TRAFFIC SIGNAL COORDINATION STUDY

New York State Route 96

Victor & Perinton, New York

Prepared for:

Town of Victor
Town of Perinton
Village of Victor

September 2007

Prepared by:

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SIEMENS

EXECUTIVE SUMMARY

The Route 96 Traffic Signal Coordination Study was undertaken to improve traffic operations on Route 96 and to develop strategies to monitor and dynamically optimize the traffic signals from Lynaugh Road in the Village of Victor to Thornell Road in Bushnell's Basin.

New 24-hour traffic data was collected at four locations along the corridor to supplement the existing data routinely collected by NYSDOT. New peak hour morning (AM), afternoon (PM), and Saturday turning movement counts were collected at the nineteen study intersections along Route 96:

1. Marsh Road
2. Kreag Road
3. I-490 access (Bushnell's Basin)
4. Garnsey Road
5. Fishers Road
6. I-490 off-ramp
7. Woodcliff Drive
8. Route 250 (Moseley Road)
9. Commons Boulevard
10. Turk Hill Road
11. Cobblestone Ct & Turk Hill Road (east of Route 96)
12. Mall Entrance/K-Mart Entrance
13. Mall Entrance/High Street
14. Hampton Inn Entrance
15. Main Street Fishers/Rowley Road
16. Route 251 (Victor Mendon Road)
17. High Street (Village)
18. School Street
19. Route 444 (Maple Avenue)

In addition, travel speeds were recorded along the corridor to assist with the calibration of the existing conditions traffic model. Capacity analysis was completed for the AM, PM, and Saturday peak periods. The existing conditions capacity analysis indicated poor traffic operations in Bushnell's Basin, at the High Street intersection with the Mall, at the Main Street Fisher's intersection, and in the Village of Victor. Of particular note, it was observed that once traffic operations and signal coordination deteriorated in the Village of Victor, the system took an inordinate amount of time to recover. The report contains Existing Conditions Level of Service tables for the study area intersections.

The existing conditions traffic model was then optimized to determine if new traffic signal timing, phasing, cycle length, or coordination changes could improve traffic operations along the corridor:

- Fourteen intersections were identified for signal timing improvements,
- Two intersections, Turk Hill Road and High Street, were identified for modified traffic signal phasing,
- The cycle length in the Village of Victor was reduced from 120 to 90 seconds during the PM and Saturday peak periods,
- Coordination patterns were recommended for Bushnell's Basin, the Mall area, and the Village of Victor
- Signal offset adjustments were made at all coordinated traffic signals

After determining that traffic signal operations could be improved through timing, phasing, cycle length, coordination, and offset changes, the study analyzed the potential for a connection to the Regional Traffic Operations Center (RTOC) on Scottsville Road in Rochester. If connected to the RTOC, the traffic signals could be monitored and dynamically optimized dependent on general traffic conditions or congestion caused by accidents, the weather, or other nonrecurring factors.

The existing and proposed Intelligent Transportation System (ITS) technologies in the area were cataloged and reviewed to determine a recommended communication strategy between the intersections along the corridor and from the corridor to the RTOC. The communication strategy recommended to connect the traffic signals to one another was with a combination of wireless technology for the signals in Monroe County and through the proposed fiber optic line to be installed by the Finger Lakes Regional Development Corporation (FLRDC) in Ontario County.

Once the traffic signals are connected to one another, a communication strategy was identified to connect to the RTOC through an existing New York State Thruway Authority (NYSTA) fiber optic line that crosses Route 96 near Main Street Fisher's. The NYSTA fiber optic line would then carry the traffic signal data to I-390. Once at I-390, the signal data would follow a new fiber optic line on I-390 eventually connecting to the existing NYSDOT fiber optic line near Jefferson Road. Once connected to the existing NYSDOT fiber optic line, the signal data can follow NYSDOT infrastructure to the RTOC. All agencies were contacted during the study and showed interest and a willingness to work together to put agreements in place that could make the connection a reality.

After determining the recommended communications strategies, a benefit / cost analysis was completed to determine how the benefits of the connection compared with the cost of the connection. The benefits of the connection were determined by calculating the delay savings that could be realized in Bushnell's Basin, the Mall Area, and the Village of Victor if the traffic signals could be dynamically monitored and optimized. The total delay savings calculations included the gas savings, value of freight, and the value of truck driver and general motorist time.

The total benefits that could be realized in one year of a connection to the RTOC was determined to be approximately $10,500,000. The total cost to connect to the RTOC, including one year of operating costs was estimated to be $1,014,000. The equates to a benefit cost ratio of approximately 10.5 : 1. This is a high benefit / cost ratio indicating the connection should be made. Other, non-quantified benefits include the reduction in response times for emergency responders, a reduction in secondary accidents if initial accidents can be cleared more quickly, maintenance crews can more effectively determine when power losses occur, when bulbs or loops need replacement, or when a signal is on flash.

The study identified four potential funding sources for the connection to the RTOC; the Shared Municipal Services Incentive Grant Program, the Governor's Traffic Safety Committee, the New York State Energy Research and Development Authority, and the Transportation Improvement Plan. Each of these funding sources should be explored to fund the administrative, engineering, testing, infrastructure, and construction costs associated with the connection.

Finally, the study recommended short term strategies that could be implemented along the corridor, prior to the communications connection to the RTOC, to improve traffic operations along Route 96. These strategies will need to be implemented and maintained in cooperation with the NYSDOT. The short term strategies include:

- Implementation of the proposed traffic signal timing, phasing, and coordination patterns identified in the study. Particular emphasis should be put on the Village of Victor, Eastview Mall area, and Bushnell's Basin.

- While implementing the proposed signal timings, NYSDOT staff should verify the existing signal offsets and coordinate the time clocks in the traffic signal controllers. This will ensure the traffic signal synchronization is optimized.

- Request the NYSDOT field optimize the proposed traffic patterns based on actual operating conditions seen in the field. Proposed traffic signal timing and phasing patterns should always be optimized in the field to achieve the full benefit of the changes.

- Request a regular review of the traffic signal operations along the corridor by NYSDOT maintenance to ensure the optimized traffic signal timing and phasing patterns operate as intended. This should include synchronization of the time clocks within the traffic signal controllers.

- As new development is approved and constructed along the corridor, review the traffic impacts and proposed mitigation in the context of the entire corridor to ensure traffic signal timing, phasing, and offset changes are in the best interest of the entire corridor, not just at the immediate driveway and adjacent intersections. The Synchro model created for this project can be used by the Towns and Village to assess the overall corridor impacts.

The next step for the Town of Perinton and Town and Village of Victor is to coordinate with the NYSDOT to implement the short term strategies identified above. The communities should also use the results of this study to apply for funding through the above mentioned sources, as well as any other sources identified by the communities grant coordinators to make the connection to the RTOC a reality.

I. INTRODUCTION

New York State (NYS) Route 96 is a heavily traveled commuter and commercial corridor through the Town of Victor, Town of Perinton (Bushnell's Basin), and Village of Victor in Monroe and Ontario Counties. Closely spaced traffic signals, proximity to I-490 and the NYS Thruway (I-90), Eastview Mall, and extensive commercial growth in the Town and Village of Victor has lead to daily traffic congestion and vehicle queuing, primarily during the peak travel periods.

In an effort to improve traffic operations on Route 96, a unique collaboration of municipalities / agencies has joined to undertake the Route 96 Traffic Signal Coordination Study to develop strategies to improve and monitor the traffic conditions from Lynaugh Road in the Village of Victor to Thornell Road in Bushnell's Basin. Active study participants include:

- Town of Victor
- Town of Perinton
- Village of Victor
- Ontario County
- Monroe County
- New York State Department of Transportation
- Genesee Transportation Council

The scope of the NYS Route 96 Traffic Signal Coordination Study (Study) is to collect new 24-hour and peak hour traffic data, analyze and optimize the traffic signal operations, and investigate Intelligent Transportation System (ITS) technology that would allow the corridor to be monitored by the Regional Traffic Operations Center (RTOC).

II. STUDY AREA

NYS Route 96 is classified as a rural minor arterial from Lynaugh Road to I-90 and classified as an urban minor arterial from I-90 to Thornell Road. The road is a local commuter route; has several connection points to NYS Route 490; indirect access to the Thruway; as well as serves large destination types of development including the Eastview Mall, other retail centers, a number of office parks and indirectly several residential communities. The following nineteen intersections along Route 96 are included in the study area:

1. Marsh Road
2. Kreag Road
3. I-490 access (Bushnell's Basin)
4. Garnsey Road
5. Fishers Road
6. I-490 off-ramp
7. Woodcliff Drive
8. Route 250 (Moseley Road)
9. Commons Boulevard
10. Turk Hill Road
11. Cobblestone Ct & Turk Hill Road (east of Route 96)
12. Mall Entrance/K-Mart Entrance
13. Mall Entrance/High Street
14. Hampton Inn Entrance
15. Main Street Fishers/Rowley Road
16. Route 251 (Victor Mendon Road)
17. High Street (Village)
18. School Street
19. Route 444 (Maple Avenue)

All of the study intersections are controlled by a traffic signal and include auxiliary turn lanes on NYS Route 96 and/or the side street approaches. The intersections from Maple Avenue to High Street, in the Village of Victor, operate as a coordinated traffic signal system during all three study periods; morning, evening and Saturday. The intersections from Hampton Inn to Commons Boulevard and from Woodcliff Drive to Marsh Road operate under individual coordination systems in the morning. During the evening, the intersections from Main Street – Fishers to Marsh Road operate under one coordinated system. Page 28 of the report also provides a table showing the existing coordination of the intersections.

III. TRAFFIC SIGNAL TIMING OPTIMIZATION PLANS

A. Establishment of Existing Conditions and Operations

- **<u>Data Collection</u>**

The data collected and used in this study included:

- Average daily traffic volume data;
- Intersection turning movement counts;
- Heavy vehicle counts by intersection movement for incorporation into the capacity analysis models;
- Pedestrian counts by intersection approach;
- Corridor travel time runs to document travel flow characteristics, queuing and travel speeds; and,
- Field observations of the network operations.

Twenty-four hour continuous traffic counts were completed for one week from September 15, 2006 to September 22, 2006.

Intersection turning movement counts were collected on:

- Wednesday, September 27, 2006 (7:00 to 9:00 AM) and (4:00 to 6:00 PM) –
  Marsh Road to NYS Route 250
- Saturday, September 30, 2006 (11:30 AM to 1:30 PM) –
  Marsh Road to NYS Route 250
- Wednesday, October 4, 2006 (7:00 to 9:00 AM) -
  Commons Boulevard to Hampton Inn Access
- Thursday, October 5, 2006 (7:00 to 9:00 AM) and (4:00 to 6:00 PM) –
  Main Street Fishers to NYS Route 444
- Saturday, October 14, 2006 (11:30 AM to 1:30 PM). –
  Commons Boulevard to NYS Route 444
- Friday, October 13, 2006 (2:00 to 6:00 PM) –
  High Street intersection in the Village of Victor -
  This count collected traffic volume data during the Victor Central School's dismissal period as well as for the evening period to determine if the peak hour between 2:00 – 4:00 PM was higher than the commuter peak hour between 4:00 - 6:00 PM.

Travel time data was collected on:

- Thursday, September 21, 2006 (7:00 to 9:00 AM) and (4:00 to 6:00PM).
- Friday, September 22, 2006 (4:00 to 6:00 PM).
- Friday, September 29, 2006 (4:00 to 6:00 PM).
- Saturday September 23, 2006 (12:00 noon to 2:00 PM).

Two transit companies serve the study area. The northern portion of the study from Marsh Road to the Eastview Mall is served by Rochester Genesee Regional Transit Authority (RGRTA) and the southern portion of the study area from the Eastview Mall through the Village of Victor is served by County Area Transit System (CATS) of Ontario County.

- **Summary of Data Collection**

Twenty-four Hour Continuous Traffic Counts

Twenty-four hour continuous traffic counts were completed for one week from September 15, 2006 to September 22, 2006. The following tables present a summary of the average daily traffic volumes.

Average Daily Traffic (ADT) – Weekday

NYS Route 96	Northbound	Southbound	Overall
South of NYS Route 251	9,800	9760	19,560
North of Main Street – Fishers	15,530	16,460	31,990
South of Turk Hill Road	11,130	12,070	23,200
South of Park Road	7890	7,010	14,900

Average Daily Traffic (ADT) – Saturday

NYS Route 96	Northbound	Southbound	Overall
South of NYS Route 251	9,790	9,880	19,670
North of Main Street – Fishers	14,400	15,060	29,460
South of Turk Hill Road	11,000	12,000	23,000
South of Park Road	5,950	6,350	12,300

Both the current and historical 24-hour count data indicated that the peak 2-hour morning commuter, evening commuter and Saturday midday periods were 7:00 to 9:00 AM, 4:00 to 6:00 PM and 11:30 AM to 1:30 PM, respectively.

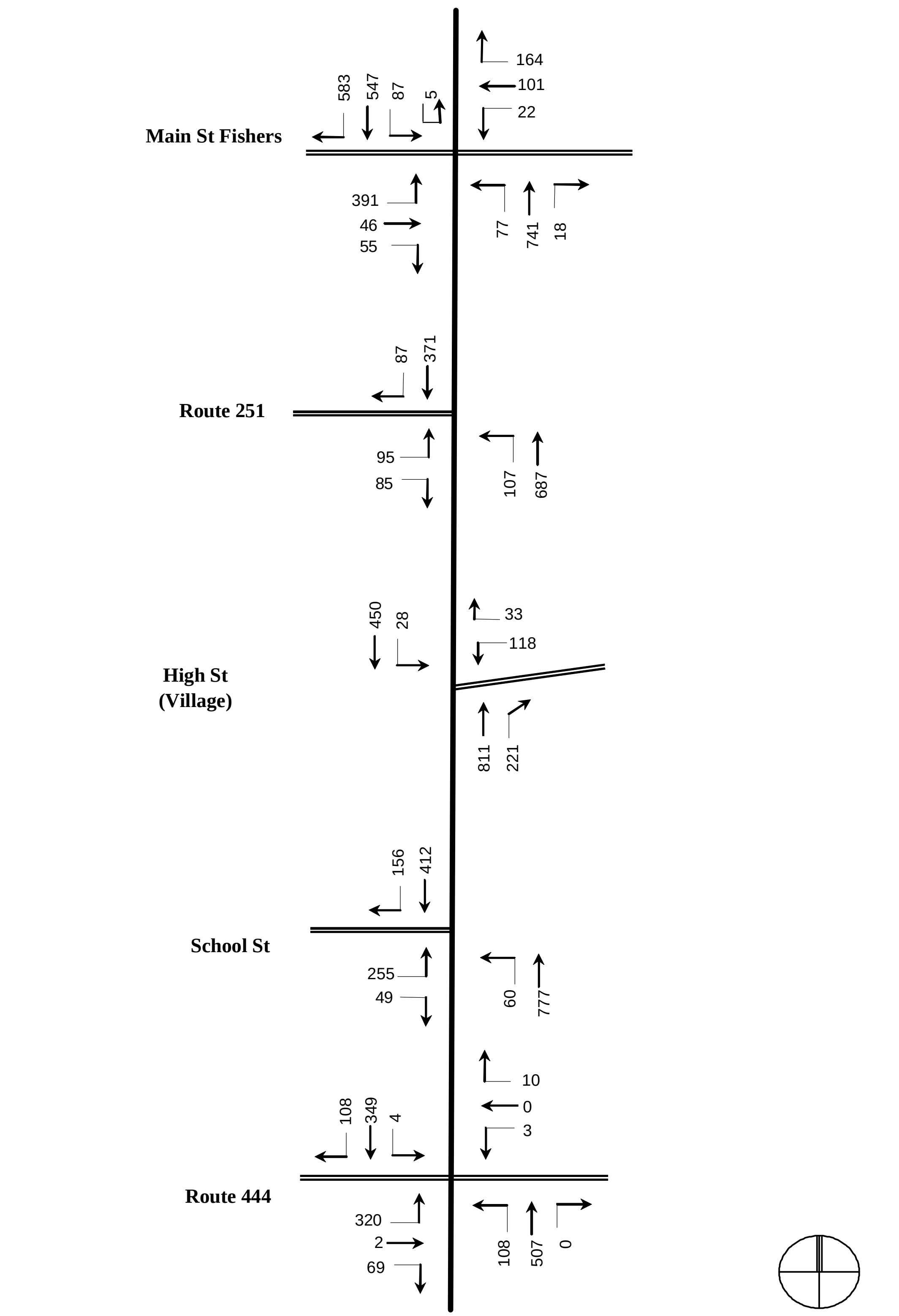
Intersection Turning Movement Counts

Based on the intersection turning movement counts the peak hours for the study network were 7:30 to 8:30 AM, 5:00 to 6:00 PM, and 12:30 to 1:30 PM for the weekday morning, evening and Saturday count periods, respectively.

