# Appendix B-1

# I-290 Travel Forecasting Model Methodology and Validation

I-290 Eisenhower Expressway Study
Cook County, Illinois

*Prepared For:*

Illinois Department of Transportation

*Prepared By:*

WSP | Parsons Brinckerhoff

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# 1.0 Introduction

## 1.1 Purpose of the Technical Memorandum

The purpose of this memorandum is to summarize the I-290 travel modeling process and methodology, to present the assumptions used in the effort, and to provide the results of the validation of the base year scenario. This document will be organized as follows:

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## 1.2 Background of the I-290 Travel Model Process

The I-290 travel model development and application is part of a larger preliminary engineering and environmental impact statement that includes alternatives evaluation, noise analysis, air quality analysis, geometric design studies, traffic and safety studies, and economic and financial analyses that require inputs from the travel model.

An initial feasibility study of a high occupancy vehicle (HOV) lane on I-290 Eisenhower Expressway was completed in 1998[i]. The feasibility study contained 1990 and 2010 future traffic estimates for an HOV lane and the general purpose lanes. Since the HOV lane feasibility study, the following has occurred:

- Regional travel demand model improvements implemented by the Chicago Metropolitan Agency for Planning (CMAP), formerly the Chicago Area Transportation Study (CATS).

- Preparation of 2020, 2030, and 2040 Long Range Transportation Plans for northeastern Illinois

- Conduct of CMAP 2007-2008 Travel Tracker Household Survey and new Census travel data.

- The rebuilding of the "Hillside Interchange" section of the I-290 Eisenhower Expressway.

## 1.3 Opportunity & Need for an I-290 Model Enhancement

Since the initial HOV feasibility study, additional considerations have come to light that affect the model application and planning assumptions. Regional socioeconomic forecasts of population, households, and employment have been updated during this period, and the forecasts horizon year is now 2040. The region's long-range transportation plan has similarly gone through several revisions and project traffic forecasts must take into account facilities and policies in the current GO TO 2040 Comprehensive Regional Plan[ii].

The CATS regional travel demand models were previously based on 1990 household travel survey,[iii] which was one of the basic sources of trip rates and distributions, along with the 1990 Census journey to work data[iv]. More current travel and socioeconomic data are now available. CMAP has recently completed a comprehensive household travel and activity survey for northeastern Illinois[v] that updates the 1990 effort. Data collection for the CMAP Travel Tracker survey took place between January 2007 and February 2008 with more than 10,500 households participating in the survey.

Additionally, the 2010 decennial census product provided other base data for the region. The long-form household sample portion of the decennial census, which collected journey to work and other detailed household and population characteristics, is no longer part of the 2010 and future decennial censuses. Long-form data are now continuously collected by the Census Bureau through the American Community Survey[vi] (ACS), which annually samples approximately three million households nationally. Although the annual sample of households for the ACS is far smaller than the number of households that previously received the long-form in the decennial census, roughly comparable quality data can be obtained by combining multiple years of the ACS.

The travel demand models used for the traffic forecasts in the initial feasibility made use of regional coded highway networks and region-wide traffic analysis zones maintained by CMAP. These regional coded highway networks exclude most local streets. A further abstraction is the CMAP schematic coding of intersections and interchanges to reduce labor intensive data entry. Evaluation of the traffic estimates from these studies indicated that a more detailed analysis of corridor traffic was desirable both to improve the model's sensitivity to corridor improvements and to understand the effects of congested operating conditions.

The needs of the current I-290 Study, the availability of CMAP's model sets and expertise, and new sources of household and trip making data combined to provide the framework for the I-290 model adaptation and update. In keeping with the congruence with CMAP planning and travel modeling activities, the base year for the I-290 study is 2010. This memo reports on the establishment and validation of the 2010 base year. In general, model validation serves two key purposes:

- Establishes a model scenario in the current year (2010) that matches observed traffic conditions. The major observed elements are IDOT Average Annual Daily Traffic (AADT), peak period traffic and peak speeds. While the focus is the study corridor, the base year validation also shows that the travel model is replicating current traffic levels throughout the region. For example, in a validated I-290 model, interstate facilities throughout the region will have modeled traffic close to the observed values.

- Prepares a solid foundation for a future base year. Once a validated current year travel model is in place, it is understood that the socioeconomic inputs, model steps and parameters are working correctly and that future base and alternative scenarios will have an accurate starting point.

The 2010 validation has been completed. The 2040 base year was prepared and compared to the 2010. 2040 alternatives in the Study Area were then developed and tested. It is important to note that the alternatives evaluation focuses on relative differences, rather than absolute numbers; the 2040 alternatives are compared to the 2040 base.

## 1.4 Continuous I-290 Model Improvement

In the years between 2010 and 2015, the I-290 Travel Model received continuous enhancement. Much of this enhancement was related to evolving requirements for model components, such as tolling, HOV (High Occupancy Vehicle) and HOT (High Occupancy Toll) lanes model alternatives and reporting protocol. Other enhancements are due to the availability of new data, such as the 2010 and 2040 Market–Based socioeconomic forecasts as input to the I-290 model. In 2013-2014, the I-290 travel models were prepared using all enhancements available to the models. This report will present and explain the enhancements.

# 2.0 Model Preparation

## 2.1 Introduction

The I-290 travel model preparation involved two major areas. The first was the preparation of the input files, both geographic (network) and data related (socioeconomic data). The second key area was composed of changes to the four-step model structure. This section will address the preparation of the input files to the model. All preparation steps and four-step model changes were done to enhance the capability of the model to analyze I-290 scenarios.

The philosophy of the I-290 model can be summarized by the following points:

- **Fidelity** to the CMAP models – The goal of the current I-290 model update process is to adapt and utilize I-290 Study socioeconomic forecasts and travel demand model for the purpose of studying the traffic on the I-290 corridor between west of Mannheim Road to just west of the Jane Byrne Interchange.

- **Detailed I-290 Subarea** – Given that the Study Area encompasses the I-290 facility, but also the parallel roadways such as Roosevelt Road and Madison/ Washington Streets, it was necessary to build a detailed network within the Study Area. The CMAP representational highway network was enhanced by preparing a ground-truthed articulated network of I-290. This task involved a process called "conflation" in which the CMAP model highway segments and attribute information were transferred to a highly accurate Geographic Information System (GIS) data layer. As an example, the complex ramping configurations on the I-290 interchanges were added to the starting point CMAP network so that the true distance and intersection geometry could be captured. This detailed network editing included I-290 highway centerline conflation, ramp placement and directionality, and the confirmation of the number of mainline and slip lanes on the facility. The placement of centroid connector links was also revisited as part of the network editing.

- **Income and Auto Occupancy** – Where it is conceptually required, major new modules were added to the CMAP models. The most important one was the stratification of low and high income workers within the Home-Based Work (HBW) trip distribution and mode split models. The low/high income categories are retained through the trip table estimation and produce Single Occupancy Vehicle (SOV), High Occupancy Vehicle (HOV2 and HOV3+) home to work tables, each containing some low and some high income workers.

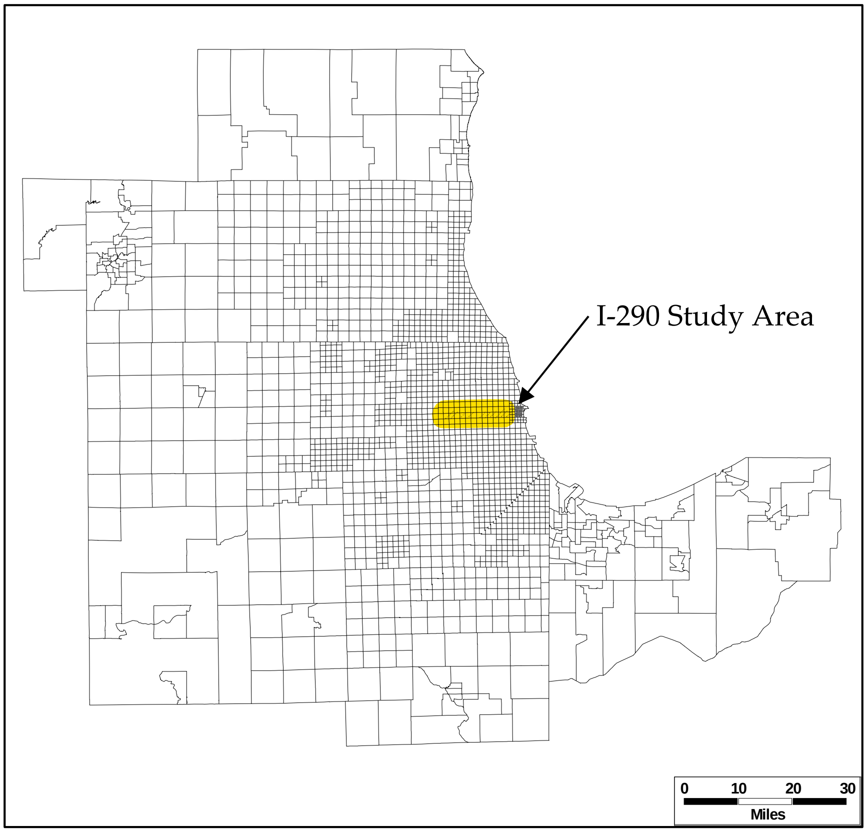
- **Focus on Efficiency and Comparability** – The regional model with all updates and revisions will be run for the 2010 base, 2040 No Build and 2040 "generalized" build cases in the full model iteration mode to establish model outputs that are very highly converged.

- **Sensitivity Testing** – The overall reason for building the model is to test alternatives in the I-290 transportation corridor. Sensitivity tests were conducted including:
  - Identification of Regional Users – Select link analysis of representative link segments on I-290 and the parallel arterials by direction by time of day for truck and passenger vehicle were conducted.
  - Estimation of Transit Use – The 2040 RTP (conformity/fiscally constrained) transit network was used for the 2040 No Build case and was the starting point for transit use analysis. Transit measures will include mode split trip reporting of the regional impacts of potential major transit alternatives in the corridor.
  - Investigation of travel model Level of Service Assumptions – Investigation into the Volume Delay Functions for use in the model to represent each of the eight time periods in the model by facility was conducted.

## 2.2 Traffic Analysis Zones

The CMAP traffic analysis zone system was used directly in the I-290 corridor. Figure 2-1 shows this zone system with the Study Area highlighted. There are a total of 1,944 zones plus seventeen external points of entry located on major roadways at the border of the region where long distance and through traffic can enter and leave the region.

**Figure 2-1. CMAP Traffic Analysis Zone System**




## 2.3 I-290 Coded Highway Network

### 2.3.1 Background on Highway Coding

The travel model required highway network refinements in the expanded Study Area so that sufficient detail could be captured in the model traffic assignment result. These refinements added a local street network to the existing network so that it is possible to better evaluate traffic on the frontage roads and parallel local streets in the Study Area.

Links in the network are typically only coded between nodes that correspond to intersections and ramp junctions. While most intersections are accurately placed, ramp junction nodes are often located for ease of representation. Shape point nodes are rarely used to improve coded roadway alignments. As a result, maps of the coded network are not geographically accurate, which increases the effort required to interpret model results and prepare meaningful exhibits.

The modeling of 2040 alternatives, such as managed lanes within the Eisenhower Expressway corridor, increases the complexity of the network coding since these lanes must be restricted to certain classes of vehicles. They may also function differently depending on the time of day, with different peak and off-peak vehicle prohibitions or lane configurations, for example. These facilities also may serve a more limited set of traffic movements than the general purpose lanes. The coded representation of special and general purpose lanes, as well as their points of access, must closely resemble the actual facility in order to ensure that the modeled version functions as designed.

As a first step, two tiers of corridor zones – one on either side of the expressway – were identified as areas warranting more detailed network coding. North and south boundaries for these two tiers of corridor zones are two arterial streets paralleling the expressway, Madison Street to the north and Roosevelt Road to the south. The east-west limits of the detailed coding extended from the Chicago central area to just west of Tri-State Tollway (I-294). Locations of local streets and frontage roads for the detailed network coding were obtained from the street network portion of the 2006 Census Topologically Integrated Geographic Encoding and Referencing system (TIGER) line files[vii]. Node numbers greater than the highest node numbers in the regional network were assigned to intersections in the TIGER network files. Network link files are customarily in a "from node" to "to node" format, unlike the TIGER network links. To create a network-like link file from the TIGER street segments, intersection node coordinates were matched against street segment endpoints and "from nodes" and "to nodes' transferred to the street segment file. The resulting network link file contained a link's defining node numbers and the distance along the link.

Nodes and links in the CMAP regional network within the detailed network area were deleted. TIGER source nodes and links were then combined with the remaining regional links and nodes to form I-290 project network files. Remaining cleanup of the network files required manual coding using transportation modeling software.

- The detailed TIGER network was stitched into the regional network at the boundaries of the detailed coding.
- Zone centroid nodes plus access links to connect centroids with the highway network were added for the new zones in the I-290 corridor.
- Eisenhower links and expressway-local street ramps were manually adjusted to more faithfully represent the actual facilities' alignments.
- Link data items from the regional network, not including distance, were copied to corresponding links in the detailed network.
- Additional data sources , the Illinois Roadway Information System[viii] and air photos, were consulted to code data items for additional links.

Figure 2-2 shows the detailed network within the zones on either side of the Eisenhower Expressway. The figure also shows zone boundaries and the locations of zone centroid nodes. It is apparent from the figure that even with the smaller zones, the number of points where traffic may enter and leave the network is still limited compared to the detail obtained from the TIGER files.

Table 2-1 summarizes the coding of the different variable fields in the network node and link records. Variable names that are preceded by the symbol @ are variables that must be coded in addition to the standard variables anticipated by the EMME/3[ix] travel demand modeling software. Assignment of vehicle trips to the coded highway network is covered in a later section. The EMME/3 macros were changed to allow highway segments to serve High Occupancy Vehicles (HOVs) alone in preparation for the alternative testing in the 2040 models. The link volume delay functions were revisited as part of the I-290 conversion although they did not differ from the original CMAP coding protocol. And finally, the CMAP Travel Tracker 2008 survey allowed for the re-estimation of the factors that allocate daily vehicle trips to time periods within a day. The issue of the volume delay function to be used for the High Occupancy Vehicle (HOV) and High Occupancy Toll (HOT) facilities will be addressed prior to the alternatives testing when travel times in the Study Area will be an important focus.

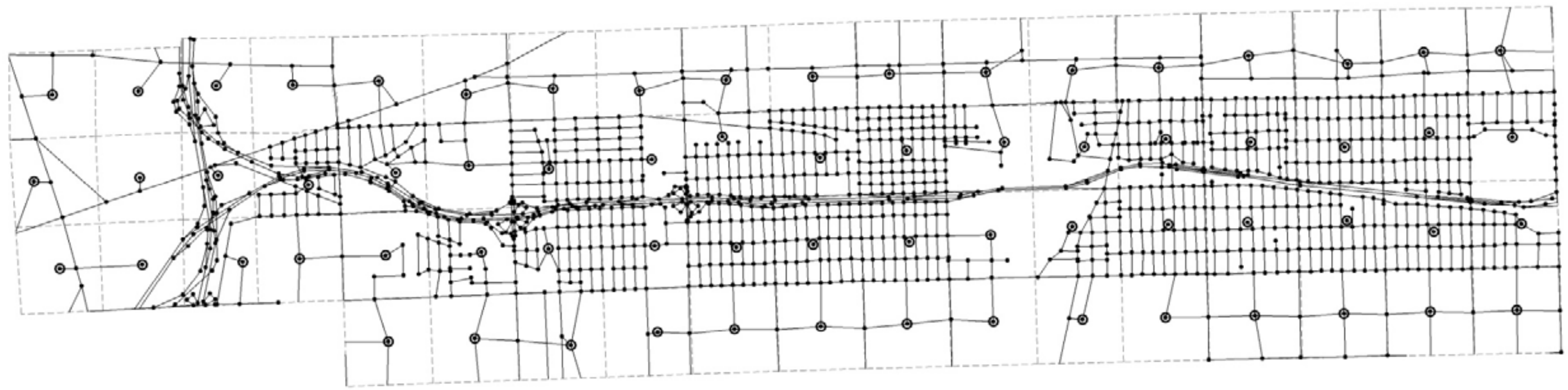
## Table 2-1. Coded Variables in I-290 Network

*(I-290 Project Specific Coding in Boldface)*

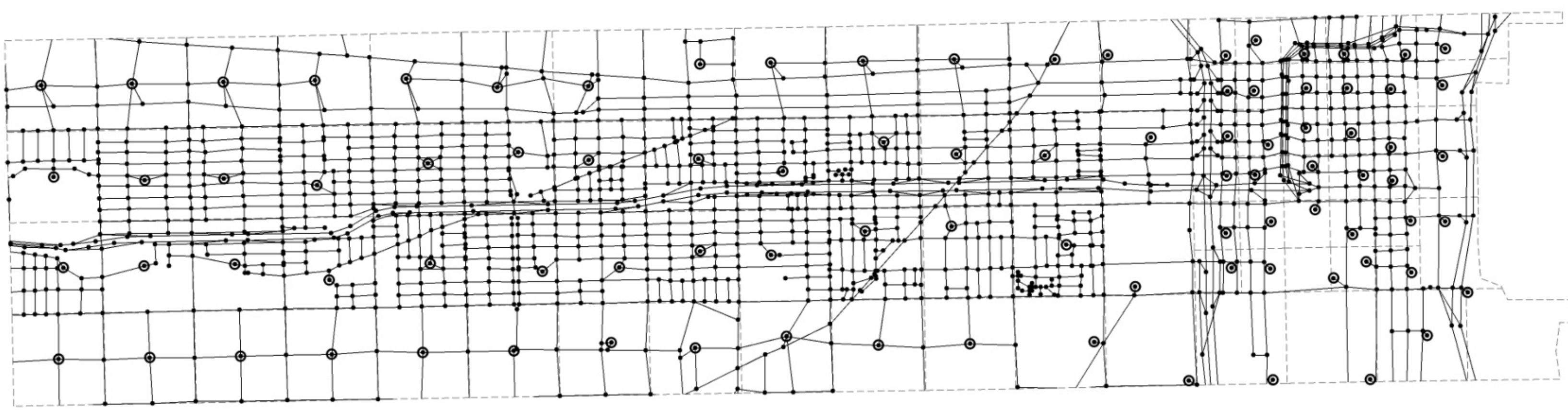
| Node Variables | Description |
|---|---|
| @zone | **I-290 zone where node is located** |
| @atypej | Area type of I-290 zone |
| | 1 = inside Chicago CBD (zones 1-47) |
| | 2 = inside Chicago Central Area (zones 48-77) |
| | 3 = inside remainder of Chicago |
| | 4 = inside inner suburbs where the Chicago major and minor arterial street grid is continued |
| | 5 = inside remainder of Chicago urbanized area |
| | 6 = inside Indiana urbanized area |
| | 7 = inside remaining Illinois suburban urbanized areas (Joliet, McHenry, etc.) |
| | 8 = inside remaining Indiana suburban urbanized areas |
| | 9 = inside remaining northeastern Illinois urban area |
| | 10 = rural |
| | 11=external area covered by Kenosha, Walworth, Racine, Boone, Winnebago, DeKalb, Ogle, Lee, LaSalle, Grundy, Kankakee, Porter, and LaPorte counties. |
| | **12 = area of detailed network within I-290 corridor** |
| | 99 = points of entry into region |
| **Link Variables** | |
| mod | Modes permitted on link |
| | A = Generalized auto |
| | S = Single occupant auto |
| | H = High occupancy vehicle |
| | T = General truck |
| | b = B plate truck |
| | l = Light truck |
| | m = Medium truck |
| | h = heavy truck |
| lan | Number of driving lanes |
| vdf | 1 = arterial street |
| | 2 = freeway |
| | 3 = freeway/expressway ramp from/to arterial street |
| | 4 = expressway |
| | 5 = freeway/expressway to freeway/expressway ramp |
| | 6 = auto access to network |
| | 7 = link where toll is paid |
| | 8 = metered expressway entrance ramp |
| | **9 = collector-distributor and local street links in I-290 corridor detailed network** |
| typ | 1 = default |
| | 10 = POE connector |
| | **88 = collector-distributor links in I-290 corridor detailed network** |
| | **99 = local street links in I-290 corridor detailed network** |
| @speed | link free speed or speed limit from CATS/CMAP network |
| @parkl | number of parking lanes on link from CATS/CMAP network |
| @width | average lane width in feet |

**Figure 2-2. Detailed Network Coding in the I-290 Corridor**

Eastern Portion from Austin Avenue (6000 West) to Lakefront



Western Portion from Eastern DuPage County to Central Avenue (5600 West)



Zone Border

### 2.3.2 Decision Rules for Highway Coding

The network coding prepared for the I-290 Study followed these guidelines:

- Provide adequate highway detail to capture movement on both I-290 and the parallel roadways. Include the capability to reflect interstate-to-interstate movements that are rational path choices for I-290 travelers.

- Provide network detail at one level below the desired analysis level of detail. Previous studies in the corridor have shown that network detail within a wide band of influence in the I-290 study corridor will be helpful in alternatives analysis.

- Build a highly detailed I-290 study network with all interchanges, merges and lane configurations matching the actual physical facility.

- Within the focused zone area, plus a one mile buffer, identify the locations for and code multiple centroid connectors.

- Prepare for a 2040 Baseline network. This network will not include any capacity enhancements on I-290, although it does include 2040 Regional Transportation Plan highway and major transit elements outside of the Study Area.

## 2.4 Socioeconomic Data

The socioeconomic data used for the I-290 study are Market-Based socioeconomic forecasts developed by The al Chalabi Group for the I-290 study.[x] Table 2-2 shows the totals for households and employment for 2010 that are based on 2010 Census data.

**Table 2-2. Socioeconomic Forecast Totals for 2010**

| County | Households | | Employment | |
|---|---|---|---|---|
| | # of Households | % of Regional | # of Workers | % of Regional |
| Cook | 1,966,343 | 64% | 3,125,691 | 64% |
| DuPage | 337,132 | 11% | 689,725 | 14% |
| Will | 225,259 | 7% | 252,316 | 5% |
| Lake | 241,709 | 8% | 428,851 | 9% |
| Kane | 170,484 | 6% | 257,348 | 5% |
| McHenry | 109,200 | 4% | 134,820 | 3% |
| Kendall | 38,021 | 1% | 29,806 | 1% |
| **Six County Subtotal** | **3,088,148** | **100%** | **4,918,557** | **100%** |
| All Other Counties* | 754,313 | | 754,839 | |
| Grand Total | 3,842,461 | | 5,673,396 | |

Source: ACG I-290 Build & No Build Socioeconomic Report & Forecasting 06-2014

Table 2-2 shows over 3 million households and over 4.9 million workers for 2010 in the six county area. 64 percent of these households and employment lie in Cook County. DuPage County contains 11 percent of the regional households and 14 percent of the employment.

# 3.0 Travel Model Enhancements

## 3.1 Need for the Model Enhancements

The zonal and network disaggregation discussed in **Section 2** were conducted in parallel to the travel model enhancement work. The travel model enhancement was done at each level of the CMAP four-step model: (1) trip generation, (2) trip distribution, (3) mode choice, and (4) traffic assignment. Added to the core capabilities of the adapted CMAP model were the capability to model and analyze High Occupancy Vehicle (HOV) lanes, High Occupancy Toll (HOT) lanes, and toll lanes. Additionally, a battery of post-processing modules was built to provide full reporting capability for the I-290 custom model results. These included the means of summarizing all auto modes, truck results, and corridor specific summaries such as person through-put for auto and transit.

## 3.2 Household Person Trip Generation Model

The CMAP household trip generation model initially used for the I-290 work was obtained from CMAP in 2009. Only minor changes to this version of the model were completed as part of the first round of the I-290 project. The most significant enhancement was the option to create a file of estimated household vehicle ownership levels by the subzones that are used by the trip generation model.

For background, the 2009 updated CMAP household person trip generation model has the following features:

- Trip generation rates for persons residing in households are estimated with trip data from the 2007-2008 CMAP household travel survey.

- Model inputs can readily be updated with ongoing ACS data.

- A synthetic four dimension (adults-workers-children-income quartile) distribution of households into 224 categories is estimated for every trip generation sub-zone.

- Trip end estimates in detailed trip categories can be output including home-work trips by low and high income workers.

- Attraction allocation, household vehicle ownership, and non-motorized sub-models are revised and re-estimated with 2007-2008 household travel survey data.

The sequence of travel demand models for the I-290 project includes a mode choice model that allocates person trips into person trips by drive alone private vehicle, two persons ride-sharing, and three or more persons carpooling. The sub-mode choice model for private vehicles includes independent variables for the proportions of households within a zone at different levels of vehicle ownership. Since the household vehicle ownership sub-model in the CMAP trip generation model estimates these proportions, the same values of household vehicle ownership should be used in both trip generation and mode choice for internal consistency.

An option was incorporated into the trip generation code to retain the household vehicle ownership estimates for later use in mode choice. The fixed format for this file is listed in Table 3-1. Low income workers are defined as workers with below median regional earnings and high income workers have above median earnings.

**Table 3-1. Household Vehicle Ownership File**

| Variable | Location |
|---|---|
| I-290 Zone | 1-5 |
| Households with One or More Low Income Workers | |
| Fraction of Households without Vehicles | 6-17 (12.4) |
| Fraction of Households with One Vehicle | 18-29 (12.4) |
| Fraction of Households with Two or More Vehicles | 30-41 (12.4) |
| Households with One or More High Income Workers | |
| Fraction of Households without Vehicles | 42-53 (12.4) |
| Fraction of Households with One Vehicle | 54-65 (12.4) |
| Fraction of Households with Two or More Vehicles | 66-77 (12.4) |

A keyword was added to the program control file to optionally create the household vehicle ownership file. The **&PARAM** and **&END** statements identify the beginning and end of the **NAMELIST** input file that now includes the following keyword variables.

1. **TITLE**: An 80 character name identifying the model run enclosed in single quotes.

2. **SUBZONES**: Trip generation sub-zones in the Study Area.

3. **PUMA5**:  Five percent sample Public Use Microdata Areas in the modeled Study Area.

4. **PUMA1**:  One percent sample Public Use Microdata Areas in the modeled Study Area.

5. **ZONES**:  Zones used in the remaining CMAP models for trip distribution (linking of trip ends into trips between zones), mode choice (allocation of trips to travel modes), and assignment (allocation of trips to highway and transit routes).

6. **COUNTIES**:  Counties in the Study Area.

7. **PUMA_TG**:  A true/false variable that defaults to false.  When true the model's logic includes an optional subroutine that prepares an updated (future) four-way cross-tabulation of households within sub-zones.  This new table is based upon (future) large area average household characteristics and the initial (base year) cross-tabulated household table.

8. **SAVE_FILE**:  A true/false variable that defaults to false and causes all intermediate program files to be retained after the model run is completed.

9. **EXP_TTYPE**:  A true/false variable that defaults to false.  When true, all files and reports include forty-nine trip types based upon trip purposes in the CMAP household travel survey.  When false, files and reports have the eleven trip types in the current CMAP trip generation.

10. **MODE_CHOICE**:  A true/false variable that defaults to false.  The optional household vehicle ownership file (Table 2) is created when keyword is true.

11. **IN_EMPFACT**:  Employment in Indiana is multiplied by this factor, which defaults to 1.00.  This variable and the following one for Wisconsin are included to offset possible systematic differences in employment definitions and estimation methods between CMAP and neighboring MPOs.

12. **WI_EMPFACT:**  Employment in Wisconsin is factored by this value that defaults to 1.00.

In 2009-2010, Parsons Brinckerhoff staff was asked by CMAP to prepare enhancements to the Trip Generation program including:

- Updating the base year trip generation model inputs to 2010 with Census 2010 Summary File 1 small area population data and 2005-2009 ACS and ACS PUMS.

- Re-estimating differential trip generation rates for members of senior and younger households from the CMAP household travel survey.

- Revising trip generation model code to incorporate age of householder.

- Preparing a utility program that creates a database with discrete records enumerating households by size, number of workers, income level, vehicles available to household, and age of householder from intermediate trip generation work files.

- Revising group quarters trip generation procedure to include university/college dorms and military facilities.

- Adjusting bias coefficients in household vehicle ownership and non-motorized trip generation sub-models as needed to reproduce observed 2010 levels.

The trip generation updates were utilized in the Round 2 and Round 3 of the I-290 model runs.

## 3.3 Trip Distribution

### 3.3.1 Pre-Distribution Transit Access Parameters

Transit access parameters stored in two legacy trip distribution input files (M01.dat and DISTR.dat) were reviewed and updated for both 2010 and 2040. These file inputs were prepared using spatial analysis with a Geographic Information System (GIS) tool.

### 3.3.2 Pre-Distribution Travel Cost Model

The next model in the sequence of CMAP regional travel models estimates the highway and transit costs for trips between zones for use by the agency's trip distribution model. Costs are here calculated as in the CMAP mode choice model and the pre-distribution code is largely the same as the mode choice model code.

The overriding objective for revisiting this model in the I-290 project was to make all cost calculations in the model consistent with current, or near current, regional conditions. To this end, cost parameters that are model control variables and input files containing data used in the model's cost calculations were reviewed and updated.

The pre-distribution model reads data directly from an EMME/3 databank, a large data file that contains all network and zone data processed by the EMME/3 travel modeling software. A few minor changes in the code were required to reflect the naming of the databank as EMMEBANK by the most recent version of the EMME/3 software.

#### Home-Work Control Variables

Table 3-2 lists the control variables for trips between home productions and work attractions. These variables are read into the pre-distribution model through five namelist variable lists, lists of control variables contained between an &NAME identifier before the list (&PARAM, &OPTION, &PROCESS, &SYSTEM, and &TABNUM) and an &END at the end of the list. The table includes the variable values in the current CMAP model setup for regional planning and the values used in the I-290 project plus a brief rationale for any adjustment of the CMAP values.

The coefficients in the mode choice model date from the original model estimation based on 1970 travel data. In particular, the coefficients for travel costs reflect 1970 dollar values. Since costs in the I-290 project are in current dollars, these coefficients needed to be adjusted. The Historical Consumer Price Index for all Urban Consumers[xi] indicates that a 1970 dollar would be worth $5.55 in current dollars and the cost coefficients were reduced accordingly.

## Table 3-2. Control Variables In & PARAM Namelist for Home-Work Trips

| Variable | Description | CMAP Regional Planning | Project | Reason for Change |
|---|---|---|---|---|
| ZONES | Highest zone number, must be less than or equal to EMMEBANK | 1944 | 2233 | Internal zones for I-290 project |
| CBDZON | CBD zone numbers (maximum of 200 zones) | 1-77 | 1-77 | I-290 project zones defined as Chicago central area |
| RNSEED | Random number seed (an integer value between 0 and 9999 with 0 implying a random value) | 1934 | 1934 | Arbitrary integer value set to allow comparison between model runs |
| COEFF1 | Six coefficients in mode choice model to weight cost components for trips with destinations not in CBD | 1. 0.0186 (Auto or transit line-haul in-vehicle time in minutes) | 1. 0.0186 | 1. CMAP historical value |
| | | 2. 0.0072 (Auto line-haul costs or transit line-haul and access/egress costs in cents) | 2. 0.00130 | 2. CMAP value factored by 0.18 (2008 to 1970 Urban Consumers' Price Index) |
| | | 3. 0.0584 (Auto walk time to/from parking or transit access/egress in-vehicle time in minutes) | 3. 0.0584 | 3. CMAP historical value |
| | | 4. -2.000 (Transit bias) | 4. 0.0 | 4. Transit bias not included in costs |
| | | 5. 0.0399 (Transit line-haul and access/egress out-of-vehicle time in minutes) | 5. 0.0399 | 5. CMAP historical value |
| | | 6. 0.0811 (Half headway of first transit line-haul service boarded in minutes) | 6. 0.0811 | 6. CMAP historical value |
| COEFF2 | Six coefficients in mode choice model to weight cost components for trips with destinations in CBD | 1. 0.0159 (Auto or transit line-haul in-vehicle time in minutes) | 1. 0.0159 | 1. CMAP historical value |
| | | 2. 0.0085 (Auto line-haul costs or transit line-haul and access/egress costs in cents) | 2. 0.00153 | 2. CMAP value factored by 0.18 (2008 to 1970 Urban Consumers' Price Index) |
| | | 3. 0.0486 (Auto walk time to/from parking or transit access/egress in-vehicle time in minutes) | 3. 0.0486 | 3. CMAP historical value |
| | | 4. 0.0 (Transit bias) | 4. 0.0 | 4. Transit bias not included in costs |
| | | 5. 0.0290 (Transit line-haul and access/egress out-of-vehicle time in minutes) | 5. 0.0290 | 5. CMAP historical value |
| | | 6. 0.0173 (Half headway of first transit line-haul service boarded in minutes) | 6. 0.0173 | 6. CMAP historical value |

### Table 3-2. Control Variables in &PARAM Namelist for Home-Work Trips (continued)

| Control Variable | Description | CMAP Regional Planning | I-290 Project | Reason for Change |
|---|---|---|---|---|
| APC | Four daily parking costs for work locations in the region in cents | 1. 400 (Chicago central area) | 1. 800 | 1. The balance of the central area outside the zones covered by the CBD parking sub-model. Set to approximately half the on-street rate to reflect free employee parking. |
| | | 2. 100 (Balance of Chicago) | 2. 100 | 2. Reflects mostly free employee parking outside the central area |
| | | 3. 100 (Dense suburban) | 3. 200 | 3. Approximately half the on-street rate in business districts in dense suburban area |
| | | 4. 0 (Low density suburban) | 4. 0 | 4. Generally free employee parking |
| WFA | Four average walking times from parked auto to workplace in minutes | 1. 5 (Chicago central area) | 1. 5 | 1. Default value for the balance of the central area outside the zones covered by the CBD parking sub-model. |
| | | 2. 3 (Balance of Chicago) | 2. 3 | |
| | | 3. 3 (Dense suburban) | 3. 3 | |
| | | 4. 3 (Low density suburban) | 4. 3 | |
| PRKZON | Zone numbers covered by CBD parking sub-model (maximum of 200 zones) | 15-18, | 2-7, | Determined by the availability of off-street parking rate data |
| | | 20-30, | 9-30, | |
| | | 32-36, | 32-36, | |
| | | 39, 40 | 39-41, | |
| | | | 45, 47, | |
| | | | 55-57 | |
| ITER | Number of trips simulated between zone pairs to produce average cost values | 10 | 100 | Faster processing speeds allow far more trips to be simulated in acceptable times |

### Table 3-3. Control Variables in &PROCESS Namelist for Home-Work Trips

| Control Variable | Description | CMAP Regional Planning | I-290 Project | Reason for Change |
|---|---|---|---|---|
| PZOI | Production/origin zones to be processed | 1-1944 | 1-2233 | More I-290 zones due to detailed zones in corridor |
| QZOI | Attraction/destination zones to be processed | 1-1944 | 1-2233 | |

**Table 3-4. Control Variables in &Option Namelist for Home-Work Trips**

| Control Variable | Description | CMAP Regional Planning | I-290 Project | Reason for Change |
|---|---|---|---|---|
| HW | Indicates home productions and work attractions are simulated | TRUE | TRUE | |
| HNW | Indicates home productions and non-work attractions are simulated | FALSE | FALSE | |
| OTH | Indicates origins and destinations without a home or work trip end are simulated | FALSE | FALSE | |
| ASM_AREA | Indicates parameters that control the simulation of distance from trip end to line-haul transit service are input by area type (Chicago central area, balance of Chicago, dense suburban sparse suburban) | FALSE | FALSE | |
| ASM_ZONES | Indicates parameters that control the simulation of distance from trip end to line-haul transit service are input by zone (DISTR input file) | FALSE<br>(Note: regional defaults are used when both ASM_AREA and ASM_ZONES are false, see discussion of DISTR input file) | TRUE | New zone distance parameters estimated for I-290 zone system, current rail transit and commuter rail stations, existing CTA bus service, and PACE regional and feeder bus. |
| INCOST | Indicates that unit modal travel costs are input by area type and not set to program defaults | TRUE<br>(Note: see discussion of M023 input file for values) | TRUE | Modal travel costs revised to approximate current values in M023 input file |
| TRACE | Indicates that extensive intermediate output is desired for program debugging | FALSE | FALSE | Used to check program calculations |

**Table 3-5. Control Variable in &SYSTEM Namelist for Home-Work Trips**

| Control Variable | Description | CMAP Regional Planning | I-290 Project | Reason for Change |
|---|---|---|---|---|
| SPDWLK | Average walking speed in tenths of a mile per hour | 30 | 30 | |
| SPEEDS | Four average auto speeds in miles per hour followed by four average bus speeds for use in the access/egress | 1. 7 (Auto in Chicago central area) | 1. 7 | |
| | | 2. 15 (Auto in balance of Chicago) | 2. 15 | |
| | | 3. 20 (Auto in dense suburban) | 3. 20 | |
| | | 4. 30 (Auto in low density suburban) | 4. 30 | |
| | | 5. 5 (Bus in Chicago central area) | 5. 5 | |
| | | 6. 10 (Bus in balance of Chicago) | 6. 10 | |
| | | 7. 12 (Bus in dense suburban) | 7. 12 | |
| | | 8. 17 (Bus in low density suburban) | 8. 17 | |
| DRVOT | Value of time for auto drivers in cents | 60 | 20 | I-290 project value is one-half the 2008 |
| AFC1 | Auto fixed costs for driver in cents per trip | 0 | 0 | Auto fixed costs not used in cost estimation |
| AFC2 | Auto fixed costs for auto passenger in cents per trip | 0 | 0 | Auto fixed costs not used in cost estimation |
| W2PNR | Walk time to station platform from park and ride lot in minutes | 3 | 3 | |
| DISCNT | Discount factor to bring costs to 1970 dollars, | 0.3 | 1 | Costs are expressed in current dollars |

**Table 3-6. Control Variables in &TABNUM Namelist for Home-Work Trips**

| Control Variable | Description | I-290 Project |
|---|---|---|
| TABLE_FMD | EMMEBANK input table number for first transit mode boarded | Table numbers depend upon data preparation in EMME software |
| TABLE_LMD | EMMEBANK input table number for last transit mode boarded | |
| TABLE_IVT | EMMEBANK input table number for transit in-vehicle time | |
| TABLE_OVT | EMMEBANK input table number for transit out-of-vehicle time | |
| TABLE_HWAY | EMMEBANK input table number for headway of first transit line boarded | |
| TABLE_PMD | EMMEBANK input table number for priority mode | |
| TABLE_FARE | EMMEBANK input table number for transit fares paid | |
| TABLE_HTIME | EMMEBANK input table number for highway travel time | |
| TABLE_HDIST | EMMEBANK input table number for highway distance traveled time | |
| TABLE_AUTIL | EMMEBANK output table number for auto general cost | |
| TABLE_TUTIL | EMMEBANK output table number for transit general cost | |

## 3.4 Transit Networks and Model Approach

The Study Area features several important rail and bus transit services with the CTA's Blue Line (O'Hare-Forest Park) of the highest importance. Capturing the transit mode is integral to getting travel right in the I-290 corridor. To this end the CMAP transit models were expanded and enhanced. The following changes were made with the goal of validating the I-290 corridor for transit:

- Daily transit trips were stratified by trip purpose including two Home-Based Work income classifications: Home-Other and Non-Home Based.
- Transit skims were set up defining "first mode" and "priority mode" to inform the transit trip processing step below.
- Transit trip start and endpoint were coded with X-Y coordinates to utilize the EMME function that steps aways from "centroid" start and end point assumptions and instead uses point location. Walk and drive access were established for transit trips by transit mode. Metra, CTA rail and bus were established as the transit modes in the region.

- Transit assignment approach, including headway preparation, was established. The assigned lines can be summarized by line and are also used as input to a set of transit post processing/reporting programs. These programs include I-290 corridor transit person miles and transit screen lines.

The transit procedure was written in a set of EMME macros and in customized data processing scripts so that it is automated and repeatable. The results of this transit effort allow analysts to quickly show the difference on the CTA Blue Line as well as commuter rail and bus in the I-290 corridor given the addition of an HOV, HOT or toll lane scenario. Transit plays a key role in the I-290 study due to its presence in the median of the facility and also due to the interplay between transit and HOV. Transit users are typically more readily influenced by the availability of HOV/HOT than are auto drivers.

## 3.5 Mode Choice Updates

### 3.5.1 Project Approach

The CMAP mode choice model was partly recalibrated for the I-290 study to reflect current travel costs and mode shares in the region. The calibration process started with the model coefficients that were estimated some years before by CATS, CMAP's predecessor agency, and currently used for agency planning projects. The cost coefficients were next adjusted so that costs could be expressed in current dollars, rather than 1970 dollars, the date of the survey used for the original model estimation. The Consumer Price Index for all Urban Consumers indicated that one 1970 dollar equaled approximately $5.50 in 2008-2009 dollars.

