PHASE I

MAY 2013

DARBY BOROUGH

GRADE CROSSING STUDY

DELAWARE VALLEY
dvrpc
REGIONAL
PLANNING COMMISSION

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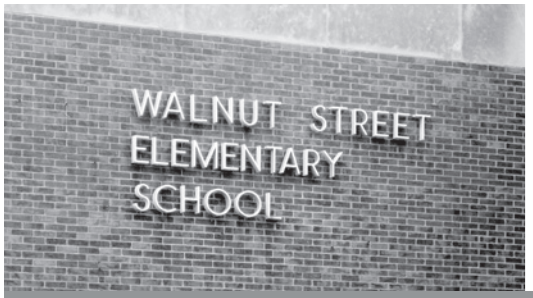

DELAWARE VALLEY
dvrpc
REGIONAL
PLANNING COMMISSION

The Delaware Valley Regional Planning Commission is dedicated to uniting the region's elected officials, planning professionals and the public with a common vision of making a great region even greater. Shaping the way we live, work, and play, DVRPC builds consensus on improving transportation, promoting smart growth, protecting the environment, and enhancing the economy. We serve a diverse region of nine counties: Bucks, Chester, Delaware, Montgomery, and Philadelphia in Pennsylvania; and Burlington, Camden, Gloucester, and Mercer in New Jersey. DVRPC is the federally designated Metropolitan Planning Organization for the Greater Philadelphia Region — leading the way to a better future.

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

The symbol in our logo is adapted from the official DVRPC seal and is designed as a stylized image of the Delaware Valley. The outer ring symbolizes the region as a whole while the diagonal bar signifies the Delaware River. The two adjoining crescents represent the Commonwealth of Pennsylvania and the State of New Jersey.

DVRPC is funded by a variety of funding sources including federal grants from the U.S. Department of Transportation's Federal Highway Administration (FHWA) and Federal Transit Administration (FTA), the Pennsylvania and New Jersey departments of transportation, as well as by DVRPC's state and local member governments. The authors, however, are solely responsible for the findings and conclusions herein, which may not represent the official views or policies of the funding agencies.

DVRPC fully complies with Title VI of the Civil Rights Act of 1964 and related statutes and regulations in all programs and activities. DVRPC's website (www.dvrpc.org) may be translated into multiple languages. Publications and other public documents can be made available in alternative languages and formats, if requested. For more information, please call (215) 238-2871.

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Figures and Tables

Executive Summary

The Delaware Valley Regional Planning Commission (DVRPC) is the officially designated Metropolitan Planning Organization (MPO) for the nine-county Philadelphia-Camden-Trenton region. The Delaware County Planning Department requested that DVRPC study two highway-railroad grade crossings in Darby Borough. This report represents the summation of Phase I of that effort.

The two grade crossings that are the focus of this study are located in Darby Borough in close proximity to one another, at Main Street (US DOT Crossing # 140641S) and Fifth Street (US DOT Crossing # 140640K), respectively. The two grade crossings are created by the Philadelphia Subdivision, which is owned and operated by CSX, a Class I railroad. The Philadelphia Subdivision runs between Baltimore and Philadelphia, and is a subsection of a main line in the CSX system that runs from Florida to New York. The grade crossing at Main Street has a highly unusual added dimension: the SEPTA Route 11 trolley, which operates in the Main Street right-of-way from 5:00 AM to 2:00 AM daily, also bisects the freight rail line. Additionally, the meeting of the freight line and SEPTA trolley takes place within the intersection of Main Street and Sixth Street.

Darby Borough is located along the eastern edge of Delaware County bordering Philadelphia. According to the U.S. Census information available at the time of this report's publication, Darby Borough has a population of 10,687, a median household income of $30,938, and a total area of 527 acres. An environmental justice analysis performed for this study shows that there are three Degrees of Disadvantage (DODs) that are found within the borough. They are non-Hispanic minorities, female heads of households with child, and poverty.

An important part of the Phase I work was data collection. DVRPC performed both manual and automated counts at and around the two grade crossings. Below is a summary of the data collected in one calendar day:

- 11,649 total vehicles were counted on both Main and Sixth streets at the grade crossing
- 4,146 was determined to be the AADT of Fifth Street at the grade crossing
- 13 freight trains moved through Darby Borough
- 763 carloads worth of goods moved through Darby Borough
- 323 total pedestrians traversed the grade crossing at Main Street between 7:00 AM and 9:00 AM
- 237 SEPTA Route 11 trolleys were scheduled to cross the Main Street grade crossing on a weekday

This report also lays out a wide array of possible improvements that can be made to highway-railroad grade crossings. This report does not recommend any specific improvements; it merely states possible improvements. Possible improvements include:

- Upgrades to existing equipment, such as signage, warning devices, and subbase
- Installation of Secondary Safety Measures, such as four-quadrant gates or channelization devices
- Changing traffic patterns of vehicles, trolleys, or trains through Darby Borough
- Fully grade separating the Darby Borough grade crossings
- Community-based improvements, such as a public education campaigns and improved walking routes

This Phase I report is concluded by discussing Next Steps, which will be undertaken in Phase II. They include conducting walkability studies for the two nearby public schools, developing possible short-, medium-, and long-term initiatives to present to the public, and analyzing the results of public outreach to determine which initiatives should be acted upon immediately and which should be advanced in the longer term.

CHAPTER 1

Introduction

The highway-railroad grade crossing at the intersection of Sixth and Main streets in Darby Borough, Pennsylvania, is the only known location in the country in which an active freight rail line intersects an active trolley line within a state-owned roadway. Because of this, the grade crossing has been on the radar of many agencies for a long time. The unique conditions at this grade crossing pose three major problems: maintenance, traffic flow, and safety. The pounding of the surface and rail where the trolley tracks and train tracks meet has caused substantial continuous pavement degradation, which has forced the grade crossing to be resurfaced many times. Main Street is an active commercial district and a main through road, with over 10,000 vehicles daily. Each train that passes creates a queue of cars and trolleys trying to proceed down Main Street. A high volume of pedestrians, many of whom are students attending one of the two nearby schools, also pass through the grade crossing daily.

While the Main Street grade crossing was the main force driving this study, a grade crossing at Fifth Street has issues of its own, and the proximity of the two grade crossings make it prudent that they be studied together. These are the driving forces behind the Darby Borough Grade Crossing Study. What follows is a Phase I report that focuses on background information and data collection, and lays out a host of possible improvements that will be built upon in the Phase II report.

