



Ministry of Transportation, Ontario

**HIGHWAY 407 TRANSITWAY:  
TRANSPORTATION STUDY FOR PROPOSED KENNEDY  
STATION**

---

FINAL REPORT

DECEMBER, 2010





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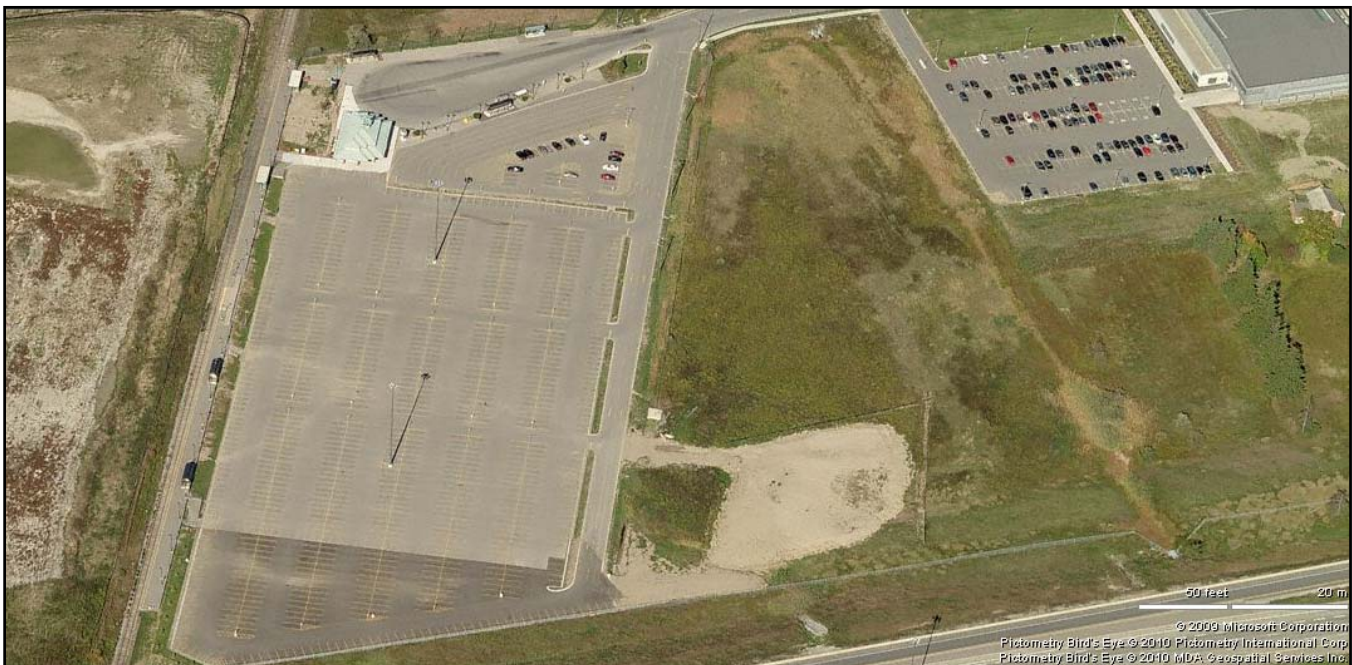
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## 1. INTRODUCTION

This transportation study report presents the preliminary findings of traffic analysis of the proposed 407 Transitway Kennedy Station. The station will be located at the site of the existing Unionville GO Station on the east side of the GO Transit Stouffville Line rail tracks and the south side of YMCA Boulevard (**Exhibit 1-1**). The analysis assesses the ability of the preferred alternative geometric layouts to accommodate projected traffic volumes.

**Exhibit 1-1 Aerial View of Proposed Kennedy Station Site**



### 1.1 Report Outline

The subsequent sections of this transportation study report are as follows:

- Section 2 – Summary of the Proposed Development;
- Section 3 – Scope for the Transportation Study;
- Section 4 – Existing Condition (2010) Analysis and Results;
- Section 5 – Future Background Condition (2031) Analysis and Results;
- Section 6 – Proposed Kennedy Station Related Traffic;
- Section 7 – Future Total Condition (2031) Analysis and Results; and
- Section 8 – Summary and Conclusions.

## 1.2 Key Issues

Key issues addressed in this transportation study report include the following:

- The existing and background traffic conditions at Study Area intersections;
- Consider background traffic growth due to both corridor growth and area specific development such as Downtown Markham (Markham Centre), a large mixed-use development centred along Enterprise Boulevard just west of the proposed station;
- The estimate of traffic generated by the proposed Kennedy Station park-and-ride;
- The assignment and distribution of site generated traffic;
- Identify and develop specific geometric configurations of the proposed access intersection(s) to the Kennedy Station to mitigate future traffic impacts; and
- Potential site access geometric configurations and other measures to mitigate projected traffic impacts.



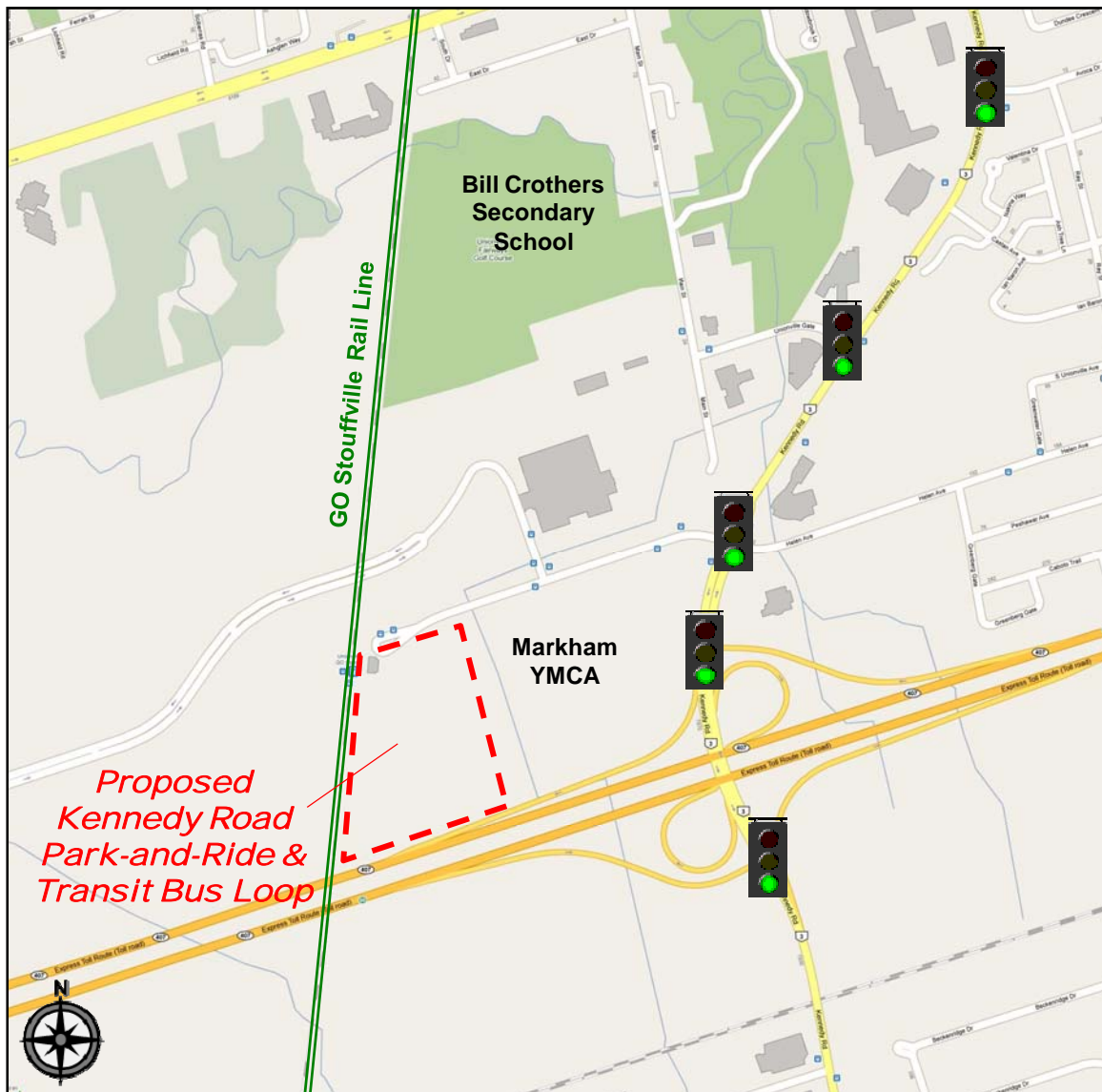
## 2. THE PROPOSED DEVELOPMENT

### 2.1 Station Location

The proposed 407 Transitway Kennedy Station ("Proposed Station") will be located at the site of the existing Unionville GO Station ("Subject Site") on YMCA Boulevard at the GO Transit Stouffville Line rail tracks. The Subject Site is located in the Town of Markham and its municipal address is 7970 Kennedy Road. The existing Unionville GO Station consists of a station building, a bus loop at the end of YMCA boulevard, a passenger pick-up and drop-off (PPUDO) area and 1,506 parking spaces (1,206 spaces in the main lot and 300 spaces in the east lot).

A map showing the location of Subject Site and Proposed Development is in **Exhibit 2-1**.

**Exhibit 2-1: Proposed Kennedy Station Site and Vacinity**



## 2.2 Site Plan

A site plan for the preferred station concept is shown in **Exhibit 2-2**. The proposed Kennedy Station will serve as a regional intermodal station for passengers transferring between the proposed 407 Transitway and existing GO Transit rail and regional bus services and Viva and YRT bus services. Based on the location, future transit oriented development (TOD) opportunities existing along both sides of YMCA Boulevard.

The northern portion of the Subject Site includes the existing Unionville Station building, a revamped passenger pick-up and drop-off (PPUDO) area and loading area for local buses. Viva buses will have their own dedicated ramp that connects Enterprise Drive with the Subject Site and YMCA Boulevard. At the southern portion of the Subject Site, a proposed Metrolinx parking structure will replace the existing surface parking lots.

The existing GO Transit parking lot has approximately 1,506 parking spaces. A new on-site parking structure is being proposed by Metrolinx and GO Transit that will essentially double the parking capacity of this station. As this parking expansion is still being planned, the future size of the parking lots has not been finalized. Therefore, for the purposes of this transportation study, the number of additional parking spaces was assumed to be the following: 407 Transitway users – 1,120 parking spaces and for carpool users – 200 parking spaces. When completed, the parking structure will have a total estimated 2,826 parking spaces.

The site plan for Kennedy Station at grade level shows the proposed 407 Transitway alignment below grade, running east-west. The alignment includes a 407 Transitway Platform Below and a Vertical Connection to 407 Transitway Platforms Below. The station is located near the intersection of Enterprise Blvd and Ymca Blvd. The plan also shows potential developable land, potential public open space, and potential GO station. The station is situated between the 407 Transitway and the 407 Highway (Westbound and Eastbound). The plan includes a key plan showing the location of the station within the Greater Toronto Area. The plan also includes a scale bar and a legend.

**Legend:**

- 407 BRT ROUTE (Green line)
- BRT STATION (Red rectangle)
- VERTICAL ACCESS (Orange rectangle)
- LOCAL BUSES (Pink rectangle)
- VIVA BUSES (Purple rectangle)
- POTENTIAL DEVELOPABLE LAND (Blue dashed line)

**Scale:** 1:2000

**Key Plan:** Shows the location of Kennedy Station within the Greater Toronto Area, near the intersection of Highway 407 and Highway 7.

**Site Plan Labels:**

- ENTERPRISE BLVD
- YMCA BLVD
- POTENTIAL DEVELOPABLE LAND
- FUTURE VIVA VERTICAL CONNECTION
- DEDICATED VIVA BRT / LRT RAMP
- FUTURE PEDESTRIAN ACCESS TO VIVA PLATFORMS
- POTENTIAL GO STATION
- KENNEDY TRANSITWAY STATION
- TRANSITWAY BELOW GRADE
- POTENTIAL VERTICAL ACCESS TO TRAIN PLATFORM
- PROPOSED METROLINK PARKING STRUCTURE LOCATION
- VERTICAL CONNECTION TO 407 TRANSITWAY PLATFORMS BELOW
- 407 TRANSITWAY PLATFORM BELOW
- ROADWAY AT GRADE
- POTENTIAL PUBLIC OPEN SPACE
- LOCAL BUSES
- POTENTIAL DEVELOPABLE LAND
- PROPOSED 407 TRANSITWAY ALIGNMENT BELOW GRADE
- PROPOSED ROAD
- HWY 407 (WESTBOUND)
- HWY 407 (EASTBOUND)

### 3. STUDY SCOPE

#### 3.1 Study Area

The Study Area for the transportation study is generally bounded by Unionville Gate to the north, the Highway 407 Westbound Off-Ramp to the south, Kennedy Road to the east and the GO Transit Stouffville Line rail tracks to the west. A list of all Study Area intersections analyzed in this study is shown in **Exhibit 3-1** and a map of the Kennedy Station Study Area is shown in **Exhibit 3-2**.

**Exhibit 3-1: List of Study Area Intersections**

No.	East-West Street	North-South Street	Intersection Type
1	Highway 407 Westbound Off-Ramp	Kennedy Road	Signalized
2	YMCA Boulevard / Helen Avenue	Kennedy Road	Signalized
3	Unionville Gate	Kennedy Road	Signalized
4	YMCA Boulevard	Enterprise Drive	Signalized
5	YMCA Boulevard	Station Access Road	Unsignalized

#### 3.2 Guidelines and Standards

Guidelines consulted for this study include the *York Region Transportation Impact Study (TIS) Guideline For Development Applications (August 2007)* and the *Ministry of Transportation, Ontario General Guidelines for the Preparation of Traffic Impact Studies (January 2008)*.

This study was carried out according to the accepted documents for geometric design standards outlined in the *York Region Road Design Guidelines*.

#### 3.3 Horizon Years and Analysis Periods

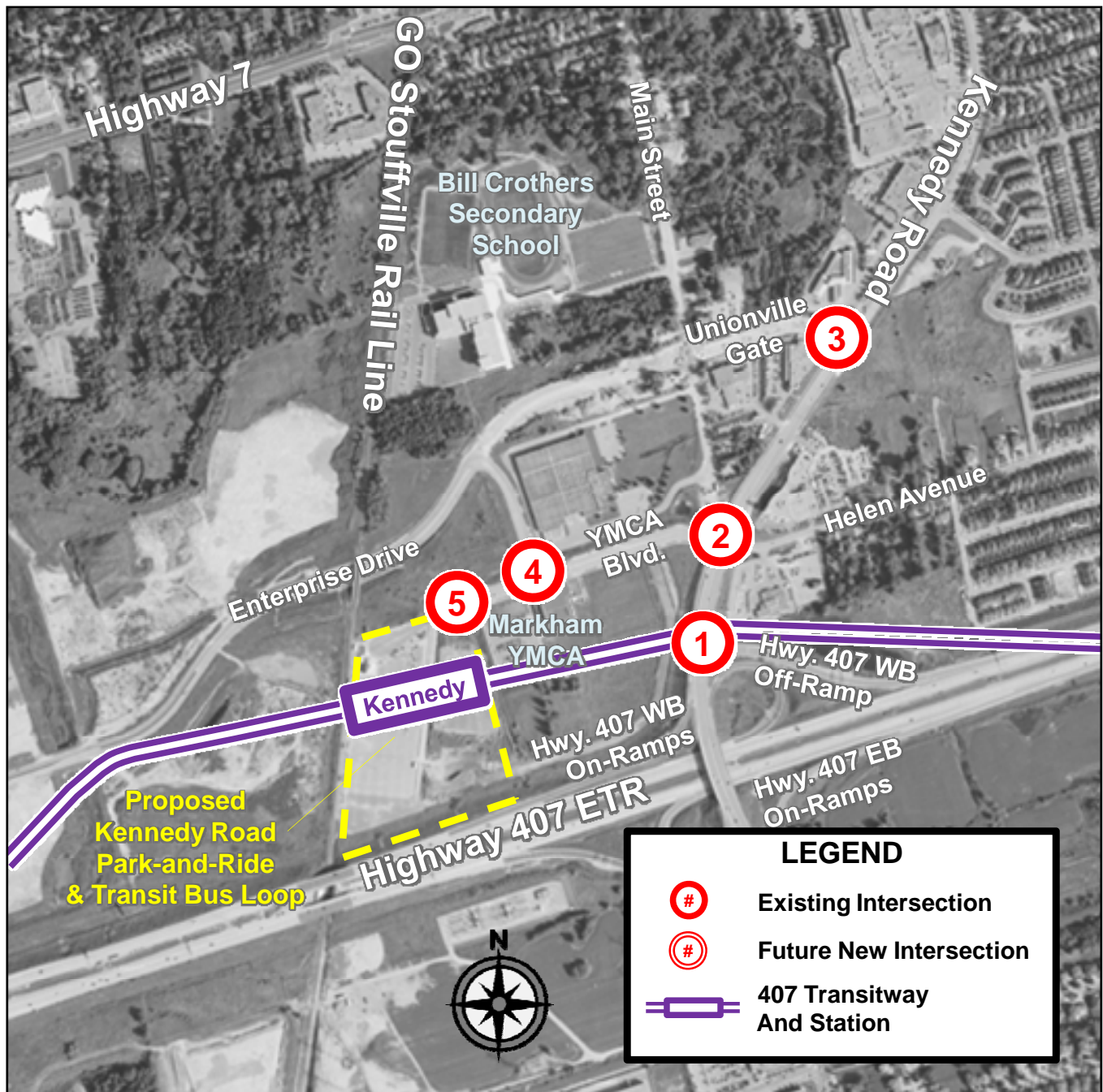
Based on these guidelines and proposed construction and operational dates for the 407 Transitway, the following existing and future horizon periods (conditions) were established as part of this study:

- 2010 (Existing Condition);
- 2031 (Background Condition);
- 2031 (Future Total Condition).

Performance of the road network was assessed during the weekday am peak hour and pm peak hour, which correspond to the peak hours for the proposed Kennedy Station.



**Exhibit 3-2: Study Area of Transportation Study**



## 3.4 Data Collection

### 3.4.1 TURNING MOVEMENT COUNTS

Turning movement counts for all Study Area intersections were obtained from York Region's Transportation Service's Department.

### 3.4.2 SIGNAL TIMING AND INTERSECTION CONFIGURATIONS

Current signal phasing and splits for the signalized study intersections were obtained from York Region's Transportation Service's Department. Intersection configurations were obtained through field studies undertaken by IBI Group staff.

## 3.5 Traffic Analysis Parameters

A Synchro signalized intersection analysis was conducted at all Study Area intersections under the existing, future background and future total traffic conditions. The operational analyses were primarily based on procedures set out in the Highway Capacity Manual (2000) with the assistance of Synchro 6.0 and Highway Capacity Software 2000. Signal cycle lengths, timing, and phasing currently in effect were obtained from York Region. The critical movements are identified for each time period.

### 3.5.1 CAPACITY AND LEVEL OF SERVICE

An intersection's overall operating conditions are typically characterized by two standard measures: the volume to capacity ratio (V/C) and the level of service (LOS). Taken together, they provide an indication of delay and the number of vehicles that can be accommodated through an intersection.

The V/C ratio is an indication of the volume of traffic attempting to make a specific movement through an intersection (i.e., northbound left, westbound straight through), versus the theoretical capacity of that movement given the lane configurations, operating conditions and signal timings provided at the intersection. A V/C ratio of 1.0 represents a condition where the theoretical capacity for a particular movement is being fully used.

The level of service (LOS) of the overall intersection of a particular movement is a measure of the average vehicle delay experienced by the motorists attempting to travel through the intersection. LOS is measured from "A" to "F" with peak hour LOS in the "A" to "D" range being considered acceptable by most and a LOS of F representing unacceptable delays.

York Region's *Transportation Impact Study (TIS) Guidelines Development Applications (August 2007)* and the Ministry of Transportation's *General Guidelines for the Preparation of Traffic Impact Studies (January 2008)* were consulted for the base parameters of this study.

Existing intersection capacity analyses were undertaken using the Highway Capacity Manual (HCM) methodology, and specifically the Synchro 6.0 Traffic Signal Coordination Software package by Trafficware. The analysis reflects the most recently available traffic volumes, current signal timings, and existing lane configurations. Peak hour factors (PHF) at each intersection were calculated using 15-minute and hourly count data.

Critical movements were identified as those operating with a volume-to-capacity (V/C) ratio of 0.85 or higher and/or the poorest level of service (LOS) among all movements.

### 3.5.2 QUEUE LENGTHS

A queue length for a turning movement that exceeds the length of the available storage bay or creates back-ups is a concern, particularly at a signalized intersection. These turning vehicles can potentially block through vehicles during a green light, which reduces the intersection efficiency.

The Synchro 6.0 Traffic Signal Coordination Software measures both the 50th percentile and 95th percentile maximum queue lengths. The 50th percentile queue (the median) is the maximum back of queue length during a typical traffic cycle. The 95th percentile queue is the maximum back of queue length during a typical traffic cycle with 95th percentile traffic volumes. The 95th percentile queue measures the queue length that 95 percent of the sample lies below.

95th percentile critical queue lengths were identified for movements where the queue surpassed the estimated length of the storage bay.

## 4. EXISTING CONDITION

### 4.1 Area Road Network

Major roadways in the Study Area include the following:

- Kennedy Road – Regional (Arterial) Road;
- Highway 407 Westbound Off-Ramp – 400 Series Provincial Highway;
- YMCA Boulevard / Helen Avenue– Urban (Local) Roads;
- Unionville Gate – Urban (Local) Road; and
- Enterprise Drive – Urban (Local) Road.

These are described in further detail below.

**Kennedy Road** is a four-lane north-south arterial road classified as a “regional primary arterial” and under the jurisdiction of York Region. According to 2009 York Region ATR counts, Kennedy Road carried approximately 40,000 vehicles per day within the Study Area. The 500 metre stretch of Kennedy Road between the Highway 407 Westbound Off-Ramp and Unionville Gate, there are three signalized intersections. Within the Study Area, the maximum posted speed on Kennedy Road is 60 km/h.



*Street View of Kennedy Road Looking North*



**Highway 407 Westbound Off-Ramp** allows westbound Highway 407 vehicles to exit to Kennedy Road. It consists of two westbound left-turn lanes and one westbound right-turn lane.



*Street View of Highway 407 Westbound Off-Ramp Looking West*

**YMCA Boulevard / Helen Avenue** are east-west urban local roadways that connect through Kennedy Road. YMCA Boulevard consists of four travel lanes and extends from the GO Train Stouffville Line rail tracks in the west with Kennedy Road in the east. Helen Avenue consists of two travel lanes and extends from just east of Harry Cook Drive in the east with Kennedy Road in the west.



*Street View of YMCA Boulevard Looking East*

**Unionville Gate** is an east-west urban local roadway that connects Main Street Unionville in the west with the west side of Kennedy Road in the east. It consists of one eastbound and one westbound travel lane with a dedicated eastbound left-turn lane at Kennedy Road.



*Street View of Unionville Gate Looking East*

**Enterprise Drive** is primarily an east-west urban local roadway that connects Warden Avenue with the north side of YMCA Boulevard. In the Study Area, it consists of two northbound and two southbound travel lanes.



*Street View of Enterprise Drive Looking South*

## 4.2 Lane Configurations

A map shown existing Study Area roadway lane configurations is shown in **Exhibit 4-2**. Through the Study Area, Kennedy Road consists of two northbound and two southbound travel lanes with dedicated left-turn lanes at key signalized intersections. The Highway 407 Westbound Off-Ramp has three westbound lanes: two left-turns and one right-turn. YMCA Boulevard has two eastbound and two westbound travel lanes. Unionville Gate has one eastbound and one westbound travel lanes. Enterprise Drive has two northbound and two southbound travel lanes.

## 4.3 Transit Services and Operations

**Exhibit 4-1** shows the existing local transit routes in the Study Area and corresponding weekday peak hour headways. In the vicinity of the Subject Site, transit bus routes include three Viva bus routes on Enterprise Drive and YMCA Boulevard: purple, green and pink and two YRT bus routes: Route #8 on Kennedy Road and Route #42 on YMCA Boulevard / Helen Avenue.