The High Street intersection in the Village of Victor was counted from 2:00 to 6:00 PM so that school bus traffic could be documented. The peak hour between 2:00 to 4:00 PM for both overall traffic volume and school bus activity was 2:45 to 3:30 PM and resulted in an intersection volume of approximately 1,995 vehicles. Of that traffic volume, 69 (approximately 3.5 %) were school buses and 45 (approximately 2%) were commercial heavy vehicles.

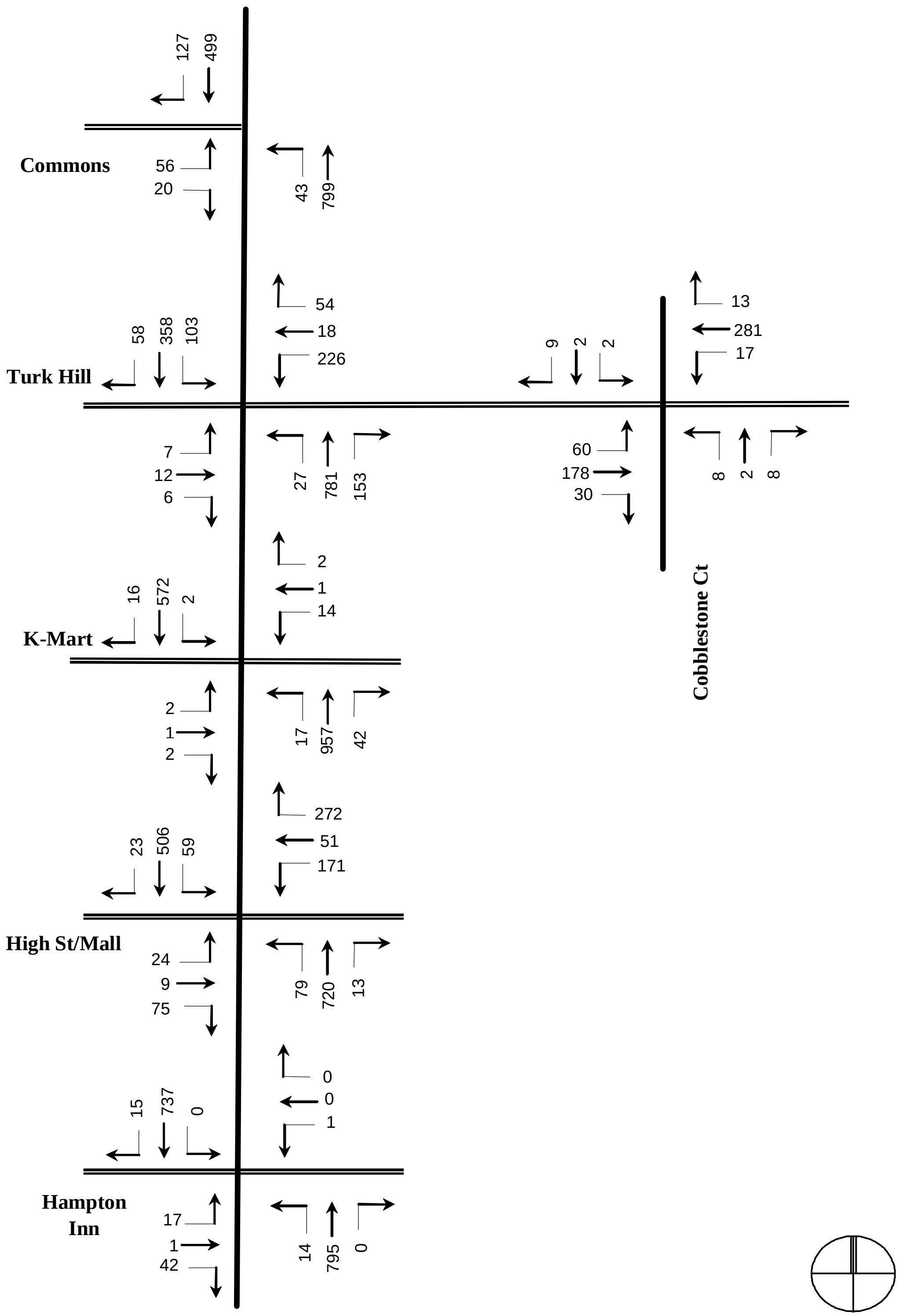
The evening commuter peak hour for the network is 5:00 to 6:00 PM and resulted in an intersection volume of approximately 2,030 vehicles for the High Street intersection. This intersection volume is 1-2% higher than the 2:45 to 3:30 PM hour. Of the total intersection volume from 5:00 to 6:00 PM, 22 (approximately 1%) were commercial heavy vehicles.

The following **Figures 1-9:** depict the morning peak hour traffic volumes **(Figures 1-3);** the evening peak hour traffic volumes **(Figures 4-6);** and, the Saturday peak hour traffic volumes **(Figures 7-9)**.



Route 96
2006 Existing Morning Traffic Volumes

Figure 1



Route 96
2006 Existing Morning Traffic Volumes

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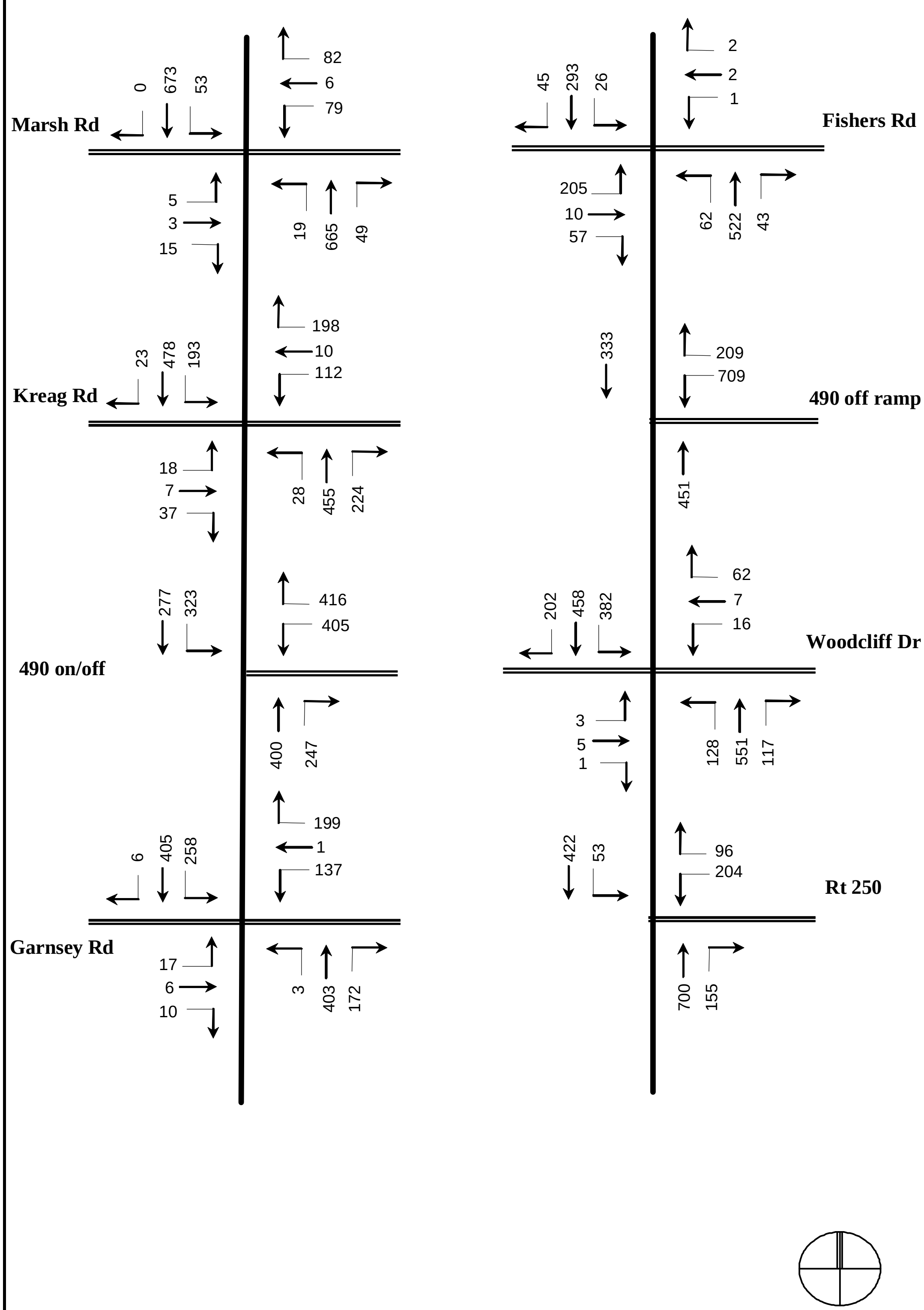
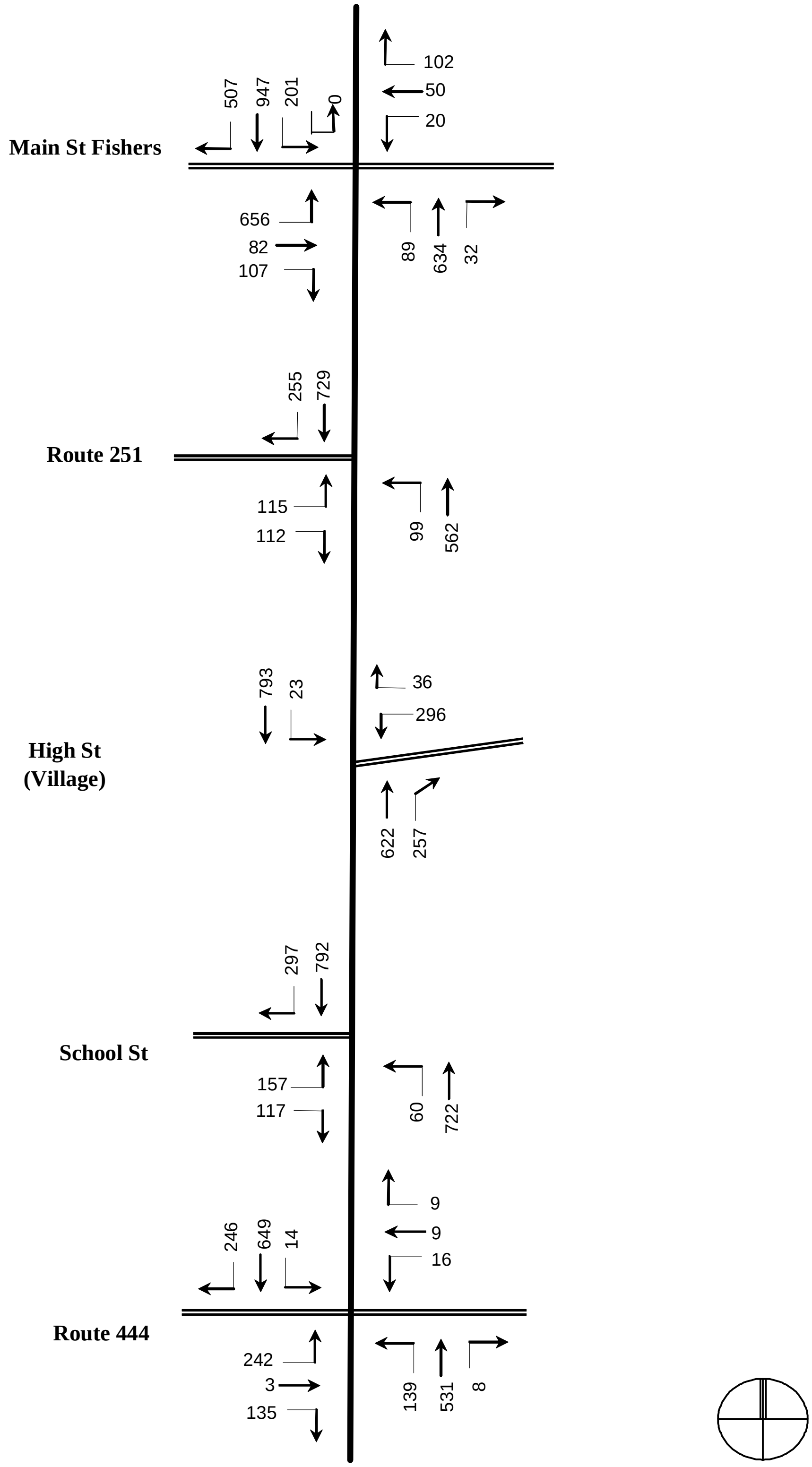
Figure 2

