TIM MILLER ASSOCIATES, INC.

10 North Street, Cold Spring, NY 10516 *(845) 265-4400* *265-4418 fax*

September 6, 2016

Steven T. Cipolla
Fredrick P. Clark Associates, Inc.
350 Theodore Fremd Avenue
Rye, NY 10580
914-967-6615

Re: Parth Knolls, LLC Residential Project

Dear Steven,

The following is provided in response to your memo dated September 1, 2016 relative to comments regarding traffic associated with the proposed Parth Knolls project at the intersection of NYS Route 9A and NYS Route 134 in Ossining, NY.

FP Clark Comment 1: Site Traffic Distribution - Review of the site traffic distribution illustrated that while 50 percent of the site traffic would arrive from the east on NYS Route 9A, only 40 percent would depart to the east on NYS Route 9A. The remaining 10 percent would turn right from Kitchawan State Road and travel south on Croton Dam Road. The Applicant should explain why there is this discrepancy. As stated at the bottom of page 2 of the Applicant's latest Response to Comments, " no traffic is rerouted based upon the congested condition."

In our previous memorandum dated March 15, 2016, it was our assumption that 50 percent of the departing site traffic would access NYS Route 9A eastbound at the NYS Route 9A/NYS Route 134 intersection. Using this assumption, it was estimated that a total of 15 and 26 vehicle trip ends generated by the proposed site would travel through this intersection during the weekday morning and weekday afternoon peak hours, respectively.

> **TMA Response 1:** *Our original analysis looked at a worst case scenario and did not take into consideration the actual volume turning distribution at Kitchaman State Road and Croton Dam Road. Based on the existing equilibrium of the traffic network, traffic was distributed for the July 2016 analysis. The increased congestion caused by No Build traffic was not considered in routing site traffic in that analysis.*
>
> *The traffic distribution has been revised balancing the percent distributions to 50 percent in each direction by sending the two additional trips as requested to the NYS Route 9A and NYS Route 134 intersection. See attachment A for a complete set of revised figures.*

FP Clark Comment 2: *Capacity Analysis* – Review of the SYNCHRO files indicates that appropriate peak hour factors (PHF), pedestrians and heavy vehicle percentages were utilized from the River Knoll Traffic Study. The capacity analysis table should be revised to show the results from SYNCHRO not HCM 2010. A storage/queue analysis should be conducted for this intersection and illustrated in a tabular format.

TMA Response 2: *The model analysis has been updated to Synchro 9. See Attachment B for a revised summary table showing the Synchro analysis. Attachment C has the revised calculations. Attachment D has the level of service performance measures.*

Attachment E contains a queue analysis summary table. Due to the existing and future congested conditions at this intersection, none of the these analysis Synchro, HCM, or SimTraffic can accurately represent the queues; in particular it is unreasonable to expect the models to shown queue changes between the No Build and Build Conditions given the minor change in volumes. Except for the low traffic volume on NYS Route 9A left turns, any movements with level of service F should be expected to have queuing.

What is clear in both the SYNCHRO and HCM analysis, is that adding left turns from northbound Croton Dam Road (NYS Route 134) to NYS Route 9A increases delay substantially. However, Parth Knolls traffic uses the Hawkes Avenue ramp and thus does not contribute to this movement. Furthermore, adding two percent per year background growth onto the NYS Route 9A through traffic also contributes to increased delays, although historically NYS Route 9A volumes are declining according to New York State Department of Transportation data.

FP Clark Comment 3: There are the following errors in the signal coding for this intersection:

- The side roads should be Phase 3 not Phases 4 and 8.
- The vehicle extension and minimum gap should be 2 seconds for Phases 1 and 5.
- There are some minor errors in the detection location.

These errors were also found in the River Knoll Traffic Study. Also, the control type should be Fully Actuated-Uncoordinated not Semi Actuated-Uncoordinated. All of these errors do not significantly change the results of the analysis; therefore, no action is needed.

TMA Response 3: *These changes have been made to the analysis although they were indicated as not being significant. For example the detector location is not a variable in the HCM analysis*[1]*. HCM does not support non-NEMA phasing so for the HCM analysis side roads could not be phase 3 as used in the revised Synchro analysis. See Attachments B and C for summary table and Synchro analysis.*

[1] Transportation Research Board of the National Academies, HCM 2010 the Highway Capacity Manual, Volume 3 page 18-8.

FP Clark Comment 4: When attempting to review the SimTraffic microscopic model, there were fatal errors and we were unable to run the simulation. The reason for the fatal errors is that the model is not properly scaled. The Applicant should provide a model that is appropriately scaled.

> **TMA Response 4:** *The model is scaled to the aerial photo underneath. The link length is not a variable used in the HCM 2010 signalized intersection analysis[2]. Therefore inputting the link lengths had no effect on the HCM results, however it does impact the SimTraffic model which was not included as part of the study. The link lengths have been extended to extent to facilitate viewing in SimTraffic, although not to the maximum link lengths.*

FP Clark Comment 5: The Applicant should provide a reason for the departing site traffic distribution used, revised capacity analysis tables, a storage/queue analysis table and a properly scaled model. When these items are received, we can provide our findings.

> **TMA Response 5:** *We trust the above responses one to four respond to your comments.*

Should you have any problem viewing SimTraffic please call.

Sincerely,

James Garofalo, AICP
Director Transportation Division
TIM MILLER ASSOCIATES, INC.

[2] Transportation Research Board of the National Academies, HCM 2010 the Highway Capacity Manual, Volume 3 page 18-8.

ATTACHMENT A

Figures

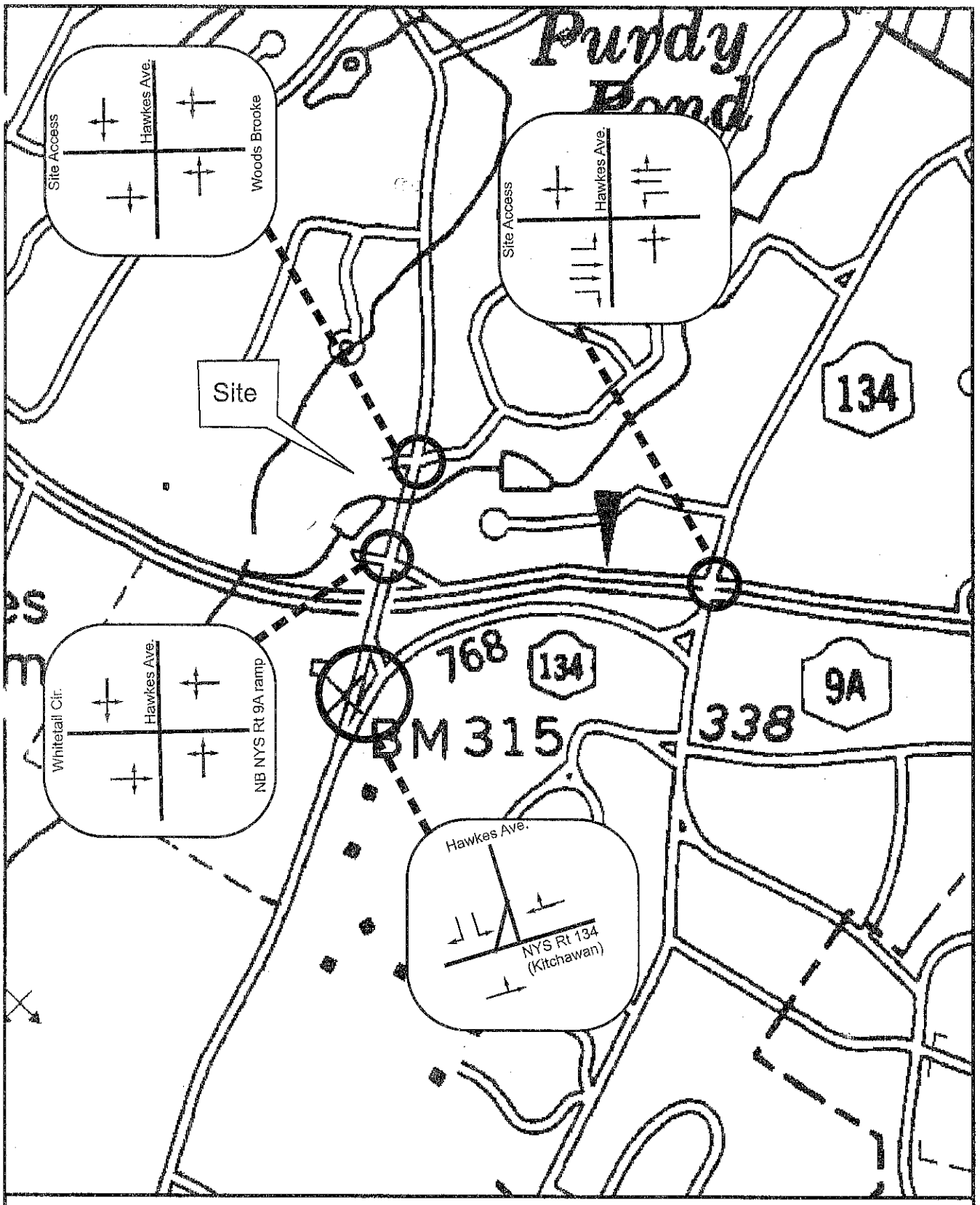

Figure 1: Site Location
Parth Knolls LLC. 87 Hawkes Avenue
Town of Ossining, Westchester County, New York
Base Map: New York State Department of Transportation
Ossining Quadangle
Approx. Scale: 1 inch = 600 feet

File 15015 01/02/16
W:\Hawkes\Figure 1.cdr

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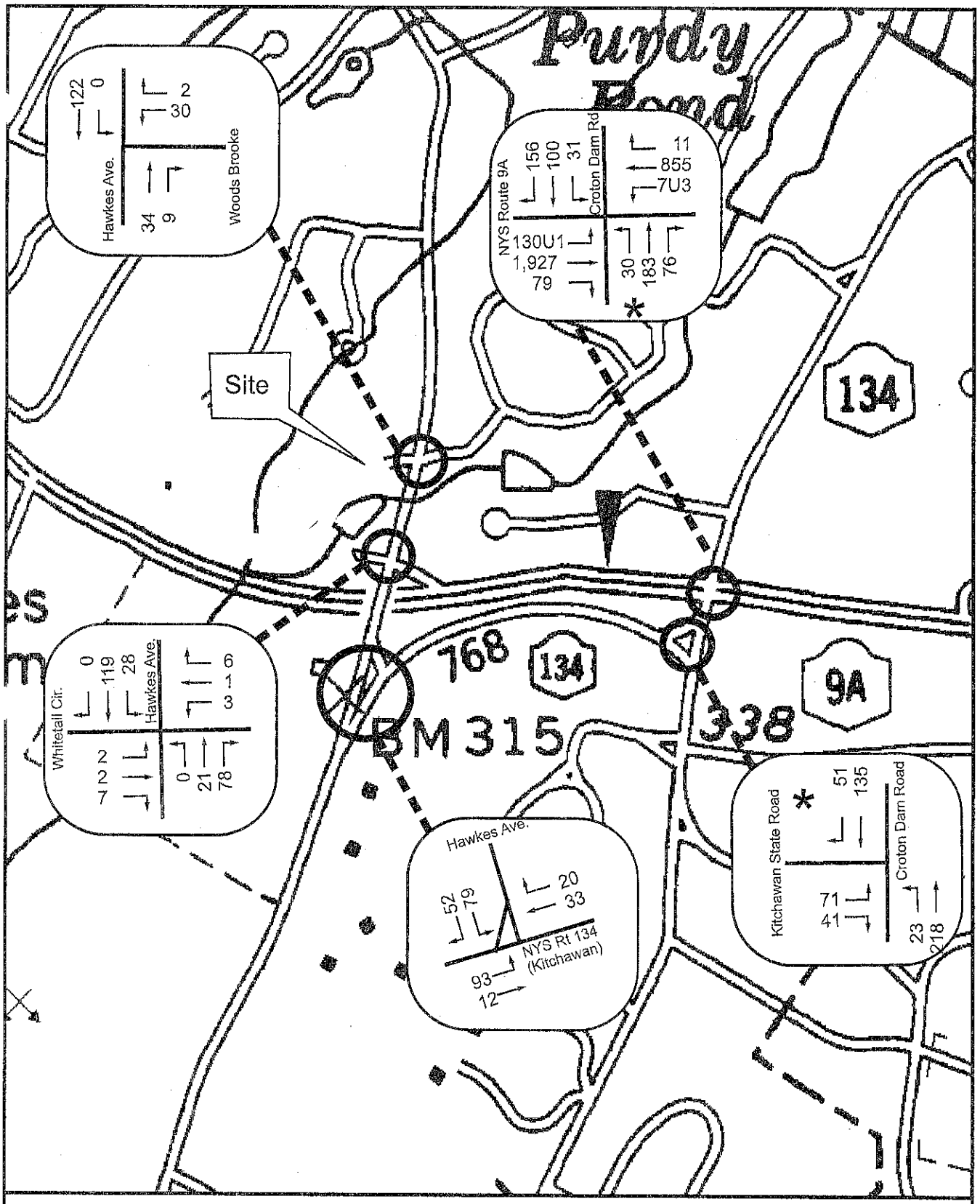