Previous Technical Work

In 2006, DVRPC published a report, the *Delaware County Highway-Railroad Grade Crossing Study*, which examined 11 highway-railroad grade crossings along the CSX Philadelphia Subdivision in Delaware County. The study contained an inventory of each grade crossing in the corridor, highlighting the existing conditions, such as DOT Identification Number, location, road owner, annual average daily traffic, number of daily trains, warning devices, adjacent land use, and crash data.

The purpose of the study was to identify improvements that might better integrate the rail freight traffic with the goals of the host communities, particularly taking into account the grade crossings. To this end, the report spelled out improvement options for the entire rail corridor and for individual grade crossings, such as supplemental safety measures, grade crossing consolidation, and grade separation.

Steering Committee

Integral to the completion of this report was the steering committee, which met to discuss the report's progress and review completed materials. Members of the steering committee also assisted by sharing data and lessons learned. The following is a

list of organizations that were invited to participate in the steering committee and made invaluable contributions to the contents of this report:

- CSX;
- Darby Borough;
- Delaware County Planning Department;
- Delaware County Transportation Management Association;
- Federal Railroad Administration;
- PennDOT;
- Pennsylvania Public Utility Commission – Rail Safety Section;
- SEPTA; and
- William Penn School District.

Report Organization

The Darby Borough Grade Crossing Study: Phase I is organized as follows:

- Current Conditions and Background
  - This section contains extensive background information about the transportation systems and land use, both at the grade crossing and in Darby Borough in general. This section also contains information on Class I Railroads in the DVRPC region, general grade-crossing guidance and laws, Operation Lifesaver, and environmental justice.

- Data Collection Endeavor
  - DVRPC collected a large amount of data for the purposes of this study. That data are summarized in this section and categorized by movement type (i.e., pedestrian data, vehicular data, trolley data, and train data).
- Possible Improvements
  - This section contains many different ways to improve a highway-railroad grade crossing. For each improvement, three sections are provided: an overview of the improvement, how the improvement would be applicable in Darby Borough, and possible considerations that need to be accounted for before moving forward with the improvement.
- Next Steps
  - This section explains what tasks DVRPC will be undertaking as part of Phase II of this study.

CHAPTER 2

Current Conditions and Background

This chapter will provide background on Darby Borough and the study area, specific information about highway-railroad grade crossings, a summary of Class I grade crossings in the region, and additional information about grade crossings in general.

Darby Borough

Darby Borough is located along the eastern edge of Delaware County bordering Philadelphia. Darby Borough is believed to have been founded in 1682 by John Blunston and other Quakers from Darbyshire, England. Traces of Darby's Quaker and colonial roots still remain, with an active Meeting House that was built in 1805, sitting at 1017 Main Street; a half-mile away from the study location. This section covers basic current conditions in Darby Borough, such as land use and demographic data, which are important to consider throughout this study.

W.C. Fields was born William Claude Dukenfield in Darby, Pennsylvania, on January 29, 1880. He was an American comedian, actor, juggler, and writer. He starred in numerous films and Broadway shows, such as Ziegfeld Follies and Poppy.

Demographics

According to the 2010 Census, Darby Borough has a population of 10,687. The borough is predominately African-American (78.9 percent of residents), with white being the second highest racial group (16.2 percent of residents). There are 3,367 households, 1,403 of which have a child under 18 years of age living in the house. The average household size for the borough is 3.03 occupants. The majority of Darby Borough is made up of single-family homes, with 52.4 percent of households being owner occupied and 47.6 percent of households being renter occupied. There are 521 vacant homes in Darby Borough.

In 2000, Darby Borough had 4,169 residents in the labor force, of which 3,688 were employed and 477 were unemployed. By far the highest sector of employment for borough residents was Educational, Health, and Social Services, with 29.6 percent of employed residents working in the sector. The median household income was $30,938. In terms of how Darby Borough residents got to work, 2,028 drove alone, 431 drove in a carpool, 854 took public transit, and 215 walked.

Land Use

Darby Borough is a small municipality of 527 acres. Eighty-five percent of the land within the borough is made up of five different land use types:

- Single-family Residential – 21 percent;
- Multifamily Residential – 16 percent;
- Transportation – 16 percent;
- Commercial – 12 percent; and
- Community Services – 20 percent.

The business district of Darby Borough runs along Main Street, from Fifth Street to MacDade Boulevard, and then continues along MacDade Boulevard in both directions (see Figure 1). The Darby Transportation Center sits in the middle of the commercial area and serves numerous bus and trolley lines. In recent years, there have been some signs of commercial revitalization in Darby Borough. In December 2010, the Save-a-Lot Food Store in the Darby Town Center officially opened, signaling the first time a grocery store existed in Darby Borough in 30 years. The 17,000-plus square foot store will anchor the town center, which will also include other retailers. In total, the new Darby Town Center will be 142,000 square feet of retail and will bring an estimated 200 permanent local jobs to Darby Borough.

As mentioned in the Demographics section above, the sector that employs the most Darby Borough residents is Educational, Heath, and Social Services. Not surprisingly, there are a number of facilities in Darby Borough that employ residents in these fields. Darby Borough has two elementary schools, Park Lane Elementary and Walnut Street Elementary, which is closer to the grade crossings. Also close to the study area is the Penn Wood Middle School, which is the only middle school in Darby Borough. There is no high school in Darby Borough, as residents attend Penn Wood High School in Lansdowne. In the health arena is the Mercy Fitzgerald Hospital, which is a 218-bed teaching hospital that has been in existence for 76 years. Little Flower Manor in the extreme western corner of Darby Borough is a nursing care facility that also offers short-term rehabilitation care for senior citizens.

