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Road Diet or No Diet: A Case Study of the Fifth Street Corridor

March 2010

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Final Report

Evaluation of Road Diet Plan for Fifth Street Corridor Improvement

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1. Introduction

The "Fifth Street Corridor" is defined as the section of Fifth that runs between A Street and L Street through Downtown Davis (See Fig. 1-1). This corridor serves many modes of transportation, including vehicles, delivery trucks, buses, emergency vehicles, pedestrians, and bicycles.

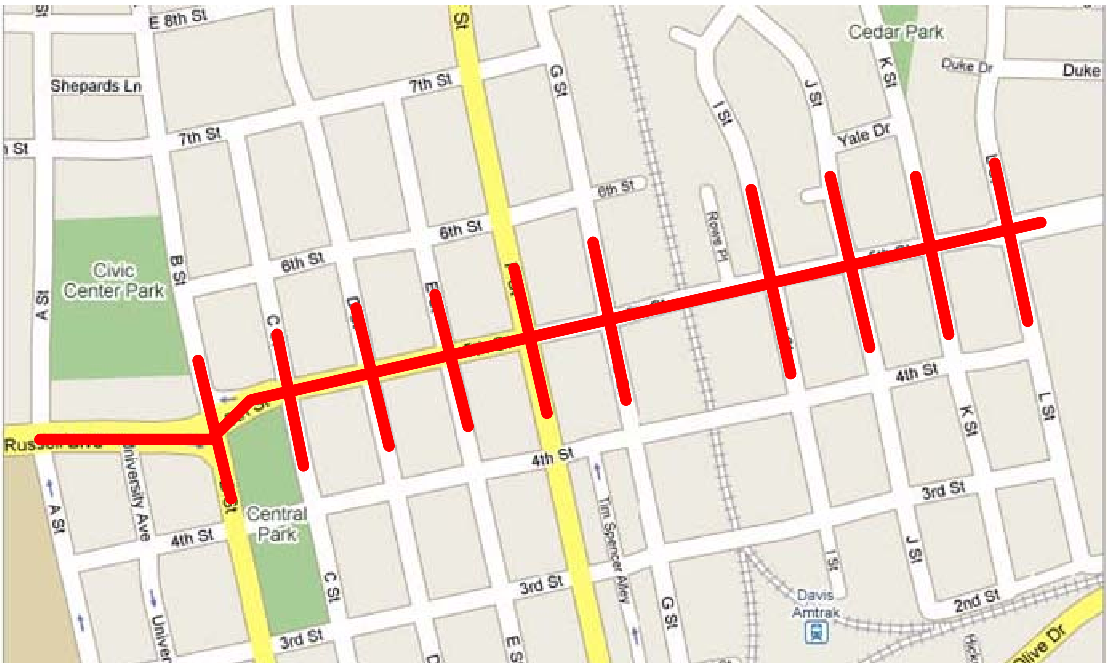


Figure 1-1 Fifth street corridor planning area

In the recent couple of years, discussions of the Fifth Street corridor raised several issues related to pedestrian safety, bicycle connectivity through the downtown core area, motor vehicle travel impacts in terms of delay and accidents, and economic impacts to the downtown business community. Different alternative strategies were carried out to partially or comprehensively deal with the multiple interests. In April 2003, staff presented to the City Council the scope for modifications to the F and G Street signals on Fifth Street (CIP #8714). During discussion of this project, the issue of pedestrian safety along the Fifth Street corridor surfaced. In July 2005, the City Council identified five issues to guide staff deliberations:

1. Bicycle route connectivity;
2. Improved pedestrian safety at street crossings;
3. Reduced motor vehicle speeds;
4. Protected left turns off of Fifth Street; and
5. The pursuit of grant funds for potential improvements.

Based on the above criteria the Old North Davis Neighborhood suggested a lane reduction approach would be an appropriate strategy to address pedestrian safety, which is so called "Road diet" plan. There was discussion of whether reducing the number of travel lanes from four to two, and incorporating bicycle lanes might be appropriate for this stretch of Fifth Street. Staff evaluated the lane reduction option and various other concepts to address issues. Ultimately, staff informed the Council that any option that would potentially achieve all of the objectives would also come with a negative impact – be it traffic delays, safety tradeoffs, loss of mature trees, or expense. With many different groups articulating different needs for the corridor, and no universally agreeable plan identified, the Council chose to table discussion for a period of time.

In June 2008, the issue of the Fifth Street corridor was raised again by the Council and staff was asked to prepare a plan to address the subject. In prior discussions, the primary driver of the analysis was responding to a proposed solution, or options, rather than making a comprehensive effort to engage the community to identify what problems, or opportunities existed in the corridor. Staff recognizes that there are myriad interests in the Fifth Street Corridor. In recognition of these interests, staff proposes engaging the community to gain a better understanding of the full breadth of interests and issues.

This research is to develop a microscopic, time step and behavior based simulation model to model the traffic operations within the planned fifth street corridor area. The program analyzes the traffic operations under constraints such as lane configuration, traffic composition, traffic signals, transit stops, etc., thus making it a useful tool for the evaluation of various design alternatives based on planning measures of effectiveness.

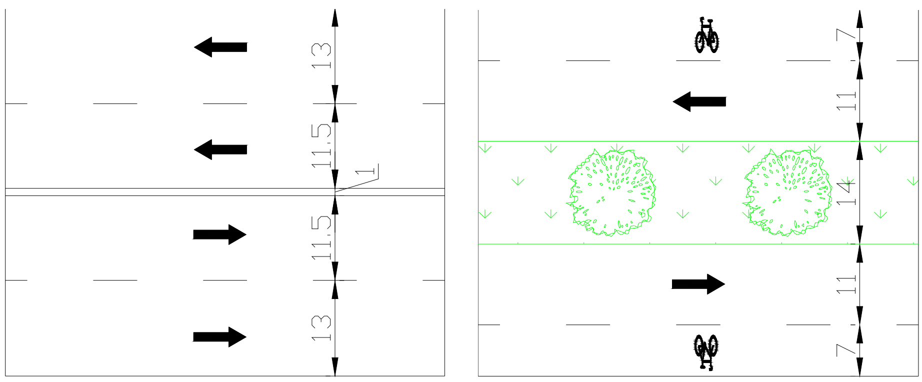
This study focuses on the comparison of two scenarios: the current plan with modification to F&G street signals and the road diet plan. Their performances are evaluated and compared in terms of vehicle speed, total stops, total delay time, queue length at the intersection, etc. In the “road diet” scenario, new signal timing plan will be proposed to optimize the operation of the whole planning area.

2. The Two Strategies for Fifth Street Corridor

In this section we first provide the details of the two strategies for Fifth Street corridor: the existing one and road diet. They have different geometric designs on both road sections and intersections, as well as signal plans.

2.1 Geometric design

In existing case, the section of Fifth Street in the corridor is bi-directional with two motor lanes on both directions, as shown in Fig. 2-1a. In road diet case, to avoid the costs of pavement rebuilding and land-use change, etc, the total width of the section of Fifth Street will remain unchanged, except that the motor lanes will be downgraded to two, with two bike lanes at each side and isolation strip in the middle (See Fig. 2-1b).



a) Existing case b) Road diet case

Figure 2-1 Geometric layout of road section

There are ten intersections along the street from B Street to L Street. The detailed layouts of these intersections are shown in Fig. 2-2 ~7.

In road diet case, the approaches from Fifth Street to each intersection will be channelized to keep the capacity, as shown in Fig. 2-8. Moreover, an exclusive left-turn lane, which replaces the isolation strip in the middle section of the road, will be added at each approach to make the turning movements smoother. Since right-turn traffic should use bike lanes to finish the turning, compared with the existing case, which has only two lanes at the approach, there are actually three lanes for through vehicle.

2.2 Signal plan

In existing case, there are four signal intersections out of ten along the whole corridor, which are B&5th St., F&5th St., G&5th St., and L&5th St. All the four signals are fully vehicle actuated.

The existing signal plans at B&5th St. and L&5th St. have four phases with ring-and-barrier structure, as shown in Fig 2-9 and 2-10. The two intersections are not running on signal procession and the geometric designs do not change too much except that the straight lanes of the east approach of B&5th St. and the west approach of L&5th St. will be reduced from two to one for each direction. Thus we keep the two signal plans unchanged in road diet plan.

The existing signal plans at F&5th St. and G&5th St. are coordinated with each other because of the short distance between them. Both plans have three phases, with a cycle length of 90 seconds at daytime and 64 seconds at night. The plans are shown in Fig 2-11 and 2-12. In the road diet plan, to improve the safety of pedestrians and cyclists and the efficiency at the intersections, protected left-turn phases are added in the signal plans of F&5th St. and G&5th St. intersections. The new signal plans have three phases with ring-and-barrier structure, as shown in Fig. 2-13 and 2-14.

3. Simulation and Optimization

In this project, we use microscopic traffic simulation to evaluate the effects of the road diet plan on the traffic on Fifth Street corridor. We choose PTV VISSIM, a widespread used simulation software package, as the simulation tool. Compared with other simulations tools, VISSIM has several characteristics fitting the needs of this study:

- Modeling options for urban traffic;
- Powerful lane-changing behavior models provide the user with realistic modeling of various merging situations;
- Modeling parallel vehicle flows, such as cars and motorbikes/cycles driving in the same lane and overtaking inside wide lanes;
- Expandable collection of different vehicle types and user-defined changes of driving behavior (e.g. desired speed distribution, acceleration and car-following behavior);
- Selecting between different types of traffic demand modeling:
- True multi-class networks, i.e. route choice can be determined for each vehicle type, thus allowing pedestrian precincts, bicycle lanes, driving restrictions for cars, etc. to be modeled.

