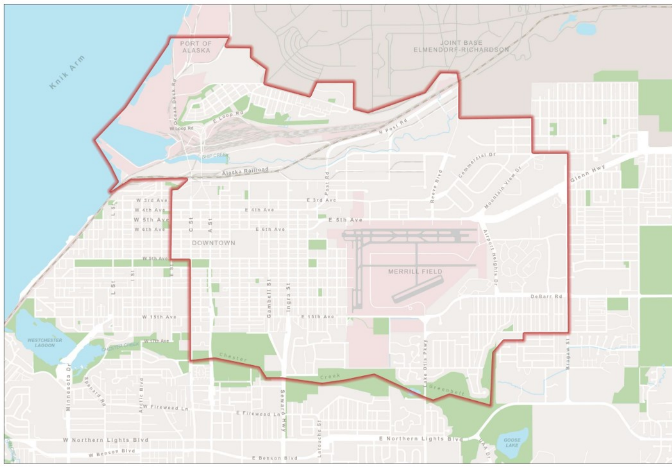

AMATS: Seward Highway to Glenn Highway Connection
Planning & Environmental Linkage Study
State Project No.: CFHWY00550
Federal Project No.: 0001653

Origin-Destination Study Memo

August 31, 2021

This planning document may be adopted in a subsequent environmental review process in accordance with 23 USC 168 Integration of Planning and Environmental Review.

The environmental review, consultation, and other actions required by applicable federal environmental laws for this project are being, or have been, carried out by DOT&PF pursuant to 23 U.S.C. 327 and a Memorandum of Understanding dated November 3, 2017, and executed by FHWA and DOT&PF.

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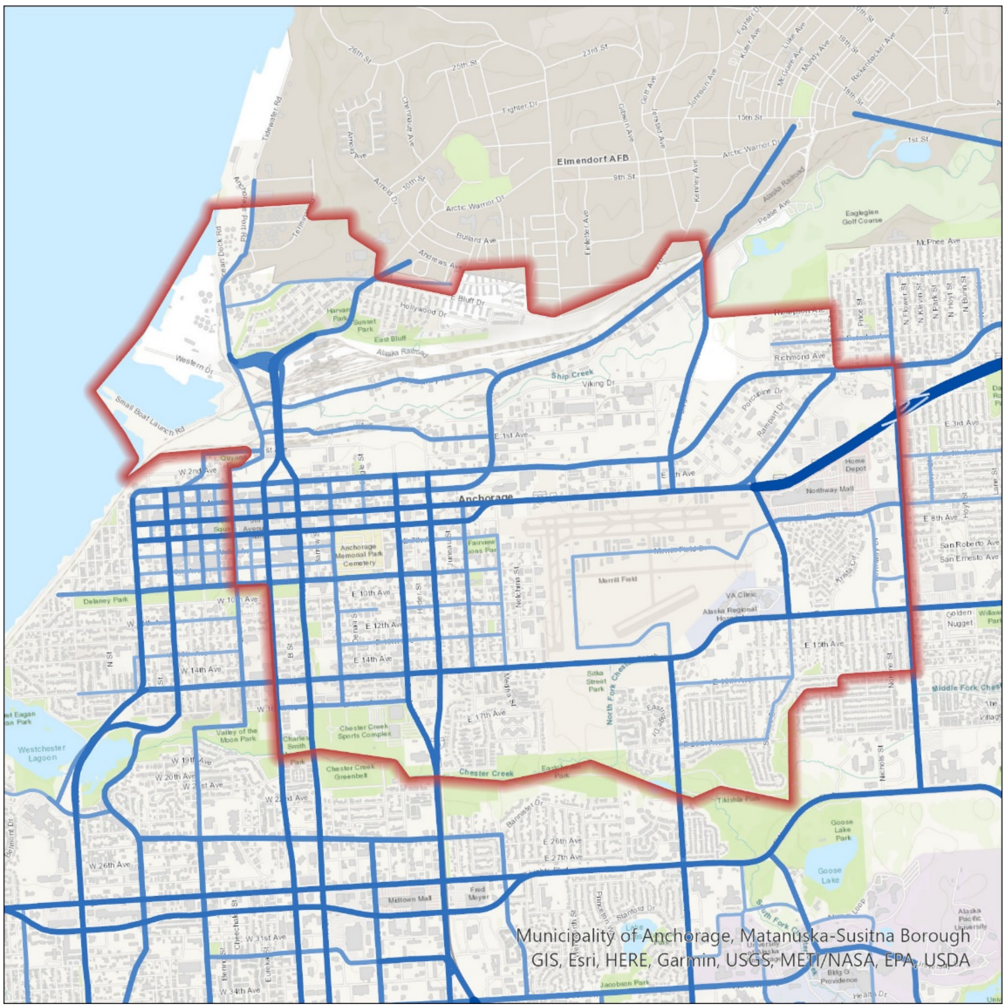
1.0 Purpose of Origin-Destination Study

