Pennoni
PENNONI ASSOCIATES INC.
CONSULTING ENGINEERS

EXECUTIVE SUMMARY REPORT

I-81 CORRIDOR IMPROVEMENT STUDY

Submitted to:

PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
DISTRICT 4-0
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August 2007

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Contents

1. Introduction

This Executive Summary Report documents the work performed and conclusions reached in the I-81 Corridor Improvement Study performed by Pennoni Associates Inc. for PennDOT District 4-0. The study process had three milestones that were documented in separate reports. These include the Baseline Conditions Report, Origin-Destination Study, and Alternative Analysis Report. Each of these reports shall be considered attachments to this document and will be referenced throughout this Executive Summary Report.

The purpose of the I-81 Corridor Study is to identify system deficiencies over the next ten, twenty and thirty years and develop cost-effective short-term and long-term strategies to make the roadway operate more efficiently, and improve safety while accommodating anticipated traffic growth within the corridor. The study limits extend from Interchange 164 (Nanicoke) in Luzerne County to Interchange 197 (Waverly) in Lackawanna County. It includes all interchanges with the exception of the recently reconstructed Interchange 178, and Interchange 190, which is currently being redesigned. It also includes the Northeast Extension of the Pennsylvania Turnpike (I-476) between Pittston/DuPont Interchange and the Clarks Summit Interchange where it parallels I-81. The study will serve as a planning and programming tool to prioritize the development of staged and system-wide improvements over the next thirty years.

1.1. Project Background

Interstate 81 (I-81) is a major north-south corridor, which extends 824 miles from Dandridge, Tennessee to northern New York State. It generally follows U.S. Route 11 and the spine of the Appalachian Mountains and serves smaller cities such as Roanoke and Winchester, Virginia; Hagerstown, Maryland; Harrisburg and Scranton, Pennsylvania; and Binghamton and Syracuse, New York. In addition to the local and intrastate travel base I-81 serves, both private travelers and commercial transports desiring to travel long-distances heavily use the I-81 corridor as an alternative to the more congested interstates that travel through the more populated cities. As a result, I-81 has become nearly as congested as the other north-south interstates that travel through more populated cities.

The focus of this study is the 33-mile corridor of I-81 extending from Interchange 164 (Nanticoke) in Luzerne County to Interchange 197 (Waverly) in Lackawanna County in Pennsylvania. See **Figure 1** for state and county location maps. It also includes the Northeast Extension of the Pennsylvania Turnpike (I-476) between Pittston/DuPont Interchange and the Clarks Summit Interchange where it parallels I-81. Interstate 81 is the main north-south traffic artery in the geographic area serving both interstate and intrastate travel as well as local trips. The corridor includes major interchanges with Interstates 380 and 476, providing access to the east-west Interstates 80 and 84, and all major routes for the movement of goods and people in the northeast United States.

Interstate 81 was designed in the late 1950 and early sixties. Over the past ten years, traffic volumes within the study corridor, including large commercial vehicles, have significantly increased over the system's capacity. Within the past five years, traffic volumes on this portion of I-81 have increased at yearly rates, which are almost twice that of other urban interstates within Pennsylvania. The resulting congestion and high rate of reported crashes have initiated a detailed study of the corridor.

A study performed in 2003[1] recommends a long term widening project that includes a cross-section consisting of three 12-foot travel lanes and two 12-foot shoulders (10-foot paved). The study recommends adding the proposed additional lanes to the inside of the existing travel way, except between milepost 188 and milepost 191, where additional right-of-way would be necessary. The proposed median treatments consist of a combination of guide rail, rock fill or mechanically stabilized earth walls treatments as determined by elevation difference between the north and south travel lanes. Replacement of the mainline the bridges and twelve sound barriers were recommended in the study.

1.2. Project Need

Growth in the Scranton/Wilkes-Barre region has caused increased traffic demand on I-81 through the study area. Increased residential and commercial growth as well as through traffic causes recurring congestion on the roadway during peak travel hours. In addition, when an incident on the roadway occurs, heavy congestion occurs on I-81 as well as the surrounding roads that can be used as alternate routes. I-81 in the study area was built in the 1960s and is currently carrying traffic volumes that exceed its original design standards.

