Huntsville Area BRAC Transfers: Economic and Transportation Impact Assessment

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by

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Executive Summary

- This report presents an assessment of the economic and transportation impacts of the Base Realignment and Closure (BRAC) 2005 transfers to the Huntsville, Alabama area. The overall economic impact on the state of Alabama and on the four-county region comprising Limestone, Marshall, Madison, and Morgan counties and the impact on roadways in the City of Huntsville E + C Network are assessed. The City of Huntsville requested this study to assist its planners in developing strategies to anticipate and mitigate adverse impacts on transportation and other infrastructure, as well as schools, parks, hospitals, etc. The goal is to maximize the economic benefits of the BRAC move while maintaining a high quality of life in the region.

- The BRAC 2005 transfers will provide a direct net gain of about 4,000 military and government civilian personnel with an average annual income of $70,000, more than double the $33,416 average for an Alabama worker in 2004.

- About 3,600 housing units will be built at a cost of $617 million for these workers and a $359 million military construction will also be undertaken. This will result in one-time economic impacts on Alabama of $1.9 billion in output, $510 million in household earnings, and nearly 16,000 direct and indirect jobs from 2006 to 2010. Most of these impacts will be in the region: $1.4 billion output, $388.5 million earnings and 10,473 direct and indirect jobs. Nearly $38 million in income and sales taxes accompany these impacts; $20.4 million state income, $8.6 million state sales, $5.5 million region sales, and $3.1 million for the 63 other counties.*

- From 2009 onward, the Redstone Arsenal BRAC 2005 payroll will generate annual output impacts of $457 million on Alabama and $374 million on the region. In addition, every $100 million of non-contract non-payroll expenditure delivered to final demand will create output impacts of $163 million for the state and $133 million for the region.** Earnings impacts are $456 million statewide and $373 million for the region. Employment impacts are 5,505 jobs on the state and 4,870 jobs for the region. Fiscal impacts are $26.5 million in state taxes; income $18.2 million, sales $7.7 million, and property $0.6 million. Tax receipts for the region total $9.2-10.3 million; $6.3 million sales and $2.9-4.0 million property. Other Alabama counties receive $1.8-1.9 million sales and property taxes.

- One billion dollars of BRAC 2005 related contract expenditures that is fully expended in Alabama will produce statewide economic and fiscal impacts of about $2 billion in output, $495 million in earnings, and 10,858 direct and indirect jobs. Region impacts are approximately $1.8 billion output, $367 million earnings, and 7,632 jobs. The average annual income for these jobs is $48,000, but 2,472 of the total jobs impacts are direct jobs that earn $83,000 annually. Fiscal

* The Regional Input-Output software, RIMS II, developed by the U.S. Department of Commerce's Bureau of Economic Analysis is used to estimate the impacts.

** Non-payroll expenditure delivered to final demand typically include retail purchases, expenditures at lodging places and eating/drinking establishments, tax payments, expenditures considered as investment, etc. (i.e. payments that are not considered as intermediate demand). Contracts are examples of intermediate demand because payments are made directly to the contractors and typically have no taxes associated.

impacts are $28.9 million for the state ($19.8 million income, $8.4 million sales, and $0.8 million property), and $10.7-12.6 million for the region comprising $6.2 million sales and $4.5-6.4 million property. Other Alabama counties receive $3.5-4.1 million sales and property taxes. The annual total is $43.2-45.6 million to all jurisdictions. These contract expenditure impacts are not definite because of uncertainty regarding the amount; the $1 billion estimate used is based on recent Redstone Arsenal contracts relative to total budget.

- The region's population is expected to rise 14.6 percent to around 614,000 by 2010 from its 2000 level of about 535,700. The population will be approximately 652,000 in 2015 and surpass 718,000 by 2030. From the 2000 level, employment is forecast to be 23 percent higher in 2010, 32 percent higher in 2015, and 81.5 percent higher to nearly 609,000 in 2030. The high income BRAC 2005 related jobs should raise average and median incomes for workers and their families in the region. Based on the population projections, fuel taxes in 2010, 2015, and 2030 will be $6.4 million, $10.9 million, and $18.9 million more than the 2004 level, respectively.

- The economic impacts and population projections presented in this report are conservative for three main reasons. First, the contract expenditure that is fully spent in the four-county region and the state will generate contractor related jobs for which there will be substantial residential housing demand. The economic impact of this particular residential construction is not included in this report although the number of jobs and related population change associated with an assumed $1 billion of contract expenditure are presented. Second, all residential construction expenditure will generate additional sales tax that is practically impossible to estimate without detailed information on the nature of the expenditure. Finally, other taxes and fees (e.g., lodgings tax, utility tax, and car tag and fees) that will be generated are not estimated.

- A potentially large infrastructure investment to meet expected future travel demand associated with the growth coming to Huntsville and the surrounding area will be required for transportation services in the City of Huntsville E + C Network. Roadway impacts show that congestion will become a serious problem if the expected growth occurs with no increase in the amount of roadway capacity in the network. Vehicle miles of travel nearly double and vehicle hours of travel more than triple from 2005 to 2030; average speed of travel falls to 15.9 mph from 30.7 mph. The miles of congested roadway rise from 1.35 percent of the total network length in 2005 to 4.65 percent in 2015 and 15.60 percent by 2030. High-occupancy and park-and-ride systems and programs as well as access management for some roadways may also be required.

- A future impact study is recommended as more information becomes available, to reduce some elements of uncertainty that were encountered in determining the BRAC transfer impacts at this stage. The critical areas of uncertainty relate to the economic impact estimates. For example, military construction expenditures changed significantly between the start of the project and the time of report preparation.

- Clearly, the BRAC transfers will have substantial impacts on the four-county region and Alabama as a whole irrespective of the above-mentioned uncertainties. It is important that communities in the region and in other areas of the state that will be affected by and benefit from BRAC begin preparations to optimize the economic benefits. Principally, investments in infrastructure and amenities that reduce congestion on the roadways, at parks, schools, libraries, etc. may be needed.

- In regard to the BRAC transportation impacts, it is important to note that even pursuing the 2030 long range transportation plan in its entirety will not enable the City and the region to avoid congestion. If the 2030 LRP network was fully in place, projected vehicle hours of travel with BRAC will be more than 1.5 times what it would be without BRAC. Consequently, BRAC-induced systemwide speeds would be about 70% of those projected without BRAC.

- It is recommended that the City, in conjunction with its regional and State-level partners, commence with the following actions:

  - Pursue full-build-out of the 2030 LRP.
  - Amend the 2030 LRP to add the following eleven projects:

Project Description	Required Improvement	Cost Estimate
• Research Park Boulevard/Bradford Drive from I-565 to University Drive	6 lanes	$7.2 million
• Eastview Drive from Slaughter Road to Hughes Road	5 lanes	$6.6 million
• Wall Triana Highway from Capshaw Road to Nick Davis Road	5 lanes	$8.1 million
• Mt. Lebanon Road from the Northern Bypass to Grimwood Road	5 lanes	$14.9 million
• US 72 East from Oakwood Avenue to the Eastern Bypass	6 lanes	$17.1 million
• Martin Road from Zierdt Road to Rideout Road	5 lanes	$8.13 million
• Interstate 565 from I-65 to Wall Triana Highway	6 lanes	$36.5 million
• Blake Bottom Road from Jeff Road to Indian Creek Road	5 lanes	$5.04 million
• Patton Road from University Drive to Redstone Road	5-7 lanes	$7.81 million
• Old Madison Pike from Slaughter Road to Hughes Road	5 lanes	$6.7 million
• Pulaski Pike from Patterson Lane to Beaver Dam Road	5 lanes	$3.9 million
Total Estimated Cost:		**$121.98 million**

  - Implement the appropriate strategy(ies) identified in the Huntsville Area Transportation Study's Congestion Management System *Procedures and Responsibilities Report* which:
    - Eliminate or reduce trips;
    - Involve traffic operational improvements and access management;
    - Shift trips from single occupancy vehicles to public transit, other HOVs, and other modes;
    - Involve Intelligent Transportation Systems; and
    - Add capacity for all vehicles

Introduction

This report presents an assessment of the economic and transportation impacts of the Base Realignment and Closure (BRAC) 2005 transfers to the Huntsville, Alabama area. Two main impacts are assessed. The first is the overall economic impact on the state of Alabama and on the four-county region comprising Limestone, Marshall, Madison, and Morgan counties. The economic impact covers the effect on gross product (or economic output), earnings, employment, and tax collections (income, sales, fuel and property) for both Alabama and the four-county region. The second is the impact on roadways in the City of Huntsville E + C Network and 2030 plan network. As defined in the City of Huntsville Area Transportation Study[1], the E+C system is the system of roads now open to traffic plus those recently opened, currently under construction or under contract for preliminary engineering. The methodology for estimating the impacts is detailed in the Appendix**.**

A major goal of this study is to provide information that the City can use to plan for strategies to anticipate and mitigate any adverse projected transportation impacts (e.g. traffic congestion) as well as impacts on schools, parks, and other infrastructure. This will ensure economic benefits of the BRAC move are maximized while maintaining or enhancing quality of life in the region. Projects undertaken to mitigate adverse impacts such as roadway and school construction will also generate additional economic benefits for the region.

Some general information on the direct effects of the BRAC 2005 transfers is shown in Table 1. The area will be gaining 4,700 personnel and losing roughly 700 for a net gain of about 4,000, with an average annual income of $70,000. This annual income level is more than double the $33,416 earnings average for an Alabama worker in 2004.[2] Residential construction of about 3,600 units and a $617 million total cost is derived from U.S. Census Bureau data on home ownership rates and home value by household income for Alabama residents, net annual home appreciation rate for the region, and the median sales price for the Huntsville metropolitan statistical area relative to Alabama's.

The payroll of Redstone Arsenal will grow by about $280 million as a result of BRAC 2005. There will be other payroll gains from the indirect effects of these jobs as well as the direct and indirect effects of contractor jobs that are certain to accompany the direct BRAC effects. Alabama and the four-county region will definitely benefit from both construction and operation activities. Spending by workers in both phases will provide jobs and increase business activity in various sectors of the Alabama and regional economies. This spending will also generate significant tax revenues. The infusion of cash impacts the gross state product (GSP), the total value of goods and services produced in the state, as well as the gross regional product (GRP). GSP and GRP are sometimes referred to as "output" and such reference is made often in this report. Estimates of the output, earnings, and employment impacts are presented together with associated earnings-based income,

[1] Huntsville Area Transportation Study developed by the Huntsville Planning Division. Adopted April 2005. Available online at http://www.hsvcity.com/Planning/FinalYear2030transplan.pdf

[2] Alabama workers earned an annualized average of $34,772 in third quarter 2005.

property, and sales tax revenues. The economic impacts indicate the total influence the construction and operation phases will have on the state and four-county economies.

Table 1. Direct BRAC 2005 Effects

Net personnel change	4,011
Average annual income	$70,000
Military construction	$358.6 million, 1.9 million square feet
Residential construction	$617 million, 3,610 units at $171,000 each
Contracts	$20 billion plus

Note: The information presented here is subject to change. The uncertainty will be reduced over time as more information becomes available on the BRAC 2005 transfers to the area.

Source: City of Huntsville; Alabama Real Estate Research and Education Center; and Center for Business and Economic Research, The University of Alabama.

The mobility of workers and residents is critical to economic development. Roadway congestion can slow or cripple such development if not addressed in time. The job creation and population increase accompanying the BRAC 2005 action necessitates addressing the impact on the region's roadways. Jobholders should be able to get to and from work and residents must also be able to run errands and go about their various activities.

