

# RESIDENTIAL PERMIT PARKING SURVEY ON KINGSTON AVENUE AND VICINITY

Piedmont, California  
May 2016

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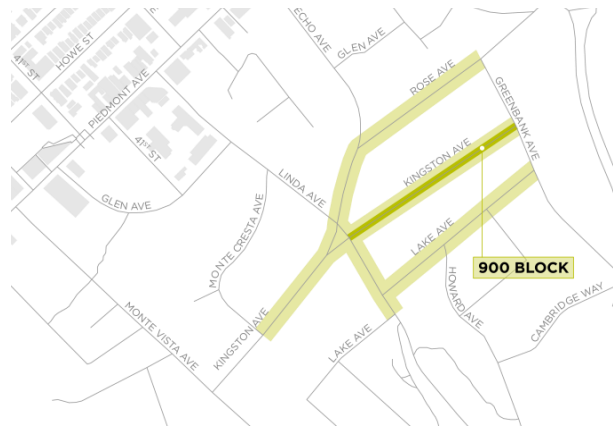
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## SUMMARY

Figure 1: Study Area Map

This study was conducted in response to a resident petition signed by 25 residents of the 900 block of Kingston Avenue in Piedmont, California and received by the City of Piedmont’s Public Works department on July 8, 2015. The petitioners requested a permit-only parking system for their block, in an effort to reduce the usage of curbspace by non-residents “both during business hours and overnight and weekends”. Although the resident petition was organized by residents of the 900 block of Kingston Avenue, the study area was enlarged to cover portions of Rose Avenue, Linda Avenue, and Lake Avenue on request of residents of these streets. This study is a data-driven assessment of parking conditions in the study area, comparing existing conditions with common thresholds used to justify residential parking permit (RPP) programs.



A short survey was sent to study area residents to determine when and where parking data should be collected. Following the collection of responses from the community, an objective and robust data collection plan was carried out. The plan consisted of twelve (12) one-hour data collection periods, selected based on the responses to the community survey.

By analyzing vehicle parking patterns over the twelve data collection periods, it was possible to (1) compute the percentage of spots that are occupied, and (2) estimate the number of vehicles that were not owned by study area residents. The data and analysis conducted for this study indicates that:

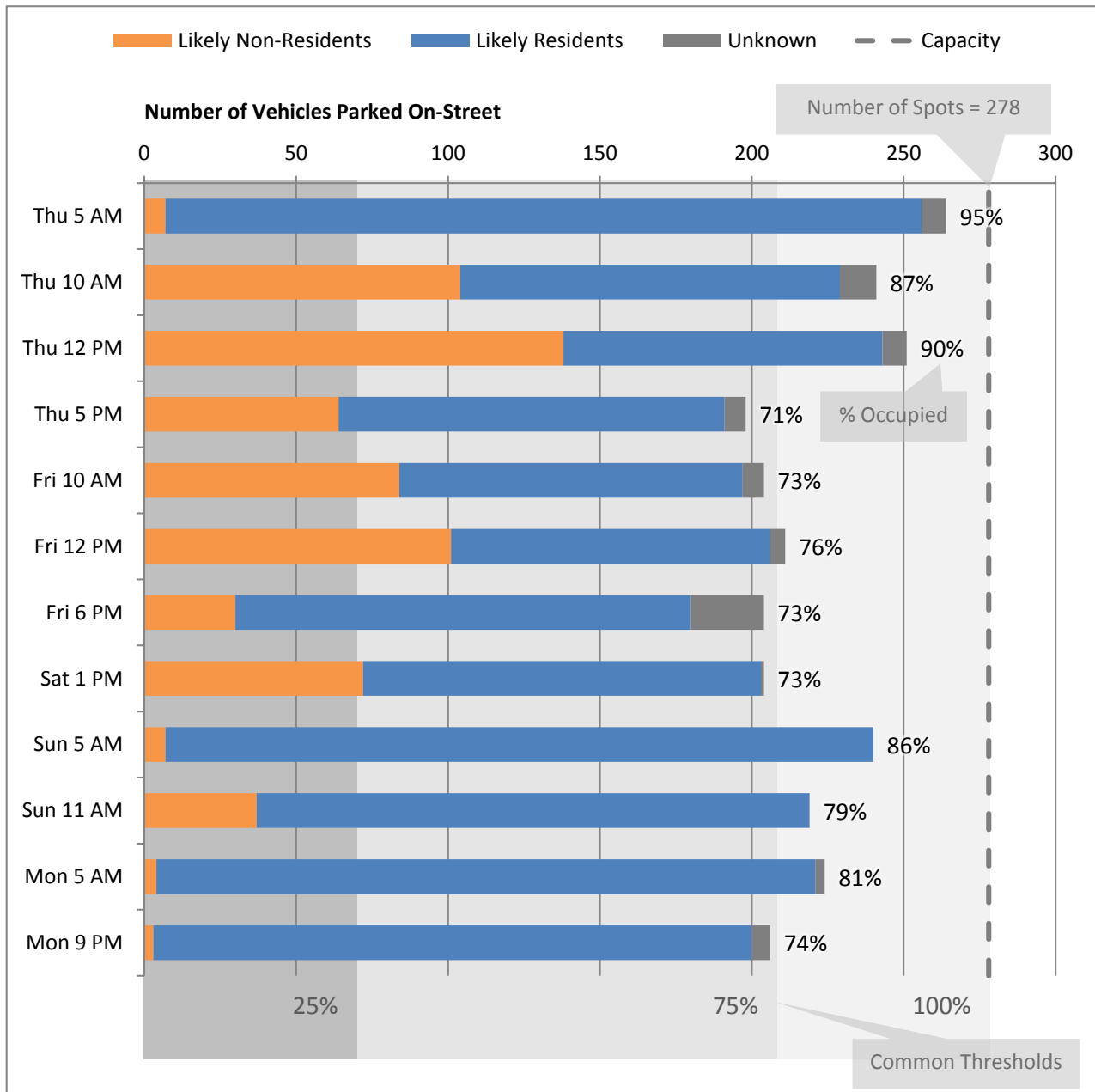
- At their fullest—during the dawn hours of Thursday, February 11<sup>th</sup> —the study streets were 95 percent occupied, although only 3 percent was due to non-residents.
- During the midday hours of this same Thursday, about 90 percent of available spaces were occupied and about 50 percent were occupied by non-residents.