1.3. Project Scope

The scope of the project was to determine the current operational status of the corridor, project future traffic volumes 10, 20, and 30 years into the future, and identify areas that will experience deficient traffic operations. An origin-destination study was conducted, between Interchanges 175 and 194 to evaluate the potential of utilizing the Pennsylvania Turnpike to a greater extent for through traffic. In addition, accident history was evaluated and correlated to operational conditions. Improvement alternatives were identified and developed. Construction cost estimates were also developed for each improvement alternative. A Benefit/Cost analysis that looked at reduction of accidents and various operational parameters was also performed. Other potential operational and congestion management strategies were also identified and evaluated as short term improvements.

[1] *I-81 Rebuild/Expansion Study- Conceptual Engineering For An Additional Third Lane, Exit 164 through Exit 194*, Prepared for Pennsylvania Department of Transportation, Engineering District 4-0, Prepared by Pennoni Associates Inc., September 2003.

2. Data Collection

Traffic volume data for the mainline and interchanges (including intersections at ramp termini) was collected in the spring of 2005. This data was supplemented by information from other current PennDOT projects active within the study limits. Video data collection was performed in order to complete an updated origin-destination study for the corridor. Field reconnaissance was performed to make certain the analysis reflected the current traffic operation characteristics, and additional traffic counts were conducted to supplement the existing of traffic data.

2.1. Traffic Data Collection

Traffic Data was collected in the Spring 2005 by utilizing automatic traffic recorders (ATR), manual turning movement counts, video data collected as part of the Origin-Destination Study, and historical data provided by District 4-0. The data was collected at all access and egress points to the study corridor, intersections at ramp termini, and mainline sections. Data received from historical sources was adjusted to reflect 2005 base year conditions. Peak hour traffic data for a typical weekday evenings and Saturdays were identified, and are summarized in **Figures 5 through 12** of the Baseline Conditions Report.

2.2. Accident Data

Accident Data was provided by PennDOT in order to help to determine high accident areas. Data was provided for the years from 1998 through 200 (Comment: See page 7). The data provided locations, types, and contributing causes for accidents. This data was reduced to determine the highest accident locations. Accident diagrams were prepared for the seven highest accident locations, and this information is provided in figures within the appendices of the Baseline Conditions Report**.**

2.3. Origin-Destination Data Collection

An origin-destination (O-D) traffic survey data was filmed by Transfomation System, Inc. (Transfo), a subconsultant to Pennoni Associates Inc. (Pennoni) for the Pennsylvania Department of Transportation District 4, (PennDOT). Analysis of the data was performed by Pennoni. The purpose of the survey was to determine the number and percentages of passenger cars, single unit trucks, and combination trucks that entered the study area on I-81 from both the north and south and passed through the study area within 30 minutes of entry into the study zone, as compared to the number and percentage that entered during the survey period and were not observed exiting within the 30 minute limits (defined as local trips). Similar analysis was performed for vehicles entering and exiting the study area to and from I-380 and US 6 in both directions. A total of twenty (20) cameras were stationed throughout the corridor to capture vehicle movements. The cameras were placed at Bear Creek, Layton Road, and throughout the I-81/US 6/I-380 interchange.

3. Operational Analysis

The analysis for the I-81 Corridor Improvement Study consisted of the evaluation of three facets that effect the daily operations of the interstate. The first facet measured how the infrastructure experiences reoccurring congestion in terms of vehicle delay and level of service (LOS) and is summarized in terms of *measures of effectiveness*. The second facet consisted of the identification of crash patterns and potential causes of crashes, while the third considered the physical constrains of the infrastructure itself and its adjacent environment. In addition, an origin-destination study was conducted, between Interchanges 175 and 194 to evaluate the potential of utilizing the Pennsylvania Turnpike to a greater extent for through traffic.

3.1. Measures of Effectiveness

As part of the Interstate 81 Corridor Improvement Study CORSIM and SYNCHRO simulation models were created in order to help determine operational measures of effectiveness (MOE) for the freeway and the adjacent urban intersections within the study area. The models replicate movement of individual vehicles as they transverse a given roadway systems, and include the influences of driver behavior, fleet characteristics, roadway geometry, and traffic control as a function of time. The effects of very complex systems and the interaction between adjacent facilities can be studied using an array of MOE produced by the models. The evaluation of the MOE provides a snapshot of the potential operational issues not only for the mainline, but also at merge/diverge locations and intersections located at the ramp termni.

Traffic data, signal timing and phasing, coordination information, and intersection geometrics were gathered and entered into the base models. The analysis focused on the weekday evening and Saturday peak hour periods. The analysis concentrated on three key measures of effectiveness: level of service, control delay, and volume-to-capacity (v/c) ratios. Detailed information regarding the methodology and the analysis can be found in the Baseline Condition Report and the Alternatives Analysis Report.