This document outlines the purpose of, and steps that will be taken to produce, an Origin-Destination (O-D) Study (O-D Study or "the study") for the Seward Highway to Glenn Highway Connection Planning & Environmental Linkage Study effort (SG PEL or "the project"). The study will create a plan to consider potential improvements from the Seward Highway, near 20th Avenue, to the Glenn Highway, east of its intersection with Airport Heights Drive, in the Municipality of Anchorage (MOA). The study will also consider improvements that could connect to Ocean Dock Road at the Port of Anchorage from the highway network. The general study area showing roadways currently in the study's travel model network appears in Figure 1.

Figure 1: SG PEL Project Area (Red) Showing Current Model Links (Blue)



The O-D Study will serve the SG PEL in two ways. First, it will calibrate the project's travel demand model (TDM) to a 2019 base year. Second, it will provide useful travel pattern insights that will help the project team, stakeholders, and decision-makers shape the SG PEL alternatives development and screening processes. Travel forecasts and the O-D Study will focus on typical weekdays in the fall season because the TDM explicitly estimates school travel, and its forecasts thus assume date ranges when schools are in session. The parallel *Travel Demand Modeling Memorandum* describes additional planned improvements to the project's TDM to prepare it for SG PEL study use, including acquiring already-available 2019 traffic count data both for the O-D Study and the TDM preparation.

For the O-D Study, RSG will:

- Obtain existing traffic count data for 2019.
- Acquire passively collected, location-based-services (LBS) data for the Anchorage region.
- Use the counts and LBS data to complete the O-D Study for 2019, with a focus on fall (September/October) so that the traffic forecasts represent a typical fall weekday.
- Use the counts and O-D Study to inform both the general SG PEL project and its travel forecasts.
- The following chapter describes the general nature of O-D studies and passively collected LBS data.

2.0 Origin-Destination Study Overview

O-D studies seek to illustrate the flow of travelers in a region from the beginnings of their trips (origins) to the ends of their trips (destinations). Origins and destinations are often aggregated to small geographies called traffic analysis zones (TAZs) for easier comprehension and analysis. O-D studies produce three primary types of information: 1) the number of trips originating in each zone; 2) the number of trips destined to each zone; and 3) the "flows" or number of movements from each origin TAZ to each destination TAZ. These primary data are usually time stamped, enabling the O-D analysts to determine the number of trips and trip ends by time of day. A typical data product of O-D studies is a set of tables in matrix form. These tables provide counts of trips between each pair of TAZs.

O-D studies can also—given enough data and the right analysis technique—identify the paths or routes travelers take during their journeys by trip purpose. For example, a home-based work trip (in which the traveler leaves home to go to work) from the Chugiak-Eagle River area to downtown Anchorage might go through the project area shown in Figure 1. Historically, projects like SG PEL might conduct their own O-D survey. A survey would ask only a small sample of travelers about their trips. The proliferation of mobile devices provides a different way to gain O-D knowledge. Travelers and their vehicles now shed large amounts of "passive" location-based data via their GPS-enabled devices. RSG will use passive LBS data from such devices to deliver much of the information in the O-D Study for the SG PEL project.

The OD Study will produce data about vehicle travel (passenger and freight). While RSG and many others continue to conduct research to enable determination of all modes, the current state of available LBS data and the best current processing methodology in the field do not support accurate determination of walking, bicycling, and transit modes. The travel forecasting for SG PEL will examine transit using ridership data from the local transit provider.

