Congested Corridor Improvement Program

Carlisle Pike Corridor

Prepared for:

PENNDOT

Pennsylvania Department of Transportation

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DRAFT REPORT
February 2003

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1. Executive Summary

The Pennsylvania Department of Transportation (PENNDOT) initiated the Congested Corridor Improvement Program (CCIP) to identify several congested corridors in the Commonwealth and, in conjunction with its partners, define and implement the needed improvements. The goal of the CCIP is a 20 percent reduction in peak hour travel time on the improved transportation corridor. A Standard Study Methodology (SSM) was developed as part of the CCIP to provide a uniform approach to identify improvements and assess their effectiveness in accordance with the goal of the program. The SSM identifies the steps involved in an engineering study of improvement alternatives and focuses on the use of simulation models as analysis tools to evaluate the operational impacts of improvement alternatives.

A total of 17 corridors were identified for analysis, including the Carlisle Pike corridor in Cumberland County. This corridor, nominated by the Tri-County Regional Planning Commission (TCRPC), is located in PENNDOT Engineering District 8-0.

The Carlisle Pike corridor is located in the Borough of Camp Hill, Hampden Township and Silver Spring Township in Cumberland County. The corridor study limits extend approximately 5 miles from S.R. 114 to the Camp Hill Bypass.

The corridor limits include 17 signalized intersections as follows:

- ❑ Carlisle Pike and S.R. 114
- ❑ Carlisle Pike and Wal-Mart Access
- ❑ Carlisle Pike and Sample Bridge Road
- ❑ Carlisle Pike and Kohl's Access
- ❑ Carlisle Pike and Silver Spring Road/Lambs Gap Road
- ❑ Carlisle Pike and Salem Church Road
- ❑ Carlisle Pike and Skyport Road
- ❑ Carlisle Pike and Brondle Road
- ❑ Carlisle Pike and Kmart Access
- ❑ Carlisle Pike and Van Patten Road
- ❑ Carlisle Pike and Gateway Drive
- ❑ Carlisle Pike and Sporting Hill Road
- ❑ Carlisle Pike and Hampden Centre Access
- ❑ Carlisle Pike and St. Johns Church Road
- ❑ Carlisle Pike and St. Johns Drive
- ❑ Carlisle Pike and Orrs Bridge Road/Central Boulevard
- ❑ Carlisle Pike and 34th Street
- ❑ Carlisle Pike and Camp Hill Bypass

Several on-going transportation projects, which are currently underway in different phases within the study limits, were considered including a highway reconstruction project on S.R. 114 and the design and construction of the St. Johns Church Road interchange with S.R. 581.

1.1. Existing Conditions

An inventory of existing roadway features was developed through available as-built plans, traffic signal permit plans, aerial photography, right-of-way plans, and field observation data for the entire length of the study limits. There are no Intelligent Transportation Systems (ITS) facilities within the study limits of the corridor. Pedestrian facilities are sporadic, and bike facilities are not provided within the project limits.

The Capitol Area Transit Authority is the provider of mass transit service for the Cumberland County area. There are 3 unmarked transit stops in each direction within the study limits. Transit turn-outs or pull-outs are not provided. The corridor is serviced by other various commercial transit companies but has no rail transit facilities. There is also one park-n-ride facility at the Kmart Access.

A comprehensive traffic data collection effort was undertaken to establish base operational conditions for the corridor. This effort included mainline traffic volume counts, manual intersection turning movement counts, and a travel time study. The mainline traffic volume counts were conducted for a period of one full week from October 18, 2002 to October 25, 2002 using Automatic Traffic Recording (ATR) devices. Vehicle and pedestrian turning movement counts were performed at the 17 signalized intersections for the AM peak period (6:00 AM to 9:00 AM), Mid-day peak period (11:00 AM to 1:00 PM), PM peak period (3:00 PM to 6:00 PM), and Saturday peak period (11:00 to 1:00 PM) from October 15, 2002 to November 16, 2002. The travel time studies were performed from November 6, 2002 to November 21, 2002 using the procedures described in the Travel Time and Delay Study guidelines in the ITE Manual of Transportation Engineering Studies.

The entire corridor was analyzed using the AM, Mid-day, PM, and Saturday peak hour volumes and the traffic analysis and simulation software packages of Synchro and SimTraffic. The packages were calibrated to match the baseline travel time study. The highest simulated travel times occurred in the both directions during the Saturday peak hour (20 minutes eastbound and 22 minutes westbound).

The software package of Synchro 5.0 was used to determine the Levels of Service (LOS) at each of the signalized intersections. The Percentile Delay Method was used to determine the intersection control delay. The LOS measurements indicate that intersections operating at LOS D or worse include four (4) during the AM peak hour, three (3) during the Mid-day peak hour, six (6) during the PM peak hour, and four (4) during the Saturday peak hour.

The reported crashes within the study limits were reviewed for the past five (5) years of available data from the PENNDOT database. A study of the crash data for the corridor identified the highest concentration of reportable crashes at the following intersections:

- Carlisle Pike and Silver Spring Road/Lambs Gap Road
- Carlisle Pike and Sporting Hill Road
- Carlisle Pike and S.R. 114

A safety audit was also conducted to assess the crash potential and safety performance of the corridor. The goal was to identify safety related issues that may contribute to roadway congestion.

1.2. 2012 No-Build Conditions

A 10-year design year was chosen for the portion of this study that focuses on the Short- to Mid-term improvements. Existing traffic volumes were utilized for identifying Immediate-term improvements that largely address traffic signal timing changes to the existing systems. Traffic volumes for any major roadway projects that fall under the Long-term improvement alternatives will most likely need to be projected to a 20-year design year for further analysis under a separate effort. The existing traffic volumes were projected to the design year using a 0.62 percent per year growth factor, based on planning information from TCRPC.

As with the existing conditions, the entire corridor was analyzed using the AM, Mid-day, PM, and Saturday peak hour volumes. For the purpose of evaluating Immediate-term improvements, an off-peak period was also analyzed. The simulated travel times increase 1 minute during the peak hours. The number of intersections operating at LOS D or worse stays the same during the AM peak hour, increases from 3 to 4 during the Mid-Day peak hour, 6 to 7 during the PM peak hour, and 4 to 5 during the Saturday peak hour.

1.3. Summary of Adverse Conditions

The Carlisle Pike has significant importance to the commuting public, is an important link for the movement of goods, and serves as one of the primary access roadways for Camp Hill Borough, Hampden Township and Silver Spring Township. Being a major commuter route, the study corridor is subject to recurring peak period traffic congestion.

As indicated earlier, many intersections will operate at LOS D or worse in the year 2012 during one or more peak hour periods, including the following:

- Carlisle Pike at S.R. 114
- Carlisle Pike at Salem Church Road
- Carlisle Pike at Skyport Road
- Carlisle Pike at Kmart Access

- Carlisle Pike at Gateway Drive
- Carlisle Pike at Sporting Hill Road
- Carlisle Pike at Orrs Bridge Road/Central Boulevard
- Carlisle pike at Camp Hill Bypass

In addition, there are several corridor-wide issues in the corridor including:

- **Access Management** – There are nearly 30 access points per mile in each direction that affect mobility during peak periods.
- **Physical Facility Conditions** – Traffic control measures are in poor condition or missing in some areas. Lack of striping, lane assignment signs, and street signs can cause driver confusion and contribute to congestion.
- **Signal Systems** – Currently, there are three signal systems along the Carlisle Pike corridor. Two systems function with similar characteristics, cycle length and share the same type of equipment, but are not interconnected. This results in poor progression between systems.
- **Transit Considerations** – Bus transit can play a major part in improving congestion problems if used properly. Currently, there is transit service along the corridor, but it along with park-n-ride services is not apparent among corridor travelers.

1.4. Alternatives Analysis

The alternatives in this study were divided into Immediate-, Short-, Mid-, and Long-term improvements. The assumed time to implement for each category of improvement is as follows:

- Immediate – Less than 1 year
- Short – 1 to 3 years
- Mid – 3 to 10 years
- Long – Greater than 10 years.

The Immediate- and Short-term improvements require a minimum time framework to implement, and therefore can be completed within the schedule of the CCIP. The Mid- and Long-term improvements may require thorough planning and extensive design, which may require special environmental consideration and right-of-way acquisition, and therefore may not be completed within the schedule of the CCIP.

1.4.1. Identification of Immediate-Term Improvement Alternatives

The following Immediate-term solutions may be applicable to the corridor as part of this program, and were evaluated as part of this study:

- ❑ Minor signing and pavement marking improvements.
- ❑ Signal timing modifications to existing signals and signal systems.
- ❑ Minor intermodal enhancements.

Considering the above potential solutions, several corridor wide improvements have been identified, including:

- ❑ Traffic Signal Retiming – Poor operational performance at the signalized intersections may be improved through traffic signal timing improvements. All traffic signal timings were optimized based on an iterative process utilizing the Synchro software package.
- ❑ Coordinate the two western most systems –. Coordination will increase the chance of encountering a larger bandwidth for that area of the corridor.
- ❑ Mast Arm Mounted Street Name Signs – The installation of mast arm, or span wire, mounted street name signs will reduce driver confusion.

In addition, the following intersection specific improvements have been identified for the Immediate-term:

- ❑ Carlisle Pike and S.R. 114 – install pavement markings to delineate lane assignments and install near side left-turn signals
- ❑ Carlisle pike and Wal-Mart Access – Program a westbound right-turn overlap phase
- ❑ Carlisle Pike and Kohl's Access – Install a dedicated right-turn lane at the unsignalized intersection to Kohl's and prohibit truck parking on shoulders in this area.
- ❑ Carlisle Pike and Silver Spring Road/Lambs Gap Road – Evaluate visibility of signal indications.
- ❑ Carlisle Pike and Salem Church Road – Delineate the northbound approach lanes.
- ❑ Carlisle Pike and Brondle Road – Install a traffic-channelizing device for overlapping mid-block turning movements for Hooter's and Hampden Commons.
- ❑ Carlisle Pike and Kmart Access – Lengthen the westbound left-turn lane, replace all missing yield signs and make the driveways between Kmart Access and Van Patten Road right-in/right-out movements.
- ❑ Carlisle Pike and Gateway Drive – Install a nearside eastbound signal head and coordinate lane assignments with study for northbound approach.
- ❑ Carlisle Pike and Sporting Hill Road – Lengthen the northbound left-turn lane.
- ❑ Carlisle Pike and Hampden Centre Access – Meter the mainline traffic to increase efficiency of Sporting Hill Road.
- ❑ Carlisle Pike and St. Johns Church Road – Lengthen the northbound left-turn lane.
- ❑ Carlisle pike and St. Johns Drive – Install signing to restrict truck traffic.

- ❑ Carlisle Pike and Orrs Bridge Road/Central Boulevard – Lengthen the westbound right-turn lane length.
- ❑ Carlisle Pike and 34th Street – Install a new controller assembly and evaluate the lane configuration.
- ❑ Carlisle Pike and Camp Hill Bypass – Coordinate with corridor study.

1.4.2. Analysis of Immediate-Term Improvement Alternatives

The entire corridor was analyzed using the AM, Mid-day, PM, and Saturday existing peak hour volumes and compared to the existing no-build conditions. The network included the corridor-wide and intersection specific improvements described above, where applicable. The simulated travel times experience a reduction of 0 to 2 minutes (0% to 12%), with the largest benefits shown in the westbound and eastbound direction during the PM peak hour. The arterial LOS did not improve or decrease for any time periods, however 12 intersections experienced an improvement in LOS during one or more peak periods.

1.4.3. Identification of Short-Term Improvements

The following Short-term solutions may be applicable to the corridor as part of this program, and were evaluated as part of this study:

- ❑ Signing and pavement marking improvements.
- ❑ Signal timing modifications to existing signals and signal systems.
- ❑ Minor geometric improvements within the existing right-of-way.

Considering the above potential solutions, several corridor wide improvements have been identified, including:

- ❑ Traffic Signal Retiming – Periodic updating of the traffic signal timings to respond to changes in traffic demands will allow the corridor to operate at peak efficiency.
- ❑ Delineation Plan for Corridor – Providing adequate delineation, through the placement of improved pavement markings, increases driver awareness.
- ❑ Advertising for Kmart Park-n-Ride – There is an existing Park-n-Ride lot in the southwest quadrant of the Kmart Access that currently has only one sign depicting it. Better advertising this lot may increase its usage.
- ❑ Transit Development –There are no transit stops along the corridor at many of the population centers. Increasing the amount of stops along the corridor at popular destinations can reduce the congestion with the corridor by making the routes convenient and user friendly.

In addition, the following intersection specific improvements have been identified for the Short-term:

- ❑ Carlisle Pike and Silver Spring Road/Lambs Gap Road – Begin the eastbound left-turn lane prior to the Silver Spring Road signal head and add highway lighting.

- ❑ Carlisle Pike and Skyport Road – Remove the Pep Boys access and make Skyport road a T intersection.
- ❑ Carlisle Pike and Brondle Road – Make all access points between Skyport Road and Brondle Road in the eastbound direction right-in-right-out.
- ❑ Carlisle Pike and Gateway Drive – Install better delineation for lane assignments between Van Patten Road and Gateway Drive.
- ❑ Carlisle Pike and Sporting Hill Road – Make all of the eastbound access points right-in-right-out between Sporting Hill Road and Hampden Centre access.
- ❑ Carlisle Pike and Hampden Centre – Combine the Firestone and Superpetz access points and eliminate the existing firestone access.
- ❑ Carlisle Pike and 34th Street – Add a northbound right-turn lane in conjunction with the adjacent development.

1.4.4. Analysis of Short-Term Improvement Alternatives

The entire corridor was analyzed using the AM, Mid-day, PM, and Saturday peak hour volumes for the design year and compared to the 2012 no-build conditions. The network included the corridor-wide and intersection specific improvements described above, where applicable. The simulated travel times experience a reduction of 1 to 3 minutes (5% to 17%), with the largest benefits shown in the eastbound and westbound direction during the PM peak hour and eastbound during the Saturday peak hour. The arterial LOS improved one letter grade for the AM eastbound, PM eastbound and Mid-day westbound peak hour (C to B). Fifteen intersections experienced an improvement in LOS during one or more peak periods.

1.4.5. Identification of Mid-Term Improvements

The following Mid-term solutions may be applicable to the corridor as part of this program, and were evaluated as part of this study:

- ❑ Geometric improvements requiring right-of-way, including major intersection modifications.
- ❑ Multi-jurisdictional improvements including inter-jurisdictional signal systems.

Considering the above potential solutions, several corridor wide improvements have been identified, including:

- ❑ Traffic Signal Retiming – Periodic updating of the traffic signal timings to respond to changes in traffic demands will allow the corridor to operate at peak efficiency.
- ❑ Inter-Jurisdictional Traffic Signal System – These types of systems allow maximum coordination of traffic signals between municipalities, providing the ability for efficient response to changing traffic situations.
- ❑ Park-n-Ride Services – Implementation of park-n-ride facilities within existing parking areas near S.R. 114, Gateway Drive, Hampden Centre, Camp Hill Mall can

reduce the number of single occupancy vehicles in the corridor, thereby reducing congestion.

- ❑ Impact Fee Assessment Plan – The implementation of a Traffic Impact Fee Ordinance will allow municipalities to collect fees from developers for needed transportation infrastructure improvements.
- ❑ Access Management Plan – Minimizing the number of driveways along the corridor will reduce conflict points and alleviate congestion.

In addition, the following intersection specific improvements have been identified for the Mid-term:

- ❑ Carlisle Pike and S.R. 114 – Construct double left-turn lanes for the east and westbound directions and improve the lane transition area to the south.
- ❑ Carlisle Pike and Sporting Hill Road – Construct northbound double left-turn lanes, widen the westbound approach to include a shared thru/right lane and widen the westbound receiving lanes to two (2) travel lanes.

1.4.6. Analysis of Mid-Term Improvement Alternatives

The entire corridor was analyzed using the AM, Mid-day, PM, and Saturday peak hour volumes for the design year and compared to the 2012 no-build conditions. The network included the corridor-wide and intersection specific improvements described above, where applicable. The simulated travel times experience a reduction of 1 to 4 minutes (7% to 21%), with the largest benefits shown in both directions for the Saturday peak hour and in the westbound direction during the PM peak hour. The arterial LOS improved to B for each time period except the PM westbound, which remained a C. Fifteen intersections experienced an improvement in LOS during one or more peak periods as compared to the Short-term model.

1.4.7. Identification of Long-Term Improvements

Long-term improvements were those identified as requiring more detailed analysis and documentation to demonstrate their need and benefit. They are improvements that would not be able to be completed within the framework of the CCIP, and generally consist of major or new roadway construction that incur significant costs. Considering these parameters, the following long-term improvements have been identified:

- ❑ Realignment of Lambs Gap Road to connect to Salem Church Road – Close the existing Lambs Gap Road connection to the Carlisle Pike and re-route traffic to Salem Church Road.
- ❑ Close Donald Road – Re-route traffic through a shared Party City and Radio Shack parking area to the Kmart Access signal.
- ❑ Construct a connector Road to the north of Carlisle Pike between Sporting Hill Road and St. Johns Church Road.

- Realign Central Boulevard to make Orrs Bridge Road a standard intersection configuration.
- Development of ITS – The construction of an incident detection system at critical junctions such as PA 114, Gateway Drive and Camp Hill Bypass as well as along neighboring roadways including SR 581 and I-81 would provide a tool to detect and monitor incidents.

1.4.8. Analysis of Long-Term Improvement Alternatives

The entire corridor was analyzed using the AM, Mid-day, PM, and Saturday peak hour volumes for the design year and compared to the 2012 no-build conditions. The network included the corridor-wide and intersection specific improvements described above, where applicable. The simulated travel times experience a reduction of 2 to 6 minutes (13% to 29%) with the largest benefits shown in both directions for the Saturday peak hour and in the westbound direction during the PM peak hour. The arterial LOS improved to a B for all time periods. The intersection LOS was improved to acceptable levels for all intersections except Gateway Drive in the PM peak period and Camp Hill Bypass in all time periods.

1.5. Findings

The immediate-, short, mid, and long-term improvement alternatives address the needs and objectives of this project. However, at this time, the immediate- and short-term improvements have the ability to be developed and constructed within the length of this program, and are therefore the focus of this study. The mid- and long-term improvement alternatives are outside the scope of this program and should be studied further under a separate effort.

The goal of the CCIP is to reduce peak hour travel time on the improved corridor by a factor of 20 percent. The modeled implementation of the immediate- and short-term improvements results in a 21 percent improvement in travel time during the most congested period (Saturday peak hour). Many of the improvements offered do not have the ability to be modeled in the software, but it is anticipated that they will further enhance the operation and safety of the corridor. The mid- and long-term improvements can reduce peak hour travel time by 29 percent. Similarly, there are other improvements outlined for this time frame that cannot be modeled in the software but will likely further enhance the operation and safety of the corridor.

This report identifies some of the needs within the corridor and specific projects that may help to address those needs. The projects can be prioritized base on the benefit/cost analysis provided in this report. The immediate- and short-term improvement alternatives are ready to be moved into the next steps, which in some cases mean final design. The extensive amount of traffic data collected for this report and traffic software input can be utilized for the next steps if the projects are procured within the next two years.

The following table provides a summary of the immediate-, short-, and mid-term improvement alternatives and their associated costs.

Alternative Recommendation	Scenario	Cost
Retime the existing signal systems	Immediate	$1,600
Begin eastbound left-turn lane prior to Silver Spring Road	Short-term	$2,000
Remove Pep Boys access at Skyport Rd	Short-term	$3,700
Add northbound right-turn lane at 34th Street	Short-term	$9,600
Construct eastbound and westbound double left-turn lanes and construct transition area on south leg at the S.R. 114 intersection.	Mid-term	$75,600
Construct northbound double left turns, a second westbound receiving lane and a second westbound approach thru/shared right lane at the Sporting Hill Road Intersection.	Mid-term	$405,700

2. Introduction

2.1. Background

The Pennsylvania Department of Transportation (PENNDOT) initiated a pilot Congested Corridor Improvement Program (CCIP) to identify congested corridors in the Commonwealth and, in conjunction with its partners, define and implement the needed improvements. **The goal of the CCIP is a 20 percent reduction in peak hour travel time** on the improved transportation corridor. The proposed improvements are directed at activities such as roadway geometry, signal operations, access management, multimodal initiatives, Intelligent Transportation Systems (ITS), traffic regulation techniques, Transportation Demand Management (TDM) measures, and planning and zoning practices that are appropriate for a particular transportation corridor. Transportation corridors and associated improvements are identified in partnership with Metropolitan Planning Organizations (MPOs) and Local Development Districts (LDDs), including utilization of existing congestion management systems, which some MPOs/LDDs have already developed.

The CCIP initiative resulted from PENNDOT's recent strategic planning process, the "Moving Pennsylvania Forward Update." It falls under the Mobility and Access Strategic Focus Area and the High-Level Goal of Efficient Movement of People and Goods. In addition, this congested corridor initiative is consistent with the principles of regional and corridor-based planning advocated by PennPlan (Pennsylvania's Statewide Long-Range Transportation Plan) and Pennsylvania's Highway Congestion Management Strategic Plan, which was developed with input from the planning partners and other stakeholders. Further information on PennPlan can be found on PENNDOT's website (www.dot.state.pa.us) under General Information – Programs and Initiatives.

The study costs are funded by PENNDOT. However, the actual implementation of the recommended improvements, including final design and construction costs, are funded through the 12-Year Program. For this reason, only corridors that receive planning partner support for placement on the Transportation Improvement Plan (TIP) and the 12-Year Program for design and construction were considered for this initiative.

PENNDOT requested each planning partner to nominate and submit information by December 31, 2000 for a maximum of two corridors in their region for possible inclusion in this pilot program. Southwestern Pennsylvania Commission (SPC), Delaware Valley Regional Planning Commission (DVRPC), and Tri-County Regional Planning Commission (TCRPC) were permitted to nominate a maximum of four corridors. PENNDOT identified certain criteria to determine which congested corridors should be nominated for a particular region. Using these criteria, the planning partners were asked to provide information about each of the corridors they nominated. PENNDOT received

a total of 38 nominations from 17 of the 23 planning partners throughout the Commonwealth.

Review meetings were scheduled with the planning partners to discuss the nominations and obtain additional information on the nominated corridors in order to fully evaluate them for inclusion in the program. A 'Nomination Checklist' was distributed to each of the planning partners in advance of the review meetings to identify criteria that may not have been addressed in the original nomination report. In addition to completing each checklist, the meetings provided a forum to discuss the background of each corridor, refine the limits if warranted, identify risk factors that may preclude achievement of program goals, and discuss potential solutions.

The corridors were evaluated and selected based on their suitability for the program and stakeholder commitments. There are currently 17 corridors included in the program including the Carlisle Pike corridor. The design funds for each corridor were placed in the TIP.

2.2. Standard Study Methodology

In addition to identifying congested corridors throughout the Commonwealth, the Department also developed a Standard Study Methodology (SSM) to identify improvements and assess their effectiveness in achieving the program goal of reducing peak hour travel time by 20 percent. This document describes the application of the SSM to the selected corridors and identifies criteria such as improvement alternatives, selection of analytical tools, data collection requirements, and measures of effectiveness.

In the past, these corridors were of local interest and typically studied on an individual basis. However, the increasingly complex problems in transportation are becoming of wide interest and are best studied through a coordinated approach. The SSM identifies the steps involved in an engineering study of improvement alternatives and focuses on the use of simulation models as analysis tools to evaluate the operational impacts of those alternatives.

The engineering study process is typically initiated after operational or safety concerns are identified. In urbanized areas with a population over 200,000, transportation concerns may be identified as part of the Congestion Management System (CMS), but smaller areas may identify concerns in local corridors through experience. The corridors involved in this program were identified through written correspondence from the MPO or LDD to PENNDOT upon a request to nominate a limited number of corridors within their boundaries. The written nominations from the MPOs/LDDs contain a description of the corridor and identified potential improvements. The goal of the SSM is to identify the most cost-effective solutions to improve the peak hour travel time on the selected corridor.

The SSM consists of multiple tasks in three specific stages, which are shown in **Exhibit 2.1**. The first stage is the identification of viable alternatives. This stage includes coordination with the multiple stakeholders to identify problems and proposed solutions. Because many engineering studies are integral to a larger, more comprehensive process in which all transportation facilities are considered, it is vital that the steps are coordinated with all the stakeholders throughout the process to ensure success of this methodology. With this in mind, discrete steps were identified that call for consensus from the project team before moving further. The second stage consists of the engineering study, which includes selection of analytic tools, data collection, and analysis. Finally, the best alternatives are identified for their effectiveness and documented.

During the identification of viable alternatives, a preliminary assessment of the bottlenecks and congested areas is made with the stakeholders, and improvement alternatives are identified. Baseline measurements are obtained to establish existing conditions and to determine bottleneck locations. The baseline conditions are critical to measure the effectiveness of alternatives and will be revisited throughout the program. Improvement alternatives consist of geometric, signal operations, access management, multimodal, ITS, traffic regulation, TDM, and planning and zoning practice improvements. Alternatives that could address the concerns are identified, and then the list of alternatives is reduced to include the most viable alternatives.

During the engineering study, the viable alternatives are evaluated in terms of their effect on travel time and other factors. The accurate assessment of these alternatives requires the application of formal analysis procedures, such as software applications. This stage will also require a data collection effort to supplement the analysis. The extent of the data collection effort should be identified up front and will depend on the amount of existing information that is recent and available. The traffic volumes are then projected for the future design year.

During the alternative selection stage, the alternatives are assessed and selected for implementation. The comparison of alternatives includes existing conditions; future no-build (includes planned projects that will be constructed within 10 years) and future build alternatives (no-build plus the alternatives). It is anticipated that there will be short-term and long-term improvement alternatives. In some cases, immediate improvements such as traffic signal timing optimization may be identified. The assessment should be focused on travel time, but it may consider other factors such as safety, disruption to the environment and adjacent property, and cost. Safety impacts may be based on informal assessment or formal quantitative evaluation, depending upon the location. Selection of alternatives may reflect construction costs as well. The methods used to determine the preferred alternatives will vary based on location and should be based upon all relevant facts. Finally, the study process is documented in a study report that includes the relevant findings and identified course of action.

Although the goal of this study is to reduce congestion by 20 percent, all alternatives considered were evaluated to ensure that they are "reasonable and feasible."

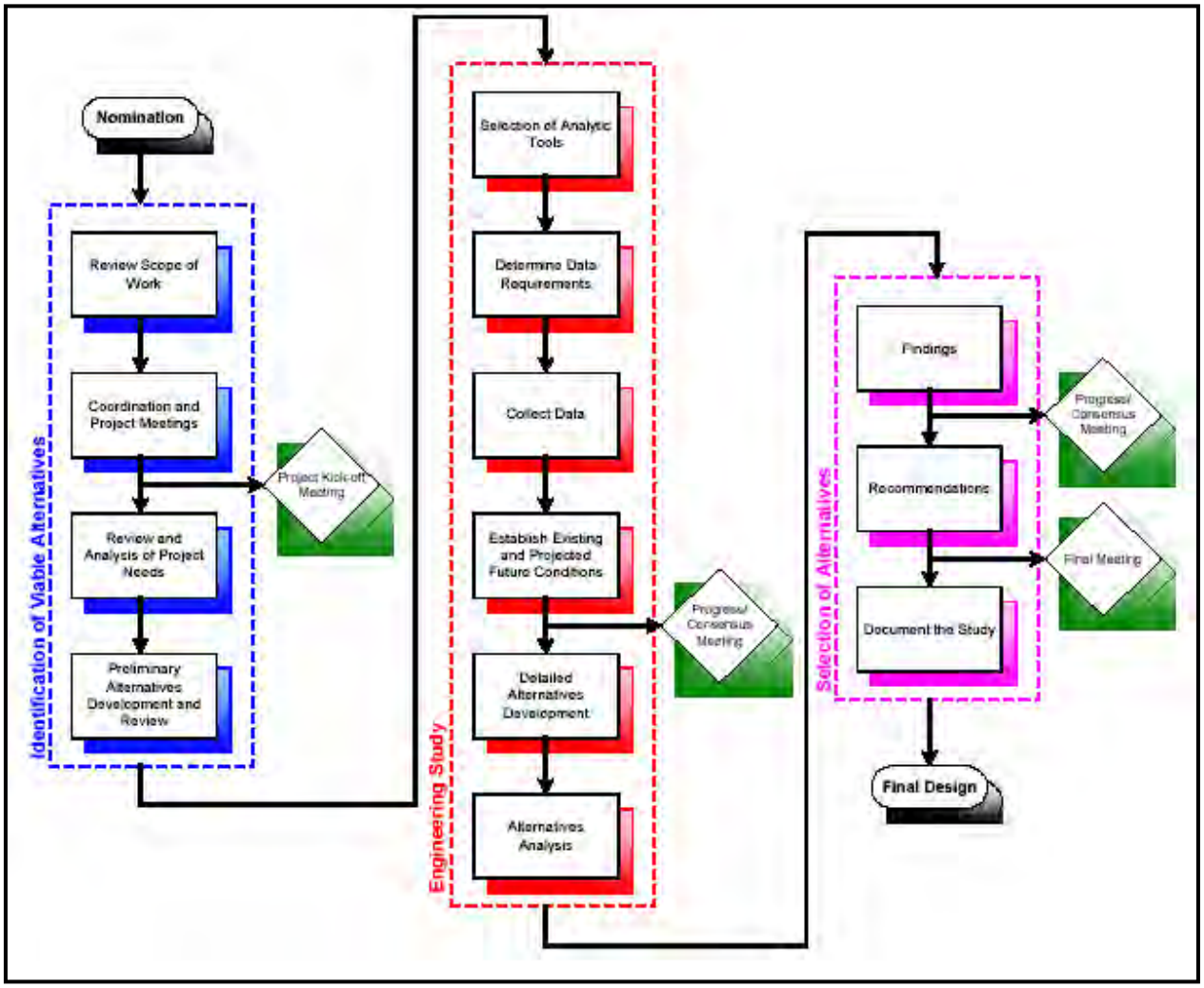

Exhibit 2.1 Standard Study Methodology Flowchart

2.3. Study Area

The Carlisle Pike corridor is located in PENNDOT Engineering District 8-0 within Cumberland County. The corridor extends from S.R. 114 in Silver Spring Township to the Camp Hill Bypass in the Borough of Camp Hill as presented in **Exhibit 2.2**. The study corridor travels through several municipalities including: Silver Spring Township, Hampden Township and Camp Hill Borough. The study corridor is 5 miles in length and includes 18 signalized intersections.

Several state routes intersect the study corridor including: S.R. 114, Silver Spring Rd./Lambs Gap Rd. (S.R. 1011), Sporting Hill Road (S.R. 1013), St. Johns Church Rd. (S.R. 2029) and Central Blvd./Orrs Bridge Rd. (S.R. 1021). The Carlisle Pike corridor is designated as S.R. 11 from S.R. 114 to Gateway Drive, S.R. 1010 from Gateway Drive to the Camp Hill Borough boundary and as Market Street in Camp Hill Borough. The corridor parallels the S.R. 581/I-81 corridor, which is a restricted access roadway system.

There are two distinctly different roadway sections for this corridor. In the western section from S.R. 114 to Gateway Drive, the roadway cross section consists of 2 travel lanes in each direction and a center left-turn lane. In the eastern portion of the corridor, from Gateway Drive to the Camp Hill Bypass, the roadway cross section consists of one travel lane in each direction with a center left-turn lane. The only exception to this cross section is a short segment of two-lane travel eastbound with no center left-turn lane in and near Camp Hill Borough. The posted speed limit for this corridor is 35 miles per hour in Camp Hill Borough and 40 miles per hour for the remainder of the study area. There are three signal systems along the corridor in Silver Spring and Hampden Townships and a single isolated intersection (34th Street). The signal at the intersection of the Camp Hill Bypass is interconnected with adjacent signals on the Camp Hill Bypass. The condition of signal equipment varies throughout the corridor.

There are a number of closely spaced traffic signals in the commercialized area near the central part of the corridor resulting in noticeable levels of congestion. From Gateway Drive to Orrs Bridge Road traffic does not flow as smoothly and traffic congestion occurs at peak hours due to signal proximity and existing cross-section limitations.

