HUNTINGTON SIGNAL OPTIMIZATION PROJECT HUNTINGTON, WV

PREPARED FOR:

KYOVA
Interstate Planning Commission

JULY 26, 2006

PREPARED BY:

R.D. Zande & Associates

RDZ JN 7834

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PREPARED FOR:

KYOVA
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Executive Summary

The KYOVA Interstate Planning Commission (KYOVA), the City of Huntington and the West Virginia Department of Transportation (WVDOT) are interested in improving the flow of traffic in Huntington. The purpose of this study is a thorough examination of the Huntington traffic signal system to assess the condition of the Huntington traffic signal system, assess the current traffic flow conditions in Huntington, and to identify and prioritize improvement recommendations.

The following is an alphabetical list of the project stakeholders who provided assistance in the preparation of this study and report.

Project Stakeholders
Ed Armbruster, West Virginia Division of Highways
Lt. Greg Brom, Huntington Police Department
Chuck Cornett, City of Huntington
Charles Holley, City of Huntington
Mike Hudson, Huntington Police Department
Bruce Kenney, West Virginia Division of Highways
Rick Napier, City of Huntington
Doug Rice, KYOVA
Saleem Salameh, KYOVA
Mark Scoular, West Virginia Department of Transportation
Jody Sigmond, KYOVA

The four principal tasks of this study were.

- Inventory of Existing Traffic Control
- Assessment of Traffic Flows
- Evaluation of the Signal System
- Study Summarizing Findings and Recommendations

The inventory of the existing traffic signal equipment, conducted in January and February 2006, included recording of equipment type and condition, and observations related to potential MUTCD and ADA issues. Travel time runs and traffic flow observations were also conducted as that time.

Traffic counts for 20 key intersections were provided by the WVDOT. These counts, along with 24-hour counts from the WVDOT 3-year counting program and traffic counts from a recent study of Hal Greer Boulevard were used to estimate traffic volumes for the remaining study intersections. These estimated volumes were then used in the Synchro and SimTraffic models for the evaluation traffic flow conditions.

The field inventory and traffic flow analysis were used to prepare a list of action items. The recommendations have been grouped into short, medium and long term. For this report short term is defined as 0-3 years, medium term 3-10 years and long term as 10-20 years.

1. **Signal Communications.** Because of several interconnect breaks; system communication is no longer working in parts of the City. These breaks cause intersections to operate independently, resulting in inefficiencies, which can in turn result in increased delay, driver irritation, and increased emissions. It is recommended that communication be reestablished. To reestablish communication these breaks could be repaired, replaced in kind, or replaced with another kind of communication equipment.

2. **Aging Infrastructure.** The signal poles at fifteen signalized intersections in the downtown area were installed over 30 years ago. Many of these signal poles are showing signs of deterioration, such as rust, or other damage. Some of the poles have hand hole covers missing, exposing internal wiring to weather and damage. It is recommended that these poles be replaced. As part of a couple of downtown streetscape improvement projects the City has upgraded two similar installations over the last two years, and is preparing to upgrade a third intersection this year. During the field inventory curb ramp layout and crosswalk layout was reviewed, and it was noted that most intersections may have ADA issues. It is recommended that ADA issues be addressed as other intersections improvements are made.

3. **Maintenance.** As part of the field inventory the following maintenance issues were noted; excessive dirt in the controller cabinets, failed loops, and burned out signal bulbs. It is recommended that a routine maintenance program be implemented to address these issues.

   Further study should also be given to replacing the incandescent bulbs with LED bulbs, in both vehicular and pedestrian signal heads. LED bulbs have a greater initial cost, but have a much longer life expectancy and use considerably less energy.

4. **Optimized Timings.** The traffic flow analysis indicates that the optimized signal timings, presented in this report, will reduce delay, improve progression, and reduce emissions. During implementation of these timings it will be necessary to observe traffic flow and make manual adjustments. These settings would not be effective though, until repairs have been made to the signal system communications. It is recommended that these timings be implemented.

In order to maintain optimized timings, it is recommended that the City develop a regular count program for the intersections in the City. This would provide an on-going means of obtaining current traffic information, and allow the opportunity to update signal timings to reflect changes in flows. A program to count each signalized intersection every 2-3 years is recommended, and more frequently if there are known changes that could affect traffic flow.

In order to use this count information effectively, it is recommended that the City have signal optimization software (such as Synchro) and the appropriate training to evaluate the existing timings and retime signals as necessary.

The existing signal system is a closed loop style system. A closed loop system consists of a master controller at one intersection controlling the operation of other intersections in the group. A central system consists of a single master computer located in a control center and all the signals communicating with it. A central system allows much greater responsiveness to traffic flow. For example, signal grouping can be changed for each signal pattern if necessary. It is recommended the City convert to a central system to better manage traffic flow. The upgraded system should be compatible with the State's ITS architecture.

5. **Crash Locations.** Traffic crash information for Cabell County was provided by KYOVA. This information was filtered and sorted by intersection, to determine the crash frequency at the signalized intersections in the study area. It is recommended that a safety study program be developed to address safety issues.

The WVDOT is to complete several upgrades and improvements to the City of Huntington Signal System in the summer of 2006. These improvements include replacement of the master controllers and computer in the City's traffic office. The addition of a switching system and phone line will be part of these improvements, and will allow WVDOT as well as City personnel to access the system software remotely. WVDOT also plans to provide a Synchro license to the City and provide training in the use of the software. These improvements will provide City staff additional tools to maintain traffic flow in the City.