The first round of calibration effort consisted of adjusting bias constants so that resulting mode shares estimated by the model matched observed mode shares. Home-work coefficients were calibrated to observed data in the 2000 Census Transportation Planning Package, while home-other and non-home model coefficients were calibrated to data from the CMAP-Northwestern Indiana Regional Planning Commission 2007-2008 household travel survey. This work fitted the model to reflect that there are very long work trips to the Chicago central area.

### 3.5.2 Descriptions of Model Coefficients

1. **COEFF1:** Six model coefficients that control binary auto-transit mode shares for trips (home-work, home-non-work, and non-home) to non-CBD destinations.

   a. **COEFF1 (1):** Zone to zone in-vehicle time on line-haul modes in minutes.

   b. **COEFF1(2):** Zone to zone auto operating costs or zone to zone line-haul transit fares plus costs to access/egress transit service in cents.

c. **COEFF1 (3):** In-vehicle time to access/egress transit in minutes.

d. **COEFF1 (4):** Transit bias constant. Although a negative number due to the negative sign associated with the variable in the transit cost (negative utility) calculation, it can be interpreted as the added inherent cost of selecting transit.

e. **COEFF1(5):** Zone to zone out-of-vehicle time accrued from the initial transit boarding to final alighting plus the out-of-vehicle time to access/egress transit except for the time spent waiting for the initial boarding due to service frequency (one-half headway) in minutes.

f. **COEFF1 (6):** One-half headway of first transit line boarded in minutes.

2. **COEFF2:** Six model coefficients as described above that control binary auto-transit mode shares for trips to non-CBD destinations.

3. **HOV_BIAS:** Two bias constants used in the submodel to allocate home-work person trips by auto into drive alone, two person shared ride, and three or more person carpool auto submodes for trips to non-CBD destinations.

    a. **HOV_BIAS (1):** Three or more persons carpool bias. The inherent added cost of selecting the three or more person carpool mode versus the two person shared ride mode. .

    b. **HOV_BIAS (2):** Shared ride (two or more persons) bias versus. The inherent added cost of shared ride modes as opposed to driving alone.

4. **HOV_CBDBIAS:** Two bias constants as described above for trips to CBD destinations.

### 3.5.3 Mode Choice Coefficients for Different Model Applications

The model can be run in six different modes depending on the trip purpose, use of the HOV submodel to allocate auto trips into occupancy level submodes, and segmentation home-work trips by earnings level.

1. Home-work trips for all workers

    a. Auto-transit binary choice

    b. Auto-transit binary choice with HOV submodel allocation

2. Home-work trips segmented by workers' earnings

    a. Auto-transit binary choice with HOV submodel allocation for low earnings (below regional median earnings) workers

b. Auto-transit binary choice with HOV submodel allocation for high earnings (above regional median earnings) workers

3. Auto-transit binary choice for home-non-work trips

4. Auto-transit binary choice for non-home trips

The following coefficients were calibrated during the preparatory work for modeling an HOV lane treatment as part of the reconstruction of the Eisenhower (I-290) Expressway.

**Table 3-7. I-290 Project Mode Choice Coefficients for Home-Work Trips**

| | Auto-Transit Binary Choice | Auto-Transit Binary Choice with HOV Submodel | Low Earnings Auto-Transit Binary Choice with HOV Submodel | High Earnings Auto-Transit Binary Choice with HOV Submodel |
|---|---|---|---|---|
| COEFF1(1) | 0.0186 | 0.0186 | 0.0186 | 0.0186 |
| COEFF1(2) | 0.0013 | 0.0013 | 0.0013 | 0.0013 |
| COEFF1(3) | 0.0584 | 0.0584 | 0.0584 | 0.0584 |
| COEFF1(4) | -0.7357 | -0.7357 | -0.9814 | -1.5484 |
| COEFF1(5) | 0.0399 | 0.0399 | 0.0399 | 0.0399 |
| COEFF1(6) | 0.0811 | 0.0811 | 0.0811 | 0.0811 |
| COEFF2(1) | 0.0159 | 0.0159 | 0.0159 | 0.0159 |
| COEFF2(2) | 0.00153 | 0.00153 | 0.00153 | 0.00153 |
| COEFF2(3) | 0.0486 | 0.0486 | 0.0486 | 0.0486 |
| COEFF2(4) | -0.8812 | -0.8812 | -0.4121 | -0.6959 |
| COEFF2(5) | 0.029 | 0.029 | 0.029 | 0.029 |
| COEFF2(6) | 0.0173 | 0.0173 | 0.0173 | 0.0173 |
| HOV_BIAS(1) | NA | 2.09 | 2.09 | 2.09 |
| HOV_BIAS(2) | NA | 1.15 | 0.263 | 0.45 |
| HOV_CBDBIAS(1) | NA | 2.51 | 2.51 | 2.51 |
| HOV_CBDBIAS(2) | NA | 1.59 | 0.583 | -0.06 |

**Table 3-8. I-290 Project Mode Choice Coefficients for Home-NW and NH Trips**

| | Home-Non-Work | Non-Home |
|---|---|---|
| COEFF1(1) | 0.0114 | 0.0114 |
| COEFF1(2) | 0.00592 | 0.00592 |
| COEFF1(3) | 0.0663 | 0.0663 |
| COEFF1(4) | -0.4482 | -1.1403 |
| COEFF1(5) | 0.0589 | 0.0589 |
| COEFF1(6) | 0.061 | 0.061 |
| COEFF2(1) | 0.0159 | 0.0159 |
| COEFF2(2) | 0.00153 | 0.00153 |
| COEFF2(3) | 0.0486 | 0.0486 |
| COEFF2(4) | -0.5507 | -1.6275 |
| COEFF2(5) | 0.029 | 0.029 |
| COEFF2(6) | 0.0173 | 0.0173 |

## 3.6 Mode Choice – High Occupancy Vehicle Integration

### 3.6.1 Non-Work High Occupancy Vehicle Mode Share Estimation

In 2012, the needs of the I-290 model required a re-estimation of the existing CMAP mode choice model to better estimate the auto submodes - single occupant, two persons, or three or more persons per vehicle – for home-work travel. This focus on commuters' behavior was reasonable due to the fact that most home-work travel takes place in the congested peak period and high occupancy highway facilities are particularly intended for commuters' use. Also, non-work trips are often too short to make use of these HOV facilities.

Non-work auto occupancy was currently estimated using observed regional average values, but more detailed estimates were needed since non-work travel is more likely to contribute to congestion. Peak period travel conditions have steadily lengthened and now encroach upon the times of the day when substantial non-work travel occurs. This is particularly the case in the early hours of the evening peak period when both workers and non-workers are returning home.

The enhancement to the CMAP mode choice model estimated home-other and non-home trip auto occupancy. Given the availability of data, it was anticipated that the model would feature independent variables that include the characteristics of the household and trip length.

As part of the mode development, the state of the practice for non-work auto occupancy models was reviewed. A non-work HOV mode share estimation was estimated. Finally the I-290 mode choice model was revised to incorporate a non-work auto occupancy submodel.

### 3.6.2 Toll and Non-Toll Mode Choice

In 2012 it was determined that the CMAP/I-290 mode choice model contained a set of options for evaluating the effect of tolls on mode choice. These features of the model had never been tested, calibrated or validated. These existing options in the model were evaluated to make them a useful part of the CMAP standard model procedure. Staff assembled the base year networks with current vehicle tolls, developed a set of model calibration traffic counts for toll and non-toll regional facilities, revised the EMME macros to prepare separate paths and skim files for toll and non-toll networks, then ran the current version of the I-290 model on the base year network.

Estimation work was then conducted to evaluate the model run and adjust model calibration coefficients as necessary to best match toll and non-toll traffic count data. The revised mode choice toll component was calibrated and used directly in the I-290 work to capture accurately household income and trip length characteristics which improve results for pricing alternatives such as HOV and HOT.

## 3.7 Traffic Assignment

The CMAP and I-290 models use the EMME/3 standard traffic assignment which is a user-optimal equilibrium assignment with linear approximation (Frank and Wolfe). It is based on the assumption that each traveler chooses the path (or route) perceived as being the best; if there is a shorter path than the one being used, the traveler will choose it. At the equilibrium, no one can improve their travel time by changing paths. With the standard traffic assignment, up to 12 classes can be assigned simultaneously. For each class there are multiple choices for saving and storing the assignment results. For the I-290 effort the class specific volumes generated from the multi-class assignment on links are saved in link segment extra attributes keyed to the vehicle class. Table 3-9 lists the seven vehicle classes for the study.

**Table 3-9. Vehicle Classes for Traffic Assignment**

| Number | Link Mode | Description | Extra Attribute Name from Assignment |
|---|---|---|---|
| 1 | H | High Occupancy Vehicle (2) | @hov2 |
| 2 | H | High Occupancy Vehicle (3+) | @hov3 |
| 3 | S | Single Occupancy Vehicle | @vauto |
| 4 | b | "B" Plate truck | @vbplt |
| 5 | l | Light Truck | @vlght |
| 6 | m | Medium Truck | @vmed |
| 7 | h | Heavy Truck | @vhevy |

The most recent EMME/3 path-based assignment was utilized with each of the seven vehicle classes cited in Table 3-9 assigned using multi-class procedure by time period. The overall assignment approach allowed integration and analysis of HOV and HOT for 2 or for 3+ persons per vehicle. The path-based assignment also facilitated the saving of assignment results and paths for each time period. These path files allow quick review and analysis of individual assignment runs and are valuable for trouble-shooting model results.

## 3.8 Computational Enhancements

### 3.8.1 Model "Batch" Processing

The recalibration and validation steps implemented in the I-290 model conversion required that the structure of the EMME/3 batch file be revisited and revised. The batch program is designed so that a scenario is prepared after which eight time periods summing to a 24-hour day are assigned in turn. A two databank structure was established for the I-290 work:

1. **Simulation Bank** – the EMME/3 databank that is alternative specific and which holds the base network, eight time of day networks, reports from the model runs, and the zonal data.
2. **Archive Bank** - An archive or "hold" databank, also alternative specific, that captures the current times and trips by purpose and mode in matrix form from each of the five full model iterations.

In the production stage is was determined that separate databanks, copied from the final archived bank for each scenario, were valuable for processing the Transportation System Plan (TSP) reporting as well as the transit results after the .

### 3.8.2 Parallel (Multi-threaded) Standard Traffic Assignment

Revision of the EMME/3 macro approach also allowed a software innovation to be introduced. INRO's EMME/3 assignment called Parallel Standard Traffic Assignment is a multi-threaded implementation of the Standard Traffic Assignment with Fixed Demand that makes use of multiprocessor systems when available. It remains an implementation of the linear approximation algorithm (Frank and Wolfe) equilibrium assignment, hence the same convergence properties as the Standard Traffic Assignment, with the distinction that computing times can be reduced significantly when run on systems with multiple processors. The user is able to select how many threads will be used in the assignment, with each thread corresponding to dedicated use of one processor. This allows users to choose how many processors to dedicate to the parallel traffic assignment and provides the opportunity to leave processors for other concurrent computing needs if desired[xii]. The I-290 model application integrates calls to the multi-threaded EMME/3 module thus enhancing run time and efficiency.

Additional computational enhancements were built during the I-290 process. These included "Hot Starts" streamlining, simultaneous execution of time of day scenario runs, and transit trip assembly and assignment. As the EMME provided updates, staff installed them and integrated the new capabilities of each updated version in the I-290 model.

## 3.9 Model Post Processing

A library of EMME macro scripts was prepared to serve the model runs with a reporting stream allowing error investigation ("trouble-shooting") and monitoring to take place. The batch processing approach was written so that both base and future years could be run with a minimum of reporting file setup changes. Post processing and reporting of the eight time of day periods and the six vehicle types originally included:

- Calculation of average daily vehicle traffic from the sum of single occupancy vehicles, high occupancy vehicles, and four classes of trucks over the eight time periods.

- Calculation of the daily Vehicle Miles Traveled (VMT) for both auto and truck.
- Calculation of the daily Vehicle Hours Traveled (VHT) for both auto and truck.
- Mode split report that facilitates the summary of trips by purpose by auto mode (SOV, HOV2 and HOV3+) and transit.

The evolution of the I-290 model has required expanded reporting protocol. Chief among the expanded reporting is:

- Person throughput for SOV, HOV and transit (three points in the corridor).
- Expanded speed and congestion reports in peak periods.
- Detailed truck reporting, including congested truck miles and hours.
- Refinement of Access to jobs reporting.
- Enhanced transit reporting by mode, cutpoint and Study Area.

# 4.0 2010 Validation of the I-290 Model

## 4.1 Introduction

A review of the I-290 performance with the full set of revised 2010 inputs as well as the model enhancements was conducted. The intent of this section is to validate 2010 I-290 model for its use in 2040 alternatives analysis. The travel model validation topics reviewed were:

1. Regional Level Traffic Validation (Six-County)
2. Peak Period Traffic Validation
3. Volume/Capacity Ratios
4. I-290 Corridor Daily Traffic Validation

## 4.2 Regional Model Validation

The eight time periods established in the CMAP models are summed to a daily vehicle traffic total on each highway segment of the model. This estimated daily traffic can then be compared to observed traffic data (Average Annual Daily Traffic or AADT). There are eight time periods in the I-290 model, including an AM and PM peak. The peaks can also be compared to observed peak traffic, which is useful particularly in the I-290 corridor.

### 4.2.1 Observed Data

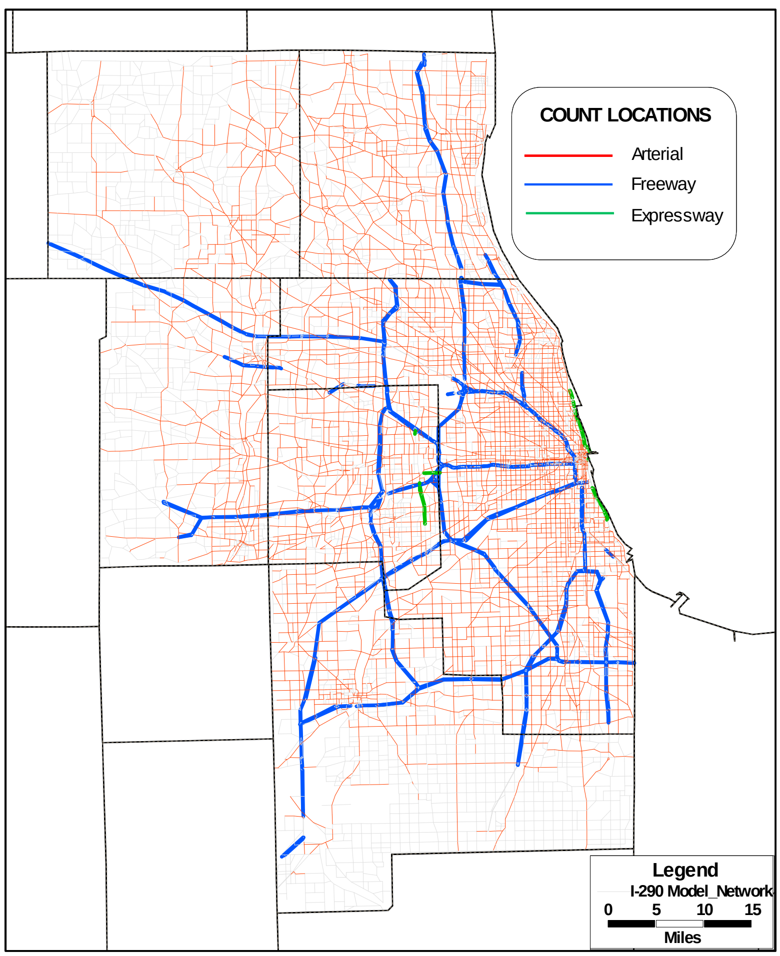
Observed data for the I-290 effort was obtained from CMAP with the ultimate source being the Illinois Department of Transportation[xiii] (IDOT). CMAP staff tabulates, geocodes, and updates the observed traffic data in EMME/3-ready format allowing the analyst to compare the counted links to the model output. Newly tabulated counts were available in 2015 for year 2010. For the I-290 project the count locations within the six county region were used. Over 10,400 link segments are counted in the CMAP model network, 62 percent of all link segments, as shown in Table 4-1. Of the arterial segments, 60 percent are counted. Of the freeway segments, 73 percent are counted. Figure 4-1 shows the locations of the CMAP observed data for the three main classes. Figure 4-2 shows a close-up of the I-290 corridor with count locations.

**Table 4-1. Number of Count Locations by Class (Using VDF Function Group)**

| Link Type | Volume Delay Function | *Count Profile* | | |
|---|---|---|---|---|
| | | Counted Links | Total Links | % Counted |
| Arterial Street | 1 | 8,901 | 14,732 | 60% |
| Freeway | 2 | 732 | 997 | 73% |
| Freeway/expressway ramp from/to arterials | 3 | 595 | 922 | 65% |
| Expressway | 4 | 48 | 88 | 55% |
| Freeway/expressway to freeway/expressway ramp | 5 | 106 | 147 | 72% |
| Link where toll is paid | 7 | 83 | 109 | 76% |
| **Total** | | **10,465** | **16,995** | **62%** |

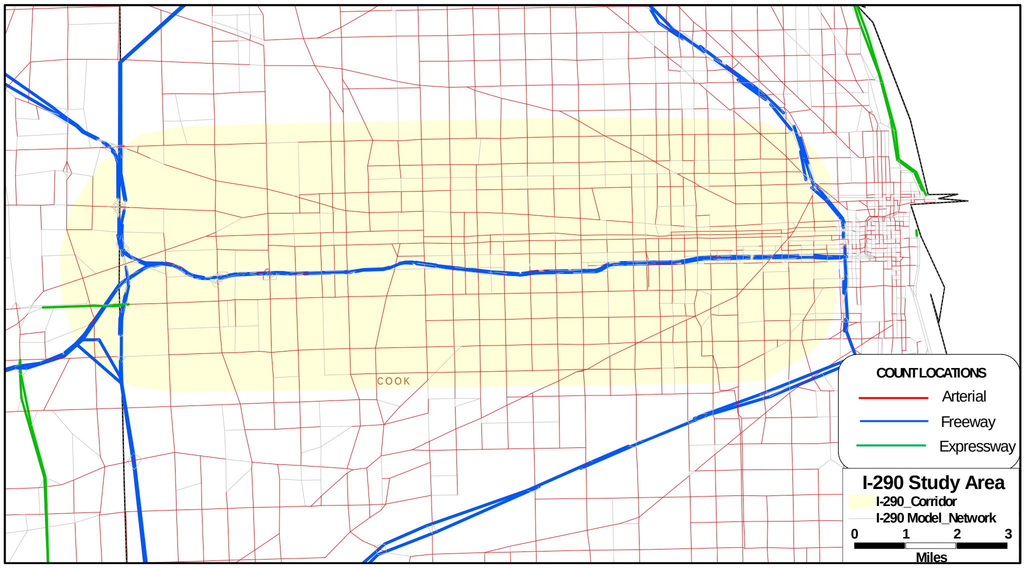
Source: CMAP Highway Network Traffic Counts

**Figure 4-1. Location of CMAP Observed Traffic Data**




Source: CMAP Highway Network Traffic Counts

Figure 4-2. Location of CMAP Observed Traffic Data (Close-up)




Source: CMAP Highway Network Traffic Counts

### 4.2.2 Regional Scale Validation Tests

As mentioned above, validation of the travel model traffic to observed conditions is an important part of establishing a base for alternatives testing. Validation has two levels:

- **Regional Validation** which shows that the model is working at reasonable levels throughout the entire metropolitan area and thus forms a stable platform for a study area such as the I-290.

- **Corridor Validation** which shows that the model is working at very close tolerances to the observed data in a study area and can replicate conditions for the daily as well as the peak periods in a study area.

Although absolute criteria for assessing the validity of all model systems cannot be precisely defined, a number of target values have been developed. Guidance on validation targets is provided by the Federal Highway Administration (FHWA)[xiv] as well as by state DOTs. Observed volumes should be checked by facility type both for the percent traffic difference and for the Root Mean Square Error (RMSE). Freeway and interstate segments should be within +/- 7 percent of the observed traffic. Less heavily traveled roadways have less stringent requirements on their fit to observed traffic. Given a reasonable regional validation result, the travel model is deemed a reliable tool for alternatives testing.

The following validation tests were performed on the I-290 Travel Model to test the daily traffic assignment:

- **All Links Observed and Modeled Traffic Volume Comparison** – This test, which compares the observed and the modeled traffic using observed and counted traffic, is presented by volume class.

- **All Links Percent Root Mean Square Error** – This test, which measures the difference between model volumes and observed traffic counts, is where the variability of the traffic counts is most evident. If the model fit were perfect, the percent root mean square error would be equal to zero. A Percent RMSE value of 35-50 is considered within normal limits. This test is also presented by volume class. Typically the higher volume ranges show lower PRMSE.

Table 4-2 presents the counted and modeled traffic stratified by volume class using one-way traffic. There are eleven volume classes; the lowest volume class covers all facilities with fewer than 10,000 AADT. The highest volume class is all facilities with 100,000 AADT or higher. Note that the percent difference between the observed and modeled ranges from -17 percent to 103 percent. This table shows that the smaller volume facilities do not perform particularly well; they show higher model traffic than observed, the result of including counts from numerous minor arterials in the model network. This difference is attributed to the fact that the arterials carry the traffic for many lower classification facilities which are not included in the model network. Note that the volume class with the poorest performance is composed of facilities carrying less than 10,000 ADT and that the ratio improves as the level of traffic measured grows. This differential is common in demand model results and is acceptable as long as the higher level roadways perform close to the observed levels. This table shows that higher volume facilities do generally operate within the travel model at very close to observed levels. This range of observed to estimated is -11 percent to +4 percent on facilities over 50,000 AADT. The Percent Root Mean Square Error shows that the variability of the model results is very small on these road segments. The total difference of all road segments over 10,000 AADT is 0 percent with a Percent RMSE of 35. PRMSE values in the 35-50 range are considered within the normal limits of MPO validation.

**Table 4-2. Traffic Validation by Volume Class**

| Volume Range | AADT Range (one-way) | # of Records | Counted Traffic (AADT) | Modeled Traffic | Difference | | Root Mean Square Error | Percent RMSE |
|---|---|---|---|---|---|---|---|---|
| | | | | | # | % | | |
| 1 | 0-10,000 | 17,635 | 69,716,375 | 141,354,381 | 71,638,006 | 103% | 5,872 | 149 |
| 2 | 10,000-20,000 | 754 | 9,488,500 | 13,089,740 | 3,601,240 | 38% | 10,440 | 83 |
| 3 | 20,000-30,000 | 214 | 5,213,000 | 4,586,896 | (626,104) | -12% | 13,697 | 56 |
| 4 | 30,000-40,000 | 130 | 4,453,700 | 4,353,668 | (100,032) | -2% | 15,984 | 47 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 5 | 40,000-50,000 | 105 | 4,769,350 | 3,980,848 | (788,502) | -17% | 19,796 | 44 |
| 6 | 50,000-60,000 | 89 | 4,957,450 | 4,899,383 | (58,067) | -1% | 13,677 | 25 |
| 7 | 60,000-70,000 | 114 | 7,447,200 | 7,193,090 | (254,111) | -3% | 13,530 | 21 |
| 8 | 70,000-80,000 | 103 | 7,770,150 | 6,918,280 | (851,870) | -11% | 14,618 | 19 |
| 9 | 80,000-90,000 | 91 | 7,766,450 | 7,216,112 | (550,338) | -7% | 13,762 | 16 |
| 10 | 90,000-100,000 | 64 | 6,026,750 | 5,705,078 | (321,672) | -5% | 12,869 | 14 |
| 11 | over 100,000 | 47 | 5,329,100 | 5,539,495 | 210,395 | 4% | 14,266 | 13 |
| | | | | | | | | |
| **All** | | **19,347** | **132,939,125** | **204,843,595** | **71,904,470** | **54%** | **6,827** | **99** |
| **Volume Range over 10,000 AADT** | | **1,711** | **63,221,650** | **63,482,588** | **260,938** | **0%** | **13,100** | **35** |

Source: CMAP Highway Network Traffic Counts, Parsons Brinckerhoff, Inc. I-290 Model Run for 2010

In summary, regional model validation is a first step to determining if the travel model is a reasonable tool to use within a focused study area. Table 4-2 is consistent in the overestimation of traffic at the lower volume classes, which is expected. The regional numbers show very good results (PRMSE of 35) in the over 10,000 ADT facilities. This result is acceptable at a regional level, particularly if it can be shown that the model will operate at very close tolerances in the study area, for peak periods.

## 4.3 Peak Periods Traffic and Percentage of Daily

Since the peak periods are an important part of the traffic model for I-290 work, the AM and PM observed traffic to the model results were compared. Table 4-3 and Table 4-4 show the observed mainline traffic at six locations during the peak periods in the I-290 study corridor. Observed IDOT peak period definitions are as follows:

- Eastbound Traffic - one hour from 7 to 8 am and 4 to 5 pm
- Westbound traffic – one hour from 8 to 9 am and 4 to 5 pm

The I-290 traffic model peak hours were extracted and compared to the observed IDOT data.

**Table 4-3. AM and PM Model and Observed Traffic on I-290 (Eastbound)**

| I-290 Facility | | Observed (1 hour) | | Modeled (1 hour) | |
|---|---|---|---|---|---|
| **From** | **To** | **AM Peak** | **PM Peak** | **AM Peak** | **PM Peak** |
| Mannheim | 25th Avenue | 5,340 | 5,240 | 6,490 | 6,530 |
| 25th Avenue | 17th Avenue | 5,430 | 5,330 | 6,400 | 6,315 |
| 9th Avenue | IL 171 (1st Avenue) | 5,840 | 5,850 | 6,265 | 6,500 |
| IL 171 | Des Plaines Ave | 6,240 | 6,510 | 6,010 | 6,170 |
| Des Plaines | Harlem | 6,100 | 6,240 | 5,850 | 5,715 |
| Austin | Central | 7,670 | 7,110 | 6,630 | 6,035 |
| Laramie | Cicero | 8,430 | 7,670 | 8,095 | 6,465 |

Source: IDOT 2010 Traffic Counts, Parsons Brinckerhoff, Inc. I-290 Model Run for 2010

**Table 4-4. AM and PM Model and Observed Traffic on I-290 (Westbound)**

| I-290 Facility | | Observed (1 hour) | | Modeled (1 hour) | |
|---|---|---|---|---|---|
| **From** | **To** | **AM Peak** | **PM Peak** | **AM Peak** | **PM Peak** |
| Mannheim | 25th Avenue | 7,130 | 6,790 | 6,225 | 6,360 |
| 25th Avenue | 17th Avenue | 6,980 | 6,700 | 6,220 | 6,445 |
| 9th Avenue | IL 171 91st Avenue) | 6,570 | 6,560 | 6,315 | 6,405 |
| IL 171 | Des Plaines Ave | 6,500 | 6,480 | 6,140 | 6,115 |
| Des Plaines | Harlem | 5,800 | 5,890 | 5,885 | 5,900 |
| Austin | Central | 5,740 | 6,410 | 6,205 | 6,790 |
| Laramie | Cicero | 6,100 | 6,650 | 6,585 | 8,235 |

Source: IDOT 2010 Traffic Counts, Parsons Brinckerhoff, Inc. I-290 Model Run for 2010

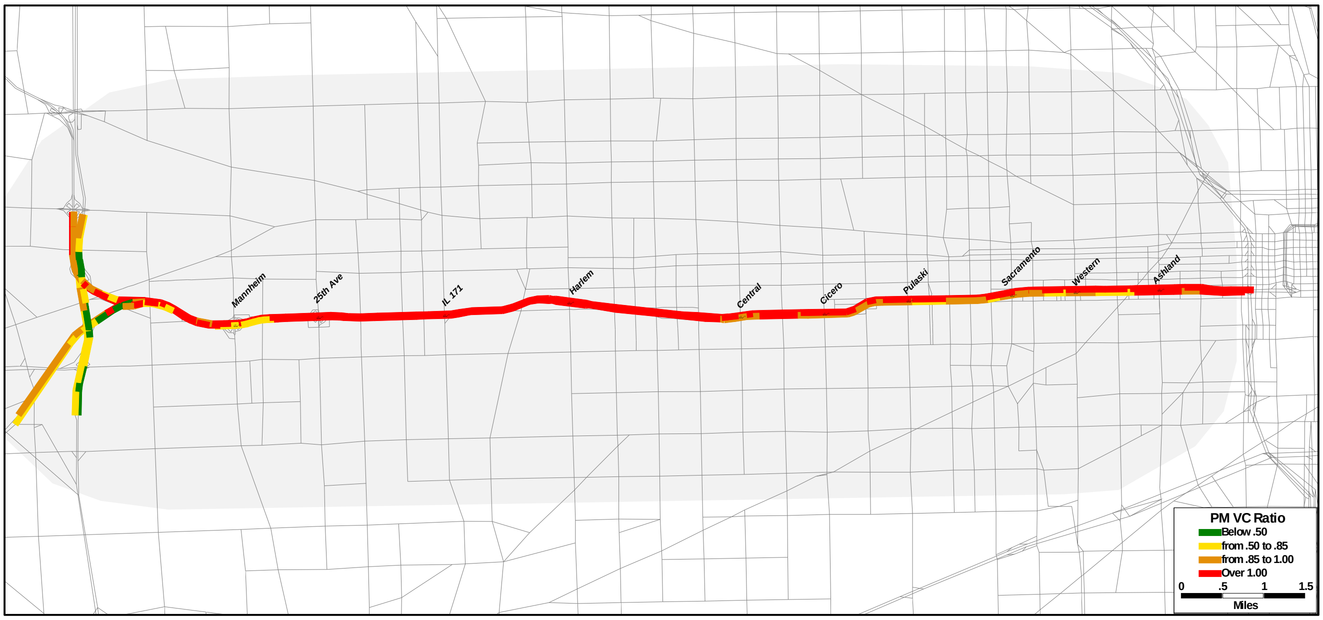
Table 4-3 and Table 4-4 show the following:

- Both observed and modeled traffic show very little directionality; both eastbound and westbound traffic flows are generally very close in magnitude in both the AM and PM peak.
- The volume of traffic produced by the I-290 model is commensurate to observed traffic levels on the I-290 facility for both the one-hour AM and PM peaks.

## 4.4 Peak Period Volume/Capacity Ratio

The volume to capacity ratio (V/C ratio) is defined as the ratio of traffic demand flow rate to capacity. In the CMAP models it may be calculated for each of the eight time periods and is calculated on each link segment of a traffic model. V/C is a planning tool used in this analysis to provide conceptual level views of congestion for the time periods provided in the model. Each time period for the 2010 base was reviewed to demonstrate that the I-290 model was able to capture basic directionality and congestion via the V/C ratio. Figure 4-3 shows the V/C ratio in the PM peak for 2010. Note that I-290 shows PM congestion of over 1.00 in both directions.

**Figure 4-3. Volume/Capacity Ratio for the PM Peak 2010**

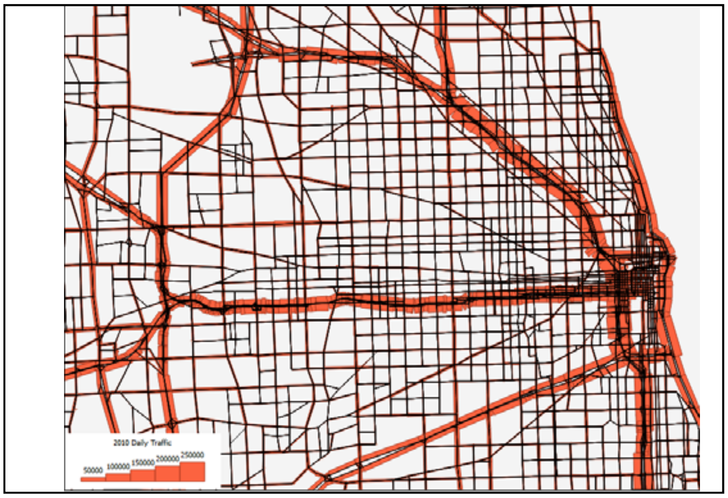



Source: Parsons Brinckerhoff, Inc. I-290 Model Run for 2010

## 4.5 I-290 Corridor

The last topic of validation is the performance of the I-290 daily traffic model in the study corridor. The performance of the model on a daily basis adds understanding of the overall validity of the model. Figure 4-4 is a snapshot of the daily model traffic for the I-290 2010 scenario. The summary attribute is total vehicles in vehicle equivalents. Note that the interstate facilities are heavily traveled, the daily facility directionality is balanced, and the traffic volumes, measured in vehicle equivalents, are in the range of 90,000 to 100,000 in each direction at most points in the I-290 study corridor.

**Figure 4-4. 2010 I-290 Daily Traffic Estimate**




Source: Parsons Brinckerhoff, Inc. I-290 Model Run for 2010

**Table 4-5. I-290 Mainline Traffic Comparison (Observed vs. Modeled)**

| ID | I-290 Facility | | AADT 2012 | Model ADT 2010 | Difference | |
|---|---|---|---|---|---|---|
| | From | To | | | # | % |
| 1 | W of Mannheim | | 187,700 | 208,174 | 20,474 | 11% |
| 2 | Mannheim | 25th Ave | 182,800 | 182,994 | 194 | 0% |
| 3 | E of 25th Avenue | | 182,200 | 182,882 | 682 | 0% |
| 4 | 9th Avenue | IL 171 | 185,700 | 185,729 | 29 | 0% |
| 5 | IL171 | Des Plaines | 182,800 | 189,657 | 6,857 | 4% |
| 6 | Des Plaines | Harlem | 167,400 | 165,331 | -2,069 | -1% |
| 7 | Harlem | Austin | 183,200 | 178,797 | -4,403 | -2% |
| 8 | Austin | Central | 183,200 | 184,920 | 1,720 | 1% |
| 9 | Laramie | Cicero | 204,600 | 200,446 | -4,154 | -2% |
| 10 | Cicero | Kostner | 191,800 | 188,032 | -3,768 | -2% |
| 11 | Kostner | Independence | 200,700 | 200,446 | -254 | 0% |
| 12 | Independence | Homan | 209,200 | 211,754 | 2,554 | 1% |
| 13 | Homan | Sacramento | 210,000 | 205,575 | -4,425 | -2% |
| 14 | Sacramento | Western | 200,500 | 190,664 | -9,836 | -5% |
| 15 | Western | Damen | 208,800 | 205,937 | -2,863 | -1% |
| 16 | Damen | Ashland | 200,500 | 203,633 | 3,133 | 2% |
| 17 | Ashland | Racine | 185,900 | 187,111 | 1,211 | 1% |

| | | | | | |
|---|---|---|---|---|---|
| | **Total** | **3,267,000** | **3,272,082** | **5,082** | **0%** |

Source of AADT: IDOT Traffic Data, 2012, Parsons Brinckerhoff Model Run for 2010

Table 4-5 tabulates seventeen segments of the I-290 corridor comparing 2012 observed traffic counts to the results by segments in the study corridor from west of Mannheim to Racine. The observed data averages about 200,000 AADT throughout the corridor. Estimated (model ADT) difference values range from -5 percent to +5 percent different from the observed data, with the exception of the segment west of Mannheim. There is an overall 0 percent difference in the sum of the segments comparing estimated to observed.

## 4.6 Findings

It has been the intent of **Section 4** to present an overview of validation steps for the I-290 Travel Model demonstrating that it provides a reliable base replicating observed conditions at the regional and corridor level.

- The I-290 model enhancements steps which included major changes in trip rates by purpose, percentage of work trips of all trip purposes, trip distribution structure, average trip lengths, auto occupancy changes, and time of day percentages resulted in a model that replicated regional and I-290 corridor traffic. Based on a set of CMAP counts obtained from IDOT for 2012, the I-290 travel model is performing at a reasonable level compared to regional traffic flows. The ratio of observed to modeled traffic on regional interstates and freeways and the Percent Root Mean Square error are within normal limits for MPO validation.

- The AM and PM peak periods in the model produce traffic levels commensurate with the IDOT observed data.

- I-290 mainline traffic for 2010 averages slightly lower (0 percent) in the model than in the observed 2012 IDOT counts. Estimated (model ADT) difference values by segment range from -5 percent to +5 percent different from the observed data, with the exception of the segment west of Mannheim.

In summary, a detailed travel model customized for I-290 was developed, including constructing a detailed network. The use of recent household survey and other data to re-estimate selected parts of the CMAP models resulted in an updated model that was validated to 2010 then applied to the 2040 study year alternatives.

# References


[i] Parsons Brinckerhoff, *HOV Lane Feasibility Study for the Eisenhower Expressway (FAI-290) from I-294/I-88 to Austin Avenue: Volumes 1-3*, Illinois Department of Transportation, Division of Highway/District 1, July 1998.

[ii] Chicago Metropolitan Agency for Planning. Updated 2030 Regional Transportation Plan for Northeastern Illinois (Reflects all Approved Updates through October 2008). October 9, 2008.

[iii] Christopher, Ed J., Alan R. Fijal, and Anne C. Ghislandi. CATS 1990 Household Travel Survey: A Methodological Overview. Working Paper 94-05. April 1994.

[iv] U.S. Census Bureau. Census Transportation Planning Package 2000 (CTPP2000).

[v] NuStats. Chicago Regional Household Travel Inventory: Draft Final Report prepared for Chicago Metropolitan Agency for Planning. Austin, TX, 2008.

[vi] U.S. Census Bureau. American Community Survey: Design and Methodology (Unedited Version). Economic and Statistics Administration, May 2006.

[vii] http://www.census.gov/geo/www/tiger/, December 8, 2008.

[viii] Illinois Highway Information System Roadway Information & Procedure Manual, July 1, 2001, (with revisions as of November 28, 2006).

[ix] INRO Transportation Modeling software, http://www.inro.ca.

[x] The al Chalabi Group, I-290 Phase 1 Study, Historic and Forecasted Growth of Population, Households and Employment in the Extended Region of Chicago, No Build Market-Driven versus Policy-Based Socio-Economic Forecasts (2010-2014) and I-290 Build Forecasts, June 2014, revised August 2015.

[xi] http://www.bls.gov/cpi/, 2009.

[xii] *INRO, EMME3 Documentation, 2009.*

[xiii] http://www.gettingaroundillinois.com/.

[xiv] FHWA, Calibration and Adjustment of System Planning Models, 1990.

# Appendix B-2

## Historic and Forecasted Growth of Population, Households and Employment in the Extended Region of Chicago

## No-Build Market-Driven versus Policy-Based Socio-Economic Forecasts (2010-2040) and I-290 Build Forecasts

I-290 Eisenhower Expressway Study
Cook County, Illinois

*Prepared for*
Illinois Department of Transportation

*Prepared By:*
ACG: The al Chalabi Group, Ltd.
in association with WSP | Parsons Brinckerhoff

June 2014
Revised September 2016

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# Table of Contents



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# List of Exhibits

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# 1.0 Introduction and Overview

The I-290 Study is among several recently-completed or in-progress transportation projects that have used a market-driven socio-economic forecast developed by ACG: The al Chalabi Group, Ltd. ACG's forecast methodology is similar to that which previously had been used by the regional planning agency, the Chicago Metropolitan Agency for Planning (CMAP), and its predecessor, the Northeastern Illinois Planning Commission (NIPC), until the development of the CMAP GO TO 2040 Comprehensive Regional Plan, in 2010. The CMAP GO TO 2040 Plan adopted a strict Policy-Based approach to forecasting.

This report documents the development of the Market-Driven forecasts that represent the I-290 No Build Scenario, which is described in Section 2.0. A comparison of the I-290 Market-Driven approach to the CMAP approach is presented in Section 3.0. This report then presents the I-290 Build forecast development in Section 4.0. An Epilogue is presented in Section 5.0 that describes the I-290 Forecasts in relation to the CMAP forecasts developed as part of the GO 2040 Comprehensive Regional Plan Update that was completed in 2014.

Year 2040 socio-economic forecasts were developed as part of the I-290 Study. Socio-economic forecasts, including population and employment forecasts, are used as input to the I-290 travel forecasting model. The I-290 travel forecasting model uses the socio-economic forecasts to estimate future traffic and transit usage for use in design, environmental, and financial analyses. The year 2040 was selected as the planning horizon for consistency with the region's metropolitan transportation plan. The metropolitan transportation plan is intended to guide public policy with respect to future infrastructure investment for the next 20+ years for the region. The metropolitan transportation plan is intended to identify an overall framework of major capital projects that are tested for air quality conformity and are within an assumed fiscally constrained scenario. The projects identified as part of the region's metropolitan transportation plan process, which include the proposed project, are consistent with plan goals and essentially represent placeholders that are subject to National Environmental Policy Act (NEPA) studies, including a rigorous analysis of alternatives. The metropolitan transportation plan does not, however, satisfy all of the NEPA planning requirements for implementing an infrastructure project.

As required by NEPA, a major infrastructure project such as I-290 is required at a project level of detail, to undergo:

- An analysis of a "No Build" alternative to define the transportation need. For the I-290 study, the "No Build" is defined as no major improvements in the Study Area; outside of the Study Area, the fiscally constrained major capital improvements contained in the GO TO 2040 Plan are assumed to be in place.
- An analysis of a range of reasonable Build alternatives. As documented in the ongoing I-290 study, a broad range of multimodal (highway/transit mode combinations) alternatives are being evaluated.