Figure 2: Existing AM Peak Hour Traffic

Parth Knolls LLC. 87 Hawkes Avenue

Town of Ossining, Westchester County, New York

Base Map: New York State Department of Transportation Ossining Quadangle

source: JMC, River Knoll Traffic Study, Armonk, NY, Nov. 2015.

U3 is u-turn volume of 3

Approx. Scale: 1 inch = 600 feet

File 15015 07/21/16
W:\Hawkes\Figure 2.cdr

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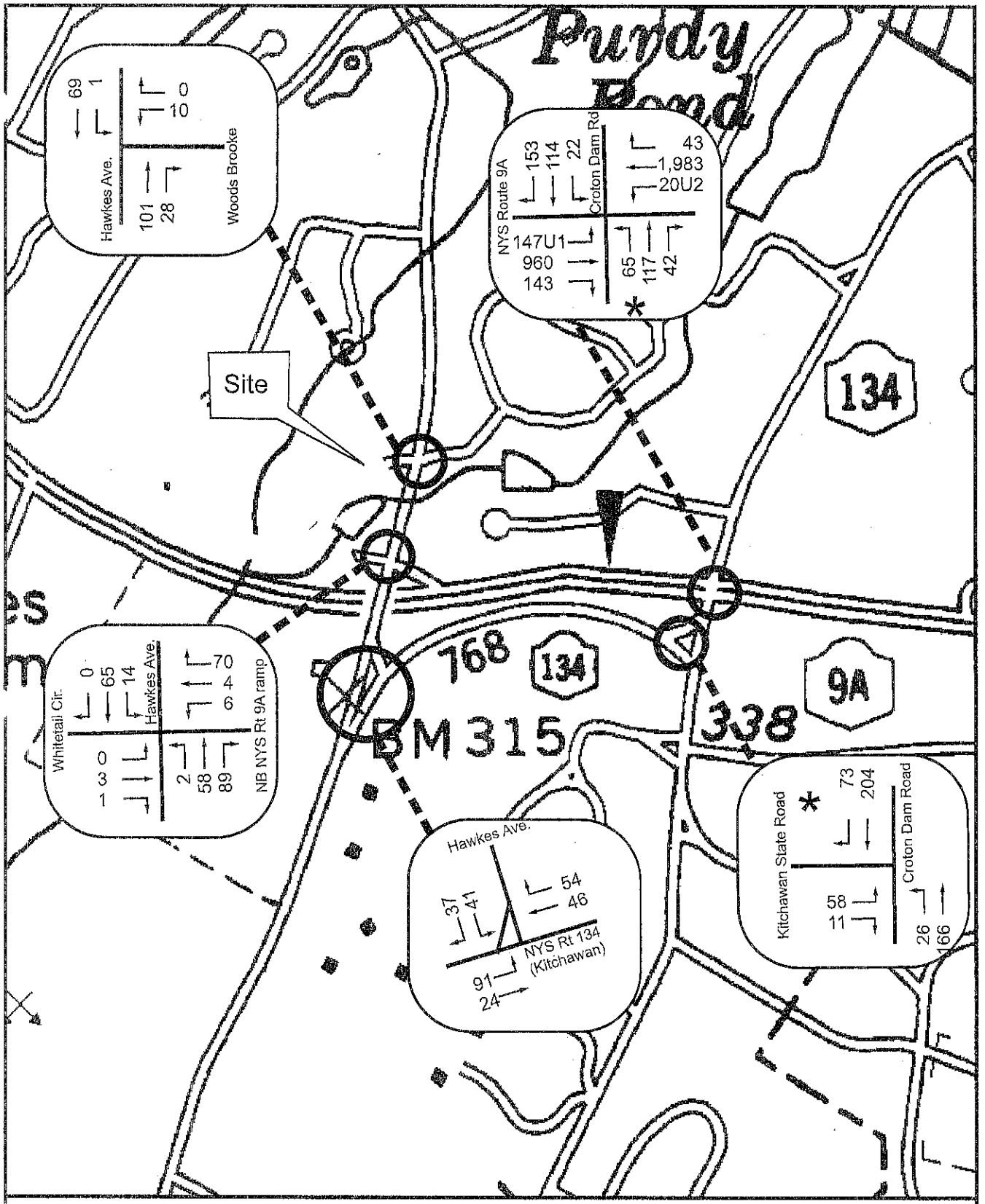

Figure 3: Existing PM Peak Hour Traffic
Parth Knolls LLC. 87 Hawkes Avenue
Town of Ossining, Westchester County, New York
Base Map: New York State Department of Transportation Ossining Quadangle
source: JMC, River Knoll Traffic Study, Armonk, NY, Nov. 2015. Approx. Scale: 1 inch = 600 feet
U2 is u-turn volume of 2

File 15015 07/21/16
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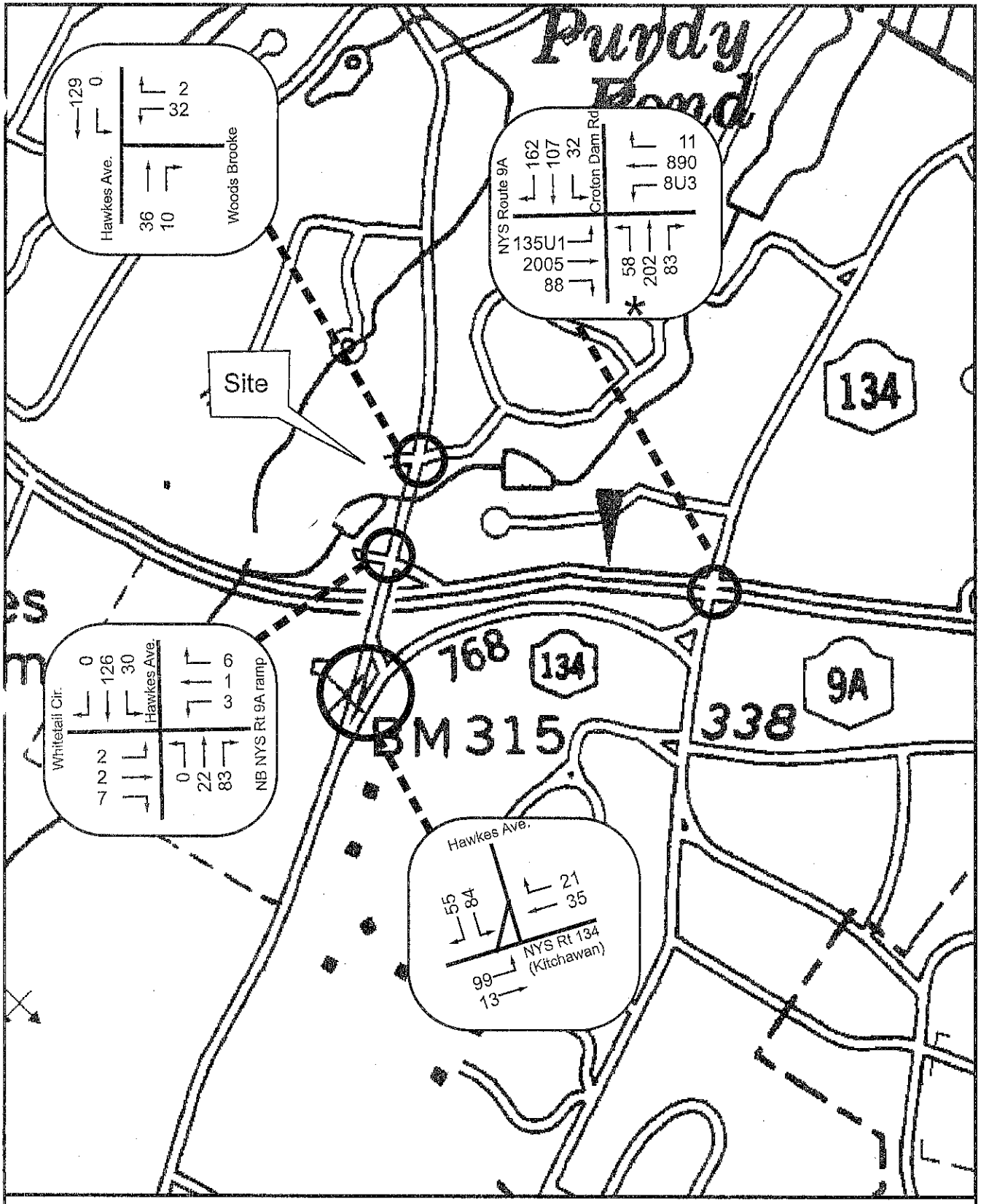

Figure 4: No Build AM Peak Hour Traffic
Parth Knolls LLC. 87 Hawkes Avenue
Town of Ossining, Westchester County, New York
Base Map: New York State Department of Transportation Ossining Quadangle
source: JMC, River Knoll Traffic Study, Armonk, NY, Nov. 2015. Approx. Scale: 1 inch = 600 feet
+U is u-turn volume

File 15015 07/21/16
W:\Hawkes\Figure 4NB AM.cdr

Tim Miller Associates, Inc.,10 North Street, Cold Spring, New York 10516 (845) 265-4400 Fax (845) 265-4418

