RESEARCH

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Utah Department of Transportation - Research Division
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Report No. UT-24.07

SOCIOECONOMIC DATA DEVELOPMENT METHODS FOR TRAVEL DEMAND MODEL INPUTS:

An Assessment of Socioeconomic Data Development Methods for Travel-Demand-Modeling Input Preparation

Prepared For:

Utah Department of Transportation
Research & Innovation Division

Final Report
February 2025

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The objective of this research project is to evaluate the current method to develop TAZ-level socioeconomic forecasts for counties in the state outside the Wasatch Front and explore options for reducing costs and improving data quality. The socioeconomic data forecasts are currently developed in a series of spreadsheets that must be manually updated and reviewed for each socioeconomic data development cycle. There are more automated and sophisticated methods for generating socioeconomic data forecasts used throughout the country that could be adapted/utilized for UDOT purposes that can possibly save staff time, consultant costs, improve data quality, and enhance scenario testing capabilities.

The key deliverable for this research project is a report documenting the existing process, methods evaluated, evaluation results and recommendations, results of recommended versus current methodology for a single county proof of concept, and an implementation plan for transitioning from the current socioeconomic data development process to the recommended alternative. During the analysis, a proof-of-concept forecasting tool will be provided to UDOT to use in further development based on recommendations in the implementation framework.</td></tr>
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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

ACS	American Community Survey
BY	Base Year
CPRC	Central Pines Regional Council
CSV	Comma-Separated Values
DOT	Department of Transportation
DWS	Department of Workforce Services
FAR	Floor Area Ratio
FBRMPO	The French Broad River MPO
FY	Future Year
GIS	Geographic Information Systems
GPI	Kem C. Gardner Policy Institute
IDE	Integrated Development Environment
LEHD	Longitudinal Employer-Household Dynamics
LODES	LEHD Origin-Destination Employment Statistics
LS-LUM	Large-Scale Land-Use Model
MAG	Mountainland Association of Governments
MPO	Metropolitan Planning Organization
NAICS	North American Industry Classification System
OSM	Open Street Maps
PSRC	Puget Sound Regional Council
REMM	Real Estate Market Model
SE	Socio-Economic
TAZ	Traffic Analysis Zone
TDOT	Tennessee Department of Transportation

UDOT	Utah Department of Transportation
UTRAC	Utah Transportation Research Advisory Council
WFRC	Wasatch Front Regional Council

EXECUTIVE SUMMARY

This UTRAC research project evaluates socioeconomic (SE)-data-forecasting tools that could be used to meet the Utah Department of Transportation's (UDOT) needs in preparing travel-demand data input forecasts, suggests a recommended tool, and evaluates the tool on one county in the state. Socioeconomic forecasts represent existing and future population, household, employment, and school data for the state's travel demand models.

The travel demand models in Utah rely on socioeconomic data forecasts at the traffic-analysis-zone (TAZ) level to estimate current and future travel demand. UDOT currently develops these forecasts using a series of spreadsheets that must be manually updated and reviewed during each socioeconomic-data-development cycle (typically every four years, with minor revisions in between). This research project evaluates the current method of developing socioeconomic forecasts for counties outside the Wasatch Front and explores options for reducing costs and staff time and improving data quality.

Research was conducted using the following process:

1. Assess Existing Forecasting Methodology
2. Conduct Best Practices Review & Peer Agency Interviews
3. Evaluate and Recommend Forecasting Method
4. Conduct Proof-of-Concept Evaluation
5. Develop Implementation Framework
6. Prepare Final Report

There are a variety of socioeconomic and land-use models used throughout the country to prepare socioeconomic forecasts for TDM input preparation. These models can be simplistic allocation models, such as the current spreadsheet process used by UDOT, or highly advanced simulation models. The research team identified a list of candidate models to further research, including CUBE Land, CommunityViz, UrbanSim, and custom agency tools such as Python scripting.

After identifying potential tools, research was conducted to document the existing process and to develop and test a new socioeconomic forecasting process. The process was not entirely data driven; the research team considered stakeholder input when they evaluated potential tools and identified a proof-of-concept scenario. The review determined that a new tool is warranted and that a custom-based Python tool was appropriate because it can emulate the existing forecasting process while allowing for greater automation and future enhancement of the process. A proof-of-concept scenario for Iron County was then used to help develop recommendations and an implementation framework to expand the new socioeconomic forecasting tool for use in the entire state by UDOT.

After development of the test scenario, the research team created an implementation framework that includes four phases:

1. Initial Implementation
2. GIS Integration
3. GIS Visualization
4. Allocation Model Update

Phases are structured so that agencies can quickly implement the socioeconomic model and add functionality and visualization as resources become available.

Research completed for this project identified several viable options for preparing socioeconomic forecasts using newer, more streamlined approaches than the existing spreadsheet process. The research team recommended a custom Python script for ArcGIS Pro and successfully completed the forecasting process for one county using the selected Python-based methodology. UDOT plans to implement this methodology to other counties and add features to improve functionality and usability. Based on the results of the methods evaluation, peer agency interviews, and the demonstration implementation, the team prepared an implementation framework to prioritize upgrades and enhancements to the demonstration Python script. Results from the demonstration Python script were compared against the results of the spreadsheet forecasting model to confirm that the Python scripts were successfully able to replicate the socioeconomic forecast process, shown in **Appendix A**.

1.0 INTRODUCTION

1.1 Problem Statement

The travel demand models in Utah rely on socioeconomic data forecasts at the traffic-analysis-zone (TAZ) level to estimate current and future travel demand. UDOT develops these forecasts using a series of spreadsheets that must be manually updated and reviewed during each socioeconomic data development cycle (typically every four years, with minor revisions in between). While this process has been successful for past socioeconomic updates, it is a labor-intensive process that requires a high level of effort from UDOT and partner agencies' staff, as well as significant consultant expenses.

1.2 Objectives

This UTRAC research project evaluates different socioeconomic data forecasting tools that could be used to meet the Utah Department of Transportation's (UDOT) needs to prepare travel demand data input forecasts. The research evaluates the current method of developing socioeconomic forecasts for Utah counties outside the Wasatch Front, explores options for reducing costs and staff time while improving data quality, and creates a "proof-of-concept" tool to prepare the socioeconomic forecasts for one county that UDOT can also use to implement for other counties. These forecasts represent existing and future population, household, employment, and school data for the state's travel demand models.

1.3 Scope

The scope of this research project included the following tasks:

1. **Overview and Assessment of Existing Methodology:** Provide an overview of the existing socioeconomic-data-development process. Document existing and emerging socioeconomic data needs for UDOT (including potential use cases that may not be well served by current methods including scenario planning and activity-based modeling).

2. **Best Practices Review & Peer Agency Interviews:** Research and summarize socioeconomic-data-development methods used by a representative sample of other DOTs/MPOs nationwide, based on available agency and vendor documentation and targeted practitioner interviews.
3. **Evaluate and Recommend Forecasting Method:** Evaluate potential tools based on alignment with UDOT needs, including utility, ease of use, input data needs, cost of implementation (including initial and ongoing costs), and adaptability (e.g., activity-based and trip-based models). Based on this evaluation, the team and stakeholders will recommend a methodology for future use.
4. **Proof-of-Concept Evaluation:** Evaluate the recommended methodology with one county in Utah to compare against the existing projection methodology.
5. **Implementation Framework:** Based on proof-of-concept testing, develop an implementation framework that includes recommended methodology, user guidance, input data needs, and obstacles to success.
6. **Final Report:** Document study findings in a final report.

1.4 Outline of Report

This report presents the following sections documenting the research process and recommendations for future research/implementation.

- Introduction – Provides an overview of the research project
- Research Methods – Details the approach of this research
- Data Collection – Describes the data collected for this project, including a review of the existing methodology, a review of potential new tools, and an outline for peer agency interviews to learn about potential tools in practice
- Data Analysis – Details the existing methodology, provides a review of potential new tools for implementation, peer-agency interview findings, and research observations
- Conclusions – Summarizes the research and provides findings and takeaways considered for recommendations and implementation
- Recommendations and Implementation – Recommends a socioeconomic forecasting tool and a process framework to implement the recommended methodology

2.0 RESEARCH METHODS

2.1 Overview

Research methods for this project included reviewing the existing methodology, reviewing forecasting tools, interviewing peer agencies, evaluating a demonstration socioeconomic forecasting model, and creating an implementation plan to adopt the recommended socioeconomic forecasting tool.

2.2 Research Process

Research was conducted through the following process:

2.2.1 Existing Methodology Assessment

Describe and assess UDOT's existing methodology to develop base year and future year socioeconomic data for travel demand model inputs in the state outside the Wasatch Front. This includes reviewing input data requirements, outputs, development methodology, and critical issues that UDOT wishes to address with an improved methodology.

2.2.2 Potential Forecasting Tools Overview

Present and discuss socioeconomic forecasting tools considered as potential replacements for the current forecasting process. This overview focuses on tools that fit UDOT's needs rather than every potential socioeconomic-forecasting-model platform available in the industry.

2.2.3 Peer Agency Review

Summarize results of targeted practitioner interviews conducted to understand the methods used, cost, advantages/disadvantages, and typical levels of effort to conduct common tasks (e.g., updating regional/statewide projections, generating socioeconomic forecast scenarios for project applications, etc.), as well as other benefits leveraged through other agencies' forecasting process.

2.2.4 Forecasting Methodology Comparison

Compare each potential land-use/socioeconomic forecast-modeling tool (including the existing method) and recommend a socioeconomic forecasting method to carry forward into a proof-of-concept scenario.

2.2.5 Forecasting Tool Demonstration

Implement the recommended forecasting tool to allocate housing and employment data for future years in a proof-of-concept scenario. Compare results against the existing methodology and provide UDOT with a working version of the proof-of-concept tool for one Utah county.

2.2.6 Recommendations and Implementation Framework

Summarize takeaways and observations from the proof-of-concept scenario and present recommendations and implementation framework to adapt the proof-of-concept scenario into a fully realized forecasting tool for UDOT's use.

2.3 Summary

The research methodology used for this project was based on assessing the existing tool, reviewing other potential socioeconomic forecasting tools, interviewing peer agencies, and ultimately evaluating and recommending a forecasting method. By reviewing data requirements and critical issues that UDOT wishes to address with an improved methodology, the team provided a recommendation on the best tool for UDOT to potentially use moving forward. Based on this recommendation, the research team implemented a land use/socioeconomic proof-of-concept forecasting tool to allocate housing and employment data for future years and compared it against the existing methodology. From this, the team provided observations from the proof-of-concept scenario and an implementation framework to guide UDOT and partner agencies in determining the next steps for subsequent forecasting processes.

3.0 DATA COLLECTION

3.1 Overview

The data collection effort for this project consisted of a combination of potential tool review and peer agency interviews. First, data on the existing spreadsheet process was collected and documented. Second, potential tools were identified for further research. For these tools, vendors and practitioners were interviewed to better understand key considerations around each tool, such as cost, ease of application, and suitability. Finally, peer agencies were interviewed to see what tools they utilize, how they utilize them, and their implementation and management process. This data was then evaluated for suitability with UDOT's needs, which is discussed in **Section 4** of this report.

3.2 Existing Forecasting Process Review

The existing forecasting process was reviewed during data collection to assess the tool functionality and steps used to create socioeconomic data forecasts by TAZ. First, the existing framework was reviewed to identify the tool structure, data inputs, and data outputs. Second, the workflow was documented to help inform comparisons against other potential tools.

3.2.1 Existing Forecasting Framework

Travel demand models in Utah use a four-step model framework: trip generation, trip distribution, mode choice, and traffic assignment. The total number of households, population, and employment by type at each TAZ is a fundamental dataset for these travel demand models. To forecast this data by TAZ, UDOT uses an allocation model, where county-level control totals generated by the Kem C. Gardner Policy Institute (GPI) for each horizon year for housing and employment are used to allocate future changes by TAZ. It is not considered a predictive model, but rather allocates growth based on existing households and employment and specified capacities and growth rate factors by TAZ.

This allocation framework uses Excel-based tools (spreadsheets) and focuses primarily on households and employment. As part of the process, household population is calculated based on forecasted households and average household size. On the employment side, projected jobs are disaggregated across 11 sector categories, as well as home-based jobs. Additional socioeconomic variables considered in the model include school enrollment data and secondary homes (for the models with a seasonal component), which are forecasted through a separate process. The focus of this research project is the development of household, population, and employment forecasts. A more detailed description of the socioeconomic data development published by UDOT can be found at https://docs.google.com/document/d/1jxslCR8CyedRJtOCl13VmQXf_Zyor8fXxUNAEmsPKjw/edit?usp=sharing

3.2.2 Spreadsheet Process Workflow

The processes to generate household and employment datasets follow similar overall workflows, but with different input datasets. **Figure 3.1** and **Figure 3.2** provide a high-level summary of the data development process of these key data types. Both processes begin by aggregating base-year data sources to the TAZ level and conducting initial data checks. The processes compare and constrain the initial base year data to county control totals (current and future year county-level housing, population, and employment estimates provided by the Gardner Policy Institute).

The spreadsheet forecasting tool requires population, employment, and geographic data from a variety of local, state, and national sources that are processed and used within the spreadsheet tool. Data utilized for the process includes:

- US Census Bureau – Census Block-Level Data on Households and Population:
- US Census Bureau – American Community Survey Data
- Utah Department of Workforce Services – Statewide Employee Location Data
- Kem C. Gardner Policy Institute – County Control Totals
- Local Areas – General Plans/Future Land-Use Maps
- Counties – Parcel Data (as available; quality varies by county)
- UDOT – Traffic Analysis Zones (TAZs)

- UDOT – TAZ Residential and Employment Capacity
- UDOT – Area Weight Factors and Seeds

This data is manually processed to create the forecast spreadsheets for each county, base-year socioeconomic forecasts by TAZ, future control totals, and capacities for future TAZ growth.

Once base year totals have been established, the process allocates future county growth to TAZs based on TAZ-level capacities (estimates of the maximum number of units based on buildable land area and existing land-use plans and zoning) and TAZ seeds (which allow forecasters to manually direct growth toward known areas where new or redevelopment is planned or anticipated by specifying new units by forecast year by TAZ).

After completing the initial review, the forecasting team shares a draft output with local governments to get feedback on the forecasts. Draft projections are typically distributed using a web map format, which allows municipal, county, and/or MPO staff to comment on TAZ-level forecasts and share known or anticipated zoning changes, master plans, or pending/approved permitting activity that may impact near- or long-term land uses. From this feedback, the forecasting team adjusts the inputs and assumptions county by county to produce final TAZ forecasts.

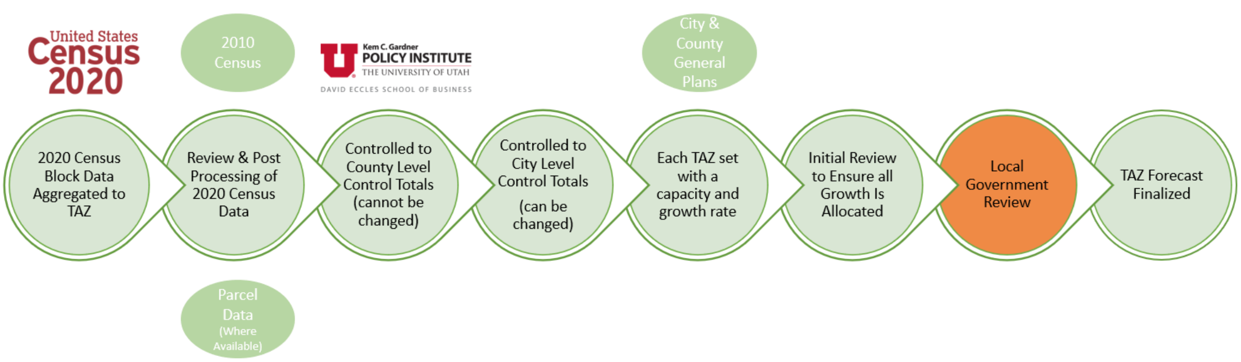


Figure 3.1 Household- and Population-Data-Development Workflow

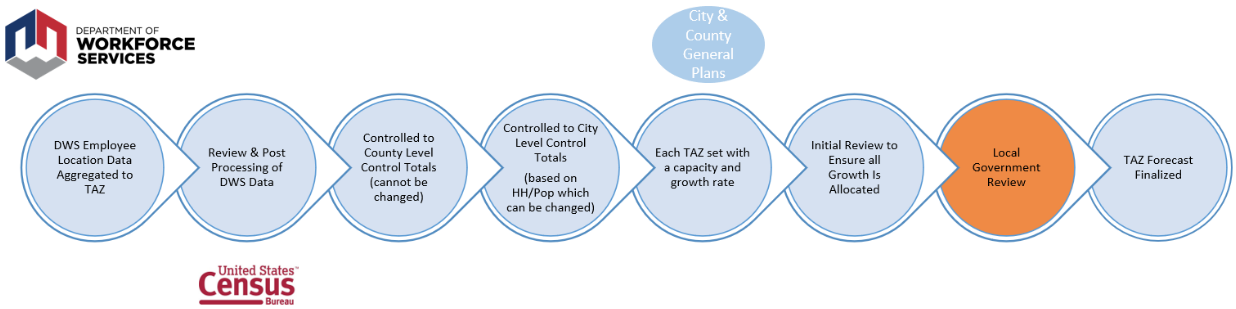


Figure 3.2 Employment-Data-Development Workflow

3.3 Potential Forecasting Tool Review

There are a variety of socioeconomic models used in practice throughout the country to prepare socioeconomic forecasts for TDM input preparation. These models can be simplistic allocation models, such as the current spreadsheet process, or highly advanced simulation models. Newer models tend to focus on integrating transportation-land use, urban simulation, and economic factors to create future forecasts. To analyze potential tools, the research team identified a list of candidate socioeconomic forecast models to further research, including the following:

- CUBE Land
- CommunityViz
- UrbanSim
- Custom Agency Tools

For these tools, relevant information was collected on key factors that would impact the potential success in meeting UDOT's needs, including these factors:

- Industry adoption
- Ease of use/ability to update
- Aggregate vs. disaggregate data needs
- Staff resources required
- Interaction with current modeling/GIS software

More information on the outcome of this research is discussed in **Section 4.2**.

