



# USER BENEFITS ASSOCIATED WITH THE IMPLEMENTATION OF A MULTI-MUNICIPAL SIGNAL COORDINATION PROJECT

State Route 228, Butler County

April 2008

**FINAL**



INTRODUCTION

State Route 228 is a high volume east-west principal arterial between State Route 19 in Cranberry Township and State Route 8 in Middlesex Township in southern Butler County, Pennsylvania. The western section of Route 228, which passes through Cranberry Township, Seven Fields Borough, and Adams Township, is a roadway segment that provides access to a high growth area and experiences a high level of congestion during peak travel periods. This segment of Route 228 between the Interstate 79 interchange to the west and Beaver Street Extension to the east carries an average daily two-way traffic volume of approximately 43,000 vehicles. This section of Route 228 also narrows from four lanes to two lanes traveling eastbound. A roadway widening project is proposed for this section of the corridor, however, until the larger scale funding for such a project is secured, the three local governments wanted to ensure that the traffic signals along this section were operating optimally.

The purpose of this study is to document the benefits of a multi-municipal signal coordination project implemented by Cranberry Township, Seven Fields Borough, and Adams Township.

## **STUDY AREA AND COOPERATION**

Six traffic signals along the western Route 228 corridor study area (see Figures 1 and 2) were not previously interconnected to provide optimal operations:

- State Route 228 and Franklin Road; (Cranberry Township-part of system to the west)
- State Route 228 and Castle Creek Drive/High Point Drive; (Seven Fields Borough)
- State Route 228 and Castle Creek Drive/High Point Drive 2; (Seven Fields Borough)
- State Route 228 and Seven Fields Boulevard; (Seven Fields Borough)
- State Route 228 and Adams Ridge Boulevard; (Adams Township) and
- State Route 228 and Heritage Creek Road (Adams Township).

Recognizing that working together on the Route 228 corridor and its traffic signals would yield benefits to all three communities, the three local governments entered into a unique multi-municipal agreement to coordinate and maintain traffic signal operations along this section of Route 228. Cranberry Township led these efforts as they owned and maintained an interconnected signal system just west of the study area and intended to extend this system to the five signals within the study area (the Franklin Road intersection is part of a fiber optic interconnect system to the west of this area in Cranberry Township).

Through the cooperation of all three local governments, a grant application was prepared by Seven Fields Borough for 50% of the required funding for an interconnected signal system for the study area. The grant was received from the Pennsylvania Department of Community and Economic Development. The remaining 50% of the funding was provided by the three local governments.

## **DESIGN AND CONSTRUCTION**

A hard-wired fiber optic cable interconnect system was considered early in the study, as it is the preferred, traditional medium utilized by Cranberry Township due to its reliability. Cranberry utilizes a hard wire fiber optic interconnect for the signals just west of the study area. However, due to its higher costs (which include trench excavation and conduit) and the potential to incur those costs again in the anticipated roadway widening project, other less expensive alternatives were investigated. Copper wire with phone communications was considered, but this option included continuous, significant monthly costs.

Radio spread spectrum wireless technology was also investigated. The term “spread spectrum” refers to a class of communication that modulates (spreads) information over a wide frequency bandwidth (spectrum). Two types of spread spectrum techniques exist, direct sequence and frequency hopping. These methods suppress or avoid interference respectively, by using the full band available for data transmission, rather than a single frequency within the band. Implementers must trade-off the greater range associated with the lower bands against the greater reliability and less interference in the higher bands. Federal Communications Commission (FCC) licensing regulations must also be taken account. The 902 MHz to 928 MHz band is generally unlicensed, meaning there are few barriers to entry for a wide range of users. This band is therefore attractive (and less expensive) compared to the higher bands, but attracts a correspondingly higher number of users and potential for interference.

Upon completion of this investigation, it was concluded that a wireless spread spectrum radio interconnect system would be the preferred system to implement due to a) lower initial costs; b) minimal maintenance costs; c) flexibility to add future signals within study area with minimal effort; and d) suitability of the corridor for line of sight data transmission.

The design of the system was completed by Cranberry Township staff and the system vendor, Path Master, Inc. Wireless radios (Communicator II Series) by Intuiticom were selected. The designed system included a new master controller, wireless radio at five intersections (the five study intersections east of Franklin Road plus one intersection that will be signalized in the future: Route 228/ Myoma Road), and coordination software. New signal timings were also generated for the corridor by Cranberry’s engineering consultant, HRG, Inc.

The installation of the radio spread spectrum system was completed and operational on January 16, 2008.