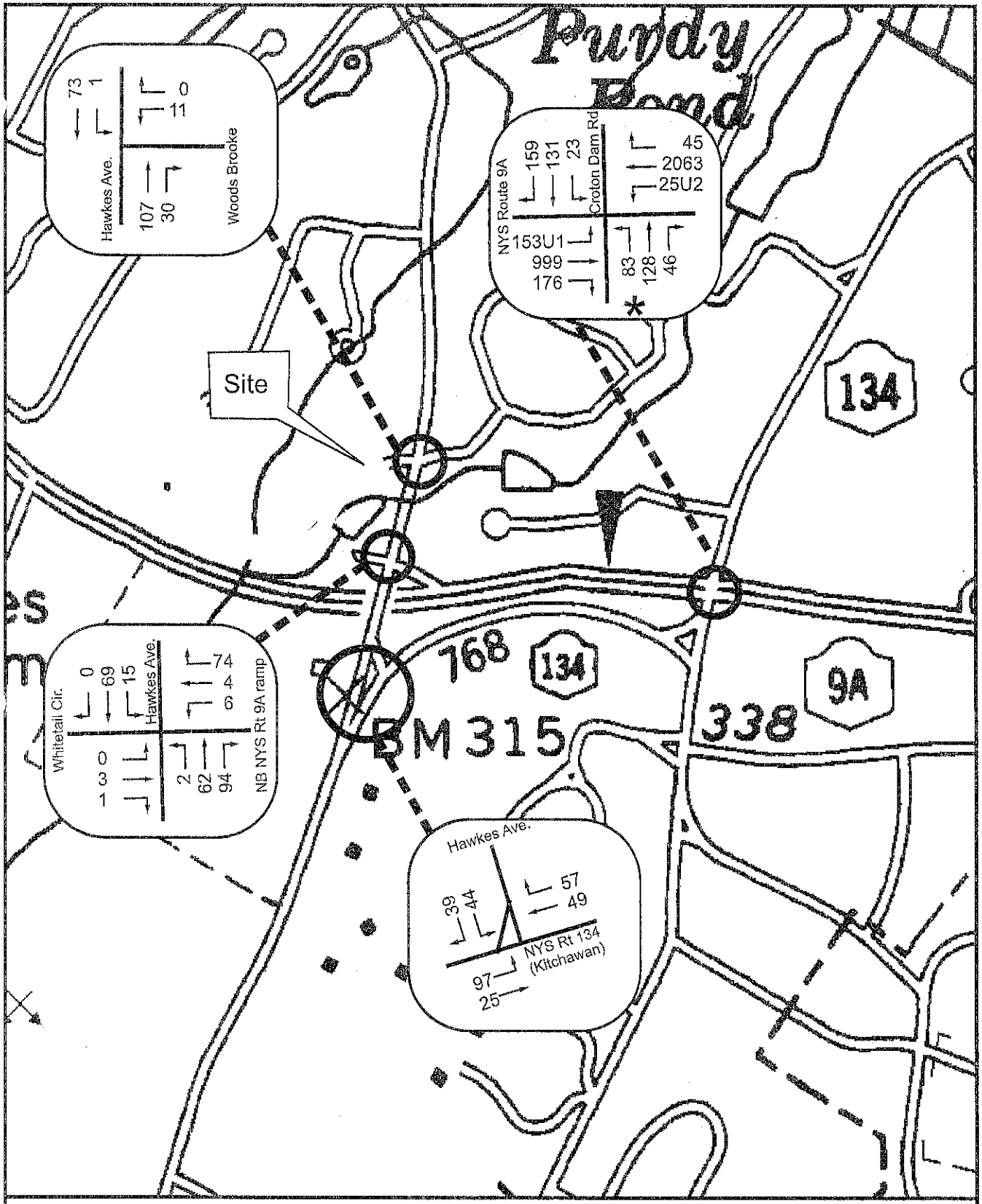

Figure 5: No Build PM Peak Hour Traffic
Parth Knolls LLC. 87 Hawkes Avenue
Town of Ossining, Westchester County, New York
Base Map: New York State Department of Transportation Ossining Quadangle
source: JMC, River Knoll Traffic Study, Armonk, NY, Nov. 2015.
+U is u-turn volume
Approx. Scale: 1 inch = 600 feet

N W E S *

File 15015 07/26/16
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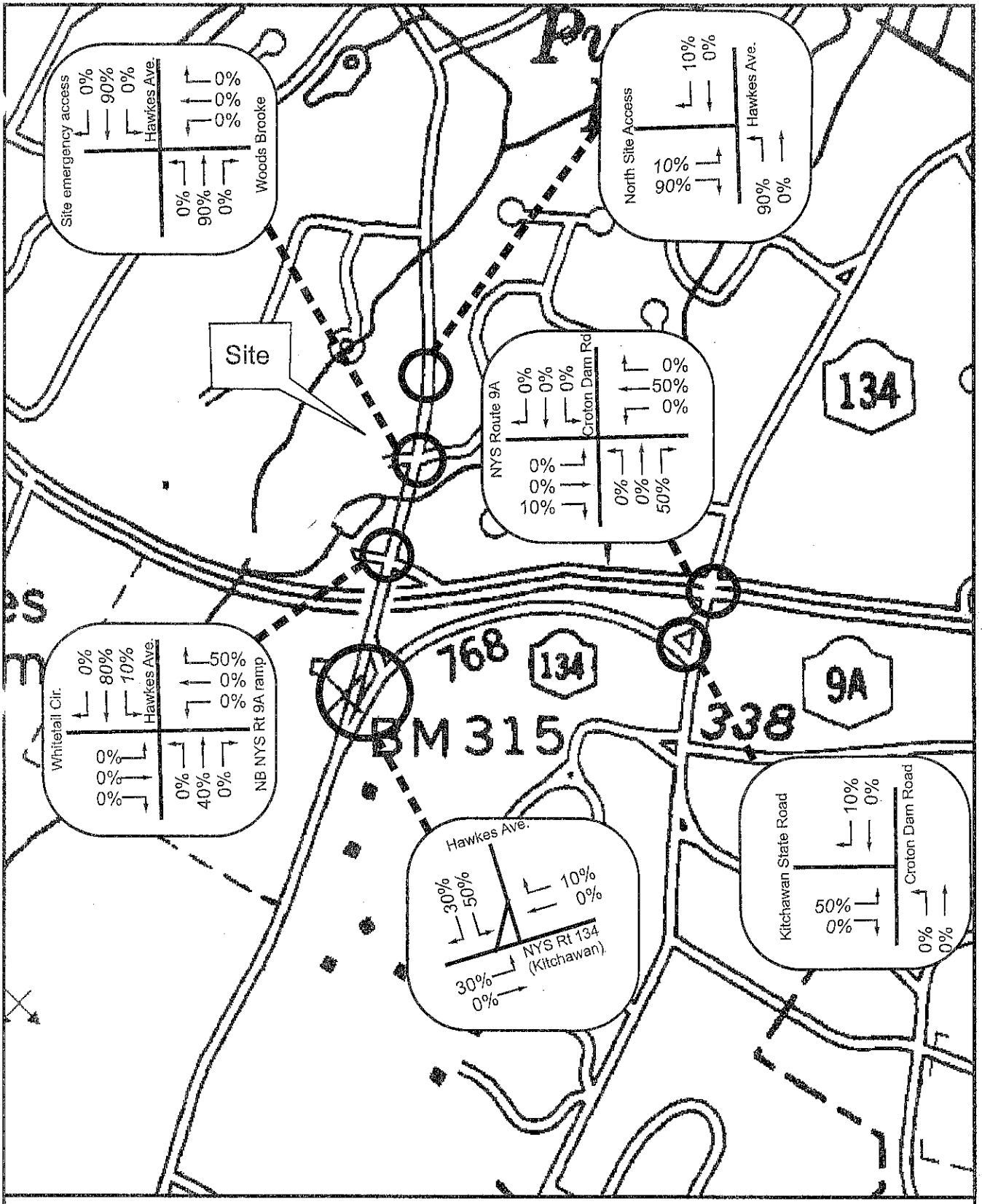
Tim Miller Associates, Inc., 10 North Street, Cold Spring, New York 10516 (845) 265-4400 Fax (845) 265-4418



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xx% outbound traffic
xx% inbound traffic

Figure 6: Site Distribution AM Peak Hour Traffic
Parth Knolls LLC. 87 Hawkes Avenue
Town of Ossining, Westchester County, New York
Base Map: New York State Department of Transportation
Ossining Quadangle
Approx. Scale: 1 inch = 600 feet

File 15015 09/01/16
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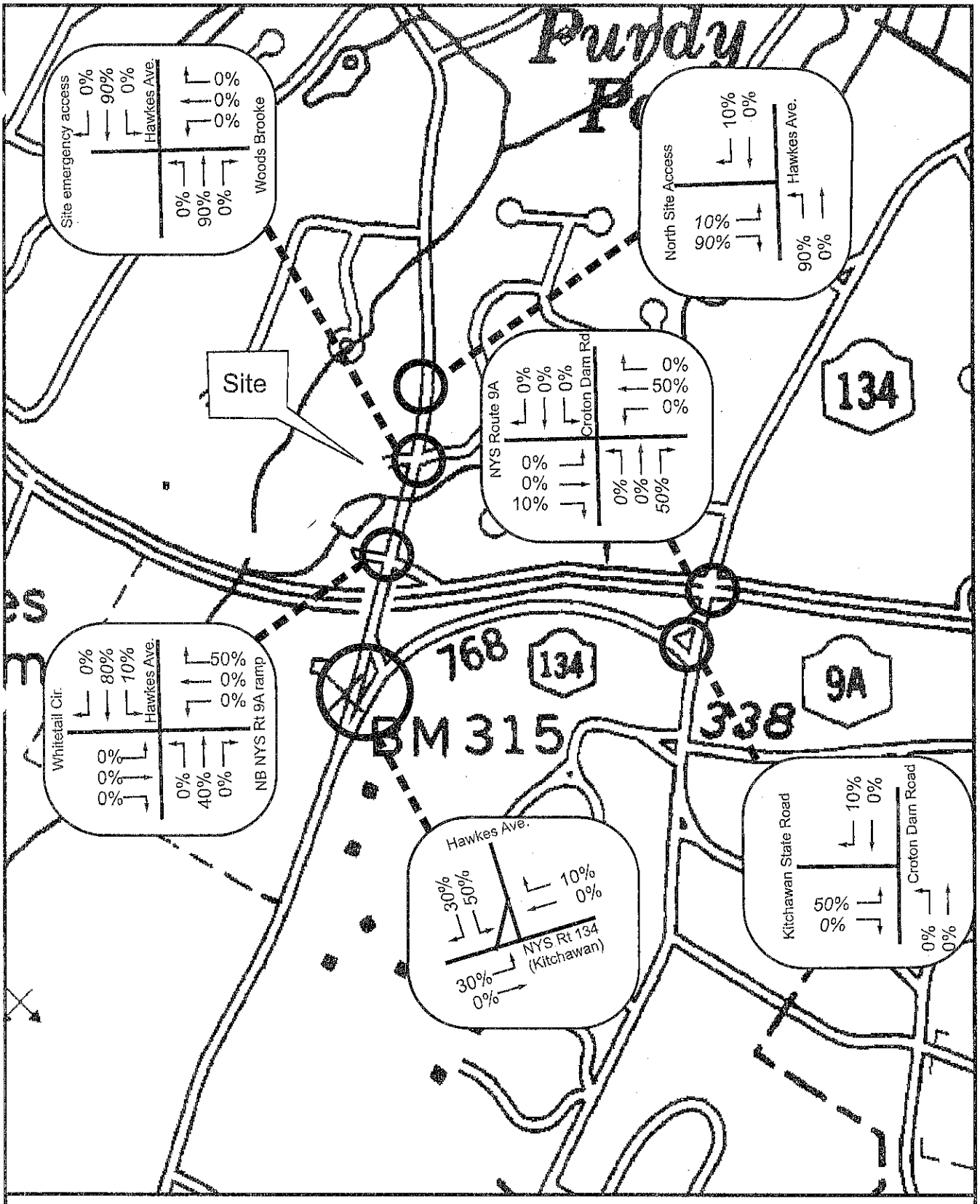

xx% outbound traffic
xx% inbound traffic

Figure 7: Site Distribution PM Peak Hour Traffic
Parth Knolls LLC, 87 Hawkes Avenue
Town of Ossining, Westchester County, New York
Base Map: New York State Department of Transportation
Ossining Quadangle
Approx. Scale: 1 inch = 600 feet

