Traffic Impact Assessment
Oxhead Rd & Stony Brook Rd

Report Due Date: December 19th, 2019

CIV305
Group 7

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Executive Summary

From a theoretical standpoint, traffic engineers aim to construct or improve upon the means of ground transportation such as roads and intersections. Ideally, this would reduce congestion and improve traffic flow within an area of interest. In 2016, Stony Brook University's former President Samuel L. Stanley along with Brookhaven Town Highway Superintendent Daniel P. Losquadro (and Brookhaven Town Supervisor Edward P. Romaine) announced a $1 Million state-funded project focused primarily on improving traffic safety on Stony Brook Road. Specifically, construction during this project would include the installation of a new left turn lane at existing signalized intersections, the extension of bike lanes along Stony Brook Road, as well as improving pedestrian crossing signals within the intersection.

Figure 1 (Left): Stony Brook Road @ Oxhead Road Intersection Before Installation of Left Turning Lane

Figure 2 (Right): New Sidewalk Development along Stony Brook Road

With the completion of the project in Fall 2019, it has become a topic of interest as engineers to conduct studies around the intersection of Oxhead Road and Stony Brook Road to evaluate the changes that occurred. Ultimately, we want to determine whether the additions favorably impacted the traffic flow, specifically the issue of saturation flow on the left turning lane on the southbound Stony Brook Rd approach.

In order to study the effectiveness of the renovations two types of counts were taken, a 5 minute volume count and a signal cycle count. Both of these were conducted for each approach during the AM, midday (MD) and PM peaks. The dates and times in which the intersection was analyzed includes:

November 19th	5:25 PM	December 3rd	12:05 PM
November 20th	8:20 AM	December 3rd	5:20 PM
November 21st	12:10 PM	December 4th	8:15 AM

Using the data collected, the Average Daily Traffic (ADT), Average Annual Daily Traffic (AADT), and Platoon Ratio values were calculated for each approach to determine the condition of the current intersection.

The findings of that resulted from the calculations is that the new dedicated left-turn lane on the Southbound approach still overflows into the southbound thru lane during the peak periods especially the AM and PM. We recommend the addition of a dedicated left-turn phase to the signal cycle. This would help reduce the queueing of vehicles for multiple cycles and alleviate overflow into the thru lane. The addition of a dedicated turning phase would not significantly impact northbound traffic in the MD and PM peaks but would mildly increased queueing during the AM peak due to the sheer volume of traffic at that approach.

Table of Contents

1.0 - Introduction

Our group conducted a traffic impact assessment for the intersection at Oxhead Road and Stony Brook Road, shown in Figures 3 and 4. Our assessment included analyzing a series of traffic counts. To further our research, we solicited help from the Town of Brookhaven Superintendent of Highways, Daniel P. Losquadro, and the Brookhaven Town Supervisor, Edward P. Romaine. They were able to supply us with the Signal Timing Plan for the intersection of Oxhead Road at Stony Brook Road. After analyzing the Signal Timing Plan, we gained further insight on the range of improvements that should be made to improve the intersection.

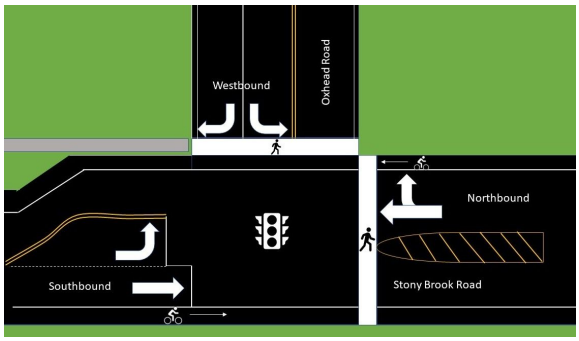

Figure 3 (Left): Aerial View of Analyzed Intersection

Figure 4 (Right): Graphic of Stony Brook Rd @ Oxhead Rd Intersection

1.1 - Problem Statement

Stony Brook Road, particularly at the intersection with Oxhead Road, underwent several roadway improvements during the Fall 2019 semester. One specific improvement of interest is the partitioning of a left-turn lane on the southbound approach of the Stony Brook @ Oxhead intersection - previous conditions are shown in Figure 1. This development granted about six left-turning vehicles a space to wait, without interrupting the flow of southbound thru traffic. This is significant as Stony Brook Road becomes heavily saturated during the PM peak period, as shown in Figure 5. Although the flow of southbound traffic has improved, there might still be room for further changes to the signal timing or signal plan to better serve the community. The goal of our traffic impact assessment was to study the intersection and suggest improvements to better manage the southbound thru traffic.

