



# Chicago Metropolitan Agency for Planning

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## CMAP Forecast Principles

For data users and forecast developers

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### Background

A significant new feature of GO TO 2040 is a wholesale shift to scenario-based evaluation and its intentional reliance on forecasts that reflect implementation of preferred regional planning strategies. This is a radical departure from previous long-range planning forecasts in the Chicago region that were based primarily on trends and an inventory of local development patterns.

CMAP'S mandate to integrate transportation and land use planning made necessary a forecasting process that would quantify actual planning outcomes rather than the historical practice of selecting planning strategies to address inevitable trends.

### **What are CMAP forecasts?**

The CMAP forecasts are quantified values of population and employment listed at a small geographic scale called "subzones". Subzones generally correspond to a grid of ¼ square mile land sections originally developed for purposes of surveying and property descriptions. A regional forecast is the sum of all values for the entire region defined by a specific future year and assumed policy scenario. For example, 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.

### **How are the forecasts calculated?**

Population and employment forecasts begin with currently observed counts recorded at a small geography. An overall growth rate resulting from a regional economic model provides a reference total for a future year. The effects of policy strategies that define the scenario under study are quantified and coded into mathematical expressions. Statistical modeling procedures equilibrate the compound effects of the policy strategies on supply, demand and accessibility. The resulting effects are used to adjust the reference values to represent the scenario forecast.

### **How are the forecasts used?**

Scenario forecasts quantify the combined outcomes of distinct planning scenarios. Once a scenario is officially adopted as the basis for a regional plan, the associated forecasts are henceforth labeled “current planning assumptions” (i.e. the assumed outcome of the plan). The use of this official scenario is codified into numerous transportation planning regulations including Air Quality Conformity, Environmental Impact and New Starts. Other regional planning evaluations often rely upon scenario forecasts including transportation project, economic development and environmental studies.

## **Principles for CMAP forecast users**

In addition to consistently and properly attributing the forecasts as the outcome of GO TO 2040's preferred regional scenario, forecast users should subscribe to several principles regarding the forecast's purpose and application:

### **Respect the regional planning process**

GO TO 2040 reflects a collectively preferred future that is the product of a broad-based consensus-building effort. It is rare that any individual will view the plan or forecasts as entirely reflective of their unique self-interest. The preferred scenario represents the regional resolution of both competing and complementary local desires. As such, the forecasts are a tangible manifestation of the compromise required to achieve a regional whole that is more desirable than the sum of its parts.

### **The forecasts are not local land use plans**

The forecasts are derived from mathematical equations that balance a location's land development potential and its transportation accessibility. To accomplish this, socioeconomic measures are listed at the subzone level so that their effects on each other can be continuously estimated over space and time. When mapped, this gives the impression of a prescribed land use pattern. This is not their purpose; authority over local land use resides with local government.

## **The forecast values must be aggregated**

Each value in the forecast is the product of mathematical operations that include statistical error. As individual values are combined, individual error terms cancel each other and the statistical reliability of the forecast is improved. The level of aggregation needed varies with geographic context, but is usually defended based on external validation of the result against existing conditions or desired outcomes.

## **Principles for forecast developers**

CMAP encourages the use of the preferred scenario forecasts for all regional planning evaluations. CMAP recognizes that many evaluations are based on the systematic comparison of two or more sets of input assumptions; i.e., the value of a single project, program or strategy is best articulated by comparing it with the regional outcome in its absence. It is important that the method used to quantify alternative assumptions is consistent with that used for the preferred scenario. The steps to accomplish this include:

### **Articulate alternative assumptions**

Prepare a narrative describing the alternative scenario and the set of conditions (or absence thereof) that produce the alternate outcome. This should include the argument for why examining the alternative is necessary to demonstrating the value of the project, program or strategy under study.

### **Show the math**

All mathematical operations should be intuitive and include quantitative worked examples. CMAP understands that many outcomes cannot be rigorously calibrated or validated and will require some analyst judgment. For uncertain outcomes (e.g. land use density and mix) CMAP encourages conservative use of stochastic (i.e. probabilistic) parameters that will produce plausible and intuitive outcomes while incorporating random variability.

### **Produce standard outputs**

CMAP will handle alternative forecasts only when they are delivered in a format that permits analysis within our regional travel demand models. In general, this requires adhering to CMAP's system for indexing geographic locations and providing household and employment quantities according to the definitions upon which the models were originally calibrated.

## **Principles for CMAP policy concurrence**

For any project, program or strategy evaluation requiring CMAP approval, inclusion of the preferred scenario is required. Results of alternative forecasts may be presented as evidence

intended to support or refine a project, program or strategy already included in GO TO 2040. Alternative forecasts, however, may not be substituted for preferred scenario forecasts with the intent of enhancing or diminishing a particular outcome. Alternative forecasts that contradict or undermine the outcome of the preferred regional scenario will not be considered.

### **Concur on methodological validity**

If an alternative forecast is included as part of an evaluation of a particular project, program or strategy, CMAP will consider concurrence **only** on the validity of the method used to prepare the forecast data; i.e. CMAP will not offer concurrence on the quantitative results.

### **Collaborate on improved methods and outcomes**

CMAP recognizes and applauds all cooperative efforts to improve the quality, reliability and usefulness of our regional planning forecasts. In the course of continued work, it is likely that we will arrive at superior methods, discover systematic flaws and uncover mistakes that contributed to the current preferred regional forecast. In these cases, we invite collaboration in improving CMAP's forecasting methods going forward. The next release of CMAP forecasts is anticipated to coincide with the scheduled update of GO TO 2040 in 2014.