This investment by WVDOT will meet or partially meet several of the action items above. The purchase of Synchro, and training in its use, will provide City staff with a tool to evaluate how signal adjustments could affect traffic flows.

In summary, the following are action items grouped as short term, medium term, and long term projects.

SHORT TERM (0-3 years) PROJECTS:

- Repair or upgrade interconnect
- Improve ADA access
- Perform cabinet maintenance
- Repair or replace loops
- Purchase signal optimization software (and training)
- Implement optimized timings in this report
- Implement intersection count program
- Develop safety study program

MEDIUM TERM (3-10 years) PROJECTS:

- Repair or upgrade interconnect
- Improve ADA accessibility
- Replace signal poles and field equipment
- Repair or replace loops
- Upgrade to LED signal and ped bulbs
- Install central system signal control

LONG TERM (10-20 year) PROJECTS:

- Improve ADA accessibility
- Upgrade to LED signal and ped bulbs
- Install central system signal control

An estimation of the probable cost of implementing the recommendations discussed in this report is 1 million dollars per year. This number was calculated with the assumption the recommendations are completed over 16 years, and 4% annual inflation.

1. Introduction

Background

The City of Huntington signal system is comprised of 118 signalized intersections. These signals are controlled by a series of 10 closed loop system master controllers and eight solo intersections. These intersections are interconnected with a combination of approximately 14 miles of twisted pair hardwire and radio interconnect. The City has a central computer and Windows based closed loop software (i.e., MARC NX from Siemens) that it uses for monitoring and managing its signals.

The existing field equipment was generally installed between 1989 and the present. A listing to the signalized intersections, system identification number, and system master identification are located in **Table 1**. This information is shown graphically in **Figure 1**.

Study Objectives

The KYOVA Interstate Planning Commission (KYOVA), the City of Huntington and the West Virginia Department of Transportation (WVDOT) are interested in improving the flow of traffic in Huntington. The purpose of this study is a thorough examination of the Huntington traffic signal system to assess the condition of the Huntington traffic signal system, assess the current traffic flow conditions in Huntington, and to identify and prioritize improvement recommendations.

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- Evaluation of the Signal System
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Crash data for the signalized intersections was also reviewed. Traffic signal warrants were also reviewed for the Veterans Memorial Boulevard & 10th Street intersection.

Table 1 – List of Signalized Intersections

Intersection No.	Street	Cross Street	System Master
307	3rd Avenue	7th Street	A
308	3rd Avenue	8th Street	A
309	3rd Avenue	9th Street	A
310	3rd Avenue	10th Street	A
311	3rd Avenue	11th Street	A
312	3rd Avenue	12th Street	A
313	3rd Avenue	13th Street	A
316	3rd Avenue	Hal Greer Boulevard	C
317	3rd Avenue	17th Street	C
318	3rd Avenue	18th Street	C
320	3rd Avenue	20th Street	C
324	3rd Avenue	24th Street	D
325	3rd Avenue	25th Street	D
326	3rd Avenue	26th Street	D
328	3rd Avenue	28th Street	D
329	3rd Avenue	29th Street	D
331	3rd Avenue	31st Street	D
333	Bridge Street	Main Street	D
335	Bridge Street	Buffington Street	D
401	4th Avenue	1st Street	B
405	4th Avenue	5th Street	A
406	4th Avenue	6th Street	A
407	4th Avenue	7th Street	A
408	4th Avenue	8th Street	A
409	4th Avenue	9th Street	A
410	4th Avenue	10th Street	A
411	4th Avenue	11th Street	A
412	4th Avenue	12th Street	A
413	4th Avenue	13th Street	A

Intersection No.	Street	Cross Street	System Master
416	4th Avenue	Hal Greer Boulevard	C
431	4th Avenue	31st Street	D
501	5th Avenue	1st Street	B
505	5th Avenue	5th Street	A
506	5th Avenue	6th Street	A
507	5th Avenue	7th Street	A
508	5th Avenue	8th Street	A
509	5th Avenue	9th Street	A
510	5th Avenue	10th Street	A
511	5th Avenue	11th Street	A
513	5th Avenue	13th Street	A
515	5th Avenue	Elm Street	C
516	5th Avenue	Hal Greer Boulevard	C
517	5th Avenue	17th Street	C
518	5th Avenue	18th Street	C
520	5th Avenue	20th Street	C
524	5th Avenue	24th Street	D
526	5th Avenue	26th Street	D
528	5th Avenue	28th Street	D
529	5th Avenue	29th Street	D
531	5th Avenue	31st Street	D
533	5th Avenue	Main Street	D
535	5th Avenue	Buffington	D
601	6th Avenue	1st Street	B
606	6th Avenue	6th Street	B
608	6th Avenue	8th Street	B
609	6th Avenue	9th Street	B
610	6th Avenue	10th Street	B
611	6th Avenue	11th Street	B