1.2 - Motivation

This problem is significant because our group conducted a traffic impact assessment to gauge the effectiveness of a very recent construction project. The study at this location was

insightful as many of us as take this route every day on our commute to and from school. Additionally, the project spanned several weeks, incurred major costs from labor and materials, and caused considerable delays from detours. As Stony Brook University students, it made sense to observe whether the improvements to this intersection were worth the cost. Pertaining to our class, this project allowed us to apply our skills to every step of the traffic assessment process, from problem identification, to field work and data analysis, to our final conclusions.

1.3 - Hypothesis

The main improvement to this intersection, the left-turning lane, does not adequately address the problems faced at the Stony Brook Road at Oxhead Road intersection. We hypothesized that this lane is not sufficient to completely eliminate the southbound thru traffic obstruction by left turning vehicles, especially during the AM and PM peaks. We believed that the southbound left turn lane should include a left turn signal to reduce the accumulation of vehicles whose queue overflows into the thru lane. The dedicated signal would also enhance the safety of the intersection to reduce possible collision that may occur.

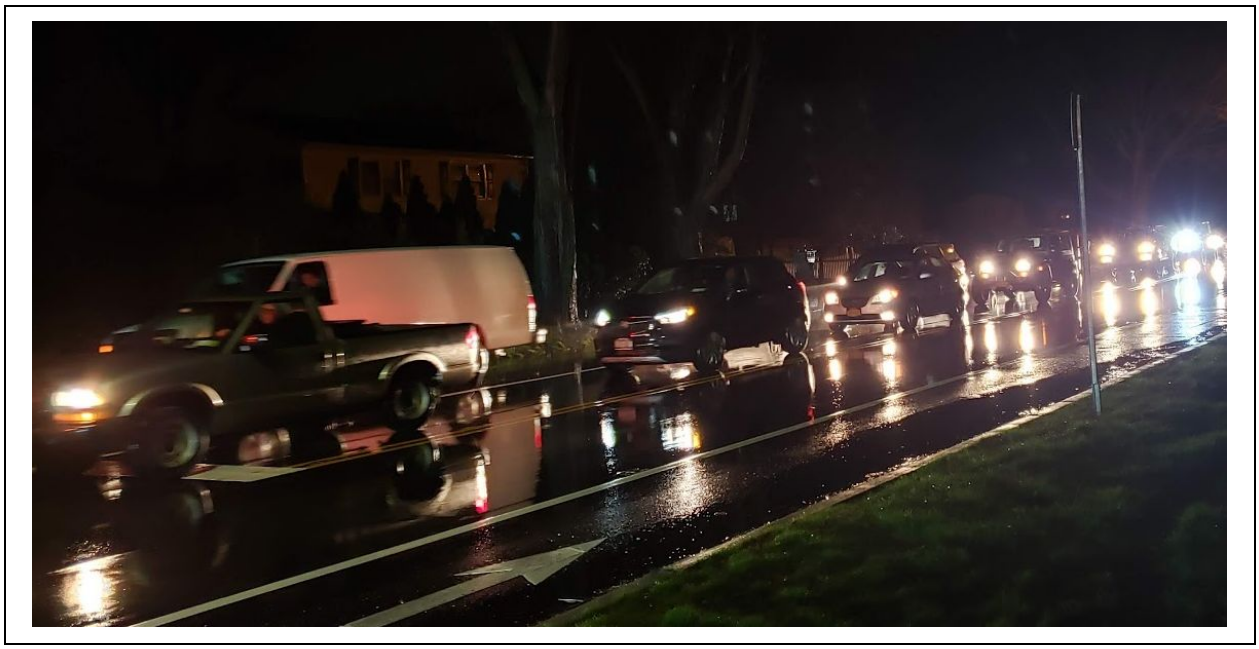

Figure 5: Stony Brook Rd Southbound approach with Full Left Turning Lane

2.0 - Approach and Methodology

2.1.0 - Approach

Our traffic impact assessment had the purpose of determining vehicle flow rates and queue lengths for the Oxhead Rd at Stony Brook Rd intersection. This was accomplished with 5 minute volume counts in addition to a count for each signal cycle. Counts were conducted for the northbound, westbound, and southbound approaches, with weekday counts in the AM, PM, and midday (MD) peaks. The study times were specifically chosen to allow us to analyze the intersection at its busiest. We determine an AM peak of 8-9am due to the assumption that most students arrive to their 8 and 8:30am classes late. For the MD peak we assumed 12-1pm as this is the middle of the day when students who only have morning classes are leaving and those with later courses arriving. Also this time is in the middle of most peoples days. The PM peak was assumed to be from 5-6pm. The reason for this was to catch Stony Brook students heading home after their afternoon courses, or arriving for night classes. This peak would also catch the flow of teachers and athletes leaving the Junior High on Oxhead Rd after extracurricular events.

As there are many variables in traffic flow, we conducted two samples for each set, one in November and one in December. The dates and times observed were:

--1st AM (11/20) - 8:20 AM | 2nd AM (12/4) - 8:15 AM
--1st MD (11/21) - 12:10 PM | 2nd MD (12/3) - 12:05 PM
--1st PM (11/19) - 5:25 PM | 2nd PM (12/3) - 5:20 PM

2.1.1 - 5 Min Vehicle Count