3.4 Peer Agency Interviews

As the first phase of the 2022 UTRAC problem statement on socioeconomic-data-development methods, research staff identified and held informational interviews with staff at six agencies that incorporate different methods to prepare future socioeconomic inputs for their travel demand models. The desired outcome of these interviews was to gain a better understanding of how different tools (UrbanSim, CommunityViz, etc.) are being utilized in practice and how well they could (or couldn't) address UDOT's socioeconomic forecasting needs. The team also interviewed two vendors/consultants who are supporting local agencies in their forecasting needs to supplement information provided by public agencies, who may rely more directly on vendors/consultants to develop and maintain their socioeconomic forecasting models.

3.4.1 Agencies Interviewed

Practitioners with varying backgrounds were identified and interviewed about their experiences with socioeconomic data forecasting. The final interview list, presented in **Table 3.1**, consisted of

- 1 software vendor
- 1 socioeconomic forecast-model-development consultant
- 4 MPO/regional agencies
- 2 state DOTs

Table 3.1: Interview Details

Agency	Software	Date(s) of Interviews
Caltrans	Custom Tool	11/7 & 11/17/2023
Central Pines Regional Council (Raleigh NC)	CommunityViz	11/9/2023
French Broad River MPO (Asheville NC)	Cube Land Hybrid with R script wrapper	11/13/2023
Puget Sound Regional Council	UrbanSim	11/9/2023

Tennessee Statewide Modeling	LS-LUM (Custom Matlab)	11/2 & 11/30/2023
WFRC	UrbanSim	11/16/2023
Manhan Consulting*	Cube Land/CommunityViz	11/15/2023
Bentley*	Cube Land	12/11/2023

*Consultant/Vendor Interview added to supplement agency information.

3.4.2 Interview Outline

Practitioners were interviewed using a semi-structured interview approach, with a set of prepared prompts/questions used as a jumping-off point to understand each interviewee's experiences and perspectives, and practices around modeling within their organization. The outline of questions was as follows:

1. When did your agency decide to transition to a land-use/spatial model for socioeconomic forecasting?
    a. What factors were decisive in making the decision to transition to a particular software?
    b. Did your previous methodology inform the current method, or did you start from scratch?
2. What did development of a new socioeconomic forecasting model look like?
    a. Timeline
    b. Initial set-up process
    c. Consultant costs
    d. In-house staff development/management effort
    e. Alignment with plan cycles, major projects
    f. Staff and/or consultant training
3. What data needs does the model have?
    a. Do you have data inconsistencies across jurisdictions/counties?
    b. Is input data automatically integrated or do you have to manually process with major updates?
    c. What resolution is the socioeconomic forecast model (parcel, TAZ, grid, etc.)
    d. Do you specify control totals and at what geography?
    e. If so, how are control totals determined?

f. How do you process interim years?
g. Do you work with land-
h. use constraints such as unbuildable areas and slopes?

4. What benefits have you seen?
    a. Applications not possible under prior forecast process?
    b. Ability to quickly update forecasts?
    c. GIS presentation/management?
    d. Quality control versus manual processes?
5. What downsides have you seen?
    a. User base?
    b. Model run time?
    c. Maintenance?
    d. Costs (staff time/consultant effort/software)
6. Have you benefitted outside of the TDM input use?
    a. Scenario Planning?
    b. Support for project-level analysis?
    c. Environmental Justice?

3.5 Summary

The data collection effort involved documenting the existing process, identifying socioeconomic forecasting tools to potentially replace the existing process, and identifying and interviewing peer agencies and vendors that can provide useful perspectives and information on new socioeconomic forecasting tools. The goal of the data collection effort was to gather necessary information to determine what tools could best meet UDOT's needs, what the process would be for implementing them, and potential costs and benefits. Section 4 of this report discusses the results of the data collection efforts.

4.0 DATA EVALUATION

4.1 Overview

Data evaluation was accomplished by reviewing the existing process, assessing potential new tools, summarizing feedback from peer agencies, and testing a potential new forecasting tool. The process was not entirely data driven; stakeholder input was considered when potential tools were evaluated, and a proof-of-concept scenario was identified. The goal of the data evaluation was to determine if a new tool is warranted, and if so, what the most appropriate tool would be. During evaluation, the proof-of-concept scenario is used to help develop recommendations and an implementation framework to scale the new socioeconomic forecasting tool for use in the entire state (except the Wasatch Front) by UDOT.

4.2 Potential Forecasting Tool Overview

Land-use/Socioeconomic models can be traced back as far as the 1960s when planners began developing tools to better understand the link between transportation and land-use patterns. Socioeconomic forecasting models have evolved over time, both with the advent of new technologies, available data, computing abilities, and further research into land use-transportation interactions. Newer models tend to focus on integrating transportation land use, urban simulation, real estate competition, and regional economics to create forecasted conditions.

Understanding that the focus of this study is to allow UDOT to better meet socioeconomic forecasting needs without necessarily replacing the current workflow described in the existing methodology, potential socioeconomic forecasting models were identified for further research. Key factors for investigation included the following:

- Industry adoption
- Ease of use/ability to update
- Aggregate vs. disaggregate data needs
- Staff resources required
- Interaction with current modeling/GIS software

Many potential options are available for future socioeconomic conditions forecasting. Based on preliminary investigation of current practices, the project team narrowed the choices down to the following tools that may best fit UDOT’s needs to produce TAZ-level household and employment forecasts:

- CUBE Land
- CommunityViz
- UrbanSim
- Custom Agency Tools

These were compared to each other and the existing spreadsheet process to evaluate the advantages and disadvantages of each tool. This evaluation was qualitative and informed by feedback from peer agency interviews and project stakeholders. The outcome of this evaluation was the selection of a demonstration forecasting tool, described further in Section 4.5.

4.2.1 Existing Spreadsheet Forecasting Tool

UDOT currently prepares data for its travel demand models using Excel-based forecasting tools. A major issue with the spreadsheet method is that developing these inputs to estimate the TAZ-level household, population, and employment requires a high level of effort.

Inputs into the forecasting spreadsheet, listed in Section 3.2.2, require manual processing and homogenizing for use in the spreadsheet forecasting tool. After processing, these inputs are used for the forecasting process.

Table 4.1 shows the main inputs and outputs of the current Excel-based socioeconomic forecasting tool as it relates to household, population, and employment.

Table 4.1: Excel-Based Forecasting Tool Inputs and Outputs

Inputs for SE Forecasts	Outputs for SE Forecasts by TAZ
• Household and employment control totals by county and year • Household and population information by TAZ (from Census or other sources) • Employment information by employment category and TAZ • Subarea control totals • Capacity, area growth, and seeds values by TAZ	• Total households • Total population • Average household size • Number of jobs by employment category: -Retail -Food -Wholesale -Office -Government -Health -Other -Agricultural -Mining -Construction -Home-Based

Each county in Utah uses a template that has the same structure, input, and output to allocate socioeconomic data to TAZ. The purpose of the tool is to develop TAZ-level population, household, and employment data used in the following travel models: Utah Statewide Travel Model (USTM), Cache Model, Dixie Model, Summit/Wasatch Model, and Iron County Model.

County control totals are allocated to each TAZ in their respective spreadsheet tab using the following process:

1. The base-year data is developed by scaling source household, population, and employment data to the county control totals in the *BY Res* and *BY Emp* spreadsheet tabs.
2. The base-year data developed in the *BY Res* and *BY Emp* tabs is imported into the forecasting processes tabs.
3. The future year growth is allocated based on the following principles:
    a. Each year starts with previous year data (i.e., 2020 employment growth is added to the employment data in 2019, etc.).
    b. Each TAZ has a capacity value that cannot be exceeded for each future year. Once this value is met no further growth is allocated to that TAZ.

c. Area Growth Weight Factors are used to accelerate the growth in TAZs expected to grow faster in future years.
d. Seeds are used to start growth in TAZs that are undeveloped in the base year and/or reflect known near-term developments.
e. The summation of all the TAZs in the county for specific years should equal the county control totals. If forecasted county totals do not match the county control totals, the TAZ capacities and/or city control totals can be adjusted to balance the county control totals.

4. After allocating, employment is split by category for future years. These projections are based on existing employment shares by sector from the Department of Workforce Services (DWS) data, which are adjusted using iterative proportional fitting to match future year county- and sector-level control totals.
5. Export tabs create comma-separated values (CSV) files for each year used as direct input to each travel demand model.
6. Export tabs create TAZ shapefiles for visualization by model horizon year (e.g., 2028, 2032, 2042, 2050).

4.2.1.1 Local Government Review Process

Following the development of the draft forecast spreadsheets, UDOT seeks feedback from local stakeholders to either confirm the forecast reflects local conditions or obtain additional information to improve the forecast.

Based on the comments, adjustments are made to the forecasting spreadsheets to better align output with comments from the agencies. Adjustments typically included updating capacities, modifying city control totals, updating seeds, and/or updating growth rates for TAZs.

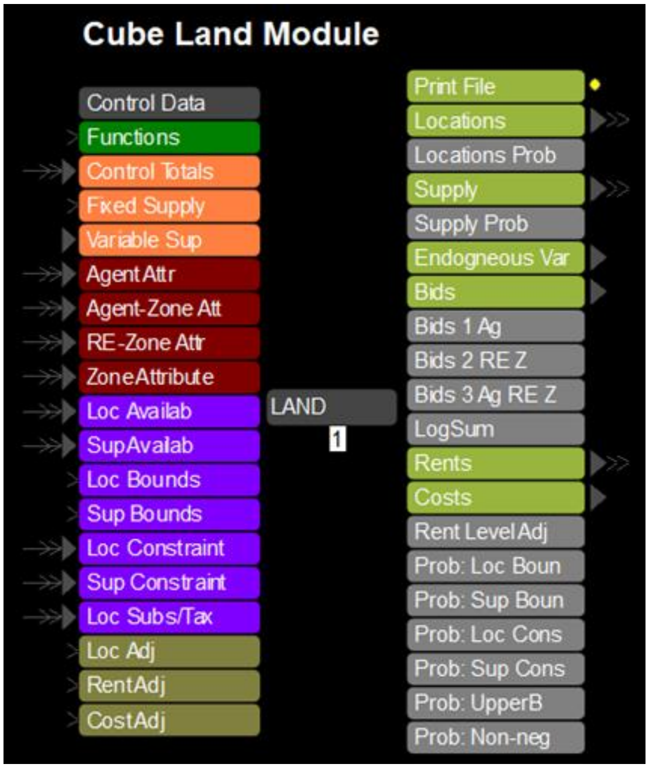
4.2.2 CUBE Land

Bentley developed CUBE land to directly integrate land-use modeling with other CUBE travel demand models. It is an economic land-use forecasting software designed to model the interaction between real estate and transportation systems. (Contrero, 2020)

Bentley describes the following key benefits of using CUBE Land for land-use modeling (Bentley Reference Guide v6.5.1):

- Possible to efficiently integrate the land-use model with a CUBE transportation model
- High program flexibility for treating transportation's effects on land use
- High program flexibility in the definition of the drivers of household and firm location and in the segmentation of the agents and real estate market
- High program flexibility in the definition of the zoning system level of detail
- Tidy management of input/output data and clear visualization of the full modeling process
- Direct management of different scenarios within the CUBE Base logic

CUBE Land operates within a module that can be added to existing model structures, illustrated in **Figure 4.1**. Inputs such as control totals and supply (available land data) are used along with model assumptions and calibration adjustments to create a balance between supply and demand for future land use. Since it is a module that can operate directly within the model workflow, it can potentially better capture impacts of transportation infrastructure on future development patterns, especially for "what if" transportation/land-use scenarios.



Source: Bentley Systems, Inc.

Figure 4.1 CUBE Land Module

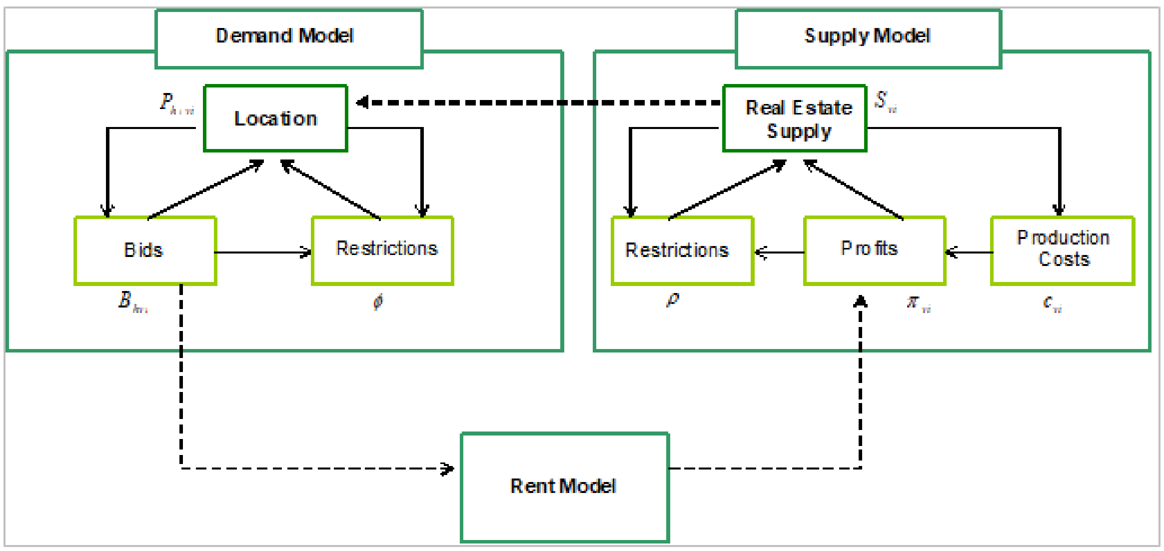
The zones, agents, and properties of the input data can all be defined by the users. Cube Land accepts the following inputs by zone:

- Zonal accessibility and attractiveness
- Total area by land-use category
- Average household income
- Zoning policies and other restrictions
- Market-segmented:
  - Residential (Households) stratified by size, income, and other variables
  - Non-residential (Firms) stratified by industry, size, and other variables
- Real estate unit characteristics:
  - Average lot size
  - Average floor space

- Floor Area Ratio (FAR)
- Average monthly rent, etc.

The land-use model, illustrated in **Figure 4.2**, predicts the interaction of real estate markets and transportation using the MUSSA II Model. CUBE Land uses "bid-rent" theory with three sub models representing housing and commercial space demand, supply provided by developers, and the rent values of properties providing equilibrium between supply and demand to model future conditions.

Results from CUBE Land can be directly integrated into other CUBE-based models, or post-processed in ArcGIS for visualization.



Source: Bentley Systems, Inc.

Figure 4.2 CUBE Land Model Process

4.2.3 CommunityViz GIS Software

CommunityViz is an ArcGIS-based platform maintained by Texas A&M for land-use modeling and scenario analysis. This platform includes a package of tools, wizards, and engines that allows users to generate many different formula-based analyses including allocation, build-out, and suitability analyses. Using CommunityViz, some practitioners have utilized it specifically to prepare socioeconomic forecasts by TAZ using land use-socioeconomic conversion processes. In CommunityViz, users can easily apply land-use policies to areas and compare different policy sets against each other with respect to potential land use and socioeconomic forecast impacts. Several "wizards" are built into CommunityViz to assist with the development and comparison of different scenarios. Because CommunityViz is an ArcGIS extension, all results are quickly visualized.