Both the existing case and road diet case are simulated in VISSIM for comparison. The simulation and optimization procedure contains six steps shown in Fig. 3-1.

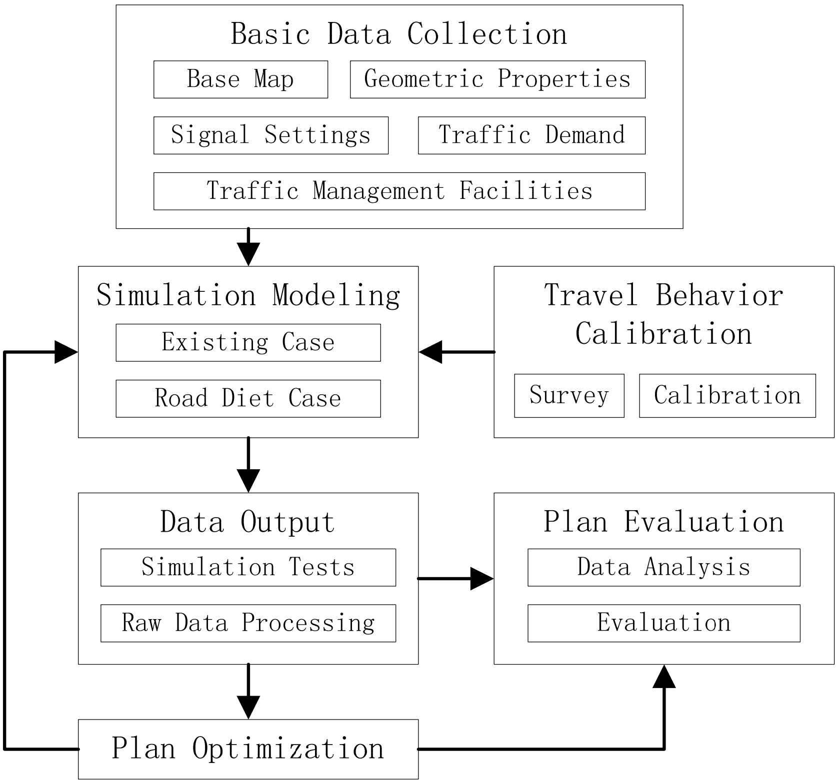


Figure 3-1 Technology roadmap of this project

3.1 Data collection

The following data are collected as inputs of the simulation model:

- Background map: we use Google earth map of Fifth Street corridor from B Street to L Street as the background map, based on which the road network is built;
- Geometric parameters: the detailed configurations and dimensions at cross section of each link and intersection and the detailed dimensions of blocks and cross street;
- Signal settings: the signal timing plans of all the four signalized intersections, B&5th St., F&5th St., G&5th St. and L&5th St., which are all full vehicle-actuated;
- Traffic demand: the flow split at each intersections during evening peak from 4:00pm-6:00pm and traffic mix (e.g. car, truck, bicycle percentages) for all links entering the network.

3.2 Model set-up

The simulation model set-up is a process to build a virtual road network to simulate the actual Fifth Street corridor based on all the necessary information we collect, which comprises three steps:

- Traffic network coding: building the road network with the same dimensions as real roads, including all the traffic management facilities;
- Travel behavior modeling: adding travelers to the network with specified volume and routes, setting the running rules and behavior factors, e.g. safety distance for travelers for different travel modes;
- Signal control coding: adding signal control facilities such as signals and detectors on the network, and setting the signal control parameters and strategies for them.

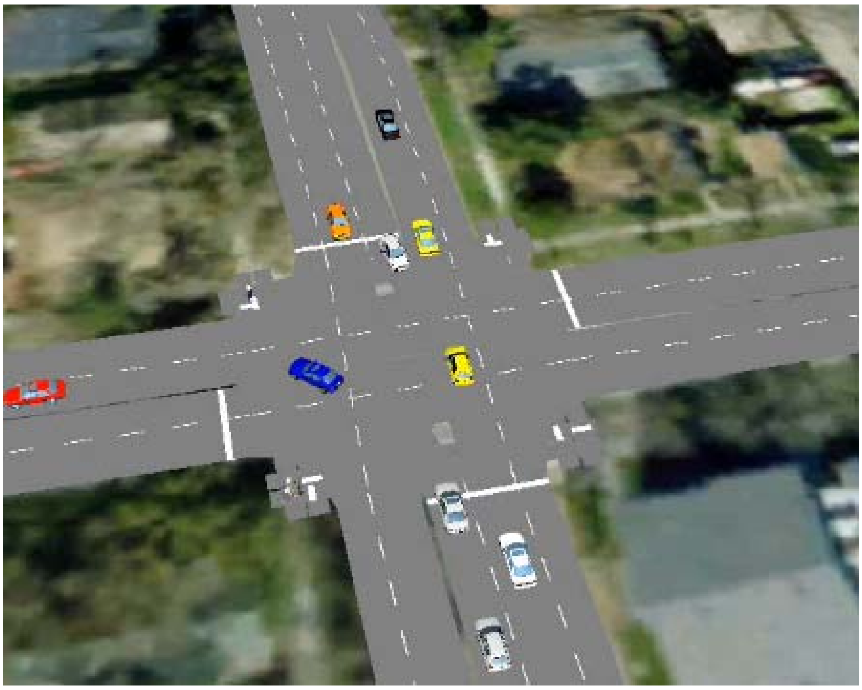


Figure 3-2 A sample intersection of the existing plan

A sample of the finished intersection in the existing plan is shown in Fig. 3-2.

3.3 Travel behavior calibration

To make the simulation results reliable, we have to calibrate the travel behavior. The calibration follows three steps:

- Operational characteristic indicators survey: the capacity and total travel time are selected as two operational characteristic indicators. The former is obtained by recording the saturation time headway and the latter by the on-road travel time measurement;

- Capacity calibration: we compare the output capacity of the simulation model with the survey data and adjust the parameter settings until they match up;
- Travel time calibration: it follows the similar procedure as the capacity calibration. Fig. 3-3 shows 10 iterations of the calibration. The procedure stops when the error is acceptable.

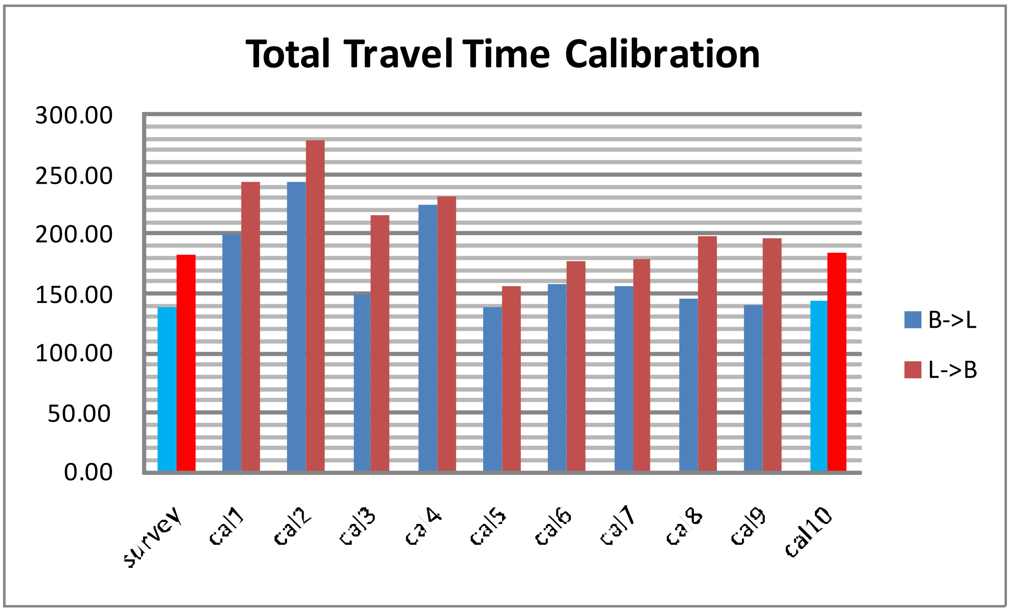


Figure 3-3 Calibration for travel time

3.4 Optimizing the road diet plan by offset adjustment

Although the geometric design and signal phases are predetermined, we still can optimize the road diet plan by adjusting the offset of the coordinative control between the two intersections F&5th St. and G&5th St. We compared the outcomes of different offset settings and the quasi-optimal one is chosen.

4. Data Analysis and Conclusions

VISSIM offers a wide range of evaluations that result in data being displayed during the simulation runs and in data being stored in text files. The text files are imported in spreadsheet applications (Microsoft Excel) for further calculation and graphical representation. The evaluation types utilized for performance measure here include:

- Through vehicle travel time;

- Through vehicle delay;
- Through vehicle speed;
- Number of stops of through vehicles;
- Network vehicle speed;
- Network vehicle delay;
- Delay of through vehicles at each intersection.

We repeated the simulation runs with 5 different random seeds for each scenario and take the average to counteract the system error. The outputs are listed in Table 4-1 below.