- A detailed assessment of the social, economic, and environmental impacts of a proposed action or project. An environmental impact statement (EIS) is being prepared for the proposed project.
- Consideration of environmental sequencing: avoidance, minimization and mitigation.
- Stakeholder involvement: coordination and consultation on every aspect of the NEPA process, including the identification of project needs, evaluation methodologies, and alternatives development and evaluation.

NEPA requires preparation of an EIS for major federal actions that may significantly affect the quality of the human environment. An EIS is a full disclosure document that details the process through which a transportation project is developed, includes consideration of a range of reasonable alternatives, analyzes the potential impacts resulting from the alternatives, and demonstrates compliance with other applicable environmental laws and executive orders. IDOT and FHWA are preparing an EIS for the I-290 Study.

An EIS requires a greater level of travel forecasting model detail than for a long range transportation plan, because of the need for environmental impact evaluation, as well as engineering design and financial analysis, including toll revenue forecasting. The socio-economic forecasts are the main input to the travel forecasting model, and should therefore reflect current available land use and socio-economic conditions, historic trends for the Study Area, and pending development and redevelopment proposals, particularly those that will exceed regulatory limits on density or other factors.[1] The I-290 socio-economic forecasts, which are market driven, are consistent with these requirements.

The No Build Scenario excludes all major capital projects in the Study Area to determine No Build conditions. The No Build Alternative serves as a benchmark against which the transportation needs are defined and the Build Alternatives are compared. To analyze the No Build Alternative, as well as the Build Alternatives for the proposed project, corresponding 2040 socio-economic forecasts are required.

Section II presents the Market-Driven No Build socio-economic forecasts developed for the proposed project. The ACG Market-Driven forecasts (i.e. No Build) were prepared in 2011 through 2013 in close collaboration with CMAP. Over this period, ACG: The al Chalabi Group, Ltd. conferred with CMAP staff in its development of a Market-Driven socio-economic forecast. Because it was intended for use in multiple projects, forecasts were prepared for the extended (21-County, three-state) Chicago Metropolitan Area. This Market-Driven forecast accepts and incorporates the 2040 total population (and corresponding household and employment) forecasts for the CMAP region; but, it differs in the distribution of those forecasts. The collaboration with CMAP staff was intended to establish the ground rules for developing an

[1] Interim Guidance on the Application of Travel and Land Use Forecasting in NEPA, Federal Highway Administration, March 2010.

alternative, but complementary, forecast for the seven-county CMAP portion of the region. These ground rules, as set by CMAP staff[2], are:

- Articulate alternative assumptions.
- Show the math.
- Produce standard outputs (required for CMAP regional travel models).

This report describes those steps, as initially employed by ACG/Parsons Brinckerhoff, Inc., in the No Build scenario for the Project Corridor, whose direct impact area includes portions of the CMAP planning region. As the CMAP transportation demand model covers 21 counties in Illinois, Indiana and Wisconsin; and as these forecasts were intended for use in multiple projects, the ACG Market-Driven forecasts were generated for the entire 21-Counties CMAP modeling area. The CMAP population forecast was accepted as a control total.

The Market-Driven socio-economic forecasts, by subzone, for the I-290 No Build Alternative scenario, as well as various build alternatives scenarios, were generated by ACG: The al Chalabi Group, Ltd., in accordance with the provisions of a subcontract with Parsons Brinckerhoff, Inc., dated July 20, 2011. The ACG subzone forecasts were based on ACG-generated Market-Driven (trends) township forecasts. The distribution of the township forecasts to subzones considered, among other factors, the distribution of the NIPC/CMAP 2030 forecasts developed under the agency's quasi Market-Driven (trends) methodology; forecasts developed for Kankakee County; forecasts prepared for Northwest Indiana counties, and forecasts prepared for the Rockford metropolitan area.

The Market-Driven forecasts were also based on 2010 Census data, 90 years of historic population and employment data for the region, current and previous regional socioeconomic forecasts, land availability for development, population holding capacity, demographic data and trends (household size, migration patterns, etc.), local land use policies, and independent Woods & Poole economic forecasts. The I-290 market-based forecasts take into account the recognizable and well-documented pattern of growth of an urban area outward from a central core, incorporating existing older towns and creating new centers at nodes of high accessibility.

As prescribed by NEPA, the I-290 market-driven No Build socio-economic forecast takes into account the transportation improvements that are committed (included in the region's Transportation Improvement Program). The No Build socio-economic forecasts also excludes all major capital projects within the Study Area (no I-290 capacity improvements or CTA Blue Line Extension), while taking into account the fiscally constrained major capital projects outside of the Study Area.

The I-290 No Build socio-economic forecasts were used in development of the project's Purpose and Need. This forecast, which is "alternatives neutral" was also used for the evaluation and

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[2] "CMAP Forecast Principles for data users and forecast developers", Chicago Metropolitan Agency for Planning, April 2011.

screening of preliminary alternatives in Round 1 Single Mode Alternatives Evaluation and Round 2 Combination Mode Alternatives Evaluation described in Sections 2.3 and 2.4 of the DEIS. Rounds 1 and 2 included 30 alternatives, which made individual forecasting for each alternative impractical.

Section 3.0 describes the differences between the CMAP Policy-Based forecasting approach and the I-290 Market-Driven approach, and why the Market-Driven approach was selected for use in the I-290 Study. CMAP's approach for the GO TO 2040 Plan was to integrate land use and transportation policy that resulted in a "policy-based plan (dealing with the investments and high-level choices that shape our region) as opposed to a land use plan (dealing with specific types of development in specific locations)."[3] Policy-based forecasts are designed to re-direct growth to achieve the desired outcome. The scenario-driven, policy-based socio-economic forecasts reflect the plan's desired outcome (i.e. the Preferred Scenario) and assume that the recommended policies will be in place by 2040 in order to achieve these. The Preferred Scenario promotes infill and reinvestment as the primary policy drivers and integrates the socioeconomic and land use assumptions with a fiscally constrained set of transportation improvements intended to support regional planning goals.

As background, the method used by CMAP to develop the 2040 population and employment forecasts was a radical departure from previous forecasting practices in the region. Prior to the GO TO 2040 Plan, the socio-economic forecasting practice in northeastern Illinois was based on municipal and county consultation, historic trends, local land use policies, local development proposals, available land for development, and regional and county level control totals, in a "market-based" approach. This prior socio-economic and land use methodology and forecast was adopted as the planning baseline for the region and used for major project development and for the long range transportation plan.

Due to the following considerations, the CMAP GO TO 2040 Plan socio-economic forecasts were not used for the NEPA process for the I-290 Study:

- While CMAP's socio-economic forecasts represent its "preferred regional scenario" for development, the agency recognizes that the implementation of its vision relies on a multitude of decisions made at different levels of local, state and federal government. CMAP does not have authority to implement local land use plans. The authority over local land use resides with local government. Local zoning ordinances often do not allow the type of high density redevelopment proposed in the CMAP GO TO 2040 Plan, so that the redevelopment in these fully-developed areas is not likely, given current local policies and prevailing market conditions.
- At the time the proposed project was initiating its socio-economic forecast development, 2010 Census results had just been released. However, CMAP chose not to update its GO TO 2040 socio-economic forecasts when the 2010 Census results became available, instead

[3] CMAP GO TO 2040 Comprehensive Regional Plan, October 2010, page 26.

basing its forecasts on 2009 estimates of the 2010 results.[4] Significantly, the actual 2010 Census showed a substantially lower population (nearly 200,000 persons) in the City of Chicago than the 2009 estimate used by CMAP. CMAP updated their socio-economic forecasts in 2014 to reflect the 2010 Census results as part of the GO TO 2040 Plan Update.

- The CMAP 2040 policy-based socio-economic forecasts were completed prior to identifying the fiscally constrained major capital transportation projects. Following the adoption of its GO TO 2040 Plan, which contained its recommended fiscally constrained major capital transportation projects, including the proposed project, CMAP opted not to revise its socio-economic forecasts. The implied assumption was that the policy-based forecasts, which reflected the desired development, would be the same regardless of which major transportation projects were included in the plan. Although the CMAP 2040 Preferred Scenario represents a Build scenario, it is not necessarily reflective of the effects of all individual major capital transportation projects.
- CMAP also prepared a "Reference Scenario" as a baseline during the early stages of the development of the GO TO 2040 Plan. Because the policy direction of GO TO 2040 had not yet been established, the Reference Scenario assumed continuation of current socio-economic and land use trends and no additional transportation improvements by 2040. The Reference Scenario, which is essentially a "no plan" scenario, does not reflect a No Build scenario, as it does not assume any major capital projects outside of the Study Area for the entire planning period.
- Recognizing that all of the intended policy-based results may not materialize, CMAP anticipated and supported the need for major project alternative socioeconomic forecasts as outlined in CMAP's Forecasting Principles.[5] CMAP staff concurred with the methodology utilized for developing the I-290 forecasts.[6]

In summary, IDOT concluded that a strict policy-based forecast, such as CMAP's 2040 socio-economic forecast, was not appropriate for evaluating specific transportation facilities, because it is aspirational in nature, does not directly address population and employment differences between No Build and Build scenarios, and relies on assumptions of redevelopment in mature areas. IDOT determined that a refined market-based forecast, similar to the type of forecasts historically prepared by CMAP, was required in order to provide the most appropriate traffic forecasts for use in the design, environmental analysis, and potential toll revenue forecasting for transportation improvements for the Study Area. In addition, with the potential for tolling options for the project, any potential toll and revenue evaluations needed to finance a project will require investment-grade forecasts. Lenders and bonding agencies are typically reluctant to assume that goal-based, policy-driven recommendations will be entirely effective in the face of

[4] CMAP itself explains that "[t]he 2010 estimates used as the base for the 2040 forecast were internally-derived and not based on 2010 Census data, which were not available during the GO TO 2040 process." https://www.cmap.illinois.gov/data/demographics/population-forecast.

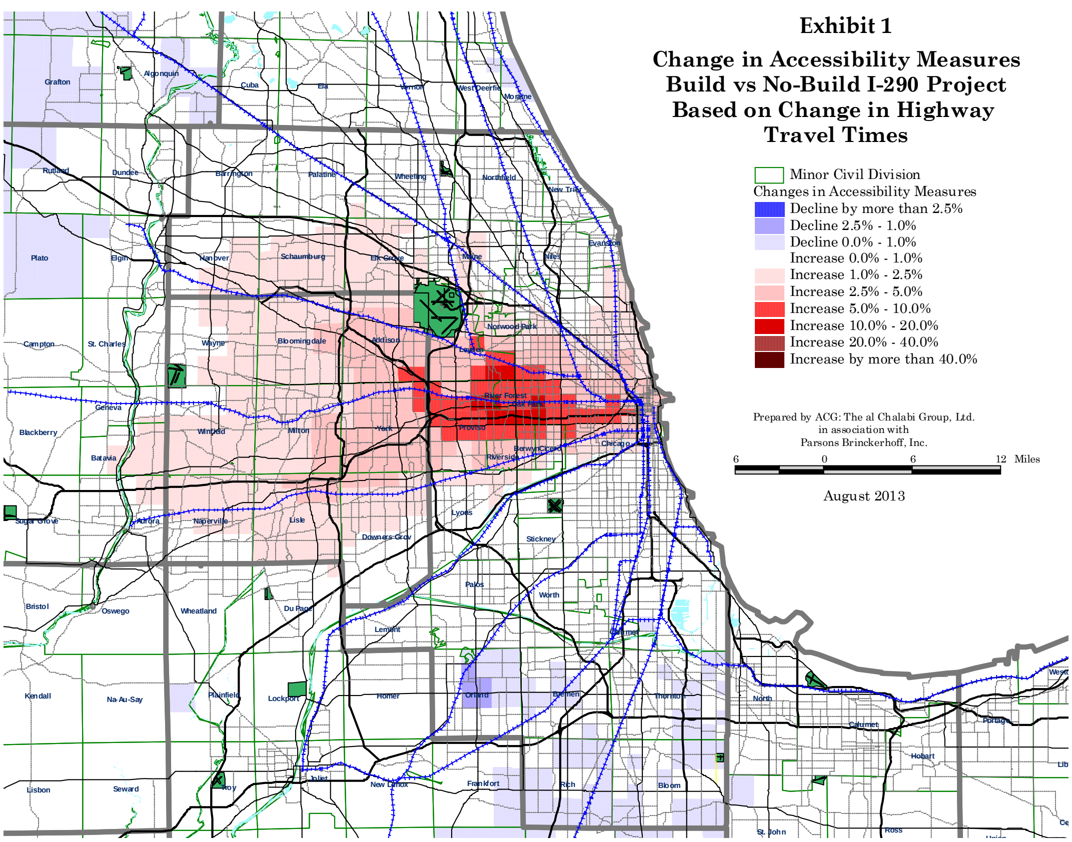
[5] "CMAP Forecast Principles for data users and forecast developers", Chicago Metropolitan Agency for Planning, April 2011 at http://www.cmap.illinois.gov/documents/10180/13313/CMAP-Forecast-Principles_10-16-12_REV.pdf/0dcb43a9-819a-4e03-80b5-ca79f3550a88.

[6] December 1, 2011 e-mail from CMAP to ACG.

*laissez-faire* market economics. The Illinois Tollway has developed a similar market-based socio-economic forecast approach for use in their toll revenue studies.

Section IV describes the development of the I-290 Build Scenario, which was used in the Round 3 DEIS Alternatives evaluation (described in Section 2.5 of the DEIS). The Build Alternatives for the I-290 DEIS are combinations of highway and transit improvements, including managed lanes, the CTA Blue Line Extension (or similar high capacity transit facility), and other transit, roadway, and non-motorized improvements.

The introduction of Build Alternative transportation improvements in the Study Area results in changes in regional accessibility, which directly effects population, household and employment forecasts. The improvement of access to developable or redevelopable sites increases the development potential of those sites, attracting development (residential, commercial/industrial, institutional) that may have occurred elsewhere in the region. Exhibit 1 graphically depicts the improved highway travel times resulting in the Build Alternative versus the No Build Alternative. As seen in this graphic, there are highway travel time improvements in the City of Chicago, suburban Cook County, and DuPage County resulting from the Build Alternative.




Because the I-290 Build scenario includes both highway and transit improvements, it was determined that composite accessibility effects should be used to measure changes in accessibility for the Build scenario. The percent change in accessibility was applied to changes in household and employment forecasts (2010-2040) to generate the impact of the Build transportation improvement. It should be noted that the sum total of positive impacts (more growth) is set to equal the sum total of negative impacts (lesser growth). The implication of this assumption is that total overall regional growth (within the transportation modeling region) is unchanged – i.e. transportation improvements result in the redistribution of socio-economic activities rather than generating additional regional growth. This assumption has been imposed, by IDOT and Federal agencies, on Build/No Build analyses to discourage the generation of exaggerated benefits for any given project. It is true that some major transportation projects do result in an increase in the accessibility of the region, as a whole; such projects may imply additional growth for the region. However, the Build/No Build analysis guidelines do not allow for changing the regional growth totals. The Build/No Build analysis is intended to measure only the redistribution impacts of the project.

Exhibits 2 and 3 show the impact of the Highway Component of the I-290 Build Alternative on the redistribution of 2010-2040 population and employment growth, whiles Exhibits 4 and 5 show the impact of the Transit Component of the I-290 Build Alternatives. These figures show that the Highway Component of the I-290 Build Scenario has a greater impact on population and employment growth than the Transit Component of the Build Scenario due to the greater improvement in accessibility from the highway improvements.

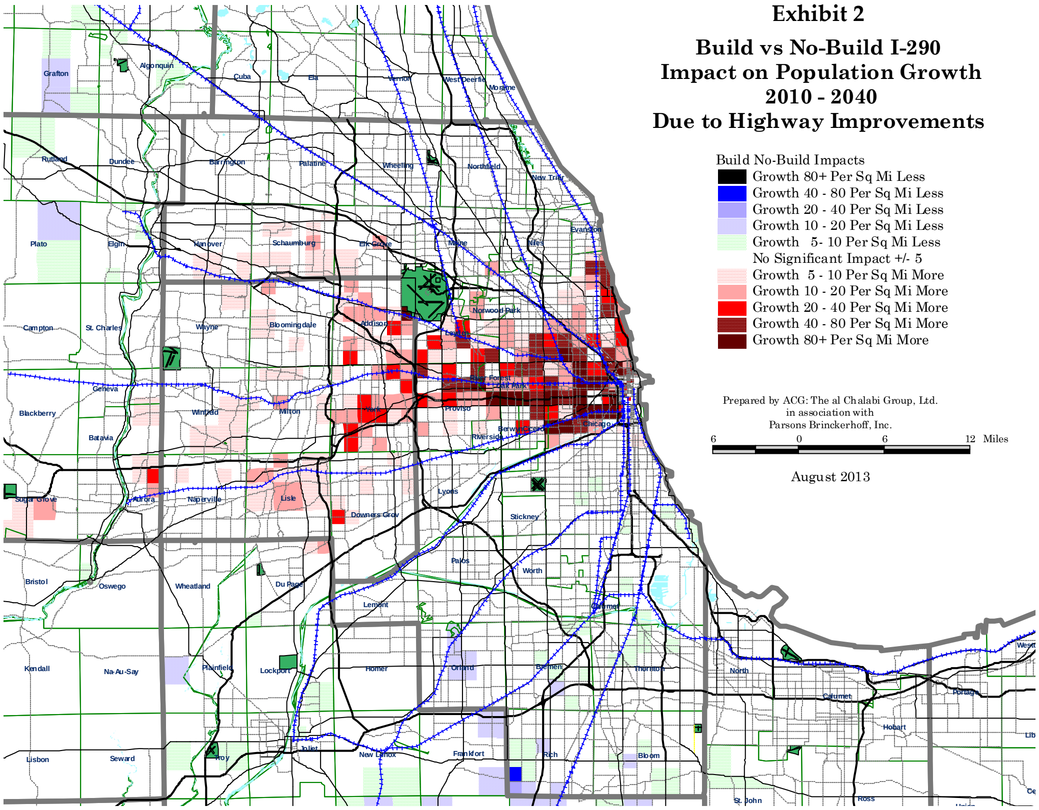



**Exhibit 2**

**Build vs No-Build I-290**
**Impact on Population Growth**
**2010 - 2040**
**Due to Highway Improvements**

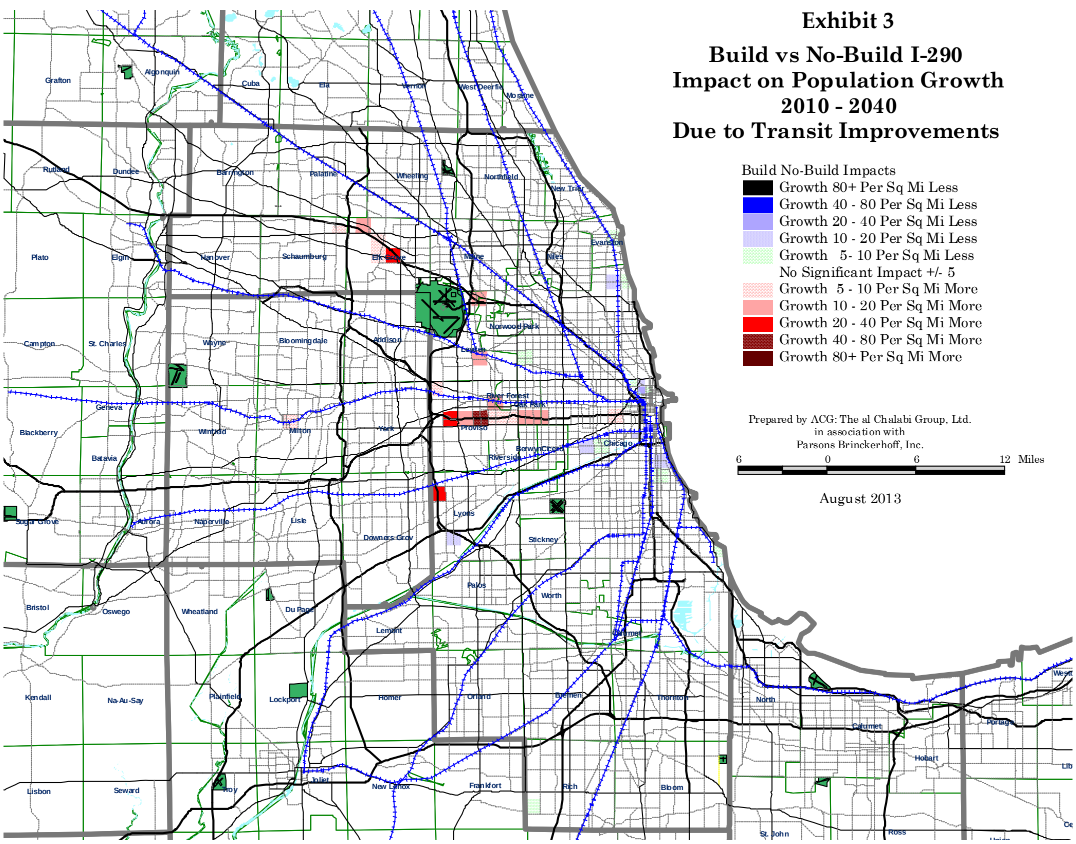



**Exhibit 3**

**Build vs No-Build I-290**
**Impact on Population Growth**
**2010 - 2040**
**Due to Transit Improvements**

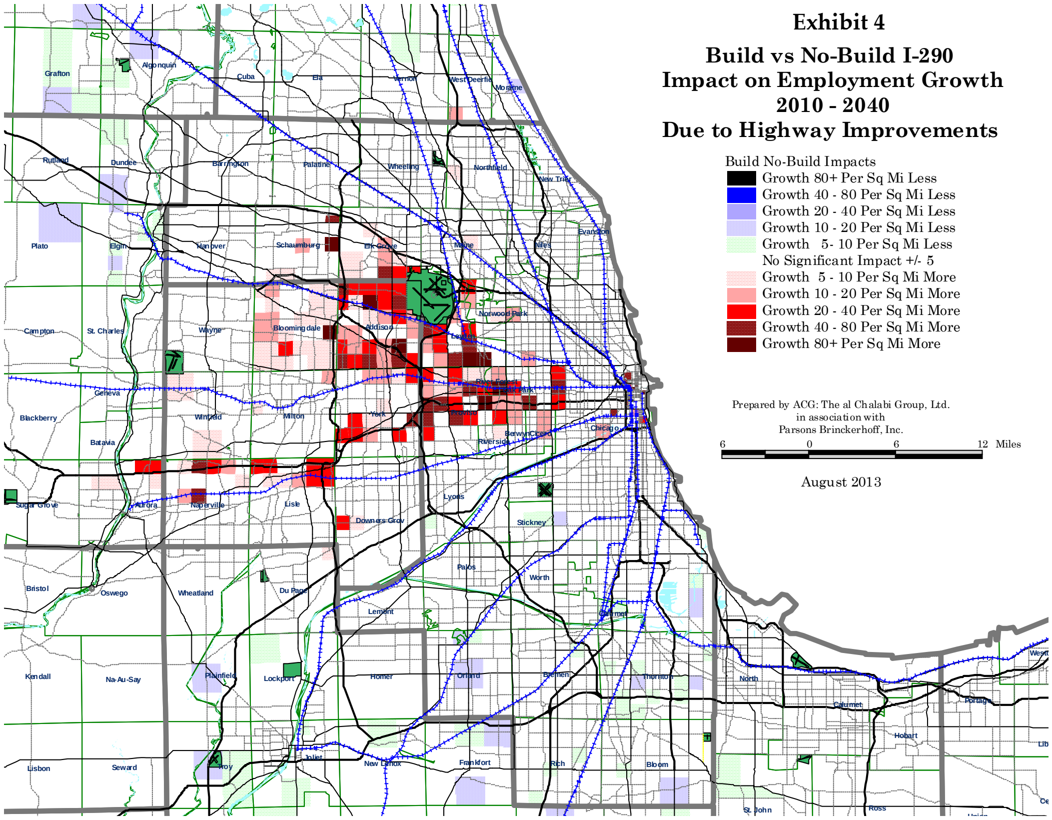


Exhibit 4
Build vs No-Build I-290
Impact on Employment Growth
2010 - 2040
Due to Highway Improvements
Build No-Build Impacts
Growth 80+ Per Sq Mi Less
Growth 40 - 80 Per Sq Mi Less
Growth 20 - 40 Per Sq Mi Less
Growth 10 - 20 Per Sq Mi Less
Growth 5- 10 Per Sq Mi Less
No Significant Impact +/- 5
Growth 5 - 10 Per Sq Mi More
Growth 10 - 20 Per Sq Mi More
Growth 20 - 40 Per Sq Mi More
Growth 40 - 80 Per Sq Mi More
Growth 80+ Per Sq Mi More
Prepared by ACG: The al Chalabi Group, Ltd.
in association with
Parsons Brinckerhoff, Inc.
6 0 6 12 Miles
August 2013

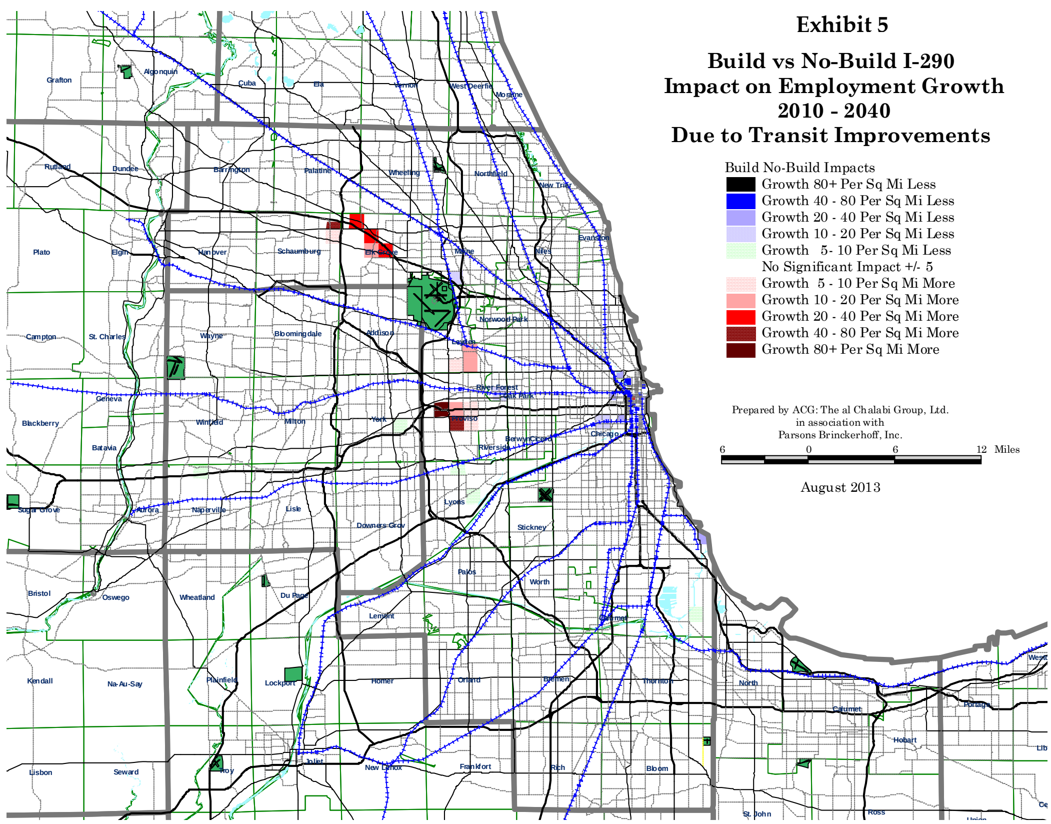


Exhibit 5
Build vs No-Build I-290
Impact on Employment Growth
2010 - 2040
Due to Transit Improvements
Build No-Build Impacts
Growth 80+ Per Sq Mi Less
Growth 40 - 80 Per Sq Mi Less
Growth 20 - 40 Per Sq Mi Less
Growth 10 - 20 Per Sq Mi Less
Growth 5- 10 Per Sq Mi Less
No Significant Impact +/- 5
Growth 5 - 10 Per Sq Mi More
Growth 10 - 20 Per Sq Mi More
Growth 20 - 40 Per Sq Mi More
Growth 40 - 80 Per Sq Mi More
Growth 80+ Per Sq Mi More
Prepared by ACG: The al Chalabi Group, Ltd.
in association with
Parsons Brinckerhoff, Inc.
6 0 6 12 Miles
August 2013

A comparison of the resulting Study Area 2040 population and employment forecasts is shown in Table 1. As seen in this table, the Study Area population and employment forecasts for the No Build versus Build Scenario show less than one percent change. This is due to the existing built-out urban conditions in the Study Area and that the I-290 Study reflects improvements to an existing facility that already provides accessibility to the Study Area.

**Table 1. Comparison of 2040 I-290 Study No Build and Build Forecasts**

| Forecast | 2040 No Build | 2040 Build | Change |
|---|---|---|---|
| Population | 649,215 | 651,912 | 0.4% |
| Employment | 309,334 | 310,967 | 0.5% |

Given the less than one percent difference in population and employment between the No Build and Build Scenarios, it was determined that a single Build Scenario could be used for the four DEIS Build Alternatives. The four DEIS Build Alternatives have nearly identical physical transportation improvements, with the primary difference among alternatives being operational – how the fourth lane in each direction is managed and if there is tolling. The HOV 2+ Alternative was used to develop the highway and transit travel times for use in determining the composite accessibility for the 2040 Build Scenario, because it represents a middle ground or operation control in terms of lane management.

Section 5.0 reflects the updated CMAP 2040 socio-economic forecasts developed for the GO TO 2040 Plan Update (2014). The updated CMAP forecasts are closer, but still higher, than the I-290 forecasts for the City of Chicago (+1.8%), Suburban Cook County (+4.8%), and DuPage County (+8), which are the main travel markets for the I-290 Corridor.

A comparison of the Study Area 2040 population and employment forecasts was performed, as shown in Table 2. As seen in this table, the Study Area population forecasts for CMAP and the I-290 EIS are within one percent of each other.

**Table 2. Comparison of 2040 Study Area Socio-Economic Forecasts**

| Forecast | 2040 Population | 2040 Employment |
|---|---|---|
| CMAP Updated Forecast | 645,950 | 256,590* |
| I-290 No Build Forecast | 649,215 | 309,334** |
| I-290 Build Forecast | 651,912 | 310,967** |

* IDES employment definition ** BEA employment definition

# 2.0 Market-Driven Socio-Economic Forecasts - “No-Build” Scenario

## A. Transportation Network Assumptions

The 2040 Market-Driven No Build baseline socio-economic forecasts reflect 2040 conditions assuming no I-290 Eisenhower Expressway improvements (no additional lanes on I-290) and no high capacity transit extension to the west of the CTA Blue Line Forest Park Branch (no Blue Line extension) within the Study Area. The 2040 No Build baseline socio-economic forecasts do assume the implementation of fiscally constrained major capital transportation projects included in the metropolitan transportation plan for the region outside of the Study Area, and the Transportation Improvement Program for the region.

Since the adoption of the metropolitan transportation plan in 2010 by the MPO Policy Committee, the Jane Byrne Interchange (formerly the Circle Interchange) and the Illiana Corridor were amended into the metropolitan transportation plan in 2013. The metropolitan transportation plan was updated and adopted by the MPO Policy Committee in 2014 and included these two major capital projects. The I-290 socio-economic forecasts were based on the metropolitan transportation plan (2010) and did not account for the two projects. The Jane Byrne Interchange project is improving the existing interchange by adding capacity to existing ramp connections, with no substantive access changes. Given the small change in population and employment for the Study Area in the 2040 Build condition versus the No Build for the proposed project, which also maintains existing access, but provides a substantial increase in mainline capacity, the ramp capacity improvements at the Jane Byrne Interchange would have a negligible effect on population and employment since the project is of a smaller scale with regards to increased capacity. The Illiana Corridor is approximately 40 miles south of the I-290 Corridor and serves an entirely different travel market, including long distance inter-state truck trips. The regional population and employment changes may be greater for the Illiana Corridor, as it is a proposed new toll road, but the effects on accessibility will typically diminish as you move away from the facility. With the I-290 Corridor 40 miles away from the Illiana Corridor, changes in population and employment with respect to the proposed project would be relatively minor.

## B. Population, Households and Employment Forecasts - General Approach

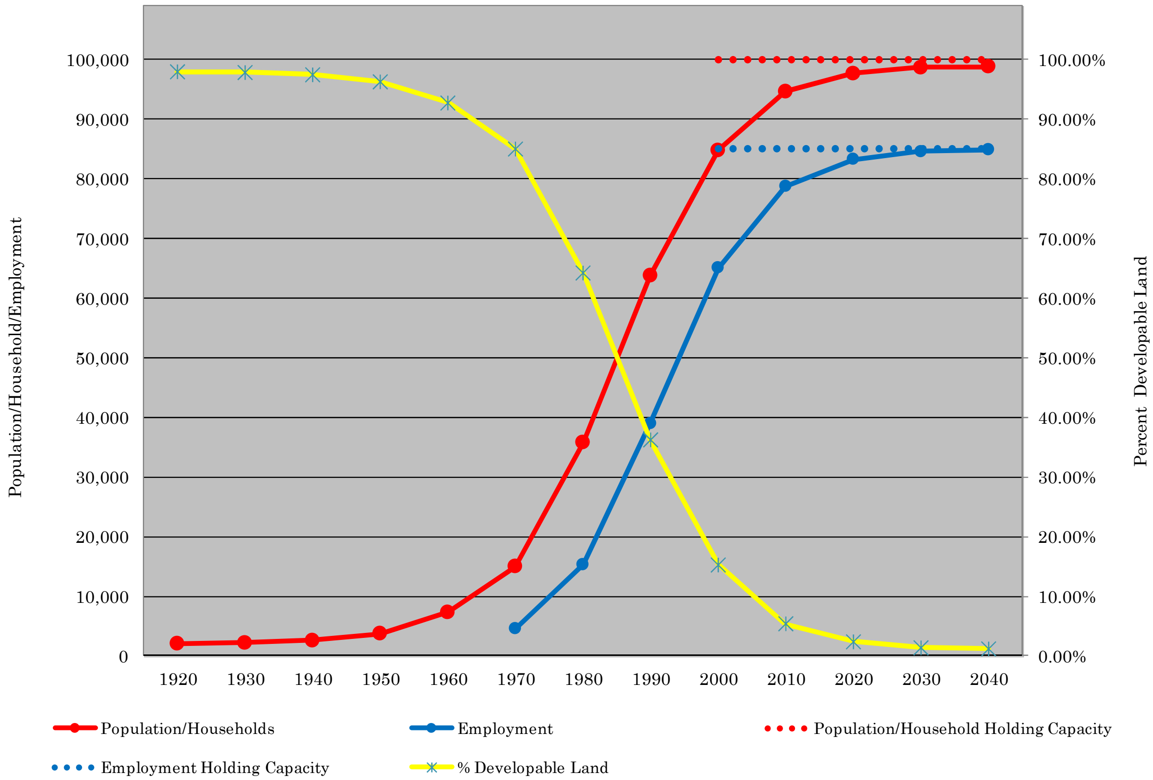
Population, households, and employment are the three most-important variables used in the socio-economic forecasts for transportation planning. To understand the growth dynamics of these three variables, it was necessary to review the development history of the region and to identify the factors that caused its spatial growth and development. National and regional economic factors: transportation networks (rail, port, expressway and airport), infrastructure development, and land availability were identified, early, as being critical. Forecasts by CMAP, supplemented by Woods & Poole Economics, were accepted as regional control totals. Local land use plans and regional land use policies were analyzed to establish the township holding capacities for population, households, and jobs. The township was the major planning unit; its totals aggregated to the County; and its details examined at the quarter-square mile level.

From these preliminary analyses, a Standard S-Curve (or logistics curve) was used to describe historic growth, take-off development, and maturity at the township level; an S-Curve describing land availability and holding capacities describes its inverse. The theoretical basis of the Market-Driven forecasts is as follows:

- Township population, household and employment growth progress through several phases:
  - Initial farming base
  - Take-off phase
  - Growth period
  - Maturity/stability
  - Opportunities for redevelopment
- Development follows a logistics function shaped by:
  - Location
  - Time/technology
  - Density/plan/zoning
  - Available land

A representation of this function – a Standard Logistics S-Curve – is shown in Exhibit 6, below. It should be noted, that the use of the S-Curve to explain population and/or household growth and forecasts, within physically-defined boundaries, dates back to the mid-nineteenth century. This formulation has gained popular acceptance, recently, among planners. However, before accepting and applying it to generate Market-Driven forecasts, it had to be tested against long-term trends, at the township level, in Northeastern Illinois – for which historic demographic, economic and land use data are available.

**Exhibit 6**
**The Standard Logistics S-Curve**




## C. Population and Employment Forecasts – Defining the Methodology

The process of metropolitan area development and suburbanization are fairly well-known and understood. The growth of an urban area – outward from a central core, incorporating existing older towns, and creating new centers at nodes of high accessibility – follows a generally-recognizable and well-documented pattern.

This process and its general pattern are tempered by four major factors:

- Technology at the time growth is occurring – in terms of transportation, manufacturing and construction.
- The underlying economy of the nation and region, plus impacts of a global economy.
- Societal preferences for, and ability to afford, densities and amenities in both residential and commercial developments.
- The siting and construction of major growth magnets – airports, universities, research facilities, corporate headquarters/campuses, regional commercial/office/medical centers, logistics centers.

There are additional demographic trends which are major factors in prompting density changes. These include:

- Family or household size
- Household income levels
- Jobs per household
- Ethnic characteristics and immigrant levels

The process and the first three factors, above, are addressed directly in this study. The fourth is addressed, indirectly, at the township level, and through past immigrant (international and domestic) trends at the county/sub-county levels. All four factors affect density levels utilizing or passing through existing structures, as well as creating demand for new.

Whatever the rate of change or density of development, growth within a county, a township, or a smaller unit ultimately reaches a point at which it can no longer continue unimpeded. The ACG research estimates that this is the point at which: available, vacant land, at the county level, has fallen to approximately three-to-five percent; and land, at the individual township level, has declined to one-to-three percent.

## D. Historical Growth of the Region and its Influence on Long-Range Development

As previously stated, a region's growth follows generally-recognizable patterns. Documenting the Greater Chicago Region's historic growth, therefore, was a crucial element in this analysis. Exhibits 7 through 15 show the population change, by township, for each decade, starting in 1920 and ending in 2010. The outward growth of the region; the influence of transportation facilities; and the phases of growth relative to regional job centers and economic conditions can be clearly identified.

It should be noted, that Exhibit 15 reflects the final results of the 2010 Census. Prior to this report, the U.S. Bureau of the Census had been releasing annual population estimates, by township, since the prior decennial Census. The actual 2010 Census population differed from the 2009 estimate, including:

- Substantial decrease in the City of Chicago, where growth was anticipated and expected during the last few years of the decade;
- Higher growth in the region's fringe; and
- Lower growth in the maturing townships, except for those receiving immigrant groups.