**Exhibit 4-1: Existing Bus Transit Routes Near/At Unionville GO Station**

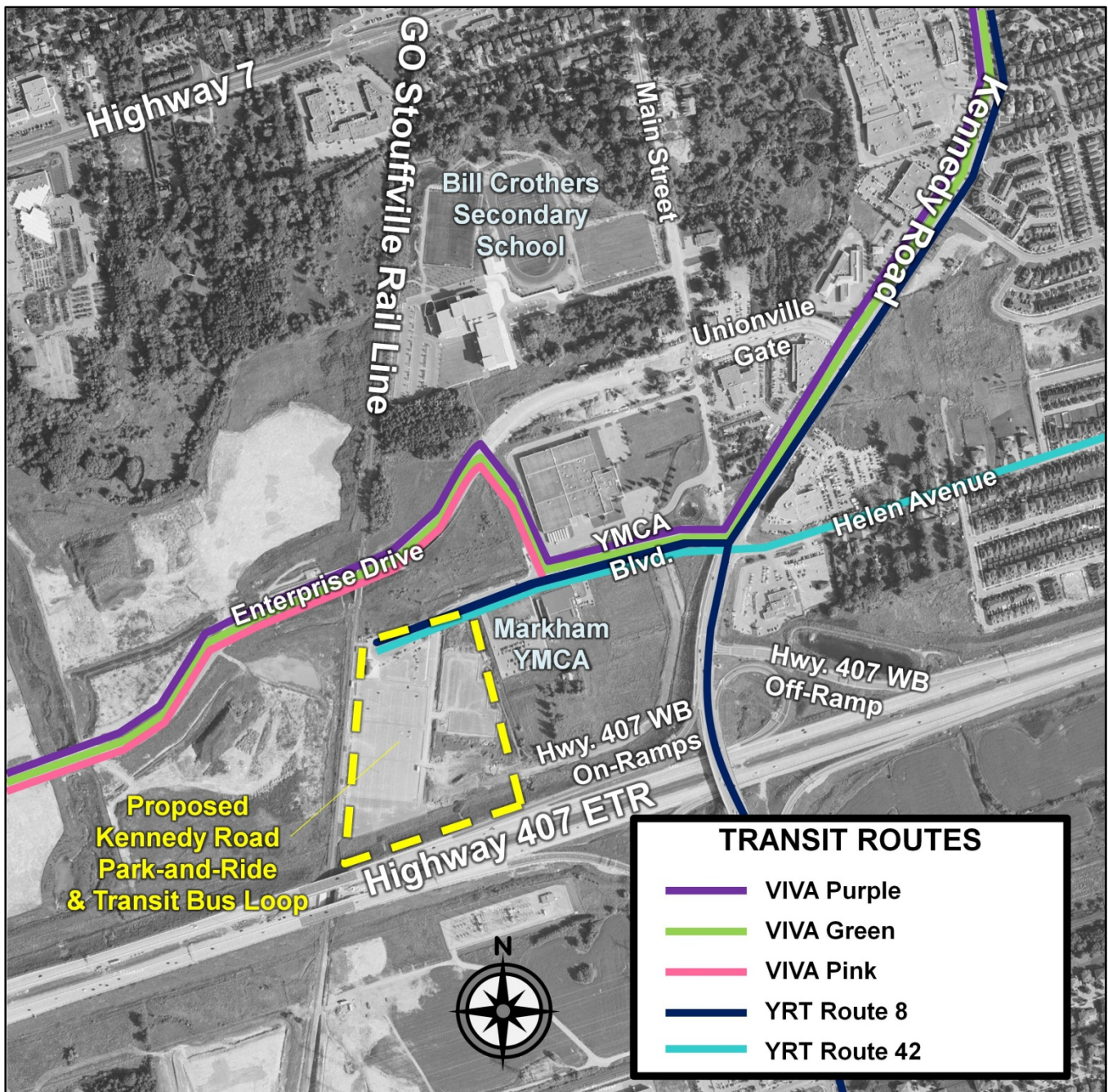
Operator	Route	Description	Weekday Peak Hour Headways (Minutes)
GO Transit	52 – Hwy 407 East GO Bus	York University to Oshawa Bus Terminal via Highway 407 and Markham Road with a stop at Unionville GO station	20
Viva	Pink (Peak Service Only)	Finch GO Bus Terminal to Unionville GO Station via Yonge Street and Highway 7	10
	Green	Don Mills Station to Highway 7 and McCowan via Don Mills Road, Warden Avenue and Highway 7 with stop on Enterprise Boulevard	15
YRT	8 – Kennedy	Kennedy & Steeles to Angus Glen Community Centre via Kennedy Road with a stop at Unionville GO Station	15
	42 – Berczy South Unionville	Unionville GO Station to Major Mackenzie Drive and Ridgecrest Road	30
	202 – Unionville GO Shuttle	Shuttle bus service between Unionville GO Station and Rodick Road/Woodbine Avenue during weekday peak periods only	30
	522 – Markham Community Bus	Hagerman's Corner to 122 Cornell Park Avenue via Kennedy Road and Highway 7 with a stop on Unionville Gate during weekday peak periods only	75

Exhibit 4-2: Existing Study Area Lane Configurations





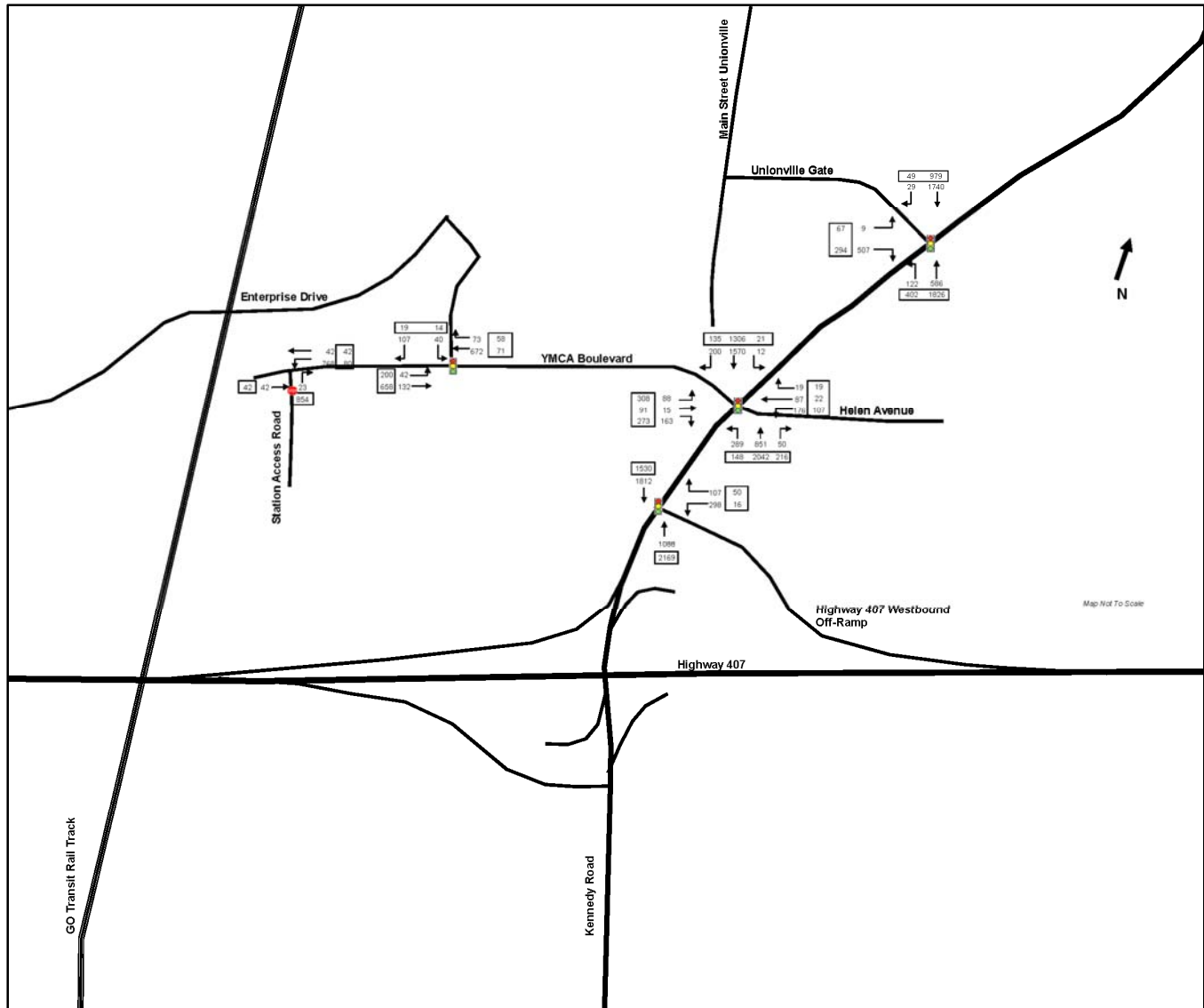
Exhibit 4-3: Transit Services in the Study Area



## 4.4 Existing Condition (2010) Traffic Volumes and Operations

The 2010 Existing Condition traffic volumes, including the weekday AM and PM peak hours, are shown in **Exhibit 4-4**. The 2010 Existing Condition intersection capacity analyses were undertaken using the methodology outlined in **Section 3.2**.

**Exhibit 4-4: 2010 Existing Condition Traffic Volumes**



#### 4.4.1 CAPACITY AND LEVEL OF SERVICE

The weekday am and pm peak hour existing condition traffic analysis results are included in **Exhibit 4-5**. Existing Condition Synchro traffic analysis reports are included in **Appendix A**.

**Exhibit 4-5: Existing Condition (2010) Intersection Operations**

Intersection		Peak Hour	Movement	Existing Condition (2010)		
				V/C	Delay	LOS
Signalized Intersections						
1	Highway 407 Westbound Off-Ramp @ Kennedy Road	AM	Overall	0.62	8	A
			WBL	0.59	53	D
			WBR	0.07	48	D
			SBT	0.62	1	A
		PM	Overall	0.65	4	A
			WBL	0.04	46	D
			WBR	0.17	47	D
			NBT	0.73	5	A
2	Helen Avenue / YMCA Boulevard @ Kennedy Road	AM	Overall	0.84	46	D
			EBL	0.51	62	E
			WBL	0.98	111	F
			NBL	0.62	57	E
			SBT	0.98	55	D
		PM	Overall	0.83	37	D
			EBL	0.67	53	D
			WBL	0.58	43	D
			NBL	0.62	50	D
			NBT	0.91	28	C
3	Unionville Gate @ Kennedy Road	AM	Overall	0.86	25	C
			EBL	0.03	37	D
			EBR	0.85	52	D
			NBL	0.56	34	C
			SBT	0.87	24	C
		PM	Overall	0.79	16	B
			EBL	0.15	35	C
			EBR	0.36	27	C
			NBL	0.97	55	E
			NBT	0.77	5	A

**Exhibit 4-5: Existing Condition (2010) Intersection Operations**

Intersection		Peak Hour	Movement	Existing Condition (2010)		
				V/C	Delay	LOS
4	YMCA Boulevard @ Enterprise Drive	AM	Overall	0.30	13	B
			EBL	0.24	13	B
			WBTR	0.61	15	B
			SBL	0.05	7	A
			SBR	0.07	7	A
		PM	Overall	0.27	21	C
			EBL	0.87	51	D
			WBTR	0.16	20	B
			SBL	0.02	8	A
			SBR	0.01	8	A
Unsignalized Intersections						
5	YMCA Boulevard @ Station Access Road	AM	EBT	0.01	0	-
			WBLT	0.49	10	A
			NBR	0.02	9	A
		PM	EBT	0.02	0	-
			WBLT	0.05	5	A
			NBR	0.83	23	C

Notes:

Critical movement(s) defined as V/C &gt;0.85 and/or poorest LOS.

Overall, the four signalized intersections in the Study Area operate at acceptable levels of service (LOS 'D' or better) under the existing weekday am and pm peak hour traffic demands, with the volume to capacity (V/C) ratio below 1.0. Overall V/C ratios range from 0.30 to 0.86 during the weekday am peak hour, and from 0.27 to 0.83 during the weekday pm peak hour.

However, at the Helen Avenue / YMCA Boulevard @ Kennedy Road intersection, the westbound left-turn movement currently operates at capacity with an LOS 'F' during the am peak hour. Due to the limited number of north-south roadways, the through movements on Kennedy Road are operating near or at capacity. In the am peak hour, the southbound through movement operates with a V/C ratio of 0.98 and in the pm peak hour, the northbound through movement operates with a V/C ratio of 0.91.

At the Unionville Gate @ Kennedy Road intersection, the northbound left-turn movement operates with a V/C of 0.97 and an LOS 'E' during the pm peak hour.

**4.4.2 QUEUE LENGTHS**

The weekday am and pm peak hour existing condition queue length analysis results are included in **Exhibit 4-6**. Existing Condition Synchro traffic analysis reports are included in **Appendix A**.



**Exhibit 4-6: Existing Condition (2010) Turning Movement Queue Lengths**

Intersection		Peak Hour	Movement	Parallel Lane Storage Length (m)	Existing Condition (2010) Synchro Queues (m)	
					50th Percentile	95th Percentile
Signalized Intersections						
1	Highway 407 Westbound Off-Ramp @ Kennedy Road	AM	WBL	WBL = 550; WBR = 160;	35	46
			WBR		0	15
		PM	WBL		2	5
			WBR		7	16
2	Helen Avenue / YMCA Boulevard @ Kennedy Road	AM	EBL	EBL = 90; WBL = 70; NBL = 70; SBL = 100;	11	19
			WBL		38	52
			NBL		71	110
		PM	EBL		46	72
			WBL		17	27
			NBL		32	69
3	Unionville Gate @ Kennedy Road	AM	EBL	EBL = 50; NBL = 180;	2	7
			EBR		110	170
			NBL		13	27
		PM	EBL		12	23
			EBR		30	52
			NBL		30	62
4	YMCA Boulevard @ Enterprise Drive	AM	EBL	EBL = 75;	3	8
			SBL		2	7
			SBR		0	7
		PM	EBL		22	54
			SBL		1	3
			SBR		0	3
Unsignalized Intersections						
5	YMCA Boulevard @ Station Access Road	AM	WBTL	-	-	20
			NBR		-	1
		PM	WBTL		-	2
			NBR		-	71

At the Helen Avenue / YMCA Boulevard @ Kennedy Road intersection, during the am peak hour, the northbound left-turn movement currently experiences queuing spillbacks, where the queued vehicles exceed the available storage space. The westbound left-turn queue is also operating at capacity. There are no queuing issues at other Study Area intersection turning movements.

## 5. FUTURE BACKGROUND CONDITION

### 5.1 Proposed Transit Services

Under the *York Region Transportation Master Plan Update Final Report (2009)*, Kennedy Road (from Highway 407 Avenue north to Highway 7) and Enterprise Drive / YMCA Boulevard from (from Warden Avenue east to Kennedy Road) have been identified as future rapid transit corridors. As part of the Viva Rapidways project, Viva bus routes will have dedicated right-of-ways along these corridors as early as 2015-2020. As such, these transit improvements have been reflected in this transportation study, particularly impacting the number of future transit vehicles entering and existing the proposed Kennedy Station.

### 5.2 Future Background Traffic Growth

Future background traffic volumes account for general corridor growth on the Study Area road network. This growth was estimated based on the forecasts obtained from the York Region Travel Demand Forecasting Model. For the purposes of this study, existing traffic volumes were factored up by 1.245, representing a compound growth rate of 1% per annum over 21 years, to develop the 2031 base background traffic volumes. These factors were applied to all movements along the Kennedy Road and YMCA Boulevard corridors.

### 5.3 Future Background Developments

The *Markham Centre Development Plan* (referred to as “Markham Centre” in this study) is a series of large mixed used development blocks planned for an area north and west of the proposed Kennedy Station – generally bounded by Woodbine Avenue to the west, Kennedy Road to the east, Highway 7 to the north and Highway 407 to the south.

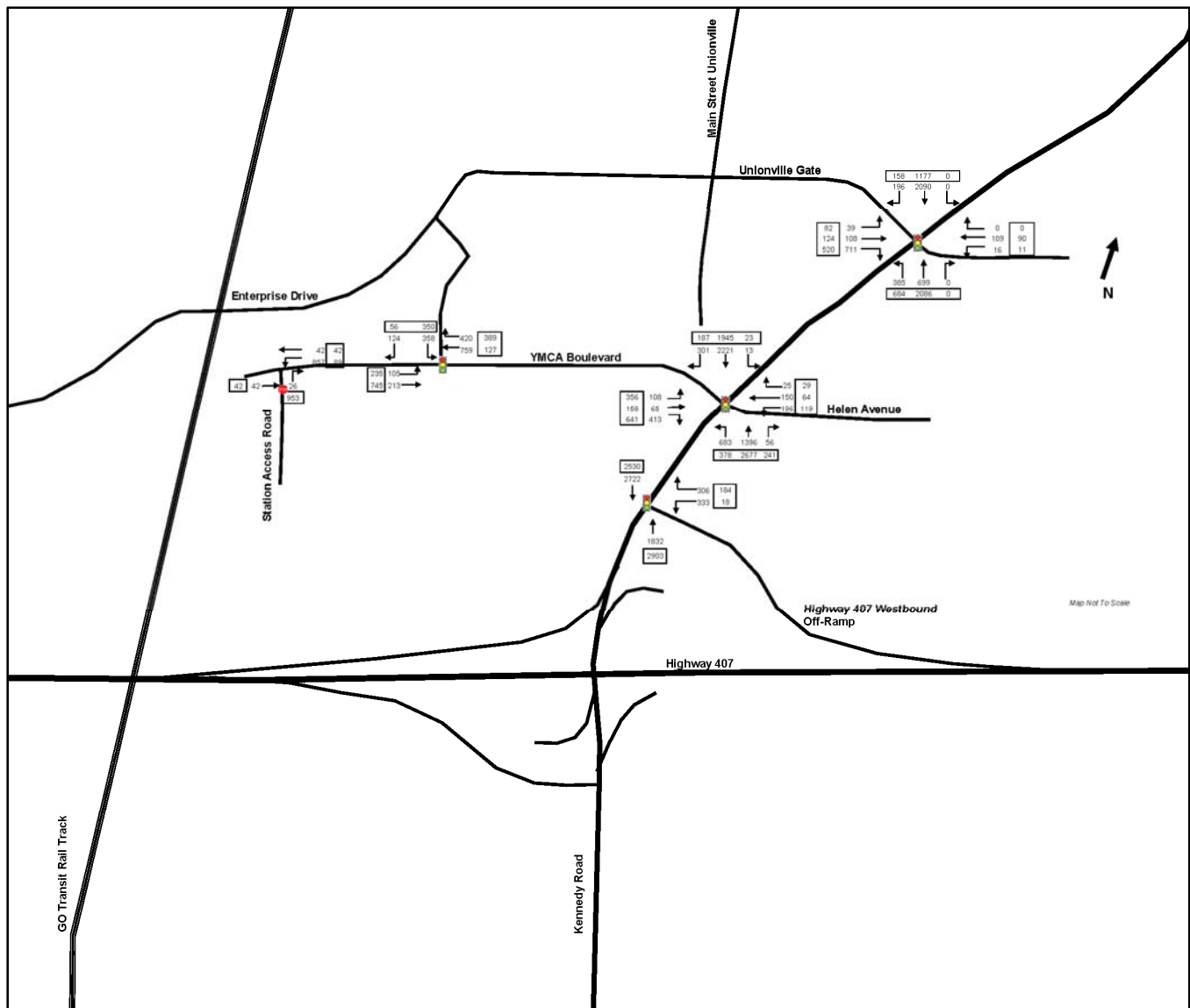
Markham Centre is a \$3 billion mixed-use development set on 243 acres of land. Major developments under construction or planned for Markham Centre include multi-unit residential buildings and single family townhouses, office developments, commercial and retail developments and community/institutional uses such as churches, schools, and parks. By 2031, under a 60% intensification growth scenario, it is forecasted that Markham Centre will be home to 28,600 people and 21,700 jobs. Under a full build-out scenario, it is forecast that the population and employment numbers be approximately 39,300 and 39,400, respectively.

Relevant transit and traffic operational changes from this transportation plan have been taken into account in this transportation study. Therefore, all traffic generated by the various residential and commercial components of the Markham Centre development has been added to the Background Condition. Through the Study Area, Markham Centre is projected to generate several hundred inbound and outbound auto trips along the Enterprise Drive / YMCA Boulevard corridor and around 400-500 auto trips along the Kennedy Road corridor during both the am and pm peak hours.

### 5.4 Future Total Background Volumes

The future (2031) background traffic volumes comprise existing (2010) base traffic volumes shown in **Exhibit 4-4** plus corridor growth traffic to the area surrounding the Subject Site and projected traffic generated by future background developments. The resultant future background traffic volumes are illustrated in **Exhibit 5-1** for the weekday am and pm peak hours, respectively.

**Exhibit 5-1: 2031 Background Condition Traffic Volumes**



## 5.5 Future Background Condition (2031) Traffic Operations

### 5.5.1 CAPACITY AND LEVEL OF SERVICE

The weekday am and pm peak hour background condition traffic analysis results are included in **Exhibit 5-2**. Full analysis summaries are included in **Appendix B**.

**Exhibit 5-2: Background Condition (2031) Compared with Existing Condition (2010)  
Intersection Operations**

Intersection		Peak Hour	Movement	Existing Condition (2010)			Background Condition (2031)		
				V/C	Delay	LOS	V/C	Delay	LOS
Signalized Intersections									
1	Highway 407 Westbound Off-Ramp @ Kennedy Road	AM	Overall	0.62	8	A	0.71	11	B
			WBL	0.59	53	D	0.52	48	D
			WBR	0.07	48	D	0.92	85	F
			SBT	0.62	1	A	0.66	2	A
		PM	Overall	0.65	4	A	0.69	8	A
			WBL	0.04	46	D	0.03	41	D
			WBR	0.17	47	D	0.65	51	D
			NBT	0.73	5	A	0.70	6	A
2	Helen Avenue / YMCA Boulevard @ Kennedy Road	AM	Overall	0.84	46	D	0.81	48	D
			EBL	0.51	62	E	0.61	66	E
			WBL	0.98	111	F	0.58	44	D
			NBL	0.62	57	E	0.79	60	E
			SBT	0.98	55	D	0.96	67	E
		PM	Overall	0.83	37	D	0.68	28	C
			EBL	0.67	53	D	0.66	51	D
			WBL	0.58	43	D	0.53	48	D
			NBL	0.62	50	D	0.70	47	D
NBT	0.91	28	C	0.75	20	B			
3	Unionville Gate @ Kennedy Road	AM	Overall	0.86	25	C	0.74	38	D
			EBL	0.03	37	D	0.12	42	D
			EBR	0.85	52	D	0.45	0.9	A
			NBL	0.56	34	C	0.96	103	F
			SBT	0.87	24	C	1.00	50	D
		PM	Overall	0.79	16	B	0.79	26	C
			EBL	0.15	35	C	0.26	38	D
			EBR	0.36	27	C	0.50	12	B
			NBL	0.97	55	E	0.90	55	D
NBT	0.77	5	A	0.55	12	B			

**Exhibit 5-2: Background Condition (2031) Compared with Existing Condition (2010)  
Intersection Operations**

Intersection		Peak Hour	Movement	Existing Condition (2010)			Background Condition (2031)		
				V/C	Delay	LOS	V/C	Delay	LOS
4	YMCA Boulevard @ Enterprise Drive	AM	Overall	0.30	13	B	0.66	19	B
			EBL	0.24	13	B	0.85	56	E
			WBTR	0.61	15	B	0.83	20	C
			SBL	0.05	7	A	0.48	14	B
			SBR	0.07	7	A	0.10	10	A
		PM	Overall	0.27	21	C	0.52	18	B
			EBL	0.87	51	D	0.68	30	C
			WBTR	0.16	20	B	0.38	23	C
			SBL	0.02	8	A	0.51	17	B
			SBR	0.01	8	A	0.03	5	A
Unsignalized Intersections									
5	YMCA Boulevard @ Station Access Road	AM	EBT	0.01	0	-	0.02	0	-
			WBLT	0.49	10	A	0.55	25	A
			NBR	0.02	9	A	0.03	1	A
		PM	EBT	0.02	0	-	0.02	0	-
			WBLT	0.05	5	A	0.06	6	A
			NBR	0.83	23	C	0.93	34	D

Notes:

Critical movement(s) defined as V/C > 0.85 and/or poorest LOS.

In the Background Condition, changes to future lane configurations primarily occur along Kennedy Road. These include the addition of one travel lane in the northbound and southbound directions of Kennedy Road, which brings the total number of travel lanes in each direction to three. During the am peak hour, eastbound right-turns onto Kennedy Road benefit from free turns that improve the capacity and delay for this movement.

Overall, the four signalized intersections in the Study Area are projected to continue to operate at acceptable levels of service (LOS 'D' or better) under the 2013 future total background condition for both the weekday am and pm peak hour with the volume to capacity (V/C) ratio projected to remain below 1.0. Overall V/C ratios are projected to range from 0.66 to 0.81 during the weekday am peak hour, and from 0.52 to 0.79 during the weekday pm peak hour.

However, due to traffic generated by background developments, several individual traffic movements are projected to operate at capacity and/or with poor levels of service:

- At the Highway 407 Westbound Off-Ramp @ Kennedy Road, the westbound right-turn movement is projected to operate near capacity with an LOS 'F' during the am peak hour;
- At the Helen Avenue / YMCA Boulevard @ Kennedy Road intersection, the southbound through movement is projected to operate at capacity with an LOS 'E' during the am peak hour; and

- At the Unionville Gate @ Kennedy Road intersection, the northbound left-turn move is projected to operate at capacity with an LOS 'F' during the am peak hour. During the pm peak hour, it operates with a V/C ratio of 0.90. Due to the limited number of north-south roadways and background traffic growth, the through movements on Kennedy Road are projected to operate near or at capacity. In the am peak hour, the southbound through movement operates with a V/C ratio of 1.00.

#### 5.5.2 QUEUE LENGTHS

The weekday am and pm peak hour existing condition queue length analysis results are included in **Exhibit 5-3**. Full analysis summaries are included in **Appendix B**.

At the Helen Avenue / YMCA Boulevard @ Kennedy Road intersection, during the am peak hour, the northbound left-turn movement is projected to experience queuing spillbacks, where the queued vehicles exceed the available storage space. The westbound left-turn queue is also projected to operate at capacity.

At the Unionville Gate @ Kennedy Road intersection, during the pm peak hour, the northbound left-turn movement is projected to experience queuing spillbacks.

There are no queuing issues at other Study Area intersection turning movements.

To achieve satisfactory queuing space at key turning lanes at the Study Area intersections, it is recommended that consideration be given to increase storage length of several turning lanes.

**Exhibit 5-3: Background Condition (2031) Compared with Existing Condition (2010) Turning Movement Queue Lengths**

Intersection		Peak Hour	Movement	Parallel Lane Storage Length (m)	Existing Condition (2010) Synchro Queues (m)		Background Condition (2031) Synchro Queues (m)	
					50th Percen.	95th Percen.	50th Percen.	95th Percen.
Signalized Intersections								
1	Highway 407 Westbound Off-Ramp @ Kennedy Road	AM	WBL	WBL = 550; WBR = 160;	35	46	37	51
			WBR		0	15	64	113
		PM	WBL		2	5	2	5
			WBR		7	16	38	56
2	Helen Avenue / YMCA Boulevard @ Kennedy Road	AM	EBL	EBL = 90; WBL = 70; NBL = 70; SBL = 100;	11	19	13	22
			WBL		38	52	40	56
			NBL		71	110	80	121
		PM	EBL		46	72	38	51
			WBL		17	27	20	29
			NBL		32	69	39	70
3	Unionville Gate @ Kennedy Road	AM	EBL	EBL = 50; NBL = 180;	2	7	8	17
			EBR		110	170	0	0
			NBL		13	27	70	124
		PM	EBL		12	23	15	28
			EBR		30	52	52	75
			NBL		30	62	148	188
4	YMCA Boulevard @ Enterprise Drive	AM	EBL	EBL = 75;	3	8	10	34
			SBL		2	7	25	44
			SBR		0	7	2	9
		PM	EBL		22	54	24	48
			SBL		1	3	28	59
			SBR		0	3	0	4
Unsignalized Intersections								
5	YMCA Boulevard @ Station Access Road	AM	WBTL	-	-	20	-	25
			NBR		-	1	-	1
		PM	WBTL		-	2	-	2
			NBR		-	71	-	104

## 6. KENNEDY STATION RELATED TRAFFIC

### 6.1 Passenger Flow Projections

The preferred station concept shown in **Exhibit 2-2** indicates that the park-and-ride facility will initially include 1,120 parking spaces for 407 Transitway users and 200 spaces for carpools by the year 2031. Vehicle access to and from the parking lot will be through a single access point from YMCA Boulevard with a separate access point for transit vehicles only.

### 6.2 Trip Generation

#### 6.2.1 ASSUMPTIONS

The following assumptions were used to establish the increase in site related traffic. The trip generation rates for the subject park-and-ride development were extracted from the *Institute of Transportation Engineers (ITE) Trip Generation Manual, 8th Edition*. The selected trip rates were taken from Land Use Code 090: Park-and-Ride Lot with Bus Service and are summarized in **Exhibit 6-1**.

**Exhibit 6-1: Trips Rates and Splits for Park-and-Ride with PPUDO Facility**

Site Users	No. of Parking Spaces	AM Split		PM Split		Trip Rates					
						AM Peak Hour			PM Peak Hour		
		In	Out	In	Out	In	Out	Total	In	Out	Total
407 Transitway	1,120	81%	19%	23%	77%	0.58	0.14	0.72	0.14	0.48	0.62
Carpool	200	81%	19%	23%	77%	0.58	0.14	0.72	0.14	0.48	0.62

#### 6.2.2 GENERATED TRIPS

The estimated trip generation for the proposed Woodbine / Rodick Station is summarized in **Exhibit 6-2**. The park-and-ride facility will generate approximately 950 and 818 two-way trips during the am and pm peak hours, respectively.

**Exhibit 6-2: Estimated Trip Generation for Kennedy Station**

Site Users	No. of Parking Spaces	AM Split		PM Split		Trip Rates					
						AM Peak Hour			PM Peak Hour		
		In	Out	In	Out	In	Out	Total	In	Out	Total
407 Transitway	1,120	81%	19%	23%	77%	653	153	806	160	535	694
Carpool	200	81%	19%	23%	77%	117	27	144	29	95	124
<b>Total Trips</b>						<b>770</b>	<b>181</b>	<b>950</b>	<b>188</b>	<b>630</b>	<b>818</b>



## 6.3 Future Bus Transit Volumes

In terms of bus traffic accessing the proposed Kennedy Station, it was assumed that a dedicated right-of-way for Viva transit vehicles would be built and operational between Enterprise Drive and YMCA Boulevard. While Viva buses will still connect with the proposed Kennedy Station, they will not travel on local streets like other transit vehicles. Therefore, it is assumed that the headways of Viva services will be doubled during the am and pm peak hours.