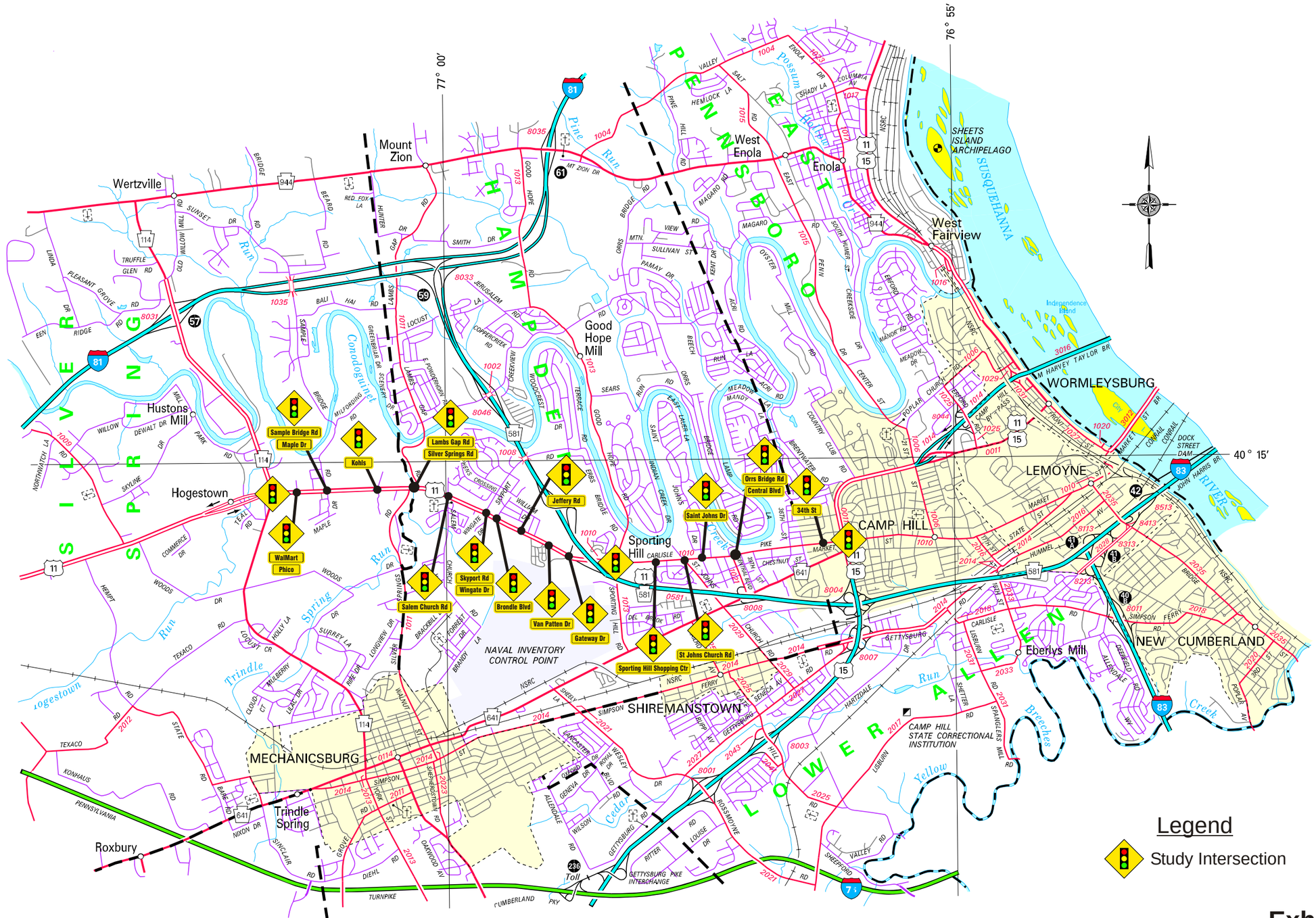

Exhibit 2.2

Location Map
Carlisle Pike

PENNDOT

Gannett Fleming

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2.4. Stakeholder Process

A stakeholder group was formed consisting of the Tri-County Regional Planning Commission, PENNDOT, and local municipalities. The purpose of the group was to help identify areas of concern, identify planned improvements, brainstorm potential solutions and provide feedback on the overall project. Study stakeholders included:

- ❑ Ed Olivieri, PENNDOT Bureau of Highway Safety & Traffic Engineering
- ❑ Ron Jones, PENNDOT Engineering District 8-0
- ❑ Diane Meyers-Krug, Tri-County Regional Planning Commission (TCRPC)
- ❑ Kelley Kelch, Silver Spring Township
- ❑ John Bradley, Hampden Township
- ❑ Jerry Spease, Hampden Township
- ❑ Ed Knittel, Borough of Camp Hill
- ❑ Mark Metil, Gannett Fleming
- ❑ Bob Taylor, Gannett Fleming
- ❑ Eric Rensel, Gannett Fleming

Three meetings were held with stakeholder group. Meeting 1 focused on the project, areas of concern and planned improvements. Meeting 2 focused on existing conditions of the corridor. The final meeting provided a review of identified preferred improvements and actions items.

Following the first meeting, a windshield tour of the study corridor was conducted with study stakeholders. During the windshield tour specific corridor issues were discussed and observed. The tour served as a valuable tool in identifying **areas of concern**, identifying **planned development and improvement**s and **brainstorming potential solutions**.

Meeting 1 – November 2002	↳ Stakeholder introductions ↳ Project introduction and overview ↳ Review of project schedule and milestones ↳ Discussion of existing conditions ↳ Discussion of possible planned improvements ↳ Discussion of possible future corridor changes ↳ Windshield tour of corridor
Meeting 2 – December 2002	↳ Data collection summary ↳ Existing Levels of Service ↳ Growth rate ↳ Future Levels of Service ↳ Synchro analysis ↳ Crash data summary ↳ Safety audit summary ↳ Comprehensive plan summary ↳ Windshield tour matrix
Meeting 3 – February 2002	↳ Summary of study progression ↳ Future "No Build" Conditions ↳ Immediate Improvements ↳ Short-term Improvements ↳ Long-term Improvements ↳ Discussion of Improvements ↳ Steps to complete program

2.5. Concurrent Projects

There are several improvement initiatives underway within or in close proximity to the study area. The most significant planned improvements impacting the study are listed below.

Project	Description	Status
Planned design of St. Johns Church Road Interchange	↳ Completion of S.R. 581 Interchange into a fully functional interchange	This project is funded through the preliminary engineering phase
S.R. 114 Expressway repaving	↳ Highway restoration from Carlisle Pike to the I-81 Interchange	Construction to take place in summer 2003

3. Existing Conditions

3.1. Roadway and Corridor Characteristics

3.1.1. Roadway Classifications

Roadway classification of the Carlisle Pike as well as intersecting roadways was taken from PENNDOT's Straight Line Diagrams and is highlighted on **Exhibit 3.1**. The Carlisle Pike is designated as an urban principal arterial roadway.

3.1.2. Posted Speed Limits

Posted speed limit data was gathered from signal permit sheets and was field verified. Posted speed limits are noted in **Exhibit 3.1.** Generally, speeds range from 35 to 40 mph.

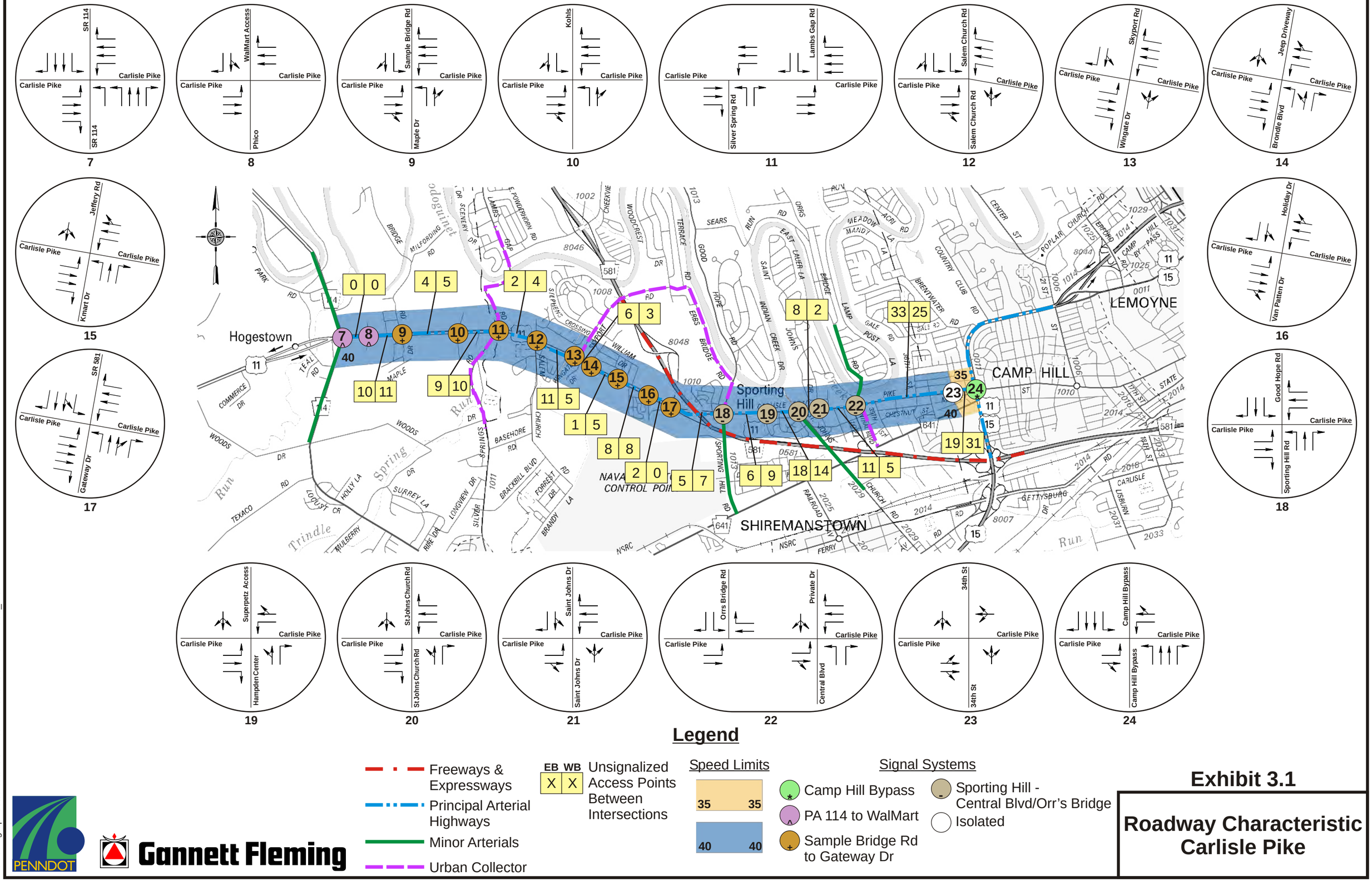
3.1.3. Unsignalized Access Points

Unsignalized access can directly impact corridor operations. The *Highway Capacity Manual* provides guidance on the impact access points have on roadway operations. For that reason, access points along the study corridor were inventoried and are noted in **Exhibit 3.1**.

3.1.4. Roadway Geometry

3.1.4.1. Intersection Lane Configurations

Intersection lane configurations were inventoried utilizing signal permit plans and a field review. Lane configurations for each study intersection are presented in **Exhibit 3.1**



Legend

- Freeways & Expressways
- Principal Arterial Highways
- Minor Arterials
- Urban Collector

EB WB — Unsignalized Access Points Between Intersections

Speed Limits: 35 35 / 40 40

Signal Systems
- Camp Hill Bypass
- PA 114 to WalMart
- Sample Bridge Rd to Gateway Dr
- Sporting Hill - Central Blvd/Orr's Bridge
- Isolated

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Exhibit 3.1

Roadway Characteristic Carlisle Pike

\40604\graphics\cdr\Carlisle Pike\11x17\Carlisle Pike Exhibit 3_1.cdr

3.1.4.2. Roadway Mapping Development

The mapping for this project was developed from aerial photogrammetry, signal permit plans and right-of-way plans where possible. Right-of-way drawings for the Carlisle Pike corridor from S.R. 114 to Gateway Drive were obtained and the legal right-of-way varies from 90 feet to 150 feet. Right-of-way drawings for the Carlisle Pike from Gateway Drive to the Camp Hill Bypass were obtained and the drawings dated 1931 indicated a 50 foot legal right-of-way. However, later signal permit plans indicate that the right-of-way in some areas is larger than the 1931 plans. Intermediate plans could not be obtained to confirm or deny this conflict. To provide a composite drawing that could be analyzed, the aerials and signal permit plans were combined. The right-of-way plans were used to verify the existing right-of-way at each intersection and provide right-of-way guidance for any area not covered on the signal permit plans. If right-of-way dimensions were not present on the signal permit plans, existing information obtained from the District 8-0 Right-of-Way Unit was considered applicable. If right-of-way dimensions were shown on the signal permit plans, that dimension was considered to be applicable since in all cases the dates for the signal permit plans were more current than the right-of-way plans provided. Before any implementation of any proposed work in this text or part of this program involving right-of-way acquisition is implemented, detailed right-of-way research must be completed for each occurrence of construction. **The right-of-way referred to herein is stated strictly to provide a basis of magnitude for implementing any proposed work. The right-of-way indicated is not a statement of ownership and does not assume ownership by any party.**

3.1.5. Signalized Intersections and Signal Systems

The Carlisle Pike Corridor is comprised of 18 signalized intersections and three signal systems as depicted in **Exhibit 3.1.** The age and variety of signal equipment varies throughout the corridor. **Exhibit 3.2** summarizes the operation and type of controller at each signalized intersection.

Exhibit 3.2 Carlisle Pike Signalized Intersections

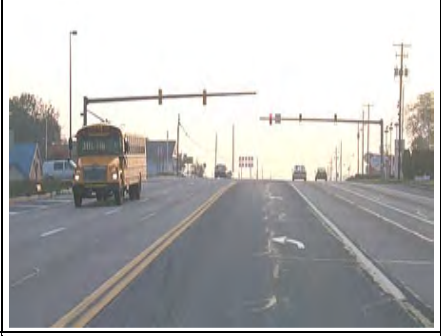
Intersection	Photo	Municipality	Controller	Model	Existing System and Cycle Lengths	Phasing
S.R. 114		Silver Spring	IDC	Multisonic 820A	Silver Spring Township System AM: 120 sec MID: 125 sec PM: 160 sec SAT: 140 sec	Carlisle Pike: Protected lefts SR 114: Protected lefts
Wal-Mart		Silver Spring	IDC	Multisonic 820A	Silver Spring Township System AM: 120 sec MID: 125 sec PM: 160 sec SAT: 140 sec	Carlisle Pike: Protected lead left EB Permitted left WB Wal-Mart/PHICO: Permitted lefts
Sample Bridge Road		Silver Spring	IDC	Multisonic 820A	Silver Spring/ Hampden System AM: 120 sec MID: 125 sec PM: 160 sec SAT: 140 sec	Carlisle Pike: Protected/Permitted lefts Sample Bridge: Permitted lefts

Exhibit 3.2 Carlisle Pike Signalized Intersections

Intersection	Photo	Municipality	Controller	Model	Existing System and Cycle Lengths	Phasing
Kohls Access		Silver Spring	IDC	Multisonic 820A	Silver Spring/ Hampden System AM: 120 sec MID: 125 sec PM: 160 sec SAT: 140 sec	Carlisle Pike: Protected/Permitted lefts Kohl's Access: Permitted lefts
Silver Spring/Lambs Gap		Silver Spring/Hampden	IDC	Multisonic 820A	Silver Spring/ Hampden System AM: 120 sec MID: 125 sec PM: 160 sec SAT: 140 sec	Carlisle Pike: Protected/Permitted lefts Silver Spring/Lamb's Gap: Split -offset intersection
Salem Church Road		Hampden	IDC	Multisonic 820A	Silver Spring/ Hampden System AM: 120 sec MID: 125 sec PM: 160 sec SAT: 140 sec	Carlisle Pike: Protected/Permitted lefts Salem Church: Split phased SB left Permitted NB left

Exhibit 3.2 Carlisle Pike Signalized Intersections

Intersection	Photo	Municipality	Controller	Model	Existing System and Cycle Lengths	Phasing
Skyport Road		Hampden	IDC	Multisonic 820A	Silver Spring/ Hampden System AM: 120 sec MID: 125 sec PM: 160 sec SAT: 140 sec	Carlisle Pike: Protected/Permitted lefts Skyport: Permitted lefts Permitted overlap phase for SB right
Brondle Road		Hampden	IDC	Multisonic 820A	Silver Spring/ Hampden System AM: 120 sec MID: 125 sec PM: 160 sec SAT: 140 sec	Carlisle Pike: Protected/Permitted lefts EB free right Brondle Road: Split phase for NB left NB free right
Kmart Access		Hampden	IDC	Multisonic 820A	Silver Spring/ Hampden System AM: 120 sec MID: 125 sec PM: 160 sec SAT: 140 sec	Carlisle Pike: Protected/Permitted lefts EB free right Kmart Access: Permitted lefts NB free right

Exhibit 3.2 Carlisle Pike Signalized Intersections

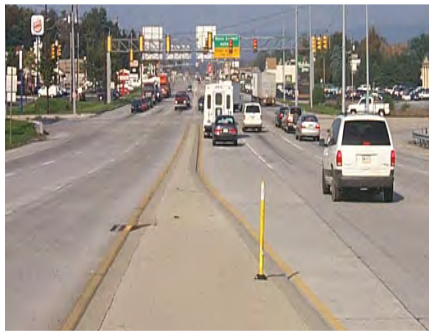
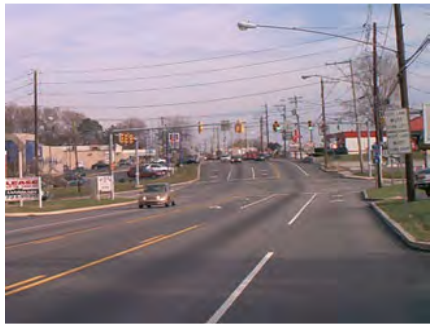
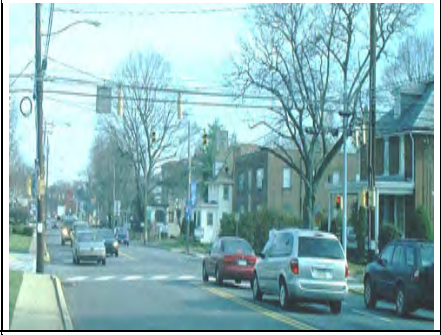
Intersection	Photo	Municipality	Controller	Model	Existing System and Cycle Lengths	Phasing
Van Patten Road		Hampden	IDC	Multisonic 820A	Silver Spring/ Hampden System AM: 120 sec MID: 125 sec PM: 160 sec SAT: 140 sec	Carlisle Pike: Protected lefts Van Patten Road: Permitted left South leg of intersection is one-way southbound
Gateway Dr./S.R. 581		Hampden	IDC	Multisonic 820A	Silver Spring/ Hampden System AM: 120 sec MID: 125 sec PM: 160 sec SAT: 140 sec	Carlisle Pike: Protected lefts Free rights Gateway Drive: Split phase lefts SB free right
Sporting Hill Road		Hampden	IDC	Multisonic 820A	Hampden Township System AM: 140 sec MID: 155 sec PM: 160 sec SAT: 155 sec	Carlisle Pike: Protected/Permitted lefts Sporting Hill Rd: Protected lefts

Exhibit 3.2 Carlisle Pike Signalized Intersections

Intersection	Photo	Municipality	Controller	Model	Existing System and Cycle Lengths	Phasing
Hampden Centre		Hampden	IDC	Multisonic 820A	Hampden Township System AM: 140 sec MID: 155 sec PM: 160 sec SAT: 155 sec	Carlisle Pike: Protected/Permitted lefts Hampden Centre: Permitted lefts
Saint Johns Church Rd		Hampden	IDC	Multisonic 820A	Hampden Township System AM: 140 sec MID: 155 sec PM: 160 sec SAT: 155 sec	Carlisle Pike: WB protected/permitted left EB Permitted left Saint Johns Church Road: Permitted lefts
Saint Johns Drive		Hampden	IDC	Multisonic 820A	Hampden Township System AM: 140 sec MID: 155 sec PM: 160 sec SAT: 155 sec	Carlisle Pike: EB protected/permitted left WB Permitted left Saint Johns Church Road: Permitted lefts

Exhibit 3.2 Carlisle Pike Signalized Intersections

Intersection	Photo	Municipality	Controller	Model	Existing System and Cycle Lengths	Phasing
Orrs Bridge Road		Hampden	IDC	Multisonic 820A	Hampden Township System AM: 140 sec MID: 155 sec PM: 160 sec SAT: 155 sec	Carlisle Pike: EB protected/permitted left WB permitted left Orrs Bridge: Each phase protected, offset intersection with 2 signals functioning as one
34th Street		Camp Hill	Krouse Heinz	DM-400	Not in any system AM: varies MID: varies PM: varies SAT: varies	Carlisle Pike: Permitted lefts Sample Bridge: Permitted lefts
Camp Hill Bypass		Camp Hill	IDC	Multisonic 820A	Camp Hill Bypass System AM: 160 sec MID: 140 sec PM: 160 sec SAT: 140 sec	Carlisle Pike: Split phase lefts Camp Hill Bypass: Protected lefts NB free right

3.1.6. Intelligent Transportation Systems

There are no identified intelligent transportation facilities currently in place within the Carlisle Pike study area; however, there are ITS systems proposed on neighboring limited access roadways.

3.1.7. Pedestrian and Bicycle Facilities

Crosswalks and pedestrian push buttons exist at many of the intersections however sidewalks are not present along the corridor with the exception of Camp Hill Borough. Dedicated bicycle facilities are not present at any area of the study corridor.

3.1.8. Transit Service

Capital Area Transit services the Carlisle Pike. There are four scheduled stops along the corridor; however only one of them (Kmart Drive) is signed. The other three are: Carlisle Pike at Camp Hill Bypass, Sporting Hill Road and S.R. 114. The corridor is serviced by other various commercial transit companies and has no rail transit facilities.

3.1.9. Adjacent Land Use

From S.R. 114 to Gateway Drive, the adjacent land use to the south of the Carlisle Pike is primarily zoned commercial with residential zoning near Salem Church Road and Van Patten Road. The Hampden Commons Plaza near the Brondle and Kmart traffic signals is the largest commercial traffic generator in this section of the Carlisle Pike. Other significant sources of traffic generation include the industrial zoned areas on Silver Spring Road and the Navy Service area located at Van Patten Road. Other potential traffic generators to the south include future use of the PHICO property, a large residential development south of the Kohl's signal and changing the residential zone between Van Patten Road and Kmart access to commercial.

On the north side of the Carlisle Pike from S.R. 114 to Gateway Drive, the adjacent land use is also primarily commercial with residential zoning from approximately the Skyport traffic signal to the Kmart traffic signal. The significant commercial traffic generator is the Silver Spring Plaza and the development near the S.R. 114 and Wal-Mart signals.

From Gateway Drive to the Camp Hill Bypass the land use adjacent to the Carlisle Pike on the south side of the roadway is a mixture of commercial, professional and residential zoning. The major source of traffic generation for this area is Hampden Centre located near the Sporting Hill and Hampden Centre traffic signals. Industrial zoning exists near the St. Johns Church Road signal. There are no large traffic generators to the north of the Carlisle Pike from Gateway Drive to the Camp Hill Bypass, however there are 93 driveways for mostly commercial or professional uses.

3.2. Traffic Data Collection

3.2.1. Automated Traffic Recordings

One of the first tasks completed was the placement of Automatic Traffic Recorders (ATRs) at three locations throughout the corridor. ATRs were placed at each end of the corridor as well as a point relatively close to the geographical center of the corridor for a seven-day period. The ATRs were used to identify the peak period of travel and provide a general profile of how traffic moves throughout the corridor. As **Exhibit 3.3** shows, the highest concentration of passenger cars (class 2) was at location 2, near Gateway Drive.

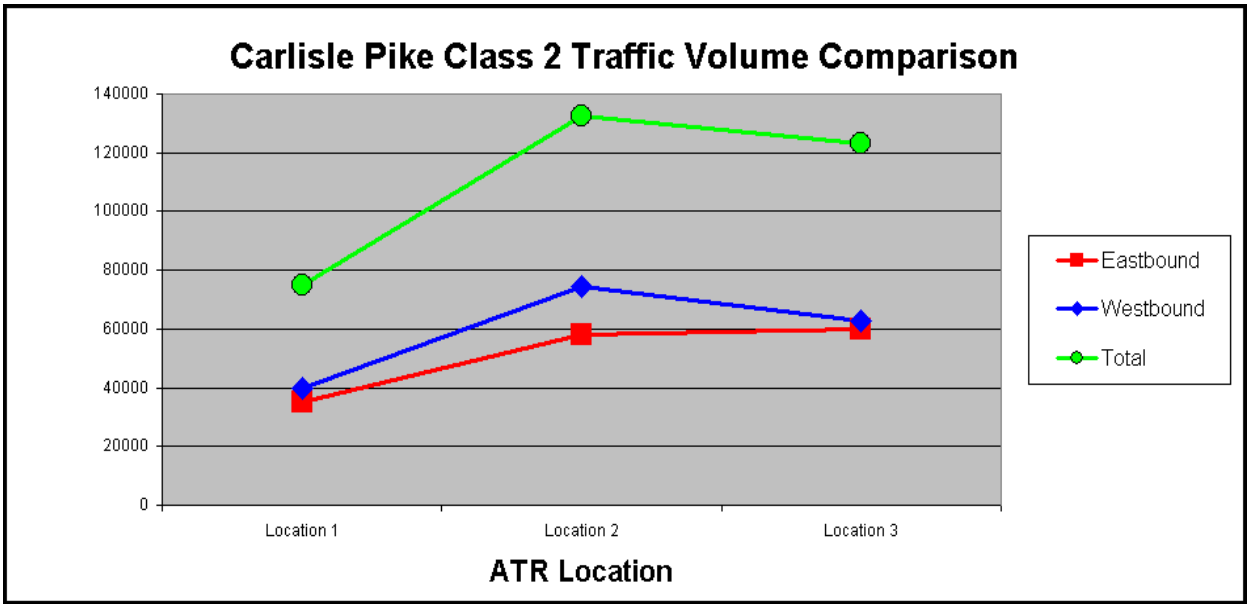


Exhibit 3.3 Class 2 Traffic Volume Comparison

Exhibit 3.4 illustrates the bi-directional, daily volume for each of the three locations where data was collected. As can be seen, Saturday experiences the highest daily volumes at all three locations.

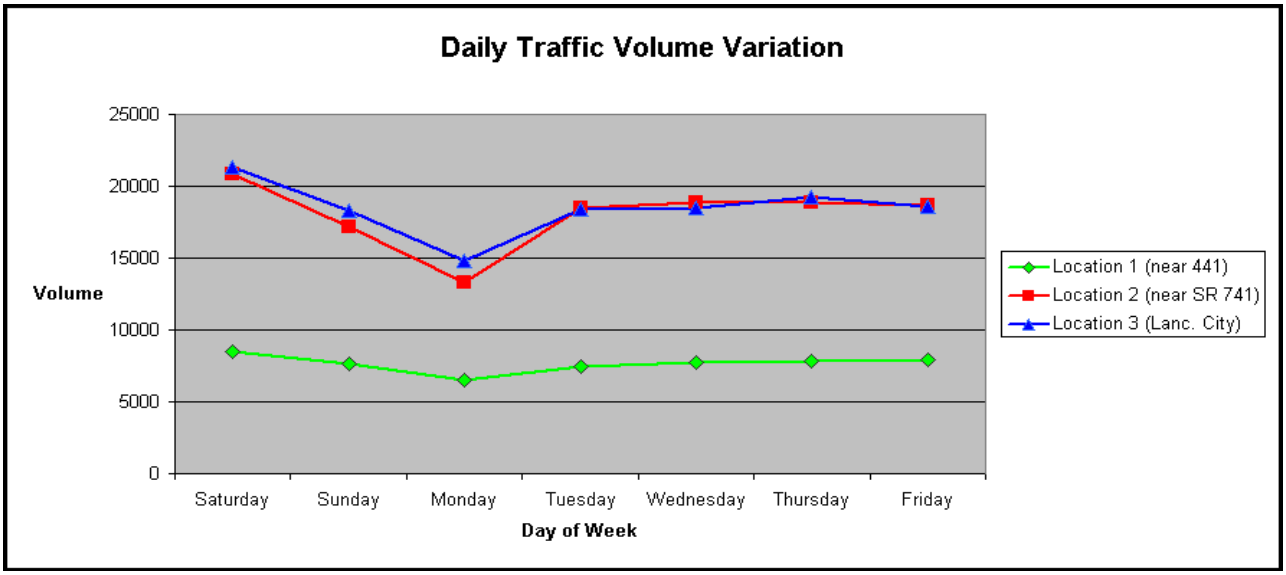


Exhibit 3.4 Daily Traffic Volume Variation

As mentioned above, analyzing the data that was obtained from the ATR counts also aided in identifying peak travel periods for collecting manual turning movement counts, **Exhibit 3.5** and **Exhibit 3.6** illustrate the peak periods for a typical weekday and Saturday, respectively. In both exhibits, the volume shown is that total of both directions in travel along the Carlisle Pike.

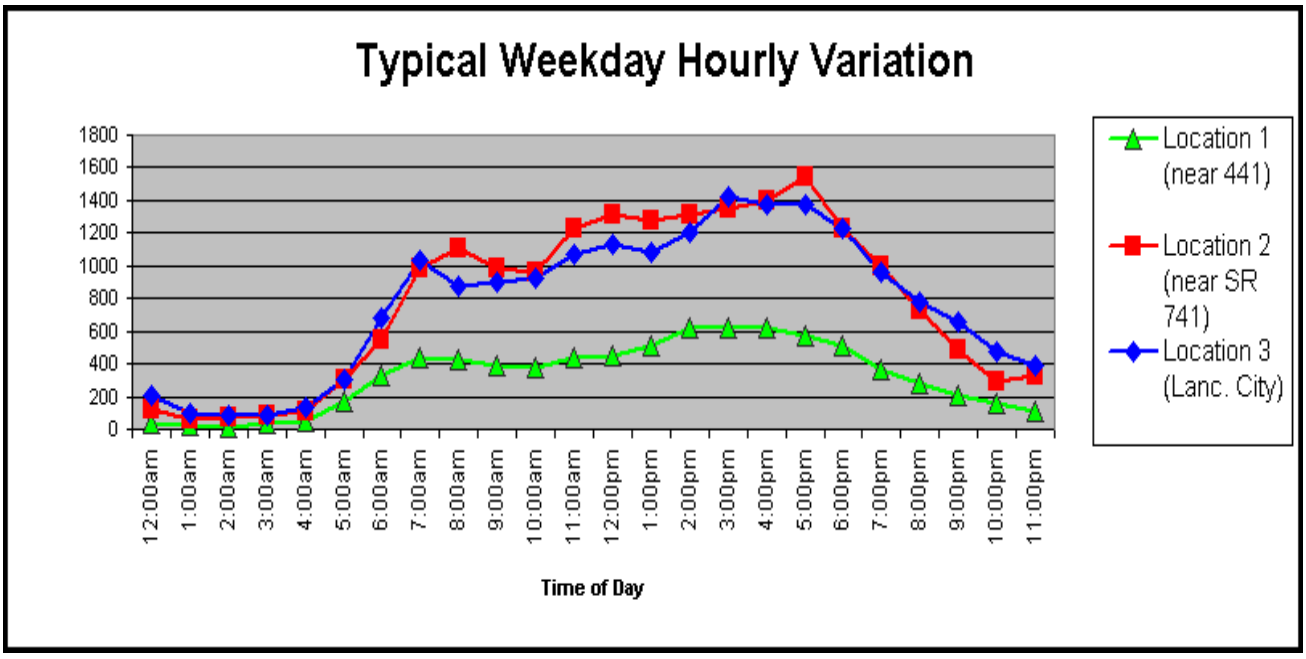


Exhibit 3.5 Typical Weekday Hourly Volume Variation

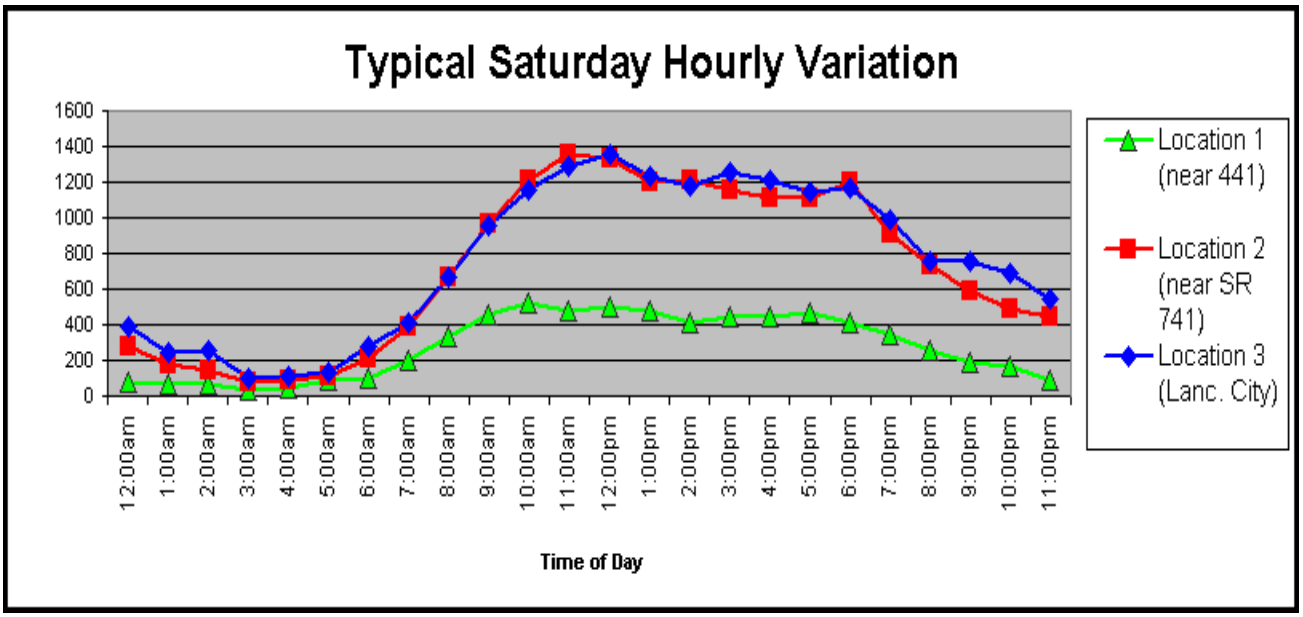


Exhibit 3.6 Typical Saturday Hourly volume Variation

Exhibit 3.5 illustrated that three distinct peak travel periods exist for a typical weekday on the Carlisle Pike: 6 a.m. to 9 a.m. (AM Peak), 11 a.m. to 1 p.m. (Mid-day Peak) and 3 p.m. to 6 p.m. (PM Peak). **Exhibit 3.6** illustrates that the highest peak travel period for a typical Saturday on the Carlisle Pike occurs between 11 a.m. and 1 p.m. (Saturday Peak).