These findings suggest that on-street parking in the study area is constrained during middays on weekdays, and that non-residents are a large contributor to the scarcity of parking spots. The implementation of an RPP program would improve access to on-street parking spaces by study area residents, and is justified by the data collected for this study.

Beyond the decision to implement or not implement an RPP program, a number of additional considerations must be evaluated. These include—but are not limited to—the number of permits per household, enforcement days and hours, exceptions for short-term parking, and non-resident permits. It is recommended that the City of Piedmont take the findings and recommendations in this study and work with residents of the study area to find the right mix of rules for their RPP program.

Figure 2 below illustrates the findings for all data collection periods, and compares them to parking occupancy thresholds commonly used in the evaluation of RPP programs. The 25 percent threshold is associated with non-resident parked vehicles, the 75 percent threshold reflects the transition point at which parking becomes hard to find, and the 100 percent threshold indicates the total on-street parking supply of the study area.

**Figure 2: Parking Occupancy by Data Collection Period**



Notes: Unknown vehicles are those for which residency could not be confidently estimated.



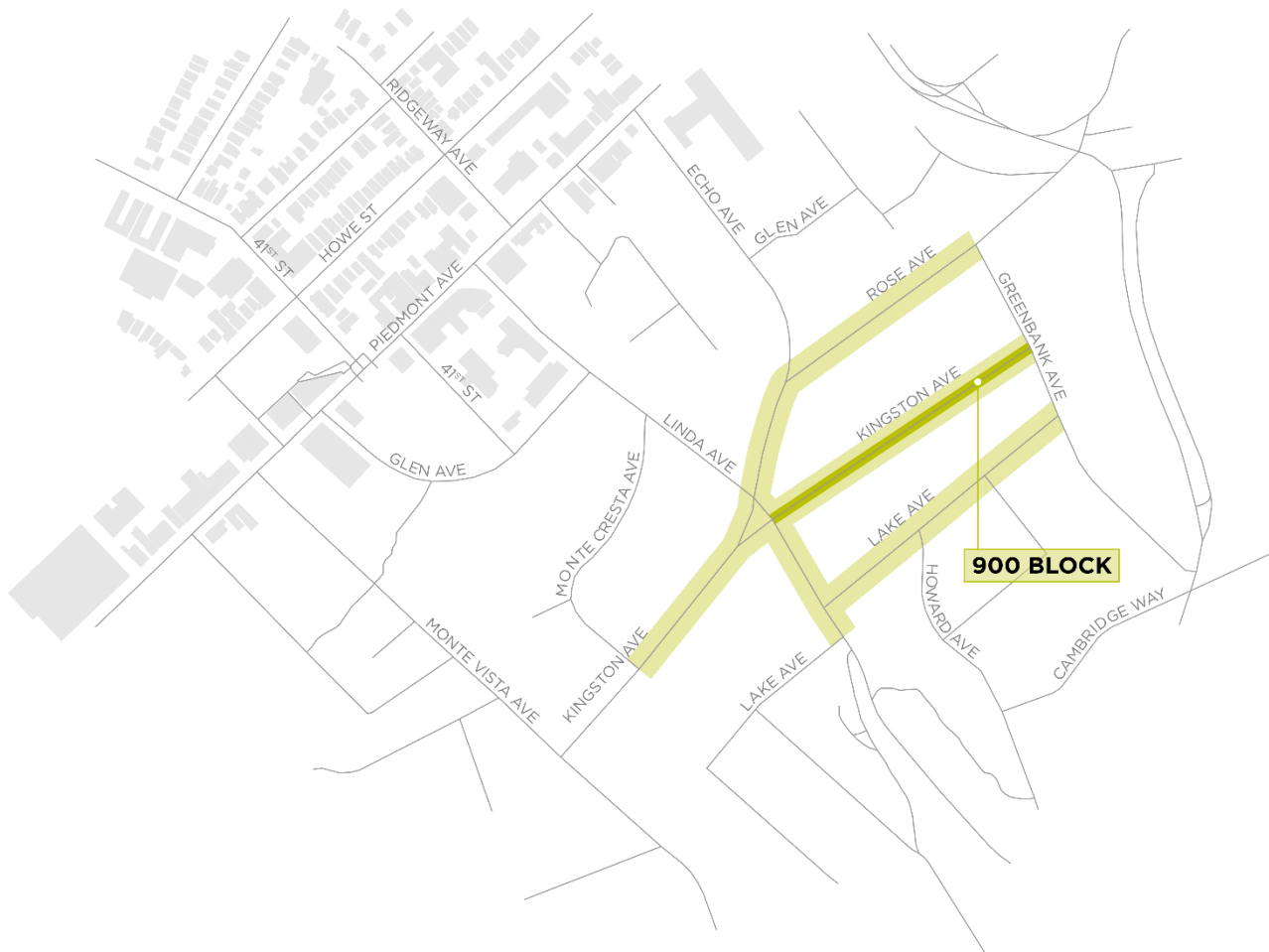
## COMMUNITY INPUT

This section summarizes the community outreach effort conducted as part of this project. It includes basic statistics from a five-minute anonymous survey as well as the dates and times of the data collection effort.

### STUDY AREA

Although the resident petition was organized by residents of the 900 block of Kingston Avenue, the study area was enlarged to cover portions of Rose Avenue, Linda Avenue, and Lake Avenue on request of residents of these streets. Figure 1, reproduced below, shows the boundaries of the study area.