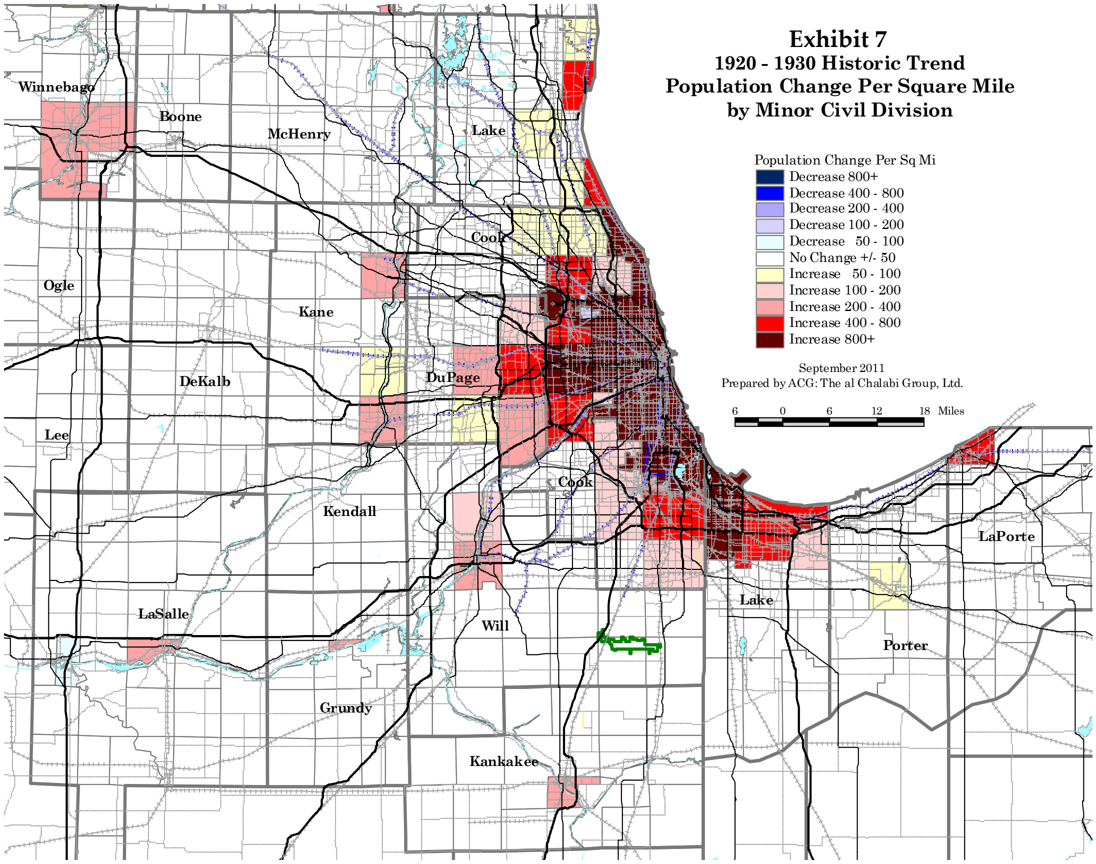


Exhibit 7
1920 - 1930 Historic Trend
Population Change Per Square Mile
by Minor Civil Division
Population Change Per Sq Mi
Decrease 800+
Decrease 400 - 800
Decrease 200 - 400
Decrease 100 - 200
Decrease 50 - 100
No Change +/- 50
Increase 50 - 100
Increase 100 - 200
Increase 200 - 400
Increase 400 - 800
Increase 800+
September 2011
Prepared by ACG: The al Chalabi Group, Ltd.
6 0 6 12 18 Miles
Winnebago
Boone
McHenry
Lake
Cook
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DeKalb
DuPage
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LaPorte
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LaSalle
Will
Porter
Grundy
Kankakee

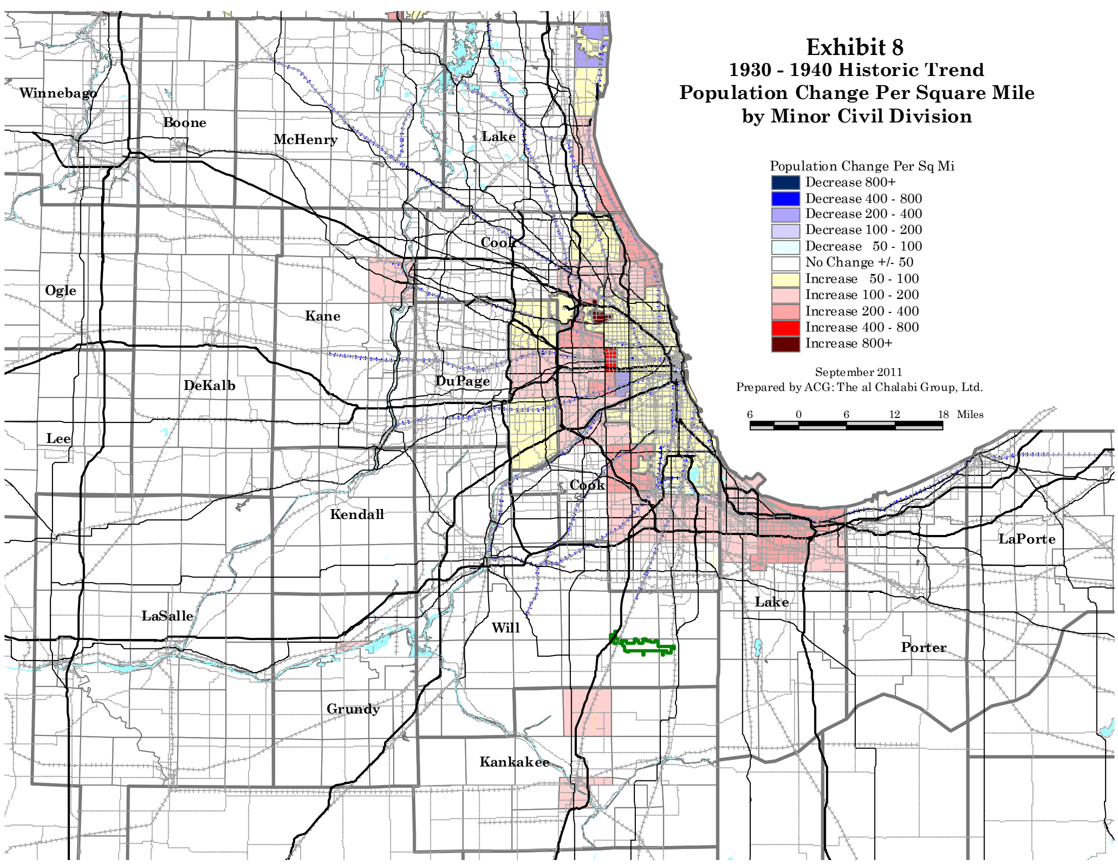
Exhibit 8
1930 - 1940 Historic Trend
Population Change Per Square Mile
by Minor Civil Division
Population Change Per Sq Mi
Decrease 800+
Decrease 400 - 800
Decrease 200 - 400
Decrease 100 - 200
Decrease 50 - 100
No Change +/- 50
Increase 50 - 100
Increase 100 - 200
Increase 200 - 400
Increase 400 - 800
Increase 800+
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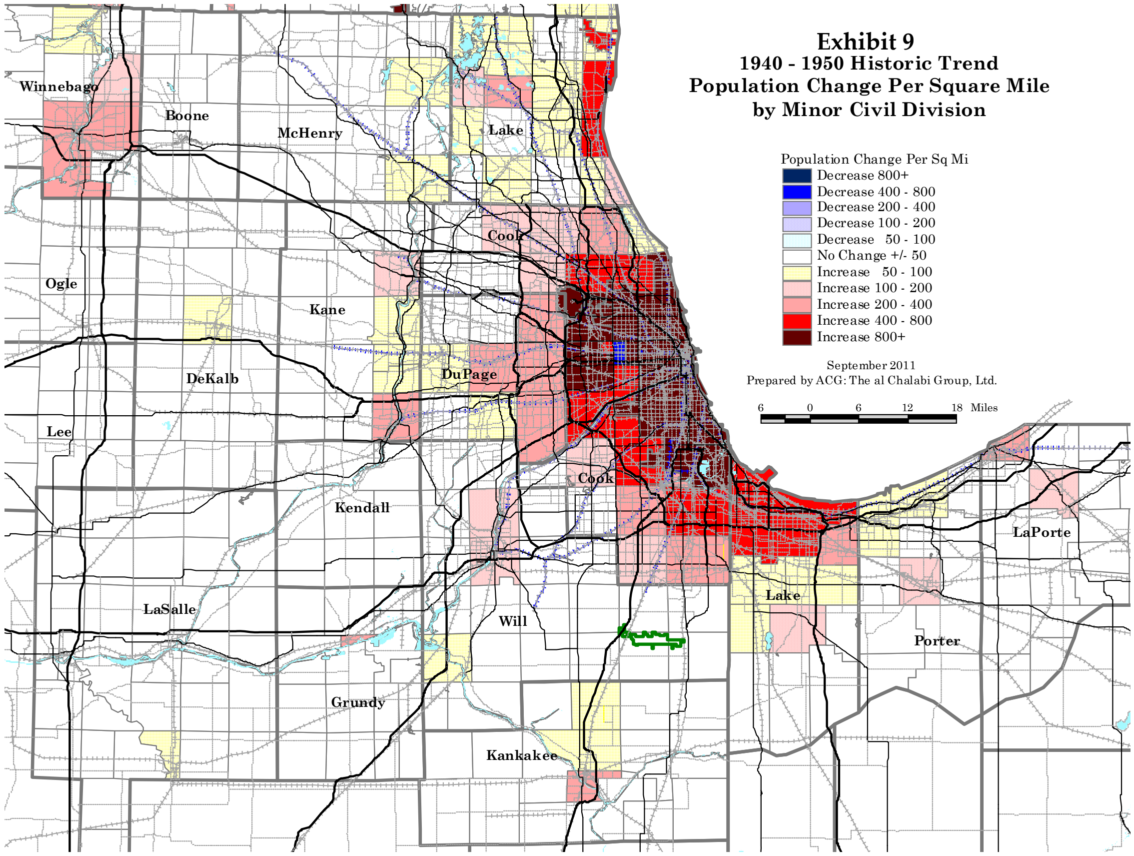
Exhibit 9
1940 - 1950 Historic Trend
Population Change Per Square Mile
by Minor Civil Division
Population Change Per Sq Mi
Decrease 800+
Decrease 400 - 800
Decrease 200 - 400
Decrease 100 - 200
Decrease 50 - 100
No Change +/- 50
Increase 50 - 100
Increase 100 - 200
Increase 200 - 400
Increase 400 - 800
Increase 800+
September 2011
Prepared by ACG: The al Chalabi Group, Ltd.
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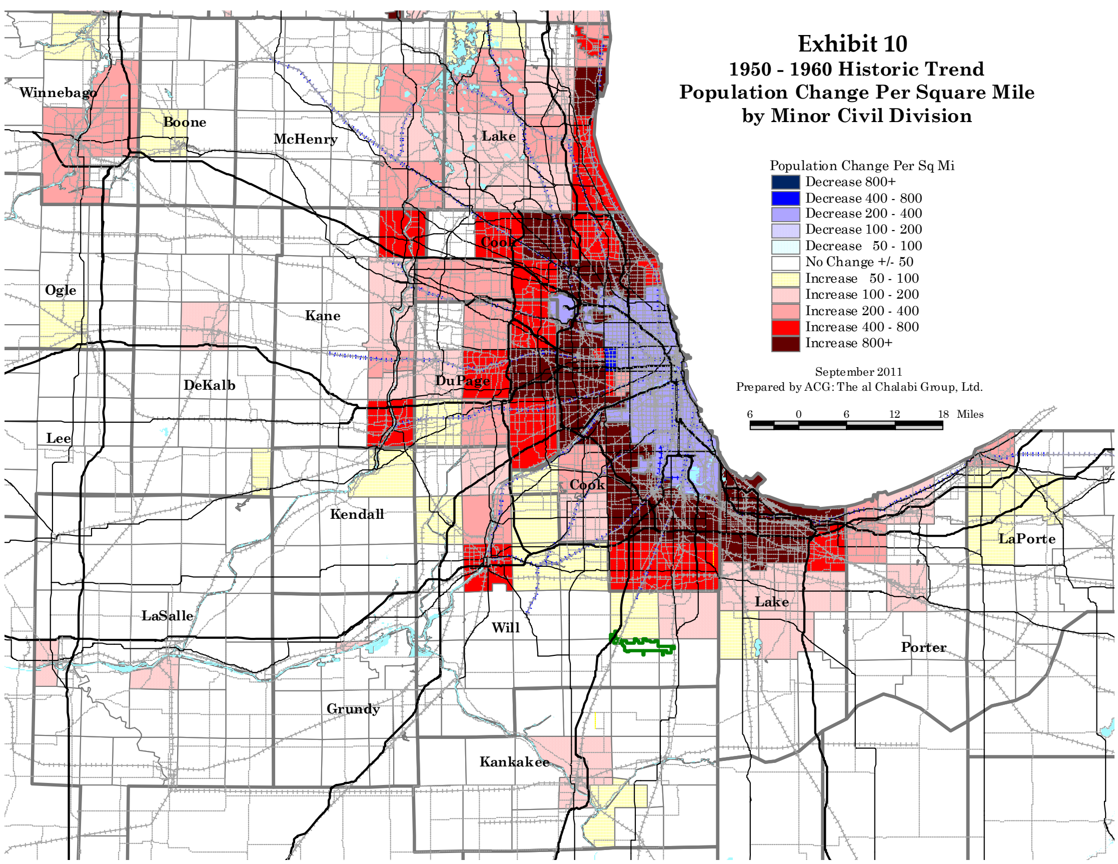
Exhibit 10
1950 - 1960 Historic Trend
Population Change Per Square Mile
by Minor Civil Division
Population Change Per Sq Mi
Decrease 800+
Decrease 400 - 800
Decrease 200 - 400
Decrease 100 - 200
Decrease 50 - 100
No Change +/- 50
Increase 50 - 100
Increase 100 - 200
Increase 200 - 400
Increase 400 - 800
Increase 800+
September 2011
Prepared by ACG: The al Chalabi Group, Ltd.
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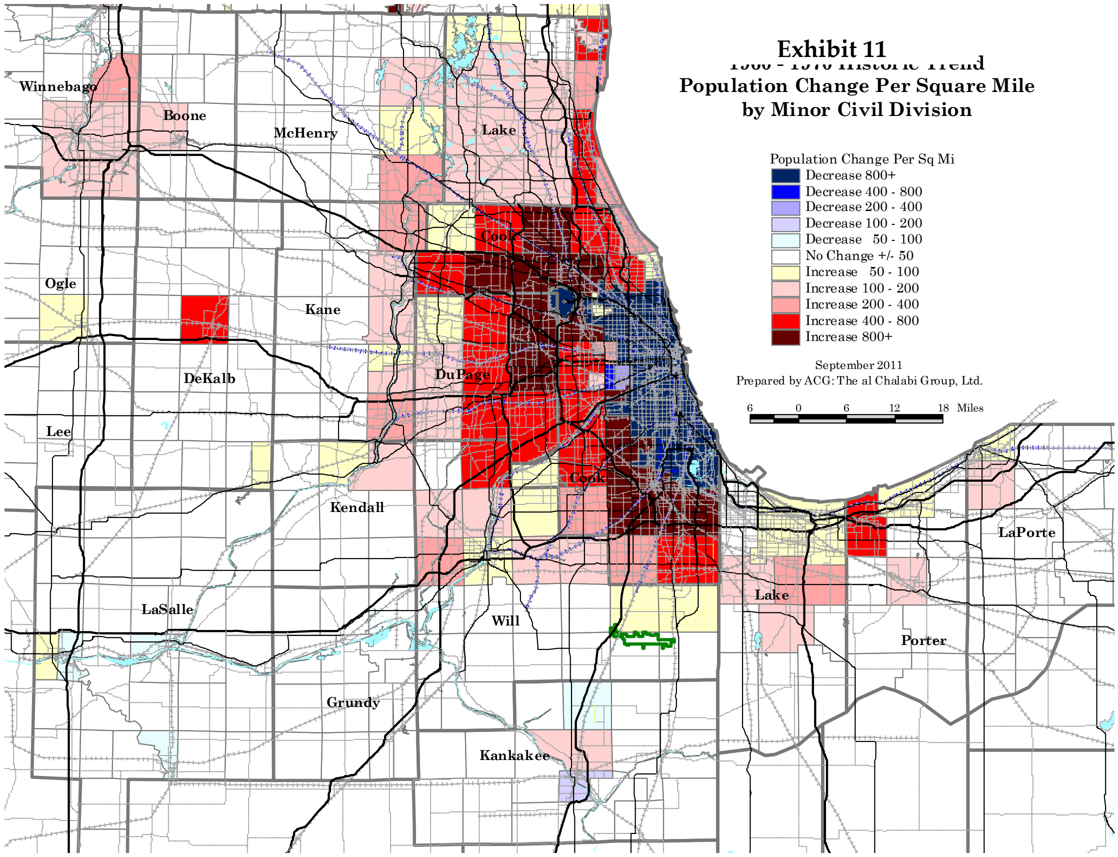
Exhibit 11
1960 - 1970 Historic Trend
Population Change Per Square Mile
by Minor Civil Division
Population Change Per Sq Mi
Decrease 800+
Decrease 400 - 800
Decrease 200 - 400
Decrease 100 - 200
Decrease 50 - 100
No Change +/- 50
Increase 50 - 100
Increase 100 - 200
Increase 200 - 400
Increase 400 - 800
Increase 800+
September 2011
Prepared by ACG: The al Chalabi Group, Ltd.
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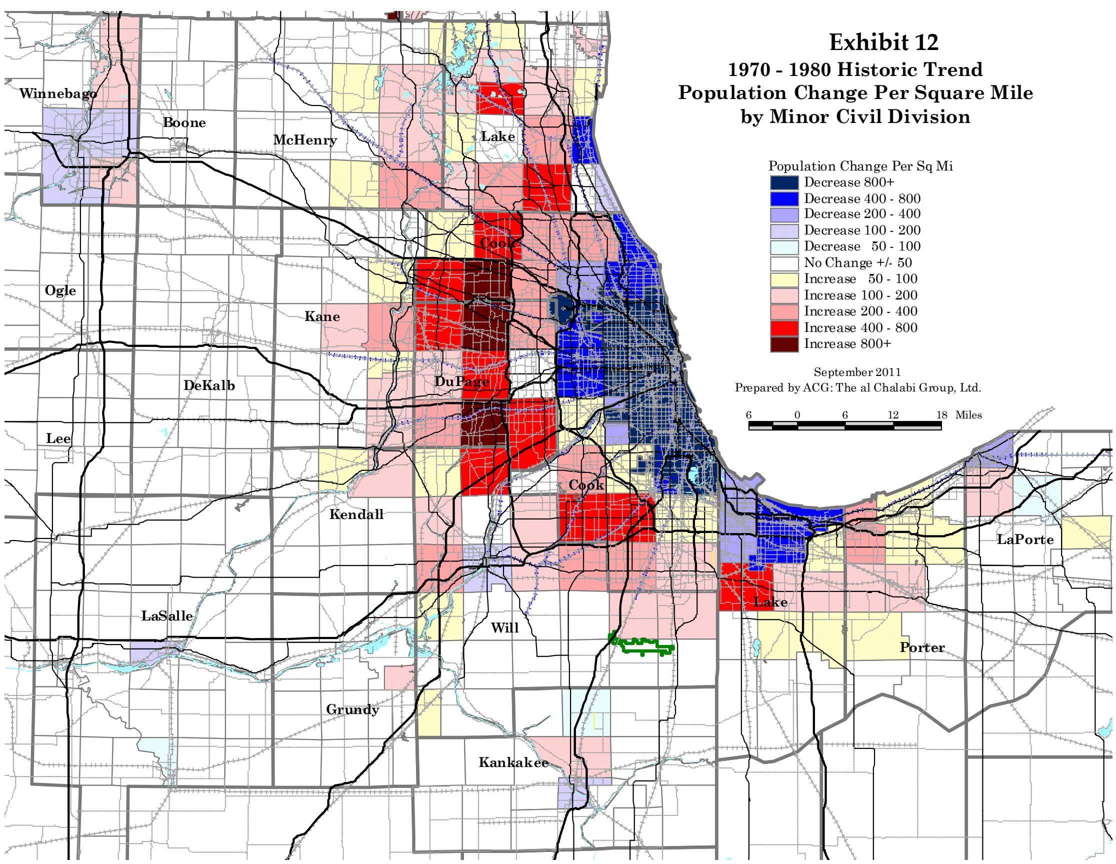
Exhibit 12
1970 - 1980 Historic Trend
Population Change Per Square Mile
by Minor Civil Division
Population Change Per Sq Mi
Decrease 800+
Decrease 400 - 800
Decrease 200 - 400
Decrease 100 - 200
Decrease 50 - 100
No Change +/- 50
Increase 50 - 100
Increase 100 - 200
Increase 200 - 400
Increase 400 - 800
Increase 800+
September 2011
Prepared by ACG: The al Chalabi Group, Ltd.
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Boone
McHenry
Lake
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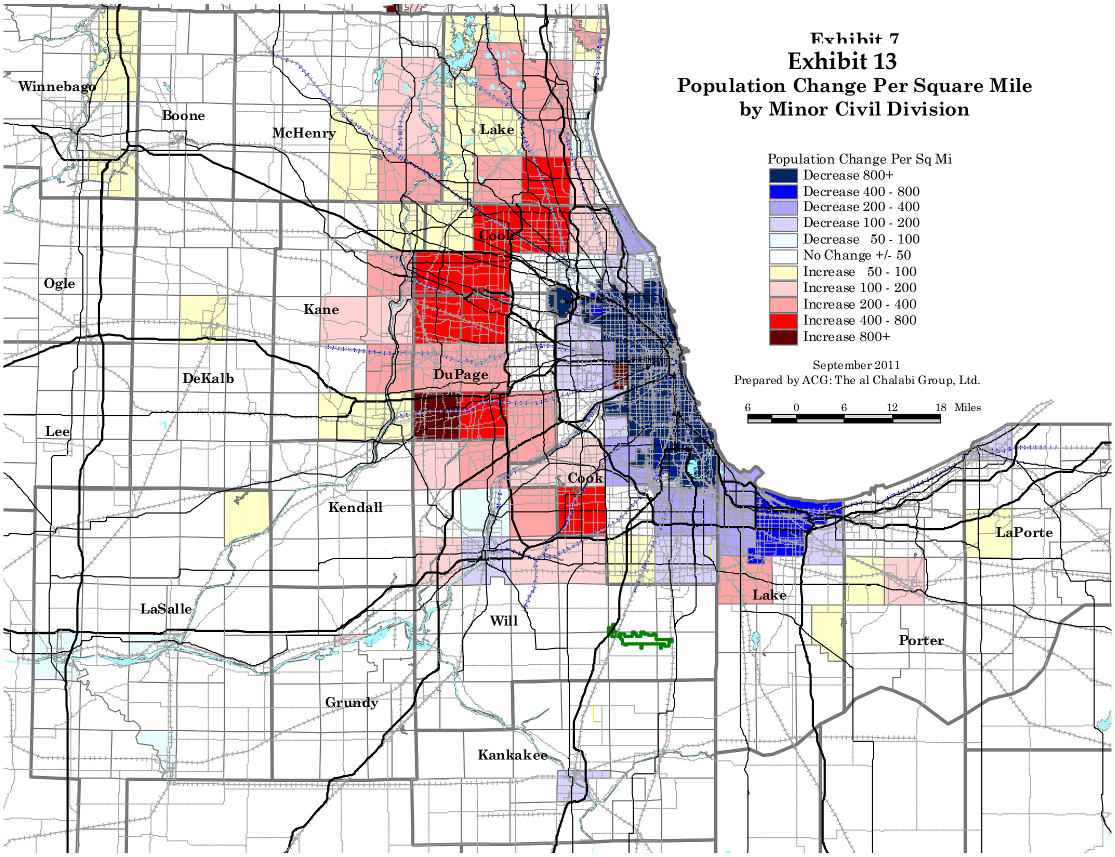



**Exhibit 13**
**Population Change Per Square Mile by Minor Civil Division**

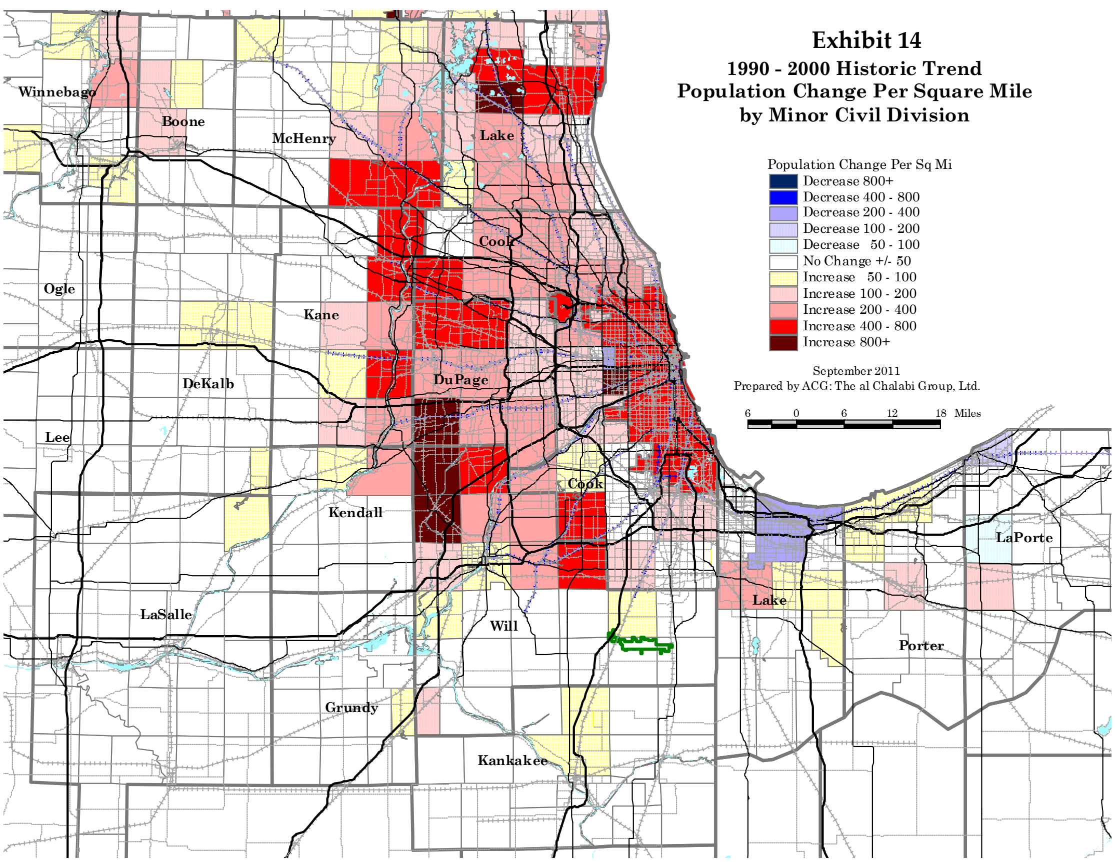
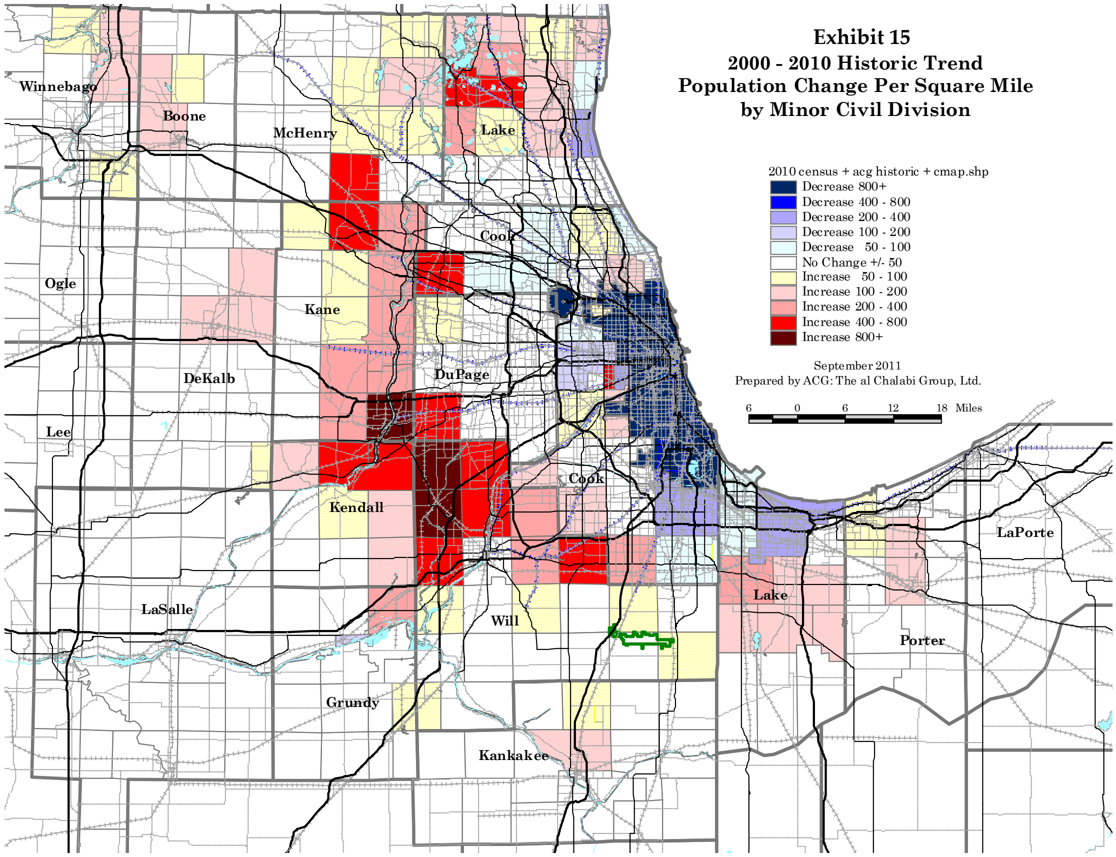


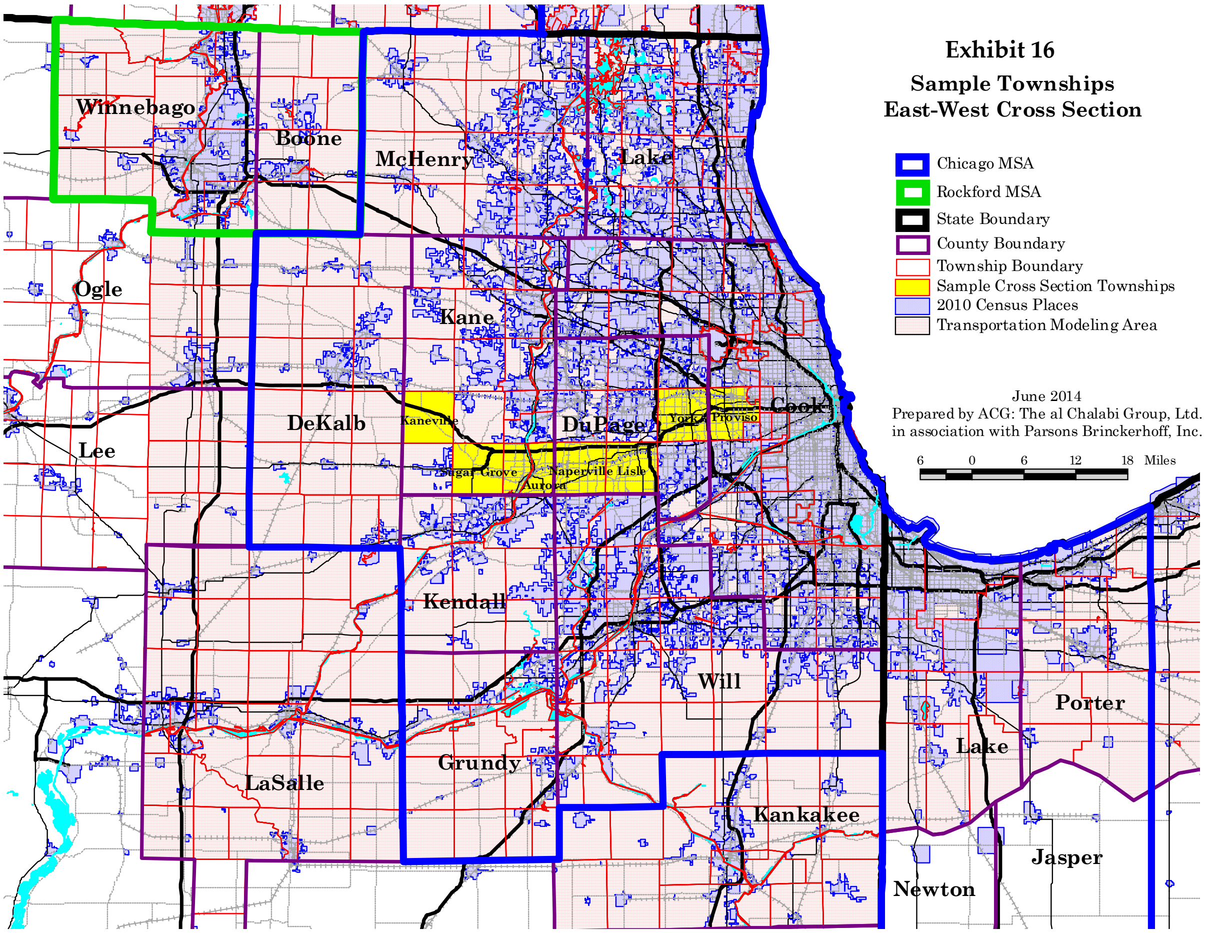

**Exhibit 14**
**1990 - 2000 Historic Trend Population Change Per Square Mile by Minor Civil Division**




## E. Market-Driven Socio-Economic Forecasts by Township – Calibration and Forecasts

The maps in the preceding section, documenting the population change by township per decade, represent one method for visualizing the outward growth of the region, the cessation of growth once land is fully developed, and the impact of local and national economic trends (cycles) on development.

A second method is to present the population, households, and/or employment trends, forecasts and S-Curve graphs for a cross-section set of townships extending from the edges of the City of Chicago outward. Seven sample townships along the Region's east-west central highway axis (Eisenhower Expressway (I-290) and Ronald Reagan Memorial Tollway) represent a typical cross-section and time-line of the Region's growth. These townships are Proviso, in Cook County; York, Lisle and Naperville, in DuPage County; and Aurora, Sugar Grove and Kaneville, in Kane County. Exhibit 16 shows the locations of these townships within the Chicago Region. Each of these townships represents a different development take-off and maturity year, generally (one exception) at a later date proceeding from east to west. Slightly different graphs, showing similar data for Community Area Groupings within the City of Chicago, along the Project Corridor, also are presented in the next section of this section.




Exhibits 17 through 23 (shown within their township descriptions) show the population, households and available land trends (through 2010) and the Market-Driven forecasts (post-2010) for the above-referenced townships. Also shown on these graphs, are the population and household (same as occupied housing units) holding capacities. Two sets of trends and three sets of forecasts are shown. The solid lines (red for population and blue for households) represent the mathematically-generated S-Curve hypothetical trends and forecasts. The dashed (also red and blue) lines represent actual past trends (through 2010) and the 2010-2040 Market-Driven forecasts generated for the I-290 Study. The large solid dots (brown for population and dark blue for households) represent the CMAP data (2010) and its two forecasts for 2030 and 2040. The S-Curve equation and its input data are:

Forecasted Household/Population/Employment =
Holding Capacity/(1+EXP(–alpha*(Year–Year0))).
Where:
alpha = (LN(1/Value1–1) – (LN(1/Value 2–1))/(T2–T1)
Year0 = (LN(1/Value1–1)/alpha+T1)
and
T1 = take-off year (at which point acceleration is pronounced) (e.g. 1948)
T2 = approaching maturity year (e.g. 2005)
Value 1 = % of peak household/population/employment at take-off year

Value 2 = % of peak household/population/employment at approaching maturity

The black lines, in these graphs, represent the S-Curve hypothetical land available for development, measured as percent of total township land, as shown on the right axis. The yellow lines represent the actual, through 2010, and the I-290 EIS (Market-Driven) forecasts beyond 2010; both are measured as percent of total land. The source of land available for development are from the Chicago Regional Plan Association (1956), and NIPC/CMAP land use survey (through 2005 with ACG extrapolation to 2010). The 2010 CMAP land use inventory was not completed until after the I-290 EIS forecasts were finalized, so was not included in this socio-economic forecast analysis.

Exhibit 17 shows the trends and forecasts for Proviso Township. Proviso Township is the first, nearly full-sized township (full-sized is 36 square miles) west of Chicago. The take-off year for residential development and population growth occurred in approximately 1920. Employment take-off occurred later that decade. By 1970, less than 10 percent of total land was available for development, an indication of approaching maturity. By 1980, only three percent of total land was available for development; this is an indication of full development beyond which redevelopment becomes the norm. It should be noted that, at the township level and applying Market-Driven assumptions, redevelopment seldom results in increased population or household densities. The household S-Curve replicates the historic trends very well; whereas, the population S-Curve underestimates the population during the period of the mid-1950's through the 1970's. This was a period of high birth rates (birth of the baby boomers) resulting in the large average household size. The better performance of the S-Curve equations in predicting household trends is the reason for shifting from using S-Curves to predict population to one of predicting households and deriving population from households.

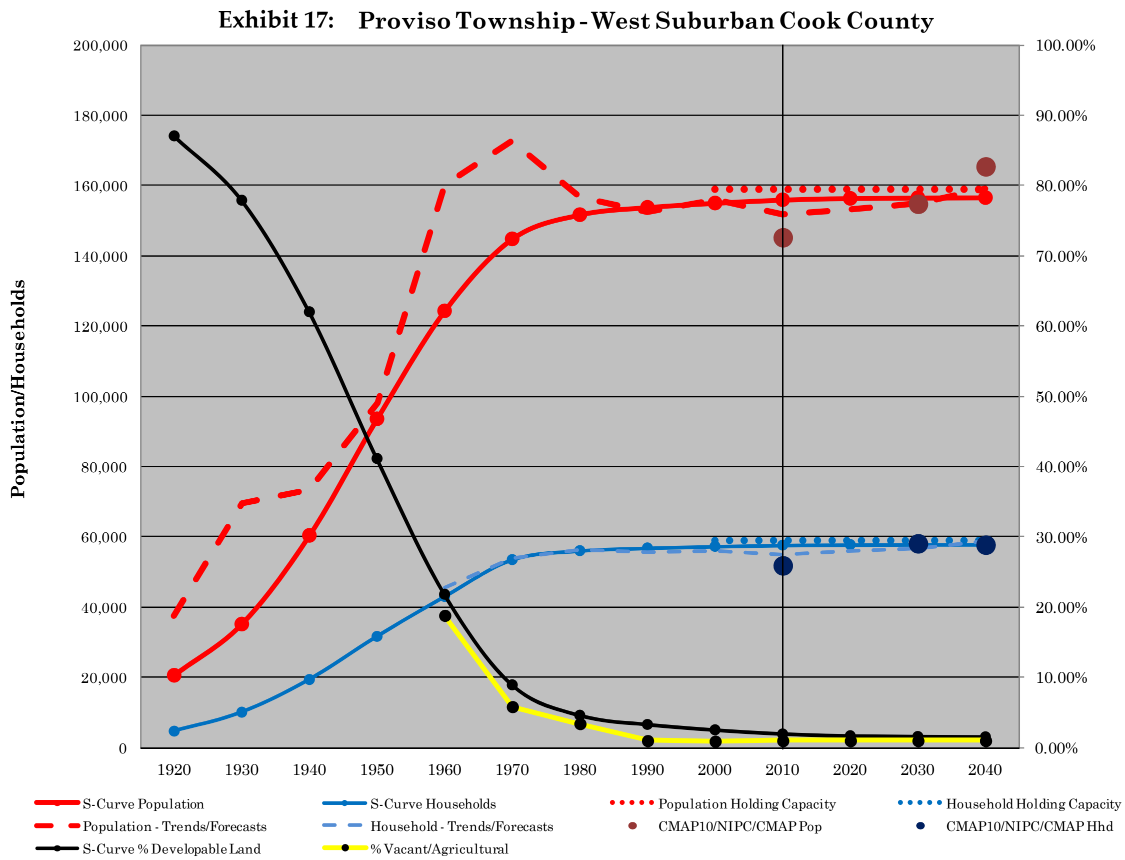
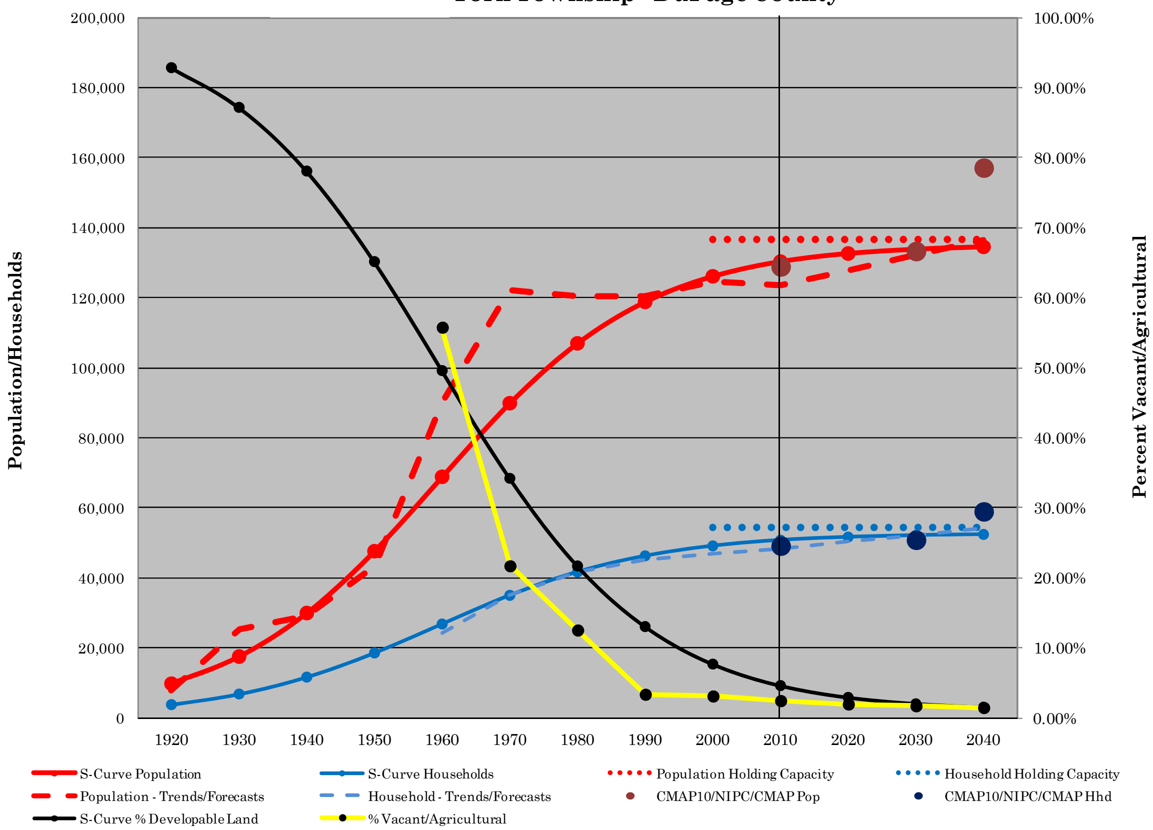


Exhibit 17: Proviso Township - West Suburban Cook County
Population/Households
Percent Vacant/Agricultural
200,000
180,000
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
100.00%
90.00%
80.00%
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
S-Curve Population
Population - Trends/Forecasts
S-Curve % Developable Land
S-Curve Households
Household - Trends/Forecasts
% Vacant/Agricultural
Population Holding Capacity
CMAP10/NIPC/CMAP Pop
Household Holding Capacity
CMAP10/NIPC/CMAP Hhd

Exhibit 18 shows the population and household trends for York Township, DuPage County[7]. The intersection of the Tri-State Tollway (I-294) and the Ronald Reagan Memorial Tollway (I-88) occur on the eastern edges of this township. This intersection, which was part of the initial Illinois Tollway system put into service in 1959, caused York Township to become one of the most-important regional centers within the Chicago MSA. The northern section of I-355 (Veteran Memorial Tollway), opened in 1989, is located along the western edges of the township, further enhancing its accessibility. York Township started its population and residential development take-off in the mid-1930's and approached its residential maturity by the mid-to-late-1980's. York Township's historic household and population trends and their relationship to the S-Curve equations are similar to those observed for Proviso Township. The household predictions are uniformly accurate; whereas, the population S-Curve underestimates the population during the high birth rates and consequent large household size experienced in the 1950's and 1960's.