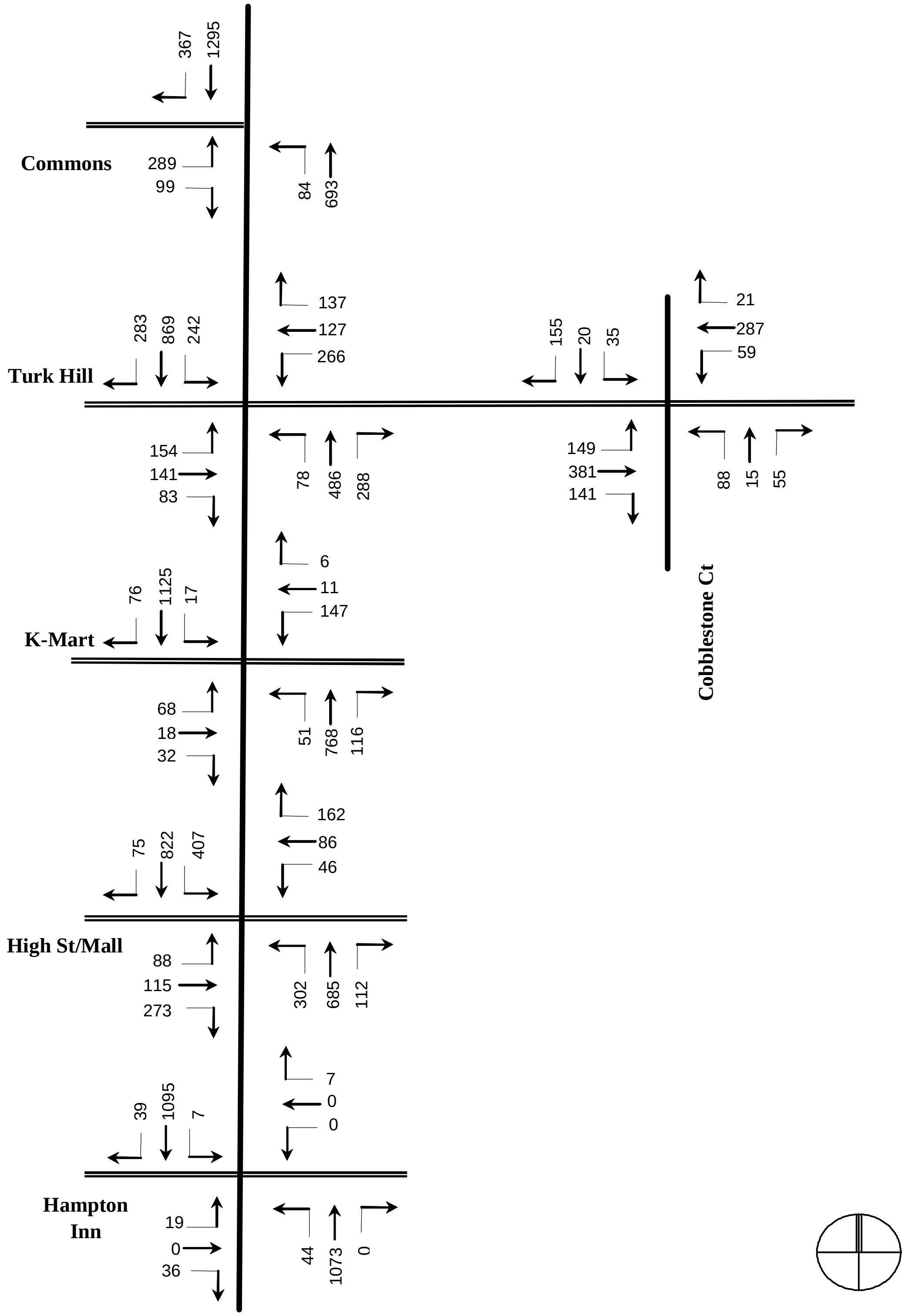


Route 96
2006 Existing Morning Traffic Volumes
Figure 3

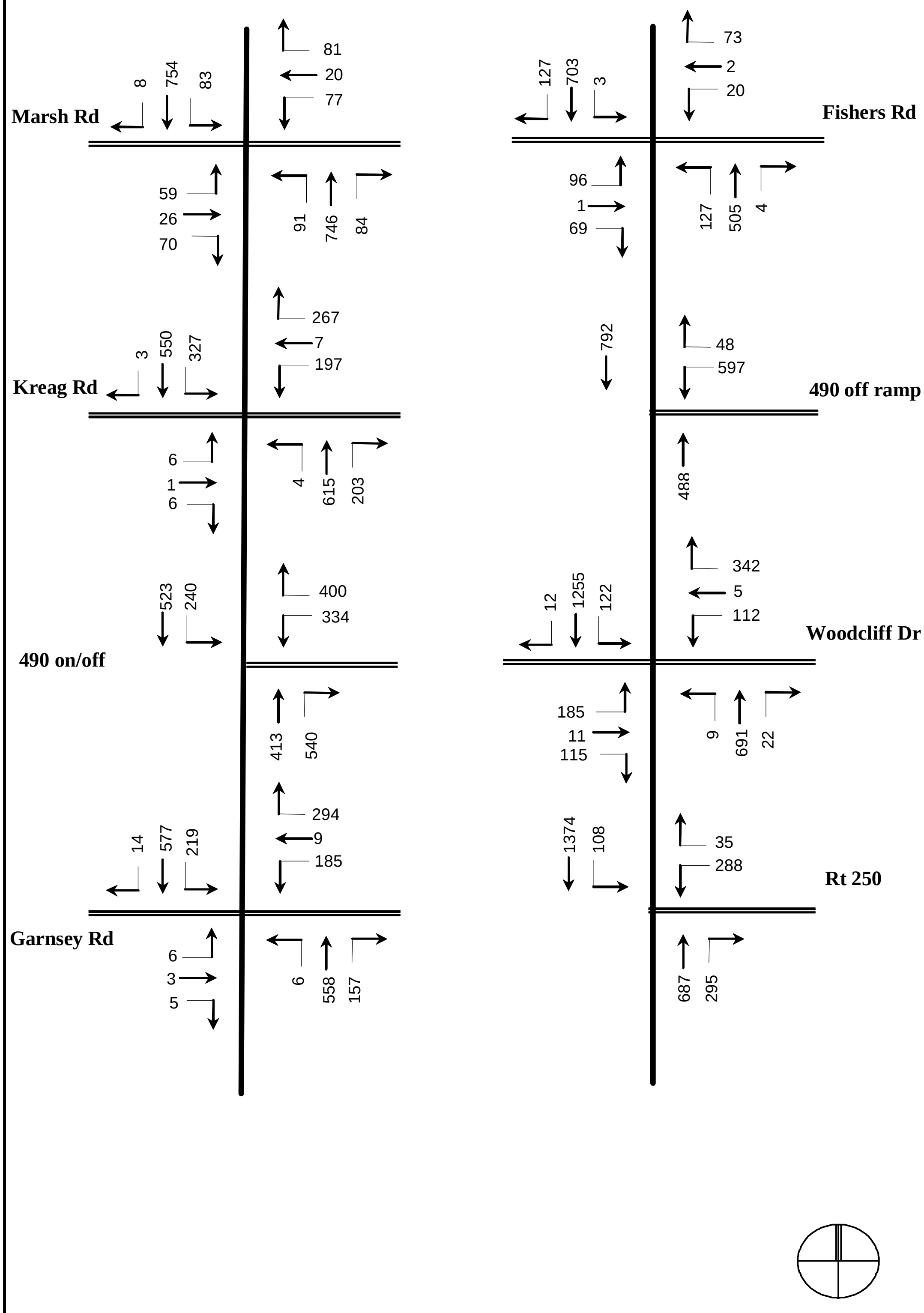


Route 96
2006 Existing Evening Traffic Volumes

Figure 4



Route 96
2006 Existing Evening Traffic Volumes
Figure 5



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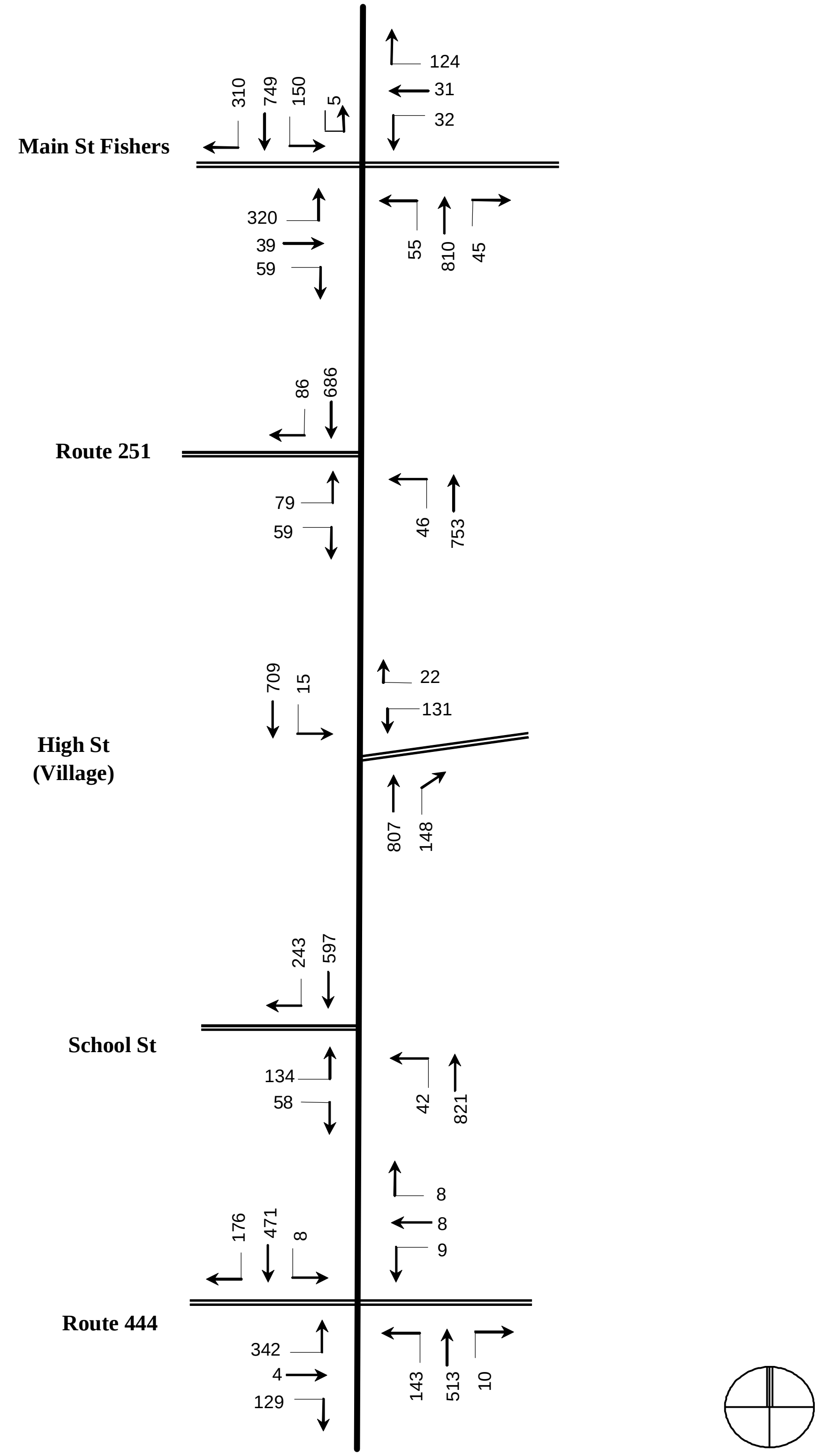
Route 96
2006 Existing Evening Traffic Volumes

Figure 6

New York State Report 96
Traffic Signal Coordination Study



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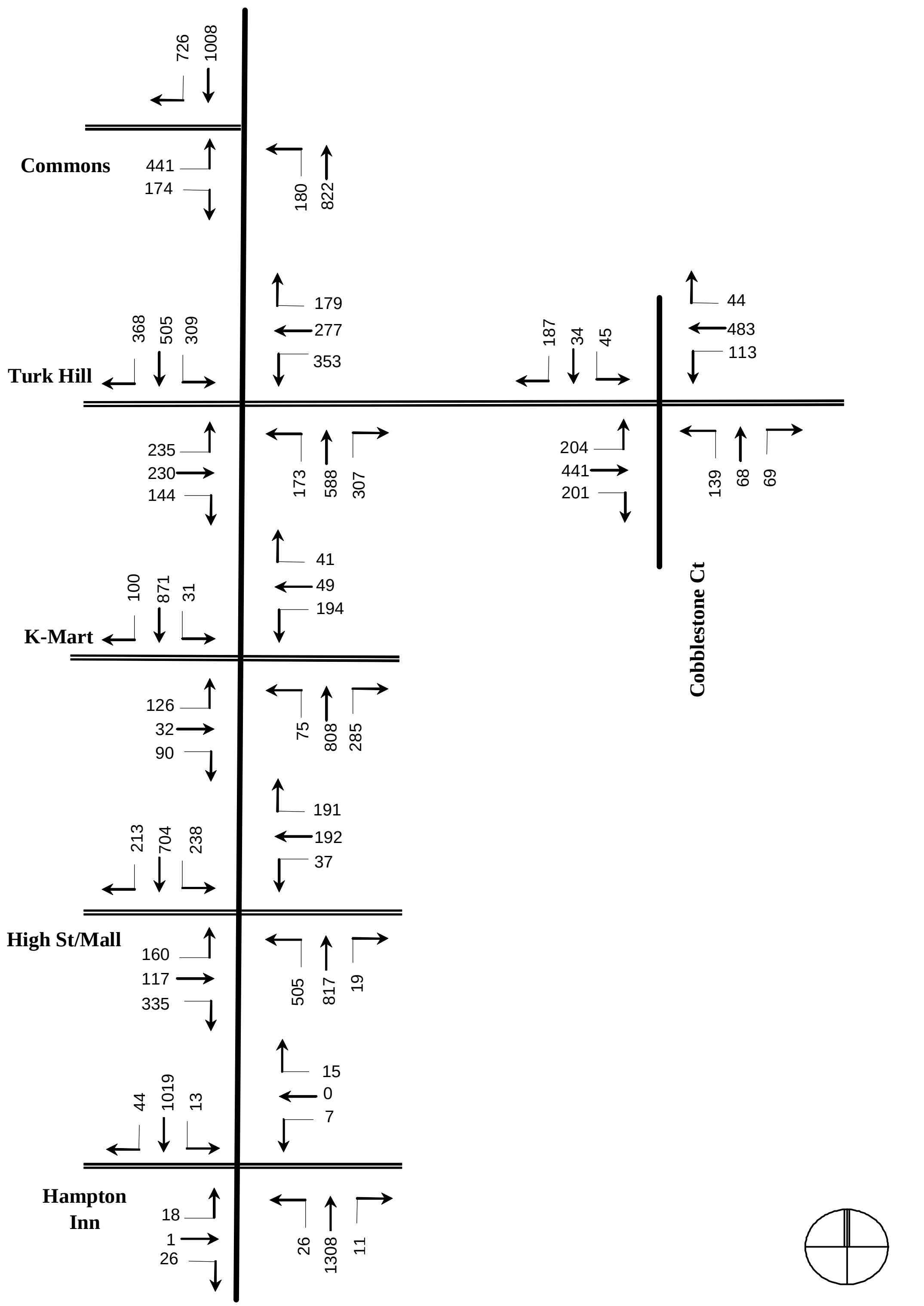
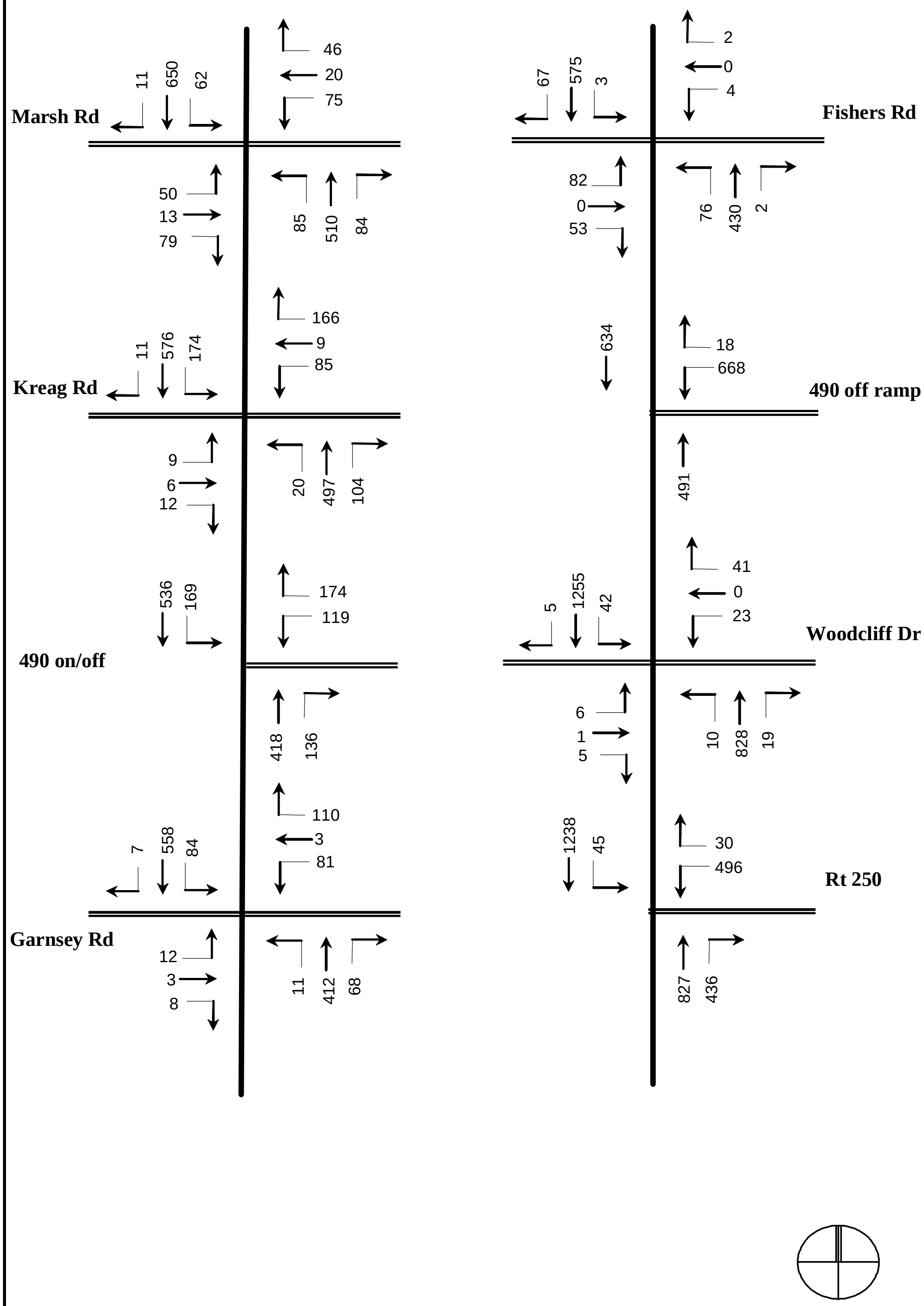
Route 96
2006 Existing Saturday Traffic Volumes

Figure 7



Route 96
2006 Existing Saturday Traffic Volumes

Figure 8



Route 96
2006 Existing Saturday Traffic Volumes
Figure 9

Travel time information for the study area was conducted during each of the three intersection turning movement count time periods. This travel time information assisted with the calibration of the capacity analysis models. The following summarizes the average travel speeds for each segment of the corridor, as well as aggregate speeds for larger corridor segments.