2.1 Passively Collected Data Advantages

Compared to travel surveys, passively collected LBS data offers three key advantages when it comes to sample size, sample period, and sample cost. For example, in the United States, currently it may be possible to observe travel for up to 50% of the population of a given area over one month. Since travelers create LBS data every day, it is cost effective to obtain LBS data for that month. Conversely, surveys may only sample 1% of the population over a two-day or one-week period. Furthermore, LBS data is usually available in any desired time period within the past few years whereas survey data is often collected during just one week of time.

2.2 Passively Collected Data Limitations and Risks

LBS data is not perfect. The three primary limitations of such data are bias in the LBS data sample, concerns about privacy, and limited knowledge about the travelers. "Bias" refers to the fact that the available LBS data does not provide a controlled random sample perfectly representative of a given region's travelers. Chapter 3.0 describes how RSG will compensate for bias. "Privacy" refers to the legal and ethical responsibility not to compromise travelers' rights to and preferences for confidentiality. RSG is committed to ensuring the privacy of all those whose data may inform the SG PEL and will not provide any O-D Study data that can be used to directly identify individuals or firms. Ensuring privacy relates to the third limitation: that the LBS data RSG uses has no explicit knowledge about individual travelers, the nature of goods in transit (in the case of freight movements), or the exact type of vehicles in motion or at rest. To compensate, RSG infers information about, say, the purpose of a trip (e.g., home-to-work) using software and analytic methods developed from its prior and current studies in many parts of the United States.[1]

The rural nature of the broader Anchorage study area, and the cellular and GPS limitations that may exist in rural places, means there may be sparse LBS data in some parts of the region. While the SG PEL project lies within downtown Anchorage, trips passing through that area may originate in, terminate in, or pass through other places with LBS data gaps. It is also possible that detailed traffic count data (essential to accurate expansion of the LBS sample) is not available in some locations. If needed, RSG may supplement sparse traffic count data by using general information (e.g., estimated annual average daily traffic) and may mitigate sparse LBS data by adjusting expansion methods.

3.0 Origin-Destination Study Methods

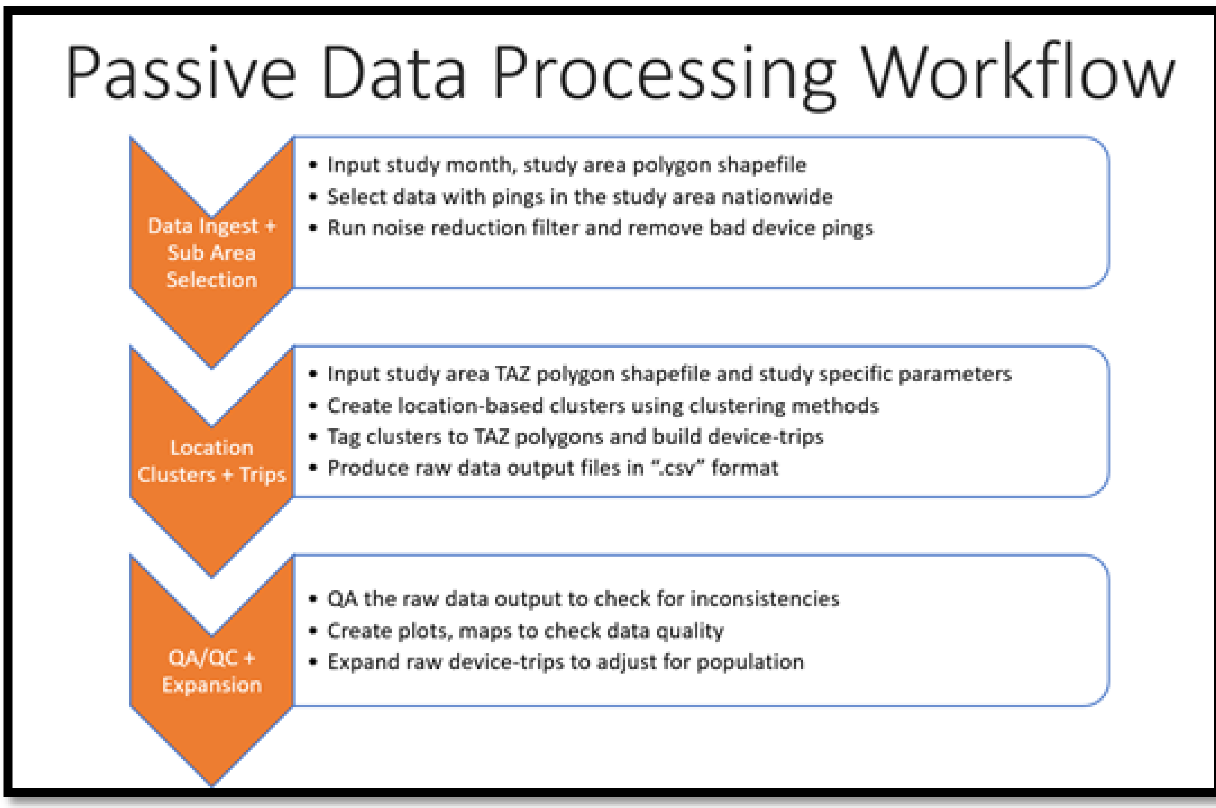
RSG will obtain raw passive location records from Veraset—a leading provider of LBS data in the United States—and process the data using software (rMerge) developed by RSG. RSG will acquire Veraset data from the September 2019 period and process it as described below. The O-D study will produce processed O-D data, an interpretation of the O-D Study findings in narrative form, an explanation of the process, and discussion of the limitations of the findings. A