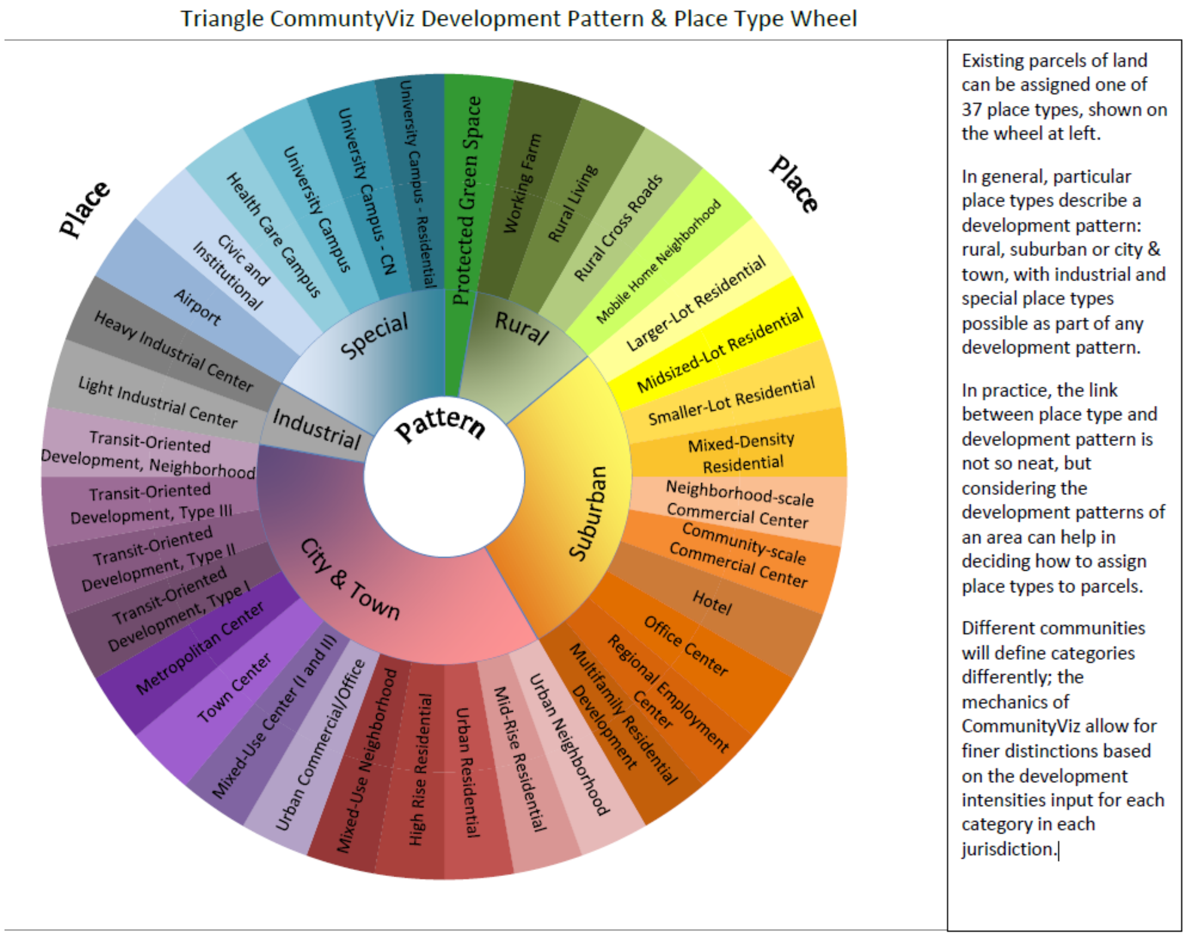
4.2.3.1 CommunityViz Input Data

The typical CommunityViz model has five main requirements:

1. Development constraints such as water bodies, steep slopes, and protected areas
2. Current and future Place Types for each TAZ (e.g., Low Density Residential, Town Center, Office)
3. The current development status of each parcel relative to its future use
4. Suitability factors that will determine how attractive each parcel is for development, such as proximity to regional economic centers, interstates, and recreation
5. Control totals by horizon year and type (households, employment by industry)

Place Types

CommunityViz uses a unique approach in which each parcel (or TAZ) is assigned one of a range of different CommunityViz Place Types spanning a range of residential, commercial, industrial, and mixed-use development possibilities. For each Place Type, assumptions are made on parameters such as the percentage of land that is single-family vs. multifamily, employment type distribution, and development density (e.g., maximum height, floor area ratio). Based on the assigned Place Type, current development; developable area; and maximum buildout is calculated for each TAZ. Place Types can vary by year to represent future land-use plans and anticipated zoning changes. An example is shown in **Figure 4.3** for the Triangle (Raleigh-Durham-Chapel Hill) area, which utilizes 37 different Place Types to forecast land data.

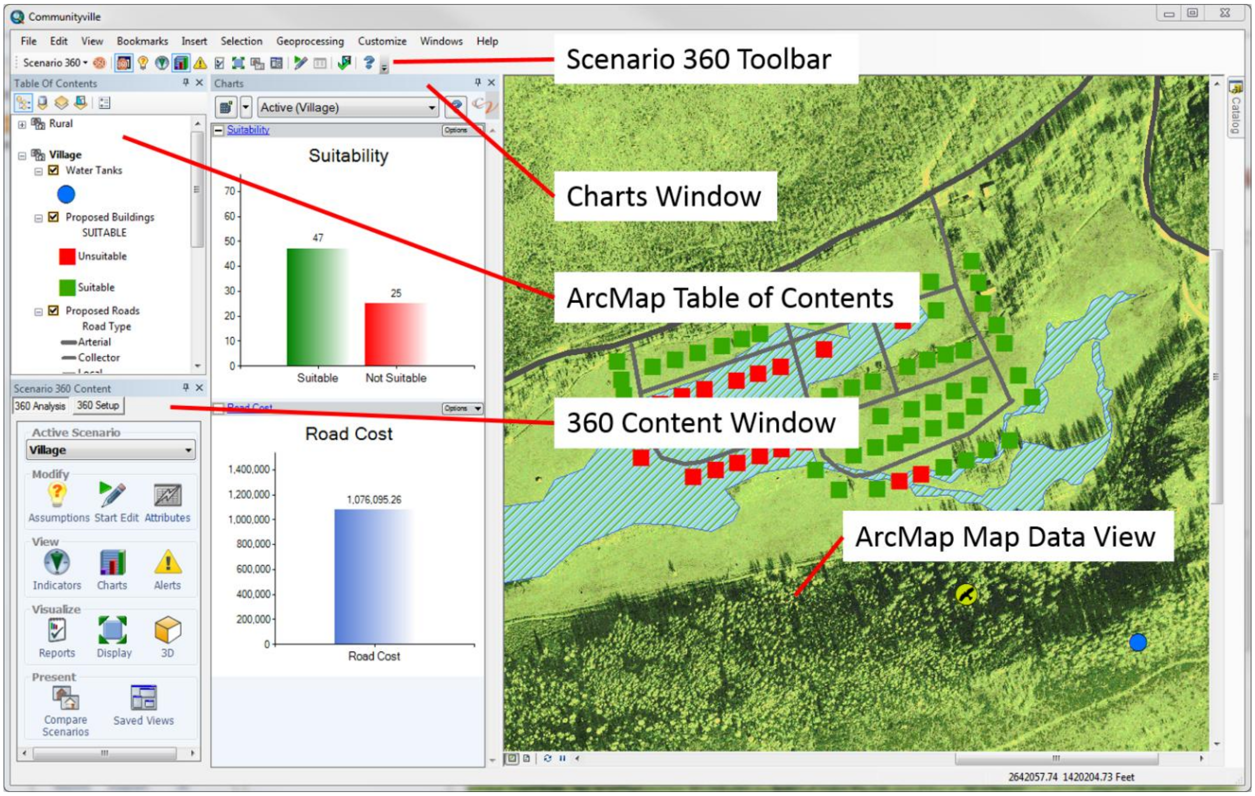


Source: NC Capital Area Metropolitan Planning Organization

Figure 4.3 Triangle Regional Model Place Types

4.2.3.2 CommunityViz Operation

The CommunityViz model runs using an ArcGIS extension. All data and model settings are managed within the Scenario360 manager, shown in **Figure 4.4**, which is highly customizable to provide desired data indicators and visualizations. Data can be referenced in its native shapefile (such as buildable areas or sewer/water locations) which allows users to quickly update analyses when reference shapefiles are updated.



Source: CommunityViz

Figure 4.4 Scenario 360 Interface

4.2.3.3 CommunityViz Output

CommunityViz output is highly customizable and can be designed to output households, population, and employment by TAZ and year for travel-demand modeling purposes. It also has some built-in “impacts” that can be produced for land-use scenarios such as the following:

- Auto emissions
- Commercial floor area
- Commercial jobs-to-housing ratio
- School-aged children
- Distance to places of interest
- Residential water use

While these impacts aren't directly applicable to travel demand modeling, they can be of use to local planners that want to use the CommunityViz model for general plans or other transportation planning purposes.

4.2.4 UrbanSim

UrbanSim is a microsimulation land-use/socioeconomic forecasting model developed by Dr. Paul Waddell. UrbanSim uses standard discrete choice models, primarily the Multinomial Logit Model to project future conditions. Agents represent the location choices households, persons, employers, and jobs make in response to real estate market conditions. UrbanSim models each year iteratively, using the previous year's results as the input for the next to replicate the changing dynamics and mismatch of supply and demand of the real estate market. UrbanSim has three different versions supporting parcel, census block, and TAZ-level analysis. UrbanSim runs on a cloud-based platform, with the option to export results for use in travel demand modeling. Users are also able to create a dashboard of charts to summarize the results of the model.

UrbanSim is an attractive choice for socioeconomic forecasting modeling in Utah because WFRC/MAG already utilizes it to prepare socioeconomic data for its regional model. The WFRC/MAG Real Estate Market Model (REMM) uses the UrbanSim modeling platform to project future and residential employment-related activities (REMM Peer Review Report, 2019).

Inputs for the WFRC/MAG REMM include the following:

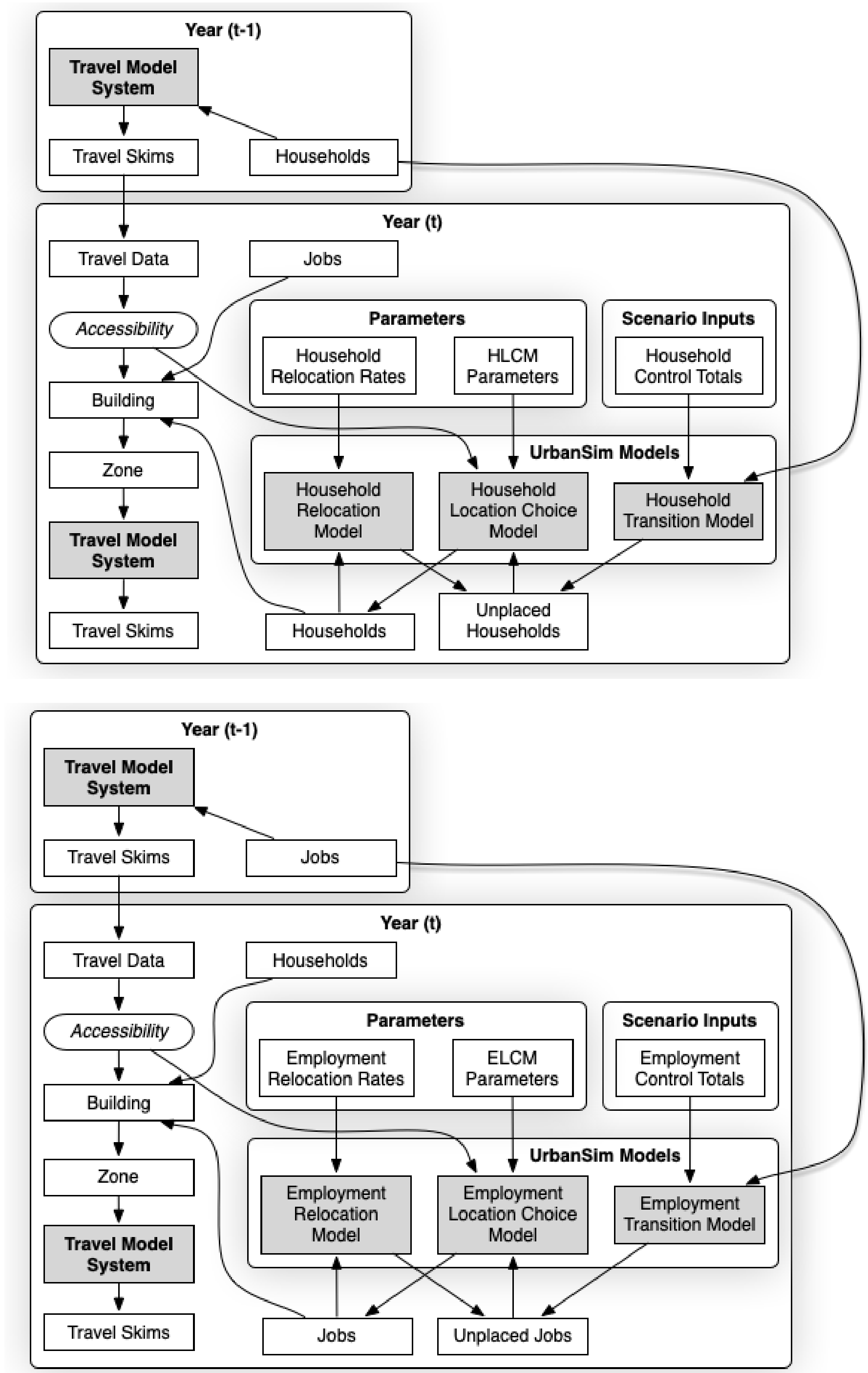
- A region-wide parcel land-use and valuation database
- An inventory of local government general plans
- A synthesized household population dataset for the model's base year based on Census data
- Address geocoded employment totals from the Utah Department of Workforce Services (DWS)
- County-level employment and population control total projections, sourced from the University of Utah's Kem C. Gardner Policy Institute

- Input from public and private sector expert advisors
- ‘Physical constraint’ map layers that depict areas where future development is prohibited or not practical due to steep terrain, wetlands, mining, or public lands (formal designations or ownership)
- Traffic Analysis Zones (TAZs)
- GIS overlays for any other planning boundaries
- Travel Model outputs (travel time matrices, model volumes, transit distances, freeway exit nodes, average commute times weighted by TAZ)
- The parcel-level model can also access the parcel database, with acreage, land use, housing units, nonresidential square footage, year built, land value, improvement value, city, and county data
- Development costs

While parcel-level and Census Block-level model versions are available, the zone-level model is likely to be most suitable for areas outside WFRC/MAG geographies to reduce model complexity and data needs. **Figure 4.5** illustrates the process for household and employment allocation. In the zone level UrbanSim model, household and employment are associated with aggregated buildings within a zone. From one year to the next, they can choose to move or stay in the current location. If they choose to move, location choice models use factors such as rent, accessibility, and local development constraints to choose a TAZ location for new and relocating households and employment.

UrbanSim also has newer tools such as the UrbanCanvas modeler that is designed to support scenario analysis. Data management tools for organizing model inputs, tracking upcoming/pipeline developments, developable areas, and model adjustments are provided to assist in managing data for the UrbanSim model. Multiple scenarios can be launched simultaneously on UrbanSim’s cloud platform to produce updated results in a short time.

Lastly, UrbanSim provides reporting tools, such as their Charts Dashboard, which can produce custom-designed visualizations for model outputs to compare items such as sub-regional growth by scenario, total households over time by scenario, or development growth by TAZ.



Source: UrbanSim Inc.

Figure 4.5 Zone-Level UrbanSim Household and Employment Models

4.2.5 Custom Agency Tools

Since every travel demand model requires forecasted socioeconomic inputs for at least one horizon year, a wide variety of techniques have been used to create future year scenarios. While some follow mainstream approaches such as those listed in this section, others have developed their own custom methodology to allocate future growth. UDOT's current process is an example of this, where control totals by year are allocated to TAZ using the approach documented in the "Existing Process Review" section.

A few custom tools were reviewed for this section because they are currently being applied by agencies on a statewide TAZ level or are based on UDOT's current process. These include the following:

- Caltrans Rural TAZ SE Data Allocation Model
- Tennessee DOT Statewide Land Use Forecasting Model
- MAG Python-Based TAZ-Level Allocation Model

Custom tools are useful in that they can meet the exact needs of a particular agency. Caltrans, for example, has a relatively simplistic model that bases future rural TAZ growth on control totals and existing growth locations. Tennessee is currently developing a full version (currently in beta) of their Large-Scale Land Use Model (LS-LUM), which incorporates gravity-model theory to assign households and employment to each TAZ based on existing land use, job opportunities, total number of houses, vacant houses, residential/commercial land available, and travel times (Mishra, Golia, Everett, Samani; 2021). Interviews with these two DOTs are summarized in the "Peer Agency Interview Findings" section.

The MAG Python-Based TAZ-Level Allocation Model is a compelling alternative because it is a translation of the current spreadsheet model into a Python-based socioeconomic forecasting model. A brief review of the tool for this project found that while it has been customized for MAG, it could easily be expanded and updated to prepare TAZ-level forecasts statewide. The model was last updated in 2013 and would need to be revised to reflect changes in the UDOT spreadsheet forecasting approach.

A custom tool could be developed to specifically suit the needs of UDOT. This tool could be hosted in GitHub to allow for version control. Developing a custom tool could allow for a flexible solution that increases visibility and useability to meet the specific needs for socioeconomic forecasting in Utah.

4.3 Peer Agency Interview Findings

During the data collection process of this research, the study team identified and held informational interviews with staff at agencies that incorporate different methods to prepare future land use inputs for their travel demand models. The purpose of these interviews was to gain a better understanding of how different tools (UrbanSim, CommunityViz, etc.) are being utilized and if they were good candidates to meet UDOT's socioeconomic forecasting needs.

4.3.1 Summary of Interview Findings

4.3.1.1 When and Why

Practitioners described development timelines for their socioeconomic forecasting models ranging from the early 2000s to today, with the first adoption in 2003 and the latest expected to be complete in 2024-2025. Puget Sound Regional Council (PSRC) was one of the earlier adopters: Due to litigation they needed to develop an integrated model that better addressed interactions between land use and transportation. Tennessee DOT (TDOT), which has developed a "beta" version of a statewide socioeconomic forecasting model, is working with the University of Memphis to create a comprehensive socioeconomic forecasting model that will be integrated with the Tennessee Statewide Model. The French Broad River MPO (FBRMPO)—who have been using their socioeconomic forecasting model since 2020—was looking to better represent potential impacts of climate changes and telecommuting. Central Pines Regional Council, (CPRC) was looking for a methodology to provide consistent forecasts across multiple MPOs for input into their regional TDM.

