CAMPO Baseline 2045 Demographic Forecast

Introduction

The 2045 Baseline forecast was developed as a component of the regional Travel Demand Model program for travel demand forecasting to support regional transportation decision making. In order to test scenarios and understand large scale effects, an MPO makes a forecast every 5 years of where development is likely to occur. The goal for this process is to determine a reasonable estimate of what demographics would be as a baseline for testing travel demand model scenarios. The forecast items include general population and employment at a level sufficient to populate the model. The base year is 2015 and the horizon is 2045.

This baseline demographic forecast represents comparisons of existing published forecasts, and incorporating jurisdiction's understanding of the general trends to determine a regional control total. The trends serve as an upper target for the regional allocation step, which then assigns known constraints to land development – floodplain, parks, zoning, development patterns. For the 2045 year forecast, Regional control totals were used as a benchmark combined with an econometric-based land-use allocation model, UrbanSim, in a 3-stage process.

The process, patterns, assumptions and results for this forecast are summarized below.

Figure 1 shows the CAMPO modeling area, which stretches over six counties: Bastrop, Burnet, Caldwell, Hays, Travis, and Williamson. The modeling area is comprised of 2,235 internal traffic analysis zones (TAZs), 97 dummy zones, and 59 external zones.

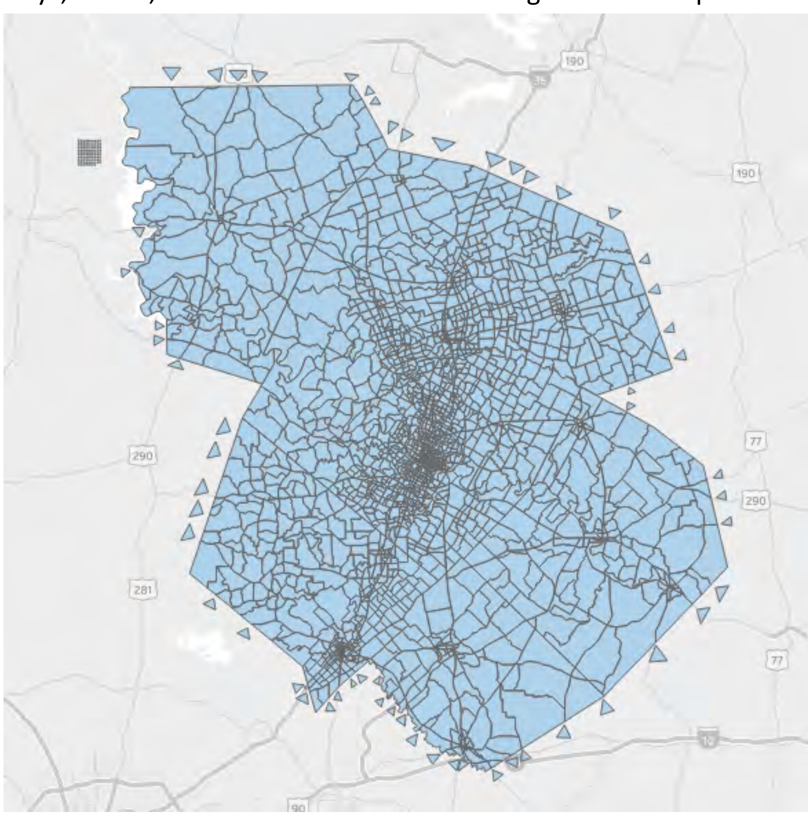


Figure 1. *CAMPO modeling area.*

Methodology

Population and Employment levels are the two key demographic inputs for the CAMPO travel demand model in order to estimate travel trends. Estimating total population and employment levels are also key inputs for the land use allocation model that informs the 2045 Baseline forecast.

The demographic forecast 3 stage process included:

1. Estimating Regional Control Totals
2. Allocating the estimated growth across the 6 counties with UrbanSim
3. Adjusting outputs for knowns and other local inputs

Stage 1. Regional Control Totals

Population

Population for the 2045 Baseline is based on a combination of demographic growth estimate sources and trends by CAMPO, member jurisdictions and others. The estimates were considered by a key group of regional travel demand model users for reasonableness, which became a benchmark estimate for input in the land use allocation model/tool in the next Stage 2-Allocation.[1]

The initial estimate for population in Stage 1 for the baseline 2045 CAMPO model demographics estimates were based on comparisons of three available demographics projection sources: two public and one private source. These sources included – the Texas State Demographer[2], The Texas Water Development Board,[3] and Woods & Poole[4]. TxDOT's One-Stop-Shop demographics tool (OSS)[5], based on projections

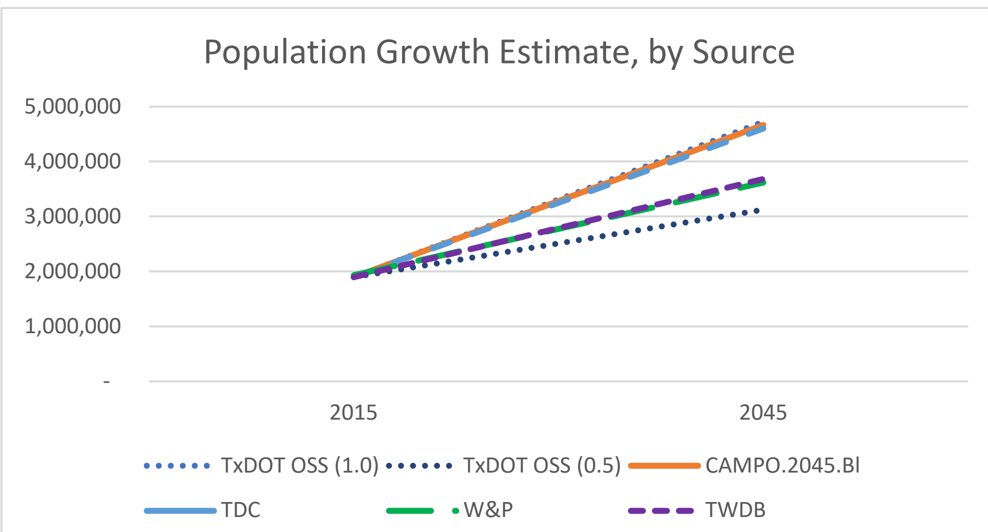


Figure 2. *Population growth rates considered for model estimate.*

[1] Core Model Users were identified as the City of Austin, Travis County, Williamson County, Capital Metro, and the Texas Department of Transportation - Transportation Planning and Programming Division.
[2] http://osd.texas.gov/Data/TPEPP/Projections/
[3] http://www.twdb.texas.gov/waterplanning/data/projections/index.asp
[4] https://www.woodsandpoole.com/
[5] https://www.txdot.gov/inside-txdot/division/transportation-planning/orgs-committees/demographic.html

from the State Demographer, provides coarse variables to reflect past trends of in-migration rates to an area. The TxDOT tool also provides a starting point for demographic trend analysis. Initially, key model stakeholders nominated the higher setting of growth in the one-stop-tool, a compound annual growth rate (CAGR) of approximately 3.0%[6], to adjust population estimates. Though this was initially viewed as a potentially realistic control total, through this process the regional growth total was scaled back slightly after accounting for additional inputs and constraints detailed below in the allocation and adjustment stages, but the total remains at 3.0% growth. The rate of 3.0% is at the initial upper OSS total and significantly higher than the more moderate Texas State Water Development Board growth rate of 2.2% or lower OSS(0.5) rate of 1.6%. The rates are shown in **Figure 2.**