This report presents a 2005 snapshot of important economic, demographic, and transportation variables followed by projected impacts for 2010, 2015, and 2030. Economic and fiscal impacts are presented first. Next are population projections and employment forecasts, followed by roadway impacts.

Economic and Fiscal Impacts

Both construction phase and operation phase economic and fiscal impacts are covered in this section. Construction phase activities involve the military and residential construction spending shown earlier in Table 1. It is important to note that there will be substantial additional residential housing demand associated with contractor jobs. However, the impact of this latter construction phase component is not considered here because of uncertainty regarding the annual contract expenditure that is expected to be fully spent in the four-county region and the state. Operational phase impacts, which begin once construction activity ends, are covered next.

Construction Phase Impacts

Construction activity is expected to be over the 2006-2010 period; residential construction (2006-2009) and military construction (2007-2010).[3] Construction phase impacts are one-time impacts that occur only over the specified construction period. The economic and fiscal impacts for this phase

[3] Residential construction related to contractor jobs could start during and continue after this period depending on the nature and pace of the creation of those jobs and the associated housing demand.

and its two components are shown in Table 2. Economic impacts on Alabama are $1.9 billion in output, about $510 million in household earnings and nearly 16,000 direct and indirect jobs. Most of these impacts are in the four-county region: $1.4 billion output, $388.5 million earnings and 10,473 direct and indirect jobs. There are clearly spillover impacts beyond the four-county region.

Table 2. Construction Phase Economic and Fiscal Impacts

Economic Impact	Military		Residential		Total	
	Alabama	Region	Alabama	Region	Alabama	Region
Output ($ millions)	843.4	620.3	1,065.1	835.3	1,908.4	1,455.6
Earnings ($ millions)	245.7	156.1	264.1	169.7	509.8	325.8
Employment (jobs)	6,941	4,402	9,035	6,072	15,975	10,473

Fiscal Impact

($ millions)	Alabama	Region	**Subtotal**	Other AL	**Total**
Income tax	20.4		20.4		20.4
Sales tax (earnings)	8.6	5.5	14.2	3.1	17.3
Total	29.0	5.5	34.6	3.1	37.7

Note: Rounding errors may be present.

Source: U.S. Department of Commerce, Bureau of Economic Analysis; Alabama Department of Revenue; and Center for Business and Economic Research, The University of Alabama.

The earnings and employment impacts generate tax revenues. Not all of the earnings impact is taxable; expenditures on sales taxable items are about 42.4 percent of total household earnings, and state taxable income (net income) is roughly 80 percent of earnings. The state income tax rate is 5.0 percent on net income.[4] Sales tax rates used are 4.0 percent for the state and also for combined county and city jurisdictions in the region for a total of 8.0 percent. Combined county and city sales tax rates vary between 2.0 to 6.0 percent among the four counties in the region and between 1.0 to 6.0 percent for other Alabama counties, but are most frequently at 4.0 percent.

The earnings impact generates $20.4 million in state income taxes and $8.6 million in state sales taxes. County and municipality sales tax receipts total $8.6 million: $5.5 million for the region and $3.1 million for the 63 other counties in the state. State and local sales tax receipts total $17.3 million. Thus $37.7 million in income and sales taxes will be collected over the 2006-2010 construction period.

There are additional sales taxes that will be generated, but which cannot be estimated without knowing further details about the total construction expenditure. Specifically, the capital expenditure will need to be broken down into construction payroll and costs for equipment,

[4] The first $500 and the next $2,500 are taxed at 2 percent and 4 percent, respectively, for single persons, head of family, and married persons filing separately. For married persons filing joint returns the first $1000 and the next $5000 are taxed at 2 percent and 4 percent, respectively. Excess net income is taxed at the 5 percent rate. Corporations pay at a 6.5 percent rate.

materials, and supplies. The Alabama share of these costs will also need to be identified. The impacts are therefore conservative.

Operation Phase Impacts

Operation phase activity is ongoing from 2009 on for the BRAC 2005 effects. The impacts are typically presented as annual impacts and we do the same here. However, it is important to note that actual operation phase impacts will change with changes in the size of the workforce, payroll, contracts, and operating expenditures for the activities during operations. Such changes are typically driven by growth, productivity, the general business climate, and in this particular case, future BRAC decisions.

Two components of operation phase economic impacts are presented for (i) non-contract Redstone Arsenal BRAC 2005 expenditures and (ii) BRAC 2005 related contract expenditures. The first involves payroll and other spending and has limited uncertainty. The second flows to contractors and has considerable uncertainty associated with it.

The economic and fiscal impacts for the non-contract BRAC 2005 expenditures are presented in Table 3. Payroll based output impacts are $457 million on Alabama and $374 million on the region. Additionally, every $100 million of non-contract non-payroll expenditure delivered to final demand will create output impacts of $163 million for the state and $133 million for the region.[5] Earnings impacts are $456 million statewide and $373 million on the region. The 4,000 direct jobs create 1,505 extra in the state for a total 5,505 jobs impact. The region gets 4,870 direct and indirect jobs.

The associated fiscal impacts are $18.2 million in state income taxes, $7.7 million in state sales taxes, and $0.6 million in state property taxes for a state total of $26.5 million. Tax receipts for the region total $9.2-10.3 million; $6.3 million sales and $2.9-4.0 million property. Other Alabama counties receive $1.8-1.9 million sales and property taxes, making for an annual total of about $38 million in income, sales, and property taxes to all jurisdictions. The property tax estimates are based on the jobs and earnings impacts, together with millage rates from the Alabama Department of Revenue, and average home values for specific income ranges from the U.S. Census Bureau. Here too, there are extra sales taxes that cannot be estimated without knowing the total amount and details of non-contract non-payroll expenditure. Other taxes and fees not estimated here include lodgings tax, utility tax, and car tag and fees. The fiscal impacts for this operation phase component are therefore conservative.

Economic and fiscal impacts for the BRAC 2005 contract expenditures are presented in Table 4 for an assumed $1 billion in contracts that is fully expended in Alabama. The impacts on the state are about $2 billion in output, $495 million in earnings, and 10,858 direct and indirect jobs. Impacts on the region are $1.8 billion output, $367 million earnings, and 7,632 jobs. The average annual income for these jobs is $48,000. Of the total jobs impacts, 2,472 are direct jobs earning $83,000 annually. These impacts are estimated using multipliers for the guided missiles and space vehicles industry.

[5] Non-payroll expenditure delivered to final demand typically include retail purchases, expenditures at lodging places and eating/drinking establishments, tax payments, expenditures considered as investment, etc. (i.e. payments that are not considered as intermediate demand). Contracts are examples of intermediate demand because payments are made directly to the contractors and typically have no taxes associated.

Table 3. Arsenal BRAC 2005 Operation Phase Annual Economic and Fiscal Impacts

Household impacts	Alabama	Region
Output ($ millions)	456.6	373.5
Earnings ($ millions)	455.7	373.1
Employment (jobs)	5,505	4,870

$100M expenditure output impact	Alabama	Region
Output ($ millions)	162.6	133.0

Fiscal impacts

($ millions)	Alabama	Region	**Subtotal**	Other AL	**Total**
Income tax	18.2		18.2		18.2
Sales tax	7.7	6.3	14.1	1.4	15.5
Property tax (low)	0.6	2.9	3.4	0.4	3.8
Property tax (high)	0.6	4.0	4.6	0.5	5.1
Total (low)	26.5	9.2	35.7	1.8	37.5
Total (high)	26.5	10.3	36.8	1.9	38.8

Note: Rounding errors may be present.

Source: U.S. Department of Commerce, Bureau of Economic Analysis; U.S. Census Bureau; Alabama Department of Revenue; and Center for Business and Economic Research, The University of Alabama.

Table 4. Contract-Based Operation Phase Annual Economic and Fiscal Impacts

Economic impacts of $1 billion in-state contract	Alabama	Region
Output ($ millions)	2,035.8	1,773.7
Earnings ($ millions)	494.5	366.5
Employment (jobs)	10,858	7,632

Fiscal impacts of $1 billion in-state contract

($ millions)	Alabama	Region	**Subtotal**	Other AL	**Total**
Income tax	19.8		19.8		19.8
Sales tax	8.4	6.2	14.6	2.2	16.8
Property tax (low)	0.8	4.5	5.3	1.4	6.6
Property tax (high)	0.8	6.4	7.2	1.9	9.1
Total (low)	28.9	10.7	39.6	3.5	43.2
Total (high)	28.9	12.6	41.5	4.1	45.6

Note: Rounding errors may be present. Guided missiles and space vehicles industry multipliers were used.

Source: U.S. Department of Commerce, Bureau of Economic Analysis; U.S. Census Bureau; Alabama Department of Revenue; and Center for Business and Economic Research, The University of Alabama.

The contract-based operation phase fiscal impacts are $28.9 million for the state ($19.8 million in state income taxes, $8.4 million in state sales taxes, and $0.8 million in state property taxes) and $10.7-12.6 million for the region comprising $6.2 million sales and $4.5-6.4 million property. Other Alabama counties receive $3.5-4.1 million sales and property taxes, making for an annual total of $43.2-45.6 million in income, sales, and property taxes to all jurisdictions. Again, there are extra sales taxes that cannot be estimated without knowing the details of non-payroll contract expenditure. Lodgings tax, utility tax, and car tag and fees are also not estimated. The fiscal impacts for this operation phase component are therefore conservative.

Population Projections and Employment Forecasts

Population projections and economic forecasts are presented for the four counties that comprise the region and the region as a whole in Table 5. Employment impacts from the previous section are incorporated into the projections and forecasts including those of the assumed $1 billion BRAC 2005 annual contract expenditure. Projections and forecasting methods are described in the Appendix.

Table 5. Population, Households, and Employment

	2000	2005	2010	2015	2030
Limestone County					
Population	65,676	70,469	77,259	83,974	97,412
Households	24,688	26,598	29,261	31,895	37,164
Employment	31,243	31,106	34,258	36,916	52,180
Madison County					
Population	276,700	298,192	325,367	345,130	372,873
Households	109,955	118,304	128,622	136,158	146,889
Employment	195,418	219,750	256,665	273,344	369,842
Marshall County					
Population	82,231	85,634	92,183	98,668	114,284
Households	32,547	33,893	36,499	39,073	45,255
Employment	44,934	43,625	49,263	53,736	80,078
Morgan County					
Population	111,064	113,740	119,128	124,090	133,494
Households	43,602	44,718	46,823	48,755	52,429
Employment	63,876	65,528	72,195	78,506	106,766
Four-County Region	**2000**	**2005**	**2010**	**2015**	**2030**
Population	535,671	568,034	613,936	651,862	718,063
Households	210,792	223,514	241,204	255,881	281,738
Employment	335,471	360,009	412,381	442,502	608,866

Note: Population is by county of residence and employment is by county that jobs are located in.

Source: Global Insight; U.S. Census Bureau; and Center for Business and Economic Research, The University of Alabama.

The population projections take into account population estimates available from the Census Bureau for 2001 through 2005 as well as ongoing development and recently announced economic activity in the region. The region's population is expected to rise 14.6 percent to around 614,000 by 2010 from its 2000 level of about 535,700 accompanied by a 14.4 percent increase in the number of households. The population will be approximately 652,000 in 2015, 21.7 percent higher than in 2000, and top 718,000 in 2030 (34 percent higher).