File 15015 09/01/16
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Tim Miller Associates, Inc., 10 North Street, Cold Spring, New York 10516 (845) 265-4400 Fax (845) 265-4418

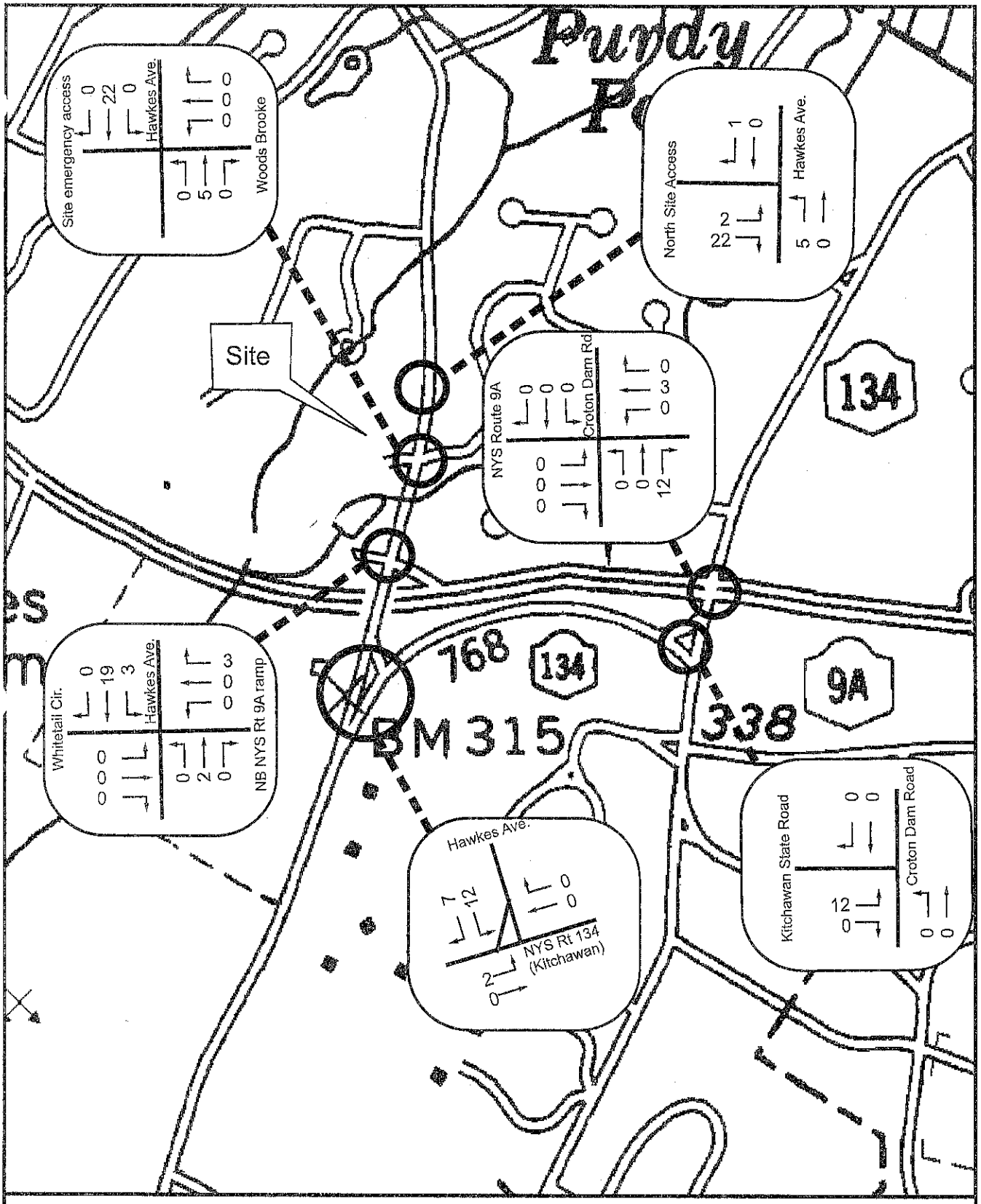

Figure 8: Site Generated AM Peak Hour Traffic
Parth Knolls LLC. 87 Hawkes Avenue
Town of Ossining, Westchester County, New York
Base Map: New York State Department of Transportation
Ossining Quadangle
Approx. Scale: 1 inch = 600 feet

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File 15015 09/01/16
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Tim Miller Associates, Inc.,10 North Street, Cold Spring, New York 10516 (845) 265-4400 Fax (845) 265-4418

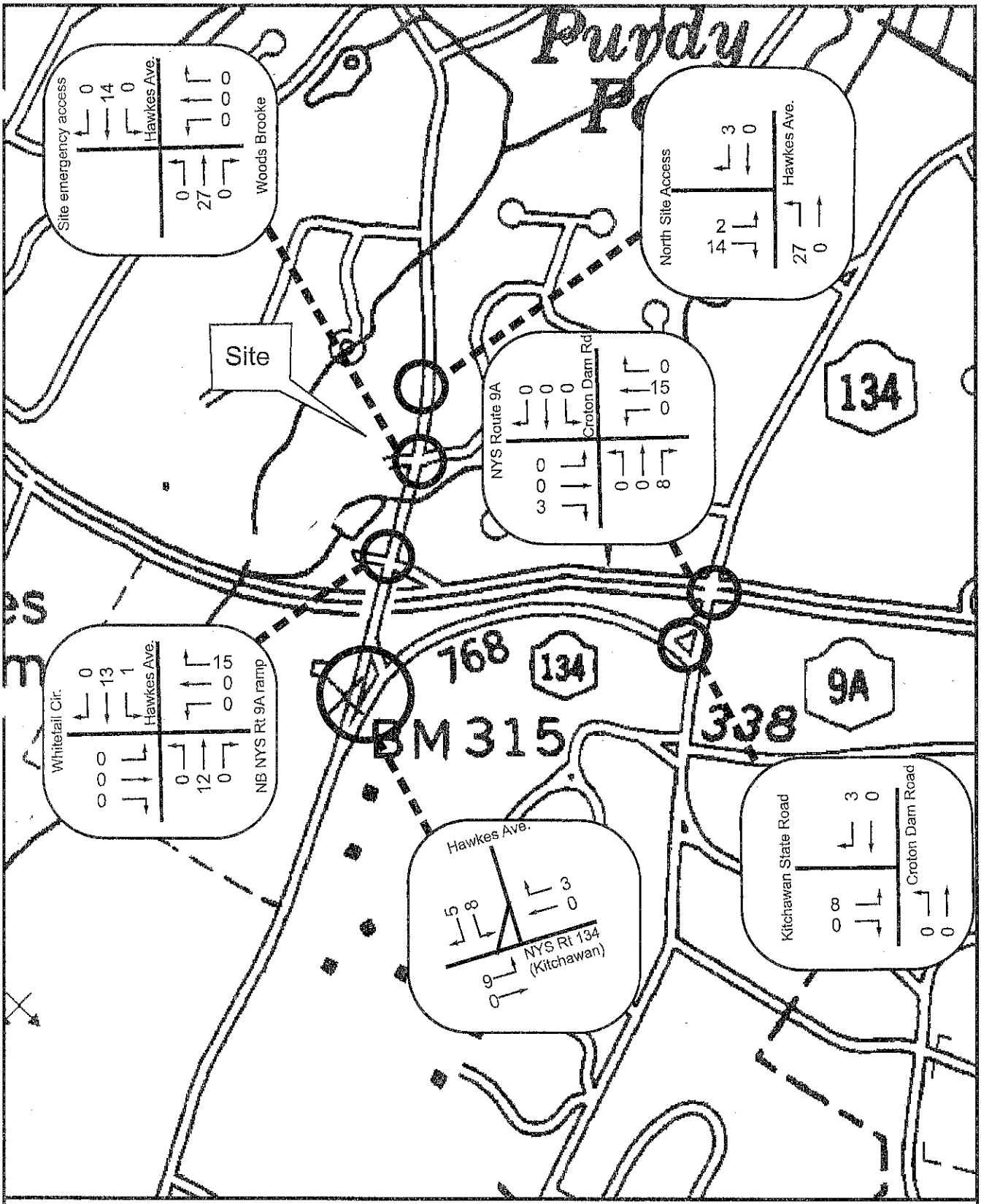

Figure 9: Site Generated PM Peak Hour Traffic
Parth Knolls LLC. 87 Hawkes Avenue
Town of Ossining, Westchester County, New York
Base Map: New York State Department of Transportation
Ossining Quadangle
Approx. Scale: 1 inch = 600 feet

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File 15015 09/01/16
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Tim Miller Associates, Inc.,10 North Street, Cold Spring, New York 10516 (845) 265-4400 Fax (845) 265-4418