Intersection No.	Street	Cross Street	System Master
613	6th Avenue	13th Street	B
616	6th Avenue	Hal Greer Boulevard	C
620	6th Avenue	20th Street	C
701	7th Avenue	1st Street	B
708	7th Avenue	8th Street	B
709	7th Avenue	9th Street	B
710	7th Avenue	10th Street	B
716	7th Avenue	Hal Greer Boulevard	C
720	7th Avenue	20th Street	C
801	8th Avenue	1st Street	B
808	8th Avenue	8th Street	B
810	8th Avenue	10th Street	B
816	8th Avenue	Hal Greer Boulevard	C
820	8th Avenue	20th Street	C
828	8th Avenue	28th Street	SOLO
829	8th Avenue	29th Street	SOLO
831	8th Avenue	31st Street	D
905	9th Avenue	5th Street	B
908	9th Avenue	8th Street	B
910	9th Avenue	10th Street	B
916	9th Avenue	Hal Greer Boulevard	C
920	9th Avenue	20th Street	C
1016	10th Avenue	Hal Greer Boulevard	C
1105	11th Avenue	5th Street	B
1108	11th Avenue	8th Street	B
1216	Charleston Avenue	Hal Greer Boulevard	C
1220	Charleston Avenue	20th Street	C
1305	13th Avenue	5th Street	B
1308	13th Avenue	8th Street	B
1505	South Boulevard	5th Street	B

Intersection No.	Street	Cross Street	System Master
1516	Medical Cntr. Dr./McD	Hal Greer Boulevard	C
1705	WV 152	I-64 Westbound	O
1708	Ridgewood Road	McCoy Road	SOLO
1716	Washington Boulevard	Hal Greer Boulevard	C
1805	WV 152	I-64 Eastbound	O
1905	WV 152	ASHLAND COAL	O
1916	Hal Greer Boulevard	HUNTINGTON HIGH	SOLO
2403	Washington Avenue	3rd Street West	B
2411	Washington Avenue	11th Street West	F
2414	Washington Avenue	14th Street West	F
2503	Adams Avenue	3rd Street West	B
2511	Adams Avenue	11th Street West	F
2514	Adams Avenue	14th Street West	F
2519	Adams Avenue	19th Street West	F
2523	Adams Avenue	23rd Street West	F
2529	US Route 60 West	Auburn Road	G
2614	Madison Avenue	14th Street West	F
2619	Madison Avenue	19th Street West	F
2637	US Route 60 West	Wayne Street	G
2646	US Route 60 West	Burlington Road	G
2729	Piedmont Road	Camden Road	G
5001	Norway Avenue	Woodland Drive	E
5006	Norway Avenue	Washington Boulevard	E
5009	Washington Boulevard	Avondale Road	E
6001	US Route 60 East	Washington Boulevard	J
6002	US Route 60 East	Roby Road	J
6003	US Route 60 East	Foodland	J
6004	US Route 60 East	Wal-Mart	J
6011	US Route 60 East	Eastern Heights	P
6012	US Route 60 East	Russell Creek	P

Study Methodology

Project Meetings

A project kick-off meeting was conducted with the project stakeholders on January 5, 2006. The purpose of the meeting was to discuss the study process, identify project issues, and gather information and input from the project stakeholders about known issues.

Progress meetings were conducted to update the stakeholders on March 2, 2006 and April 26, 2006. On May 5, 2006 a presentation was made to the KYOVA Technical Advisory Committee and to the KYOVA Policy Board.

An Open House session was held on May 25, 2006 to make the public aware of the study and for public input and comment. This session was held at the TTA office in Pullman Square. Information from the public meeting is included in **Appendix B**.

Field Inventory

To determine the state of the existing infrastructure an inventory of existing traffic control equipment was conducted in January and February 2006. The information collected included:

- Intersection lane geometry
- Posted speed limits along study corridors
- Non standard intersection signage
- Number and type of signal heads
- Detection equipment/loop detectors
- Current signal phasing
- Relative conditions of signal poles
- Controller cabinet equipment and relative condition
- Review of intersection ramp layout and other ADA features
- Communication cable
- Travel time runs
- Traffic flow observations

Copies of the field inventory data collection sheets for each intersection are located in **Appendix C**.

The participating agencies also provided the following historical information.

- City of Huntington
    - Existing signal timing data
    - Existing signal plans

- West Virginia Department of Transportation, Division of Highways
  - Turning movement counts (at key intersections)
  - Machine counts
  - Planned improvements for Hal Greer Boulevard
  - Roadway functional classification

- KYOVA Interstate Planning Commission
  - Traffic Crash Data
  - *Hal Greer Boulevard Corridor Study*

Traffic counts for 20 key intersections were provided by the WVDOT. These counts, along with 24-hour counts from the WVDOT 3-year counting program and traffic counts from a recent study of Hal Greer Boulevard were used to estimate traffic volumes for the remaining study intersections. These estimated volumes were then used in the Synchro and SimTraffic models to evaluate traffic flow conditions.

The provided traffic volumes were also used to conduct a traffic signal warrant analysis at Veterans Memorial Boulevard & 10th Street. That signal warrant indicated a signal is not warranted at this time.

The traffic counts and excerpts from the Hal Greer Study can be found in **Appendix A**.

2. Inventory of Existing Traffic Control

As part of the field review an inventory was conducted of existing signal equipment. Several photos were also taken at each intersection and are provided separately, in electronic format.

Signal Communications

There are several breaks and/or missing segments of interconnect in the signal system interconnect. Along 5th Avenue between 20th and 24th Street there are several breaks. As a result it is recommended the entire segment should be replaced. Along 10th Street, between 6th and 7th Avenue the entire block is missing. Along US 60 West, west of Camden Road, there is a break. The magnitude of this break is not known, it may be able to restore communication here with a repair. This represents a loss of communication to about 20 intersections.

These breaks need to be repaired or replaced to reestablish communication. The interconnect cable could be replaced in kind, replaced with fiber optic cable, replaced with wireless equipment, or it could be repaired with a splice.