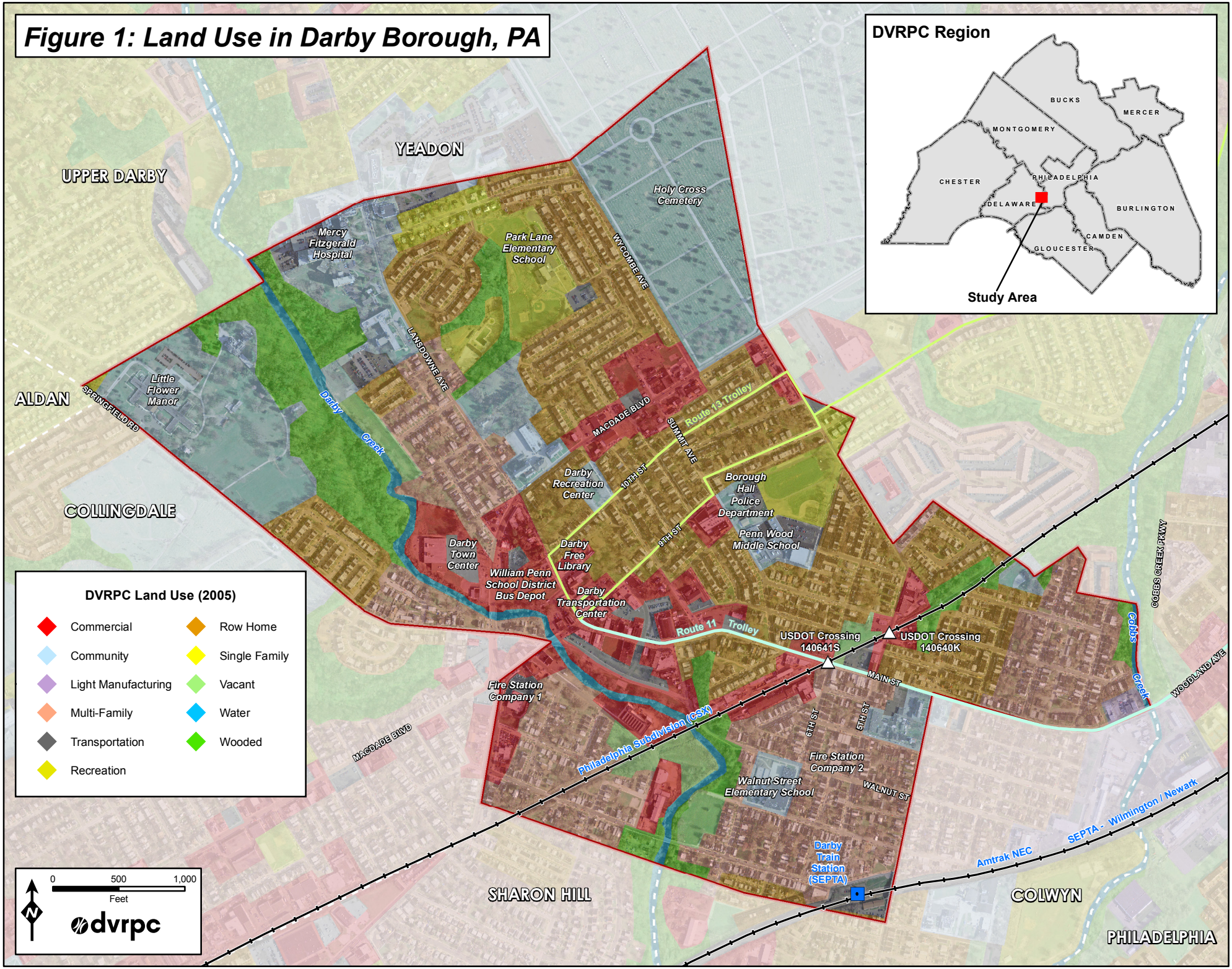
Figure 1: Land Use in Darby Borough, PA
DVRPC Region
BUCKS
MERCER
MONTGOMERY
CHESTER
PHILADELPHIA
DELAWARE
BURLINGTON
CAMDEN
GLOUCESTER
Study Area
YEADON
UPPER DARBY
ALDAN
COLLINGDALE
SHARON HILL
COLWYN
PHILADELPHIA
Holy Cross Cemetery
Mercy Fitzgerald Hospital
Park Lane Elementary School
WYCOMBE AVE
LANSDOWNE AVE
SPRINGFIELD RD
Little Flower Manor
Darby Creek
MACDADE BLVD
Route 13 Trolley
SUMMIT AVE
10TH ST
9TH ST
Darby Recreation Center
Borough Hall Police Department
Penn Wood Middle School
Darby Free Library
Darby Town Center
William Penn School District Bus Depot
Darby Transportation Center
Route 11 Trolley
USDOT Crossing 140641S
USDOT Crossing 140640K
COBBS CREEK PKWY
Cobbs Creek
WOODLAND AVE
MAIN ST
Fire Station Company 1
Philadelphia Subdivision (CSX)
6TH ST
Fire Station Company 2
Walnut Street Elementary School
WALNUT ST
Darby Train Station (SEPTA)
Amtrak NEC
SEPTA - Wilmington / Newark
DVRPC Land Use (2005)
Commercial
Community
Light Manufacturing
Multi-Family
Transportation
Recreation
Row Home
Single Family
Vacant
Water
Wooded
0
500
1,000
Feet
N
dvrpc

From the perspective of social services, the borough is home to a number of facilities for local government, police, and fire. On April 7, 2011, the new Darby Recreation Center opened. The 11,000-square-foot building has a gymnasium, conference space, and a full-service kitchen. The borough has received an additional $2,000,000 in funding to expand the recreation center to include a new municipal center, which will include new headquarters for the police force, administration offices, and district court chambers.

Highways and Streets

Much of the street system in Darby Borough is grid-like, with numbered streets (there are 10 numbered streets, First Street through 10th Street) running north to south, and named streets (primarily named after trees) running east to west. Main Street runs through the middle of Darby Borough and connects to roads on either end that link to the surrounding communities and greater highway system.

At the east end of Darby Borough, Main Street intersects with three other roads: Cobbs Creek Parkway, Woodland Avenue, and Island Avenue. Cobbs Creek Parkway carries vehicles north along the Philadelphia city line and becomes 63rd Street north of Market Street in West Philadelphia. Woodland Avenue is the natural extension of Main Street to the east and allows vehicles to travel into the University City area. Island Avenue runs south and connects Darby Borough into both I-95 and the Philadelphia International Airport.

At the west end of Darby Borough, Main Street connects into four major roads: MacDade Boulevard, Chester Pike, Lansdowne Avenue, and Springfield Road. MacDade Boulevard and Chester Pike (US 13) run parallel to each other, south from Darby Borough through Delaware County along the I-95 Corridor. MacDade Boulevard connects to I-476 at Interchange #1 and then turns into 22nd street in Chester, Pennsylvania. Chester Pike (US 13) also extends into Chester, Pennsylvania, turning into Morton Avenue and then Ninth Street (both of which are designated as US 13). Springfield Road allows vehicles to travel west out of Darby Borough and connects into Clifton Heights and Springfield Township before ultimately turning into Sproul Road (PA 320) in Marple Township. Lansdowne Avenue is the most natural extension of Main Street. At the western edge of Darby Borough, it connects into Lansdowne Borough before intersecting West Chester Pike (PA 3).

