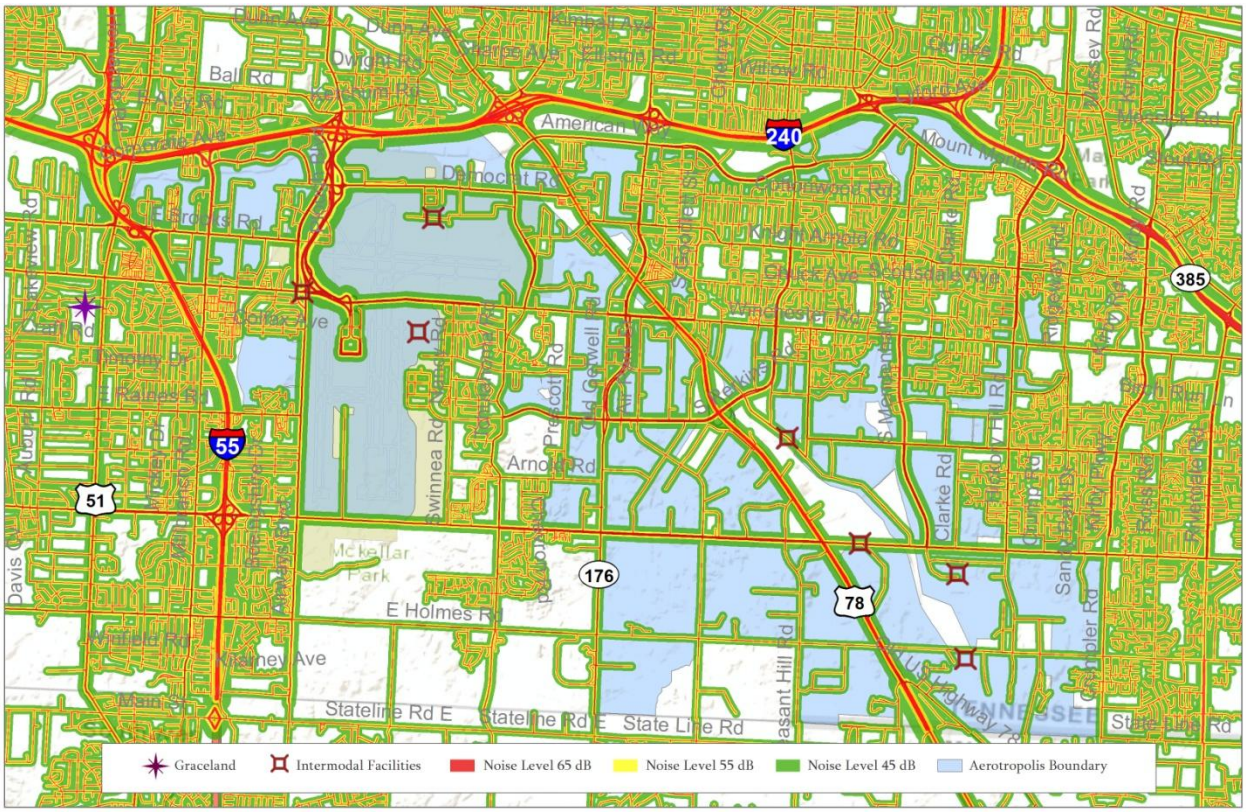

Figure 3.20. Aerotropolis transportation noise from traffic

3.12.3.2 Rail Noise Maps

The noise and/or vibrations from high-speed trains, lower-speed trains, and train horns all affect communities near the tracks or guide ways. The FRA has modeled how the train horn sound propagates and dissipates from its source (John P. Redden, P.E., 2005). Generally, sound intensity drops with $1/r^2$ at a distance from the sound source by following trend:

$$L_2 = L_1 - 10 \times \log\left(\frac{r_1}{r_2}\right)^2$$

Where,
L_2 = intensity of sound at distance of r_2
L_1 = reference sound intensity at distance of r_1
Using logarithm rule, we can write the equation as:

$$L_2 = L_1 - 20 \times \log\left(\frac{r_1}{r_1}\right)$$

So required distance from the reference point id calculated as:

$$r_2 = r_1 \times 10^{\left(\frac{L_1 - L_2}{20}\right)}$$

Assuming an average of 95 dB of noise at 50 feet from the train, the following chart shows required buffers around railroads to receive desired noise of 85, 75, 65, and 55 (Table 1.6).