3.2.2. Manual Turning Movement Counts

Manual Turning Movement Counts (TMCs) were conducted at each signalized intersection in the study area. The counts were conducted during the peak periods identified previously. Counts were analyzed and the peak hour during each peak period was identified. **Exhibit 3.7** indicates the distribution of traffic within the corridor by intersection. The volume illustrated is the total approach volume for all legs approaching the intersection.

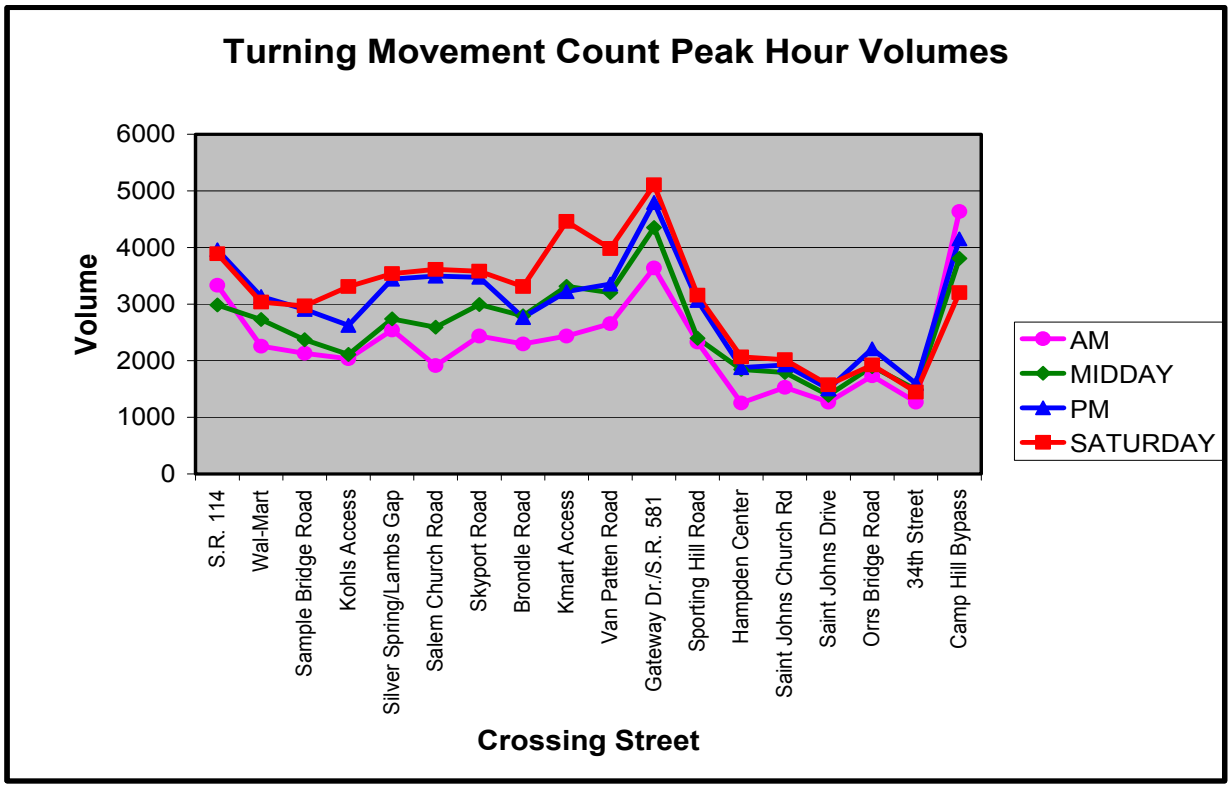
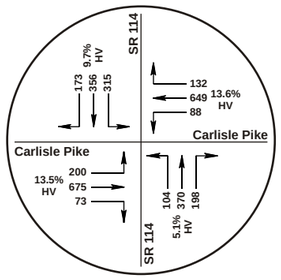


Exhibit 3.7 Turning Movement Count Peak Hour Volumes

Exhibit 3.7 illustrates that the largest volume of traffic is concentrated near the middle of the study area on Saturday. **Exhibit 3.8** is the tabular form of **Exhibit 3.7.** It indicates the exact peak hour volumes (total vehicles) that were collected. **Exhibits 3.9 – 3.12** illustrate the turning volumes of each intersection during the respective time periods.

CROSSING STREET	AM	MIDDAY	PM	SATURDAY
S.R. 114	3333	2984	3962	3890
Wal-Mart/PHICO Access	2258	2729	3134	3036
Sample Bridge Road	2131	2372	2907	2969
Kohl's Access	2035	2111	2625	3309
Silver Spring Rd/Lamb's Gap Rd	2544	2740	3442	3538
Salem Church Road	1916	2592	3498	3614
Skyport Road	2436	2994	3474	3581
Brondle Road	2296	2793	2764	3310
Kmart Access/Jeffery Drive	**2434**	**3315**	**3223**	**4460**
Van Patten Road	2654	3205	3352	3982
Gateway Drive/S.R. 581	3641	4354	4798	5107
Sporting Hill Road	2330	2395	3065	3158
Hampden Centre	1255	1848	1880	2067
Saint John's Church Road	1530	1794	1924	2017
Saint John's Drive	1267	1391	1505	1575
Orr's Bridge Rd/ Central Blvd	1733	1895	2212	1924
34th Street	1269	1492	1595	1448
Camp Hill Bypass	4635	3808	4152	3203

Exhibit 3.8 Turning Movement Count Peak Hour Volumes



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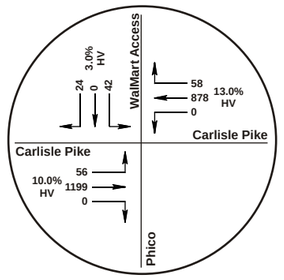

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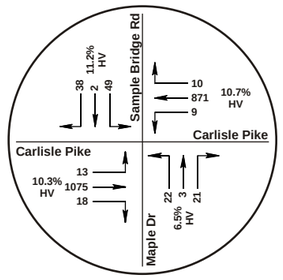

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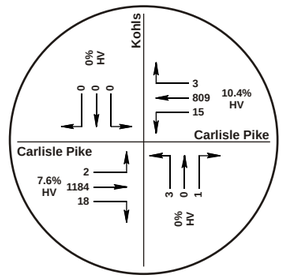

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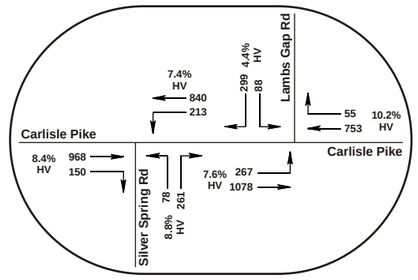

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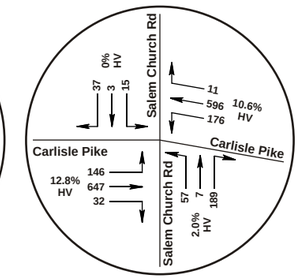

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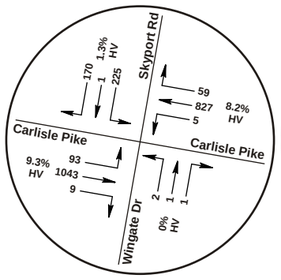

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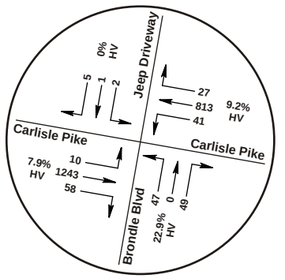

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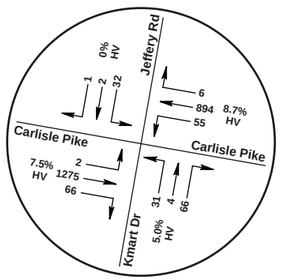

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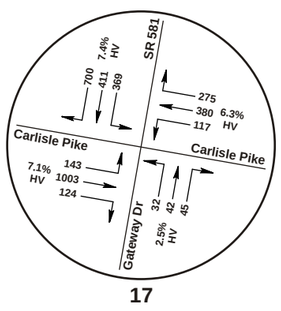

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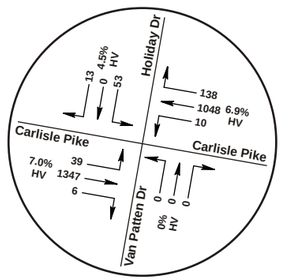

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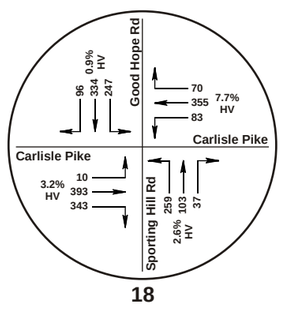

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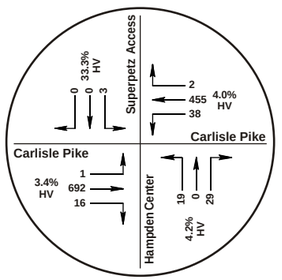

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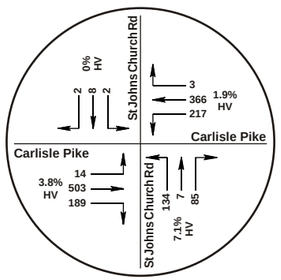

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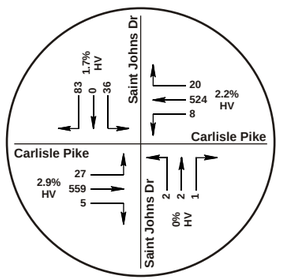

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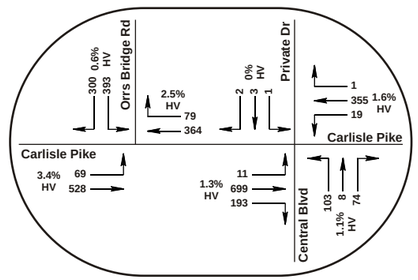

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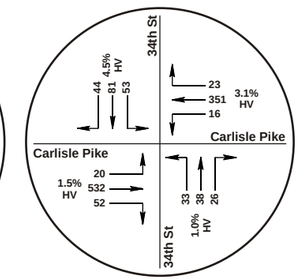

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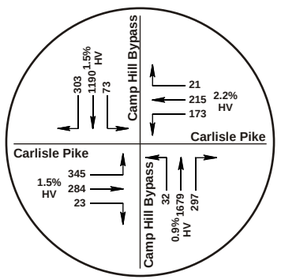

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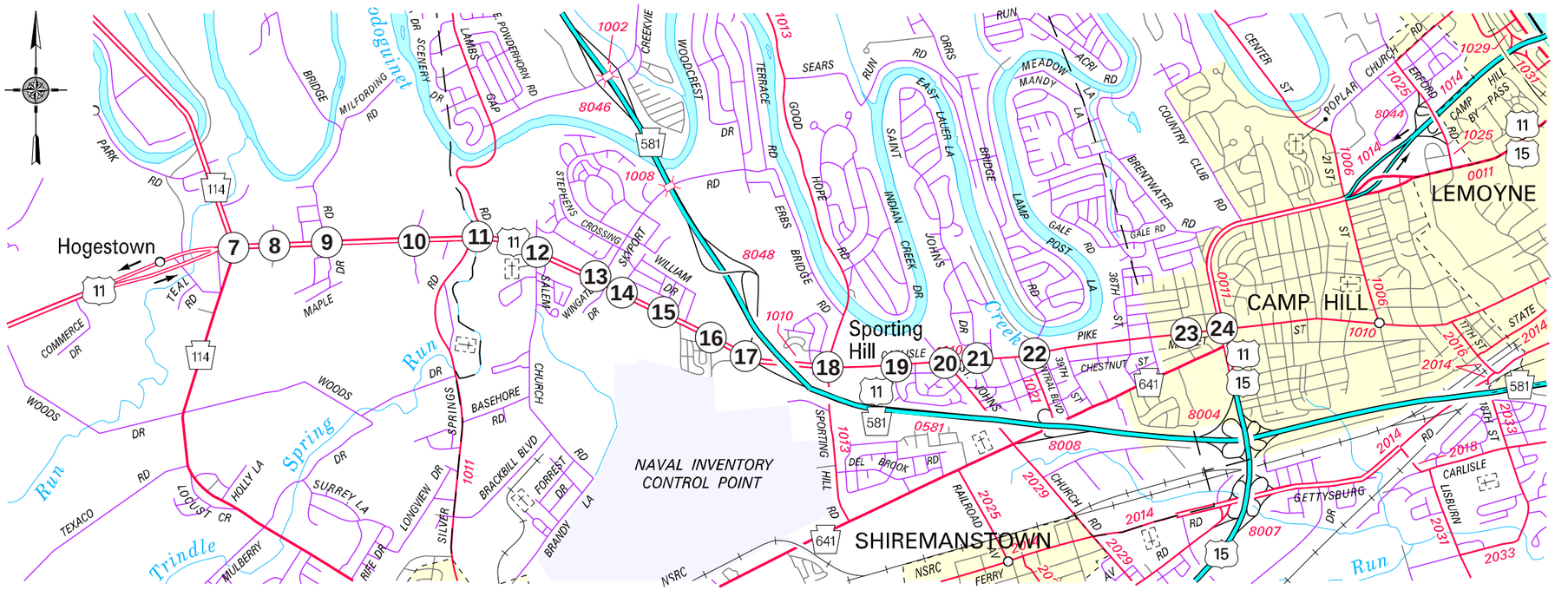

<u>Legend</u>
HV - Heavy Vehicles

Exhibit 3.9

2002 Existing AM Peak Hour Traffic Volumes Carlisle Pike

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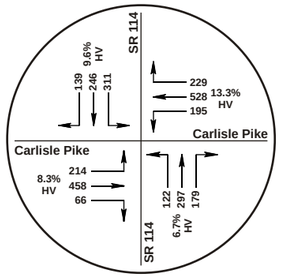
Gannett Fleming

\40604\graphics\cdr\Carlisle Pike\11x17\Carlisle Pike Exhibit 3_9.cdr



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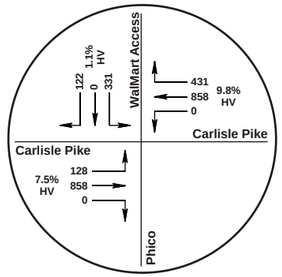

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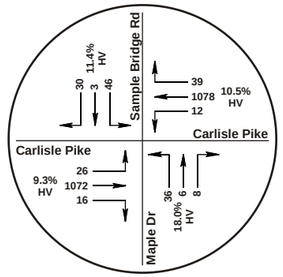

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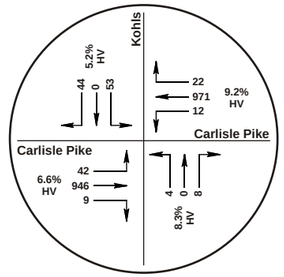

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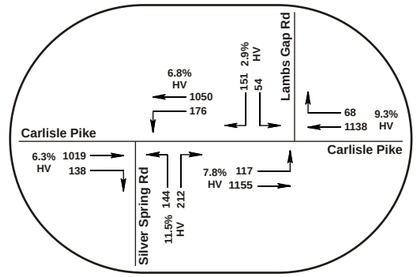

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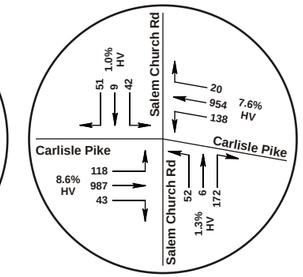

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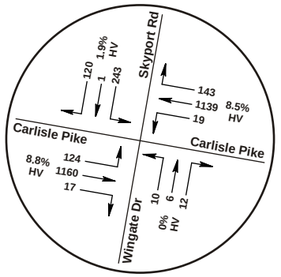

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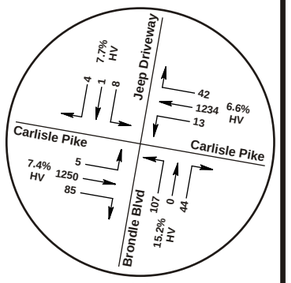

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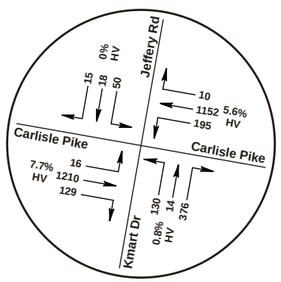

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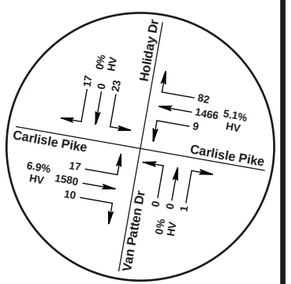

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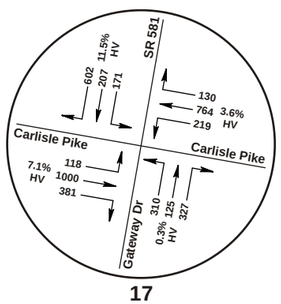

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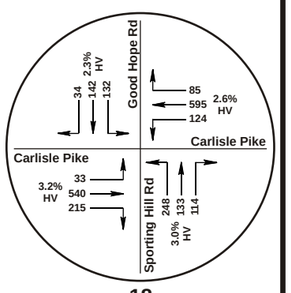

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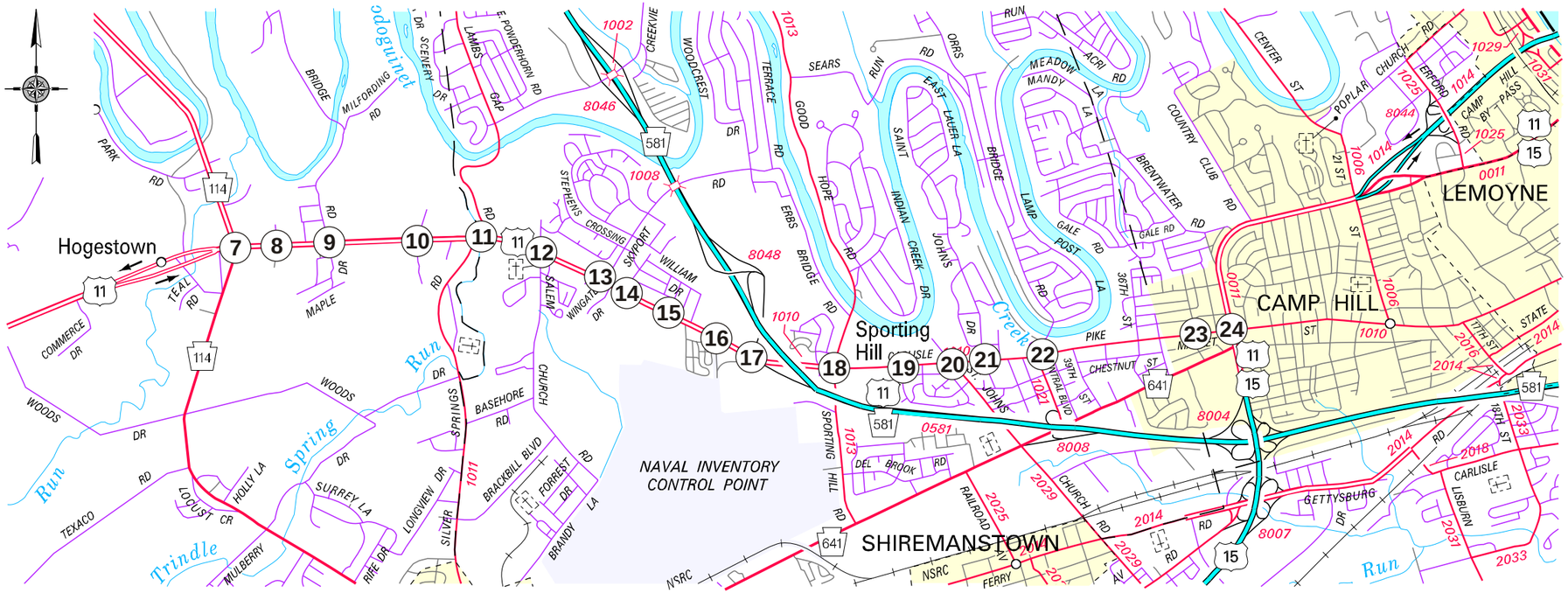

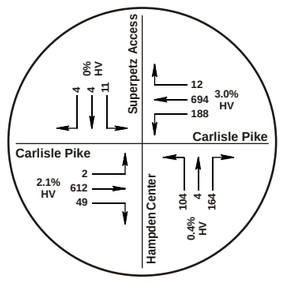

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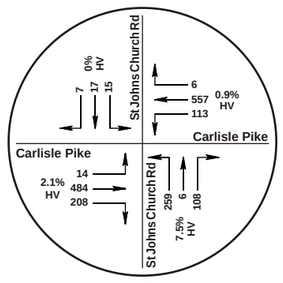

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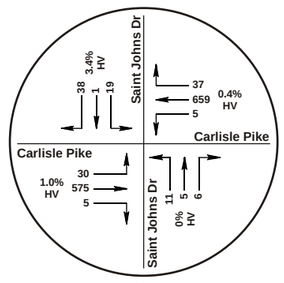

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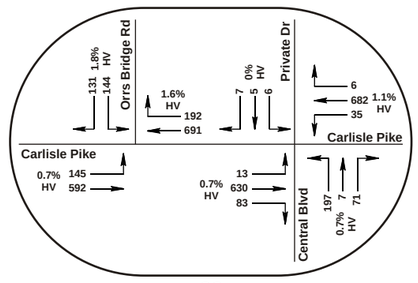

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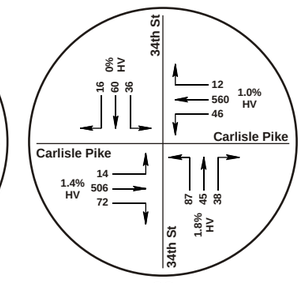

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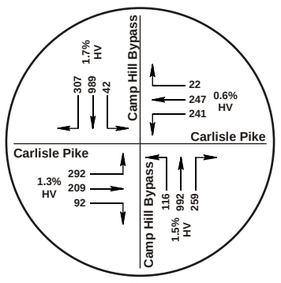

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Legend

HV - Heavy Vehicles

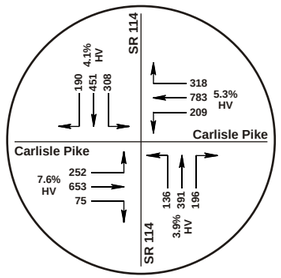
Exhibit 3.10

2002 Existing Mid-day Peak Hour Traffic Volumes Carlisle Pike

PENNDOT

Gannett Fleming

\40604\graphics\cdr\Carlisle Pike\11x17\Carlisle Pike Exhibit 3_10.cdr



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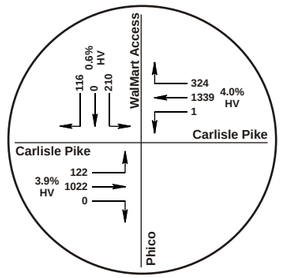

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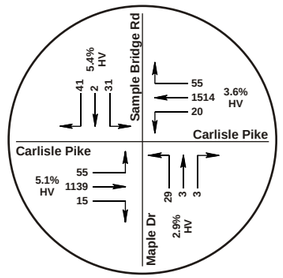

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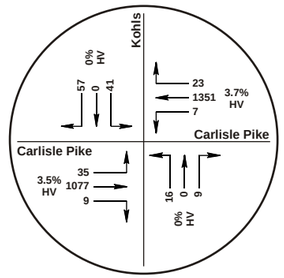

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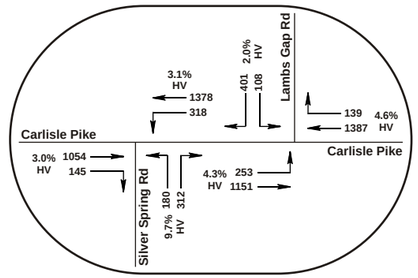

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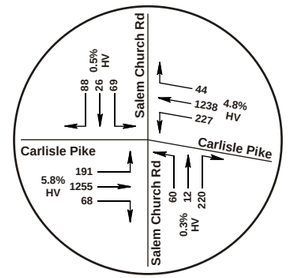

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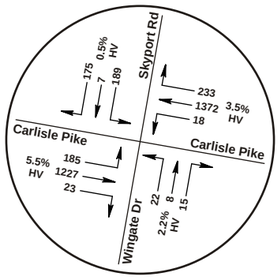

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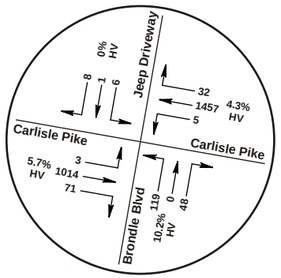

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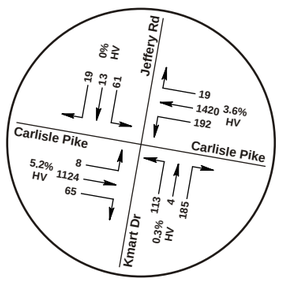

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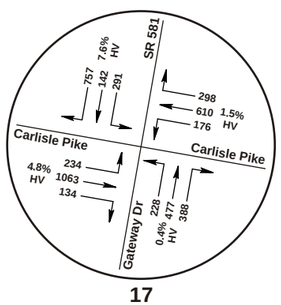

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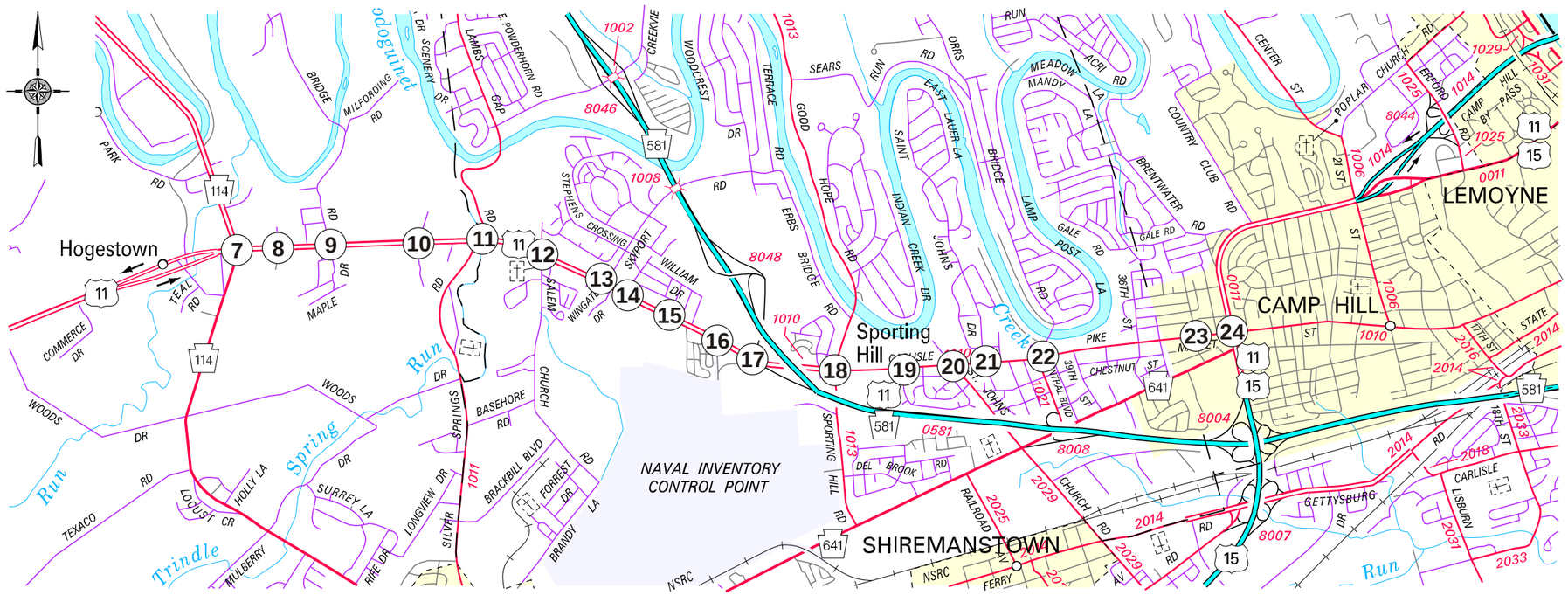

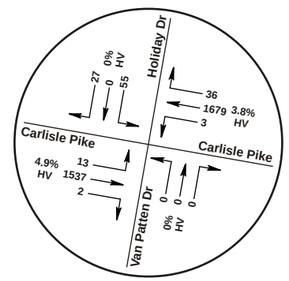

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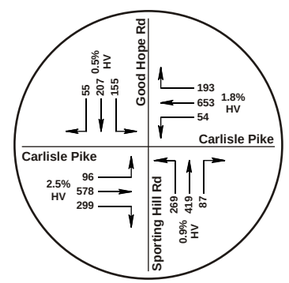

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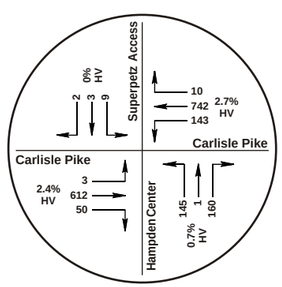

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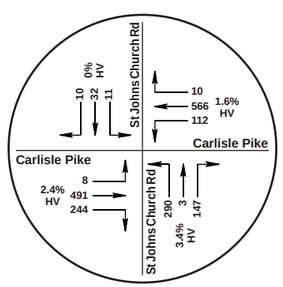

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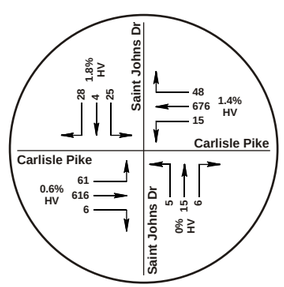

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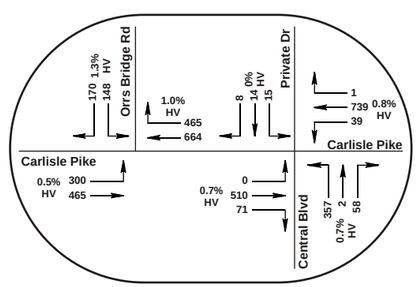

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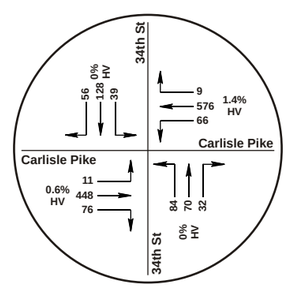

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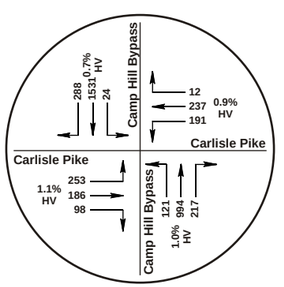


