Transportation Planning Study – Section 2

Stamford, Connecticut

06905

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Urban Transportation Planning

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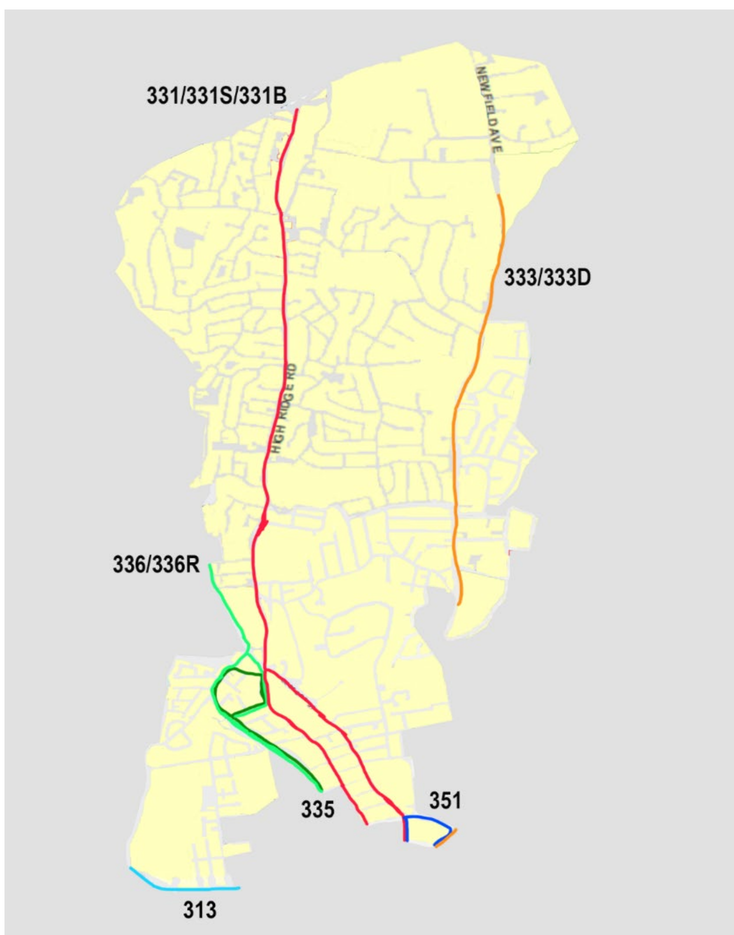
There are six bus routes in the ZIP Code, all originating from the Stamford Transportation Center. Those bus routes are 313, 331, 333, 335, 336, and 351. The 313 runs along Connecticut Avenue and West Broad Street, but the entire route is not in the ZIP Code, and only the bit of it running on West Broad Street is in 06905. The 331 runs along High Ridge Road and there are three sub-routes of this bus line. The 331 with no letter following runs to the Stamford Museum and Nature Center, which is not in the ZIP Code. The 331S runs to the Smith House, which is additionally not in the ZIP Code. Lastly, the 331B, which runs the farthest, ends at the intersection of High Ridge Road and Briar Brae Road, which is also not in the ZIP Code.

Figure 1: 06905 Bus route map



The 333 runs along Newfield Avenue and has two sub-routes. The 333 with no letter following runs to the Newfield Green, which falls at the middle of the route of the 333D, which goes to Davenport Elementary School on the northern end of the ZIP Code. The 335 loops around Bulls Head and goes back to the transportation center, which is south of the ZIP Code. The 336 follows a similar route to the 335, but extends to Long Ridge Road, most of which is not in the ZIP Code. A sub-route of the 336, the 336R, goes to a sequence of stops on Roxbury Road upon request. Lastly, the 351 is the Downtown Loop, which runs exclusively during peak hours, timed to pick up passengers from certain trains. The level of service for buses is a B since all higher-density areas are served, but lower-density areas are less accessible.

Crosswalks are common at most intersections throughout the ZIP Code, but they are less concentrated in the northern part of the ZIP Code. Bikes typically share lanes with cars, and dedicated bike lanes are uncommon.