**Exhibit 18: York Township - DuPage County**




The York Township take-off for employment (Exhibit 18A) occurred in the 1960's, shortly after completion of the initial Illinois Tollway system. The township employment began approaching

[7] For the sake of clarity and readability, employment trends were shown on separate graphs; an example (York Township) is shown as Exhibit 13A.

its employment maturity by 2000. The recent Great Recession caused many of York Township's employers to reduce their number of employees. Most of the employment in York Township is office or retail-based and is assumed to return to pre-recession level and expand to occupy available holding capacity by 2040. It is worth noting that York Township, due to its excellent accessibility to the rest of the Chicago MSA, has more jobs and a larger employment holding capacity than population and household holding capacities. York Township's population and household growth patterns anticipated those of its employment growth. Once again, the population/household patterns reflect the baby boom experience of the 1950's and 1960's.

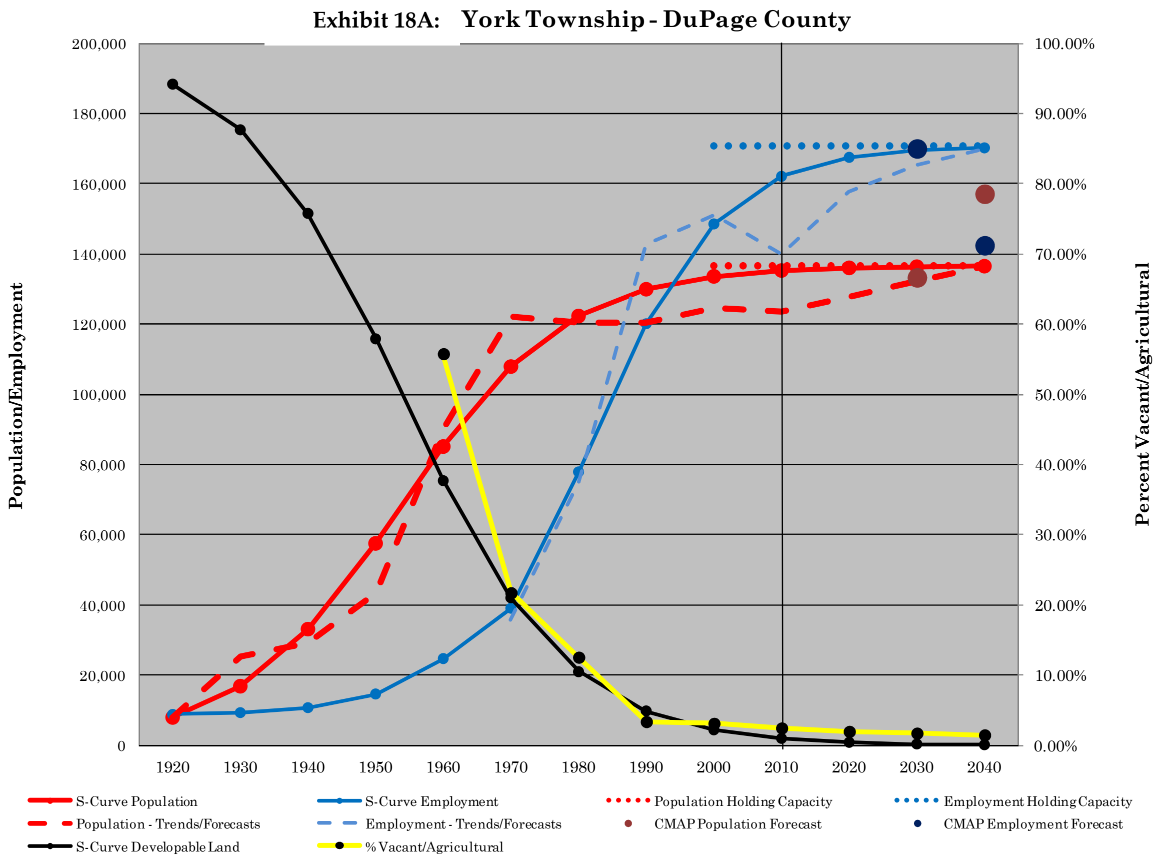



Exhibit 19 shows the population and household trends and forecasts for Lisle Township, DuPage County. The residential take-off for this township occurred in the early 1960's and approached maturity by the mid-2000's. Again, the household S-Curve is a better predictor than the population S-Curve. The difference is not as stark as those observed in York and Proviso Townships because most of the growth of this township occurred shortly after the birth of the Baby Boomers.

Exhibit 19: Lisle Township - DuPage County

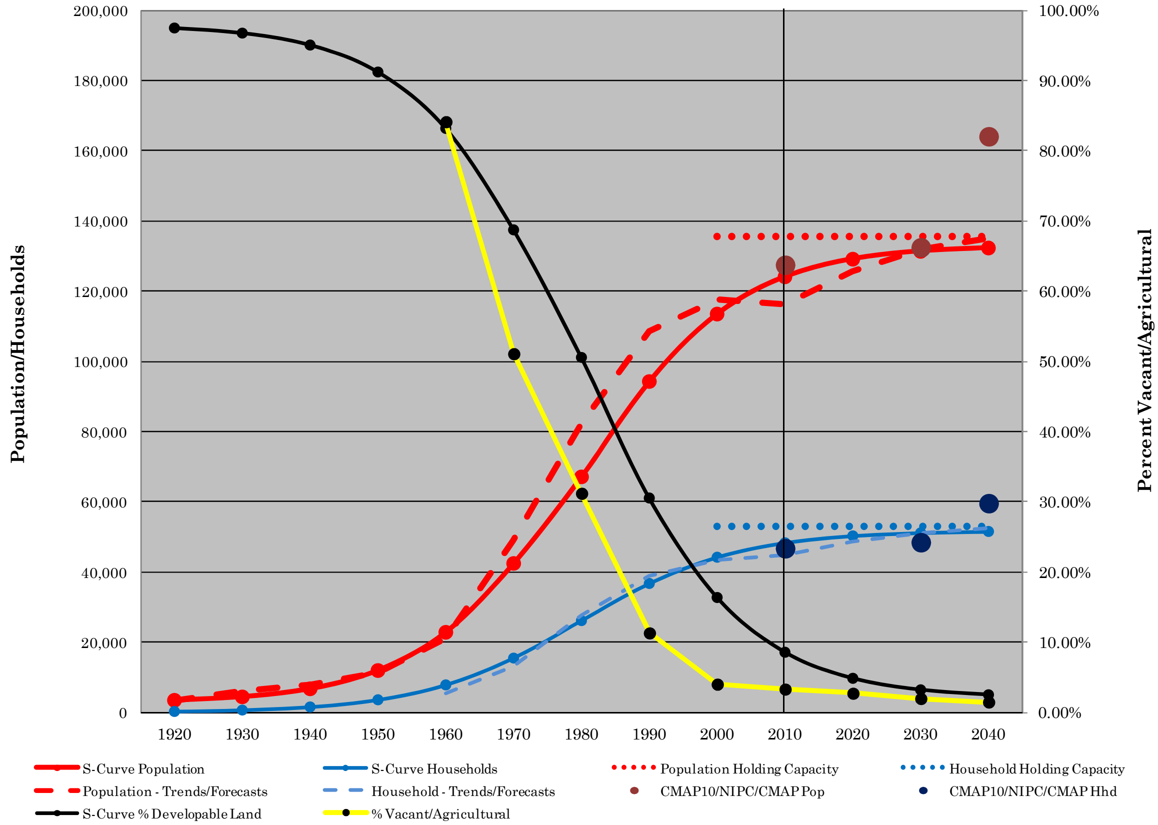



Exhibit 20 shows the trends and forecasts for Naperville Township. The residential and population take-off occurred during the early-1980's – almost two decades after Lisle. Maturity is forecasted to be approached by the mid-2010's. Both the household and population S-Curves are good predictors of past growth as most of this township growth had occurred after the large average household size associated with the Baby Boomers.

**Exhibit 20:** **Naperville Township - DuPage County**

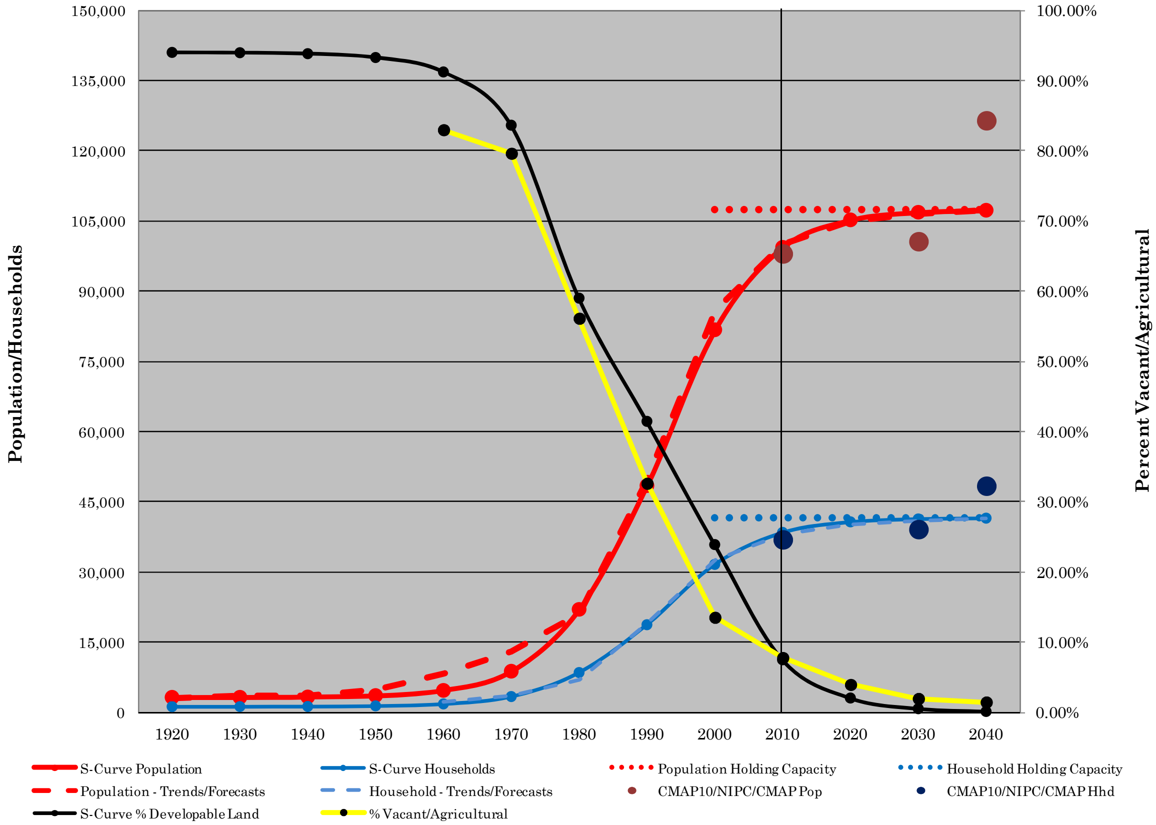



Exhibit 21 presents the growth trends and forecasts for Aurora Township. This township is one of four unique townships within the CMAP Region. Each of these four townships include one of four satellite cities (Aurora, Elgin, Joliet, and Waukegan). Each of these satellite cities was a pre-railroad city, established in the first half of the 19th Century and located approximately 45 miles from Chicago, which was established at approximately the same time. These satellite towns grew and developed as industrial centers, independent of Chicago. Each of these towns reached a mature, stable population and employment by the 1960's, at which time they remained separated from Chicago by large tracts of agricultural land and operating farms. In the 1990's, the suburban edges of a developing Chicago reached them. Since they still contained agricultural and vacant land, development was relatively reasonable; and these townships started growing again. Aurora Township's growth is shown as a double S-Curve. The mathematical equation is slightly more complex; but the hypothetical curves are presented for population and household growth. However, the hypothetical prediction of the percent of land available for development, which is the inverse of the sum of the population and employment S-Curves, is not shown as a double curve.

**Exhibit 21:** **Aurora Township - Kane County**

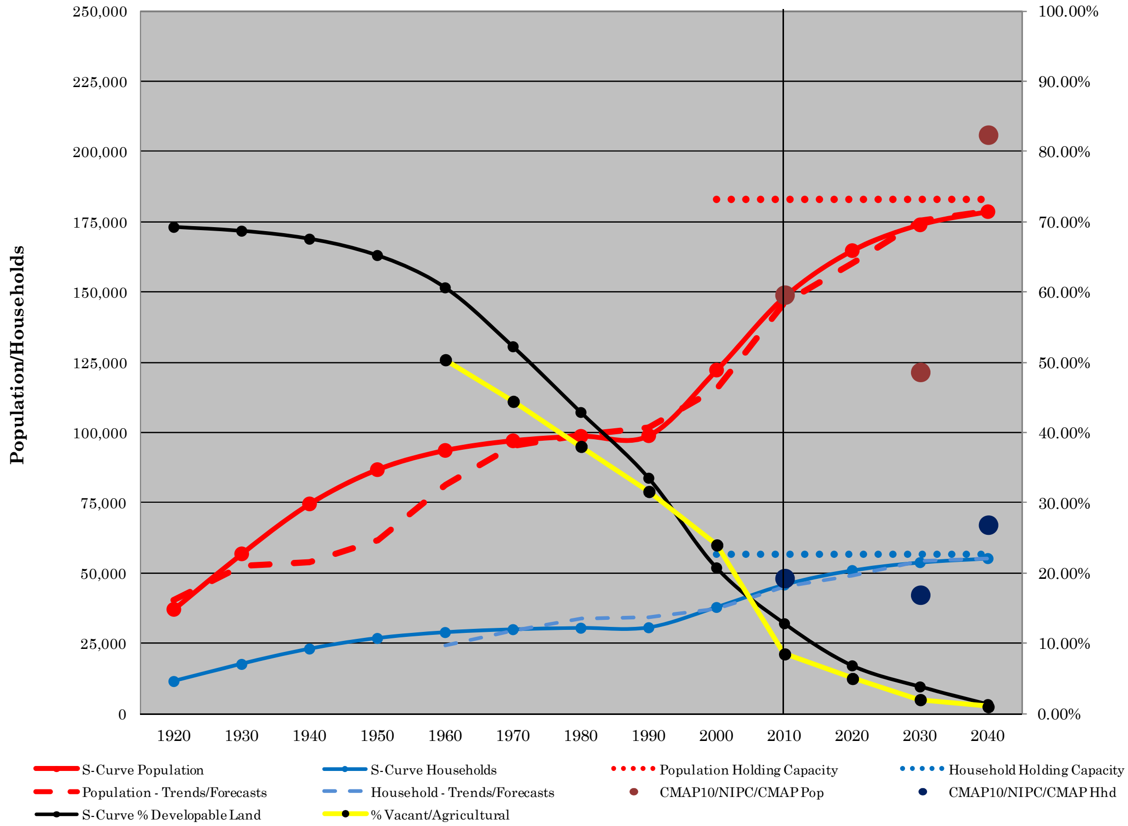



Exhibit 22 shows the growth trends and forecasts for Sugar Grove Township. Development take-off started in the mid-2000's and is forecasted to approach maturity by 2050. As the townships in DuPage reach full development, and developable land is no longer available there, urban growth will push outward. Sugar Grove Township is one of those outward townships that, currently, is starting to experience growth. Growth during the coming decade will be slower than predicted by the hypothetical S-curve because its early years will reflect the impact of the recent recession, and its slower-than-historical return to normalcy.

Exhibit 23 shows Kaneville Township; this township is the west-most township along the I-88 corridor within the CMAP Region. Development take-off is forecasted to start by the mid-2030's and tentatively is assumed to reach maturity by 2070. The township west of Kaneville is Pierce Township, in DeKalb County; this township is forecast to remain an agricultural township throughout the entire forecast period, 2010-2040. The population of Pierce Township declined from 638 in 1920 to 454 in 2010 and is forecasted to remain at approximately 450 through 2040.

Exhibit 22: **Sugar Grove Township - Kane County**

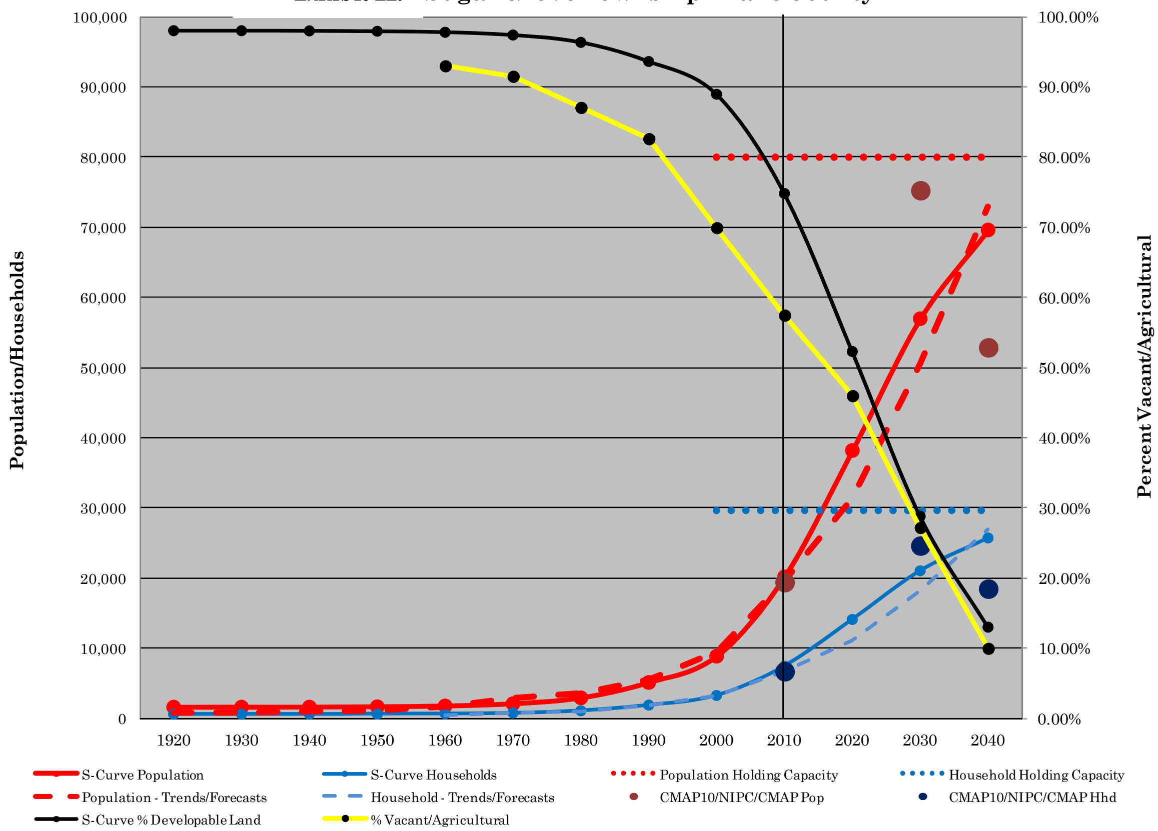
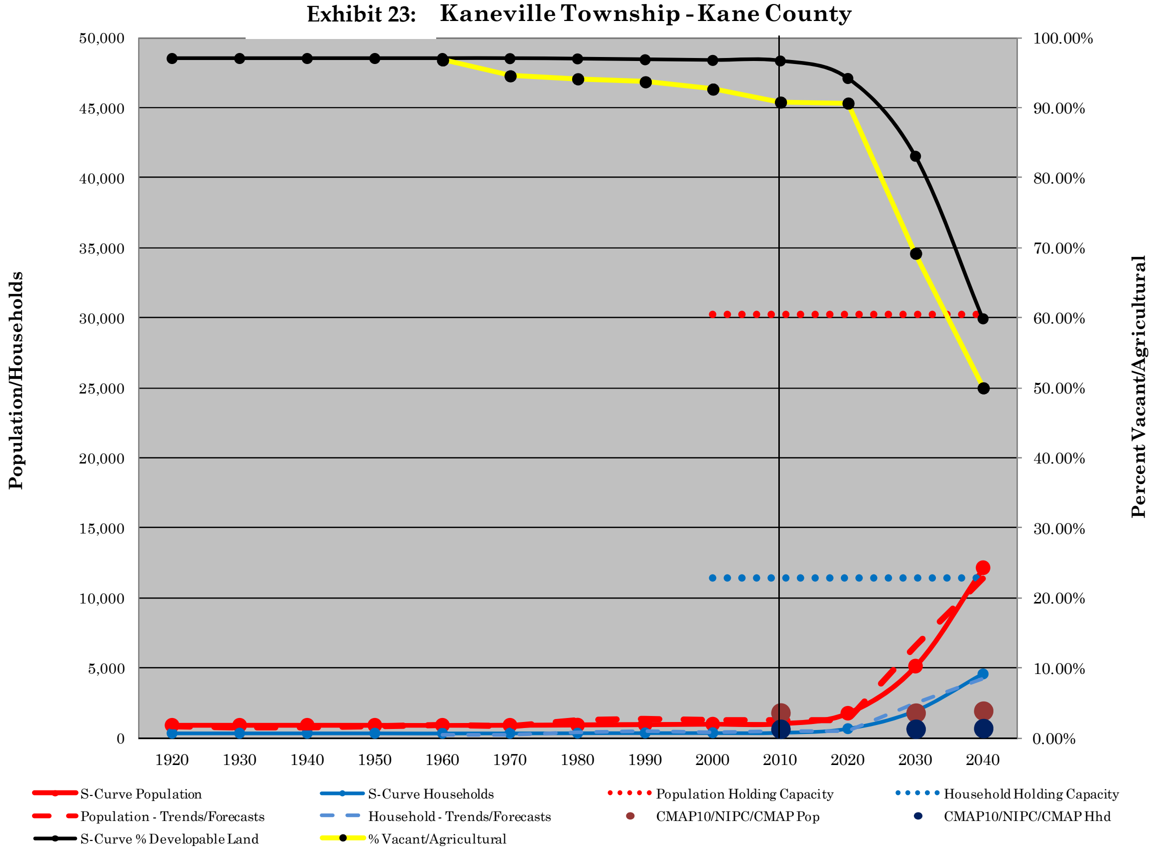



Exhibit 23: **Kaneville Township - Kane County**

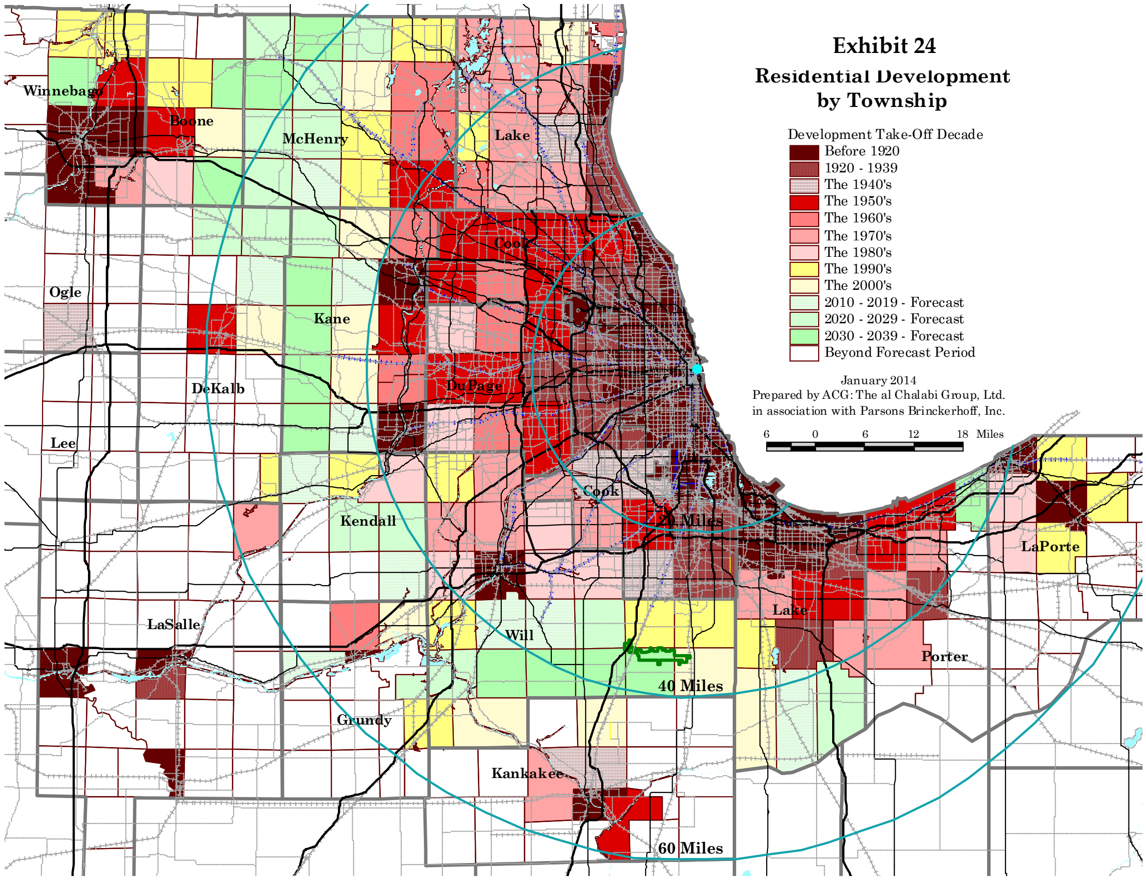


Graphs similar to those presented here, have been prepared for each of the 118 townships (several of the 124 political townships were combined to better approximate the 36-square mile surveyor townships) in the CMAP Region and the 168 townships, in Illinois and Indiana, that are within the CMAP transportation modeling area, but outside CMAP. The 168 external townships lack land use data. However, most of these are agricultural townships and are forecasted to remain so throughout the forecast period. For the few external townships where land use data are needed to calculate holding capacities, web-available satellite photographs were used to approximate land use data. For all townships, the population and employment forecasts, as generated by ACG, are influenced by available local, county and regional plans and forecasts; tempered by the S-Curve graphs; and constrained by the regional population forecasts initially generated by CMAP and accepted for the I-290 EIS.

Exhibit 24 shows the Take-Off Year of Residential Development for each Township, as implied by the S-Curve equation data for the previously-illustrated townships and each of the 300-plus townships in the Greater Chicago Region. It illustrates and verifies the historic expansion and maturation of the region; whose development was located:

- First, along the Lake Michigan shore; in the region's satellite cities (Waukegan, Elgin, Aurora and Joliet), and in further-out, independent cities (Rockford, Ottawa, Kankakee and Michigan City).
- Second, along early interurban commuter rail and historic highways (e.g. U.S. 30 and US 41).
- Third, along major expressways constructed in the 1950s and 1960s and in post-WWII suburban areas.
- Fourth, reflecting the impact of O'Hare International Airport, in pulling development from its historic concentric focus, as it competes with the Central Area of Chicago as the region's dominant economic focus.
- Fifth, the expanding edges of the region.
- Sixth, growth of satellite cities toward the expanding urban edge.

This map clearly shows: the constraints imposed, in the 1930's and 1940's, of Post-Depression economics and World War II (there was no significant growth in the 1930's); the exuberance of post-WWII (1950's) expressway building and low-rate mortgages; the economic impact of Central Chicago, the attraction of the lakefront, and the impact of their access to one another on the region's early development; the economic attraction (in the 1960's, 1970's and 1980's) of O'Hare as national and international businesses grew and required access to clients and as professionals required access to the airport; and the continual search for affordable housing, amenities, and good schools close to job opportunities.




## F. Market-Driven Socio-Economic Forecasts by Community Area in the City of Chicago

The City of Chicago is classified as a single township, a township that reached full development by the early 1930's. The population of the City peaked, in 1950, at 3.621 million and, with one exception (in 2000), declined each subsequent decade, reaching a low of 2.695 million in 2010. The occupied household units remained relatively stable; it fluctuated in a narrow band of 1.080 million, in 1950; peaking at 1.155 million, in 1960; declining, thereafter, to a low of 1.025 million, in 1990; and rising to 1.046 million, in 2010. Whereas, between 1950 and 2010, the City of Chicago's population experienced a decline of 25.6 percent, its households decreased by only 3.1 percent over the same period.

The above-cited gross changes in the City of Chicago have camouflaged many serious changes that occurred in the City's communities and sub-areas. Almost all of the changes were the product of redevelopment; as vacant land, available for development, stayed at approximately five percent through the period, 1960-2010. Given these facts, it became evident that it was necessary to subdivide this single township into sub-areas and prepare individual population, household and employment forecasts for each. Furthermore, the use of the S-Curve for replicating past trends and generating future forecasts proved unreasonable, as all sub-areas within the City of Chicago are fully-matured communities. Accordingly, a more detailed approach, cognizant of the development history and potential of each community, was necessary. This led to the analysis of community areas.

The City of Chicago is composed of 76 Community Areas (77, if the Old Uptown is divided into New Uptown #03 and Edgewater #77). The structure of these Community Areas dates back to the 1930's; and there is a wealth of historic data on the social, geographic, demographic and economic characteristics of each. These 76 Community Areas are aggregated into 12 Community Area Groups (CAG), which are relatively homogenous, by location, physical layout, structures, socio-economics, land use and history. Three of these CAG straddle the I-290 Corridor within the City of Chicago. These three CAG's are (from the Lake westward):

- Central Lakefront composed of Community Areas: 8-Near North Side, 32-The Loop, and 33-Near South Side.
- Near West composed of Community Areas: 24-West Town, 28-Near West Side, and 31-Lower West Side.
- West composed of Community Areas: 23-Humboldt Park, 25-Austin, 26-West Garfield Park, 27-East Garfield Park, 29-North Lawndale, and 30-South Lawndale.

Two approaches were used in forecasting population, households and employment for the City of Chicago. The first, was generated for the City as one township. This 2040 forecast, with a population of 3,000,000, was reported in the 2012 forecasts incorporated into the initial I-290 "No-Build" forecasts. These initial forecasts were further refined through the preparation of forecasts for each of the twelve Community Area Groupings. These refined forecasts are detailed in the report, Comparison of Historic Data and ACG/CMAP Forecasts to 2040 of Population and Housing for the City of Chicago and its Community Areas, prepared for the Illinois Department of Transportation, by ACG: The al Chalabi Group, Ltd, in association with Parsons Brinckerhoff, Inc., in February 2013.

The above forecasts reflect a continuation of the trends of the past few decades, interrupted by the recent Great Recession, which affected both the job and housing markets. Chicago, currently, is resuming these long-term trends, which have resulted in a gradual and unremitting improvement of housing stock and a spreading gentrification of neighborhoods from the Central Area and the Lakefront, outward. Additional trends include:

1. **Combining/Enlarging Housing Units –** This growing phenomenon is flourishing in both single-family neighborhoods and in high-rise condominiums. There has been an on-going trend to combine units in major condominium towers, as homeowners/buyers seek to modernize and enlarge their residences. For example, the Hancock Center and high-rises along the north lakefront show percentage reductions in units (through combination) and residents that closely parallel the city's decline in population over a similar period of time (1990-2010).
   There is a similar trend to replace older, smaller, single-family housing with much larger units, often on several city lots. These units, often referred to as McMansions, line many of the tonier streets of Lincoln Park and Lakeview. Large single-family residences – previously

converted into apartments – have been renovated and returned to single-family use. There also has been major adaptive reuse of industrial and office buildings into lofts and residences, often conferring considerable square footage to individual units.

2. **Abandonment and Demolition –** Over the past twenty years, there has been significant demolition of high-rise public housing, with little replacement. Families often were relocated to nearby suburbs, with the assistance of housing vouchers. In some of the better-served areas, privately-funded market or 80/20 development has occurred – all at a significantly lower density. While vacant land still remains, access is often compromised by elevated rail or highway structures. The result is both reduced housing units and lower density.

3. **Impacts of the Recession on Housing –** Adding to the former abandonment and demolitions, described above, is the very substantial abandonment and foreclosure brought about by the recent Great Recession. Chicago was, and still is, hard hit by this economic challenge, with a foreclosure rate estimated at approximately 3.3 percent of housing units, more than double that of the national average, as of late 2012. At the same time, the foreclosure rate in the State of Illinois was the highest in the U.S.

4. **Available Vacant Land –** In addition to the above-cited vacant land, there are major parcels of land (former U.S. Steel, central railroad land, Chicago River banks, the former Michael Reese Hospital, former Taylor Homes, etc.) which have been or are currently undergoing planning. Most plans show gradual development over the next 20 to 30 years. Development of these parcels has been taken into consideration in this forecast. The result is a slightly larger number of housing units, in 2040, than those forecast by CMAP.

5. **Infill Development –** As a result of older urban renewal programs and the civil disruptions of the 1960's and 1970's, many neighborhoods were confronted with gaps created by demolitions, fires, or abandonments. The treatment of these infill spaces has been very different. In the lakefront communities – Lincoln Park, Lakeview, South Loop, Hyde Park, Near North – and communities radiating outward from the Loop – Near West, Logan Square, Ukrainian Village, etc. – the infill spaces have been filled with new structures. In the still-struggling areas of Lawndale and the South and Far Central communities, they have not. But, infill has simply replaced units that were once there; while at a greater value, they remain at their former or lower densities. It should be noted that infill occurs only when the general area is served or upgraded by a major economic asset, such as a medical center, university campus, regional retail, or access to the Chicago Central Area.

6. **Second-Home Development –** A fairly recent phenomenon is the development of second homes in the City of Chicago – for suburbanites who want a small pied-à-terre in the City to enjoy its lively cultural and entertainment offerings; and for those who enjoy residences in two or more regions across the country or beyond. In some Central Area high rises, second homes now represent five percent or more of the units. Second homes for global citizens have not developed in Chicago at levels comparable to those in London, Paris, New York

and Miami. However, such development is possible, in the near future, given the marketing and emergence of Chicago as a "Global City".

7. **In-Migration, Out-Migration and Household Size –** Immigrants to the United States have, traditionally, been attracted to its large cities. As such, Chicago has accommodated a full range of immigrants. In most instances – as it is currently – this has meant larger-than-average family size, gradually transitioning into that of the average of the surrounding urban area. The current influx of immigrants to Chicago is Hispanic. The impact of their location into the neighborhoods of the North Central, North and South Central and Midway areas, has resulted in higher densities. These densities are the result of both larger family size and smaller housing units. As this population is assimilated, it is assumed that both family size and housing choice will approach those of the general population. The housing stock in these areas is – for the most part – single-family bungalows on small lots and low-rise apartments.

   A recent immigration trend is to skip over the central city, in a major urban area, in favor of a mature suburb, for an initial settlement. This pattern currently is apparent in the Chicago Metro Area. Furthermore, the immigrant group is more likely to leave the urban core for the suburbs fairly quickly, if these urban neighborhoods gentrify, become more expensive, and attract smaller households.

8. **Expansion of Institutions –** As the Chicago economy has undergone major structural changes, its universities, institutions and hospital/medical facilities have been major beneficiaries. And, with change, has come significant development, primarily of a high-density campus nature. The City's prime hospitals – Northwestern, University of Chicago, Rush, University of Illinois, Stroger, etc. – have expanded into their surrounding residential areas; and they are expected to continue expanding. The University of Chicago, with its medical facilities, has always been a key player in the development/redevelopment of Hyde Park, from the time of its earliest urban renewal programs. The University of Illinois Chicago was the direct result of urban renewal on the Near West Side; and, while its expansion has greatly changed its neighborhood, in some instances, it has reinforced historic preservation. Loyola and DePaul Universities are expanding their campuses on the edges of Lincoln Park and Edgewater. These are vibrant developments that benefit the surrounding areas with a wide array of jobs and local improvements; and their expansions are expected to be publicly assisted or encouraged.

To illustrate the impacts of these trends, the forecast for the three Community Area (CA) Grouping straddling the Project Corridor are presented and discussed below:

Exhibit 25 shows the population and housing trends and forecasts for the Central Lakefront Community Areas. This grouping is composed of three CA's: Loop, Near North Side and Near South Side. Considerable housing construction has occurred in this area during the last two decades. The Great Recession occurred before many major projects were completed, resulting in a vacant housing overhang. Most of this overhang has been absorbed; however relatively high vacancy rates will continue due to the prevalence of second homes. Second homes are classified as vacant by the U.S. Bureau of the Census. Construction has resumed, but as condominium units will continue to combine to form larger units, the increase in housing units is forecasted to be less than the units constructed. Finally, average household size has already declined to almost 1.6 and is not forecasted to decline below that level.