Table 1.6. Required buffer around rail roads

Noise (dB)	Calculated Buffer (ft.)	Applied Buffer (ft.)
85	158	160
75	500	500
65	1581	1600
55	5000	-

The FRA model states that train horn noise is reduced by 4.5 dBA whenever the distance from the train is doubled. The FRA model also considers shielding from buildings and includes a 3 dBA reduction at the first row of buildings, located 200 feet from the track, and additional 1.5 dBA reductions for each succeeding row at 400, 600, 800 and 1,000 feet. In addition, usually there are some rail noise abatement constructions which help to reduce the noise before it reaches the community, noise walls can be installed and the buffer zone between the rail and

community can be increased (John P. Redden, P.E., 2005). Also, improved sound insulation in the buildings will help reduce the noise level. Figure 3.21 shows the noise exposure in Memphis Aerotropolis from railroads.

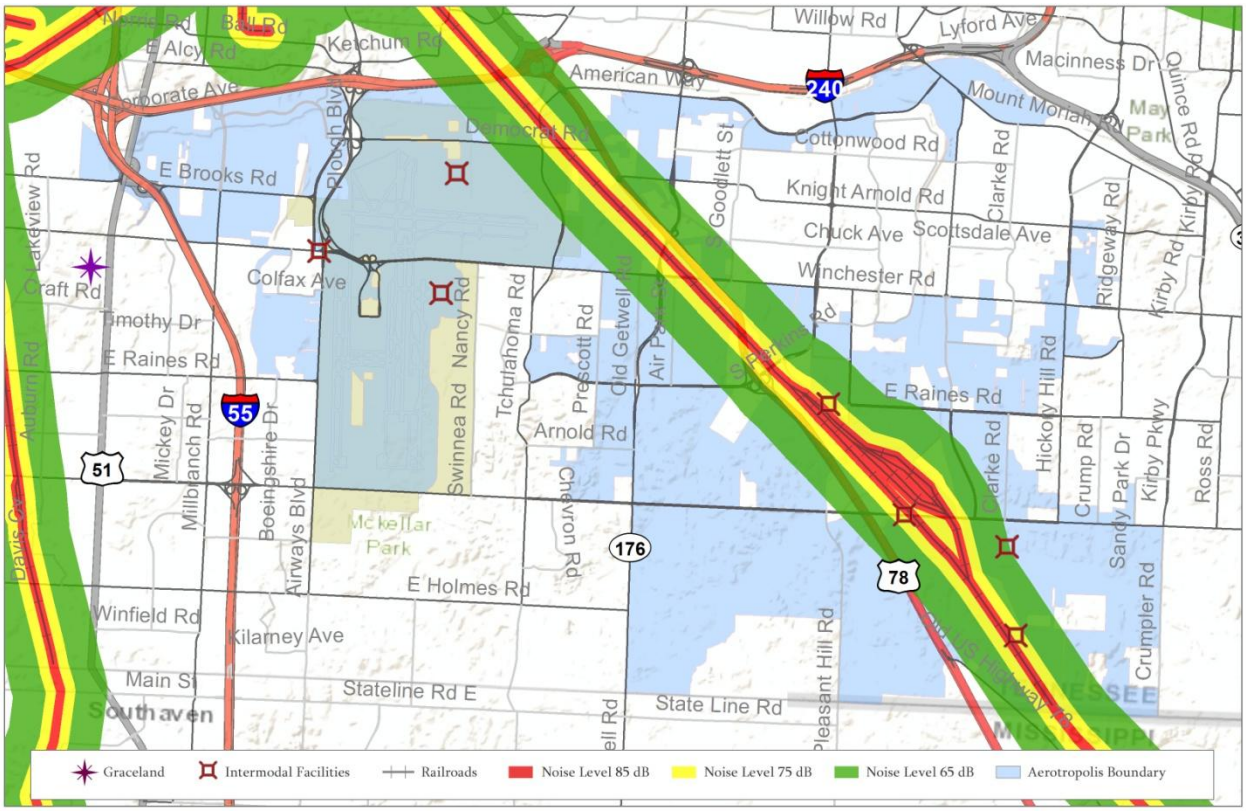

Figure 3.21. Aerotropolis transportation noise from railroad

3.12.3.3 Airport Noise

The noise generated from aircraft is attributed to the engines and aerodynamic noise sources. Each type of aircraft generates a distinctive type of sound that is dependent on its construction. For fixed-wing aircraft, jets in general can be heard on the ground as a broadband noise source, with some having higher-frequency tones (1000 Hz); the sound of propeller-driven aircraft in general is more biased toward lower frequencies, usually with a prominent low-frequency tone (500 Hz) 0