The roughly 609,000 employment forecast for 2030 is 81.5 percent higher than in 2000. This suggests the likelihood of serious roadway congestion if no significant roadway capacity expansion is undertaken. From the 2000 level, employment is expected to be 23 percent higher in 2010 and 32 percent higher in 2015. The high income BRAC 2005 related jobs should raise the average income for workers in the region, and in turn raise average and median family incomes.

The population projections are used to generate the region's future state and local fuel tax collections based on per capita state and local fuel tax collections in fiscal year 2004. Fuel taxes are excise taxes applied to gasoline, motor fuels, aviation gas, jet fuel, and lubricating oil. The state fuel tax on gasoline is 16 cents per gallon and there are additional county gasoline taxes of up to 3 cents per gallon as well as municipality rates of 1-3 cents per gallon. State and local fuel taxes in 2010, 2015, and 2030 are respectively, $6.4 million, $10.9 million, and $18.9 million more than the 2004 level.

Table 6. Estimated State and Local Fuel Tax Projections

County	Estimated Fuel Tax Per Capita, 2004	2004	2010	2015	2030
Limestone	$115.07	$7,984,697	$8,890,517	$9,663,342	$11,209,669
Madison	$116.56	$34,160,384	$37,924,632	$40,228,296	$43,461,921
Marshall	$128.62	$10,904,219	$11,856,219	$12,690,258	$14,698,837
Morgan	$128.15	$14,507,761	$15,266,027	$15,901,884	$17,107,029
Region	**$120.54**	**$67,557,060**	**$73,937,395**	**$78,483,782**	**$86,477,456**

Note: Rounding errors may be present.

Source: Alabama Department of Revenue; and Center for Business and Economic Research, The University of Alabama.

Transportation Impacts

A set of transportation planning analyses were conducted to estimate the impacts of the BRAC-induced growth on the transportation network in the Huntsville area. The background and results of these analyses are presented in the following sections. Pursuant to a statement made in the *Huntsville Area Transportation Study, "*It is also assumed that area residents will still rely primarily on their motor vehicles for most trips…," the analyses presented herein are confined to the highway element of the transportation plan. Nonetheless, recommendations relevant to non-highway modes are offered at the end of this section. The methodology summarized in the following sections is presented in detail in the Appendix.

Land Use Impacts

Socioeconomic data for the four counties (Limestone, Madison, Marshall and Morgan) was provided at the Census block group level by CBER. The data included the number of occupied dwelling units, retail employment and non-retail employment. This data was divided into traffic analysis zones (TAZ) as used in the Huntsville travel demand model. The City of Huntsville E + C Network and 2030 plan network developed for the previous *Huntsville Area Transportation Study* was the roadway infrastructure used to determine the impacts.

The socioeconomic data provided by CBER (disaggregated to the TAZ level) was input into the Trip Generation software, which converts socioeconomic data into production and attraction values. Huntsville-specific data curves (provided by the City of Huntsville) were incorporated into the Trip Generation analysis. The relevant socioeconomic and production and attraction values are summarized in Tables 7 and 8, respectively.

Table 7. Regional Socioeconomic Data Summary

	2000 (Base)	2005	2010	2015	2030
Retail and Service Employment	87,105	124,549	144,747	163,821	233,747
Other Employment	97,775	98,846	116,244	115,566	146,560
Occupied Dwelling Units	113,952	123,692	134,933	143,492	156,135

Table 8. Results from Trip Generation – Productions and Attractions

	2005	2010	2015	2030
Home Based Work	180,315	197,051	209,769	228,552
Home Based Other	434,407	474,755	505,384	550,566
Non Home Based	204,888	223,922	238,364	259,701
Truck / Taxi	126,215	137,934	146,845	159,958
Internal / External	158,944	188,780	224,211	375,633
External / External	13,902	16,511	19,611	32,856
Total Trips	**1,118,671**	**1,238,953**	**1,344,184**	**1,607,266**

Traffic Impacts

Output files from the Trip Generation software were entered into the CUBE/TRANPLAN control files for running the City of Huntsville Travel Demand Model as specified in the methodology section (see Appendix). The CUBE/TRANPLAN software output includes model assigned volume for the major roadways in the community and some general travel statistics. The CUBE/ TRANPLAN software was used to model the following six scenarios:

- 2005 Baseline scenario representing pre-BRAC conditions;
- 2010 BRAC projections & Huntsville E+C network;
- 2015 BRAC projections & Huntsville E+C network;
- 2030 BRAC projections & Huntsville E+C network;
- 2015 BRAC projections & 2030 Long Range Plan (LRP) network; and
- 2030 BRAC projections & 2030 LRP network.

Table 9 provides a summary of the systemwide travel characteristics expected under each of the six scenarios.

Table 9. Model Output from CUBE/TRANPLAN

	2005 E+C	2010 E+C	2015 E+C	2030 E+C	2015 Data LRP Network	2030 Data LRP Network
Vehicle Miles of Travel	10,622,802	11,988,119	13,498,489	18,136,320	13,202,900	17,400,384
Vehicle Hours of Travel	345,701	448,370	606,058	1,500,082	472,428	1,092,558
Average Speed (MPH)	30.73	26.74	22.27	12.09	27.95	15.93

The model output reported in Table 9 suggests substantial increases in future congestion as vehicle miles of travel nearly double and vehicle hours of travel more than triple by 2030 from the 2005 levels. The systemwide average speed is estimated to be roughly half of the 2005 speed.

To further illustrate the impact of BRAC, Table 10 shows systemwide statistics for build out of the Long Range Plan projects with and without[6] BRAC growth.

Table 10. Long Range Plan Network with and without BRAC-attributable growth

	2030 LRP Network Without BRAC	2030 LRP Network With BRAC
Vehicle Miles of Travel	14,567,827	17,400,384
Vehicle Hours of Travel	691,530	1,092,558
Average Speed (MPH)	21.1	15.9

[6] As reported in the Huntsville Area Transportation Study developed by the Huntsville Planning Division.

Table 10 indicates that the additional traffic attributed to BRAC is projected to substantially impact travel. It can be seen that projected vehicle hours of travel are more than 1.5 times as much with BRAC as without. Consequently, BRAC-induced systemwide speeds would be expected to be roughly 70% of those projected without BRAC.

The output assigned model volume was compared with the existing capacity of roadways throughout the network to predict the amount and locations of expected congestion. Table 11 shows the miles of congested facility in each of the study years and Figures 1 through 6 show the locations in each of the study years where the assigned volumes exceed the capacity (i.e., congested sections of roadway).

Table 11. Roadway Congestion Projections

	2005 E+C	2010 E+C	2015 E+C	2030 E+C	2015 Data LRP Network	2030 Data LRP Network
Miles of Congested Roadways	33.19	58.73	114.58	384.21	43.37	160.94
Percent of network	1.35	2.22	4.65	15.60	1.70	6.29
The total length of the roadways in the E+C network is 2,462.62 miles.						
The total length of the roadways in the LRP network is 2,557.51 miles						

The miles of congested roadway are predicted to rise from 1.35 percent of the total network length in 2005 to 15.6 percent by 2030 if the BRAC growth occurs and there is no increase in the amount of roadway capacity in the system. While systemwide travel speeds decrease under the 2030 LRP Network, they are forecasted to remain higher than those expected if the City is confined to the E+C Network. Similarly, Table 11 indicates that pursuing full build-out of projects already in the LRP would substantially reduce both the miles of congested roadway and the percentage of the network classified as congested into the year 2030. In summary, it can be concluded that completion of the highway projects in the 2030 plan would mitigate much of the congestion anticipated with the BRAC-attributable growth. This point is reinforced by comparing Figures 4 and 6.

There are 114 highway-related projects specified in the City of Huntsville 2030 Long Range Plan. With the realization that full build-out of the LRP may not be feasible (due to costs, changing priorities, additional development, etc.), an attempt was made to illustrate where the BRAC-attributable traffic congestion is forecasted to occur. As seen in Figure 7, some roads are expected to experience congestion as a result of BRAC even with full build out of all projects in the 2030 LRP. Table 12 indicates the specific roadway segments not currently appearing in the 2030 LRP, that will be most impacted by BRAC.