Employment

The initial estimate for employment in Stage 1 was based on comparisons of two available demographics projection sources: one public and one private. These sources included CAMPO's 2040 Long Range Plan and Woods & Poole[7]. Initially, the growth rate from the 2040 plan, extended out to 2045 (approximately 3.6%), was seen as aggressive given long-term growth trends for this demographic update, where growth rates for large numbers tend to taper off the larger they become. Another traditional, commercial source for employment demographics growth, Woods & Poole, was considered with their internally consistent growth rate of 2.1% for non-farm based employment as an initial input for allocation. However, through the allocation and adjustment stage, the employment total was also scaled to a level consistent with other trends at the regional and county levels. Key among these trends is the concept of jobs-population balance, whereby a region is considered to be 'balanced' at having approximately one job per two population.[8] For example, the 2015 or 'current' jobs-housing balance for the CAMPO region is approximately 0.52. The number of jobs then tracks along a similar growth trend as

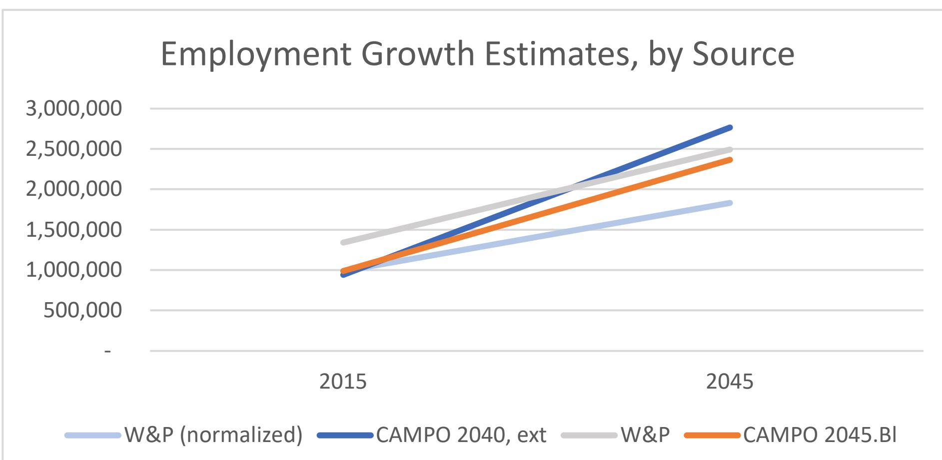


Figure 3. *Employment growth rates considered for model estimate.*

[6] Represents an in-migration factor setting of "1" in the TxDOT OSS tool for all six counties in the CAMPO region. The alternative, an in-migration factor setting of "0.5" was seen by key stakeholders as unrealistically low for the CAMPO region, based on current and past trends.

[7] https://www.woodsandpoole.com/

[8] The 2016 TxDOT Socio-Economic Guidelines document recommends that employment to population ratios be between 0.3 and 0.5. However, a slightly higher ratio is not unexpected given employment levels in Central Texas, and Travis County, specifically.

population, where the two are related for forecast purposes. The resulting baseline rate of 3.0% compound annual growth in employment is between the initial upper CAMPO 2040-plan trend and the more moderate Woods & Poole trend rate of 2.1%. The resulting jobs-population rate for the 2045 baseline remains 0.50. The rates and employment totals are illustrated in **Figure 3.**

Stage 2. Allocation

The control totals in Stage 1 were used as initial input for the UrbanSim land use allocation tool.

Inputs – Zoning, Floodplains, Parks, travel time skims etc.

As outlined in the UrbanSim methodology, inputs for the model included "Zoning", defined for the UrbanSim model in terms of upper capacities on population and employment densities per zone. These were based on local zoning, demographic projections from available county or city-level plans, and prevailing development densities.

UrbanSim is also able to consider shapefiles for prohibition to growth. GIS layers for state and local parks and floodplains were included as areas to not allocate additional growth to. In the later adjustment stage, some corrections were needed to re-introduce existing housing back in to zones where it had been removed by algorithms. This adjustment step was not optimal considering that new households should not locate in flood hazard zones but was considered reasonable for this dataset given the general durability of existing housing and their travel patterns for this plan forecast.
UrbanSim also uses existing travel time skims for determining elasticity of where to place development. This allows the allocation algorithms to consider jobs access and travel times as part of the 'attractiveness' of a geographic area for new-development or redevelopment. Prior base year model inputs were used as per the UrbanSim documentation.

Output – Jobs and Households

UrbanSim grows census-based block groups through its algorithms in a process that has had many iterations and extensive documentation over the model brand's 20+ years of development and production. The methodology and data was tailored to the CAMPO region through licensing directly with the cloud-based platform as detailed in the attached CAMPO-specific methodology brief **(Attachment A)**.[9]

The outputs from the allocation process were converted to CAMPO TAZs, and totals for households and jobs were reviewed and adjusted as noted in Stage 3.

[9] Additional UrbanSim methodology and documentation:
http://cloud.urbansim.com/docs/general/documentation/urbansim.html
http://www.urbansim.com/resources/

Special Generators, ED1 and ED2

Special Generators denotations were continued from the 2015 base year reviewed demographics, noted in **Table 1,** with absolute growth continued from the 2040 assumed values. Labels for some zones previously considered special generators were included, though awareness of special generator trip generation studies are unknown as of this writing.

Employer Name	Number of Employees 2015	Number of Employees 2045	Employment Type	TAZs include
Zilker Park	10	100	Service	436
Central Texas Medical Center	643	900	Service	776
St. David's South Austin Hospital	983	1,100	Service	490
Seton Northwest Hospital	1,900	2,100	Service	1820
St. David's Medical Center	4,500	5,000	Service	1651
IKEA	350	350	Retail	115
Tanger Outlets San Marcos	2,267	2,500	Retail	790
Round Rock Premium Outlets	2,495	3,000	Retail	1406
San Marcos Premium Outlets	3,164	3,500	Retail	1489
Southwestern University	0*	0*	Education	858
St. Edwards University	0*	0*	Education	479
Texas State University	0*	0*	Education	703
Huston-Tillotson University	137*[10]	0*	Education	411
ACC Highland	891	1,000	Education	1448

***Table 1**. Potential Special Generators.*

ED1 and ED2 represent K-12 and Post K-12 education employment in the dataset, and were also largely held over form the 2040 dataset. A prototypical elementary school was estimated to have approximately 60 employees, a middle school 100, and a high school approximately 180. In some cases, zones were allocated additional ED1 employment after a review of the residential allocation from UrbanSim, to reflect the co-location of new education facilities.

ED2 facilities were reviewed to continue their location and a generalized growth rate. Texas State University has a posted growth plan of approximately 1.5% per year, and the University of Texas was assumed to have a growth rate of approximately 10% over the forecast after accounting for the siting of the new dell medical school at 15th and Red River in Austin.

Special note needs mention of **Austin Bergstrom International Airport and the University of Texas at Austin** central campus as special generators since their trip making patterns are separated into specific trip purposes in the CAMPO model (UT and AIR).

[10] *Note, Special Generators for specific college education locations were moved in the database to ED2 for these locations and labeled uses to be more consistent. In all cases, modest growth was considered (10% approximate) unless other documentation was readily available through online research.

Stage 3. Adjustments to UrbanSim outputs

The raw outputs of UrbanSim were reviewed over several iterations to calibrate the results to expectations and predominant development patterns. General reasonableness reviews centered around 'does the output reflect the inputs and constraints', 'do the annual growth rates by county reflect a realistic pattern (ie. Not above 4% per year growth for all years for large counties less able to sustain high rates of growth, comparison to historical growth rates, general housing and population balances within the region and specific counties. Adjustments were then made to the following:

Parameter trends at the county level – use of control targets

For the reasonableness adjustments conducted after UrbanSim's allocation, it was necessary to determine target employment to population ratio ranges so that reviewers had a benchmark range to make edits within. The table at right illustrates the current base year ratios (2015) and forecast result ratios (2045).