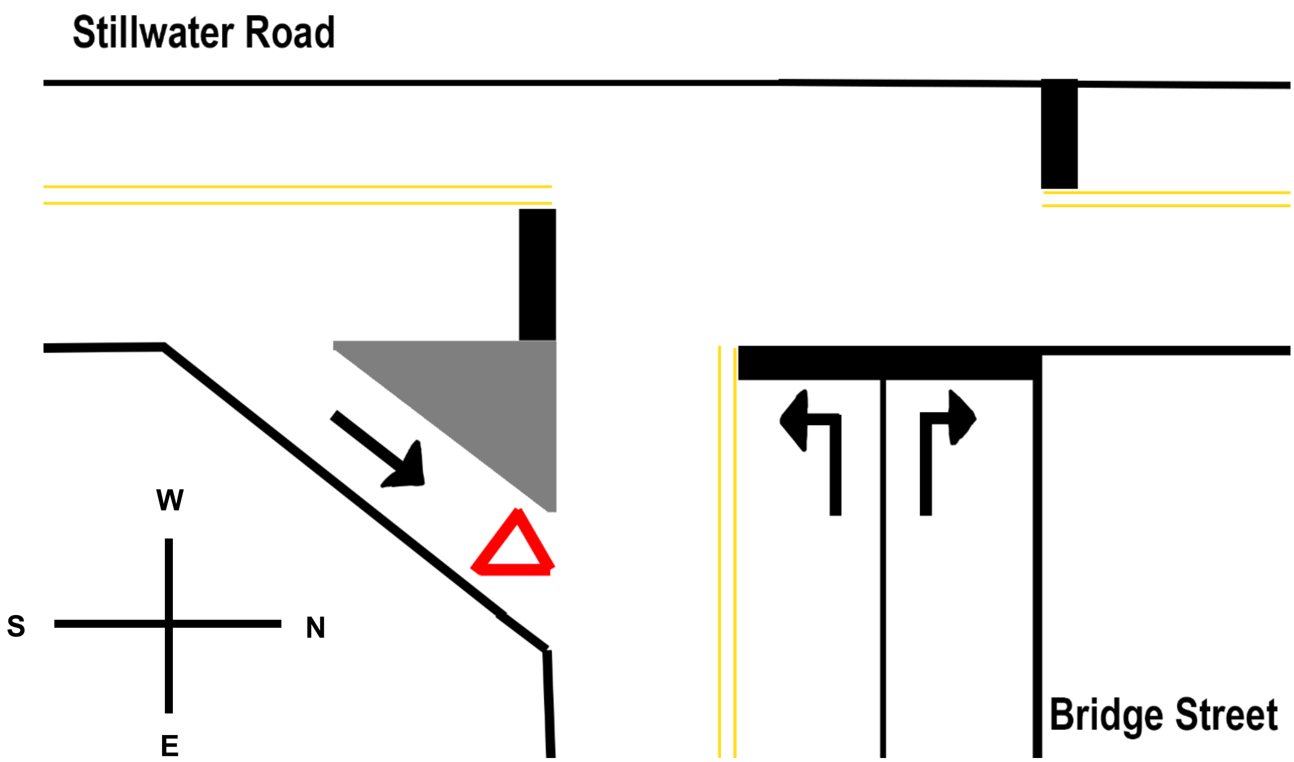
Table 1: Time intervals of bus routes in 06905

	313	**331**	**333**	**335/336**	**351**
5:30 AM – 7:30 AM	40	50/30	30	20	15
7:30 AM – 9:30 AM	40	30	30	20	15
9:30 AM – 3:00 PM	40	30	60	80/20	-
3:00 PM – 7:05 PM	40/60	30	30	20/50	10
7:05 PM – 10:05 PM	60	60	60	-	-

The rows of the table correspond to the time intervals of the routes and the columns of the table correspond to the bus routes in the ZIP Code. The cells are measured in minutes.

Intersection Analysis

Figure 2: Intersection diagram (Stillwater Road and Bridge Street)



The intersection depicted above is a three-way intersection between Bridge Street and Stillwater Road. Bridge Street has one lane dedicated for right turns and one lane dedicated for left turns, while Stillwater Road has a dedicated lane for right turns in the northbound direction. The southbound direction of Stillwater Road has no dedicated turn lane.