In order to calculate the volume of traffic for a specific time frame, the number of vehicles that went through the intersection were tracked during 6 consecutive 5 minute intervals. Each of these 5 minute intervals were tracked for the North, South, and Westbound approaches. The North, South and Westbound approaches are shown in Figures 6, 8 and 7, respectively. The reason for using 5 minute intervals as opposed to 30 minute intervals was to get a more accurate average value for the 30 minute and 60 minute flow values. The Average Daily Traffic (ADT) and Average Annual Daily Traffic (AADT) values for each direction of flow at this intersection can be found using this data.

2.1.1 - Signal Cycle Counts

At the intersection, the Northbound (Stony Brook Rd), Southbound (Stony Brook Rd) and Westbound (Oxhead Rd) approaches were also tracked through a cycle count based on the traffic signal intervals (green-yellow-red) within an approximate 30 minute period. As the traffic signals within the intersection are actuated rather than fixed or timed, the traffic light sequence is dependent on whether vehicles arrive on the westbound (Oxhead Rd) approach. As a result, the cycle counts may exceed the intended 30 minute interval.

2.2 - Pedestrians and Bikes

For the intersection analysis, pedestrians and bikers were ignored. The number of bikers and pedestrians that went through the intersection was insignificant. The greatest number of pedestrians and bikers during any observation was 5 and 2 respectively. Had the number of pedestrians and bikers been larger, their presence could be considered due to their usage of the signalized pedestrian crossing on the northbound and westbound approaches.

2.3 - Platoon Ratio

To analyze the effectiveness of the traffic signal at dispersing the queue build up, we observed traffic patterns going through the intersection. This included counting each queue at the beginning of the red light and green light, as well as, traffic going through the intersection during the effective green interval. With these values, the Platoon Ratio can be calculated. The Platoon Ratio determines the quality of the traffic progression through the intersection. If a Progression Quality of very poor (1) or unfavorable (2) is found within the traffic analysis, improvements should be made to the intersection.

3.0 - Analysis

Below is the analysis of the Stony Brook Road at Oxhead Road intersection. The analysis is split into the 5 minute count and the signal cycle count. Each section is then split again into a separate analysis of North, West, and Southbound approaches. North and Southbound traffic flows are on Stony Brook Road, while Westbound traffic flow is on Oxhead Road.

3.1 - 5 Minute Count

After performing the six consecutive 5 minute counts, the average value for a 5 minute count in each direction was found. This average value is multiplied by 12 to find the average number of cars that passed through the intersection per hour. The hourly, daily, and monthly expansion factors were found in tables 4.6, 4.7, and 4.8 in the textbook, Traffic and Highway Engineering 5th Edition by Garber, N. and Hoe, L. To find the total volume in a 24 hour period, the average hourly volume is multiplied by the hourly expansion factor. The total average volume for a week was found by multiplying the total 24 hour volume by the daily expansion factor. The ADT is then found by dividing the average weekly volume by seven. The AADT is then found by multiplying the average daily traffic by the monthly expansion factor.