Figure 3 is a map of the existing interconnect system.

Maintenance

The controller cabinets are in generally good condition. However, they are in need of cleaning and general maintenance. Cleaning would include filter replacement, lubrication of hinges and locks, and removal of debris such as dirt, dust, and vegetation from inside the controller cabinet.

Maintenance of controller cabinets is expected to result in longer equipment life. Additionally, regularly scheduled maintenance allows technicians to check for equipment failures while they are performing other tasks. For example, they may notice loop failures or bulb outages.

Numerous loop detectors are not operating either due to loop failure or to broken connections between the controller cabinet and the loop. When the loops are broken it is necessary to place the controller on recall for the phase where the loop has failed. This can result in the signal providing green time to a movement even when there is no traffic demand. This results in greater intersection delay, causing motorists impatience and potential disregard of traffic controls by motorists, leading to safety concerns and increased vehicle emissions.

Also, it was noted that several of the signal bulbs are burned out, which can be a safety issue. Replacement of the existing incandescent bulbs with LED bulbs could be completed as part of regularly scheduled bulb replacement maintenance. Further investigation is recommended to determine the cost of converting from incandescent to LED bulbs, which save money by reducing energy costs and require less frequent changing of the bulbs, requiring less maintenance hours by field personnel. LED bulbs represent significant saving in energy consumption, and also last longer, which represents a savings in maintenance cost. In early 2006 WVDOT reported an average cost of $65 per signal section (to replace the lamp only), and a savings of about 80% in energy costs. Typically, the cost to replace all the bulbs in a 3-section head is about $300; to replace the entire unit is approximately $600. Therefore, at a typical intersection replacement cost would range from about $2,400 for lamp replacement to $4,800 to replace the signal heads. WVDOT indicated an approximate 3-5 year break-even period for bulb replacement.

Aging Infrastructure

The signal poles at the fifteen downtown signalized intersections listed below were installed over 30 years ago. Many of these signal poles are showing signs of deterioration, such as rust, or other damage. Some of the poles have hand hole covers missing, exposing internal wiring to weather and damage. It is recommended that these poles be replaced. As part of a couple of downtown streetscape improvement projects the City has upgraded two similar installations over the last two years, and is preparing to upgrade a third intersection this year.

Several of the intersections in the downtown area have signal poles that are around 35 years old. Many of these signal poles are showing signs of deterioration, such as rust, or other damage. Some of the poles have hand hole covers missing, which expose internal wiring to weather and damage. Replacement of these poles would also enhance the appearance of the downtown area. The intersections are:

- 3rd Avenue & 7th Street
- 3rd Avenue & 8th Street
- 3rd Avenue & 11th Street
- 3rd Avenue & 12th Street
- 3rd Avenue & 13th Street
- 4th Avenue & 6th Street
- 4th Avenue & 7th Street
- 4th Avenue & 8th Street
- 4th Avenue & 9th Street *
- 4th Avenue & 10th Street
- 4th Avenue & 11th Street
- 5th Avenue & 8th Street
- 5th Avenue & 9th Street
- 5th Avenue & 10th Street
- 5th Avenue & 11th Street

* (Note: Improvements planned.)

During the field inventory current ADA criteria was compared to existing conditions. For example, part of the field inventory checklist was to identify if ramps or push buttons were currently in place. For this study an intersection was considered not to meet criteria even if only one feature was missing from one quadrant. For example, it was determined that most intersections do not meet current ADA criteria, however, often there was just one issue at the intersection.

Field inventory data can be found in **Appendix C**.

3. Assessment of Traffic Flows

Traffic Volumes

<u>Volume Estimates for Model</u>

The first step in the optimization process was to create a Synchro model of the existing traffic flows. The existing condition required the input of many parameters, such as: intersection spacing, approach lane geometry, posted speed limit, pedestrian clearance times, and vehicle clearance times.

The traffic counts provided by the WVDOT were used to estimate turning movement volumes at the remaining intersections in the study area. Turning movement count estimates were prepared for AM, Midday, PM and Weekday off peak periods. Copies of the traffic counts are in **Appendix A.**

It is important to note that implementation of timings will require field observation and adjustments. This is particularly important, because some of the timings presented in this report are based on estimated traffic volumes.

<u>Count Program</u>

In order to maintain optimized timings, it is recommended that the City develop a regular count program for the intersections in the City. This would provide an on-going means of obtaining current traffic information, and allow the opportunity to update signal timings to reflect changes in flows. A program to count each signalized intersection every 2-3 years is recommended, and more frequently if there are known changes that could affect traffic flow.

Travel Time Runs

Peak period travel time runs were conducted along major corridors (e.g. 3rd Avenue, 4th Avenue, 5th Street) during the field inventory. During these runs notes were kept about the number of stops, and their duration. This information was compared to the Synchro output of the existing conditions to compare similar stops and delay times. Information from the travel time runs is in **Appendix C**.

This data was then incorporated into Synchro software (Version 6) to define values for the current quality of traffic flows. Once the existing model was complete then cycle lengths, splits and offsets were optimized.

Pedestrian Times In The Optimization Process

Many intersections currently have exclusive pedestrian phases. Exclusive pedestrian phases require longer cycle lengths than pedestrian phasing that is concurrent with vehicle phases. Hence, identifying the type of pedestrian phasing used is important because the phasing selected effects output results. Cycle lengths longer than necessary to accommodate vehicular volume typically increase delays.