Table 4-1 Comparison of evaluations

Average	Current plan	Road Diet(Optimal Signal)	Percentage Change
Travel time(Through)	161.71	141.38	-12.57%
Speed(Through)	14.5	16.7	15.56%
Delay(Through)	71.60	50.42	-29.58%
Stop delay(Through)	51.36	25.67	-50.03%
Stop times(Through)	1.71	1.23	-27.64%
Speed(Network)	13.72	13.06	-4.80%
Delay(Network)	44.50	49.37	10.95%
Stop delay(Network)	31.77	32.82	7.89%
Stop times(Network)	1.31	1.42	3.30%
Delay(Side street)	24.26	32.68	34.71%

From the comparison we have following observations:

- Compared with the current plan, the travel time, number of stops (See Fig. 4-1~2), vehicle delay, stop delay, for the through traffic are all reduced by the road diet plan, except that the delay of the whole network is increased by 11%, which indicates that the road diet plan will not add significant congestion to the corridor; The signal timing is set to give priority to the through traffic instead of side street traffic for the consideration of the overall performance of the corridor area;
- The stop delay of the through traffic is reduced by half, which provides significant advantage for addressing the fuel consumption and Emission issues, since most emissions are released during the time when vehicle stops;
- The average speed of the through traffic is increased by 15.56%, which helps to maintain the vehicle throughput of the corridor after the road capacity is reduce by half;
- The reduced street motor lane width makes the pedestrian and cyclists easier and safer to cross the street and in some degree reduces the vehicle confliction, which have been serious issues along the fifth street corridor for long. The improved bicycle lane connectivity will significantly reduce the risks of cyclists who have to ride on the

motor lanes under the current situation, and also reduce the delays for not only cyclists but vehicles;

- The average vehicle delay for the side street is increased by 34.71% because of the road diet plan. Most of the delay occurs at the non-signalized intersections. The major reason causing the problem may come from the lane reduction. Under the current plan, the capacity of the four-lane street is not fully utilized. However, after one lane is cut for each direction in the road diet plan, to satisfy the same or even higher through traffic demand, the density of the through traffic increases a lot. As a result, the turning vehicles from the side street can then hardly find a gap to get into the flow. This is the major negative side of the road diet plan that we could find in our simulation. The stop delay of the whole network is also increased by 7.89%, most of which comes from the side street traffic. Such amount of increase may not be serious because of high demand level we proposed in the model: first, the demand we input into the simulation model is already 25% higher than the existing demand; second, we didn't consider traffic redistribution here. If we look at the whole downtown network, some of the traffic may switch to alternative routes when they face a higher delay, so that the delay along the 5^{th} street corridor might be over-estimated by our simulation;
- A planting isolation strip is added in the middle of the road to isolate the traffics in two opposite directions. Such strip could increase the driving safety by reducing crossing street violations, purify the air in downtown area and add to the visual effects.

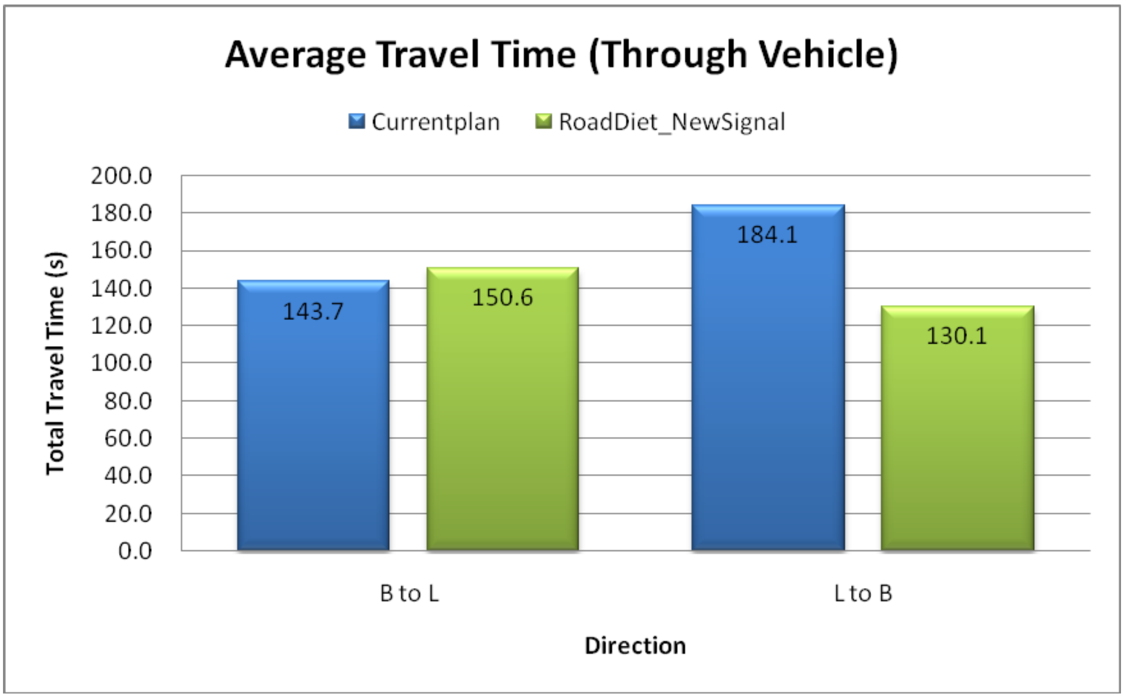


Figure 4-1 Comparison of average travel time

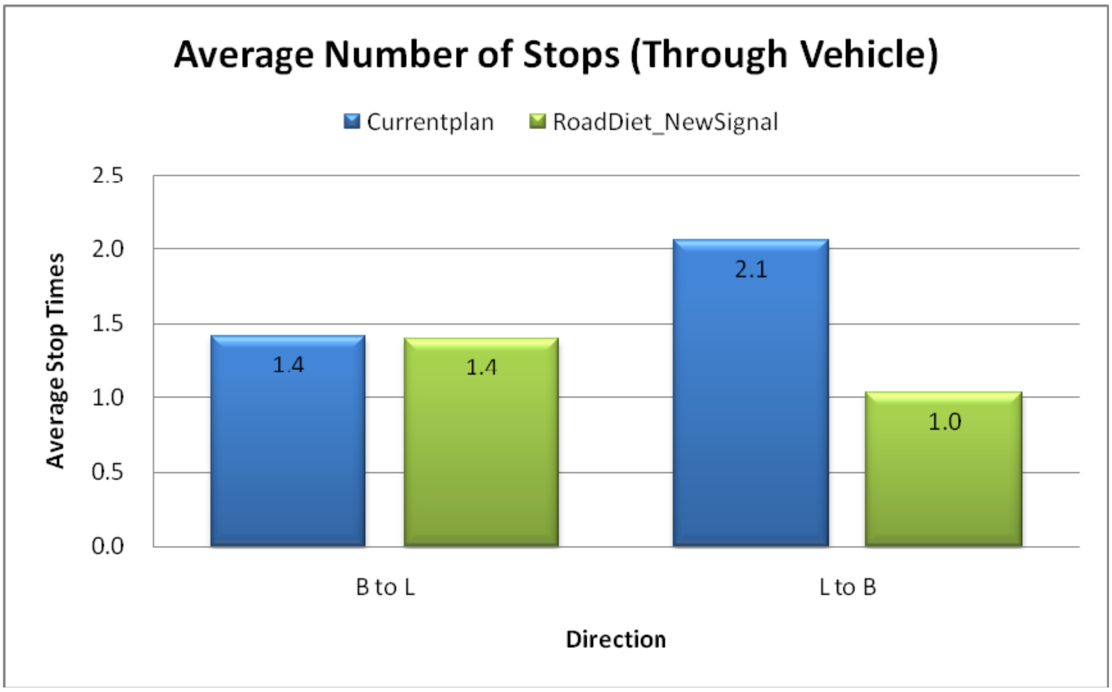


Figure 4-2 Comparison of average number of stops

The density and speed distributions in Figure 4-2~5 for both the current plan and road diet also support our conclusion that the road diet plan will not seriously increase congestion along the corridor, yet congestion will still exist under the road diet plan at intersections B, F, G and L&5th, since these are the four intersections with signal controls and high demands.

Acknowledgement:

We wish to thank Steve Tracy for providing the initial impetus for this study and for sharing with us traffic data. This study is made possible by a seed grant from the Sustainable Transportation Center at University of California, Davis. The opinions and conclusions contained in this report are those of the authors alone.