The Northbound lane group AADT was maximum during the AM peak, with an average value of approximately 28,868 vehicles per day. The Southbound lane group AADT was maximum during the PM peak, with an average value of approximately 18,058 vehicles per day.

The Westbound lane group AADT was at maximum during the AM peak, with an average value of approximately 10,501 vehicles per day.

3.1.1 - North Bound

Figure 6: Northbound Approach

During the AM peak, the lane group AADT was maximum at a value of 28,868 vehicles per day. The thru traffic had an AADT of 27,767 vehicles per day. The right turning traffic had an AADT of 1,102 vehicles per day. For the AM peak, the difference in the AADT values is a result of large volume of traffic commuting northbound to Stony Brook University.

During the MD peak, the lane group AADT was 12,096 vehicles per day. The thru traffic had an AADT of 11,198 vehicles per day. The right traffic had an AADT of 898 vehicles per day. The large amount of thru traffic is a result of people going to South P Lot to attend their class. It is less than the thru AADT of AM peak as there are less people attending classes that start in the afternoon rather than the morning.

During the PM peak, the lane group AADT was 8,879 vehicles per day. The thru traffic had an AADT of 6,749 vehicles per day while the right traffic had an AADT of 2,130 vehicles per day. The reduction in AADT both in thru and right traffic as compared to AM and MD is a result of most classes being finished by 5PM, causing a significant reduction in the amount of people going to Stony Brook University.

3.1.2 - West Bound

Figure 7: Westbound Approach

Since this is a T-intersection, the westbound approach can make a left or right turn. During the AM, the overall approach had an AADT of 10,663 vehicles per day. The left lane had an AADT 2,585 vehicles per day and the right lane had an AADT of 8,078 vehicles per day. This is considerably less than the northbound traffic, as Oxhead is not too heavily congested. The majority of traffic turning right can be likened to the fact that the majority of students arrive to campus.

During the MD peak, the left lane AADT was 577 vehicles per day while the right lane AADT was 2,932 vehicles per day.

During the PM peak, the left lane AADT was 1,620 vehicles per day. The right lane AADT was 1,995 vehicles per day. The reduction in the right lane AADT is a result of most classes being finished at Stony Brook, so most people are leaving campus, and not going to South P Lot. The uptick in overall vehicles can be attributed to the Junior High School on Oxhead Rd, with teachers and athletes leaving for the day.