4.3.1.2 Development Processes

Development processes looked quite different across agencies as some completely outsourced the development process to consultants while others used internal resources, along with consultant support, to develop their socioeconomic forecasting models. TDOT utilized university resources to develop the initial version of their model along with support to develop a new, integrated model which reduced overall costs greatly because of the amount of effort required to analyze parcel-level data for the entire state. PSRC had an approximately 10-year evolution of their socioeconomic forecasting model that went from grid based to parcel based, and initially cost $1 million in 2003 dollars along with internal staff resources. On the other end of the spectrum, FBRMPO completely outsourced their process for approximately $100,000 per update.

Overall, the typical development cycle was 2–3 years at a consultant cost of $100,000–$2.5 million and staff resources ranging from no dedicated staff to a three-person land-use team.

4.3.1.3 Resource Needs

Socioeconomic forecasting models for contacted agencies ranged from low-fidelity TAZ rural allocation models such as the one used by Caltrans, to agent-level regional simulations such as WFRC and PSRC. Typically, more disaggregated models (parcel- or building-based) require more data, and consultant/staff resources to build and maintain the model. For example, PSRC has approximately 1.25 million parcel records in the model, and staff have built tools to synthesize households and population based on Open Street Maps (OSM) and ACS data and to develop employment data based on Longitudinal Employer-Household Dynamics (LEHD) Origin-Destination Employment Statistics (LODES) data from the US Census. CPRC has a parcel-based CommunityViz land-use model, one staff member, and a small consultant team that helps support model updates. This model is run sub-regionally and aggregated to the TAZ level for analysis. For TDOT’s TAZ-level analysis, inputs (employment, utility lines, existing developments, developable land, undevelopable land, property values, size) are all parcel based.

Control Totals

Control Totals for the socioeconomic forecasting models reviewed typically were considered at the county level. For CPRC, population comes from the North Carolina Office of State Budget and Management. They use ACS data on the average household size for single-family and multifamily households by county to calculate how many dwelling units for both single-family and multifamily development by county. Employment control data comes from

Woods and Poole. Caltrans relies on the California Department of Finance to determine county-level forecasts. WFRC, like UDOT, utilizes demographic data provided at the county level from the Gardner Policy Institute. While TDOT controls their population to the county, they control employment data at the statewide level to allow it to allocate more naturally.

Interim Year Forecasting

For the agencies interviewed, there were three types of interim year forecasts provided:

- Iterative agent-level simulation every year (each year is simulated, building on the results from the previous year)
- Iterative TAZ-level forecasting every five years (forecast considers where growth went in the past five years)
- Non-iterative TAZ-level allocation every one to five years (scaled to control the total for the particular year)

Identified Developments

One common theme among interviews is that information provided for pipeline developments and comprehensive plans can greatly improve the quality of socioeconomic forecasts. All three vendor tools reviewed—CUBE Land, CommunityViz, and UrbanSim—have some built-in capabilities to handle scheduled and phased developments. Some areas have ad-hoc development trackers while other areas have developed online tools to allow local agencies to submit development information (and x, y points) to the planning team.

4.3.1.4 Socioeconomic Forecasting Model Benefits

A variety of socioeconomic forecasting model benefits were recorded, including the ability to update forecasts quickly, improved interagency coordination, and better consideration of land use-transportation interactions. The following are some specific benefits mentioned during interviews:

- Increased accuracy with the socioeconomic forecasting model, leading to the desire to use it for scenario planning and to highlight where congestion is coming from.

- UrbanSim output is customizable for a variety of data requests.
- The updated socioeconomic forecasting model can be directly integrated into the standard MPO travel demand model.
- Previous methodologies were much more dependent on each local jurisdiction providing information on their own anticipated growth, which led to a patchwork of different estimation methodologies as well as some disagreements between jurisdictions or across jurisdictions about the amount of growth each might have.
- CommunityViz makes it easy to test different scenarios by adapting parameters instead of having to modify data.
- Data can be used for comprehensive plan reviews or updates. Utility and wastewater are also common request sources. Cities like to see the distribution of data.
- Moving to a newer socioeconomic forecast model enables quick analysis of different scenarios. The previous method was largely manual and there was a lack of actual scenario planning. The ability to model specific scenarios such as low and high growth scenarios is appealing for stress testing the transportation network.
- Can force multiple agencies to agree on a common, standardized forecasting process.
- Pipeline developments help capture "business as usual" development patterns.
- Household location choice models can improve realism of growth scenarios.
- Mapping and visualization can be easily built into the process to view desired output and compare scenarios.

4.3.1.5 Socioeconomic Forecasting Model Downsides/Issues

With any socioeconomic forecast tool there are potential downsides or development issues that should be considered when identifying the best tool to fit UDOTs needs. Some of the issues noted during the interviews included the following:

- Repairs to socioeconomic forecast model code can take longer than would be in equations in a spreadsheet, as more review is needed when the model is not operating properly or producing unrealistic results.

- More complicated models may be reliant on consultants, which could take away some staff control over the technical side of the forecasting process.
- Some socioeconomic forecast models require a significant amount of data; models yield many benefits in metropolitan counties but fewer benefits in rural areas.
- Lack of centralized and standardized data between counties can require significant effort to request and manually clean/format inputs, coupled with an inability to use parcel data for other projects.
- Parcel Maintenance is daunting, and determining maintenance intervals is difficult when data is needed from many counties.
- Long Run Time: Full travel demand model runs with integrated socioeconomic forecast model feedback can take several days for a single run. For example, projecting from 2018 to 2050 in UrbanSim takes approximately 24 hours for PSRC, compared to 5-6 days for the activity-based model. Run-time improvements are anticipated.
- Some agencies use NAICS to describe a job type, and the job types in the transportation model mean something different than the job type may mean from a land-use standpoint, which requires a translation between data sets.
- CommunityViz does not currently support ArcGIS Pro, requiring continued use of older software.
- Travel-demand-model network structure (such as inaccurately direct centroid connectors in rural areas that yield overly short travel times) can impact the realism of land-use allocation to hard-to access areas. There is a need for stricter constraints in mountainous areas.
- Not having a cohesive list of identified developments can impact the quality of the socioeconomic forecast model output as this is highly correlated to future growth areas.
- Elaborate land-use models may not be fully utilized because of their complexity and limited staff knowledge.

- A disaggregate model simulates policy, which cannot be done with a gravity model. The assumptions behind these can be a huge challenge. Consider the staff needed to run and maintain a model.

4.3.1.6 Benefits Outside of TDM Use

While the principal application of the socioeconomic forecasting model is to provide socioeconomic data input to the travel demand model, different tools and techniques may provide "complementary" uses that extend the utility of the model to the following:

- Comprehensive plan updates
- Utility and wastewater demand estimates
- Estimated future urban footprint boundaries
- Testing policy and zoning changes
- Model structure is available for some environmental justice analysis (but isn't very well used)
- New setup created standardized information on pipeline developments across agencies, which is being used for other planning purposes

4.3.1.6.1 Overall Takeaways

While travel demand models are required to be regularly updated during the planning process and have a fairly common set of structures (trip based vs. tour based), socioeconomic forecasting has no such requirements and varies wildly from region to region. Interviews with agencies revealed that the type of socioeconomic data model used for forecasting depends on the budget available, motivation to provide more refined socioeconomic forecasts, and number and technical abilities of agency staff. Some comments from agencies that were found to be relevant as UDOT considers potential socioeconomic forecasting tools:

- Find a good "pencils down" time for base year data before you need to start developing forecasts for long-range planning purposes.
- It is important to have the existing conditions and capacity layer from the latest general plans be as accurate as possible.

- Database management is important, with a structured approach to making changes (e.g., using ArcGIS Pro and Python). The ability to automate is key for updates and keeping in schedule with long-range plans.
- Switching to grids will make disaggregate models run faster than parcels.
- Use additional population growth scenarios to show a range of growth.
- Development tracking should inform control totals.
- Consider how in-depth a tool you need to avoid the pitfalls of an overcomplicated model.

4.4 Research Observations

Results of the data evaluation process were summarized and discussed with project stakeholders. Stakeholders were presented with advantages and disadvantages of the current practice, a comparison of potential tools, and from that the team and stakeholders chose a tool to move forward with for project analysis. A demonstration Python forecasting tool was then developed for Iron County, Utah to evaluate how well a custom agency tool (the selected methodology) would work for UDOT's needs.

4.4.1 Advantages and Disadvantages of the Current Practice

The current socioeconomic forecasting method has been successfully implemented through several rounds of Long-Range Plan updates to provide residential and employment forecasts for each of the models (except the Wasatch Front model) and provides forecasts that have been accepted as reasonable by local agencies and planners. With that, there are advantages and disadvantages to the current process, which has been the catalyst for researching potential new methods to produce TAZ-level SE forecasts.

4.4.1.1 Advantages

Transparent and Consistent Process: All fields/calculations can be traced through the process. The same process is utilized for each county, providing consistent output for each TAZ throughout the state.

Common, Open Platform: Can be shared/utilized by anyone that has Microsoft Excel. No "vendor lock-in" based on development of the forecasts through a vendor-licensed tool.

Easily Updatable: Openness of software/calculations makes modifying the spreadsheet structure easy (although the structure of the spreadsheet tools may be challenging for new users to understand).

Quick: New forecasts for a county can be quickly produced, after adjustments, to travel-model input data (less than 15 minutes)

4.4.1.2 Disadvantages

Repetitive: Forecasts are produced by 26 separate and independent spreadsheet tools (which start from the same template). Methodological updates or bug fixes in the process can be very time consuming to create and repeat for each county.

Lack of Visualization and Data Quality Checks: Input and output data is difficult to visualize, and it is difficult to track changes in underlying data and/or assumptions. Each spreadsheet's results need to be exported and processed to compare against previous versions. GIS mapping is manual, and all analyst adjustments in the core forecasting sheets must be manually added to large matrices, which have few safeguards to prevent data entry errors. The large number of calculations, lack of visual components, and time-consuming nature required to look at or compare the data make quality checking difficult and increase the risk of errors not being caught.

Simplistic Allocation Functionality: Forecasts are primarily based on "reactive" information where new growth is typically allocated where old growth is until those areas reach capacity; predictive modeling could include accessibility measures that reallocate growth based on future changes in policy or the transportation network along with other external factors (zoning, new sewer/water service, new major employment locations such as an electric battery factory).

Limited Data Management Functionality: There are no versioning capabilities to track changes to source inputs, outputs, or model methodology, increasing the risk of work being lost or outdated versions being used erroneously. Products are standalone spreadsheets for each county, with no direct connection to travel demand models, GIS mapping, or each other.

4.4.2 Comparison of Potential Forecasting Tools

As documented in the potential forecasting tool overview and findings from agency interviews, there are many tools available that have been successfully used to prepare socioeconomic forecasts for travel demand model forecasts. This section covers the research team's observations on each tool, the best tool moving forward for socioeconomic forecasting, and some basic design elements to consider.

4.4.2.1 Current Spreadsheet

The current spreadsheet method has stood through several rounds of model updates. This method is inherently consistent, as it is used for every county. The current model is implemented in Excel, a commonly used open platform. While complicated, the Excel base also provides a high level of transparency by allowing users to see and trace every operation, avoiding hidden processes that may impact the outcome of the model. The current model can be run in minutes after the input data is adjusted, allowing users to quickly understand the impacts of different assumptions. However, using the current model can be very repetitive for modelers as it is split into 26 different counties, making updates to the model structure or input data once the forecasting process has begun cumbersome and error prone. A lack of data visualization capability reduces how immediately understandable the results are and requires post-processing graphics, which can delay the discovery of errors. The model is also limited to a simplistic formula-based functionality that does not take nuances of the real estate market into account.

4.4.2.2 CUBE Land

CUBE Land uses an advanced forecasting process that aims to model the influence of the real estate market on socioeconomic forecasts. Being a CUBE product, CUBE Land can be directly integrated into existing statewide and sub-area travel demand models as an additional module (because the travel demand models in Utah are CUBE based), allowing the two models to inform each other. Users can customize data by county or area as they see fit, allowing users to modify zones. As with any vendor, if UDOT shifts away from an internal toolset to a vendor-based solution, any future model iterations would be locked to that vendor or require being rebuilt in a different environment. Currently, there is a very limited local pool of users who are familiar with the CUBE ecosystem and able to generate results with CUBE Land. This software package has a challenging calibration process, requiring the user to fully calibrate the initial scenario to match base year conditions before future conditions can be modeled. Both this calibration process and the bid-rent model inputs will require a significant amount of staff effort and data processing before the model can be run.

4.4.2.3 CommunityViz

CommunityViz is a formula-based GIS toolset package that uses planning-based assumptions such as land-use policy to predict future socioeconomic conditions. Results from CommunityViz are customizable by the analysis area or county as needed, with the application of new policies or wizards. Using Scenario360, customizations are applied separately from the input data, allowing for easy comparisons between different customization options. This tool also updates scenarios as baseline data changes, without manual updates. As a GIS-based toolset, the potential user pool for CommunityViz is much larger than for CUBE Land or UrbanSim. This open platform also creates the opportunity for local MPOs, municipalities, or other groups to use the tool for socioeconomic forecasting or other analyses such as water use modeling, auto emissions modeling, and labor force impacts that may not directly impact travel demand models. This toolset also has strong map visualizations available for use as soon as an analysis is complete, without post-processing. As with CUBE Land, any external toolset will limit UDOT to that vendor without putting significant effort into rebuilding the model. CommunityViz is currently based in ArcMap, which will no longer be supported as of March 1, 2026. An updated version for ArcGIS Pro is expected but has not been formally announced. Regardless of the host platform, this toolset can complete a wide range of analyses, which requires a lot of up-front development effort to facilitate the final rapid scenario comparisons.

4.4.2.4 UrbanSim

UrbanSim uses a microsimulation-based land-use model to predict future land-use and socioeconomic conditions based on the interaction of households, employers, persons, and jobs. UrbanSim has been widely used by many organizations, building up a large national user group.

While UrbanSim has been used to create the REMM model used by WFRC and MAG across the Wasatch Front, the local analysis user pool is limited. UrbanSim can only be run in a cloud-based system at this time, which requires an annual fee. This system has a dedicated internal dashboard that allows users to visualize data without post-processing the data in another program and provides exports that facilitate post-processing, if desired. As with all proprietary solutions, leaving UrbanSim would require redeveloping the model. Additionally, UrbanSim can run at the TAZ or block level, which would be more suitable for statewide applications.

4.4.2.5 Custom GIS-Based Solution

A custom GIS-based solution would allow UDOT to develop a tool that matches specific needs without dedicating resources to unnecessary analyses or data preparation work. MAG prepared a Python-based forecasting tool approximately ten years ago to replicate the spreadsheet forecasting process in GIS for their area. While the forecasting process has changed since that time, the overall structure is still close to the structure of the current allocation method. Updating and expanding the current tool to run in ArcGIS Pro would address many of the issues with the forecasting spreadsheet in terms of visualization and quality control. Being GIS-based rather than CUBE-based would allow a larger user pool to run the model for planning purposes for their area. A logical step forward from the current model, GIS-based scripts would also provide strong data visualization without post-processing as with the current model. Developing this new tool could require a large up-front development effort and means UDOT would not have an external community to tap into when issues are encountered. Additionally, a new method for allocation should be developed. Currently, growth is added to a TAZ until the maximum is reached and then spread to other TAZs in that subarea. It is recommended that a new model include functionality to account for additional factors such as access to opportunity, zoning, roadways, transit, and neighborhood centers to a) provide more realistic allocation procedures and b) provide capabilities to test land use-transportation interactions, policy changes, and planning scenarios.

4.4.3 Recommended Methodology

Based on the research completed for this study, there are many potential solutions that could work for UDOT to update the socioeconomic forecasting process for TDM inputs. Each tool has its own benefits that could guide decisions on the best tool for the job:

- Existing Spreadsheet: These tools already exist and do not require ongoing fees/subscriptions or a major model development effort.
- CUBE Land: This model would easily integrate into existing TDMs but would initially have a very limited user base in Utah.
- CommunityViz: This package has the strongest visualization tools and could have many applications beyond TDM inputs, as well as a broader potential user base.
- UrbanSim: Already used by WFRC, this package could integrate well with potential future ABMs (if adopted by UDOT or MPOs).
- Custom Tools: Allows UDOT to evolve the existing forecasting spreadsheet into a GIS-based format but would require the highest level of custom tool development and self-sufficiency.

Based on these findings, our recommendation is to move forward with a custom GIS-based Python tool. This tool would build upon work already completed by MAG to convert the spreadsheets into Python scripts and update them to be consistent with the current forecasting process. Then, the Python tool could be modified to use some of the logic utilized by other tools (CUBE Land, CommunityViz) to have more sensitivity in the housing and employment allocation process. Additionally, visualization tools and data checks could be built in to provide more utility and quality control in the process.