Public Transit

The Southeastern Pennsylvania Transportation Authority (SEPTA) operates six subway-surface trolleys, which are collectively referred to as the “Green Line.” The subway–surface lines are remnants of the far more extensive streetcar system that developed after the arrival of electric trolleys. Two of these lines terminate at the Darby Transportation Center, the Route 11 and the Route 13 (note, the Route 13 has limited service to Darby Borough).

The Route 11, when running from east to west, starts at the 13th Street station under Market Street in Philadelphia. It stops at multiple underground stations before surfacing near 40th Street and Baltimore Avenue. Once above ground, the trolley runs southwest along Woodland Avenue, making stops at every block for boarding and departing. At the intersection of Island Road and the Cobbs Creek Parkway, the Route 11 moves northwest from Woodland Avenue onto Main Street as it crosses Cobbs Creek and enters Darby Borough. In Darby Borough, the Route 11 travels down Main Street, across the highway-railroad grade crossing at Sixth and Main streets, and terminates at the Darby Transportation Center.

Internet research indicates that the Route 11 was established as the West Philadelphia Passenger Railway Company in Darby Borough in 1858, and ran as horse cars from Ninth and Main Streets in Darby to 49th Street and Woodland Avenue in West Philadelphia. The line was integrated into the subway-surface trolley system in 1906.

The Route 13 primarily terminates at Chester Avenue in Yeadon, just before the Darby Borough border, but there is limited service to the Darby Transportation Center, mostly during rush hour. While the Route 13 uses Ninth and 10th streets to access the transportation center, the Route 13 trolley still occasionally runs down Main Street because those trolleys may be stored in the Island Avenue Trolley Yard when not in operation. The Island Avenue Trolley Yard is located at the intersection of Island and Elmwood avenues, approximately a quarter mile from the intersection of Island Avenue and Main Street.

OcTrolleyFest is an annual event that occurs in Darby, Pennsylvania, in October. This day celebrates the transportation heritage of Darby. Residents and visitors are able to board a historic trolley that will take them to the many events at the festival.

In addition to trolley service, the Darby Transportation Center acts as a hub for three suburban bus routes. The Route 113 runs from the 69th Street Transportation Center to the Darby Transportation Center, down MacDade Boulevard, through Chester City, and terminates at the Tri-State Mall in Delaware. The Route 114 originates at the Darby Transportation Center, from which it runs down Chester Pike, through Chester City, and out Route 452, terminating at the Granite Run Mall on Baltimore Pike. The Route 115's principal route is between the Darby Transportation Center and the Philadelphia International Airport; however, the line also runs limited service to the Delaware County Community College via Lansdowne Avenue and West Chester Pike.

Environmental Justice

Title VI of the Civil Rights Act of 1964 and President Clinton's 1994 Executive Order on Environmental Justice (#12898) state that no person or group shall be excluded from participation in or denied the benefits of any program or activity utilizing federal funds. DVRPC, the Metropolitan Planning Organization (MPO) for the Delaware Valley, is required to evaluate its plans and programs for environmental justice (EJ) sensitivity, including expanding its outreach efforts to low-income, minority, and other disadvantaged populations.

As a result of DVRPC's EJ work, an internal method of analysis was created as a way to identify disadvantaged communities within the region. Using the 2010 U.S. Census data, DVRPC evaluated eight degrees of disadvantage (DOD), which includes poverty, non-Hispanic minorities, Hispanics, elderly (75 years of age and older), carless households, physically disabled, Limited English Proficiency (LEP), and female heads of household with children.

There are three census tracts for Darby Borough. Two of these tracts are most directly linked to this study. The DOD analysis for these two tracts shows that three DODs can be found in both tracts. The DODs that are found within the study area are non-Hispanic minorities, female heads of household with child, and poverty. This analysis indicates that any potential impacts of transportation improvement projects should take into consideration the interests and concerns of these groups.

The Hilldale Daisies, also known as the Darby Daisies, was an African American professional baseball team based in Darby, Pennsylvania. This baseball team was established in 1910 as a boy's club team and later became a professional team in 1916. The team won the Negro League World Series Championship in 1925.

The Study Area: Main Street and Fifth Street Grade Crossings

The two grade crossings that shape the study area are created by the Philadelphia Subdivision rail line, which is owned and operated by CSX, a Class I railroad. The Philadelphia Subdivision runs between Baltimore and Philadelphia, and is a subsection of a main line in the CSX system, which runs from Florida to New York. The Philadelphia Subdivision was built by the Baltimore and Philadelphia Railroad in Pennsylvania as a branch of the B&O Railroad in Delaware and Maryland, and began full operation in 1886.

In Delaware County, the Philadelphia Subdivision has one main track and a series of passing sidings. There are two major facilities that the line serves in Delaware County, an intermodal automobile facility in Twin Oaks and a Transflo bulk facility in Chester. The Philadelphia Subdivision carries mostly through trains and has few, if any, local customers along the line. The line is heavily used, with a range of approximately 15 to 25 trains operating on a daily basis. Freight trains operating on this line haul virtually any substance, including consumer products, bulk commodities, hazardous materials, and even solid waste. Freight trains may be seen carrying various types of rail equipment, such as box cars, tank cars, hopper cars, containers, and trailers on flat cars. These cars travel along the main line until they are shifted to more local lines (shortlines or secondary lines) or handled in an intermodal facility.

USDOT Number

All highway-railroad grade crossings in the United States, public or private, both at-grade and separated, are required by law (Rail Safety Improvement Act of 2008) to have a DOT Crossing Inventory Number. For at-grade crossings, the number should be posted at the crossing. A crossing inventory number contains six digits followed by a letter.

In Darby Borough, the Main Street grade crossing is designated as crossing #140641S and the Fifth Street grade crossing is designated as crossing #140640K. The number is unique to specific location and should be posted, preferably on sign on both sides of the grade crossing. Responsibility for purchasing and displaying the signs is the responsibility of the railroad.

The Crossing ID placard at the Fifth Street grade crossing (#140640K) in Darby, PA. (Source: DVRPC)

The crossing numbers are useful for reporting an incident or maintenance concern at a grade crossing. Each grade crossing should be equipped with placards that display this number, along with a phone number for the railroad that owns the rail line.