**Figure 1: Study Area Map**





## SURVEY AND GENERAL RESPONSES

A short survey was sent to study area residents to determine when and where parking data should be collected. Eighty-seven households answered the survey, which was provided through their representative, Peter deVroede. The survey was intended to answer a few basic questions that guided the data collection plan. The questions and a summary of the residents' responses are provided below.

- Which days and times are **most** likely to have non-resident parked vehicles?
  - Residents responded that non-resident parked vehicles were common during weekdays between 7 AM and 7 PM, as well as on weekends between 10 AM and 2 PM. Not as many residents pointed to Beach Elementary let-out hours as times during which non-residents parked their vehicles in the study area.
- Which days and times are **least** likely to have non-resident parked vehicles?
  - Early morning and late night times were considered by residents to be least likely to have non-resident parked vehicles.
- Where do the concerned residents typically park on-street?
  - A large majority of residents park within two blocks of where they live.
- Are the residents aware of any upcoming special events in the neighborhood which may impact parking supply?
  - No special events were identified for the second week of February 2016 for Beach Elementary School.

To complement this technical report, a select number of survey comments are included as text boxes near relevant sections<sup>1</sup>. The comments are presented as received—without editorial or grammatical edits—to convey the residents' perspective on the potential implementation of an RPP program.

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*This problem has been very bad for past 18 months or more. It is getting much worse, and it is now very rare we can park in front or close to our own home. Very difficult with small kids, groceries, etc.*

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*I don't think it really makes sense to restrict parking to residents only. While there is a fair bit of parking congestion on the Oakland side of the neighborhood (i.e., on Monte Vista), I've never had to/never had a visitor whose had to park further away than Kingston across Linda.*

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<sup>1</sup> The full set of survey responses can be accessed through [this](#) link (also printed below)

[https://docs.google.com/spreadsheets/d/1fULTVmAlkO8ijPKs-a8Ok5VfefrF\\_pVrN9gENJepNEo/edit](https://docs.google.com/spreadsheets/d/1fULTVmAlkO8ijPKs-a8Ok5VfefrF_pVrN9gENJepNEo/edit)



## DATA COLLECTION PERIOD

Collecting parking data during times when residents' vehicles are most likely to occupy a majority of the curbspace, as well as during times when non-residents' vehicles are most likely to be present, provides a good understanding of parking demand during a typical week.

Figure 3 illustrates the days and times that are most likely to have non-resident parked vehicles, according to the residents' responses. Seven of the answers included in the "Other/Blank" categories are residents that did not answer the question. The rest of the answers included in the "Other/Blank" category were mostly about evenings.

**Figure 3: Days and times that are most likely to have non-resident parked vehicles**

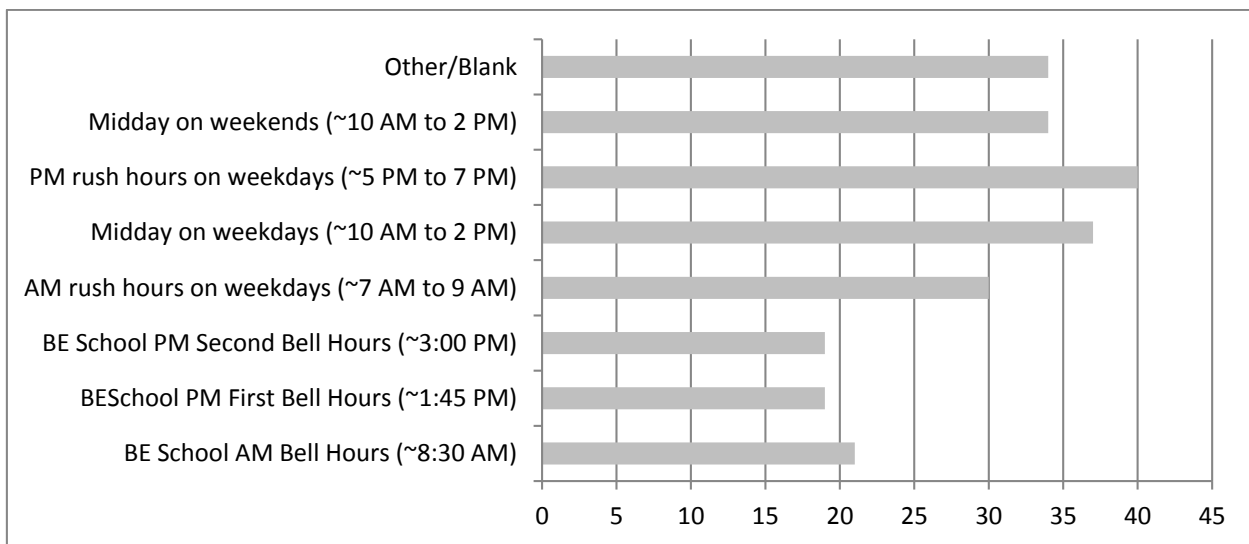
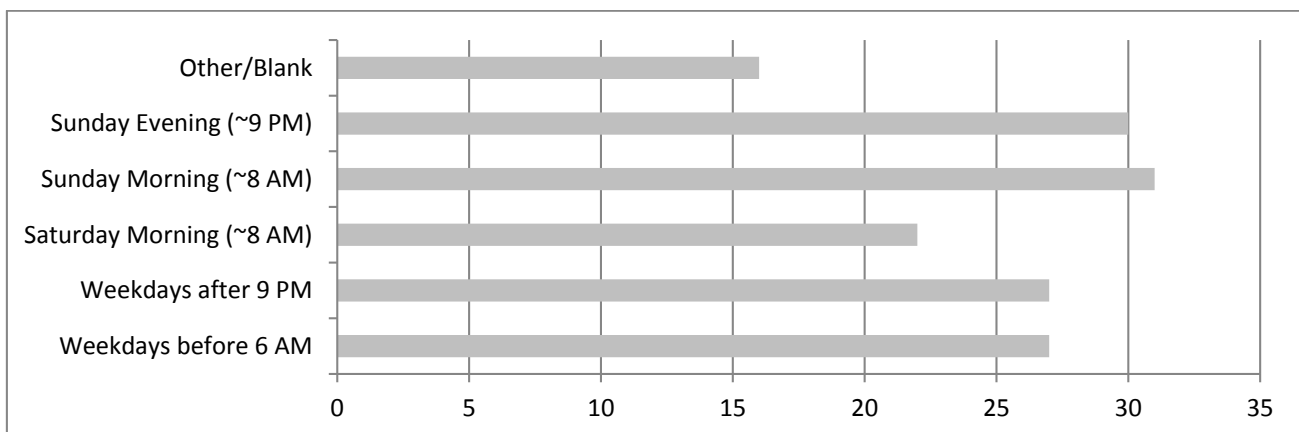


Figure 4 illustrates the days and times that are least likely to have non-resident parked vehicles according to residents.