4.5 Demonstration Python Forecasting Tool

4.5.1 Python Model Overview

A Python script was developed to replicate the current spreadsheet model, to serve both as proof of concept and as a starting point for the development of a fully customized tool. This pilot script was developed using Iron County data for the run years 2020–2060, and historical data from 2010–2020. This script can be run in any IDE (integrated development environment) capable of running a Jupyter Notebook and can completely run and generate GIS and CSV exports in a few minutes, with the GIS export using much of the run time. The script generates a final CSV with the desired export years and updates a user-provided geodatabase with the SE data generated assigned to each TAZ. The only significant deviation from the spreadsheet model is the inability to adjust individual TAZ values, as is currently adjustable in a single Excel cell; instead, all modifications to the data must occur through the input CSVs.

4.5.2 Python Model Implementation

Much like the spreadsheet model with its input tabs, this model is based on a series of input CSVs. All the required input files are documented in **Table 4.2**. These inputs are built on the standard setup used in the spreadsheet model and should be able to accommodate any county's data as long as it follows the standard formatting. Before running the model, the user needs to ensure these values are correctly assigned to the CSV files on their computer. All changes to the input data must be made to the input files and cannot be handled within the current Python script.

Table 4.2: Python Script Input Files

Variable Name	Type	Data
Census	CSV	Census Population
CountyControlTotals	CSV	County Control Totals
SubCountyControlTotals	CSV	Sub County Control Totals
AllDWSData	CSV	DWS Employment Data
Seeds	CSV	Households Seeds
Growth Curves	CSV	Growth Curves
Dev_data	CSV	Development Data
HandAdjustedCapacity	CSV	Hand-Adjusted Capacity
AreaGrowthWeightFactor	CSV	Area Growth Weight Factor
EMPSeeds	CSV	Employment Seeds
EmpHandAdjustedCapacity	CSV	Employment Hand-Adjusted Capacity
EmpAreaGrowthWeightFactor	CSV	Employment Area Growth Weight Factor
SecondHomesOther	CSV	Second Homes other than Cabins, Condos, and Hotels

Variable Name	Type	Data
SecondHomesCabin	CSV	Second Homes – Cabins
SecondHomesCondo	CSV	Second Homes – Condos
SecondHomesHotel	CSV	Second Homes – Hotels
Enrollment	CSV	School Enrollment
MedianIncome	CSV	Median Income
sedf_taz	Shapefile	TAZ Shapefile

Additionally, there are some hard-coded variables that must be adjusted if the county or desired model run years need to be adjusted. These values are used by the script to select groups of TAZs and must match the formatting in the input sheets. These variables are listed in **Table 4.3**.

Table 4.3: Python Script Hard-Coded Variables

Name	Type	Currently set to
County	Text, all caps	IRON
Base Year	The beginning forecast year	2020
StartYear	The beginning validation year	2010
End Year	The ending validation year	2019
EMPCTBaseYear	Base Year for employment control totals	2019
EMPEndYear	Final Employment Validation Year	2018
ForecastEndYear	Final Projected Year	2060
ExportYear	Output Year for the final CSV	2050
export_years	A list of years for the GIS export	2010, 2019, 2020, 2023, 2042, 2050, 2060
ExportPath	A path where the final CSV will be saved	
gdb_loc	The Export geodatabase and layer name	

4.5.3 Python Model Structure

The script is broken into several sections, each replicating a tab from the original spreadsheet Socioeconomic Model.

4.5.3.1 Import Libraries

In this section of the script, all needed libraries are added. This script is built on the Pandas, NumPy, and ArcGIS features libraries.

4.5.3.2 Import Data

This section is where the input CSVs and shapefiles are linked for the script to use for analysis. Variables in this section will need to be updated to the appropriate files before the script is run. The input variables are organized by what section of the script they are first used in, but may appear in other sections.

4.5.3.3 Global Settings

This section sets display settings for the Jupyter Notebook and does not impact the final exports.

4.5.3.4 Global Variables

All global variables are housed in this section and will need to be updated to change the forecast years, county, or desired output CSV settings.

4.5.3.5 BY_Res Analysis

The Base Year Residential analysis replicates the BY_Res analysis in the Excel-based tool. This section uses census data, county control totals, and sub-county control totals to develop the housing and population allocated figures for 2010–2020.

4.5.3.6 BY_Emp Analysis

Following the Base Year Employment analysis tab, this section uses employment data from the Department of Workforce Services, county control totals, and sub-county control totals to develop employment totals for 2010–2020.

4.5.3.7 City_ConTot

Emulating the original spreadsheet model, this section generates the city control totals based on the results of the previous analyses. This section does not reflect manual updates to the city control totals like those used in the current spreadsheet model.

4.5.3.8 HH

This section builds off the BY_Res analysis and calculates the predicted households per TAZ for 2020–2060.

4.5.3.9 Pop

This section builds off the BY_Res analysis and calculates the predicted population per TAZ for 2020–2060.

4.5.3.10 Emp

This section builds off the BY_Emp analysis and calculates the predicted employment per TAZ for 2020–2060.

4.5.3.11 Emp_Pct

This section of the script develops the percentage of each employment type in each TAZ.

4.5.3.12 GIS TAZ Export

This section has several hard-coded factors that will need to be adjusted by the user to change the final product. Currently, this section produces a data frame that includes the households, household size, population, capacity, total employment, and secondary homes for 2010, 2019, 2023, 2042, 2050, and 2060. The change between 2019 and 2050 for population, households, and employment is recorded in this dataset. Finally, school enrollment and median income figures are added to the final data frame per TAZ. The data will then be assigned to the proper TAZ shapefile in the user-provided geodatabase. The script uses the location on the script as the beginning of the geodatabase pathway, so the user only needs to add the internal reference point. For example, 'outputs\PythonExports.gdb\AllTAZ' is used instead of "C:\Documents\SE_Forceasting\Python\outputs\PythonExports.gdb\AllTAZ."

4.5.4 Design Considerations for Full Implementation

A Python script was developed as a pilot study to confirm the current model could be transferred to the Python environment. This script could be built upon in the future to improve the functionality and reduce the amount of prep work for future users. For example, the script could be modified to read in more information from the input data or input GIS files, reducing the hard-coded variables. To better reflect the current script, the hand adjustment of specific values could be better facilitated within the script. To help clarify the outputs during many rounds of iteration, tools such as versioning controls or run comparisons could be integrated. With the proper tools, this script could be integrated into GIS as a full tool or implemented in ArcGIS online allowing individual counties to upload their data, provide feedback, and get real-time results.

Going outside of the spreadsheet model capabilities, this script could serve as a basis for many expanded tools such as creating a single statewide model or model by subarea and creating the ability to filter or create statewide SE data in a single process. The capacities process could be updated to calculate buildout for each TAZ based on assumptions for maximum density assumptions by land use/zoning. This model could be adapted to use agent-based modeling to allow households and employment to compete for space. Future scripts could also include secondary homes in the allocation process, have primary and secondary homes compete for space, or divvy out new secondary homes from forecasted new households.

4.5.5 Comparison to Current Spreadsheet Tool

While the Python script was developed to replicate the current spreadsheet-based tool, certain aspects are not reflected in the current script. **Table 4.4** shows the total households, employment, and population from the spreadsheet tool and the Python script for 2050. As seen in this table, the values are typically very close to each other; however, as seen in TOTEMP for TAZ 21003, the manual insertion of new values outside of the input files can lead to differences between the two tools. These changes will need to be added to the input files in the current script, and future versions of this script could be updated to better handle individual changes like the current spreadsheet tool. The population maps shown in **Figure 4.6** and **Figure 4.7** and employment maps shown in **Figure 4.8** and **Figure 4.9** show the impact of the difference between the calculated city control totals, and the hand-entered city control totals from the current forecasting spreadsheet.

Table 4.4: Result Comparison

Tool Result Comparison						
CO_TAZ ID	**Forecasting Spreadsheet**			**Python Script**		
21001	**TOTHH**	**HHPOP**	**TOTEMP**	**HHAllo2050**	**PopAllo2050**	**EmpAllo2050**
21002	17.28	22.97	0	17.36	23.33	0
21003	21.09	45.63	14.53	20.78	45.43	0
21004	0	0	0	0	0	0
21005	0	0	0	0	0	0
21006	23.22	61.78	0	22.80	61.29	0
21007	86.57	195.24	0	85.48	194.82	0
21008	18.26	31.37	0	17.95	31.19	0
21009	125.96	229.72	38.03	125.08	230.62	40.04
21010	137.96	275.65	72.0	135.82	274.31	76.23