Main Street Grade Crossing

The Main Street grade crossing is the only known grade crossing in the country in which an active freight rail line crosses an active fixed-rail transit line, with vehicular traffic also operating in the grade crossing. The Main Street grade crossing is made even more unique by the fact that the crossing is located within the intersection of Main and Sixth streets. Main Street is one lane in each direction, while Sixth Street is one way southbound to the south of Main Street and two way north of Main Street. There is parking on either side of both Main and Sixth streets. Additionally, there are sidewalks on either side of both Main and

Sixth streets at the grade crossing, but the sidewalk on the east side of Sixth Street north of Main Street ends abruptly shortly after the intersection.

The Main Street grade crossing is equipped with warning devices, including: gates, pedestrian gates, flashing lights (over lane and mast mounted), and warning signs. There are three vehicular gates, blocking each of the three lanes that enter the grade crossing/intersection. Sixth Street south of Main Street is one way, away from the crossing; thus, there is no traffic lane that enters the intersection from this direction. Because of this, there is no gate, but there are overhead and mast mounted flashing lights.

The gates closing for an oncoming train at the Main Street grade crossing (facing west). (Source: DVRPC)

Fifth Street Grade Crossing

The Fifth Street grade crossing is located 500 feet northeast of the Main Street grade crossing. This grade crossing is more traditional in nature in that there is no trolley or other roadway bisecting Fifth Street at the grade crossing. The grade crossing is located 350 feet north of the intersection of Fifth and Main streets, which is signaled and has a Route 11 trolley stop, and 125 feet south of the intersection of Greenway Avenue and Fifth Street, which is only a three-way intersection, with Greenway deadending into Fifth Street.

Like Main Street, Fifth Street is equipped with gates, flashing lights (over lane and mast mounted), and warning signs. While the Main Street grade crossing is relatively flat, Fifth Street slopes upward on either side of the rail line. The sidewalks along Fifth Street are not clearly defined through the grade crossing, and there are no pedestrian gates.

The Fifth Street grade crossing looking south toward Main Street. (Source: DVRPC)

Land Use at the Crossings

The crossing at Main Street is surrounded on three sides by commercial development and on one side by a vacant lot owned by CSX. In the northwest quadrant of the Main Street grade crossing is a bar/restaurant. This establishment is set off from the street and has a parking area located between the front door and the Main Street grade crossing. In the southwest corner of the Main Street grade crossing is a business that rents out heavy-duty machinery. This business generates significant truck traffic, some traditional tractor trailers, and some nontraditional oversized commercial vehicles. The business' property line

runs directly along the rail line, and the entrance is directly adjacent to the Main Street grade crossing. Commercial vehicle drivers serving this business occasionally choose to stop in the grade crossing in order to turn into the entrance.

In the southeast corner of the Main Street grade crossing, there is a strip of various commercial operations, mixed with buildings that appear seldom used or vacant. Directly at the intersection is a large building, the use of which is undistinguishable. Following that as the buildings proceed east toward Fifth Street are:

- An upholstery store;
- A building that may house apartments;
- A food market, which created significant foot traffic during morning and evening peak periods during field work;
- A Chinese restaurant, which created significant foot traffic in the evenings;
- A Laundromat;
- A residential-looking property; and
- A barbershop.

The land use around the Fifth Street grade crossing consists of three industrial buildings and one commercial building. The industrial buildings include two businesses, one of which distributes and serves HVAC and air-filtration products, and the other, which is a metal-recycling facility, as well as a possibly vacant building. The one commercial business at the Fifth Street grade crossing is a bar located in the northwestern quadrant of the grade crossing. There is residential housing in close proximity, along both Fifth Street and Darby Terrace, but not adjacent to the grade crossing.

Sidewalks Adjacent to the Grade Crossings

The Main Street and the Fifth Street grade crossings are subjected to high levels of daily pedestrian activity. This activity is primarily due to the adjacent residential areas, the business district along Main Street, and the elementary and middle schools in the nearby vicinity.

The condition of the sidewalks near the Main Street grade crossing is significant because of the amount of pedestrian activity, as well as for pedestrian safety. Along the north side of Main Street, the sidewalks were recently upgraded by CSX from brick to concrete. The curbs for these portions of sidewalk are in poor condition. In addition, along the east side of Sixth Street north of Main Street, the sidewalk unexpectedly ends soon after the intersection. The section of sidewalk located along the west side of Sixth Street south of Main Street is poorly separated from the roadway. There is no curb to indicate where the roadway begins.

The section of sidewalk along the south end of Main Street west of Sixth Street, as well as the section along the east side of Sixth Street north of Main Street, is interrupted by the location of the CSX tracks.

In the vicinity of the Fifth Street grade crossing, the sidewalks are also in poor condition. First, they are not clearly delineated from the roadway. This can create potential hazards between pedestrians and vehicles. Additionally, there are no pedestrian gates to deter pedestrians from crossing the rail lines when there is an oncoming freight train. Finally, the roadway slopes uphill and downhill before and after the rail lines, respectively. This may cause a difficult situation for any disabled person seeking to cross the rail line.

Class I Grade Crossings in DVRPC Area

Class I rail lines are comparable to interstate highways in that they have the highest volumes of train traffic, are engineered for the highest speeds, and are better maintained than other rail lines in the region. Trains on these lines are owned and operated by Class I carriers, the nation's highest classification of railroad. Class I railroads are generally defined as those with annual operating revenues of $250 million or more. The Delaware Valley is uniquely served by three Class I freight railroads: CSX, Norfolk Southern, and the Canadian Pacific (note: Amtrak is also classified as a Class I carrier).

The Class I rail system in the Delaware Valley can be simplified into four primary lines. The Harrisburg Line, owned and operated by Norfolk Southern, connects Philadelphia to Harrisburg and points beyond. The Morrisville Line, also owned and operated by Norfolk Southern, connects an intermodal facility in Morrisville with the Harrisburg Line. The Philadelphia and Trenton subdivisions are owned and operated by CSX, and make up parts of the CSX main line, which runs north-south along the East Coast from Florida to New Jersey (note: the Canadian Pacific is able to serve the region by virtue of trackage rights and agreements that it enjoys on the lines owned by CSX and Norfolk Southern). These lines lead to rail lines in other states, other Class I carriers, and even Canada and Mexico.

In the DVRPC region, there are 29 highway-railroad grade crossings along these Class I rail lines. Because of the high train volumes, speeds, and carloads, these 29 locations are important in terms of safety, pedestrians, and train and vehicular operations. Of the four primary lines, the Philadelphia Subdivision has the most highway-railroad grade crossings, 12, while the Harrisburg Line has eight, the Trenton Subdivision has seven, and the Morrisville Line has two.

