Model Background

Travel Demand Forecasting

The travel demand models are used by the City for Comprehensive Plan development, transportation concurrency management, and other transportation planning and policy applications. Sammamish uses AM and PM peak hour travel demand models to calculate travel demand forecasts for city streets and intersections based on funded Transportation Improvement Plan (TIP) projects, permitted "pipeline" development, and long-range development forecasts.

Traffic volume forecasts were developed using the Sammamish travel demand model, which was updated in September 2023 to reflect the latest development inventory, driver behavior, trip generation rates, modeling procedures, and traffic counts. The travel demand model follows a three-step modeling process which includes trip generation, trip distribution, and traffic assignment.

This section describes the general structure of the travel demand model. A detailed description of travel demand model methods and assumptions are provided in the *Sammamish 2023 Travel Demand Model and Intersection Level of Service Model Update Final Report*, which has been produced as a supplemental document to the TMP.

3.1.1. Highways of Statewide Significance

Street Segments

The travel demand model's transportation network includes all functionally classified streets and most local streets in and near Sammamish, representing a total of 394 centerline miles of roadway. During the model development and calibration process, modeled links were reviewed to confirm the accuracy of roadway alignment, channelization, posted speeds, and directional prohibitions. Street characteristics were verified through field visits, satellite photography, online street-view photography, and discussion with City and consultant staff.

Links were modeled using planning-level inputs which are consistent with prior Sammamish travel demand models and are used by several other western Washington agencies. The model uses a lookup table which assigns free flow speed, number of lanes, and capacity based on a single "link type" input. This system streamlines model development, scenario testing, maintenance and is standard practice for a citywide planning model. Link speeds were adjusted during the model validation process to improve the accuracy of the model's traffic assignment results.

Street Disconnects

The Sammamish roadway network includes several disconnection points which include bollards, gates, or other physical barriers on otherwise continuous public streets. City staff provided a geographic file on May 2, 2023, which identified all existing disconnection points in Sammamish network. All disconnects as of May 2023 were incorporated to the model.

Intersections

The 2023 model update included implementation of refined intersection geometry and control settings to facilitate turn delay functions using *Highway Capacity Manual* (HCM) methodologies. This represents a refinement of the 2016 model, which utilized planning-level delay functions that included limited consideration for intersection channelization and signal phasing. The use of HCM methodologies allows more accurate delay forecasts and therefore a more accurate forecasting tool.

To implement HCM6 delay methodologies, intersections were updated to reflect detailed intersection characteristics, including channelization, turn bays, control devices, signal phasing, and signal timing. Intersection attributes were verified using satellite and street-level imagery, timing plan sheets, and field visits.

The 2044 Baseline travel demand model assumed a partial buildout of the Sammamish Town Center Street network. The baseline network buildout, shown in **Figure 22**, included the following notable street network improvement projects:

- Intersection control: Convert 228th Ave & E Main St from signal to stop control with right-in/right-out turn

restrictions,

- Intersection control: Convert 228th Ave SE & SE 1st Pl from stop control to signal control,
- New street: "Northwest Connector" beginning at SE 4th St & 225th Pl SE proceeding north and turning east before terminating at 228th Ave SE & SE 1st Place. (2024-2029 TIP #124),
- New street: "Northeast Connector" beginning at E Main Street and proceeding south to terminate at Crusader Way (2024-2029 TIP #TR-126),
- Street extension: Extend SE 1st Place east to connect with Northeast Connector, and
- New streets in northwest and southwest Town Center quadrants, including SE 6th Street and 226th Ave SE extensions.