## 6.4 Trip Distribution

Site generated traffic was assigned to the road network based on the indicated trip generation, trip distribution, and proposed site access parameters. **Exhibit 6-3** summarizes the trip distribution parameters used for this study.

**Exhibit 6-3: Distribution of Park-and-Ride Traffic**

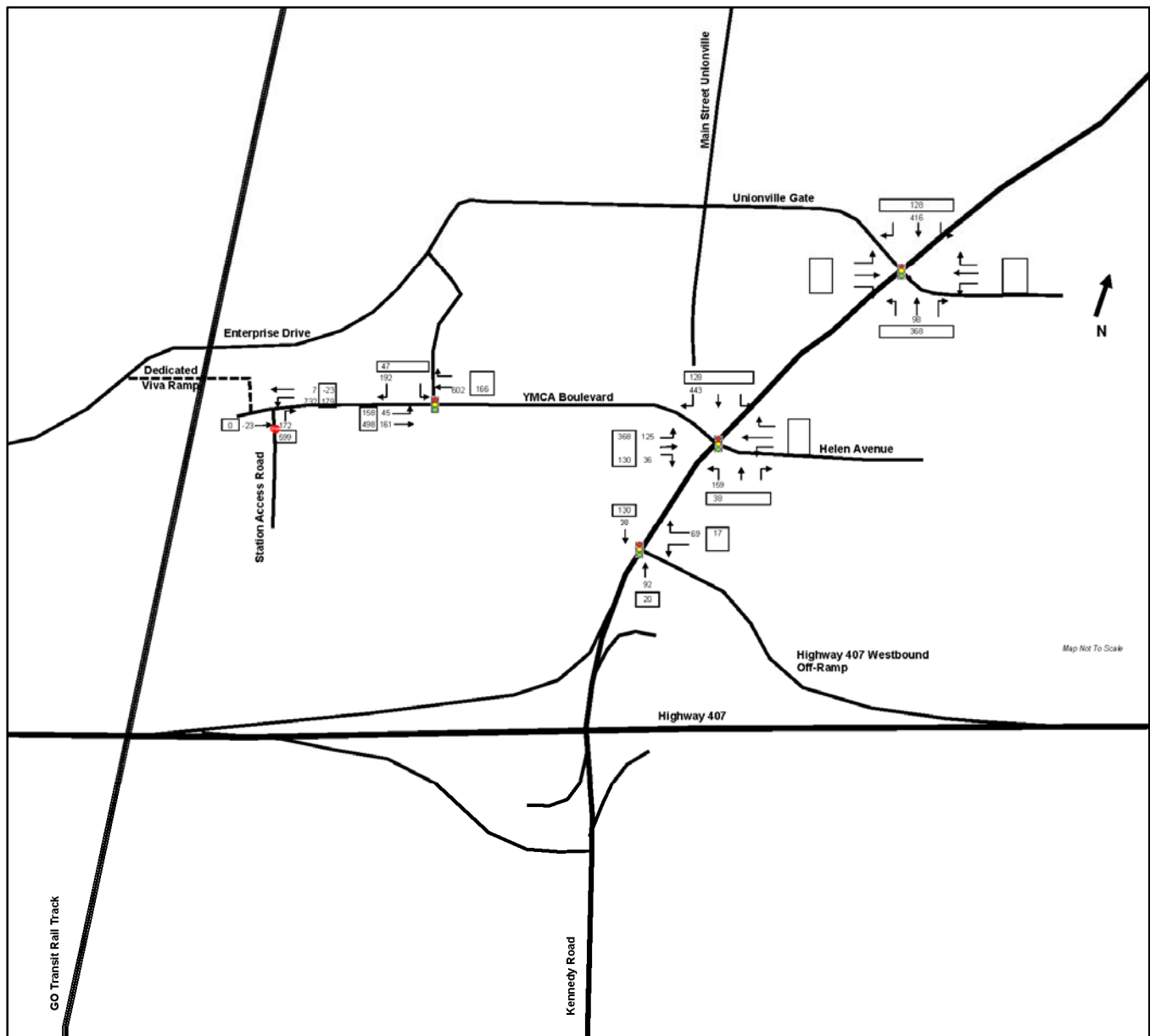
To / From	AM Peak Hour		PM Peak Hour	
	IN	OUT	IN	OUT
Kennedy Road (North)	54%	54%	54%	54%
Kennedy Road (South)	12%	21%	12%	21%
Highway 407 (West)	9%	-	9%	-
Enterprise Drive	25%	25%	25%	25%
<b>Total</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>

The source of the trip distribution is associated with Transportation Tomorrow Survey (TTS) data. As indicated in the TTS data, it is expected that during weekday peak hours, approximately 54% of all inbound and outbound vehicles originate from and are destined to the Kennedy Road north approach. 21% of % of all inbound vehicles originates from the Kennedy Road south approach and the Highway 407 westbound off-ramp and 21% are destined to the Kennedy Road south approach. The remaining 25% of vehicles are destined to Enterprise Drive. Minor differences in inbound and outbound trip patterns reflect the relative convenience of alternative trip routings afforded by the regional road network.

## 6.5 Trip Assignment

The site generated trips were assigned to the street network based on the trip distribution percentages discussed above, taking into account the directionality of the trips (inbound vs. outbound). The site generated traffic volumes for the weekday AM and PM peak hour are illustrated in **Exhibit 6-4**.

**Exhibit 6-4: 2031 Site Generated Traffic Volumes**



## 7. FUTURE TOTAL CONDITION

### 7.1 Future Transit Services and Operations

Based on the existing transit route configuration at the existing Unionville GO Station and Study Area, the physical configuration of the future transit operations were evaluated to achieve optimum geometric configurations for the proposed Kennedy Station and surrounding road network. The following can be concluded for future transit operations:

- Viva buses will have their own dedicated ramp that connects Enterprise Drive, the proposed Kennedy Station YMCA Boulevard. On parts of their routes, Viva buses will use dedicated rights-of-ways and not operate on local streets;
- The existing bus loop will be configured into a larger bus pick-up and drop-off area for non-Viva bus services; and
- A newly developed PPUDO area will occupy the location of the old bus loop.

### 7.2 Future Pedestrian / Bicycle Facilities and Operations

As the existing Unionville GO Station is already in place, some existing pedestrian and bicycle facilities are already in place. However, in order to ensure the Subject Site evolves into a complete and sustainable community, especially if TOD opportunities are pursued along YMCA Boulevard, it is recommended that walking and cycling infrastructure be improved. Some recommendations include:

- Increase bicycle storage facilities at the proposed Kennedy Station;
- Add sidewalks on the north side of YMCA Boulevard to improve east-west pedestrian connections; and
- Add bicycle lanes on YMCA Boulevard and Enterprise Drive to facilitate bicycle connections between the proposed Kennedy Station with Kennedy Road and proposed background developments to the northwest.

### 7.3 Site Access and Configurations

Site access to the proposed Kennedy Station will remain relatively unchanged from existing conditions. While the internal site configuration of the proposed Kennedy Station will change slightly, station access will be from the existing Station Access Road on the south side of YMCA Boulevard. To accommodate increased station traffic, particularly in the pm peak hour, a second northbound right-turn lane is recommended.

## 7.4 Future Traffic Control and Lane Configurations

A map shown future Study Area roadway lane configurations is shown in **Exhibit 7-1** with recommended future background and future total site lane configurations and storage lengths shown in blue and green, respectively. Other geometrical improvements including proposed signals and stop controls are also shown.

Geometric improvements are required at the Helen Avenue / YMCA Boulevard @ Kennedy Road intersection to accommodate the expected background and future traffic increases. A second northbound left-turn lane and a new eastbound right-turn lane will be added.

Unionville Gate is expected to be extended east of Kennedy Road, which will create a four-way signalized intersection.

## 7.5 Future Total Traffic Volumes

Site traffic volumes were added to future background traffic volumes to obtain the corresponding future total traffic volumes at the study area intersections. The 2031 future total traffic volumes are shown in **Exhibit 7-2**.

## 7.6 Future Total Condition (2031) Traffic Operations

### 7.6.1 CAPACITY AND LEVEL OF SERVICE

The weekday am and pm peak hour background condition traffic analysis results are included in **Exhibit 5-2**. Full analysis summaries are included in **Appendix C**.

The addition of site traffic will moderately impact future operations at Study Area signalized intersections. Overall, Unionville Gate @ Kennedy Road intersection is projected to operate at LOS 'F' during the am peak hour. This is primarily due to an increase in southbound through traffic along the Kennedy Road corridor.

Overall, YMCA Boulevard @ Enterprise Drive intersection is also projected to operate at LOS 'F' during the AM peak hour with the eastbound left-turn and westbound through / right-turn movements projected to operate at LOS 'F' and V/C ratios of 1.22 and 1.28, respectively.

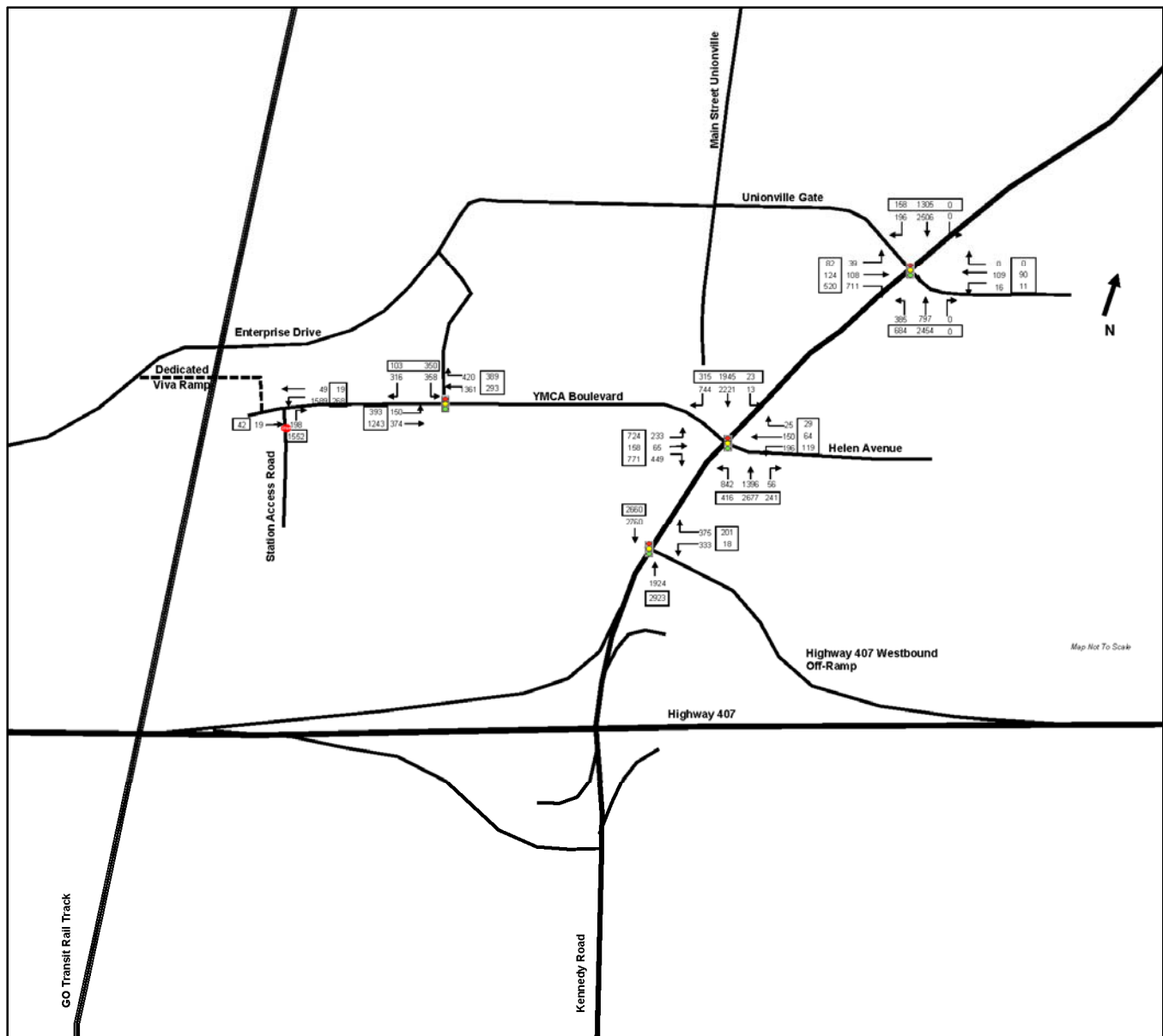
Overall, other signalized movements are projected to operate at LOS 'D' or better. At the Helen Avenue / YMCA Boulevard @ Kennedy Road intersection, the eastbound left-turn movement is projected to operate with an LOS 'F' and V/C's of 1.27 and 1.28 during the am and pm peak hours, respectively.

As geometrical improvements have already be undertaken at Study Area intersections, other operational improvements will have to be explored to deal with capacity and delay issues.

**Exhibit 7-1: Future Study Area Recommended Lane and Geometrical Configurations**



Exhibit 7-2: 2031 Future Total Traffic Volumes



**Exhibit 7-3: Future Total Condition (2031) Compared with Background Condition (2031)  
Intersection Operations**

Intersection		Peak Hour	Movement	Background Condition (2031)			Future Condition (2031)		
				V/C	Delay	LOS	V/C	Delay	LOS
Signalized Intersections									
1	Highway 407 Westbound Off-Ramp @ Kennedy Road	AM	Overall	0.71	11	B	0.77	17	B
			WBL	0.52	48	D	0.51	48	D
			WBR	0.92	85	F	1.15	153	F
			SBT	0.66	2	A	0.67	3	A
		PM	Overall	0.69	8	A	0.70	9	A
			WBL	0.03	41	D	0.03	41	D
			WBR	0.65	51	D	0.69	53	D
			NBT	0.70	6	A	0.71	7	A
2	Helen Avenue / YMCA Boulevard @ Kennedy Road	AM	Overall	0.81	48	D	0.90	54	D
			EBL	0.61	66	E	1.29	226	F
			WBL	0.58	44	D	0.58	44	D
			NBL	0.79	60	E	0.98	83	F
			SBT	0.96	67	E	0.95	66	E
		PM	Overall	0.68	28	C	0.85	47	D
			EBL	0.66	51	D	1.28	192	F
			WBL	0.53	48	D	0.52	48	D
			NBL	0.70	47	D	0.67	46	D
			NBT	0.75	20	B	0.76	21	C
3	Unionville Gate @ Kennedy Road	AM	Overall	0.74	38	D	0.84	82	F
			EBL	0.12	42	D	0.12	42	D
			EBR	0.45	0.9	A	0.45	1	A
			NBL	0.96	103	F	0.96	154	F
			SBT	1.00	50	D	1.20	128	F
		PM	Overall	0.79	26	C	0.80	27	C
			EBL	0.26	38	D	0.27	40	D
			EBR	0.50	12	B	0.52	14	B
			NBL	0.90	55	D	0.90	58	E
			NBT	0.55	12	B	0.64	13	B

**Exhibit 7-3: Future Total Condition (2031) Compared with Background Condition (2031)  
Intersection Operations**

Intersection		Peak Hour	Movement	Background Condition (2031)			Future Condition (2031)		
				V/C	Delay	LOS	V/C	Delay	LOS
4	YMCA Boulevard @ Enterprise Drive	AM	Overall	0.66	19	B	0.89	102	F
			EBL	0.85	56	E	1.25	181	F
			WBTR	0.83	20	C	1.28	147	F
			SBL	0.48	14	B	0.50	15	B
			SBR	0.10	10	A	0.48	15	B
		PM	Overall	0.52	18	B	0.70	28	C
			EBL	0.68	30	C	1.03	81	F
			WBTR	0.38	23	C	0.59	26	C
			SBL	0.51	17	B	0.56	21	C
			SBR	0.03	5	A	0.06	6	A
Unsignalized Intersections									
5	YMCA Boulevard @ Station Access Road	AM	EBT	0.02	0	-	0.01	0	-
			WBLT	0.55	25	A	0.99	38	E
			NBR	0.03	1	A	0.09	9	A
		PM	EBT	0.02	0	-	0.02	0	-
			WBLT	0.06	6	A	0.17	8	A
			NBR	0.93	34	D	0.75	19	C

Notes:

Critical movement(s) defined as V/C > 0.85 and/or poorest LOS.

#### 7.7.1 QUEUE LENGTHS

The weekday am and pm peak hour existing condition queue length analysis results are included in **Exhibit 7-4**. Full analysis summaries are included in **Appendix C**.

Similar queuing issues that are projected to occur in the background condition will continue in the future condition.

At the YMCA Boulevard @ Enterprise Drive intersection, during the pm peak hour, significant queuing spillbacks are projected to occur at the northbound left-turn movement, where the queued vehicles exceed the available storage space.

There are other significant queuing issues at other Study Area intersection turning movements.



**Exhibit 7-4: Future Total Condition (2031) Compared With Background Condition (2031)  
Intersection Operations**

Intersection		Peak Hour	Movement	Parallel Lane Storage Length (m)	Background Condition (2031) Synchro Queues (m)		Future Condition (2031) Synchro Queues (m)	
					50th Percen.	95th Percen.	50th Percen.	95th Percen.
Signalized Intersections								
1	Highway 407 Westbound Off-Ramp @ Kennedy Road	AM	WBL	WBL = 550; WBR = 160;	37	51	37	51
			WBR		64	113	97	154
		PM	WBL		2	5	2	5
			WBR		38	56	41	61
2	Helen Avenue / YMCA Boulevard @ Kennedy Road	AM	EBL	EBL = 90; WBL = 70; NBL = 70; SBL = 100;	13	22	36	61
			WBL		40	56	40	56
			NBL		80	121	101	156
		PM	EBL		38	51	102	135
			WBL		20	29	20	29
			NBL		39	70	44	80
3	Unionville Gate @ Kennedy Road	AM	EBL	EBL = 50; NBL = 180;	8	17	8	17
			EBR		0	0	0	0
			NBL		70	124	70	124
		PM	EBL		15	28	15	28
			EBR		52	75	52	75
			NBL		148	188	146	187
4	YMCA Boulevard @ Enterprise Drive	AM	EBL	EBL = 75;	10	34	20	47
			SBL		25	44	25	44
			SBR		2	9	21	39
		PM	EBL		24	48	51	113
			SBL		28	59	34	66
			SBR		0	4	0	6
Unsignalized Intersections								
5	YMCA Boulevard @ Station Access Road	AM	WBTL	-	-	25	-	168
			NBR		-	1	-	3
		PM	WBTL		-	2	-	5
			NBR		-	104	-	53

## 8. SUMMARY AND CONCLUSIONS

Based on the analysis presented above, the following have been concluded / recommended:

- The preferred transit scenario for the proposed Kennedy Station is a separate unloading and loading area for non-Viva buses and to keep the existing Station Access Road for Go Transit, 407 Transitway and carpool users;
- As part of future transit developments in York Region, Viva buses will operate in their own separate right-of-way for part of their routes;
- There is no need to signalize the YMCA Boulevard @ Station Access Road intersection, but improvements recommended at this intersection include a second northbound right-turn lane to accommodate pm peak hour traffic;
- Geometrical improvements along the Kennedy Road corridor include the addition of one northbound and one southbound travel lane; It is recommended that a second northbound left-turn lane and a dedicated eastbound right-turn lane be added to the Helen Avenue / YMCA Boulevard @ Kennedy Road intersection to accommodate background traffic growth and future site generated traffic;
- Preliminary traffic analysis shows that signalized Study Area intersections will operate with relatively higher delays but at acceptable levels of service under the existing and future background conditions;
- Some signalized intersections are projected to operate at unacceptable levels of service under future conditions; and
- It is recommended that further studies be undertaken to develop amicable solutions to alleviate projected future traffic capacity and delay issues at Study Area intersections and movements.

## APPENDIX A

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### 2010 EXISTING CONDITION SYNCHRO SUMMARY OUTPUTS



2010 Existing - Weekday AM Peak Hour  
1: Hwy 407 WB Ramp & Kennedy Road

Queues  
Highway 407 Transitway: Kennedy Station



Lane Group	WBL	WBR	NBT	SBT
Lane Configurations	↰↰	↱	↰↰	↰↰
Volume (vph)	298	107	1088	1812
Lane Group Flow (vph)	298	107	1088	1812
Turn Type	Perm			
Protected Phases	8		2	6
Permitted Phases		8		
Detector Phases	8	8	2	6
Minimum Initial (s)	15.0	15.0	25.0	25.0
Minimum Split (s)	29.0	29.0	31.0	31.0
Total Split (s)	29.0	29.0	101.0	101.0
Total Split (%)	22.3%	22.3%	77.7%	77.7%
Yellow Time (s)	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0
Lead/Lag				
Lead-Lag Optimize?				
Recall Mode	None	None	C-Max	C-Max
v/c Ratio	0.59	0.33	0.37	0.62
Control Delay	56.0	11.1	3.8	1.5
Queue Delay	0.0	0.0	0.0	0.5
Total Delay	56.0	11.1	3.8	2.0
Stops (vph)	272	17	229	81
Fuel Used(l)	29	5	42	30
CO Emissions (g/hr)	539	94	775	560
NOx Emissions (g/hr)	105	18	151	109
VOC Emissions (g/hr)	125	22	180	130
Dilemma Vehicles (#)	0	0	38	12
Queue Length 50th (m)	34.5	0.0	26.3	2.9
Queue Length 95th (m)	45.2	14.1	30.7	6.4
Internal Link Dist (m)	346.4		308.0	86.3
Turn Bay Length (m)	140.0			
Base Capacity (vph)	653	388	2905	2905
Starvation Cap Reductn	0	0	0	570
Spillback Cap Reductn	0	0	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.46	0.28	0.37	0.78

Intersection Summary

Cycle Length: 130

Actuated Cycle Length: 130

Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBT, Start of Green

Natural Cycle: 70

Control Type: Actuated-Coordinated











m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 1: Hwy 407 WB Ramp & Kennedy Road



2010 Existing - Weekday AM Peak Hour  
1: Hwy 407 WB Ramp & Kennedy Road

HCM Signalized Intersection Capacity Analysis  
Highway 407 Transitway: Kennedy Station

						
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0			4.0
Lane Util. Factor	0.97	1.00	*1.00			*1.00
Frt	1.00	0.85	1.00			1.00
Flt Protected	0.95	1.00	1.00			1.00
Satd. Flow (prot)	3395	1566	3684			3684
Flt Permitted	0.95	1.00	1.00			1.00
Satd. Flow (perm)	3395	1566	3684			3684
Volume (vph)	298	107	1088	0	0	1812
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	298	107	1088	0	0	1812
RTOR Reduction (vph)	0	91	0	0	0	0
Lane Group Flow (vph)	298	16	1088	0	0	1812
Heavy Vehicles (%)	2%	2%	2%	0%	0%	2%
Turn Type	Perm					
Protected Phases	8		2			6
Permitted Phases		8				
Actuated Green, G (s)	17.5	17.5	100.5			100.5
Effective Green, g (s)	19.5	19.5	102.5			102.5
Actuated g/C Ratio	0.15	0.15	0.79			0.79
Clearance Time (s)	6.0	6.0	6.0			6.0
Vehicle Extension (s)	3.0	3.0	3.0			3.0
Lane Grp Cap (vph)	509	235	2905			2905
v/s Ratio Prot	c0.09		0.30			c0.49
v/s Ratio Perm		0.01				
v/c Ratio	0.59	0.07	0.37			0.62
Uniform Delay, d1	51.5	47.4	4.1			5.7
Progression Factor	1.00	1.00	0.78			0.18
Incremental Delay, d2	1.7	0.1	0.3			0.4
Delay (s)	53.2	47.6	3.6			1.4
Level of Service	D	D	A			A
Approach Delay (s)	51.7		3.6			1.4
Approach LOS	D		A			A
<b>Intersection Summary</b>						
HCM Average Control Delay			8.3		HCM Level of Service	A
HCM Volume to Capacity ratio			0.62			
Actuated Cycle Length (s)			130.0		Sum of lost time (s)	8.0
Intersection Capacity Utilization			82.3%		ICU Level of Service	E
Analysis Period (min)			15			
c Critical Lane Group						

2010 Existing - Weekday AM Peak Hour  
2: YMCA Blvd. & Kennedy Road

Queues  
Highway 407 Transitway: Kennedy Station



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	←←	→	←	→	←	→	→	←	→	←
Volume (vph)	88	15	176	87	289	851	50	12	1570	200
Lane Group Flow (vph)	88	178	176	106	289	851	50	12	1570	200
Turn Type	Prot		pm+pt		Prot		custom	Perm		pm+ov
Protected Phases	7		3	8	5				6	7
Permitted Phases		4	8			2	2	6		6
Detector Phases	7	4	3	8	5	2	2	6	6	7
Minimum Initial (s)	6.0	10.0	6.0	10.0	6.0	20.0	20.0	20.0	20.0	6.0
Minimum Split (s)	10.0	29.0	10.0	29.0	10.0	52.0	52.0	52.0	52.0	10.0
Total Split (s)	12.0	38.0	12.0	38.0	20.0	80.0	80.0	60.0	60.0	12.0
Total Split (%)	9.2%	29.2%	9.2%	29.2%	15.4%	61.5%	61.5%	46.2%	46.2%	9.2%
Yellow Time (s)	3.0	4.0	3.0	4.0	3.0	4.0	4.0	4.0	4.0	3.0
All-Red Time (s)	1.0	2.0	1.0	2.0	1.0	2.0	2.0	2.0	2.0	1.0
Lead/Lag	Lead	Lag	Lead	Lag	Lead			Lag	Lag	Lead
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes			Yes	Yes	Yes
Recall Mode	None	None	None	None	None	C-Max	C-Max	C-Max	C-Max	None
v/c Ratio	0.51	0.55	0.76	0.46	0.62	0.33	0.04	0.04	0.98	0.23
Control Delay	69.6	16.2	66.1	54.6	62.2	6.4	1.5	23.8	54.3	8.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Total Delay	69.6	16.2	66.1	54.6	62.2	6.5	1.5	23.8	54.3	8.7
Stops (vph)	85	32	169	88	272	252	3	10	1460	55
Fuel Used(l)	9	8	25	14	27	24	1	1	160	9
CO Emissions (g/hr)	168	146	454	251	493	450	16	17	2962	169
NOx Emissions (g/hr)	33	28	88	49	96	87	3	3	576	33
VOC Emissions (g/hr)	39	34	105	58	114	104	4	4	687	39
Dilemma Vehicles (#)	0	0	0	0	0	30	0	0	29	0
Queue Length 50th (m)	10.5	3.3	37.1	22.2	70.9	27.3	0.0	2.1	185.0	12.4
Queue Length 95th (m)	18.6	21.4	51.6	35.8	#110.0	43.5	3.0	m2.2	#230.4	m13.5
Internal Link Dist (m)		105.9		425.2		28.0			122.7	
Turn Bay Length (m)	90.0		70.0		70.0		85.0	100.0		85.0
Base Capacity (vph)	181	504	233	475	466	2595	1149	284	1608	874
Starvation Cap Reductn	0	0	0	0	0	689	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.49	0.35	0.76	0.22	0.62	0.45	0.04	0.04	0.98	0.23

Intersection Summary

Cycle Length: 130

Actuated Cycle Length: 130

Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBTL, Start of Green

Natural Cycle: 115

Control Type: Actuated-Coordinated

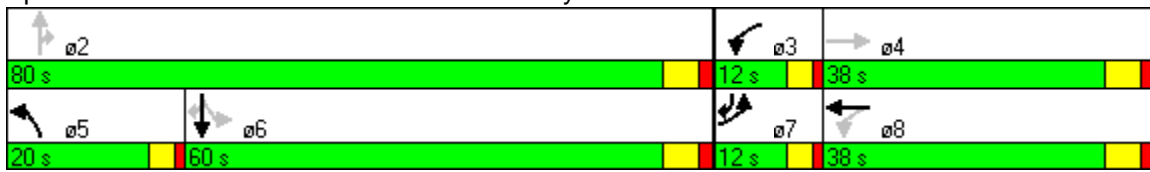
# 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

m Volume for 95th percentile queue is metered by upstream signal.

