[1] Descriptions of how RSG will make such inferences also appear in Chapter3.0.

key deliverable will be the O-D matrices themselves. This material (except for the data files) will be packaged in a final report.

After acquiring the raw data from Veraset, RSG will apply its rMerge software. In brief terms, this means RSG analysts will create study-area-specific O-D trip lists by extracting raw sightings from a national dataset, filtering out low-quality data, and processing the remaining high-quality data to identify relevant trips. In addition to trip origins and destinations, and if sufficient data is available for the study area, RSG can infer trip purpose—whether a trip end is a “home,” “work,” or “other” location. Figure 2 presents the general workflow for the O-D Study. Section 3.2 describes the process in more detail to provide transparency to the full project team and stakeholders.

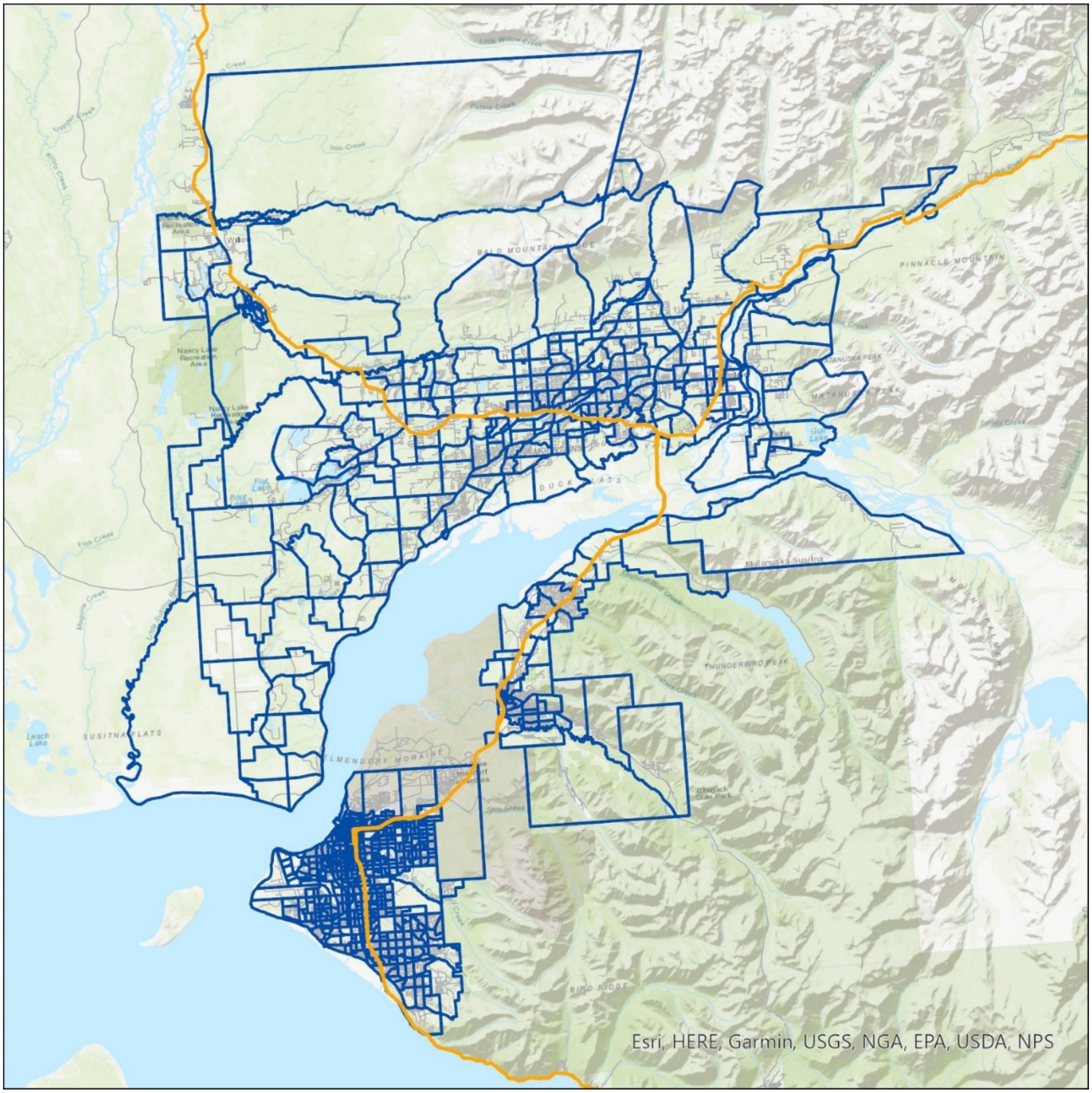
Figure 2: O-D Study Trip Table Workflow



3.1 Origin-Destination Study Geography