**Exhibit 25: Population and Housing Trends and Forecasts: 1930-2040**
**City of Chicago – Central Lakefront Community Areas**

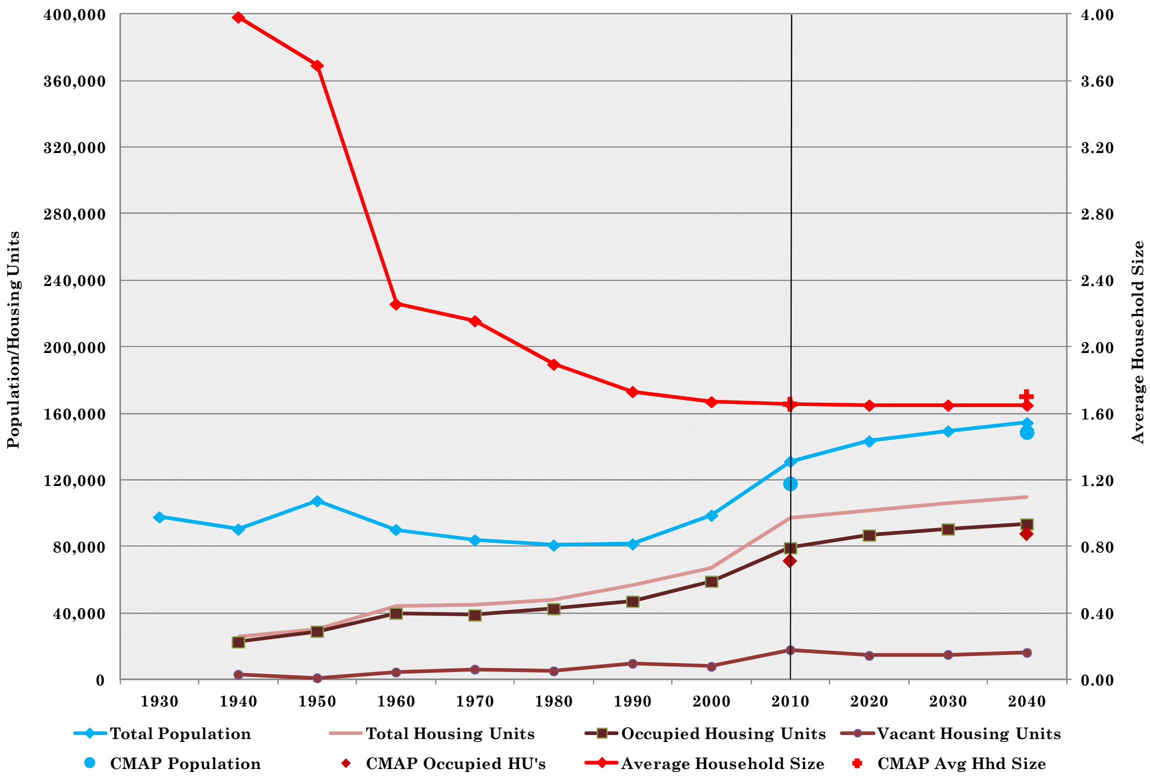
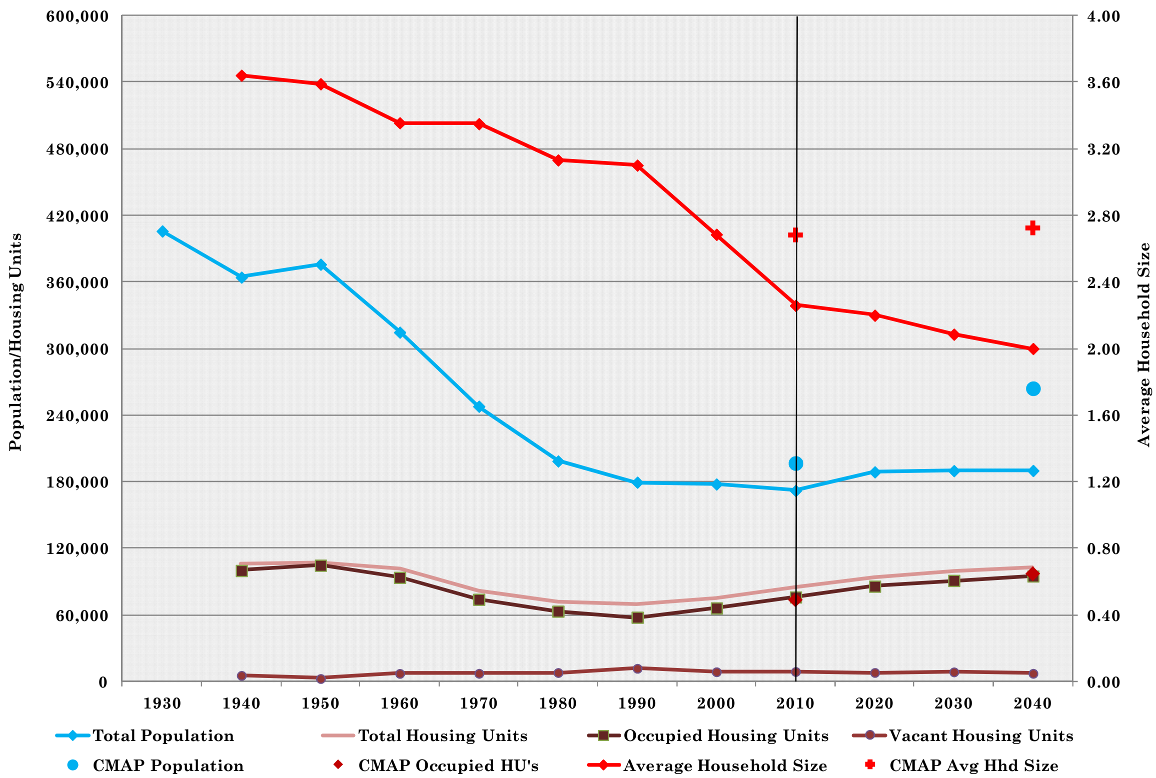



Exhibit 26 shows the past trends and forecasts for the Near West Community Area Group. This area is bounded by the Chicago River (east), California (West), North Avenue (North) and I-55 (South). The Near West benefits from the spillover development from the Central Area, which produced Presidential Towers. This area is also home to the University of Illinois Chicago, the Rush/County Medical Center and the Chicago Stadium. The older communities in this area are being revitalized, including Pilsen, with its arts and restaurants, as well as Ukrainian Village and Noble Square.

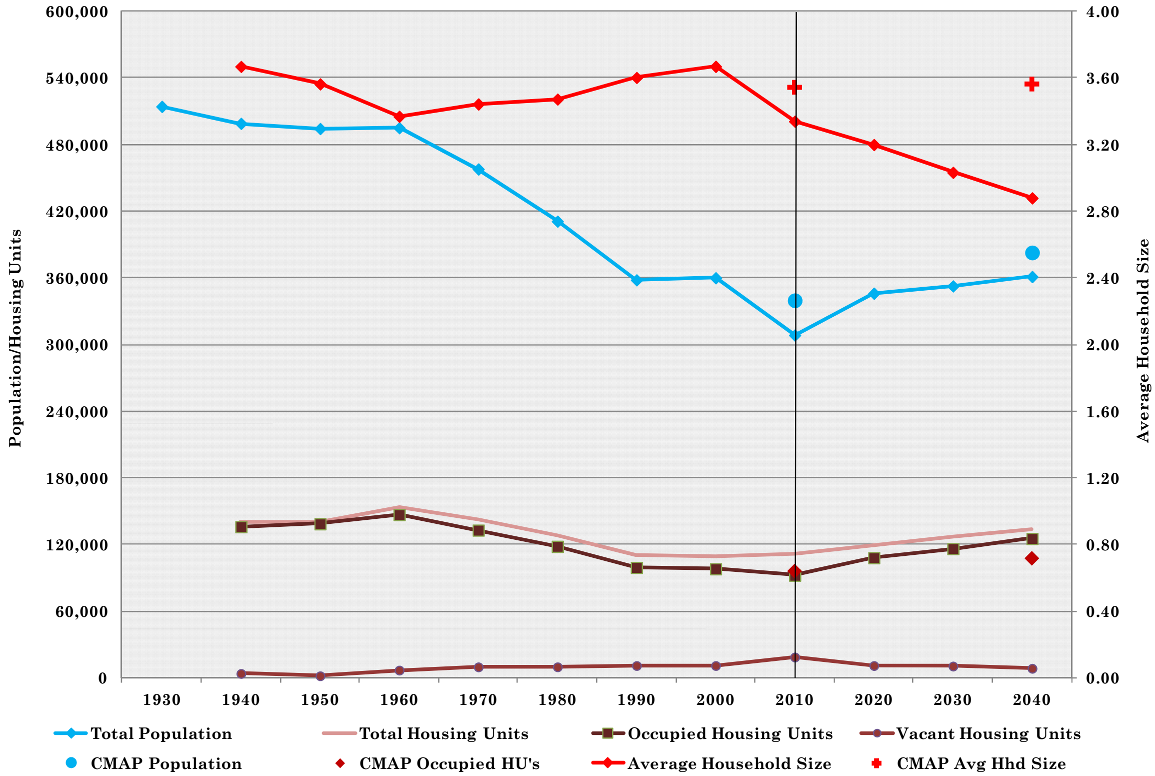
**Exhibit 26: Population and Housing Trends and Forecasts: 1930-2040**
**City of Chicago – Near West Community Areas**




Both population and average household size in these communities have been declining for decades. But, occupied housing units (i.e. households) are currently more than they were in 1970. The ACG Market-Driven forecasts to 2040 show total population increasing from 172,082 to 190,077. This is much lower than the CMAP Policy-Based forecast of 264,215, which was based, in part, on a much higher average household size and a 2010 population estimate which was nearly 25,000 higher than the Census. CMAP forecasts of Average Household Size are shown as red crosses on Exhibits 20 through 22. Household forecasts for 2040, however, are almost the same – 95,038 by ACG and 97,005 by CMAP.

Exhibit 27 shows the trends and forecasts for the West Community Areas Grouping. This area is located at the Western edge of the City of Chicago between Irving Park and the I-55. Much of this general area has been affected by highly-charged factors of racial change; the over-arching impact of the 1968 riots; and the loss of major industries – Sunbeam, Sears, Zenith, Brach, etc. There have been several attempts at revitalization: Shaw Development at Homer Square and retail revitalization at Little Village (South Lawndale). However, the needs of this greater area continue to be substantial, particularly housing and jobs.

Exhibit 27: Population and Housing Trends and Forecasts: 1930-2040
City of Chicago – West Community Areas




Total population for this West CAG has been declining since 1930. This is in spite of the fact that household size has remained approximately the same through 2000; it has started to decline post-2000. The population decline is due to the very substantial loss of housing units. Population has declined from 514,326 in 1930 to 308,605 in 2010; total housing units declined from 153,967, in 1960, to 111,202 in 2010. The ACG 2040 forecast for households is slightly higher than the CMAP forecast. However, the CMAP population forecast is higher due to CMAP's assumption that the 2040 average household size will stay approximately the same as that of 2000 (3.60). ACG's assumption is that the average household size will continue to decline (post-2000) reaching 2.80 by 2040.

Appendix A is a table presenting, by suburban township and City of Chicago Community Area Grouping (CAG), the 2010 base year data and 2040 Market-Driven total population, households, and total employment. These Market-Driven forecasts represent the I-290 No-Build Scenario. The socio-economic variables, required as input into the transportation demand model (I-290 No-Build Scenario) were derived from these township and CAG control totals.

## G. Statistical Verification of the S-Curve Forecasting Methodology

As noted earlier, graphs similar to those presented as Exhibits 12-18 (preceding section) were prepared for each of 118 suburban townships (or combined townships). These graphs offer a visual verification of the strong correlation between the S-Curve equations and historical data. To quantify the statistical relationship between the S-Curve predictions and actual observed data, ACG plotted these two sets against each other. The actual Census population for each of the 118 townships for each decade was plotted against S-Curve predictions for that township and year. As the period 1920-2010 implied ten Censuses, there are 1,180 population observations to compare. The statistical observations for households were 708, as they cover the shorter period 1960-2010 (six-Censuses). The observations for employment are 545, as they cover the period 1970-2010 and do not include townships in Kendall County, as comparable employment data are not available for years prior to 2000. All the above numbers of observations are large enough to enable robust statistical analysis.

Table 3 presents the R-squared for the correlations between actual and S-Curve predictions for population, household and employment. The R-squared for all three variables are extremely good, as they approach 1.0, which indicates a perfect fit of the data. The R-squared are consistently high for the longer (1920-2010) period, as they are for the shorter (1960-2010, 1970-2010). It is the household statistic, however, that fares best, albeit slightly; at 0.991 (1960-2010) and 0.992 (1970-2010); these are almost perfect correlations between forecast and actual growth. As noted earlier, land availability controls housing construction and, therefore, households. As hypothesized earlier, it is logical to expect better predictions of households than population, using the S-Curve methodology.

**Table 3. Actual Versus S-Curve Predictions**

| Factor | Period | Observations | $R^2$ |
|---|---|---|---|
| Population | 1920-2010 | 1,180 | 0.975 |
| Population | 1960-2010 | 708 | 0.977 |
| Households | 1960-2010 | 708 | 0.991 |
| Employment | 1970-2010 | 545 | 0.971 |
| Population | 1970-2010 | 545 | 0.979 |
| Households | 1970-2010 | 545 | 0.992 |

Exhibits 28 and 29 show the plots of actual population versus S-Curve-predicted population for the period 1920-2010 and 1960-2010, respectively. The 28 significant outliers in the latter graph were reviewed. Of these, the S-Curve under-estimated the population of 17, 14 of which were mature, or nearing-maturity, townships in 1960 or 1970. The high birth rates, followed by large average household size, caused these 14 observations to be underestimated. Of the 11 outliers where the S-Curve over-estimated the population, five were Berwyn and Cicero, in 1970, 1980 and 1990. During this period, these two mature townships included many older householders; but had not yet gone through a generational shift. The generational shift for these two townships occurred in the following decade or two and their actual populations approached S-

Curve-predicted. Another five over-estimated outliers are mature townships in 2010 which are on the verge of generational shift.

**Exhibit 28: Actual Population vs. S-Curve Predicted: 1920-2010**

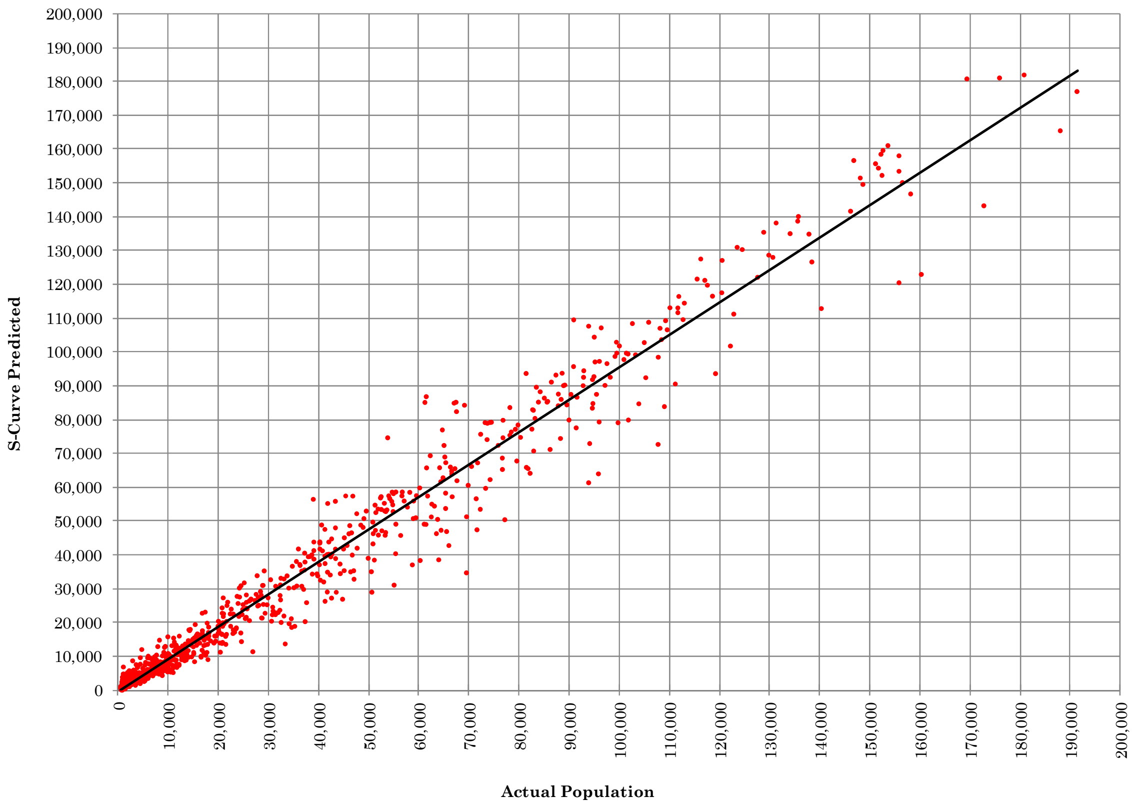



**Exhibit 29: Actual Population vs. S-Curve Predicted: 1960-2010**

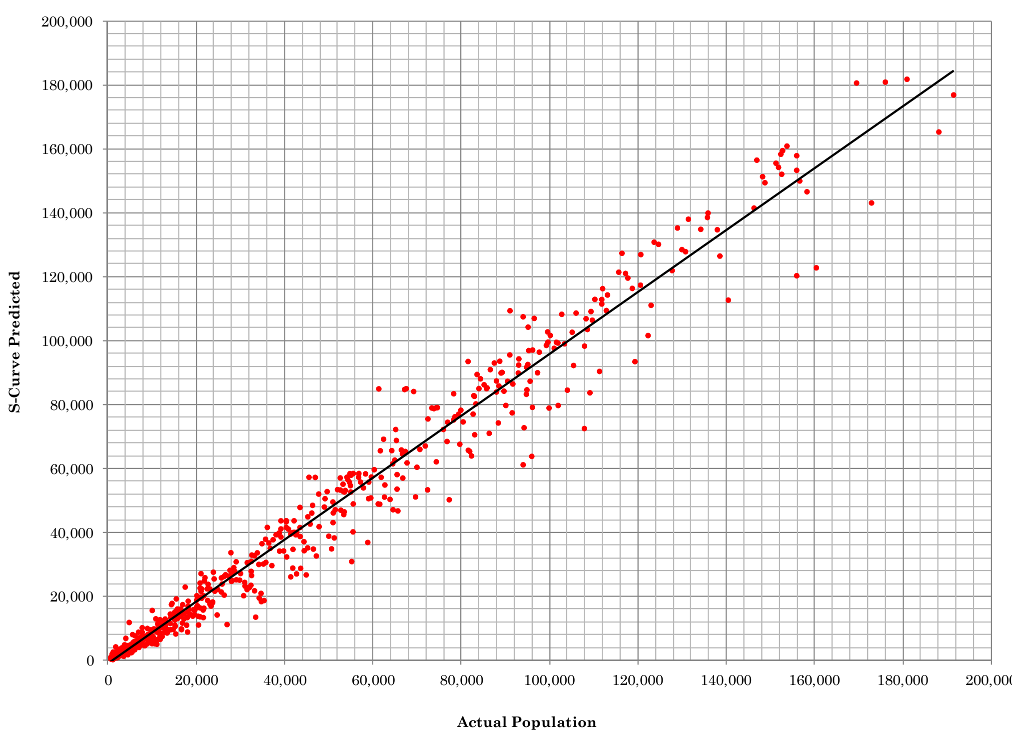


Exhibit 30 shows the plot for actual households versus S-Curve-predicted households for 1960-2010. The graph contains virtually no significant outliers and these few outliers are random. It is for this reason, that ACG considers households to be the most-reliable and accurate forecast factor for regional growth – at township or similar size geographic units using the S-Curve methodology.

**Exhibit 30: Actual Households vs. S-Curve Predicted: 1960-2010**

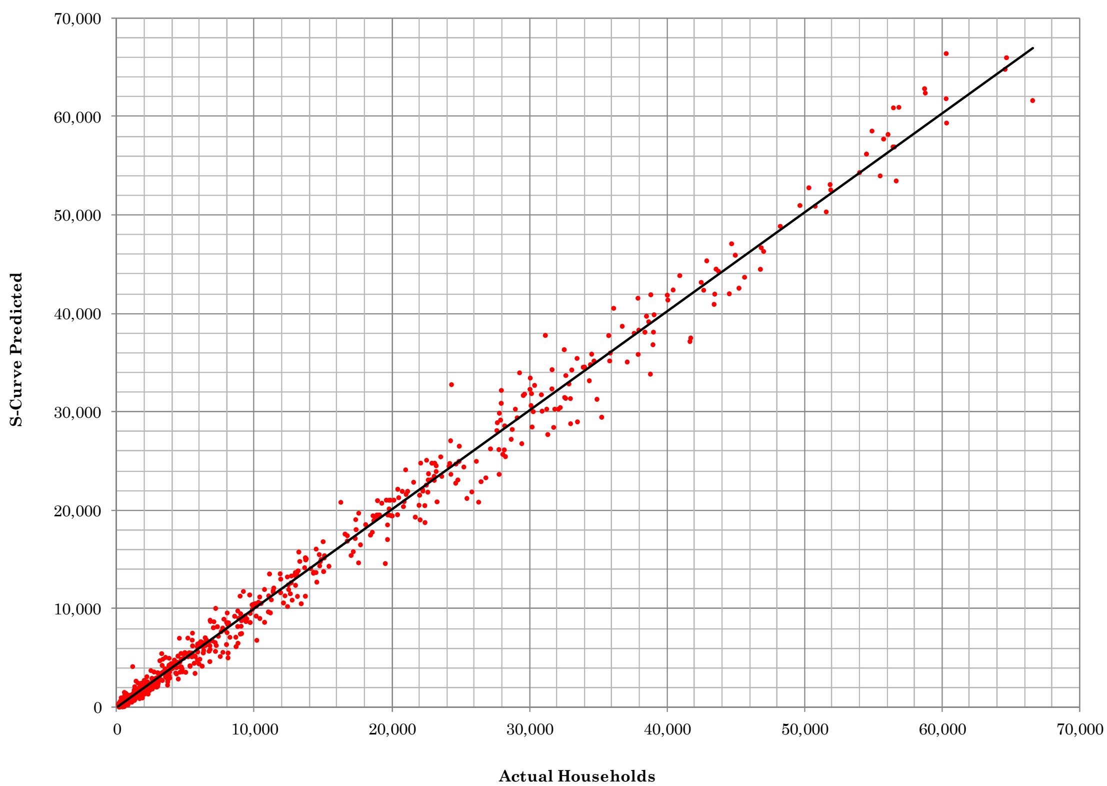
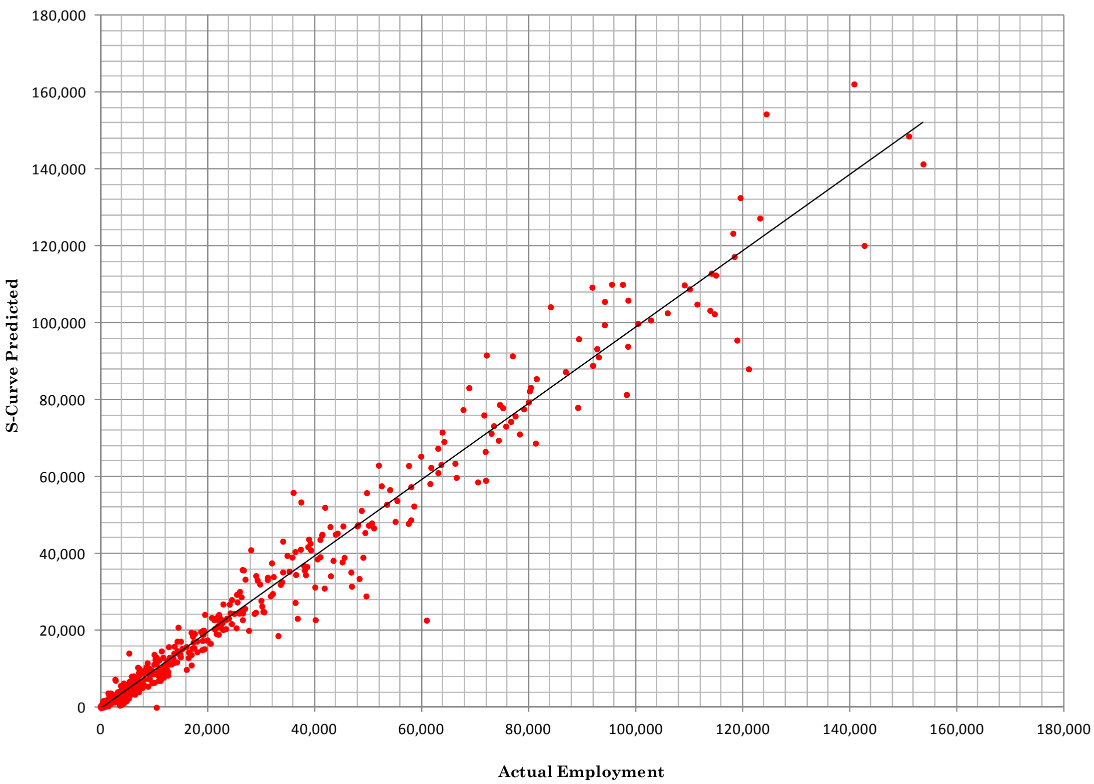



Exhibit 31 shows the graph for actual employment versus S-Curve-predicted employment for 1970-2010. Its R-squared, of 0.971, is the lowest, among the variables tested, but is still robust. Most of the outliers, above the predicted line, are mature townships with high employment (e.g. 2010 York, 2010 Elk Grove, 2010 Aurora) which suffered significant employment losses due to the Great recession. Most of the outliers, below the prediction line, are townships during their very fast growth periods (e.g. 1980 Elk Grove, 1990 Schaumburg).

## Exhibit 31: Actual Employment vs. S-Curve Predicted: 1970-2010



# 3.0 The CMAP/NIPC Socio-Economic Forecasts: Historic and Comparison with I-290 Market-Driven Forecasts

## A. Background

The Chicago Metropolitan Agency for Planning (CMAP) and its predecessor agency, Northeastern Illinois Planning Commission (NIPC) have been generating socio-economic forecasts as input into transportation planning since the mid-1960's. The methodology for generating these socio-economic forecasts evolved, reflecting improvements in the state of the profession, changes in federal regulations, and Federal court decisions relating to EIS studies.

Starting in the mid 1990's and extending to 2010, the NIPC and CMAP socio-economic forecasts included the following characteristics:

- Incorporated commonly-accepted planning principles – e.g. encouraging residential infill and adaptive reuse of sound structures; encouraging high-density development near high-accessibility transportation nodes and transit stations; avoiding development in environmentally-sensitive areas; providing and/or protecting adequate spaces for public facilities (schools, parks, local streets, etc.)
- Recognized and reflected the market forces that influence and shape urban development in the Chicago Region.
- Developed planning objectives in cooperation with local and county planners and officials, ensuring adherence to local regulations and ordinances.
- Included two sets of socio-economic forecasts: one, reflecting a "No-Plan" scenario; and, a second, developed following the adoption of the Regional Transportation Plan (RTP) and referred to as the "Plan" or "Plan-Build" scenario.

The last comprehensive socio-economic forecasts, developed in accordance with the above principles, was that generated by NIPC for the 2030 RTP following the release of the 2000 Census results. That set of socio-economic forecasts was updated in 2006 and used by CMAP for the update of its 2030 RTP. Those forecasts remained the official CMAP forecasts until the GO TO 2040: Comprehensive Regional Plan, published late in 2010.

The CMAP 2040 socio-economic forecast represented a major departure from prior CMAP/NIPC forecasting methodology. It is a "wholesale shift to scenario-based evaluation and its intentional reliance on forecasts that reflect implementation of preferred regional planning strategies. The current official CMAP forecasts are for the year 2040 and reflect the expected outcome of the preferred regional scenario adopted by the CMAP Board."[8]

Recognizing that all intended Policy-Based results may not materialize, CMAP opted not to adopt its forecasts as the official forecasts to be used for infrastructure planning studies. The

[8] "CMAP Forecast Principles", Internal Memorandum, April 2011.

CMAP staff noted that such planning studies would be permitted to develop their own forecasts, provided that such forecasts use reasonable methodologies and acknowledge their differences from the CMAP forecasts. The CMAP principles for generating the alternative forecasts were discussed in Section 1.0.

The differences between the NIPC/CMAP 2030 and the CMAP 2040 forecasts are, themselves, the result of two different approaches to forecasting. The first includes market-driven forecast principles and also reflecting local plans and preferences; whereas, the second represents a policy-based forecast channeling development within the policies prescribed in the GO TO 2040: Comprehensive Regional Plan.

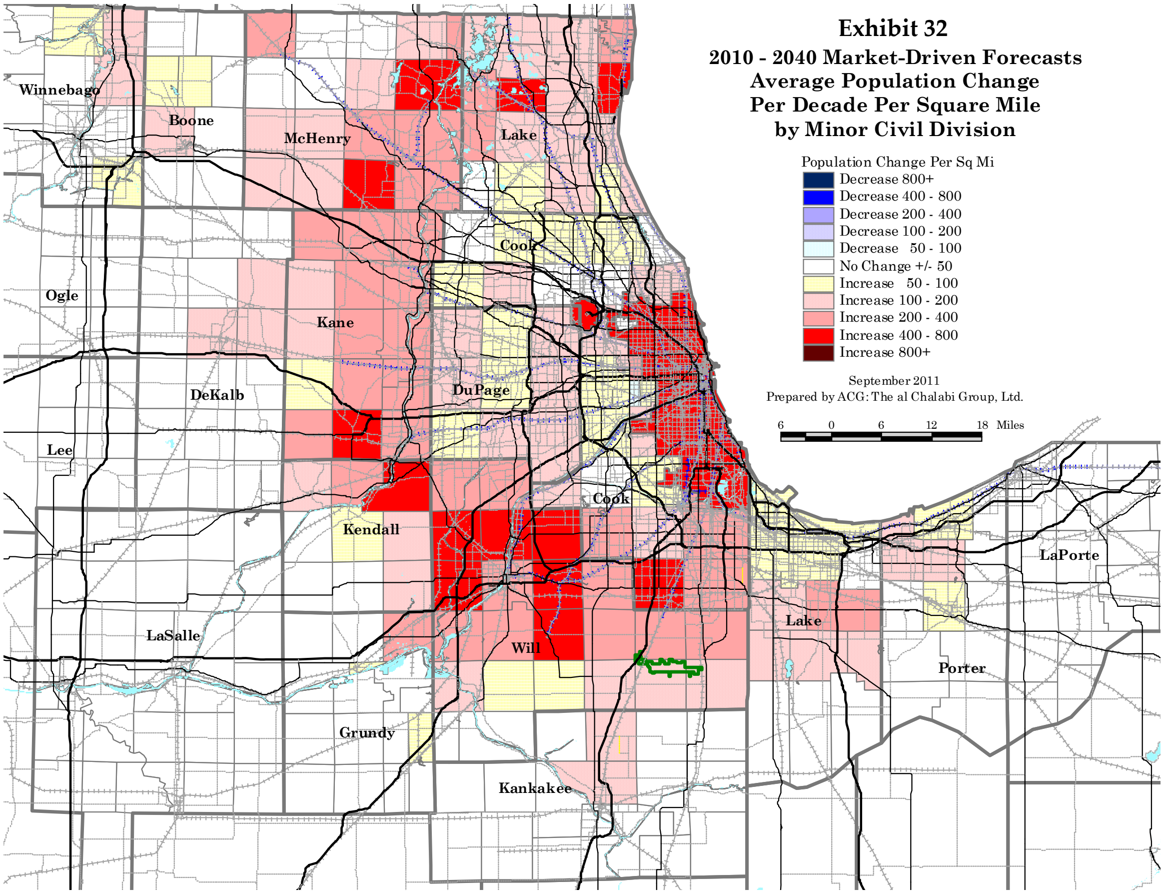
CMAP initially generated a "Reference Scenario" forecast for 2040; it assumed current trends for the socio-economic forecasts and no transportation project, a "No-Plan" scenario. The CMAP 2040 Policy-Based forecasts were developed as part of the "Preferred Scenario" development, which was completed prior to identifying the major transportation project or finalizing the Transportation Plan. Following the adoption of its GO TO 2040 Plan, CMAP opted not to revise its forecasts. The implied assumption was that the Policy-Based forecasts, which reflected the desired development, would be the same regardless of which major transportation projects were adopted and/or implemented.

As is stated in the Introduction, the 2040 Forecast, prepared by the PB/ACG team for the I-290 No Build Scenario, are more closely related to extrapolations of the NIPC/CMAP 2030 forecast than to the CMAP 2040 forecasts, as both (NIPC and ACG) share the same market approach to forecasting and consider local zoning and prevailing densities as the basis for estimating the holding capacities of townships.

## B. Comparing the I-290 Market-Driven No-Build Forecast with the CMAP Policy-Based Forecast (2010)

Exhibit 32 shows the total population change between 2010 and 2040 of the Market-Driven forecast for the I-290 Study. The data is presented as change per decade per square mile, by township, to provide a more-consistent basis for comparison with prior exhibits. The general picture is of a central city (Chicago) remaining vibrant and growing; a south portion of the region growing to levels previously experienced in the north and west sections of the metropolitan area; substantial growth, creating higher densities, at the region's edges; and an inner suburban area with moderate growth.

Exhibit 33 shows the CMAP Policy-Based forecast distribution of population for 2010-2040. Under this scenario, the City of Chicago and the North Shore lakefront provide a major part of the region's growth. These areas and close-in counties (DuPage, North Cook) are allocated growth which would appear to require substantial increases in density. For this density increase to materialize would require considerable replacement of existing stock, since many areas already are developed to mature levels. The City of Chicago grows to 3,303,768 by 2040. This increase, of 608,170 persons, is nearly double the increase of the Market-Driven forecast. There are major population increases in the close-in townships of Will, McHenry, Kane and Kendall counties; but, growth beyond these areas is limited or contained. Exhibit 34 shows the difference in forecasts of the two population forecast alternatives.



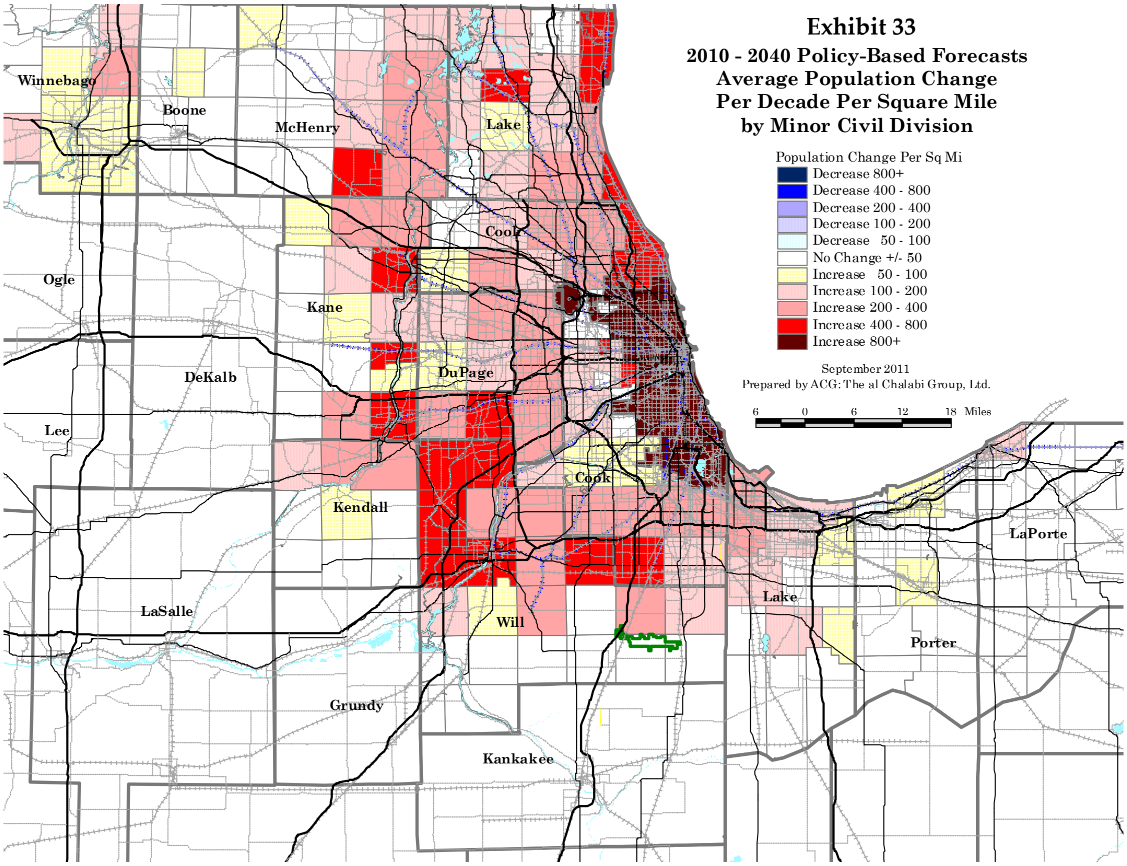


Exhibit 33
2010 - 2040 Policy-Based Forecasts
Average Population Change
Per Decade Per Square Mile
by Minor Civil Division
Population Change Per Sq Mi
Decrease 800+
Decrease 400 - 800
Decrease 200 - 400
Decrease 100 - 200
Decrease 50 - 100
No Change +/- 50
Increase 50 - 100
Increase 100 - 200
Increase 200 - 400
Increase 400 - 800
Increase 800+
September 2011
Prepared by ACG: The al Chalabi Group, Ltd.
6 0 6 12 18 Miles
Winnebago
Boone
McHenry
Lake
Cook
Ogle
Kane
DuPage
DeKalb
Lee
Cook
Kendall
LaPorte
LaSalle
Lake
Will
Porter
Grundy
Kankakee

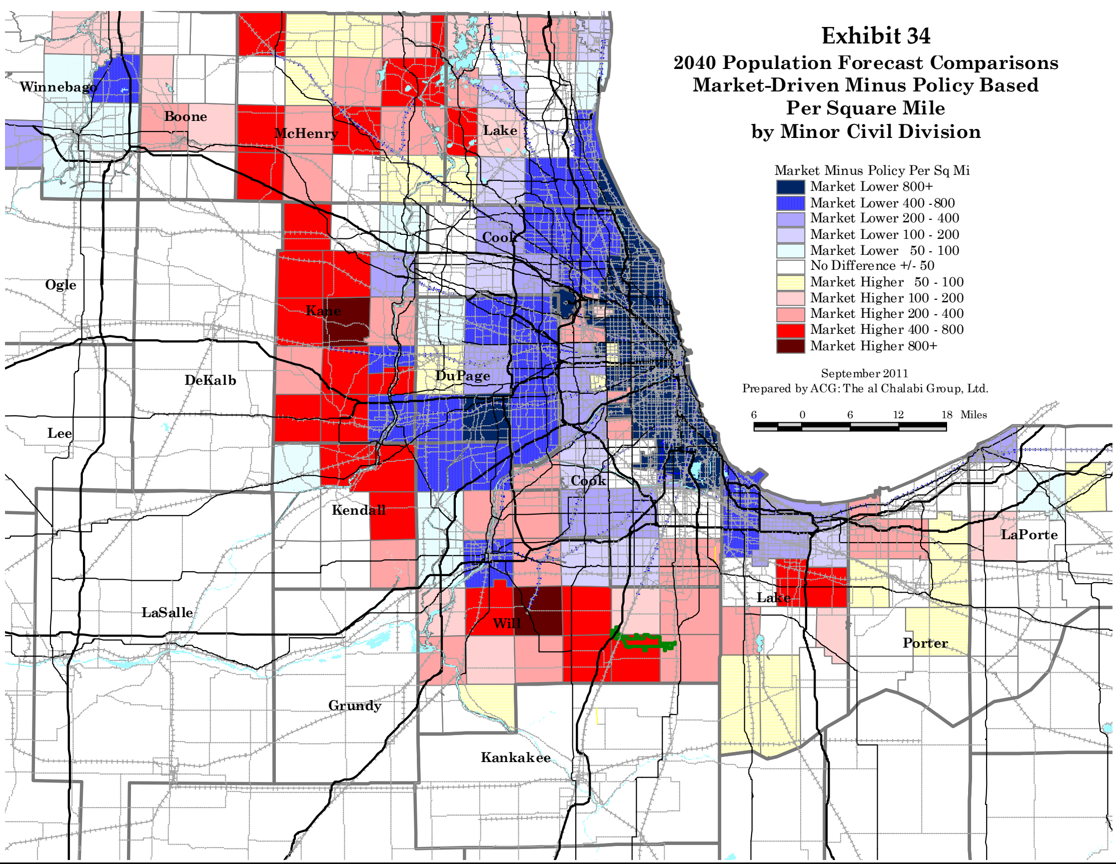


Exhibit 34
2040 Population Forecast Comparisons
Market-Driven Minus Policy Based
Per Square Mile
by Minor Civil Division
Market Minus Policy Per Sq Mi
Market Lower 800+
Market Lower 400 -800
Market Lower 200 - 400
Market Lower 100 - 200
Market Lower 50 - 100
No Difference +/- 50
Market Higher 50 - 100
Market Higher 100 - 200
Market Higher 200 - 400
Market Higher 400 - 800
Market Higher 800+
September 2011
Prepared by ACG: The al Chalabi Group, Ltd.
6 0 6 12 18 Miles
Winnebago
Boone
McHenry
Lake
Cook
Ogle
Kane
DuPage
DeKalb
Lee
Cook
Kendall
LaPorte
LaSalle
Lake
Will
Porter
Grundy
Kankakee

Table 4 compares these two forecasts for population and employment for 18 counties and the four Cook sub-county areas in the Illinois/Indiana parts of the extended Chicago region.

The most significant reason for the differences in township population forecasts, between the I-290 Market-Driven (I-290 No Build) and the CMAP Policy-Based forecasts, relates to the above-referenced differing density assumptions for the fully-developed inner suburbs. Most of the housing stock in these inner suburbs, designated for redevelopment by CMAP, is in excellent condition and has high market value. Furthermore, local zoning ordinances, in most of these areas, do not allow for such high-density redevelopment. Accordingly, substantial redevelopment of these fully-developed inner suburbs is not likely, given current local policies and prevailing market conditions.

However, there are other reasons for the differences between the above two population forecasts. The CMAP forecasts were completed prior to the release of the 2010 Census. The initial 2010 population estimates, by CMAP, for many of these fully-developed townships were higher than those shown in the 2010 Census. Once the Census results were released, CMAP lowered its 2010 base year data, but not its 2040 forecasts. Furthermore, the 2010 Census results revealed smaller households than initially assumed by CMAP. Within the City of Chicago, both forecasts (I-290 Market-Driven and CMAP Policy-Based) have similar household forecasts for 2040, but population forecasts which are significantly different; the difference is due mainly to differing household size. CMAP's average household sizes are closer to 2000 data than the 2010 Census.