24

Legend

HV - Heavy Vehicles

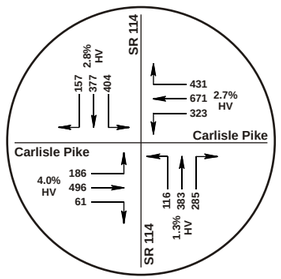
Exhibit 3.11

2002 Existing PM Peak Hour Traffic Volumes Carlisle Pike

PENNDOT

Gannett Fleming

\40604\graphics\cdn\Carlisle Pike\11x17\Carlisle Pike Exhibit 3_11.cdr



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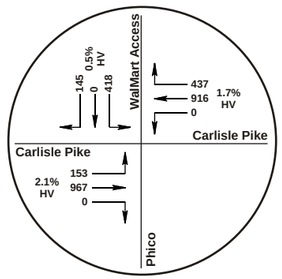

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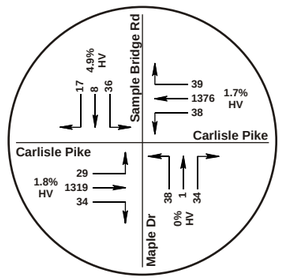

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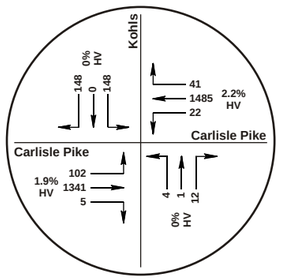

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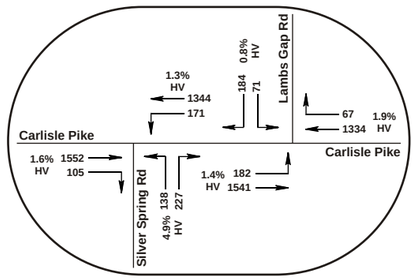

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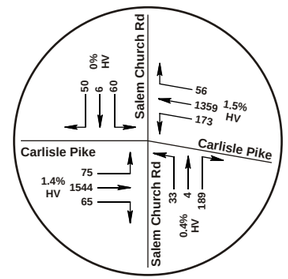

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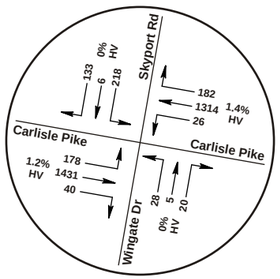

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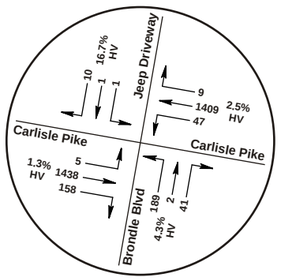

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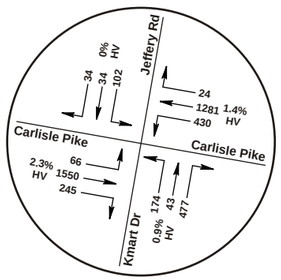

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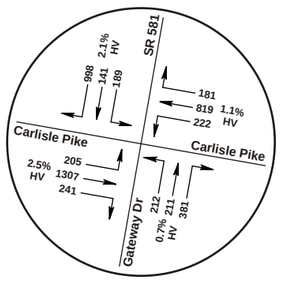

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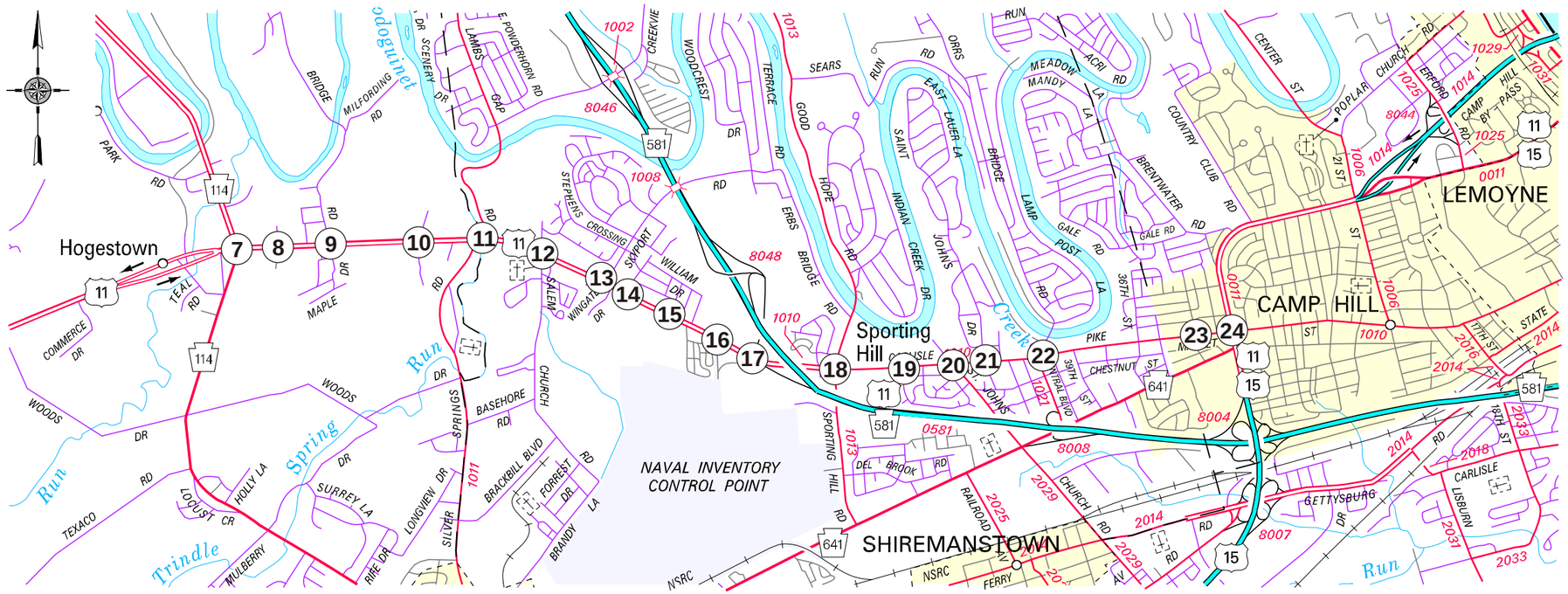

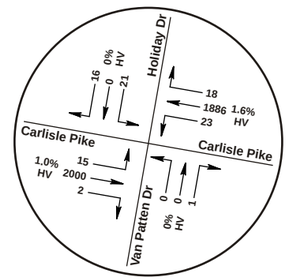

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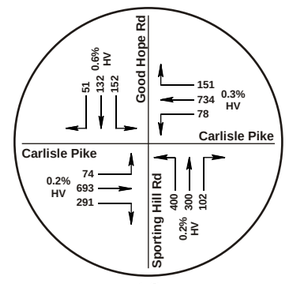

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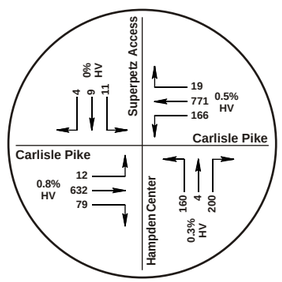

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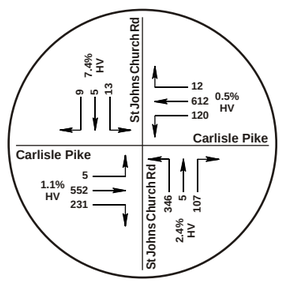

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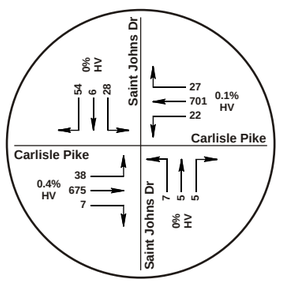

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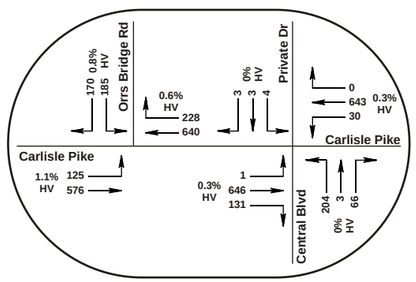

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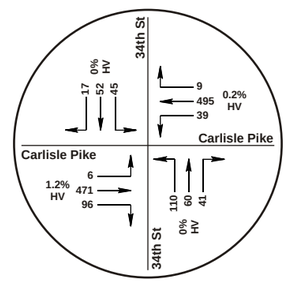

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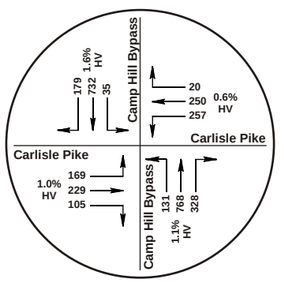


24

Legend

HV - Heavy Vehicles

Exhibit 3.12

2002 Existing Saturday Peak HourTraffic Volumes Carlisle Pike

PENNDOT

Gannett Fleming

\40604\graphics\cdr\Carlisle Pike\11x17\Carlisle Pike Exhibit 3_12.cdr

3.2.3. Travel Time and Delay Studies

As Section 2.1 pointed out, the goal of the Congested Corridor Improvement Program is to reduce the travel time through the corridor by 20 percent. To provide a baseline for measuring the effectiveness of the program, a travel time study and delay study were conducted for the Carlisle Pike corridor. The corridor was traversed five times in each direction for each peak period (AM, Mid-day, PM and Saturday) to determine the travel time eastbound and westbound for the corridor. During the travel time study, a delay study was also conducted. As the corridor was traversed, any time the vehicle speedometer went below 10 miles per hour the duration of time less than 10 miles per hour was recorded. The cumulative delay time recorded between signalized intersections was applied to the approaching signal as delay. From that information graphs such as the one shown in **Exhibit 3.13** and **Exhibit 3.14** were developed to see how the travel speed compared to the posted speed limit for the roadway.

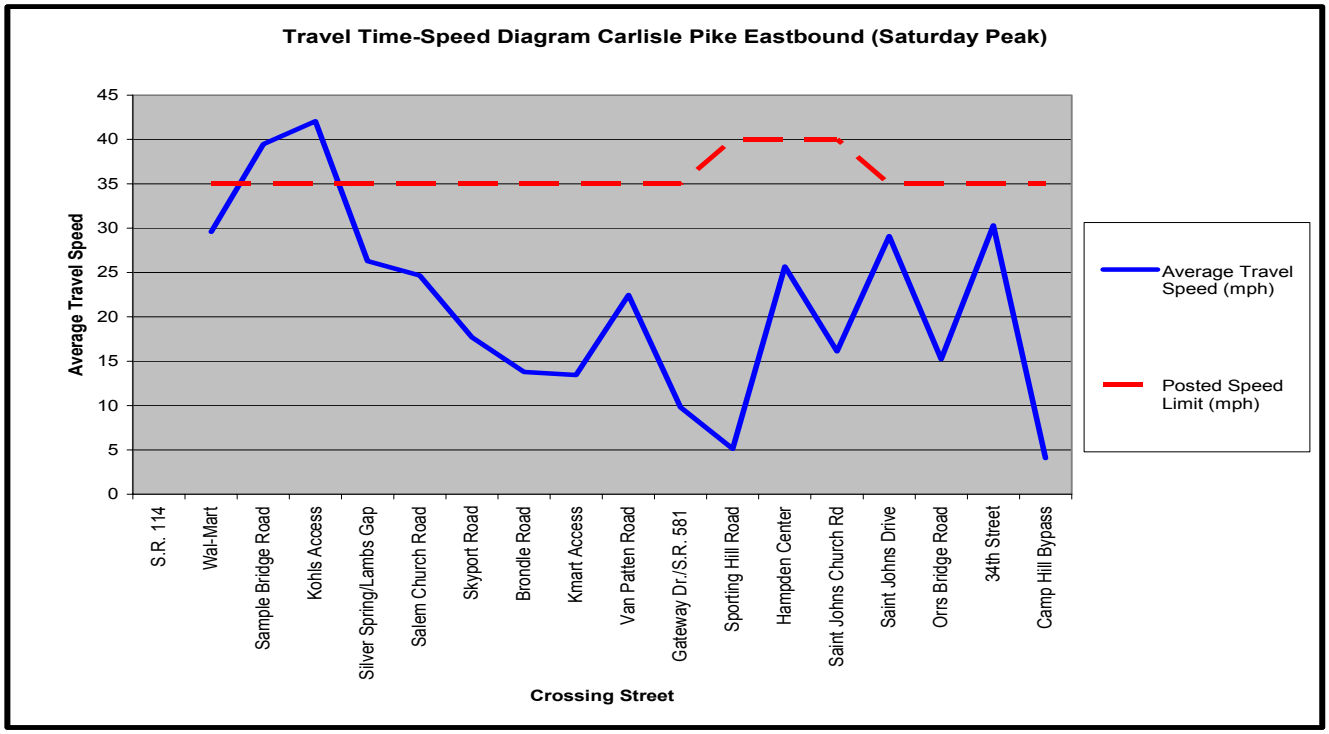


Exhibit 3.13 Travel Time-Speed Diagram Carlisle Pike Eastbound (Saturday)

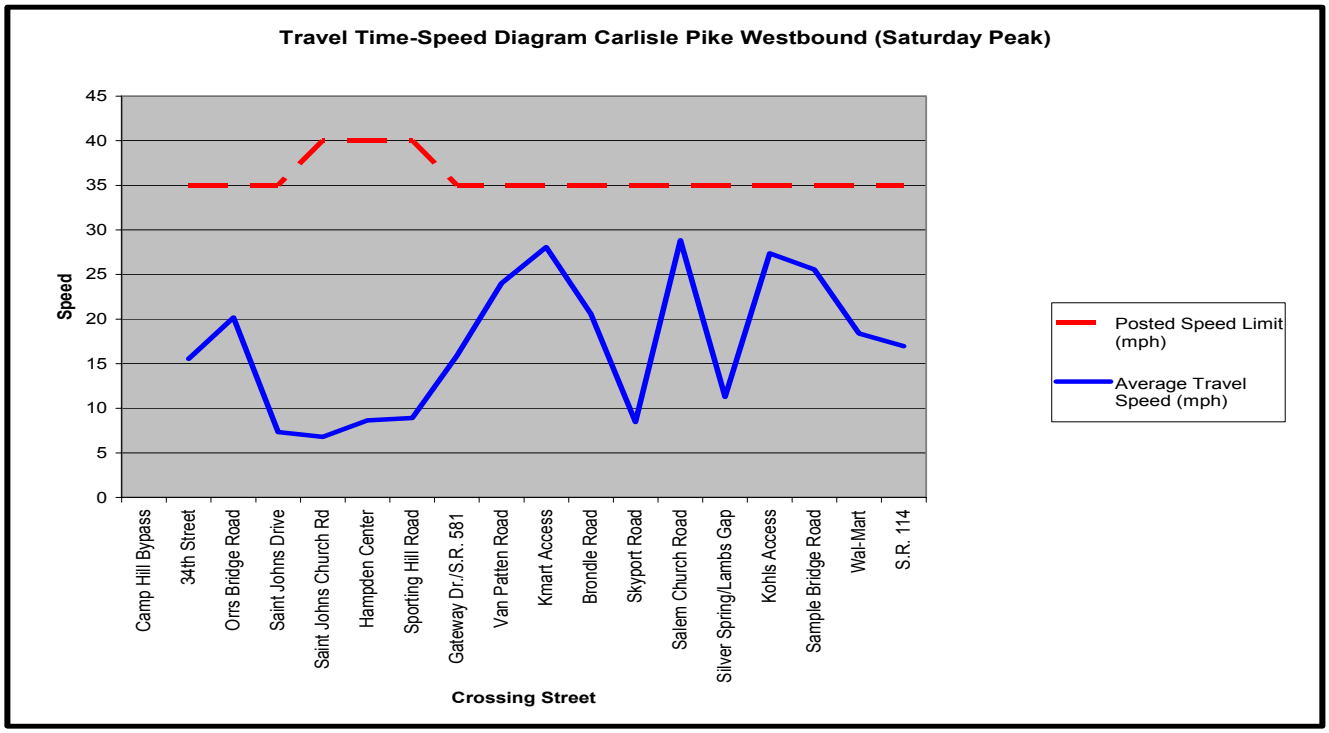


Exhibit 3.14 Travel Time-Speed Diagram Carlisle Pike Westbound (Saturday)

Complete travel time-speed diagrams may be viewed in the Technical Appendix to this report. **Exhibit 3.15** lists the average travel times and travel speeds that were recorded in each direction for the Carlisle Pike corridor.

Direction	Trip Time (min)	Travel Speed (mph)
AM EASTBOUND	15	28
MID-DAY EASTBOUND	13	28
PM EASTBOUND	16	28
SATURDAY EASTBOUND	20	21
AM WESTBOUND	12	30
MID-DAY WESTBOUND	14	25
PM WESTBOUND	15	26
SATURDAY WESTBOUND	22	17

Exhibit 3.15 Average Travel Times and Speeds

The delay portion of the study helps determine what areas in the corridor cause a significant disruption to a driver's trip. Delay diagrams such as **Exhibit 3.16** and **Exhibit 3.17** demonstrate which intersections cause delay on Saturday.

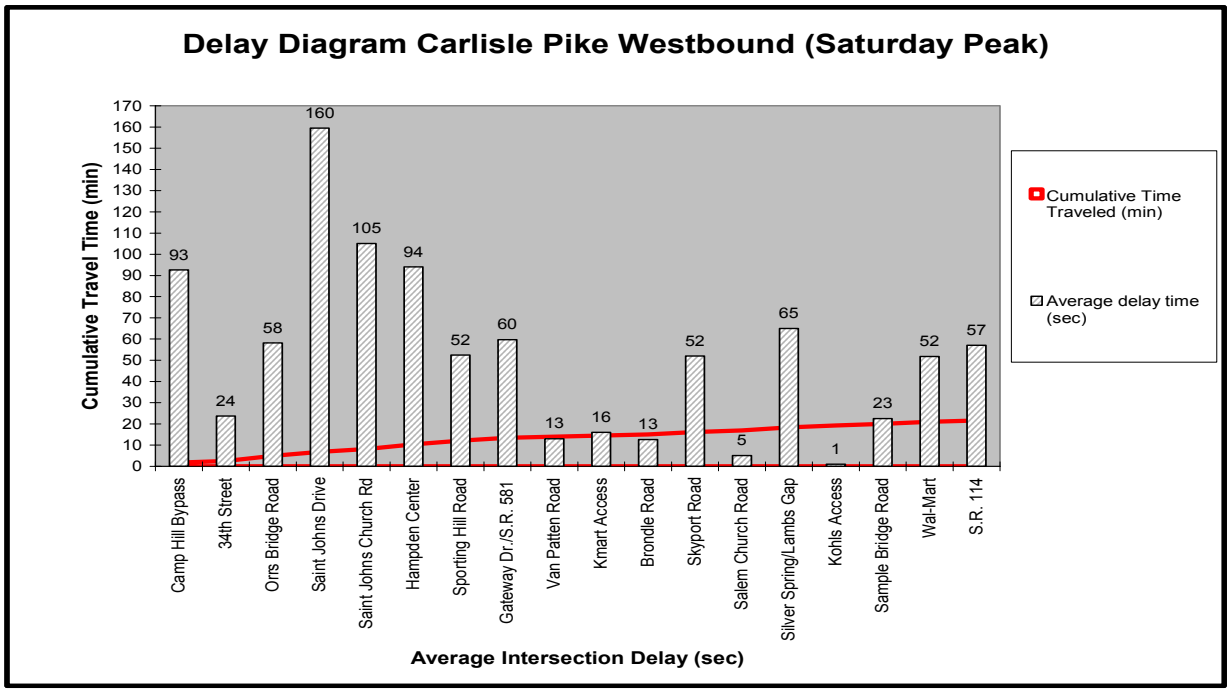


Exhibit 3.16 Delay Diagram Carlisle Pike Westbound (Saturday)

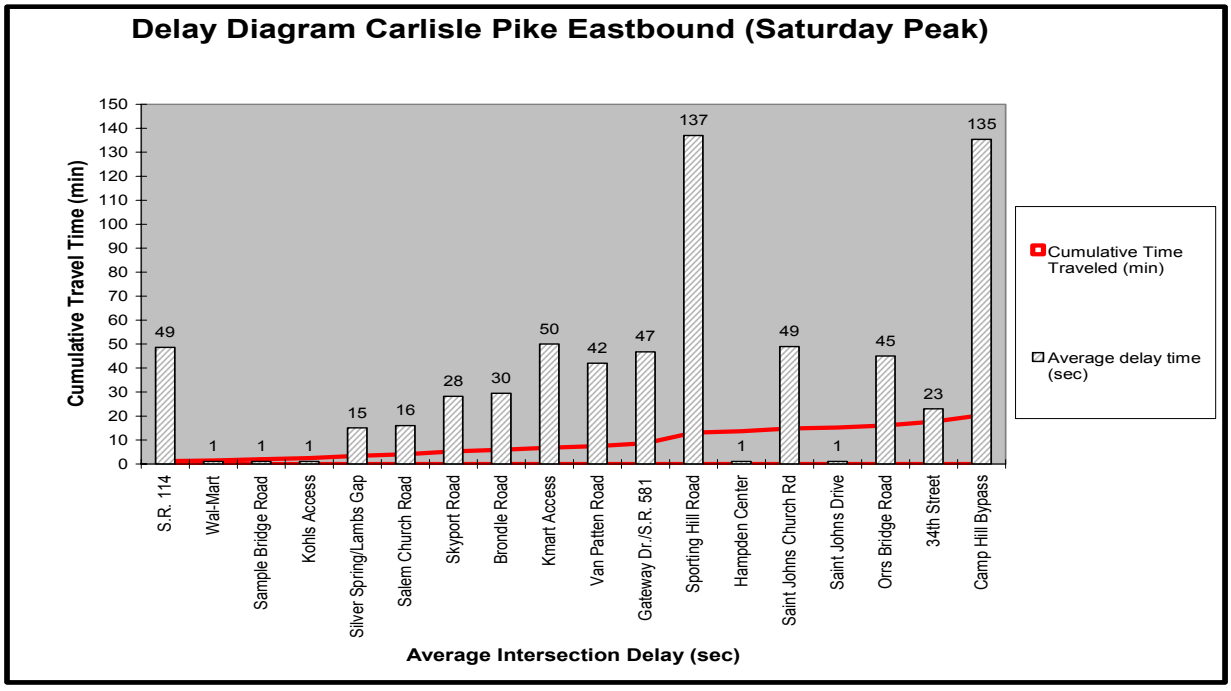


Exhibit 3.17 Delay Diagram Carlisle Pike Eastbound (Saturday)

Graphs for other time periods are presented in the Technical Appendix.

The area between Gateway Drive and Sporting Hill Road appears to be the point where traffic is most congested. **Exhibit 3.18** shows the delay that was recorded for each peak period in each direction through the corridor.

Intersection	AM Delay WB (sec)	Am Delay EB (sec)	Mid-Day Delay WB (sec)	Mid-Day Delay EB (sec)	PM Delay WB (sec)	PM Delay EB (sec)	Saturday Delay WB (sec)	Saturday Delay EB (sec)
S.R. 114	71	37	53	46	78	48	57	49
Wal-Mart Access	14	1	21	1	1	1	52	1
Sample Bridge Rd	6	1	15	1	13	1	23	1
Kohl's Access	13	1	1	1	1	1	1	1
Silver Spring/Lambs Gap Rd	40	39	55	19	38	69	65	15
Salem Church Road	40	1	25	10	32	1	5	16
Skyport Road	1	1	18	39	42	26	52	28
Brondle Road	1	1	18	1	1	30	13	30
Kmart Access	10	28	1	54	1	1	16	50
Van Patten Road	1	6	6	1	9	1	13	42
Gateway Drive	28	11	36	30	32	58	60	47
Sporting Hill Road	21	88	56	51	94	68	52	137
Hampden Centre	1	19	22	1	38	1	94	1
St. John's Church Rd	1	5	15	13	24	50	105	49
St. John's Drive	1	1	1	11	1	1	160	1
Orr's Bridge Rd/ Central Blvd	24	35	30	19	81	23	58	45
34th Street	1	9	10	14	17	29	24	23
Camp Hill Bypass	103	72	74	57	130	150	93	135

Exhibit 3.18 Peak Period Delay

3.3. Operational Conditions

3.3.1. Selection of An Operational Tool

One of the most critical aspects of the study is the selection of an appropriate software package for analysis and simulation. The two most commonly used traffic simulation packages used are SimTraffic and CORSIM. SimTraffic is the simulation arm of the traffic operations program Synchro developed by Trafficware. CORSIM is a powerful simulation tool, developed by the Federal Highway Administration. CORSIM consists of subprograms including ITraf, NETSIM, FREESIM and TRAFVU.

Most studies comparing the two simulation programs have indicated there are nominal differences in the outputs of the two programs. Vehicular speeds, delay and level of service in corridor assessments have been shown to be comparable.

Some of the primary differences between the two software packages include:

- Data Entry and Software Interaction– SimTraffic data is input through Synchro and is supported by a mapping interface that allows the user to validate inputs as well as to develop the network using CADD files or aerial images. Synchro can optimize traffic operations and can integrate with TRANSYT as an alternate optimization tool. Synchro and SimTraffic permit output to the Highway Capacity Software. The capabilities of Synchro and SimTraffic limit redundant data entry and transfer of operational results resulting in timesavings and reducing the possibility of errors in data entry. CORSIM does not readily interact with other software packages and does not have optimization features; therefore this must be accomplished through alternate software packages.
- Freeway Operations – Most independent studies indicate that CORSIM more accurately models freeway operations.
- Unsignalized Intersections – SimTraffic can model various methods of unsignalized traffic control including YIELD conditions and all-way STOP control. CORSIM can only model two-way STOP control intersection.
- Pedestrians – SimTraffic can model individual pedestrians while CORSIM cannot.
- Transit - CORSIM can model transit operation while SimTraffic cannot.
- Queuing – The programs define queuing differently producing slightly different results.
- Graphical Output – SimTraffic allows a network to be displayed over a CADD file or aerial image while CORSIM does not.

Both programs have strengths and weaknesses, but both must be used properly and require network validation. Due to the flexibility of the Synchro/SimTraffic software packages and the arterial makeup of the study corridor it was concluded by the Study Team that Synchro would be used as the base input tool and SimTraffic would be used as the simulation program.

3.3.2. Calibration of Analysis Tool

After creating a Synchro model for each peak period, the travel time and delay times calculated within the model were compared to the results of the travel time and delay study. The following sub-sections describe the calibration techniques that were employed.

3.3.2.1. Mid-block Travel Time

The Travel Time and Delay study section of this report described how any delay that was recorded was applied to the approaching intersection. However, another contributing factor to delay through out this corridor is many uncontrolled access points. The Highway Capacity Manual (2000 Edition) discusses adjusting the Free Flow Speed (FFS) based on access point density per mile. Exhibit 21-7 "Access-Point Density Adjustment" from the HCM (2000 Edition), page 21-7 shows the suggested reduction in FFS.

HIGHWAY CAPACITY MANUAL, EXHIBIT 21-7.
ACCESS-POINT DENSITY ADJUSTMENT[1]

Access Points/Mile	Reduction in FFS (mi/h)
0	0.0
10	2.5
20	5.0
30	7.5
≥40	10

1. Exhibit 21-7 Access-Point Density Adjustment taken from TRB NRC Washington, D.C. (2000)

The Carlisle Pike corridor is 4.96 miles long and has 153 access points in the eastbound direction and 134 access points in the westbound direction. That equates to approximately 30 access points per mile eastbound and 27 access points per mile westbound. This illustrates that even though the delay was applied to the approaching signal, a portion of the delay could be attributed to mid-block traffic activities.

3.3.2.2. Intersection Delay and Flow

The most significant source of delay on the Carlisle Pike corridor comes from traffic signal delay. The travel time and delay study was compared with the Synchro model delay calculations for existing conditions. It is important to remember that the delays observed in the field are not necessarily indicative of the delays that Synchro calculates. The field observed delay is an average of five runs in each direction, whereas the Percentile Delay Method is utilized to calculate the Synchro delay. The Percentile Delay Method is based on the effective red time of the phase, the arrival rate of vehicles, the saturated flow rate and the maximum queue length. The process uses trigonometric relationships to determine maximum queue lengths, vehicle delay and percentile scenarios to find the standard deviations for those scenarios. Then, based on the operation of the signal, other calculation processes are entered to determine the delay that is given. A delay comparison between the field-observed delay and Synchro calculated delay is available in the Technical Appendix.

3.3.2.3. Corridor Travel Times

In addition to the comparisons of mid-block travel time and intersection delay, field-observed and calculated corridor travel times were compared. **Exhibit 3.19** shows the trip time comparison of the calibrated Synchro model and the observed trip time from the travel time and delay study. As the chart presents, only three time periods differed by more than 4 minutes. From this comparison it is clear that the model is emulating field conditions very closely and is therefore considered calibrated. The delay comparison that is provided in the Technical Appendix should be consulted when implementing any proposed changes to the existing traffic signal timing plans in the field.

Peak Period and Direction	Field Trip Time (min)	Synchro Trip Time (min)
AM EASTBOUND	15	16
MID-DAY EASTBOUND	13	14
PM EASTBOUND	13	17
SATURDAY EASTBOUND	20	18
OFF-PEAK EASTBOUND	N/A	13
AM WESTBOUND	12	15
MID-DAY WESTBOUND	14	16
PM WESTBOUND	16	20
SATURDAY WESTBOUND	22	18
OFF-PEAK WESTBOUND	N/A	13

Exhibit 3.19 Calibrated SYNCHRO Travel Time vs. Field Observed Travel Time

3.3.3. Arterial Level of Service

Level of service is a measure of operational conditions. There are six levels of service, A – F. A represents free flow while F represents congested conditions.

Synchro calculates the arterial level of service based on speed and the arterial class. The arterial class is calculated automatically based on distances between intersections and link speeds. Synchro calculates the Carlisle Pike as a Class IV roadway, with speeds of 30 to 35 mph and segment distances less than 2000 feet.

Exhibit 3.20 shows the existing arterial level of service that was calculated by Synchro for the Carlisle Pike Corridor.

3.3.4.

Peak Period	Existing Arterial Operational Level of Service Eastbound	Existing Arterial Operational Level of Service Westbound
AM	B	B
MID-DAY	B	B
PM	C	C
SATURDAY	C	C

Exhibit 3.20 Operational Arterial Level of Service

Intersection Level of Service

The level of service for each intersection was calculated using the methodologies set forth in the Highway Capacity Manual and utilizing the Synchro software package. Intersection level of service is a measure of intersection operations. For signalized intersections, a letter grade is based on the delay that is encountered at the intersection. **Exhibit 3.21** shows the parameters for the control delay per vehicle and the corresponding grade based on the Highway Capacity Manual (2000 Edition). In urban settings, level of service D or better is generally deemed acceptable.

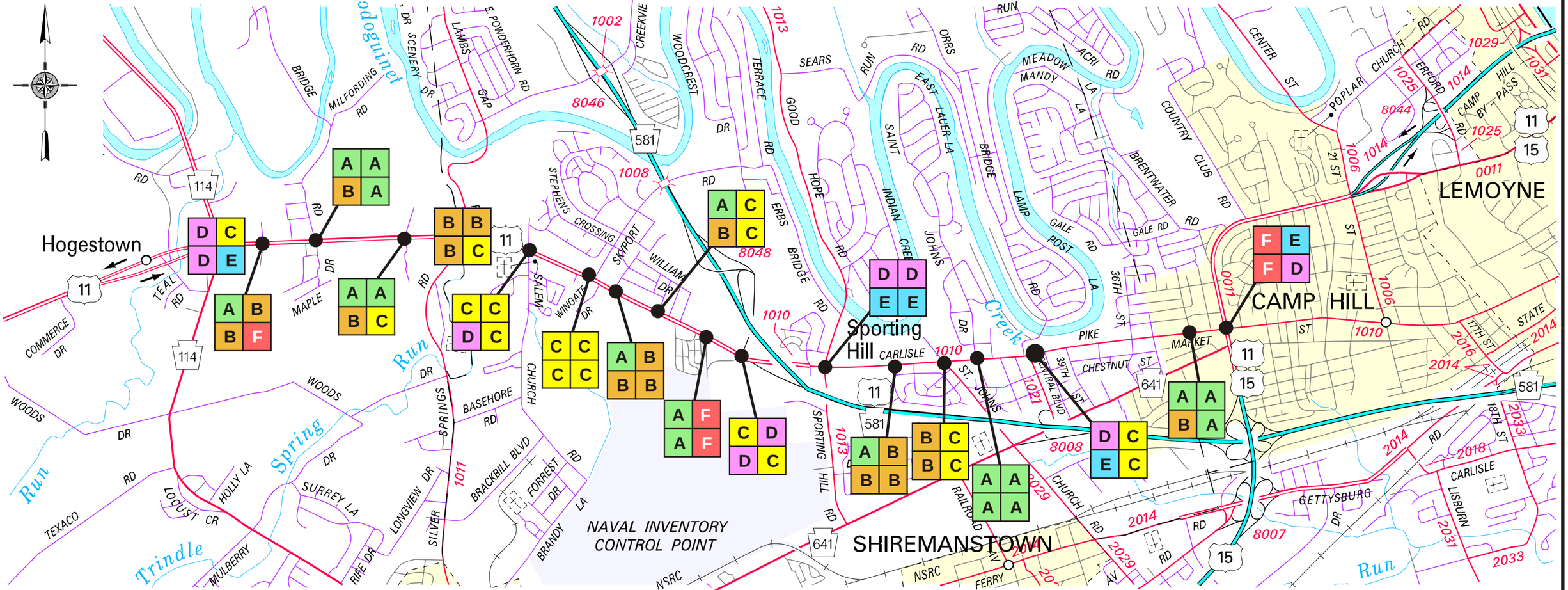
Level of Service	Control Delay Per Vehicle (sec)
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>50

Exhibit 3.21 Highway Capacity Manual (2000) Level of Service Grades

Exhibit 3.22 shows the existing levels of service for all of the signalized intersections in the CARLISLE PIKE study area. **Exhibit 3.23** illustrates the overall intersection level of service for each time period analyzed.