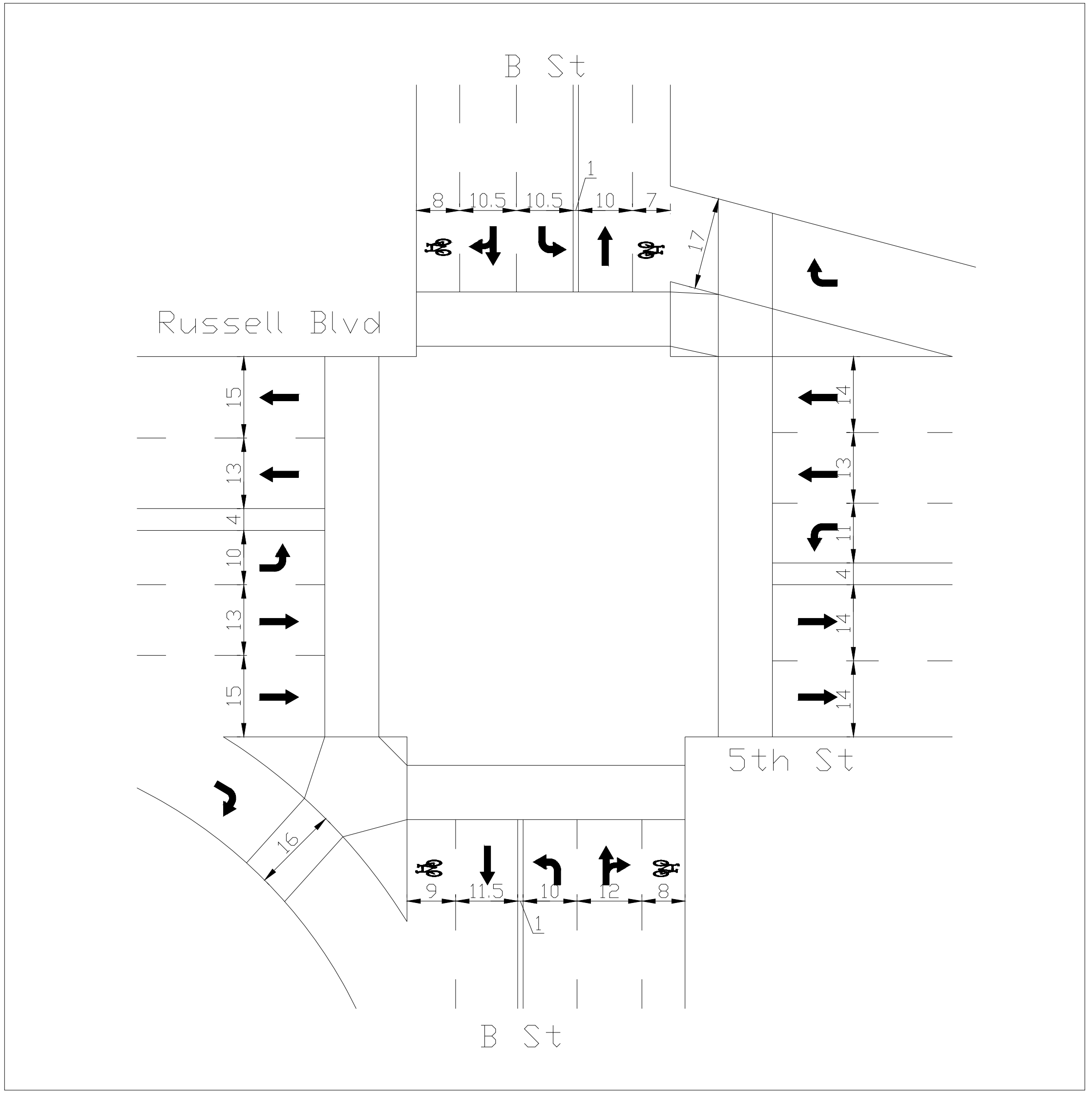


Figure 2-2 Existing geometric layout of B & 5th St. intersection

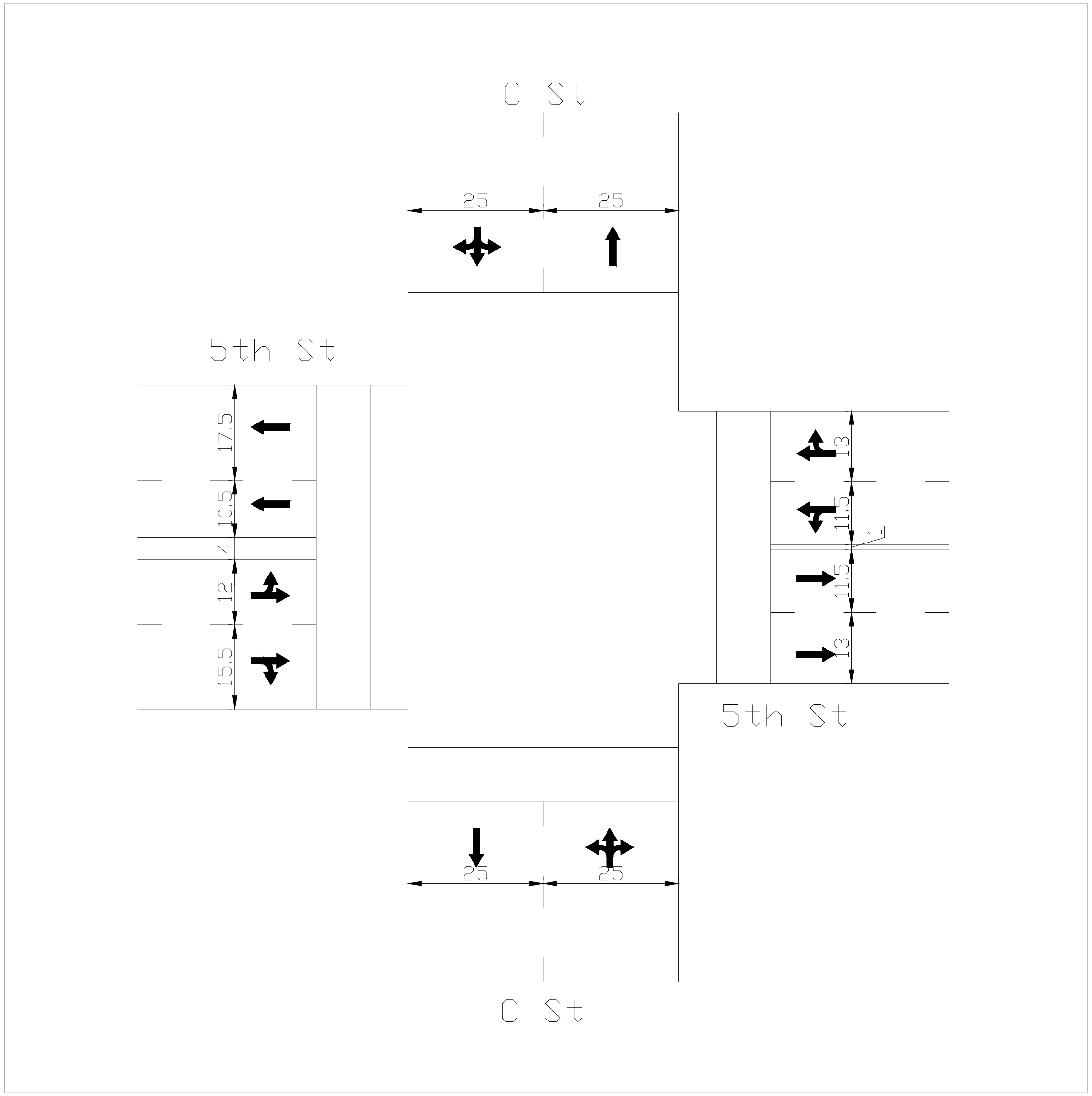


Figure 2-3 Existing geometric layout of C & 5th St. intersection

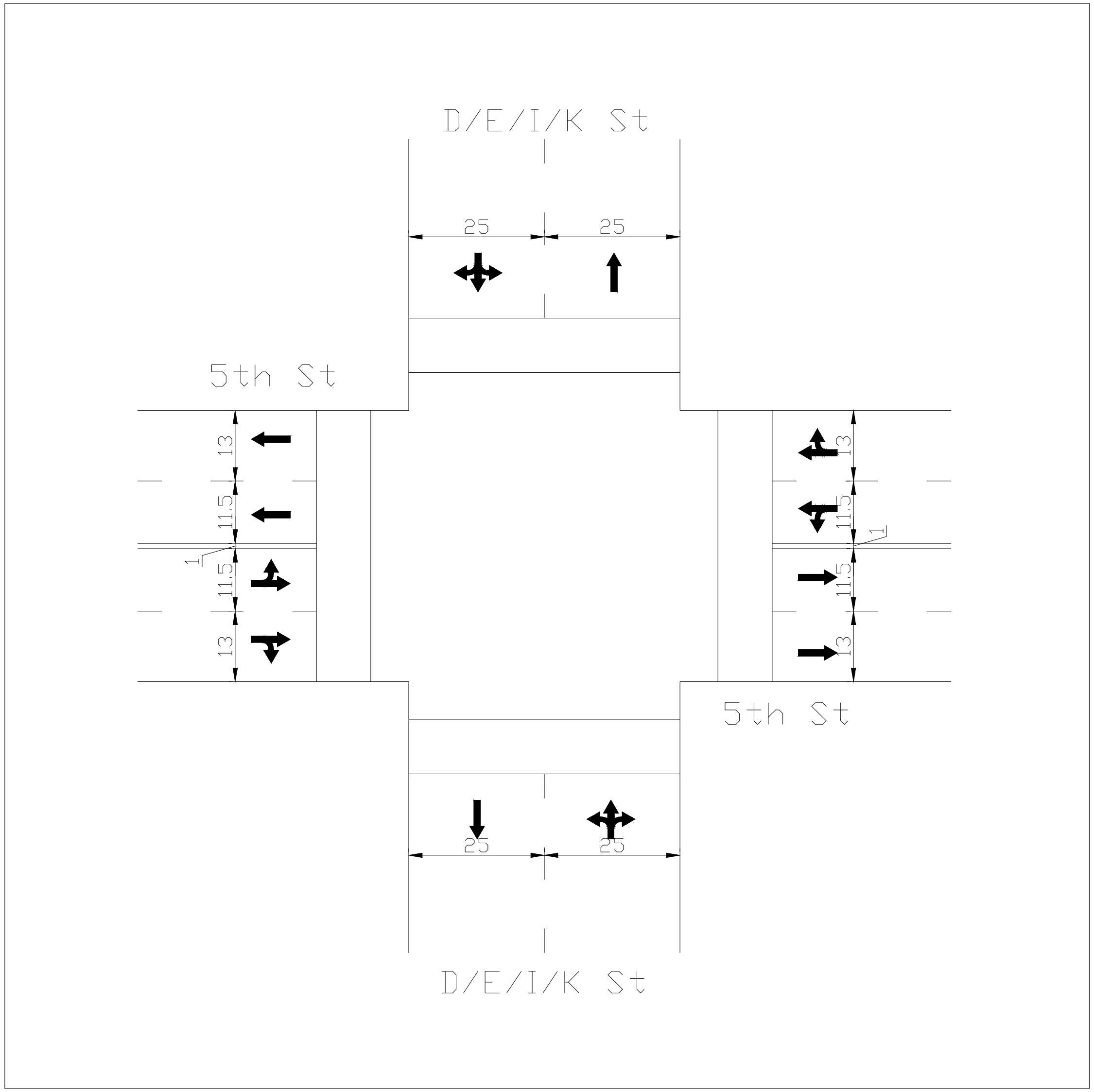