The geographic area of the O-D Study will be the geography modeled by the TAZ system of the Anchorage Metropolitan Area Transportation Solutions (AMATS) regional travel model, as shown in Figure 3. The consultant team realizes that the TAZ system excludes areas like Girdwood and the Alyeska resort that contribute travel flows to the project area. However, given the nature of the LBS data to be used for the study, RSG will capture all data for all trips that begin in, end in, or pass through the modeled geography. This is important for understanding long-distance trips and ensuring that they are properly represented in the traffic forecasts and other project information. The OD Study and its passive data will thus capture and report on travel to and from areas like Girdwood; it will simply be reported as travel with one end external to the modeled geography.

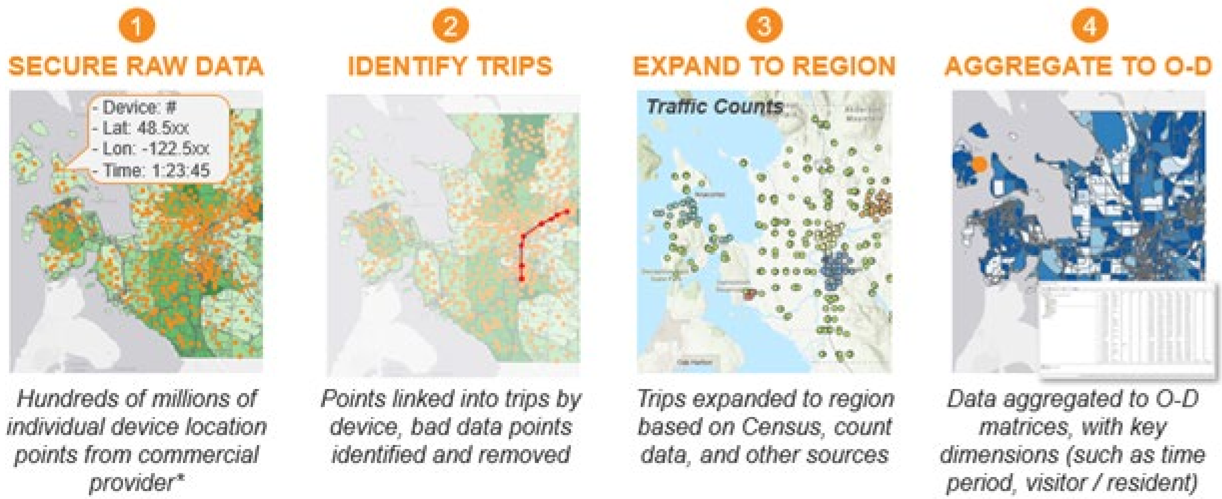
Figure 3: O-D Study Geography Showing TAZ Boundaries (BLUE)



3.2 Detailed Passively Collected Data Workflow

RSG performs several steps when using passively collected LBS data to understand O-D patterns. The following narrative and Figure 4 describe the process.