Figure 1
2005 Socio-Economic Data
with E+C Roadway Network

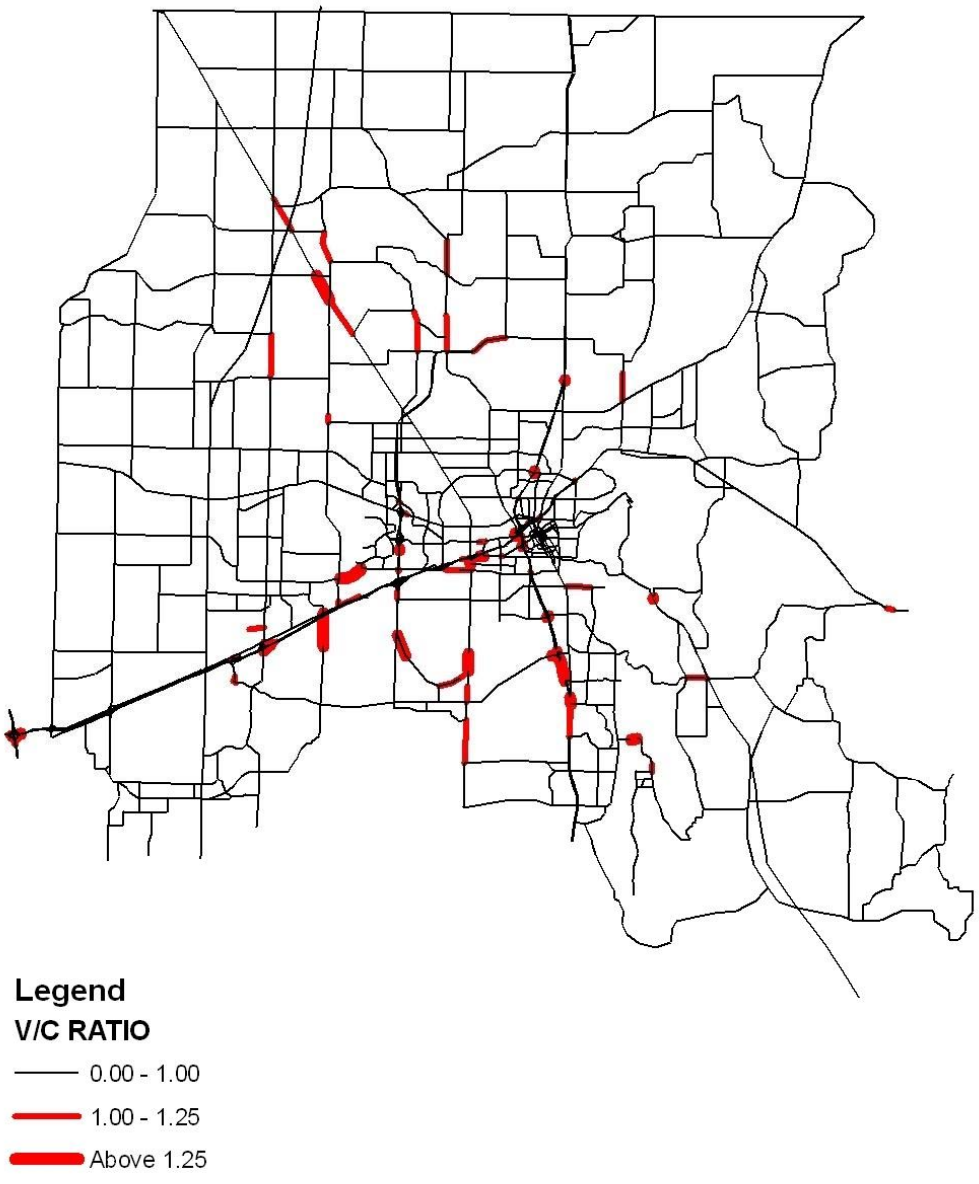


Figure 2
2010 Socio-Economic Data
with E+C Roadway Network

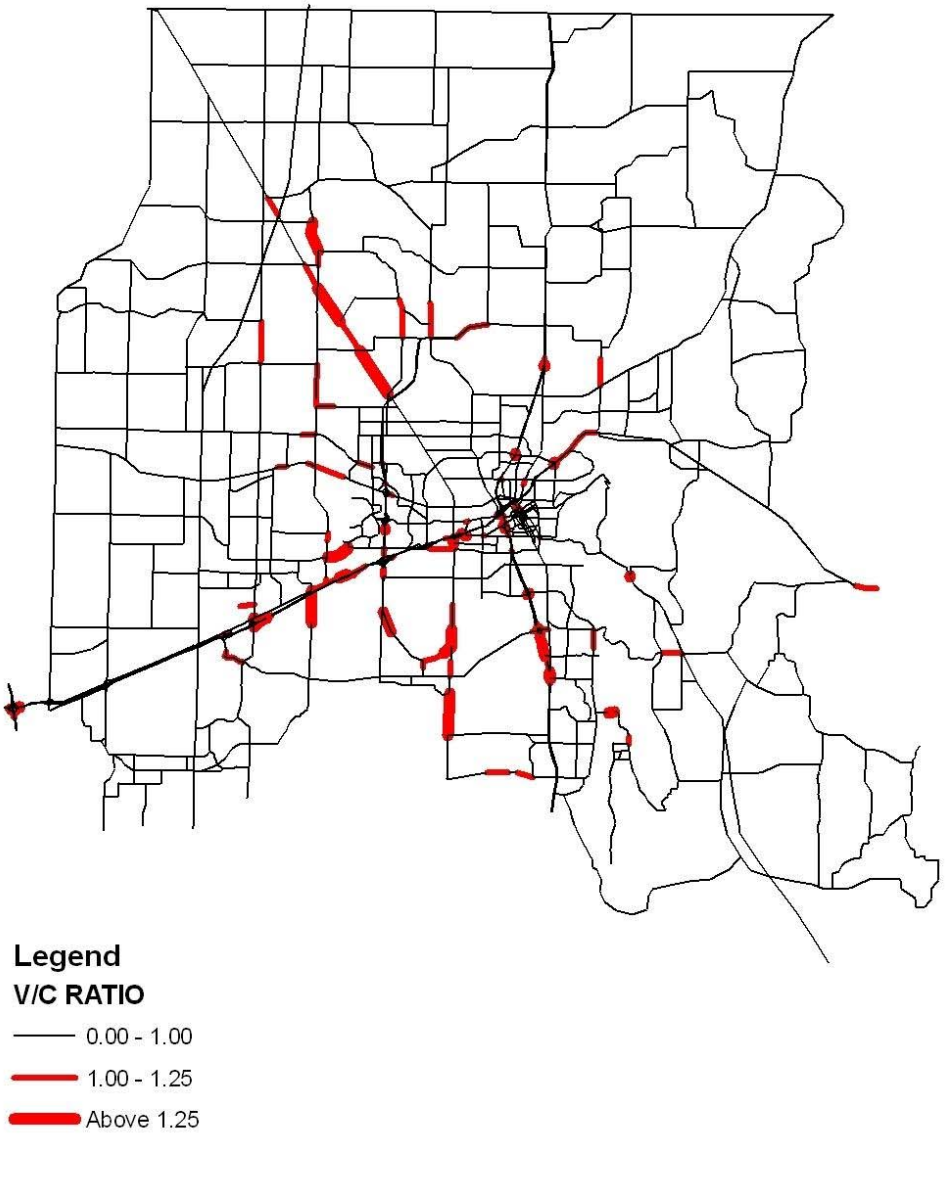


Figure 3
2015 Socio-Economic Data
with E+C Roadway Network

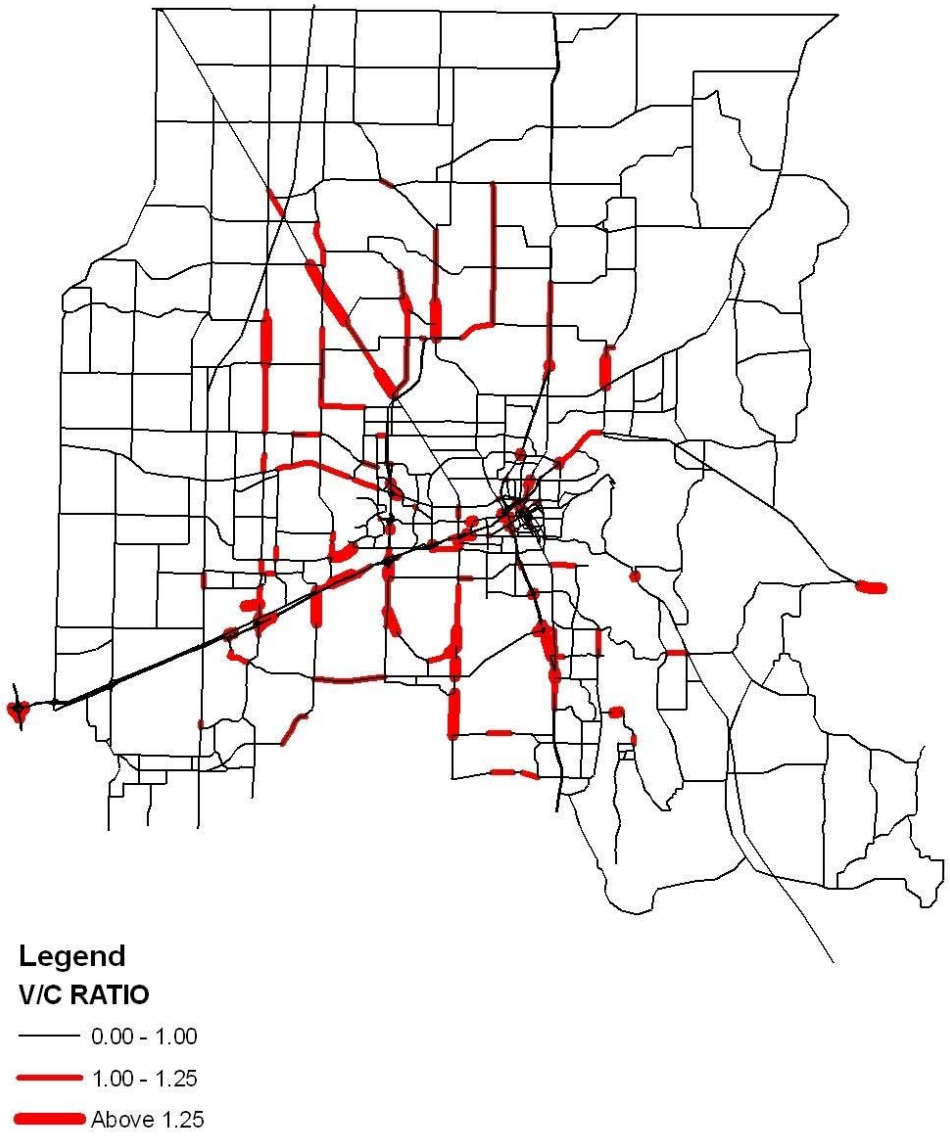


Figure 4
2030 Socio-Economic Data
with E+C Roadway Network

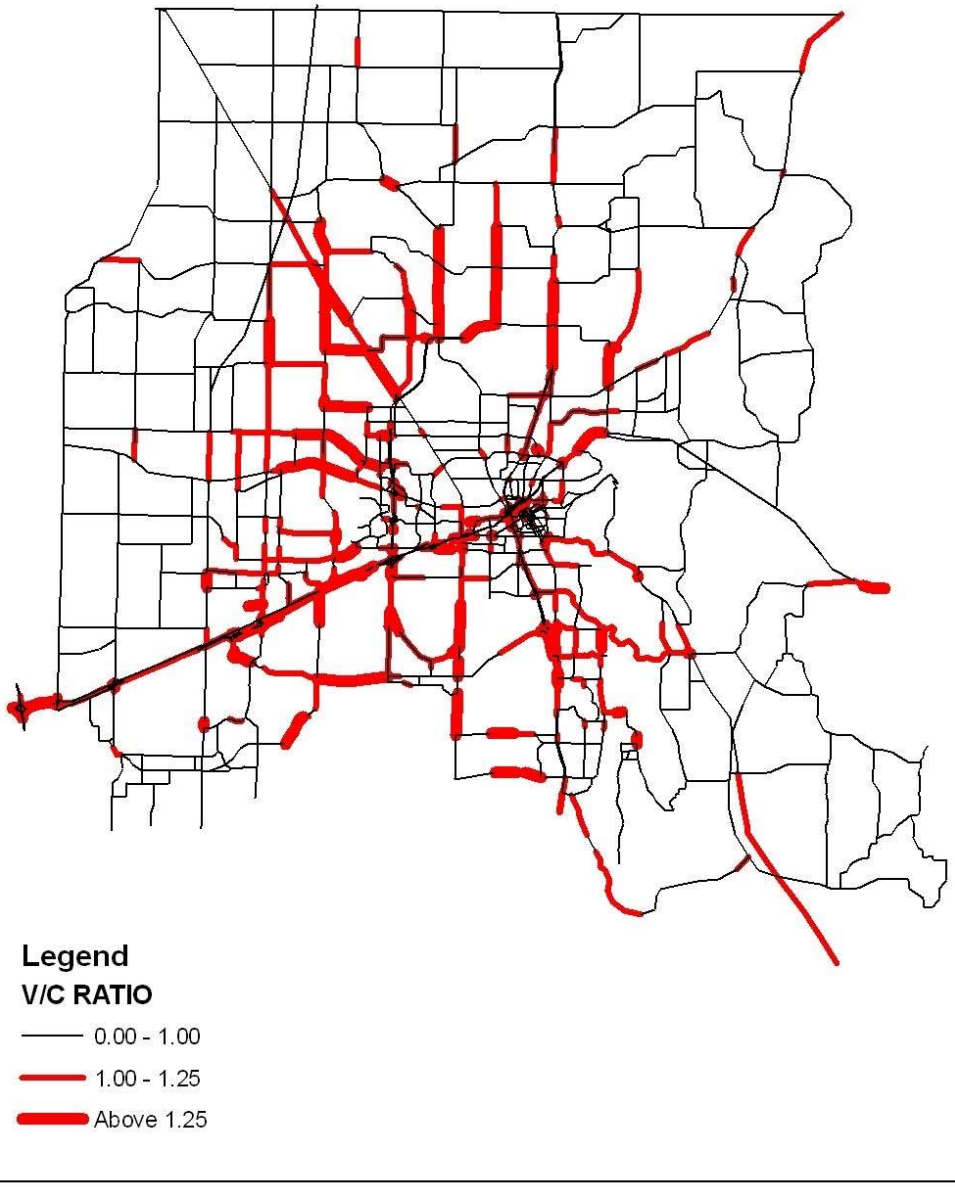


Figure 5
2015 Socio-Economic Data
with Plan Roadway Network

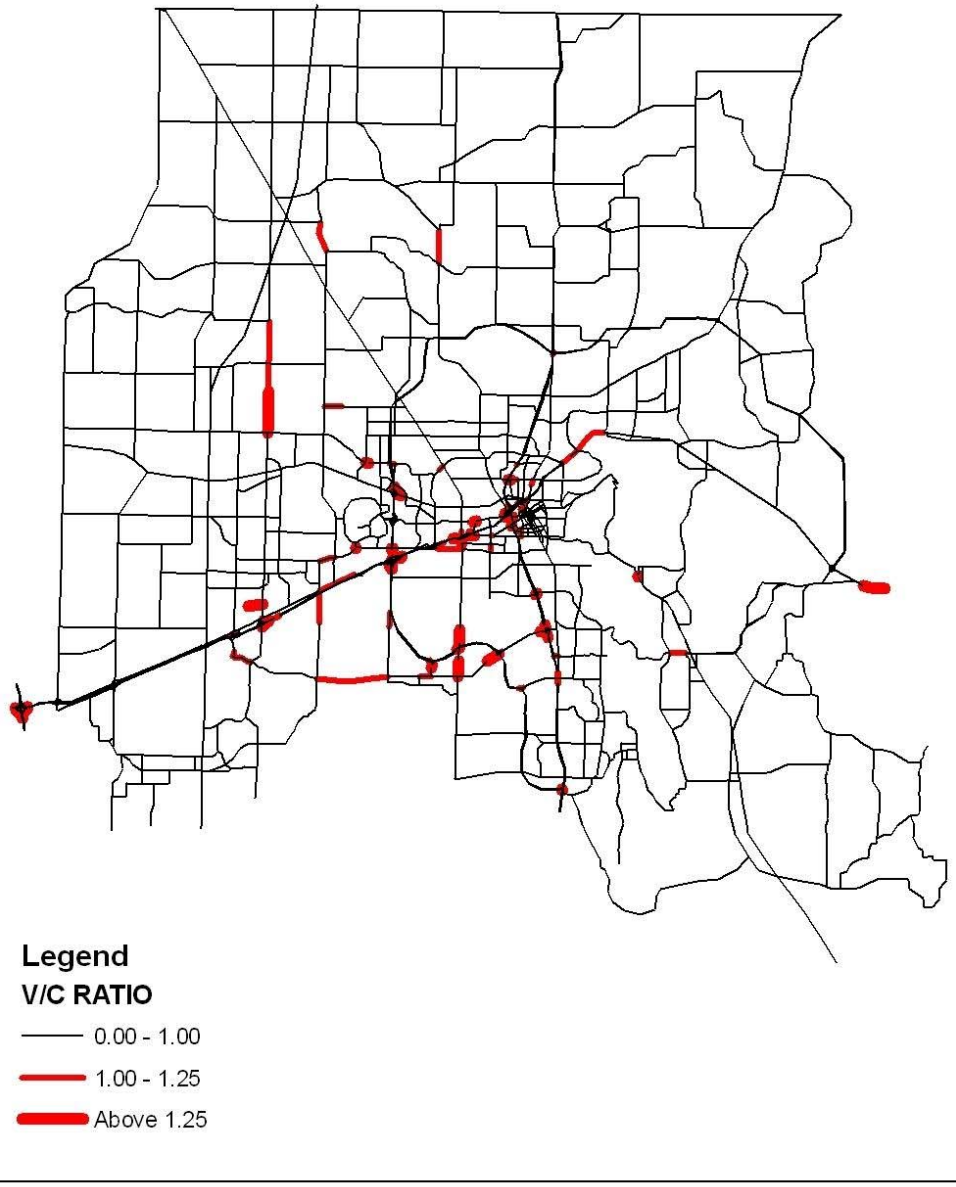


Figure 6
2030 Socio-Economic Data
with Plan Roadway Network

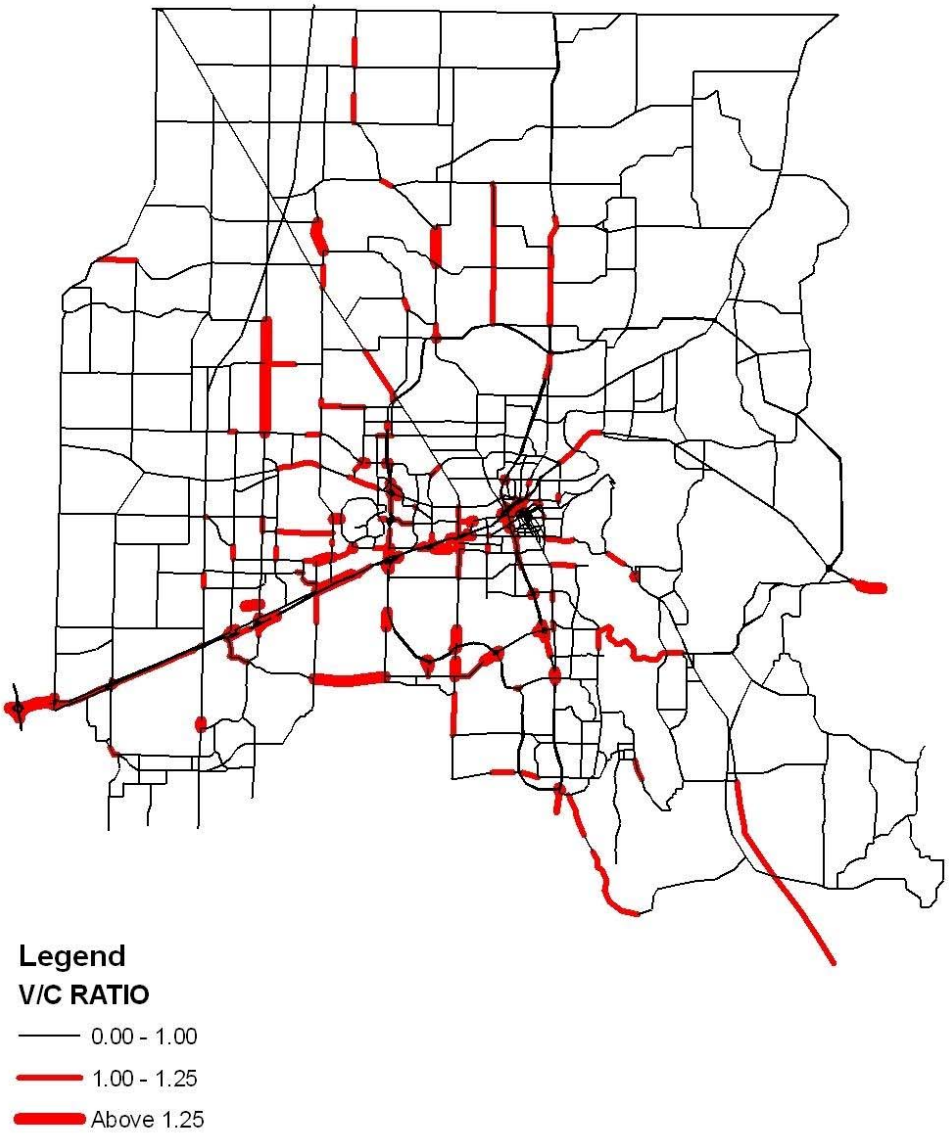
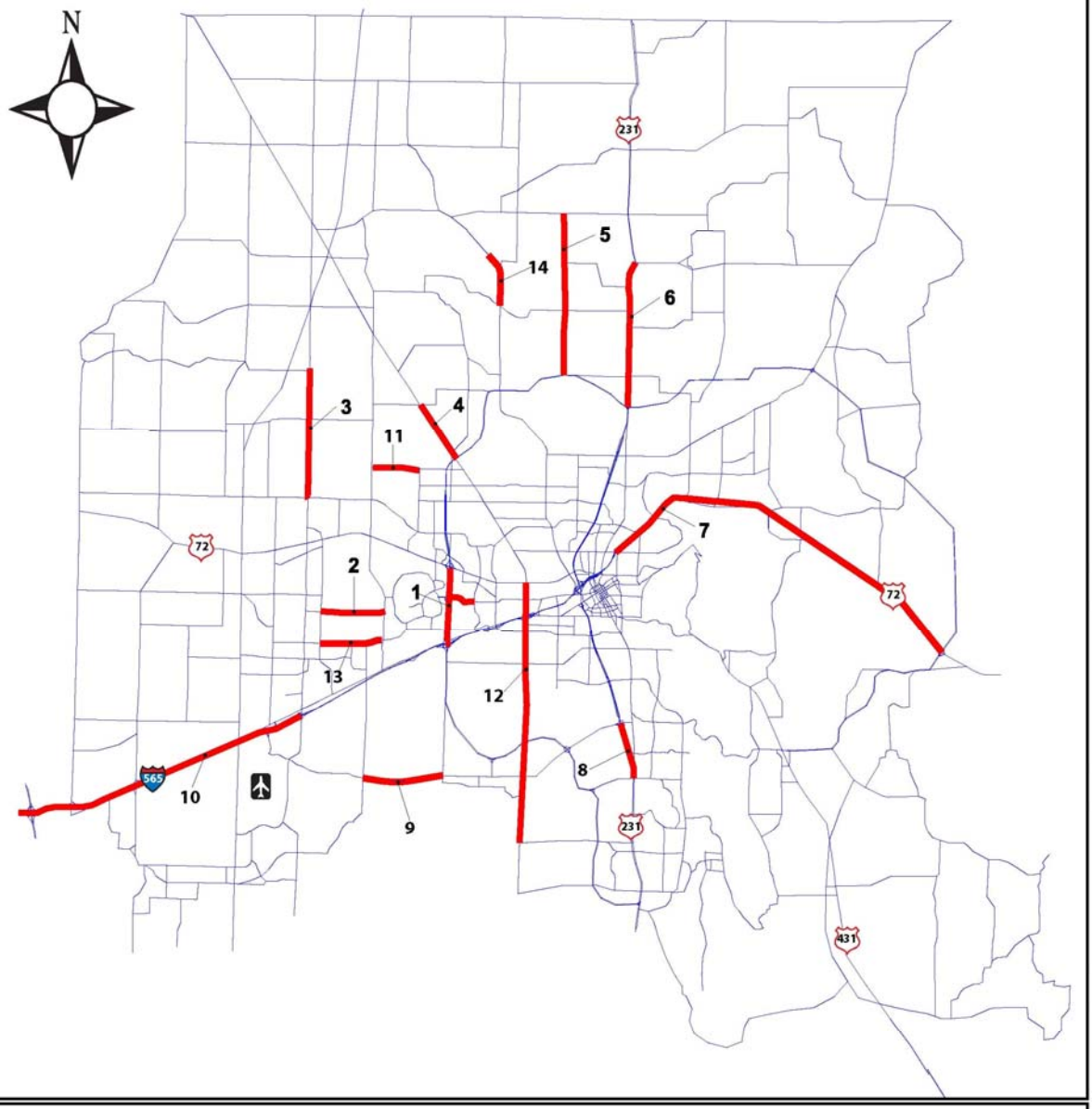


Figure 7

Projected Congested Roadway Segments Attributable to BRAC
Year 2030 Plan Network



1 - Research Park Blvd / Bradford Dr From I-565 to University Dr.
2- Eastview Dr From Slaughter Rd to Hughes Rd.
3- Wall Triana Hwy From Capshaw Rd to Nick Davis Rd.
4- Hwy 53 From Martin Luther King Dr to Kelly Springs Rd.
5- Mt Lebanon Rd from Northern Bypass to Grimwood Rd.
6 - US 231 N from Northern Bypass to Steger Rd.
7- US 72 E from Oakwood Rd to Eastern Bypass
8 - Memorial Parkway from Martin Rd to Weatherly Rd.
9 - Martin Rd from Zierdt Rd to Rideout Rd.
10- Interstate 565 from I-65 to Wall Triana Hwy.
11- Blake Bottom From Jeff Rd to Indian Creek Rd.
12 - Patton Rd from University Dr to Redstone Rd.
13 - Old Madison Pike from Slaughter Rd to Hughes Rd.
14 - Pulaski Pike from Patterson Rd to Beaver Dam Rd.