Figure 2-4 Existing geometric layout of D/E/I/K & 5th St. intersection

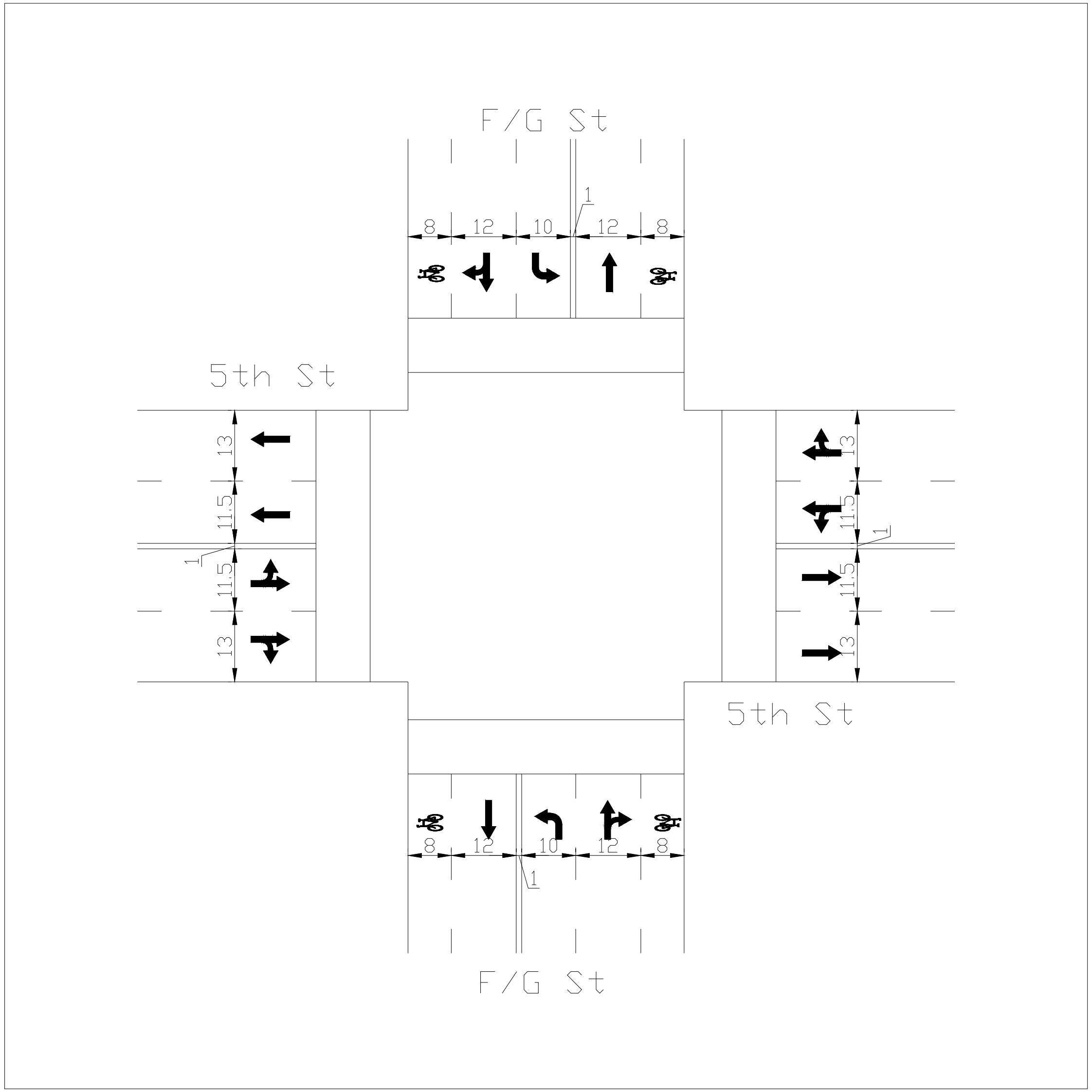


Figure 2-5 Existing geometric layout of F/G & 5th St. intersection

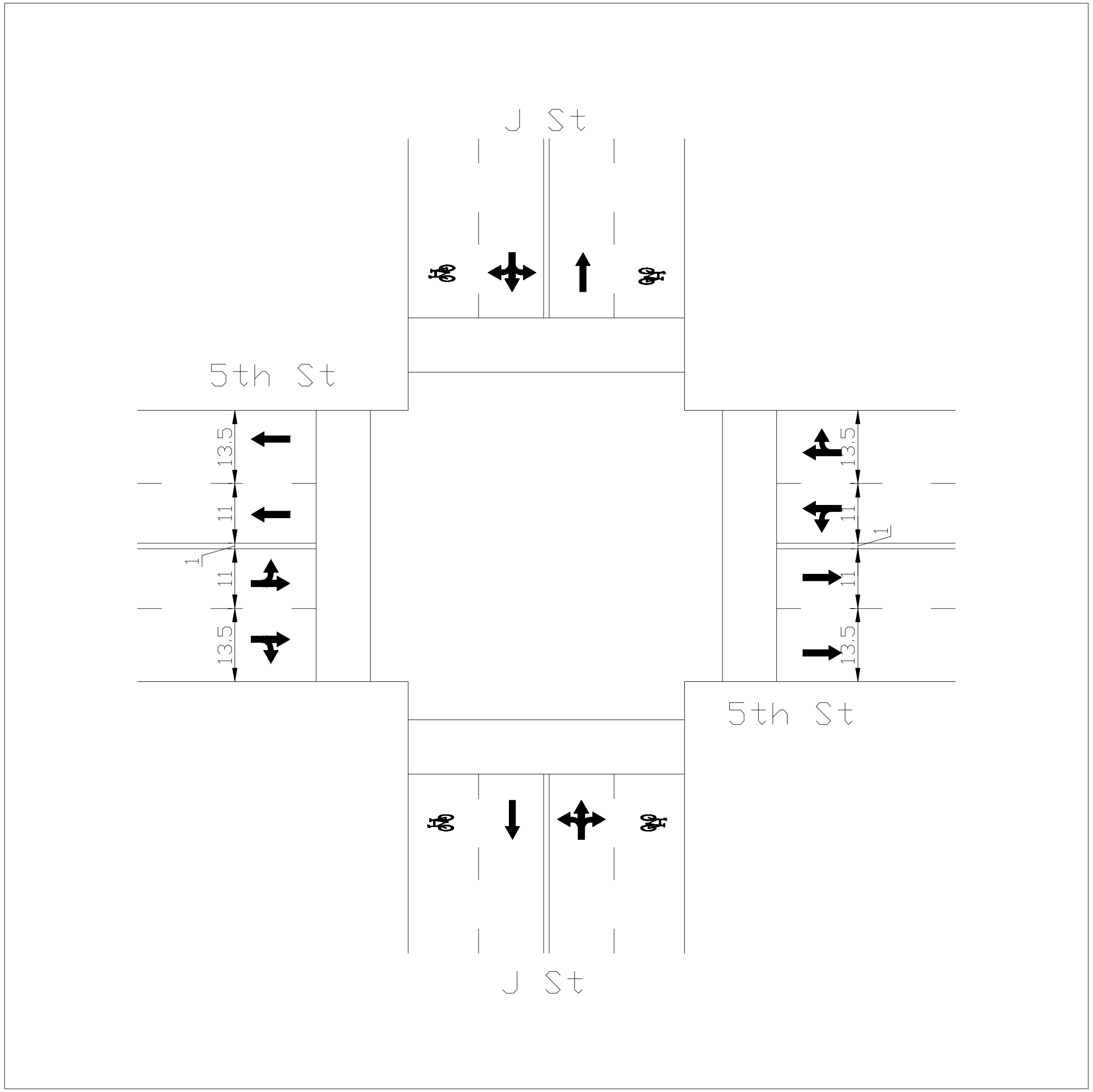


Figure 2-6 Existing geometric layout of J & 5th St. intersection