**Figure 4: Days and times that are least likely to have non-resident parked vehicles**



Based on the input from the residents, the hours illustrated in Figure 5 below were determined to be representative of the parking demand throughout the week.

**Figure 5: Dates and Times for Parking Data Collection**

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
Feb 7	8	9	10	11	12	13
5:00am Heavy Resident Hour				5:00am Heavy Resident ... 10:00am Neutral Hour 12:00pm Heavy Non-Res... 5:00pm Heavy Non-Resi...	10:00am Neutral Hour 12:00pm Heavy Non-Resident Hour 6:00pm Heavy Non-Resi...	1:00pm Heavy Non-Resident Hour
14	15	16	17	18	19	20
11:00am Heavy Non-Resident Hour	5:00am Heavy Resident Hour 9:00pm Heavy Resident Hour					

Download this calendar in Outlook format [here](#).

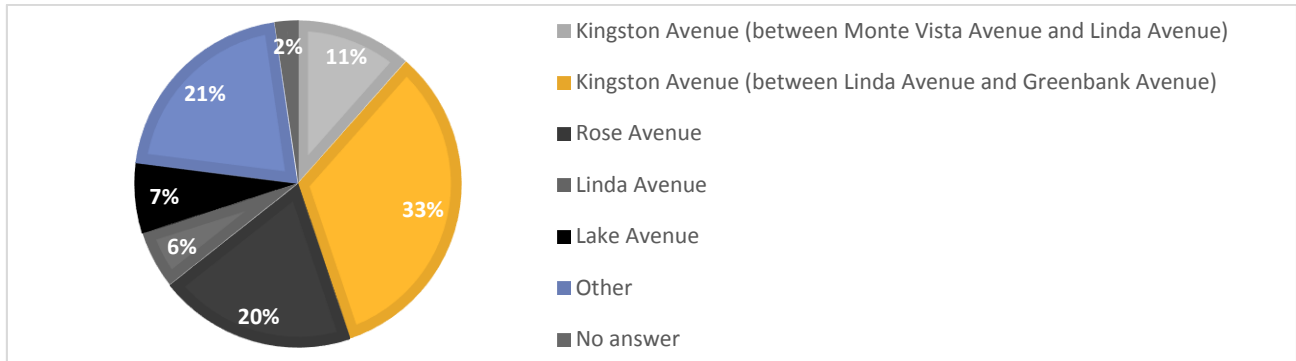




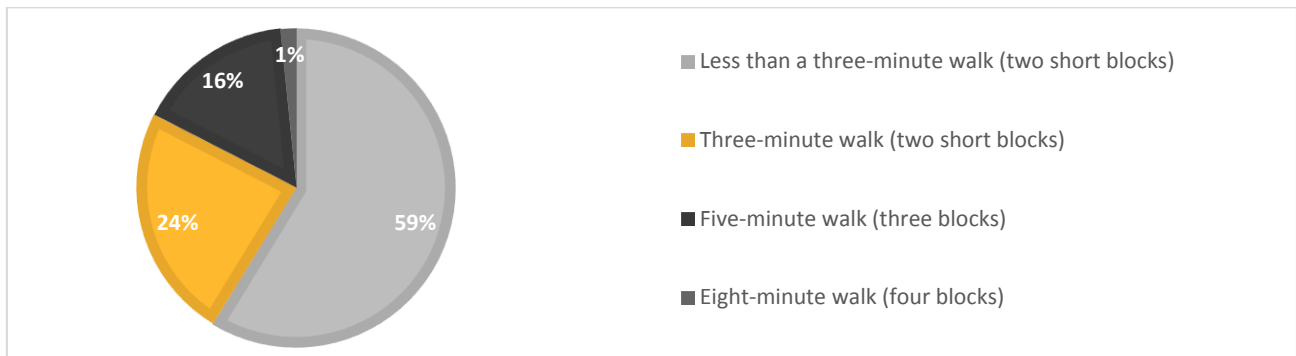
## DATA COLLECTION AREA

The survey sent to residents also included a question about where they live. The answers to this question informed the extent of the data collection area, which covered the study area and their immediate vicinity. Figure 6 illustrates the breakdown of the answers. Figure 7 shows a breakdown of respondent's answers to a question on the farthest they have had to park in the last month.