3.2. Crash Analysis

A review of the crash information was completed for the study area mainline and interchanges. Crash information consisting of location, severity, and collision type was complied for the period between January 1, 1998 and December 31, 2003 (excluding year 2002). Available information was obtained from PennDOT's Bureau of Highway Safety and Traffic Engineering for each ramp associated with the interchange and the mainline, within 500 feet of the ramps. This information and the corresponding crash diagrams can be found in the Baseline Conditions Report.

Eight interchanges with the highest crash rates were evaluated for trends. The crash data provided information regarding probable causes of crashes at individual locations. These factors included geometric problems, signing and striping issues, as well as factors such as weather, impaired driving (fatigue, alcohol), and aggressive driving. The high crash segments are identified in **Table 3.1 and Appendix A** of the Baseline Conditions Report along with their crash rates, crash clusters, and probable causes.

3.3. Physical Constraints

The final facet of the operations analysis process was the consideration of various factors such as right-of-way (ROW) acquisition, physical constraints, utility relocation, displacement of homes and businesses and how those would all relate to the potential cost of an improvement. Each improvement alternative discussed later in this report was developed utilizing PennDOT criteria. The aforementioned factors were compared to current design criteria in order to develop feasible alternatives from an approval and design standpoint.

Interchanges 164 to 197 were investigated to determine if improvements could be made to the overall operation and level of service by bringing the individual ramps up to current design standards. Interchanges 178, 182, 186, 188, and 190 were excluded from this investigation as they were not part of the study and have either been or are in the process of being redesigned and constructed to current PennDOT criteria. The geometric design deficiencies are illustrated in **Tables 2-3 and 2-4** in the Baseline Conditions Report and detailed information can be found in the Baseline Conditions Report.

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Table 3-1. Top Eight Highest Crash Sites with Crash Rates, Crash Clusters, and Probable Causes

Location	Crash Rate	Total Crashes	Crash Clusters	Probable Causes
Int. 165 Ramp G Exit (I-81 SB to SR 6309)	2.25	29	• 41% Rear-end • 41% Angle • 10% Major Injuries	• Inadequate road design for traffic conditions • Inadequate lighting • Inadequate signal timing • Lack of intersection warnings and other TCDs • Restricted sight distance • Poor signal visibility
Int. 165 Ramp M Entrance (SR 6309 NB to I-81 SB)	0.83	4	• 50% Angle • 75% Minor Injuries	• Inadequate road design for traffic conditions • Inadequate signal timing • Lack of intersection warnings and other TCDs • Restricted sight distance • Poor signal visibility
Int. 184 Ramp H Exit (I-81 NB to River Street)	0.44	15	• 65% Angle • 20% Moderate Injuries	• Inadequate road design for traffic conditions • Lack of intersection warnings and other TCDs • Restricted sight distance
Int. 182 Ramp A Entrance (SR 3016 to I-81 SB)	0.33	10	• 60% Rear-end • 10% Major Injuries	This interchange has been rebuilt as of September 26, 2003.
Int. 191 Ramp W (SR 6006 EB to I-81NB)	0.32	8	• 33% Rear-end • 33% Fixed Objects • 17% Moderate Injuries	• Inadequate road design for traffic conditions • Inadequate lighting • Obstructions close to roadway (rock cut)
Int. 170 Ramp M (I-81 NB to SR 115 SB)	0.31	21	• 76% Rear-end • 19% Fixed Objects • 5% Moderate Injuries	• Inadequate road design for traffic conditions • Inadequate lighting
Int. 175 Ramp E Exit (I-81 NB to SR 315 NB)	0.30	21	• 86% Rear-end • 14% Fixed Objects • 5% Major Injuries • 5% Moderate Injuries	• Inadequate road design for traffic conditions • Inadequate lighting • Inadequate signal timing
Int. 194 Ramp M Exit (I-81 SB to I-476/ I-81 Con)	0.29	8	• 63% Fixed Objects • 5% Moderate Injuries	• Inadequate road design for traffic conditions • Inadequate TDCs and obstructions close to roadway

3.4. Origin-Destination Study Data Reduction

At each survey station, the license plates of vehicles passing the cameras were recorded on videotape. The license plates were recorded and time stamped, and then matched at the various exit points of the study area in order to determine the direction of travel for recorded vehicles. The survey covered a 4 hour period from 2:30 to 6:30 on Sunday May 1 and Tuesday May 3, 2005. A total of 37,757 license plate records were recorded and 45,995 vehicles were observed at all count locations on Sunday May 1, 2005. A total of 39,254 license plate records were recorded and 47,729 vehicles were observed at all count locations on Tuesday May 3, 3005.