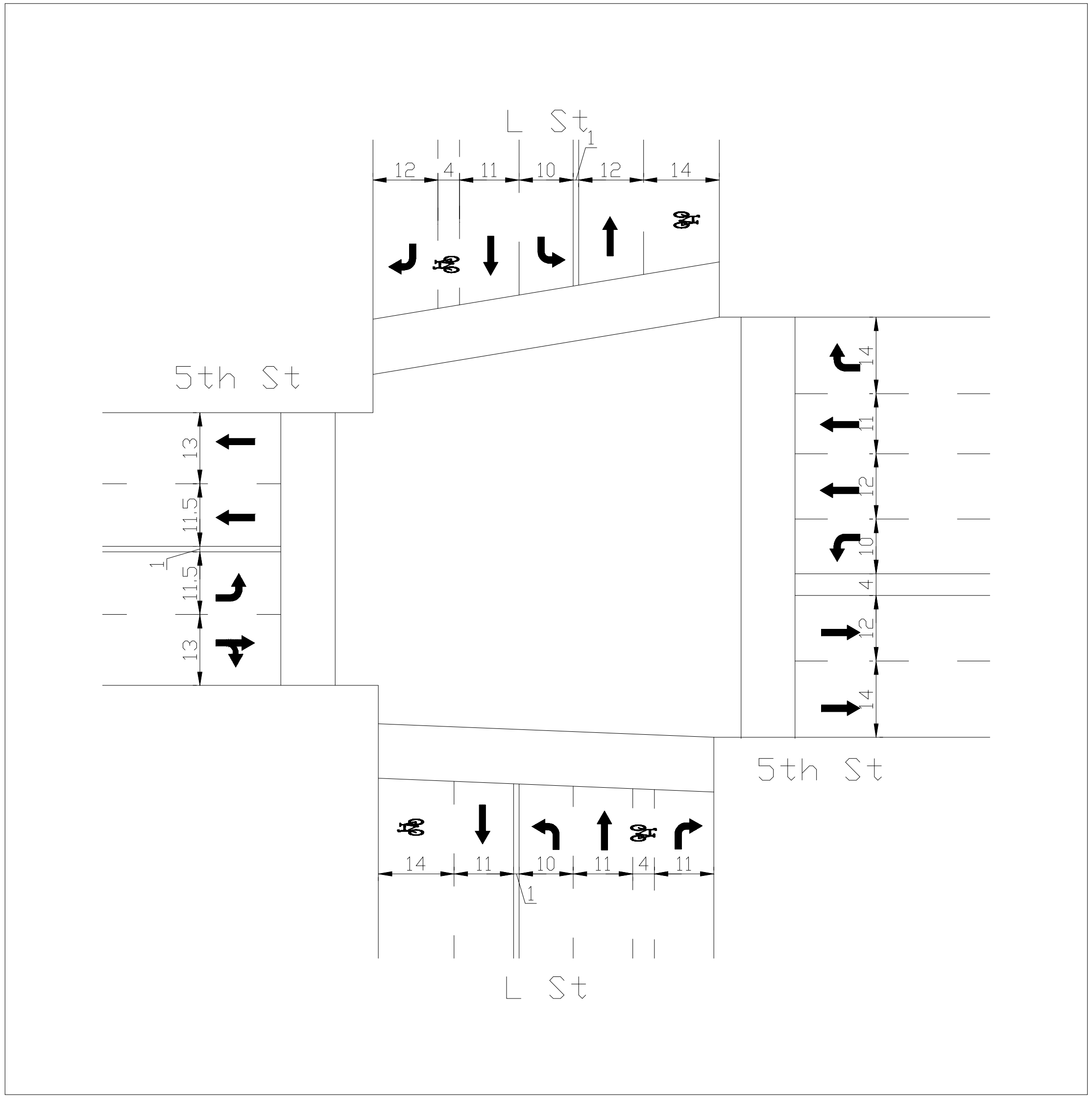
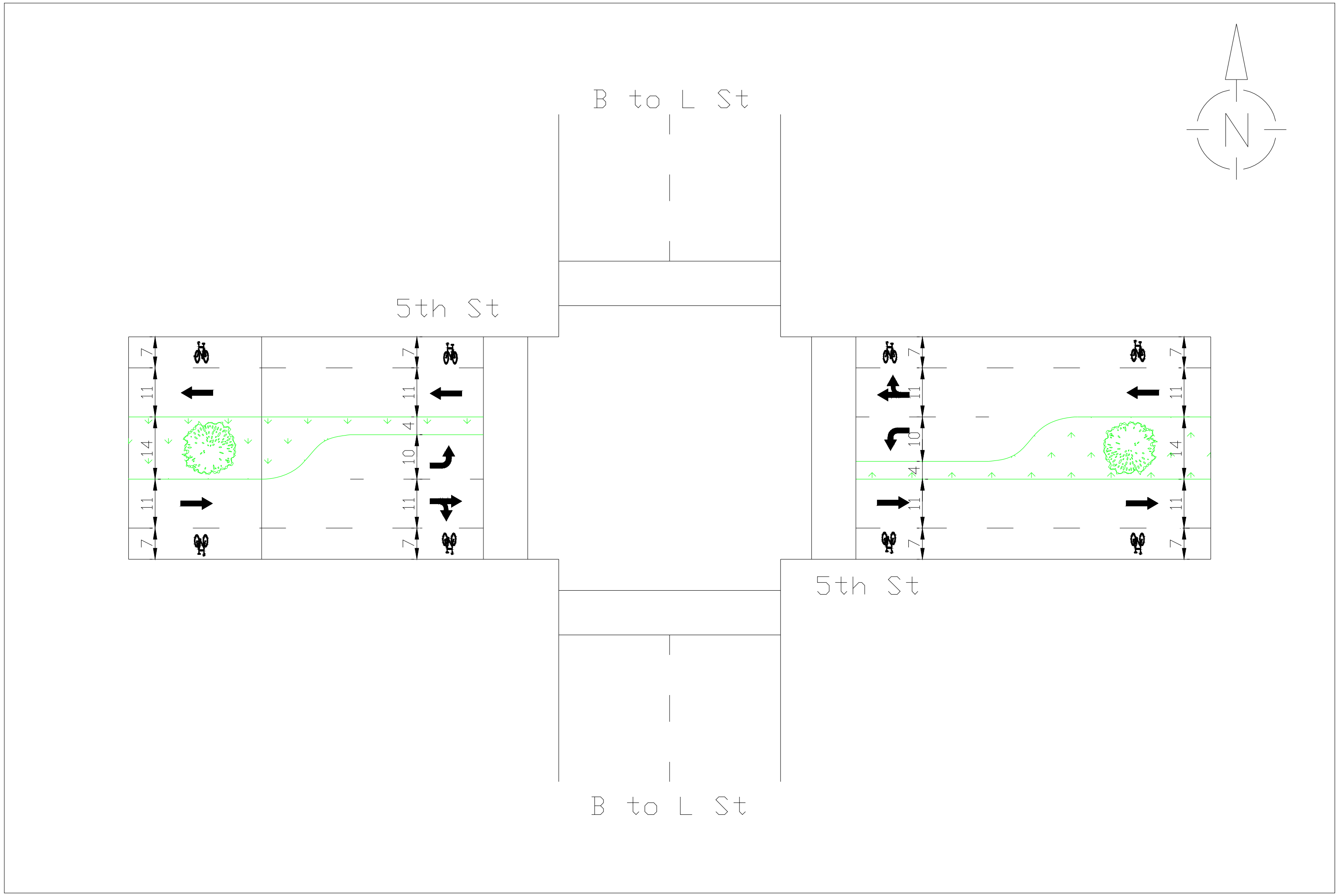


Figure 2-7 Existing geometric layout of L & 5th St. intersection



Note: the west approach of B&5th St. and the east approach of L&5th St. will keep unchanged.