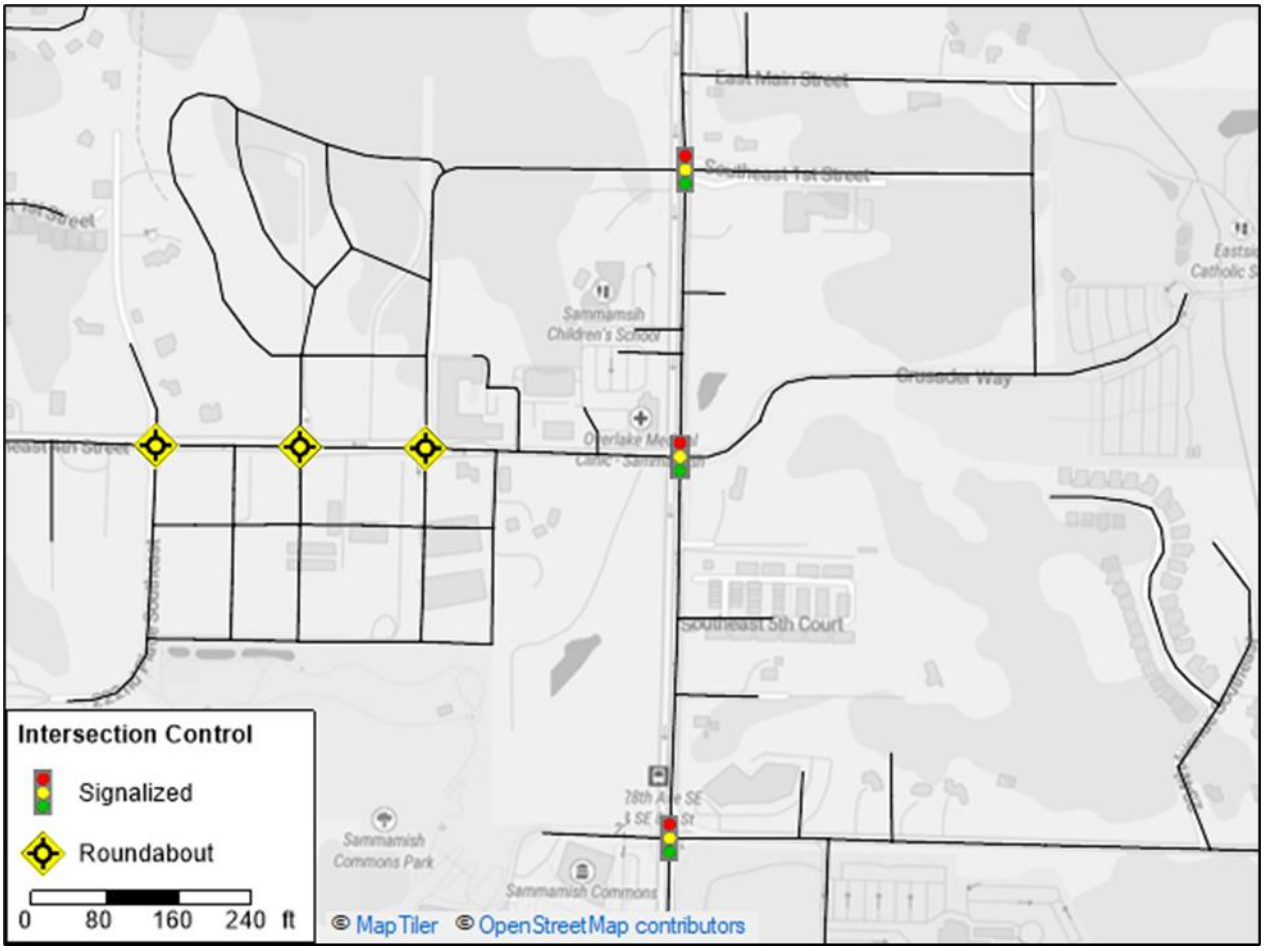

Figure 22. Sammamish Town Center 2044 Baseline Street Network

3.1.2. Land Use Architecture

Transportation Analysis Zones

Land use in travel demand models is represented by geographic units called Transportation Analysis Zones (TAZs). The 2023 model development process included a review of TAZ boundaries to improve consistency with ongoing development patterns, particularly in the Town Center area, as well as city limit boundaries. Several TAZs in the Town Center area were split and their boundaries modified to improve consistency with parcel boundaries.