Average Travel Speed Comparison – Morning Northbound

Morning - Northbound	Posted Speed (mph)	Range of Travel Speeds (mph) *(see note 2)*	Average (mph)
Lynaugh Rd to Route 444	30	17-23	19.7
Route 444 to School St	30	8-9	8.2
School St to High St	30	15-16	15.5
High St to Route 251	30-50	31-36	33.6
Route 251 to Main St Fishers Rd	50	33-45	39.4
Main St Fishers Rd to Hampton Inn Entrance	50-45	44	44.0
Hampton Inn Entrance to Mall Entrance/High St	45	34-42	38.0
Mall Entrance/High St to Mall/K-Mart Entrance	45	32-34	33.3
Mall/K-Mart Entrance to Turk Hill Rd/Mall Entrance	45	10-38	24.5
Turk Hill Rd/Mall Entrance to Commons Blvd	45	35-39	37.4
Commons Blvd to Route 250	45	24-45	34.3
Route 250 to Woodcliff Dr	45	20-49	34.6
Woodcliff Dr to 490 on/off ramps	45	24-30	27.0
490 on/off ramps to Fishers Rd	45	36-39	37.7
Fishers Rd to Garnsey Rd	45	27-33	29.8
Garnsey Rd to 490 Bushnells Basin	45	22-32	27.2
490 Bushnells Basin to Kreag Rd	30	14-35	24.6
Kreag Rd to Marsh Rd	30	24-32	28.2
Marsh Rd to Thornell Rd	30	30-32	31.0

Aggregate Average Travel Speed Comparison – Morning Northbound

Morning - Northbound	Posted Speed (mph)	Range of Average Travel Speeds (mph) *(see note 2)*	Weighted Average (mph) *(see note 3)*
Lynaugh Road to High Street (Village)	30	8-20	17
High Street to Hampton Inn Entrance *(see note 1)*	50	34-44	38
Hampton Inn Entrance to Kreag Road	45	25-38	32
Kreag Road to Thornell Road	30	28-31	29

Note 1 – Posted Speed limit village limits
Note 2 – Range of travel speeds based on two or more travel runs
Note 3 – Weighted average based on segment length

Average Travel Speed Comparison – Morning Southbound

Morning - Southbound	Posted Speed (mph)	Range of Travel Speeds (mph) *(see note 2)*	Average (mph)
Thornell Rd to Marsh Rd	30	17-21	18.7
Marsh Rd to Kreag Rd	30	22-23	22.5
Kreag Rd to 490 Bushnells Basin	30	3-18	10.6
490 Bushnells Basin to Garnsey Rd	45	3-6	4.7
Garnsey Rd to Fishers Rd	45	25-34	29.5
Fishers Rd to 490 on/off ramps	45	32-39	35.3
490 on/off ramps to Woodcliff Dr	45	33-40	36.7
Woodcliff Dr to Route 250	45	39-41	40.0
Route 250 to Commons Blvd	45	40-50	44.6
Commons Blvd to Turk Hill Rd/Mall Entrance	45	22-32	27.2
Turk Hill Rd/Mall Entrance to Mall/K-Mart Entrance	45	34	34.2
Mall/K-Mart Entrance to Mall Entrance/High St	45	17	17.0
Mall Entrance/High St to Hampton Inn Entrance	45	42-44	43.0
Hampton Inn Entrance to Main St Fishers Rd	45-50	30-45	37.4
Main St Fishers Rd to Route 251	50	36-42	39.4
Route 251 to High St	50-30	36-38	37.2
High St to School St	30	7-15	11.0
School St to Route 444	30	19-25	22.1
Route 444 to Lynaugh Rd	30	29-33	31.1

Aggregate Average Travel Speed Comparison – Morning Southbound

Morning - Southbound	Posted Speed (mph)	Range of Average Travel Speeds (mph) *(see note 2)*	Weighted Average (mph) *(see note 3)*
Thornell to Kreag Road	30	19-23	20
Kreag Road to Hampton Inn Entrance	45	5-45	30
Hampton Inn Entrance to High Street *(see note 1)*	50	37-39	38
High Street (Village) to Lynaugh Road	30	11-31	27

Note 1 – Posted Speed limit village limits
Note 2 – Range of travel speeds based on two or more travel runs
Note 3 – Weighted average based on segment length

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Traffic Signal Coordination Study

Average Travel Speed Comparison – Evening Northbound

Evening - Northbound	Posted Speed (mph)	Range of Travel Speeds (mph) *(see note 2)*	Average (mph)
Lynaugh Rd to Route 444	30	30	29.8
Route 444 to School St	30	11-30	20.7
School St to High St	30	10-35	20.3
High St to Route 251	30-50	33-45	39.7
Route 251 to Main St Fishers Rd	50	33-50	41.8
Main St Fishers Rd to Hampton Inn Entrance	50-45	38-48	43.4
Hampton Inn Entrance to Mall Entrance/High St	45	18-44	30.1
Mall Entrance/High St to Mall/K-Mart Entrance	45	23-36	29.7
Mall/K-Mart Entrance to Turk Hill Rd/Mall Entrance	45	10-40	25.8
Turk Hill Rd/Mall Entrance to Commons Blvd	45	21-39	28.7
Commons Blvd to Route 250	45	14-40	30.0
Route 250 to Woodcliff Dr	45	32-49	38.4
Woodcliff Dr to 490 on/off ramps	45	25-50	35.1
490 on/off ramps to Fishers Rd	45	24-49	35.0
Fishers Rd to Garnsey Rd	45	26-47	38.0
Garnsey Rd to 490 Bushnells Basin	45	19-45	29.5
490 Bushnells Basin to Kreag Rd	30	14-34	19.8
Kreag Rd to Marsh Rd	30	10-32	24.4
Marsh Rd to Thornell Rd	30	22-36	28.7

Aggregate Average Travel Speed Comparison – Evening Northbound

Evening - Northbound	Posted Speed (mph)	Range of Average Travel Speeds (mph) *(see note 2)*	Weighted Average (mph) *(see note 3)*
Lynaugh Road to High Street (Village)	30	20-30	27
High Street to Hampton Inn Entrance *(see note 1)*	50	40-43	41
Hampton Inn Entrance to Kreag Road	45	20-38	32
Kreag Road to Thornell Road	30	24-29	26

Note 1 – Posted Speed limit village limits
Note 2 – Range of travel speeds based on two or more travel runs
Note 3 – Weighted average based on segment length

Average Travel Speed Comparison – Evening Southbound

Evening - Southbound	Posted Speed (mph)	Range of Travel Speeds (mph) *(see note 2)*	Average (mph)
Thornell Rd to Marsh Rd	30	12-28	20.6
Marsh Rd to Kreag Rd	30	26-32	29.1
Kreag Rd to 490 Bushnells Basin	30	10-39	27.4
490 Bushnells Basin to Garnsey Rd	45	31-36	33.6
Garnsey Rd to Fishers Rd	45	29-41	35.4
Fishers Rd to 490 on/off ramps	45	26-44	37.4
490 on/off ramps to Woodcliff Dr	45	19-52	35.6
Woodcliff Dr to Route 250	45	33-44	38.9
Route 250 to Commons Blvd	45	20-43	31.5
Commons Blvd to Turk Hill Rd/Mall Entrance	45	14-38	25.8
Turk Hill Rd/Mall Entrance to Mall/K-Mart Entrance	45	18-40	31.1
Mall/K-Mart Entrance to Mall Entrance/High St	45	21-38	28.0
Mall Entrance/High St to Hampton Inn Entrance	45	40-45	42.4
Hampton Inn Entrance to Main St Fishers Rd	45-50	27-46	38.6
Main St Fishers Rd to Route 251	50	30-48	36.5
Route 251 to High St	50-30	14-39	19.7
High St to School St	30	5-22	10.6
School St to Route 444	30	9-27	15.7
Route 444 to Lynaugh Rd	30	28-34	31.1

Aggregate Average Travel Speed Comparison – Evening Southbound

Evening - Southbound	Posted Speed (mph)	Range of Average Travel Speeds (mph) *(see note 2)*	Weighted Average (mph) *(see note 3)*
Thornell to Kreag Road	30	21-29	24
Kreag Road to Hampton Inn Entrance	45	26-42	33
Hampton Inn Entrance to High Street *(see note 1)*	50	22-39	31
High Street (Village) to Lynaugh Road	30	11-31	26

Note 1 – Posted Speed limit village limits
Note 2 – Range of travel speeds based on two or more travel runs
Note 3 – Weighted average based on segment length

Average Travel Speed Comparison – Saturday Northbound

Saturday - Northbound	Posted Speed (mph)	Range of Travel Speeds (mph) *(see note 2)*	Average (mph)
Lynaugh Rd to Route 444	30	19-30	26.0
Route 444 to School St	30	23-25	24.3
School St to High St	30	11-30	18.4
High St to Route 251	30-50	30-38	34.7
Route 251 to Main St Fishers Rd	50	38-39	38.4
Main St Fishers Rd to Hampton Inn Entrance	50-45	43-45	43.6
Hampton Inn Entrance to Mall Entrance/High St	45	14-44	27.4
Mall Entrance/High St to Mall/K-Mart Entrance	45	19-38	29.4
Mall/K-Mart Entrance to Turk Hill Rd/Mall Entrance	45	14-21	16.8
Turk Hill Rd/Mall Entrance to Commons Blvd	45	38-39	38.4
Commons Blvd to Route 250	45	45	45.1
Route 250 to Woodcliff Dr	45	29-50	42.3
Woodcliff Dr to 490 on/off ramps	45	18-29	23.7
490 on/off ramps to Fishers Rd	45	36-41	38.2
Fishers Rd to Garnsey Rd	45	24-41	34.8
Garnsey Rd to 490 Bushnells Basin	45	28-39	34.8
490 Bushnells Basin to Kreag Rd	30	29-34	28.8
Kreag Rd to Marsh Rd	30	30-32	30.5
Marsh Rd to Thornell Rd	30	33	33.0

Aggregate Average Travel Speed Comparison – Saturday Northbound

Saturday Midday - Northbound	Posted Speed (mph)	Range of Average Travel Speeds (mph) *(see note 2)*	Weighted Average (mph) *(see note 3)*
Lynaugh Road to High Street (Village)	30	18-26	25
High Street to Hampton Inn Entrance *(see note 1)*	50	35-44	38
Hampton Inn Entrance to Kreag Road	45	17-45	33
Kreag Road to Thornell Road	30	31-33	31

Note 1 – Posted Speed limit village limits
Note 2 – Range of travel speeds based on two or more travel runs
Note 3 – Weighted average based on segment length

Average Travel Speed Comparison – Saturday Southbound

Saturday - Southbound	Posted Speed (mph)	Range of Travel Speeds (mph) *(see note 2)*	Average (mph)
Thornell Rd to Marsh Rd	30	19-30	24.9
Marsh Rd to Kreag Rd	30	13-30	24.0
Kreag Rd to 490 Bushnells Basin	30	29-32	31.2
490 Bushnells Basin to Garnsey Rd	45	21-41	30.8
Garnsey Rd to Fishers Rd	45	37-43	39.3
Fishers Rd to 490 on/off ramps	45	20-35	26.8
490 on/off ramps to Woodcliff Dr	45	35-39	37.7
Woodcliff Dr to Route 250	45	27-35	29.8
Route 250 to Commons Blvd	45	20-27	22.9
Commons Blvd to Turk Hill Rd/Mall Entrance	45	12-33	25.8
Turk Hill Rd/Mall Entrance to Mall/K-Mart Entrance	45	20-42	28.0
Mall/K-Mart Entrance to Mall Entrance/High St	45	8-27	14.5
Mall Entrance/High St to Hampton Inn Entrance	45	36-41	38.8
Hampton Inn Entrance to Main St Fishers Rd	45-50	21-30	26.0
Main St Fishers Rd to Route 251	50	32-44	37.5
Route 251 to High St	50-30	36-38	37.0
High St to School St	30	11-27	16.8
School St to Route 444	30	4-30	13.3
Route 444 to Lynaugh Rd	30	28-32	29.6

Aggregate Average Travel Speed Comparison – Saturday Southbound

Saturday Midday - Southbound	Posted Speed (mph)	Range of Average Travel Speeds (mph) *(see note 2)*	Weighted Average (mph) *(see note 3)*
Thornell to Kreag Road	30	24-25	25
Kreag Road to Hampton Inn Entrance	45	15-39	30
Hampton Inn Entrance to High Street *(see note 1)*	50	26-38	34
High Street (Village) to Lynaugh Road	30	13-30	25

Note 1 – Posted Speed limit village limits
Note 2 – Range of travel speeds based on two or more travel runs
Note 3 – Weighted average based on segment length

In general, the slowest travel speeds were experienced in the vicinity of the Village of Victor or Bushnell's Basin and the highest travel speeds were experienced in the vicinity of the Route 251 to the Hampton Inn Entrance. The travel time data for each time period is attached.

- **General Observations**

  The following field operations were observed:

  - During the evening study period, traffic queued along NYS Route 96 northbound from Marsh Road past Kreag Road. Moderate levels of traffic queuing were observed on the eastbound approach for the left turn movement at the Woodcliff Drive intersection, and at the Main Street – Fishers intersection.

  - Due to construction in the vicinity of Garnsey Road and the I-490 interchange traffic traveled at an uncommonly slow rate and motorists would wait up to three traffic signal cycles before being able to proceed.

  - Congestion in the vicinity of Eastview Mall from Turk Hill Road to High Street was significant during the Saturday study period. Traffic signal phase failures were noted for the side street approaches and for the left turn movements on NYS Route 96. It was also noted that the westbound approach to the High Street intersection experienced congestion and occasionally traffic signal phase failures during the morning study period.

  - At times, the Village of Victor experienced very little congestion while at other times, congestion and queuing was significant. There did not appear to be a consistent average queue length or average congestion level. Traffic flowed well through the corridor or was stop and go with several cycle failures on Route 96. The extreme swing or variation in travel conditions is not uncommon, and it has existed for many years. The significant queuing is attributable to many factors including large truck traffic and turning maneuvers at School and Maple Streets; pedestrian activations at High and others; and drifting signal operations. **Once a breakdown in the existing coordination occurs, it takes an inordinate time for the system to recover**.

  - Sidewalks are located on both sides of NYS Route 96 within the Village of Victor, and located on the eastside of NYS Route 96 between Garnsey Road and I-490 as well as in the vicinity of Kreag Road and Marsh Road intersections. The remaining portions of the roadway contained paved shoulders that are 6-8' wide.

- There was minimal pedestrian crossing activity observed throughout the study area during all three study periods.

- **<u>Intersection Capacity Analysis Methodology</u>**

Intersection analysis was conducted using Synchro software. The program is based on methods presented in the 2000 Highway Capacity Manual published by the Transportation Research Board that describes the operation of intersections controlled by traffic signals and regulated by stop signs. Using this analytical approach, a Level of Service is provided to traffic traveling through an intersection.

The Level of Service at traffic signal-controlled as well as stop-controlled intersections is defined or quantified in terms of delay (in seconds) per vehicle for the peak 15-minute analysis period. Within this assessment all of the intersections are controlled by traffic signals. The Level of Service groups for a traffic signal-controlled intersection range from ‘A’ to ‘F’. An overall intersection Level of Service below ‘D’ for a traffic signal-controlled intersection indicates that during the peak 15 minute travel period at the intersection, the average delay per vehicle will exceed 55 seconds. This is generally considered the threshold of acceptable levels of operations in an urban area.

- **<u>Existing Conditions Intersection Capacity Analysis</u>**

The capacity analysis models for all three study periods confirm field observations. For the morning study period the network, overall, is experiencing acceptable or better levels of operations. However, as noted and modeled in the capacity analysis, there is a notable levels of congestion being experienced in the Village of Victor.

For the evening period, the Woodcliff Drive, Main Street-Fishers and School Street intersections had movements experiencing level of service of ‘E’ or ‘F’. In addition, the evening model was calibrated to represent congested conditions in the Village of Victor.

For the Saturday study period the intersection of Turk Hill Road and High Street intersections had movements experiencing levels of service of ‘E’.

A summary of the level of service for all three time periods is attached along with the printouts of the capacity analysis.