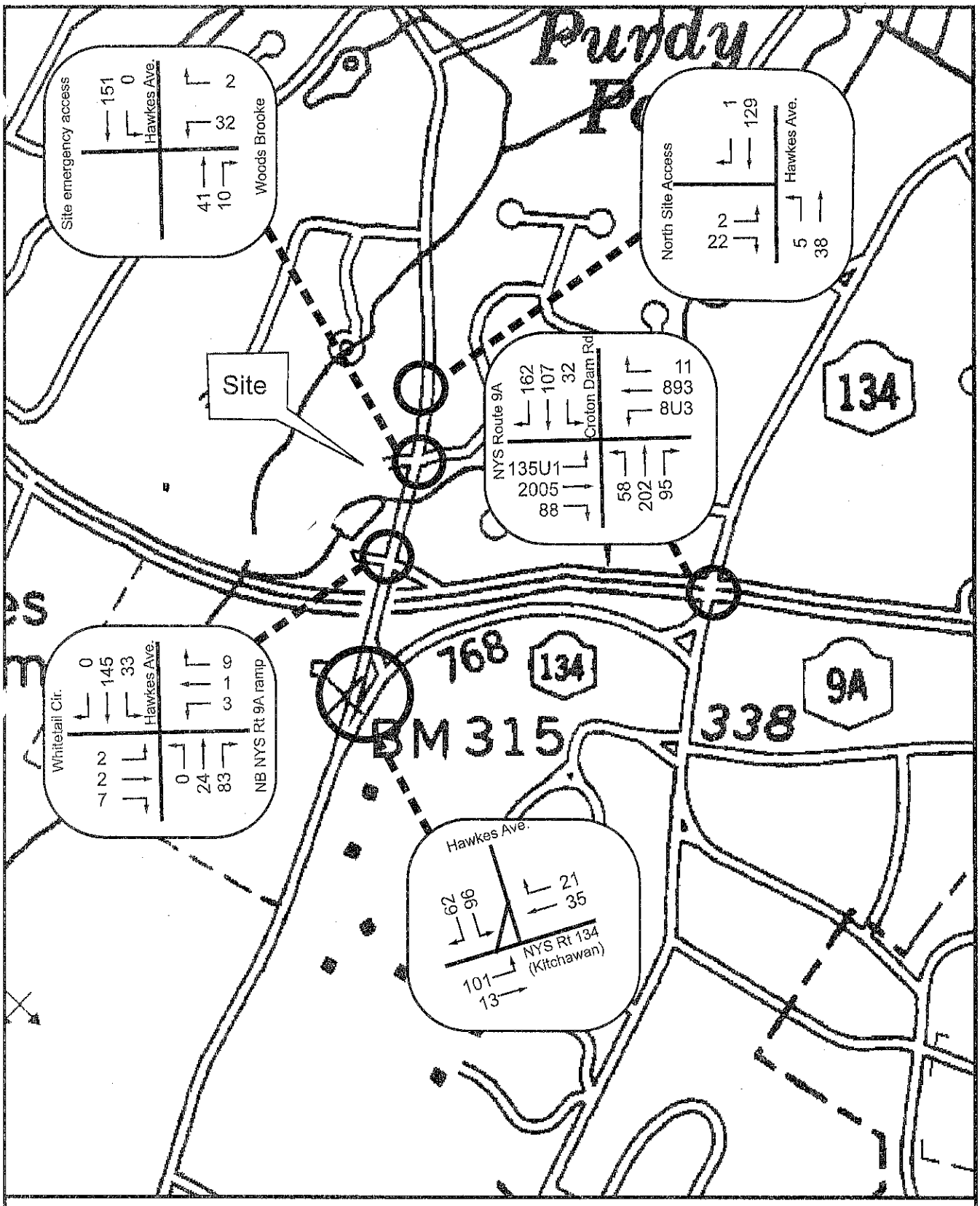

Figure 10: Build AM Peak Hour Traffic
Parth Knolls LLC. 87 Hawkes Avenue
Town of Ossining, Westchester County, New York
Base Map: New York State Department of Transportation
Ossining Quadangle
Approx. Scale: 1 inch = 600 feet

File 15015 09/01/16
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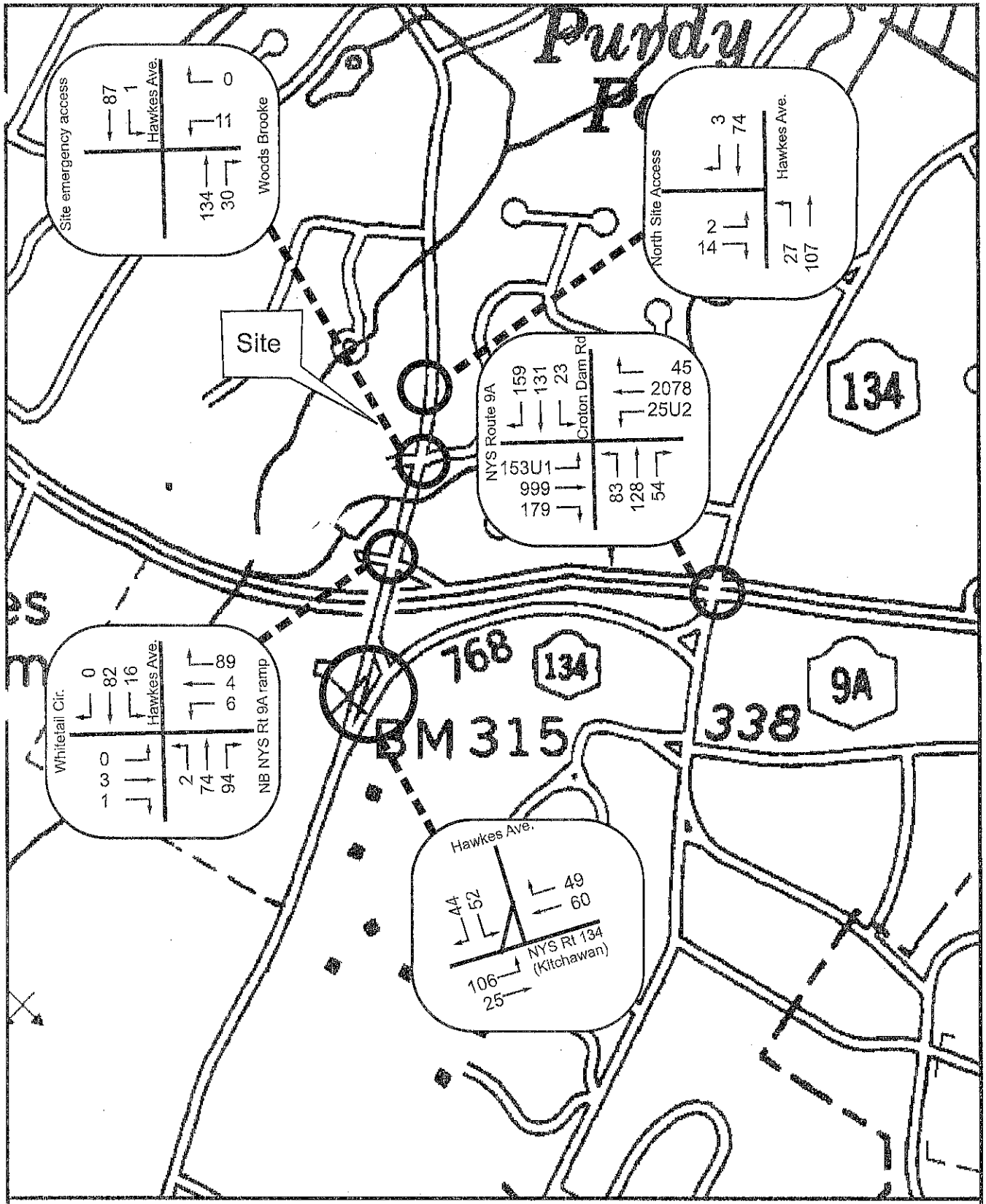

Figure 11: Build PM Peak Hour Traffic
Parth Knolls LLC. 87 Hawkes Avenue
Town of Ossining, Westchester County, New York
Base Map: New York State Department of Transportation
Ossining Quadangle
Approx. Scale: 1 inch = 600 feet

File 15015 09/01/16
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ATTACHMENT B

Level of Service Summary Table

Table B-1
Level of Service Summary All Conditions
NYS Route 9A and Croton Dam Road NYS Route 134

Intersection Road	Lane Group Approach Direction - Movement	Levels of Service (Delay in seconds per vehicle) Volume to Capacity Ratio					
		Weekday A.M. Peak Hour			Weekday PM Peak Hour		
		Existing	No Build	Build	Existing	No Build	Build
NYS Route 9A and Croton Dam Road (NYS Route 134) signalized							
NYS Route 9A	EB - L	E (72.5) 0.71	E (75.9) 0.72	E (75.9) 0.72	F (88.1) 0.78	F (89.1) 0.79	F (89.1) 0.79
	EB - T	C (21.1) 0.86	C (33.9) 0.95	C (33.9) 0.95	B (11.8) 0.42	B (12.2) 0.44	B (12.2) 0.44
	EB - R	A (8.1) 0.09	B (10.7) 0.10	B (10.7) 0.10	A (9.7) 0.15	B(10.1) 0.18	B(10.1) 0.18
NYS Route 9A	WB - L	E (65.7) 0.17	F (102.8) 0.40	F (102.8) 0.40	E (79.9) 0.32	F (81.4) 0.37	F (81.4) 0.37
	WB - T, R*	C (22.1) 0.53	C (27.6) 0.59	C (27.7) 0.60	E* (67.3) 1.06	F (84.7) 1.10	F (87.8) 1.11
Croton Dam Rd	NB - L, T, R	F (109.8) 1.03	F (144.8) 1.16	F (155.9) 1.19	F (517.9) 2.03	F (887.3) 2.88	F (901.3) 2.91
Croton Dam Rd	SB - L, T, R	F (139.9) 1.13	F (82.3) 0.92	F (84.5) 0.94	F (171.0) 1.20	F (207.1) 1.30	F (211.0) 1.31
	Overall	D (39.7)	D (47.5)	D (49.0)	F (86.4)	F (124.2)	F (128.4)

NB = Northbound, SB = Southbound, EB = Eastbound, WB = Westbound.
L = left, R= right, T = through, (e.g. WB-L = Westbound left).

*Through-Right lane data shown.

* By Volume to Capacity ratio this is level of service is F.

ATTACHMENT C

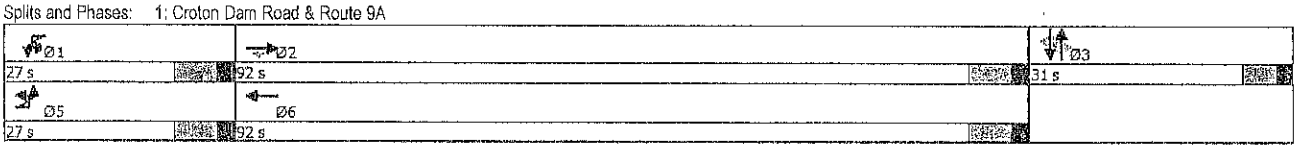
Level of Sevice and Queuing Calculations

Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations														
Traffic Volume (vph)	1	130	1927	79	3	7	855	11	30	183	76	31	100	156
Future Volume (vph)	1	130	1927	79	3	7	855	11	30	183	76	31	100	156
Satd. Flow (prot)	0	1538	3567	1460	0	1334	3408	0	0	1843	0	0	1700	0
Flt Permitted		0.950				0.950				0.798			0.784	
Satd. Flow (perm)	0	1538	3567	1460	0	1334	3408	0	0	1478	0	0	1339	0
Satd. Flow (RTOR)							1							
Confl. Peds. (#/hr)														1
Confl. Bikes (#/hr)														
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	100%	14%	4%	8%	0%	43%	7%	9%	0%	3%	1%	0%	1%	1%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)														
Mid-Block Traffic (%)			0%				0%			0%			0%	
Shared Lane Traffic (%)														
Lane Group Flow (vph)	0	139	2050	84	0	10	922	0	0	308	0	0	305	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	R NA	Left	Left	Right	R NA	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)			11				11			0			0	
Link Offset(ft)			0				0			0			0	
Crosswalk Width(ft)			16				16			16			16	
Two way Left Turn Lane														
Headway Factor	1.03	1.03	1.03	1.03	1.05	1.05	1.05	1.05	0.96	0.96	0.96	1.02	1.02	1.02
Turning Speed (mph)	9	15		9	9	15		9	15		9	15		9
Turn Type	Prot	Prot	NA	Perm	Prot	Prot	NA		Perm	NA		Perm	NA	
Protected Phases	5	5	2		1	1	6			3			3	
Permitted Phases				2					3			3		
Detector Phase	5	5	2	2	1	1	6		3	3		3	3	
Switch Phase														
Minimum Initial (s)	3.0	3.0	10.0	10.0	3.0	3.0	10.0		5.0	5.0		5.0	5.0	
Minimum Split (s)	10.0	10.0	17.0	17.0	10.0	10.0	17.0		11.0	11.0		11.0	11.0	
Total Split (s)	27.0	27.0	92.0	92.0	27.0	27.0	92.0		31.0	31.0		31.0	31.0	
Total Split (%)	18.0%	18.0%	61.3%	61.3%	18.0%	18.0%	61.3%		20.7%	20.7%		20.7%	20.7%	
Yellow Time (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0		4.0	4.0		4.0	4.0	
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0		2.0	2.0	
Lost Time Adjust (s)		0.0	0.0	0.0		0.0	0.0			0.0			0.0	
Total Lost Time (s)		7.0	7.0	7.0		7.0	7.0			6.0			6.0	
Lead/Lag	Lead	Lead	Lag	Lag	Lead	Lead	Lag							
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes							
Recall Mode	None	None	Min	Min	None	None	Min		None	None		None	None	
Act Effct Green (s)		15.8	83.5	83.5		5.5	63.3			25.1			25.1	
Actuated g/C Ratio		0.13	0.67	0.67		0.04	0.51			0.20			0.20	
v/c Ratio		0.71	0.86	0.09		0.17	0.53			1.03			1.13	
Control Delay		72.5	21.1	8.1		65.7	22.1			109.8			139.9	
Queue Delay		0.0	0.0	0.0		0.0	0.0			0.0			0.0	
Total Delay		72.5	21.1	8.1		65.7	22.1			109.8			139.9	
LOS		E	C	A		E	C			F			F	
Approach Delay			23.8				22.6			109.8			139.9	
Approach LOS			C				C			F			F	