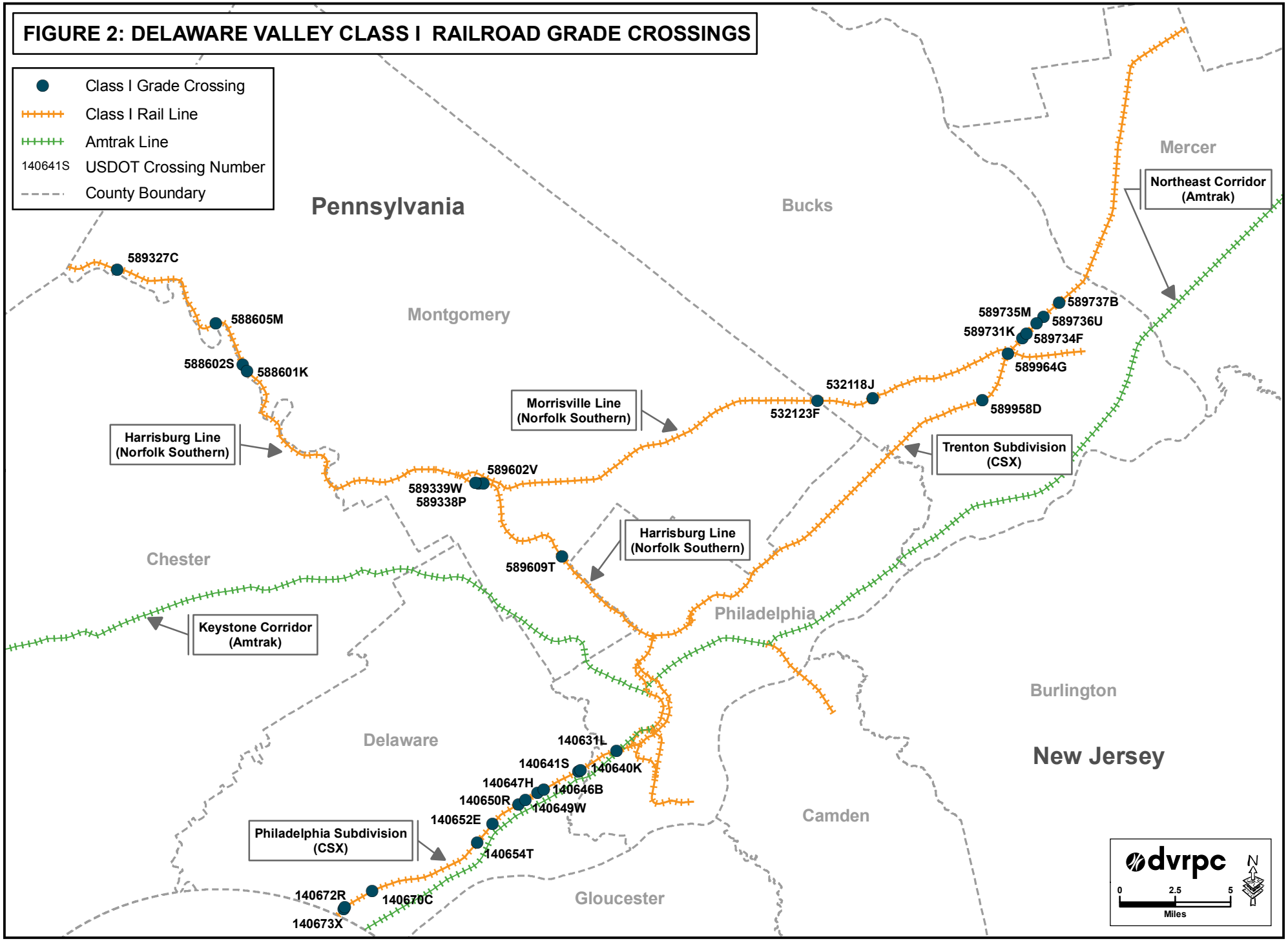
FIGURE 2: DELAWARE VALLEY CLASS I RAILROAD GRADE CROSSINGS
Class I Grade Crossing
Class I Rail Line
Amtrak Line
140641S USDOT Crossing Number
County Boundary
Pennsylvania
Bucks
Mercer
Montgomery
Chester
Delaware
Philadelphia
Burlington
Camden
Gloucester
New Jersey
Northeast Corridor (Amtrak)
Morrisville Line (Norfolk Southern)
Harrisburg Line (Norfolk Southern)
Trenton Subdivision (CSX)
Keystone Corridor (Amtrak)
Philadelphia Subdivision (CSX)
589327C
588605M
588602S
588601K
589602V
589339W
589338P
589609T
532118J
532123F
589735M
589737B
589736U
589731K
589734F
589964G
589958D
140631L
140641S
140640K
140647H
140646B
140650R
140649W
140652E
140654T
140672R
140670C
140673X
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Grade Crossing Background

This section provides general information regarding grade crossings. The majority of the information is taken from the *Railroad-Highway Grade Crossing Handbook, US Department of Transportation, Revised Second Edition, August 2007.*

Horn Noise

All locomotives are equipped with air-powered horns, which are required by law to be used when approaching a grade crossing. The engineer inside the locomotive will sound the horn in a sequence of two long blasts, followed by a short blast, followed by another long blast, as the train approaches the grade crossing. The federal regulations require that the horn sequence be initiated between 15 and 20 seconds prior to the arrival of the train at the grade crossing; however, most existing state laws and railroad rules require that the horn be sounded beginning at a point a quarter-mile in advance of the grade crossing and continue to be sounded until the grade crossing is occupied by the locomotive. There are a series of exceptions to the train horn rules, the most prevalent and well known of which are quiet zones.

Quiet Zone regulations are intended to maintain a high level of public safety, while providing local communities with relief from unwanted train noise. There is a series of "supplementary safety measures," "alternative safety measures," education, and enforcement options that can be used to raise public safety at a grade crossing to the point that a community can seek a quiet zone designation. Once a quiet zone is established, the railroad is barred from sounding the horn at the affected grade crossing, or grade crossings (note: a railroad may still need to initiate the horn in a quiet zone for railroad-operations-related reasons). The local entity (e.g., Darby Borough) tasked with maintenance or enforcement of the roadway at the grade crossing is the only entity that may apply for a quiet zone. Additionally, both the capital and maintenance costs of the added safety measures needed to secure quiet zone statues fall on the applying entity, not the railroad.