Group A was selected to compare the affect of concurrent pedestrian phases to exclusive pedestrian phases. The Synchro output indicated that using concurrent pedestrian phasing would allow progression to be improved by over 20%, and emissions and delays could also be decreased.

Based on this assessment R.D. Zande determined that the optimization process would proceed with pedestrian phases as concurrent, with two exceptions. The exceptions were 3rd Avenue & the Pedestrian Crossing (Morrow Library) and 4th Avenue & 9th Street. These two intersections are exclusively pedestrian crossings. At 4th Avenue & 9th Street signal plans are being prepared and concurrent pedestrian phasing expected with the new installation.

Optimization Objectives

The coordination analysis was conducted with the initial intent of at least providing a LOS D at each intersection. However, where existing conditions might show LOS E or F conditions, without optimization, the optimization analysis was conducted to at least reduce the delay conditions.

For this study cycle lengths ranging from 60 to 150 seconds, in 5-second increments, were selected for analysis.

Two factors were used in the selection of the recommended cycle lengths and splits; the performance index (PI value) and bandwidth. The PI value is a measure of vehicle stops and delay. The higher the PI value the greater delay and number of stops. Bandwidth is the minimum amount of time provided for progression through the corridor. The recommended cycle length was determined by selecting the cycle length with the best PI value that would also be long enough to provide coordination. The minimum network PI value (i.e. the least delay for all vehicles in the corridor) does not necessarily provide optimal progression. To optimize progression, manual adjustments were made to the signal offsets to provide the greatest bandwidth possible, even though this would typically increase side street delays.

In conducting the coordination analysis for the AM, Midday, PM, and Weekday off peaks, three steps were completed.

Synchro Optimization

Steps Completed In The Optimization Process

- Step 1: Cycle Length Optimization

As noted previously, Synchro was to evaluate cycle lengths ranging from 60 to150 seconds. The cycle length that was selected at least provided minimum green times at all the corridor intersections. Double cycling was also considered during this step in the optimization process, but was not selected for any of the time periods evaluated.

- Step 2: Phase Time and Offset Optimization

The cycle length selected in Step 1 was used and the phase splits and offsets were optimized by Synchro.

- Step 3: Manual Bandwidth Adjustment

While Steps 1 and 2 provide the minimal network PI value (i.e. the least delay for all vehicles in the corridor) they do not necessarily provide optimal progression. To optimize progression, manual adjustments were made to the signal offsets to provide bandwidths for traffic progression.

When making manual adjustments to the offsets cross street progression could be affected. For example, when making an adjustment to the offset at an intersection to improve north-south progression it could negatively impact east-west progression through that same intersection. Whether or not the side street is coordinated the delay may increase when offset adjustments are made, resulting in a higher PI value. However, this change in PI value is typically very small.

Updating The Model

In order to maintain optimized timings it is recommended that the City purchase a Synchro license and obtain training in how to use Synchro. This would allow the City to assess how changes in traffic volumes impact signal operation and make adjustment to signal operation as necessary.

Existing Signal Groups

The existing system is comprised of closed loop groups. Because of this hardwire grouping the optimization was conducted for the existing signal groups, not for citywide coordination. As a result there are a few occasions where groups operate at different cycle lengths. It is possible better traffic flow could be achieved if a different grouping was assumed. Field observation and adjustments should be made to the optimized timing patterns to achieve maximum benefit.

The City could achieve more flexibility with a centralized signal system. A centralized system consists of a single central computer (at the City offices) that is connected to each intersection. The master controllers that are part of the existing closed loop systems would no longer be necessary. The upgraded system should be compatible with the State's ITS architecture.

Time of Day Operation

The signal timing plans in this report are recommended to operate about the same time of day the existing patters are operating. The time of day and recommended pattern are:

AM Peak	6:00 am to 10:00 am
Midday Peak	10:00 am to 2:00 pm
PM Peak	2:00 pm to 7:00 pm
Off Peak	7:00 pm to 6:00 am

Public meeting comments included a suggestion that traffic signals be placed on flash during periods of low traffic flow, such as overnight. However, WVDOT discourages flash operation of signals because of safety concerns.

3.1 Group A: Downtown Signal Group #1

Group A is comprised of the intersections that make up the heart of the downtown area. **Figure 2** shows the intersections in Group A.

The PI value improved for all time periods, by up to 46%. The emissions output shows emissions were improved for all time periods also.

Table 2 shows cycle length and PI value for existing and optimized settings. **Table 3** compares emissions data for existing and optimized settings. Additional information can be found in **Appendix D**.

Table 2 – Group A Cycle Length and PI Value Comparison

	Cycle Length (sec)				PI value			
	AM	Midday	PM	Off Peak	AM	Midday	PM	Off Peak
Existing	90	90	90	75	89.7	118.7	166.6	56.1
Optimized	70	90	90	70	73.1	92.4	110.5	30.1

Table 3 – Group A Emissions Data

	CO (kg)				NOx (kg)				VOC (kg)			
	AM	Midday	PM	Off Peak	AM	Midday	PM	Off Peak	AM	Midday	PM	Off Peak
Existing	13.01	16.70	19.94	8.17	2.53	3.25	3.88	1.59	3.02	3.87	4.62	1.89
Optimized	12.35	14.73	16.79	6.55	2.40	2.87	3.27	1.27	2.86	3.41	3.89	1.52

3.2 Group B: Downtown Signal Group #2

Other groups surround this group; because of this interaction with other groups there are more constraints on the optimization process. This signal group is shown in **Figure 3**.