Int #	Crossing Road	Approach LOS				
		AM	MID	PM	SAT	OFF PEAK
7	S.R. 114	D	C	D	**E**	C
8	Wal-Mart Access	A	C	B	B	B
9	Sample Bridge Rd	B	A	A	A	A
10	Kohls Access	A	A	A	B	A
11	Silver Spring/Lambs Gap	B	B	C	C	A
12	Salem Church Rd	C	C	D	C	B
13	Skyport Rd	C	C	C	C	B
14	Brondle Road	B	B	B	B	A
15	Kmart Access/Jeffery Dr	B	B	B	C	A
16	Van Patten Road	A	A	A	A	A
17	Gateway Dr/S.R. 581	C	D	D	D	C
18	Sporting Hill Road	D	D	**E**	**E**	C
19	Hamden Centre	B	B	A	C	A
20	St. Johns Church Rd.	B	C	C	C	B
21	Saint Johns Drive	A	A	A	A	A
22	Orrs Bridge Road	D	C	**E**	C	B
23	34th Street	A	B	B	A	B
24	Camp Hill Bypass	**F**	**E**	**F**	D	D

Exhibit 3.22 Existing Levels of Service



LEGEND

LEVEL OF SERVICE

A	FREE FLOW CONDITION
B	STABLE FLOW
C	STABLE FLOW W/ INTERACTION
D	HIGH DENSITY STABLE FLOW
E	AT OR NEAR CAPACITY
F	FORCED OR BREAKDOWN FLOW

INTERSECTION LEVEL OF SERVICE

AM	A	A	MID-DAY
PM	F	F	SAT

PENNDOT

Gannett Fleming

Exhibit 3.23

2002 Level of Service Carlisle Pike

\40604\graphics\cdr\Carlisle Pike11x17\Carlisle Pike Exhibit 3_23.cdr

3.3.5. Crash Data

Although this study focuses on congestion related issues, the study team agreed that a review of safety related conditions was appropriate since often non-reoccurring congestion related to crashes impacts corridor operations.

Reportable crash data from 1996 through 2000 was reviewed. Generally, reportable crashes are defined as those requiring a vehicle to be towed or those involving injuries. Crashes by intersection as presented in **Exhibit 3.24**

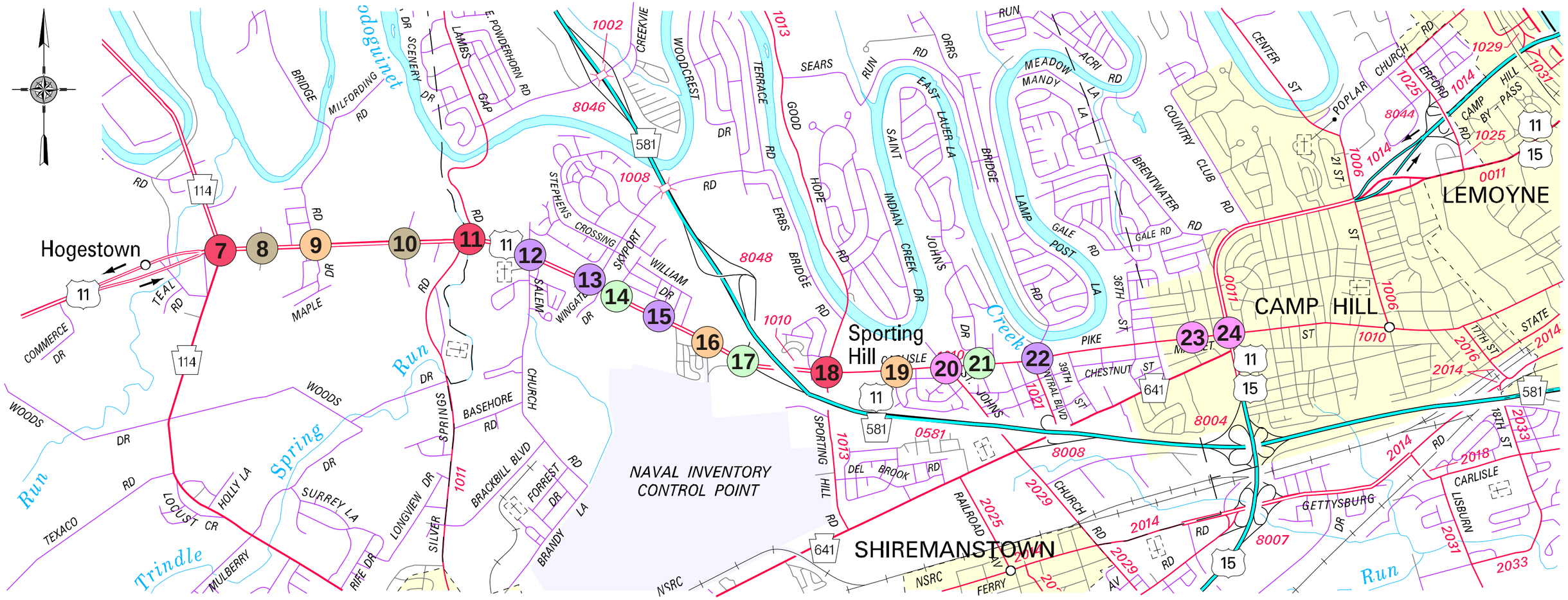
Three intersections have a crash history of five or more crashes per year as are detailed below:

Silver Spring Road/Lambs Gap Road
- ❑ 36 crashes over a five-year period
- ❑ 19 percent rear-end crashes
- ❑ 78 percent angle crashes

Sporting Hill Road
- ❑ 31 crashes over a five-year period
- ❑ 48 percent rear-end crashes
- ❑ 45 percent angle crashes

S.R. 114
- ❑ 31 crashes over a five-year period
- ❑ 70 percent rear-end crashes
- ❑ 12 percent angle crashes

All three intersections experience mostly rear-end and angle collisions, which are often attributed to congestion.



Legend

- XX 0 - 4 Crashes
- XX 5 - 9 Crashes
- XX 10 - 14 Crashes
- XX 15 - 19 Crashes
- XX 20 - 24 Crashes
- XX ≥ 25 Crashes
- XX Not Available

PENNDOT

Gannett Fleming

Exhibit 3.24

Crash Data Summary
1996 - 2000
Carlisle Pike

\40604\graphics\cdr\Carlisle Pike\11x17\Carlisle Pike Exhibit 3_24.cdr

3.3.6. Safety Audit Summary

A Road Safety Audit is a formal examination of a roadway that assesses its crash potential and safety performance. A goal is to identify safety related issues that may contribute to roadway congestion.

Using the checklists provided in the PENNDOT Road Safety Audit Manual, a Stage 5 (Operation/Existing Roads) Road Safety Audit was conducted. The Technical Appendix contains the detailed Road Safety Audit checklists. The following summarizes the results of the Road Safety Audit.

3.3.6.1. General Topics

- ❑ Parking adjacent to some driveways and side streets obstructs intersection sight distance. (Exhibit 3.25)
- ❑ In the area of Silver Spring Speedway, small parking lots at several businesses prevent trucks from entering to deliver goods. One truck was observed unloading goods from the shoulder of Carlisle Pike and blocking sight distance for vehicles exiting the business. (Exhibit 3.26)

Exhibit 3.25 Parking Obstructions

3.3.6.2. Alignment and Cross Section

- ❑ A quick shift in the alignment of the roadway just south of Van Patten Drive is located on a crest vertical curve, making it somewhat difficult for motorists to see the alignment of the roadway until they are at the crest.
- ❑ The right-turn lane for southbound traffic at Lambs Gap Road is only 10 feet wide with a reverse cross slope for the curvature on this section of roadway (curve to left with cross slope to right). (Exhibit 3.27)
- ❑ The two-way left-turn lane (TWLTL) from near Sporting Hill Road to 34th

Exhibit 3.26 Obstructions near Silver Spring Raceway

Street is only 11 feet wide.

- ❑ Gravel and potholes contribute to poor a shoulder surface from Silver Spring Road to SR 114. (Exhibit 3.28)

3.3.6.3. Intersections

- ❑ Increased use of curbs, islands, and medians are important to improve safety through access management techniques. Inconsistent and ineffective means of access control include rolled asphalt curb and concrete parking bumpers. As shown, the asphalt curb is not at a standard height due to a recent overlay of the roadway. In this photo, the parking bumpers create numerous access points. (Exhibit 3.29)

- ❑ Turning radii at 34th Street intersection are extremely restrictive.

- ❑ Lane markings on Gateway Square approach to SR 11 are faded. If drivers miss the overhead guide sign, they may be unaware of the proper lane configuration.

Exhibit 3.27 Narrow Turn Lane on Super-elevated Section

Exhibit 3.28 Deteriorated Shoulder

3.3.6.4. Non-Motorized Traffic

- ❑ Curb ramps and sidewalks are not provided at all locations even when pushbuttons and crosswalks are present.

- ❑ Frequent bus stops exist but no pull offs are present.

- ❑ The sidewalk width is insufficient near 34th because of utility pole obstructions.

- ❑ Most inlets are bicycle-safe, however, several exist which are not.

3.3.6.5. Signs and Lighting

- ❑ Lighting appears to be adequate in all locations with the exception of the Lambs Gap/Silver Spring Road intersection.
- ❑ Several signs have lost their retroreflectivity. Pavement markings are worn west of Sporting Hill and Lambs Gap Road.
- ❑ Black shadow markings should be installed on concrete pavement in the area of Gateway Drive to improve daytime contrast of pavement and skip line markings, particularly where Carlisle Pike eastbound becomes three lanes.

Exhibit 3.29 Curbing with Inadequate Reveal

3.3.6.6. Traffic Signals

- ❑ Because of the wide intersection at Gateway Drive/SR 581, eastbound US 11 left-turn vehicles have difficulty viewing the left-turn signal when preceded by a truck. The same situation is present on eastbound US 11 at SR 114. High truck traffic percentages are characteristic of both left-turn volumes.
- ❑ Pedestrian signals and pushbuttons are provided at most locations, however, even these locations are lacking ADA ramps.
- ❑ Eastbound vehicle queues from Gateway Drive sometime extend to near Van Patten. These queues can be somewhat obstructed because of the crest vertical curve just west of Van Patten Drive.

3.3.6.7. Physical Objects

- ❑ Throughout much of the corridor, utility poles may be close to the travel way in both curbed and uncurbed sections.
- ❑ Guardrail on the north side of US 11 near Lambs Gap Road is only 20 inches from ground to top of rail, less than the required 27 inches.
- ❑ A non-standard end section is in use on the north side of US 11 near Kohls.

3.3.6.8. Delineation

- ❑ No raised reflective pavement markers (RRPMs) are present on the corridor.

3.3.6.9. Pavement

- ❑ Rutting becomes evident at Lambs Gap and Silver Spring Roads and worsens moving westward toward SR 114.
- ❑ Asphalt bleeding was noted between Lambs Gap Road and SR 114.
- ❑ Shoulders between Silver Spring and Sample Bridge Roads are covered with gravel and loose screenings.

4. Future "No Build" Conditions

4.1. Future Development

The Carlisle Pike corridor is nearly fully developed east of Gateway Drive, however, many areas to the west of Gateway Drive have the potential to grow and develop in the future. The future "No Build" model considered how the operating conditions would be if no improvements were implemented in the study corridor. To do this, traffic was forecasted for a ten-year period and then analyzed in the model developed as part of the existing conditions analyses.

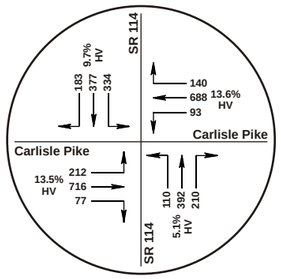
4.2. Planned Projects

There are currently two planned projects on PENNDOT's Twelve Year plan for the study corridor. One is the upgrade of the pavement structure from the Carlisle Pike to Interstate 81 on S.R. 114. In Hampden Township, the St. John's Church Road interchange at S.R. 581 is currently programmed for 2007.

4.3. Traffic Forecasts

As mentioned, the future model projects the conditions of the roadway ten years into the future. To do that, historical growth trends were analyzed. Both PENNDOT and Tri-County Regional Planning Commission data was examined and the study team members agreed upon the TCRPC data. The analysis of the TCRPC model yielded a compounded growth rate of 0.62 percent per year. Using the resulting projected growth factor of 1.06, 2012 projected conditions could be calculated.

The growth factor was applied to existing traffic volumes to forecast traffic for Year 2012. Anticipated future turning movement volumes are presented as **Exhibits 4.1 - 4.4.**



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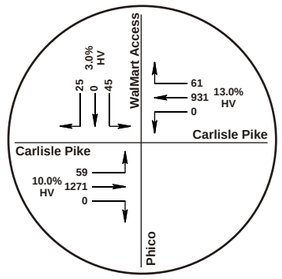

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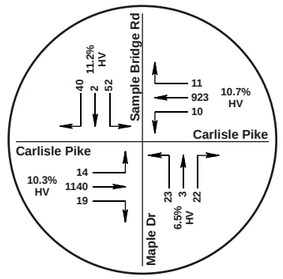

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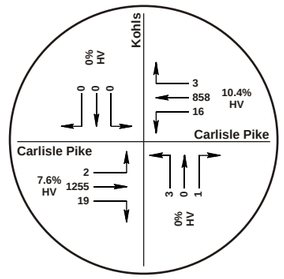

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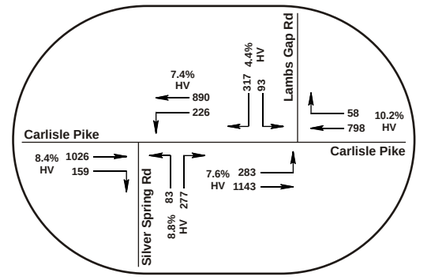

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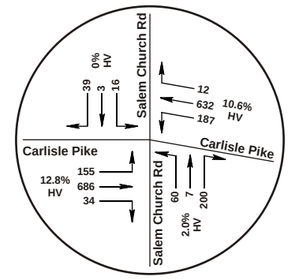

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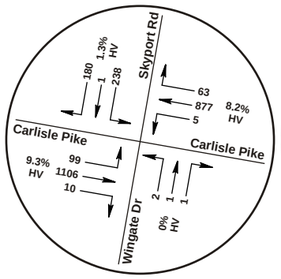

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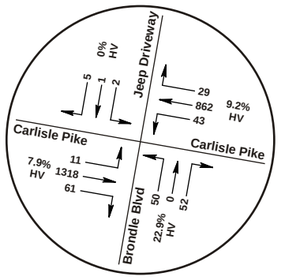

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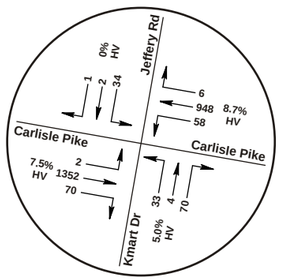

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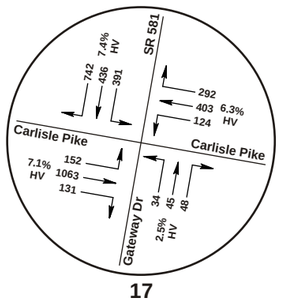

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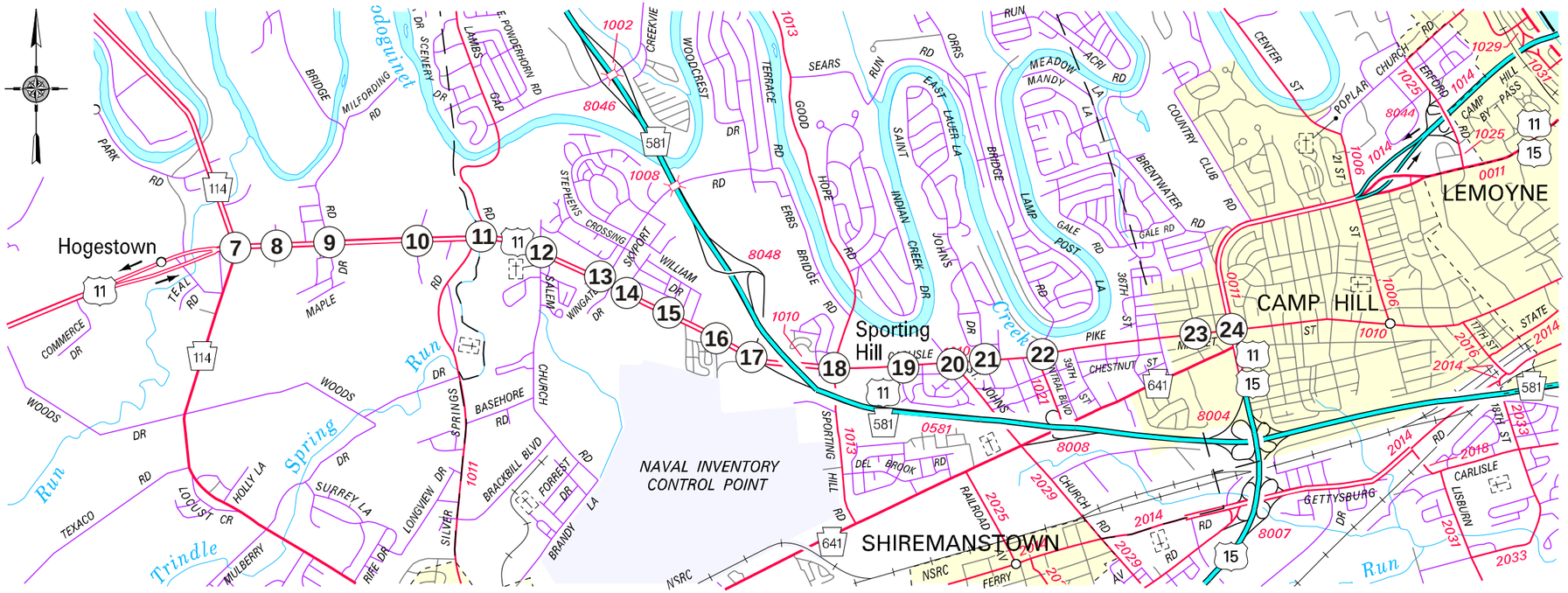

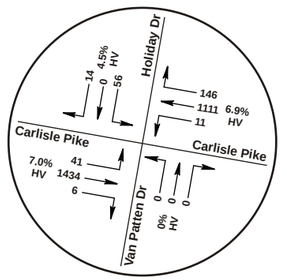

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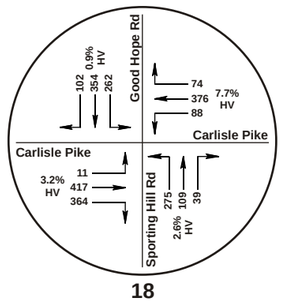

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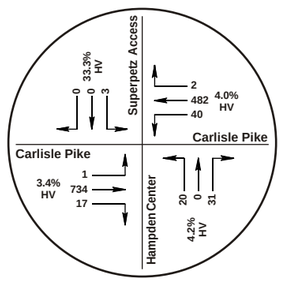

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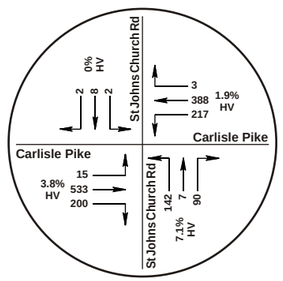

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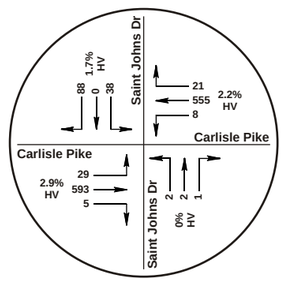

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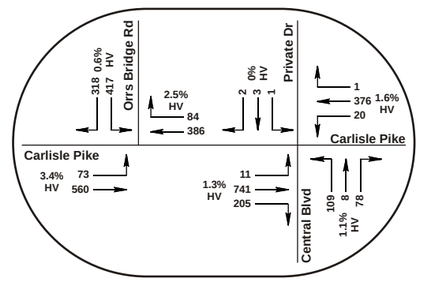

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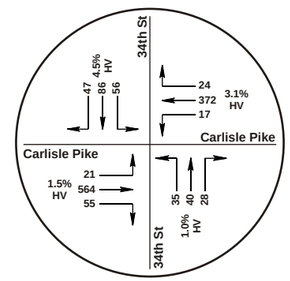

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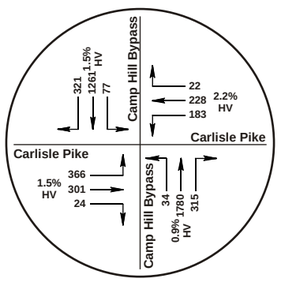

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Legend

HV - Heavy Vehicles

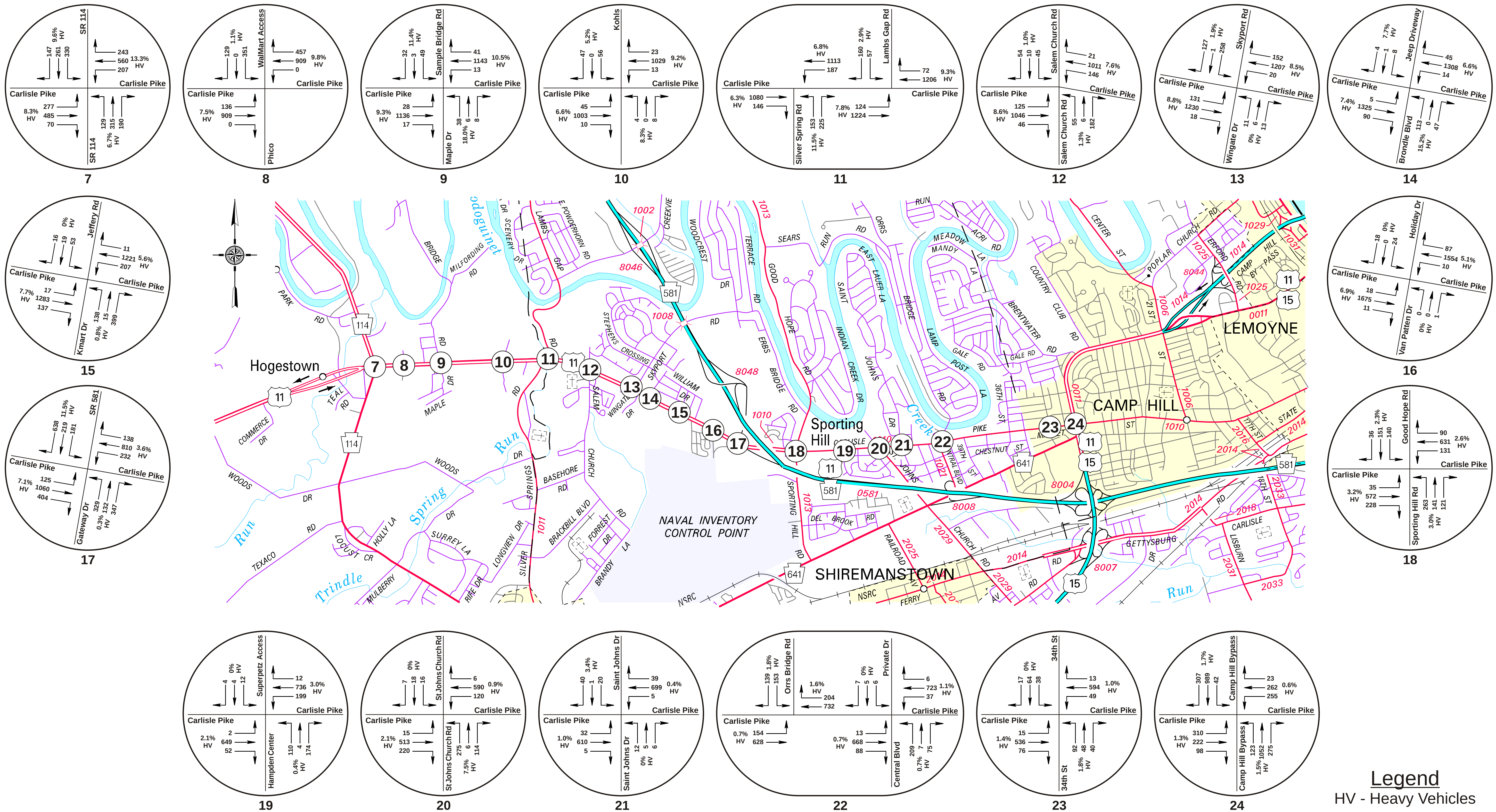
Exhibit 4.1

2012 Projected AM Peak Hour Traffic Volumes Carlisle Pike

PENNDOT

Gannett Fleming

\40604\graphics\cdr\Carlisle Pike\11x17\Carlisle Pike Exhibit 4_1.cdr



Legend
HV - Heavy Vehicles

Exhibit 4.2

2012 Projected Mid-day Peak Hour Traffic Volumes Carlisle Pike

PENNDOT

Gannett Fleming

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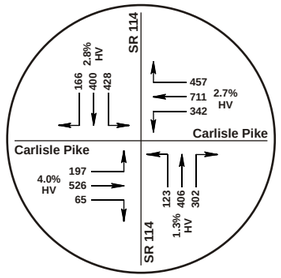

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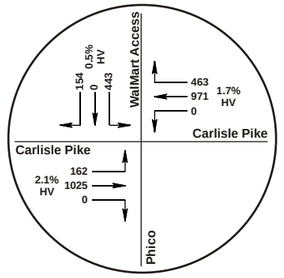

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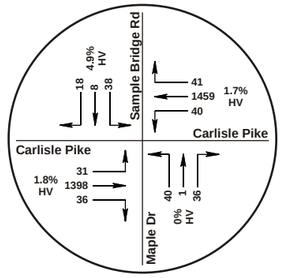

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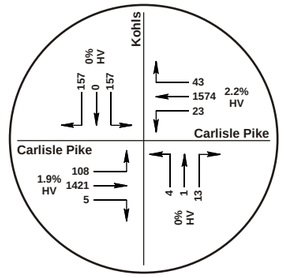

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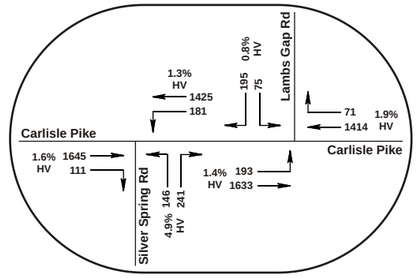

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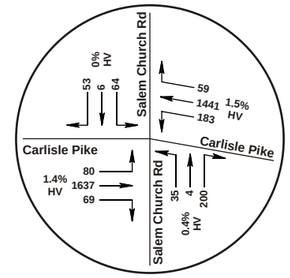

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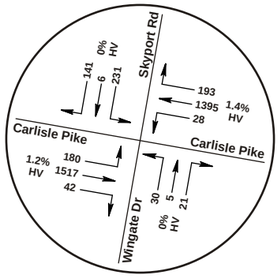

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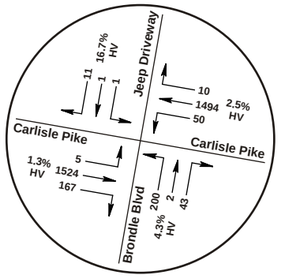

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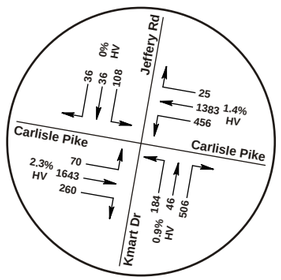

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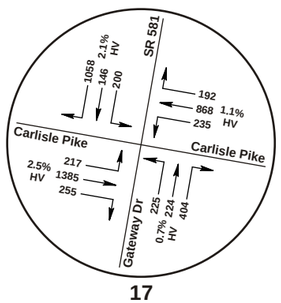

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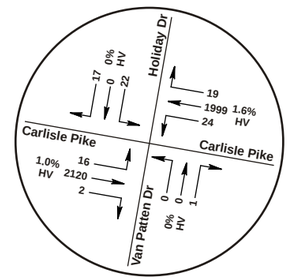

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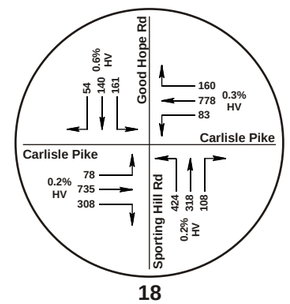

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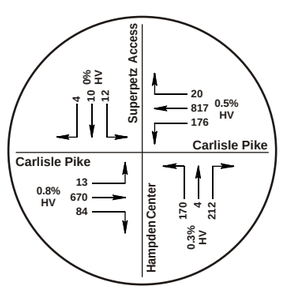

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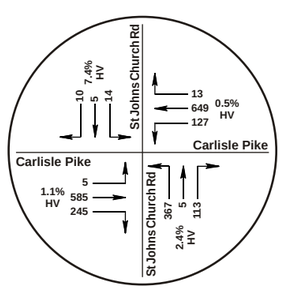

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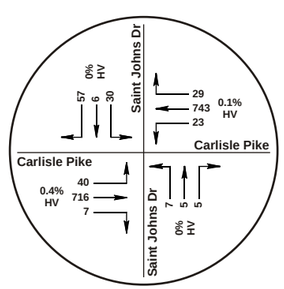

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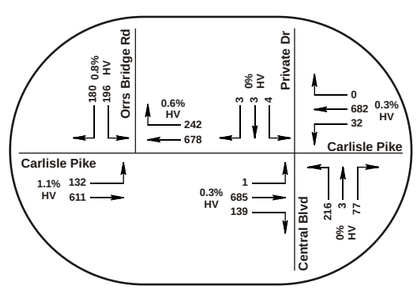

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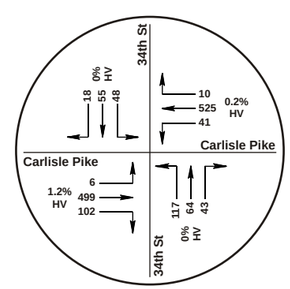

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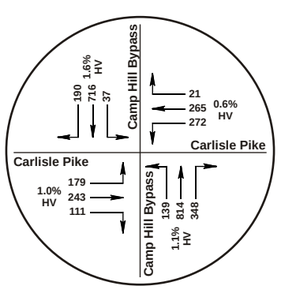

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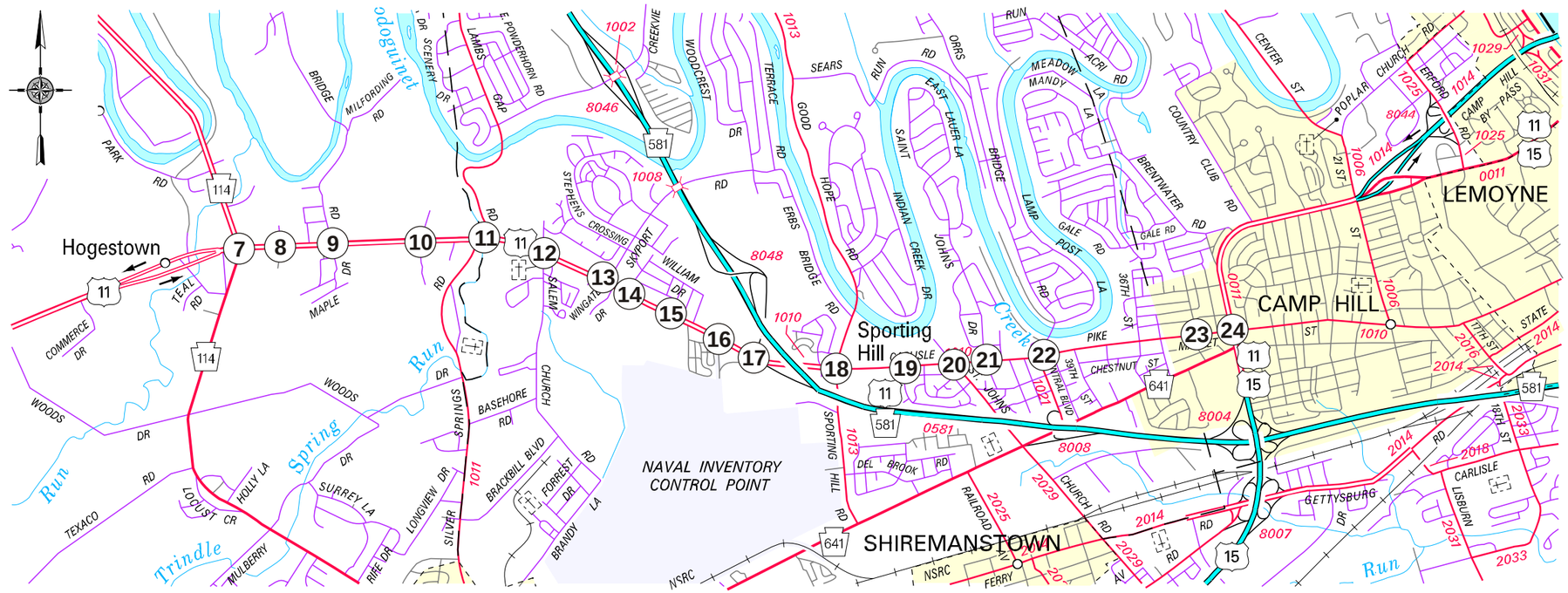