Train Detection

In the DVRPC region, 27 of the 29 Class I grade crossings have active warning devices (lights, bells, and/or gates) that notify highway traffic of an oncoming train. An important aspect in the functioning of these systems is the train-detection systems along the rail line. There are multiple technologies that serve this purpose, some that use electricity that the train trips at a certain point, and some that are specially designed to use the motion of the train to activate the warning devices. On tracks where trains operate in excess of 20 MPH (such as the CSX Philadelphia Subdivision), the federal guidelines state that, "The circuits controlling automatic flashing light signals shall provide a minimum operation of 20 seconds before the arrival of any train" (*Railroad-Highway Grade Crossing Handbook, US Department of Transportation, Revised Second Edition, August 2007, Page 114).*

Roles and Responsibilities for Grade Crossings

Many federal, state, local, and private agencies play a role in grade crossing safety and maintenance. Below is a list of the most important agencies and a brief description of their general responsibility.

- Federal Highway Administration (FHWA). FHWA administers federally funded programs, several of which can be used to fund capital improvements at grade crossings.
- Federal Railroad Administration (FRA). FRA maintains data about each highway railroad grade crossing in the "National Highway Rail Crossing Inventory," as well as data about each incident at a crossing in the "Railroad Accident/Incident Reporting System."
- Pennsylvania Public Utility Commission (PUC). Jurisdiction over highway-railroad grade and grade-separated crossings falls mostly to each state. In Pennsylvania, the responsible agency is the PUC. Anything regarding improvements, cost allocation, and closings that has to do with grade crossings must be approved by the PUC.
- Railroads. Railroads are responsible for all installation and maintenance of tracks and roadway within the grade crossing. The railroad is also responsible for the design, construction, operation, and maintenance of highway-railroad grade crossing signals (cross bucks, lights, gates, etc.).
- State and local government. The enforcement of traffic laws within the grade crossing falls to the local police department (e.g., Darby Borough Police). The roadway owner, be it the state or local entity (e.g. PennDOT), is responsible for making sure that the standards set forth by the federal government are followed by the railroad in regards to the design, construction, operation, and maintenance of railroad grade crossing signals (cross bucks, lights, gates, etc.). These agencies are responsible for all traffic control devices on the approaches to the grade crossing. This includes, but is not limited to, traffic signals (even if interconnected with the railroad warning systems), and passive signs, such as "Do Not Stop on Tracks."

Traffic Laws at Grade Crossings

In general, the laws of the roadway extend into the grade crossing when no train is in the vicinity. Once the active warning system has been initiated, drivers that enter the grade crossing are subject to heavy fines and suspension of their driver's license. All buses (such as public transit, tour, and school buses) are legally required to come to a complete stop at every grade crossing, regardless of whether the active train warning devices are in operation. This law also extends to all trucks that are carrying hazardous materials.

Operation Lifesaver

Operation Lifesaver is a nonprofit organization devoted to increasing the safety at highway-railroad grade crossings through public education. The organization was founded in Idaho in 1972, and in 1986, a national office was opened to support the efforts of the state-level programs and raise national awareness. Today, Operation Lifesaver provides a network of certified volunteers to speak to a wide range of groups, including schools, community groups, professional groups, and law enforcement. The national Operation Lifesaver office produces flyers and give-away items intended to raise awareness and make learning about the dangers of grade crossings fun and meaningful.

As part of this study, DVRPC staff and certified Operation Lifesaver volunteers conducted three events in Darby Borough. On the morning of September 14, 2011, an official Operation Lifesaver brochure was distributed to all pedestrians at the Main Street grade crossing. In the evening of that same day, DVRPC staff attended the Walnut Street Elementary School back-to-school night. DVRPC staff was assigned a table from which they handed out a wide array of kid-friendly Operation Lifesaver merchandise, such as erasers, pens, pencils, and coloring books, and safety flyers for the parents. On Thursday, September 15, DVRPC staff and an Operation Lifesaver volunteer attended the Penn Wood Middle School back-to-school night and talked to students and parents about safety, and handed out additional flyers and age-appropriate merchandise.

CHAPTER 3

Data Collection Endeavor

When considering improvement options at a particular grade crossing, having accurate and up-to-date data is essential. Through the study's steering committee, DVRPC coordinated with Delaware County, Darby Borough, SEPTA, PennDOT, and CSX to collect representative data at the two grade crossings in Darby Borough. Multiple varieties of data collection were performed and are organized in this chapter into five categories: pedestrian counts, vehicular counts, trolley counts, train counts and gate closures, and accidents/incidents. The chapter ends with a section that attempts to break down all the different aspects of the grade crossings into a brief summary of the data collected.

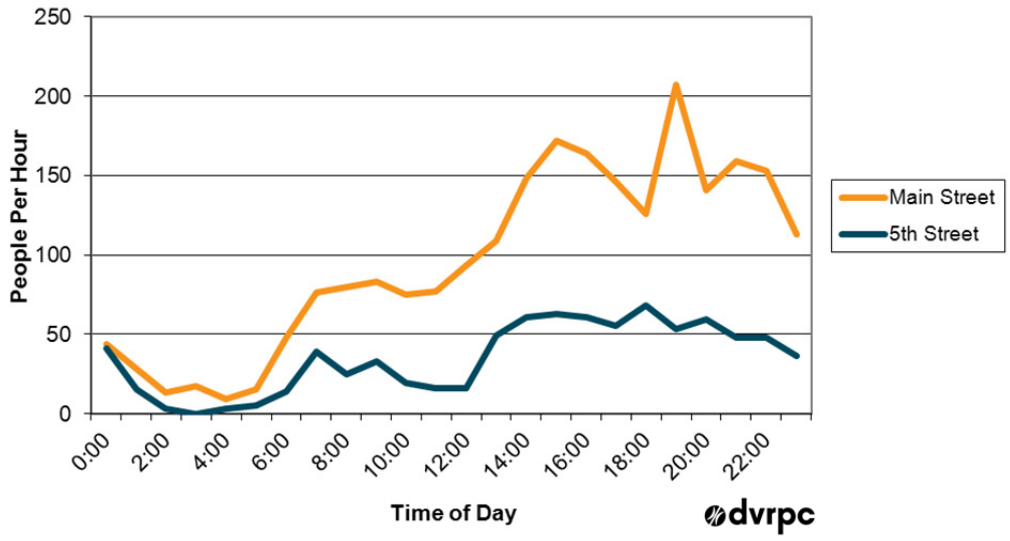
The data collection effort was concentrated into one 24-hour period. Working with the steering committee, a date of April 27, 2011, was selected. DVRPC has augmented the data collected in this intensive one-day effort with other field work, by coordinating with other agencies that have provided data and information contained in this section. The data presented in this chapter leads to a better understanding of operations at the grade crossing and will feed into future applications in Phase II of this study.