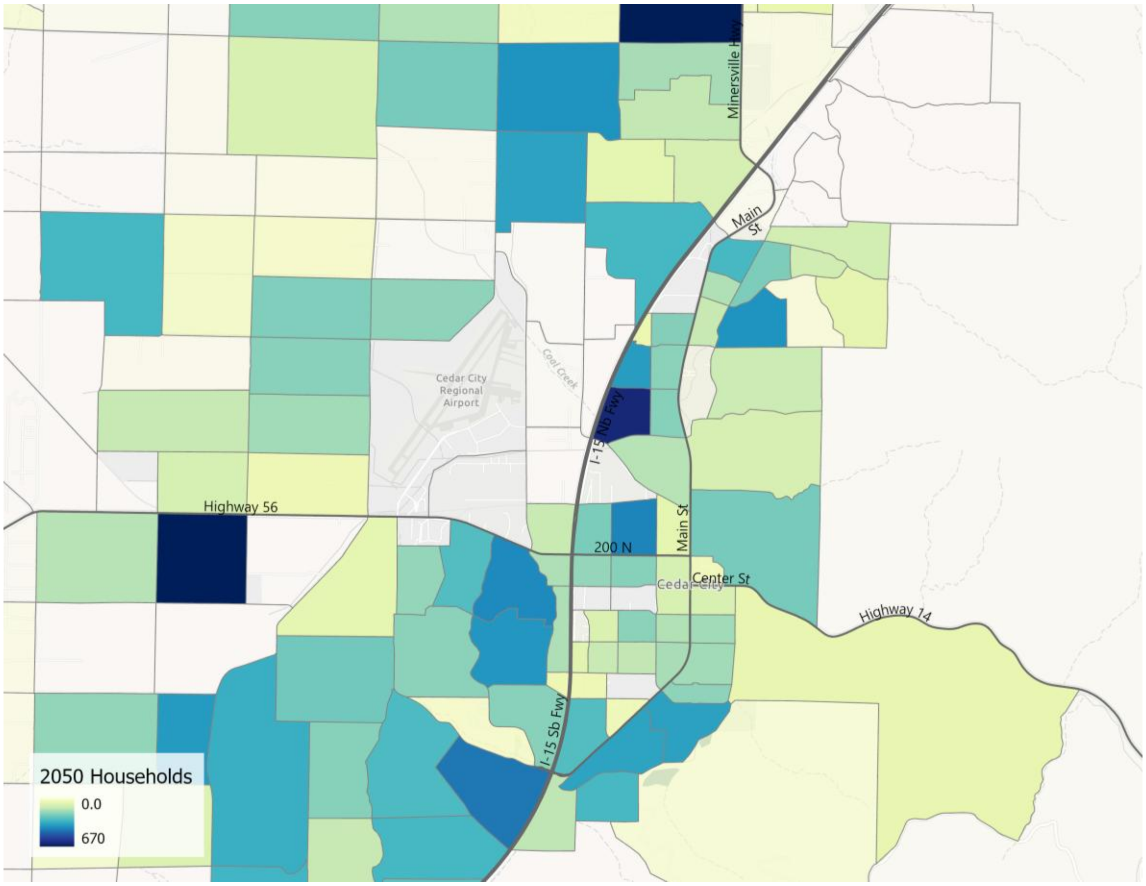


Figure 4.6 Python Script 2050 Households Map

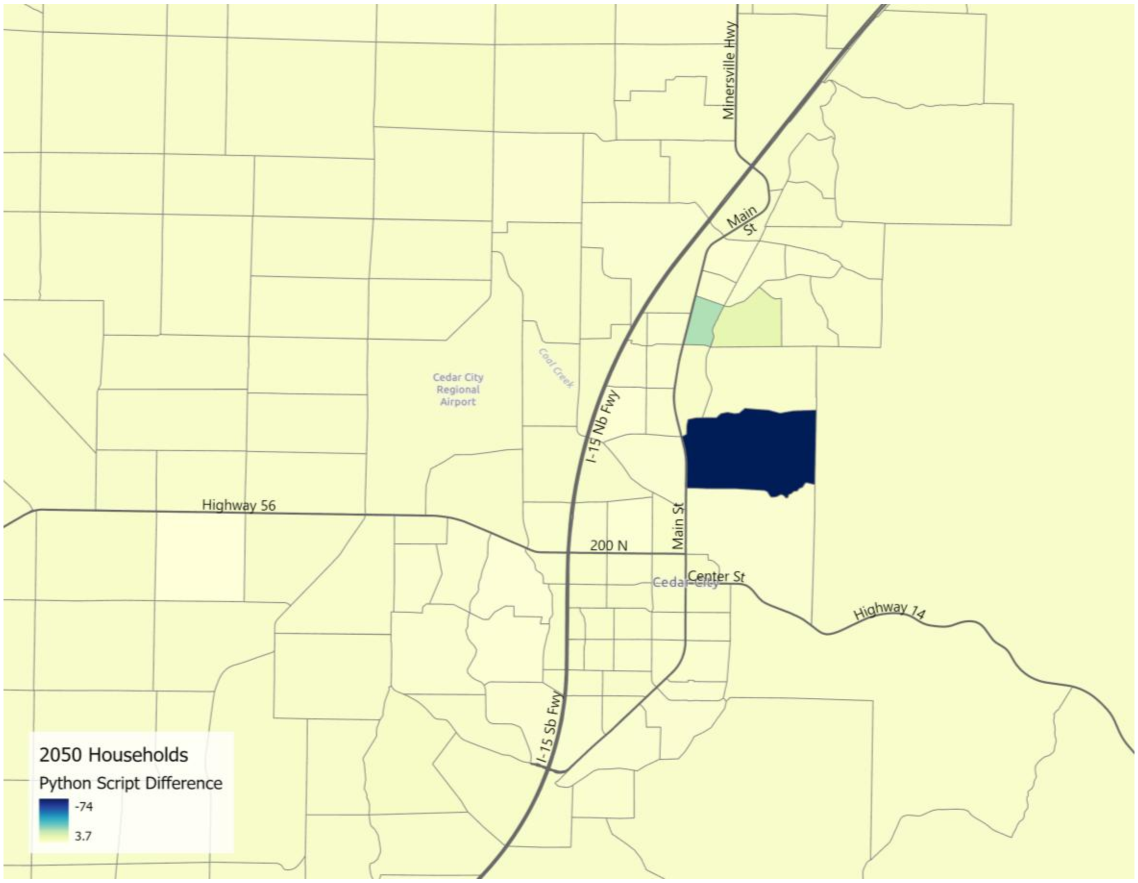


Figure 4.7 Forecasting Spreadsheet 2050 Household Differences Map

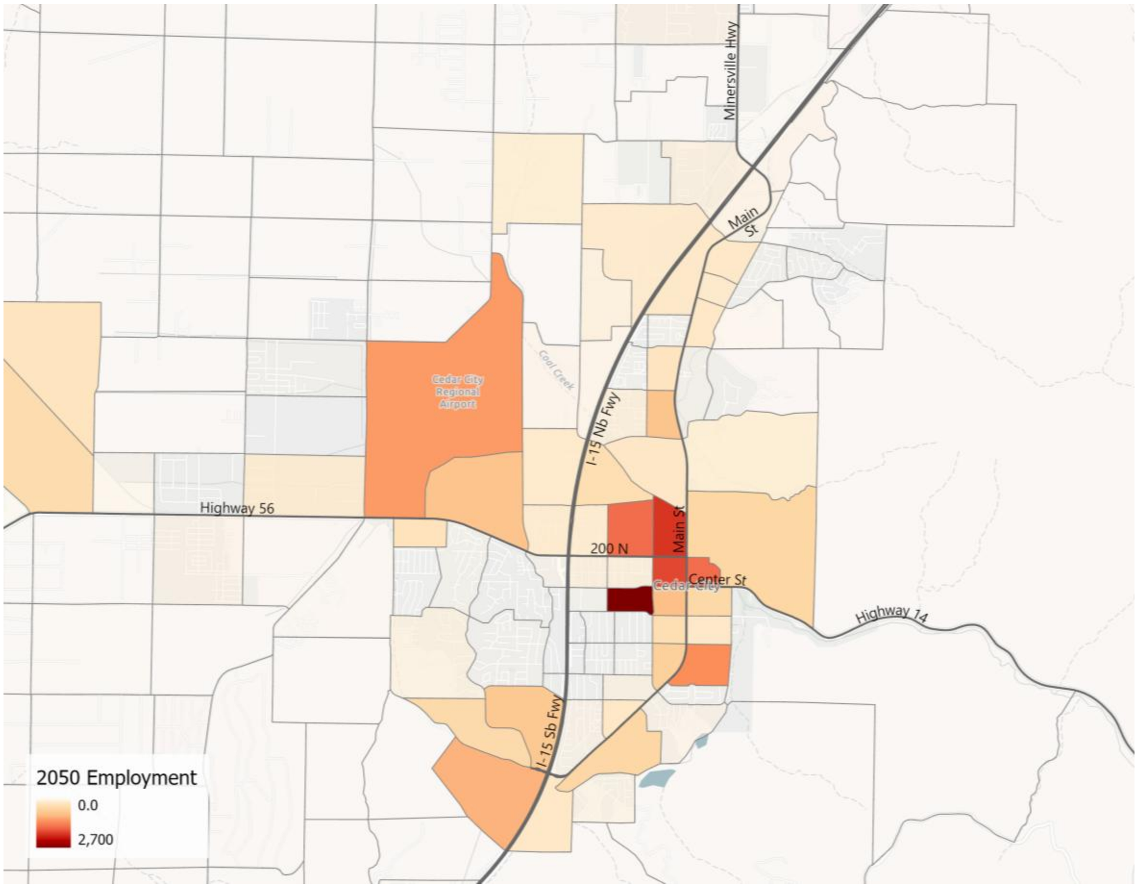


Figure 4.8 Python Script 2050 Employment Map

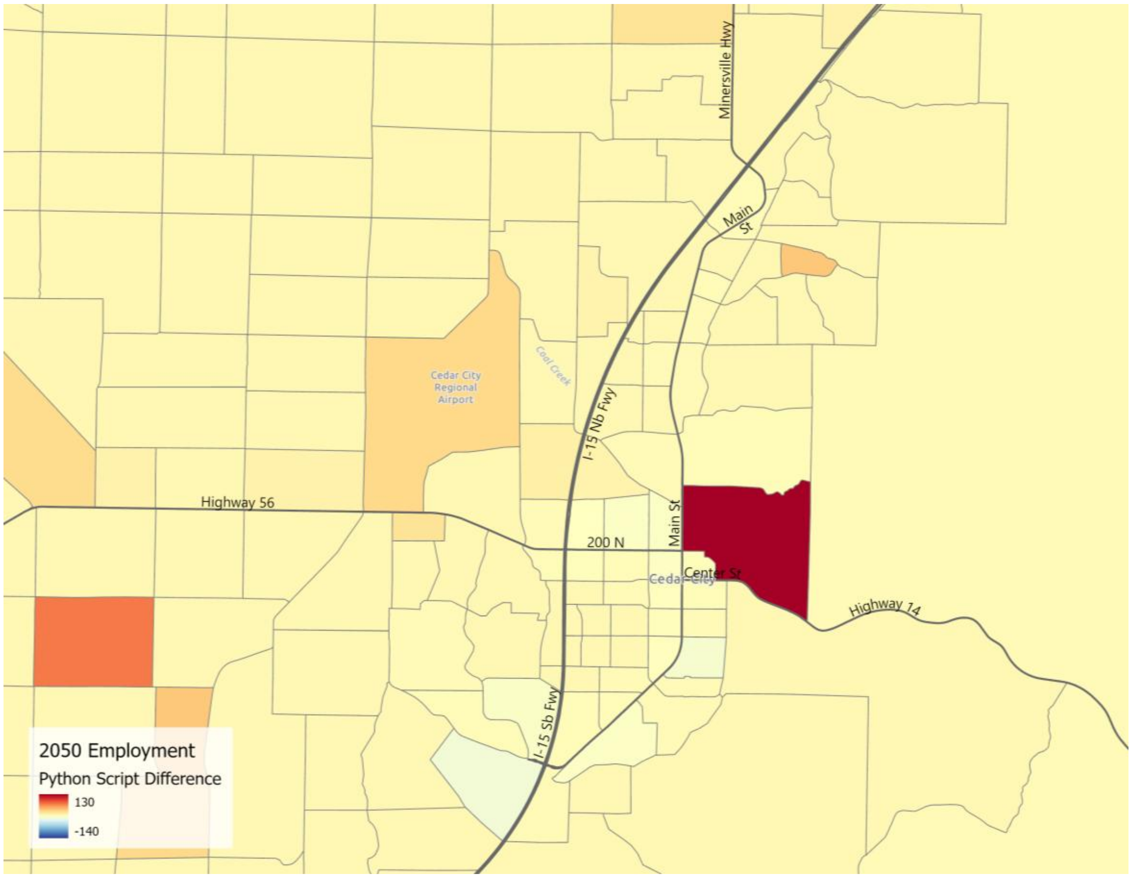


Figure 4.9 Forecasting Spreadsheet 2050 Employment Differences Map

4.6 Summary

The data evaluation goal for this project was to review the existing process, assess potential new tools, summarize feedback from peer agencies, and test a potential new forecasting tool. The analysis of the existing process identified the most important aspects of the current process and where improvements are needed. Through the existing process review it was determined that many of the newer potential forecasting tools could meet UDOT's needs as well as or better than the current process. Potential forecasting tools were evaluated to determine what the advantages, disadvantages, and implementation considerations would be.

As the process is not entirely data driven, stakeholder input is crucial to identifying the desired tool for a proof-of-concept scenario. A custom Python script approach was identified by the team and stakeholders as the best candidate. A socioeconomic forecasting tool was successfully developed for Iron County using the Python script approach. From this proof of concept, recommendations and an implementation framework were developed (see Section 6.2) to expand the new socioeconomic forecasting tool for use in the entire state by UDOT.

5.0 CONCLUSIONS

5.1 Summary

As the first phase of the 2022 UTRAC problem statement on socioeconomic data development methods, research staff identified and held informational interviews with staff at agencies that incorporate different methods to prepare future socioeconomic data inputs for their travel demand models. The desired outcome of these interviews was to gain a better understanding of how agencies use different tools (UrbanSim, CommunityViz, etc.) and how well they could (or couldn't) address UDOT's socioeconomic forecasting needs. The team also interviewed consultants and vendors who are supporting local agencies in their forecasting needs to supplement information provided by public agencies, who may rely more directly on vendors/consultants to develop and maintain their socioeconomic forecasting models.

While travel demand models are required to be regularly updated during the planning process and have a common set of structures (trip based vs. tour based), socioeconomic forecasting has no such requirements and varies wildly from region to region. Agency interviews revealed that the type of socioeconomic forecasting model depends on the budget available, motivation to provide more refined socioeconomic forecasts, and number and technical abilities of agency staff.

Many socioeconomic forecasting methods require a large up-front development effort to produce new TAZ-level forecasts. Consideration should be given to how a new forecasting process aligns with previous methodologies, available data, and desired input from external communities that may be using a particular tool. Additionally, a new method for allocation is recommended. Currently, growth is added to a TAZ until the maximum is reached and then spread to other TAZs in that subarea. This may present an issue when forecasting in currently undeveloped areas or areas that are gaining new access to freeways, for example. It is recommended that a new model include functionality to account for additional factors such as access to opportunity, zoning, roadways, transit, and neighborhood centers to a) provide more realistic allocation procedures and b) provide capabilities to test land use-transportation interactions, policy changes, and planning scenarios.

5.2 Findings

Research completed for this project details several viable options for preparing socioeconomic forecasts using newer, more streamlined approaches than the existing spreadsheet process. The assessment of potential tools produced several options (CUBE Land, UrbanSim, CommunityViz, and custom agency tools such as Python scripts). The team successfully completed the forecasting process for one county using the selected Python-based proof of concept. UDOT plans to implement this methodology to other counties and add features to improve functionality and usability. Based on the results of the software evaluation, peer agency interviews, and the demonstration implementation, the research team prepared an implementation framework to prioritize upgrades and enhancements to the demonstration Python script.

5.2.1 Results of Tool Evaluation

There are several potential solutions that could improve the current socioeconomic forecasting process for TDM inputs. The potential tools, discussed in more detail in Section 4.4, include the following:

- Existing Spreadsheet
- CUBE Land
- CommunityViz
- UrbanSim
- Custom Python-Based Tool

After reviewing each tool, the team selected and developed the custom GIS-based Python tool. This tool is built upon work already completed by MAG to convert the socioeconomic spreadsheet forecasting tool into Python scripts and revised to be consistent with the current forecasting process. The results of the tool evaluation demonstrated that the Python-based tool can quickly prepare socioeconomic forecasts using inputs similar to the existing process. While this is not revolutionary, it can become the foundation for a GIS-integrated forecasting process with the Python script operating in the background. It also provides the opportunity to systemically upgrade the script logic to provide enhancements and additional functionality to the forecasting tool to have more sensitivity in the housing and employment allocation process and offer better visualization tools and quality control review opportunities in the process.

5.2.2 Design Considerations

During this research project, the team reviewed the existing process, the processes used by other potential tools, and feedback from peer agencies to develop design considerations for a full implementation tool. The objective of these design considerations is to provide the most streamlined, functional tool for the state that can serve as a basis for future forecasts and continue to evolve with more capabilities in the future. Design considerations for the GIS-based Python tool include the following:

1. **Create a single socioeconomic statewide model or a model** with the ability to filter or create SE data for all counties or model areas in a single process.
2. **Upgrade "Capacities" process** to calculate buildout for each TAZ based on assumptions for maximum density by land use/zoning. The current process has manually specified capacities which may or may not realistically reflect an actual buildout capacity for each TAZ.
3. **Create a process where households and employment compete** for space based on an updated capacities process that includes buildout for both households and employment based on potential land-use assumptions for each TAZ. Currently, the process does not consider how much space is utilized by households when evaluating employment and vice-versa.
4. **Include secondary homes in the allocation process** (primary and secondary homes compete for space). Currently, the process does not consider how much space new secondary homes consume when forecasting primary households and employment.
5. **Formalize pipeline developments in a geodatabase or web map** for use in growth allocation (year expected, size and type of development) that impact the household and employment seeds. Allow access to agencies for review and possible maintenance. Currently, pipeline developments are coded in an "ad-hoc" process with input from local agencies with varying qualities of information available.
6. **Enhance model visualization tools** for input, output, and results comparisons between iterations. The current process has limited visualization capabilities and is geared only toward viewing final forecast output rather than having the ability to review the quality of input data or compare forecast scenarios against each other.

5.2.3 Research Takeaways

The primary takeaway from this research is that there are multiple potential options for UDOT to prepare socioeconomic forecasts for TDM inputs. Of these options, some are vendor based, some are open source, and some are custom agency tools. All could successfully provide forecasts in a more streamlined process than the existing forecasts method. Based on evaluation of the tools, software developers, and discussions with stakeholders and peer agencies, the team selected a Python-based script to prepare demonstration forecasts for Iron County. This proof of concept shows that the Python script can successfully replicate the existing process and also provides opportunities for enhancements and updates to add more functionality to the test tool for full implementation by the state.

5.3 Limitations and Challenges

Challenges to this research were related to two aspects of the study: 1) socioeconomic model documentation and 2) manual adjustments used in the existing spreadsheet.

In general, socioeconomic forecasting models are poorly documented, or such documentation is dated. To complete a true assessment of each model will require additional review and gleaning information from vendors and peer agencies. The research team reviewed each land-use/socioeconomic model at a cursory level without the ability to test with Utah-specific data.

For manual adjustments in the spreadsheet, it was not possible to exactly replicate the spreadsheet results in the Iron County Model script due to manual value overrides contained in the spreadsheet. Instead of using embedded questions to calculate values, these cells had a specified value that did not change with adjustment to control totals. Moving forward, the implementation framework will recommend a methodology to add the capability to provide specified values for a specific cell in the Python script when required.

6.0 RECOMMENDATIONS AND IMPLEMENTATION

6.1 Recommendations

As documented in the potential forecasting tool overview and findings from agency interviews, there are many tools available that have been successfully used to prepare socioeconomic forecasts for travel demand model forecasts. A custom GIS-based solution allows UDOT to develop a tool that matches specific needs, without dedicating resources to unnecessary analyses or data preparation work. A Python-based forecasting tool prepared during this research project replicates the spreadsheet forecasting process in GIS for Iron County.

Updating and expanding this new Python script in ArcGIS Pro addresses many of the issues with the forecasting spreadsheet in terms of visualization and quality control. Being GIS-based rather than CUBE-based allows a larger user pool to utilize the model for planning purposes for their area. A logical step forward from the current model is a GIS-based python script that can provide the capability to develop strong data visualization without post-processing (as with the current model).

This socioeconomic tool can also address one of the main desires of this effort for UDOT: to improve the process of developing inputs to the model in a streamlined process that is repeatable and reduces staff effort.

6.1.1 Benefits of Recommended Model

- **Flexible**: UDOT can add and remove features.
- **Comparable**: UDOT can easily compare against the current method.
- **Compatibility with other areas:** UDOT can use the same inputs developed in the past.
- **Control**: UDOT has more control over the forecasting process with a Python script than with a vendor software.
- **Efficient**: Requires less effort from UDOT staff to prepare forecast updates in a repeatable, consistent methodology.

6.2 Implementation Plan

Initial implementation of the demonstration socioeconomic forecasting model can be completed by UDOT using the files created for this research project. While the proof of concept was for Iron County, it was designed to be portable to any county in Utah using input files from the forecasting spreadsheets prepared for the previous socioeconomic forecast. After initial implementation, a phased implementation plan is recommended for further upgrades and updates. This plan is shown in **Figure 6.1**. The vision of this plan is to take the existing spreadsheet tool, convert it into the recommended python script for other counties, transition to GIS, and add additional capabilities.

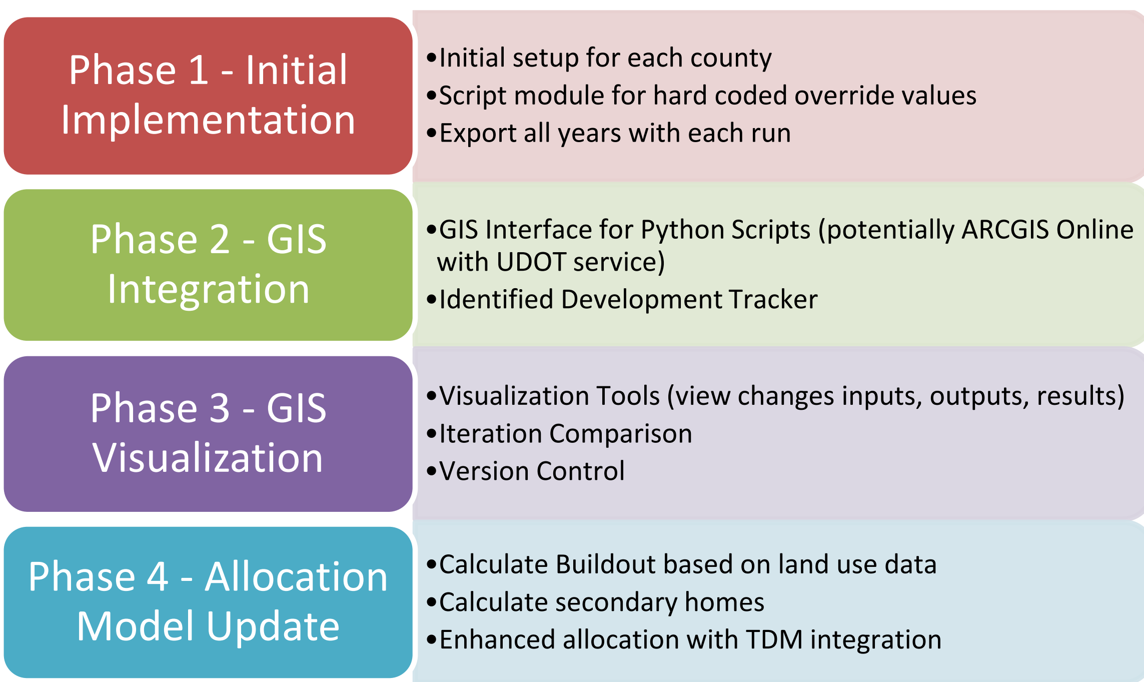


Figure 6.1 Phased Socioeconomic Forecast Model Implementation Plan

6.2.1 Implementation Framework

Full implementation of the socioeconomic forecasting model is divided into four phases:

1. Initial Implementation
2. GIS Integration
3. GIS Visualization

4. Allocation Model Update

Phase 1 – Initial Implementation is intended to transition the demonstration script into practice for each county UDOT prepares forecasts for in the state. Efforts should focus on converting input files from the existing spreadsheets into CSV files required to run the Python script for each county. Additional tasks for this phase include minor updates to the Python scripts, including 1) additional input file(s) to accommodate manual override of specific values in city control totals, seeds, capacities, and area growth factors, and 2) updating the script to export all years with each forecast run (current logic creates all years but only exports one specified year).

Phase 2 – GIS Integration moves the Python scripts created in Phase 1 into a GIS environment. Depending on UDOT's desires, this could be either in ArcGIS Pro or hosted by UDOT on ArcGIS online. The online method allows UDOT to share the socioeconomic forecasting model with stakeholders for collaboration, forecast review, and eventual scenario planning capabilities. Phase 2 is also an ideal time to integrate a development tracker that catalogs identified and planned developments in a uniform manner through the state. This tracker would have a standard template local agencies could use to enter, update, and review information. This development tracker should standardize the information so the socioeconomic forecasting model can use it on subsequent forecast runs. An example of this type of tracker in practice is used for the Bay Area in California, where Caltrans and local agencies can collaborate to develop information in an access-controlled online environment.

Phase 3 – GIS Visualization adds an interface and additional functionality to the GIS environment for the socioeconomic forecasting model. The intent of this phase would be to add scenario comparison tools, dialog boxes, and other interface tools to manage and visualize inputs/outputs. For example, the user would be able to select a county from a pull-down list, select "view growth seeds," and a map showing the growth seeds for TAZs in the county would appear. The user could then adjust the growth seeds and produce a map that compares the results of that iteration with the previous iteration to view changes in the number of households and/or employment by TAZ. This phase would also add version control, where the user can "roll back" changes and restore a previous version and view a log of previous modifications to input files.