Splits and Phases: 2: YMCA Blvd. & Kennedy Road



2010 Existing - Weekday AM Peak Hour  
2: YMCA Blvd. & Kennedy Road

HCM Signalized Intersection Capacity Analysis  
Highway 407 Transitway: Kennedy Station

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	1.00		1.00	1.00		1.00	*1.00	1.00	1.00	*1.00	1.00
Frpb, ped/bikes	1.00	0.98		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.86		1.00	0.97		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		1.00	1.00		1.00	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	2935	1465		1857	1793		1807	3579	1566	1785	3684	1479
Flt Permitted	0.95	1.00		0.29	1.00		1.00	1.00	1.00	0.35	1.00	1.00
Satd. Flow (perm)	2935	1465		536	1793		1807	3579	1566	651	3684	1479
Volume (vph)	88	15	163	176	87	19	289	851	50	12	1570	200
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	88	15	163	176	87	19	289	851	50	12	1570	200
RTOR Reduction (vph)	0	143	0	0	7	0	0	0	14	0	0	98
Lane Group Flow (vph)	88	35	0	176	99	0	289	851	36	12	1570	102
Confl. Peds. (#/hr)			7	7								
Heavy Vehicles (%)	18%	0%	9%	1%	0%	11%	4%	5%	2%	0%	2%	8%
Turn Type	Prot			pm+pt			Prot		custom	Perm		pm+ov
Protected Phases	7			3	8		5				6	7
Permitted Phases		4		8				2	2	6		6
Actuated Green, G (s)	7.7	13.7		22.0	14.0		33.5	92.3	92.3	54.8	54.8	62.5
Effective Green, g (s)	7.7	15.7		24.0	16.0		33.5	94.3	94.3	56.8	56.8	64.5
Actuated g/C Ratio	0.06	0.12		0.18	0.12		0.26	0.73	0.73	0.44	0.44	0.50
Clearance Time (s)	4.0	6.0		4.0	6.0		4.0	6.0	6.0	6.0	6.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	174	177		180	221		466	2596	1136	284	1610	779
v/s Ratio Prot	0.03			c0.06	0.06		c0.16				c0.43	0.01
v/s Ratio Perm		0.02		c0.12				0.24	0.02	0.02		0.06
v/c Ratio	0.51	0.20		0.98	0.45		0.62	0.33	0.03	0.04	0.98	0.13
Uniform Delay, d1	59.3	51.5		50.7	52.9		42.6	6.4	5.0	21.0	35.9	17.7
Progression Factor	1.00	1.00		1.00	1.00		1.29	0.87	0.74	1.09	1.22	3.55
Incremental Delay, d2	2.3	0.5		59.9	1.4		2.4	0.3	0.0	0.1	10.6	0.0
Delay (s)	61.6	52.0		110.6	54.3		57.2	5.9	3.8	23.1	54.5	62.7
Level of Service	E	D		F	D		E	A	A	C	D	E
Approach Delay (s)		55.2			89.5			18.3			55.2	
Approach LOS		E			F			B			E	
<b>Intersection Summary</b>												
HCM Average Control Delay			45.5				HCM Level of Service			D		
HCM Volume to Capacity ratio			0.84									
Actuated Cycle Length (s)			130.0				Sum of lost time (s)			12.0		
Intersection Capacity Utilization			95.6%				ICU Level of Service			F		
Analysis Period (min)			15									
c Critical Lane Group												

2010 Existing - Weekday AM Peak Hour  
3: Unionville Gate & Kennedy Road

Queues  
Highway 407 Transitway: Kennedy Station



Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	9	507	122	586	1740	29
Lane Group Flow (vph)	9	507	122	586	1740	29
Turn Type	pm+ov		pm+pt		pm+ov	
Protected Phases	6	7	7	4	8	6
Permitted Phases		6	4			8
Detector Phases	6	7	7	4	8	6
Minimum Initial (s)	15.0	6.0	6.0	20.0	20.0	15.0
Minimum Split (s)	32.0	10.0	10.0	32.0	32.0	32.0
Total Split (s)	33.0	16.0	16.0	97.0	81.0	33.0
Total Split (%)	25.4%	12.3%	12.3%	74.6%	62.3%	25.4%
Yellow Time (s)	4.0	3.0	3.0	4.0	4.0	4.0
All-Red Time (s)	2.0	1.0	1.0	2.0	2.0	2.0
Lead/Lag		Lead	Lead		Lag	
Lead-Lag Optimize?		Yes	Yes		Yes	
Recall Mode	C-Max	None	None	None	None	C-Max
v/c Ratio	0.03	0.86	0.56	0.26	0.87	0.02
Control Delay	39.9	52.9	32.9	6.3	24.7	0.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	39.9	52.9	32.9	6.3	24.7	0.8
Stops (vph)	8	425	90	179	1464	1
Fuel Used(l)	1	41	10	26	120	1
CO Emissions (g/hr)	12	767	179	487	2229	13
NOx Emissions (g/hr)	2	149	35	95	434	3
VOC Emissions (g/hr)	3	178	41	113	517	3
Dilemma Vehicles (#)	0	0	0	42	59	0
Queue Length 50th (m)	1.7	109.8	12.5	14.5	145.5	0.0
Queue Length 95th (m)	6.1	#169.7	26.2	36.6	213.4	m0.9
Internal Link Dist (m)	210.0			177.1	242.3	
Turn Bay Length (m)	50.0		180.0			65.0
Base Capacity (vph)	359	596	220	2364	2073	1272
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.03	0.85	0.55	0.25	0.84	0.02

Intersection Summary

Cycle Length: 130

Actuated Cycle Length: 130

Offset: 0 (0%), Referenced to phase 2: and 6:EBL, Start of Green

Natural Cycle: 90

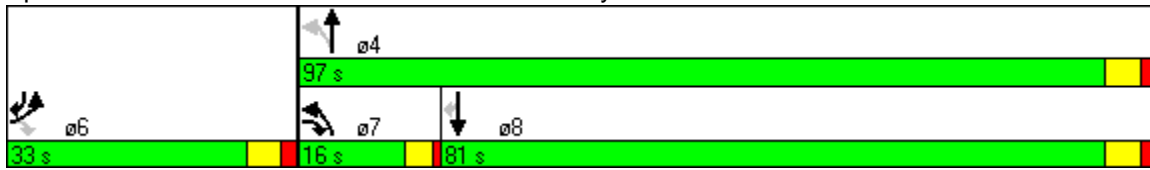
Control Type: Actuated-Coordinated

# 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.













m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 3: Unionville Gate & Kennedy Road



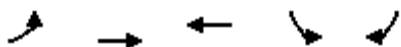
2010 Existing - Weekday AM Peak Hour  
3: Unionville Gate & Kennedy Road

HCM Signalized Intersection Capacity Analysis  
Highway 407 Transitway: Kennedy Station

						
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	0.95	0.95	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	1.00	1.00
Satd. Flow (prot)	1463	1581	1807	3305	3500	1493
Flt Permitted	0.95	1.00	0.05	1.00	1.00	1.00
Satd. Flow (perm)	1463	1581	92	3305	3500	1493
Volume (vph)	9	507	122	586	1740	29
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	9	507	122	586	1740	29
RTOR Reduction (vph)	0	13	0	0	0	5
Lane Group Flow (vph)	9	494	122	586	1740	24
Heavy Vehicles (%)	22%	1%	4%	8%	2%	7%
Turn Type	pm+ov		pm+pt		pm+ov	
Protected Phases	6	7	7	4	8	6
Permitted Phases		6	4			8
Actuated Green, G (s)	29.9	41.6	88.1	88.1	72.4	102.3
Effective Green, g (s)	31.9	43.6	90.1	90.1	74.4	106.3
Actuated g/C Ratio	0.25	0.34	0.69	0.69	0.57	0.82
Clearance Time (s)	6.0	4.0	4.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	359	579	218	2291	2003	1267
v/s Ratio Prot	0.01	c0.08	0.05	0.18	c0.50	0.00
v/s Ratio Perm		0.24	0.34			0.01
v/c Ratio	0.03	0.85	0.56	0.26	0.87	0.02
Uniform Delay, d1	37.2	40.2	31.9	7.4	23.6	2.2
Progression Factor	1.00	1.00	0.97	0.83	0.82	1.52
Incremental Delay, d2	0.1	11.6	3.0	0.1	4.1	0.0
Delay (s)	37.4	51.8	33.9	6.2	23.5	3.3
Level of Service	D	D	C	A	C	A
Approach Delay (s)	51.6			11.0	23.2	
Approach LOS	D			B	C	
<b>Intersection Summary</b>						
HCM Average Control Delay			25.2		HCM Level of Service	C
HCM Volume to Capacity ratio			0.86			
Actuated Cycle Length (s)			130.0		Sum of lost time (s)	8.0
Intersection Capacity Utilization			86.2%		ICU Level of Service	E
Analysis Period (min)			15			
c Critical Lane Group						

2010 Existing - Weekday AM Peak Hour  
4: YMCA Blvd. & Enterprise Drive

Queues  
Highway 407 Transitway: Kennedy Station



Lane Group	EBL	EBT	WBT	SBL	SBR
Lane Configurations					
Volume (vph)	42	132	672	40	107
Lane Group Flow (vph)	42	132	745	40	107
Turn Type	custom			Perm	
Protected Phases			8	6	
Permitted Phases	4	4			6
Detector Phases	4	4	8	6	6
Minimum Initial (s)	10.0	10.0	10.0	10.0	10.0
Minimum Split (s)	23.0	23.0	29.0	29.0	29.0
Total Split (s)	30.0	30.0	30.0	30.0	30.0
Total Split (%)	50.0%	50.0%	50.0%	50.0%	50.0%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	None	None	None	Max	Max
v/c Ratio	0.22	0.10	0.62	0.05	0.14
Control Delay	14.5	11.0	15.8	9.1	3.1
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	14.5	11.0	15.8	9.1	3.1
Stops (vph)	30	74	534	23	16
Fuel Used(l)	2	4	41	8	20
CO Emissions (g/hr)	28	73	763	152	378
NOx Emissions (g/hr)	5	14	148	30	73
VOC Emissions (g/hr)	7	17	177	35	88
Dilemma Vehicles (#)	0	0	0	0	0
Queue Length 50th (m)	2.5	3.9	26.5	1.7	0.0
Queue Length 95th (m)	7.9	7.7	39.1	6.4	6.3
Internal Link Dist (m)		71.6	139.2	186.9	
Turn Bay Length (m)	75.0				
Base Capacity (vph)	228	1517	1437	814	785
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.18	0.09	0.52	0.05	0.14

Intersection Summary

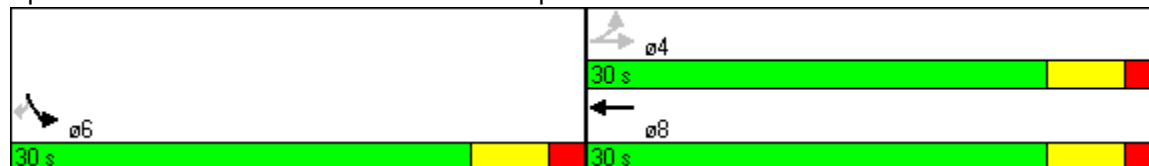
Cycle Length: 60

Actuated Cycle Length: 53.7

Natural Cycle: 60

Control Type: Semi Act-Uncoord

Splits and Phases: 4: YMCA Blvd. & Enterprise Drive












2010 Existing - Weekday AM Peak Hour  
4: YMCA Blvd. & Enterprise Drive

HCM Signalized Intersection Capacity Analysis  
Highway 407 Transitway: Kennedy Station



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0	4.0
Lane Util. Factor	1.00	0.95	0.95		1.00	1.00
Frpb, ped/bikes	1.00	1.00	1.00		1.00	0.98
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	0.99		1.00	0.85
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1714	3500	3286		1668	1497
Flt Permitted	0.26	1.00	1.00		0.95	1.00
Satd. Flow (perm)	476	3500	3286		1668	1497
Volume (vph)	42	132	672	73	40	107
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	42	132	672	73	40	107
RTOR Reduction (vph)	0	0	15	0	0	55
Lane Group Flow (vph)	42	132	730	0	40	52
Confl. Peds. (#/hr)	5			5	8	4
Heavy Vehicles (%)	4%	2%	5%	24%	7%	5%
Turn Type	custom				Perm	
Protected Phases			8		6	
Permitted Phases	4	4				6
Actuated Green, G (s)	17.4	17.4	17.4		24.2	24.2
Effective Green, g (s)	19.4	19.4	19.4		26.2	26.2
Actuated g/C Ratio	0.36	0.36	0.36		0.49	0.49
Clearance Time (s)	6.0	6.0	6.0		6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	172	1267	1189		815	732
v/s Ratio Prot			c0.22		0.02	
v/s Ratio Perm	0.09	0.04				c0.03
v/c Ratio	0.24	0.10	0.61		0.05	0.07
Uniform Delay, d1	12.0	11.3	14.0		7.2	7.3
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	0.7	0.0	0.9		0.1	0.2
Delay (s)	12.7	11.4	15.0		7.3	7.4
Level of Service	B	B	B		A	A
Approach Delay (s)		11.7	15.0		7.4	
Approach LOS		B	B		A	
<b>Intersection Summary</b>						
HCM Average Control Delay			13.4		HCM Level of Service	B
HCM Volume to Capacity ratio			0.30			
Actuated Cycle Length (s)			53.6		Sum of lost time (s)	8.0
Intersection Capacity Utilization			53.5%		ICU Level of Service	A
Analysis Period (min)			15			
c Critical Lane Group						

						
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	42	0	768	42	0	23
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (vph)	42	0	768	42	0	23
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume			42		1620	42
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			42		1620	42
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			51		100	98
cM capacity (veh/h)			1567		58	1029
Direction, Lane #	EB 1	WB 1	NB 1			
Volume Total	42	810	23			
Volume Left	0	768	0			
Volume Right	0	0	23			
cSH	1700	1567	1029			
Volume to Capacity	0.02	0.49	0.02			
Queue Length 95th (m)	0.0	19.6	0.5			
Control Delay (s)	0.0	9.2	8.6			
Lane LOS		A	A			
Approach Delay (s)	0.0	9.2	8.6			
Approach LOS			A			
Intersection Summary						
Average Delay		8.8				
Intersection Capacity Utilization		54.8%	ICU Level of Service	A		
Analysis Period (min)		15				



2010 Existing - Weekday PM Peak Hour  
1: Hwy 407 WB Ramp & Kennedy Road

Queues  
Highway 407 Transitway: Kennedy Station



Lane Group	WBL	WBR	NBT	SBT
Lane Configurations	↰↰	↰	↗↗	↗↗
Volume (vph)	16	50	2169	1530
Lane Group Flow (vph)	16	50	2169	1530
Turn Type	Perm			
Protected Phases	8		2	6
Permitted Phases		8		
Detector Phases	8	8	2	6
Minimum Initial (s)	15.0	15.0	25.0	25.0
Minimum Split (s)	29.0	29.0	31.0	31.0
Total Split (s)	29.0	29.0	91.0	91.0
Total Split (%)	24.2%	24.2%	75.8%	75.8%
Yellow Time (s)	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0
Lead/Lag				
Lead-Lag Optimize?				
Recall Mode	None	None	C-Max	C-Max
v/c Ratio	0.03	0.19	0.72	0.51
Control Delay	41.5	32.1	6.2	1.7
Queue Delay	0.0	1.9	0.2	0.4
Total Delay	41.5	34.1	6.4	2.1
Stops (vph)	16	29	783	237
Fuel Used(l)	1	4	98	31
CO Emissions (g/hr)	26	67	1816	578
NOx Emissions (g/hr)	5	13	353	112
VOC Emissions (g/hr)	6	16	421	134
Dilemma Vehicles (#)	0	0	81	21
Queue Length 50th (m)	1.5	6.2	82.5	3.0
Queue Length 95th (m)	4.2	15.6m	106.4	21.8
Internal Link Dist (m)	346.4		308.0	86.3
Turn Bay Length (m)	140.0			
Base Capacity (vph)	707	341	3021	3021
Starvation Cap Reductn	0	0	0	823
Spillback Cap Reductn	0	203	178	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.02	0.36	0.76	0.70

Intersection Summary

Cycle Length: 120

Actuated Cycle Length: 120

Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBT, Start of Green

Natural Cycle: 90

Control Type: Actuated-Coordinated











m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 1: Hwy 407 WB Ramp & Kennedy Road



2010 Existing - Weekday PM Peak Hour  
1: Hwy 407 WB Ramp & Kennedy Road

HCM Signalized Intersection Capacity Analysis  
Highway 407 Transitway: Kennedy Station

						
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0			4.0
Lane Util. Factor	0.97	1.00	*1.00			*1.00
Frt	1.00	0.85	1.00			1.00
Flt Protected	0.95	1.00	1.00			1.00
Satd. Flow (prot)	3395	1566	3684			3684
Flt Permitted	0.95	1.00	1.00			1.00
Satd. Flow (perm)	3395	1566	3684			3684
Volume (vph)	16	50	2169	0	0	1530
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	16	50	2169	0	0	1530
RTOR Reduction (vph)	0	16	0	0	0	0
Lane Group Flow (vph)	16	34	2169	0	0	1530
Heavy Vehicles (%)	2%	2%	2%	0%	0%	2%
Turn Type	Perm					
Protected Phases	8		2			6
Permitted Phases	8					
Actuated Green, G (s)	13.6	13.6	94.4			94.4
Effective Green, g (s)	15.6	15.6	96.4			96.4
Actuated g/C Ratio	0.13	0.13	0.80			0.80
Clearance Time (s)	6.0	6.0	6.0			6.0
Vehicle Extension (s)	3.0	3.0	3.0			3.0
Lane Grp Cap (vph)	441	204	2959			2959
v/s Ratio Prot	0.00		c0.59			0.42
v/s Ratio Perm	c0.02					
v/c Ratio	0.04	0.17	0.73			0.52
Uniform Delay, d1	45.6	46.4	5.6			4.0
Progression Factor	1.00	1.00	0.80			0.28
Incremental Delay, d2	0.0	0.4	0.7			0.4
Delay (s)	45.7	46.8	5.2			1.5
Level of Service	D	D	A			A
Approach Delay (s)	46.5		5.2			1.5
Approach LOS	D		A			A
<b>Intersection Summary</b>						
HCM Average Control Delay			4.4		HCM Level of Service	A
HCM Volume to Capacity ratio			0.65			
Actuated Cycle Length (s)			120.0		Sum of lost time (s)	8.0
Intersection Capacity Utilization			89.1%		ICU Level of Service	E
Analysis Period (min)			15			
c Critical Lane Group						

2010 Existing - Weekday PM Peak Hour  
2: YMCA Blvd. & Kennedy Road

Queues  
Highway 407 Transitway: Kennedy Station



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations										
Volume (vph)	308	91	107	22	148	2042	216	21	1306	135
Lane Group Flow (vph)	308	364	107	41	148	2042	216	21	1306	135
Turn Type	Prot	pm+pt			Prot	custom		Perm		pm+ov
Protected Phases	7		3	8	5				6	7
Permitted Phases		4	8			2	2	6		6
Detector Phases	7	4	3	8	5	2	2	6	6	7
Minimum Initial (s)	6.0	10.0	6.0	10.0	6.0	20.0	20.0	20.0	20.0	6.0
Minimum Split (s)	10.0	29.0	10.0	29.0	10.0	52.0	52.0	52.0	52.0	10.0
Total Split (s)	12.0	38.0	12.0	38.0	12.0	70.0	70.0	58.0	58.0	12.0
Total Split (%)	10.0%	31.7%	10.0%	31.7%	10.0%	58.3%	58.3%	48.3%	48.3%	10.0%
Yellow Time (s)	3.0	4.0	3.0	4.0	3.0	4.0	4.0	4.0	4.0	3.0
All-Red Time (s)	1.0	2.0	1.0	2.0	1.0	2.0	2.0	2.0	2.0	1.0
Lead/Lag	Lead	Lag	Lead	Lag	Lead			Lag	Lag	Lead
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes			Yes	Yes	Yes
Recall Mode	None	None	None	None	None	C-Max	C-Max	C-Max	C-Max	None
v/c Ratio	0.67	0.83	0.57	0.12	0.62	0.88	0.20	0.34	0.78	0.14
Control Delay	58.8	45.2	44.7	32.2	57.6	26.1	5.3	50.8	42.1	4.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.1	0.0
Total Delay	58.8	45.2	44.7	32.2	57.6	27.3	5.3	50.8	42.2	4.4
Stops (vph)	199	234	80	28	119	1380	37	18	1031	30
Fuel Used(l)	27	28	13	4	12	114	5	2	115	5
CO Emissions (g/hr)	499	519	235	82	231	2113	95	38	2127	102
NOx Emissions (g/hr)	97	101	46	16	45	411	18	7	414	20
VOC Emissions (g/hr)	116	120	54	19	54	490	22	9	493	24
Dilemma Vehicles (#)	0	0	0	0	0	103	0	0	141	0
Queue Length 50th (m)	~46.0	51.0	16.9	6.1	31.6	133.9	5.1	3.6	118.9	1.8
Queue Length 95th (m)	#71.9	77.0	26.5	13.6m	#68.7	#263.4	m21.8	m8.1	142.2	8.0
Internal Link Dist (m)		105.9		425.2		28.0			122.7	
Turn Bay Length (m)	90.0		70.0		70.0		85.0	100.0		85.0
Base Capacity (vph)	461	545	190	499	238	2320	1065	61	1678	952
Starvation Cap Reductn	0	0	0	0	0	121	0	0	0	0
Spillback Cap Reductn	0	1	0	0	0	0	0	0	32	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.67	0.67	0.56	0.08	0.62	0.93	0.20	0.34	0.79	0.14

Intersection Summary

Cycle Length: 120

Actuated Cycle Length: 120

Offset: 107 (89%), Referenced to phase 2:NBT and 6:SBTL, Start of Green

Natural Cycle: 105

Control Type: Actuated-Coordinated

~ Volume exceeds capacity, queue is theoretically infinite.

Queue shown is maximum after two cycles.

# 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.























m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 2: YMCA Blvd. & Kennedy Road



2010 Existing - Weekday PM Peak Hour  
2: YMCA Blvd. & Kennedy Road

HCM Signalized Intersection Capacity Analysis  
Highway 407 Transitway: Kennedy Station

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	1.00		1.00	1.00		1.00	*1.00	1.00	1.00	*1.00	1.00
Frpb, ped/bikes	1.00	0.98		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.89		1.00	0.93		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00		1.00	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3298	1603		1765	1748		1824	3721	1597	1700	3648	1426
Flt Permitted	0.95	1.00		0.24	1.00		1.00	1.00	1.00	0.08	1.00	1.00
Satd. Flow (perm)	3298	1603		447	1748		1824	3721	1597	136	3648	1426
Volume (vph)	308	91	273	107	22	19	148	2042	216	21	1306	135
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	308	91	273	107	22	19	148	2042	216	21	1306	135
RTOR Reduction (vph)	0	97	0	0	5	0	0	0	73	0	0	57
Lane Group Flow (vph)	308	267	0	107	36	0	148	2042	143	21	1306	78
Confl. Peds. (#/hr)			7	7								
Heavy Vehicles (%)	5%	0%	3%	1%	0%	0%	3%	1%	0%	5%	3%	12%
Turn Type	Prot			pm+pt			Prot		custom	Perm		pm+ov
Protected Phases	7			3	8		5				6	7
Permitted Phases		4		8				2	2	6		6
Actuated Green, G (s)	16.8	25.7		24.7	16.8		15.6	70.4	70.4	50.8	50.8	67.6
Effective Green, g (s)	16.8	27.7		26.7	18.8		15.6	72.4	72.4	52.8	52.8	69.6
Actuated g/C Ratio	0.14	0.23		0.22	0.16		0.13	0.60	0.60	0.44	0.44	0.58
Clearance Time (s)	4.0	6.0		4.0	6.0		4.0	6.0	6.0	6.0	6.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	462	370		186	274		237	2245	964	60	1605	875
v/s Ratio Prot	c0.09			0.04	0.02		0.08				0.36	0.01
v/s Ratio Perm		c0.17		0.09				c0.55	0.09	0.15		0.04
v/c Ratio	0.67	0.72		0.58	0.13		0.62	0.91	0.15	0.35	0.81	0.09
Uniform Delay, d1	48.9	42.6		39.1	43.6		49.4	20.9	10.4	22.2	29.3	11.2
Progression Factor	1.00	1.00		1.00	1.00		0.93	1.07	1.86	1.42	1.39	1.87
Incremental Delay, d2	3.6	6.8		4.3	0.2		3.8	5.4	0.2	14.0	4.2	0.0
Delay (s)	52.6	49.4		43.4	43.8		49.6	27.7	19.6	45.5	44.9	20.9
Level of Service	D	D		D	D		D	C	B	D	D	C
Approach Delay (s)		50.8			43.5			28.3			42.7	
Approach LOS		D			D			C			D	
<b>Intersection Summary</b>												
HCM Average Control Delay			36.5				HCM Level of Service			D		
HCM Volume to Capacity ratio			0.83									
Actuated Cycle Length (s)			120.0				Sum of lost time (s)			8.0		
Intersection Capacity Utilization			114.5%				ICU Level of Service			H		
Analysis Period (min)			15									
c Critical Lane Group												

2010 Existing - Weekday PM Peak Hour  
3: Unionville Gate & Kennedy Road

Queues  
Highway 407 Transitway: Kennedy Station



Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	67	294	402	1826	979	49
Lane Group Flow (vph)	67	294	402	1826	979	49
Turn Type	pm+ov		pm+pt		pm+ov	
Protected Phases	6	7	7	4	8	6
Permitted Phases		6	4			8
Detector Phases	6	7	7	4	8	6
Minimum Initial (s)	15.0	6.0	6.0	20.0	20.0	15.0
Minimum Split (s)	32.0	10.0	10.0	32.0	32.0	32.0
Total Split (s)	33.0	18.0	18.0	87.0	69.0	33.0
Total Split (%)	27.5%	15.0%	15.0%	72.5%	57.5%	27.5%
Yellow Time (s)	4.0	3.0	3.0	4.0	4.0	4.0
All-Red Time (s)	2.0	1.0	1.0	2.0	2.0	2.0
Lead/Lag		Lead	Lead		Lag	
Lead-Lag Optimize?		Yes	Yes		Yes	
Recall Mode	C-Max	None	None	None	None	C-Max
v/c Ratio	0.15	0.42	0.95	0.77	0.54	0.04
Control Delay	36.8	19.0	43.1	5.7	16.3	0.2
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	36.8	19.0	43.1	5.7	16.3	0.2
Stops (vph)	51	142	304	532	417	1
Fuel Used(l)	5	14	35	80	48	1
CO Emissions (g/hr)	84	259	653	1487	895	22
NOx Emissions (g/hr)	16	50	127	289	174	4
VOC Emissions (g/hr)	19	60	151	345	207	5
Dilemma Vehicles (#)	0	0	0	17	45	0
Queue Length 50th (m)	11.5	29.9	29.6	15.5	46.7	0.1
Queue Length 95th (m)	22.6	52.0m#62.0		0.0	57.1	0.4
Internal Link Dist (m)	210.0			177.1	242.3	
Turn Bay Length (m)	50.0		180.0			65.0
Base Capacity (vph)	456	699	422	2445	1877	1219
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.15	0.42	0.95	0.75	0.52	0.04

Intersection Summary

Cycle Length: 120

Actuated Cycle Length: 120

Offset: 81 (68%), Referenced to phase 2: and 6:EBL, Start of Green

Natural Cycle: 80

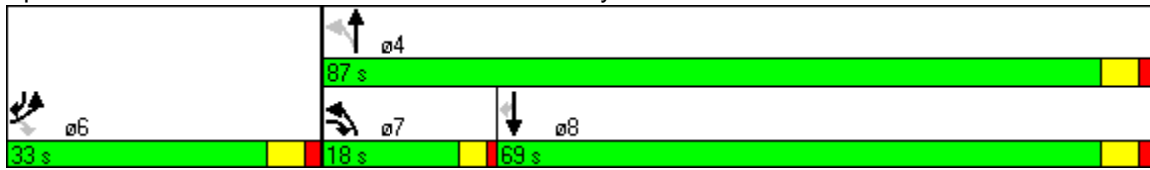
Control Type: Actuated-Coordinated

# 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

m Volume for 95th percentile queue is metered by upstream signal.