Intersection Summary

Cycle Length: 150
Actuated Cycle Length: 124.2
Natural Cycle: 100
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 1.13
Intersection Signal Delay: 39.7 — Intersection LOS: D
Intersection Capacity Utilization 95.5% — ICU Level of Service F
Analysis Period (min) 15

Splits and Phases: 1: Croton Dam Road & Route 9A



Intersection: 1: Croton Dam Road & Route 9A

Movement	EB	EB	EB	EB	WB	WB	WB	NB	SB
Directions Served	UL	T	T	R	UL	T	TR	LTR	LTR
Maximum Queue (ft)	135	662	641	214	20	293	255	449	935
Average Queue (ft)	134	519	473	140	4	173	141	365	677
95th Queue (ft)	135	737	672	282	17	284	251	466	978
Link Distance (ft)		626	626			645	645	559	1091
Upstream Blk Time (%)		14	5						
Queuing Penalty (veh)		0	0						
Storage Bay Dist (ft)	110			190	150				
Storage Blk Time (%)	36	24	17	0		10			
Queuing Penalty (veh)	366	33	15	1		1			

Network Summary

Network wide Queuing Penalty: 415

Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations														
Traffic Volume (vph)	1	147	960	143	2	20	1983	43	65	117	42	22	114	153
Future Volume (vph)	1	147	960	143	2	20	1983	43	65	117	42	22	114	153
Satd. Flow (prot)	0	1762	3602	1546	0	1660	3570	0	0	1838	0	0	1676	0
Flt Permitted		0.950				0.950				0.378			0.912	
Satd. Flow (perm)	0	1762	3602	1546	0	1660	3570	0	0	705	0	0	1535	0
Satd. Flow (RTOR)							2							
Confl. Peds. (#/hr)														1
Confl. Bikes (#/hr)														
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	0%	0%	3%	2%	0%	5%	2%	5%	6%	0%	5%	9%	1%	3%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)														
Mid-Block Traffic (%)			0%				0%			0%			0%	
Shared Lane Traffic (%)														
Lane Group Flow (vph)	0	159	1032	154	0	24	2178	0	0	241	0	0	312	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	R NA	Left	Left	Right	R NA	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)			11				11			0			0	
Link Offset(ft)			0				0			0			0	
Crosswalk Width(ft)			16				16			16			16	
Two way Left Turn Lane														
Headway Factor	1.03	1.03	1.03	1.03	1.05	1.05	1.05	1.05	0.96	0.96	0.96	1.02	1.02	1.02
Turning Speed (mph)	9	15		9	9	15		9	15		9	15		9
Turn Type	Prot	Prot	NA	Perm	Prot	Prot	NA		Perm	NA		Perm	NA	
Protected Phases	5	5	2		1	1	6			3			3	
Permitted Phases				2					3			3		
Detector Phase	5	5	2	2	1	1	6		3	3		3	3	
Switch Phase														
Minimum Initial (s)	3.0	3.0	10.0	10.0	3.0	3.0	10.0		5.0	5.0		5.0	5.0	
Minimum Split (s)	10.0	10.0	17.0	17.0	10.0	10.0	17.0		11.0	11.0		11.0	11.0	
Total Split (s)	27.0	27.0	92.0	92.0	27.0	27.0	92.0		31.0	31.0		31.0	31.0	
Total Split (%)	18.0%	18.0%	61.3%	61.3%	18.0%	18.0%	61.3%		20.7%	20.7%		20.7%	20.7%	
Yellow Time (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0		4.0	4.0		4.0	4.0	
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0		2.0	2.0	
Lost Time Adjust (s)		0.0	0.0	0.0		0.0	0.0			0.0			0.0	
Total Lost Time (s)		7.0	7.0	7.0		7.0	7.0			6.0			6.0	
Lead/Lag	Lead	Lead	Lag	Lag	Lead	Lead	Lag							
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes							
Recall Mode	None	None	Min	Min	None	None	Min		None	None		None	None	
Act Effct Green (s)		17.1	100.4	100.4		6.6	85.0			25.0			25.0	
Actuated g/C Ratio		0.12	0.68	0.68		0.04	0.58			0.17			0.17	
v/c Ratio		0.78	0.42	0.15		0.32	1.06			2.03			1.20	
Control Delay		88.1	11.8	9.7		79.9	67.3			517.9			171.0	
Queue Delay		0.0	0.0	0.0		0.0	0.0			0.0			0.0	
Total Delay		88.1	11.8	9.7		79.9	67.3			517.9			171.0	
LOS		F	B	A		E	E			F			F	
Approach Delay			20.6				67.4			517.9			171.0	
Approach LOS			C				E			F			F	

Intersection Summary

Cycle Length: 150
Actuated Cycle Length: 147.2
Natural Cycle: 150
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 2.03
Intersection Signal Delay: 86.4 — Intersection LOS: F
Intersection Capacity Utilization 111.0% — ICU Level of Service H
Analysis Period (min) 15

Splits and Phases: 1: Croton Dam Road & Route 9A

Ø1	Ø2	Ø3
27 s	92 s	31 s
Ø5	Ø6	
27 s	92 s	

Queuing and Blocking Report

Intersection: 1: Croton Dam Road & Route 9A

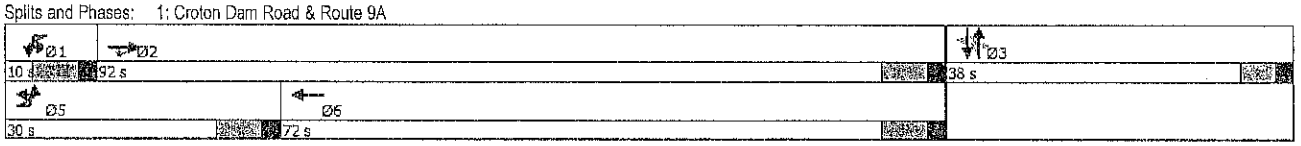
Movement	EB	EB	EB	EB	WB	WB	WB	NB	SB
Directions Served	UL	T	T	R	UL	T	TR	LTR	LTR
Maximum Queue (ft)	87	187	218	70	48	506	522	223	1055
Average Queue (ft)	74	139	137	38	23	465	445	171	890
95th Queue (ft)	91	201	226	78	51	501	515	250	1116
Link Distance (ft)		1018	1018			1519	1519	855	1092
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)	110			190	150				
Storage Blk Time (%)		14	2			35			
Queuing Penalty (veh)		22	3			8			

Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations														
Traffic Volume (vph)	1	135	2005	88	3	8	890	11	58	202	83	32	107	162
Future Volume (vph)	1	135	2005	88	3	8	890	11	58	202	83	32	107	162
Satd. Flow (prot)	0	1538	3567	1460	0	1313	3408	0	0	1846	0	0	1700	0
Flt Permitted		0.950				0.950				0.697			0.834	
Satd. Flow (perm)	0	1538	3567	1460	0	1313	3408	0	0	1297	0	0	1425	0
Satd. Flow (RTOR)							1							
Confl. Peds. (#/hr)														1
Confl. Bikes (#/hr)														
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	100%	14%	4%	6%	0%	43%	7%	9%	0%	3%	1%	0%	1%	1%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)														
Mid-Block Traffic (%)			0%				0%			0%			0%	
Shared Lane Traffic (%)														
Lane Group Flow (vph)	0	145	2133	94	0	12	959	0	0	365	0	0	320	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	R NA	Left	Left	Right	R NA	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)			11				11			0			0	
Link Offset(ft)			0				0			0			0	
Crosswalk Width(ft)			16				16			16			16	
Two way Left Turn Lane														
Headway Factor	1.03	1.03	1.03	1.03	1.05	1.05	1.05	1.05	0.96	0.96	0.96	1.02	1.02	1.02
Turning Speed (mph)	9	15		9	9	15		9	15		9	15		9
Turn Type	Prot	Prot	NA	Perm	Prot	Prot	NA		Perm	NA		Perm	NA	
Protected Phases	5	5	2		1	1	6			3			3	
Permitted Phases				2					3			3		
Detector Phase	5	5	2	2	1	1	6		3	3		3	3	
Switch Phase														
Minimum Initial (s)	3.0	3.0	10.0	10.0	3.0	3.0	10.0		5.0	5.0		5.0	5.0	
Minimum Split (s)	10.0	10.0	17.0	17.0	10.0	10.0	17.0		11.0	11.0		11.0	11.0	
Total Split (s)	30.0	30.0	92.0	92.0	10.0	10.0	72.0		38.0	38.0		38.0	38.0	
Total Split (%)	21.4%	21.4%	65.7%	65.7%	7.1%	7.1%	51.4%		27.1%	27.1%		27.1%	27.1%	
Yellow Time (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0		4.0	4.0		4.0	4.0	
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0		2.0	2.0	
Lost Time Adjust (s)		0.0	0.0	0.0		0.0	0.0			0.0			0.0	
Total Lost Time (s)		7.0	7.0	7.0		7.0	7.0			6.0			6.0	
Lead/Lag	Lead	Lead	Lag	Lag	Lead	Lead	Lag							
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes							
Recall Mode	None	None	Min	Min	None	None	Min		None	None		None	None	
Act Effct Green (s)		17.2	83.0	83.0		3.0	62.5			32.1			32.1	
Actuated g/C Ratio		0.13	0.63	0.63		0.02	0.47			0.24			0.24	
v/c Ratio		0.72	0.95	0.10		0.40	0.59			1.16			0.92	
Control Delay		75.9	33.9	10.7		102.8	27.6			144.8			82.3	
Queue Delay		0.0	0.0	0.0		0.0	0.0			0.0			0.0	
Total Delay		75.9	33.9	10.7		102.8	27.6			144.8			82.3	
LOS		E	C	B		F	C			F			F	
Approach Delay			35.5				28.6			144.8			82.3	
Approach LOS			D				C			F			F	

Intersection Summary

Cycle Length: 140
Actuated Cycle Length: 131.9
Natural Cycle: 150
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 1.16
Intersection Signal Delay: 47.5 Intersection LOS: D
Intersection Capacity Utilization 104.9% ICU Level of Service G
Analysis Period (min) 15