**Figure 6: Answers to "Where do you live?"**



**Figure 7: Answers to "In the last month, what is the farthest you've had to park from your house?"**



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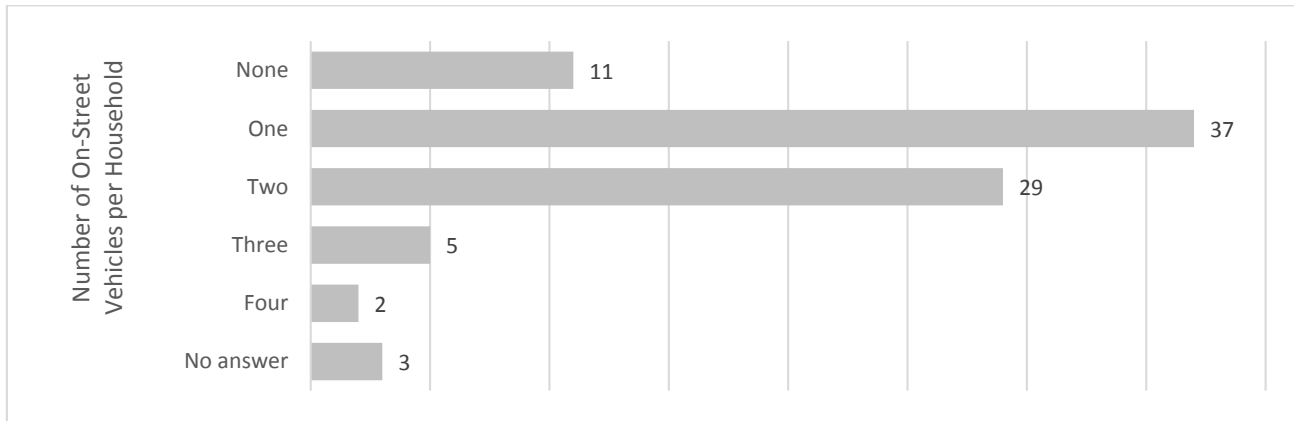
*in your question 3 [Figure 7], you need to recalibrate your distances to reflect number of' houses away not number of blocks away. no way are people parking off of the street they live on, unless they are very near a corner. people are freaking out if they don't get to park directly in front of their house. for reference, the farthest i've had to park away from my house EVER is 5-6 houses away down the block.*

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## VEHICLE OWNERSHIP AND PARKING BEHAVIOR

The team asked residents how many vehicles they typically park on street to estimate parking demand and to inform potential RPP policies. The median household uses one on-street parking spot, while the average household uses 1.23 spots.

**Figure 8: Answers to "How many vehicles does your household typically park on the street?"**



## OTHER CONCERNS

Residents' expressed additional concerns through the survey, which can be grouped as follows:

- The elimination of many of the parking spaces on Linda Avenue after the Beach Elementary School renovation worsens the parking problem;
- There is no delineation between parking spots, so people often take too much space;
- Parked vehicles on both sides of the road on Kingston Avenue from Monte Vista Avenue to Linda Avenue leave barely enough space to drive through the street;
- Non-residential parking comes from people working on/going to Piedmont Avenue;
- According to a few residents, other residents of the study area "have more cars than household members" and their vehicles are "parked for months" on-street.

## DATA ANALYSIS

Following the collection of responses from the community, an objective and robust data collection plan was carried out. The plan consisted of twelve (12) one-hour data collection periods, selected based on the responses to the community survey. These periods are shown in Figure 5. The data collection days and times covered periods when non-residents were highly likely, equally likely, and not very likely to be parked on the study streets.

Quality Counts, LLC—a subconsultant to Kittelson & Associates, Inc.—performed most of the field data collection. On the first data collection period, Quality Counts staff inventoried the supply of legal on-street parking spaces for all study streets. This information is contained in Appendix A.

For all study periods, Quality Counts staff recorded the license plate and location of all vehicles parked within the study streets and their immediate vicinity. Table 1 presents a sample of the data collection format.

**Table 1: Data Sample**

Submission Date	License Plate <sup>1</sup>	Car Location	Geolocation <sup>2</sup>
2016-02-12 21:06:04	7-----7	Study Street	37.82575, -122.24654
2016-02-12 21:05:53	6-----3	Study Street	37.82684, -122.24678
2016-02-12 21:05:52	7-----3	Study Street	37.82500, -122.22989

<sup>1</sup> License plates truncated for privacy

<sup>2</sup> Geolocation was obtained from the data collection device's GPS unit

By analyzing vehicle parking patterns over the twelve data collection periods, it was possible to (1) compute the percentage of spots that are occupied, and (2) estimate the number of vehicles that were not owned by study area residents. A statistical technique called Bayesian updating, which merges known likelihoods with observed data, was used to inform these estimates. Appendix B expands on this topic.

## FINDINGS

The need for a RPP program is usually based on the level of parking occupancy and the proportion of the parking supply that is occupied by non-residents. The Arlington (Virginia) County Code quantifies these factors, and was used as a guiding reference. The thresholds Arlington County uses to determine whether to designate a permit parking zone include<sup>2</sup>:

- At least 75 percent of the available parking on the block should be occupied, and
- At least 25 percent of the available parking on the block should be occupied by out-of-area vehicles such as commuters, shoppers, students, etc.

The data and analysis conducted for this study indicates that:

- At their fullest—during the dawn hours of Thursday, February 11<sup>th</sup> —the study streets were 95 percent occupied, although only 3 percent was due to non-residents.
- During the midday hours of this same Thursday, about 90 percent of available spaces were occupied and about 50 percent were occupied by non-residents.

As can be seen on Figure 2 (reproduced below for ease of reference), these results are not limited to Thursday, February 11<sup>th</sup>: the study streets were at least 71 percent occupied during the data collection periods, indicating consistently high usage of the on-street parking supply.

Out of the four weekday data collection periods intended to capture high non-resident parking activity, three met both of the thresholds presented above: Thursday February 11<sup>th</sup> at 10 AM, Thursday February 11<sup>th</sup> at noon, and Friday February 12<sup>th</sup> at noon. These findings suggest that on-street parking in the study area is constrained during middays on weekdays, and that non-residents are a large contributor to the scarcity of parking spots.