Travel demand modeling utilizes two types of TAZs. Internal TAZs reflect development which exists or is expected to occur within a defined geographic area. External TAZs are used to generate traffic entering and exiting the model area at key access points. The model includes a total of 267 internal TAZs and 13 external TAZs. TAZ boundaries are shown in **Figure 23**.

Land Use Categories

The 2023 travel demand model includes 15 land use categories, consisting of 4 residential, 10 non-residential, and one mixed-use category. Land use categories were reviewed during the 2023 model development process and expanded from the 10 categories used in previous models. The expansion of land use categories was made possible through the availability of detailed parcel-level development data and was designed to create a more flexible and accurate travel demand model. Modeled land use categories are identified in **Table 13**. The methods and assumptions used to define the land use categories are described in the memorandum "2023 Travel Demand Model Land Use Categories."

Development Inventory

The 2023 travel demand model update included a comprehensive update of the model's development inventory using geospatial parcel data acquired from the King County Department of Assessments in March 2023. The parcel data provides boundary and usage data for every tax parcel in the model area, including a description of existing land use type, number of residential units, and non-residential floor area. Parcel data was aggregated by TAZ to provide a detailed development inventory current to March 2023, the month in which traffic counts were collected for travel demand model calibration.

Educational uses were expressed in terms of number of students. 2023 enrollment at each educational institution in the model area was verified through review of publicly available data. The 2023 land use inventory indicated a total of 22,697 dwelling units, 1,426,000 square feet of commercial and institutional floor area (excluding schools), and 15,084 pre-kindergarten through post-secondary students within the City of Sammamish.