The PI value improved for all time periods, by up to 28%. The emissions output shows emissions were improved for all time periods also.

Table 4 shows cycle length and PI value for existing and optimized settings. **Table 5** compares emissions data for existing and optimized settings. More detailed information about this group can be found in **Appendix E**.

Table 4 – Group B Cycle Length and PI Value Comparison

	Cycle Length (sec)				PI value			
	AM	Midday	PM	Off Peak	AM	Midday	PM	Off Peak
Existing	90	90	90	75	118.3	102.3	127.9	44.2
Optimized	70	90	90	70	85.1	94.4	114.1	36.1

Table 5 – Group B Emissions Data

	CO (kg)				NOx (kg)				VOC (kg)			
	AM	Midday	PM	Off Peak	AM	Midday	PM	Off Peak	AM	Midday	PM	Off Peak
Existing	20.71	18.33	21.85	8.89	4.03	3.57	4.25	1.73	4.80	4.25	5.06	2.06
Optimized	18.61	18.02	20.92	8.22	3.62	3.50	4.07	1.60	4.32	4.18	4.85	1.91

3.3 Group C: Marshall Area

The signals in this group contain four corridors. This signal group is shown in **Figure 4**. Hal Greer Boulevard and 20th Street are each major north-south corridors. Additionally, 3rd Avenue (westbound) and 5th Avenue (eastbound) are part of one-way pairs that extend through the City.

The PI value improved for all time periods, by up to 27%. The emissions output shows emissions were improved for all time periods also.

Table 6 shows cycle length and PI value for existing and optimized settings. **Table 7** compares emissions data for existing and optimized settings. More detailed information about this group can be found in **Appendix F**.

Table 6 – Group C Cycle Length and PI Value Comparison

	Cycle Length (sec)				PI value			
	AM	Midday	PM	Off Peak	AM	Midday	PM	Off Peak
Existing	90	90	90	75	211.7	166.5	255.2	67.4
Optimized	100	90	100	70	154.5	121.0	239.4	49.3

Table 7 – Group C Emissions Data

	CO (kg)				NOx (kg)				VOC (kg)			
	AM	Midday	PM	Off Peak	AM	Midday	PM	Off Peak	AM	Midday	PM	Off Peak
Existing	29.69	28.10	38.98	12.88	5.78	5.47	7.58	2.51	6.88	6.51	9.03	2.99
Optimized	26.31	23.30	37.04	10.96	5.12	4.53	7.21	2.13	6.10	5.40	8.58	2.54

3.4. Group D: East Huntington

The intersections in this group are part of a one-way pair system that provides access from southeast of the City. The intersections in Group D are shown in **Figure 5**.

The PI value improved for all time periods, by up to 68%. There are two instances where the nitrogen oxide (NOx) emissions show a slight increase, however other emissions output improved for all time periods.

Table 8 shows cycle length and PI value for existing and optimized settings. **Table 9** compares emissions data for existing and optimized settings. More detailed information about this group can be found in **Appendix G**.

Table 8 – Group D Cycle Length and PI Value Comparison

	Cycle Length (sec)				PI value			
	AM	Midday	PM	Off Peak	AM	Midday	PM	Off Peak
Existing	90/75[a]	90/120[b]	90/120[b]	90/120[b]	262.8	101.3	216.1	50.1
Optimized	75	65	90	70	82.8	66.1	134.7	26.7

NOTE: a-31st Street at 90 seconds, others at 75 seconds. b-8th & 31st at 120 seconds.

Table 9 – Group D Emissions Data

	CO (kg)				NOx (kg)				VOC (kg)			
	AM	Midday	PM	Off Peak	AM	Midday	PM	Off Peak	AM	Midday	PM	Off Peak
Existing	30.33	21.71	34.59	10.82	5.90	4.22	6.73	2.11	7.03	5.03	8.02	2.51
Optimized	20.14	19.18	29.22	9.08	3.92	3.73	5.69	1.77	4.67	4.45	6.77	2.11

3.5 Group F: Central City Area

Adams Avenue and Washington Avenue are one-way pairs that provide east-west access to the City. This signal group is shown in **Figure 9**.

The PI value improved for all time periods, by up to 36%. The emissions output shows emissions were either improved or remained the same for all time periods also.

Table 10 shows cycle length and PI value for existing and optimized settings. **Table 11** compares emissions data for existing and optimized settings. More detailed information about this group can be found in **Appendix H**.

Table 10 – Group F Cycle Length and PI Value Comparison

	Cycle Length (sec)				PI value			
	AM	Midday	PM	Off Peak	AM	Midday	PM	Off Peak
Existing	90	90	90	75	20.5	18.3	28.0	11.5
Optimized	70	70	70	70	14.0	18.1	25.4	7.4

Table 11 – Group F Emissions Data

	CO (kg)				NOx (kg)				VOC (kg)			
	AM	Midday	PM	Off Peak	AM	Midday	PM	Off Peak	AM	Midday	PM	Off Peak
Existing	7.07	6.96	8.69	3.79	1.38	1.35	1.69	0.74	1.64	1.61	2.01	0.88
Optimized	6.40	6.93	8.50	3.33	1.25	1.35	1.65	0.65	1.48	1.61	1.97	0.77

3.6 Group J: US 60 East & Washington Boulevard Area

The intersections in this group function primarily to move traffic between I-64 and the City of Huntington. The signals in this group area shown in **Figure 7**.

The PI value improved for all time periods, by up to 29%. Some emissions show slight increases, however overall emissions were improved for all time periods.