Table 12. Specific Roadway Segments to be Added to the 2030 Long Range Plan

Projected Congested Roadway Segment	Required Improvement	Cost Estimate
Research Park Boulevard/Bradford Drive from I-565 to University Drive	6 lanes	$7.2 million
Eastview Drive from Slaughter Road to Hughes Road	5 lanes	$6.6 million
Wall Triana Highway from Capshaw Road to Nick Davis Road	5 lanes	$8.1 million
Mt. Lebanon from the Northern Bypass to Grimwood Road	5 lanes	$14.9 million
US 72 East from Oakwood Avenue to the Eastern Bypass	6 lanes	$17.1 million
Martin Road from Zierdt Road to Rideout Road	5 lanes	$8.13 million
Interstate 565 from I-65 to Wall Triana Highway	6 lanes	$36.5 million
Blake Bottom Road from Jeff Road to Indian Creek Road	5 lanes	$5.04 million
Patton Road from University Drive to Redstone Road	5-7 lanes	$7.81 million
Old Madison Pike from Slaughter Road to Hughes Road	5 lanes	$6.7 million
Pulaski Pike from Patterson Lane to Beaver Dam Road	5 lanes	$3.9 million
	Total Estimated Cost:	**$121.98 million**

Of the fourteen roadway segments shown in Figure 7, three are projected to be congested due to BRAC even after specific projects currently designated in the LRP are implemented. These three projects are: Highway 53 from Martin Luther King Drive to Kelly Springs Road, US 231 from the Northern Bypass to Steger Road, and Memorial Parkway from Martin Road to Weatherly Road. The remaining eleven segments, shown in Table 12, are projected to be congested but have no specific projects currently designated in the 2030 LRP. Using today's dollars, the estimated cost of constructing these eleven identified projects is $121.98 million.

It is important to note that the LRP modeled in the above sections is financially constrained. Nonetheless, Figure 7 and Table 12 indicate that the BRAC-attributable traffic growth will result in congestion that was not anticipated in the current 2030 LRP for the Huntsville Area.

Highway Improvements

The City of Huntsville is aware of growing congestion in the region and plans proactively to address it. In March 2006, the City issued a *Report on Mobility*[7] that was developed as part of its Congestion Management System (CMS). When Figure 6 is compared with Map 3 from the *Report on Mobility* it is clear that BRAC will result in additional congestion not anticipated in previous planning efforts.

As conveyed in Figures 7 and 8, even pursuing the 2030 LRP in its entirety will not allow the City to "build its way out" of congestion. To this end the *Report on Mobility* offers insight into the City's awareness of alternative means of managing congestion. For example, the report explicitly addresses Transportation Demand Management (TDM) strategies such as ridesharing (carpooling, vanpooling, park-and-ride facilities, high-occupancy vehicle facilities, etc.). The *Report on Mobility* lists twenty

[7] *Report on Mobility* developed by the Huntsville Planning Division. Adopted March 2006. Available online at http://www.hsvcity.com/Planning/reportonmobility.pdf.

roadway sections (ten corridors and ten isolated segments) where congestion mitigation strategies are recommended. Of these twenty sections, however, the strategies are solely roadway-related although only eight of them are currently served by any level of transit service. It should be noted that the employment increases associated with BRAC will likely lend themselves to enhanced TDM measures (rideshare, vanpool, etc.) due to the jobs being concentrated around the Arsenal and other large employers in the area.

Many of the projects listed in the 2030 LRP consist of roadway widening projects. In some cases, roadways are slated to be widened to five- and seven-lane sections. It is worth noting at this point, that without proper access management the new capacity of the additional lanes will quickly be compromised by increased "friction" from vehicles turning to and from driveways and side streets. Table 13 shows data presented in the *Access Management Manual*[8] developed by the Transportation Research Board that supports this assertion.

Table 13. Relationship between Friction along a Roadway and Travel Speeds

Access Points per Mile	Reduction in Free-Flow Speed (mph)
0	0.0
10	2.5
20	5.0
30	7.5
40 or more	10

The model is intended to provide a look into the future if no progress is made regarding the addition of lane miles through new roadway infrastructure or roadway widening projects. The model demonstrates that the transportation services in the community require a potentially large infrastructure investment to meet the expected future travel demand associated with the growth coming to Huntsville and the surrounding area.

Conclusions

This report presents an assessment of the economic and transportation impacts of the BRAC 2005 transfers to the Huntsville, Alabama area. Two main impacts are assessed: (i) the overall economic impact on the state of Alabama and on the four-county region comprising Limestone, Marshall, Madison, and Morgan counties and (ii) the impact on roadways in the City of Huntsville E + C Network and 2030 plan network. City planners are requiring this information for use in developing planning strategies to anticipate and mitigate adverse impacts on transportation and other infrastructure, as well as schools, parks, hospitals, etc. The goal is to maximize the economic benefits of the BRAC move while maintaining or enhancing quality of life in the region. Adverse impacts mitigation projects such as roadway and school construction will also generate additional economic benefits for the region.

[8] *Access Management Manual*. Transportation Research Board, Washington D.C. 2003

The BRAC 2005 transfers will provide a direct net gain of about 4,000 military and government civilian personnel with an average annual income of $70,000, which is more than double the $33,416 average for an Alabama worker in 2004. About 3,600 housing units will be built at a cost of $617 million for these workers. A $359 million military construction will also be undertaken. The one-time construction phase 2006-2010 economic impacts on Alabama are $1.9 billion in output, about $510 million in household earnings and nearly 16,000 direct and indirect jobs. Most of these impacts are in the four-county region: $1.4 billion output, $388.5 million earnings and 10,473 direct and indirect jobs. Associated fiscal impacts are $20.4 million in state income taxes and $8.6 million in state sales taxes. County and municipality sales tax receipts total $8.6 million: $5.5 million for the region and $3.1 million for the 63 other counties in the state. State and local sales tax receipts total $17.3 million for a total of $37.7 million in income and sales taxes.

Two components of operation phase economic impacts are presented for (i) non-contract Redstone Arsenal BRAC 2005 expenditures and (ii) BRAC 2005 related contract expenditures (Table 14). Output impacts of the non-contract BRAC 2005 expenditures are $457 million on Alabama and $374 million on the region. Additionally, every $100 million of non-contract non-payroll expenditure delivered to final demand will create output impacts of $163 million for the state and $133 million for the region. Earnings impacts are $456 million statewide and $373 million on the region. Employment impacts are 5,505 jobs on the state and 4,870 jobs on the region. Fiscal impacts are $26.5 million in state taxes; $18.2 million income, $7.7 million sales, and $0.6 million property. Tax receipts for the region total $9.2-10.3 million; $6.3 million sales and $2.9-4.0 million property. Other Alabama counties receive $1.8-1.9 million sales and property taxes, making for an annual total of about $38 million in income, sales, and property taxes to all jurisdictions.

The statewide economic and fiscal impacts for $1 billion in BRAC 2005 contract expenditures that is fully expended in Alabama are about $2 billion in output, $495 million in earnings, and 10,858 direct and indirect jobs. Impacts on the region are $1.8 billion output, $367 million earnings, and 7,632 jobs. The average annual income for these jobs is $48,000. Of the total jobs impacts, 2,472 are direct jobs earning $83,000 annually. Fiscal impacts are $28.9 million for the state ($19.8 million income, $8.4 million sales, and $0.8 million property), and $10.7-12.6 million for the region comprising $6.2 million sales and $4.5-6.4 million property. Other Alabama counties receive $3.5-4.1 million sales and property taxes, making for an annual total of $43.2-45.6 million in income, sales, and property taxes to all jurisdictions. These contract expenditure impacts have considerable uncertainty associated with them.

The region's population is expected to rise 14.6 percent to around 614,000 by 2010 from its 2000 level of about 535,700 accompanied by a 14.4 percent increase in the number of households. The population will be approximately 652,000 in 2015, 21.7 percent higher than in 2000, and top 718,000 in 2030 (34 percent higher). The roughly 609,000 employment forecast for 2030 is 81.5 percent higher than in 2000 indicating serious roadway congestion if no significant roadway capacity expansion is undertaken. From the 2000 level, employment is expected to be 23 percent higher in 2010 and 32 percent higher in 2015. The high income BRAC 2005 related jobs should raise the average income for workers in the region, and in turn raise average and median family incomes. Based on the population projections, fuel taxes in 2010, 2015, and 2030 will be respectively, $6.4 million, $10.9 million, and $18.9 million more than the 2004 level.

Table 14. Operation Phase Annual Economic and Fiscal Impacts Summary

Arsenal BRAC 2005 Impacts

Household impacts

	Alabama	Region
Output ($ millions)	456.6	373.5
Earnings ($ millions)	455.7	373.1
Employment (jobs)	5,505	4,870

Output impact per $100M expenditure

	Alabama	Region
Output ($ millions)	162.6	133.0

Fiscal impacts

($ millions)	Alabama	Region	**Subtotal**	Other AL	**Total**
Income tax	18.2		18.2		18.2
Sales tax	7.7	6.3	14.1	1.4	15.5
Property tax	0.6	2.9-4.0	3.4-4.6	0.4-0.5	3.8-5.1
Total	26.5	9.2-10.3	35.7-36.8	1.8-1.9	37.5-38.8

Contract-Related Impacts

Economic impacts per $1 billion in-state contract

	Alabama	Region
Output ($ millions)	2,035.8	1,773.7
Earnings ($ millions)	494.5	366.5
Employment (jobs)	10,858	7,632

Fiscal impacts of $1 billion in-state contract

($ millions)	Alabama	Region	**Subtotal**	Other AL	**Total**
Income tax	19.8		19.8		19.8
Sales tax	8.4	6.2	14.6	2.2	16.8
Property tax	0.8	4.5-6.4	5.3-7.2	1.4-1.9	6.6-9.1
Total (low)	28.9	10.7-12.6	39.6-41.5	3.5-4.1	43.2-45.6

Note: Rounding errors may be present. Guided missiles and space vehicles industry multipliers were used.

Source: U.S. Department of Commerce, Bureau of Economic Analysis; U.S. Census Bureau; Alabama Department of Revenue; and Center for Business and Economic Research, The University of Alabama.

The economic impacts and population projections presented in this report are conservative for three main reasons. First, the contract expenditure that is fully spent in the four-county region and the state will generate contractor related jobs for which there will be substantial residential housing demand from 2010 on; some such homes may be built prior to 2010. The economic impact of this particular residential construction is not included in this report although the number of jobs and related population change associated with an assumed $1 billion of contract expenditure are presented. Second, all residential construction expenditure will generate additional sales tax beyond

that generated from the associated earnings impact, but it is impossible to estimate this fiscal impact without detailed information on the nature of the expenditure. Finally, the fiscal impacts reported here do not include other taxes and fees (e.g., lodgings tax, utility tax, and car tag and fees) that will be generated.