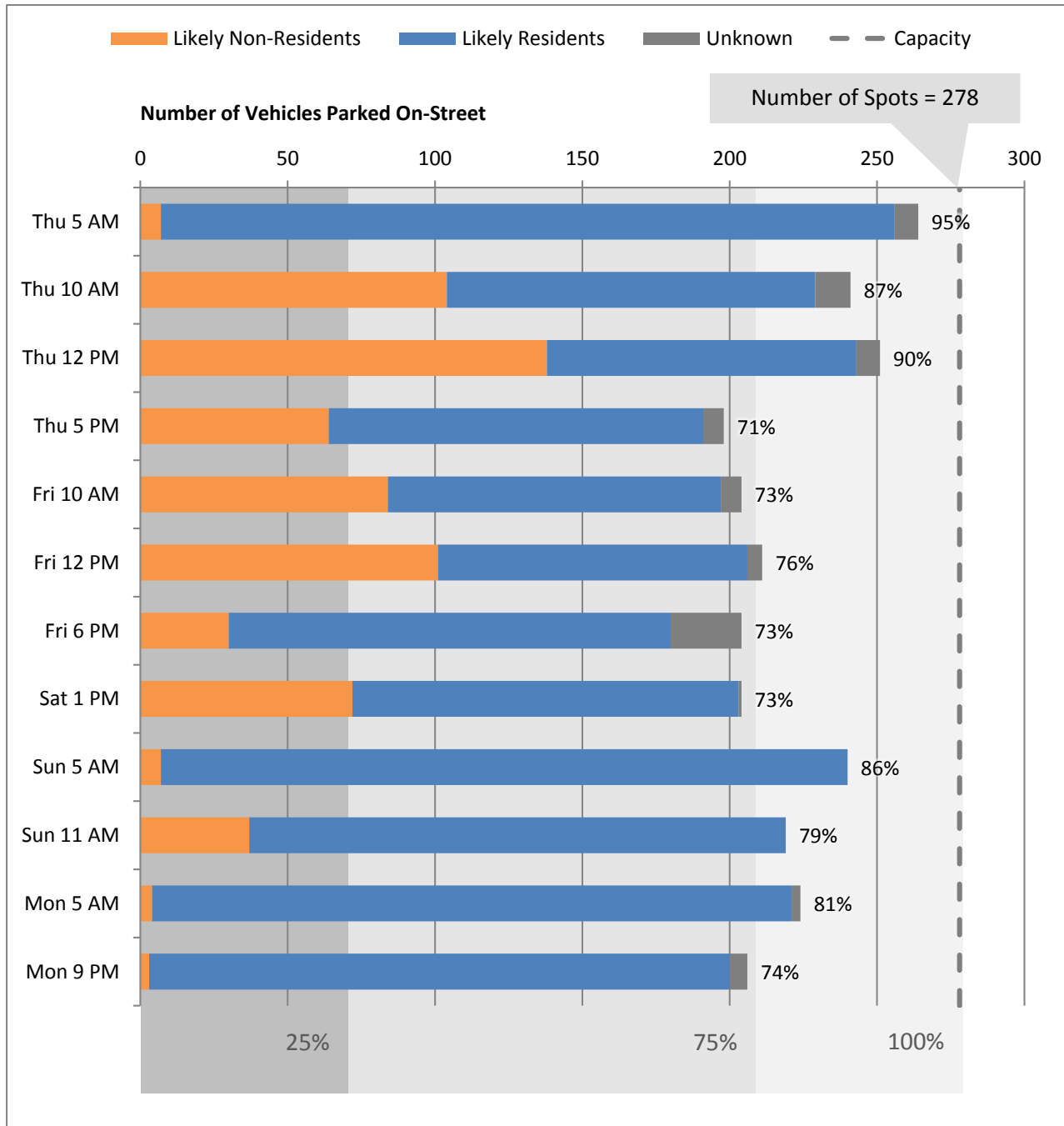
Enforcement on Saturdays or Sundays is not supported by the available data. Although Saturday, February 13<sup>th</sup> data show a large number of non-resident vehicles parked in the study area, fewer resident vehicles on this day resulted in more than a quarter of parking spots being available. Monitoring of Saturday conditions in the future could better inform the decision to extend the RPP program to Saturdays.

The data suggest that parking is harder to find on Sundays, but that it is primarily due to more residents parking on-street. As such, the thresholds to justify Sunday enforcement of the RPP program were not met.

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<sup>2</sup> Besides these data-based thresholds, Arlington County consults with residents of the RPP zone. If both thresholds are met—and 60+ percent of residents are in favor—the RPP program is implemented.

Figure 2: Parking Occupancy by Data Collection Period



Notes: Unknown vehicles are those for which residency could not be confidently estimated.

## ADDITIONAL CONSIDERATIONS

Beyond the decision to implement or not implement an RPP program, a number of additional considerations must be evaluated. These include—but are not limited to—the number of permits per household, enforcement days and hours, exceptions for short-term parking, and non-resident permits. This section provides guidance for evaluating these additional considerations incorporating information from survey respondents.

### NUMBER OF PERMITS PER HOUSEHOLD

The number of RPPs made available to each household directly affects the demand for on-street parking. If RPPs are made available upon request, the parking patterns of residents are likely to remain unchanged. Although parking demand would be lower than in existing conditions—due to a reduction in non-resident parking—it would not address the concerns expressed by some residents that a few neighbors take up more than their “fair share” of public curbspace.

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*Between 2 neighbors who have a total of 5 & 9 (nine!) autos parked on the street at any time, it's a nightmare.*

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Managing the number of RPPs allotted to each household is one lever available to the City of Piedmont to encourage residents to park more vehicles on their private property. The information obtained from the resident survey can be used by the City to evaluate this consideration. Currently, slightly more than 55 percent of survey respondents park zero or one vehicles on-street (see Figure 8). Another 33 percent of residents park two vehicles. About 8 percent of residents park three or four vehicles on the public curbspace.

Pricing is a commonly used tool to manage shared resources. For example, an airline trying to manage its luggage capacity may make the first bag free, the second bag \$50, and the third bag \$200. This encourages passengers to be conscientious about what they pack and results in better use of the shared resource. Similarly, increasing the cost of RPPs from free to a sufficiently large amount could encourage some residents to declutter a garage, sell a rarely-used car, or take similar measures to avoid paying for an expensive RPP.

### ENFORCEMENT DAYS AND HOURS

One of the primary decision points in the implementation of an RPP program is the days and times of enforcement. It is generally recommended that enforcement days and hours be consistent across a city, although certain trip generators may justify zone-specific adjustments.