Splits and Phases: 1: Croton Dam Road & Route 9A



Queuing and Blocking Report

Intersection: 1: Croton Dam Road & Route 9A

Movement	EB	EB	EB	EB	WB	WB	WB	NB	SB
Directions Served	UL	T	T	R	UL	T	TR	LTR	LTR
Maximum Queue (ft)	134	943	777	214	24	278	232	420	399
Average Queue (ft)	102	606	599	58	9	215	180	293	314
95th Queue (ft)	167	1011	882	190	28	276	254	461	429
Link Distance (ft)		1018	1018			1155	1155	559	1092
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)	110			190	150				
Storage Blk Time (%)	11	25	30			18			
Queuing Penalty (veh)	121	37	28			2			

Network Summary

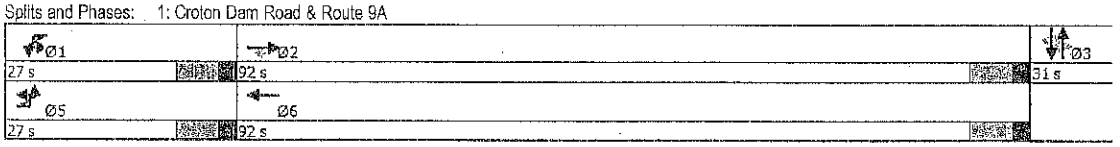
Network wide Queuing Penalty: 188

Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations														
Traffic Volume (vph)	1	153	999	176	2	25	2063	45	83	128	46	23	131	159
Future Volume (vph)	1	153	999	176	2	25	2063	45	83	128	46	23	131	159
Satd. Flow (prot)	0	1762	3602	1546	0	1659	3570	0	0	1834	0	0	1681	0
Flt Permitted		0.950				0.950				0.307			0.908	
Satd. Flow (perm)	0	1762	3602	1546	0	1659	3570	0	0	572	0	0	1533	0
Satd. Flow (RTOR)							2							
Confl. Peds. (#/hr)														1
Confl. Bikes (#/hr)														
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	0%	0%	3%	2%	0%	5%	2%	5%	6%	0%	5%	9%	1%	3%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)														
Mid-Block Traffic (%)			0%				0%			0%			0%	
Shared Lane Traffic (%)														
Lane Group Flow (vph)	0	166	1074	189	0	29	2266	0	0	276	0	0	337	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	R NA	Left	Left	Right	R NA	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)			11				11			0			0	
Link Offset(ft)			0				0			0			0	
Crosswalk Width(ft)			16				16			16			16	
Two way Left Turn Lane														
Headway Factor	1.03	1.03	1.03	1.03	1.05	1.05	1.05	1.05	0.96	0.96	0.96	1.02	1.02	1.02
Turning Speed (mph)	9	15		9	9	15		9	15		9	15		9
Turn Type	Prot	Prot	NA	Perm	Prot	Prot	NA		Perm	NA		Perm	NA	
Protected Phases	5	5	2		1	1	6			3			3	
Permitted Phases				2					3			3		
Detector Phase	5	5	2	2	1	1	6		3	3		3	3	
Switch Phase														
Minimum Initial (s)	3.0	3.0	10.0	10.0	3.0	3.0	10.0		5.0	5.0		5.0	5.0	
Minimum Split (s)	10.0	10.0	17.0	17.0	10.0	10.0	17.0		11.0	11.0		11.0	11.0	
Total Split (s)	27.0	27.0	92.0	92.0	27.0	27.0	92.0		31.0	31.0		31.0	31.0	
Total Split (%)	18.0%	18.0%	61.3%	61.3%	18.0%	18.0%	61.3%		20.7%	20.7%		20.7%	20.7%	
Yellow Time (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0		4.0	4.0		4.0	4.0	
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0		2.0	2.0	
Lost Time Adjust (s)		0.0	0.0	0.0		0.0	0.0			0.0			0.0	
Total Lost Time (s)		7.0	7.0	7.0		7.0	7.0			6.0			6.0	
Lead/Lag	Lead	Lead	Lag	Lag	Lead	Lead	Lag							
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes							
Recall Mode	None	None	Min	Min	None	None	Min		None	None		None	None	
Act Effct Green (s)		17.6	100.6	100.6		7.0	85.1			25.0			25.0	
Actuated g/C Ratio		0.12	0.68	0.68		0.05	0.58			0.17			0.17	
v/c Ratio		0.79	0.44	0.18		0.37	1.10			2.88			1.30	
Control Delay		89.1	12.2	10.1		81.4	84.7			887.3			207.1	
Queue Delay		0.0	0.0	0.0		0.0	0.0			0.0			0.0	
Total Delay		89.1	12.2	10.1		81.4	84.7			887.3			207.1	
LOS		F	B	B		F	F			F			F	
Approach Delay			20.9				84.7			887.3			207.1	
Approach LOS			C				F			F			F	

Intersection Summary

Cycle Length: 150
Actuated Cycle Length: 147.7
Natural Cycle: 150
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 2.88
Intersection Signal Delay: 124.2 Intersection LOS: F
Intersection Capacity Utilization 120.7% ICU Level of Service H
Analysis Period (min) 15

Splits and Phases: 1: Croton Dam Road & Route 9A



Queuing and Blocking Report

Intersection: 1: Croton Dam Road & Route 9A

Movement	EB	EB	EB	EB	WB	WB	WB	NB	SB
Directions Served	UL	T	T	R	UL	T	TR	LTR	LTR
Maximum Queue (ft)	134	506	435	214	174	1534	1534	769	914
Average Queue (ft)	124	349	303	131	46	1241	1231	550	819
95th Queue (ft)	150	548	499	238	153	1557	1543	776	965
Link Distance (ft)		1018	1018			1519	1519	855	1092
Upstream Blk Time (%)						9	5		
Queuing Penalty (veh)						0	0		
Storage Bay Dist (ft)	110			190	150				
Storage Blk Time (%)	54	13	6	0		43			
Queuing Penalty (veh)	287	21	11	0		12			

Network Summary

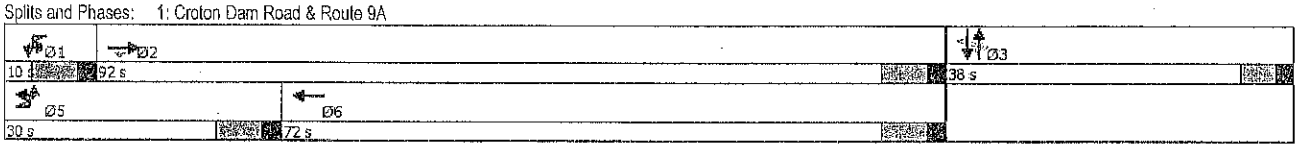
Network wide Queuing Penalty: 332

Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations														
Traffic Volume (vph)	1	135	2005	88	3	8	893	11	58	202	95	32	107	162
Future Volume (vph)	1	135	2005	88	3	8	893	11	58	202	95	32	107	162
Satd. Flow (prot)	0	1538	3567	1460	0	1313	3408	0	0	1841	0	0	1700	0
Flt Permitted		0.950				0.950				0.704			0.824	
Satd. Flow (perm)	0	1538	3567	1460	0	1313	3408	0	0	1307	0	0	1408	0
Satd. Flow (RTOR)							1							
Confl. Peds. (#/hr)														1
Confl. Bikes (#/hr)														
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	100%	14%	4%	8%	0%	43%	7%	9%	0%	3%	1%	0%	1%	1%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)														
Mid-Block Traffic (%)			0%				0%			0%			0%	
Shared Lane Traffic (%)														
Lane Group Flow (vph)	0	145	2133	94	0	12	962	0	0	378	0	0	320	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	R NA	Left	Left	Right	R NA	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)			11				11			0			0	
Link Offset(ft)			0				0			0			0	
Crosswalk Width(ft)			16				16			16			16	
Two way Left Turn Lane														
Headway Factor	1.03	1.03	1.03	1.03	1.05	1.05	1.05	1.05	0.96	0.96	0.96	1.02	1.02	1.02
Turning Speed (mph)	9	15		9	9	15		9	15		9	15		9
Turn Type	Prot	Prot	NA	Perm	Prot	Prot	NA		Perm	NA		Perm	NA	
Protected Phases	5	5	2		1	1	6			3			3	
Permitted Phases				2					3			3		
Detector Phase	5	5	2	2	1	1	6		3	3		3	3	
Switch Phase														
Minimum Initial (s)	3.0	3.0	10.0	10.0	3.0	3.0	10.0		5.0	5.0		5.0	5.0	
Minimum Split (s)	10.0	10.0	17.0	17.0	10.0	10.0	17.0		11.0	11.0		11.0	11.0	
Total Split (s)	30.0	30.0	92.0	92.0	10.0	10.0	72.0		38.0	38.0		38.0	38.0	
Total Split (%)	21.4%	21.4%	65.7%	65.7%	7.1%	7.1%	51.4%		27.1%	27.1%		27.1%	27.1%	
Yellow Time (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0		4.0	4.0		4.0	4.0	
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0		2.0	2.0	
Lost Time Adjust (s)		0.0	0.0	0.0		0.0	0.0			0.0			0.0	
Total Lost Time (s)		7.0	7.0	7.0		7.0	7.0			6.0			6.0	
Lead/Lag	Lead	Lead	Lag	Lag	Lead	Lead	Lag							
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes							
Recall Mode	None	None	Min	Min	None	None	Min		None	None		None	None	
Act Effct Green (s)		17.2	83.0	83.0		3.0	62.5			32.1			32.1	
Actuated g/C Ratio		0.13	0.63	0.63		0.02	0.47			0.24			0.24	
v/c Ratio		0.72	0.95	0.10		0.40	0.60			1.19			0.94	
Control Delay		75.9	33.9	10.7		102.8	27.7			155.9			84.5	
Queue Delay		0.0	0.0	0.0		0.0	0.0			0.0			0.0	
Total Delay		75.9	33.9	10.7		102.8	27.7			155.9			84.5	
LOS		E	C	B		F	C			F			F	
Approach Delay			35.5				28.6			155.9			84.5	
Approach LOS			D				C			F			F	

Intersection Summary

Cycle Length: 140
Actuated Cycle Length: 131.9
Natural Cycle: 150
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 1.19
Intersection Signal Delay: 49.0 Intersection LOS: D
Intersection Capacity Utilization 105.6% ICU Level of Service G
Analysis Period (min) 15

Splits and Phases: 1: Croton Dam Road & Route 9A



Queuing and Blocking Report

Intersection: 1: Croton Dam Road & Route 9A

Movement	EB	EB	EB	EB	WB	WB	NB	SB
Directions Served	UL	T	T	R	T	TR	LTR	LTR
Maximum Queue (ft)	134	373	366	215	293	305	346	456
Average Queue (ft)	109	310	291	105	223	227	288	381
95th Queue (ft)	174	390	392	253	301	300	367	498
Link Distance (ft)		1018	1018		1155	1155	559	1092
Upstream Blk Time (%)								
Queuing Penalty (veh)								
Storage Bay Dist (ft)	110			190				
Storage Blk Time (%)	30	23	13	0	25			
Queuing Penalty (veh)	322	34	12	0	3			