Legend

HV - Heavy Vehicles

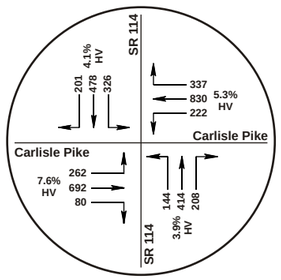
Exhibit 4.3

2012 Projected PM Peak Hour Traffic Volumes Carlisle Pike

PENNDOT

Gannett Fleming

\40604\graphics\cdr\Carlisle Pike\11x17\Carlisle Pike Exhibit 4_3.cdr



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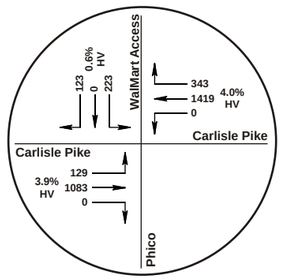

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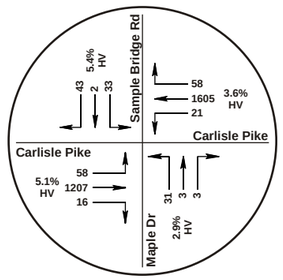

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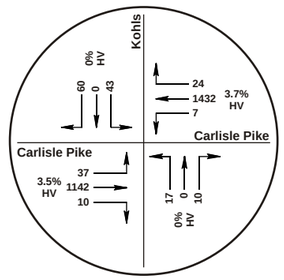

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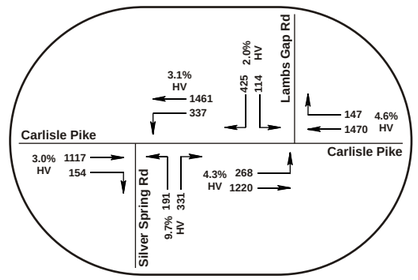

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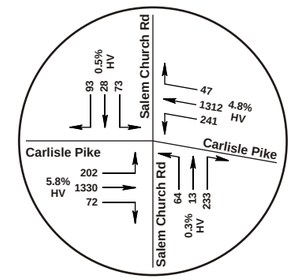

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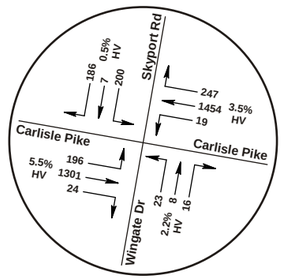

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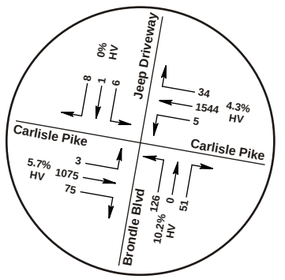

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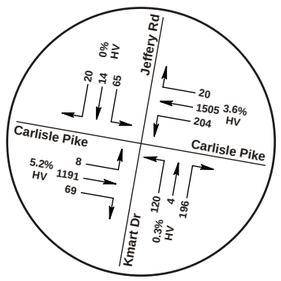

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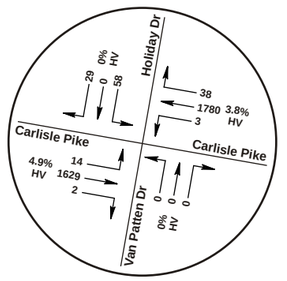

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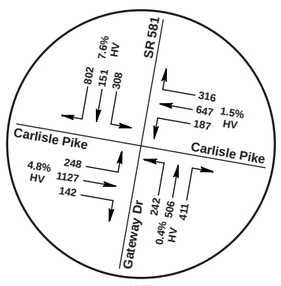

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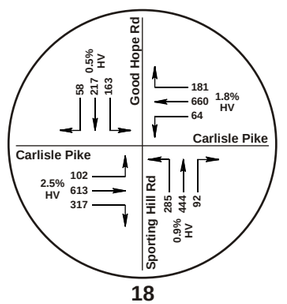

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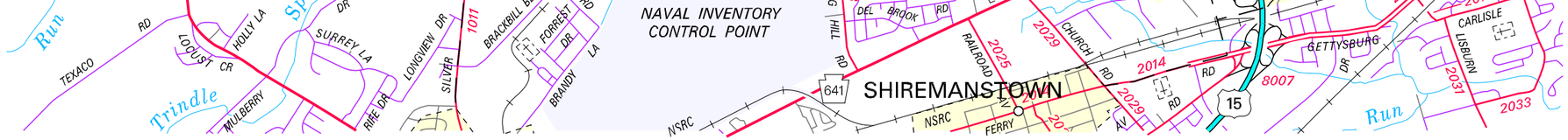

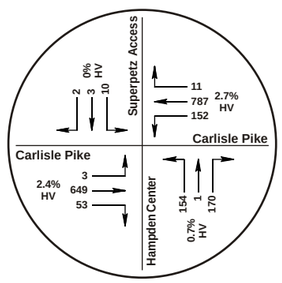

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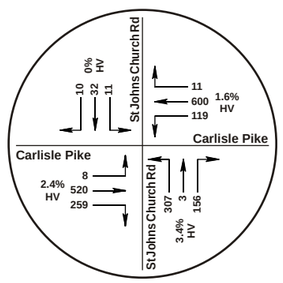

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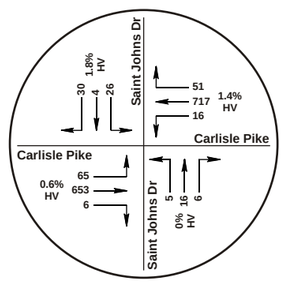

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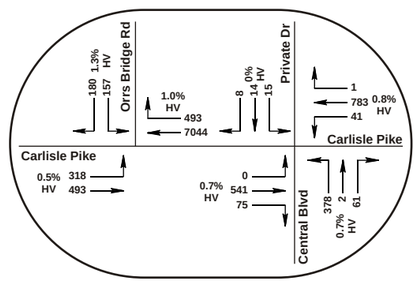

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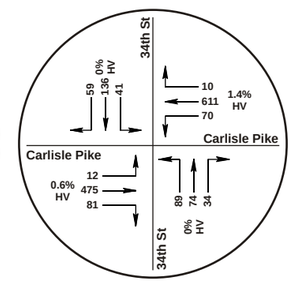

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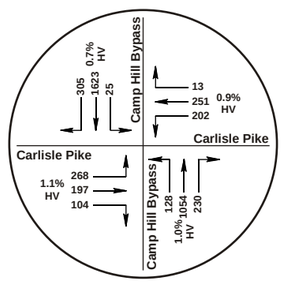

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Legend

HV - Heavy Vehicles

Exhibit 4.4

2002 Projected Saturday Peak Hour Traffic Volumes Carlisle Pike

PENNDOT

Gannett Fleming

\40604\graphics\cdr\Carlisle Pike\11x17\Carlisle Pike Exhibit 4_4.cdr

4.4. Future "No Build" Operational Conditions

The operational conditions for the future "No Build" alternative were quantified in the same manner as the existing conditions described in Section 3. Corridor travel times, arterial level of service and intersection level of service were calculated and are presented in subsequent sections.

4.4.1. Corridor Travel Times

Exhibit 4.5 shows a comparison of corridor travel times under existing conditions and under future "no build" conditions.

Peak Period and Direction	Existing Trip Time (min)	Projected Trip Time (min)
AM EASTBOUND	16	17
MID-DAY EASTBOUND	14	15
PM EASTBOUND	17	18
SATURDAY EASTBOUND	18	19
OFF-PEAK EASTBOUND	13	13
AM WESTBOUND	15	15
MID-DAY WESTBOUND	16	16
PM WESTBOUND	20	21
SATURDAY WESTBOUND	18	19
OFF-PEAK WESTBOUND	13	14

Exhibit 4.5 Projected "No Build" Travel Time vs. Existing Travel Time

4.5. Arterial Level of Service

Exhibit 4.6 shows how Carlisle Pike will operate versus the current conditions on a corridor wide basis.

Peak Period	Existing Arterial Operational Level of Service Eastbound	Existing Arterial Operational Level of Service Westbound	Projected Arterial Operational Level of Service Eastbound	Projected Arterial Operational Level of Service Westbound
AM	B	B	C	B
MIDDAY	B	B	B	C
PM	C	C	C	C
SATURDAY	C	C	C	C

Exhibit 4.6 Projected "No Build" Arterial Level of Service vs. Existing Arterial Level of Service

On the average, the arterial level of service will degrade by one letter grade.

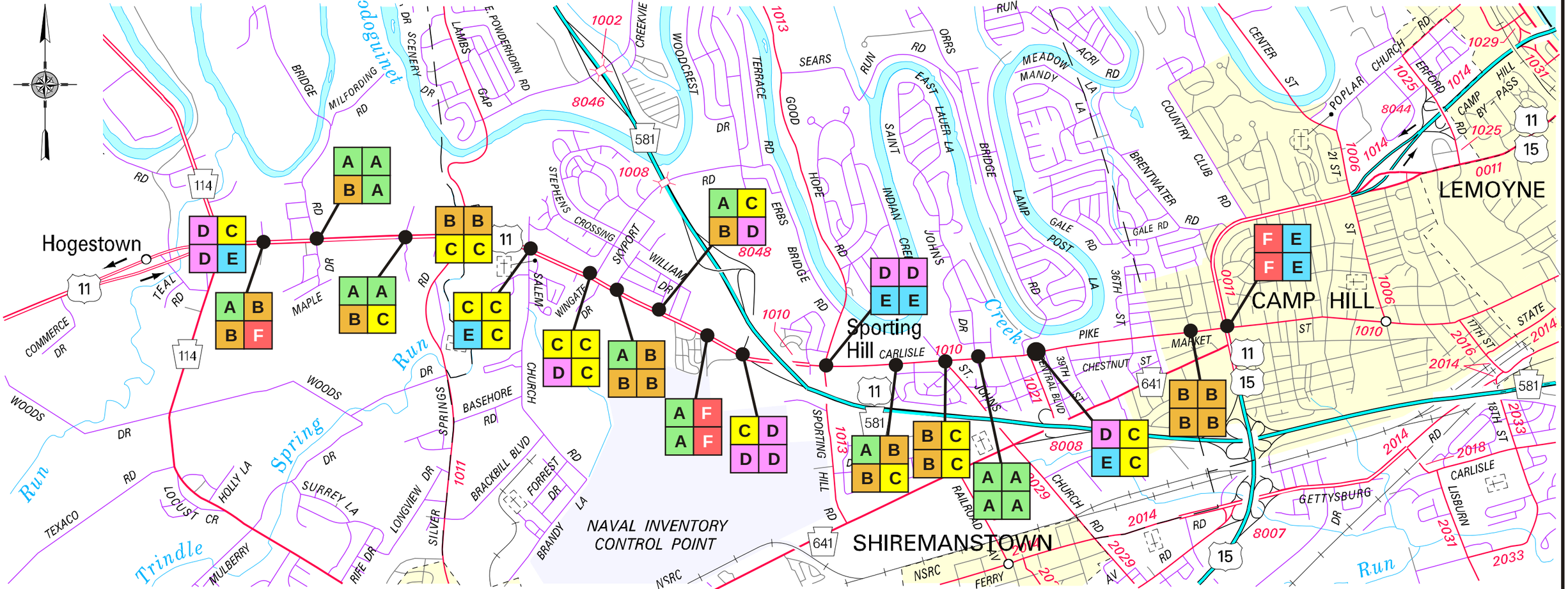
4.5.1. Intersection Level of Service

Exhibit 4.7 indicates what the projected level of service for each intersection will be in the year 2012. **Exhibit 4.8** illustrates overall intersection level of service for each time period analyzed.

Crossing Road	Approach LOS				
	AM	MID	PM	SAT	OFF PEAK
S.R. 114	D	D	D	**E**	C
Wal-Mart Access	A	C	B	B	B
Sample Bridge Rd	B	B	A	A	A
Kohls Access	A	A	A	C	A
Silver Spring/Lambs Gap	B	B	C	C	A
Salem Church Rd	C	C	**E**	C	B
Skyport Rd	C	C	D	C	B
Brondle Road	B	B	B	B	A
Kmart Access/Jeffery Dr	B	B	C	D	A
Van Patten Road	A	A	B	A	A
Gateway Dr/S.R. 581	C	D	**E**	D	C
Sporting Hill Road	D	D	**E**	**E**	C
Hamden Centre	B	B	B	C	A
St. Johns Church Rd.	B	C	C	C	B
Saint Johns Drive	A	A	A	A	A
Orrs Bridge Road	D	C	**E**	C	B
34th Street	B	B	C	B	B
Camp Hill Bypass	**F**	**E**	**F**	**E**	D

Exhibit 4.7 Projected "No-Build" Level of Service

As **Exhibit 4.7** indicates, S.R. 114, Salem Church Road, Gateway Drive, Sporting Hill Road and Orrs Bridge Road will be at near failing conditions within 10 years. The Camp Hill Bypass will be at failing conditions during the AM and PM peak hours.



LEGEND

LEVEL OF SERVICE

A	FREE FLOW CONDITION
B	STABLE FLOW
C	STABLE FLOW W/ INTERACTION
D	HIGH DENSITY STABLE FLOW
E	AT OR NEAR CAPACITY
F	FORCED OR BREAKDOWN FLOW

INTERSECTION LEVEL OF SERVICE

AM	A	A	MID-DAY
PM	F	F	SAT

PENNDOT

Gannett Fleming

Exhibit 4.8

2012 Level of Service Carlisle Pike

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5. Summary of Adverse Conditions

5.1. Corridor Wide Issues

By year 2012, it is expected that the Carlisle Pike corridor will experience at least a 6.2 percent increase in traffic. If the corridor is not upgraded to accommodate anticipated growth, it will experience failing conditions or near failing conditions at several intersections along the corridor. The conditions are such that any unexpected growth could force more of this high volume corridor into failing conditions.

5.2. Access Management

One of the most prominent situations involving the Carlisle Pike corridor is the lack of access management. As this corridor has been developed, little has been done to consolidate and manage how properties access the facility. As Section 3.3.2.1 discussed, there are nearly 30 access points per mile on this corridor in each direction. Research has indicated that 60 access points per mile can decrease the travel speed by over 10 miles per hour and dramatically increase the travel time.

5.3. Coordination of Transportation Enhancements

A major issue facing the corridor stakeholders is the challenge of coordinating the design, construction and financing of transportation enhancements. Corridor stakeholders are cautious not to dedicate valuable resources at the benefit of development that may or may not occur in the future.

5.4. Physical Facility Conditions

Currently, there are many areas within the study area where physical traffic control measures are in poor condition or missing. Features such as paint, lane assignment signs and street signs cannot be modeled as they affect congestion, however, the absence of such features can cause driver confusion and hesitation as well as unsafe conditions.

5.5. Signal Systems

Currently, there are three signal systems along the Carlisle Pike corridor. Two of the systems are west of Gateway Drive, while the third is to the east of Gateway Drive. The two systems to the west function with similar characteristics, cycle length and share the same type of equipment, but are not interconnected. This results in poor progression between systems. Additionally, the majority of signals to the east of Gateway Drive utilize the same equipment and could be integrated into one system.

5.6. Transit Considerations and Alternative Route Planning

Bus transit can play a major part in improving congestion problems. Currently, there is transit service along the corridor, but it along with Park-n-Ride services is not apparent among corridor travelers.

6. Alternatives Analyses

6.1. Description of Alternative Scenarios

In order to support the planning and programmatic needs of the stakeholder group, four alternative categories were identified as detailed in **Exhibit 6.1.** For each category, an estimated timeframe was assumed based on the anticipated levels of resources needed to implement the improvement.

The **Immediate** Alternatives are low-cost initiatives that can be carried out in the near future. To that end, detailed guidance on these initiatives is provided in subsequent sections and the Technical Appendix such that minimal engineering is required.

From an alternatives standpoint, there is little deviation between **Short-term** and **Mid-term** Alternatives. Distinguishing between the two categories was largely based on engineering judgment as a result of anticipated environmental documentation and right-of-way needs as well as overall complexity of the improvement.

Long-term Alternatives are items that require substantially more analysis and documentation than can be provided within the context of this study. These items are expected to have significant costs.

Alternative Categories	Estimated Timeframe	Description
Immediate	Less than 1 year	↳ Minor signing and pavement marking improvements ↳ Signal timing modifications to existing signal systems and individual intersections ↳ Minor inter-modal enhancements
Short-term	1 to 3 years	↳ Signing and pavement marking improvements. ↳ Minor geometric improvements within existing right-of-way ↳ Signal timing modifications to existing signal systems and individual intersections
Mid-term	3 to 10 years	↳ Geometric improvements requiring right-of-way including major intersection improvements ↳ Multi-jurisdictional improvements such as inter-jurisdictional signal systems, etc.
Long-term	Greater than 10 years	↳ Improvements requiring additional studies, planning and programmatic funding such as major or new roadway construction

Exhibit 6.1 Alternative Categories

6.2. Development of Alternative Ideas

The development of alternative ideas was an iterative process. Problem areas were identified as a result of **stakeholder input**, a review of **operational deficiencies** and causes, and **safety** concerns. Considering those issues, possible solutions were identified during a brainstorming session. After the brainstorming session, possible solutions were field assessed to determine if it was felt they were "reasonable and feasible."

Exhibit 6.2 shows the improvements that were considered within the study corridor. The table shows the ideas that were originally brainstormed as the team looked at each intersection. Each potential solution was analyzed and was carried forward only if it had some level of benefit.

Exhibit 6.2 Brainstormed – Potential Solutions

Intersection	Location	Immediate (<1 year)	Short-term (1-3 years)	Mid-term (3-10 years)	Long-term (>10 years)
S.R. 114	Silver Spring	↳ Coordinate with development improvements ↳ Install skip lines to delineate lanes ↳ Install near side left turn signals		↳ WB double left-turn lanes (consider EB double left also) ↳ Transition area to south	
Wal-Mart	Silver Spring	↳ Coordinate with development improvements ↳ WB right-turn overlap phase	↳ Free WB right-turn movement		
Sample Bridge Road	Silver Spring	↳ Install emergency preemption devices			
Kohls Access	Silver Spring	↳ WB right-turn lane at unsignalized entrance ↳ Prohibit truck parking on shoulders			
Silver Spring/Lambs Gap	Silver Spring/Hampden	↳ Evaluate visibility of signal indications ↳ Prohibit truck parking on shoulders	↳ Start EB left-turn lane before Silver Spring Road ↳ Lighting		↳ Realignment including possible closure of Lambs Gap and connection to Salem Church Road
Salem Church Road	Hampden	↳ Delineate existing NB right-urn lane			↳ Realignment including possible closure of Lambs Gap and connection to Salem Church Road

Exhibit 6.2 Brainstormed – Potential Solutions

Intersection	Location	Immediate (<1 year)	Short-term (1-3 years)	Mid-term (3-10 years)	Long-term (>10 years)
Skyport Road	Hampden		↳ Remove Pep Boys access, make "T" and sign to Brondle		
Brondle Road	Hampden	↳ Mid-block overlapping left-turns at Circuit City and Hooters (pork chop)	↳ Make Access points right-in-right-out and sign traffic to Brondle Rd		
Kmart Access	Hampden	↳ Lengthen WB left-turn lane ↳ Add EB right-turn yield sign ↳ Make All-First right-in right-out and provide full access through KMart		↳ WB double left-turn if developed	↳ Combine Radio Shack and Party City parking areas, close Donald Rd. and send traffic to Jeffery Dr.
Van Patten Road	Hampden				
Gateway Dr./S.R. 581	Hampden	↳ Nearside signal for EB left-turn movement ↳ Coordinate with study evaluating change to NB configuration including left, left/, thru and right	↳ Better delineation Van Patten to Gateway transition including black shadow skip lines on concrete section		↳ Lengthen transition area ↳ EB double left

Exhibit 6.2 Brainstormed – Potential Solutions

Intersection	Location	Immediate (<1 year)	Short-term (1-3 years)	Mid-term (3-10 years)	Long-term (>10 years)
Sporting Hill Road	Hampden	↳ Length of NB left-turn lane	↳ Make all access points to Hampden Centre right-in-right-out	↳ NB double left-turn lanes ↳ WB left, thru and thru/right configuration ↳ Four-lane section from Sporting Hill Road to Gateway Drive	↳ Connector Road to north from St Johns Church Road to Sporting Hill Road or SuperPetz
Hampden Center	Hampden	↳ Meter mainline green time to reduce stacking at Sporting Hill Road	↳ Consider combining access points (Firestone to Superpetz)		↳ Connector Road to north from St Johns Church Road to Sporting Hill Road
Saint Johns Church Rd	Hampden	↳ Length of NB left-turn lane			↳ Connector Road to north from St Johns Church Road to Sporting Hill Road
Saint Johns Drive	Hampden	↳ Truck signing to limit usage by St Johns Church Rd trucks			
Orrs Bridge Road	Hampden	↳ WB right-turn signing ↳ Length of WB right-turn storage			↳ Realign intersection
34th Street	Camp Hill	↳ New controller ↳ Evaluate lane configuration on Carlisle Pike (left and thru/right vs. left/thru and thru/right)	↳ Consider NB right lane as per development concept		

Exhibit 6.2 Brainstormed – Potential Solutions

Intersection	Location	Immediate (<1 year)	Short-term (1-3 years)	Mid-term (3-10 years)	Long-term (>10 years)
Camp Hill Bypass	Camp Hill	↳ Review and coordinate with EK study ↳ Remove split phase ↳ Accommodate exclusive pedestrian in coordinated timing plan			
Corridor wide		↳ Retime existing signal systems ↳ Time-based interconnection of two western most systems ↳ Install mast arm street signs where not currently existing	↳ Preemption ↳ Delineation plan for corridor including RPM's ↳ Better advertise Kmart park-n-ride ↳ Transit service at population centers such as Silver Spring, Kmart, Gateway and Hampden Center	↳ Inter-jurisdictional signal system ↳ Consider impact fee assessment plan ↳ Develop an access management plan	↳ Incident detection system at critical junctions with VMS signing at Bypass, Gateway and 114 including CCTV and signing on 581 and I81 ↳ Four-lane section from Gateway to Camp Hill Bypass ↳ Truck connector route between Silver Spring and Gateway/581

7. Identified Improvement Alternatives

7.1. Corridor-wide Improvements

The first area of improvements is those related corridor as a whole. These improvements should be considered for the entire corridor to improve traffic operations.

7.1.1. Immediate Improvements

Immediate improvements focus on what can be implemented in one year or less. They are generally low cost alternatives that are designed to have immediate impacts. The following highlights corridor-wide immediate improvements for consideration.

- Retime Traffic Signals -The existing signal systems should be retimed to improve traffic operations in the near future. The Technical Appendix contains updated coordination sheets for each of the signalized intersections in the study area.

- Coordinate the two western most systems – There is a break in signal systems between Wal-Mart's access drive and Sample Bridge Road These two systems currently use the same cycle lengths for the peak periods and will continue to do so under the immediate recommendation to retime the signal systems. Coordination will increase the chance of encountering a larger bandwidth for that area of the corridor. In the immediate timeframe, this can be accomplished through time-based coordination, although it is desirable to physically interconnect them in the near future.

- Install Street Name Signs – Several intersections do not have street name signs. The installation mast arm or pan wire street name signs will aid motorists unfamiliar with the area.

7.1.2. Short-term Improvements

Short-term alternatives are developed to further reduce the congestion within the study area by providing geometric improvements that can be contained within the existing right-of-way limits, adding signs that may be missing or needed and updating pavement markings including lengthening turn lanes where possible. General short-term recommendations include:

- Additional Refinement of Signal Timings – Signal timings should be refined on a regular basis or as a result of development or other transportation enhancements.

- Delineation Plan for the Corridor – Currently, several areas along the corridor lack desirable levels of delineation. By providing adequate delineation, driver awareness

of the roadway is increased. An example of an area needing additional delineation, is the transition area between Van Patten Drive and Gateway Drive.

- ❑ Advertising for Kmart Park-n-Ride – There is an existing Park-n-Ride lot in the southwest quadrant of the Kmart Access that currently has one identification sign. Better advertising for this lot may increase its usage.

- ❑ Transit Development –There are no transit stops along the corridor at many of the population centers. Increasing the amount of stops along the corridor at popular destinations can reduce the congestion within the corridor by making the routes convenient and user friendly. However, proper transit facilities must be constructed to avoid causing congestion and safety concerns.

7.1.3. Mid-term Improvements

The main focus of mid-term alternatives is on areas that were not improved to acceptable levels of service by implementing either in whole or in part the proposed improvements identified in the immediate and short-term categories.

- ❑ Additional Refinement of Traffic Signal Timings - Signal timings should be refined on a regular basis or as a result of development or other transportation enhancements.

- ❑ Inter-jurisdictional Signal System - Inter-jurisdictional signal systems allow maximum coordination of signals throughout a corridor and between municipalities. It provides the ability for efficient response to traffic situations, better system diagnostics and allows municipalities to share resources. Most software tools permit zoned or corridor operations as needed.

- ❑ Park-n-ride Services - Park-n-ride facilities could be effective near S.R. 114, Hampden Centre or Gateway Drive as well as a defined Park-n-Ride area in the Camp Hill Mall parking lot. Many of these locations have large parking areas all ready so that posting signs and advertising might be all that is necessary.

- ❑ Impact Fee Assessment Plan - Impact fee assessments are a legal and effective way to help mitigate problems that emerge for the facility due to development and unexpected traffic generators. Act 209, enacted in 1990 enables Pennsylvania municipalities to assess impact fees after compiling a Land Use Assumptions Report, Roadway Sufficiency Analysis, Capital Improvements Plan and Transportation Impact Fee Ordinance. Assessing impact fees allows municipalities to collect fees from developers, which will provide capital for improving the roadways within the municipality. Act 209 outlines specific items that must be included as part of the aforementioned documents. Currently, the practice of assessing impact fees is not used on the Carlisle Pike corridor.

- Access Management Plan - Joint and cross access points are valuable ways to reduce the number of driveways for a given section of roadway. Joint access and cross access points are terminology for legally combining driveways. Joint access is when two adjacent properties share a mutual driveway that parallels the property line between to adjacent parcels. Cross access is when a property has access to a driveway on another property by way of an easement to the parcels deed. One article published by the Center for Transportation Research and Education says that the rule of thumb for driveway sharing is that if a property has less than 60 feet of frontage on the arterial that it borders, it should not have an individual driveway. Dedicated right-turn lanes, continuous two-way left-turn lanes, driveway consolidation and right-in-right-out driveways are all ways to minimize the effect mid-block access points have on the Carlisle Pike Corridor.

7.2. Detailed Intersection Improvements

This section will provide specific improvement information for each intersection within the corridor.