The results of the survey taken on Sunday May 1, 2005 established that 'through' traffic along Interstate 81 ranged from approximately **18 percent of vehicles traveling in the northbound** direction to **16 percent traveling in the southbound direction**. This translates to approximately 5,555 vehicles per day (vpd) (5,188 passenger cars, 367 trucks) or approximately 555 vph during peak weekend Saturday travel hours (518 passenger cars, 37 trucks) traveling northbound. In the southbound direction, this translates to approximately 4,402 vpd (4054 passenger cars, 348 trucks) or approximately 440 vph (405 passenger cars, 35 trucks) during peak Saturday travel hours.

Similarly, the results of the survey taken on Tuesday May 3, 2005 established that 'through' traffic along Interstate 81 ranged from approximately **7 percent traveling in the northbound direction** to **8 percent traveling in the southbound direction**. This translates to approximately 2,168 vpd (1783 passenger cars, 385 trucks) or approximately 216 vph during peak weekday travel hours (178 passenger cars, 38 trucks) traveling northbound, and approximately 2,293 vpd (1576 passenger cars, 717 trucks) or approximately 229 vph (157 passenger cars, 72 trucks) during peak weekday evening travel hours in the southbound direction.

4. Alternatives Analysis

Improvement alternatives for corridor study segments were identified, developed and prioritized based on the current operational deficiencies along with specific projects within these areas. Construction cost estimates were developed for each alternative. Benefit cost analysis considered the combination of the reduction of accidents and various operational parameters. The improvement segments were analyzed and categorized as 10, 20 and 30-year improvements, to identify required funding levels.

Both maintenance and other alternative traffic management strategies were also evaluated as potential short-term improvements. In addition to the Turnpike Diversion Alternative, consideration was also given to truck climbing lanes and a truck pull-enforcement area, although they were not part of the original scope of this project.

4.1. Corridor Segments Analysis

Based on the operational analysis discussed above and documented in the Baseline Conditions Report, areas of the corridor study segments were prioritized based upon the overall greatest level of need to improve traffic flow based upon current conditions. Specific projects within these areas have also been developed. These projects were then further refined and prioritized based upon the level of improvement they achieve on the areas which currently experience the highest levels of recurring congestion or crash rates.

The general areas of the study corridor were prioritized as follows:

1. Interchanges 180 to 185

2. Interchanges 175 to 180

3. Interchanges 188 to 191

4. Interchanges 168 to 175

5. Interchanges 164 to 168

6. Interchanges 191 to 197

The Baseline Conditions Report also provided recommendations for short-term maintenance improvements throughout the corridor which consist of signing, striping, and other improvements that can be made by PennDOT forces without detailed design or construction services procurement. The improvements include improving signing, striping, replacement of worn reflective devices and improved trail blazing signs, particularly at interchange areas. These

improvements can be performed by PennDOT maintenance forces and do not require the procurement of outside engineering and contracting services. As of the writing of the Baseline Conditions Report, many of these recommendations have been performed by PennDOT District 4-0 maintenance forces.

The study corridor currently has numerous intelligent transportation systems (ITS) components and technologies in place to help aid in maximizing traffic flow and managing incidents. These technologies include: dynamic message signs (DMS) – (portable and permanent); highway advisory radio (HAR); traffic monitoring cameras; and roadway weather information system (RWIS). The effects of these were also considered in the alternative analysis.

4.2. Cost Estimates

For non-roadway related items, current bid prices were obtained from USDOT, PennDOT and the Pennsylvania Turnpike Commission to determine an accurate cost item for purchase and installation of various signal and ITS related items. In Table 7-1 of the Alternative Analysis Report, summarized costs are presented. The cost estimates were originally calculated utilizing 2006 construction data estimates. The sum total of the projects was then escalated to 2008 dollars utilizing a 5% per year escalation factor provided by PennDOT.

*The total projected cost of the alternatives and improvements presented in this report in 2008 dollars is **$1.090 Billion***. Further discussion of the alternatives and improvements can be found in Section 5 of this document and in Sections 6 and 7 of the Alternative Analysis Report.