3.1.3 - South Bound

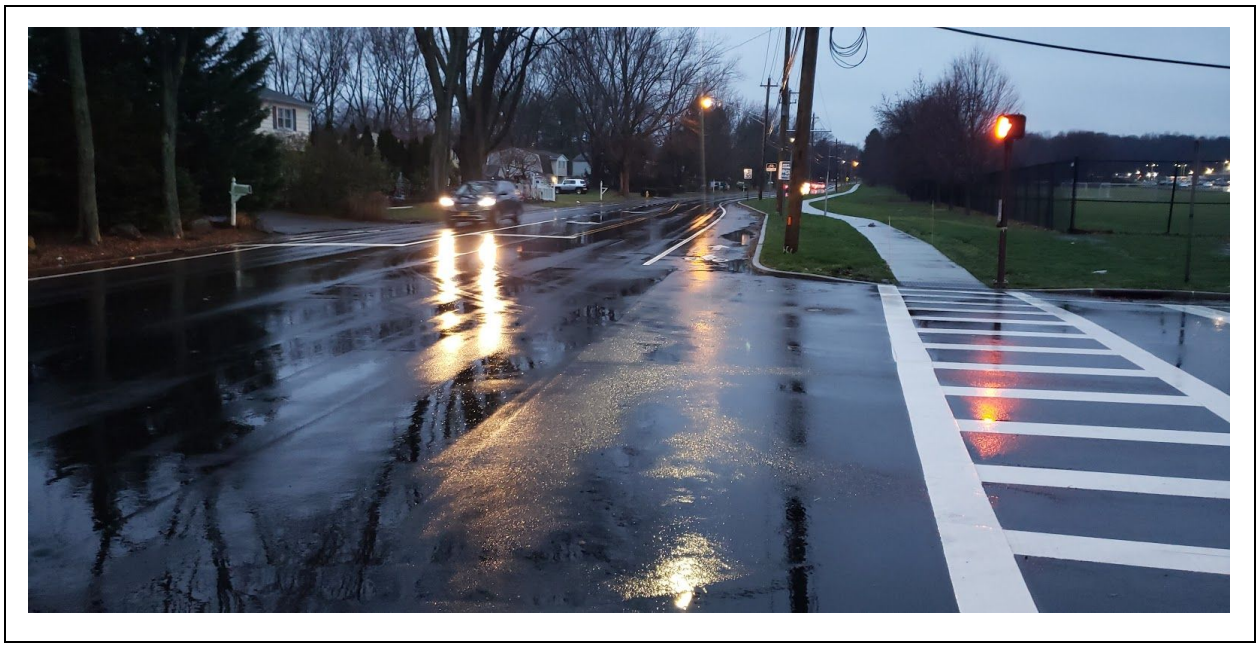

Figure 8: Southbound Approach

The thru lane AADT hit a maximum value of 14,283 vehicles per day during the PM peak. The left lane AADT also hit a maximum value during the PM peak, hitting 4,803 vehicles per day. The reason for the discrepancy between the left and thru lanes of traffic has to do with how during the evening, most people are heading to route 347 to head home from school and work.

The maximum AADT values for the AM and MD thru lane are 6,277 vehicles per day and 8,893 vehicles per day respectively. The maximum AADT values for the AM and MD left turn lane are 3,544 and 2,088 vehicles per hour respectively. Less people are heading southbound during the MD and AM periods since less people are heading away from the University during these time frames.

3.2 - Signal Count

After counting the amount of cars going through the intersection, the Platoon Ratio was found. To find the Platoon Ratio, first the averages of the Queue at Green (Q_G), Queue at Red (Q_R), and Thru Traffic (V) were computed. With the average values the proportion of all vehicles in the movement arriving during the green indication (P) was found. Next, the time for the effective green light (g), and the total time of the light cycle was found (C). The effective green light, and the total light cycle data was found by data given by the Town of Brookhaven. The Platoon Ratio was then found using P, C, and g.

3.2.1 - North Bound

The Platoon Ratio was not determined for the Northbound approach as it was not an area of interest for our project approach.

3.2.2 - West Bound

The Platoon ratio was also not determined for the Westbound approach not because of a lack of interest but rather the data accumulated for this area showed little to no progression flow, due to a small amount of vehicles at queue.

3.2.3 - South Bound

Shown in Table 1, several Platoon Ratio values were calculated and their corresponding Progression Qualities were determined for the Southbound direction. The Progression Quality for AM was either Unfavorable (2) or Very Poor (1), signifying a largely dense platoon (80% +) at the start of the red phase. MD Progression Quality was determined to be Random Arrivals (3), which signifies relatively random arrival of vehicles at the intersection at parts of the green and red phases. The Progression Quality during the PM period hovered between Random Arrivals (3) and Unfavorable (2), showing a relatively dense platoon during the red interval (40% - 80%). The Southbound direction, although congested, had periods where northbound thru traffic was light, allowing vehicles to perform left turns.

AADTs for Southbound Traffic

November - Wednesday

AM #1 SB

Name: Robert Seaman

	1	2	3	4	5	6
Left	5	9	12	13	4	5
Thru	16	6	13	11	15	13

	30m Vol	Hr Vol	HEF	24hr Vol	DEF	7day Vol	ADT	MEF	AADT
Left	48	96	29	2784	6.582	18324	2618	1.185	3102
Thru	74	148	29	4292	6.582	28250	4036	1.185	4782

December - Wednesday

AM #2 SB

Name: Robert Seaman

	1	2	3	4	5	6
Left	3	9	7	14	10	5
Thru	13	21	13	9	10	19

	30m Vol	Hr Vol	HEF	24hr Vol	DEF	7day Vol	ADT	MEF	AADT
Left	48	96	29	2784	6.582	18324	2618	1.354	3544
Thru	85	170	29	4930	6.582	32449	4636	1.354	6277