## **Appendix A: Preferred Scenario Modeled Forecast Assumptions**

The GO TO 2040 preferred scenario forecasts were developed by mathematically estimating the effects of selected transportation and land development strategies using the "access product" method outlined in the report: [Socioeconomic Inventory Validation and Forecasting Method](#). During early GO TO 2040 strategy analysis, a unique access product equation was developed and applied to the initial reference activity distribution; defined as the sum of households and jobs in each subzone. The set of planning strategies found plausible, reasonable and achievable mirrors the set of access product equations that resulted in the GO TO 2040 preferred scenario forecast. In many cases, these equations include an "uncalibrated parameter" that was estimated either from secondary research in another context or as an intuitively conservative constraint on the outcome.

### **Compound Access Product**

Access Product = Land Value Index(p) \* Accessibility (p,q)

Where: Land Value Index is the average assessed value of land in a subzone (p), standardized across counties and normalized across the region.

Accessibility is the inverse logsum of highway and transit network generalized travel cost between each zone pair (p,q).

## Land Use Strategies

Land use strategies operate exclusively on the Land Value Index term of the Access Product equation. An increased Land Value Index contributes to an increased Access Product when combined with high transportation accessibility. A higher Access Product results in higher activity levels.

### Open space preservation

Strategy Land Value Index = Land Value Index(p) \* (1 – percent protected land(p))

Where: Percent protected land is the proportion of a subzone with a natural resource score that falls within 225,000 acres of the top ranked scores region-wide.

### Brownfield reinvestment

Strategy Land Value Index = Land Value Index(p) + (10% per subsidized brownfield(p))

Where: A brownfield is identified as such by Illinois EPA. Subsidies restricted to subzones with a Land Value Index less than +0.024. The 10% increment is an uncalibrated parameter.

### Transit oriented development

Strategy Land Value Index=Land Value Index(p) + (10% per transit subzone(p))

Where: Transit is identified with subzone (p). The 10% increment is an uncalibrated parameter.

### Urban design

Strategy Land Value Index = Land Value Index(p) + (10% per unit of improved pedestrian environment (p))

Where: Land value was increased for subzone (p) within existing municipal boundaries. Pedestrian environment was increased when the subzone was in a growing area or near planned bike facilities. The 10% increment is an uncalibrated parameter.

## Transportation Strategies

Transportation strategies operate exclusively on the Accessibility term of the Access Product equation. Increased Accessibility contributes to an increased Access Product when combined with high land values. A higher Access Product results in higher activity levels.

### Transit Wait Time Reductions

Strategy Accessibility(p,q) = Accessibility(p,q) with Transit Wait Time (p,q) \* 0.5

Where: Transit Wait Time is the accumulated minutes assumed waiting for a transit vehicle when traveling between zones p and q. 0.5 is an uncalibrated parameter.

### Variable Pricing on Expressways

Strategy Accessibility(p,q) = Accessibility(p,q) with Expressway Auto Generalized Cost (p,q) \* 2.5

Where: Expressway auto generalized cost is a compound measure of congested time, distance and operating costs. The 2.5 shadow price was calibrated to achieve an overall volume/capacity ratio on expressways of less than 1.0.

### Additional Bus Routes

Strategy Accessibility(p,q) = Accessibility(p,q) with additional bus network

Where: Additional bus lines were added in a comprehensive grid covering the CTA and Pace service areas based on the Strategic Regional Transit System included in the 2030 RTP.

### Increase Transit Speeds

Strategy Accessibility(p,q) = Accessibility(p,q) with lower rail segment times

Where: Individual segment times on existing rail transit facilities were lowered to meet the average time for the entire line.

### Transit Signal Priority and Arterial Rapid Transit

Strategy Accessibility(p,q) = Accessibility(p,q) with selected uncongested bus segment times

Where: Individual segment times on selected segments of the existing CTA and Pace bus system were permitted to run according to schedule rather than being subjected to congestion delays.

### Advanced arterial signal systems on TSP/ART segments

Strategy Accessibility(p,q) = Accessibility(p,q) with Arterial Intersection Auto Generalized Cost (p,q) \* 0.1

Where: Arterial Intersection auto generalized cost is a compound measure of intersection geometry and signal characteristics. The 0.1 cost savings is an uncalibrated parameter.

### Parking charges

Strategy Accessibility(p,q) = Accessibility(p,q) with Auto Generalized Cost (q) \* 1.1

Where: Auto generalized cost(q) is a compound measure of time, distance and operating cost at the destination zone of an auto trip. The 1.1 cost burden is an uncalibrated parameter.

### Transportation demand management

Strategy Accessibility(p,q) = Accessibility(p,q) with Transit Fare (q) \* (0.95-(0.15 \* dense(q)))

Where: Transit Fare is the accumulated out-of-pocket cost incurred when traveling by transit between zones p and q. Dense is arbitrary and the parameters are uncalibrated.

### Access product resolution

The individual strategy LVI and Accessibility values are combined into a single zonal factor that is applied to the logsum generalized cost metric that is the basis for trip distribution and mode choice in the travel demand model. The difference in logsums for two scenarios, with and without the strategies, are taken and exponentiated to produce the probability that a zone's activity level will change in response to the set of strategies being tested.

Probability  $(p1/p2)=(0+(10*(0.2*(1-\exp(-10*(\text{"logsum difference"}*0.1)^2))))*32.30978$

Where: this is a standard probability formulation. In the absence of any calibration data, all of the parameters are simple and intuitive bounds constraining the probability of change to within 10 percent of the original value. The final parameter scales the probability to the match the range of generalized cost values in the travel demand model.