Table 12 shows cycle length and PI value for existing and optimized settings. **Table 13** compares emissions data for existing and optimized settings. More detailed information about this group can be found in **Appendix I**.

Table 12 – Group J Cycle Length and PI Value Comparison

	Cycle Length (sec)				PI value			
	AM	Midday	PM	Off Peak	AM	Midday	PM	Off Peak
Existing	105	130	105	80	42.8	59.7	10.2	24.7
Optimized	100	100	130	75	37.3	54.9	9.7	17.6

Table 13 – Group J Emissions Data

	CO (kg)				NOx (kg)				VOC (kg)			
	AM	Midday	PM	Off Peak	AM	Midday	PM	Off Peak	AM	Midday	PM	Off Peak
Existing	10.67	13.52	4.21	6.60	2.08	2.63	0.82	1.28	2.47	3.13	0.98	1.53
Optimized	10.80	14.58	4.21	6.04	2.10	2.84	0.82	1.18	2.50	3.38	0.98	1.40

3.7 Group O: WV 152/5th Street & I-64 Area

The intersections in this group function primarily to move traffic from south of the City and from I-64 to the downtown area. This signal group is shown in **Figure 8**.

The PI value improved for all time periods, by up to 29%. The emissions output shows emissions were improved for all time periods also.

Table 14 shows cycle length and PI value for existing and optimized settings. **Table 15** compares emissions data for existing and optimized settings. More detailed information about this group can be found in **Appendix J**.

Table 14 – Group O Cycle Length and PI Value Comparison

	Cycle Length (sec)				PI value			
	AM	Midday	PM	Off Peak	AM	Midday	PM	Off Peak
Existing	90	90	90	75	12.6	6.8	13.3	3.5
Optimized	90	80	90	75	8.9	6.5	9.5	3.0

Table 15 – Group O Emissions Data

	CO (kg)				NOx (kg)				VOC (kg)			
	AM	Midday	PM	Off Peak	AM	Midday	PM	Off Peak	AM	Midday	PM	Off Peak
Existing	4.29	2.94	4.57	1.50	0.84	0.57	0.89	0.29	1.00	0.68	1.06	0.35
Optimized	3.74	2.83	4.02	1.41	0.73	0.55	0.78	0.27	0.87	0.66	0.93	0.33

4. Signal Warrant Analysis and Crash Summary

Signal Warrant for Veterans Memorial Boulevard & 10th Street

A signal warrant analysis was conducted for the intersection of Veterans Memorial Boulevard & 10th Street. The analysis was based on the criteria in the *Manual on Uniform Traffic Control Devices (2003 Edition).* For the warrant, vehicle volumes and crash history were considered. The results of the analysis indicate that a signal is not warranted at this time. The signal warrant analysis is included in **Appendix K**.

While a signal is not presently warranted at this intersection, a roundabout could be considered. As noted in *Roundabouts: An Informational Guide*, published by the FHWA, (Publication No. FHWA-RD-00-067) multilane roundabouts have the potential to reduce the average annual crash frequency of injury crashes by 31%. This decrease may be attributed to the speed reduction generally associated with roundabouts. Additionally, the Guide mentions a reduction in crash severity for pedestrians and bicyclists.

Crash Summary

<u>Summary of Findings</u>

Crash data from January 2002 to December 2004 was provided by KYOVA. The crash data was used to rank the signalized intersections by crash frequency. Crash rates were calculated for the top 20 intersections with the greatest crash frequency. Crash rates calculations were based on entering volumes model estimates, provided by KYOVA, and by counts taken by WVDOT. The crash rates provided are therefore estimates of the crash rate and indicate intersections where further study is recommended.

Crash rates are calculated in units of crashes per million vehicles entering the intersection. The WVDOT categories intersections based on the crash rates as follows:

- Crash rates of 0-1.5 is considered normal.
- Crash rates of 1.5-2.5 indicates the intersection needs studied to identify improvements to enhance safety.
- Rates greater than 2.5 to indicate high priority intersections where changes are needed.

Table 16 shows the crash rates for signalized intersections with the greatest crash frequency, additional information is included in **Appendix L**.

Table 16 – Crash Summary

	Rank	# Of Crashes	Injury Crashes	Fatalities	Severity Ratio	Crash Rate

Safety Study Program

It is recommended that a Traffic Safety Committee be formed to initiate a Safety Study Program for the City. The committee should include the City Safety Coordinator, and representatives from the police department, public works department, planning department, KYOVA and the WVDOT.

Historic traffic crash data should be used to identify crash frequency at both signalized and unsignalized intersections. The committee should identify a benchmark, such as intersections with an average of more than one crash per month, for further investigation.

Once intersections are identified that exceed the crash frequency threshold, counts should be taken to determine the crash rate at these intersections. The count program discussed earlier in this report would provide updated counts, at signalized intersections, every three years. If the intersection crash rate is unacceptable, then the intersection should be studied to identify possible improvements.

Typical elements of a safety study would include a field investigation, a review of police reports, and a collision diagram. The field investigation would include observation to identify obvious safety concerns, such as sight distance issues. Police reports provide information on weather condition, vehicle condition and other contributing factors. A collision diagram would aid in identifying the crash location and type.

5. Evaluation of Signal System and Conclusions

The action items found as a result of this study are presented below. The recommendations have been grouped into short, medium and long term. For this report short term is defined as 0-3 years, medium term 3-10 years and long term as 10-20 years.