Splits and Phases: 3: Unionville Gate & Kennedy Road





2010 Existing - Weekday PM Peak Hour  
3: Unionville Gate & Kennedy Road

HCM Signalized Intersection Capacity Analysis  
Highway 407 Transitway: Kennedy Station

						
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	0.95	0.95	1.00
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	0.99
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	1.00	1.00
Satd. Flow (prot)	1733	1551	1860	3535	3466	1542
Flt Permitted	0.95	1.00	0.19	1.00	1.00	1.00
Satd. Flow (perm)	1733	1551	356	3535	3466	1542
Volume (vph)	67	294	402	1826	979	49
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	67	294	402	1826	979	49
RTOR Reduction (vph)	0	61	0	0	0	11
Lane Group Flow (vph)	67	233	402	1826	979	38
Confl. Peds. (#/hr)			1			1
Heavy Vehicles (%)	3%	3%	1%	1%	3%	2%
Turn Type	pm+ov		pm+pt		pm+ov	
Protected Phases	6	7	7	4	8	6
Permitted Phases		6	4			8
Actuated Green, G (s)	29.5	43.5	78.5	78.5	60.5	90.0
Effective Green, g (s)	31.5	45.5	80.5	80.5	62.5	94.0
Actuated g/C Ratio	0.26	0.38	0.67	0.67	0.52	0.78
Clearance Time (s)	6.0	4.0	4.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	455	640	414	2371	1805	1259
v/s Ratio Prot	0.04	c0.04	c0.11	0.52	0.28	0.01
v/s Ratio Perm		0.11	c0.54			0.02
v/c Ratio	0.15	0.36	0.97	0.77	0.54	0.03
Uniform Delay, d1	33.9	26.8	19.4	13.4	19.2	2.9
Progression Factor	1.00	1.00	1.59	0.33	0.79	0.24
Incremental Delay, d2	0.7	0.4	24.3	0.8	0.3	0.0
Delay (s)	34.6	27.2	55.1	5.3	15.6	0.7
Level of Service	C	C	E	A	B	A
Approach Delay (s)	28.6			14.3	14.9	
Approach LOS	C			B	B	
<b>Intersection Summary</b>						
HCM Average Control Delay			15.9		HCM Level of Service	B
HCM Volume to Capacity ratio			0.79			
Actuated Cycle Length (s)			120.0		Sum of lost time (s)	8.0
Intersection Capacity Utilization			71.8%		ICU Level of Service	C
Analysis Period (min)			15			
c Critical Lane Group						

2010 Existing - Weekday PM Peak Hour  
4: YMCA Blvd. & Enterprise Drive

Queues  
Highway 407 Transitway: Kennedy Station



Lane Group	EBL	EBT	WBT	SBL	SBR
Lane Configurations	↰	↑↑	↑↑	↰	↰
Volume (vph)	200	658	71	14	19
Lane Group Flow (vph)	200	658	129	14	19
Turn Type	Prot				Perm
Protected Phases	7		8	6	
Permitted Phases		4			6
Detector Phases	7	4	8	6	6
Minimum Initial (s)	6.0	10.0	10.0	10.0	10.0
Minimum Split (s)	10.0	23.0	29.0	29.0	29.0
Total Split (s)	10.0	50.0	40.0	30.0	30.0
Total Split (%)	12.5%	62.5%	50.0%	37.5%	37.5%
Yellow Time (s)	3.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	2.0	2.0	2.0	2.0
Lead/Lag	Lead		Lag		
Lead-Lag Optimize?	Yes		Yes		
Recall Mode	None	None	None	Max	Max
v/c Ratio	0.85	0.51	0.19	0.02	0.03
Control Delay	63.2	14.6	11.7	8.5	4.5
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	63.2	14.6	11.7	8.5	4.5
Stops (vph)	142	463	61	9	6
Fuel Used(l)	15	24	6	3	4
CO Emissions (g/hr)	272	439	113	53	69
NOx Emissions (g/hr)	53	85	22	10	13
VOC Emissions (g/hr)	63	102	26	12	16
Dilemma Vehicles (#)	0	0	0	0	0
Queue Length 50th (m)	~21.9	23.2	2.8	0.7	0.0
Queue Length 95th (m)	#53.2	34.4	7.9	2.9	2.5
Internal Link Dist (m)		71.6	139.2	186.9	
Turn Bay Length (m)	75.0				
Base Capacity (vph)	236	2013	1323	805	731
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.85	0.33	0.10	0.02	0.03

Intersection Summary

Cycle Length: 80

Actuated Cycle Length: 54.2

Natural Cycle: 70

Control Type: Semi Act-Uncoord

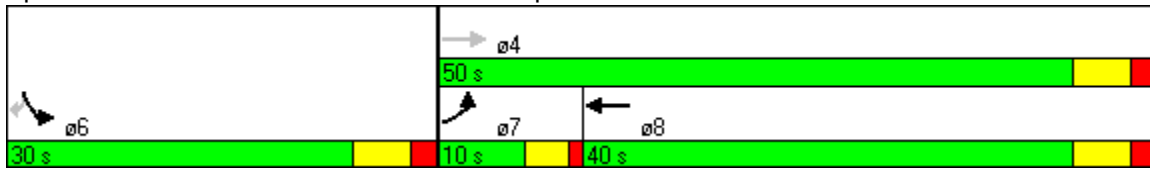
~ Volume exceeds capacity, queue is theoretically infinite.

Queue shown is maximum after two cycles.

# 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.






Splits and Phases: 4: YMCA Blvd. & Enterprise Drive



2010 Existing - Weekday PM Peak Hour  
4: YMCA Blvd. & Enterprise Drive

HCM Signalized Intersection Capacity Analysis  
Highway 407 Transitway: Kennedy Station



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0	4.0
Lane Util. Factor	1.00	0.95	0.95		1.00	1.00
Frpb, ped/bikes	1.00	1.00	0.99		1.00	0.98
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	0.93		1.00	0.85
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1716	3500	2910		1668	1497
Flt Permitted	0.95	1.00	1.00		0.95	1.00
Satd. Flow (perm)	1716	3500	2910		1668	1497
Volume (vph)	200	658	71	58	14	19
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	200	658	71	58	14	19
RTOR Reduction (vph)	0	0	48	0	0	10
Lane Group Flow (vph)	200	658	81	0	14	9
Confl. Peds. (#/hr)	5			5	8	4
Heavy Vehicles (%)	4%	2%	5%	24%	7%	5%
Turn Type	Prot			Perm		
Protected Phases	7		8		6	
Permitted Phases	4				6	
Actuated Green, G (s)	7.5	19.4	7.9		24.2	24.2
Effective Green, g (s)	7.5	21.4	9.9		26.2	26.2
Actuated g/C Ratio	0.13	0.38	0.18		0.47	0.47
Clearance Time (s)	4.0	6.0	6.0		6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	231	1347	518		786	705
v/s Ratio Prot	c0.12		0.03		c0.01	
v/s Ratio Perm	c0.19				0.01	
v/c Ratio	0.87	0.49	0.16		0.02	0.01
Uniform Delay, d1	23.6	13.0	19.3		7.8	7.8
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	27.0	0.3	0.1		0.0	0.0
Delay (s)	50.5	13.2	19.5		7.9	7.9
Level of Service	D	B	B		A	A
Approach Delay (s)	21.9		19.5		7.9	
Approach LOS	C		B		A	
Intersection Summary						
HCM Average Control Delay			21.2		HCM Level of Service C	
HCM Volume to Capacity ratio			0.27			
Actuated Cycle Length (s)			55.6		Sum of lost time (s) 8.0	
Intersection Capacity Utilization			44.5%		ICU Level of Service A	
Analysis Period (min)			15			
c Critical Lane Group						

	→	↘	↙	←	↖	↗
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑			↑		↑
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	42	0	80	42	0	854
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (vph)	42	0	80	42	0	854
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None		
Median storage veh						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume			42		244	42
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			42		244	42
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			95		100	17
cM capacity (veh/h)			1567		706	1029
Direction, Lane #	EB 1	WB 1	NB 1			
Volume Total	42	122	854			
Volume Left	0	80	0			
Volume Right	0	0	854			
cSH	1700	1567	1029			
Volume to Capacity	0.02	0.05	0.83			
Queue Length 95th (m)	0.0	1.1	70.3			
Control Delay (s)	0.0	5.0	22.9			
Lane LOS		A	C			
Approach Delay (s)	0.0	5.0	22.9			
Approach LOS			C			
Intersection Summary						
Average Delay		19.8				
Intersection Capacity Utilization		62.9%		ICU Level of Service		B
Analysis Period (min)		15				



## APPENDIX B

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### 2031 BACKGROUND CONDITION SYNCHRO SUMMARY OUTPUTS





2031 Background - Weekday AM Peak Hour  
1: Hwy 407 WB Ramp & Kennedy Road

Queues  
Highway 407 Transitway: Kennedy Station

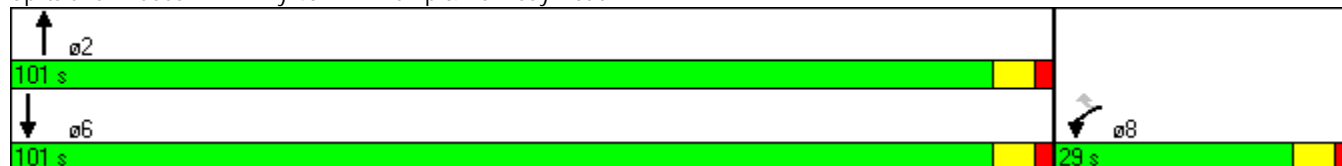


Lane Group	WBL	WBR	NBT	SBT
Lane Configurations	↰↰	↰	↰↰↰	↰↰↰
Volume (vph)	333	306	1832	2722
Lane Group Flow (vph)	333	306	1832	2722
Turn Type	Perm			
Protected Phases	8		2	6
Permitted Phases		8		
Detector Phase	8	8	2	6
Switch Phase				
Minimum Initial (s)	15.0	15.0	25.0	25.0
Minimum Split (s)	29.0	29.0	31.0	31.0
Total Split (s)	29.0	29.0	101.0	101.0
Total Split (%)	22.3%	22.3%	77.7%	77.7%
Yellow Time (s)	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0
Total Lost Time (s)	4.0	4.0	4.0	4.0
Lead/Lag				
Lead-Lag Optimize?				
Recall Mode	None	None	C-Max	C-Max
v/c Ratio	0.52	0.93	0.44	0.66
Control Delay	50.5	79.5	4.6	2.3
Queue Delay	0.0	0.0	0.0	0.7
Total Delay	50.5	79.5	4.6	2.9
Queue Length 50th (m)	36.6	63.1	29.0	8.0
Queue Length 95th (m)	50.4	#112.2	31.4	9.6
Internal Link Dist (m)	346.4		308.0	86.3
Turn Bay Length (m)		140.0		
Base Capacity (vph)	653	333	4137	4137
Starvation Cap Reductn	0	0	0	917
Spillback Cap Reductn	0	0	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.51	0.92	0.44	0.85

Intersection Summary

Cycle Length: 130  
Actuated Cycle Length: 130  
Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBT, Start of Green  
Natural Cycle: 65  
Control Type: Actuated-Coordinated  
# 95th percentile volume exceeds capacity, queue may be longer.  
Queue shown is maximum after two cycles.

Splits and Phases: 1: Hwy 407 WB Ramp & Kennedy Road



2031 Background - Weekday AM Peak Hour  
1: Hwy 407 WB Ramp & Kennedy Road

HCM Signalized Intersection Capacity Analysis

Highway 407 Transitway: Kennedy Station

























Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰↰	↱	↰↰↰			↰↰↰
Volume (vph)	333	306	1832	0	0	2722
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0			4.0
Lane Util. Factor	0.97	1.00	*1.00			*1.00
Frt	1.00	0.85	1.00			1.00
Flt Protected	0.95	1.00	1.00			1.00
Satd. Flow (prot)	3395	1566	5526			5526
Flt Permitted	0.95	1.00	1.00			1.00
Satd. Flow (perm)	3395	1566	5526			5526
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	333	306	1832	0	0	2722
RTOR Reduction (vph)	0	32	0	0	0	0
Lane Group Flow (vph)	333	274	1832	0	0	2722
Heavy Vehicles (%)	2%	2%	2%	0%	0%	2%
Turn Type	Perm					
Protected Phases	8		2			6
Permitted Phases		8				
Actuated Green, G (s)	22.7	22.7	95.3			95.3
Effective Green, g (s)	24.7	24.7	97.3			97.3
Actuated g/C Ratio	0.19	0.19	0.75			0.75
Clearance Time (s)	6.0	6.0	6.0			6.0
Vehicle Extension (s)	3.0	3.0	3.0			3.0
Lane Grp Cap (vph)	645	298	4136			4136
v/s Ratio Prot	0.10		0.33			c0.49
v/s Ratio Perm		c0.17				
v/c Ratio	0.52	0.92	0.44			0.66
Uniform Delay, d1	47.3	51.7	6.2			8.1
Progression Factor	1.00	1.00	0.69			0.22
Incremental Delay, d2	0.7	31.3	0.3			0.5
Delay (s)	48.0	83.0	4.6			2.3
Level of Service	D	F	A			A
Approach Delay (s)	64.7		4.6			2.3
Approach LOS	E		A			A
<b>Intersection Summary</b>						
HCM Average Control Delay			10.8		HCM Level of Service	B
HCM Volume to Capacity ratio			0.71			
Actuated Cycle Length (s)			130.0		Sum of lost time (s)	8.0
Intersection Capacity Utilization			78.5%		ICU Level of Service	D
Analysis Period (min)			15			

c Critical Lane Group

2031 Background - Weekday AM Peak Hour  
2: YMCA Blvd. & Kennedy Road

Queues  
Highway 407 Transitway: Kennedy Station

											
Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations											
Volume (vph)	108	65	413	196	150	683	1396	56	13	2221	301
Lane Group Flow (vph)	108	65	413	196	175	683	1396	56	13	2221	301
Turn Type	Prot		Free	pm+pt		Prot		custom	Perm		pm+ov
Protected Phases	7			3	8	5				6	7
Permitted Phases		4	Free	8			2	2	6		6
Detector Phase	7	4		3	8	5	2	2	6	6	7
Switch Phase											
Minimum Initial (s)	6.0	10.0		6.0	10.0	6.0	20.0	20.0	20.0	20.0	6.0
Minimum Split (s)	10.0	29.0		10.0	29.0	10.0	52.0	52.0	52.0	52.0	10.0
Total Split (s)	12.0	34.0	0.0	14.0	36.0	22.0	82.0	82.0	60.0	60.0	12.0
Total Split (%)	9.2%	26.2%	0.0%	10.8%	27.7%	16.9%	63.1%	63.1%	46.2%	46.2%	9.2%
Yellow Time (s)	3.0	4.0		3.0	4.0	3.0	4.0	4.0	4.0	4.0	3.0
All-Red Time (s)	1.0	2.0		1.0	2.0	1.0	2.0	2.0	2.0	2.0	1.0
Lost Time Adjust (s)	0.0	-2.0	0.0	0.0	-2.0	0.0	-2.0	-2.0	-2.0	-2.0	0.0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lead/Lag	Lead	Lag		Lead	Lag	Lead			Lag	Lag	Lead
Lead-Lag Optimize?	Yes	Yes		Yes	Yes	Yes			Yes	Yes	Yes
Recall Mode	None	None		None	None	None	C-Max	C-Max	C-Max	C-Max	None
v/c Ratio	0.61	0.25	0.29	0.62	0.62	0.81	0.37	0.05	0.08	0.93	0.33
Control Delay	74.7	50.7	0.5	50.7	59.1	63.8	6.7	1.1	37.4	62.9	12.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	242.2	0.0
Total Delay	74.7	50.7	0.5	50.7	59.1	63.8	6.8	1.1	37.4	305.2	12.3
Queue Length 50th (m)	13.0	14.0	0.0	39.4	38.0	79.5	31.1	0.0	3.0	186.0	25.3
Queue Length 95th (m)	22.0	25.1	0.0	55.6	56.1	m#121.3	m41.1	m2.2	m3.4	198.5	m30.1
Internal Link Dist (m)		105.9			204.5		28.0			122.1	
Turn Bay Length (m)	90.0			70.0		70.0		85.0	100.0		85.0
Base Capacity (vph)	181	434	1445	315	450	847	3736	1107	168	2380	917
Starvation Cap Reductn	0	0	0	0	0	0	900	0	0	940	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.60	0.15	0.29	0.62	0.39	0.81	0.49	0.05	0.08	1.54	0.33

Intersection Summary

Cycle Length: 130

Actuated Cycle Length: 130

Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBTL, Start of Green

Natural Cycle: 115

Control Type: Actuated-Coordinated

# 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

m Volume for 95th percentile queue is metered by upstream signal.

2031 Background - Weekday AM Peak Hour  
 2: YMCA Blvd. & Kennedy Road

Queues  
 Highway 407 Transitway: Kennedy Station
























Splits and Phases: 2: YMCA Blvd. & Kennedy Road



2031 Background - Weekday AM Peak Hour  
2: YMCA Blvd. & Kennedy Road

HCM Signalized Intersection Capacity Analysis

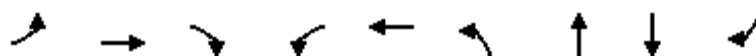
Highway 407 Transitway: Kennedy Station

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	108	65	413	196	150	25	683	1396	56	13	2221	301
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	1.00	1.00	1.00	1.00		*1.00	*1.00	1.00	1.00	*1.00	1.00
Frpb, ped/bikes	1.00	1.00	0.99	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	0.99	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.98		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	1.00		1.00	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	2935	1879	1445	1851	1810		3613	5368	1566	1785	5526	1479
Flt Permitted	0.95	1.00	1.00	0.54	1.00		1.00	1.00	1.00	0.21	1.00	1.00
Satd. Flow (perm)	2935	1879	1445	1007	1810		3613	5368	1566	388	5526	1479
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	108	65	413	196	150	25	683	1396	56	13	2221	301
RTOR Reduction (vph)	0	0	0	0	5	0	0	0	18	0	0	161
Lane Group Flow (vph)	108	65	413	196	170	0	683	1396	38	13	2221	140
Confl. Peds. (#/hr)			7	7								
Heavy Vehicles (%)	18%	0%	9%	1%	0%	11%	4%	5%	2%	0%	2%	8%
Turn Type	Prot		Free	pm+pt			Prot		custom	Perm		pm+ov
Protected Phases	7			3	8		5				6	7
Permitted Phases		4	Free	8				2	2	6		6
Actuated Green, G (s)	7.8	13.9	130.0	30.7	18.9		30.5	87.3	87.3	52.8	52.8	60.6
Effective Green, g (s)	7.8	15.9	130.0	30.7	20.9		30.5	89.3	89.3	54.8	54.8	60.6
Actuated g/C Ratio	0.06	0.12	1.00	0.24	0.16		0.23	0.69	0.69	0.42	0.42	0.47
Clearance Time (s)	4.0	6.0		4.0	6.0		4.0	6.0	6.0	6.0	6.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	176	230	1445	321	291		848	3687	1076	164	2329	689
v/s Ratio Prot	0.04			c0.06	c0.09		c0.19				c0.40	0.01
v/s Ratio Perm		0.03	0.29	0.08				0.26	0.02	0.03		0.08
v/c Ratio	0.61	0.28	0.29	0.61	0.58		0.81	0.38	0.04	0.08	0.95	0.20
Uniform Delay, d1	59.6	51.9	0.0	42.5	50.5		46.9	8.6	6.5	22.5	36.4	20.5
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.20	0.75	0.52	1.63	1.68	6.74
Incremental Delay, d2	6.2	0.7	0.5	3.4	3.0		4.9	0.3	0.1	0.4	5.3	0.1
Delay (s)	65.8	52.5	0.5	45.9	53.5		61.3	6.7	3.4	37.1	66.5	138.0
Level of Service	E	D	A	D	D		E	A	A	D	E	F
Approach Delay (s)		18.3			49.5			24.1			74.8	
Approach LOS		B			D			C			E	
<b>Intersection Summary</b>												
HCM Average Control Delay			48.0				HCM Level of Service			D		
HCM Volume to Capacity ratio			0.81									
Actuated Cycle Length (s)			130.0				Sum of lost time (s)			12.0		
Intersection Capacity Utilization			97.2%				ICU Level of Service			F		
Analysis Period (min)			15									
c Critical Lane Group												

2031 Background - Weekday AM Peak Hour  
3: Unionville Gate & Kennedy Road

Queues

Highway 407 Transitway: Kennedy Station



Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	SBT	SBR
Lane Configurations									
Volume (vph)	39	108	711	16	109	385	699	2090	196
Lane Group Flow (vph)	39	108	711	16	109	385	699	2090	196
Turn Type	Prot		Free	Perm		pm+pt			pm+ov
Protected Phases	1				2	7	4	8	1
Permitted Phases		6	Free	2		4			8
Detector Phase	1	6		2	2	7	4	8	1
Switch Phase									
Minimum Initial (s)	15.0	15.0		10.0	10.0	6.0	20.0	20.0	15.0
Minimum Split (s)	32.0	32.0		21.0	21.0	10.0	32.0	32.0	32.0
Total Split (s)	32.0	52.0	0.0	20.0	20.0	25.0	78.0	53.0	32.0
Total Split (%)	24.6%	40.0%	0.0%	15.4%	15.4%	19.2%	60.0%	40.8%	24.6%
Yellow Time (s)	4.0	4.0		3.0	3.0	3.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0		2.0	2.0	1.0	2.0	2.0	2.0
Lost Time Adjust (s)	-2.0	-2.0	0.0	-1.0	-1.0	0.0	-2.0	-2.0	-2.0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lead/Lag	Lead			Lag	Lag	Lead		Lag	Lead
Lead-Lag Optimize?	Yes			Yes	Yes	Yes		Yes	Yes
Recall Mode	Max	C-Max		C-Min	C-Min	None	None	None	Max
v/c Ratio	0.12	0.16	0.45	0.10	0.48	0.96	0.26	1.00	0.20
Control Delay	42.5	28.3	0.9	52.6	60.9	85.6	10.4	50.2	1.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	42.5	28.3	0.9	52.6	60.9	85.6	10.4	50.2	1.8
Queue Length 50th (m)	7.5	17.0	0.0	3.4	24.3	69.6	22.5	~117.0	1.7
Queue Length 95th (m)	16.6	29.1	0.0	10.0	41.6	#124.0	26.7	#190.6	5.3
Internal Link Dist (m)		216.2			297.9		177.1	242.3	
Turn Bay Length (m)	50.0					180.0			65.0
Base Capacity (vph)	315	680	1581	156	227	402	2703	2083	1004
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.12	0.16	0.45	0.10	0.48	0.96	0.26	1.00	0.20

Intersection Summary

Cycle Length: 130

Actuated Cycle Length: 130

Offset: 0 (0%), Referenced to phase 2:WBTL and 6:EBT, Start of Green

Natural Cycle: 125

Control Type: Actuated-Coordinated

~ Volume exceeds capacity, queue is theoretically infinite.

Queue shown is maximum after two cycles.