Figure 4: Detailed LBS Data Workflow



** Device location counts for the entire United States. Veraset will be the provider for the SG PEL study.*

3.2.1 Step 1: Secure and Filter Raw Data

National LBS datasets include device sightings for well over a hundred million devices. However, not all devices are relevant to a given study area and many of these devices are observed only sporadically. Inferring trip patterns from sporadic data can lead to false inferences and generally poor-quality O-D matrices. To ensure robust results, RSG only uses the subset of the total LBS data that provides the highest-quality data stream. This reduces the chance of false trip inferences and provides high-quality results.

RSG first filters out low-quality devices based on extensive experience detecting noise in the data. This process includes using filters to remove low-quality data such as unreasonable speeds, long average gaps between GPS sightings, improbable geographic variation in sightings, and anomalous frequency and time range between sightings. The product of filtering is the high-quality subset of the raw LBS data useful to the study area.

3.2.2 Step 2: Identify Trips

RSG analysts will identify trips from the raw coordinate-timestamped data using a two-step process. First, individual sightings will be classified as stopped or in motion based on the speed computed over a rolling time window. Second, a clustering algorithm will assess all stopped sightings to identify stop locations (the algorithm filters out stops at traffic signals and stop-and-go situations from congestion). Finally, the process infers device home and workplace locations from clusters of trustworthy stop locations using indicators such as a device remaining in one place for an entire night (overnighting).

A time-ordered diary of dwells (times when a device is stationary at a cluster) is then assembled, and trips are constructed by connecting all dwells in the diary. Clusters are then tagged to study area custom geographies (TAZs) so trip ends can be assigned to zones. Finally, long-distance trips are identified and intermediate stops (e.g., a quick stop at a service station on a longer trip) are identified and flagged to allow summaries of long-distance trips.

The result of the trip identification step is a database of distinct trips in the form of geolocated origins, destinations, and location traces (routes). These are the observed trips, which are a sample (a subset of) all trips made in the region in the relevant time frame.

3.2.3 Step 3: Expand to Region

Since the filtered LBS trip lists are only a sample, RSG's process next expands the sample to represent all travel in the region. As previously mentioned, LBS data is not a controlled random sample. RSG uses the process described in the next section to correct for the resulting biases and ensure that the final expanded trip list reasonably represents all travel in the study area.

Correcting for Different Types of Bias

Three main known types of bias exist in LBS data. Each of these has its own challenges that require specific methods to address.

Demographic Bias. Given smartphone ownership and device usage trends, LBS data tends to underrepresent seniors and low-income populations and overrepresent young adults and affluent populations. These biases are decreasing and there are now more seniors and low-income travelers in the data. Members of such groups present in the data will be weighted more heavily to achieve representation in the final products consistent with their observed share of the study area population.

Duration Bias. Short-distance trips or short-duration activities are often under-represented due to technological issues, user settings preferences and cellular coverage limitations. Shorter trips more easily "slip through the cracks" in LBS data. RSG has found that the degree to which short-distance trips are under-sampled with LBS data varies by region and over time, and that network-based expansion methods generally correct for this bias without additional expansion steps. RSG will compare the trip distance distribution after network-based expansion to the expected trip distance distribution from independent sources (e.g. ACS data) and, if significant differences remain, apply parametric scaling factor to further scale up short-distance trips that are in the passive data.

Geographic Bias. Travel in locations with poor cellular coverage can go un- or under-detected. Such instances might appear as "holes" in a trip "trace," where a vehicle seems to disappear in one location only to reappear in a different location some distance away. Such data as is available in locations with spotty data can be expanded at proportionally higher weights to ensure reasonable overall geographic coverage; in other cases, knowledge of the transport network may be used to infer trip paths through cell coverage gaps.