Comments - 2 Bikers during 5th 5 minute interval

November - Thursday

MD #1 SB

Name: Robert Seaman

	1	2	3	4	5	6
Left	10	4	10	5	9	9
Thru	30	32	32	22	19	25

	30m Vol	Hr Vol	HEF	24hr Vol	DEF	7day Vol	ADT	MEF	AADT
Left	47	94	18.71	1759	7.012	12332	1762	1.185	2088
Thru	160	320	18.71	5987	7.012	41982	5997	1.185	7107

MD #2 SB

December - Tuesday

Name: Robert Seaman

	1	2	3	4	5	6
Left	3	8	7	1	8	6
Thru	32	34	24	17	21	31

	30m Vol	Hr Vol	HEF	24hr Vol	DEF	7day Vol	ADT	MEF	AADT
Left	33	66	18.71	1235	7.727	9542	1363	1.354	1846
Thru	159	318	18.71	5950	7.727	45974	6568	1.354	8893

November - Tuesday

PM #1 SB

Name: Robert Seaman

	1	2	3	4	5	6
Left	22	11	21	23	29	12
Thru	61	37	65	66	57	66

	30m Vol	Hr Vol	HEF	24hr Vol	DEF	7day Vol	ADT	MEF	AADT
Left	118	236	13.85	3269	7.727	25256	3608	1.185	4276
Thru	352	704	13.85	9750	7.727	75341	10763	1.185	12754

December - Tuesday

PM #2 SB

Name: Robert Seaman (Thru) and Aaron Marizadeh (Left)

	1	2	3	4	5	6
Thru	45	63	54	67	64	52
Left	30	16	16	10	23	21

	30m Vol	Hr Vol	HEF	24hr Vol	DEF	7day Vol	ADT	MEF	AADT
Thru	345	690	13.85	9557	7.727	73843	10549	1.354	14283
Left	116	232	13.85	3213	7.727	24828	3547	1.354	4803

Table 1 - Platoon Ratios for Southbound Left Turning Traffic

SB Count	Platoon Ratio	Arrival Type	Progression Quality
AM #1	0.454	1	Very Poor
AM #2 (a)	0.841	2-3	Random - Unfavorable
AM #2 (b)	0.829	2	Unfavorable
MD #1	0.981	3	Random Arrivals
MD #2 (a)	1.158	3	Random Arrivals
MD #2 (b)	1.158	3	Random Arrivals
PM #1 (a)	1.02	3	Random Arrivals
PM #1 (b)	0.909	3	Random Arrivals
PM #2 (a)	0.848	2-3	Random - Unfavorable
PM #2 (b)	0.739	2	Unfavorable

4.0 - General Conclusion

It is our belief that the Stony Brook Road and Oxhead Road intersection would benefit from a dedicated left turn signal on the southbound approach of Stony Brook Road. Specifically during the AM and PM peak when the left turning lane was observed to overflow into the thru lane of traffic frequently.

4.1 - Recommendation

Our recommendation to improve the level of service of the intersection is to implement a dedicated left turn signal for the southbound approach. This phase would be added after interval 9 of the current signal timing plan. This interval would continue the effective green time of phase 6, which is the movement of the southbound left-turn and thru lanes, for an additional 3 seconds. To maintain the current cycle length of 81 seconds, interval 8 will be reduced by 7 seconds to 43 seconds. This was determined by subtracting the new 3 second interval and interval 10 from interval 8. This new plan is only necessary for the AM and PM peaks due to the overflow not being observed in the MD peak.

In addition, the new phase could be actuated so it would it would only occur when the camera sensors recognize a vehicle queued in the left turn lane. This would be similar to how the

current plan is actuated for the westbound approach. This alternative would further reduce delays incurred on the northbound approach.