The transportation impact results show that between 2005 and 2030, roadway congestion will become a serious problem if the expected growth occurs and there is no increase in the amount of roadway capacity in the City of Huntsville E + C Network. Vehicle miles of travel nearly double and vehicle hours of travel more than triple. Average speed of travel declines to about half of the 2005 speed of 30.7 mph. The miles of congested roadway rise from 1.35 percent of the total network length in 2005 to 4.65 percent in 2015 and 15.60 percent by 2030. Thus transportation services in the network require a potentially large infrastructure investment to meet expected future travel demand associated with the growth coming to Huntsville and the surrounding area. High-occupancy and park-and-ride systems and programs may need to be considered. Access management may need to be included for some roadways.

A future impact study is recommended as more information becomes available, to reduce some elements of uncertainty that were encountered in determining the BRAC transfer impacts at this stage. The critical areas of uncertainty relate to the economic impact estimates and population projections. For example, the military construction expenditures changed significantly between the start of the project and the time of report preparation.

The BRAC transfers will have substantial impacts on the four-county region and Alabama as a whole irrespective of the aforementioned uncertainties. It is important that communities in the region and in other areas of the state that will be affected by and benefit from BRAC begin preparations to maximize the economic benefits and minimize costs. Principally, investments in infrastructure and amenities that reduce congestion on the roadways, at parks, schools, libraries, etc. may be needed.

In regard to the BRAC transportation impacts, it is important to note that even pursuing the 2030 long range plan (LRP) in its entirety will not enable the City to "build its way out" of congestion. If the 2030 LRP network were in place, projected vehicle hours of travel with BRAC would be more than 1.5 times what it would be without BRAC. Consequently, BRAC-induced systemwide speeds would be about 70% of those projected without BRAC.

It is recommended that the City, in conjunction with its regional and State-level partners, commence with the following anticipatory actions:

- Pursue full-build-out of the 2030 LRP.
- Amend the 2030 LRP to add the following eleven projects:

Project Description	Required Improvement	Cost Estimate
• Research Park Boulevard/Bradford Drive from I-565 to University Drive	6 lanes	$7.2 million
• Eastview Drive from Slaughter Road to Hughes Road	5 lanes	$6.6 million
• Wall Triana Highway from Capshaw Road to Nick Davis Road	5 lanes	$8.1 million
• Mt. Lebanon Road from the Northern Bypass to Grimwood Road	5 lanes	$14.9 million

• US 72 East from Oakwood Avenue to the Eastern Bypass	6 lanes	$17.1 million
• Martin Road from Zierdt Road to Rideout Road	5 lanes	$8.13 million
• Interstate 565 from I-65 to Wall Triana Highway	6 lanes	$36.5 million
• Blake Bottom Road from Jeff Road to Indian Creek Road	5 lanes	$5.04 million
• Patton Road from University Drive to Redstone Road	5-7 lanes	$7.81 million
• Old Madison Pike from Slaughter Road to Hughes Road	5 lanes	$6.7 million
• Pulaski Pike from Patterson Lane to Beaver Dam Road	5 lanes	$3.9 million
Total Estimated Cost:		**$121.98 million**

- Implement the appropriate strategy(ies) identified in the Huntsville Area Transportation Study's Congestion Management System *Procedures and Responsibilities Report* which:
  - Eliminate or reduce trips;
  - Involve traffic operational improvements and access management;
  - Shift trips from single occupancy vehicles to public transit, other HOVs, and other modes;
  - Involve Intelligent Transportation Systems; and
  - Add capacity for all vehicles.

APPENDIX

Methodology

Economic Impact Analysis

Economic impact analysis measures the effects of a specific economic activity or event on a specified geographic area. Examples include the economic impact of a proposed industrial plant on a state or county; the economic impact of an existing industry; and the economic impact of closing a military installation on a state, county, or city. In some cases, federal laws, as well as state and local regulations, require economic impact studies prior to the implementation of a particular policy (relocation of an economic activity, changes in zoning ordinance, etc.). Whatever the justification, impact studies are designed to provide information for instituting policies to mitigate potential negative impacts, and/or facilitate any positive economic impacts. Economic impact analysis is therefore an important decision making tool which can enhance the quality of decisions made, as well as the decision making process in both public and private sectors.

The analysis typically focuses on one or more of the major economic indicators: output, employment, and income. The purpose of an impact study usually determines which socioeconomic variable(s) should be monitored. In this study, the primary focus is on all three major indicators and the consequent changes in tax revenues: income, property, and sales taxes.

Economic impacts can be classified into two types: direct and indirect impacts. Direct impacts are those that are most obvious and include the wages and salaries of the employees who work directly for a firm or industry, as well as all other expenditures of the firm or industry, including taxes and profits. Indirect economic impacts, often referred to as the "ripple" or "multiplier" effects, occur because of the additional demands arising from new income and expenditures for inputs and products related to the activity under study. The spending activity of supplier organizations and employees may create a demand for the output of the firm or industry under study, creating further economic impacts, also known as induced impacts. For example, a road contractor creates an indirect impact on wholesale and retail industries through purchases of supplies, etc. These trade industries purchase electricity and products from manufacturing industries that also use power. The electricity industry in turn, working with property developers may contract with the road contractor for roads in a new development. Economic impacts include these induced impacts. The combined direct, indirect, and induced effects constitute the total economic impact of the organization being studied. The ratio of the total economic impact to the direct is the multiplier that can be used to summarize the economic effects of the organization on the region or area of focus.

Economic relationships do not obey strict geographic boundaries; workers and their incomes, and industry purchases flow across these boundaries enabled by transportation and communication. Thus a portion of the indirect effects of purchases or expenditures may occur beyond the boundaries of the specified region. Such occurrences are called *leakages*, as opposed to *linkages* (supplier-purchaser relationships) within the region. In general a small geographic area will have a small *absolute* economic impact due to a high likelihood of leakage. A large region will have a larger absolute economic impact, but a smaller *relative* economic impact of an individual firm or industry on that area. The closure of one plant within a state, for example, may have only a small relative impact even if the plant employs thousands of workers; the absolute impact could be very large. The

important point is that the effect or size of the economic impact is influenced by the size of the study area. If the area is too broadly defined, the relative impact will be small. If narrowly defined, the relative impact will be large.

Several methodological approaches are used in estimating economic impacts. These include the construction of econometric models, economic base models, and input-output (I-O) models. Econometric models can be very costly and time-consuming to build. Economic base models require a very detailed set of information that is sometimes not available. The other methodological approaches generate slightly smaller multipliers than I-O models because of assumptions on factors such as input substitution and optimization behavior by economic agents.

The I-O modeling framework is used in this study. The technique generates multipliers for the economic activity of interest by focusing on economic interactions among all industries and all other economic transactions in the specified region. Interindustry relationships exist in both a backward direction (suppliers and other upstream linkages and leakages), and a forward direction (distributors, retailers, customers, and other downstream linkages and leakages). The number and strength of these backward and forward linkages and leakages determines the multiplier effects of the industry. In general products that require a small number of inputs and little additional processing will have relatively small multiplier effects. Complex products requiring thousands of inputs and extensive processing (value added) will have large multipliers, and hence large impacts.

The three main types of multipliers–output, income or earnings, and employment–are defined as follows. Output multipliers represent the total dollar change in all industries that results from a $1 change in output delivered to final demand (final consumption) by the industry under study. Earnings multipliers represent the total dollar change in earnings of households employed by all industries for each dollar of payroll expenditure or each dollar of output delivered to final demand by the industry whose economic impact is being estimated. Employment multipliers represent the total change in the number of jobs in all industries for each direct job or for each million dollars of output delivered to final demand by the industry whose economic impact is being estimated.

The nature of the product and technology largely determine the degree of interindustry linkages and leakages (and thus the overall impact), and the specific impact on a region depends upon the degree to which these interindustry relationships are localized. Technology determines inputs and economics determines the geographic source of supply. Inputs purchased outside the economic impact study area constitute a leakage of potential impact. The leakage represents activities of local firms that have no economic impact on the local economy, and provides opportunities for "localizing" such impact. Identifying leakage can provide valuable planning information to local economic development authorities for commercial or industrial development. An activity's maximum impact on a specific area is obtained when all interindustry linkages occur within the area. A system-wide view is required since different firms have different linkages. The I-O technique permits the incorporation of such system-wide perspectives.

To estimate the economic impact of the BRAC 2005 effects on the Huntsville area, linkages between this activity or the industry it belongs to and all its suppliers and customers must be traced. This task is greatly facilitated by the Regional Input-Output Modeling System (RIMS II), an I-O model developed and maintained by BEA. The model is available for every state in the nation, and also for many counties. This study uses RIMS II.

The RIMS II I-O model consists of several hundred industries. Data on each industry reflects the value of inputs used per dollar of output in the production of that industry's output. For example, data for the construction phase shows the value of each input per dollar of product (or service) produced in the state. Since the rows (outputs) are produced by specific industries, they are also columns (inputs). Demand for a particular input will cause supply from the industry that produces it. This then creates demand for the inputs that are used to produce the particular product, and so on. The round-by-round impacts decrease and provide convergence. The I-O model captures the total effect of these rounds of spending as the multiplier effect. RIMS II multipliers for an economy take into account all the linkages within and leakages from that economy. I-O models are based on a table of transaction balances, which ensures economy-wide accounting consistency. Total payments equal total receipts for each producing sector. Aggregate final demand equals aggregate value added.

Multipliers are derived mathematically from I-O tables constructed from observed data for the economic area of interest. The economy is divided into a number of producing industries or sectors that sell and purchase goods and services to and from each other (*interindustry* or *intersectoral* flows). These interindustry flows are key data. Sector goods and services are purchased by domestic consumers (households), international customers (exports), government (federal, state, and local), and for private investment purposes. These external to production purchases are for direct use and termed *final demand*. Assume an economy with n sectors, let X_i represent total output for sector i, Y_i be final demand for sector i products, and z_{ij} represent interindustry flows. Then for each sector,

$$X_i = \sum_{j=1}^{n} z_{ij} + Y_i \qquad (1)$$

If we let a_{ij} represent the I-O technical coefficients where $a_{ij} = z_{ij} / X_j$ so that sectors use inputs in fixed proportions (the constant returns to scale Leontief production function) then the above equation becomes

$$X_i = \sum_{i=1}^{n} a_{ij} X_i + Y_i \qquad (2)$$

The standard formulation of the basic I-O model and its application, in matrix notation is as follows:

Transactions balance: $X = AX + Y$ (3)

Solving for X: $X = (I - A)^{-1}Y$ (4)

For a change in Y: $\Delta X = (I - A)^{-1}\Delta Y$ (5)

where X is the gross output column vector, A is the matrix of fixed I-O coefficients, Y is the final demand column vector, and I is the identity matrix. With this basic model, the resulting output is computed given changes in final demand levels (consumption, investment, government, or exports). The Leontief inverse, $(I - A)^{-1}$, is the source of multipliers for determining impacts in the I-O methodology. The elements of the matrix capture in a single number, an entire series of direct and indirect effects. Gross output requirements are translatable into employment coefficients in a diagonal matrix that is used together with the Leontief inverse to generate employment impacts. Similar manipulations generate income and earnings multipliers.

Population and Household Projections

County and block group population projections are generated using an in-house cohort-component model developed by the Center for Business and Economic Research (CBER). The model is driven by measured demographic change including population growth (or decline) between 1990 and 2000

and recent county birth and death rates. Any remaining population change is assumed to be the result of migration as people move into and out of the county during the decade. Net migration is calculated as the residual between the 2000 Census count and its 1990 tally after adding births between 1990 and 2000 and subtracting deaths. Announced changes in group quarter population and permitted and ongoing real estate developments are also taken into consideration.