	2015 emp/pop	Baseline **2045** emp/pop	target
Bastrop	0.43	0.51	0.45
Burnet	0.43	0.39	0.44
Caldwell	0.47	0.49	0.50
Hays	0.51	0.47	0.50
Travis	0.55	0.55	0.53
Williamson	0.50	0.47	0.50
Total	0.52	0.50	0.50

***Table 2**. Existing and Forecast Population-Housing ratios, and calibration "target"*

Calibration "Target" ratios are also included. The calibration targets were established based on an internal goal of improving the perceived accuracy of the land use allocations over the 2040 demographics data. The results are considered reasonable because they: a) make improvement over the 2040 dataset, b) are more in balance than individual county- growth-rate-based ratios from the comparable data sources are, c) more closely represent 'balanced' jobs-to-population sub-areas, and c) more closely represent existing data ratios.

Edits for reasonableness and peak smoothing (Negatives)

12 TAZs received a disproportionately high share of regional growth which exceeded the constraint inputs for UrbanSim. The outputs of these zones were generally deleted or balanced between adjacent TAZs using the control target levels above.

TAZs located in a number of the region's smaller cities (Lockhart, Burnet, Marble Falls, Bastrop, Giddings, Manor, Jarrell, Florence) and their employment-centric TAZ's showed negative employment growth – heavy losses of jobs, that was seen as unreasonable. Those negatives were reversed to a more neutral or slightly positive trend closer to existing data.

Retail output adjusted/conversion from Service employment sector

UrbanSim assigned relatively higher growth to the service sectors, and relatively fewer retail jobs. Where growth in service employment was observed, a percentage was converted to retail so that the regional growth in retail trend correlates with the population growth.

Land Use analysis from COA's Impact Fee Land Use Assumptions

The City of Austin completed a land use analysis of demographic growth for a transportation impact fee in 2017 with extensive documentation. The analysis was done on a TAZ level, combined with extensive review by city staff for reasonableness. The results of this projection were totaled at the impact fee service area and compared to UrbanSim results.

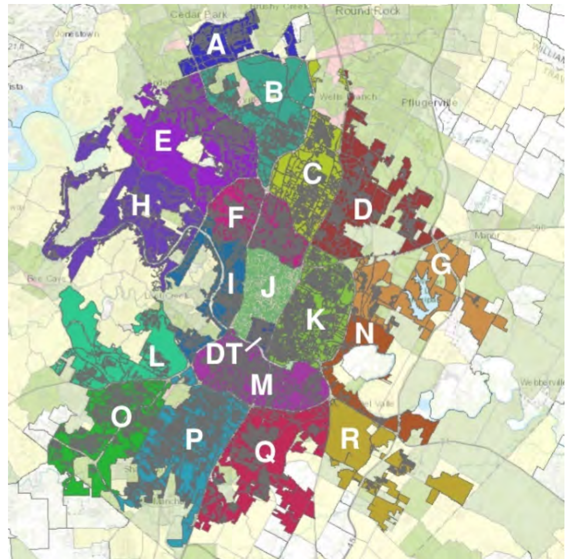


Figure 4. *Austin Impact Fee Study Zones - Land Use Assumptions (City of Austin 2017)*

Reviewers subsequently modified inputs for UrbanSim to better reflect the City of Austin-noted growth capacities, which included a 'buildout' estimate by service area.

These comparisons proved very useful for calibrating the 2045 results for the core of the regional model area, and adjusting employment and population totals at the impact fee study-zone level. Summary of Service area comparison between the City of Austin "Buildout" scenario and CAMPO Baseline 2045 assumptions are included as **Attachment B.**

Comprehensive Plan demographics allocation from Bastrop County

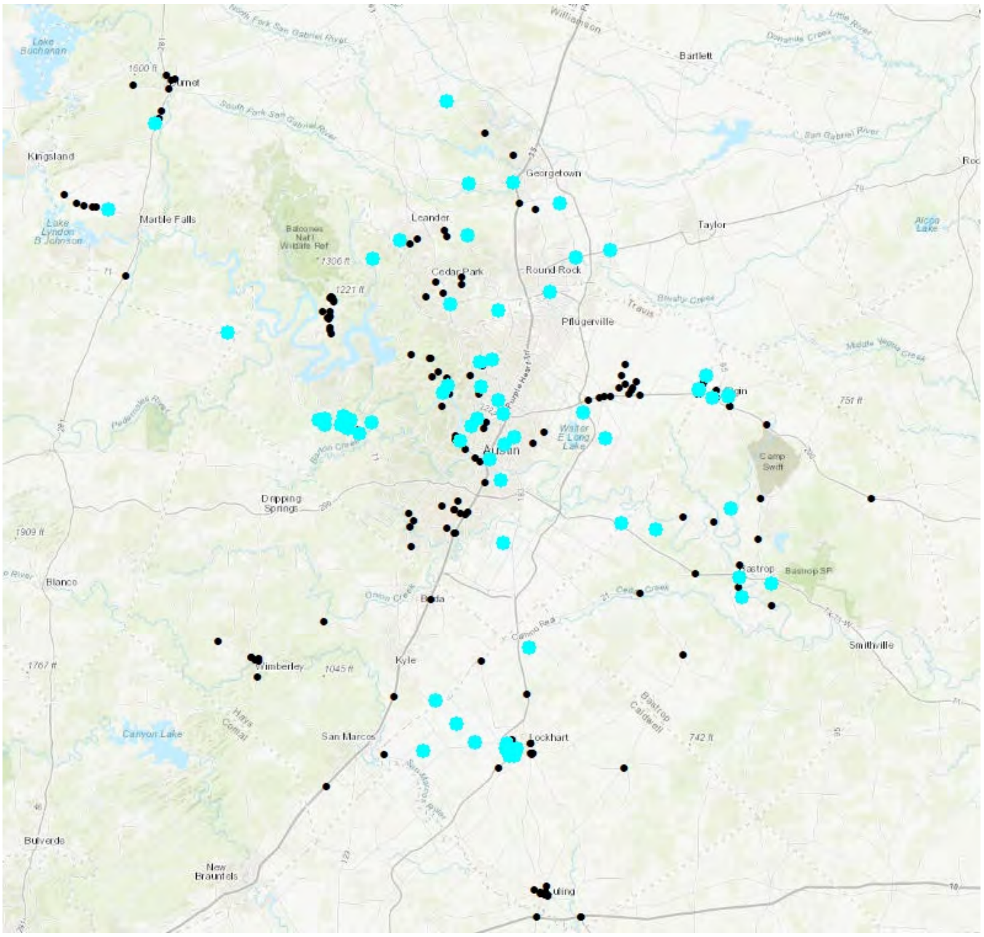
Bastrop County completed a Comprehensive Plan update in December, 2016 which included county-level demographic projections and adjustments to the then-assumed 2040 CAMPO demographic growth for the county. The analysis was done on a TAZ level, with incorporation of staff understanding of pending developments for reasonableness. The results of this were then used for travel demand modeling at the County level for the Bastrop Plan.

Figure 5. *2016 Bastrop County Comprehensive Plan demographic allocations*

Reviewers subsequently adjusted outputs from the UrbanSim model run to better reflect the distribution of growth shown in the Bastrop plan. Bastrop County also provided comments to staff for inclusion.

Modifications for CAMPO RAP-sourced known developments

CAMPO undertook a Regional Arterial Concept Inventory (RACI) to coordinate arterials between jurisdictions along their borders. Part of the outreach to inform the plan included asking jurisdictions to identify significant developments on the horizon. These developments are included in the area snapshot as blue dots in the image below. For the 2045 Baseline allocation, these data points were also reviewed, and data adjusted to reflect them.