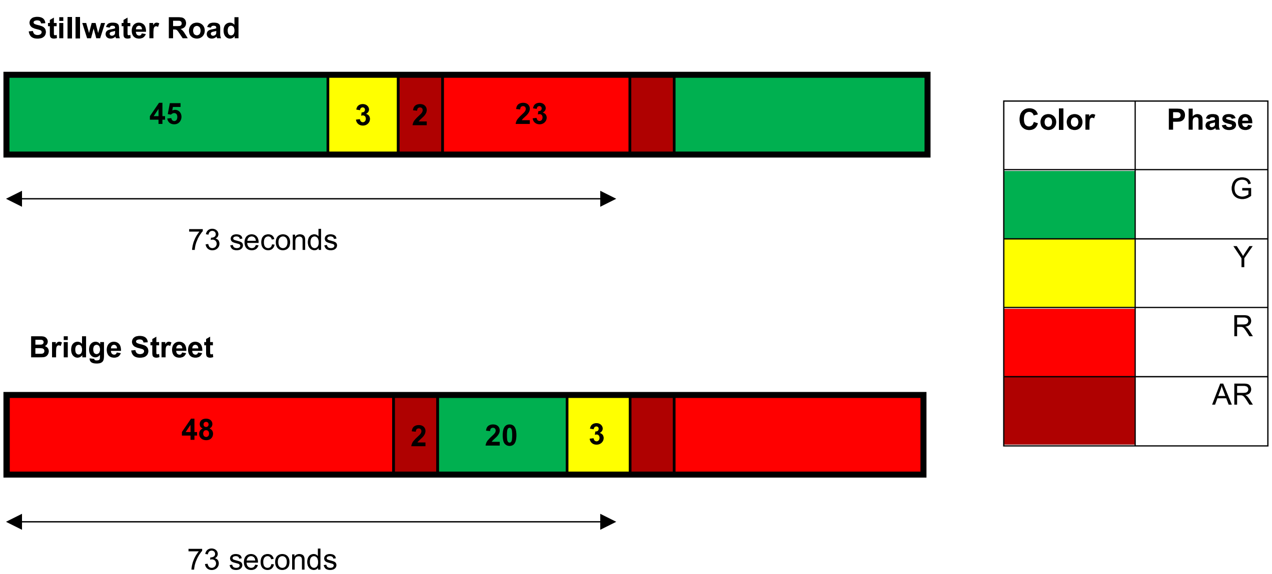
The volume of pedestrians is typically very low at this intersection, as a result there are no crosswalks. During rush hour, the volume of cars on Stillwater Road is significantly higher than the volume of cars on Bridge Street. The total volume of cars counted in a 10-minute interval from Stillwater Road northbound was 45, from Stillwater Road southbound was 38, and from Bridge Street was 19. A table displaying cars counted per cycle is found below.

Table 2: Cars observed in intersection per cycle

	STILLWATER ROAD N/B	STILLWATER ROAD S/B	BRIDGE STREET
CYCLE 1	19	9	2
CYCLE 2	10	14	7
CYCLE 3	5	7	6
CYCLE 4	11	8	4
TOTAL	45	38	19

Because of the higher volume on Stillwater Road, it has more than double the green time (G) of Bridge Street. The figure below depicts the green time (G), the change interval (Y), which is the time that the traffic light is yellow, the red time (R), and the clearance interval (AR), which is the time that all traffic lights are red. The traffic cycle length (C) is 73 seconds. Based on the field survey, the volume to cycle length ratio in the intersection is 0.46, which means the level of service of the intersection is an A, and operations are generally uncongested.

Figure 3: Intersection light cycle



The green time, red time, change interval, and clearance interval were all recorded, but there are other aspects of an intersection that must be calculated. The start-up lost time, or I_1 is the amount of time used by the first few vehicles in line as they react to the transition into the green phase, which is typically two seconds, but it was observed that reaction times were slightly faster at the intersection. The clearance lost time, or I_2, is the time between signal phases in which traffic does not use the intersection, which is typically two seconds.