Phase 4 – Allocation Model Update adds additional functionality to the way growth is allocated to each TAZ in the model. Currently, the process relies on specified capacities by TAZs, growth seeds, city control totals, and existing development to allocate growth. Updates to this model could include adding proximity/accessibility information from the TDM, adding secondary home forecasts to the household forecasts, having households and employment compete for space, and using land-use data such as zoning, developable area, and basic policy assumptions to calculate potential buildout for each zone. This update could leverage open-source work already developed by others such as Open Land-Use Allocation Framework (OLAF) or Python toolkit for GIS-based land-use suitability analysis (PyLUSAT). It would still be an allocation model that relies on control totals but adds some sensitivity to transportation projects and allows for high-level policy testing for high-/low-growth scenarios and land-use/zoning changes.

6.2.2 Implementation Costs

It has not been determined if UDOT will require outside assistance to complete Phases 1 through 4 of the implementation plan. Therefore, costs of the implementation are presented in an estimate of total required hours for each phase to complete. **Table 6.1** presents these estimated hours to complete each phase. Total effort is presented in ranges since the desired tasks to be completed in each phase may vary in complexity and desired features.

Table 6.1: Python Script Input Files

Phase	Description	Total Hours of Effort
1	Initial Implementation	250-300
2	GIS Integration	200-300
3	GIS Visualization	100-300
4	Allocation Model Update	250-500

<u>**REFERENCES**</u>

Contriero, F. (2020). "Introduction to CUBE Land," Bentley Systems Incorporated.

Mishra, S., Golias, M., Everett, J., and Samani, A., "Developing Statewide Land Use Forecating Model and Intergrate with TDOT's Statewide Travel Demand Model," University of Memphis Department of Civil Engineering.

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Various (2019). "Real Estate Market Model Peer Review Report," WFRC and MAG.

APPENDIX A: COMPARISON OF FORECAST OUTPUT

This appendix presents a comparison of forecast output from the original (Microsoft Excel) socioeconomic forecasting spreadsheet and the test case Python script. Comparison columns show that the total number of households and employment by TAZ have slight variations. During the test script development, it was identified that some TAZs had manually coded values in the spreadsheet forecasting process in place of a uniform calculation process, like the Python script. While not implemented during the proof-of-concept process, the Python script could be updated with additional functionality to read manually coded values in a similar manner as the spreadsheet.

Tool Result Comparison

	Forecasting Spreadsheet			Python Script			Difference		
TAZID	TOTHH	HHPOP	TOTEMP	HHAllo2050	PopAllo2050	EmpAllo2050	Households	Population	Employment
21001	17.3	23.0	0.0	17.4	23.3	0.0	0.1	0.4	0.0
21002	21.1	45.6	14.5	20.8	45.4	0.0	-0.3	-0.2	-14.5
21003	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21004	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21005	23.2	61.8	0.0	22.8	61.3	0.0	-0.4	-0.5	0.0
21006	86.6	195.2	0.0	85.5	194.8	0.0	-1.1	-0.4	0.0
21007	18.3	31.4	0.0	18.0	31.2	0.0	-0.3	-0.2	0.0
21008	126.0	229.7	38.0	125.1	230.6	40.0	-0.9	0.9	2.0
21009	138.0	275.7	72.0	135.8	274.3	76.2	-2.1	-1.3	4.2
21010	20.3	73.0	29.0	20.1	73.2	31.1	-0.2	0.2	2.0
21011	161.7	460.2	115.4	161.2	463.6	124.3	-0.5	3.4	8.9
21012	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21013	0.0	0.0	32.3	0.0	0.0	32.8	0.0	0.0	0.5
21014	16.6	36.1	0.0	16.2	35.6	0.0	-0.4	-0.5	0.0
21015	44.5	111.6	0.0	44.3	112.3	0.0	-0.2	0.6	0.0
21016	3.0	4.1	0.0	3.0	4.2	0.0	0.0	0.1	0.0
21017	52.5	75.8	0.0	52.5	76.6	0.0	-0.1	0.8	0.0
21018	14.9	23.3	0.0	15.0	23.7	0.0	0.1	0.4	0.0
21019	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21020	3.0	9.6	0.0	3.0	9.7	0.0	0.0	0.2	0.0
21021	2.0	4.6	162.1	2.0	4.6	172.4	0.0	0.1	10.4
21022	3.8	11.7	7.4	3.7	11.5	7.8	-0.1	-0.2	0.5
21023	31.9	79.5	10.4	30.9	77.5	11.4	-1.0	-2.0	1.0
21024	19.7	62.9	1.3	18.8	60.3	1.3	-0.9	-2.6	0.0
21025	15.0	36.1	22.4	14.6	35.4	24.9	-0.4	-0.7	2.4
21026	11.8	37.6	0.0	11.6	37.0	0.0	-0.2	-0.6	0.0

21027	15.2	52.8	12.2	15.0	52.2	13.5	-0.2	-0.6	1.3
21028	20.3	70.4	1.2	19.7	68.8	1.2	-0.5	-1.5	0.0
21029	46.8	113.7	1.2	45.7	111.6	1.3	-1.1	-2.1	0.0
21030	6.5	16.8	0.0	6.1	15.8	0.0	-0.4	-1.0	0.0
21031	91.8	277.9	4.1	91.4	277.9	4.9	-0.4	0.0	0.8
21032	87.1	165.2	28.8	83.8	159.8	29.3	-3.3	-5.4	0.4
21033	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21034	62.8	159.6	115.3	16.3	41.4	0.0	-46.4	-118.2	-115.3
21035	0.0	0.0	38.0	0.0	0.0	0.0	0.0	0.0	-38.0
21036	54.5	138.6	2.7	4.9	12.4	2.7	-49.7	-126.3	0.0
21037	265.4	318.2	0.0	158.7	190.3	0.0	-106.7	-127.9	0.0
21038	0.0	0.0	1.2	0.0	0.0	1.2	0.0	0.0	0.0
21039	67.5	228.9	16.7	66.4	226.1	17.2	-1.1	-2.7	0.5
21040	56.6	148.0	187.1	55.7	146.2	187.4	-1.0	-1.8	0.3
21041	343.3	953.6	28.0	342.6	956.2	29.7	-0.7	2.6	1.7
21042	74.7	155.2	12.3	73.8	154.1	13.2	-0.9	-1.1	0.9
21043	333.8	905.0	0.0	126.3	341.9	0.0	-207.5	-563.1	0.0
21044	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21045	152.6	503.6	136.5	45.2	148.7	0.0	-107.5	-354.8	-136.5
21046	0.0	0.0	1.3	0.0	0.0	1.3	0.0	0.0	0.0
21047	66.4	209.6	0.0	37.2	117.4	0.0	-29.1	-92.2	0.0
21048	249.5	595.9	4.7	156.3	372.7	4.7	-93.2	-223.1	-0.1
21049	152.8	601.1	128.9	99.3	390.3	130.6	-53.4	-210.8	1.7
21050	29.2	93.1	4.4	29.2	93.4	4.6	0.0	0.4	0.3
21051	385.8	1158.9	20.2	274.0	821.9	20.2	-111.8	-336.9	0.0
21052	540.3	2012.9	7.8	400.1	1488.2	7.7	-140.3	-524.7	-0.1
21053	140.8	579.1	0.0	67.9	278.9	0.0	-72.9	-300.2	0.0
21054	11.7	14.0	2.6	14.9	17.9	3.7	3.2	3.9	1.1
21055	8.5	25.8	1.9	14.2	45.0	2.2	5.7	19.2	0.3
21056	41.7	105.2	0.9	335.2	402.8	1.2	293.5	297.6	0.3
21057	205.7	517.0	1.8	827.5	2189.3	2.3	621.8	1672.3	0.5
21058	192.7	488.1	0.0	188.8	480.6	0.0	-3.9	-7.6	0.0
21059	206.2	577.3	72.6	202.7	570.3	76.4	-3.5	-7.0	3.8
21060	29.3	61.1	0.0	29.2	61.3	0.0	0.0	0.3	0.0
21061	540.5	1381.7	82.7	382.2	975.5	80.0	-158.3	-406.2	-2.6
21062	534.5	1634.1	232.9	428.3	1307.6	229.4	-106.2	-326.5	-3.5
21063	452.9	1547.3	12.0	370.1	1262.7	11.9	-82.8	-284.6	-0.1
21064	496.8	1577.9	72.2	361.7	1147.2	72.1	-135.1	-430.7	-0.1
21065	2.5	6.3	0.0	1.6	4.2	0.0	-0.9	-2.2	0.0
21066	5.3	24.5	0.0	5.0	23.3	0.0	-0.3	-1.1	0.0
21067	46.8	117.8	1.0	80.7	213.4	1.0	33.8	95.7	0.0
21068	14.6	17.6	1.8	23.7	28.4	2.3	9.0	10.9	0.5
21069	4.7	14.1	0.9	5.0	15.9	1.1	0.3	1.8	0.2
21070	242.5	1215.0	0.9	425.8	2240.2	1.2	183.3	1025.2	0.3

21071	192.2	510.5	0.0	226.6	633.3	0.0	34.4	122.8	0.0
21072	67.8	160.4	0.0	75.2	187.4	0.0	7.4	27.0	0.0
21073	672.1	2019.6	162.7	444.9	1335.0	160.3	-227.2	-684.6	-2.4
21074	62.7	109.8	0.0	51.6	90.3	0.0	-11.1	-19.5	0.0
21075	91.1	188.4	1.3	86.6	179.9	1.4	-4.6	-8.5	0.0
21076	13.9	46.5	45.7	13.5	45.3	49.5	-0.4	-1.2	3.8
21077	22.2	59.3	0.0	21.8	58.6	0.0	-0.4	-0.7	0.0
21078	32.7	60.5	13.7	76.3	148.7	14.5	43.6	88.2	0.9
21079	0.0	0.0	1.0	0.0	0.0	1.0	0.0	0.0	0.0
21080	0.0	0.0	2.0	0.0	0.0	2.0	0.0	0.0	0.0
21081	0.0	0.0	0.9	0.0	0.0	1.1	0.0	0.0	0.1
21082	20.6	24.7	0.0	25.0	30.1	0.0	4.5	5.4	0.0
21083	130.0	292.3	0.0	303.6	718.6	0.0	173.6	426.4	0.0
21084	262.1	707.3	0.0	301.3	855.6	0.0	39.3	148.4	0.0
21085	415.8	1146.6	0.0	500.3	1451.7	0.0	84.6	305.1	0.0
21086	204.0	678.2	0.0	98.9	328.2	0.0	-105.1	-350.0	0.0
21087	33.3	114.9	65.0	33.3	115.3	66.1	-0.1	0.3	1.2
21088	0.0	0.0	1.7	0.0	0.0	1.7	0.0	0.0	0.0
21089	170.0	429.9	19.9	157.7	431.4	20.1	-12.4	1.5	0.1
21090	131.5	342.0	207.3	131.1	368.9	208.2	-0.4	26.9	0.9
21091	0.0	0.0	133.7	0.0	0.0	134.1	0.0	0.0	0.4
21092	0.0	0.0	6.7	0.0	0.0	6.7	0.0	0.0	0.0
21093	0.0	0.0	4.7	0.0	0.0	4.9	0.0	0.0	0.2
21094	0.0	0.0	1.0	0.0	0.0	1.0	0.0	0.0	0.0
21095	0.0	0.0	3.0	0.0	0.0	3.0	0.0	0.0	0.0
21096	0.0	0.0	0.9	0.0	0.0	1.1	0.0	0.0	0.2
21097	20.6	62.1	0.0	25.0	79.3	0.0	4.5	17.3	0.0
21098	31.7	79.8	0.0	40.2	106.3	0.0	8.5	26.5	0.0
21099	22.3	65.8	0.0	20.1	64.2	0.0	-2.2	-1.6	0.0
21100	382.5	922.6	270.4	371.1	969.1	274.9	-11.4	46.4	4.5
21101	102.3	303.3	45.9	99.1	317.6	46.1	-3.2	14.3	0.2
21102	18.3	54.4	182.0	17.5	56.3	180.7	-0.8	1.9	-1.4
21103	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21104	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21105	15.1	45.5	1.8	24.8	78.5	2.3	9.7	33.1	0.5
21106	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21107	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21108	331.1	787.3	0.0	402.9	1008.5	0.0	71.8	221.2	0.0
21109	63.5	151.3	0.0	75.7	189.6	0.0	12.1	38.4	0.0
21110	59.9	156.1	0.0	101.0	276.8	0.0	41.1	120.7	0.0
21111	8.8	26.1	0.0	8.2	26.2	0.0	-0.6	0.1	0.0
21112	7.3	22.5	0.0	7.2	23.6	0.0	-0.2	1.2	0.0
21113	330.1	830.1	300.6	303.0	824.6	302.8	-27.1	-5.5	2.2
21114	0.0	0.0	323.1	0.0	0.0	324.4	0.0	0.0	1.3

21115	326.6	760.0	327.1	323.4	815.1	327.2	-3.1	55.1	0.1
21116	251.9	673.4	55.9	251.3	726.5	55.8	-0.7	53.1	-0.1
21117	143.1	439.9	35.8	139.8	464.7	35.7	-3.2	24.7	0.0
21118	143.8	498.1	16.8	144.3	539.9	49.6	0.5	41.7	32.8
21119	0.0	0.0	223.4	0.0	0.0	229.2	0.0	0.0	5.8
21120	86.1	220.8	1.2	85.0	235.8	1.2	-1.1	15.1	0.0
21121	243.9	747.1	97.5	237.5	786.2	97.5	-6.4	39.0	0.0
21122	184.6	394.4	340.8	158.5	367.0	340.8	-26.1	-27.4	0.0
21123	195.1	385.4	323.0	191.7	410.6	321.6	-3.5	25.2	-1.5
21124	421.1	806.8	102.3	379.7	789.4	102.3	-41.4	-17.4	0.1
21125	43.6	99.7	0.0	39.3	97.3	0.0	-4.3	-2.4	0.0
21126	98.9	313.2	4.5	97.2	332.6	4.6	-1.7	19.5	0.0
21127	250.5	750.8	2.9	249.7	808.9	2.9	-0.8	58.1	0.0
21128	234.9	367.8	21.7	235.0	400.1	21.8	0.1	32.3	0.0
21129	423.6	1280.4	2.4	504.4	1603.6	5.4	80.8	323.1	3.0
21130	0.0	0.0	40.4	0.0	0.0	53.7	0.0	0.0	13.3
21131	0.0	0.0	407.9	0.0	0.0	409.5	0.0	0.0	1.6
21132	23.2	110.9	0.0	20.8	107.1	0.0	-2.4	-3.8	0.0
21133	241.3	881.0	60.2	236.8	933.5	60.7	-4.4	52.6	0.6
21134	0.0	0.0	1222.8	0.0	0.0	1247.0	0.0	0.0	24.2
21135	9.0	20.9	136.4	9.0	22.8	137.2	0.0	1.8	0.9
21136	0.0	0.0	162.5	0.0	0.0	163.5	0.0	0.0	1.0
21137	393.8	893.1	54.5	377.4	927.3	54.5	-16.4	34.1	0.1
21138	235.6	623.3	402.8	226.0	646.9	402.5	-9.6	23.5	-0.2
21139	23.9	70.2	110.6	22.0	70.1	109.6	-1.8	-0.1	-1.0
21140	155.3	402.6	58.1	154.9	434.6	58.2	-0.3	32.0	0.2
21141	629.2	1532.9	228.7	609.6	1607.6	228.6	-19.7	74.7	-0.1
21142	243.0	463.2	877.9	242.2	500.9	878.2	-0.8	37.7	0.3
21143	1.4	3.6	505.6	1.3	3.7	529.2	0.0	0.1	23.6
21144	165.9	415.6	0.0	163.2	195.7	0.0	-2.8	-220.0	0.0
21145	210.2	642.8	0.0	209.2	691.3	0.0	-1.0	48.5	0.0
21146	1.3	3.2	113.5	1.2	1.4	118.3	-0.1	-1.8	4.9
21147	133.0	459.4	23.7	130.3	486.0	23.6	-2.7	26.6	0.0
21148	79.3	172.2	276.1	76.0	179.0	282.3	-3.2	6.8	6.2
21149	2.0	5.0	887.7	2.0	5.5	888.9	0.0	0.5	1.2
21150	3.0	12.5	307.3	3.0	13.6	317.2	0.0	1.1	9.9
21151	4.9	15.6	489.0	5.0	16.9	494.2	0.0	1.4	5.2
21152	186.8	567.1	349.7	187.2	614.2	349.2	0.4	47.1	-0.5
21153	206.8	422.9	272.7	128.6	285.3	271.6	-78.1	-137.6	-1.1
21154	159.9	323.8	299.1	155.1	340.6	300.1	-4.8	16.8	1.0
21155	253.8	552.8	307.8	252.0	594.9	301.6	-1.8	42.1	-6.2
21156	439.4	804.0	1626.3	434.1	862.3	1622.5	-5.3	58.3	-3.8
21157	103.2	190.7	1995.3	101.5	203.6	1992.9	-1.7	12.8	-2.4
21158	259.1	588.5	505.3	253.4	623.5	630.6	-5.7	34.9	125.3