Modifications by local governments

CAMPO presented draft baseline results to the TAC December 17, 2019, including this draft methodology. An additional round of comments and adjusting modifications was coordinated in early 2019 to incorporate local-specific understanding. Specific comments received at the TAZ level consisted primarily of moving certain projected demographics from one TAZ to another within the jurisdiction based on local understanding of potential allocation at the sub-regional level. This feedback was considered important for the MPO to take local understanding into consideration within the larger context of the forecast. In their review and comments, Williamson County chose to provide specific comments based on a detailed, separate county-growth total based forecast and allocation that was considered more in-line with local expectations. CAMPO was able to incorporate much of TAZ-specific recommendations within the parameters of the approach outlined above.

From Williamson County's supporting backup provided in support of their commends, their allocation process also uses developable land-area, time access between zones, and predominant development densities as core methodological factors.

> "The demographic allocation process utilizes zone to zone travel time, development density and developable land to allocate demographics at the TAZ level. Population is allocated first at the TAZ level and then employment categories. For population, available developable land is estimated using the amount of developable land and existing development density. Existing development density is calculated based on existing population and employment. Then available developable land together with accessibility measures are used to produce the population development scores. These scores are used to allocate County control total of non-group quarter population to TAZs. For households, county level change in the number of households is proportionally distributed to TAZs based on their non-group quarter population changes."[11]

In CAMPO review, the differences in allocation methodology consists of the Urban Sim methodology taking in to account land costs and changes to land uses as the pressure to redevelop, wages influence on employees abilities to access jobs from housing, and other economic factors noted on page 4 of this document. Both methods are considered reasonable by oversight agencies such as TxDOT.

Modifications to clear TxDOT QC

For the 2045 RTP Travel Demand Model development, TxDOT has partnered with CAMPO to provide a model architecture "refresh", and the baseline demographics were a standing critical path benchmark point for the contractual delivery of the model back to CAMPO for use. CAMPO exchanged interim draft results with TxDOT over several months of 2018 for comments and QC review consistent with their oversight and reasonability checks provided to all MPOs in the state. TxDOT's review of demographics included referrals of the data to both TTI and the State Demographer for comments that were then addressed to their satisfaction by CAMPO. Subsequent to the local governments review and comments, a revised, Draft-Final baseline 2045 demographic file was exchanged with TxDOT in March 2019 in order to meet the model architecture "refresh" partnership expectation allowing TxDOT's contractor to test the model before releasing it back to CAMPO for use.

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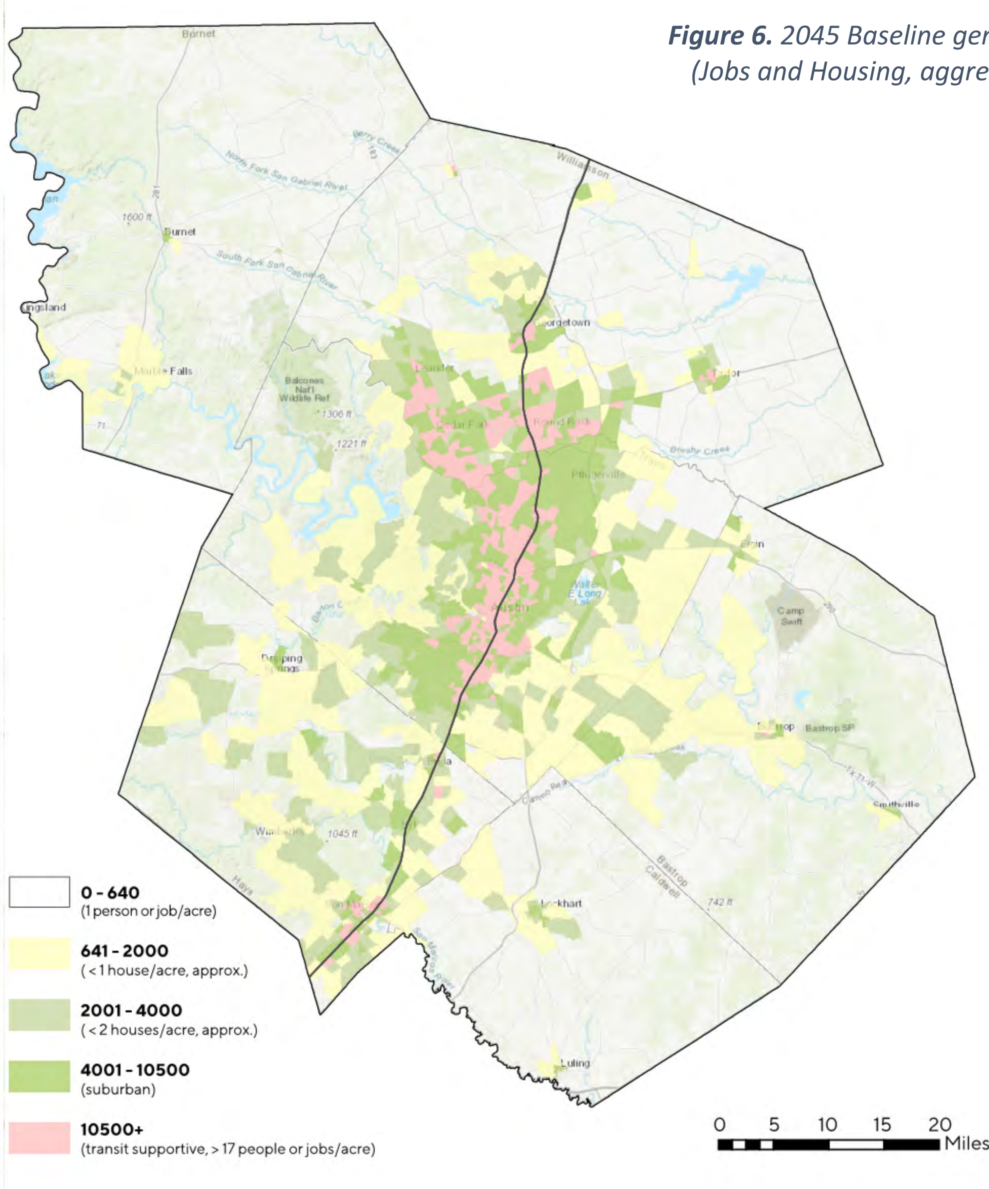
[11] Memo to Williamson County Transportation Coordinator re: Williamson County TAZ level Socioeconomic data, April 10, 2019.