4.2 - Improve Traffic Flow

Implementing a left turn signal would improve southbound traffic flow since it would reduce left turn queue length. Presently, drivers with an intention to turn left onto Oxhead Road from Stony Brook Road, have a dedicated 152' turning lane. Assuming an average 20' vehicle length and 5 feet between each vehicle, the maximum capacity is roughly six cars. While this is a large improvement from the previous conditions with no left turning lane shown in Figure 1, it is not sufficient in times of heavy traffic flow. For our study, the intersection experienced the largest volume of traffic during the PM peak. Analyzing the data and taking into account our field observations, the left turning lane is often overcome by vehicular traffic. This causes queued left turning vehicles to block part of the thru lane. This effect is compounded from signal phase to signal phase as the queue at red often consisted of values greater than one vehicle. In extreme circumstances, nine vehicles were part of the queue red. With the implementation of a left turn signal, a portion of the queue would be able to clear the intersection, thus eliminating some of the queue at red. This would improve the overall traffic flow for both the thru and left lanes of the Stony Brook Rd southbound approach .

4.3 - Decrease Crash Frequency

The addition of a dedicated left-turn signal minimizes danger to drivers, bikers and pedestrians. Normally, in order to turn, a driver has to wait for a gap in northbound traffic during a green cycle, or inch into the intersection and turn during the red clearance phase (interval 11), which in turn poses a large risk to pedestrians and bikers. Several drivers become visibly frustrated and choose to take increased risk when turning in front of other vehicles. This would lead to an increased accident and near accident rate at the intersection. Likewise, when vehicles are making a rushed turn, they are less aware of pedestrians and bikers in the crosswalk which could lead to a vehicle-pedestrian collision. With a designated turn signal, drivers will have more opportunity to execute a left turn under safe conditions thus decreasing the risk of collision.

4.4 - Effect On Northbound Traffic Flow

Adding a dedicated left turn signal on the Southbound approach would have an insignificant effect on northbound thru traffic for the MD and PM peaks. Through analyzing our data, it is evident that the northbound MD and PM peak period queue at red (QR) is virtually nonexistent during this time frame. Therefore, halting the flow of traffic northbound for a few seconds to allow for a dedicated southbound left turn phase, would have little effect on the northbound flow.

During the AM peak the impact would be marginal but not insignificant. This is due to the heavy flow at the northbound approach mostly caused by Stony Brook University commuter

students. The addition of the new signal phase would increase the queue at green as well as impact the platoon ratio for the approach.

5.0 - References and Sample Calculations

5.1 - References

Garber, N., and Hoel, L. Traffic and Highway Engineering. Cengage Learning (Fifth Edition). Cengage Learning, 2014.

Google Maps, 2019.

Town of Brookhaven. “Signal Timing at Oxhead Road at Stony Brook Road, Stony Brook .” 1 Independence Hall, 2019.

5.2 - Sample Calculations

AADT for SB Thru Traffic @ 8AM on a Wednesday in November

$$\begin{aligned} average\ 5\ minute\ volume &= \frac{1}{6}\sum(5\ minute\ counts) \\ &= \frac{16+6+13+11+15+13}{6} \\ &= 12.33\ vehicles\ per\ 5\ minutes \end{aligned}$$

$$\begin{aligned} average\ hourly\ volume &= (average\ 5\ min\ volume) \times 12 \\ &= 12.33 \times 12 \\ &= 148\ vehicles\ per\ hour \end{aligned}$$

assume factors given in Tables 4.6, 4.7, and 4.8 apply

$$\begin{aligned} total\ volume\ for\ 24\ hr\ period &= (HEF) \times (volume\ for\ particular\ hour) \\ &= 29 \times 148 \\ &= 4{,}292\ vehicles\ per\ day \end{aligned}$$

$$\begin{aligned} average\ total\ volume\ for\ week &= (DEF) \times (average\ volume\ for\ particular\ day) \\ &= 6.582 \times 4292 \\ &= 28{,}249.94 \approx 28{,}250\ vehicles\ per\ week \end{aligned}$$

$$\begin{aligned} ADT &= (average\ total\ volume\ for\ week)/7 \\ &= 28{,}249.94/7 \\ &= 4{,}035.7 \approx 4{,}036\ vehicles\ per\ day \end{aligned}$$

$$\begin{aligned} AADT &= (MEF) \times (ADT) \\ &= 1.185 \times 2181.46 \\ &= 4{,}782.3 \approx 4{,}783\ vehicles\ per\ day \end{aligned}$$