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Existing Conditions Level of Service

	Intersection	Approach and Movement		Morning Peak Hour Delay	Morning Peak Hour LOS	Evening Peak Hour Delay	Evening Peak Hour LOS	Saturday Peak Hour Delay	Saturday Peak Hour LOS
1	Marsh Road & Route 96	Eastbound	LT	33	C	34	C	31	C
			R	10	B	13	B	5	A
		Westbound	L	43	D	43	D	33	C
			TR	11	B	20	C	13	B
		Northbound	L	3	A	28	C	6	A
			TR	7	A	22	C	12	B
		Southbound	L	5	A	36	D	5	A
			TR	9	A	27	C	13	B
			Overall	**10**	**B**	**25**	**C**	**13**	**B**
2	Kreag Road & Route 96	Eastbound	LTR	19	B	29	C	22	C
		Westbound	L	50	D	102	F	41	D
			TR	11	B	69	E	12	B
		Northbound	L	7	A	31	C	8	A
			T	9	A	26	C	11	B
			R	2	A	5	A	2	A
		Southbound	L	12	B	42	D	5	A
			TR	6	A	11	B	5	A
			Overall	**11**	**B**	**35**	**D**	**10**	**B**
3	I-490 Access (Bushnell's Basin) & Route 96	Westbound	LR	27	C	22	C	17	B
		Northbound	TR	8	A	24	C	3	A
		Southbound	LT	14	B	40	D	4	A
			Overall	**18**	**B**	**29**	**C**	**6**	**A**
4	Garnsey Road & Route 96	Eastbound	LTR	22	C	17	B	13	B
		Westbound	LT	43	D	40	D	19	B
			R	3	A	10	B	2	A
		Northbound	L	7	A	8	A	7	A
			TR	19	B	18	B	11	B
		Southbound	L	5	A	8	A	6	A
			TR	4	A	8	A	8	A
			Overall	**13**	**B**	**15**	**B**	**9**	**A**
5	Fishers Road & Route 96	Eastbound	LTR	38	D	39	D	11	B
		Westbound	LTR	13	B	14	B	9	A
		Northbound	L	23	C	16	B	8	A
			TR	22	C	4	A	5	A
		Southbound	L	10	B	4	A	5	A
			TR	8	A	4	A	6	A
			Overall	**21**	**C**	**9**	**A**	**6**	**A**
6	I-490 offramp & Route 96	Westbound	L	32	C	41	D	23	C
			R	0	A	0	A	0	A
		Northbound	T	3	A	3	A	7	A
		Southbound	T	7	A	6	A	8	A
			Overall	**16**	**B**	**16**	**B**	**13**	**B**
7	Woodcliff Drive & Route 96	Eastbound	L	35	D	35	D	25	C
			TR	32	C	19	B	15	B
		Westbound	L	37	D	36	D	26	C
			TR	14	B	18	B	0	A
		Northbound	L	9	A	29	C	5	A
			T	13	B	26	C	7	A
			R	3	A	13	B	4	A
		Southbound	L	21	C	22	C	4	A
			TR	3	A	27	C	6	A
			Overall	**11**	**B**	**26**	**C**	**7**	**A**
8	Route 250 (Moseley Road) & Route 96	Westbound	LR	21	C	40	D	40	D
		Northbound	T	9	A	8	A	9	A
			R	2	A	2	A	2	A
		Southbound	L	5	A	4	A	5	A
			T	4	A	3	A	7	A
			Overall	**10**	**B**	**9**	**A**	**13**	**B**
9	Commons Boulevard & Route 96	Eastbound	LR	32	C	37	D	26	C
		Northbound	L	1	A	4	A	31	C
			T	1	A	1	A	8	A
		Southbound	T	5	A	16	B	19	B
			R	0	A	0	A	1	A
			Overall	**4**	**A**	**13**	**B**	**14**	**B**
10	Turk Hill Road/Mall Entrance & Route 96	Eastbound	L	39	D	45	D	49	D
			LT	40	D	45	D	56	E
			R	22	C	9	A	12	B
		Westbound	L	42	D	41	D	35	D
			T	34	C	42	D	61	E
			R	7	A	4	A	8	A
		Northbound	L	6	A	43	D	63	E
			T	7	A	29	C	35	D
			R	1	A	8	A	14	B
		Southbound	L	16	B	28	C	51	D
			T	6	A	28	C	20	C
			R	0	A	0	A	10	B
			Overall	**12**	**B**	**26**	**C**	**34**	**C**

Note: Shaded cells represent Levels of Service calculated in SimTraffic to achieve more accurate results

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11	Cobblestone Court & Turk Hill Road	Eastbound	L	4	A	6	A	8	A
			T	4	A	12	B	18	B
			R	3	A	3	A	3	A
		Westbound	L	3	A	6	A	7	A
			TR	3	A	12	B	14	B
		Northbound	L	11	B	28	C	50	D
			TR	8	A	9	A	15	B
		Southbound	L	11	B	18	B	20	C
			TR	8	A	7	A	7	A
			Overall	**4**	**A**	**11**	**B**	**15**	**B**
12	Mall Entrance/K-Mart & Route 96	Eastbound	L	27	C	31	C	20	C
			T	27	C	27	C	17	C
			R	17	B	10	B	6	A
		Westbound	LTR	25	C	35	D	21	C
		Northbound	L	4	A	29	C	21	C
			T	6	A	8	A	11	B
			R	1	A	3	A	2	A
		Southbound	L	2	A	8	A	9	A
			TR	3	A	19	B	12	B
			Overall	**5**	**A**	**16**	**B**	**12**	**B**
13	Mall Entrance/High Street & Route 96	Eastbound	L	29	C	51	D	*98*	*F*
			T	24	C	39	D	*53*	*D*
			R	4	A	15	B	*12*	*B*
		Westbound	LT	46	D	44	D	*62*	*E*
			R	21	C	9	A	*42*	*D*
		Northbound	L	44	D	37	D	*143*	*F*
			T	14	B	33	C	*38*	*D*
			R	5	A	13	B	*9*	*A*
		Southbound	L	42	D	48	D	*59*	*E*
			TR	16	B	12	B	*75*	*E*
			Overall	**21**	**C**	**27**	**C**	***67***	***E***
14	Hampton Inn Entrance & Route 96	Eastbound	L	42	D	43	D	27	C
			TR	16	B	1	A	13	B
		Westbound	L	37	D	0	A	26	C
			TR	2	A	0	A	0	A
		Northbound	L	2	A	3	A	3	A
			TR	2	A	4	A	5	A
		Southbound	L	0	A	2	A	4	A
			TR	3	A	4	A	5	A
			Overall	**3**	**A**	**4**	**A**	**5**	**A**
15	Main Street Fishers/Rowley Road & Route 96	Eastbound	L	42	D	54	D	38	D
			LT	45	D	55	E	40	D
			R	9	A	6	A	9	A
		Westbound	L	31	C	46	D	33	C
			TR	49	D	44	D	16	B
		Northbound	L	18	B	35	D	13	B
			TR	28	C	38	D	19	B
		Southbound	L	22	C	44	D	18	B
			T	24	C	36	D	15	B
			R	4	A	1	A	1	A
			Overall	**26**	**C**	**36**	**D**	**18**	**B**
16	Route 251 (Victor Mendon Road) & Route 96	Eastbound	L	20	C	20	C	19	B
			R	7	A	6	A	7	A
		Northbound	L	6	A	19	B	7	A
			T	11	B	10	B	10	B
		Southbound	T	6	A	16	B	9	A
			R	0	A	0	A	0	A
			Overall	**9**	**A**	**12**	**B**	**9**	**A**
17	High Street (Village) & Route 96	Westbound	LR	*50*	*D*	*57*	*E*	*25*	*C*
		Northbound	T	*19*	*B*	*21*	*C*	*21*	*C*
			R	*15*	*B*	*12*	*B*	*12*	*B*
		Southbound	L	*63*	*E*	*323*	*F*	*64*	*E*
			T	*16*	*B*	*291*	*F*	*32*	*C*
			Overall	***22***	***C***	***136***	***F***	***25***	***C***
18	School Street & Route 96	Eastbound	L	*116*	*F*	*54*	*D*	*29*	*C*
			R	*71*	*E*	*34*	*C*	*7*	*A*
		Northbound	L	*48*	*D*	*39*	*D*	*13*	*B*
			T	*53*	*D*	*10*	*B*	*11*	*B*
		Southbound	T	*22*	*C*	*27*	*C*	*6*	*A*
			R	*7*	*A*	*14*	*B*	*4*	*A*
			Overall	***53***	***D***	***23***	***C***	***10***	***B***
19	Route 444/Maple Avenue & Route 96	Eastbound	L	*39*	*D*	*55*	*E*	*39*	*D*
			TR	*9*	*A*	*25*	*C*	*11*	*B*
		Westbound	LTR	*23*	*C*	*47*	*D*	*28*	*C*
		Northbound	L	*36*	*D*	*49*	*D*	*24*	*C*
			TR	*45*	*D*	*22*	*C*	*20*	*C*
		Southbound	L	*15*	*B*	*23*	*C*	*12*	*B*
			T	*14*	*B*	*36*	*D*	*19*	*B*
			R	*4*	*A*	*13*	*B*	*4*	*A*
			Overall	***30***	***C***	***32***	***C***	***22***	***C***

Note: Shaded cells represent Levels of Service calculated in SimTraffic to achieve more accurate results

B. Proposed Traffic Signal Timings and Operations

- **Signal System Improvements**

To conduct this assessment the morning, afternoon, and Saturday study periods were iteratively reviewed both in SYNCHRO and SimTraffic with respect to coordination, traffic signal timing, phasing, cycle length, and offset changes. Various timing and phasing patterns were analyzed throughout the study and the recommended timing and phasing patterns are presented in the report.

Coordinated signals are synched with adjacent traffic signals via off-sets while uncoordinated signals adapt feely to the traffic demand. The off-set is the time difference between set points within a traffic signal cycle, such as the beginning of a green light phase, at two or more intersections.

Traffic signal timing changes adjust the amount of time each direction of traffic has a green light. Phasing changes may add or remove exclusive left- or right-turn phases or the order in which the traffic signal phases operate. Cycle length changes determine the length of time a traffic signal use to serve all directions of traffic.

The following tables present the existing and proposed signal system operations improvements as well as a level of service for proposed traffic operations. The resulting timing and coordination scheme is one of many potential schemes that may improve operations within the corridor. It is acknowledged that the study corridor is very dynamic (time of day, day of week, seasonal, etc) and serves a wide range of traffic types making it difficult to identify on particular timing and/or coordination scheme that will work for a majority of the time. As a result it is anticipated that this corridor would benefit from being monitored on a regular basis and adjusted to facilitate traffic conditions.

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Proposed Conditions Level of Service

	Intersection	Approach and Movement		Morning Peak Hour		Evening Peak Hour		Saturday Peak Hour	
				Delay	LOS	Delay	LOS	Delay	LOS
1	Marsh Road & Route 96	Eastbound	LT	33	C	*43*	*D*	38	D
			R	10	B	*11*	*B*	6	A
		Westbound	L	43	D	*46*	*D*	41	D
			TR	11	B	*18*	*B*	16	B
		Northbound	L	3	A	*16*	*B*	6	A
			TR	7	A	*12*	*B*	6	A
		Southbound	L	5	A	*22*	*C*	5	A
			TR	9	A	*15*	*B*	12	B
			Overall	**10**	**B**	***16***	***B***	**12**	**B**
2	Kreag Road & Route 96	Eastbound	LTR	19	B	*21*	*C*	25	C
		Westbound	L	50	D	*48*	*D*	47	D
			TR	11	B	*18*	*B*	13	B
		Northbound	L	7	A	*29*	*C*	3	A
			T	9	A	*23*	*C*	6	A
			R	2	A	*6*	*A*	1	A
		Southbound	L	12	B	*26*	*C*	4	A
			TR	6	A	*8*	*A*	3	A
			Overall	**11**	**B**	***20***	***C***	**8**	**A**
3	I-490 Access (Bushnell's Basin) & Route 96	Westbound	LR	27	C	*22*	*B*	20	C
		Northbound	TR	8	A	*23*	*C*	13	B
		Southbound	LT	14	B	*22*	*C*	4	A
			Overall	**18**	**B**	***23***	***C***	**10**	**B**
4	Garnsey Road & Route 96	Eastbound	LTR	14	B	15	B	13	B
		Westbound	LT	23	C	28	C	19	B
			R	2	A	6	A	2	A
		Northbound	L	8	A	9	A	7	A
			TR	15	B	21	C	11	B
		Southbound	L	8	A	10	A	6	A
			TR	8	A	10	A	8	A
			Overall	**11**	**B**	**15**	**B**	**9**	**A**
5	Fishers Road & Route 96	Eastbound	LTR	16	B	20	C	11	B
		Westbound	LTR	6	A	9	B	9	A
		Northbound	L	12	B	15	B	8	A
			TR	11	B	5	A	5	A
		Southbound	L	12	B	5	A	5	A
			TR	10	B	6	A	6	A
			Overall	**12**	**B**	**8**	**A**	**6**	**A**
6	I-490 offramp & Route 96	Westbound	L	22	C	21	C	23	C
			R	0	A	0	A	0	A
		Northbound	T	9	A	7	A	7	A
		Southbound	T	9	A	8	A	8	A
			Overall	**13**	**B**	**11**	**B**	**13**	**B**
7	Woodcliff Drive & Route 96	Eastbound	L	27	C	*31*	*C*	25	C
			TR	25	C	*11*	*B*	15	B
		Westbound	L	28	C	*28*	*C*	26	C
			TR	11	B	*8*	*A*	0	A
		Northbound	L	7	A	*20*	*C*	5	A
			T	12	B	*18*	*B*	7	A
			R	3	A	*8*	*A*	4	A
		Southbound	L	10	B	*20*	*C*	4	A
			TR	8	A	*18*	*B*	6	A
			Overall	**10**	**B**	***18***	***B***	**7**	**A**
8	Route 250 (Moseley Road) & Route 96	Westbound	LR	21	C	30	C	40	D
		Northbound	T	9	A	10	B	9	A
			R	2	A	2	A	2	A
		Southbound	L	5	A	6	A	5	A
			T	4	A	7	A	7	A
			Overall	**10**	**B**	**10**	**B**	**13**	**B**
9	Commons Boulevard & Route 96	Eastbound	LR	15	B	37	D	36	D
		Northbound	L	4	A	3	A	21	C
			T	4	A	2	A	18	B
		Southbound	T	7	A	11	B	22	C
			R	0	A	0	A	1	A
			Overall	**6**	**A**	**11**	**B**	**19**	**B**
10	Turk Hill Road/Mall Entrance & Route 96	Eastbound	L	29	C	45	D	*38*	*D*
			LT	29	C	45	D	*44*	*D*
			R	17	B	9	A	*6*	*A*
		Westbound	L	26	C	41	D	*34*	*C*
			T	24	C	42	D	*44*	*D*
			R	5	A	4	A	*7*	*A*
		Northbound	L	9	A	13	B	*39*	*D*
			T	19	B	24	C	*35*	*D*
			R	1	A	8	A	*15*	*B*
		Southbound	L	10	B	10	B	*71*	*E*
			T	10	B	19	B	*36*	*D*
			R	0	A	0	A	*10*	*B*
			Overall	**15**	**B**	**21**	**C**	***33***	***C***

Note: Shaded cells represent Levels of Service calculated in SimTraffic to achieve more accurate results