2045 Baseline Results

Generally

The results of the process generally match expectations – with new residential development spreading out through the MPO area, and along predominant development densities with employment growth generally following major roadway corridors. **Figure 6** shows the 2045 aggregated densities (represented as jobs plus housing) visually. **Figure 7** shows the existing conditions (2015). Tabular summaries are included on the following pages. **Table 2** summarizes the UrbanSim allocated growth, as adjusted, by county, and **Table 3** compares 2015 to 2045 statistics. [12]

***Figure 6.** 2045 Baseline general densities (Jobs and Housing, aggregated by TAZ)*



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[12] *Totals in Table 2 reflect employment and population allocated by the UrbanSim process, and do not including GQ population, SGZ, ED1 or ED2 employment*

Table 2. *2045 Baseline results and growth, as adjusted, by county.*

	POP	growth	CAGR	Employment		CAGR
Bastrop:	265,512	188,564	4.2%	134,120	101,782	4.9%
Burnet:	94,360	50,216	2.6%	37,217	18,547	2.3%
Caldwell:	103,815	64,468	3.3%	50,582	33,889	3.8%
Hays:	632,937	455,375	4.3%	299,000	211,760	4.2%
Travis:	2,196,582	1,074,937	2.3%	1,199,239	598,917	2.3%
Williamson:	1,377,323	903,731	3.6%	646,912	413,463	3.5%
Allocated - Total:	4,670,529		3.0%	2,367,070		3.0%

Table 3. Comparative Statistics for Forecast

	2015	2045	Absolute Growth	Percent Growth	Annualized Growth
Population	1,899,617	4,672,794	2,773,177	145.99%	3.05%
Households	711,859	1,900,276	1,188,417	166.95%	3.33%
POP/HH	2.67	2.46			
Total EMP	995,216	2,367,070	1,371,854	137.84%	2.39%
Total EMP*100/POP	52.39	50.66			
Total EMP/HH	1.40	1.25			
Total EMP/POP	0.52	0.51			
Basic	199,603	397,934	198,331	99.36%	2.33%
Retail	238,159	447,670	209,511	87.97%	2.13%
Service	469,897	1,302,410	832,513	177.17%	3.46%
Education	87,557	219,056	131,499	150.19%	3.10%
Retail EMP * 100 / POP	12.54	9.58			
Service EMP * 100 / POP	24.74	27.87			

Table 4. Base Year Summary Statistics

	Total	DA1 Total	Special Generators Total
Population	1,899,617	1,897,352	2,265
Households	711,859	711,859	0
Population/Households	2.67	2.67	
Employment			
Basic	199,603	199,603	0
Retail	238,159	227,754	10,405
Service	469,897	461,861	8,036
Education	87,557	82,891	4,666
Employment Total (DA1 + SG + EDU)	995,216		
Employment/Population	0.52		
Population/Employment	1.91		
Median Income	$55,451		

Table 5. Forecast Year Summary Statistics

	Total	DA1 Total	Special Generators Total
Population	4,672,794	4,670,529	2,265
Households	1,900,276	1,900,276	0
Population/Households	2.46		
Employment			
Basic	397,934	397,934	0
Retail	447,670	430,317	17,353
Service	1,302,410	1,294,130	8,280
Education	219,056	218,056	1,000
Employment Total (DA1 + SG + EDU)	2,367,070		
Employment/Population	0.51		
Population/Employment	1.97		
Median Income	$59,100		