Platoon Ratio for SB Left Turn Traffic @ 8 AM on a Wednesday in November

$$Average\ Q_G = \frac{1}{26}\sum Q_G$$
$$= 2.308$$

$$Average\ Q_R = \frac{1}{26}\sum Q_R$$
$$= 1.615$$

$$Average\ V = \frac{1}{26}\sum V$$
$$= 1.692$$

$$P = \frac{(V - Q_G) + Q_R}{V + Q_G}$$
$$= \frac{(1.692 - 2.308) + 1.615}{1.692 + 2.308}$$
$$= 0.302$$

$$g = 50 + 3.9$$
$$= 53.9s$$
$$C = 53.9 + 2 + 2 + 23$$
$$= 80.9s$$

$$R_p = P(\frac{C}{g})$$
$$= (0.302)(\frac{80.9}{53.9})$$
$$= 0.454$$

5.3 - Figures

Figure 1: Stony Brook Road @ Oxhead Road Intersection Before Installation of Left Turning Lane

Figure 2: New Sidewalk Development along Stony Brook Road

Figure 3: Aerial View of Analyzed Intersection

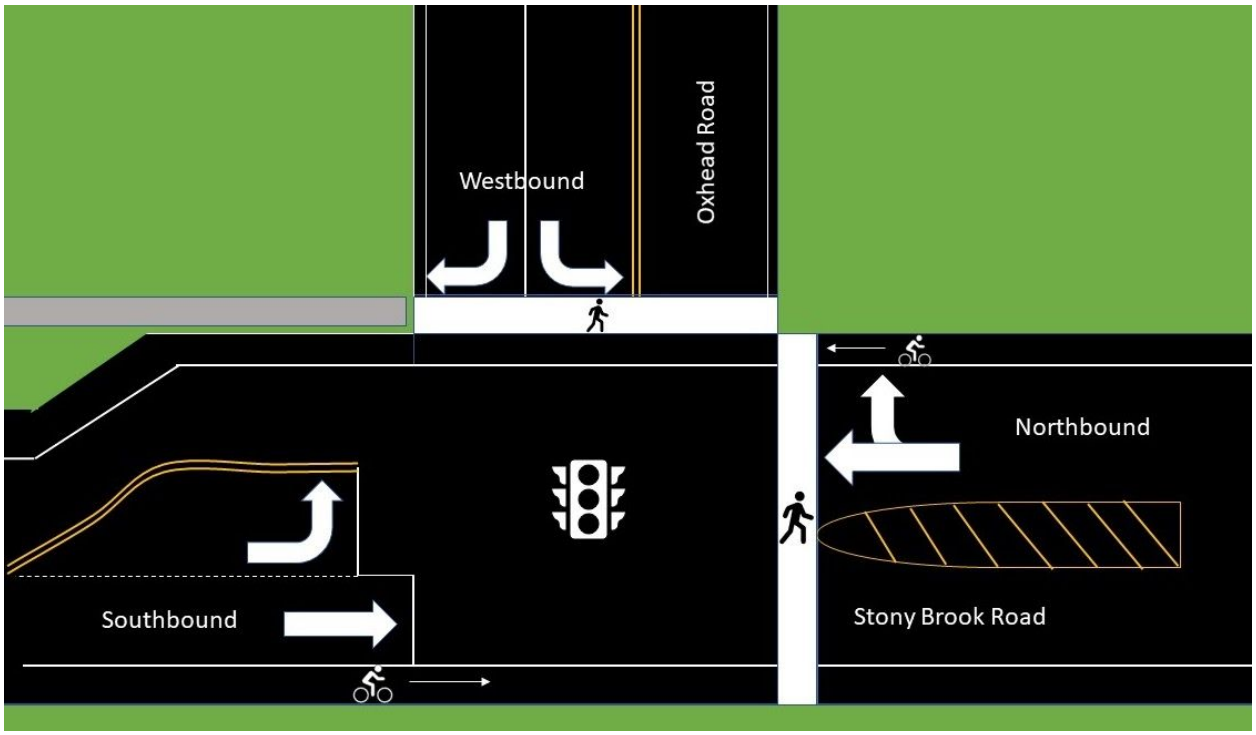

Figure 4: Graphic of Stony Brook Rd @ Oxhead Rd Intersection

Figure 5: Stony Brook Rd Southbound approach with Full Left Turning Lane

Figure 6: Northbound Approach

Figure 7: Westbound Approach

Figure 8: Southbound Approach