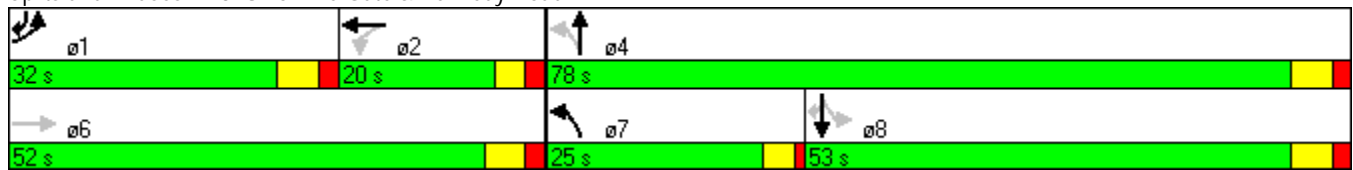
# 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

2031 Background - Weekday AM Peak Hour  
3: Unionville Gate & Kennedy Road

Queues  
Highway 407 Transitway: Kennedy Station























Splits and Phases: 3: Unionville Gate & Kennedy Road



2031 Background - Weekday AM Peak Hour  
3: Unionville Gate & Kennedy Road

HCM Signalized Intersection Capacity Analysis

Highway 407 Transitway: Kennedy Station

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	39	108	711	16	109	0	385	699	0	0	2090	196
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0			4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00		1.00	0.91			*1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00		1.00	1.00			1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		1.00	1.00			1.00	1.00
Satd. Flow (prot)	1463	1842	1581	1750	1842		1807	4749			5526	1493
Flt Permitted	0.95	1.00	1.00	0.69	1.00		0.15	1.00			1.00	1.00
Satd. Flow (perm)	1463	1842	1581	1266	1842		271	4749			5526	1493
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	39	108	711	16	109	0	385	699	0	0	2090	196
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	80
Lane Group Flow (vph)	39	108	711	16	109	0	385	699	0	0	2090	116
Heavy Vehicles (%)	22%	2%	1%	2%	2%	2%	4%	8%	2%	2%	2%	7%
Turn Type	Prot		Free	Perm			pm+pt			Perm		pm+ov
Protected Phases	1				2		7	4			8	1
Permitted Phases		6	Free	2			4			8		8
Actuated Green, G (s)	26.0	46.0	130.0	15.0	15.0		72.0	72.0			47.0	73.0
Effective Green, g (s)	28.0	48.0	130.0	16.0	16.0		72.0	74.0			49.0	77.0
Actuated g/C Ratio	0.22	0.37	1.00	0.12	0.12		0.55	0.57			0.38	0.59
Clearance Time (s)	6.0	6.0		5.0	5.0		4.0	6.0			6.0	6.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	5.0			5.0	3.0
Lane Grp Cap (vph)	315	680	1581	156	227		398	2703			2083	930
v/s Ratio Prot	0.03				0.06		c0.16	0.15			c0.38	0.03
v/s Ratio Perm		0.06	c0.45	0.01			0.38					0.05
v/c Ratio	0.12	0.16	0.45	0.10	0.48		0.97	0.26			1.00	0.12
Uniform Delay, d1	41.1	27.5	0.0	50.6	53.1		28.2	14.1			40.5	11.7
Progression Factor	1.00	1.00	1.00	1.00	1.00		2.01	0.72			0.73	1.03
Incremental Delay, d2	0.8	0.5	0.9	1.3	7.1		35.2	0.1			20.1	0.1
Delay (s)	41.9	28.0	0.9	51.9	60.2		91.8	10.3			49.6	12.2
Level of Service	D	C	A	D	E		F	B			D	B
Approach Delay (s)		6.2			59.2			39.2			46.4	
Approach LOS		A			E			D			D	
<b>Intersection Summary</b>												
HCM Average Control Delay			37.0			HCM Level of Service				D		
HCM Volume to Capacity ratio			0.76									
Actuated Cycle Length (s)			130.0			Sum of lost time (s)				8.0		
Intersection Capacity Utilization			84.2%			ICU Level of Service				E		
Analysis Period (min)			15									
c Critical Lane Group												



2031 Background - Weekday AM Peak Hour  
4: YMCA Blvd. & Enterprise Drive

Queues  
Highway 407 Transitway: Kennedy Station



Lane Group	EBL	EBT	WBT	SBL	SBR
Lane Configurations					
Volume (vph)	105	213	759	358	124
Lane Group Flow (vph)	105	213	1179	358	124
Turn Type	custom			Perm	
Protected Phases			8	6	
Permitted Phases	4	4			6
Detector Phase	4	4	8	6	6
Switch Phase					
Minimum Initial (s)	10.0	10.0	10.0	10.0	10.0
Minimum Split (s)	23.0	23.0	29.0	29.0	29.0
Total Split (s)	30.0	30.0	30.0	30.0	30.0
Total Split (%)	50.0%	50.0%	50.0%	50.0%	50.0%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0	-2.0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	None	None	None	Max	Max
v/c Ratio	0.86	0.14	0.84	0.49	0.17
Control Delay	75.1	10.7	19.4	14.9	4.2
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	75.1	10.7	19.4	14.9	4.2
Queue Length 50th (m)	9.0	6.5	42.9	24.8	1.1
Queue Length 95th (m)	#32.6	11.4	#69.2	43.5	8.1
Internal Link Dist (m)		71.6	139.2	174.6	
Turn Bay Length (m)	75.0				
Base Capacity (vph)	127	1545	1450	736	718
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.83	0.14	0.81	0.49	0.17

Intersection Summary

Cycle Length: 60

Actuated Cycle Length: 59

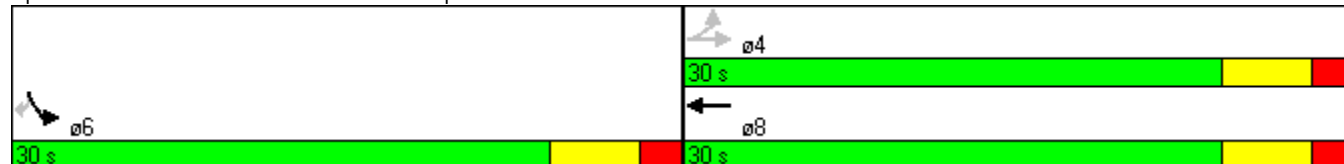
Natural Cycle: 65

Control Type: Semi Act-Uncoord

# 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

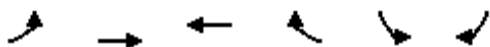
Splits and Phases: 4: YMCA Blvd. & Enterprise Drive



2031 Background - Weekday AM Peak Hour  
4: YMCA Blvd. & Enterprise Drive

HCM Signalized Intersection Capacity Analysis

Highway 407 Transitway: Kennedy Station












Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	105	213	759	420	358	124
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0	4.0
Lane Util. Factor	1.00	0.95	0.95		1.00	1.00
Frpb, ped/bikes	1.00	1.00	0.99		1.00	0.98
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	0.95		1.00	0.85
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1715	3500	3005		1668	1497
Flt Permitted	0.16	1.00	1.00		0.95	1.00
Satd. Flow (perm)	289	3500	3005		1668	1497
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	105	213	759	420	358	124
RTOR Reduction (vph)	0	0	127	0	0	58
Lane Group Flow (vph)	105	213	1052	0	358	66
Confl. Peds. (#/hr)	5			5	8	4
Heavy Vehicles (%)	4%	2%	5%	24%	7%	5%
Turn Type	custom				Perm	
Protected Phases			8		6	
Permitted Phases	4	4				6
Actuated Green, G (s)	23.0	23.0	23.0		24.0	24.0
Effective Green, g (s)	25.0	25.0	25.0		26.0	26.0
Actuated g/C Ratio	0.42	0.42	0.42		0.44	0.44
Clearance Time (s)	6.0	6.0	6.0		6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	122	1483	1273		735	660
v/s Ratio Prot			0.35		c0.21	
v/s Ratio Perm	c0.36	0.06				0.04
v/c Ratio	0.86	0.14	0.83		0.49	0.10
Uniform Delay, d1	15.4	10.4	15.1		11.8	9.7
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	42.2	0.0	4.5		2.3	0.3
Delay (s)	57.7	10.5	19.6		14.1	10.0
Level of Service	E	B	B		B	A
Approach Delay (s)		26.1	19.6		13.0	
Approach LOS		C	B		B	
<b>Intersection Summary</b>						
HCM Average Control Delay			19.0		HCM Level of Service	B
HCM Volume to Capacity ratio			0.67			
Actuated Cycle Length (s)			59.0		Sum of lost time (s)	8.0
Intersection Capacity Utilization			72.8%		ICU Level of Service	C
Analysis Period (min)			15			
c Critical Lane Group						

# 2031 Background - Weekday AM Peak Hour HCM Unsignalized Intersection Capacity Analysis

## 5: YMCA Blvd. & Station Access Road

Highway 407 Transitway: Kennedy Station

						
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	42	0	857	42	0	26
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (vph)	42	0	857	42	0	26
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume			42	1798		42
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			42	1798		42
tC, single (s)			4.1	6.4		6.2
tC, 2 stage (s)						
tF (s)			2.2	3.5		3.3
p0 queue free %			45	100		97
cM capacity (veh/h)			1567	40		1029
Direction, Lane #	EB 1	WB 1	NB 1			
Volume Total	42	899	26			
Volume Left	0	857	0			
Volume Right	0	0	26			
cSH	1700	1567	1029			
Volume to Capacity	0.02	0.55	0.03			
Queue Length 95th (m)	0.0	24.4	0.5			
Control Delay (s)	0.0	9.8	8.6			
Lane LOS			A			
Approach Delay (s)	0.0	9.8	8.6			
Approach LOS			A			
Intersection Summary						
Average Delay			9.4			
Intersection Capacity Utilization			59.7%		ICU Level of Service	
Analysis Period (min)			15			

2031 Background - Weekday PM Peak Hour  
1: Hwy 407 WB Ramp & Kennedy Road

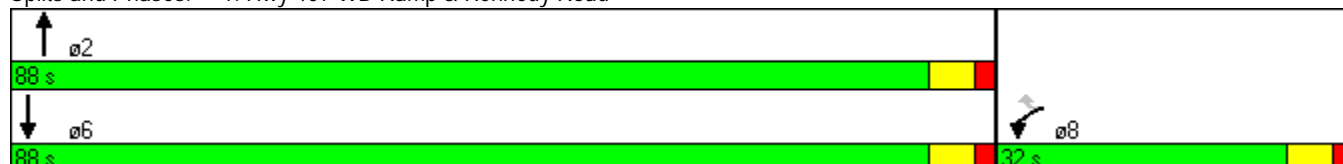
Queues  
Highway 407 Transitway: Kennedy Station

	↙	↖	↑	↓
Lane Group	WBL	WBR	NBT	SBT
Lane Configurations	↖↖	↖	↑↑↑	↑↑↑
Volume (vph)	18	184	2903	2530
Lane Group Flow (vph)	18	184	2903	2530
Turn Type	Perm			
Protected Phases	8		2	6
Permitted Phases		8		
Detector Phase	8	8	2	6
Switch Phase				
Minimum Initial (s)	15.0	15.0	25.0	25.0
Minimum Split (s)	29.0	29.0	31.0	31.0
Total Split (s)	32.0	32.0	88.0	88.0
Total Split (%)	26.7%	26.7%	73.3%	73.3%
Yellow Time (s)	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0
Total Lost Time (s)	4.0	4.0	4.0	4.0
Lead/Lag				
Lead-Lag Optimize?				
Recall Mode	None	None	C-Max	C-Max
v/c Ratio	0.03	0.65	0.70	0.61
Control Delay	38.1	55.0	6.5	7.9
Queue Delay	0.0	46.2	0.0	1.0
Total Delay	38.1	101.3	6.5	8.9
Queue Length 50th (m)	1.7	37.0	56.3	165.3
Queue Length 95th (m)	4.3	55.1	93.3	184.7
Internal Link Dist (m)	346.4		308.0	86.3
Turn Bay Length (m)		140.0		
Base Capacity (vph)	792	368	4160	4160
Starvation Cap Reductn	0	0	0	1257
Spillback Cap Reductn	0	191	61	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.02	1.04	0.71	0.87

Intersection Summary

Cycle Length: 120  
Actuated Cycle Length: 120  
Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBT, Start of Green  
Natural Cycle: 70  
Control Type: Actuated-Coordinated

Splits and Phases: 1: Hwy 407 WB Ramp & Kennedy Road



2031 Background - Weekday PM Peak Hour  
1: Hwy 407 WB Ramp & Kennedy Road

HCM Signalized Intersection Capacity Analysis

Highway 407 Transitway: Kennedy Station



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	←←	→	↑↑↑			↑↑↑
Volume (vph)	18	184	2903	0	0	2530
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0			4.0
Lane Util. Factor	0.97	1.00	*1.00			*1.00
Frt	1.00	0.85	1.00			1.00
Flt Protected	0.95	1.00	1.00			1.00
Satd. Flow (prot)	3395	1566	5526			5526
Flt Permitted	0.95	1.00	1.00			1.00
Satd. Flow (perm)	3395	1566	5526			5526
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	18	184	2903	0	0	2530
RTOR Reduction (vph)	0	2	0	0	0	0
Lane Group Flow (vph)	18	182	2903	0	0	2530
Heavy Vehicles (%)	2%	2%	2%	0%	0%	2%
Turn Type	Perm					
Protected Phases	8		2			6
Permitted Phases		8				
Actuated Green, G (s)	19.7	19.7	88.3			88.3
Effective Green, g (s)	21.7	21.7	90.3			90.3
Actuated g/C Ratio	0.18	0.18	0.75			0.75
Clearance Time (s)	6.0	6.0	6.0			6.0
Vehicle Extension (s)	3.0	3.0	3.0			3.0
Lane Grp Cap (vph)	614	283	4158			4158
v/s Ratio Prot	0.01		c0.53			0.46
v/s Ratio Perm		c0.12				
v/c Ratio	0.03	0.64	0.70			0.61
Uniform Delay, d1	40.5	45.5	7.7			6.8
Progression Factor	1.00	1.00	0.72			1.01
Incremental Delay, d2	0.0	4.9	0.5			0.5
Delay (s)	40.5	50.4	6.0			7.4
Level of Service	D	D	A			A
Approach Delay (s)	49.6		6.0			7.4
Approach LOS	D		A			A























Intersection Summary

HCM Average Control Delay	8.2	HCM Level of Service	A
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	86.4%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

2031 Background - Weekday PM Peak Hour  
2: YMCA Blvd. & Kennedy Road

Queues  
Highway 407 Transitway: Kennedy Station

											
Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations											
Volume (vph)	356	158	641	119	64	378	2677	241	23	1945	187
Lane Group Flow (vph)	356	158	641	119	93	378	2677	241	23	1945	187
Turn Type	Prot		Free	pm+pt		Prot		custom	Perm		pm+ov
Protected Phases	7			3	8	5				6	7
Permitted Phases		4	Free	8			2	2	6		6
Detector Phase	7	4		3	8	5	2	2	6	6	7
Switch Phase											
Minimum Initial (s)	6.0	10.0		6.0	10.0	6.0	20.0	20.0	20.0	20.0	6.0
Minimum Split (s)	10.0	29.0		10.0	29.0	10.0	52.0	52.0	52.0	52.0	10.0
Total Split (s)	22.0	41.0	0.0	10.0	29.0	17.0	69.0	69.0	52.0	52.0	22.0
Total Split (%)	18.3%	34.2%	0.0%	8.3%	24.2%	14.2%	57.5%	57.5%	43.3%	43.3%	18.3%
Yellow Time (s)	3.0	4.0		3.0	4.0	3.0	4.0	4.0	4.0	4.0	3.0
All-Red Time (s)	1.0	2.0		1.0	2.0	1.0	2.0	2.0	2.0	2.0	1.0
Lost Time Adjust (s)	0.0	-2.0	0.0	0.0	-2.0	0.0	-2.0	-2.0	-2.0	-2.0	0.0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lead/Lag	Lead	Lag		Lead	Lag	Lead			Lag	Lag	Lead
Lead-Lag Optimize?	Yes	Yes		Yes	Yes	Yes			Yes	Yes	Yes
Recall Mode	None	None		None	None	None	C-Max	C-Max	C-Max	C-Max	None
v/c Ratio	0.74	0.40	0.42	0.48	0.39	0.72	0.75	0.22	0.38	0.77	0.19
Control Delay	59.6	42.1	0.8	39.6	46.8	51.5	21.4	4.4	50.0	37.5	11.4
Queue Delay	306.3	0.0	0.1	0.0	0.0	0.0	0.8	0.0	0.0	21.0	0.0
Total Delay	366.0	42.1	0.9	39.6	46.8	51.5	22.2	4.4	50.0	58.5	11.4
Queue Length 50th (m)	37.2	30.2	0.0	19.8	17.3	38.8	135.5	4.8	4.6	144.8	16.0
Queue Length 95th (m)	50.9	42.0	0.0	28.4	29.0	#69.6	147.5	21.0	m8.8	161.2	35.0
Internal Link Dist (m)		105.9			425.2		28.0			121.5	
Turn Bay Length (m)	90.0			70.0		70.0		85.0	100.0		85.0
Base Capacity (vph)	537	579	1529	248	380	523	3558	1102	60	2522	985
Starvation Cap Reductn	0	0	0	0	0	0	502	0	0	642	0
Spillback Cap Reductn	324	0	100	0	0	0	207	0	0	360	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	1.67	0.27	0.45	0.48	0.24	0.72	0.88	0.22	0.38	1.03	0.19

Intersection Summary

Cycle Length: 120

Actuated Cycle Length: 120

Offset: 107 (89%), Referenced to phase 2:NBT and 6:SBTL, Start of Green

Natural Cycle: 105

Control Type: Actuated-Coordinated

# 95th percentile volume exceeds capacity, queue may be longer.

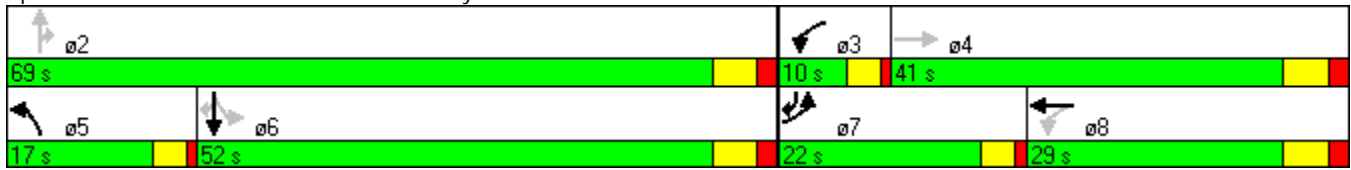
Queue shown is maximum after two cycles.

m Volume for 95th percentile queue is metered by upstream signal.

2031 Background - Weekday PM Peak Hour  
 2: YMCA Blvd. & Kennedy Road

Queues  
 Highway 407 Transitway: Kennedy Station
























Splits and Phases: 2: YMCA Blvd. & Kennedy Road



2031 Background - Weekday PM Peak Hour  
2: YMCA Blvd. & Kennedy Road

HCM Signalized Intersection Capacity Analysis

Highway 407 Transitway: Kennedy Station

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	356	158	641	119	64	29	378	2677	241	23	1945	187
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	*1.00	1.00	1.00	1.00	1.00		*1.00	*1.00	1.00	1.00	*1.00	1.00
Frpb, ped/bikes	1.00	1.00	0.99	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	0.99	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.95		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3579	1879	1529	1850	1791		3648	5581	1597	1700	5472	1426
Flt Permitted	1.00	1.00	1.00	0.66	1.00		1.00	1.00	1.00	0.07	1.00	1.00
Satd. Flow (perm)	3579	1879	1529	1215	1791		3648	5581	1597	129	5472	1426
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	356	158	641	119	64	29	378	2677	241	23	1945	187
RTOR Reduction (vph)	0	0	0	0	8	0	0	0	84	0	0	79
Lane Group Flow (vph)	356	158	641	119	85	0	378	2677	157	23	1945	108
Confl. Peds. (#/hr)			7	7								
Heavy Vehicles (%)	5%	0%	3%	1%	0%	0%	3%	1%	0%	5%	3%	12%
Turn Type	Prot		Free	pm+pt			Prot		custom	Perm		pm+ov
Protected Phases	7			3	8		5				6	7
Permitted Phases		4	Free	8				2	2	6		6
Actuated Green, G (s)	16.1	23.5	120.0	19.4	13.4		17.2	74.5	74.5	53.3	53.3	69.4
Effective Green, g (s)	16.1	25.5	120.0	19.4	15.4		17.2	76.5	76.5	55.3	55.3	69.4
Actuated g/C Ratio	0.13	0.21	1.00	0.16	0.13		0.14	0.64	0.64	0.46	0.46	0.58
Clearance Time (s)	4.0	6.0		4.0	6.0		4.0	6.0	6.0	6.0	6.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	480	399	1529	228	230		523	3558	1018	59	2522	825
v/s Ratio Prot	c0.10			0.03	0.05		0.10				0.36	0.02
v/s Ratio Perm		0.08	c0.42	0.06				c0.48	0.10	0.18		0.06
v/c Ratio	0.74	0.40	0.42	0.52	0.37		0.72	0.75	0.15	0.39	0.77	0.13
Uniform Delay, d1	50.0	40.6	0.0	45.1	47.9		49.1	15.2	8.7	21.3	27.1	11.5
Progression Factor	1.00	1.00	1.00	1.00	1.00		0.90	1.22	2.24	1.15	1.26	7.10
Incremental Delay, d2	6.1	0.6	0.8	2.2	1.0		3.8	1.2	0.2	15.7	2.0	0.1
Delay (s)	56.0	41.3	0.8	47.2	48.9		48.1	19.7	19.9	40.0	36.0	82.0
Level of Service	E	D	A	D	D		D	B	B	D	D	F
Approach Delay (s)		23.4			48.0			23.0			40.0	
Approach LOS		C			D			C			D	
<b>Intersection Summary</b>												
HCM Average Control Delay			29.2			HCM Level of Service				C		
HCM Volume to Capacity ratio			0.69									
Actuated Cycle Length (s)			120.0			Sum of lost time (s)			8.0			
Intersection Capacity Utilization			100.2%			ICU Level of Service			G			
Analysis Period (min)			15									
c Critical Lane Group												



# 2031 Background - Weekday PM Peak Hour 3: Unionville Gate & Kennedy Road

Queues  
Highway 407 Transitway: Kennedy Station

Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	SBT	SBR
Lane Configurations									
Volume (vph)	82	124	520	11	90	684	2086	1177	158
Lane Group Flow (vph)	82	124	520	11	90	684	2086	1177	158
Turn Type	Perm		pm+ov	Perm		pm+pt			Perm
Protected Phases		6	7		2	7	4	8	
Permitted Phases	6		6	2		4			8
Detector Phase	6	6	7	2	2	7	4	8	8
Switch Phase									
Minimum Initial (s)	15.0	15.0	6.0	4.0	4.0	6.0	20.0	20.0	20.0
Minimum Split (s)	32.0	32.0	10.0	21.0	21.0	10.0	32.0	32.0	32.0
Total Split (s)	33.0	33.0	51.0	33.0	33.0	51.0	87.0	36.0	36.0
Total Split (%)	27.5%	27.5%	42.5%	27.5%	27.5%	42.5%	72.5%	30.0%	30.0%
Yellow Time (s)	4.0	4.0	3.0	3.0	3.0	3.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	1.0	2.0	2.0	1.0	2.0	2.0	2.0
Lost Time Adjust (s)	-2.0	-2.0	0.0	-1.0	-1.0	0.0	-2.0	-2.0	-2.0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lead/Lag			Lead			Lead		Lag	Lag
Lead-Lag Optimize?			Yes			Yes		Yes	Yes
Recall Mode	C-Max	C-Max	None	None	None	None	None	None	None
v/c Ratio	0.26	0.27	0.50	0.04	0.19	0.88	0.55	0.89	0.30
Control Delay	39.5	38.5	12.0	35.5	37.4	52.4	11.3	43.5	4.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.0
Total Delay	39.5	38.5	12.0	35.5	37.4	52.7	11.4	43.5	4.9
Queue Length 50th (m)	14.5	22.0	51.5	1.8	15.6	146.1	83.0	89.1	7.9
Queue Length 95th (m)	27.8	37.5	74.3	6.3	28.6	#185.4	99.3	#108.2	12.8
Internal Link Dist (m)		210.0			87.7		177.1	242.3	
Turn Bay Length (m)	50.0					180.0			65.0
Base Capacity (vph)	315	466	1053	289	466	792	3860	1328	525
Starvation Cap Reductn	0	0	0	0	0	6	588	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.26	0.27	0.49	0.04	0.19	0.87	0.64	0.89	0.30

## Intersection Summary

Cycle Length: 120

Actuated Cycle Length: 120

Offset: 81 (68%), Referenced to phase 6:EBTL, Start of Green

Natural Cycle: 90

Control Type: Actuated-Coordinated

# 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.























Splits and Phases: 3: Unionville Gate & Kennedy Road



2031 Background - Weekday PM Peak Hour  
3: Unionville Gate & Kennedy Road

HCM Signalized Intersection Capacity Analysis

Highway 407 Transitway: Kennedy Station

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	82	124	520	11	90	0	684	2086	0	0	1177	158
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0			4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00		1.00	*1.00			0.91	1.00
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00			1.00	0.99
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00			1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00		1.00	1.00			1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		1.00	1.00			1.00	1.00
Satd. Flow (prot)	1733	1842	1551	1750	1842		1860	5581			4980	1545
Flt Permitted	0.68	1.00	1.00	0.62	1.00		0.12	1.00			1.00	1.00
Satd. Flow (perm)	1244	1842	1551	1140	1842		220	5581			4980	1545
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	82	124	520	11	90	0	684	2086	0	0	1177	158
RTOR Reduction (vph)	0	0	1	0	0	0	0	0	0	0	0	113
Lane Group Flow (vph)	82	124	519	11	90	0	684	2086	0	0	1177	45
Confl. Peds. (#/hr)							1					1
Heavy Vehicles (%)	3%	2%	3%	2%	2%	2%	1%	1%	2%	2%	3%	2%
Turn Type	Perm	pm+ov		Perm	pm+pt					Perm		Perm
Protected Phases		6	7		2		7	4			8	
Permitted Phases	6		6	2			4			8		8
Actuated Green, G (s)	28.4	28.4	74.1	29.4	29.4		79.6	79.6			29.9	29.9
Effective Green, g (s)	30.4	30.4	74.1	30.4	30.4		79.6	81.6			31.9	31.9
Actuated g/C Ratio	0.25	0.25	0.62	0.25	0.25		0.66	0.68			0.27	0.27
Clearance Time (s)	6.0	6.0	4.0	5.0	5.0		4.0	6.0			6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0			3.0	3.0
Lane Grp Cap (vph)	315	467	958	289	467		771	3795			1324	411
v/s Ratio Prot		0.07	c0.21		0.05		c0.34	0.37			0.24	
v/s Ratio Perm	0.07		0.13	0.01			c0.25					0.03
v/c Ratio	0.26	0.27	0.54	0.04	0.19		0.89	0.55			0.89	0.11
Uniform Delay, d1	35.8	35.9	13.2	33.8	35.2		28.8	9.8			42.3	33.3
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.59	1.12			0.80	0.58
Incremental Delay, d2	2.0	1.4	0.6	0.1	0.2		7.9	0.1			7.5	0.1
Delay (s)	37.8	37.3	13.8	33.8	35.4		53.8	11.1			41.6	19.4
Level of Service	D	D	B	C	D		D	B			D	B
Approach Delay (s)		20.5			35.2			21.6			39.0	
Approach LOS		C			D			C			D	
<b>Intersection Summary</b>												
HCM Average Control Delay			26.5			HCM Level of Service				C		
HCM Volume to Capacity ratio			0.76									
Actuated Cycle Length (s)			120.0			Sum of lost time (s)				8.0		
Intersection Capacity Utilization			83.1%			ICU Level of Service				E		
Analysis Period (min)			15									
c Critical Lane Group												

2031 Background - Weekday PM Peak Hour  
4: YMCA Blvd. & Enterprise Drive

Queues  
Highway 407 Transitway: Kennedy Station



Lane Group	EBL	EBT	WBT	SBL	SBR
Lane Configurations					
Volume (vph)	235	745	127	350	56
Lane Group Flow (vph)	235	745	516	350	56
Turn Type	Prot				pm+ov
Protected Phases	7		8	6	7
Permitted Phases		4			6
Detector Phase	7	4	8	6	7
Switch Phase					
Minimum Initial (s)	6.0	10.0	10.0	10.0	6.0
Minimum Split (s)	10.0	23.0	29.0	29.0	10.0
Total Split (s)	20.0	49.0	29.0	31.0	20.0
Total Split (%)	25.0%	61.3%	36.3%	38.8%	25.0%
Yellow Time (s)	3.0	4.0	4.0	4.0	3.0
All-Red Time (s)	1.0	2.0	2.0	2.0	1.0
Lost Time Adjust (s)	0.0	-2.0	-2.0	-2.0	0.0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0
Lead/Lag	Lead		Lag		Lead
Lead-Lag Optimize?	Yes		Yes		Yes
Recall Mode	None	None	None	Max	None
v/c Ratio	0.68	0.45	0.61	0.51	0.06
Control Delay	35.1	12.7	9.9	19.0	1.6
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	35.1	12.7	9.9	19.0	1.6
Queue Length 50th (m)	23.8	28.1	6.4	27.8	0.0
Queue Length 95th (m)	47.3	38.8	18.0	57.8	3.0
Internal Link Dist (m)		71.6	139.2	178.9	
Turn Bay Length (m)	75.0				
Base Capacity (vph)	417	2393	1235	684	1002
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.56	0.31	0.42	0.51	0.06