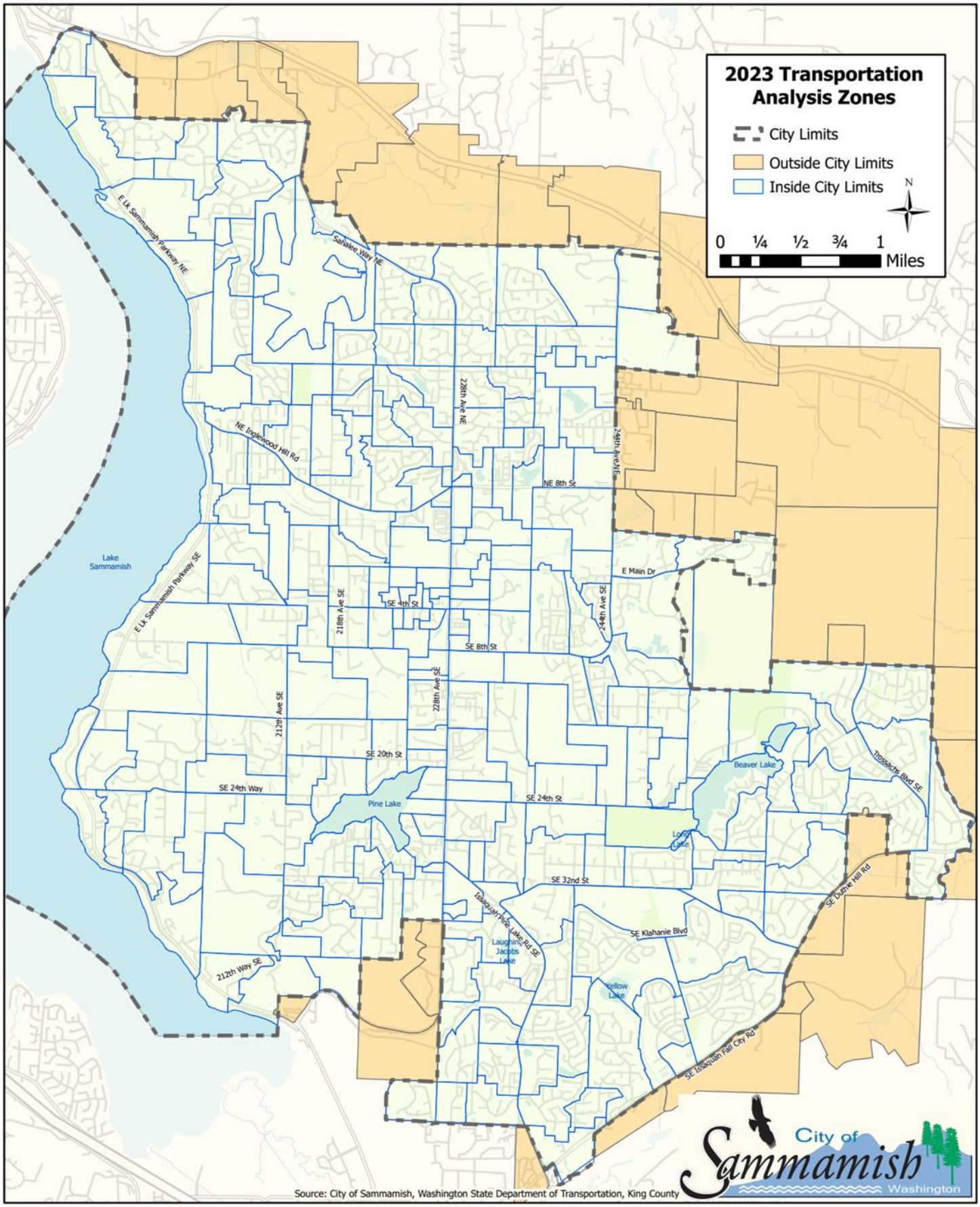

Figure 23. Transportation Analysis Zones

Table 13. 2023 Travel Demand Model Land Use Categories

	Model Land Use	ITE Land Use[1]	Units
Residential	Single-Family Detached Housing	Single-Family Detached (#210)	dwelling units (DU)
	Townhomes (2-3 5ldg.s/bldg.)	Single-Family Attached (#215)	dwelling units (DU)
	Multifamily Housing (>3 5ldg.s/bldg.)	Multifamily Housing (Low-Rise) (#220)	dwelling units (DU)
	Age-Restricted Housing	Senior Adult Housing – Single-Family (#251)	dwelling units (DU)
Mixed-Use	Mixed-Use Residential with Ground-Floor Commercial	Mid-Rise Residential with Ground-Floor Commercial (1-25k) (#231)	dwelling units (DU)
Non-Residential	Retail	Shopping Center (>150k) (#820)	1,000 sf
	Office	General Office Bldg (#710)	1,000 sf
	Medical/Dental	Medical-Dental Office Bldg (#720)	1,000 sf
	Community Center / Public Assembly	Recreational Community Center (#495)	1,000 sf
	PreK-8 Education	Elementary School (#520)	Students
	High School & Post-Secondary Education	High School (#525)	Students
	Wholesale Trade, Construction, & Utilities	Warehousing (#150)	1,000 sf
	Industrial & Manufacturing	General Light Industrial (#110)	1,000 sf
	Active Land/Parks	Public Park (#411)	acres
	Park & Ride	Park & Ride (#090)	spaces

LAND USE GROWTH

2029 travel demand growth was generated using the Sammamish development pipeline. Pipeline development included a total of 94 projects which were permitted or under construction at the time of model validation.

Pipeline projects consist of a total of 1,128 new dwelling units (DU) and 100,000 square feet (sf) of commercial floor area, of which 900 DU and all commercial area are in the Sammamish Town Center (STC) area. Pipeline development is expected to generate a total of 1,246 trips during the AM peak hour and 788 trips during the PM peak hour of travel. The pipeline trip generation forecast is summarized in **Table 14**.