The findings illustrated in Figure 2 support Monday through Friday enforcement. Enforcement on Saturdays or Sundays is not supported by the data, although Saturday does show a large percentage of





non-resident vehicles parking in the study area. Monitoring of Saturday conditions in the future could better inform the decision to extend the RPP program to Saturdays.

To be consistent with enforcement hours in Oakland and Berkeley, the hours of 8 AM to 6 PM are recommended for enforcement.

## PROVISION OF TIME-LIMITED PARKING DURING ENFORCEMENT HOURS

As would be expected, some residents of the study area retain the services of child care, pet care, white glove delivery, or landscaping companies. These service providers, as well as others of a similar nature, are also users of the study area’s curbspace and would be affected by the implementation of the RPP program. A common allowance is to provide an exception for vehicles that park for less than a specified time limit—usually two hours. A downside of this exception is that it may result in non-residents “shuffling” their vehicle every two hours to stay within the limits, undermining the effectiveness of the RPP program.

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*We have two main problems - people leaving their cars parked on our street while they work (about 9AM to 5PM) and nearby residents parking their cars overnight and over weekends (7PM to 8AM and often all weekend)*

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## GUEST PERMITS

Cities with RRP programs typically provide a way for residents to obtain short-term parking permits for visitors. The City of Piedmont could make this part of the RPP program by offering permits such as the one pictured in Figure 9. The City may still control parking demand by setting the price, validity period, and maximum number of guest permits issued to each household.

Figure 9: Sample Guest Permit



Source: Hoboken, NJ

## SPECIAL PERMITS

Some non-residents may have powerful reasons for regularly using the curbspace in the study area, including teachers, social workers, and employees of certain businesses on Piedmont Avenue. These non-residents could argue that they directly or indirectly serve residents of the study area. The City of Piedmont may consider offering special permits on a case-by-case basis.

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*want to be sure the decision doesnt impact teachers at beach elementary*

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## LANDLORD PERMITS

Property owners who live elsewhere and rent their property (i.e., landlords) may need to park their vehicles in the study area for long periods of time. The City of Piedmont may consider including a landlord category in the RPP program, which would give resident parking rights to landlords.

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*we rent out our house and so both we and our tenants need parking at various times*

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## COORDINATION

Due to the proximity of the study area with City of Oakland boundaries and the Piedmont Avenue retail area, additional coordination may be necessary before implementing an RPP program. This may include in-person meeting, flyers, email notices, etc.

## CONCLUSION

The findings of this study suggest that on-street parking in the study area is constrained and that non-residents are a large contributor to the scarcity of parking spots, particularly during midday on weekdays. The implementation of an RPP program would improve access to on-street parking spaces by study area residents, and is justified by the data collected for this study.

Beyond the decision to implement or not implement an RPP program, a number of additional considerations must be evaluated. These include—but are not limited to—the number of permits per household, enforcement days and hours, exceptions for short-term parking, and non-resident permits. It is recommended that the City of Piedmont take the findings and recommendations in this study and work with residents of the study area to find the right mix of rules for their RPP program.

# APPENDIX A: PARKING SUPPLY INVENTORY

## Piedmont Parking Study Inventory



	Street name	Total	Space Located				Date
			N	S	E	W	
1	Piedmont Ct	19	5		8	6	12/17/2015
2	Guilford Rd	39	16	12	5	6	12/17/2015
3	Kingston Ave	133	62	71			12/17/2015
4	Lake Ave	51	24	27			12/17/2015
5	Rose Ave	76	36	40			12/17/2015
6	Linda Ave	18			10	8	12/17/2015
7	Study Streets Inventory Total	336					
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## APPENDIX B: ANALYSIS METHODOLOGY

### MODEL

A quantitative model allows for efficient and repeatable analysis of the collected data. To complement the observed data with prior knowledge of the patterns of parking occupancy, a Bayesian inference model was developed. Bayesian inference is a method of statistical inference in which Bayes' theorem is used to update the probability for a hypothesis as more evidence or information becomes available.

In this situation, the initial hypothesis (i.e., prior to even the first observation) was that any vehicle has equal probability of being owned by a resident or a visitor. Once the first observation of that vehicle became available, the probability of being resident-owned was updated based on the observation. For example, if the vehicle was seen on-street at 5 AM—at which time we know mostly residents park on-street—the probability of the vehicle being resident-owned updated upward. If on the next observation, the same vehicle was observed to be parked on-street at 9 PM on a Monday—another time that the street is mostly resident-occupied—the probability was updated even higher. The model continued updating probabilities for each vehicle every time an observation became available.

**Appendix Exhibit 1: Model Schematic**

Observation 1		Observation 2	
Resident-Owned P= 50%	Parked on-street at 5 AM	Resident-Owned P>50%	Parked on-street at 9 PM
Non-Resident-Owned P= 50%	Parked on-street at 5 AM	Non-Resident - Owned P<50%	Parked on-street at 9 PM

## PARAMETERS

A Bayesian inference model is based on a combination of data and prior knowledge. In this case, the prior knowledge is the proportion of parked vehicles belonging to residents by day of week, time of day, and location. For example, a vehicle parked on-street during dawn hours of a weekday most likely belongs to an area resident. The tables below present the weekday and weekend likelihood assumptions used for this study.