There may also be yet unrecognized forms of bias in passively collected data. For this reason, RSG designed its expansion processes to have some flexibility that can detect and correct for additional issues.

Control Data Used for Expansion

RSG will expand the observed trip data using several control datasets using two types of control data obtained from sources other than the purchased LBS data:

1. **Demographic and employment data** from federal, state, and local sources.[2]
2. **Traffic counts**, primarily roadway vehicle counts and observed transit ridership.[3]

Expansion in general is a two-step process mirroring these two data inputs: first RSG expands the sample trip list to represent the entire traveling population ("demographic expansion"), then RSG expands the full population trip list to actual trips on the transportation network using the traffic counts ("network expansion"). It is important to note that the demographic and traffic count data provide control totals for the passive data expansion; they are inputs to rather than outputs of the passive data processing.

Multiple Techniques Inform Expansion

RSG typically customizes its expansion methods to the task at hand, and its standard practice is to use multiple expansion methods when dealing with passively collected data. This is called "ensemble" expansion, with ensemble referring to the multiple techniques applied. Multiple methods may be necessary because there is no single method that can address all three of the systematic biases described above. Within this flexible framework, RSG adds methods or drops them from the ensemble expansion process if others suffice.

RSG corrects for demographic biases using census and state demographic data as the control. Traffic count data addresses geographic biases and duration biases when local smartphone coverage creates data gaps. The independent data (census, traffic counts) provides a means of quantifying error in each expansion method by comparing trial expanded data to observed real world conditions. RSG applies all possible methods and retains only those that reduce the quantified error.

Data expansion takes the observed trip list sample as an input and scales it to represent all study area travel in two stages: demographic expansion and network traffic count expansion. The former uses the home location of the device and the independently observed demographic distribution of travelers in that location to ensure that the expanded data represents the entire traveling population. Input data for demographic expansion include Census products such as the ACS five-year data ending in 2019; Alaska Department of Labor (ADOL) population, household, and employment estimates by borough; and Bureau of Economic Analysis (BEA) employment estimates.

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[2] The companion *Travel Demand Model Memo* describes the socio-economic data acquisition process.
[3] The companion *Travel Demand Model Memo* describes the count data acquisition process.

After demographic expansion, RSG chooses the network expansion method (such as iterative proportional fitting or O-D matrix estimation) most likely to be effective based on the quality and coverage of available traffic counts. Network expansion ensures that the trip effects on the network of the demographically expanded data match independent observations (the traffic counts) of how the network was performing at the time.

RSG will use counts as control data in its network-based expansion process, the goal of which is to adjust the observed OD matrix to account for sampling bias across space. While the method seeks to minimize the error of LBS-derived link volumes compared to observed counts, as pointed out above the traffic counts are inputs to this process not outcomes. Further, RSG typically only uses count data above a specific threshold (typically 2,000 AADT for regional models) due to the uncertainty of LBS-derived traffic flows on smaller facilities and uncertainty associated with low-volume counts. It should be noted that the passive data does not distinguish vehicle types. RSG will use traffic classification counts, where available, to provide vehicle type breakdowns of traffic flows for model calibration.

The expansion step produces an O-D trip list that represents all vehicles travelling within the study area in the selected time frame, in this case a typical fall weekday.

3.2.4 Step 4: Aggregate to O-D

The final step in preparing the O-D data for use is to aggregate the trips into tables (matrices) compatible with the TAZ structure of the TDM for the desired times of day. This step is relatively simple given the geographic precision of the LBS data and the existing definition of the model's TAZs in geospatial data files (e.g., shapefiles).

3.3 RSG Needs from the Rest of the Project Team

As described in the accompanying *Travel Demand Model Memo*, the primary need for support to RSG in completing the O-D Study is for local and state agencies to supply traffic count information. RSG will also need to coordinate with the rest of the project team on understanding and communicating the nature and application of any findings of the O-D Study, including any seasonal variations revealed by the traffic count data. Indeed, RSG and ADOT&PF staff agreed at a meeting on August 21, 2021, to work cooperatively to ensure that RSG processes the traffic count data consistently with ADOT&PF protocols and quality standards and to review the draft OD Study products carefully before release.