Table 14. 2029 Development and Trip Growth

Scenario	Dwelling Units (DU)	Commercial Floor Area (ksf)	Trip Ends in City	
			AM Peak Hr	PM Peak Hr
Existing (2023)	22,697	1,207	21,989	22,456
Pipeline (2023-2029)	+1,128	+100	+1,246	+788
2029 Total	**23,825**	**1,307**	**23,235**	**23,244**

2044 travel demand growth was generated using the Land Use Element long-range housing and commercial growth forecasts. Long-range growth forecasts included 2,100 new dwelling units and 269,000 square feet (sf) of commercial development citywide, of which 810 dwelling units and all commercial development are anticipated to occur in the Sammamish Town Center area. The 2044 development forecast is summarized in **Table 15**.

Table 15. 2044 Development and Trip Growth

Scenario	Dwelling Units (DU)	Retail/Office/ Healthcare Floor Area (ksf)	Trip Ends in City	
			AM Peak Hr	PM Peak Hr
Existing (2023)	22,697	1,207	21,989	22,456
Pipeline (2023-2029)	+1,128	+100	+1,246	+788
Long-Range (2029-2044)	+2,100	+269	+1,045	+1,571
2044 Total	**25,925**	**1,577**	**24,280**	**24,815**

Regional growth for the 2029 and 2044 analysis years were forecast using data obtained from the Puget Sound Regional Council (PSRC) VISION 2050 regional travel demand model at key access points to the city. The regional travel demand model indicates an average growth rate of 0.6 percent per year at the key access points to Sammamish.

3.1.3. Travel Demand Model Methodology

Trip Generation

Modeled trip generation rates were based on a May 2023 trip generation study conducted at 23 major developments throughout Sammamish. Supplemental trip generation data was obtained from the Institute of Transportation Engineers *Trip Generation Manual 11th Edition*, and external trip generation totals were calculated based on traffic counts collected at model boundaries.

Trips were divided into five purposes: home-to-work (HW), work-to-home (WH), home-to-other (HO), other-to-home (OH), and non-home based (NHB) trips. Trip purposes by land use were selected based on prior model updates and trip purpose data from other agencies.

Trip Distribution

Trips were distributed between TAZs using a gravity model, which is based on the principle that the attraction between two bodies is directly proportional to the bodies' masses and inversely proportional to the distance between the bodies. In the context of travel demand modeling, a TAZ's "mass" is represented by the number of trips generated by the TAZ, while the distance factor is represented by route travel time. The model calculates the attraction between any two TAZs using the utility function:

$$f(U) = a * (U^b) * (e^{cU})$$

In the utility function, U is defined as travel time between zones. The parameters a, b, and c are calibration factors which influence the weight of travel time in the gravity model. The gravity parameters used in the 2023 model were calibrated based on guidance from *NCHRP Report 716* (TRB 2012) to allow 2023 modeled volumes to match traffic count data.

Traffic Assignment

Trips were assigned to the transportation network using an equilibrium assignment process which allocates vehicle trips between origins and destinations along the route with the lowest travel time. The assignment routine updates network travel time iteratively to reflect network congestion, re-assigning traffic until no vehicle can decrease its travel time by shifting to a new path. Link and turn travel times are calculated using travel demand model volume-delay functions (VDFs). Link VDFs utilized the Visum software implementation of the Speiss conical volume-delay function, which is utilized in other local agency travel demand models in Western Washington. Turn VDFs utilized *Highway Capacity Manual* volume-delay equations, except for roundabouts which utilized the TRL/Kimber method.

3.1.4. Travel Demand Model Calibration

Travel demand model calibration consists of adjusting model procedures and formulas to allow the model to reflect local travel behavior for an observed condition. This may involve adjusting trip generation rates, trip distribution gravity model parameters, volume-delay functions, and other model parameters.

Travel demand model validation consists of comparing the model's traffic assignment output to actual traffic counts, and sometimes other available survey data, to establish correlation between the base-year model and base-year survey data. A well-calibrated model, when populated with land use and street network data that existed at the time traffic counts were collected, will generate traffic volumes that closely correlate with traffic counts. Calibration errors should be minimal and evenly distributed to consider a model "validated" and therefore suitable for use in concurrency tests, planning, and design studies.