For each aircraft the generated noise is affected by the aircraft's operations. Three operational states are: 1. taking off from a runway or helipad, 2. approaching a runway or helipad, 3. en route flight (cruise).

Several computer software packages are available for obtaining aircraft noise predictions. Clint Morrow et al. (2009), mapped existing noise exposure and predicted future condition for next 5 years. David Southgate (2003) discussed related studies and draw national guidelines for Australian airports.

Delineating the buffer will require negotiation and/or the agreement on a set of criteria for determining the buffer boundaries. Developing buffer zone boundaries through negotiation has many advantages over using computer generated noise contours. At several airports recent interest has been shown in using the location of flight paths, rather than noise contours, to determine land use planning areas (David Southgate 2003). At certain categories of airports around the world it is not uncommon to simply use a buffer based on distance from the airport to delineate airport influence/planning zones (ASRMA, City of Glendale, 2002).

A simple alternative to defining flight path zones or flight path corridors would be to use distance from an airport as the means of defining a buffer zone to implement local planning controls in the vicinity of the airport. The buffer zone could be chosen to encompass the areas impacted by training circuits and to extend to natural boundaries such as major roads. A circle with a radius of 3 nautical miles (~5.6 km) from an airport would include all or most of the regions overflown by pilots performing circuits (David Southgate 2003).