In the calculation of the lost time, or t_L, the sum of the start-up lost time and the clearance lost time is taken. This can be used to calculate the effective green time (g) and the effective red time (r). The effective green time is the time available for movement. This is taken by summing the green time, change interval, and the clearance interval and subtracting the lost time. The effective red time is the time where traffic cannot move. This is the effective green time subtracted from the cycle length (C).

Equation 1: Lost time

$$t_L = I_1 + I_2$$

Equation 2: Effective green time

$$g = G + Y + AR - t_L$$

Equation 3: Effective red time

$$r = C - g$$

Table 3: Traffic light cycle information in seconds

	STILLWATER ROAD	BRIDGE STREET
GREEN TIME (G)	45	20
RED TIME (R)	23	48
CHANGE INTERVAL (Y)	3	3
CLEARANCE INTERVAL (AR)	2	2
CYCLE LENGTH (C)	73	73
START-UP LOST TIME (l_1)	1	1
CLEARANCE LOST TIME (l_2)	2	2
LOST TIME (T_L)	3	3
EFFECTIVE GREEN TIME	47	12
EFFECTIVE RED TIME	26	51

Saturation flow rate (s) is the maximum hourly flow that could pass through an intersection if the entirety of the light cycle consisted of green time. Saturation flow rate is calculated by the multiplication of many factors: f_W is the lane width factor, f_{HV} is the heavy vehicle factor, f_g is the grade factor, f_P is the parking factor, f_{bb} is the bus blockage factor, f_a is the area type factor, f_{LU} is the lane utilization factor, f_{RT} is the right turn factor, f_{LT} is the left turn factor, and f_{pb} is the pedestrian and bicycle factor. Multiply the product of these factors by the number of lanes (N in the equation below) and s_0, which is the base saturation flow rate for all intersections.

Equation 4: Saturation flow rate

$$s = s_0 * N * f_w * f_{HV} * f_g * f_P * f_{bb} * f_a * f_{LU} * f_{RT} * f_{LT} * f_{pb}$$

The approach capacity (c) is the maximum hourly flow of vehicles that can go through the intersection under current circumstances. This is calculated by multiplying the saturation flow rate by the proportion of effective green time.

Equation 5: Approach capacity

$$c = s * g/C$$

Table 4: Saturation flow rate and approach capacity calculation

	STILLWATER ROAD	BRIDGE STREET
S_O	1900	1900
N	1	2
F_W	0.93	0.93
F_{HV}	0.97	1
F_G	1	0.97
F_P	0.9	0.95
F_{BB}	1	1
F_A	1	1
F_{LU}	1	0.92
F_{RT}	0.85	0.85
F_{LT}	0.98	0.95
F_{PB}	1	1
S	**1295.06**	**2413.78**
C	**833.8**	**396.79**

Trip Generation

Trip generation (G_i) is the number of home-based work trips generated in a given zone. This is calculated by adding three components of a ZIP Code together, multiplying each by a constant factor. The first component, X_{i1}, is the population of the ZIP Code. The second component, X_{i2}, is the number of dwellings in the ZIP Code. The third component, X_{i3}, is the number of registered vehicles.

Equation 6: Trip generation

$$G_i = 0.3X_{i1} + 0.4X_{i2} + 0.7X_{i3}$$

The trip generation was calculated for 06905 and two neighboring ZIP Codes, 06903 and 06902. This will be utilized in calculating the trip distribution (T_{ij}), which involves calculating travel times between each of these ZIP Codes.

Figure 4: Trip generation calculation

$$G_i = 0.3 * 19649 + 0.4 * 7694 + 0.7 * 9148 = 15376 \text{ trips generated for } 06905$$

$$G_i = 0.3 * 14499 + 0.4 * 5275 + 0.7 * 5215 = 10110 \text{ trips generated for } 06903$$

$$G_i = 0.3 * 63406 + 0.4 * 28739 + 0.7 * 28271 = 50307 \text{ trips generated for } 06902$$

Trip Distribution

Trip distribution (T_{ij}), is the connection of zonal trip ends using a population's travel characteristics and special distribution. The first step is to determine the trips produced and attracted in each of three ZIP Codes, one being the ZIP Code studied (06905) and two being neighboring ZIP Codes (06903 and 06902). The trip production is equivalent to the trip generation which was calculated above. Trip attraction is the population employed in each ZIP Code. Information on trip production and attraction for the three ZIP Codes is below.