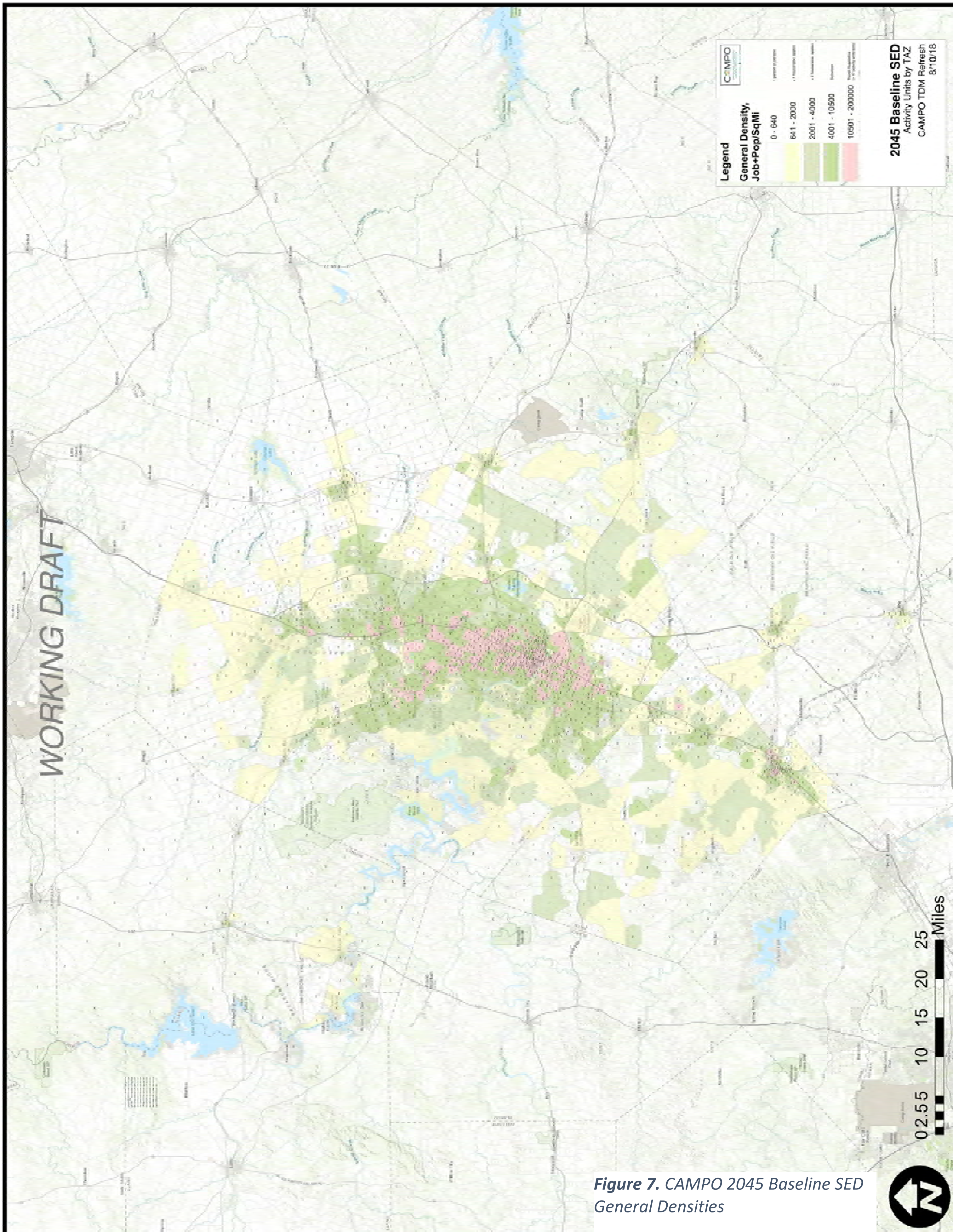

Figure 7. *CAMPO 2045 Baseline SED General Densities*

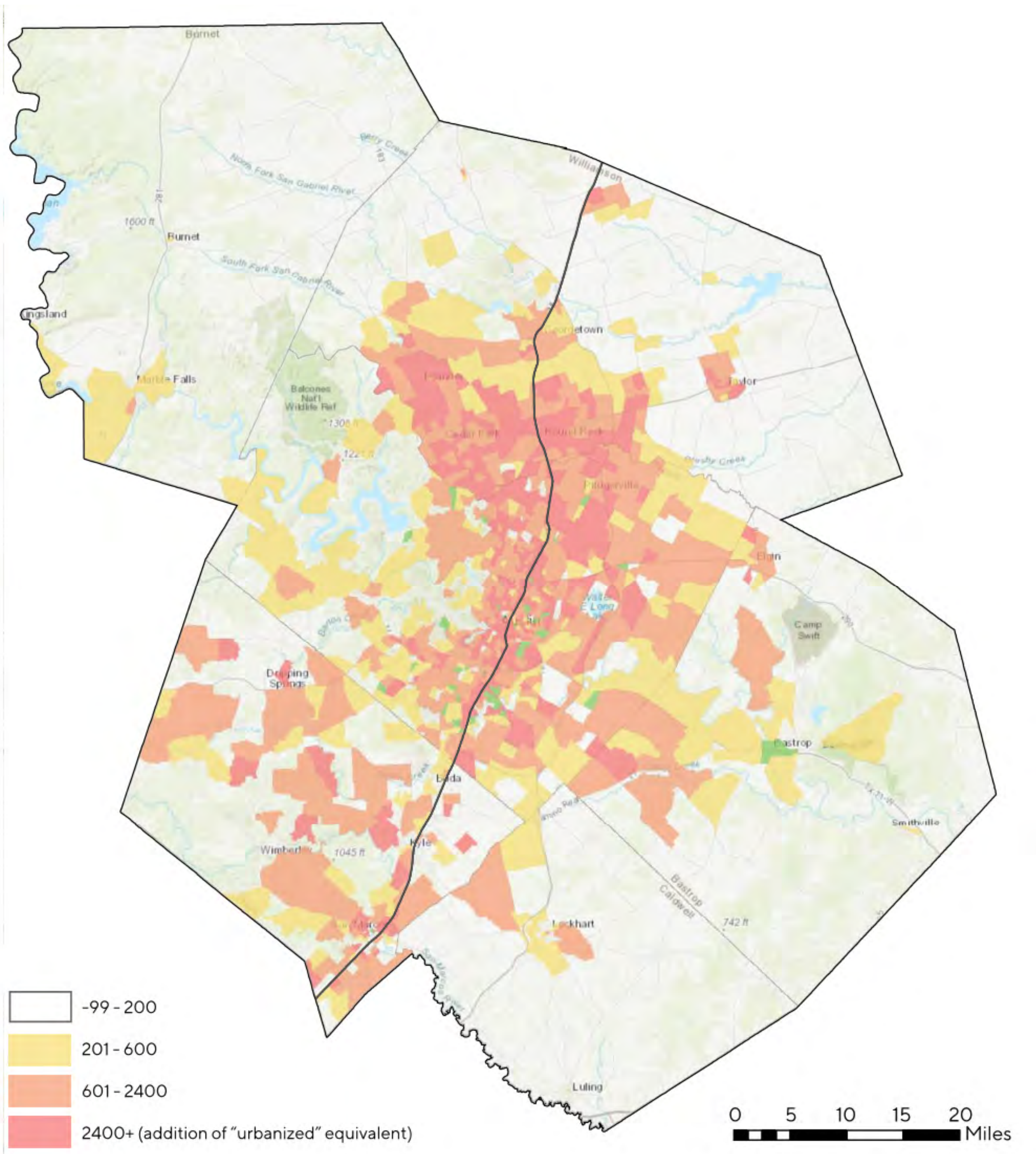

Figure 8. *TAZs assigned significant population growth. (Additional population per square mile)*

Population Growth

Figure 8 shows the distribution of allocated population growth between 2015 and 2045. The pattern illustrates areas generally within the ETJs of existing cities experience the largest increases in population density changes, and growth occurring across the region. Areas with less significant growth in population density (an increase of fewer than 200 persons per square mile) are omitted from this exhibit to contrast the more significant changes.

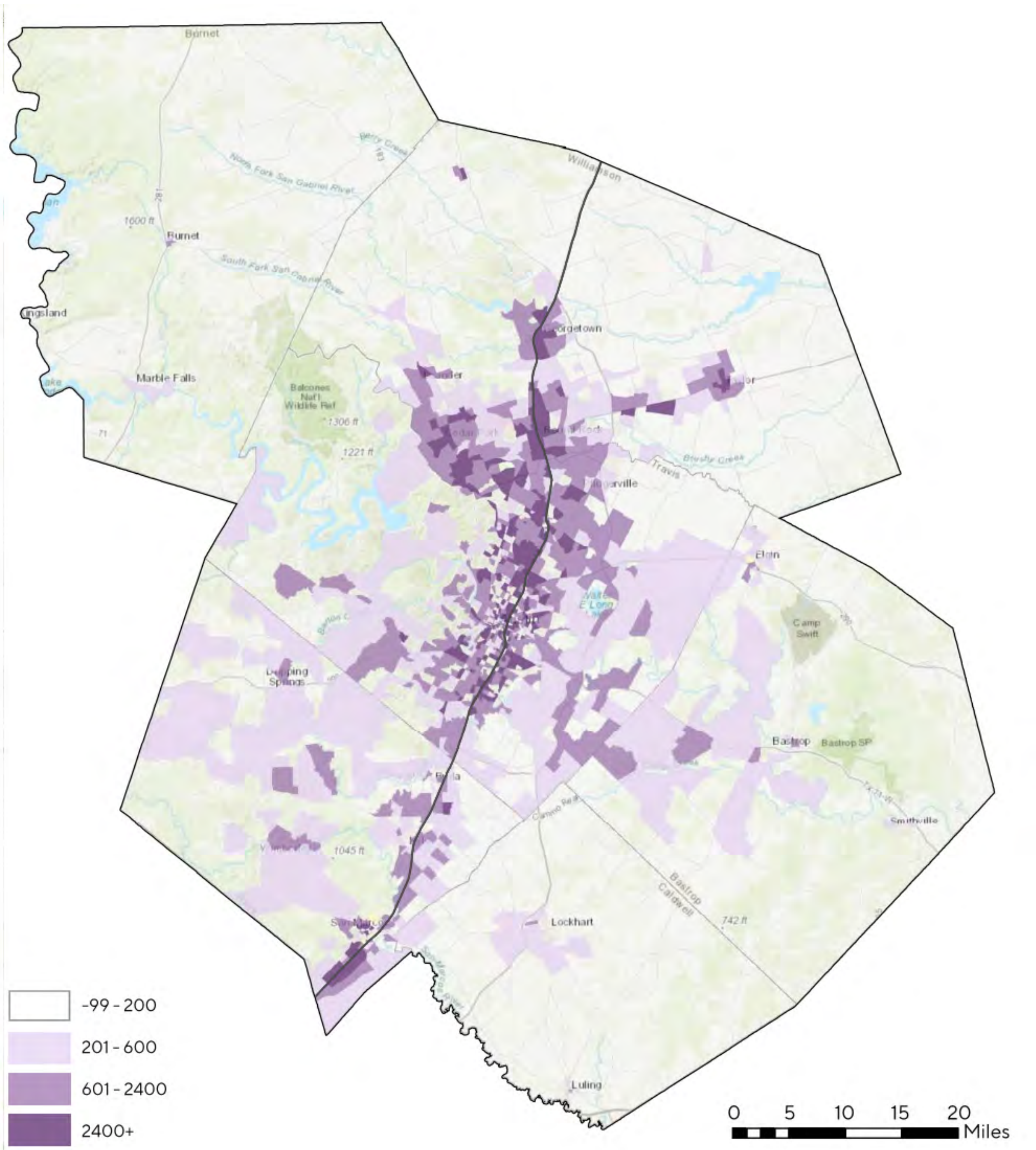

Figure 9. *TAZs assigned significant growth in employment.*

Employment

Figure 9 shows the distribution of allocated employment growth between 2015 and 2045. The pattern illustrates areas generally within the ETJs of existing cities experience the largest increases in employment density increases, and growth occurring across the region oriented along the major highways. IH-35 is illustrated for orientation, with notable employment growth expected along the corridor. Areas with less significant growth in population density (an increase of fewer than 200 jobs per square mile) are omitted from this exhibit to contrast the more significant changes.

Household Size

The average household size is a function of UrbanSim process. In the few cases where results in a TAZ deviated from a reasonable output (HHSize >5), averages from adjacent TAZs were used to nominally adjust the size and population totals.

Area Type

For the CAMPO TDM, the area type factors are calculated according to the formula below:

$$\text{Area type factor} = \frac{\text{Pop}_\text{i} + \left(\frac{\text{Regional Population}}{\text{Regional Employment}}\right) \text{x Emp}_\text{i}}{\text{Acres}_\text{i}}$$

Where i is a TAZ in the study area.