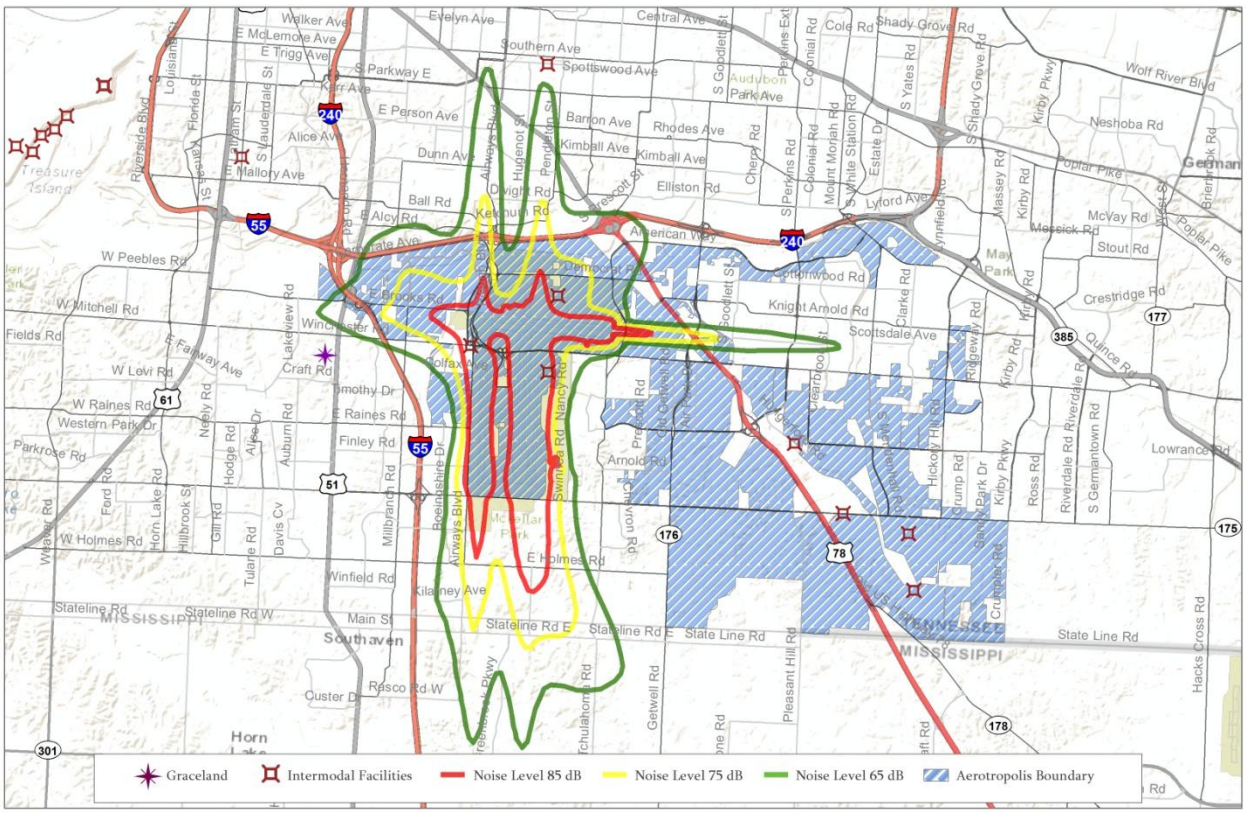

Figure 3.22 Aerotropolis transportation noise from airport

3.12.3.4 Total Traffic Noise

Because of the logarithmic nature of the decibel scale, a doubling of the power or intensity of a sound, for instance adding up two identical sounds, generally leads to an increase of 3dB, not a doubling of the decibel rating. Multiplying the sound power by ten leads to an increase of 10dB (Figure) (Morris, P., Therivel, R. 2009).

So in order to integrate different noise maps together and create the maximum of amounts for overlaying maps were used. Figure 3.22 shows the final noise map for Shelby County which is created by integrating noise from different transportation facilities.

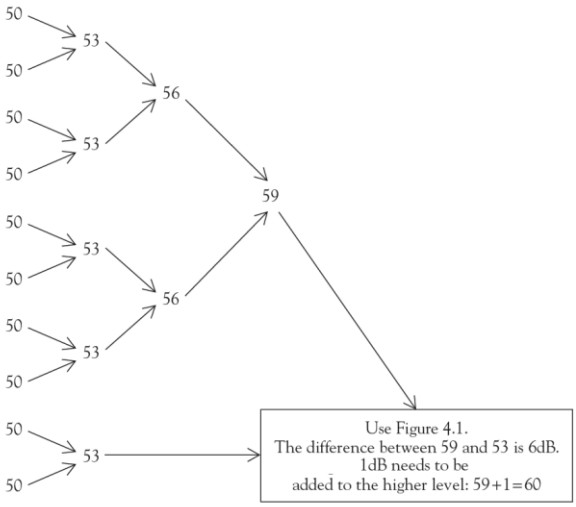

Figure 3.23. Adding impact of sound sources (Morris, P., Therivel, R. 2009).