### Weekday Likelihood Distribution

*Likelihood of capturing a resident-owned vehicle*

Hour	Driveway (along Study Street)	Study Street	Secondary Street	Driveway (along Secondary Street)
0	0.98	0.9	0.7	0.01
1	0.98	0.9	0.7	0.01
2	0.98	0.9	0.7	0.01
3	0.98	0.9	0.7	0.01
4	0.98	0.9	0.7	0.01
5	0.98	0.9	0.7	0.01
6	0.98	0.9	0.7	0.01
7	0.98	0.8	0.6	0.01
8	0.98	0.7	0.6	0.01
9	0.98	0.5	0.4	0.01
10	0.98	0.4	0.3	0.01
11	0.98	0.4	0.3	0.01
12	0.98	0.4	0.3	0.01
13	0.98	0.4	0.3	0.01
14	0.98	0.4	0.3	0.01
15	0.98	0.4	0.3	0.01
16	0.98	0.4	0.3	0.01
17	0.98	0.4	0.3	0.01
18	0.95	0.5	0.4	0.03
19	0.95	0.5	0.4	0.03
20	0.95	0.6	0.5	0.03
21	0.95	0.8	0.6	0.03
22	0.98	0.9	0.7	0.01
23	0.98	0.9	0.7	0.01

## Weekend Likelihood Distribution

*Likelihood of capturing a resident-owned vehicle*

<b>Hou r</b>	<b>Driveway (along Study Street)</b>	<b>Study Street</b>	<b>Secondary Street</b>	<b>Driveway (along Secondary Street)</b>
0	0.98	0.8	0.6	0.01
1	0.98	0.8	0.6	0.01
2	0.98	0.8	0.6	0.01
3	0.98	0.8	0.6	0.01
4	0.98	0.8	0.6	0.01
5	0.98	0.9	0.7	0.01
6	0.98	0.9	0.7	0.01
7	0.98	0.8	0.6	0.01
8	0.98	0.7	0.6	0.01
9	0.98	0.7	0.6	0.01
10	0.98	0.6	0.5	0.01
11	0.98	0.4	0.3	0.01
12	0.95	0.4	0.3	0.01
13	0.95	0.4	0.3	0.01
14	0.95	0.4	0.3	0.01
15	0.95	0.4	0.3	0.01
16	0.95	0.4	0.3	0.01
17	0.95	0.4	0.3	0.01
18	0.95	0.4	0.3	0.03
19	0.95	0.4	0.3	0.03
20	0.95	0.4	0.3	0.03
21	0.95	0.4	0.3	0.03
22	0.95	0.6	0.5	0.01
23	0.98	0.8	0.6	0.01



## EQUATIONS

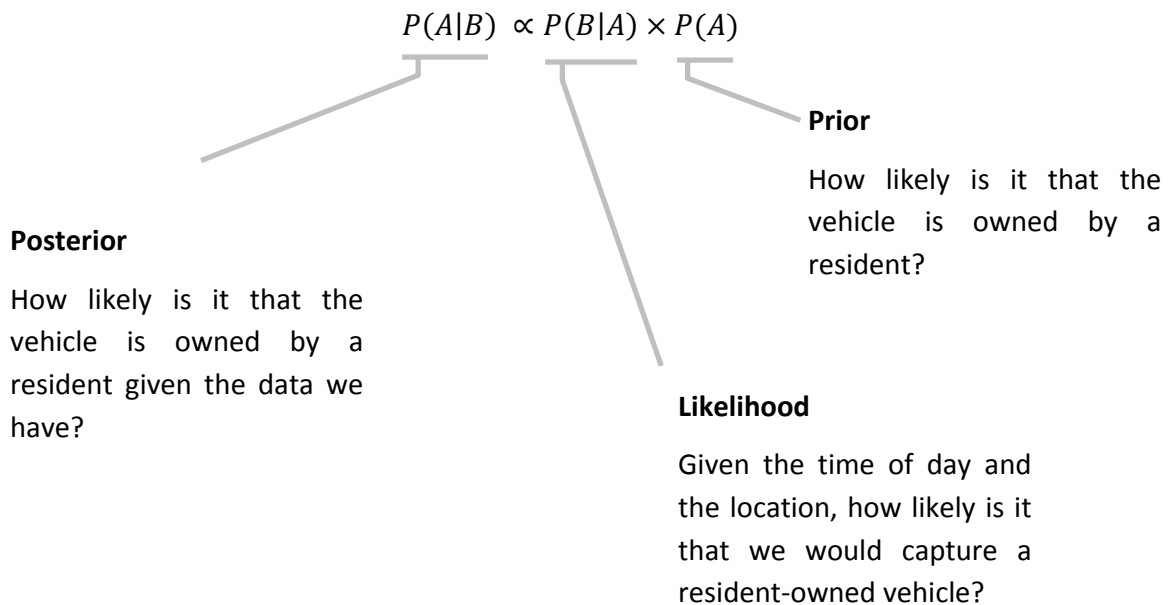
Bayesian inference is based on the Bayes theorem, which can be stated mathematically as the following equation<sup>3</sup>:

$$P(A|B) = \frac{P(B|A) \times P(A)}{P(B)}$$

where A and B are events.

- P(A) and P(B) are the probabilities of A and B without regard to each other.
- P(A | B), a conditional probability, is the probability of observing event A given that B is true.
- P(B | A) is the probability of observing event B given that A is true.

The Bayesian inference model is simply a repetition of this process based on prior knowledge and continued observation. By re-calculating the “prior” probability for each time a vehicle is recorded, the estimate of whether it is resident-owned or non-resident owned becomes progressively more reliable. The following annotated equation describes this process.



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<sup>3</sup> Stuart, A.; Ord, K. (1994), Kendall's Advanced Theory of Statistics: Volume I—Distribution Theory, Edward Arnold, §8.7.

## PRESENTATION

The results of the Bayesian inference model—the probabilities that vehicles were resident-owned—were expected to be two-peaked, with a large number of vehicles with probabilities near 1.0 (likely residents) and another large number of vehicles with low probabilities (likely non-residents).

As can be seen in the histogram below, there is an appreciable two-peak distribution of probabilities, with the likely residents on the right side and the likely non-residents on the left side. For purposes of data presentation and development of findings, vehicles that had probabilities at or below 0.4 were categorized as likely non-residents. Vehicles that had probabilities at or above 0.6 were categorized as likely residents. For vehicles that could not be recorded (e.g., no license plates or covered) and vehicles with ambiguous probabilities between 0.4 and 0.6, an “unknown” category was used.