Figure 2-8 Road diet geometric layout of intersections on 5th St. corridor

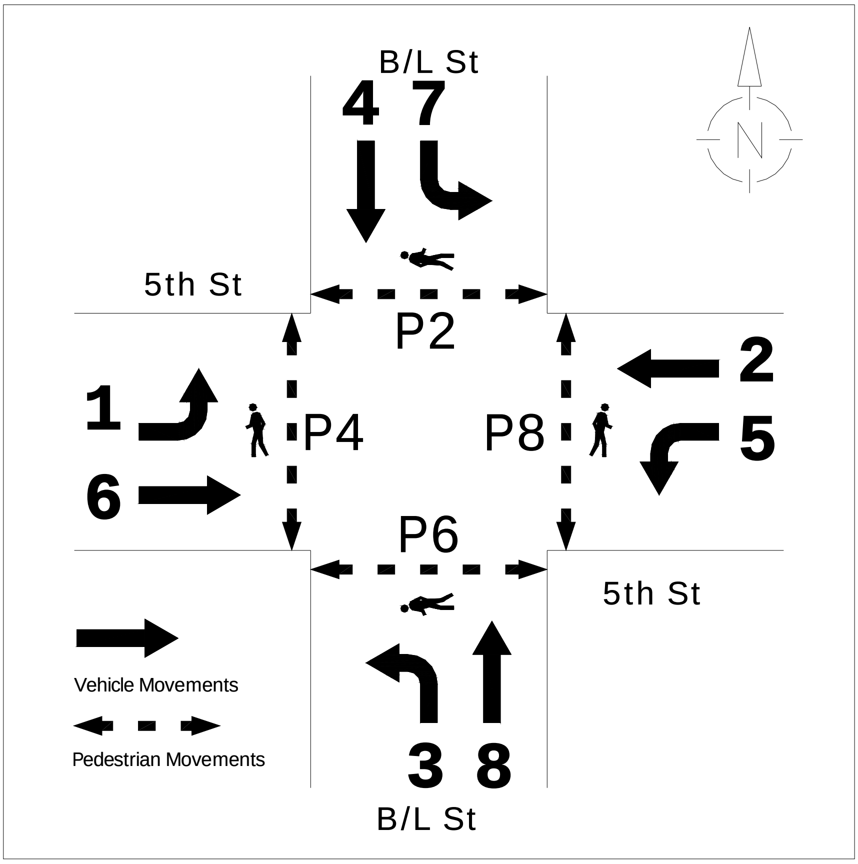


Figure 2-9 Traffic movements at B/L&5th St. intersection

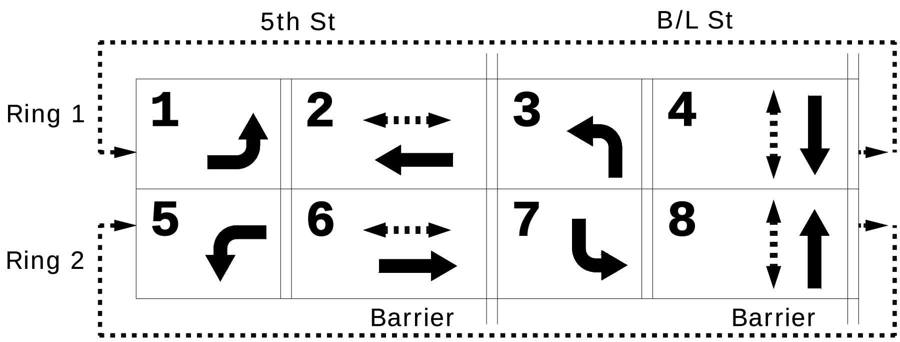


Figure 2-10 Signal phase diagram of B/L&5th St. intersection

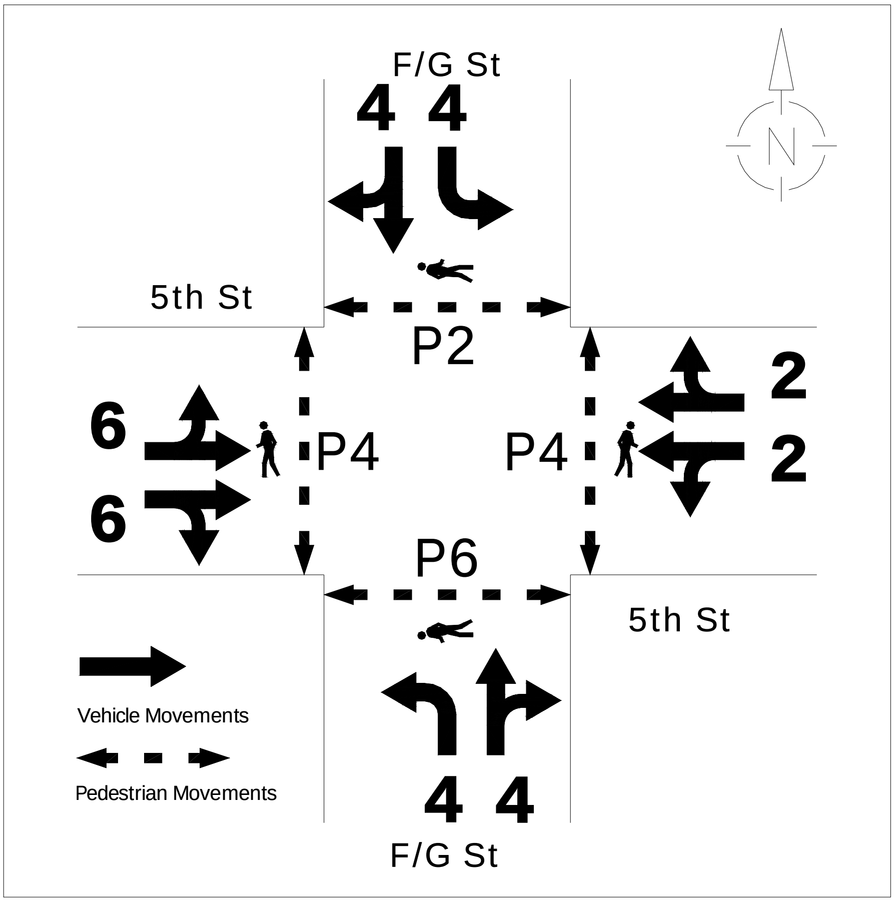


Figure 2-11 Traffic movements at F/G&5th St. intersection in existing case

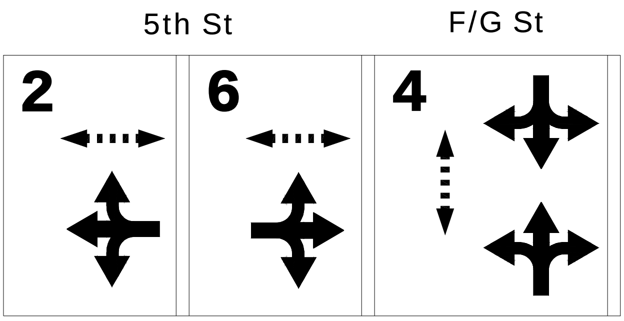


Figure 2-12 Signal phase diagram of F/G&5th St. intersection in existing case

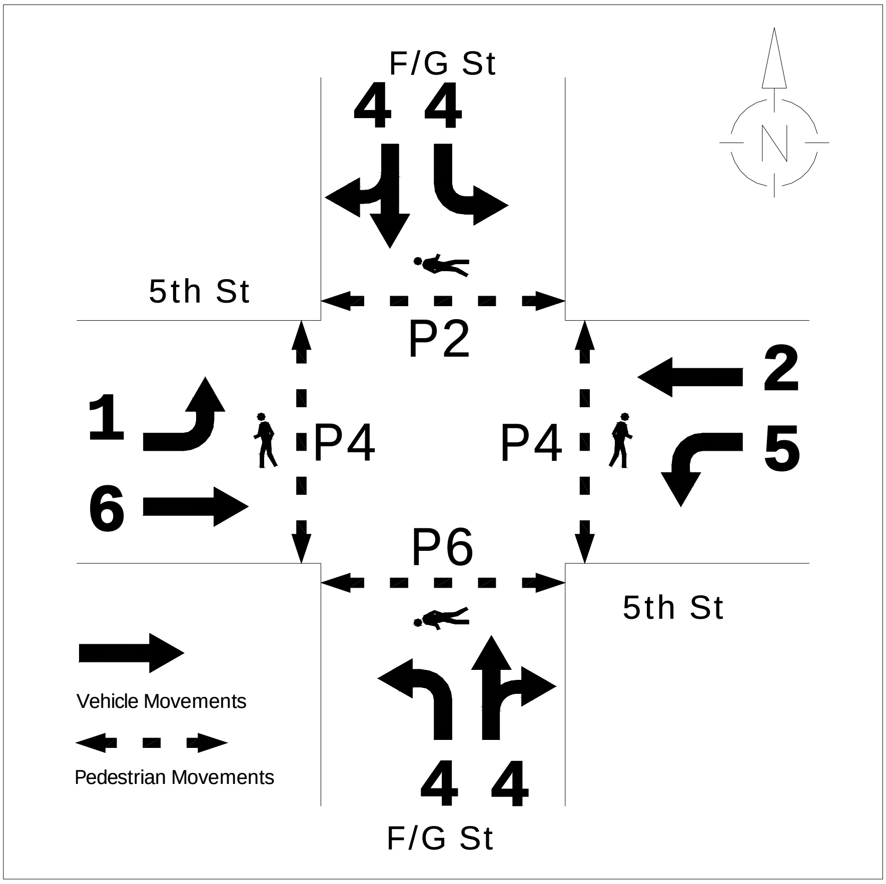


Figure 2-13 Traffic movements at F/G&5th St. intersection in road diet case

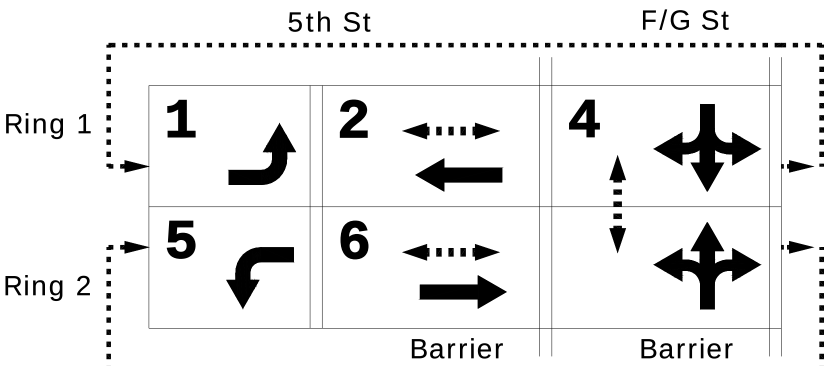


Figure 2-14 Signal phase diagram of F/G&5th St. intersection in road diet case

Figure 4-2 Density distribution (Existing plan)