21159	0.0	0.0	2.9	0.0	0.0	3.2	0.0	0.0	0.2
21160	281.8	696.2	1.0	302.7	363.7	1.1	20.9	-332.5	0.1
21161	6.8	17.2	4.8	17.6	46.7	5.4	10.8	29.5	0.6
21162	43.3	161.2	0.0	50.1	196.3	0.0	6.9	35.1	0.0
21163	0.0	0.0	70.6	0.0	0.0	71.7	0.0	0.0	1.1
21164	10.2	35.2	0.0	9.9	36.9	0.0	-0.3	1.7	0.0
21165	188.2	553.4	16.0	170.1	540.6	16.2	-18.1	-12.8	0.2
21166	666.0	1799.1	152.3	650.2	1899.8	152.6	-15.8	100.7	0.3
21167	0.0	0.0	80.2	0.0	0.0	80.3	0.0	0.0	0.1
21168	101.5	313.3	80.2	99.3	331.6	80.5	-2.1	18.2	0.3
21169	0.0	0.0	401.5	0.0	0.0	419.6	0.0	0.0	18.0
21170	225.9	652.9	26.9	222.7	696.1	27.1	-3.1	43.2	0.2
21171	309.9	659.3	99.2	305.3	704.1	99.1	-4.6	44.8	-0.1
21172	431.5	1111.4	26.2	432.2	1204.4	26.4	0.7	93.1	0.2
21173	196.5	385.3	117.4	196.2	417.2	115.5	-0.3	31.9	-1.9
21174	226.1	506.3	228.1	221.0	536.2	224.6	-5.1	29.9	-3.5
21175	241.3	469.7	233.0	234.0	494.1	230.6	-7.3	24.4	-2.4
21176	134.1	237.3	1884.4	134.3	258.1	1880.3	0.2	20.7	-4.2
21177	71.0	141.8	1616.5	66.4	143.9	1615.6	-4.6	2.1	-0.9
21178	196.3	336.4	0.0	189.6	353.1	0.0	-6.6	16.7	0.0
21179	0.0	0.0	81.1	0.0	0.0	81.3	0.0	0.0	0.2
21180	0.0	0.0	2706.8	0.0	0.0	2705.5	0.0	0.0	-1.3
21181	127.7	153.2	937.2	125.9	151.0	939.2	-1.8	-2.2	1.9
21182	128.8	251.4	581.7	126.7	268.2	581.2	-2.1	16.8	-0.6
21183	93.7	236.0	14.9	94.3	257.0	14.9	0.6	21.1	0.0
21184	16.3	37.4	0.0	14.9	37.0	0.0	-1.4	-0.4	0.0
21185	122.2	301.5	29.1	122.5	327.1	28.7	0.3	25.6	-0.4
21186	238.2	550.0	15.4	230.5	576.3	15.3	-7.7	26.4	-0.1
21187	191.9	379.3	503.5	189.6	406.5	500.2	-2.3	27.2	-3.3
21188	211.2	353.0	329.2	208.5	378.6	328.6	-2.7	25.6	-0.6
21189	13.3	20.2	0.0	28.9	46.2	0.0	15.5	26.0	0.0
21190	28.8	80.7	0.0	47.3	139.2	0.0	18.4	58.5	0.0
21191	30.3	58.0	1.2	47.5	95.9	1.9	17.2	37.9	0.8
21192	0.0	0.0	0.2	0.0	0.0	68.4	0.0	0.0	68.2
21193	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21194	269.2	675.3	0.0	268.0	321.4	0.0	-1.2	-353.9	0.0
21195	237.0	688.8	207.3	232.9	731.8	206.8	-4.1	43.0	-0.4
21196	403.6	1178.9	65.0	403.7	1274.7	64.7	0.1	95.9	-0.3
21197	108.8	237.0	0.0	105.8	249.8	0.0	-3.0	12.8	0.0
21198	163.3	418.8	17.9	162.0	449.6	17.8	-1.3	30.7	-0.1
21199	174.0	448.3	57.2	172.8	481.7	57.2	-1.2	33.4	0.0
21200	202.4	325.8	727.9	203.2	355.5	723.3	0.8	29.8	-4.6
21201	211.5	550.6	1356.9	210.1	591.9	1347.6	-1.4	41.3	-9.2
21202	78.4	215.5	13.2	77.0	228.7	13.2	-1.5	13.2	0.0

21203	0.0	0.0	190.3	0.0	0.0	189.4	0.0	0.0	-0.9
21204	233.1	579.0	66.8	230.6	620.1	66.1	-2.5	41.1	-0.7
21205	164.5	525.9	2.3	201.8	678.5	4.5	37.3	152.6	2.2
21206	19.1	32.1	0.0	37.1	65.8	0.0	18.0	33.8	0.0
21207	28.4	50.2	0.0	40.7	75.7	0.0	12.2	25.5	0.0
21208	30.3	76.1	6.7	47.5	125.7	9.3	17.2	49.6	2.6
21209	32.5	79.8	0.0	48.0	124.0	0.0	15.5	44.2	0.0
21210	230.4	770.3	9.7	251.1	882.4	14.3	20.7	112.1	4.5
21211	397.4	1255.7	23.5	425.1	1412.6	56.6	27.8	156.8	33.1
21212	354.0	704.1	26.5	376.4	789.0	26.8	22.4	84.9	0.3
21213	243.5	616.4	0.0	240.4	288.3	0.0	-3.1	-328.2	0.0
21214	320.7	811.3	0.0	311.1	373.0	0.0	-9.6	-438.3	0.0
21215	59.9	150.1	577.4	58.0	69.6	574.4	-1.9	-80.5	-3.0
21216	239.1	406.2	841.4	240.4	443.8	832.5	1.3	37.6	-8.9
21217	311.0	738.7	152.9	305.4	785.4	150.7	-5.6	46.7	-2.2
21218	76.4	99.6	341.6	76.8	109.1	340.1	0.4	9.5	-1.6
21219	379.8	846.6	623.3	372.1	898.6	615.5	-7.7	52.0	-7.8
21220	385.1	810.6	152.0	364.8	832.3	150.8	-20.3	21.7	-1.2
21221	49.3	95.1	0.0	50.2	102.1	0.0	0.9	7.0	0.0
21222	463.2	1162.0	1087.1	458.6	549.9	1071.5	-4.6	-612.2	-15.6
21223	177.1	222.4	341.0	175.2	240.0	341.5	-1.9	17.6	0.5
21224	326.4	886.0	170.6	323.7	950.5	170.8	-2.7	64.5	0.2
21225	1.1	2.7	1.2	1.0	1.2	1.2	0.0	-1.4	0.0
21226	1.1	2.7	1.2	1.0	1.2	1.2	0.0	-1.4	0.0
21227	1.1	2.7	1.2	1.0	1.2	1.2	0.0	-1.4	0.0
21228	54.0	176.4	6.9	53.5	188.7	6.9	-0.5	12.4	0.0
21229	121.6	437.9	25.9	116.2	451.8	49.3	-5.4	13.9	23.4
21230	15.0	37.6	1.9	35.2	93.2	2.2	20.3	55.6	0.3
21231	1.1	2.7	1.2	1.0	1.2	1.2	0.0	-1.4	0.0
21232	1.1	2.7	1.2	1.0	1.2	1.2	0.0	-1.4	0.0
21233	1.1	2.8	1.4	1.1	1.3	1.4	0.0	-1.5	0.0
21234	1.1	2.8	1.4	1.1	1.3	1.4	0.0	-1.5	0.0
21235	334.5	401.2	14.7	332.0	398.1	14.7	-2.5	-3.1	0.0
21236	165.4	417.7	0.0	163.4	196.0	0.0	-2.0	-221.8	0.0
21237	329.9	827.7	0.0	327.2	392.3	0.0	-2.8	-435.4	0.0
21238	293.8	823.2	66.0	292.3	885.7	66.1	-1.5	62.5	0.1
21239	1.2	3.0	0.0	1.2	3.2	0.0	0.0	0.2	0.0
21240	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21241	193.2	430.4	0.0	304.2	713.9	0.0	111.0	283.5	0.0
21242	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21243	423.8	702.6	82.0	605.6	1059.4	60.1	181.8	356.8	-21.9
21244	156.3	392.1	14.7	154.1	184.8	14.5	-2.2	-207.3	-0.2
21245	173.8	537.5	38.6	200.5	652.1	40.6	26.7	114.6	2.0
21246	15.1	35.0	12.4	23.8	57.9	13.0	8.6	22.9	0.6

21247	18.9	28.7	0.0	28.8	46.0	0.0	9.8	17.3	0.0
21248	7.3	9.6	0.0	9.8	13.6	0.0	2.5	4.1	0.0
21249	13.3	16.0	0.0	15.1	18.1	0.0	1.8	2.1	0.0
21250	259.1	474.4	2.4	301.3	581.7	5.2	42.2	107.3	2.8
21251	6.9	15.5	0.0	9.7	23.1	0.0	2.8	7.6	0.0
21252	52.2	97.1	0.0	51.4	96.7	0.0	-0.8	-0.5	0.0
21253	4.3	19.4	0.0	4.3	19.4	0.0	0.0	0.0	0.0
21254	15.2	37.8	25.6	15.2	38.3	27.3	0.1	0.6	1.8
21255	20.2	24.1	4.2	19.8	23.7	4.8	-0.3	-0.4	0.5
21256	1.7	4.0	0.0	1.7	4.0	0.0	0.0	0.0	0.0
21257	3.8	5.2	0.0	3.6	5.0	0.0	-0.2	-0.2	0.0
21258	3.5	8.2	0.0	3.5	8.1	0.0	-0.1	-0.1	0.0
21259	9.5	21.9	0.0	9.3	21.7	0.0	-0.2	-0.1	0.0
21260	98.0	219.5	76.1	96.4	217.1	75.4	-1.6	-2.4	-0.7
21261	195.6	433.0	94.9	192.3	428.1	93.9	-3.3	-4.8	-1.0
21262	5.5	12.7	0.0	5.4	12.5	0.0	-0.1	-0.1	0.0
21263	3.8	8.7	26.9	3.6	8.4	28.9	-0.2	-0.3	1.9
21264	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21265	58.4	97.3	0.0	58.3	98.2	0.0	-0.1	0.9	0.0
21266	6.9	11.4	0.0	6.9	11.6	0.0	0.0	0.2	0.0
21267	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21268	2.3	7.4	2.1	2.3	7.4	2.1	0.0	0.1	0.0
21269	3.4	5.8	1.1	3.4	5.8	1.1	0.0	0.1	0.0
21270	3.0	9.8	0.0	3.0	9.7	0.0	0.0	0.0	0.0
21271	3.4	6.8	11.1	3.4	6.9	12.2	0.0	0.1	1.1
21272	7.9	26.6	0.0	7.8	26.7	0.0	0.0	0.1	0.0
21273	23.0	84.7	0.0	22.2	82.9	0.0	-0.7	-1.8	0.0
21274	2.0	4.6	0.0	2.0	4.6	0.0	0.0	0.1	0.0
21275	18.4	23.5	19.8	17.9	23.2	0.0	-0.5	-0.3	-19.8
21276	17.7	35.5	0.0	17.1	34.5	0.0	-0.6	-0.9	0.0
21277	23.0	40.3	5.1	21.8	38.6	5.9	-1.2	-1.7	0.8
21278	1.4	3.3	0.0	1.4	3.3	0.0	0.0	0.0	0.0
21279	1.3	3.2	0.0	1.3	1.6	0.0	0.0	-1.6	0.0
21280	1.3	3.2	0.0	1.3	1.6	0.0	0.0	-1.6	0.0
21281	38.4	71.3	10.5	38.2	71.4	10.5	-0.2	0.1	0.0
21282	63.5	113.3	14.0	62.8	112.7	13.7	-0.8	-0.6	-0.2
21283	33.5	97.6	0.0	32.8	96.3	0.0	-0.7	-1.4	0.0
21284	41.7	150.0	29.4	41.2	148.9	29.1	-0.6	-1.1	-0.3
21285	95.5	232.3	6.8	93.5	228.9	6.8	-2.0	-3.3	-0.1
21286	47.2	113.4	7.7	46.0	111.2	7.6	-1.2	-2.2	-0.1
21287	2.3	5.3	0.0	2.2	5.2	0.0	-0.1	-0.1	0.0
21288	23.0	27.5	0.0	22.1	26.4	0.0	-0.9	-1.1	0.0
21289	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21290	4.8	9.9	0.0	4.8	10.0	0.0	0.0	0.1	0.0

21291	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21292	4.5	6.3	0.0	4.3	6.0	0.0	-0.3	-0.3	0.0
21293	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21294	30.4	66.6	37.2	29.0	64.1	41.1	-1.5	-2.5	3.9
21295	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21296	8.3	20.4	6.7	7.4	8.9	6.6	-0.9	-11.5	-0.1
21297	8.3	20.4	23.9	7.4	8.9	23.3	-0.9	-11.5	-0.6
21298	161.4	744.1	0.0	151.7	706.6	0.0	-9.7	-37.6	0.0
21299	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21300	71.4	244.1	0.0	67.7	237.0	0.0	-3.7	-7.1	0.0
21301	227.2	425.4	50.1	223.6	429.4	49.9	-3.7	4.1	-0.2
21302	85.9	162.9	43.0	85.3	165.9	43.8	-0.6	3.0	0.8
21303	67.2	316.7	45.7	62.9	303.8	45.2	-4.3	-12.9	-0.5
21304	4.5	10.4	16.8	4.3	9.9	21.2	-0.3	-0.5	4.4
21305	47.9	110.4	27.1	45.9	106.8	32.9	-2.0	-3.5	5.8
21306	29.0	40.1	0.0	27.7	38.7	0.0	-1.3	-1.4	0.0
21307	22.1	54.1	0.0	21.2	53.2	0.0	-0.9	-0.9	0.0
21308	120.4	223.7	11.5	120.2	229.1	11.5	-0.2	5.4	0.0
21309	112.9	178.7	73.1	112.7	183.3	72.6	-0.1	4.5	-0.5
21310	145.7	326.0	115.4	145.1	333.0	114.7	-0.6	7.0	-0.8
21311	125.2	280.1	27.1	124.1	284.6	27.0	-1.1	4.5	-0.1
21312	16.2	34.9	9.8	15.7	34.2	11.0	-0.5	-0.7	1.2
21313	71.4	157.2	6.7	67.7	152.8	6.6	-3.7	-4.4	-0.1
21314	133.2	275.4	30.5	132.2	280.4	30.3	-1.0	5.0	-0.2
21315	40.5	96.9	41.8	39.0	46.7	41.6	-1.5	-50.2	-0.2
21316	49.0	87.0	29.6	49.1	89.4	29.4	0.0	2.3	-0.2
21317	44.6	138.9	34.4	44.4	141.6	34.2	-0.2	2.8	-0.2
21318	98.1	239.8	171.3	98.1	246.0	170.7	0.0	6.2	-0.7
21319	8.9	12.3	0.0	8.5	12.0	0.0	-0.3	-0.3	0.0
21320	127.8	266.4	6.7	124.7	266.6	6.6	-3.1	0.3	-0.1
21321	122.8	147.1	61.4	121.0	145.0	60.4	-1.8	-2.1	-1.0
21322	124.1	310.4	52.5	121.9	312.5	51.7	-2.2	2.1	-0.8
21323	74.1	176.0	84.0	73.5	179.1	83.0	-0.6	3.1	-1.0
21324	103.8	230.3	11.6	101.3	230.5	11.5	-2.5	0.2	-0.1
21325	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21326	0.0	0.0	42.7	0.0	0.0	0.0	0.0	0.0	-42.7
21327	20.1	50.9	0.0	19.4	49.8	0.0	-0.6	-1.0	0.0
21328	28.6	114.5	0.0	27.8	112.2	0.0	-0.8	-2.3	0.0
21329	16.8	42.9	0.0	16.9	44.3	0.0	0.1	1.4	0.0
21330	0.0	0.0	33.2	0.0	0.0	34.4	0.0	0.0	1.3
21331	0.0	0.0	21.4	0.0	0.0	21.6	0.0	0.0	0.1
21332	126.0	225.2	0.0	124.2	224.5	0.0	-1.7	-0.7	0.0
21333	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21334	10.8	13.0	0.0	10.9	13.1	0.0	0.1	0.1	0.0

21335	5.9	16.4	28.3	6.0	16.6	27.3	0.0	0.3	-1.0
21336	0.0	0.0	57.4	0.0	0.0	57.4	0.0	0.0	0.0
21337	1.0	1.2	0.0	1.0	1.2	0.0	0.0	0.0	0.0
21338	3.9	4.7	0.0	4.0	4.8	0.0	0.0	0.0	0.0
21339	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21340	15.3	21.2	0.0	14.9	20.9	0.0	-0.4	-0.3	0.0
21341	2.7	6.2	0.0	2.6	6.1	0.0	-0.1	-0.1	0.0
21342	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21343	8.9	15.9	0.0	8.9	16.2	0.0	0.1	0.3	0.0
21344	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21345	50.9	63.9	240.7	50.1	63.5	235.1	-0.8	-0.4	-5.5
21346	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21347	9.4	21.3	128.5	9.1	20.8	126.3	-0.3	-0.4	-2.1
21348	18.8	75.4	0.0	18.2	73.8	0.0	-0.6	-1.6	0.0
21349	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21350	24.1	32.9	246.5	24.0	33.1	245.0	-0.1	0.2	-1.5
21351	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21352	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21353	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21354	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21355	2.0	3.6	0.0	2.0	3.7	0.0	0.0	0.1	0.0
21356	8.2	18.8	0.0	3.9	9.2	0.0	-4.2	-9.6	0.0
21357	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21358	6.9	24.1	27.3	6.9	24.5	26.3	0.0	0.4	-1.0
21359	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21360	6.9	14.1	0.0	6.9	14.3	0.0	0.0	0.2	0.0