Network Summary

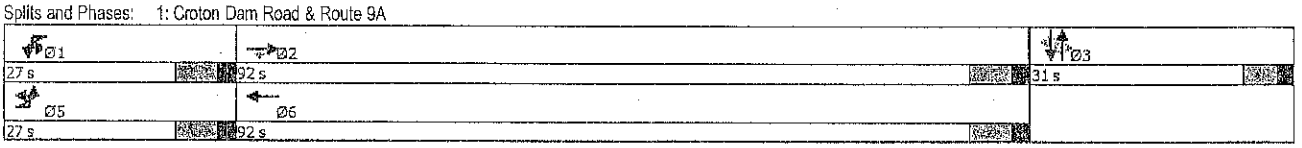
Network wide Queuing Penalty: 371

Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations														
Traffic Volume (vph)	1	153	999	179	2	25	2078	45	83	128	54	23	131	159
Future Volume (vph)	1	153	999	179	2	25	2078	45	83	128	54	23	131	159
Satd. Flow (prot)	0	1762	3602	1546	0	1659	3570	0	0	1829	0	0	1681	0
Flt Permitted		0.950				0.950				0.314			0.902	
Satd. Flow (perm)	0	1762	3602	1546	0	1659	3570	0	0	583	0	0	1523	0
Satd. Flow (RTOR)							2							
Confl. Peds. (#/hr)														1
Confl. Bikes (#/hr)														
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	0%	0%	3%	2%	0%	5%	2%	5%	6%	0%	5%	9%	1%	3%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)														
Mid-Block Traffic (%)			0%				0%			0%			0%	
Shared Lane Traffic (%)														
Lane Group Flow (vph)	0	166	1074	192	0	29	2282	0	0	285	0	0	337	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	R NA	Left	Left	Right	R NA	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)			11				11			0			0	
Link Offset(ft)			0				0			0			0	
Crosswalk Width(ft)			16				16			16			16	
Two way Left Turn Lane														
Headway Factor	1.03	1.03	1.03	1.03	1.05	1.05	1.05	1.05	0.96	0.96	0.96	1.02	1.02	1.02
Turning Speed (mph)	9	15		9	9	15		9	15		9	15		9
Turn Type	Prot	Prot	NA	Perm	Prot	Prot	NA		Perm	NA		Perm	NA	
Protected Phases	5	5	2		1	1	6			3			3	
Permitted Phases				2					3			3		
Detector Phase	5	5	2	2	1	1	6		3	3		3	3	
Switch Phase														
Minimum Initial (s)	3.0	3.0	10.0	10.0	3.0	3.0	10.0		5.0	5.0		5.0	5.0	
Minimum Split (s)	10.0	10.0	17.0	17.0	10.0	10.0	17.0		11.0	11.0		11.0	11.0	
Total Split (s)	27.0	27.0	92.0	92.0	27.0	27.0	92.0		31.0	31.0		31.0	31.0	
Total Split (%)	18.0%	18.0%	61.3%	61.3%	18.0%	18.0%	61.3%		20.7%	20.7%		20.7%	20.7%	
Yellow Time (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0		4.0	4.0		4.0	4.0	
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0		2.0	2.0	
Lost Time Adjust (s)		0.0	0.0	0.0		0.0	0.0			0.0			0.0	
Total Lost Time (s)		7.0	7.0	7.0		7.0	7.0			6.0			6.0	
Lead/Lag	Lead	Lead	Lag	Lag	Lead	Lead	Lag							
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes							
Recall Mode	None	None	Min	Min	None	None	Min		None	None		None	None	
Act Effct Green (s)		17.6	100.6	100.6		7.0	86.1			25.0			25.0	
Actuated g/C Ratio		0.12	0.68	0.68		0.05	0.58			0.17			0.17	
v/c Ratio		0.79	0.44	0.18		0.37	1.11			2.91			1.31	
Control Delay		89.1	12.2	10.1		81.4	87.8			901.3			211.0	
Queue Delay		0.0	0.0	0.0		0.0	0.0			0.0			0.0	
Total Delay		89.1	12.2	10.1		81.4	87.8			901.3			211.0	
LOS		F	B	B		F	F			F			F	
Approach Delay			20.8				87.7			901.3			211.0	
Approach LOS			C				F			F			F	

Intersection Summary

Cycle Length: 150
Actuated Cycle Length: 147.7
Natural Cycle: 150
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 2.91
Intersection Signal Delay: 128.4 Intersection LOS: F
Intersection Capacity Utilization 121.6% ICU Level of Service H
Analysis Period (min) 15

Splits and Phases: 1: Croton Dam Road & Route 9A



Queuing and Blocking Report

Intersection: 1: Croton Dam Road & Route 9A

Movement	EB	EB	EB	EB	WB	WB	WB	NB	SB
Directions Served	UL	T	T	R	UL	T	TR	LTR	LTR
Maximum Queue (ft)	134	264	245	72	46	1553	1553	668	1107
Average Queue (ft)	109	165	152	34	11	1509	1507	575	974
95th Queue (ft)	145	259	232	87	40	1615	1612	754	1244
Link Distance (ft)		1018	1018			1519	1519	855	1092
Upstream Blk Time (%)						38	38		42
Queuing Penalty (veh)						0	0		0
Storage Bay Dist (ft)	110			190	150				
Storage Blk Time (%)	16	8	3			43			
Queuing Penalty (veh)	88	13	6			12			

Network Summary

Network wide Queuing Penalty: 120

ATTACHMENT D

Level of Service Criteria

Traffic: Performance Measures

Introduction

The Highway Capacity Manual[1] and the *Synchro 8 Software*[2] procedures document the methodology used for modeling levels of service, average vehicle delay, and volume -to-capacity ratios at both signalized and unsignalized intersections. Level of service is a measure of the operational quality of an intersection; level of service A is the highest, most efficient level, and level of service F is the lowest level. The operational quality of an intersection for the automobile mode is based on the average amount of time vehicles are delayed. Levels of service are examined by 'lane group', the set of lanes allowing common movement(s) on an approach.

The *Synchro 8 Software* modeled results apply to peak hour periods only. During off peak periods, which is the majority of the time, drivers typically will find operations better than the modeled peak hour periods. During peak periods the experience of individual drivers can vary, because the model calculates average delay.

Level of Service Criteria Signalized Intersections

When analyzing activity at signalized intersections, an understanding of the definition of level of service for the Automobile mode is essential:

Automobile Mode

Level of service can be characterized for the entire intersection, each intersection approach, and each lane group. Control delay alone is used to characterize level of service for the entire intersection or an approach. Control delay and volume-to-capacity ratio are used to characterize level of service for a lane group. Delay quantifies the increase in travel time due to traffic signal control. It is also a surrogate measure to driver discomfort and fuel consumption. The volume-to-capacity ratio quantifies the degree to which a phase's capacity is utilized by a lane group. The following paragraphs describe each level of service.

Level of service A describes operations with a control delay of 10 seconds per vehicle or less and a volume-to-capacity ratio no greater than 1.0. This level is typically assigned when the volume-to-capacity ratio is low and either progression is exceptionally favorable or the cycle length is very short. If it is due to favorable progression, most vehicles arrive during the green indication and travel through the intersection without stopping.

Level of service B describes operations with control delay between 10 and 20 seconds per vehicle and a volume-to-capacity ratio no greater than 1.0. This level is typically assigned when the volume-to-capacity ratio is low and either progression is highly favorable or the cycle length is short. More vehicles stop than with Level of service A.

Level of service C describes operations with control delay between 20 and 35 seconds per vehicle and a volume-to-capacity ratio no greater than 1.0. This level is typically assigned when progression is favorable or the cycle length is moderate. Individual cycle failures (i.e., one or more queued vehicles are not able to depart as a result of depart as a result of insufficient capacity during the cycle) may begin to appear at this level. The number of vehicles stopping is significant, although many vehicles still pass through the intersection without stopping.

Level of service D describes operations with control delay between 35 and 55 seconds per vehicle and a volume-to-capacity ratio no greater than 1.0. This level is typically assigned

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[1] Transportation Research Board of the National Academies, Highway Capacity Manual, Washington D.C., 2010.
[2] *Synchro 8*, Computer software, Trafficware, Sugar Land, Texas, 2011.

when the volume-to-capacity ratio is higher and either progression is ineffective or the cycle length is long. Many vehicles stop and individual cycle failures are noticeable.

Level of service E describes operations with control delay between 55 and 80 seconds per vehicle and a volume-to-capacity ratio no greater than 1.0. This level is typically assigned when the volume-to-capacity ratio is high, progression is unfavorable, and the cycle length is long. Individual cycle failures are frequent.

Level of service F describes operations with control delay exceeding 80 seconds per vehicle or a volume-to-capacity ratio greater than 1.0. This level is typically assigned when the volume-to-capacity ratio is very high, progression is very poor, and the cycle length is long. Most cycles fail to clear the queue.

A lane group can incur a delay less than 80 seconds per vehicle when the volume-to-capacity ratio exceeds 1.0. This condition typically occurs when the cycle length is short, the signal progression is favorable, or both. As a result, both the delay and volume-to-capacity ratio are considered when lane group level of service is established. A ratio of 1.0 or more indicates that cycle capacity is fully utilized and represents failure from a capacity perspective (just as delay in excess of 80 seconds per vehicle represents failure from a delay perspective).

Exhibit 18-4 lists the level of service thresholds established for the automobile mode at a signalized intersection.[3]

Signalized Intersections Level of Service Criteria Automobile Mode For Lane Groups		
Average Control Delay (Seconds Per Vehicle)	Volume-to-capacity Ratio less than or equal to one **Level of Service**	Volume-to-capacity Ratio greater than one **Level of Service**
less than or equal to 10	A	F
greater than 10 and less than or equal to 20	B	F
greater than 20 and less than or equal to 35	C	F
greater than 35 and less than or equal to 55	D	F
greater than 55 and less than or equal to 80	E	F
greater than 80	F	F

[1] From Transportation Research Board of the National Academies, Highway Capacity Manual, Washington D.C., Volume 3 page 18-6, Exhibit 18-4, 2010. Abbreviations and mathematical symbols have been replaced for reader clarity. Table limited to lane groups (lane or group of lanes sharing a common movement).

The New York State Department of Transportation (NYS DOT) generally seeks in urban areas for a level of service D or better (delay of 55 seconds or less for a signalized intersection) for all lane groups however:

> In some cases, it may be necessary to accept level of service E or F on individual lane groups due to unreasonable costs or impacts associated with improving the level of service.[4]

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[3] From Transportation Research Board of the National Academies, Highway Capacity Manual, Washington D.C., Volume 3 page 18-6, 2010. Abbreviations and mathematical symbols have been replaced for reader clarity.

[4] From NYS DOT, Highway Design Manual, Revision 62, April 13, 2011, (page 5-103) with abbreviations replaced for reader clarity.

ATTACHMENT E

Queueing Summary

Table E-1
Queuing Summary All Conditions
NYS Route 9A and Croton Dam Road NYS Route 134

Intersection Road	Lane Group Approach Direction - Movement	Queue in Feet					
		Weekday A.M. Peak Hour			Weekday PM Peak Hour		
		Existing	No Build	Build	Existing	No Build	Build
NYS Route 9A and Croton Dam Road (NYS Route 134) signalized							
NYS Route 9A	EB - L	135	167	174	91	149	190
	EB - T	737	1011	390*	201	269	318
	EB - T	672	882	392*	226	238	306
	EB - R	282	190	253	78	131	131
NYS Route 9A	WB - L	17	28	0	51	154	152
	WB - T,	284	276	301	501	1854	1667
	WB - T, R	251	254	300	515	1839	1492
Croton Dam Rd	NB - L, T, R	466	461	367	250	661	537
Croton Dam Rd	SB - L, T, R	978	429	498	1116	1131	969

NB = Northbound, SB = Southbound, EB = Eastbound, WB = Westbound.

L = left, R= right, T = through, (e.g. WB-L = Westbound left).

* based on Synchro analysis these should be comparable to No Build Condition.