The 2023 model was calibrated according to best practices identified in *National Cooperative Highway Research Program Report 765: Analytical Travel Forecasting Approaches for Project-Level Planning and Design* (TRB 2014) and *Travel Model Validation and Reasonableness Checking Manual Second Edition* (FHWA 2010). A total 359 AM peak hour and 351 PM peak hour volume counts were used as reference points for model calibration. The base year model traffic volumes were checked against the base year link volume counts and model inputs were calibrated to improve the correlation between the modeled volumes and traffic counts.

The most common statistical measures of travel demand model accuracy are the coefficient of determination (R^2) and the percent root-mean square error (%RMSE) statistics. The R^2 statistic can be interpreted as a "goodness of fit" statistic and measures the strength of the linear relationship between the calculated model volumes and observed (counted) traffic volumes. Percent RMSE measures the average error between the modeled and observed traffic volumes and can be calculated using the following formula:

$$\%\text{RMSE} = 100 \text{ x } \frac{\sqrt{\frac{\sum(\text{Assignment Errors})^2}{\text{Number of Links}}}}{\text{Average Count}}$$

R^2 and %RMSE measure the overall degree to which modeled volumes correspond to observed count data, where perfection would be 100 percent correlation of modeled volumes to counts ($R^2 = 1$) with no error (%RMSE = 0). There are no national standards for R^2 or %RMSE. However, the *Model Validation and Reasonableness Checking Manual* (FHWA 1997) provides suggested guidelines for model calibration including R^2 value of at least 0.88 and %RMSE less than or equal to 35%.

The 2023 calibrated model meets the suggested calibration guidelines identified by FHWA. The calibrated AM peak hour model has an R^2 statistic of 0.98 and 13% root-mean-squared error, while the calibrated PM peak hour model has an R^2 statistic of 0.98 and 10% root-mean-squared error. These results indicate a close correlation between traffic counts and modeled volumes. All AM and PM peak hour volumes fall within the recommended allowable error curves identified in NCHRP Report 765.

Even in the most well-calibrated travel demand model, some differences will exist between raw model volumes and traffic counts. These remaining errors were reduced using Visum's origin-destination matrix correction procedure, which compares traffic counts to raw model flows and calculates an origin-destination correction matrix which is applied at the end of the trip distribution step of the model procedure sequence.

Future year model volumes were post-processed to further reduce model error using the "difference method." This method consists of subtracting the base year (2023) model volume from the future year model volume and adding that difference to the base year traffic counts. This method, summarized in NCHRP Report 716, reduces the influence of base year model error. However, model results must still be checked for reasonableness in any given application.

Town Center

The development forecasts applied in this analysis include a total of 1,737 new dwelling units and 339,000 square feet of commercial development in the Sammamish Town Center area, in addition to a new 600-student public high school on the east side of 228th Ave SE north of SE 4th Street.

The intersection of 228th Avenue SE & SE 4th Street constitutes to be a critical access point to Town Center and a key location for citywide mobility due to its location on the 228th Avenue SE principal arterial corridor. As such, it will be important to maintain acceptable operations at this location. The 2044 analysis indicates that the intersection will operate at LOS C or better in both peak hour periods of all 2044 scenarios and will satisfy the minimum LOS standard. Intersection LOS results at 228th Avenue SE & SE 4th Street are summarized in **Table 19**.

Table 19. 2044 Intersection LOS Results, 228TH Ave SE & SE 4th St

ID	Name	Control	LOS Std	AM Peak Hr		PM Peak Hr	
				Delay	LOS	Delay	LOS
	2044 Baseline	Signal		19	B	19	B
	2044 Alternative 1: STC Network Buildout	Signal		19	B	18	B
	2044 Alternative 2: Back-to-Office	Signal		20	B	23	C
	2044 Alternative 3: Transit Shift	Signal		19	B	18	B