Table 5: Trip generation and attraction

	06905	06903	06902	TOTAL
POPULATION	19649	14499	63406	97554
DWELLINGS	7694	5275	28739	41708
VEHICLES	9148	5215	28271	42634
TRIPS GENERATED	15376	10110	50307	75793
TRIPS ATTRACTED	11160	7027	39761	57948

The impedance of travel (F_{ij}) is typically a function of travel time between ZIP Codes. This is crucial for calculating the trip distribution using the gravity model. The table below shows the travel time between the centers of each ZIP Code. Along the main diagonal, the times recorded are from one extreme of the ZIP Code to another.

Table 6: Impedance of travel

	06905	06903	06902
06905	8	11	12
06903	11	20	16
06902	12	17	17

The method used to estimate the trip distribution is the Gravity Model. The gravity model uses the trips generated (P_i), the trips attracted (A_j), and the impedance of travel (F_{ij}). The zone-to-zone adjustment factor (K_{ij}) is assumed to be 1 in this case. The equation and first iteration of the gravity model can be found below.

Equation 7: Trip distribution estimation using the Gravity Model

$$T_{ij} = P_i \frac{A_j F_{ij} K_{ij}}{\sum_{n=1}^{i} A_j F_{ij} K_{ij}}$$

Table 7: Trips produced – first iteration

	06905	06903	06902	PRODUCTIONS
06905	2133	1214	37289	40636
06903	2098	1580	35581	39259
06902	2216	1300	36591	40106

The computed attractions can be determined by taking the sum of the corresponding column for each ZIP Code. These attractions are quite far off from the ones obtained in Table 5. To get a set of attractions closer to the ones computed in Table 5, an adjusted attraction factor must be used. This factor is the sum of the corresponding column (A_j) divided by the computed attractions in Table 5 ($C_{j(k-1)}$), multiplied by the sum of the corresponding column ($A_{j(k-1)}$).

Equation 8: Adjusted attraction factor

$$A_{jk} = \frac{A_j}{C_{j(k-1)}} A_{j(k-1)}$$

Table 8: Attractions

	06905	06903	06902
COMPUTED ATTRACTIONS	6447	4093	109461
GIVEN ATTRACTIONS	11160	7027	39761
ADJUSTED ATTRACTIONS	19318	12063	14443

This set of three new adjusted attractions are now used for a second iteration instead of the ones from Table 5. Using the adjusted factor results in the computed attractions being closer in value to the given attractions from Table 5. The results of the second iteration are below.

Table 9: Trips produced – second iteration

	06905	06903	06902	PRODUCTIONS
06905	5160	2913	18932	27004
06903	4771	3562	16975	25308
06902	5223	3038	18100	26362
COMPUTED ATTRACTIONS	15154	9513	54007	

Mode Choice

Mode choice can be estimated by using journey-to-work data for the ZIP Code. The primary mode of transportation is driving alone in a car, truck, or van. The mean travel time to work is 26.7 minutes in the ZIP code. The journey-to-work data for 06905 can be found below.