4.3. Benefit Cost Analysis

A Benefit Cost Analysis (BCA) was performed in order to quantify potential benefits in crash reduction versus estimated construction costs. In order to perform the BCA in a quantifiable manner, the study corridor was studied in the six prioritized sections as described earlier.

Within each section, individual ramp improvement projects were evaluated individually as well as the addition of a third mainline lane. Separate BCAs were performed that evaluated ramp improvements alone, mainline widening alone, and the combination of both ramp improvements and mainline widening through each corridor section. The BCA to date evaluates the mainline interchange improvements only on the projected reduction of crashes through each corridor section.

The BCA also incorporates performance-related changes relative to each of the abovementioned improvement scenarios. The measures of effectiveness (MOE) were used to quantify changes in performance included: vehicle-miles traveled vehicle-hours of move time, vehicle-hours of delay time, fuel consumption, and emissions. This component of the BCA utilized value of time, fuel, and emission costs that are available as part of the Federal Highway Administration's *Surface Transportation Efficiency Analysis Model (STEAM Version 2.01).*

5. Improvement Projects

As mentioned previously the potential improvements were prioritized in segments and have been further categorized as 10-, 20-, and 30-year improvements. This is to help identify required funding levels, construction sequencing, and possible right of-way acquisitions in order to have projects programmed and funded as necessary looking out to the year 2035. The improvement alternatives and cost estimates are discussed in detail the Alternatives Analysis Report. Intent of identifying these major projects in 10-year increments is to provide a manageable and steady program of projects in the funding stream that occur in a timely manner in order to ensure the continued safe and efficient operation of the study corridor.

The improvement alternatives presented herein follow the order of the prioritized areas. In addition, the mainline widening cost estimates are based upon the study *I-81 Rebuild/Expansion Study –Conceptual Engineering for an Additional Third Lane, Exit 164 through Exit 194, Luzerne and Lackawanna Counties,* Pennoni prepared for PennDOT District 4-0, September 2003. The cost estimates presented in this report were updated using current cost values as obtained from PennDOT. The appropriate sections of mainline widening were considered in each group of improvement priorities. The 10-, 20-, and 30-year improvement projects for the study corridor are shown in **Figures 1 through 7** and listed in the following sections.

5.1. 10-Year Projects

10-year projects are to include:

- Mainline widening between Interchanges 180 and 185 and Ramp Improvements at Interchanges 180,184, and 185. Estimated construction cost: $166.1 million (2006 Dollars).

- Mainline widening between Interchanges 175 and 180 and Ramp Improvements at Interchange 175. Estimated construction cost: $124.5 million (2006 Dollars).

5.2. 20-Year Projects

20-year projects are to include:

- Mainline widening between Interchanges 168 to 175 and Ramp Improvements at Interchange 170. Estimated construction cost: $147.4 million (2006 Dollars).

- Mainline widening between Interchanges 188 and 191 and Ramp Improvements at Interchange 191. Estimated construction cost: $51.8 million (2006 Dollars). (Note: Does not include current Interchange 190 project projected costs.)

5.3. 30-Year Projects

30-year projects are to include:

- Mainline widening between Interchanges 164 to 168 and Ramp Improvements at Interchanges 164 and 165. Estimated construction cost: $76.4 million (2006 Dollars).

- Mainline widening between Interchanges 191 and 197 and Ramp Improvements at Interchanges 194 and 197. Estimated construction cost: $151.9 million (2006 Dollars). All costs presented above do not include engineering fees, right-of-way acquisition, or utilities.

5.4. Intersection Improvement Projects

Each intersection at the terminus of each interchange ramp was evaluated as part of the capacity and operational analyses performed as part of these studies. Numerous intersection locations have individual movements that currently operate at unacceptable LOS. The worst intersections (both existing and projected) were identified along with improvement projects. Estimated Construction Costs: $3.49 Million (2006) Dollars.

5.5. ITS Projects

Intelligent Transportation Systems (ITS) projects were preliminarily evaluated in order to asses their impacts to increase capacity from the existing road network and increase driver awareness to incidents or construction activities. ITS technologies include Dynamic Message Signs (DMS), in-road speed sensors, Highway Advisory Radio (HAR) and commercial radio station broadcasting, and email incident notification services. As part of reconstruction of the I-81 corridor, a fiber-optic communications backbone should be programmed as a design element of improvement projects. Estimated Construction Costs: $8.16 Million (2006 Dollars).

To summarize Section 5 and to re-state Section 4.2, *The total projected cost of the alternatives and improvements presented in this report in 2008 dollars is* ***$1.090 Billion***.