Intersection Summary

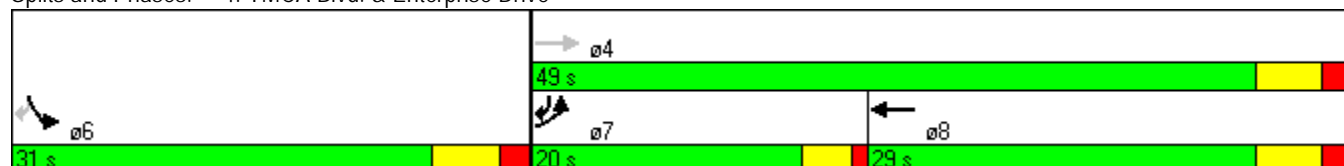
Cycle Length: 80

Actuated Cycle Length: 66.1

Natural Cycle: 70

Control Type: Semi Act-Uncoord

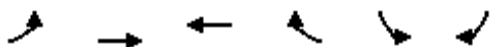
Splits and Phases: 4: YMCA Blvd. & Enterprise Drive



2031 Background - Weekday PM Peak Hour  
4: YMCA Blvd. & Enterprise Drive

HCM Signalized Intersection Capacity Analysis

Highway 407 Transitway: Kennedy Station












Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	235	745	127	389	350	56
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0	4.0
Lane Util. Factor	1.00	0.95	0.95		1.00	1.00
Frpb, ped/bikes	1.00	1.00	0.99		1.00	0.99
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	0.89		1.00	0.85
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1716	3500	2618		1668	1505
Flt Permitted	0.95	1.00	1.00		0.95	1.00
Satd. Flow (perm)	1716	3500	2618		1668	1505
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	235	745	127	389	350	56
RTOR Reduction (vph)	0	0	309	0	0	23
Lane Group Flow (vph)	235	745	207	0	350	33
Confl. Peds. (#/hr)	5			5	8	4
Heavy Vehicles (%)	4%	2%	5%	24%	7%	5%
Turn Type	Prot				pm+ov	
Protected Phases	7		8		6	7
Permitted Phases		4				6
Actuated Green, G (s)	13.4	28.9	11.5		25.1	38.5
Effective Green, g (s)	13.4	30.9	13.5		27.1	38.5
Actuated g/C Ratio	0.20	0.47	0.20		0.41	0.58
Clearance Time (s)	4.0	6.0	6.0		6.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	348	1639	536		685	878
v/s Ratio Prot	c0.14		0.08		c0.21	0.01
v/s Ratio Perm		c0.21				0.01
v/c Ratio	0.68	0.45	0.39		0.51	0.04
Uniform Delay, d1	24.3	11.9	22.7		14.5	5.9
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	5.1	0.2	0.5		2.7	0.0
Delay (s)	29.4	12.1	23.1		17.2	5.9
Level of Service	C	B	C		B	A
Approach Delay (s)		16.2	23.1		15.7	
Approach LOS		B	C		B	
<b>Intersection Summary</b>						
HCM Average Control Delay			18.0		HCM Level of Service	B
HCM Volume to Capacity ratio			0.52			
Actuated Cycle Length (s)			66.0		Sum of lost time (s)	8.0
Intersection Capacity Utilization			58.9%		ICU Level of Service	B
Analysis Period (min)			15			
c Critical Lane Group						

# 2031 Background - Weekday PM Peak Hour HCM Unsignalized Intersection Capacity Analysis

## 5: YMCA Blvd. & Station Access Road

Highway 407 Transitway: Kennedy Station

						
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	42	0	89	42	0	953
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (vph)	42	0	89	42	0	953
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume			42		262	42
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			42		262	42
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			94		100	7
cM capacity (veh/h)			1567		686	1029
Direction, Lane #	EB 1	WB 1	NB 1			
Volume Total	42	131	953			
Volume Left	0	89	0			
Volume Right	0	0	953			
cSH	1700	1567	1029			
Volume to Capacity	0.02	0.06	0.93			
Queue Length 95th (m)	0.0	1.3	103.3			
Control Delay (s)	0.0	5.2	33.6			
Lane LOS		A	D			
Approach Delay (s)	0.0	5.2	33.6			
Approach LOS			D			
Intersection Summary						
Average Delay			29.0			
Intersection Capacity Utilization			69.0%	ICU Level of Service		C
Analysis Period (min)			15			



## APPENDIX C

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### 2031 FUTURE CONDITION SYNCHRO SUMMARY OUTPUTS





2031 Future - Weekday AM Peak Hour  
1: Hwy 407 WB Ramp & Kennedy Road

Queues  
Highway 407 Transitway: Kennedy Station



Lane Group	WBL	WBR	NBT	SBT
Lane Configurations	↰↰	↰	↰↰↰	↰↰↰
Volume (vph)	333	375	1924	2760
Lane Group Flow (vph)	333	375	1924	2760
Turn Type	Perm			
Protected Phases	8		2	6
Permitted Phases		8		
Detector Phase	8	8	2	6
Switch Phase				
Minimum Initial (s)	15.0	15.0	25.0	25.0
Minimum Split (s)	29.0	29.0	31.0	31.0
Total Split (s)	29.0	29.0	101.0	101.0
Total Split (%)	22.3%	22.3%	77.7%	77.7%
Yellow Time (s)	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0
Total Lost Time (s)	4.0	4.0	4.0	4.0
Lead/Lag				
Lead-Lag Optimize?				
Recall Mode	None	None	C-Max	C-Max
v/c Ratio	0.51	1.14	0.47	0.67
Control Delay	50.2	135.7	4.8	2.5
Queue Delay	0.0	0.0	0.0	0.7
Total Delay	50.2	135.7	4.8	3.3
Queue Length 50th (m)	36.6	~96.7	30.5	8.7
Queue Length 95th (m)	50.4	#153.5	32.9	10.4
Internal Link Dist (m)	346.4		308.0	86.3
Turn Bay Length (m)		140.0		
Base Capacity (vph)	653	329	4123	4123
Starvation Cap Reductn	0	0	0	901
Spillback Cap Reductn	0	0	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.51	1.14	0.47	0.86

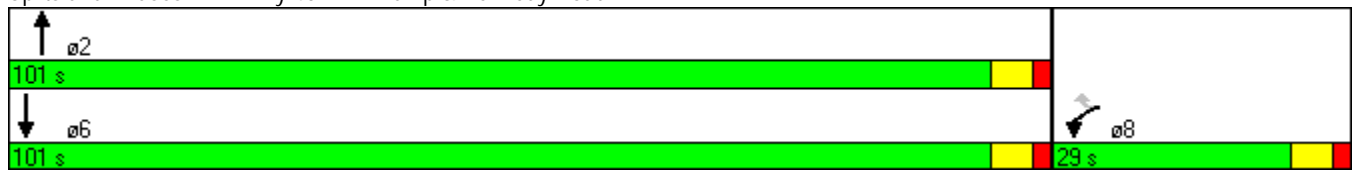
#### Intersection Summary

Cycle Length: 130  
 Actuated Cycle Length: 130  
 Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBT, Start of Green  
 Natural Cycle: 65  
 Control Type: Actuated-Coordinated  
 ~ Volume exceeds capacity, queue is theoretically infinite.  
 Queue shown is maximum after two cycles.  
 # 95th percentile volume exceeds capacity, queue may be longer.  
 Queue shown is maximum after two cycles.

2031 Future - Weekday AM Peak Hour  
1: Hwy 407 WB Ramp & Kennedy Road

Queues  
Highway 407 Transitway: Kennedy Station











Splits and Phases: 1: Hwy 407 WB Ramp & Kennedy Road



2031 Future - Weekday AM Peak Hour  
1: Hwy 407 WB Ramp & Kennedy Road























HCM Signalized Intersection Capacity Analysis

Highway 407 Transitway: Kennedy Station

						
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	333	375	1924	0	0	2760
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0			4.0
Lane Util. Factor	0.97	1.00	*1.00			*1.00
Frt	1.00	0.85	1.00			1.00
Flt Protected	0.95	1.00	1.00			1.00
Satd. Flow (prot)	3395	1566	5526			5526
Flt Permitted	0.95	1.00	1.00			1.00
Satd. Flow (perm)	3395	1566	5526			5526
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	333	375	1924	0	0	2760
RTOR Reduction (vph)	0	27	0	0	0	0
Lane Group Flow (vph)	333	348	1924	0	0	2760
Heavy Vehicles (%)	2%	2%	2%	0%	0%	2%
Turn Type	Perm					
Protected Phases	8		2			6
Permitted Phases		8				
Actuated Green, G (s)	23.0	23.0	95.0			95.0
Effective Green, g (s)	25.0	25.0	97.0			97.0
Actuated g/C Ratio	0.19	0.19	0.75			0.75
Clearance Time (s)	6.0	6.0	6.0			6.0
Vehicle Extension (s)	3.0	3.0	3.0			3.0
Lane Grp Cap (vph)	653	301	4123			4123
v/s Ratio Prot	0.10		0.35			c0.50
v/s Ratio Perm		c0.22				
v/c Ratio	0.51	1.15	0.47			0.67
Uniform Delay, d1	47.0	52.5	6.4			8.4
Progression Factor	1.00	1.00	0.69			0.24
Incremental Delay, d2	0.6	100.5	0.3			0.5
Delay (s)	47.6	153.0	4.8			2.5
Level of Service	D	F	A			A
Approach Delay (s)	103.4		4.8			2.5
Approach LOS	F		A			A
<b>Intersection Summary</b>						
HCM Average Control Delay			16.6		HCM Level of Service	B
HCM Volume to Capacity ratio			0.77			
Actuated Cycle Length (s)			130.0		Sum of lost time (s)	8.0
Intersection Capacity Utilization			78.5%		ICU Level of Service	D
Analysis Period (min)			15			
c Critical Lane Group						

2031 Future - Weekday AM Peak Hour  
2: YMCA Blvd. & Kennedy Road

Queues  
Highway 407 Transitway: Kennedy Station

											
Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations											
Volume (vph)	233	65	449	196	150	842	1396	56	13	2221	744
Lane Group Flow (vph)	233	65	449	196	175	842	1396	56	13	2221	744
Turn Type	Prot		Free	pm+pt		Prot		custom	Perm		pm+ov
Protected Phases	7			3	8	5				6	7
Permitted Phases		4	Free	8			2	2	6		6
Detector Phase	7	4		3	8	5	2	2	6	6	7
Switch Phase											
Minimum Initial (s)	6.0	10.0		6.0	10.0	6.0	20.0	20.0	20.0	20.0	6.0
Minimum Split (s)	10.0	29.0		10.0	29.0	10.0	52.0	52.0	52.0	52.0	10.0
Total Split (s)	12.0	34.0	0.0	14.0	36.0	22.0	82.0	82.0	60.0	60.0	12.0
Total Split (%)	9.2%	26.2%	0.0%	10.8%	27.7%	16.9%	63.1%	63.1%	46.2%	46.2%	9.2%
Yellow Time (s)	3.0	4.0		3.0	4.0	3.0	4.0	4.0	4.0	4.0	3.0
All-Red Time (s)	1.0	2.0		1.0	2.0	1.0	2.0	2.0	2.0	2.0	1.0
Lost Time Adjust (s)	0.0	-2.0	0.0	0.0	-2.0	0.0	-2.0	-2.0	-2.0	-2.0	0.0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lead/Lag	Lead	Lag		Lead	Lag	Lead			Lag	Lag	Lead
Lead-Lag Optimize?	Yes	Yes		Yes	Yes	Yes			Yes	Yes	Yes
Recall Mode	None	None		None	None	None	C-Max	C-Max	C-Max	C-Max	None
v/c Ratio	1.29	0.25	0.31	0.62	0.62	1.00	0.37	0.05	0.08	0.93	0.81
Control Delay	211.4	50.7	0.6	50.4	59.1	86.1	6.6	1.1	36.8	62.2	36.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	242.2	16.3
Total Delay	211.4	50.7	0.6	50.4	59.1	86.1	6.7	1.1	36.8	304.5	52.9
Queue Length 50th (m)	~36.0	14.0	0.0	39.4	38.0	101.6	30.2	0.0	3.0	185.9	126.2
Queue Length 95th (m)	#60.3	25.1	0.0	55.6	56.1	m#155.3	m38.9	m1.9	m3.4	198.5	m137.9
Internal Link Dist (m)		105.9			204.5		28.0			122.1	
Turn Bay Length (m)	90.0			70.0		70.0		85.0	100.0		85.0
Base Capacity (vph)	181	434	1445	318	450	842	3729	1105	168	2380	919
Starvation Cap Reductn	0	0	0	0	0	0	928	0	0	940	177
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	1.29	0.15	0.31	0.62	0.39	1.00	0.50	0.05	0.08	1.54	1.00

Intersection Summary

Cycle Length: 130

Actuated Cycle Length: 130

Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBTL, Start of Green

Natural Cycle: 145

Control Type: Actuated-Coordinated

~ Volume exceeds capacity, queue is theoretically infinite.

Queue shown is maximum after two cycles.

# 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

m Volume for 95th percentile queue is metered by upstream signal.

2031 Future - Weekday AM Peak Hour  
 2: YMCA Blvd. & Kennedy Road
























Queues  
 Highway 407 Transitway: Kennedy Station

Splits and Phases: 2: YMCA Blvd. & Kennedy Road



2031 Future - Weekday AM Peak Hour  
2: YMCA Blvd. & Kennedy Road

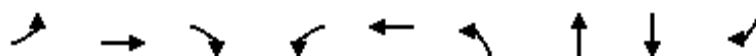
HCM Signalized Intersection Capacity Analysis  
Highway 407 Transitway: Kennedy Station

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	233	65	449	196	150	25	842	1396	56	13	2221	744
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	1.00	1.00	1.00	1.00		*1.00	*1.00	1.00	1.00	*1.00	1.00
Frpb, ped/bikes	1.00	1.00	0.99	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	0.99	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.98		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	1.00		1.00	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	2935	1879	1445	1851	1810		3613	5368	1566	1785	5526	1479
Flt Permitted	0.95	1.00	1.00	0.54	1.00		1.00	1.00	1.00	0.21	1.00	1.00
Satd. Flow (perm)	2935	1879	1445	1007	1810		3613	5368	1566	388	5526	1479
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	233	65	449	196	150	25	842	1396	56	13	2221	744
RTOR Reduction (vph)	0	0	0	0	5	0	0	0	18	0	0	162
Lane Group Flow (vph)	233	65	449	196	170	0	842	1396	38	13	2221	582
Confl. Peds. (#/hr)			7	7								
Heavy Vehicles (%)	18%	0%	9%	1%	0%	11%	4%	5%	2%	0%	2%	8%
Turn Type	Prot		Free	pm+pt			Prot		custom	Perm		pm+ov
Protected Phases	7			3	8		5				6	7
Permitted Phases		4	Free	8				2	2	6		6
Actuated Green, G (s)	8.0	13.9	130.0	30.9	18.9		30.3	87.1	87.1	52.8	52.8	60.8
Effective Green, g (s)	8.0	15.9	130.0	30.9	20.9		30.3	89.1	89.1	54.8	54.8	60.8
Actuated g/C Ratio	0.06	0.12	1.00	0.24	0.16		0.23	0.69	0.69	0.42	0.42	0.47
Clearance Time (s)	4.0	6.0		4.0	6.0		4.0	6.0	6.0	6.0	6.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	181	230	1445	324	291		842	3679	1073	164	2329	692
v/s Ratio Prot	c0.08			c0.06	c0.09		c0.23			c0.40		0.05
v/s Ratio Perm		0.03	0.31	0.08				0.26	0.02	0.03		0.34
v/c Ratio	1.29	0.28	0.31	0.60	0.58		1.00	0.38	0.04	0.08	0.95	0.84
Uniform Delay, d1	61.0	51.9	0.0	42.3	50.5		49.9	8.7	6.6	22.5	36.4	30.4
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.20	0.73	0.47	1.61	1.66	2.21
Incremental Delay, d2	164.3	0.7	0.6	3.2	3.0		28.1	0.2	0.1	0.4	5.3	4.1
Delay (s)	225.3	52.5	0.6	45.5	53.5		87.9	6.6	3.2	36.6	65.7	71.1
Level of Service	F	D	A	D	D		F	A	A	D	E	E
Approach Delay (s)		75.2			49.3			36.3			66.9	
Approach LOS		E			D			D			E	
<b>Intersection Summary</b>												
HCM Average Control Delay			55.9				HCM Level of Service			E		
HCM Volume to Capacity ratio			0.90									
Actuated Cycle Length (s)			130.0				Sum of lost time (s)		12.0			
Intersection Capacity Utilization			101.7%				ICU Level of Service		G			
Analysis Period (min)			15									
c Critical Lane Group												

2031 Future - Weekday AM Peak Hour  
3: Unionville Gate & Kennedy Road

Queues

Highway 407 Transitway: Kennedy Station



Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	SBT	SBR
Lane Configurations									
Volume (vph)	39	108	711	16	109	385	797	2506	196
Lane Group Flow (vph)	39	108	711	16	109	385	797	2506	196
Turn Type	Prot		Free	Perm		pm+pt			pm+ov
Protected Phases	1				2	7	4	8	1
Permitted Phases		6	Free	2		4			8
Detector Phase	1	6		2	2	7	4	8	1
Switch Phase									
Minimum Initial (s)	15.0	15.0		10.0	10.0	6.0	20.0	20.0	15.0
Minimum Split (s)	32.0	32.0		21.0	21.0	10.0	32.0	32.0	32.0
Total Split (s)	32.0	52.0	0.0	20.0	20.0	25.0	78.0	53.0	32.0
Total Split (%)	24.6%	40.0%	0.0%	15.4%	15.4%	19.2%	60.0%	40.8%	24.6%
Yellow Time (s)	4.0	4.0		3.0	3.0	3.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0		2.0	2.0	1.0	2.0	2.0	2.0
Lost Time Adjust (s)	-2.0	-2.0	0.0	-1.0	-1.0	0.0	-2.0	-2.0	-2.0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lead/Lag	Lead			Lag	Lag	Lead		Lag	Lead
Lead-Lag Optimize?	Yes			Yes	Yes	Yes		Yes	Yes
Recall Mode	Max	C-Max		C-Min	C-Min	None	None	None	Max
v/c Ratio	0.12	0.16	0.45	0.10	0.48	0.96	0.29	1.20	0.20
Control Delay	42.5	28.3	0.9	52.6	60.9	85.7	9.6	125.9	1.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	42.5	28.3	0.9	52.6	60.9	85.7	9.6	125.9	1.9
Queue Length 50th (m)	7.5	17.0	0.0	3.4	24.3	69.6	23.5	~235.3	1.6
Queue Length 95th (m)	16.6	29.1	0.0	10.0	41.6	#124.0	27.6	#257.9	5.0
Internal Link Dist (m)		216.2			297.9		177.1	242.3	
Turn Bay Length (m)	50.0					180.0			65.0
Base Capacity (vph)	315	680	1581	156	227	402	2703	2083	997
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.12	0.16	0.45	0.10	0.48	0.96	0.29	1.20	0.20

Intersection Summary

Cycle Length: 130

Actuated Cycle Length: 130

Offset: 0 (0%), Referenced to phase 2:WBTL and 6:EBT, Start of Green

Natural Cycle: 135

Control Type: Actuated-Coordinated

~ Volume exceeds capacity, queue is theoretically infinite.

Queue shown is maximum after two cycles.

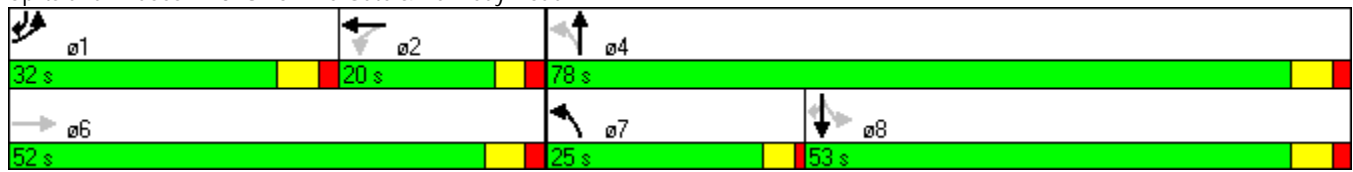
# 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

2031 Future - Weekday AM Peak Hour  
3: Unionville Gate & Kennedy Road

Queues  
Highway 407 Transitway: Kennedy Station























Splits and Phases: 3: Unionville Gate & Kennedy Road





2031 Future - Weekday AM Peak Hour  
3: Unionville Gate & Kennedy Road

HCM Signalized Intersection Capacity Analysis  
Highway 407 Transitway: Kennedy Station

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	39	108	711	16	109	0	385	797	0	0	2506	196
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0			4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00		1.00	0.91			*1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00		1.00	1.00			1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		1.00	1.00			1.00	1.00
Satd. Flow (prot)	1463	1842	1581	1750	1842		1807	4749			5526	1493
Flt Permitted	0.95	1.00	1.00	0.69	1.00		0.15	1.00			1.00	1.00
Satd. Flow (perm)	1463	1842	1581	1266	1842		271	4749			5526	1493
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	39	108	711	16	109	0	385	797	0	0	2506	196
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	72
Lane Group Flow (vph)	39	108	711	16	109	0	385	797	0	0	2506	124
Heavy Vehicles (%)	22%	2%	1%	2%	2%	2%	4%	8%	2%	2%	2%	7%
Turn Type	Prot		Free	Perm			pm+pt			Perm		pm+ov
Protected Phases	1				2		7	4			8	1
Permitted Phases		6	Free	2			4			8		8
Actuated Green, G (s)	26.0	46.0	130.0	15.0	15.0		72.0	72.0			47.0	73.0
Effective Green, g (s)	28.0	48.0	130.0	16.0	16.0		72.0	74.0			49.0	77.0
Actuated g/C Ratio	0.22	0.37	1.00	0.12	0.12		0.55	0.57			0.38	0.59
Clearance Time (s)	6.0	6.0		5.0	5.0		4.0	6.0			6.0	6.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	5.0			5.0	3.0
Lane Grp Cap (vph)	315	680	1581	156	227		398	2703			2083	930
v/s Ratio Prot	0.03				0.06		c0.16	0.17			c0.45	0.03
v/s Ratio Perm		0.06	c0.45	0.01			0.38					0.05
v/c Ratio	0.12	0.16	0.45	0.10	0.48		0.97	0.29			1.20	0.13
Uniform Delay, d1	41.1	27.5	0.0	50.6	53.1		28.2	14.5			40.5	11.7
Progression Factor	1.00	1.00	1.00	1.00	1.00		2.01	0.64			0.76	0.77
Incremental Delay, d2	0.8	0.5	0.9	1.3	7.1		35.2	0.1			96.1	0.1
Delay (s)	41.9	28.0	0.9	51.9	60.2		91.9	9.4			127.0	9.1
Level of Service	D	C	A	D	E		F	A			F	A
Approach Delay (s)		6.2			59.2			36.3			118.5	
Approach LOS		A			E			D			F	
<b>Intersection Summary</b>												
HCM Average Control Delay			77.2			HCM Level of Service				E		
HCM Volume to Capacity ratio			0.84									
Actuated Cycle Length (s)			130.0			Sum of lost time (s)				8.0		
Intersection Capacity Utilization			92.2%			ICU Level of Service				F		
Analysis Period (min)			15									
c Critical Lane Group												

2031 Future - Weekday AM Peak Hour  
4: YMCA Blvd. & Enterprise Drive

Queues  
Highway 407 Transitway: Kennedy Station



Lane Group	EBL	EBT	WBT	SBL	SBR
Lane Configurations					
Volume (vph)	150	374	1361	358	316
Lane Group Flow (vph)	150	374	1781	358	316
Turn Type	custom			Perm	
Protected Phases			8	6	
Permitted Phases	4	4			6
Detector Phase	4	4	8	6	6
Switch Phase					
Minimum Initial (s)	10.0	10.0	10.0	10.0	10.0
Minimum Split (s)	23.0	23.0	29.0	29.0	29.0
Total Split (s)	30.0	30.0	30.0	30.0	30.0
Total Split (%)	50.0%	50.0%	50.0%	50.0%	50.0%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0	-2.0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	None	None	None	Max	Max
v/c Ratio	1.25	0.25	1.27	0.50	0.48
Control Delay	189.2	11.3	145.5	15.2	14.7
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	189.2	11.3	145.5	15.2	14.7
Queue Length 50th (m)	~19.6	12.0	~122.1	24.8	20.7
Queue Length 95th (m)	#46.8	19.0	#158.4	43.5	38.2
Internal Link Dist (m)		71.6	139.2	174.6	
Turn Bay Length (m)	75.0				
Base Capacity (vph)	120	1517	1407	723	656
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	1.25	0.25	1.27	0.50	0.48

Intersection Summary

Cycle Length: 60

Actuated Cycle Length: 60

Natural Cycle: 120

Control Type: Semi Act-Uncoord

~ Volume exceeds capacity, queue is theoretically infinite.

Queue shown is maximum after two cycles.