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11	Cobblestone Court & Turk Hill Road	Eastbound	L	4	A	6	A	8	A
			T	4	A	12	B	18	B
			R	3	A	3	A	3	A
		Westbound	L	3	A	6	A	7	A
			TR	3	A	12	B	14	B
		Northbound	L	11	B	28	C	50	D
			TR	8	A	9	A	15	B
		Southbound	L	11	B	18	B	20	C
			TR	8	A	7	A	7	A
			Overall	**4**	**A**	**11**	**B**	**15**	**B**
12	Mall Entrance/K-Mart & Route 96	Eastbound	L	12	B	15	B	16	B
			T	11	B	12	B	15	B
			R	8	A	7	A	4	A
		Westbound	LTR	11	B	18	B	17	B
		Northbound	L	4	A	14	B	21	C
			T	7	B	9	A	16	B
			R	2	A	3	A	2	A
		Southbound	L	4	A	10	B	18	B
			TR	5	A	13	B	30	C
			Overall	**6**	**A**	**11**	**B**	**20**	**C**
13	Mall Entrance/High Street & Route 96	Eastbound	L	19	B	51	D	136	F
			T	17	B	39	D	70	E
			R	3	A	20	C	11	B
		Westbound	LT	27	C	43	D	79	E
			R	12	B	12	B	56	E
		Northbound	L	8	A	31	C	70	E
			T	18	B	22	C	28	C
			R	7	A	5	A	9	A
		Southbound	L	8	A	32	C	37	D
			TR	14	B	13	B	62	E
			Overall	**16**	**B**	**23**	**C**	**53**	**D**
14	Hampton Inn Entrance & Route 96	Eastbound	L	22	C	32	C	27	C
			TR	10	B	1	A	13	B
		Westbound	L	20	C	0	A	26	C
			TR	0	A	0	A	0	A
		Northbound	L	4	A	3	A	3	A
			TR	3	A	4	A	5	A
		Southbound	L	0	A	3	A	4	A
			TR	4	A	7	A	5	A
			Overall	**4**	**A**	**5**	**A**	**5**	**A**
15	Main Street Fishers/Rowley Road & Route 96	Eastbound	L	42	D	53	D	38	D
			LT	45	D	54	D	40	D
			R	9	A	6	A	9	A
		Westbound	L	31	C	46	D	33	C
			TR	49	D	44	D	16	B
		Northbound	L	18	B	35	D	13	B
			TR	28	C	38	D	19	B
		Southbound	L	22	C	44	D	18	B
			T	24	C	36	D	15	B
			R	4	A	1	A	1	A
			Overall	**26**	**C**	**36**	**D**	**18**	**B**
16	Route 251 (Victor Mendon Road) & Route 96	Eastbound	L	20	C	20	C	19	B
			R	7	A	6	A	7	A
		Northbound	L	6	A	19	B	7	A
			T	11	B	10	B	10	B
		Southbound	T	6	A	16	B	9	A
			R	0	A	0	A	0	A
			Overall	**9**	**A**	**12**	**B**	**9**	**A**
17	High Street (Village) & Route 96	Westbound	LR	49	D	42	D	35	D
		Northbound	T	19	B	12	B	8	A
			R	14	B	6	A	5	A
		Southbound	L	56	E	50	D	33	C
			T	15	B	33	C	18	B
			Overall	**20**	**C**	**25**	**C**	**14**	**B**
18	School Street & Route 96	Eastbound	L	104	F	42	D	39	D
			R	54	D	13	B	8	A
		Northbound	L	44	D	17	B	12	B
			T	45	D	8	B	8	A
		Southbound	T	22	C	10	B	8	A
			R	6	A	6	A	5	A
			Overall	**47**	**D**	**11**	**B**	**10**	**B**
19	Route 444/Maple Avenue & Route 96	Eastbound	L	38	D	36	D	36	D
			TR	11	B	14	B	11	B
		Westbound	LTR	29	C	34	C	34	C
		Northbound	L	38	D	35	D	28	C
			TR	48	D	22	C	21	C
		Southbound	L	17	B	17	B	16	B
			T	15	B	22	C	17	B
			R	4	A	8	A	4	A
			Overall	**32**	**C**	**22**	**C**	**21**	**C**

Note: Shaded cells represent Levels of Service calculated in SimTraffic to achieve more accurate results

Existing Timing Plan

	Intersection	Controller Operations			Signal Timing Adjustment			Phasing Added			Cycle Length			Offsets		
		AM	PM	SAT	AM	PM	SAT	AM	PM	SAT	AM	PM	SAT	AM	PM	SAT
1	Marsh Road & Route 96	C	C	U							90	90	90	10	70	-
2	Kreag Road & Route 96	C	C	U							90	90	90	87	15	-
3	I-490 Access (Bushnell's Basin) & Route 96	C	C	U							90	90	85	65	20	-
4	Garnsey Road & Route 96	C	C	U							90	90	90	25	75	-
5	Fishers Road & Route 96	C	C	U							90	90	90	40	15	-
6	I-490 offramp & Route 96	C	C	U							90	90	60	55	45	-
7	Woodcliff Drive & Route 96	C	C	U							90	90	90	25	75	-
8	Route 250 (Moseley Road) & Route 96	U	C	U							90	90	90	-	15	-
9	Commons Boulevard & Route 96	C	C	U							90	90	90	60	7	-
10	Turk Hill Road/Mall Entrance & Route 96	C	C	U							90	90	90	40	60	-
11	Cobblestone Court & Turk Hill Road	U	U	U							90	90	90	-	-	-
12	Mall Entrance/K-Mart & Route 96	C	U	U							90	90	90	15	85	-
13	Mall Entrance/High Street & Route 96	C	C	U							90	90	90	0	10	-
14	Hampton Inn Entrance & Route 96	C	C	U							90	90	90	60	40	-
15	Main Street Fishers/Rowley Road & Route 96	U	U	U							95	120	95	-	-	-
16	Route 251 (Victor Mendon Road) & Route 96	U	U	U							85	85	85	-	-	-
17	High Street (Village) & Route 96	C	C	C							90	120	60	16	0	20
18	School Street & Route 96													75	8	55
19	Route 444/Maple Avenue & Route 96													0	16	52

Note: Shaded areas to be filled in on the Proposed Timing Plan table on the following page.

Controller Operations: “C” – Coordinated; “U” – Uncoordinated

Proposed Timing Plan

	Intersection	Controller Operations			Signal Timing Adjustment			Phasing Added			Cycle Length			Offsets		
		AM	PM	SAT	AM	PM	SAT	AM	PM	SAT	AM	PM	SAT	AM	PM	SAT
1	Marsh Road & Route 96	C	C	**C**	NO	**YES**	NO	NO	NO	NO	90	90	90	10	**65**	**15**
2	Kreag Road & Route 96	C	C	**C**	NO	**YES**	NO	NO	NO	NO	90	90	90	87	**71**	**20**
3	I-490 Access (Bushnell's Basin) & Route 96	C	C	**C**	NO	NO	**YES**	NO	NO	NO	90	90	**90**	65	**28**	**0**
4	Garnsey Road & Route 96	**U**	**U**	U	NO	NO	NO	NO	NO	NO	90	90	90	-	-	-
5	Fishers Road & Route 96	**U**	**U**	U	NO	**YES**	NO	NO	NO	NO	90	90	90	-	-	-
6	I-490 offramp & Route 96	**U**	**U**	U	NO	**YES**	NO	NO	NO	NO	90	90	60	-	-	-
7	Woodcliff Drive & Route 96	**U**	**U**	U	NO	**YES**	NO	NO	NO	NO	90	90	90	-	-	-
8	Route 250 (Moseley Road) & Route 96	U	**U**	U	NO	**YES**	NO	NO	NO	NO	90	90	90	-	-	-
9	Commons Boulevard & Route 96	**U**	C	**C**	NO	NO	NO	NO	NO	NO	90	90	90	-	**45**	**12**
10	Turk Hill Road/Mall Entrance & Route 96	**U**	C	**C**	NO	NO	**YES**	NO	**YES**	**YES**	90	90	90	-	**70**	**20**
11	Cobblestone Court & Turk Hill Road	U	U	U	NO	NO	NO	NO	NO	NO	90	90	90	-	-	-
12	Mall Entrance/K-Mart & Route 96	**U**	**C**	**C**	NO	**YES**	**YES**	NO	NO	NO	90	**45**	90	-	**25**	**40**
13	Mall Entrance/High Street & Route 96	**U**	C	**C**	NO	**YES**	**YES**	NO	**YES**	**YES**	90	90	90	-	**85**	**80**
14	Hampton Inn Entrance & Route 96	**U**	**U**	U	NO	**YES**	NO	NO	NO	NO	90	90	90	-	-	-
15	Main Street Fishers/Rowley Road & Route 96	U	U	U	NO	NO	NO	NO	NO	NO	95	120	95	-	-	-
16	Route 251 (Victor Mendon Road) & Route 96	U	U	U	NO	NO	NO	NO	NO	NO	85	85	85	-	-	-
17	High Street (Village) & Route 96				NO	**YES**	**YES**	NO	NO	NO				16	0	**9**
18	School Street & Route 96	C	C	C	NO	**YES**	**YES**	NO	NO	NO	90	**90**	**90**	75	8	**16**
19	Route 444/Maple Avenue & Route 96				NO	**YES**	**YES**	NO	NO	NO				0	16	**39**

Note - Bold indicates a change from Existing to Proposed.

Controller Operations: "C" – Coordinated; "U" – Uncoordinated

- **<u>Cost / Benefit of Optimized of Proposed Traffic Signal Plans.</u>**

The proposed conditions for the morning, evening and Saturday study periods were analyzed to determine the cost/benefit of signal timing improvements. Signal timing optimization and updating signal control equipment will provide reoccurring benefits to the corridor including improved traffic flow conditions and decreased delay. Total cost of delay for an average commuter was determined to be $20.69 per hour using the following equation from the NYSDOT:

Total Cost per Hour of Delay =			**$20.69**
Total Value of time + Total Value of freight + Value of gas			
Total Cost per Hour of Delay = {(AVOa x .8Sa) x (1-Pt/100) + (St + Ft) x (Pt/100)} + Ga			
Input needed to derive Total Cost per hour of Delay			
AVO = Average Vehice Occupancy	=	1.15	
Pt = Percent Truck Traffic	=	2	
Constants applied to derive Total Cost per hour of Delay			
Ft= Value of Freight (in Truck)	=	$39.00	
St = Value of Time (of person in truck)	=	$21.00	
Sa = Value of Time (per person in vehicle)	=	$16.65	
Ga=Gt = Value of gas (vehicle or truck) per hour of delay	=	$4.48	1.45gal/hr x $3.086/gal

At the time of the analysis, average price for gas in the Rochester, NY area was found to be $3.086 per gallon. The value of time per person in a vehicle is valued at $16.65 per hour of delay in traffic which was determined from the average wage for Monroe and Ontario counties.

The time saved from the decrease in vehicle delay was used to determine the total savings for the peak hour on Friday evening and peak hour on Saturday (note that the morning peak hour was not included as there was minimal delay reduction with the optimized timing pattern).

Beyond the peak hours, it was assumed that the corridor would see benefits for those hours surrounding the evening and Saturday peaks. The current cost/benefit analysis includes any hour where the total traffic volume traveling through an intersection was greater than 90-percent of the peak hour volume. These hours were valued at the same percent as the amount of traffic traveling through the intersection.

For example, let us assume the peak hour traffic through an intersection was 1,000 vehicles between 4 and 5 PM. Then assume the total traffic traveling through the intersection between 3 and 4 PM was 930 vehicles (93-percent of the peak hour). The traffic signal optimization benefits between 3 and 4 PM would be 93-percent of the peak hour benefits.

Once the benefits were calculated for the appropriate hours of the day, the totals were aggregated into weeks and into a full year.

The following table represents the cost benefit analysis for the three major sections of the study area that are proposed for coordination:

	Evening	Saturday	
Bushnell's Basin:			
Cost savings per peak hour:	$1,172	$0	
Cost savings for 90% peak hour traffic for entire day:	$2,227	$0	
Cost savings per year:	$578,974	$0	
Mall Area:			
Cost savings per PM peak hour:	$1,200	$100	
Cost savings for 90% peak hour traffic for entire day:	$2,279	$662	
Cost savings per year:	$592,628	$34,444	
Village of Victor:			
Cost savings per PM peak hour:	$4,782	$358	
Cost savings for 90% peak hour traffic for entire day:	$35,627	$2,383	
Cost savings per year:	$9,262,935	$123,913	
TOTAL COST SAVINGS:	$10,434,536	$158,357	**$10,592,893**

Next, the total cost of the connection to the RTOC was determined to develop a benefit/cost ratio. The following table is a planning level cost estimate for the RTOC connection.

Order of Magnitude Costs - Route 96 Traffic Signal System Communications

		Capital Cost		Annual Operating Cost		Total**	Notes
Items	**Quantity**	**Unit Cost**	**Subtotal**	**Unit Cost**	**Subtotal**		
Signal System Costs							
Wireless Site Radios (8 intersections)	8	$6,000	$48,000	$900	$7,200	$55,200	Assumes line of site between the eight radios.
Wireless Site Testing / Engineering	3	$2,000	$6,000			$6,000	Allows for three days of line of site testing.
FLRDC Leased Fiber Communications	4.5 miles	$1,000	$1,000			$1,000	Eleven intersections beginning at County line.
NYSTA Leased Fiber Communications	13 miles	$1,000	$1,000	0.25/ft/yr	$17,000	$18,000	
Cameras	3	$12,000	$36,000	$1,800	$5,400	$41,400	
Conduit & Fiber	2 miles	$25/ft.	$264,000		$39,600	$303,600	From Route 96, along I-490 to NYSTA splice can at intersection.
Field Hardened Ethernet Switch	2	$2,000	$4,000	$300	$600	$4,600	For multiplexing wireless cameras and multiplexing fiber cameras.
New Traffic Signal Cabinets/Controllers	19	$15,000	$285,000	$2,250	$42,750	$327,750	
Other Costs							
Documentation / Testing			$20,000		$0	$20,000	
Training			$5,000		$0	$5,000	
Miscellaneous			$5,000		$2,000	$7,000	
Subtotal			$675,000		$114,550	$789,550	
15% Contingency Cost			$101,250		$10,770	$112,020	
15% Engineering & Administration			$101,250		$10,770	$112,020	
Total Cost			$877,500		$138,090	$1,013,590	

** The "total" column is the capital cost plus one year of operating costs.

The costs for the infrastructure (radios, cameras, fiber, Ethernet switches, and traffic signal controllers/cabinets) are based on recent similar projects. The operation and maintenance costs (repair, replacements, labor costs) are approximately 15-percent of the initial capital cost, a common estimate for ITS communications equipment. Finally, the lease costs are based on similar lease situations in New York.

The total cost of the RTOC connection as well as one year of operating costs would be approximately $1,013,590. One year of benefits from the delay savings alone would be $10,592,893. This equates to a benefit / cost ratio of approximately 10.5:1. It is unlikely any roadway widening or other infrastructure improvement could come close to the benefit / cost ratio achieved through the RTOC connection.

- **Incident Management Benefits.**

Traffic related incidents cause a substantial amount of congestion and increased delay on roadways. Billions of travel time hours and gallons of fuel are wasted each year from commercial and commuter traffic delayed due to traffic-related incidents. Traffic incident management involving the application of mechanical and technical systems provides many important benefits including reduced traffic delay, reduced congestion and reduced fuel consumption. In addition to improvement of traffic flow, advanced incident management improves roadway safety along the corridor which decreases the danger for secondary crashes and injuries to emergency personnel and other motorists exposed to the traffic stream. Managing traffic incidents is extremely dangerous for both motorists and responders. Emergency personnel cannot help those in an accident if they become involved in an incident themselves.

There are significant monetary benefits to the regional economy if incidents can be addressed quicker, especially related to the increased value of truck travel time and freight costs. The cost of travel delay boosts freight costs which are then passed on to consumers through increased prices of goods and services. The region’s economy also benefits greatly from the shorter incident duration time and the emergency responders valued time on the scene. With reliable and timely information about an incident, drivers can either delay their trip or take an alternative route. Incident responders would have less congestion to deal with, reducing delay to commercial and non-commercial traffic.

A communications connection to the Regional Traffic Operations Center (RTOC) would provide a number of these traffic incident benefits along the NYS Route 96 study corridor. Reducing traffic delay and congestion in turn reduces the duration and impacts of incidents and improves the safety of motorists, accident victims and emergency responders. Communications with RTOC could mitigate impacts by decreasing detection, response, and clearance times. Secondary accidents are caused by the change in traffic conditions associated with an incident including dramatic drop in traffic speed, extended queues, and onlookers. Closed Circuit Television (CCTV) surveillance cameras, highway emergency patrols and communication networks including wireless site radios are some of the technical systems involved in traffic incident management.

IV. TRAFFIC SIGNAL CONTROL AND SURVEILLANCE

A key element to ensure the new traffic signal system installed along Route 96 provides the most expeditious and efficient flow of traffic will be to dynamically manage the system. In order to do this, the traffic signal system must be connected to a control center, via center-to-field communications, so that operators can monitor traffic operations, alter signal parameters or initiate alternate timing plans. The most obvious place in the Greater Rochester Area for this to occur is in the Regional Traffic Operations Center (RTOC) where operators are already responsible for managing a majority of traffic signals in Monroe County.