1. **Signal Communications.** Because of several interconnect breaks; system communication is no longer working in parts of the City. These breaks cause intersections to operate independently, resulting in inefficiencies, which can in turn result in increased delay, driver irritation, and increased emissions. It is recommended that communication be reestablished. To reestablish communication these breaks could be repaired, replaced in kind, or replaced with another kind of communication equipment. This could be addressed in the short term by repairing the breaks and in the medium term by replacing or upgrading the interconnect.

2. **Aging Infrastructure.** The signal poles at fifteen signalized intersections in the downtown area were installed over 30 years ago. Many of these signal poles are showing signs of deterioration, such as rust, or other damage. Some of the poles have hand hole covers missing, exposing internal wiring to weather and damage. It is recommended that these poles be replaced. As part of a couple of downtown streetscape improvement projects the City has upgraded two similar installations over the last two years, and is preparing to upgrade a third intersection this year. During the field inventory curb ramp layout and crosswalk layout was reviewed, and it was noted that most intersections may have ADA issues. It is recommended that ADA issues be addressed as other intersections improvements are made.

3. **Maintenance.** As part of the field inventory the following maintenance issues were noted; excessive dirt in the controller cabinets, failed loops, and burned out signal bulbs. It is recommended that a routine maintenance program be implemented in the short to medium term to address these issues.

   Further study should also be given to replacing the incandescent bulbs with LED bulbs, in both vehicular and pedestrian signal heads. LED bulbs have a greater initial cost, but have a much longer life expectancy and use considerably less energy. The conversion to LED bulbs could take place over the medium term, with the goal of completing the conversion by the end of the long term.

4. **Optimized Timings.** The traffic flow analysis indicates that the optimized signal timings, presented in this report, will reduce delay, improve

progression, and reduce emissions. During implementation of these timings it will be necessary to observe traffic flow and make manual adjustments. These settings would not be effective though, until repairs have been made to the signal system communications. It is recommended that these timings be implemented over the short term.

In order to maintain optimized timings, it is recommended that the City develop a regular count program for the intersections in the City. This would provide an on-going means of obtaining current traffic information, and allow the opportunity to update signal timings to reflect changes in flows. A program to count each signalized intersection every 2-3 years is recommended, and more frequently if there are known changes that could affect traffic flow. The implementation of the count program is recommended to occur over the short term.

In order to use this count information effectively, it is recommended that the City have signal optimization software (such as Synchro) and the appropriate training to evaluate the existing timings and retime signals as necessary. The purchase of Synchro and training is recommended to occur over the short term.

The existing signal system is a closed loop style system. A closed loop system consists of a master controller at one intersection controlling the operation of other intersections in the group. A central system consists of a single master computer located in a control center and all the signals communicating with it. A central system allows much greater responsiveness to traffic flow. For example, signal grouping can be changed for each signal pattern if necessary. It is recommended the City convert to a central system over the medium to long term to better manage traffic flow. The upgraded system should be compatible with the State ITS architecture.

5. **Crash Locations.** Traffic crash information for Cabell County was provided by KYOVA. This information was filtered and sorted by intersection, to determine the crash frequency at the signalized intersections in the study area. It is recommended that a safety study program be developed in the short term.

The WVDOT is to complete several upgrades and improvements to the City of Huntington Signal System in the summer of 2006. These improvements include replacement of the master controllers and computer in the City's traffic office. The addition of a switching system and phone line will be part of these improvements, and will allow WVDOT as well as City personnel to access the system software remotely. WVDOT also plans to provide a Synchro license to the City and provide training in the use of the software. These improvements will provide City staff additional tools to maintain traffic flow in the City.

This investment by WVDOT will meet or partially meet several of the action items above. The purchase of Synchro, and training in its use, will provide City staff with a tool to evaluate how signal adjustments could affect traffic flows.

In summary, the following are the action items summarized by short term, medium term, and long term projects.

SHORT TERM (0-3 years) PROJECTS:

- Repair or upgrade interconnect
- Improve ADA access
- Perform cabinet maintenance
- Repair or replace loops
- Purchase signal optimization software (and training)
- Implement optimized timings in this report
- Implement intersection count program
- Develop safety study program

MEDIUM TERM (3-10 years) PROJECTS:

- Repair or upgrade interconnect
- Improve ADA accessibility
- Replace signal poles and field equipment
- Repair or replace loops
- Upgrade to LED signal and ped bulbs
- Install central system signal control

LONG TERM (10-20 year) PROJECTS:

- Improve ADA accessibility
- Upgrade to LED signal and ped bulbs
- Install central system signal control

An estimation of the probable cost of implementing the recommendations discussed in this report is provided in **Appendix M**. With the assumption that the recommendations are completed over 16 years, and 4% annual inflation, on average approximately 1 million dollars per year would be required to complete the work. The signals have been placed into groups, representing projects, to complete the recommendations discussed in this report. A listing of the intersections in each signal group are included in **Appendix A** and **Table 1**. The project groupings are intersections in the following areas:

- Downtown (HURA), 15 signals
- Downtown, 24 signals
- East Huntington, 9 signals
- Marshall, 10 signals
- 20th Street, 5 signals
- 31st Street, 7 signals
- 1st Street, 7 signals
- 5th Street, 4 signals
- Central City, 8 signals
- Hal Greer, 8 signals
- Norway, 3 signals
- Solo intersections, 5 signals
- US 60 east, 6 signals
- West Huntington, 4 signals
- WV 152, 3 signals

Figures