Assumptions about future migration trends are key factors in the projections process. Age groups which have been experiencing strong in-migration are unlikely to see in-migration continue at the same rate, so migration expectations for these cohorts are generally dampened during each five-year projection period. Similarly, age groups having more residents move out than in will likely not experience the same level of out-migration in the future. In all geographic areas, the demographics of aging will naturally come into play to dampen population growth, with the number and percent of population 65 and over increasing rapidly as the first of the baby boom generation enter this age group in 2011.

Since recent population estimates data are available, population projections have been modified to account for the trend between April 1, 2000 and July 1, 2005 using Census Bureau estimates. Annual rates of change are calculated for the various geographies for this time period and used in the projections model, which works in five-year increments. With all the necessary information, 2010 through 2030 population projections are derived.

Household projections are derived from the projected total county populations. The household population of an area is defined as the resident population minus the population living in group quarters. Group quarters include institutional populations such as correctional facilities, nursing homes, and mental hospitals as well as non-institutional dwellings such as college dormitories, military barracks, group homes, and shelters.

Census 2000 data provide the average number of persons per household for the various geographies. Calculation of household projections is then accomplished by subtracting the group quarters population (assumed to hold constant at the 2000 number plus any announcements) from the projected total population for a given projection year and dividing by the average number of persons per household. While there are indications that persons per household could be declining as an aging population creates more one- and two-person households, the Census Bureau has not yet projected household size based on the 2000 Census. Thus there currently is no reasonable basis for revising average household size from the 2000 value.

Economic Forecasts

Economic output and employment forecasts of the county economies are made to 2030 in five-year increments at the 1-digit SIC level. Forecasts at the block group level are made by distribution of county control totals. County versions of the Alabama Econometric Model (AEM) were developed and used to make the economic forecasts. The AEM is developed by CBER based on Global Insight's macroeconomic forecasting model. At the one-digit SIC level, the sectors are (in parentheses are the two-digit SIC industries that make up the sector and in some cases an acronym):

Agriculture, Fisheries, Forestry, and Farming (AFFF, SIC 01-09);
Mining (SIC 10-14);
Construction (SIC 15-17);

Manufacturing (SIC 20-39);
Transportation, Communications, and Utilities (TCPU, SIC 40-49);
Wholesale and Retail Trade (SIC 50-59);
Finance, Insurance, and Real Estate (FIRE, SIC 60-67);
Services (SIC 70-89);
Government (SIC 91-97);

The AEM is a simultaneous equation model with more than 250 equations, including approximately 230 stochastic equations and 38 identities. The simultaneous equation structure captures the interrelationships and feedbacks among economic variables and provides consistent measures of economic activity across all sectors of the state economy, including the gross state product (GSP), employment, wage rates, and income. This consistency is achieved because all of the equations included in the model are solved simultaneously. Simultaneous equation econometric models are based on sound statistical methodology that enables the testing of estimated structural relationships. These models are powerful tools for regional economic forecasting and economic impact analysis because they represent a compromise between simplistic economic base models and detailed input-output models. AEM consists of five major components or blocks, each consisting of a set of equations for every major sector and industry in the state economy.

Output Block. This models gross output in 1996 dollars (real gross output) for the major sectors. In general, the component of GSP originating from a state sector is influenced by the national counterpart, aggregate state demand as represented by total real personal income, and competitive factors such as the relative tax burden and the relative wage rate. U.S. output and state total personal income are positively related to output. Typically, a negative relationship exists with the relative tax burden variable as higher state and local taxes reduce output. A lower relative wage rate tends to increase investment and production. Total GSP is obtained through the use of an identity that sums up each sector's output. The general functional form of the output equation is:

State sector real output = *F*(U.S. same sector output, relative sector wage rate, relative tax burden, …)

For sectors such as trade and finance, insurance, and real estate (FIRE), the state real personal income could be a better driving force of the output variable because internal demand tends to play a stronger role. The final selection of independent variables for the output equation depends on model fitness and is therefore determined empirically. Use of state real personal income as the driving variable introduces more feedback effects in the model through the output-employment-income relationship.

Employment Block. This block models demand for labor. Each sector's wage and salary employment is derived from its real gross output and real wage rate. Theoretically, real gross output should be positively related to employment, while the real wage rate has a negative relationship. The total state wage and salary employment is obtained as the sum of the employment for each sector. The general functional form of the employment equation is:

State sector wage and salary employment = *F*(Same state sector real output, real sector wage rate, …)

Unemployment Rate. State unemployment rate is typically a function of the U.S. unemployment rate and total state employment or the change in total state employment. The state unemployment rate is positively related to the U.S. unemployment rate and negatively related to the level of state employment or the change in total state employment, as rising employment creates additional aggregate demand generating downward pressure on unemployment. The general functional form of the unemployment rate equation is:

State unemployment rate = *F*(U.S. unemployment rate, change in or actual state total employment, …)

Wage Rates. Each sector's wage rate is explained by the corresponding U.S. sector wage rate and the state unemployment rate. While the state wage rate has a tendency to move together with the U.S. wage rate, its rise can be tempered by a high state unemployment rate. The general functional form of the wage rate equation is:

State sector wage rate = *F*(corresponding U.S. sector wage rate, state unemployment rate,…)

Income Block. Wages and salary income is obtained by multiplying wages and salary employment by the wage rate for each sector and then summing up across the sectors. Other income categories such as dividends, interest, and rent; transfer payments; other labor income; proprietors' income; and adjustment for residence are driven by their national level counterparts. The general functional form of the income equations are:

State income category = *F*(The Corresponding U.S. Income Category, …).

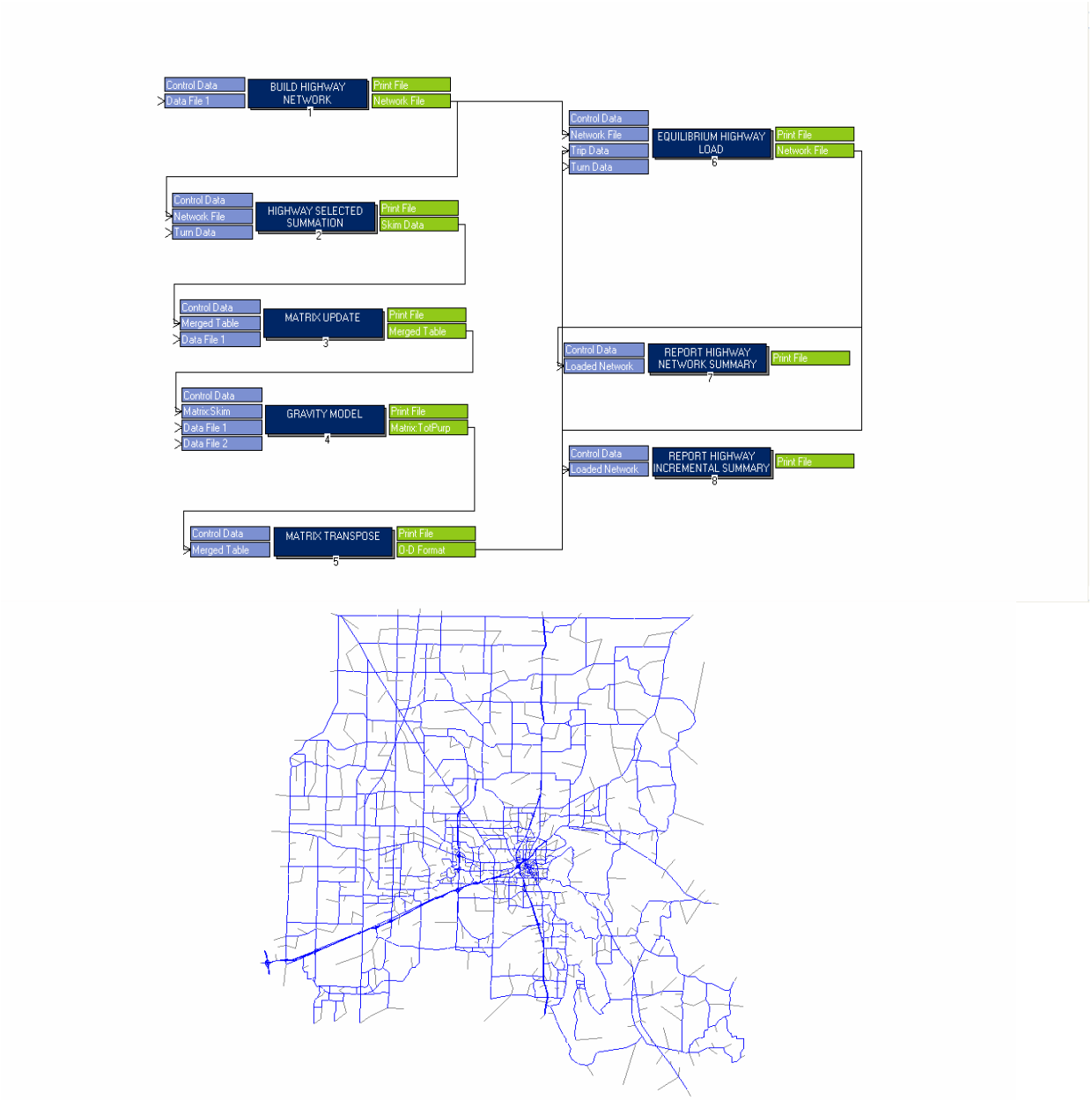
Total personal income is the sum of total wages and salary income and the other income categories. Very often total personal income, deflated by the GNP price deflator, is used to drive the output variables of such sectors as construction, TCPU, FIRE, and services.

Transportation Impacts

Socioeconomic data for the four counties—Limestone, Madison, Marshall and Morgan—provided by CBER at the block group level for assessing the roadway impacts included the number of occupied dwelling units, retail employment and non-retail employment. This data was divided into traffic analysis zones (TAZ) for the Huntsville travel demand model using ArcGIS, U.S. Census Bureau location data, and a TAZ coverage provided by the City of Huntsville. In instances where block groups had multiple TAZs, the socioeconomic data for each block group was evenly divided into the underlying TAZs. The TAZ level data was formatted for entry into the Trip Generation software, which was developed by Dr. Anderson at the University of Alabama in Huntsville on a grant funded by the Alabama Department of Transportation. This software is the accepted means of converting socioeconomic data into production and attraction values. The software was run using the data curves specific to Huntsville and provided by the City of Huntsville. The software provides a summary of socioeconomic values and production and attraction values during the operation.

Output files from the Trip Generation Software were entered into the CUBE/TRANPLAN control files for running the City of Huntsville Travel Demand Model. The production and attraction values

were entered into the Trip Distribution step of the process, which is performed through a gravity model. The roadway infrastructure used for each run of the model was the City of Huntsville E + C Network developed for the previous Huntsville Long Range Transportation Plan. The format for the control files used to run the model and the network used are shown in the following figure.



Output obtained from running the CUBE/TRANPLAN software includes model assigned volume for the major roadways in the community and some general travel statistics (e.g. vehicle miles of travel, vehicle hours of travel, and average speed. The output assigned model volume obtained can be compared with the existing capacity level of roadway to determine the amount and location of congestion expected in the network. The model is intended to provide a look into the future if no progress is made regarding the addition of lane miles – either through new roadway infrastructure or roadway widening projects.