7.2.1. Carlisle Pike at S.R. 114

Scenario	Considerations and Improvements	Anticipated Operations			
		AM	MD	PM	SAT
Future "No Build"	↳Balanced intersection volumes ↳Surrounded by commercial land uses ↳Possible future development near intersection ↳Major point of traffic entering and exiting the facility	**D**	**D**	**D**	**E**
Immediate	↳Install broken white lines to delineate lanes ↳Install near side left-turn signal for eastbound left-turn lane **SEE EXHIBIT 7.1**	**NA**	**NA**	**NA**	**NA**
Short-term	↳No specific improvements other than timing refinements	**C**	**C**	**C**	**D**
Mid-term	↳Westbound and eastbound double left-turns o Improve transition to south **SEE EXHIBIT 7.2**	**C**	**A**	**C**	**C**

7.2.2. Carlisle Pike at Wal-Mart Access

Scenario	Considerations and Improvements	Anticipated Operations			
		AM	MD	PM	SAT
Future "No Build"	↳Possible usage of northbound approach lanes if property is sold or developed ↳Possible increase of traffic from Silver Spring Commons	**A**	**C**	**B**	**B**
Immediate	↳Westbound right-turn overlap phase	**NA**	**NA**	**NA**	**NA**
Short-term	↳No specific improvements other than timing refinements	**A**	**B**	**B**	**B**
Mid-term	↳No specific improvements other than timing refinements	**A**	**B**	**B**	**B**

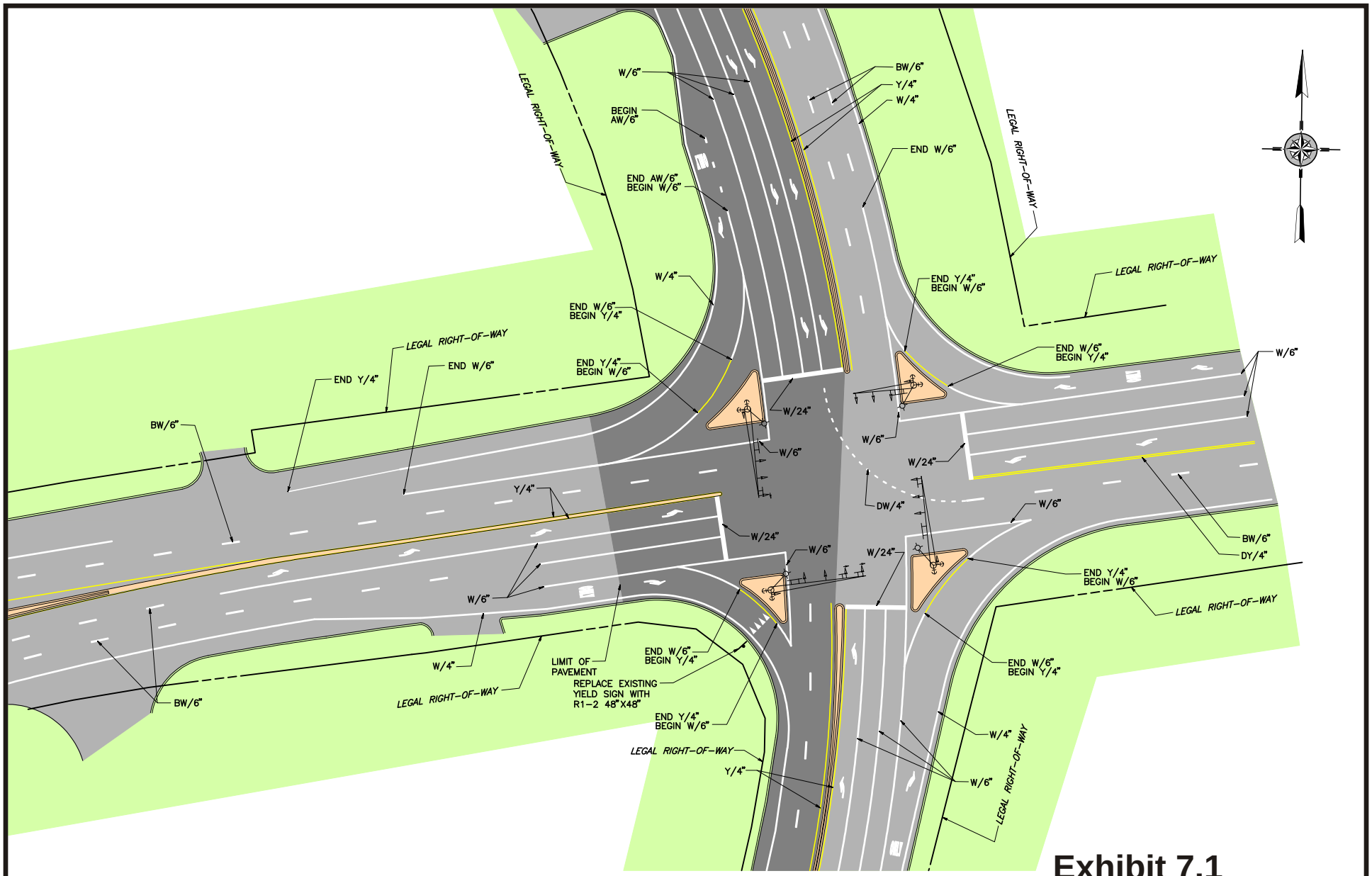

Exhibit 7.1

Immediate Intersection Improvements Carlisle Pike and SR 114

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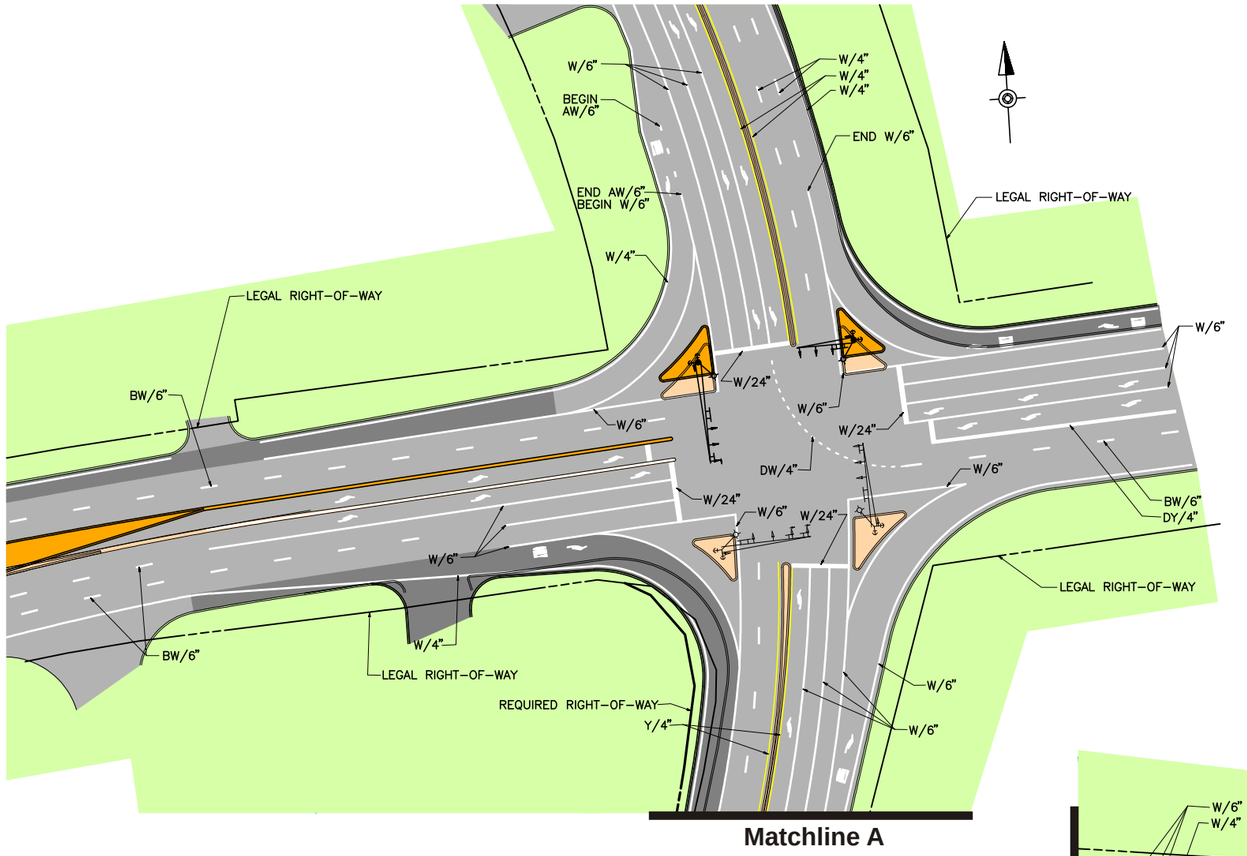

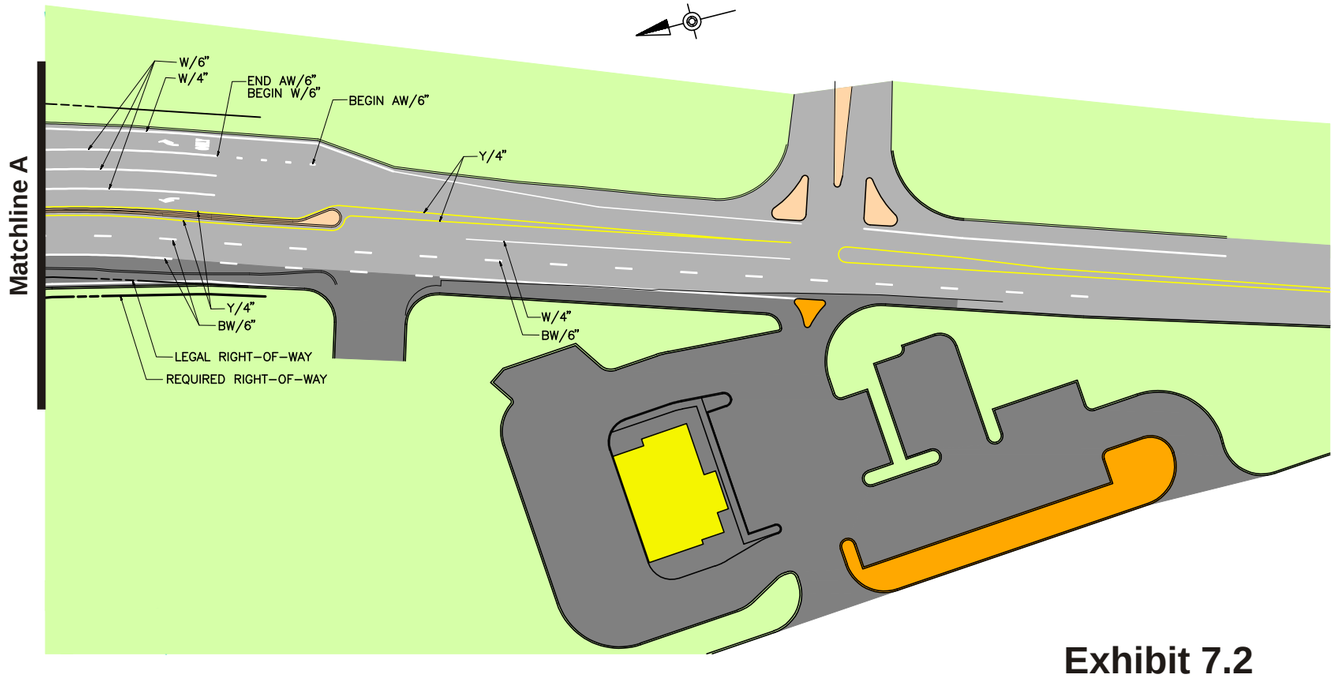

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Exhibit 7.2

Mid-Term
Intersection Improvement
Carlisle Pike and SR 114

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7.2.3. Carlisle Pike at Sample Bridge Road

Scenario	Considerations and Improvements	Anticipated Operations			
		AM	MD	PM	SAT
Future "No Build"	↳Silver Spring emergency services in southeast quadrant	B	B	A	A
Immediate	↳No specific improvements other than timing refinements	NA	NA	NA	NA
Short-term	↳No specific improvements other than timing refinements	A	A	A	A
Mid-term	↳No specific improvements other than timing refinements	A	A	A	A

7.2.4. Carlisle Pike at Kohl's Access

Scenario	Considerations and Improvements	Anticipated Operations			
		AM	MD	PM	SAT
Future "No Build"	↳Possible large residential development and other commercial development to south	A	A	A	B
Immediate	↳Add a westbound right-turn lane at the unsignalized entrance to Kohl's ↳Prohibit truck parking on shoulders	NA	NA	NA	NA
Short-term	↳No specific improvements other than timing refinements	A	A	A	B
Mid-term	↳No specific improvements other than timing refinements	A	A	A	B

7.2.5. Carlisle Pike at Silver Spring Road/Lambs Gap Road

Scenario	Considerations and Improvements	Anticipated Operations			
		AM	MD	PM	SAT
Future "No Build"	↳Continued high percentage of truck traffic due to industrial facilities to south	B	B	C	C
Immediate	↳Evaluate visibility of optically-programmed signal indications ↳Enforce no parking on shoulders between Silver Spring and Kohl's access	NA	NA	NA	NA
Short-term	↳Extend eastbound left-turn lane before Silver Spring Road ↳Consider adding intersection lighting	A	A	B	A
Mid-term	↳No specific improvements other than timing refinements	A	A	B	A

7.2.6. Carlisle Pike at Salem Church Road

Scenario	Considerations and Improvements	Anticipated Operations			
		AM	MD	PM	SAT
Future "No Build"	↳Possibility of residential development to north	C	C	D	C
Immediate	↳Delineate existing northbound lane assignments	NA	NA	NA	NA
Short-term	↳No specific improvements other than timing refinements	B	B	D	C
Mid-term	↳No specific improvements other than timing refinements	B	B	D	C

7.2.7. Carlisle Pike at Skyport Road

Scenario	Considerations and Improvements	Anticipated Operations			
		AM	MD	PM	SAT
Future "No Build"		C	C	D	C
Immediate	↳No specific improvements other than timing refinements	NA	NA	NA	NA
Short-term	↳Remove Pep Boys access; make intersection a "T" and install signs that direct traffic to the Brondle Road intersection via the parallel road to the south	A	B	B	B
Mid-term	↳No specific improvements other than timing refinements	A	B	B	B

7.2.8. Carlisle Pike at Brondle Road

Scenario	Considerations and Improvements	Anticipated Operations			
		AM	MD	PM	SAT
Future "No Build"		B	B	B	B
Immediate	↳Eliminate mid-block overlapping left-turns at Circuit City and Hooters with a pork-chop island	NA	NA	NA	NA
Short-term	↳Consider allowing only right-in/right-out movements for all access points between Brondle and Skyport on south side of roadway	A	B	B	B
Mid-term	↳No specific improvements other than timing refinements	A	A	B	A

7.2.9. Carlisle Pike at Kmart Access/Jeffery Drive

Scenario	Considerations and Improvements	Anticipated Operations			
		AM	MD	PM	SAT
Future "No Build"	↳Possible commercial development that will access this signal	B	B	C	D
Immediate	↳Re-stripe westbound left-turn lane to 800' ↳Replace YIELD sign to the northbound right-turn movement	NA	NA	NA	NA
Short-term	↳No specific improvements other than timing refinements	A	A	A	C
Mid-term	↳No specific improvements other than timing refinements	A	A	A	C

7.2.10. Carlisle Pike at Van Patten Road

Scenario	Considerations and Improvements	Anticipated Operations			
		AM	MD	PM	SAT
Future "No Build"	↳Continue emphasis on importance of coordinating timing program with Gateway Drive	A	A	B	B
Immediate	↳No specific improvements other than timing refinements	NA	NA	NA	NA
Short-term	↳No specific improvements other than timing refinements	A	A	A	A
Mid-term	↳No specific improvements other than timing refinements	A	A	A	A

7.2.11. Carlisle Pike at Gateway Drive/S.R. 581 Ramp

Scenario	Considerations and Improvements	Anticipated Operations			
		AM	MD	PM	SAT
Future "No Build"	↳Completion of St. John's Church Road interchange could affect operation ↳Continued truck traffic from industrial facilities at south of Silver Spring Road affects eastbound left-turn lane ↳Major point of traffic entering and exiting study area	**C**	**D**	**E**	**D**
Immediate	↳Install nearside signal for eastbound left-turn movement ↳Coordinate with study evaluating change to northbound configuration including left, left / thru, and right	**NA**	**NA**	**NA**	**NA**
Short-term	↳Better delineation of Van Patten to Gateway transition including black shadow skip lines on concrete section	**C**	**C**	**E**	**D**
Mid-term	↳No specific improvements other than timing refinements	**C**	**C**	**E**	**D**

7.2.12. Carlisle Pike at Sporting Hill Road

Scenario	Considerations and Improvements	Anticipated Operations			
		AM	MD	PM	SAT
Future "No Build"	↳St. John's Church Road interchange could alleviate some congestion ↳Proximity to Hampden Centre signal makes coordination very important	D	D	E	E
Immediate	↳Re-stripe northbound left-turn lane to 860 feet or as long as possible.	NA	NA	NA	NA
Short-term	↳Consider limiting the Sporting Hill Road, Hampden Centre access to right-in-right out for peak hours	C	C	D	D
Mid-term	↳Construct northbound double left-turn lanes ↳Configure the westbound approach as follows: left, thru, thru/right ↳Widen the west leg of the intersection to a four-lane section **SEE EXHIBIT 7.3**	C	C	D	C

7.2.13. Carlisle Pike at Hampden Centre

Scenario	Considerations and Improvements	Anticipated Operations			
		AM	MD	PM	SAT
Future "No Build"	↳Less green time for side streets at this intersection causes stacking from Sporting Hill Road through Hampden Centre signal	B	B	B	C
Immediate	↳Meter mainline green time to reduce stacking at Sporting Hill Road	NA	NA	NA	NA
Short-term	↳Make all access points between Sporting Hill and Hampden Centre signals right-in right-out ↳Combine access points (Firestone to Superpetz)	A	A	B	B
Mid-term	↳No specific improvements other than timing refinements	A	A	B	B

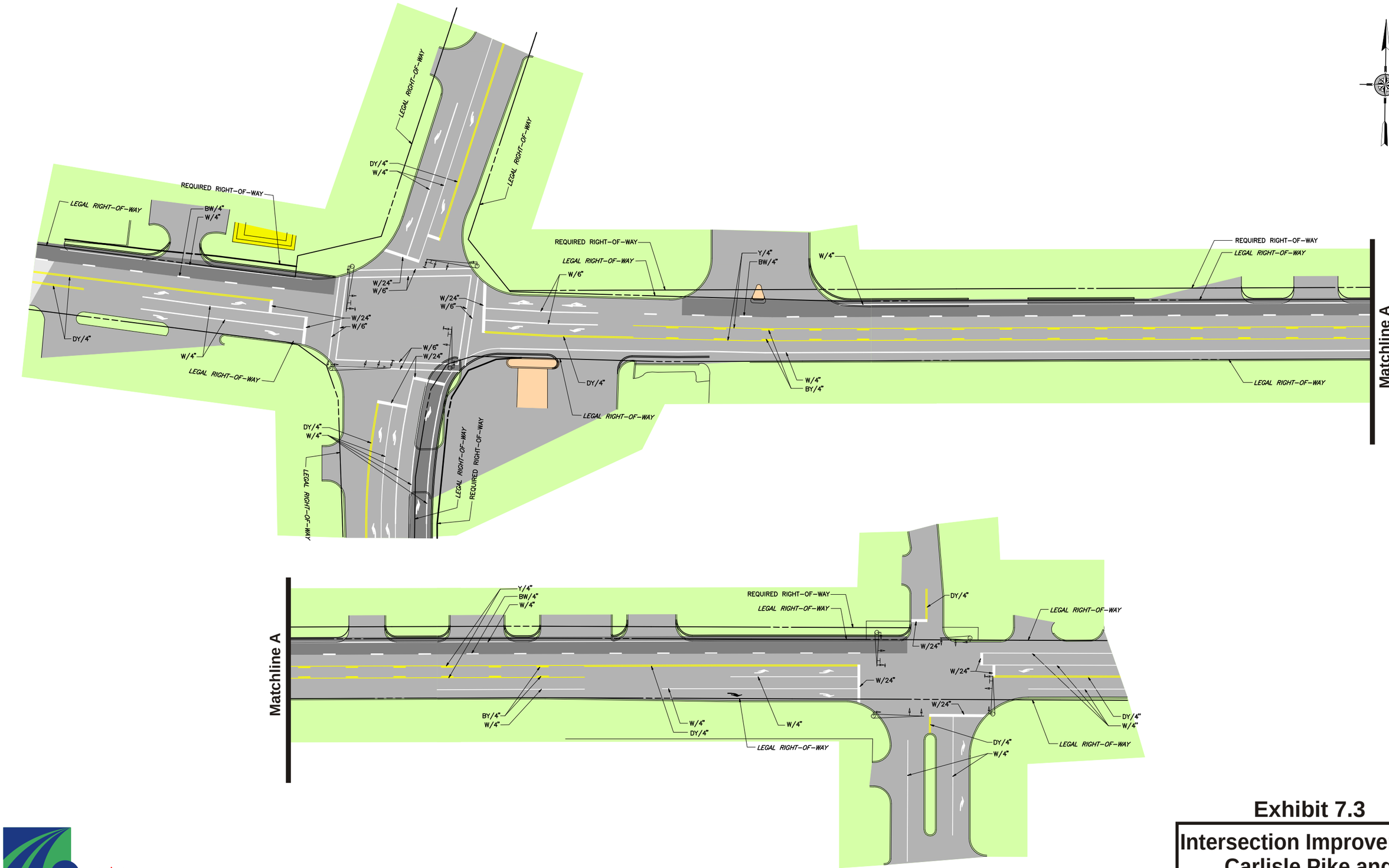

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Exhibit 7.3

Intersection Improvement Carlisle Pike and Sporting Hill Road

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7.2.14. Carlisle Pike at St. Johns Church Road

Scenario	Considerations and Improvements	Anticipated Operations			
		AM	MD	PM	SAT
Future "No Build"	↳Industrial parks to the south cause extra delay to this intersection by truck traffic trying to access limited access facilities	B	C	C	C
Immediate	↳Lengthen the northbound left-turn lane to accommodate a higher percentage of trucks	NA	NA	NA	NA
Short-term	↳No specific improvements other than timing refinements	A	B	B	B
Mid-term	↳No specific improvements other than timing refinements	A	B	B	B

7.2.15. Carlisle Pike at Saint John's Drive

Scenario	Considerations and Improvements	Anticipated Operations			
		AM	MD	PM	SAT
Future "No Build"	↳Trucks have difficulty finding St. John's Church Rd.	A	A	A	A
Immediate	↳Install truck signing to limit usage by St Johns Church Road trucks	NA	NA	NA	NA
Short-term	↳No specific improvements other than timing refinements	A	A	A	A
Mid-term	↳No specific improvements other than timing refinements	A	A	A	A

7.2.16. Carlisle Pike at Orr's Bridge Road/Central Boulevard

Scenario	Considerations and Improvements	Anticipated Operations			
		AM	MD	PM	SAT
Future "No Build"	↳Southbound grade and offset intersection situation create majority of delay		B	D	C
Immediate	↳Lengthen westbound right-turn lane storage	NA	NA	NA	NA
Short-term	↳No specific improvements other than timing refinements	C	A	C	B
Mid-term	↳No specific improvements other than timing refinements	C	A	C	B

7.2.17. Carlisle Pike at 34th Street

Scenario	Considerations and Improvements	Operations			
		AM	MD	PM	SAT
Future "No Build"	↳Wide paved areas increase confusion for drivers in both directions on the Carlisle Pike	B	B	C	C
Immediate	↳New traffic signal controller	NA	NA	NA	NA
Short-term	↳Consider northbound right-turn lane as per development concept	B	B	C	B
Mid-term	↳No specific improvements other than timing refinements	B	B	C	B

7.2.18. Carlisle Pike at Camp Hill Bypass

Scenario	Considerations and Improvements	Anticipated Operations			
		AM	MD	PM	SAT
Future "No Build"	↳This intersection is connected to Camp Hill Bypass system	**F**	**E**	**F**	**E**
Immediate	↳Review and coordinate with ongoing study ↳Remove traffic signal split phase ↳Accommodate exclusive pedestrian phase in coordinated timing plan	**NA**	**NA**	**NA**	**NA**
Short-term	↳Not analyzed in detail since there is an ongoing study of the Camp Hill Bypass corridor				
Mid-term					

7.3. Long-term Considerations

As was stated previously, long-term considerations include items that require more detailed analyses and documentation to demonstrate their true benefit. These items have significant costs associated with implementation.

- Connect Lambs Gap Road to Salem Church Road and Close existing Lambs Gap Road – Offset intersections often function as one signal with split phasing to accommodate the side street traffic movements. This results in inefficient operations and lost green time. Silver Spring Road and Lambs Gap Road are currently configured as an offset intersection. This is magnified by the high percentage of truck traffic and the steep approach grade along Lambs Gap Road

  Although this improvement will result in the same number of signalized intersections, the current offset intersection would be replaced by a conventional four-legged intersection. The phasing associated with a conventional four-legged intersection will be more efficient than current conditions.

- Restrict Access at Donald Drive– The transverse grade on the Carlisle Pike, mid-block turns and proximity to both the Kmart Access signal and Van Pattern Road signal make turning eastbound onto the Carlisle Pike from Donald Drive very difficult. With the cooperation of Radio Shack and Party City this situation can be mitigated if Donald Drive is restricted to westbound traffic only, and the mid-block congestion created by this intersection could be significantly reduced. Traffic currently accessing Donald Drive in the eastbound direction could be service at the K-Mart signal through Jeffery Drive. It is suggested that a service road through the Radio Shack and Party City parking areas be created.

  Drawing to be final

- Connector Road from Sporting Hill Road to St. Johns Church Road – A distributor roadway built to the north of the businesses between Sporting Hill Road and St. Johns Church Road would alleviate mid-block congestion that is experienced in this area. Although this would not eliminate a need for a center left-turn lane since the lane would be needed to service properties to the south of Carlisle Pike, it would reduce the number of conflicts associated with the center left-turn lane.

- Realign the Orrs Bridge/Central Boulevard Intersection – As was stated previously, offset intersections negatively impact traffic operations. Although it may be costly due to right-of-way requirements, realigning this intersection would decrease the delay time experienced in this area through more efficient signal phasing. The possible expansion of the Trindle Road and SR 581 interchange may result in increased traffic volumes at this intersection. It is suggested that the needs of this intersection as well as neighboring intersection be considered and studied as part of the study and design process.

- Development of ITS – The construction of an incident detection system at critical junctions such as PA 114, Gateway Drive and Camp Hill Bypass as well as along neighboring roadways including SR 581 and I-81 would provide a tool to detect and monitor incidents. Key components would include CCTV and Variable Message Signs (VMS). By using ITS technology a system can be constructed that lets drivers know which route has the least amount of delay, tell them about incident and detour information and allow officials to monitor situations from one operations center

- Four-lane section from Gateway Drive to Camp Hill Bypass - Although this option would require the acquisition of high value right-of-way, geometrically it would provide a capacity benefit. This was not considered in long-term models, but analyses indicated that it would improve travel times by as much as 7%.

- Truck connector route between Silver Spring Rd and Gateway Drive - If the industrial area to the south expands or increases demand on the facility, a connector route to 581 would mitigate that demand. Currently, truck traffic especially at traffic signals negatively impacts the corridor.

8. Alternatives Measures of Effectiveness

8.1. Immediate Improvement Comparison

8.1.1. Corridor Travel Times

As discussed in previous sections, the corridor travel time is the primary measure of effectiveness used in determining the success of the program. The immediate improvement corridor travel times are depicted in **Exhibit 8.1**.

Time Period	Existing Travel Time (min)	Immediate Alternative Travel Time (min)
AM Eastbound	16	15
Mid-day Eastbound	15	14
PM Eastbound	17	15
Saturday Eastbound	18	17
Off-Peak Eastbound	13	12
AM Westbound	15	15
Mid-day Westbound	16	15
PM Westbound	20	18
Saturday Westbound	18	18
Off-Peak Westbound	13	12

Exhibit 8.1 Immediate Alternative Travel Times

The immediate alternative models were developed using existing volumes that were recorded in October 2002. As **Exhibit 8.1** indicates, the travel times experienced a reduction by simply re-timing the existing traffic signal systems. Through retiming, the PM peak period experienced a reduction of 2 minutes in each direction.

8.1.2. Arterial Level of Service

As Section 3.3.3 discussed, the Arterial level of service is calculated by Synchro by comparing link speed, intersection separation and travel times to come up with a letter grade similar to the intersection level of service grade.

Time Period	Existing Arterial LOS	Immediate Alternative LOS
AM Eastbound	B	B
Mid-day Eastbound	B	B
PM Eastbound	C	B
Saturday Eastbound	C	C
Off-Peak Eastbound	B	A
AM Westbound	B	B
Mid-day Westbound	B	B
PM Westbound	C	C
Saturday Westbound	C	C
Off-Peak Westbound	B	B

Exhibit 8.2 Immediate Alternative Arterial Level of Service

The arterial level of service for the immediate alternative improves upon the PM and Off-Peak eastbound movements only.

8.1.3. Intersection Level of Service

Exhibit 8.3 shows what the levels of service will be after the immediate alternative signal timings are installed. All letter grades that are underlined in **Exhibit 8.3** were improved from the existing levels of service. All letter grades that are in italics in **Exhibit 8.3** decreased from the existing levels of service. One of the identified intersections with high peak hour travel, Sporting Hill Road, was improved in five out of five time periods. All intersections were improved to at least LOS D except the Camp Hill Bypass.

Crossing Road	Approach LOS				
		MID	PM	SAT	OFF PEAK
S.R. 114	C	C	C	**D**	C
Wal-Mart Access	A	C	B	B	A
Sample Bridge Rd	A	A	A	A	A
Kohls Access	A	A	A	B	A
Silver Spring/Lambs Gap	A	A	B	B	A
Salem Church Rd	C	C	D	C	A
Skyport Rd	B	B	B	C	A
Brondle Road	A	B	A	A	A
Kmart Access/Jeffery Dr	A	B	B	C	A
Van Patten Road	A	*B*	A	A	A
Gateway Dr/S.R. 581	C	C	D	C	B
Sporting Hill Road	C	C	**D**	**D**	B
Hampden Centre	A	B	B	B	A
St. Johns Church Rd.	B	B	B	B	A
Saint Johns Drive	A	A	A	A	A
Orrs Bridge Road	C	B	**C**	B	A
34th Street	*B*	B	B	*B*	B
Camp Hill Bypass	**F**	**E**	**F**	D	D

Exhibit 8.3 Immediate Alternative Intersection Levels of Service

8.1.4. Immediate Alternative Conclusion

The immediate alternative models were only able to include signal system adjustments. While this is the major accomplishment of the alternative, other immediate recommendations made in **Exhibit 6.2** will also contribute to reducing the congestion experienced in this corridor. Items such as replacing missing signs, trimming vegetation

and updating pavement markings can reduce congestion by reducing driver confusion and indecision and can also improve safety through out the corridor. The proposed immediate alternatives are able to improve the facility to acceptable levels of service with the exception of the Camp Hill Bypass. The Camp Hill Bypass is part of another signal system, which is currently under review. In conclusion, implementing the changes proposed by the immediate alternative will contribute to reduced congestion and will provide a noticeable difference to the driver but will not meet the goal of the program. Additional improvements should be considered.

8.2. Short-term Improvements

8.2.1. Corridor Travel Times

The corridor travel times for the proposed short-term improvements are shown in **Exhibit 8.4**.

Time Period	Projected Travel Time (min)	Short-Term Alternative Travel Time (min)
AM Eastbound	17	15
Mid-day Eastbound	15	14
PM Eastbound	18	15
Saturday Eastbound	19	16
AM Westbound	15	14
Mid-day Westbound	16	15
PM Westbound	21	18
Saturday Westbound	19	18

Exhibit 8.4 Short-term Alternative Travel Times

After ten-year projected volumes were applied to the existing models, the short-term alternatives discussed in **Exhibit 6.2** were incorporated and the intersection offsets were re-optimized based on the timings that were used for the immediate alternative. Based on those adjustments, a reduction in travel time was recorded for all time periods; 3 minutes for PM eastbound, Saturday eastbound and PM westbound; 2 minutes for AM eastbound and 1 minute for all other time periods. A 3-minute reduction in this case is equal to a 15-17 percent reduction in travel time.

8.2.2. Arterial Level of Service

Exhibit 8.5 illustrates the arterial level of service as a result of short-term alternatives.

The interesting thing to note about **Exhibit 8.5** is that just by implementing the short-term alternatives discussed in **Exhibit 6.2** the current arterial level of service that exists on the Carlisle Pike can be maintained or improved for the ten-year period that this program addresses.

Time Period	Projected Arterial LOS	Short-term Alternative LOS
AM Eastbound	C	B
Mid-day Eastbound	B	B
PM Eastbound	C	B
Saturday Eastbound	C	C
AM Westbound	B	B
Mid-day Westbound	C	B
PM Westbound	C	C
Saturday Westbound	C	C

Exhibit 8.5 Short-term Alternative Arterial Levels of Service

8.2.3. Intersection Level of Service

The shaded areas on **Exhibit 8.6** indicate intersection levels of service that were at failing conditions for the projected No-Build model while the underlined letters represent intersection levels of service that were improved from the projected no-build model.

Crossing Road	Approach LOS			
	AM	MID	PM	SAT
S.R. 114	C	C	C	**D**
Wal-Mart Access	A	B	B	B
Sample Bridge Rd	A	A	A	A
Kohls Access	A	A	A	B
Silver Spring/Lambs Gap	A	A	B	A
Salem Church Rd	B	B	**D**	C
Skyport Rd	A	B	B	B
Brondle Road	A	B	B	B
Kmart Access/Jeffery Dr	A	A	A	C
Van Patten Road	A	A	A	A
Gateway Dr/S.R. 581	C	C	**E**	D
Sporting Hill Road	C	C	**D**	**D**
Hampden Centre	A	A	B	B
St. Johns Church Rd.	A	B	B	B
Saint Johns Drive	A	A	A	A
Orrs Bridge Road	C	A	**C**	B
34th Street	B	B	C	B
Camp Hill Bypass	**F**	**E**	**F**	**E**

Exhibit 8.6 Short-term Alternative Intersection Levels of Service

8.2.4. Short-term Alternative Conclusion

The short-term alternative models included minor geometric improvements that were contained within the right-of-way and timing refinements based on the geometric improvements. Providing a delineation plan for the corridor can also reduce congestion during periods of poor visibility and provide safety benefits. In conclusion, the short-term alternatives begin to address the congestion within the Carlisle Pike corridor. The most traffic in this corridor was identified as being near the geographical center of the corridor, therefore, more extensive alternatives are necessary to alleviate the congestion experienced in that area.

8.3. Mid-term Improvements

8.3.1. Corridor Travel Times

Exhibit 6.2 discusses all of the proposed improvements that were applied to the mid-term models and **Exhibit 8.7** indicates the corridor travel times that resulted from those improvements.

Time Period	Projected Travel Time (min)	Short-Term Alternative Travel Time (min)
AM Eastbound	17	14
Mid-day Eastbound	15	14
PM Eastbound	18	15
Saturday Eastbound	19	15
AM Westbound	15	14
Mid-day Westbound	16	14
PM Westbound	21	17
Saturday Westbound	19	15

Exhibit 8.7 Mid-term Alternative Travel Times

As **Exhibit 8.7** indicates, the Saturday peak period meets the program goal of a 20 percent travel time reduction, while the PM westbound travel time decreased by 19 percent.

8.3.2. Arterial Level of Service

Once again, as in the short-term model, the arterial level of service was compared to the projected no-build level of service. This comparison was made to be sure that proposed improvements that were being suggested for specific areas of the corridor did not adversely affect the operation of the entire facility.

Exhibit 8.8 shows that the overall level of service from the short-term model to the mid-term model will increase to a level of service "B" for all periods except PM westbound. It is more important that this exhibit does not indicate a decrease in level of service from the short-term model to the mid-term model. Instead, this exhibit shows that the additional proposed changes can be made to the specific areas identified and still not penalize the rest of the facility.

Time Period	Projected Arterial LOS	Mid-term Alternative LOS
AM Eastbound	C	B
Mid-day Eastbound	B	B
PM Eastbound	C	B
Saturday Eastbound	C	B
AM Westbound	B	B
Mid-day Westbound	C	B
PM Westbound	C	C
Saturday Westbound	C	B

Exhibit 8.8 Mid-term Alternative Arterial Levels of Service

8.3.3. Intersection Level of Service

Exhibit 8.9 shows that after the mid-term improvements are installed, users of the facility will only experience one level of service E at any location except for the Camp Hill Bypass. Additionally, S.R. 114, which had one time period with LOS E and three time periods that were at level "D" will operate at acceptable conditions as well as Sporting Hill Road. Salem Church Road, which had one period with LOS E in the no-build model, will experience acceptable delays in all time periods evaluated. None of the intersections will experience a decrease in level of service.