**Table 4.**
**I-290/Eisenhower Corridor Study**
**Forecasts for the Region of Chicago**
**Market-Driven Socio-Economic Forecasts 2010 - 2040**

| | Final Market -Driven Population Forecasts | | | | | Final Market-Driven Employment Forecasts (BEA) | | | | | CMAP/NIRPC/RMAP Population Forecasts | | CMAP/NIRPC/RMAP Employment Forecasts | | I-290 Minus Local Population | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **2000** | **2010** | **2020** | **2030** | **2040** | **2000** | **2010** | **2020** | **2030** | **2040** | **2030** | **2040** | **2030** | **2040** | **2030** | **2040** |
| **County Summary: CMAP Region** | | | | | | | | | | | | | | | | |
| City of Chicago | 2,896,014 | 2,695,934 | 2,900,000 | 2,950,000 | 3,000,996 | 1,748,373 | 1,607,821 | 1,630,000 | 1,650,000 | 1,717,925 | 3,261,464 | 3,303,768 | 1,779,852 | 1,537,982 | (311,464) | (302,772) |
| Suburban Cook - North | 1,047,250 | 1,062,687 | 1,087,039 | 1,112,134 | 1,124,872 | 834,534 | 824,815 | 874,052 | 901,486 | 921,377 | 1,106,516 | 1,257,047 | 839,391 | 793,552 | 5,618 | (132,175) |
| Suburban Cook - South | 789,353 | 793,996 | 865,798 | 934,175 | 973,991 | 344,617 | 334,761 | 388,187 | 437,335 | 468,070 | 936,353 | 985,682 | 369,853 | 352,447 | (2,178) | (11,691) |
| Suburban Cook - West | 644,124 | 642,682 | 651,635 | 661,564 | 674,671 | 394,079 | 358,294 | 393,271 | 418,509 | 430,406 | 648,459 | 692,700 | 350,757 | 303,653 | 13,105 | (18,029) |
| Cook County | 5,376,741 | 5,195,299 | 5,504,472 | 5,657,873 | 5,774,530 | 3,321,603 | 3,125,691 | 3,285,510 | 3,407,330 | 3,537,778 | 5,952,792 | 6,239,197 | 3,339,853 | 2,987,634 | (294,919) | (464,667) |
| DuPage County | 904,159 | 917,084 | 963,362 | 998,729 | 1,022,204 | 696,726 | 689,725 | 773,722 | 824,359 | 851,739 | 1,003,704 | 1,160,364 | 830,293 | 770,940 | (4,975) | (138,160) |
| Kane County | 404,119 | 515,650 | 632,678 | 796,695 | 953,519 | 239,975 | 257,348 | 351,782 | 433,261 | 509,619 | 718,464 | 804,249 | 352,207 | 368,496 | 78,231 | 149,270 |
| Kendall County | 54,544 | 114,760 | 168,607 | 224,269 | 262,439 | n/a | 29,806 | 50,038 | 74,460 | 94,492 | n/a | 207,780 | n/a | 73,189 | n/a | 54,659 |
| Lake County | 644,356 | 703,882 | 793,486 | 881,852 | 941,616 | 415,337 | 428,851 | 508,143 | 586,502 | 638,086 | 841,860 | 970,959 | 463,509 | 470,937 | 39,992 | (29,343) |
| McHenry County | 260,077 | 309,000 | 381,303 | 566,698 | 692,183 | 110,734 | 134,820 | 173,528 | 261,706 | 321,513 | 457,593 | 527,649 | 168,575 | 187,829 | 109,105 | 164,534 |
| Will County | 502,266 | 677,936 | 868,986 | 1,146,722 | 1,366,677 | 184,449 | 252,316 | 376,427 | 536,548 | 672,954 | 1,076,447 | 1,217,879 | 415,550 | 481,883 | 70,275 | 148,798 |
| **Total: Seven-County CMAP Region** | **8,146,262** | **8,433,611** | **9,312,894** | **10,272,838** | **11,013,168** | **n/a** | **4,918,557** | **5,519,150** | **6,124,166** | **6,626,181** | **n/a** | **11,128,077** | **n/a** | **5,340,908** | **(2,291)** | **(114,909)** |
| **County Summary: NIRPC Region** | | | | | | | | | | | | | | | | |
| Lake County (IN) | 484,564 | 496,005 | 537,419 | 584,068 | 625,000 | 242,849 | 229,563 | 255,486 | 283,500 | 309,598 | 504,808 | 625,019 | n/a | 282,844 | 79,260 | (19) |
| LaPorte County | 110,140 | 111,474 | 114,827 | 119,026 | 123,229 | n/a | 54,402 | 58,878 | 63,354 | 67,830 | n/a | 123,229 | n/a | 68,106 | n/a | 0 |
| Porter County | 146,798 | 164,343 | 185,303 | 203,933 | 222,563 | 70,218 | 71,768 | 83,634 | 95,500 | 107,060 | 164,582 | 190,768 | n/a | 82,131 | 39,351 | 31,795 |
| **Total: Three-County NIRPC Region** | **741,502** | **771,822** | **837,549** | **907,027** | **970,792** | **n/a** | **355,733** | **397,998** | **442,354** | **484,488** | **n/a** | **939,016** | **n/a** | **433,081** | **118,611** | **31,776** |
| **Summary: Other Illinois Counties** | | | | | | | | | | | | | | | | |
| Boone | 41,786 | 54,165 | 64,877 | 75,676 | 86,973 | - | 19,849 | 23,658 | 27,493 | 31,499 | - | 68,516 | - | 27,319 | - | 18,457 |
| DeKalb | 88,969 | 105,160 | 122,413 | 139,201 | 155,000 | - | 52,772 | 58,837 | 64,898 | 70,963 | - | - | - | - | - | - |
| Grundy | 37,535 | 50,063 | 61,265 | 72,463 | 83,665 | - | 21,873 | 26,907 | 31,941 | 36,975 | - | - | - | - | - | - |
| Kankakee | 103,833 | 113,449 | 125,632 | 137,817 | 150,000 | - | 55,231 | 61,820 | 68,411 | 75,000 | - | - | - | - | - | - |
| LaSalle | 111,509 | 113,924 | 118,178 | 121,928 | 125,686 | 58,303 | 52,676 | 56,658 | 60,643 | 64,414 | - | - | - | - | - | - |
| Lee | 34,590 | 36,031 | 35,274 | 36,411 | 37,548 | 17,958 | 15,381 | 17,932 | 19,091 | 20,150 | - | - | - | - | - | - |
| Ogle | 51,032 | 53,497 | 58,839 | 63,025 | 67,214 | 25,385 | 22,404 | 25,944 | 29,481 | 31,795 | - | - | - | - | - | - |
| Winnebago | 278,418 | 295,266 | 315,259 | 335,654 | 356,250 | - | 155,293 | 168,449 | 181,600 | 194,756 | - | 380,506 | - | 187,654 | - | (24,256) |

* Dated March 15, 2010 and used for the I-290 transportation modeling of the I-290 "No-Build" Scenario.

There are two reasons for the differences between the I-290 Market-Driven and CMAP Policy-Based employment forecasts. The first and more-important reason relates to the definitions and sources of employment data. The primary source for the CMAP/NIPC employment data is the Illinois Department of Employment Security (IDES). The IDES employment data has been historically used by CMAP/NIPC because of the detailed place of work information. CMAP/NIPC compiled its employment data by geo-coding the IDES addresses to quarter-sections and aggregating the employment data to townships and municipalities. Corrections were also made for corporate headquarters reporting. The IDES data does not include employment not covered by unemployment insurance.

The source of the I-290 Market-Driven employment data and forecasts is the Bureau of Economic Analysis (BEA), of the U.S. Department of Commerce, which publishes employment data, by county. The BEA employment data is the most-complete measure of all full-time and part-time jobs by place of work. Unlike the IDES employment data, it includes all proprietors, agricultural workers, household workers and miscellaneous workers (including those paid in cash). The BEA employment is almost identical to that produced by the National Income and Product Accounts (i.e. data used in Input/Output models); and in the Woods & Poole Economics forecasts used by many regions and states, including Illinois. BEA employment data are available, by County, for a period dating back to 1969. Recently, several commercial resources have started making this data available by township; and ACG has obtained such data for 1990, 2000 and 2010. ACG checked this data against official BEA data, by county, and undertook minor adjustments to ensure compatibility with county data. BEA employment estimates, by township, were generated by ACG using NIPC IDES data and BEA county control totals. Differences between IDES and BEA employment is increasing as both the number of self-employed and the cash economy continue to increase. Since the employment estimates are used as input to the travel forecasting model to estimate work trips, the BEA's more comprehensive employment estimate provides a more representative starting point for travel forecasting.

The second reason for the differences in employment forecasts (I-290 vs. CMAP) is due to differences in market trends vs. CMAP policies. Market trends allow for townships with high concentrations of jobs to continue to grow provided expansion space is available and locational advantages are still present. One of the CMAP policy goals is to balance jobs with nearby residences (workers). Accordingly, job growth in high job townships (e.g. York Township) is discouraged and reduced from historic trends even if vacant space is available.

## C. Why Use the Market-Driven Forecasts for the I-290 EIS Study?

The Federal Highway Administration (FHWA) has issued guidelines on the application of travel and land use forecasting for NEPA/EIS studies[9]. Among the FHWA requirements:

[9] Interior Guidance on the Application of Travel and Land Use Forecasting in NEPA", Federal Highway Administration, March 2010.

- Recent available data should be used – not using 2010 Census data would jeopardize the validity of the EIS forecasts, which was not included in the CMAP GO TO 2040 forecasts (2010).
- "Understanding existing conditions and trends." The Market-Driven forecasts and their S-Curve Model reflect, almost exactly, the growth of the Region during the past 90 years (documented by ten decennial Censuses). The Policy-Based forecasts represent a new methodology that does not cite or explain past trends; furthermore, its intention is to change past trends.
- Inventory land with development potential: This step identifies undeveloped and underdeveloped open land and, in combination with environmental restrictions and zoning regulations, quantifies land available to absorb growth. The Market-Driven forecasts use this principle to determine the household, population and employment holding capacities of each township. The Policy-Based forecasts are not constrained by such factors.
- Assign population and employment to specific locations: This step uses land availability, the cost of development, and the attractiveness of various areas to estimate the amount and type of growth that will occur in each zone. Again the Market-Driven forecasts and their S-Curve models reflect this FHWA requirement.

The CMAP staff recognized, initially, the special requirements of FHWA for NEPA/EIS studies. This recognition was one of the reasons why the CMAP staff allowed (and even encouraged) the development of alternative forecasts for project-specific studies. The CMAP staff established guidelines for preparing these alternative forecasts. The I-290 Team adhered to these CMAP guidelines in developing the Market-Driven socio-economic forecasts.

Also, the CMAP GO TO 2040 forecasts scenarios did not include a No Build scenario consistent with NEPA requirements for use in project level analysis. CMAP had developed a "Reference Scenario" as a baseline to evaluate over 100 proposed major capital improvements. Because the policy direction of the GO TO 2040 Plan had not yet been established, the Reference Scenario assumed no action, based on the continuation of current socioeconomic and land use trends and no additional transportation infrastructure in 2040. Thus, no major capital projects were assumed and the socio-economic forecasts were based on a straight extrapolation of previous 2030 forecasts. This CMAP Reference Scenario essentially represents a no plan scenario.

# 4.0 The I-290 Build Socio-Economic Forecasts

## A. Overview

The general methodology employed in the Build/No-Build analysis recognizes the important interrelationships between transportation systems and urban development (i.e., accessibility influences locational decisions which, in turn, influence accessibility). In selecting a location for an activity (e.g. industrial plant, office building, residence) the decision-maker considers the accessibility of the various potential sites to concentrations of various activities (e.g. labor force, job concentrations, schools, recreational activities). This fact is general knowledge to every market analyst, real estate broker and developer; and is used in conducting their day-to-day business. It also is understood that improving the access of developable or redevelopable sites increases the development potential of those sites, attracting development (residential, commercial/industrial, institutional) that may have occurred elsewhere in the region.

The general method employed, in this analysis, compares the existing accessibility with that provided by the proposed improvements. The I-290 Phase 1 Study uses as its baseline (2010-2040) forecasts, the Market-Driven No Build forecasts prepared by ACG and whose methodology and results were described, previously, in Section 2.0 of this report.

The Market-Driven No Build baseline forecasts reflect 2040 conditions assuming no I-290 Eisenhower Expressway improvements (no additional lanes on I-290) and no Blue Line Forest Park Branch transit extension. The No Build baseline forecasts, however, do assume the implementation of other major capital transportation projects included in the approved, financially-constrained, metropolitan transportation plan for the region (outside of the Study Area), and the Transportation Improvement Program for the region.

## B. Build Forecast Methodology

There are many factors influencing the distribution of households, population and employment within a metropolitan region. Among these factors are:

- Availability and cost of developable land.
- Quality of education.
- Availability and quality of other urban services, e.g. water, sewers, public safety, open space.
- Quality of the landscape, e.g.: terrain, tree coverage, scenery and waterfront.
- Accessibility considerations, especially between jobs and labor.

The introduction of new transportation facilities and/or services changes the accessibility of an area and directly impacts population, household and employment forecasts. The I-290 analysis retains the accessibility measures and methodology for determining them that were used, previously, in the studies cited in the Overview. This methodology compares the changes in highway travel times, only. This methodology is used for generating the socio-economic forecasts for the first of the I-290 Build Scenarios – the highway improvement only.

Because the second of the I-290 Build Scenarios includes both highway and transit (Blue Line) extension, it was determined that Composite Accessibility impacts must be used to measure changes in accessibility and developmental impacts for this scenario. To ensure that the results of this composite forecast are reasonable, they are compared with those of the Highway-Only Accessibility analysis, which technique has been accepted in prior EIS analyses, and which may be construed as the state of the profession. Two composite measures of accessibility were prepared, evaluated and compared to the Highway travel time measures; these two measures are "General Cost" and Travel Time Equivalent". The latter measure (travel time equivalent) was selected for the combined highway/transit improvement as its highway component better-approximated the travel time impact of the highway-only improvements.

The percent change in accessibility is applied to changes in household and employment forecasts (2010-2040) to generate the impact of the transportation improvement. It should be noted, that the sum total of positive impacts (more growth) is set to equal the sum total of negative impacts (lesser growth). The implication of this assumption is that the total regional growth (within the transportation modeled region) is unchanged – i.e. transportation improvements cause redistribution of socio-economic activities rather than generating additional regional growth. This assumption has been imposed, by IDOT and Federal agencies, on Build/No Build analyses to discourage the generation of exaggerated benefits for any given project. It is true that some major transportation projects do cause an increase in the accessibility of the region, as a whole; such projects may imply additional growth for the region. However, the Build/No Build analysis guidelines do not allow for changing the regional growth totals. The Build/No Build analysis is intended to measure only the redistribution impacts of the project.

## C. Measuring Accessibility

Each Transportation Analysis Zone (TAZ) has an accessibility index which measures the travel impedances between that TAZ and other TAZ's within a region. The introduction of a new transportation facility changes this accessibility. TAZ's which improve their accessibility to jobs or labor force become more attractive for residential or industrial/commercial developments, respectively. The reverse also is true. The first operational issue is to generate indexes for measuring accessibility to jobs and labor force. These generated indexes:

- have a theoretical basis
- can be calibrated using historical data
- can be forecasted using acceptable models

In selecting jobs, workers put more emphasis (weight) on jobs closer to their residences than on jobs farther away. The varying weights are the functions of the inter-zonal impedances in a gravity-type trip distribution model. The method for calibrating this function is described in Appendix B – Travel Time Impedance Estimation.

Exhibit 35, below, shows these weights, $F_{i,j}$s, as functions of travel time. The sum product of these weights and the travel times from a given origination zone to all destinations generates an accessibility index for the origination zone for a specified transportation network. The percent change in the accessibility index for a zone, given two alternative transportation methods, provides the basis for calculating the household or employment forecast differential of these two alternatives. This method for measuring changes in accessibility is used for the highway-only improvement.

**Exhibit 35: Final Weight – $F_{i,j}$s**

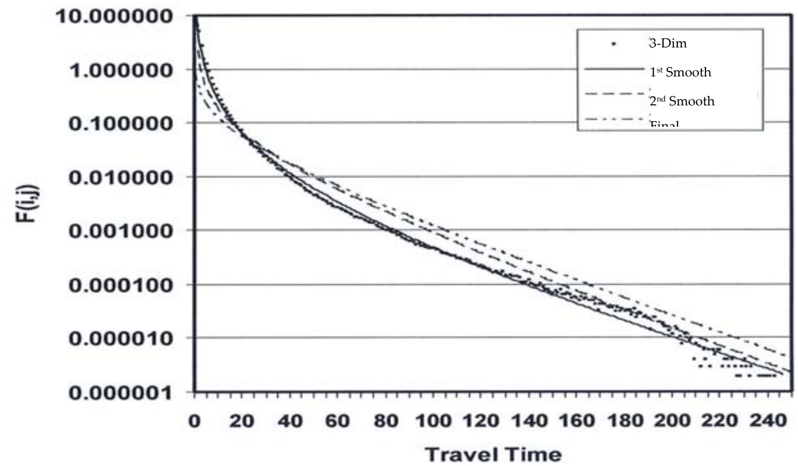



Exhibit 36 shows the percent change in accessibility measures, by TAZ, between the I-290 Build and No Build highway-only improvement scenarios. As anticipated, the TAZ's for the Build Alternative that experience the most increases are those in the vicinity of the I-290 improvements, followed by those along the balance of the corridor and radiating from there along existing expressways. TAZ's which experience relative decline in accessibility are those farther out and away from the proposed improvement.

For the combined highway and transit improvement, the percent changes in accessibility measures, as derived from the travel time equivalent for each of the highway and transit modes, are calculated for each TAZ. These changes in accessibility are adjusted to reflect the modal share for each TAZ. Such adjustments are necessary to eliminate distortions caused by changes in transit accessibility in TAZ's with little or no transit usage.

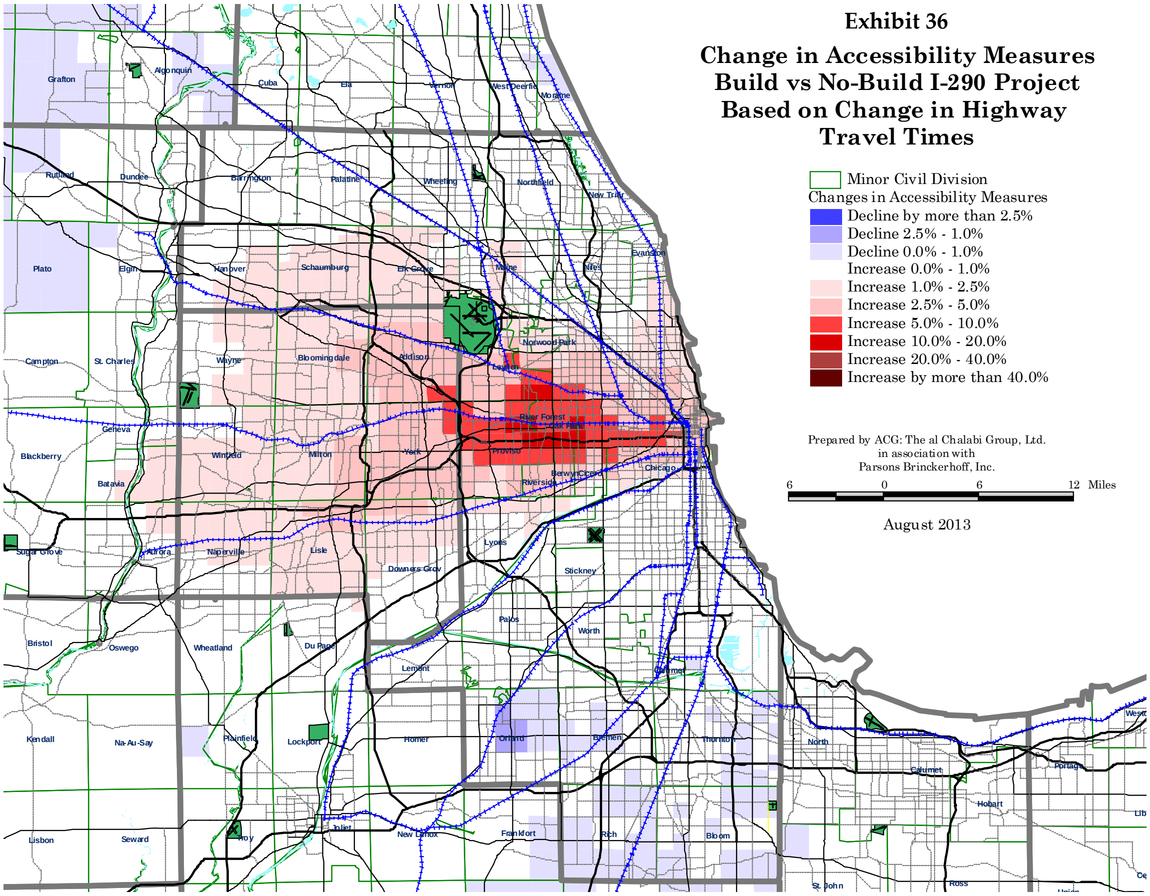



**Exhibit 36**

**Change in Accessibility Measures Build vs No-Build I-290 Project Based on Change in Highway Travel Times**

## D. Impact of Changes in Accessibility Indexes on Residential Development (Household and Population)

Improving access to jobs makes a TAZ/township more attractive for residential development, assuming all other factors influencing development are held constant. Applying the changes in the accessibility measures, discussed in the preceding section, to the 2010-2040 forecasted baseline growth in households, yielded an initial redistribution of households representing the impact of building the proposed project. Following this initial redistribution, two levels of adjustments were made.

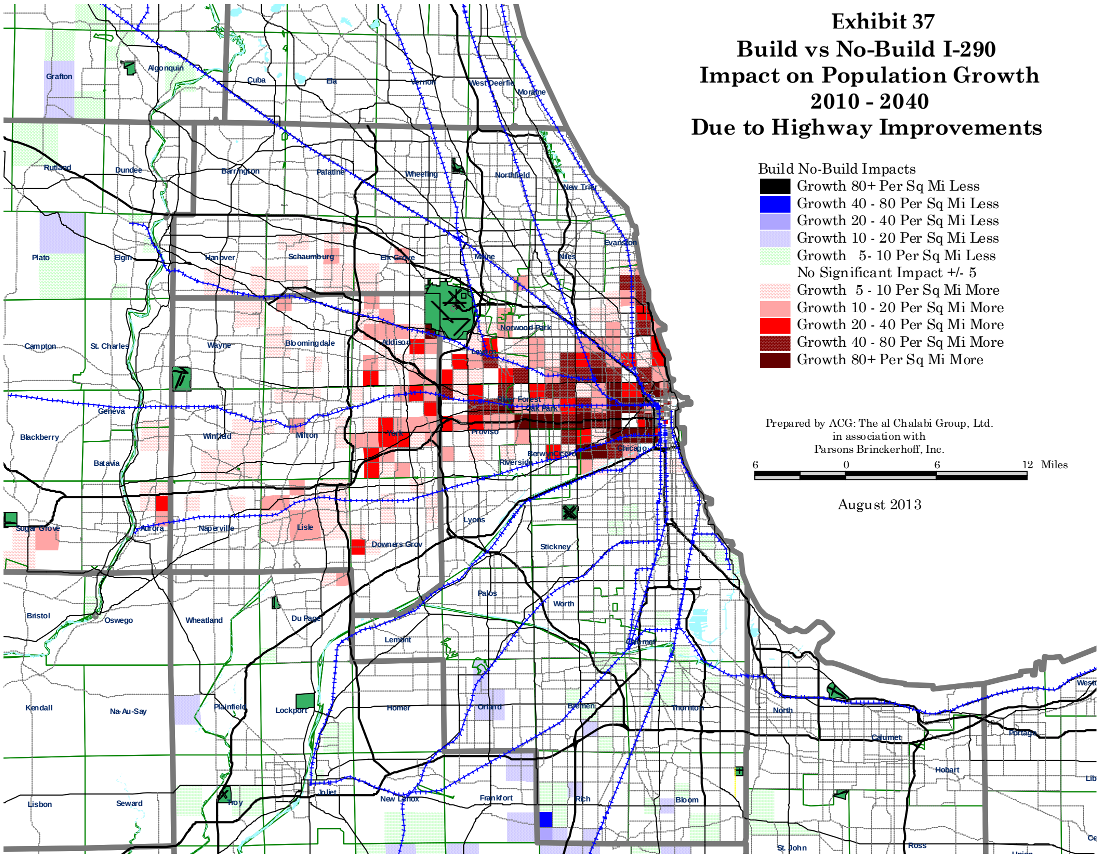
- **Setting a ceiling** – The holding capacity (households) for each TAZ is calculated using such criteria as prevailing densities and available developable land. Households in excess of these capacities are redistributed to nearby zones experiencing increases in accessibility to jobs – a large number of TAZ's required this adjustment.
- **Balancing the accessibility-induced adjustments –** The sum of the induced growth in households and population, as adjusted by the preceding two steps, is balanced by reduction in growth elsewhere in the Chicago CMSA. The magnitude of the reduction in growth, is determined by the change in the accessibility index in each TAZ.

As stated earlier, balancing the increases with decreases in forecasted growth is a policy assumption of the Build/No Build impact analysis model. Not undertaking such balancing implies more growth in the Chicago CMSA at the expense of other regions within the U.S. There is no basis for assuming such transfers among regions in the absence of a nationwide, single transportation modeling effort. It should be noted that, in the case of the I-290, impact analysis, the accessibility of the Region, as a whole, increases slightly. Accordingly, the increase in household and population forecasts, prior to the balancing process, do exceed the reductions. To achieve the desired balance, areas whose accessibility improved more than the regional average attracted additional residential development from the areas whose accessibility declined or increased at levels below the regional average.

Exhibit 37 shows the impact of the Highway Improvement Component of the proposed project on the redistribution of population, by TAZ. Population impacts of the I-290 are derived by multiplying the household impacts by the average household size, by TAZ. The TAZ's receiving most of the additional growth in population are those experiencing significant changes in accessibility. TAZ's experiencing lesser growth are the TAZ's experiencing reduction in accessibility or increases below the regional average, but which are forecasted to experience considerable 2010-2040 growth in households under the Baseline Alternative. It should be noted, that no TAZ would experience an actual decline in households during the period 2010-2040.

Exhibit 38 shows the impact of the Transit Improvement Component of the I-290 Study on the redistribution of 2010-2040 population. The combined impacts of both the Highway and Transit Components, by County/Cook Subdivisions, are shown on Table 5. This table shows these impacts, by county and sub-area of Cook, for the Seven County (CMAP) area total and for 14 total or partial external counties of the region.

## Exhibit 37
## Build vs No-Build I-290 Impact on Population Growth 2010 - 2040 Due to Highway Improvements




## Exhibit 38
## Build vs No-Build I-290 Impact on Population Growth 2010 - 2040 Due to Transit Improvements

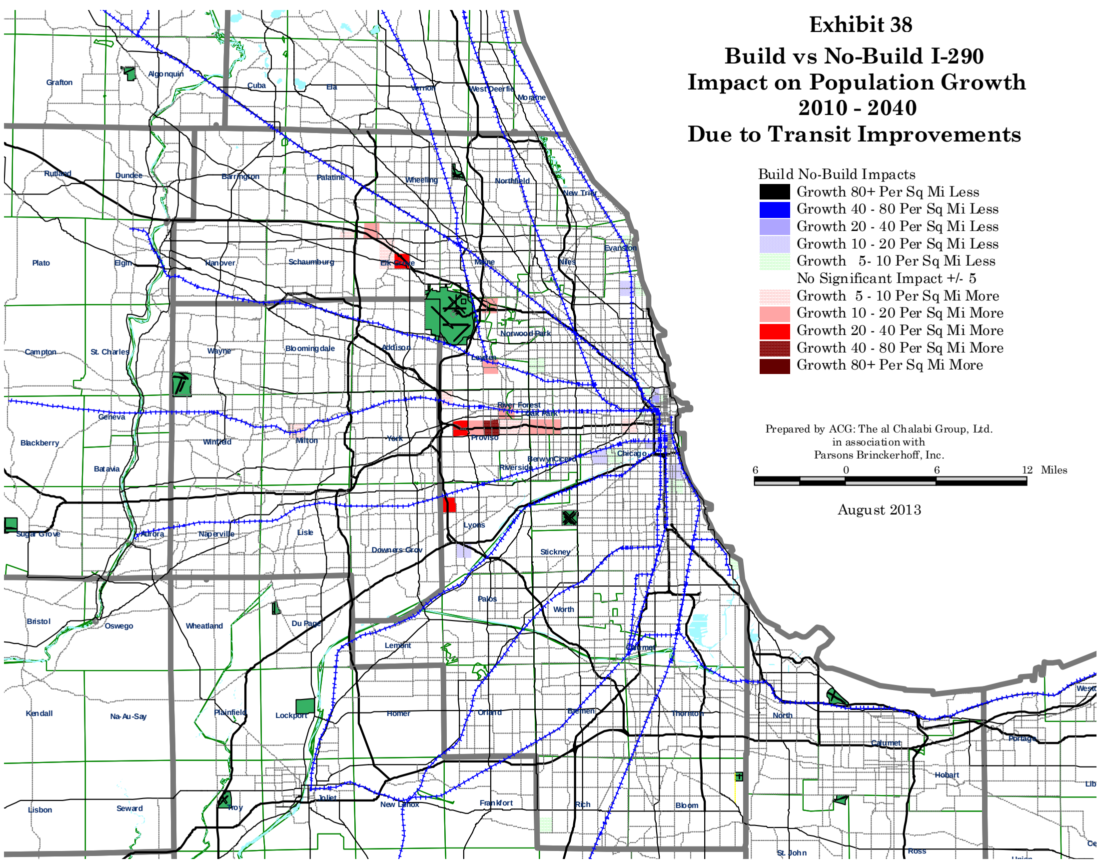


**Table 5**
**Population Impacts of the Proposed Project**
**Comparison of Recommended Build Alternatives - Highway and Transit with No-Build Alternative**

| Geography | Net Highway Impacts | Positive Highway Impacts | Negative Highway Impacts | Net Transit Impacts | Positive Transit Impacts | Negative Transit Impacts | Sum of Net Impacts | Sum of Positive Impacts | Sum of Negative Impacts |
|---|---|---|---|---|---|---|---|---|---|
| **CMAP County Summary** | | | | | | | | | |
| City of Chicago | 3,411 | 3,535 | -124 | -162 | 23 | -185 | 3,249 | 3,558 | -309 |
| Suburban Cook – North | 251 | 251 | 0 | 51 | 63 | -12 | 302 | 314 | -12 |
| Suburban Cook – South | -687 | 0 | -687 | -12 | 0 | -12 | -699 | 0 | -699 |
| Suburban Cook – West | 1,293 | 1,293 | 0 | 164 | 191 | -27 | 1,457 | 1,484 | -27 |
| Cook County | 4,268 | 5,079 | -811 | 41 | 277 | -236 | 4,309 | 5,356 | -1,047 |
| DuPage County | 1,634 | 1,634 | 0 | 11 | 25 | -14 | 1,645 | 1,659 | -14 |
| Kane County | -466 | 240 | -706 | -21 | 0 | -21 | -487 | 240 | -727 |
| Kendall County | -100 | 0 | -100 | 0 | 0 | 0 | -100 | 0 | -100 |
| Lake County | -393 | 6 | -399 | -7 | 8 | -15 | -400 | 14 | -414 |
| McHenry County | -1,425 | 0 | -1,425 | 0 | 0 | 0 | -1,425 | 0 | -1,425 |
| Will County | -1,745 | 59 | -1,804 | -12 | 3 | -15 | -1,757 | 62 | -1,819 |
| | | | | | | | | | |
| Seven-County Total | 1,773 | 7,018 | -5,245 | 12 | 313 | -301 | 1,785 | 7,331 | -5,546 |
| Township Sum | 1,773 | 7,018 | -5,245 | 12 | 313 | -301 | 1,785 | 7,331 | -5,546 |
| **County Summary: External to CMAP** | | | | | | | | | |
| Boone County | -213 | 0 | -213 | 0 | 0 | 0 | -213 | 0 | -213 |
| DeKalb County | -99 | 0 | -99 | -3 | 0 | -3 | -102 | 0 | -102 |
| Grundy County | -40 | 0 | -40 | -3 | 0 | -3 | -43 | 0 | -43 |
| Kankakee County | -148 | 0 | -148 | -3 | 0 | -3 | -151 | 0 | -151 |
| LaSalle County (partial) | -32 | 0 | -32 | 0 | 0 | 0 | -32 | 0 | -32 |
| Lee County (partial) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ogle County (partial) | -12 | 0 | -12 | 0 | 0 | 0 | -12 | 0 | -12 |
| Winnebago County | -182 | 11 | -193 | 0 | 0 | 0 | -182 | 11 | -193 |
| Lake County (IN) | -429 | 0 | -429 | -3 | 0 | -3 | -432 | 0 | -432 |
| LaPorte County | -19 | 0 | -19 | 0 | 0 | 0 | -19 | 0 | -19 |
| Porter County | -126 | 0 | -126 | 0 | 0 | 0 | -126 | 0 | -126 |
| Kenosha County | -368 | 0 | -368 | 0 | 0 | 0 | -368 | 0 | -368 |
| Racine County | -69 | 0 | -69 | 0 | 0 | 0 | -69 | 0 | -69 |
| Walworth County | -36 | 13 | -49 | 0 | 0 | 0 | -36 | 13 | -49 |
| | | | | | | | | | |
| 21-County Tri-State Region | 0 | 7,042 | -7,042 | 0 | 313 | -313 | 0 | 7,355 | -7,355 |
| 21-County Region - Subzones | 0 | 7,042 | -7,042 | 0 | 313 | -313 | 0 | 7,355 | -7,355 |

## E. Impact of Changes in Accessibility Indexes on Employment Distribution

Whereas improving a TAZ's accessibility to jobs makes it more attractive for residential development, the opposite also is true. Improved accessibility to residential concentrations implies better access to labor and consumption, making the area more attractive to industrial and commercial development. In the case of the I-290 Study, the improved accessibility provided by it makes these two factors equally responsible for growth.

The methodology for determining the impact of changes in accessibility indexes on employment distribution is the same as that used for residential re-distribution. Once the distribution of additional growth in employment was completed, a balancing process was undertaken, similar to that described for studying the residential impacts, as discussed earlier. Again, the total 2040 employment forecast for the transportation modeling region is assumed to remain unchanged.

Exhibit 39 shows the impact of the Highway Component of the I-290 Build Alternative on the redistribution of employment. The TAZ's that are forecasted to receive additional growth (above the baseline forecast) in employment are concentrated. Most of the TAZ's with positive impact (more growth in employment) is concentrated within the employment centers located along the I-290 alignment or along expressways or arterials connecting to I-290. Most of the TAZ's with negative (lesser) growth are located at a distance from I-290. It should be noted, again, that no TAZ is forecasted to experience a loss of employment as a result of the proposed project, only reduction in the forecasted growth. However, there are TAZ's forecasted to lose employment as a result of other factors; and these losses are reflected in the baseline forecasts. The overall impact of the proposed project is to attract both population and employment to the center of the Chicago Region.

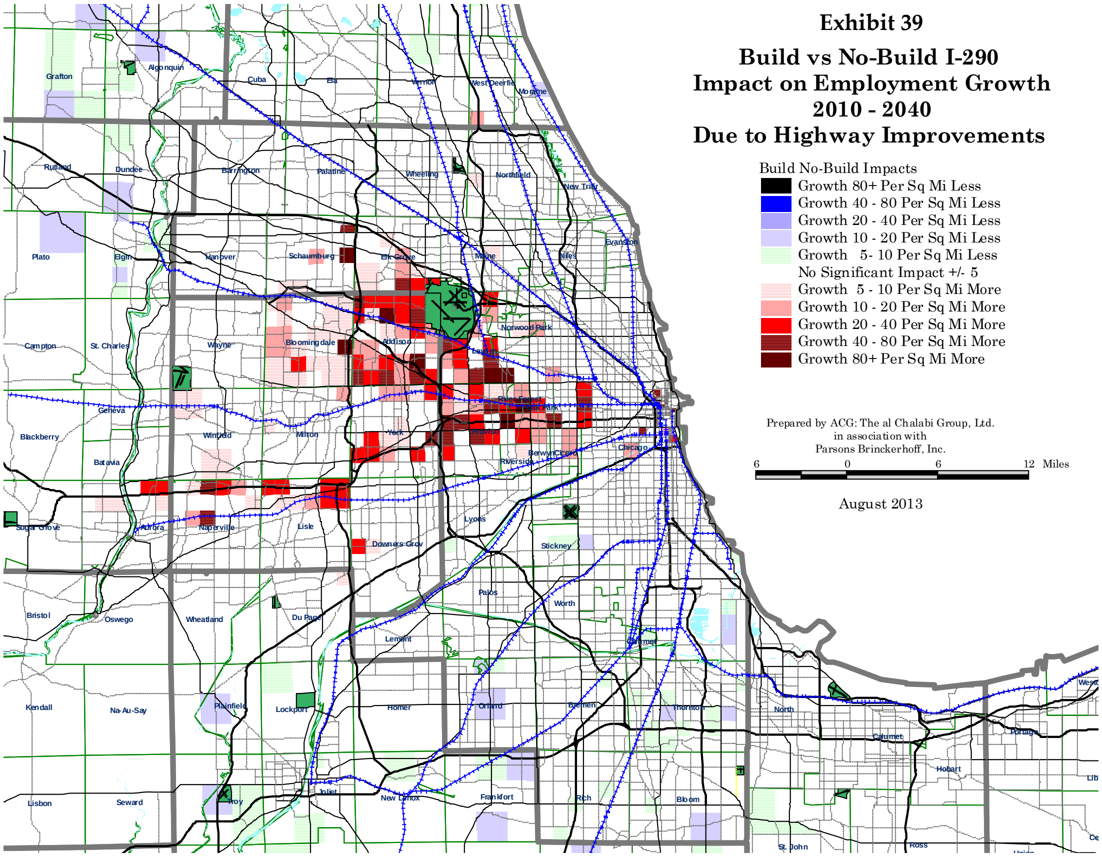



Exhibit 40 shows the impact of the Transit Improvement Component of the I-290 Study on the redistribution of employment growth. The transit improvement consists of the extension of the CTA Blue Line to Mannheim Road and the introduction of express bus service connecting to the Blue Line extension. The positive employment impacts occur at the location of the new stations and the termini of the express bus service.

Table 6 shows the combined employment impacts of both the highway and transit components of the proposed project. These impacts are shown for the seven-county CMAP region and 14 external counties.