The RTOC is located on Scottsville Road and provides co-location and joint operations for the transportation networks owned by both Monroe County and New York State Department of Transportation (NYSDOT). This allows the two agencies to leverage resources, devices and communication infrastructure while also allowing staff of both agencies to regularly interact and consult one another. Currently, county traffic signals and those state-owned signals maintained by the county are monitored by county forces in real-time at the RTOC though a central traffic monitoring system. The state oversees freeway systems at the RTOC, and both the County and State can monitor and control their closed-circuit television (CCTV) cameras at the RTOC. These signals come back to the RTOC mainly over coaxial cable; however Monroe County is gradually switching each signal over to fiber as additional fiber is installed. The state's freeway surveillance system and both agencies' CCTV cameras are brought back via privately owned fiber.

The purpose of this task will be to examine the different alternatives for developing a line of communication between the signals along Route 96 and the RTOC. Information will be gathered from surrounding agencies to determine if there is any existing infrastructure or if there are any agencies that the Town of Victor, Town of Perinton, or Village of Victor can align with in order to facilitate this communication. The feasibility and pros / cons of each alternative will be qualitatively assessed in order to develop a communications strategy for recommendation for the corridor.

A. Existing Communications Infrastructure

Currently, all of the Route 96 intersections are stand-alone (no connectivity to the RTOC or any other monitoring location), and run coordination using time-base-coordination (TBC). The study area signals are grouped with signals along Route 96 that continue into Monroe County, extending into the Town of Perinton. There is no hardwire interconnect for any of these signals.

A number of different agencies currently have communications infrastructure installed or have plans in motion to implement new or additional infrastructure. The agencies whose infrastructure may be relevant for connecting the traffic signals in Victor to the RTOC include: Monroe County, Monroe County Department of Transportation (MCDOT), Monroe County Pure Water (MCPW), NYSDOT, Ontario County, Finger Lake Regional Development Corporation (FLRDC) and the New York State Thruway Authority (NYSTA).

- **Monroe County**

  Monroe County consists of a number of different departments who install their own fiber, but work together by allowing one another to access and use any of the fiber installed. For the purposes of this report it is not important to separate fiber ownership, thus these departments will be referenced as one entity, Monroe County.

  Existing Monroe County fiber is located in the following areas:

  - I-590 southward along Winton Road to the Canal
  - Along S. Clinton Avenue from I-590 to Westfall Road
  - Along Brighton-Henrietta Townline Road from MCC to I-390
  - From the Monroe County Water Authority (Norris Drive) to South Winton onto I-490 extending to the I-590 split
  - I-590 South to I-390 North following the Erie Canal to East Henrietta Road
  - From East Henrietta Road to the RTOC via Westfall Road, Mount Hope Avenue, Elmwood Avenue and Scottsville Road
  - From MCC across East Henrietta Road following Crittenden Road to West Henrietta Road and stopping at the Board of Elections

  Monroe County has put forth an initiative to interconnect all local government offices with fiber. In order to achieve this initiative the County is currently progressing a project to run fiber down I-390 to I-251 to Rush and beyond to Honeoye Falls. A fiber optic pull box will be provided at the intersection of I-390 and the Thruway for a possible future interconnection between County Fiber and NYSTA fiber. However, at the current time the NYSTA will only allow Monroe County to connect to this fiber in order to communicate with dynamic message signs located along the Thruway. Based on this, an interconnection to NYSTA fiber will not be able to be utilized to facilitate the connection of the Route 96 Signal System to the RTOC.

  Monroe County also plans to install fiber to the Village / Town of Pittsford Offices. A route for this fiber has not yet been determined, but it could be achieved via extending fiber from I-590 along Monroe Avenue into the Village and / or north / south runs along Routes 64, 96 or 153. Currently, no fiber is planned east of the Village of Pittsford.

In addition to fiber, Monroe County currently has an extensive coaxial cable system which extends throughout the City of Rochester. This coaxial cable system carries the majority of the County-owed traffic signals back to the RTOC. In addition, as part of the Phase II ITS Camera Deployment Project that is currently underway, the coaxial cable system will also transmit video images from thirteen cameras back to the RTOC using video over internet protocol technology.

The nearest points of coaxial cable connection to Victor would be at either the intersection of East Henrietta Road and Westfall Road or at the intersection of East Avenue and S. Highland Drive. Each of these intersections is greater than nine miles to Bushnell's Basin, where the new signal system is planned to begin.

- **New York State Department of Transportation**

  NYSDOT owns and maintains more than 700 traffic signals in the region, many of which are stand-alone. Of these 700+ signalized intersections, more than 200 are coordinated via TBC. The State has a number of traffic cameras deployed throughout the Rochester area. These traffic cameras are brought back to the RTOC via fiber. NYSDOT's fiber network extends through the following locations:

  - From NY-104 at Basket Road to I-590 South
  - From NY-104 at Goodman Street to I-590 South
  - Along I-590 S to I-390 N at East Henrietta Road
  - Along Jefferson Road from the NYSDOT Regional Office to I-390 N
  - From I-390 N to East Henrietta Road and back to the RTOC via Monroe County facilities

  NYSDOT also has new fiber planned for the following locations:
  - Ridge Road between the Veterans Memorial Bridge to North Greece
  - Brighton-Henrietta Townline Road between the I-390 bridge and the MCC entrance

  Where no fiber is available, NYSDOT uses T-1 and dial-up connections between some field devices and the RTOC.

- **Ontario County / Finger Lakes Regional Development Corporation (FLRDC)**

  The Finger Lakes Regional Development Corporation is a non-profit corporation that was recently established in order to promote the development of the Finger Lakes through the use of technology. Together with Ontario County, FLRDC is in the process of advertising for the Ontario County Fiber-Optic Ring Project. This project will provide for the construction of a 144-fiber trunk line from the County line on Route 96 to Canandaigua and on to Geneva. The purpose of installing the fiber network is to begin to connect all local governments with high speed data communications as well as police and fire agencies as the network expands. The fiber backbone is anticipated to be provided free to municipalities and will be available for lease by private companies such as phone and data providers. The construction of the fiber backbone is expected to be complete by the end of 2007.

- **New York State Thruway Authority (NYSTA)**

  The New York State Thruway Authority has three entrance and exit points in the Rochester area including Exit 44 – Canandaigua, Exit 45 – Victor / I-490 and Exit 46 – Rochester / I-390. The NYSTA fiber trunk line runs along the entire length of the Thruway and provides a means for communicating with the traffic cameras, dynamic message signs, highway advisory radio and other field devices. Currently, NYSTA fiber is not connected to the fiber of any other agency, however there are plans to make a connection at Exit 46 so that Thruway dynamic message signs can be monitored by NYSDOT from the RTOC. No agreement exists to allow any further sharing or interconnection of NYSTA infrastructure with other agencies. NYSDOT has inquired with NYSTA regarding infrastructure sharing, however nothing further has yet evolved.

B. CCTV CAMERAS

Four CCTV cameras have been tentatively placed within the corridor (see figure 3). The goal in locating these cameras was to increase cost effectiveness by strategically placing cameras where one camera has the ability to view multiple intersections, thus providing coverage for much of the corridor. For the purposes of this effort, no additional analysis has been completed regarding camera locations based on the level of detail it would require. To determine a more adequate CCTV strategy, a needs analysis must be completed with the Town of Victor and NYSDOT to determine the requirements for a CCTV system along this corridor.

C. COMMUNICATIONS OPTIONS

When addressing the options for communicating, two overlapping elements must be examined, how to communicate between intersections and how to communicate from the intersections to the RTOC. Communication between intersections involves determining how to interconnect the individual signals into a system. Interconnection of signals is advantageous if one of the goals of the effort is to provide monitoring and control capabilities from the RTOC, as it is with this project. To continue with TBC, there would have to be communication from the RTOC to each individual intersection, which would be costly and inefficient. By tying the intersections together in a loop, a single point of communication between the RTOC and the system would be necessary. (It is noted that there is a possibility of having multiple systems along the corridor, and as such, multiple connections may have to be provided.)

The second element of communication involves the link from the field system to the central system located at the RTOC. As previously stated, this would allow operators in the RTOC to monitor and manage the signals dynamically in order to provide the most efficient and expeditious movement of traffic. This could be achieved either through a hardwire connection, such as coaxial cable, telephone wire or fiber optic cable, through wireless technology or through a hybrid combination of these alternatives.

For this corridor, every intersection, including those that may be running free, should be interconnected in order to establish communications with each from the RTOC. This is crucial for fault reporting and status monitoring of each intersection. With a connection to the RTOC, not only can operators adjust signal timing to improve the flow of traffic, but maintenance crews can more effectively determine when there is a power loss to a signal, when a signal bulb needs to be replaced, or when a signal is operating on flash.

A number of issues have to be addressed when examining communications for a traffic system. The two primary issues are bandwidth and cost.

- **Bandwidth**
  Bandwidth is a measure of the data (or video) carrying capacity of the communication medium. Typical traffic signal data that has to be transmitted is very small which allows for every available medium to be used. Distance, however, can be an inhibitor. (This is addressed is the cost section as well). Different types of communication media are distance limited and require repeating with electronic equipment.

  For this effort, the communication system is being examined with the expectation of transmitting data and video. Video requires large bandwidth, assuming full motion video is desired. To that end, the bandwidth of some communication media is prohibitive.

- **Cost**

  Communications *costs* can also be prohibitive. Wireline media must be installed in conduit (or overhead), and the costs for this installation can be extremely expensive over long distances, as is the case for connecting from the signal system along the corridor to the fiber point-of-presence. Even connecting between intersections can be cost prohibitive. Further, the suburban setting lends itself to extra expense with the need to avoid sidewalks, and bore under roadways, etc.

There are a number of different communication infrastructure options that can be pursued to allow the traffic signal system along the corridor to be connected to the RTOC. Each option has its own set of pros / cons associated with it. This section will examine each option for availability, feasibility, advantages and disadvantages.

D. MEDIA

- **Coaxial Cable**

Coaxial cable was the standard for many years for the transmission of video and data. Monroe County still has over 60 miles in use for the Urban Traffic Control System (UTCS). It typically costs about $10 / foot installed in existing conduit.

In general, since fiber optic cable has become available, coaxial cable has decreased in popularity. Some of the disadvantages of using coaxial cable for a new installation are:

- Requires active amplifiers approximately every 1500 feet, which leads to an increased maintenance burden
- Over time mechanical connectors can become corroded and cause system degradation, also creating an increased maintenance burden
- Subject to interference from electromagnetic and radio frequency sources
- Has limited bandwidth

Using the County's existing coaxial cable system to transmit information from the traffic signals along the corridor is not currently feasible as the nearest interconnection to the Monroe County coaxial cable system is nine miles from Bushnell's Basin where the traffic signal system upgrade would begin. In addition, the data could not be driven the distance required to connect the RTOC to the signal system along Route 96.

- **Twisted Pair / Telephone Wire**

Twisted pair is a form of cabling in which two conductors are twisted together in order to cancel out electromagnetic interference from other sources or cross-talk between wires in the same bundle. Twisted pair is copper wire that provides basic telephone service and is referred to as Plain Old Telephone Service (POTS). The cost for installed twisted pair is typically $1-$2 per foot.

Twisted Pair could be utilized in remote areas where the underground construction would be cost prohibitive. This communications procedure would require a lease agreement with a private utility to allow dial up access to the video signal. This strategy does not allow for complete control over the communication infrastructure but does minimize the amount of new underground construction. It also only provides limited bandwidth. This technology is not a preferred communication medium for general use on this project due to the long term lease agreement and operating costs and bandwidth constraints.

- **Wireless**

There are a number of different wireless technologies that can provide higher bandwidth than the older wireline systems, without the high installation costs of newer wireline systems such as fiber. These include both point-to-point systems such as spread spectrum and microwave radio, as well as point-to-multi-point systems such as Wi-Fi and Wi-Max.

Point-to-point systems communicate between fixed locations using radio transmission. Microwave radio systems allow for communications between two points up to twenty miles apart. Microwave radio systems have allotted frequencies with some frequencies requiring a license for use from the Federal Communications Commission. The frequencies in the 6 and 11 gigahertz ranges require a license, while frequencies in the 900 megahertz, 2 gigahertz and 23 gigahertz frequencies do not. Having a license is beneficial because the FCC ensures that systems using these frequencies do not interfere, whereas in the unlicensed bans, users must resolve their own interference problems.

Another point-to-point system is spread spectrum. Spread spectrum radio systems allow the communications being transmitted to be spread over a group of radio frequencies in the 900, 2400, and 5800 MHz frequency bands. To do this, a spread spectrum transmitter is used to code the signal then spread it over a bandwidth of 20-30MHz. Once the signal reaches its destination, the receiver then despreads the signal for interpretation. The benefits of spread spectrum are that it doesn't require an FCC license and it is immune to interference.

Wi-Fi, or wireless fidelity, is a point-to-multi-point communication service. Wi-Fi allows communication between points within a local area. Wi-MAX is a wireless system that is wide area with miles of coverage area. Wi-MAX provides fixed point-to-multipoint coverage with broadband capabilities. Wi-MAX provides high-speed mobile data and telecommunications services. Wi-MAX can be a wireless alternative to fiber optic cable or it can be combined with cable technology to provide "last mile" connectivity where no fiber exists. In environments where line-of-sight exists, Wi-MAX can provide up to 70 Mbit / sec over 70 miles. However in more urban environments where line of sight may not exist, Wi-MAX provides closer to 10 Mbps over 2 miles. Similar to DSL, Wi-MAX can either provide large bandwidth over short distances or small bandwidth over large distances.

Cost vary greatly depending upon the architecture, but a good estimate for a single point to signal point (one-hop) microwave system is $7,000 to $10,500 installed.

- **Fiber Optic Cable**

Fiber optic cable is the preferred communication medium for long and short haul applications such as those required for this project. Fiber optic cables are manufactured with two internal structures: those fibers that support multi-mode transmission and those that support single-mode transmission. In the past multi-mode has been used for short haul applications because of the lower cost of transmission and reception equipment. As technology has matured the higher cost associated with single-mode fiber cable transmission equipment is on the decline, therefore making the use of single-mode cable the choice for incident/traffic management systems.

Fiber optic cable is the highest band-width alternative and is the most secure type of communication medium. It can transmit data at greater speeds over greater distances than both coaxial cable and wireless systems. The rate at which data can be transferred over fiber optic cable depends on the sophistication of the devices connected to the cable. In addition, fiber optic cable is not sensitive to electromagnetic fields or weather conditions unlike wireless systems.

The disadvantage to fiber is that it requires large up-front costs for implementation, yet the overall cost to operate and maintain fiber is much less than other high-bandwidth, high-security systems. The greatest cost associated with fiber is not the cost of the fiber itself, but rather the cost to install the fiber into conduit in the ground. Installing fiber in existing residential areas typically costs about $8 to $10 per foot installed in existing conduit, and as much as $25 per installed with conduit. If fiber could be installed along overhead utility poles, as is already done in some outlying areas, this per foot cost could be reduced. However, when installed in this fashion the fiber may have a shorter lifespan due to damage from weather and other potential incidents along the roadway. Thus the overall cost may balance out.

The other disadvantage to fiber optic cable is that it would require an agreement to be pursued between NYSDOT, NYSTA, Ontario and Monroe Counties to allow communication via this connection.

E. COMMUNICATION RECOMMENDATION

While the emphasis for the communications network is for low bandwidth traffic signal data, it is likely that CCTV images will need to be transmitted as well. To that end, it is recommended that a broadband transmission system be used. However, due to the cost of installation of a broadband system, it is recommended that the Town of Victor use a hybrid of technologies to both interconnect and transmit traffic signal data and video to the RTOC. (See Figure 3)

- **Intersection Interconnection Recommendation**

  The fiber trunk line being constructed by the Ontario County / Finger Lakes Regional Development Corporation is recommended to connect the traffic signals in the Town and Village of Victor. Due to the length of the system to Bushnell's Basin, a wireless solution is the only feasible alternative to connect the remainder of the traffic signals. The cost to install conduit and cable is cost prohibitive.

  Should the Ontario County / Finger Lakes Regional Development Corporation fiber line not be accessible, a wireless solution could be used for the entire corridor.