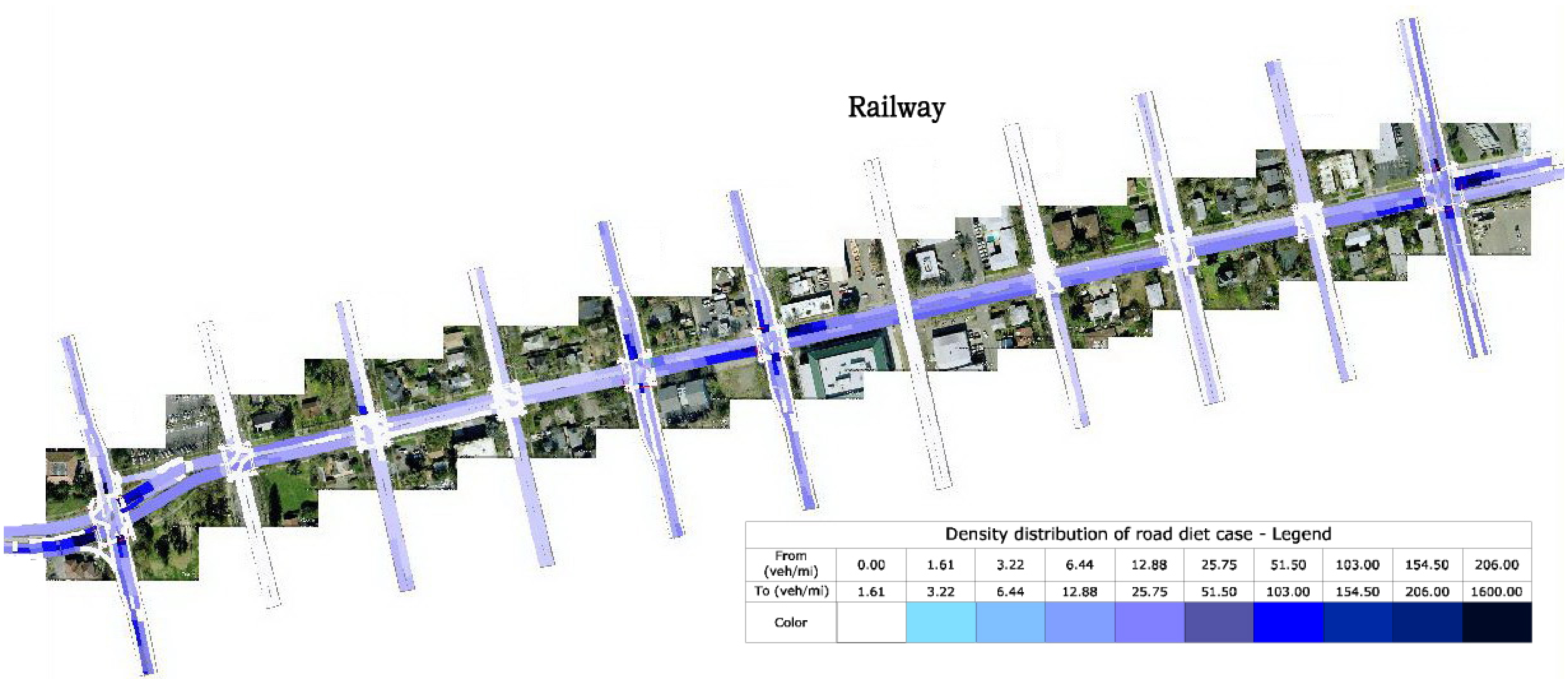
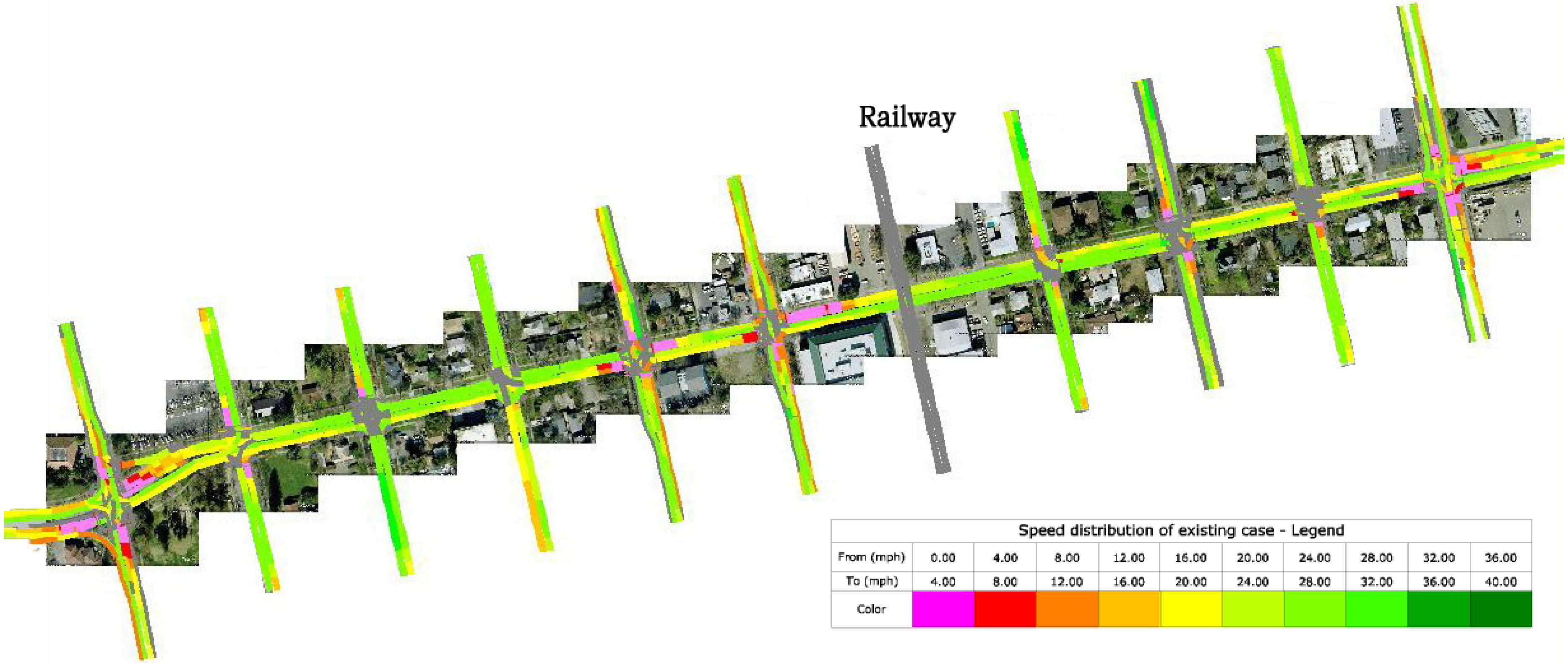


Figure 4-3 Density distribution (Road diet plan)



Speed distribution of existing case - Legend

From (mph)	0.00	4.00	8.00	12.00	16.00	20.00	24.00	28.00	32.00	36.00
To (mph)	4.00	8.00	12.00	16.00	20.00	24.00	28.00	32.00	36.00	40.00
Color										

Figure 4-4 Speed distribution (Existing plan)

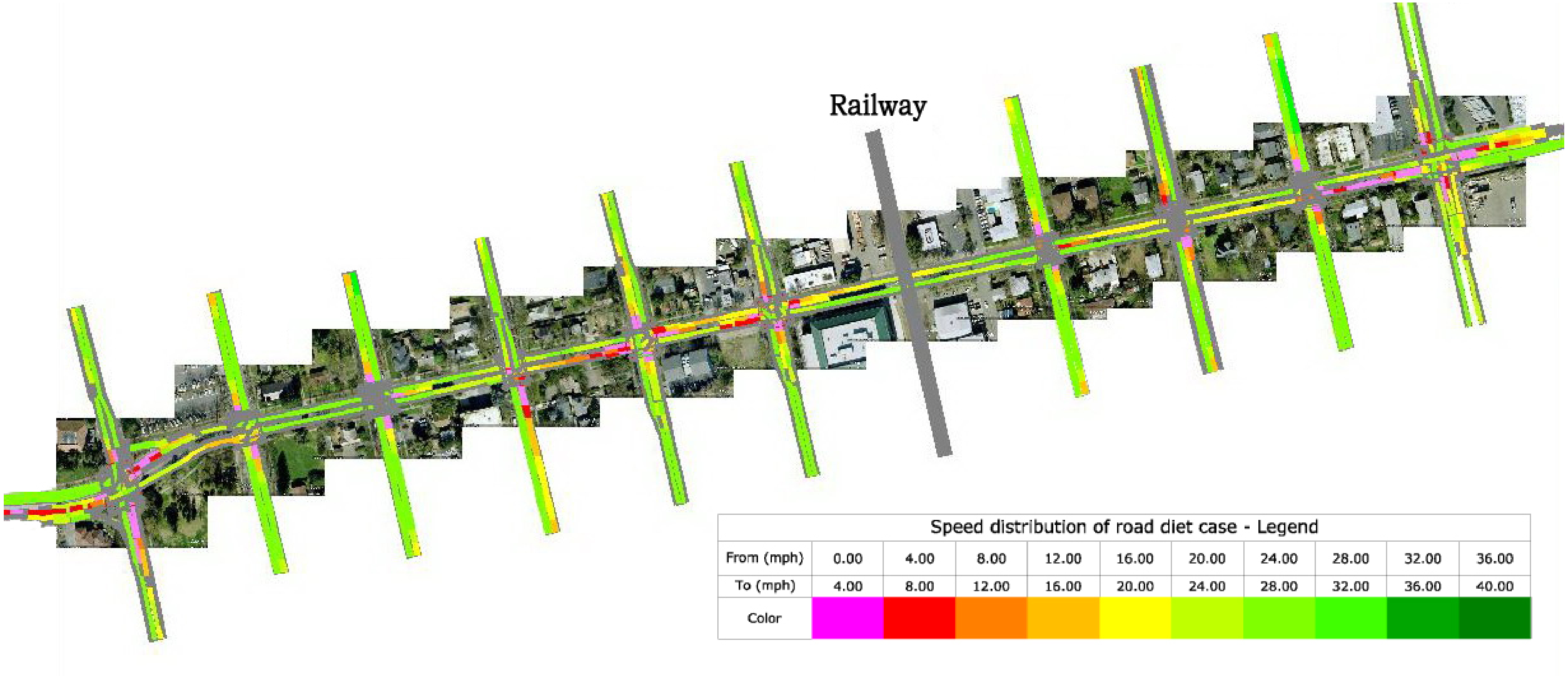


Figure 4-5 Speed distribution (Road diet plan)