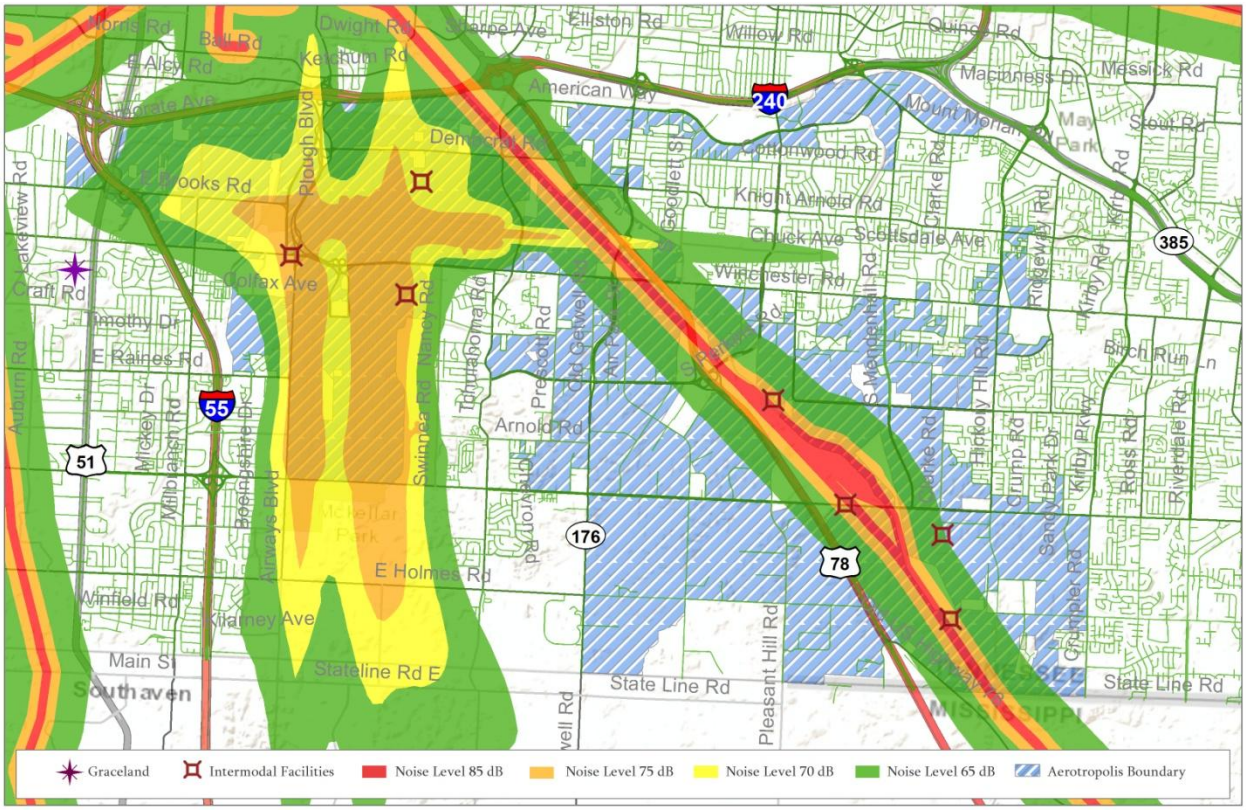

Figure 3.24. Aerotropolis transportation noise from traffic, railroad, and airport

3.12.4. Recommendations for Noise Analysis

Noise pollution is a big concern in Shelby County. This study shows that about 15% of county area is influenced by at least one type of noise pollution from transportation facilities. One of the major noise pollutants in the area is railroad and locomotive horn. However, in comparison to the noise from other transportation facilities, it is easy to deal with.

- Construct bridges over the tracks to remove the need for horn. Also limiting the direction of sound using solid barriers construction is another option.
- Growing employment of Memphis Aerotropolis necessitates nearby residential/commercial development and housing for airport area workers and frequent air travelers. Because these urban uses are both noise and emission sensitive, they should be located outside noise and emission zones. Whether residential/commercial land uses are impacted by the noise generated by the airport should be evaluated with a more robust approach by conducting surveys and also examining health outcomes and land values.
- For future studies, it is recommended to use population data to assess the number of people suffering from noise pollution in Shelby County.
- In addition, model used in this study was very simple and primitive. So it is suggested to create a more detailed model using detail traffic data (including factors like speed, percentage of truck etc). As mentioned, the noise from airport is calculated by simple buffers. It would be very helpful to carry out a field measurement for Memphis International Airport study and map the noise based on existing conditions.

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