The area type factors are then aggregated into five area types according to the cutoff points in Table , which are retrieved from the CAMPO 2010 Planning Model Guide document.

Table 6. Area Type Classes

Area Type	Range	Description
1	Historic – Manually Assigned	CBD
2	$\text{Area Type factor} \geq 25$	Urban Intense
3	$9 \leq \text{Area Type factor} < 25$	Urban Residential
4	$1 \leq \text{Area Type factor} < 9$	Suburban Residential
5	$\text{Area Type factor} < 1$	Rural

Figure 10 (Appendix C) shows the spatial distribution of the area types in the model area. It is reasonable that urban and suburban activity would continue to center around the cities of Austin, Cedar Park, Round Rock, Georgetown, and San Marcos. The CBD area located in downtown Austin is consistent with the 2015 CBD delineation.

Median Family income

Travel demand models use median family income (MFI) to adjust the number of trips, and by what mode, a household makes. For this reason, the forecast includes an output of how incomes may change in a geography. Median Family Income (MFI) determination for the 2045 baseline forecast is a function of UrbanSim, which includes a capability for median family income output based on median family income from the 2009-2013 ACS Census data (in 2013-year dollars) and changes resulting from the model. For 2045 data development purposes, median income is kept in constant dollars across the forecast years. Initial results of the UrbanSim model were reviewed and adjusted for reasonableness in very few areas. Areas adjusted included TAZs west of Mopac but east of Loop 360 where negative growth trends were removed reflecting the stable higher income demographic of the area. Some smaller TAZs with households but no assigned MFI values were adjusted to an average of the adjacent TAZs.

The CAMPO TDM is not intended nor used as economic forecast. MFI indicators are used for the CAMPO TDM model functions only.

City-Specific Projections

CAMPO does not provide city-specific forecasts. TAZs do not match existing political subdivision boundaries exactly, and the MPO does not assume where future city limits would change. Any figure forecast for a specific city is an approximation of the population and employment, assumes standard development patterns, and that the employment or population from a partially covered TAZ is evenly distributed. City- and County-level aggregate forecasts are provided as informational items and will differ from projections produced by or specifically for any city or County using a place-focused forecasting method.

Updates to the forecasts for local jurisdictions are highly dependent on local land use laws, economic activity and annexation plans, if any. Comprehensive plans and demographic projections should be consulted for more representative data at the local level. Where available at the County or major city level, these plans have been incorporated into this baseline regional forecast.

Disclaimer

This data was developed for regional transportation planning activities and discussion and has not been evaluated for other use. The Capital Area Metropolitan Planning Organization makes no warranty, express or implied, including fitness or applicability for any particular purpose. Responsibility for the use of these data lies solely with the user.

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Allocation Process Methodology- CAMPO Block-level UrbanSim Model

UrbanSim is a microsimulation land use model, designed to support the need of Metropolitan Planning Organizations (MPOs), cities and other organizations for analyzing the potential effects of land use policies and infrastructure investments on the development and character of cities and regions. The modeling system relies upon a data-driven, transparent, and behaviorally-focused methodology that is designed to attempt to reflect the interdependencies in dynamic urban systems, focusing on the real estate market and the transportation system, and on the effects of individual and combinations of interventions on patterns of development, travel demand, and household and firm location. UrbanSim has become the operational modeling approach for a variety of metropolitan areas in the United States and abroad, and is actively used by metropolitan planning organizations in Albuquerque, Austin, Denver, Detroit, Honolulu, Phoenix, Salt Lake City, San Diego, San Francisco, Eugene-Springfield, Seattle, and Paris among others.

UrbanSim has been developed from over more than a decade of research led by Paul Waddell, currently Professor of City and Regional Planning at the University of California, Berkeley, from multiple grants from the National Science Foundation and from a number of MPOs in the United States. The research behind UrbanSim has been cited widely in the academic literature. In reviews of advanced models by independent studies such as the National Cooperative Highway Research Program (NCHRP), UrbanSim has consistently emerged as one of the most sophisticated and credible land use modeling methodologies. The core model code has been developed in the Python programming language as Open Source software and is publically available on the Urban Data Science Toolkit GitHub page.

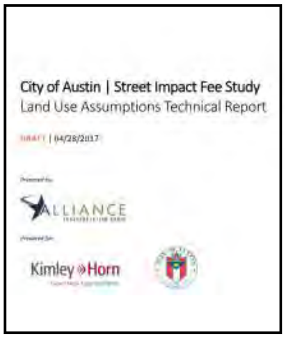
UrbanSim is different from prior operational land use models that are based on cross-sectional, equilibrium, aggregate approaches in that UrbanSim models individual decision-makers (households, employers, real estate developers), and their changes from one year to the next as a consequence of economic changes, policy interventions, and market interactions. A dynamic perspective of time is used, with the simulation proceeding in annual steps, and the urban system evolving in a path dependent manner. The real estate market is used as a central organizing focus of the model system, with consumer choices and supplier choices explicitly represented, as well as the resulting effects on real estate prices. UrbanSim uses standard discrete choice models to represent the choices made by households and firms and developers (principally location choices). Although more sophisticated choice model structures can be used, the most common in practice is the Multinomial Logit Model (MNL). Discrete choice models derive a model of the probability of choosing among a set of available alternatives based on the characteristics of the chooser (e.g. households) and the attributes of the alternative (e.g. blocks), and the relative utility that the alternatives generate for the chooser.

The choice models in the block-level implementation of UrbanSim used by CAMPO are: household location choice, employment location choice, and residential unit location choice. In addition, a set of regression models representing residential prices are used to update prices in each simulation year. The household location choice model in the CAMPO model is segmented by income quartile and is estimated off of recent-movers in the synthetic population. The employment location choice model is segmented by 2-digit NAICS sector and is estimated off of LEHD data. The residential unit location choice model is segmented by tenure (rent versus own) and structure type (single-family versus multi-family), and is estimated off of recently constructed units in the synthetic residential units table which is based on 2010 SF1 residential unit counts with detailed unit characteristics imputed from ACS data. Each location choice model is estimated using cross-sectional local data and explanatory variables selected using a step-wise variable selection algorithm that takes behavioral considerations into mind. Regional accessibility variables are present in the model specifications (e.g. jobs within 30 minutes), and are calculated based on zone-to-zone travel times (i.e. skims) provided by CAMPO.

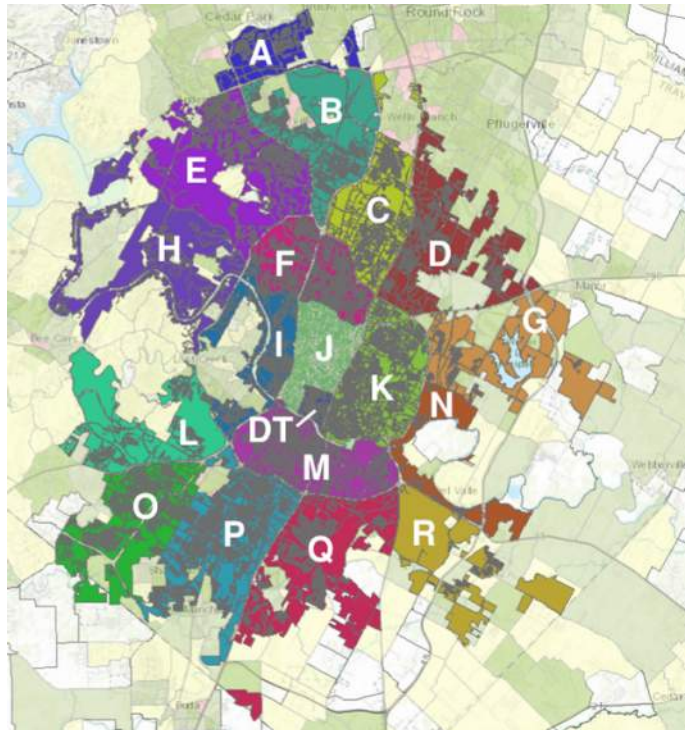
After model estimation, the location choice models were initially calibrated to longitudinal county-level growth targets, but this resulted in undesirable boundary effects. To mitigate this, the location choice models were then calibrated at a "place-type" geography, with calibration targets being longitudinal data summarized at the place-type level. Location choice model calibration in UrbanSim based on place-types instead of counties as the calibration geography can better reflect existing agglomerations at the sub-county level and reduce 'bunching' of development at county political boundaries. Calibration at the "place type" level is a more spatially detailed calibration option within the UrbanSim service package. The steps included:

1. Incorporate the constraints from the 2045_v2_2-23 scenario directly into the model file used in calibration to accelerate model performance
2. Perform clustering analysis to group tract geographies into place types based on similar characteristics
3. Summarizing calibration targets (ACS / LEHD change over time data) at the place type level instead of county
4. Calibrate the location choice models to move simulated patterns in the direction of observed place-type level growth shares

For additional information on the UrbanSim methodology, please see the suggested research papers listed here:
http://www.urbansim.com/research



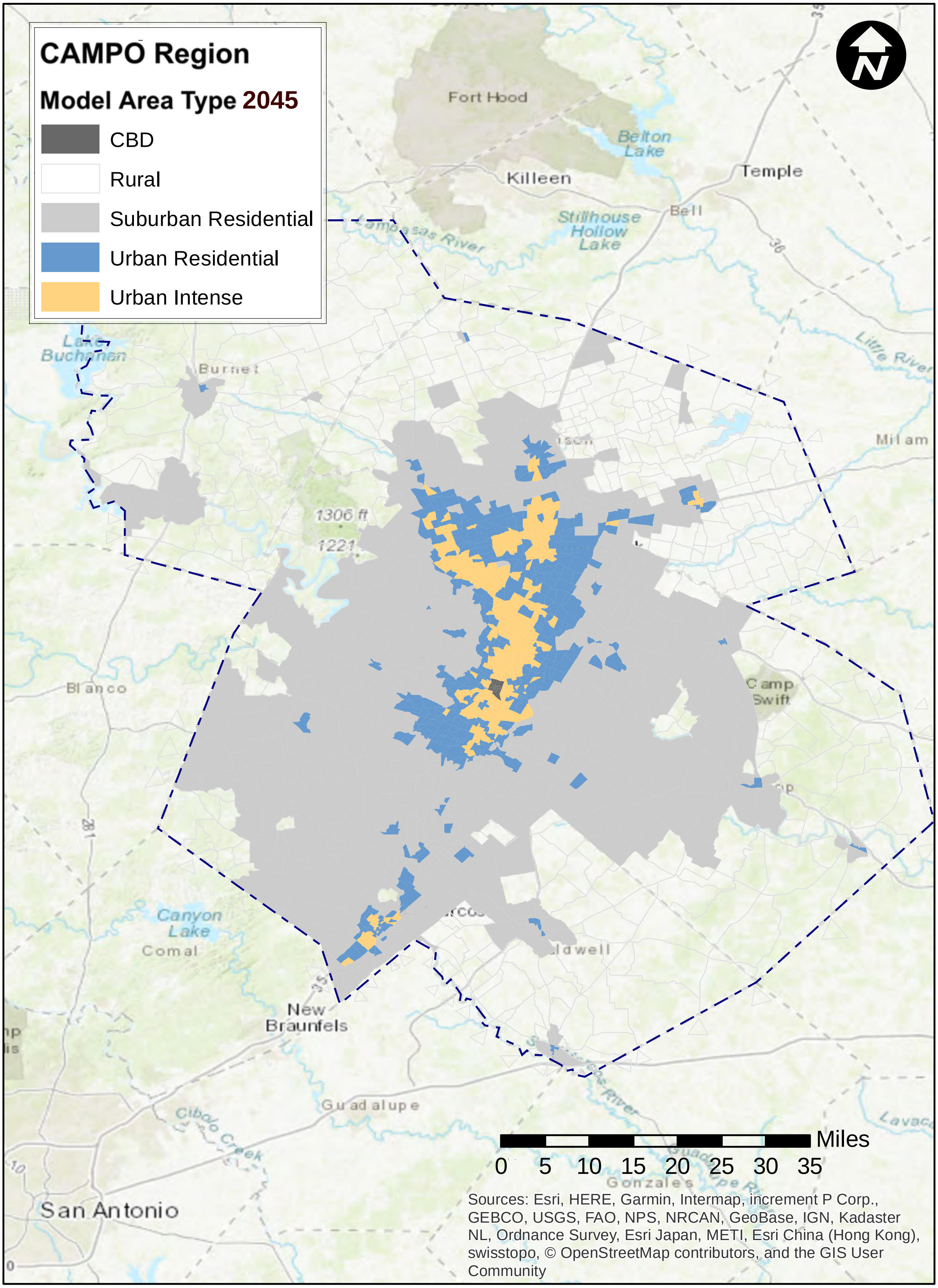
Proposed City of Austin Roadway Impact Fee Service Areas - Land Use Assumptions Technical Report (2017).



Comparison of City of Austin Land Use Assumption "Buildout" condition, by Impact Fee Service Area zones and CAMPO 2045 Baseline demographics.

Note: Approximate. Service areas and CAMPO TAZ estimates will not match exactly because COA service areas must conform to city limits boundaries which do not align exactly with TAZs.

	City of Austin "Buildout"		CAMPO 2045.BI v20.06.14.18			
Service Area	Population	Employment	Population	Employment	Population Difference	Employment Difference
A	43,490	11,864	44,680	21540	2.7%	81.6%
B	102,265	49,416	131,095	76,085	28.2%	54.0%
C	100,313	68,814	161,293	92,008	60.8%	33.7%
D	83,618	56,958	151,830	67,102	81.6%	17.8%
DT	44,925	100,038	71787	97,301	59.8%	-2.7%
E	83,985	31,388	110,058	57,297	31.0%	82.5%
F	97,598	62,619	81,852	67,144	-16.1%	7.2%
G	27,513	9,679	48,267	14,252	75.4%	47.2%
H	31,816	16,588	39,526	14,958	24.2%	-9.8%
I	30,750	22,535	31,938	31,886	3.9%	41.5%
J	124,100	82,788	98,052	112,761	-21.0%	36.2%
K	142,597	56,672	130,722	69,480	-8.3%	22.6%
L	41,646	27,005	42,074	30,543	1.0%	13.1%
M	165,219	70,484	165,857	93,514	0.4%	32.7%
N	9,815	6,645	11,840	7,257	20.6%	9.2%
O	63,967	9,664	98,650	25,749	54.2%	166.4%
P	149,125	42,749	145,858	61,884	-2.2%	44.8%
Q	74,731	34,514	94,840	47,291	26.9%	37.0%
R	19,617	7,654	31,834	20,533	62.3%	168.3%
	1,437,090	768,074	1,692,053	1,008,585		


CAMPO Region
Model Area Type 2045
CBD
Rural
Suburban Residential
Urban Residential
Urban Intense
Fort Hood
Belton Lake
Killeen
Temple
Bell
Stillhouse Hollow Lake
Lake Buchanan
Burnet
Milam
Blanco
Camp Swift
Canyon Lake
Comal
New Braunfels
Guadalupe
Cibolo Creek
San Antonio
Gonzales
Miles
0
5
10
15
20
25
30
35
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community