The approximate costs associated with implementing this system were as follows:

1. Engineering, Design, and Administration: \$15,000
2. Construction cost: \$53,000
3. Anticipated maximum annual cost of maintenance for this system (years 2-5): \$500/year

**Over a 5 year horizon, the total cost associated with the radio spread spectrum system is approximately \$70,000.**

Radio Antenna at the Intersection of State Route 228/Heritage Creek Boulevard



## TRAVEL TIME TRIALS BEFORE AND AFTER INSTALLATION OF RADIO SYSTEM

In June 2007, Cranberry Township conducted travel time run trials through the study area prior to the installation of the radio system. As shown in Figure 2, the travel time trials were conducted along Route 228 between Franklin Road and Beaver Street Extension, a 2.72 mile segment of the corridor. SPC conducted similar travel time trials through the study corridor after the installation of the radio system in March and April 2008 to document the impact of the project. Both of these trials recorded travel times and vehicular delays between the intersections and for the overall study corridor. This data is presented in the Technical Appendix to this report.

## CALCULATION OF USER BENEFITS

The significant user benefits that were calculated for this project include:

- Reduced delay to the motorist (value of time)
- Reduced fuel consumption (due to reduced delay and reduced vehicle stops)
- Reduced emissions of carbon monoxide (CO), nitrogen oxide (NO<sub>x</sub>), and volatile oxygen compounds (VOC)

It was assumed that these benefits would diminish over time due to the growth of traffic volumes along the Route 228 corridor. A 5 year horizon was used, assuming that the benefits would diminish at a uniform rate over that time period. The methodologies presented in Synchro 6 Traffic Signal Coordination Program by TrafficWare were utilized to calculate user benefits.

Reduced delay to the motorist. A comparison of the travel time trials before and after the installation of the radio system indicates the following time savings to the motorist traveling along Route 228 as a result of the implemented radio system:

- AM Peak Period: 18.62 vehicle hours, an 18% reduction in average delay
- Midday Peak Period: 44.54 vehicle hours, a 33% reduction in average delay
- PM Peak Period: 39.05 vehicle hours, a 26% reduction in average delay
- Through all three peak periods along the corridor, there were over 9,400 less vehicle stops, a 21% reduction
- In the morning peak direction, westbound, an average of 23 seconds of travel time savings was realized over the 2.72 mile corridor
- In the evening peak direction, eastbound, an average of 21 seconds of travel time savings was realized over the 2.72 mile corridor

When calculating the value of time to the user through all three peak periods, the above figures represent a user daily cost savings of \$2,342.33. Table 1 of this report provides a summary of the daily user benefits associated with time savings.

Reduced fuel consumption. Given the reductions in delay and vehicle stops, the total daily fuel consumption savings was calculated at 111.5 gallons. Utilizing a cost per gallon of \$3.35, the user daily cost savings are \$373.50. Table 2 of this report provides a summary of the daily user benefits associated with reduced fuel consumption.

Reduced emissions. Emission reductions were approximated for carbon monoxide (CO), nitrogen oxide (NOx), and volatile organic compounds (VOC). An overall reduction in emissions of 8.23% was calculated based on the calculated reduction in fuel consumption that resulted in a user daily cost savings of \$4.30. Table 3 of this report provides a summary of the daily user benefits associated reduced emissions.

## **USER BENEFIT SUMMARY**

Based on the above analyses, the total user daily cost savings from reduced delay, reduced fuel consumption and reduced emissions is \$2,720.14. Assuming 260 weekdays per year, the annual user benefit (in the first year) is calculated at \$707,235.25. As stated previously, It was assumed that these benefits would be in effect over a five year period, diminishing at a uniform rate each year. Given this assumption, the total user benefit over the five year period is calculated at \$2,121,705.

When compared to the total five year cost of the radio system project (including design, construction and maintenance) of \$70,000, the public realizes a benefit to cost ratio of 30:1 (see summary below).

Total daily user benefits: \$2,720.14

Number of days per year: 260

Annual benefit year 1: \$707,235.25

(Assume that benefits are in effect for 5 years, declining at a uniform rate to zero, when increasing traffic volumes render system less effective)

Annual benefit year 2: \$565,788.20

Annual benefit year 3: \$424,341.15

Annual benefit year 4: \$282,894.10

Annual benefit year 5: \$141,447.05

Total benefits over 5 years: \$2,121,705.76

Total costs of project over 5 years: \$70,000

**Benefit-cost ratio: 30.31:1**

## **CONCLUSIONS**

The more than 30:1 return on the investment made by Cranberry Township, Seven Fields Borough, and Adams Township is significant and typical of signal improvement/retiming projects across the United States. By consolidating resources, the three local governments were able to implement an improvement that will yield user and environmental benefits for a number of years. In addition, the local governments assured that the corridor would be operating at peak efficiency as they continue to try to secure funding for larger scale capacity improvement projects.

SPC's new Regional Traffic Signal Program will be focused on signal retiming and signal improvement projects along key corridors similar to the completed Route 228 corridor project presented here. The goal of the program is to make investments in the signal infrastructure that will yield significant public user benefits similar to those obtained on the Route 228 multi-municipal signal improvement project.