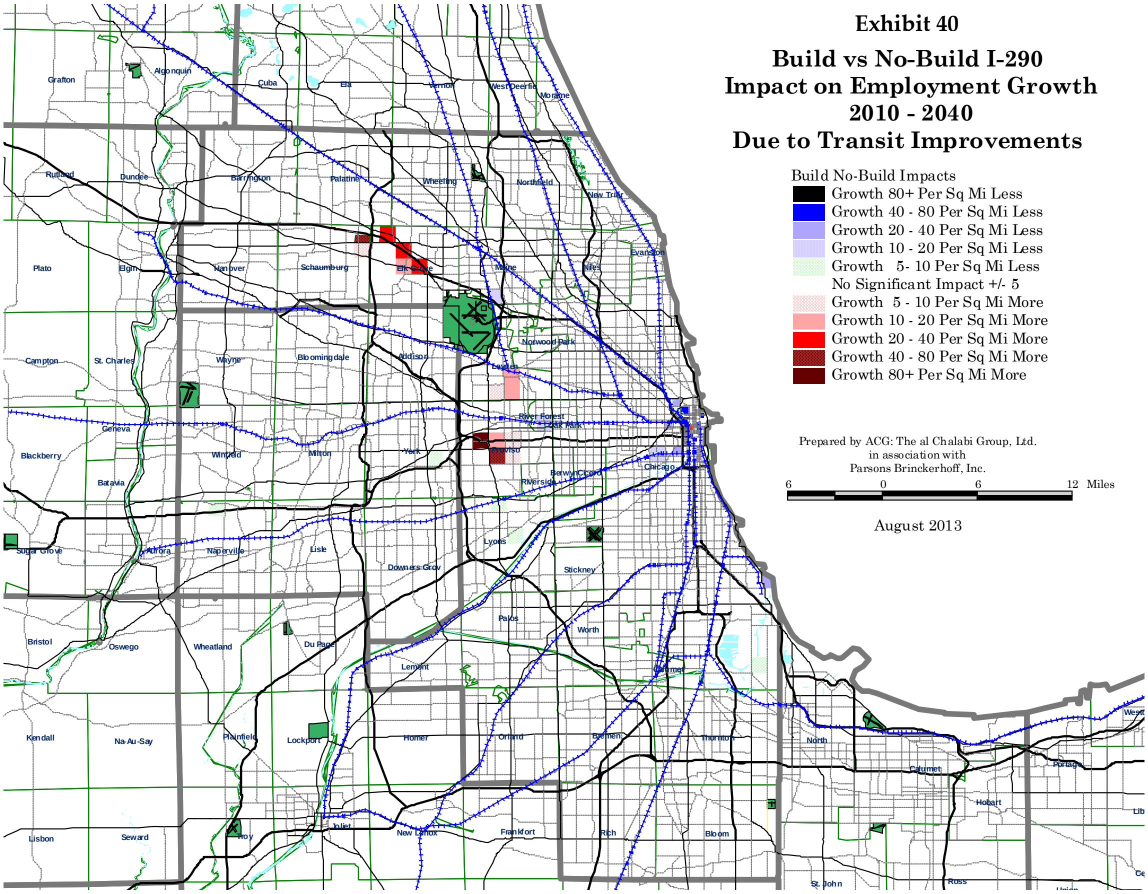


Exhibit 40
Build vs No-Build I-290
Impact on Employment Growth
2010 - 2040
Due to Transit Improvements
Build No-Build Impacts
Growth 80+ Per Sq Mi Less
Growth 40 - 80 Per Sq Mi Less
Growth 20 - 40 Per Sq Mi Less
Growth 10 - 20 Per Sq Mi Less
Growth 5- 10 Per Sq Mi Less
No Significant Impact +/- 5
Growth 5 - 10 Per Sq Mi More
Growth 10 - 20 Per Sq Mi More
Growth 20 - 40 Per Sq Mi More
Growth 40 - 80 Per Sq Mi More
Growth 80+ Per Sq Mi More
Prepared by ACG: The al Chalabi Group, Ltd.
in association with
Parsons Brinckerhoff, Inc.
6 0 6 12 Miles
August 2013

**Table 6**
**Employment Impacts of the Proposed Project**
**Comparison of Recommended Build Alternatives – Highway and Transit with No-Build Alternative**

| Geography | Net Highway Impacts | Positive Highway Impacts | Negative Highway Impacts | Net Transit Impacts | Positive Transit Impacts | Negative Transit Impacts | Sum of Net Impacts | Sum of Positive Impacts | Sum of Negative Impacts |
|---|---|---|---|---|---|---|---|---|---|
| **CMAP County Summary** | | | | | | | | | |
| City of Chicago | 1,398 | 1,501 | -103 | -361 | 49 | -410 | 1,037 | 1,550 | -513 |
| Suburban Cook - North | 359 | 393 | -34 | 86 | 142 | -56 | 445 | 535 | -90 |
| Suburban Cook - South | -623 | 0 | -623 | -50 | 0 | -50 | -673 | 0 | -673 |
| Suburban Cook - West | 1,773 | 1,803 | -30 | 850 | 904 | -54 | 2,623 | 2,707 | -84 |
| Cook County | 2,907 | 3,697 | -790 | 525 | 1,095 | -570 | 3,432 | 4,792 | -1,360 |
| DuPage County | 2,595 | 2,604 | -9 | -79 | 5 | -84 | 2,516 | 2,609 | -93 |
| Kane County | -412 | 194 | -606 | -103 | 0 | -103 | -515 | 194 | -709 |
| Kendall County | -99 | 0 | -99 | -17 | 0 | -17 | -116 | 0 | -116 |
| Lake County | -600 | 16 | -616 | -79 | 2 | -81 | -679 | 18 | -697 |
| McHenry County | -917 | 0 | -917 | -48 | 0 | -48 | -965 | 0 | -965 |
| Will County | -1,391 | 23 | -1,414 | -131 | 0 | -131 | -1,522 | 23 | -1,545 |
| | | | | | | | | | |
| Seven-County Total | 2,083 | 6,534 | -4,451 | 68 | 1,102 | -1,034 | 2,151 | 7,636 | -5,485 |
| Township Sum | 2,083 | 6,534 | -4,451 | 68 | 1,102 | -1,034 | 2,151 | 7,636 | -5,485 |
| | | | | | | | | | |
| **County Summary: External to CMAP** | | | | | | | | | |
| | | | | | | | | | |
| Boone County | -80 | 0 | -80 | 0 | 0 | 0 | -80 | 0 | -80 |
| DeKalb County | -51 | 0 | -51 | -1 | 0 | -1 | -52 | 0 | -52 |
| Grundy County | -34 | 0 | -34 | -2 | 0 | -2 | -36 | 0 | -36 |
| Kankakee County | -98 | 0 | -98 | -2 | 0 | -2 | -100 | 0 | -100 |
| LaSalle County | -44 | 0 | -44 | 0 | 0 | 0 | -44 | 0 | -44 |
| Lee County | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ogle County | -9 | 0 | -9 | 0 | 0 | 0 | -9 | 0 | -9 |
| Winnebago County | -184 | 5 | -189 | 0 | 0 | 0 | -184 | 5 | -189 |
| Lake County (IN) | -348 | 0 | -348 | -13 | 0 | -13 | -361 | 0 | -361 |
| LaPorte County | -35 | 0 | -35 | 0 | 0 | 0 | -35 | 0 | -35 |
| Porter County | -112 | 0 | -112 | -5 | 0 | -5 | -117 | 0 | -117 |
| Kenosha County | -548 | 0 | -548 | -19 | 0 | -19 | -567 | 0 | -567 |
| Racine County | -377 | 0 | -377 | -18 | 0 | -18 | -395 | 0 | -395 |
| Walworth County | -163 | 2 | -165 | -8 | 0 | -8 | -171 | 2 | -173 |
| | | | | | | | | | |
| 21-County Tri-State Region | 0 | 6,541 | -6,541 | 0 | 1,102 | -1,102 | 0 | 7,643 | -7,643 |
| 21-County Region - Subzones | 0 | 6,541 | -6,541 | 0 | 1,102 | -1,102 | 0 | 7,643 | -7,643 |

## F. Socio-Economic Forecast Files as Delivered to Parsons Brinckerhoff Inc., as Input into the Transportation Modeling Process

In the summer of 2013, ACG prepared and submitted to PB, three sets of socio-economic forecasts for 2040. The first of these sets represented the I-290 No Build Scenario; the methodology and principles guiding the preparation of this set are detailed in Section 2.0 of this report. The second set represented the I-290 Build scenario assuming the implementation of only the highway component of the I-290 Study. The third set represented the I-290 Build Scenario assuming the implementation of both the highway and transit components of the proposed project. The two Build forecasts were prepared in accordance with the methodology described in the preceding section of this section.

Each of these three socio-economic files contained the 2010 (base year) and 2040 (forecast) values of 11 variables for each of 16,676 transportation sub-zones in the 21-County CMAP transportation modeling area. With few exceptions, the sub-zone size varied from quarter-section (1/4 square mile), within the CMAP region, to township in some external counties. The variables are required input into the CMAP transportation modeling package used by PB to estimate future transportation demand and evaluate current and future performance of the region's transportation system and facilities with and without the proposed I-290 improvements. The 11 variables, for each sub-zone, of the socio-economic forecasts files are:

- Number of households
- Adults per household
- Workers per household
- Children per household
- Children 12-15 years old as percent of all children
- Average household income as ratio of regional average
- Workers in non-institutionalized group quarters
- Non-workers in non-institutionalized group quarters
- Population in institutionalized group quarters
- Total employment
- Retail employment

In generating the above variables, other variables had to be generated either as input or as reasonable checks. Examples of these additional variables include: number of adults, children, workers; average household size; average household income; and total population.

# 5.0 Epilogue

Almost a year following the completion of the No Build and Build forecasts for the I-290 Phase 1 Study, CMAP started the process of revising its 2040 socio-economic forecasts to reflect the 2010 Census and its 2010 land use survey results. These CMAP revisions are incorporated into their GO TO 2040 Comprehensive Regional Plan Update that was adopted in October 2014.

The updated CMAP forecasts are closer, but still higher, than the I-290 forecasts for the City of Chicago (+1.8%), Suburban Cook County (+4.8%), and DuPage County (+8), which are the main travel markets for the I-290 Corridor.

A comparison of the Study Area 2040 population and employment forecasts was also performed, as shown in Table 7. As seen in this table, the Study Area population forecasts for CMAP and the I-290 EIS are within one percent of each other. For employment, it should be noted that there are definitional differences. The I-290 EIS forecasts use the U.S. Bureau of Economic Analysis (BEA) definition of employment, while CMAP uses the Illinois Department of Employment Security (IDES) definition of employment. The BEA based employment estimate is higher than the IDES based estimate because the BEA defines employment to include the cash economy and self-employed. Therefore, the BEA definition of employment provides a more comprehensive definition of employment.

**Table 7. Comparison of 2040 Study Area CMAP and I-290 No Build and Build Population and Employment Forecasts**

| Forecast | 2040 Population | 2040 Employment |
|---|---|---|
| CMAP Updated Forecast | 645,950 | 256,590* |
| I-290 EIS No Build Forecast | 649,215 | 309,334** |
| I-290 EIS Build Forecast | 651,912 | 310,967** |

* IDES employment definition ** BEA employment definition

# Appendix A

## I-290 Phase 1 Study Market Driven Socio-Economic Forecasts: I-290 No Build Scenario Seven-County CMAP Region, by Township and City of Chicago Sub-Areas

## Market-Driven Socio-Economic Forecasts: I-290 No Build Scenario
## Seven-County CMAP Region, by Township and City of Chicago Sub-Areas

| County/ Sub-County | Township/ Chicago Sub-Area | Area (Sq. Mi.) | Total Population 2010 | Households 2010 | Total Employment 2010 (BEA) | Total Population 2040 | Households 2040 | Total Employment 2040 (BEA) |
|---|---|---|---|---|---|---|---|---|
| Chicago | 01. Central Lakefront | 6.39 | 131,968 | 79,139 | 669,080 | 162,999 | 91,230 | 700,251 |
| Chicago | 02. North Lakefront | 13.96 | 340,475 | 179,271 | 132,211 | 393,671 | 206,601 | 126,362 |
| Chicago | 03. South Lakefront | 10.48 | 144,123 | 66,340 | 61,315 | 163,372 | 77,768 | 58,712 |
| Chicago | 04. North Central | 20.48 | 362,841 | 136,956 | 115,764 | 416,680 | 148,732 | 111,553 |
| Chicago | 05. Northwest | 40.92 | 331,789 | 116,474 | 135,810 | 324,223 | 121,970 | 159,832 |
| Chicago | 06. Near West | 14.57 | 179,684 | 77,812 | 200,826 | 272,349 | 102,139 | 234,298 |
| Chicago | 07. West | 21.66 | 310,220 | 91,486 | 72,143 | 357,389 | 103,154 | 75,058 |
| Chicago | 08. South Central | 23.73 | 242,116 | 83,632 | 62,799 | 266,808 | 93,539 | 62,799 |
| Chicago | 09. Extended Midway | 21.36 | 256,539 | 73,006 | 83,633 | 228,231 | 74,999 | 87,854 |
| Chicago | 10. Southeast | 25.09 | 100,566 | 35,382 | 18,574 | 112,806 | 40,779 | 37,913 |
| Chicago | 11. Far South | 25.07 | 196,510 | 71,708 | 32,250 | 208,292 | 78,476 | 38,408 |
| Chicago | 12. Far Southwest | 13.71 | 99,103 | 34,372 | 23,416 | 94,176 | 35,773 | 24,885 |
| North Cook | Barrington | 36.05 | 15,639 | 5,515 | 18,544 | 20,800 | 7,679 | 27,475 |
| North Cook | Elk Grove | 28.20 | 92,937 | 36,751 | 116,539 | 96,082 | 38,952 | 134,521 |
| North Cook | Evanston | 8.09 | 74,488 | 30,049 | 46,652 | 76,824 | 32,892 | 47,499 |
| North Cook | Hanover | 33.59 | 99,521 | 32,874 | 33,019 | 106,656 | 35,847 | 38,643 |
| North Cook | Maine | 25.42 | 135,762 | 51,866 | 87,100 | 137,600 | 53,789 | 96,603 |
| North Cook | New Trier | 16.31 | 55,431 | 19,601 | 25,634 | 56,002 | 20,189 | 26,002 |
| North Cook | Niles | 20.76 | 105,889 | 38,835 | 93,105 | 114,234 | 42,851 | 109,139 |
| North Cook | Northfield | 34.70 | 85,075 | 32,633 | 115,212 | 90,237 | 35,694 | 127,654 |
| North Cook | Palatine | 36.09 | 113,005 | 43,557 | 77,945 | 119,747 | 46,393 | 80,126 |
| North Cook | Schaumburg | 30.87 | 131,315 | 50,309 | 115,446 | 144,548 | 55,426 | 127,331 |
| North Cook | Wheeling | 36.07 | 153,625 | 60,313 | 95,619 | 162,142 | 64,116 | 106,384 |
| South Cook | Bloom | 46.73 | 90,925 | 31,163 | 34,910 | 127,996 | 44,409 | 66,476 |
| South Cook | Bremen | 37.82 | 110,137 | 40,029 | 47,524 | 128,067 | 47,247 | 57,762 |

| County/ Sub-County | Township/ Chicago Sub-Area | Area (Sq. Mi.) | Total Population 2010 | Households 2010 | Total Employment 2010 (BEA) | Total Population 2040 | Households 2040 | Total Employment 2040 (BEA) |
|---|---|---|---|---|---|---|---|---|
| South Cook | Calumet | 4.03 | 20,779 | 7,316 | 6,727 | 24,293 | 8,592 | 11,342 |
| South Cook | Lemont | 20.78 | 21,137 | 7,387 | 9,690 | 32,891 | 12,164 | 12,096 |
| South Cook | Orland | 36.40 | 97,561 | 35,883 | 37,016 | 120,672 | 45,094 | 49,639 |
| South Cook | Palos | 35.44 | 54,618 | 21,586 | 28,539 | 58,352 | 23,349 | 36,829 |
| South Cook | Rich | 36.57 | 76,808 | 29,118 | 27,362 | 122,981 | 50,246 | 45,841 |
| South Cook | Thornton | 47.46 | 169,387 | 60,304 | 70,291 | 198,784 | 71,509 | 104,383 |
| South Cook | Worth | 31.97 | 152,644 | 58,739 | 72,702 | 159,955 | 62,055 | 83,702 |
| West Cook | Berwyn | 4.67 | 56,659 | 18,912 | 13,349 | 55,476 | 19,034 | 14,464 |
| West Cook | Cicero | 4.35 | 83,893 | 22,101 | 21,313 | 85,584 | 22,968 | 23,332 |
| West Cook | Leyden | 18.69 | 92,894 | 33,463 | 81,765 | 98,982 | 35,799 | 108,066 |
| West Cook | Lyons | 36.88 | 111,703 | 40,928 | 61,452 | 119,974 | 44,795 | 77,602 |
| West Cook | Norwood Park | 2.85 | 26,387 | 10,080 | 20,880 | 26,911 | 10,430 | 21,500 |
| West Cook | Oak Park | 4.69 | 51,878 | 22,670 | 23,601 | 54,935 | 23,844 | 24,301 |
| West Cook | Proviso | 29.35 | 151,724 | 54,909 | 91,828 | 158,974 | 58,011 | 105,837 |
| West Cook | River Forest | 2.82 | 11,174 | 3,962 | 8,948 | 12,194 | 4,508 | 10,782 |
| West Cook | Riverside | 4.04 | 15,598 | 6,247 | 8,831 | 16,530 | 6,725 | 9,181 |
| West Cook | Stickney | 11.95 | 40,772 | 13,665 | 26,327 | 45,111 | 15,164 | 35,341 |
| DuPage | Addison | 32.43 | 88,613 | 30,153 | 123,587 | 98,441 | 34,050 | 159,587 |
| DuPage | Bloomingdale | 35.44 | 111,899 | 40,068 | 71,177 | 118,975 | 43,428 | 95,709 |
| DuPage | Downers Grove | 51.22 | 146,806 | 56,864 | 92,136 | 165,088 | 64,325 | 103,351 |
| DuPage | Lisle | 36.01 | 116,277 | 44,707 | 67,302 | 134,967 | 52,604 | 82,409 |
| DuPage | Milton | 35.28 | 117,082 | 42,899 | 72,525 | 123,267 | 45,596 | 75,207 |
| DuPage | Naperville | 35.79 | 100,040 | 37,950 | 79,622 | 107,467 | 41,557 | 105,589 |
| DuPage | Wayne | 36.48 | 66,583 | 21,150 | 19,154 | 79,504 | 25,787 | 24,880 |
| DuPage | Winfield | 36.15 | 46,237 | 15,104 | 24,327 | 58,016 | 19,559 | 35,197 |
| DuPage | York | 35.62 | 123,547 | 48,237 | 139,895 | 136,479 | 54,271 | 169,810 |
| Kane | Aurora | 35.27 | 146,171 | 44,977 | 69,048 | 178,928 | 55,160 | 111,651 |
| Kane | Geneva/Batavia | 35.13 | 61,770 | 22,032 | 40,612 | 87,189 | 31,506 | 56,702 |
| Kane | Big Rock | 35.14 | 1,859 | 680 | 1,816 | 31,497 | 11,983 | 12,361 |
| Kane | Blackberry | 35.09 | 15,091 | 4,763 | 3,708 | 39,654 | 13,685 | 11,790 |
| Kane | Burlington | 33.75 | 1,923 | 689 | 933 | 22,057 | 8,508 | 8,743 |
| Kane | Campton | 34.80 | 17,178 | 5,475 | 3,693 | 53,008 | 17,627 | 20,883 |

| County/ Sub-County | Township/ Chicago Sub-Area | Area (Sq. Mi.) | Total Population 2010 | Households 2010 | Total Employment 2010 (BEA) | Total Population 2040 | Households 2040 | Total Employment 2040 (BEA) |
|---|---|---|---|---|---|---|---|---|
| Kane | Dundee | 35.94 | 64,167 | 20,432 | 32,394 | 94,587 | 30,390 | 56,142 |
| Kane | Elgin | 32.67 | 100,943 | 33,084 | 52,100 | 131,977 | 43,827 | 82,018 |
| Kane | Hampshire | 35.91 | 7,604 | 2,794 | 3,125 | 29,773 | 11,029 | 11,856 |
| Kane | Kaneville | 35.11 | 1,265 | 482 | 837 | 11,384 | 4,272 | 6,493 |
| Kane | Plato | 33.47 | 6,170 | 2,026 | 1,647 | 43,527 | 15,128 | 18,225 |
| Kane | Rutland | 36.15 | 19,109 | 7,527 | 5,037 | 59,835 | 24,706 | 24,497 |
| Kane | St. Charles | 35.30 | 50,840 | 18,091 | 35,339 | 75,410 | 26,765 | 51,118 |
| Kane | Sugar Grove | 35.28 | 19,622 | 6,714 | 5,927 | 72,863 | 26,912 | 28,480 |
| Kane | Virgil | 35.02 | 1,938 | 718 | 1,132 | 21,830 | 8,448 | 8,660 |
| Kendall | Big Grove | 35.76 | 1,640 | 612 | 671 | 1,926 | 790 | 635 |
| Kendall | Bristol | 28.72 | 26,227 | 8,660 | 6,469 | 56,980 | 19,390 | 22,579 |
| Kendall | Fox | 36.32 | 1,671 | 580 | 281 | 2,125 | 770 | 460 |
| Kendall | Kendall | 39.03 | 7,745 | 2,691 | 2,818 | 14,418 | 5,128 | 5,704 |
| Kendall | Lisbon | 36.63 | 899 | 303 | 90 | 1,058 | 392 | 221 |
| Kendall | Little Rock | 35.68 | 13,085 | 4,349 | 3,743 | 29,682 | 10,188 | 9,803 |
| Kendall | Na-Au-Say | 34.22 | 8,147 | 2,419 | 449 | 27,055 | 9,669 | 5,949 |
| Kendall | Oswego | 40.93 | 50,890 | 17,049 | 14,458 | 113,966 | 38,832 | 45,794 |
| Kendall | Seward | 35.09 | 4,456 | 1,358 | 827 | 15,229 | 5,055 | 3,347 |
| Lake | Antioch | 42.18 | 27,750 | 10,747 | 8,056 | 47,382 | 18,237 | 17,580 |
| Lake | Avon | 23.84 | 65,049 | 20,999 | 26,225 | 98,730 | 32,337 | 33,375 |
| Lake | Benton/Zion | 24.64 | 43,383 | 15,005 | 11,225 | 58,534 | 20,123 | 21,472 |
| Lake | Cuba | 24.26 | 16,826 | 6,518 | 15,030 | 19,998 | 7,734 | 20,028 |
| Lake | Ela | 35.90 | 42,673 | 14,104 | 23,307 | 50,607 | 17,096 | 33,625 |
| Lake | Fremont | 35.82 | 32,492 | 11,371 | 10,266 | 46,101 | 16,529 | 24,081 |
| Lake | Grant | 23.02 | 26,536 | 10,305 | 6,064 | 37,558 | 14,683 | 13,165 |
| Lake | Lake Villa | 25.99 | 40,281 | 13,742 | 7,085 | 53,318 | 18,825 | 19,248 |
| Lake | Libertyville | 36.52 | 53,132 | 19,271 | 74,882 | 69,018 | 24,561 | 85,661 |
| Lake | Moraine/W. Deerfield | 30.36 | 65,209 | 23,558 | 72,637 | 72,513 | 26,893 | 97,739 |
| Lake | Newport | 31.95 | 6,770 | 2,353 | 1,863 | 18,463 | 7,030 | 7,795 |
| Lake | Shields | 18.38 | 39,070 | 9,214 | 26,179 | 50,121 | 13,085 | 39,712 |
| Lake | Vernon | 36.24 | 67,233 | 24,885 | 63,112 | 79,987 | 29,848 | 95,054 |
| Lake | Warren | 36.70 | 64,854 | 23,640 | 36,946 | 79,238 | 29,005 | 55,361 |
| Lake | Wauconda | 24.12 | 21,731 | 8,032 | 12,308 | 43,306 | 16,175 | 20,793 |
| Lake | Waukegan | 22.09 | 90,893 | 27,965 | 33,666 | 116,742 | 35,065 | 53,397 |
| McHenry | Alden | 33.26 | 1,405 | 561 | 249 | 4,582 | 1,772 | 1,086 |
| McHenry | Algonquin | 47.99 | 88,422 | 31,645 | 42,429 | 131,978 | 46,682 | 73,393 |
| McHenry | Chemung | 32.96 | 9,136 | 3,048 | 2,740 | 33,306 | 11,628 | 14,912 |
| McHenry | Coral | 35.99 | 3,554 | 1,266 | 1,976 | 15,470 | 5,912 | 8,399 |
| McHenry | Dorr | 35.94 | 20,920 | 7,872 | 20,589 | 54,994 | 20,944 | 37,135 |
| McHenry | Dunham | 35.84 | 2,846 | 952 | 1,093 | 5,934 | 2,128 | 1,568 |
| McHenry | Grafton | 36.13 | 53,299 | 17,198 | 7,961 | 101,722 | 35,177 | 36,847 |
| McHenry | Greenwood | 35.85 | 13,986 | 4,706 | 3,279 | 34,816 | 11,865 | 12,615 |

| County/ Sub-County | Township/ Chicago Sub-Area | Area (Sq. Mi.) | Total Population 2010 | Households 2010 | Total Employment 2010 (BEA) | Total Population 2040 | Households 2040 | Total Employment 2040 (BEA) |
|---|---|---|---|---|---|---|---|---|
| McHenry | Hartland | 35.88 | 2,033 | 726 | 1,141 | 5,627 | 2,296 | 2,030 |
| McHenry | Marengo | 35.76 | 7,563 | 2,812 | 3,120 | 26,001 | 9,500 | 9,416 |
| McHenry | McHenry | 47.97 | 47,630 | 17,584 | 15,226 | 113,589 | 41,106 | 43,478 |
| McHenry | Nunda | 48.09 | 38,284 | 13,726 | 26,228 | 84,995 | 32,634 | 47,321 |
| McHenry | Richmond-Burton | 43.95 | 11,694 | 4,196 | 6,484 | 39,992 | 15,064 | 19,680 |
| McHenry | Riley | 36.02 | 2,923 | 988 | 504 | 18,822 | 6,914 | 6,818 |
| McHenry | Seneca | 35.89 | 2,949 | 1,029 | 700 | 14,292 | 5,570 | 4,624 |
| Will | Channahon | 35.53 | 10,322 | 3,357 | 5,021 | 30,475 | 10,811 | 16,931 |
| Will | Crete | 44.31 | 23,774 | 9,671 | 5,869 | 66,545 | 26,017 | 27,752 |
| Will | DuPage | 36.78 | 87,839 | 27,667 | 48,252 | 114,997 | 38,660 | 78,509 |
| Will | Florence | 36.50 | 934 | 350 | 216 | 8,261 | 3,185 | 2,675 |
| Will | Frankfort | 36.81 | 57,091 | 19,032 | 30,682 | 99,483 | 33,710 | 71,723 |
| Will | Green Garden | 36.66 | 4,011 | 1,310 | 633 | 32,998 | 12,397 | 14,358 |
| Will | Homer | 36.09 | 39,081 | 12,933 | 7,471 | 82,677 | 29,521 | 32,178 |
| Will | Jackson | 36.20 | 4,101 | 1,531 | 934 | 28,928 | 11,209 | 18,558 |
| Will | Joliet | 36.04 | 87,375 | 30,069 | 43,520 | 109,712 | 37,639 | 59,729 |
| Will | Lockport | 36.60 | 60,202 | 20,763 | 17,729 | 108,980 | 40,347 | 45,731 |
| Will | Manhattan | 36.87 | 9,219 | 3,073 | 1,383 | 82,000 | 30,890 | 25,617 |
| Will | Monee | 35.81 | 15,670 | 5,668 | 7,762 | 58,457 | 22,724 | 34,790 |
| Will | New Lenox | 36.00 | 40,273 | 13,312 | 12,491 | 92,471 | 33,372 | 42,266 |
| Will | Peotone | 36.31 | 4,432 | 1,647 | 1,855 | 25,021 | 9,512 | 10,884 |
| Will | Plainfield | 35.21 | 80,318 | 24,276 | 18,718 | 126,982 | 40,621 | 46,245 |
| Will | Reed | 17.97 | 6,952 | 2,611 | 2,043 | 9,457 | 3,739 | 4,205 |
| Will | Troy | 35.33 | 46,061 | 16,603 | 22,512 | 92,995 | 34,143 | 61,496 |
| Will | Washington | 44.75 | 6,264 | 2,244 | 1,455 | 27,524 | 10,233 | 10,197 |
| Will | Wesley/Custer | 54.98 | 3,663 | 1,389 | 315 | 7,573 | 2,975 | 2,039 |
| Will | Wheatland | 35.82 | 81,493 | 24,297 | 20,192 | 109,988 | 34,647 | 47,578 |
| Will | Will | 36.22 | 1,821 | 662 | 292 | 20,042 | 8,031 | 5,652 |
| Will | Wilmington | 35.92 | 6,196 | 2,490 | 2,849 | 21,094 | 8,520 | 11,662 |
| Will | Wilton | 36.36 | 844 | 304 | 122 | 10,017 | 3,763 | 2,179 |
| County/Sub-County Summary | | | | | | | | |
| City of Chicago | | 237.43 | 2,695,934 | 1,045,578 | 1,607,821 | 3,000,996 | 1,175,160 | 1,717,925 |
| Suburban Cook – North | | 306.16 | 1,062,687 | 402,303 | 824,815 | 1,124,872 | 433,828 | 921,377 |
| Suburban Cook – South | | 297.20 | 793,996 | 291,525 | 334,761 | 973,991 | 364,665 | 468,070 |
| Suburban Cook – West | | 120.27 | 642,682 | 226,937 | 358,294 | 674,671 | 241,278 | 430,406 |
| Cook County | | 961.06 | 5,195,299 | 1,966,343 | 3,125,691 | 5,774,530 | 2,214,931 | 3,537,778 |
| DuPage County | | 334.42 | 917,084 | 337,132 | 689,725 | 1,022,204 | 381,177 | 851,739 |
| Kane County | | 524.04 | 515,650 | 170,484 | 257,348 | 953,519 | 329,946 | 509,619 |
| Kendall County | | 322.37 | 114,760 | 38,021 | 29,806 | 262,439 | 90,214 | 94,492 |
| Lake County | | 472.02 | 703,882 | 241,709 | 428,851 | 941,616 | 327,226 | 638,086 |
| McHenry County | | 610.56 | 309,000 | 109,200 | 134,820 | 692,183 | 251,460 | 321,513 |
| Will County | | 849.07 | 677,936 | 225,259 | 252,316 | 1,366,677 | 486,666 | 672,954 |
| Seven-County Total | | 4,073.53 | 8,433,611 | 3,088,148 | 4,918,557 | 11,013,168 | 4,081,620 | 6,626,181 |

# Appendix B

## I-290 Phase 1 Study Travel Time Impedance Estimation

## Travel Time Impedance Estimation

The following paragraphs describe the procedure to estimate a travel time based impedance function based on northeastern Illinois-northwestern Indiana work trip data. This function is the inter-zonal impedance in a gravity type trip distribution model. The calibrated function was provided to the subconsultant responsible for the development forecasts for the project.

To estimate this function, a gravity model was calibrated to Census Transportation Planning Package (CTPP) Part III journey to work flow tables produced from Census 2000 long-form questionnaires. The estimation procedure is an iterative approach frequently used to calibrate gravity type trip distribution models to observed travel time distributions. Impedances are initially estimated, then used in a gravity model to distribute trips. The travel time distribution for these trips is compared against an observed travel time distribution and the impedances factored by the ratio of observed to distributed trips in a travel time interval. Trips are repeatedly distributed by the model and the impedances factored iteratively until reasonable agreement between the observed and distributed trips travel time distribution is achieved.

### General Trip Distribution Gravity Model

The general formulation of the trip distribution gravity model consists of the following equation that relates the number of trips between zones to the travel impedance between zones.

$$T_{i,j} = a_i \, b_j \, F_{i,j}$$

In this equation: $T_{i,j}$ equals the number of trips between zone $i$ and zone $j$; $a_i$ and $b_j$ are balancing coefficients that depend on trip productions and trip attractions respectively, and; $F_{i,j}$ is the inter-zonal impedance between zones $i$ and $j$.

In a doubly constrained gravity model the trips distributed from a zone must equal the trip productions in the zone ($P_i$), and the trips received by a zone must equal the zone's trip attractions ($A_j$).

1. $P_i = a_i \sum_{j} b_j \, F_{i,j}$

2. $A_j = b_j \sum_{i} a_i \, F_{i,j}$

These three sets of simultaneous equations (the trip distribution and the two constraints) can then be readily solved using two-dimensional matrix balancing when the inter-zonal impedances $F_{i,j}$ s are known.

For gravity type trip distribution models, the most widely used mathematical relationship between the inter-zonal impedance and travel time is the Gamma function. This function has three parameters (◎, ◎ and ◎) that permit a number of different forms for these impedance-travel time relationships, from negative exponential to near normal.

$$F_{i,j} = \alpha\, t_{i,j}^{\beta}\, e^{\gamma t_{i,j}}$$

**Steps in the $F_{i,j}$ Estimation Algorithm**

Several matrices must be prepared before the algorithm to estimate Fi,j can be implemented.

1. A zone to zone matrix of travel time categories is prepared. In this case, the base year I-290 peak period highway travel times are first rounded to integer minutes. All travel times greater than 250 minutes are set to 250. Intra-zonal travel times are assumed to equal two-thirds the travel time to the nearest neighbor zone. No travel times are less than one minute.
2. The auto driver, carpool, taxi, and motorcycle journey to work flows from the northeastern Illinois and northwestern Indiana CTPPs are tabulated into a table of flows between I-290 zones.
3. Zone level trip productions and attractions are summed from the CTPP trip table.
4. The travel time frequency distribution (the number of trips at travel times between 1 and 250) is tabulated from the CTPP trip table and I-290 zone to zone peak highway times.

**Initial $F_{i,j}$ Estimate.** An initial estimate of the $F_{i,j}$s were developed using the three-dimensional balancing module available in the EMME/2 transportation planning software. In this approach, a third constraint is specified for the modeled trip table that requires the distributed trips to match a specified travel time distribution.

The general gravity model distribution is rewritten as:

$$T_{i,j} = a_i\, b_j\, f_{t_{i,j}}\, m_{i,j}$$

The $f_{t_{i,j}}$ is the balancing coefficient for the travel time t required to move between zone i and zone *j*, while $m_{i,j}$ is an initial matrix to be balanced. All other quantities are as defined previously.

As described above, the $F_{i,j}$s are iteratively estimated as in a typical gravity model calibration and the initial starting estimate of the $F_{i,j}$s need only be a crude approximation. However, the best initial estimates of $F_{i,j}$ are obtained when the matrix to be balanced has cells equal to one where interchanges exist in the calibration trip table and zero for pairs of zones without movements.

The three constraints on the distributed trips are as follows:

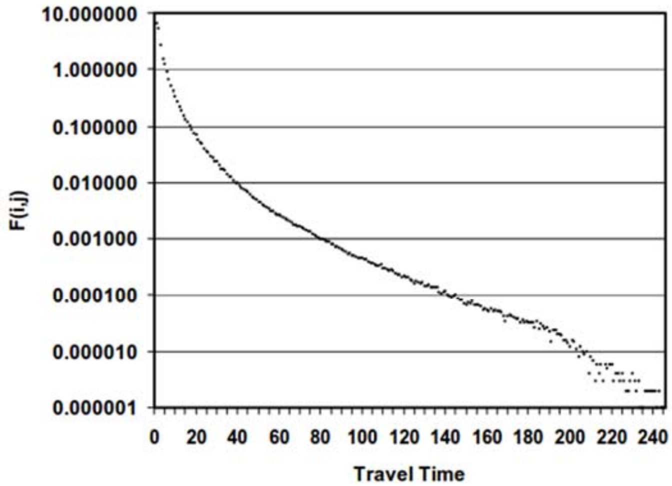
1. $P_i = a_i \sum_j b_j f_{t_{i,j}} m_{i,j}$

2. $A_j = b_j \sum_i a_i f_{t_{i,j}} m_{i,j}$

3. $P_t = \sum_{(i,j) \text{ with } t_{i,j}=t} a_i b_j f_{t_{i,j}} m_{i,j}$

The first two constraints are the same as in a doubly constrained gravity model, requiring trips sent to equal productions and trips received to equal attractions. The third constraint states that the summed distributed trips for all zone pairs at travel time t must equal the number of trips specified in the travel time frequency distribution at travel time t. The four sets of simultaneous equations are again solved iteratively by the three-dimensional balancing algorithm in EMME/2.

**FIGURE 1 Initial Estimated $F_{i,j}$s from Three-Dimensional Balancing**

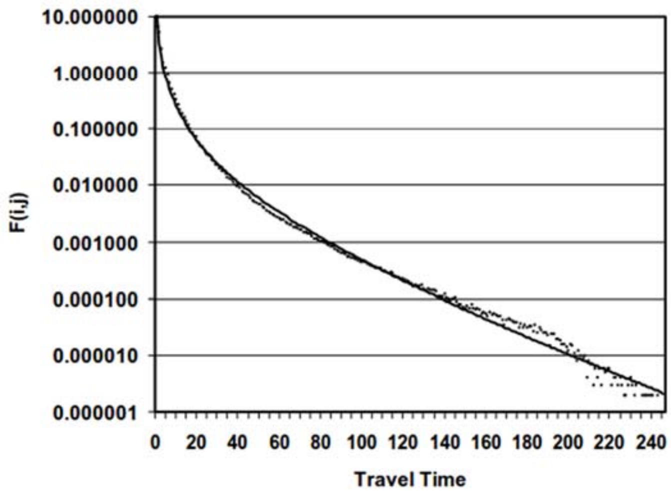



The resulting balancing coefficients ($ft_{i,j}$s) for the third travel time distribution constraint are initial estimates of the $F_{i,j}$s. Figure 1 is a plot of these estimated $F_{i,j}$s for the estimation.

**Smoothing of $F_{i,j}$ Values.** A Gamma impedance function is next fit to the above $F_{i,j}$ data points. Least squares regression is used to fit the natural log of the Gamma function values to the above $F_{i,j}$ data points, smoothing the $F_{i,j}$ values to a continuous function of travel time. The function estimated by the least squares regression is:

$$Ln(F_{i,j}) = Ln(\alpha) + \beta Ln(t_{i,j}) + \gamma\, t_{i,j}$$

**FIGURE 2 First Smoothed $F_{i,j}$s**




The resulting regression equation is plotted against the initial $F_{i,j}$ data points in Figure 2. The values for the three Gamma function parameters $\alpha$, $\beta$, and $\gamma$ estimated by the regression are 25.3, -1.8 and -0.03.

**First Trip Distribution.** Base year person auto work trips were distributed using a gravity model with the smoothed $F_{i,j}$s. The travel time distributions for the CTPP highway commute trips and the I-290 auto work trip distribution are shown in Figure 3. There are clearly too many short distributed trips compared to the CTPP travel time distribution.

**Factoring and Second Smoothed $F_{i,j}$s.** The $F_{i,j}$s were adjusted by the ratio of observed to distributed trips for each minute travel time category. Since the CTPP and the I-290 trip tables have different totals the ratio was calculated from the proportions of trips at a given travel time. The Gamma impedance function was then re-estimated using the factored $F_{i,j}$s as data points, and these second smoothed $F_{i,j}$s are shown in Figure 4. The new values estimated for $\alpha$, $\beta$, and $\gamma$ are 2.4, -1.0 and -0.03. Note that these parameters are such that the $F_{i,j}$s are reduced for short trips and increased for longer trips, which is consistent with the differences in the observed and distributed trip travel time distributions.

**FIGURE 3 Travel Time Distribution for CTPP and First Distributed Trips**

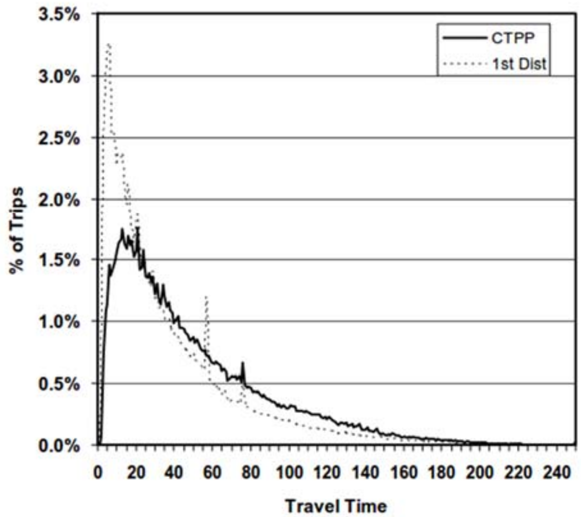
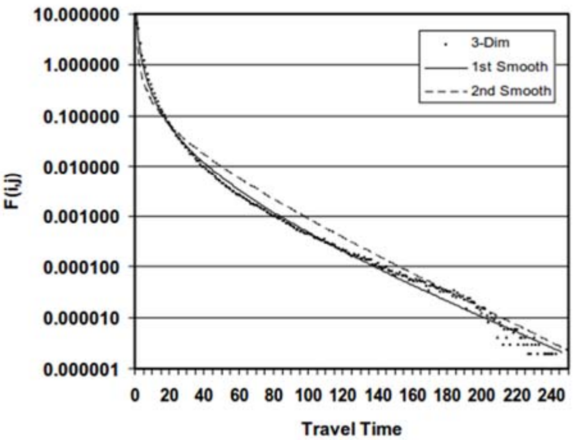



**FIGURE 4 Second Smoothed $F_{i,j}$s**




**Second Trip Distribution.** Trips were redistributed with the revised Gamma impedance function and the revised travel time frequency distribution is shown in Figure 5. Reasonable agreement between the two travel time frequency distributions is achieved after two iterations.

Factoring and Final Smoothed $F_{i,j}$s. The factoring and smoothing of the $F_{i,j}$s was carried out a third and final time. The results are shown in Figure 6 for the final estimates of the values for the three parameters $\alpha$, $\beta$, and $\gamma$ which are 0.9, -0.7 and -0.03.

**FIGURE 5 Travel Time Distribution for CTPP and Second Distributed Trips**

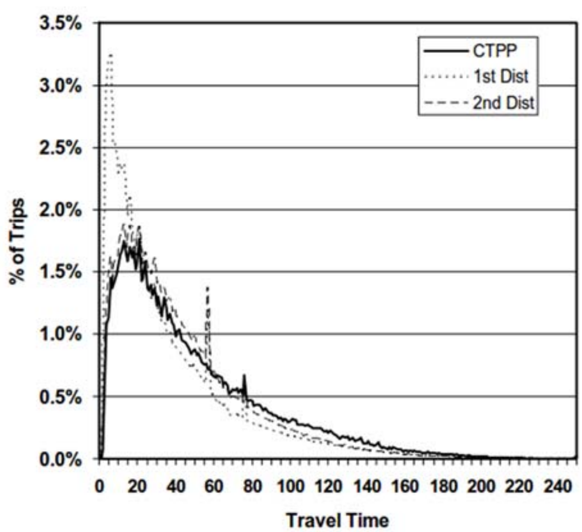



**FIGURE 6 Final Smoothed $F_{i,j}$s**