Table 10: Journey-to-Work Data for 06905

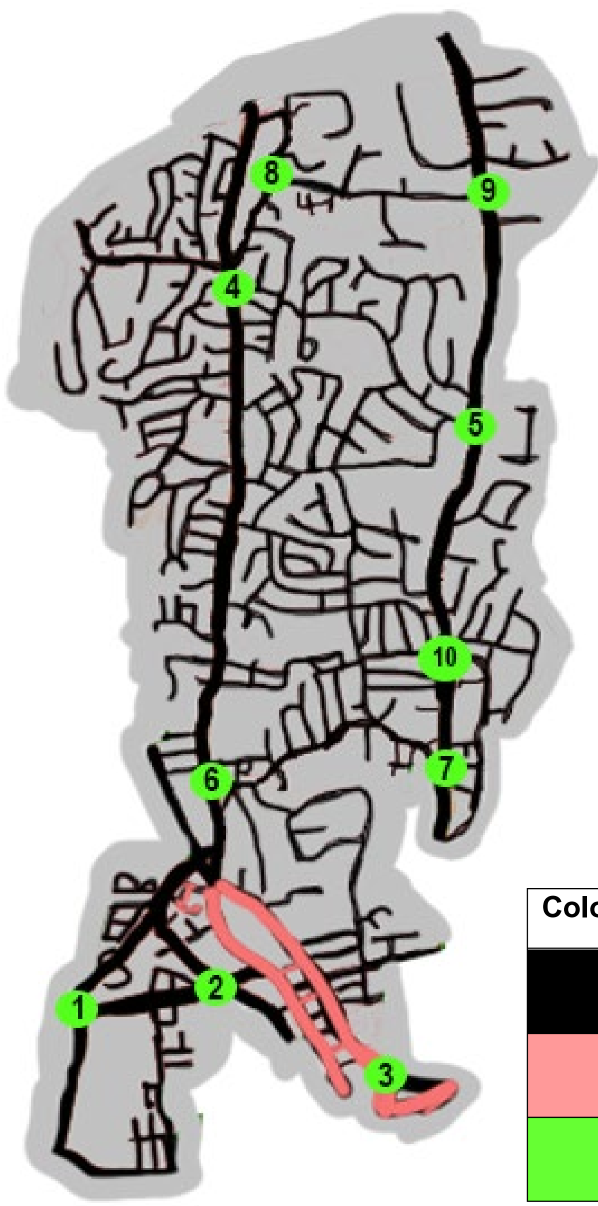
MODE OF TRANSPORTATION	2019	%
CAR, TRUCK, OR VAN – ALONE	8,123	73.8%
PUBLIC TRANSPORTATION	1,112	10.1%
CAR, TRUCK, OR VAN – CARPOOLED	1,057	9.6%
WORKED FROM HOME	406	3.7%
WALKED	271	2.5%
OTHER MEANS	41	0.4%

The percentage of the population of the ZIP Code who chose to transport by car, truck or van is 83.4%, while the percentage who chose to use public transportation was 10.1%. Others either worked from home or walked.

Trip Assignment

The trip assignment map depicts 10 nodes placed throughout the ZIP code. These nodes have been placed at popular intersections. There are not many one-way roads throughout the ZIP Code, but there is a large concentration of them in the southern part of the ZIP Code. The tables on the following page show information on each node and some travel times between them.

Figure 4: Trip assignment map



Color	Key
	Two-Way Road
	One-Way Road
	Node

Table 11: Node intersections

NODE	INTERSECTION
1	Stillwater Road and Bridge Street
2	Washington Boulevard and Bridge Street
3	Bedford Street and Hoyt Street
4	High Ridge Road and Vine Road
5	Newfield Avenue and Vine Road
6	High Ridge Road and Oaklawn Avenue
7	Newfield Avenue and Oaklawn Avenue
8	Turn of River Road and Intervale Road
9	Newfield Avenue and Newfield Drive
10	Newfield Avenue and Belltown Road

Table 12: Assumed travel times between nodes

NODES	TIME (MIN)	NODES	TIME (MIN)
1 → 2	2	**2 → 4**	5
1 → 3	4	**2 → 5**	7
1 → 4	6	**2 → 6**	3
1 → 5	8	**2 → 7**	5
1 → 6	4	**2 → 8**	6
1 → 7	5	**2 → 9**	8
1 → 8	7	**2 → 10**	5
1 → 9	9	**3 → 4**	6
1 → 10	6	**3 → 5**	6
2 → 3	5	**3 → 6**	4

References

Census Data From 2019. 2021, data.census.gov/.

"Zip Code 06905 Profile, Map and Demographics." *ZipDataMaps*, 2021, www.zipdatamaps.com/06905.

"CTTransit Route Map" *CTTransit*, 2018, https://www.cttransit.com/sites/default/files/maps/division/stam_MAR2018_local.pdf.

Google Maps, 2021, https://www.google.com/maps/.