Crossing Road	Approach LOS			
	AM	MID	PM	SAT
S.R. 114	C	C	C	**D**
Wal-Mart Access	A	B	B	B
Sample Bridge Rd	A	A	A	A
Kohls Access	A	A	A	B
Silver Spring/Lambs Gap	A	A	B	A
Salem Church Rd	B	B	**D**	C
Skyport Rd	A	B	B	B
Brondle Road	A	B	B	B
Kmart Access/Jeffery Dr	A	A	A	C
Van Patten Road	A	A	A	A
Gateway Dr/S.R. 581	C	C	**E**	D
Sporting Hill Road	C	C	**D**	**D**
Hampden Centre	A	A	B	B
St. Johns Church Rd.	A	B	B	B
Saint Johns Drive	A	A	A	A
Orrs Bridge Road	C	A	**C**	B
34th Street	B	B	C	B
Camp Hill Bypass	**F**	**E**	**F**	**E**

Exhibit 8.9 Mid-term Alternative Intersection Levels of Service

8.3.4. Mid-term Alternative Conclusion

Overall, implementing the changes that have been identified up to this point by the immediate, short-term and mid-term categories will address the majority of the congestion issues on this corridor as it relates to intersection delay. For Saturday, the highest volume peak period, the travel time will be reduced by 4 minutes in each

direction meeting the program goal of a 20 percent reduction in peak hour travel. Most other peak travel times are approaching the goal of the program as well. The reductions identified up until this point will provide a noticeable difference to the everyday user of the facility.

8.4. Long-term Improvement

8.4.1. Corridor Travel Times

As **Exhibit 8.10** shows, the travel time for the corridor will be reduced significantly by implementing the long-term improvement recommendations for the Carlisle Pike corridor. The Saturday peak hour will be reduced by the program goal of 20 percent. Other peak periods will nearly meet or exceed the goal for reduction in travel time.

Time Period	Projected Travel Time (min)	Long-Term Alternative Travel Time (min)/ Percent Reduction
AM Eastbound	17	14(18%)
Mid-day Eastbound	15	13(13%)
PM Eastbound	18	15(17%)
Saturday Eastbound	19	15(21%)
AM Westbound	15	13(13%)
Mid-day Westbound	16	13(19%)
PM Westbound	21	15(29%)
Saturday Westbound	19	15(21%)

Exhibit 8.10 Long-term Alternative Travel Times

8.4.2. Arterial Level of Service

Once the long-term recommendations are implemented the Carlisle Pike corridor will function at an arterial level of service of "B".

Time Period	Projected Arterial LOS	Mid-term Alternative LOS
AM Eastbound	C	B
Mid-day Eastbound	B	B
PM Eastbound	C	B
Saturday Eastbound	C	B
AM Westbound	B	B
Mid-day Westbound	C	B
PM Westbound	C	B
Saturday Westbound	C	B

Exhibit 8.11 Long-term Alternative Arterial Levels of Service

8.4.3. Intersection Level of Service

Exhibit 8.12 shows intersections underlined that were improved from the mid-term

Crossing Road	Approach LOS			
	AM	MID	PM	SAT
S.R. 114	C	C	C	**C**
Wal-Mart Access	A	B	B	B
Sample Bridge Rd	A	A	A	A
Kohls Access	A	A	A	B
Silver Spring/Lambs Gap	A	A	B	A
Salem Church Rd	B	B	**C**	C
Skyport Rd	A	B	B	B
Brondle Road	A	B	B	A
Kmart Access/Jeffery Dr	A	A	A	C
Van Patten Road	A	A	A	A
Gateway Dr/S.R. 581	C	C	**E**	D
Sporting Hill Road	C	C	**D**	**C**
Hampden Centre	A	A	B	B
St. Johns Church Rd.	A	B	B	B
Saint Johns Drive	A	A	A	A
Orrs Bridge Road	C	A	**C**	B
34th Street	B	B	C	B
Camp Hill Bypass	**F**	**E**	**F**	**E**

Exhibit 8.12 Long-term Alternative Intersection Levels of Service

model. As the exhibit indicates, the S.R. 114 intersection will have no time periods below level of service "C".

8.4.4. Long-term Alternative Conclusion

Implementing the long-term recommendations for the Carlisle Pike will result in a corridor where the travel time will be nearly 20 percent lower than the projected no-build scenario. As **Exhibit 8.12** indicates, only one intersection has a peak period that does not have at least a level of service "D" or higher except for the Camp Hill Bypass. The arterial level of service will be at "B" and the busiest day, Saturday will meet a 20 percent reduction in travel time. Any improvement in travel time at the Camp Hill Bypass will most likely improve the travel time of the corridor to the program goal of 20 percent for all time periods.

8.5. Comparison of Improvement Alternatives with Existing Conditions

8.5.1. Measures of Effectiveness Definitions

- Alternative Category – Identification of the model, peak period and direction for the measures of effectiveness to be reported.

- Arterial Level of Service – Based on speed and arterial class. Arterial class is based on the distances between intersections and the speed between intersections. Speed is the total distance divided by the total travel time.

- Average Speed – The distance between intersections divided by the travel time including delays.

- Emissions:
  - CO – Carbon Monoxide Emissions (Fuel Consumption x 69.9 g/gal)
  - NOx – Nitrogen Oxides Emissions (Fuel Consumption x 13.6 g/gal)
  - VOC – Volatile Oxygen Compounds Emissions (Fuel Consumption * 16.2 g/gal)

- Fuel Consumption – Total Travel * Speed + Total Delay + Stops
  - Each of the items for fuel consumption have additional factors applied to them.

- Fuel Economy – the average distance a vehicle can travel on 1 gallon of gas.

- Number of Stops – Calculated by the number of vehicles being delayed for more than 10 seconds. The number of stopped vehicles is calculated by counting the number of delayed vehicles for each delay time and adjusting the vehicles that stop less than 10 seconds.

- Signal Delay – The percentile delay for a lane group. Signal Delay is equal to 1.3 times the stopped delay.

- Travel Time – Equal to running speed plus signal delay

Alternative Category	Signal Delay	Number of Stops	Arterial Level of Service	Average Speed	Fuel Consumption	Fuel Economy	Emissions			Travel Time
							CO	NOx	VOC	
Existing AM Eastbound	7 min	9790	B	16 mph	342 gal	14.2 mpg	23.88 kg	4.65 kg	5.53 kg	16 min
Immediate AM Eastbound	6 min	7460	B	17 mph	301 gal	16.1 mpg	21.01 kg	4.09 kg	4.87 kg	15 min

Exhibit 8.13 Immediate Alternative AM Eastbound Measures of Effectiveness

Alternative Category	Signal Delay	Number of Stops	Arterial Level of Service	Average Speed	Fuel Consumption	Fuel Economy	Emissions			Travel Time
							CO	NOx	VOC	
Existing AM Westbound	6 min	6254	B	19 mph	231 gal	15.6 mpg	16.17 kg	3.15 kg	3.75 kg	15 min
Immediate AM Westbound	5 min	5956	B	20 mph	225 gal	16.0 mpg	15.76 kg	3.07 kg	3.65 kg	15 min

Exhibit 8.14 Immediate Alternative AM Westbound Measures of Effectiveness

Alternative Category	Signal Delay	Number of Stops	Arterial Level of Service	Average Speed	Fuel Consumption	Fuel Economy	Emissions			Travel Time
							CO	NOx	VOC	
Existing MD Eastbound	5 min	8489	B	18 mph	321 gal	15.5 mpg	22.41 kg	4.36 kg	5.19 kg	15 min
Immediate MD Eastbound	5 min	9750	B	18 mph	331 gal	15 mpg	23.13 kg	4.50 kg	5.36 kg	14 min

Exhibit 8.15 Immediate Alternative Mid-day Eastbound Measures of Effectiveness

Alternative Category	Signal Delay	Number of Stops	Arterial Level of Service	Average Speed	Fuel Consumption	Fuel Economy	Emissions			Travel Time
							CO	NOx	VOC	
Existing MD Westbound	6 min	9890	B	16 mph	346 gal	14.8 mpg	24.20 kg	4.71 kg	5.61 kg	16 min
Immediate MD Westbound	5 min	9871	B	17 mph	334 gal	15.3 mpg	23.36 kg	4.55 kg	5.41 kg	15 min

Exhibit 8.16 Immediate Alternative Mid-day Westbound Measures of Effectiveness

Alternative Category	Signal Delay	Number of Stops	Arterial Level of Service	Average Speed	Fuel Consumption	Fuel Economy	Emissions			Travel Time
							CO	NOx	VOC	
Existing PM Eastbound	7 min	10581	C	14 mph	392 gal	13.3 mpg	27.38 kg	5.33 kg	6.34 kg	17 min
Immediate PM Eastbound	6 min	9692	B	15 mph	359 gal	14.5 mpg	25.10 kg	4.88 kg	5.82 kg	15 min

Exhibit 8.17 Immediate Alternative PM Eastbound Measures of Effectiveness

Alternative Category	Signal Delay	Number of Stops	Arterial Level of Service	Average Speed	Fuel Consumption	Fuel Economy	Emissions			Travel Time
							CO	NOx	VOC	
Existing PM Westbound	10 min	12471	C	15 mph	452 gal	13.5 mpg	31.62 kg	6.15 kg	7.33 kg	20 min
Immediate PM Westbound	8 min	14462	C	16 mph	452 gal	13.5 mpg	31.59 kg	6.15 kg	7.32 kg	18 min

Exhibit 8.18 Immediate Alternative PM Westbound Measures of Effectiveness

Alternative Category	Signal Delay	Number of Stops	Arterial Level of Service	Average Speed	Fuel Consumption	Fuel Economy	Emissions			Travel Time
							CO	NOx	VOC	
Existing SAT Eastbound	7 min	12653	C	11 mph	450 gal	13.8 mpg	31.47 kg	6.12 kg	7.29 kg	18 min
Immediate SAT Eastbound	7 min	13876	C	12 mph	449 gal	13.8 mpg	31.37 kg	6.10 kg	7.27 kg	17 min

Exhibit 8.19 Immediate Alternative Saturday Eastbound Measures of Effectiveness

Alternative Category	Signal Delay	Number of Stops	Arterial Level of Service	Average Speed	Fuel Consumption	Fuel Economy	Emissions			Travel Time
							CO	NOx	VOC	
Existing SAT Westbound	6 min	12147	C	11 mph	428 gal	14.1 mpg	29.95 kg	5.83 kg	6.94 kg	18 min
Immediate SAT Westbound	7 min	12980	C	12 mph	416 gal	14.6 mpg	29.05 kg	5.65 kg	6.73 kg	18 min

Exhibit 8.20 Immediate Alternative Saturday Westbound Measures of Effectiveness

Alternative Category	Signal Delay	Number of Stops	Arterial Level of Service	Fuel Consumption	Average Speed	Emissions			Travel Time
						CO	NOx	VOC	
No Build AM Eastbound	8 min	11019	C	379 gal	15.0 mph	26.47 kg	5.15 kg	6.13 kg	17 min
Short-term AM Eastbound	5 min	8174	B	320 gal	16.0 mph	22.34 kg	4.35 kg	5.18 kg	15 min
Mid-term AM Eastbound	5 min	8250	B	322 gal	17 mph	22.52 kg	4.38 kg	5.22 kg	14 min
Long-term AM Eastbound	5 min	7379	B	306 gal	17 mph	21.39 kg	4.16 kg	4.96 kg	14 min

Exhibit 8.21 AM Eastbound Measures of Effectiveness

Alternative Category	Signal Delay	Number of Stops	Arterial Level of Service	Fuel Consumption	Average Speed	Emissions			Travel Time
						CO	NOx	VOC	
No Build AM Westbound	6 min	7013	B	253 gal	19.0 mph	17.66 kg	3.44 kg	4.09 kg	15 min
Short-term AM Westbound	5 min	5167	B	220 gal	17.3 mph	15.39 kg	3.00 kg	3.57 kg	14 min
Mid-term AM Westbound	4 min	4910	B	216 gal	21.0 mph	15.12 kg	2.94 kg	3.50 kg	14 min
Long-term AM Westbound	4 min	5068	B	221gal	22.0 mph	15.42 kg	3.00 kg	3.57 kg	13 min

Exhibit 8.22 AM Westbound Measures of Effectiveness

Alternative Category	Signal Delay	Number of Stops	Arterial Level of Service	Fuel Consumption	Average Speed	Emissions			Travel Time
						CO	NOx	VOC	
No Build Mid-day Eastbound	6 min	9409	B	349 gal	17 mph	24.41 kg	4.75 kg	5.66 kg	15 min
Short-term Mid-day Eastbound	4 min	8069	B	317 gal	19 mph	22.17 kg	4.31 kg	5.14 kg	14 min
Mid-term Mid-day Eastbound	4 min	9047	B	327 gal	18 mph	22.87 kg	4.45 kg	5.30 kg	13 min
Long-term Mid-day Eastbound	4 min	8359	B	317 gal	18 mph	22.14 kg	4.31 kg	5.13 kg	13 min

Exhibit 8.23 Mid-day Eastbound Measures of Effectiveness

Alternative Category	Signal Delay	Number of Stops	Arterial Level of Service	Fuel Consumption	Average Speed	Emissions			Travel Time
						CO	NOx	VOC	
No Build Mid-day Westbound	7 min	11107	C	380 gal	16 mph	26.55 kg	5.17 kg	6.15 kg	16 min
Short-term Mid-day Westbound	5 min	9333	B	337 gal	18 mph	23.58 kg	4.59 kg	5.47 kg	15 min
Mid-term Mid-day Westbound	5 min	8870	B	332 gal	20 mph	23.20 kg	4.51 kg	5.38 kg	14 min
Long-term Mid-day Westbound	4 min	7704	B	319 gal	21 mph	22.28 kg	4.34 kg	5.16 kg	13 min

Exhibit 8.24 Mid-day Westbound Measures of Effectiveness

Alternative Category	Signal Delay	Number of Stops	Arterial Level of Service	Fuel Consumption	Average Speed	Emissions			Travel Time
						CO	NOx	VOC	
No Build PM Eastbound	8 min	11901	C	437 gal	13 mph	30.54 kg	5.94 kg	7.08 kg	18 min
Short-term PM Eastbound	6 min	10400	B	382 gal	15 mph	26.67 kg	5.19 kg	6.18 kg	15 min
Mid-term PM Eastbound	6 min	10921	B	386 gal	16 mph	26.99 kg	5.25 kg	6.26 kg	15 min
Long-term PM Eastbound	5 min	9656	B	362 gal	17 mph	25.31 kg	4.92 kg	5.87 kg	15 min

Exhibit 8.25 PM Eastbound Measures of Effectiveness

Alternative Category	Signal Delay	Number of Stops	Arterial Level of Service	Fuel Consumption	Average Speed	Emissions			Travel Time
						CO	NOx	VOC	
No Build PM Westbound	11 min	14269	C	508 gal	14 mph	35.48 kg	6.90 kg	8.22 kg	21 min
Short-term PM Westbound	8 min	11888	C	438 gal	17 mph	30.60 kg	5.95 kg	7.09 kg	18 min
Mid-term PM Westbound	7 min	11810	C	431 gal	18 mph	30.16 kg	5.87 kg	6.99 kg	17 min
Long-term PM Westbound	6 min	11634	B	430 gal	20 mph	30.02 kg	5.84 kg	6.96 kg	15 min

Exhibit 8.26 PM Westbound Measures of Effectiveness

Alternative Category	Signal Delay	Number of Stops	Arterial Level of Service	Fuel Consumption	Average Speed	Emissions			Travel Time
						CO	NOx	VOC	
No Build SAT Eastbound	8 min	13257	C	467 gal	12 mph	32.63 kg	6.35 kg	7.56 kg	19 min
Short-term SAT Eastbound	5 min	10885	B	404 gal	13 mph	28.27 kg	5.50 kg	6.55 kg	16 min
Mid-term SAT Eastbound	6 min	11835	B	432 gal	15 mph	30.18 kg	5.87 kg	6.99 kg	15 min
Long-term SAT Eastbound	6 min	10875	B	415 gal	15 mph	29.00 kg	5.64 kg	6.72 kg	15 min

Exhibit 8.27 Saturday Eastbound Measures of Effectiveness

Alternative Category	Signal Delay	Number of Stops	Arterial Level of Service	Fuel Consumption	Average Speed	Emissions			Travel Time
						CO	NOx	VOC	
No Build SAT Westbound	7 min	13559	C	473 gal	11 mph	33.08 kg	6.44 kg	7.67 kg	19 min
Short-term SAT Westbound	6 min	12343	**C**	425 gal	12 mph	29.69 kg	5.78 kg	6.88 kg	18 min
Mid-term SAT Westbound	5 min	12559	B	429 gal	18 mph	30.00 kg	5.84 kg	6.95 kg	15 min
Long-term SAT Westbound	5 min	11279	B	415 gal	19 mph	28.99 kg	5.64 kg	6.72 kg	15 min

Exhibit 8.28 Saturday Eastbound Measures of Effectiveness

8.5.2. Cost and Right-of-Way Information

Alternative Category	Cost	Required Right-of-Way
No Build	$0	0 Ac
Immediate	$26,000	0 Ac
Short-term	$62,000	0 Ac
Mid-term	$493,000 (R/W Not Included)	0.1Ac
Long-term	$1,550,000 (R/W Not Included)	1.4 Ac

Exhibit 8.29 Carlisle Pike Construction Cost and Required Right-of-Way

9. Implementation Plan

9.1. Evaluation of Improvement Alternatives

9.1.1. Description and Design Details

In order to prioritize the proposed improvement alternatives that the congested corridor program has identified, a programming cost estimate as well as a benefit/cost analysis must be completed for each proposed improvement.

9.1.2. Costs

For the benefit/cost analysis to be completed, first a construction cost must be estimated. This cost estimate is not intended to be used to outline all of the work that will take place if the proposed improvement is implemented but rather to provide a basis of magnitude for the benefit/cost analysis. For the costs that were developed, the "big ticket" items were estimated and a contingency was then applied to each subtotal to find the construction cost that would be used for the benefit/cost analysis. For the immediate category, 20 % was added to the estimated amount for construction; for the short-term category, 22.5% was added to the estimated amount for construction; for the mid-term category 25% was added to the estimated amount for construction.

Additionally, to gain a more conservative benefit/cost ratio, 12% was added to the short-term and mid-term categories intended for final design costs.

Also, a discount was applied to each benefit/cost calculation to account for maintenance and operations of proposed improvements. This discount was applied to the benefit for the useful life of the recommendation.

Lastly, if any right-of-way must be acquired as a result of any proposed improvement than an estimate of $20,000 per acre was added for partial takes since most of the area surrounding the facility in the study area would be considered high value property.

Exhibit 9.1 indicates what the costs were for the alternatives that were carried forward.

Alternative Recommendation	Scenario	Cost
Retime the existing signal systems	Immediate	$1,600
Begin eastbound left-turn lane prior to Silver Spring Road	Short-term	$2,000
Remove Pep Boys access at Skyport Rd	Short-term	$3,700
Add northbound right-turn lane at 34th Sreet	Short-term	$9,600
Construct eastbound and westbound double left-turn lanes and construct transition area on south leg at the S.R. 114 intersection	Mid-term	$75,600
Construct northbound double left turns, a second westbound receiving lane and a second westbound approach thru/shared right lane at the Sporting Hill Road intersection	Mid-term	$405,700

Exhibit 9.1 Congested Corridor Improvement Program Benefit Cost Items

Exhibit 9.1 contains the items that were estimated and were part of the models that were developed. Other costs for items that were not included in the model, but will still help reduce congestion on the corridor, are in Appendix M.

9.1.3. Benefit-Cost

After the construction costs for the proposed alternatives were developed, a benefit/cost analysis was completed for each item identified in **Exhibit 9.1**. The congested corridor improvement program's standard study methodology identifies how the benefit should be calculated.

Benefit

The benefit (numerator of the B/C ratio) is calculated in the following four (4) steps:

Step 1: Calculate Weekday Benefit (WDB) = AM +MD + PM

Step 2: Calculate Weekend Benefit (WEB) = W (If applicable)

Whereas:

$AM = [(C_{AM} \times TVC_c \times S_{AM}) + (T_{AM} \times TVC_t \times S_{AM}) + (T_{AM} \times IC_t \times S_{AM}) + (C_{AM} \times TVC_c \times S_{AM})]$

$MD = [(C_{MD} \times TVC_c \times S_{MD}) + (T_{MD} \times TVC_t \times S_{MD}) + (C_{MD} \times IC_c \times S_{MD}) + (T_{MD} \times IC_t \times S_{MD})]$

$PM = [(C_{PM} \times TVC_c \times S_{PM}) + (T_{PM} \times TVC_t \times S_{PM}) + (C_{PM} \times IC_c \times S_{PM}) + (T_{PM} \times IC_t \times S_{PM})]$

$W = [(C_W \times TVC_c \times S_W) + (T_W \times TVC_t \times S_W) + (C_W \times IC_c \times S_W) + (T_W \times IC_t \times S_W)$

$C_{AM, MD, PM,W}$ = Total cars during the AM, Mid-day, PM, or Weekend peak hour

$T_{AM, MD, PM,W}$ = Total trucks during the AM, Mid-day, PM, or Weekend peak hour

TVC_c = Time Value Cost of cars per hour

TVC_t = Time Value Cost of trucks per hour

IC_c = Idling Cost of cars per hour

IC_t = Idling Cost of trucks per hour

$S_{AM, MD, PM,W}$ = Savings in time during the AM, Mid-day, PM, or Weekend peak hour

The total cars per hour and total trucks per hour are taken directly from (1) the projected turning movement counts for intersection improvements, and (2) the projected automatic traffic recorder (ATR) data for corridor-wide improvements.

The commuter costs (time value and idling) of cars and trucks are calculated as directed in the PENNDOT Publication 242 – *Pavement Policy Manual*. Cost factors for Time Value and Idling were determined for cars, single-unit trucks, and combination trucks in 1972 and were published in NCHRP Report 133, *Procedures for Estimating Highway User Costs, Air Pollution, and Noise Effects*. The Time Value Costs were $3.00/hour for cars and $5.00/hour for all trucks. The Idling Costs were $0.1819/hour for cars, $0.2017/hour for single unit trucks, and $0.2166/hour for combination trucks. An average Idling Cost value of $0.2092 is used for trucks as an average of single unit trucks and combination trucks. The cost factors are adjusted to 2002 dollars by use of the Inflation Factor (I), which is based on the Engineering News Record (ENR) Construction Cost Index. The 1972 Construction Cost Index is 1753. The current Construction Cost Index in the January 20, 2003 edition of the ENR is 6580.54. The Inflation Factor (I) is then calculated by dividing the Current Index by the 1972 Index, which results in an Inflation Factor of 3.75. **The current calculated Time Value Costs for cars is $11.25/hour ($3.00/hour * 3.75), and the current Time Value Costs for trucks is $18.75/hour ($5.00/hour * 3.75). The current calculated Idling Costs for cars is $0.76/hour ($0.2017 * 3.75), and the current Idling Costs for trucks is $0.79/hour ($0.2092 * 3.75).**

The savings in time per peak hour are extracted from the simulation models developed for each corridor. For each improvement, the future no-build delay/travel time is compared to the future build delay/travel time to estimate the savings in time. For example, intersection improvements should compare the average vehicle delay at each intersection from the 2012 No-Build analysis to 2012 Short-term Build analysis. If the

improvements are not part of the simulation model, such as intelligent transportation systems (ITS), then expected or projected delay/travel time improvement results from similar applications are applied to the 2012 No-Build travel time. The expected or project improvements along with the reference source should be clearly documented. *** Note: The savings in delay/travel time were evaluated for the design year in this program, which is 10 years in the future, but the calculated costs do not need to be adjusted up since the values would just have to be brought back into present value. ***

The benefits are only developed for the time periods that were evaluated in the corridor study, therefore the off-peak hours time savings will not be included in the calculations. A typical day will include three hours of delay/travel time improvements for the purpose of this program including one hour in the AM peak period, one hour in the Mid-Day peak period, and one hour in the PM peak period. If a weekend peak hour was evaluated, then that one hour should be evaluated separately.

Step 3: Calculate Yearly Benefit (YB) = (WDB x 254 Weekdays) + (WEB x 52 Weekends)

The days of year of benefit will only include working days, unless weekends were evaluated.

Therefore, the total days per year of benefit will include five days per week x 52 weeks per year minus six holidays (New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving and Christmas) for a total of 254 days. Weekend peak hours will be evaluated for 52 weeks per year.

Step 4: Calculate Total Anticipated Benefit (B) = YB x Anticipated years of benefit (Present Value Factor applied)

The yearly benefit is then evaluated over the life cycle of the improvement or anticipated years of benefit. The anticipated years of benefit will vary according to the type of project. For example, geometric improvements may have 20 years of benefit, a typical traffic signal modernization and interconnect project may have 15 years of benefit, and a traffic signal retiming may have three years of benefit. The anticipated years of benefit should be developed through similar applications or prior experience. The anticipated years of benefit will be applied to the total benefit by using a net present value factor that applies a 4.5% discount rate over each year.

Cost

The cost (denominator of the B/C ratio) is calculated as follows:

C = FD + CON + O&M

Whereas:

FD = Final Design (Estimated)

CON = Construction (Estimated)

O&M = Operations and Maintenance (Estimated)

The cost of the final design is typically ten to twelve percent of the construction cost, but some of the more labor-intensive work for traffic improvements including the traffic data collection and simulation model development may need to be removed since these items were completed during the CCIP study.

The cost of the construction is developed through PENNDOT Publication 287 – *Construction Item Cost Catalogue*, similar applications, and prior experience. Cost of construction should be included in the CCIP study final report.

Alternative Recommendation	Scenario	Benefit/Cost Ratio
Retime the existing signal systems	Immediate	10,017.45
Begin eastbound left-turn lane prior to Silver Spring Road	Short-term	190.48
Remove Pep Boys access at Skyport Rd	Short-term	1,283.16
Add northbound right-turn lane at 34th Sreet	Short-term	15.34
Construct eastbound and westbound double left-turn lanes and construct transition area on south leg at the S.R. 114 intersection	Mid-term	56.00
Construct northbound double left turns, a second westbound receiving lane and a second westbound approach thru/shared right lane at the Sporting Hill Road intersection	Mid-term	14.69

Exhibit 9.2 Congested Corridor Improvement Program Benefit Cost Items

The cost of operations and maintenance is applicable to improvements that will require additional resources to keep the infrastructure efficient, such as traffic signal retiming every three years on a new traffic signal system. Similar to the anticipated years of benefit, a net present value factor is applied to the cost of operations and maintenance using the 4.5% discount rate.

Using the methodology, the following benefit/cost ratios were determined for the improvement alternatives that were included in the model. **Exhibit 9.2** shows the benefit/cost ratios. The detailed Benefit/Cost analysis can be found in Appendix N.

9.1.4. Action Items

As stated in the introduction, the goal of this program is reduce congestion that is experienced during the peak time periods on the Carlisle Pike corridor. Local municipality and agency coordination will play a key role in determining the success of this program. Therefore, **Exhibit 9.3** has been developed, as an action list to help clarify how the implementation of improvement alternatives identified in this document will be accomplished.

Exhibit 9.3 Carlisle Pike Congested Corridor Improvement Program Action List

Municipality	Improvement Alternative	Jurisdiction	Next Step	Projected Date of Completion	Approximate Cost
Silver Spring Twp	Adjust existing signal timings (5 signals)	Local/PENNDOT	PENNDOT to change permits and approve timing changes	Timings changed by Summer 2003	$500
Silver Spring Twp	Prohibit truck parking on shoulders near Kohl's access	Local	Install striping and signing to restrict parking	Construction completed by 2004	$1,700
Silver Spring Twp	Construct eastbound and westbound double left-turn lanes and transition area to south	Local/PENNDOT	Seek funding, procure design services	Construction completed by 2013	$75,600
Silver Spring/Hampden	Re-stripe eastbound left-turn lane and install highway lighting at Silver Spring/Lambs Gap	Local/PENNDOT	Purchase materials, alter permit plan	Construction completed by 2004	$2,000
Hampden Twp	Adjust existing signal timings (12 signals)	Local/PENNDOT	PENNDOT to change permits and approve timing changes	Timings changed by Summer 2003	$1,200
Hampden Twp	Reinstall delineation for existing northbound lane assignments at Salem Church	Local/PENNDOT	Purchase materials, alter permit plan	Construction completed by 2004	$200
Hampden Twp	Construct channelizing device to control mid-block overlapping turns near Brondle Rd	Local	Procure design services	Construction completed by 2004	$6,800

Exhibit 9.3 Carlisle Pike Congested Corridor Improvement Program Action List

Municipality	Improvement Alternative	Jurisdiction	Next Step	Projected Date of Completion	Approximate Cost
Hampden Twp	Lengthen turn lanes, replace signing control access to east to right-in-right-out at Kmart Access	Local/PENNDOT	Purchase materials, alter permit plan	Construction completed by 2004	$800
Hampden Twp	Install nearside signal for eastbound left-turn movement at Gateway Drive	Local/PENNDOT	Purchase materials, alter permit plan	Construction completed by 2004	$1,200
Hampden Twp	Coordinate with study altering northbound approach to Gateway Drive	Local/PENNDOT	N/A	N/A	N/A
HampdenTwp	Lengthen northbound left-turn lane at Sporting Hill	Local/PENNDOT	Coordinate with Hampden Centre, purchase materials	Construction completed by 2004	$800
Hampden Twp	Meter mainline traffic for Sporting Hill Road at Hampden Centre signal	Local/PENNDOT	Coordinate with CCIP study	Timings changed by Summer 2003	N/A
Hampden Twp	Lengthen northbound left-turn lane at St. Johns Church Rd	Local/PENNDOT	Purchase materials, alter permit plan	Construction completed by 2004	$300
Hampden Twp	Install signing to restrict truck traffic at St. Jjohns Drive	Local/PENNDOT	Purchase materials, mobilize	Construction completed by 2004	$900
Hampden Twp	Lengthen westbound right-turn storage	Local/PENNDOT	Purchase materials	Construction completed by 2004	$300

Exhibit 9.3 Carlisle Pike Congested Corridor Improvement Program Action List

Municipality	Improvement Alternative	Jurisdiction	Next Step	Projected Date of Completion	Approximate Cost
Hampden Twp	Remove Pep Boys access at Skyport Road	Local/PENNDOT	Coordinate with Pep Boys	Construction completed by 2007	$3,700
Hampden Twp	Make all access points from Skyport road to Brondle Rd right-in-right-out	Local	Coordinate with businesses	Construction completed by 2007	$3,100
Hampden Twp	Install better delineation between Van Patten Rd and Gateway Drive	Local	purchase materials, mobilize	Construction completed by 2007	$7,100
Hampden Twp	Make all access points from Sporting Hill Rd to Hampden Center signal right-in-right-out only	Local	Coordinate with businesses	Construction completed by 2007	$3,100
Hampden Twp	If land is developed near Kmart, install a double left-turn lane	Local/PENNDOT	N/A	N/A	N/A
Hampden Twp	Construct double left-turn lanes and receving lanes at Sporting Hill Rd. Also expand westbound Carlisle Pike to 2 lanes	Local/PENNDOT	Procure design services	Construction completed by 2013	$405,700
Hampden Twp	Realign Lambs Gap Rd to intersect Carlisle Pike at Salem Church Road	Local/PENNDOT	Procure design services	N/A	$2,000,000

Exhibit 9.3 Carlisle Pike Congested Corridor Improvement Program Action List

Municipality	Improvement Alternative	Jurisdiction	Next Step	Projected Date of Completion	Approximate Cost
Hampden Twp	Combine Radio Shack and Party City near Donald Rd, make Donald Rd right-in-right-out	Local	Coordinate with businesses	N/A	$51,500
Hampden Twp	Construct eastbound double left-turn lanes at Gateway Drive	Local/PENNDOT	Procure design services	N/A	$26,000
Camp Hill Borough	Install new equipment at 34th Street, evaluate lane configurations	Local/PENNDOT	Coordinate with developer	Construction completed by 2004	$7,400
All	Install mast arm street signs where not existing	Local	Local forces or contractors to install signs. PENNDOT to update permits.	Construction completed by 2004	$250/sign
All	Install emergency pre-emption devices where not existing	Local/PENNDOT	Procure design services	Construction completed by 2013	$3,000/ approach
All	Impact Fee Assessments	Local	Adopt resolution	Completion by 2013	N/A
All	Create a delineation plan that includes raised pavement markings	PENNDOT	Procure design services	Construction completed by 2007	$500/mile
All	Inter-jurisdictional signal system	Local/PENNDOT	Arrange meetings to define systems and to designate governing body	Construction completed by 2013	N/A
All	Install an incident detection system	Local/PENNDOT	Research	N/A	N/A

10. Next Steps

This document is intended to provide alternatives that will move directly into final design for the immediate, short-term and possibly mid-term scenarios. The final design and construction of these items will be funded through the 12-Year Program. The Tri-County Regional Planning Commission was asked to include final design costs on the 2003 Transportation Improvement Plan (TIP) Update.

The final designs of some mid-term and all of the long-term improvement recommendations are outside the scope of this program. The long-term improvement recommendations that are associated with major roadway construction will be subject to PENNDOT's five-phase Transportation Project Development Process. The five-phases of this process include Planning, Prioritization & Programming, Design, Construction and Maintenance & Operations. Major roadway construction projects will require Preliminary Engineering, which is a subset of the Design Phase, for preliminary engineering studies, environmental studies and public involvement.