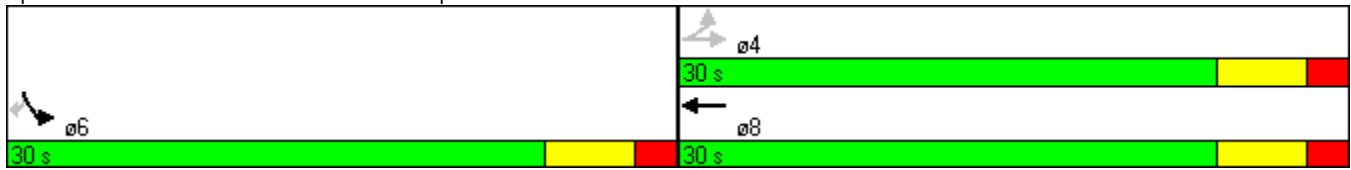
# 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

2031 Future - Weekday AM Peak Hour  
4: YMCA Blvd. & Enterprise Drive

Queues  
Highway 407 Transitway: Kennedy Station

Splits and Phases: 4: YMCA Blvd. & Enterprise Drive



2031 Future - Weekday AM Peak Hour  
4: YMCA Blvd. & Enterprise Drive

HCM Signalized Intersection Capacity Analysis  
Highway 407 Transitway: Kennedy Station












Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations	↗	↑↑	↑↑		↗	↗
Volume (vph)	150	374	1361	420	358	316
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0	4.0
Lane Util. Factor	1.00	0.95	0.95		1.00	1.00
Frpb, ped/bikes	1.00	1.00	1.00		1.00	0.98
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	0.96		1.00	0.85
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1716	3500	3133		1668	1496
Flt Permitted	0.15	1.00	1.00		0.95	1.00
Satd. Flow (perm)	278	3500	3133		1668	1496
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	150	374	1361	420	358	316
RTOR Reduction (vph)	0	0	49	0	0	8
Lane Group Flow (vph)	150	374	1732	0	358	308
Confl. Peds. (#/hr)	5			5	8	4
Heavy Vehicles (%)	4%	2%	5%	24%	7%	5%
Turn Type	custom				Perm	
Protected Phases			8		6	
Permitted Phases	4	4				6
Actuated Green, G (s)	24.0	24.0	24.0		24.0	24.0
Effective Green, g (s)	26.0	26.0	26.0		26.0	26.0
Actuated g/C Ratio	0.43	0.43	0.43		0.43	0.43
Clearance Time (s)	6.0	6.0	6.0		6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	120	1517	1358		723	648
v/s Ratio Prot			c0.55		c0.21	
v/s Ratio Perm	0.54	0.11				0.21
v/c Ratio	1.25	0.25	1.28		0.50	0.48
Uniform Delay, d1	17.0	10.8	17.0		12.3	12.1
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	164.0	0.1	129.9		2.4	2.5
Delay (s)	181.0	10.9	146.9		14.7	14.6
Level of Service	F	B	F		B	B
Approach Delay (s)		59.6	146.9		14.7	
Approach LOS		E	F		B	
<b>Intersection Summary</b>						
HCM Average Control Delay			101.6		HCM Level of Service	F
HCM Volume to Capacity ratio			0.89			
Actuated Cycle Length (s)			60.0		Sum of lost time (s)	8.0
Intersection Capacity Utilization			89.3%		ICU Level of Service	E
Analysis Period (min)			15			
c Critical Lane Group						

2031 Future - Weekday AM Peak Hour  
5: YMCA Blvd. & Station Access Road

HCM Unsignalized Intersection Capacity Analysis

Highway 407 Transitway: Kennedy Station

						
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	19	0	1589	49	0	198
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (vph)	19	0	1589	49	0	198
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume			19		3246	19
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			19		3246	19
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			1		100	81
cM capacity (veh/h)			1597		0	1059
Direction, Lane #	EB 1	WB 1	NB 1	NB 2		
Volume Total	19	1638	99	99		
Volume Left	0	1589	0	0		
Volume Right	0	0	99	99		
cSH	1700	1597	1059	1059		
Volume to Capacity	0.01	0.99	0.09	0.09		
Queue Length 95th (m)	0.0	167.2	2.2	2.2		
Control Delay (s)	0.0	37.8	8.7	8.7		
Lane LOS		E	A	A		
Approach Delay (s)	0.0	37.8	8.7			
Approach LOS			A			
Intersection Summary						
Average Delay		34.3				
Intersection Capacity Utilization		100.6%		ICU Level of Service		G
Analysis Period (min)		15				

2031 Future - Weekday PM Peak Hour  
1: Hwy 407 WB Ramp & Kennedy Road

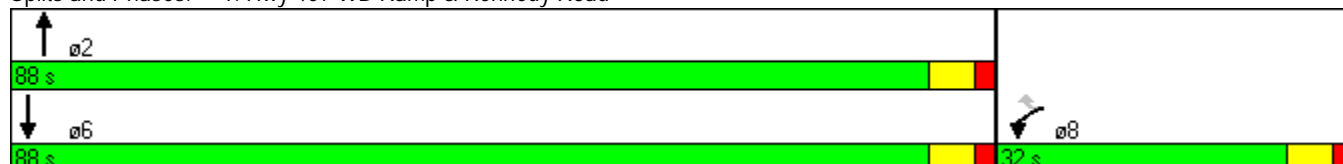
Queues  
Highway 407 Transitway: Kennedy Station

	↖	↗	↑	↓
Lane Group	WBL	WBR	NBT	SBT
Lane Configurations	↖↖	↗	↑↑↑	↑↑↑
Volume (vph)	18	201	2923	2660
Lane Group Flow (vph)	18	201	2923	2660
Turn Type	Perm			
Protected Phases	8		2	6
Permitted Phases		8		
Detector Phase	8	8	2	6
Switch Phase				
Minimum Initial (s)	15.0	15.0	25.0	25.0
Minimum Split (s)	29.0	29.0	31.0	31.0
Total Split (s)	32.0	32.0	88.0	88.0
Total Split (%)	26.7%	26.7%	73.3%	73.3%
Yellow Time (s)	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0
Total Lost Time (s)	4.0	4.0	4.0	4.0
Lead/Lag				
Lead-Lag Optimize?				
Recall Mode	None	None	C-Max	C-Max
v/c Ratio	0.03	0.68	0.71	0.64
Control Delay	37.5	56.3	6.8	6.7
Queue Delay	0.0	97.4	0.0	1.4
Total Delay	37.5	153.6	6.8	8.1
Queue Length 50th (m)	1.6	40.4	61.4	173.5
Queue Length 95th (m)	4.3	60.4	93.9	192.5
Internal Link Dist (m)	346.4		308.0	86.3
Turn Bay Length (m)		140.0		
Base Capacity (vph)	792	368	4125	4125
Starvation Cap Reductn	0	0	0	1179
Spillback Cap Reductn	0	198	60	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.02	1.18	0.72	0.90

Intersection Summary

Cycle Length: 120  
Actuated Cycle Length: 120  
Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBT, Start of Green  
Natural Cycle: 70  
Control Type: Actuated-Coordinated











Splits and Phases: 1: Hwy 407 WB Ramp & Kennedy Road



2031 Future - Weekday PM Peak Hour  
1: Hwy 407 WB Ramp & Kennedy Road























HCM Signalized Intersection Capacity Analysis

Highway 407 Transitway: Kennedy Station

						
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	18	201	2923	0	0	2660
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0			4.0
Lane Util. Factor	0.97	1.00	*1.00			*1.00
Frt	1.00	0.85	1.00			1.00
Flt Protected	0.95	1.00	1.00			1.00
Satd. Flow (prot)	3395	1566	5526			5526
Flt Permitted	0.95	1.00	1.00			1.00
Satd. Flow (perm)	3395	1566	5526			5526
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	18	201	2923	0	0	2660
RTOR Reduction (vph)	0	2	0	0	0	0
Lane Group Flow (vph)	18	199	2923	0	0	2660
Heavy Vehicles (%)	2%	2%	2%	0%	0%	2%
Turn Type	Perm					
Protected Phases	8		2			6
Permitted Phases		8				
Actuated Green, G (s)	20.4	20.4	87.6			87.6
Effective Green, g (s)	22.4	22.4	89.6			89.6
Actuated g/C Ratio	0.19	0.19	0.75			0.75
Clearance Time (s)	6.0	6.0	6.0			6.0
Vehicle Extension (s)	3.0	3.0	3.0			3.0
Lane Grp Cap (vph)	634	292	4126			4126
v/s Ratio Prot	0.01		c0.53			0.48
v/s Ratio Perm		c0.13				
v/c Ratio	0.03	0.68	0.71			0.64
Uniform Delay, d1	39.9	45.5	8.2			7.4
Progression Factor	1.00	1.00	0.71			0.77
Incremental Delay, d2	0.0	6.4	0.5			0.5
Delay (s)	39.9	51.8	6.3			6.2
Level of Service	D	D	A			A
Approach Delay (s)	50.9		6.3			6.2
Approach LOS	D		A			A
<b>Intersection Summary</b>						
HCM Average Control Delay			8.0	HCM Level of Service		A
HCM Volume to Capacity ratio			0.70			
Actuated Cycle Length (s)			120.0	Sum of lost time (s)		8.0
Intersection Capacity Utilization			86.4%	ICU Level of Service		E
Analysis Period (min)			15			
c Critical Lane Group						

2031 Future - Weekday PM Peak Hour  
2: YMCA Blvd. & Kennedy Road

Queues  
Highway 407 Transitway: Kennedy Station

											
Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations											
Volume (vph)	720	158	773	119	64	416	2677	241	23	1945	315
Lane Group Flow (vph)	720	158	773	119	93	416	2677	241	23	1945	315
Turn Type	Prot		Free	pm+pt		Prot		custom	Perm		pm+ov
Protected Phases	7			3	8	5				6	7
Permitted Phases		4	Free	8			2	2	6		6
Detector Phase	7	4		3	8	5	2	2	6	6	7
Switch Phase											
Minimum Initial (s)	6.0	10.0		6.0	10.0	6.0	20.0	20.0	20.0	20.0	6.0
Minimum Split (s)	10.0	29.0		10.0	29.0	10.0	52.0	52.0	52.0	52.0	10.0
Total Split (s)	22.0	41.0	0.0	10.0	29.0	17.0	69.0	69.0	52.0	52.0	22.0
Total Split (%)	18.3%	34.2%	0.0%	8.3%	24.2%	14.2%	57.5%	57.5%	43.3%	43.3%	18.3%
Yellow Time (s)	3.0	4.0		3.0	4.0	3.0	4.0	4.0	4.0	4.0	3.0
All-Red Time (s)	1.0	2.0		1.0	2.0	1.0	2.0	2.0	2.0	2.0	1.0
Lost Time Adjust (s)	0.0	-2.0	0.0	0.0	-2.0	0.0	-2.0	-2.0	-2.0	-2.0	0.0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lead/Lag	Lead	Lag		Lead	Lag	Lead			Lag	Lag	Lead
Lead-Lag Optimize?	Yes	Yes		Yes	Yes	Yes			Yes	Yes	Yes
Recall Mode	None	None		None	None	None	C-Max	C-Max	C-Max	C-Max	None
v/c Ratio	1.34	0.37	0.51	0.48	0.40	0.69	0.77	0.22	0.39	0.84	0.32
Control Delay	205.3	40.5	1.2	38.7	51.2	50.5	22.6	4.4	49.8	42.2	12.1
Queue Delay	517.8	0.0	0.1	0.0	0.0	0.0	1.2	0.0	0.0	51.3	0.0
Total Delay	723.1	40.5	1.3	38.7	51.2	50.5	23.8	4.4	49.8	93.5	12.1
Queue Length 50th (m)	~101.9	29.7	0.0	19.4	19.0	43.6	136.4	4.8	4.6	145.7	25.5
Queue Length 95th (m)	#134.8	42.0	0.0	28.4	30.6	#79.0	148.4	m20.4	m9.1	160.7	53.7
Internal Link Dist (m)		105.9			425.2		28.0			121.5	
Turn Bay Length (m)	90.0			70.0		70.0		85.0	100.0		85.0
Base Capacity (vph)	537	579	1529	250	374	601	3462	1079	59	2310	988
Starvation Cap Reductn	0	0	0	0	0	0	506	0	0	558	0
Spillback Cap Reductn	316	0	102	0	0	0	144	0	0	366	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	3.26	0.27	0.54	0.48	0.25	0.69	0.91	0.22	0.39	1.11	0.32

Intersection Summary

Cycle Length: 120

Actuated Cycle Length: 120

Offset: 107 (89%), Referenced to phase 2:NBT and 6:SBTL, Start of Green

Natural Cycle: 125

Control Type: Actuated-Coordinated

~ Volume exceeds capacity, queue is theoretically infinite.

Queue shown is maximum after two cycles.

# 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

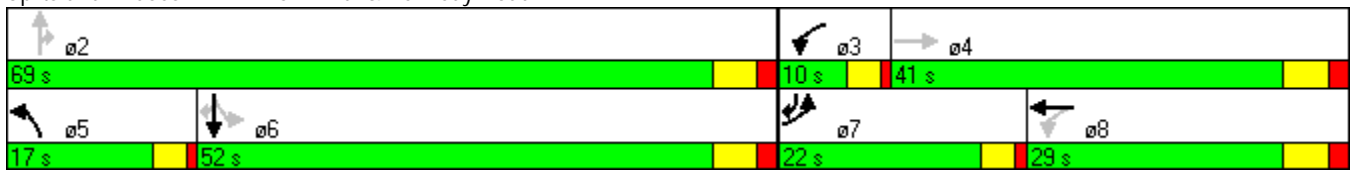
m Volume for 95th percentile queue is metered by upstream signal.



2031 Future - Weekday PM Peak Hour  
 2: YMCA Blvd. & Kennedy Road
























Queues  
 Highway 407 Transitway: Kennedy Station

Splits and Phases: 2: YMCA Blvd. & Kennedy Road





















2031 Future - Weekday PM Peak Hour  
2: YMCA Blvd. & Kennedy Road

HCM Signalized Intersection Capacity Analysis  
Highway 407 Transitway: Kennedy Station

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	720	158	773	119	64	29	416	2677	241	23	1945	315
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	*1.00	1.00	1.00	1.00	1.00		*1.00	*1.00	1.00	1.00	*1.00	1.00
Frpb, ped/bikes	1.00	1.00	0.99	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	0.99	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.95		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3579	1879	1529	1850	1791		3648	5581	1597	1700	5472	1426
Flt Permitted	1.00	1.00	1.00	0.66	1.00		1.00	1.00	1.00	0.08	1.00	1.00
Satd. Flow (perm)	3579	1879	1529	1215	1791		3648	5581	1597	141	5472	1426
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	720	158	773	119	64	29	416	2677	241	23	1945	315
RTOR Reduction (vph)	0	0	0	0	1	0	0	0	88	0	0	140
Lane Group Flow (vph)	720	158	773	119	92	0	416	2677	153	23	1945	175
Confl. Peds. (#/hr)			7	7								
Heavy Vehicles (%)	5%	0%	3%	1%	0%	0%	3%	1%	0%	5%	3%	12%
Turn Type	Prot		Free	pm+pt			Prot		custom	Perm		pm+ov
Protected Phases	7			3	8		5				6	7
Permitted Phases		4	Free	8				2	2	6		6
Actuated Green, G (s)	18.0	25.6	120.0	19.6	13.6		19.8	72.4	72.4	48.6	48.6	66.6
Effective Green, g (s)	18.0	27.6	120.0	19.6	15.6		19.8	74.4	74.4	50.6	50.6	66.6
Actuated g/C Ratio	0.15	0.23	1.00	0.16	0.13		0.17	0.62	0.62	0.42	0.42	0.55
Clearance Time (s)	4.0	6.0		4.0	6.0		4.0	6.0	6.0	6.0	6.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	537	432	1529	230	233		602	3460	990	59	2307	791
v/s Ratio Prot	c0.20			0.03	0.05		0.11				c0.36	0.03
v/s Ratio Perm		0.08	c0.51	0.06				c0.48	0.10	0.16		0.09
v/c Ratio	1.34	0.37	0.51	0.52	0.40		0.69	0.77	0.15	0.39	0.84	0.22
Uniform Delay, d1	51.0	38.8	0.0	44.9	47.9		47.2	16.7	9.6	24.0	31.1	13.5
Progression Factor	1.00	1.00	1.00	1.00	1.00		0.94	1.21	2.25	1.12	1.23	8.95
Incremental Delay, d2	165.6	0.5	1.2	2.0	1.1		2.6	1.3	0.2	16.0	3.5	0.1
Delay (s)	216.6	39.4	1.2	46.9	49.0		47.1	21.4	21.8	42.8	41.7	121.3
Level of Service	F	D	A	D	D		D	C	C	D	D	F
Approach Delay (s)		98.8			47.8			24.6			52.7	
Approach LOS		F			D			C			D	
<b>Intersection Summary</b>												
HCM Average Control Delay			50.2				HCM Level of Service			D		
HCM Volume to Capacity ratio			0.86									
Actuated Cycle Length (s)			120.0				Sum of lost time (s)			12.0		
Intersection Capacity Utilization			110.6%				ICU Level of Service			H		
Analysis Period (min)			15									
c Critical Lane Group												

2031 Future - Weekday PM Peak Hour  
3: Unionville Gate & Kennedy Road

Queues  
Highway 407 Transitway: Kennedy Station

									
Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	SBT	SBR
Lane Configurations									
Volume (vph)	82	124	520	11	90	684	2454	1305	158
Lane Group Flow (vph)	82	124	520	11	90	684	2454	1305	158
Turn Type	Perm		pm+ov	Perm		pm+pt			Perm
Protected Phases		6	7		2	7	4	8	
Permitted Phases	6		6	2		4			8
Detector Phase	6	6	7	2	2	7	4	8	8
Switch Phase									
Minimum Initial (s)	15.0	15.0	6.0	4.0	4.0	6.0	20.0	20.0	20.0
Minimum Split (s)	32.0	32.0	10.0	21.0	21.0	10.0	32.0	32.0	32.0
Total Split (s)	33.0	33.0	51.0	33.0	33.0	51.0	87.0	36.0	36.0
Total Split (%)	27.5%	27.5%	42.5%	27.5%	27.5%	42.5%	72.5%	30.0%	30.0%
Yellow Time (s)	4.0	4.0	3.0	3.0	3.0	3.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	1.0	2.0	2.0	1.0	2.0	2.0	2.0
Lost Time Adjust (s)	-2.0	-2.0	0.0	-1.0	-1.0	0.0	-2.0	-2.0	-2.0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lead/Lag			Lead			Lead		Lag	Lag
Lead-Lag Optimize?			Yes			Yes		Yes	Yes
Recall Mode	C-Max	C-Max	None	None	None	None	None	None	None
v/c Ratio	0.27	0.28	0.51	0.04	0.20	0.89	0.64	0.95	0.30
Control Delay	39.9	38.9	12.6	35.5	37.7	53.6	12.2	49.7	5.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.0
Total Delay	39.9	38.9	12.6	35.5	37.7	53.7	12.4	49.7	5.4
Queue Length 50th (m)	14.5	22.0	51.6	1.8	15.6	145.1	97.4	103.1	8.5
Queue Length 95th (m)	27.8	37.5	74.5	6.3	28.6	#186.2	114.8	#133.8	13.4
Internal Link Dist (m)		210.0			87.7		177.1	242.3	
Turn Bay Length (m)	50.0					180.0			65.0
Base Capacity (vph)	303	450	1038	277	450	791	3860	1378	528
Starvation Cap Reductn	0	0	0	0	0	4	442	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.27	0.28	0.50	0.04	0.20	0.87	0.72	0.95	0.30

Intersection Summary

Cycle Length: 120

Actuated Cycle Length: 120

Offset: 81 (68%), Referenced to phase 6:EBTL, Start of Green

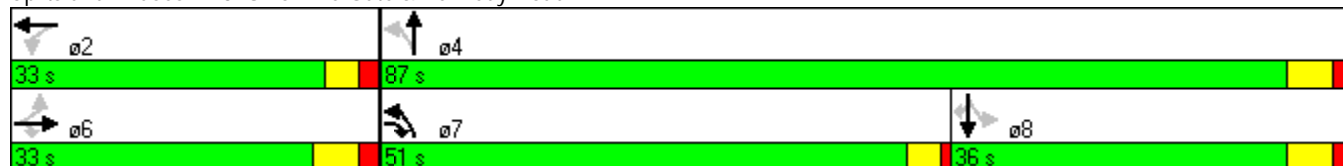
Natural Cycle: 90

Control Type: Actuated-Coordinated

# 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.























Splits and Phases: 3: Unionville Gate & Kennedy Road



2031 Future - Weekday PM Peak Hour  
3: Unionville Gate & Kennedy Road

HCM Signalized Intersection Capacity Analysis

Highway 407 Transitway: Kennedy Station

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	82	124	520	11	90	0	684	2454	0	0	1305	158
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0			4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00		1.00	*1.00			0.91	1.00
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00			1.00	0.99
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00			1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00		1.00	1.00			1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		1.00	1.00			1.00	1.00
Satd. Flow (prot)	1733	1842	1551	1750	1842		1860	5581			4980	1545
Flt Permitted	0.68	1.00	1.00	0.61	1.00		0.11	1.00			1.00	1.00
Satd. Flow (perm)	1241	1842	1551	1132	1842		211	5581			4980	1545
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	82	124	520	11	90	0	684	2454	0	0	1305	158
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	101
Lane Group Flow (vph)	82	124	520	11	90	0	684	2454	0	0	1305	57
Confl. Peds. (#/hr)							1					1
Heavy Vehicles (%)	3%	2%	3%	2%	2%	2%	1%	1%	2%	2%	3%	2%
Turn Type	Perm	pm+ov		Perm	pm+pt					Perm		Perm
Protected Phases		6	7		2		7	4			8	
Permitted Phases	6		6	2			4			8		8
Actuated Green, G (s)	27.3	27.3	72.8	28.3	28.3		80.7	80.7			31.2	31.2
Effective Green, g (s)	29.3	29.3	72.8	29.3	29.3		80.7	82.7			33.2	33.2
Actuated g/C Ratio	0.24	0.24	0.61	0.24	0.24		0.67	0.69			0.28	0.28
Clearance Time (s)	6.0	6.0	4.0	5.0	5.0		4.0	6.0			6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0			3.0	3.0
Lane Grp Cap (vph)	303	450	941	276	450		767	3846			1378	427
v/s Ratio Prot		0.07	c0.21		0.05		c0.34	0.44			c0.26	
v/s Ratio Perm	0.07		0.13	0.01			0.26					0.04
v/c Ratio	0.27	0.28	0.55	0.04	0.20		0.89	0.64			0.95	0.13
Uniform Delay, d1	36.7	36.7	14.0	34.6	36.0		29.2	10.3			42.5	32.6
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.58	1.11			0.81	0.50
Incremental Delay, d2	2.2	1.5	0.7	0.1	0.2		9.1	0.2			13.3	0.1
Delay (s)	38.9	38.3	14.7	34.7	36.3		55.2	11.8			47.7	16.5
Level of Service	D	D	B	C	D		E	B			D	B
Approach Delay (s)		21.4			36.1			21.2			44.3	
Approach LOS		C			D			C			D	
<b>Intersection Summary</b>												
HCM Average Control Delay			27.8				HCM Level of Service				C	
HCM Volume to Capacity ratio			0.81									
Actuated Cycle Length (s)			120.0				Sum of lost time (s)			12.0		
Intersection Capacity Utilization			86.6%				ICU Level of Service			E		
Analysis Period (min)			15									
c Critical Lane Group												

2031 Future - Weekday PM Peak Hour  
4: YMCA Blvd. & Enterprise Drive

Queues  
Highway 407 Transitway: Kennedy Station



Lane Group	EBL	EBT	WBT	SBL	SBR
Lane Configurations	↰	↱↱	↰↱	↰	↰
Volume (vph)	393	1243	293	350	103
Lane Group Flow (vph)	393	1243	682	350	103
Turn Type	Prot				pm+ov
Protected Phases	7		8	6	7
Permitted Phases		4			6
Detector Phase	7	4	8	6	7
Switch Phase					
Minimum Initial (s)	6.0	10.0	10.0	10.0	6.0
Minimum Split (s)	10.0	23.0	29.0	29.0	10.0
Total Split (s)	20.0	49.0	29.0	31.0	20.0
Total Split (%)	25.0%	61.3%	36.3%	38.8%	25.0%
Yellow Time (s)	3.0	4.0	4.0	4.0	3.0
All-Red Time (s)	1.0	2.0	2.0	2.0	1.0
Lost Time Adjust (s)	0.0	-2.0	-2.0	-2.0	0.0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0
Lead/Lag	Lead		Lag		Lead
Lead-Lag Optimize?	Yes		Yes		Yes
Recall Mode	None	None	None	Max	None
v/c Ratio	1.03	0.69	0.71	0.56	0.11
Control Delay	86.2	15.5	14.8	23.2	1.9
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	86.2	15.5	14.8	23.2	1.9
Queue Length 50th (m)	~51.0	57.3	16.4	33.3	0.0
Queue Length 95th (m)	#112.2	75.2	31.9	65.3	5.1
Internal Link Dist (m)		71.6	139.2	178.9	
Turn Bay Length (m)	75.0				
Base Capacity (vph)	381	2189	1222	626	940
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	1.03	0.57	0.56	0.56	0.11

Intersection Summary

Cycle Length: 80

Actuated Cycle Length: 72.3

Natural Cycle: 80

Control Type: Semi Act-Uncoord

~ Volume exceeds capacity, queue is theoretically infinite.

Queue shown is maximum after two cycles.

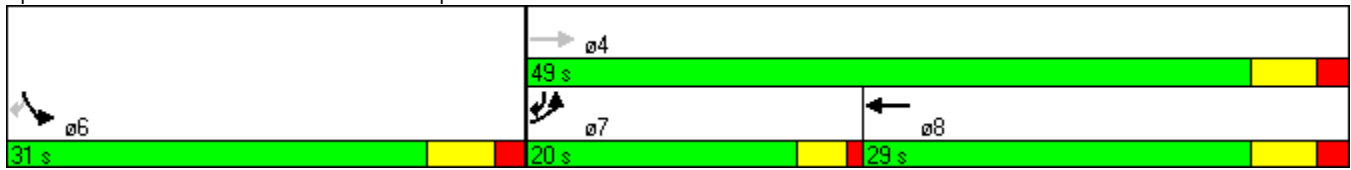
# 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

2031 Future - Weekday PM Peak Hour  
4: YMCA Blvd. & Enterprise Drive

Queues  
Highway 407 Transitway: Kennedy Station

Splits and Phases: 4: YMCA Blvd. & Enterprise Drive



2031 Future - Weekday PM Peak Hour  
4: YMCA Blvd. & Enterprise Drive

HCM Signalized Intersection Capacity Analysis  
Highway 407 Transitway: Kennedy Station












Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	393	1243	293	389	350	103
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0	4.0
Lane Util. Factor	1.00	0.95	0.95		1.00	1.00
Frpb, ped/bikes	1.00	1.00	0.99		1.00	0.99
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	0.91		1.00	0.85
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1716	3500	2789		1668	1505
Flt Permitted	0.95	1.00	1.00		0.95	1.00
Satd. Flow (perm)	1716	3500	2789		1668	1505
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	393	1243	293	389	350	103
RTOR Reduction (vph)	0	0	297	0	0	44
Lane Group Flow (vph)	393	1243	385	0	350	59
Confl. Peds. (#/hr)	5			5	8	4
Heavy Vehicles (%)	4%	2%	5%	24%	7%	5%
Turn Type	Prot				pm+ov	
Protected Phases	7		8		6	7
Permitted Phases		4				6
Actuated Green, G (s)	16.1	35.1	15.0		25.1	41.2
Effective Green, g (s)	16.1	37.1	17.0		27.1	41.2
Actuated g/C Ratio	0.22	0.51	0.24		0.38	0.57
Clearance Time (s)	4.0	6.0	6.0		6.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	383	1798	657		626	859
v/s Ratio Prot	c0.23		0.14		c0.21	0.02
v/s Ratio Perm		c0.36				0.02
v/c Ratio	1.03	0.69	0.59		0.56	0.07
Uniform Delay, d1	28.1	13.2	24.5		17.8	6.9
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	52.8	1.2	1.3		3.6	0.0
Delay (s)	80.9	14.4	25.8		21.4	7.0
Level of Service	F	B	C		C	A
Approach Delay (s)		30.4	25.8		18.1	
Approach LOS		C	C		B	
<b>Intersection Summary</b>						
HCM Average Control Delay			27.2		HCM Level of Service	C
HCM Volume to Capacity ratio			0.70			
Actuated Cycle Length (s)			72.2		Sum of lost time (s)	8.0
Intersection Capacity Utilization			72.1%		ICU Level of Service	C
Analysis Period (min)			15			
c Critical Lane Group						

2031 Future - Weekday PM Peak Hour  
5: YMCA Blvd. & Station Access Road

HCM Unsignalized Intersection Capacity Analysis

Highway 407 Transitway: Kennedy Station

						
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	42	0	268	19	0	1552
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (vph)	42	0	268	19	0	1552
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume			42		597	42
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			42		597	42
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			83		100	0
cM capacity (veh/h)			1567		386	1029
Direction, Lane #	EB 1	WB 1	NB 1	NB 2		
Volume Total	42	287	776	776		
Volume Left	0	268	0	0		
Volume Right	0	0	776	776		
cSH	1700	1567	1029	1029		
Volume to Capacity	0.02	0.17	0.75	0.75		
Queue Length 95th (m)	0.0	4.3	52.2	52.2		
Control Delay (s)	0.0	7.3	18.4	18.4		
Lane LOS		A	C	C		
Approach Delay (s)	0.0	7.3	18.4			
Approach LOS			C			
Intersection Summary						
Average Delay		16.3				
Intersection Capacity Utilization		64.3%		ICU Level of Service		C
Analysis Period (min)		15				