- **Signal System to RTOC Connection Media Alternatives**

  Twisted pair and coaxial cable are two alternatives that are based on older technology. Each of these has carrier limitations, is expensive for the length of runs needed to tie into an existing system, and because the upgrade of the Route 96 Signal System is based on the need to upgrade technology for the better management of traffic through the corridor, it is not recommended that either of these alternatives be chosen.

  Fiber and wireless offer state-of-the-art broadband service. Between fiber and wireless, fiber provides many advantages over wireless; however, its installation costs can be prohibitive for the length of installation runs required for this project. Wireless networks have a shorter transmission distance when there is no line of sight and wireless networks are susceptible to being knocked out of commission due to bad weather. Although not as desirable as a dedicated hard connection, another transmission alternative may be to lease a T-1 line to close the gap between the corridor and the RTOC. T-1 lines are expensive to operate, but NYSDOT has used them in situations where no better alternative for communication exists.

- **Signal System to RTOC Connection Recommendation**

  The nearest existing point-of-presence for high-speed communication is the Thruway (Figure 1). The recommended path then would be to connect to the Thruway fiber trunk, run west along the Thruway to Exist 46, and tie into the County fiber trunk as shown in Figure 2. Agreements will need to be made with all involved agencies to follow the recommended path, however, all have indicated a willingness to work together to make the connection a reality.

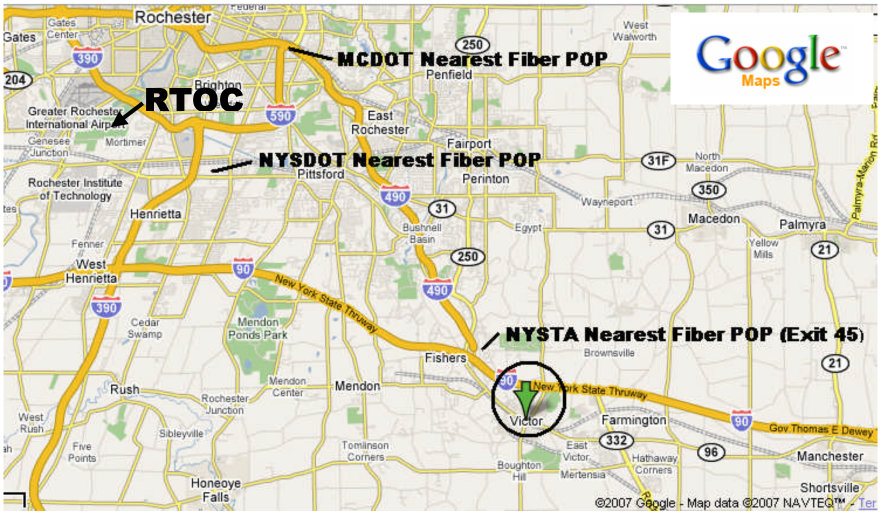

Figure 1. Existing Fiber Optic Points of Presence

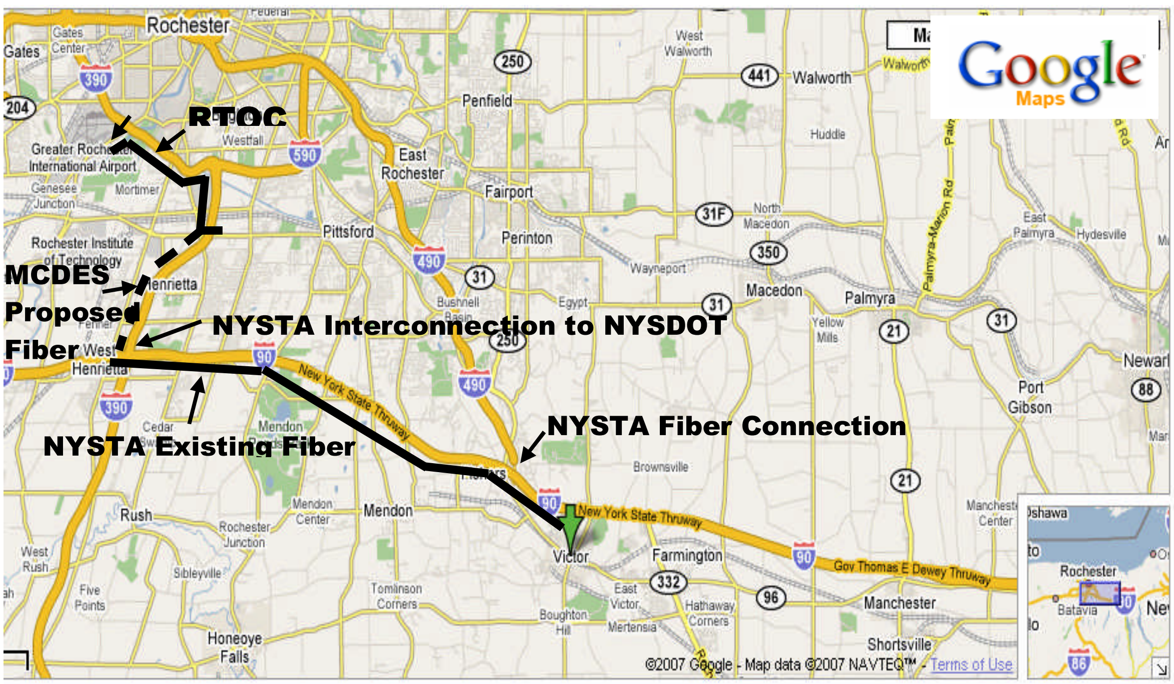

Figure 2: Recommended Path from Route 96 to the RTOC

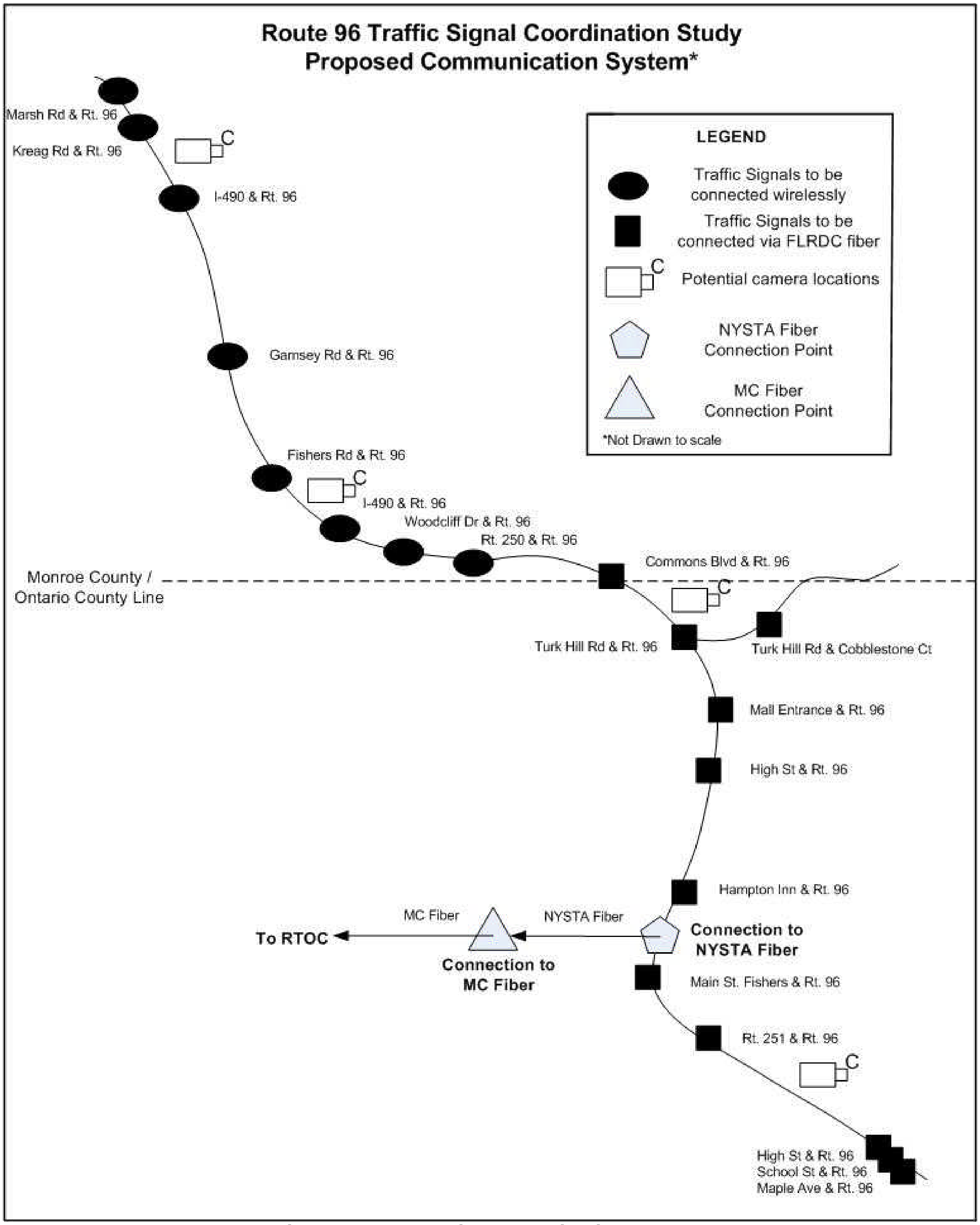

Figure 3: Proposed Communication System

V. IMPLEMENTATION PLAN FOR REGIONAL TRAFFIC OPERATIONS CENTER CONTROL AND SURVEILLANCE

A. Necessary Inter-municipal agreements

Several Inter-municipal agreements will be necessary to complete the connection to the RTOC. This section of the report will identify the necessary agreements and the reason(s) for the agreements.

- **Town/Village of Victor, Town of Perinton – NYSDOT**

  The Towns and Village will need an agreement with the NYSDOT to be able to complete the improvements to the Route 96 corridor (as the corridor is State owned) and to monitor the corridor from the RTOC. Currently, NYSDOT does not actively monitor many traffic signal corridors in the region.

  Monroe County does monitor many of the County owned traffic signals and the Towns and Village could attempt to obtain an agreement where the MCDOT monitors the corridor, however, the agreement would be further reaching as a significant portion of the corridor is outside Monroe County in Ontario County. In addition, the traffic signals are State owned, thereby increasing the complexity of the agreement.

- **NYSDOT – NYS Thruway Authority**

  An agreement would be necessary between the NYSDOT and the NYSTA for the use of the NYSTA owned fiber optic line between Exits 45 and 46. The fiber optic line is proposed for use to transmit the data from the corridor to the RTOC.

- **NYSDOT – FLRDC**

  Assuming the FLRDC fiber trunk line is constructed and utilized for the connection of the traffic signals in Ontario County, the NYSDOT will need to obtain an agreement with the FLRDC for use of the fiber.

- **NYSDOT – Monroe County**

  The proposed alternative follows the NYSTA fiber optic line to Exit 46 (I-390), then through a proposed Monroe County fiber line along I-390. There will need to be an agreement between Monroe County and the NYSDOT for use of that portion of the fiber line.

In addition, if the decision is made for Monroe County to monitor the corridor, as was suggested above, the agreement between Monroe County and the NYSDOT will need to be extended to cover the monitoring and timing of the signals.

B. Funding

Four funding sources were identified through meetings with the Town of Victor's grant writing consultant (Stu Brown Associates) that could potentially fund both the administrative portions of the connection to the RTOC (inter-municipal agreements, coordination with the agencies), and the engineering and construction of the connection. Note that there may be other funding sources available to the Town's, Counties, and State to assist with funding and these other sources should be explored if available. The grant writing consultant for the Town of Victor has indicated they will continue to consider potential options and will provide the Town with updated information as it is identified.

Shared Municipal Services Incentive (SMSI) Grant Program: The New York Department of State administers a cooperative grant program to cover costs associated with shared services, cooperative agreements, consolidations, mergers and dissolutions. Shared highway services has been identified as a priority. Grants can be for a maximum of $200,000 per municipality, with a ten percent local cost share. No part of the grant may be used for recurring expenses, such as salaries. Awards are granted only for services that would otherwise be individually provided by each grantee and for which demonstratable financial savings result from sharing (except for feasibility studies).

Governor's Traffic Safety Committee (GTSC): The GTSC awards Federal highway safety grant funds to local, state and not-for-profit agencies for projects to improve highway safety and reduce deaths and serious injuries due to crashes. Projects must be consistent with the State's Highway Safety Strategic Plan which is prepared annually and submitted to the National Highway Traffic Safety Administration (NHTSA) for approval prior to the beginning of the federal fiscal year. The "call letter" requesting applications is usually released early in the year. Proposals must be endorsed by the County Traffic Safety Board before being submitted to the GTSC. Proposals submitted by May 15th receive first priority.

This funding source may need additional safety related studies to be completed along the corridor to be eligible for funding. Existing crash rates could be calculated along the corridor, then the safety related benefit for monitoring the corridor could be estimated.

New York State Energy Research and Development Authority (NYSERDA): NYSERDA provides a range of funding opportunities, including, but not limited to: providing technical assistance to municipalities, private businesses and not-for-profit organizations; offering incentives for the purchase of energy efficient equipment and fixtures; and providing grants to develop commercial applications for new and emerging technologies. From time to time solicitations (call for projects) are released for improvements to transportation infrastructure. This may include, but is not necessarily limited to: congestion mitigation, operational efficiencies, improved efficiency during infrastructure maintenance and intelligent transportation applications. Although funding opportunities vary in size, recent solicitations indicate that NYSERDA's participation can be for as much as $50,000 for feasibility studies and may range as high as several hundred thousand dollars for implementation actions.

Transportation Improvement Plan (TIP): The TIP programs the timing and funding of all transportation improvements in the region that involve federal funds over the next five years. These projects typically emerge from the Unified Planning Work Program (UPWP) planning process and must be consistent with the overall objectives and strategies identified in the region's Long Range Transportation Plan. It should be noted that the Long Range Transportation Plan recognizes that the deployment of Intelligent Transportation Systems (ITS), Transportation System Management (TSM) and Transportation Demand Management (TDM) are cost-effective alternatives to adding capacity to the highway network. The TIP must be updated at least every two years. The current TIP was adopted by the Genesee Transportation Council (GTC) on June 21, 2007. Funding for approved projects is generally 80% Federal: 20% non-Federal.

In relation to the TIP, each Town and County has local budget and funding processes that could be used to fund portions of the connection to the RTOC. For example, inter-municipal agreement conversations could be started using local funds or local officials, while parallel funding applications or grants could be used to fund other portions of the connection. It is likely that several grants and funding sources could be used to complete the work.

C. Implementation Schedule

The Town of Perinton and Town and Village of Victor should use this study as support for one or all of the funding sources identified above, as well as other local funding sources. Applications should be submitted as soon as they are available.

In the meantime, several short term strategies have been developed to quickly improve traffic operations on Route 96. Each of these strategies will require the close cooperation of the NYSDOT:

- Implementation of the proposed traffic signal timing, phasing, and coordination patterns identified in the study.. Particular emphasis should be put on the Village of Victor, Eastview Mall area, and Bushnell's Basin.

- While implementing the proposed signal timings, NYSDOT staff should verify the existing signal offsets and coordinate the time clocks in the traffic signal controllers. This will ensure the traffic signals are working together to the best of their ability.

- Request the NYSDOT field optimize the proposed traffic patterns based on actual operating conditions seen in the field. Proposed traffic signal timing and phasing patterns should always be optimized in the field to achieve the full benefit of the changes.

- Request a regular review of the traffic signal operations along the corridor by NYSDOT maintenance to ensure the optimized traffic signal timing and phasing patterns operate as intended. This should include synchronization of the time clocks within the traffic signal controllers.

- As new development is approved and constructed along the corridor, review the traffic impacts and proposed mitigation in the context of the entire corridor to ensure traffic signal timing, phasing, and offset changes are in the best interest of the entire corridor, not just at the immediate driveway and adjacent intersections. The Synchro model created for this project can be used by the Towns and Village to assess the overall corridor impacts.

The Towns and Village should attempt to secure funding through one or more of the sources by the end of 2008. Between now and then, the local government officials should begin conversations with the NYSDOT, MCDOT, and NYSTA in an attempt to put inter-municipal agreements in place that will allow the recommended communication path to the RTOC. If funding does become available, and the inter-municipal agreement are in place, the design and construction of the communications connection could be completed by the end of 2009 or mid-2010.