3.4 Exploration of Additional Data and Past Work

RSG will explore previous passively collected data work conducted as part of the 2013 AMATS TDM update. RSG will determine if there is existing data available from past collection efforts. If licensing terms permit, some past data may provide additional O-D information for SG PEL, such as truck movement details.

3.5 Understanding Seasonal Variations

As mentioned above, and in the accompanying *Travel Demand Model Memo,* a key purpose of the O-D Study is to help calibrate the project's travel model to a 2019 base year. To support this update, a primary output of the O-D Study will be trip matrices representing the fall 2019 season.

The SG PEL project team also wants to understand whether there are seasonal variations in travel flows to, from, and through the project area. Such variations may affect desired system configuration and the characteristics of the build alternatives to be studied.

The LBS data will be acquired for one month during fall 2019, so RSG will analyze traffic count data and available seasonal variation factors (e.g., those derived from the Alaska Department of Transportation & Public Facilities and MOA count data) to illustrate the seasonality of traffic in the project area.

4.0 Origin-Destination Study Products

With the data likely to be available to the project, RSG expects to produce the following expanded and unexpanded trip matrices by TAZ and by home-based work (HBW), home-based other (HBO), non-home-based work (NHBW), and non-home-based other (NHBO) trip purposes. RSG will use these results to inform travel model calibration (note that the O-D Study midday and off-peak periods taken together match the model's off-peak period). The O-D Study will produce these trip matrices:

- Daily: all vehicles.
- Morning (AM) period (7:00 a.m. to 9:00 a.m.): all vehicles.
- Midday (MD) period (9:00 a.m. to 3:00 p.m.): all vehicles.
- Afternoon (PM) period (3:00 p.m. to 6:00 p.m.): all vehicles.
- Off-peak (OP) period (6:00 p.m. to 7:00 a.m.): all vehicles.

Table 1 shows an example of the O-D matrix format.

Table 1: Example Origin-Destination Matrix

Vehicles During Time of Day	DESTINATION TAZ						
ORIGIN TAZ	1	2	3	.	.	.	N
1	45	28	99	.	.	.	75
2	24	30	67	.	.	.	62
3	61	54	26	.	.	.	77
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
N	121	99	17	.	.	.	88

4.1 Implications of the O-D Study

RSG will supply tabular and visual products describing the O-D Study findings and any seasonal variations that the traffic count detect. RSG will also provide a narrative interpretation of the findings. These will be packaged in the forthcoming final report. Depending on the nature of the O-D Study findings, the report contents will include maps such as desire line renditions showing the key travel flows affecting the project area; tables and statistics describing the flows' origins, destinations, patterns, and volumes; and tables and statistics illustrating any significant seasonal variations derived from the traffic count data. An example visual might be a map color-coding TAZs by the number of trip origins for those trips passing through the project area.

4.1.1 Travel Model Calibration

RSG will calibrate the model to the base year (2019) using the newly acquired count data, the new O-D Study findings, and other sources of information, as needed.

4.1.2 Support for the Project Planning Process

Understanding the travel flow patterns of travelers and vehicles using the transport facilities in the project area is important to project success. For example, a large volume of trips passing through the project area may suggest design solutions different from a situation where most of the trips originate in or are destined for the project area. Via the products described above, RSG's work on the O-D Study will help the project stakeholders understand the scale and nature of travel flows in the region as a whole and the project area specifically.

4.2 Summary of Origin-Destination Study Deliverables and Coordination

RSG will deliver:

- Unexpanded O-D travel data for all vehicles for AM, MD, PM, and OP periods for fall 2019 by TAZ.
- Expanded O-D travel matrices for total vehicles for AM, MD, PM, and OP periods for fall 2019 by TAZ, by trip purpose as the data permits.
- Final traffic count data table to be used for model calibration work.
- Final report with sufficient tables, visuals, and descriptive narrative to make the O-D Study findings clear to the stakeholders, including analysis methods used for SG PEL expansion.

4.3 Project Team Touchpoints on Key Origin-Destination Study Topics

The project team will have several planned coordination points in the process of the OD Study:

- Written permission to RSG to commence the O-D Study tasks.
- Mid-study check-in on geographic detail and seasonal variation preliminary findings.
- Reviewing draft findings and their interpretations prior to sharing with stakeholders.
- Delivering the final report and communicating findings to stakeholders.