Pedestrian Counts

The movement of people at a grade crossing is a key form of activity from a safety perspective. This is especially true in a densely developed community such as Darby Borough. Along Main Street, in direct proximity to the grade crossing, a number of businesses attract significant pedestrian traffic. A sampling of some of the businesses include a food market, a Chinese restaurant, and a barber shop, all located on the south side of Main Street east of the grade crossing, and a bar located in the northwestern corner of the grade crossing. In addition to these businesses, pedestrian traffic is generated by the Route 11 trolley stop, which occurs at the Main Street grade crossing. The amount of pedestrian traffic at this grade crossing is significantly higher than at most Class I grade crossings in the region. Given the amount of traffic and the possible safety concerns, pedestrian counts were important to include in the data collection effort.

DVRPC collected pedestrian counts on both Main Street and Fifth Street near the grade crossings using state-of-the-art automated pedestrian counters. Figure 3 contains a profile of pedestrian activity along both Main Street and Fifth Street that these counters captured.

Figure 3: 24-hour Pedestrian Counts along Main Street and Fifth Street



The counts portrayed in Figure 3 reflect movements (in any direction) on the sidewalks along either side of the roadway. The counters are designed to record each movement of a person past the machine, so the numbers above do not represent total pedestrians, but rather total movements. For example, it is possible that some people were counted twice if they went to and returned from a destination using the same route. For both Main Street and Fifth Street, pedestrian activity peaked in the evening between roughly 7:00 and 9:00 PM. There were also slight peaks in the morning and afternoon rush hours, which are likely the result of student activity before and after school.

An automated pedestrian counter on the north side of Main Street. (Source: DVRPC)

During field views, DVRPC staff observed that Sixth Street carried a high amount of pedestrian traffic, specifically students walking to the local elementary and middle schools. Because of the placement of the automated pedestrian counters, this activity was not documented on April 27, 2011; therefore, on May 11, 2011, manual pedestrian counts were performed from 7:00 to 9:00 AM.

Figure 4: Total Number of Pedestrians during the Morning Peak Hours (7:00-9:00 AM)

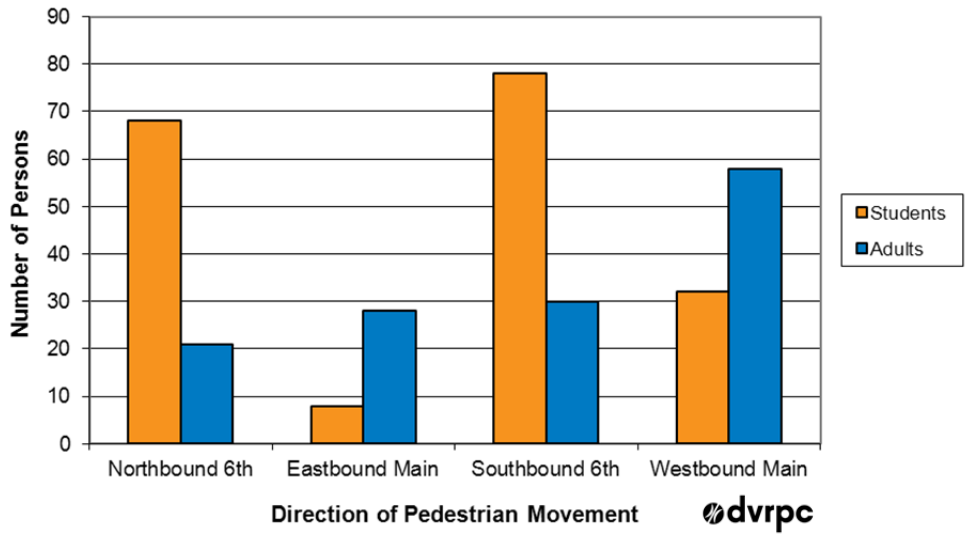


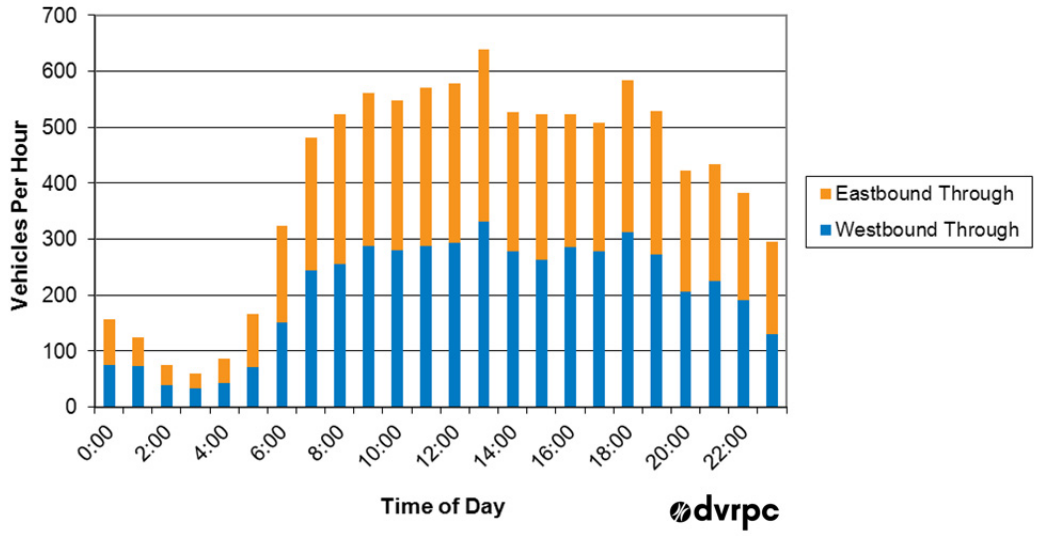
Figure 4 displays the number of pedestrians by their direction of movement away from the Main Street grade crossing. This illustrates which students are going toward the Penn Wood Middle School and which are going toward the Walnut Street Elementary School. Students (shown in orange) exiting the grade crossing going southbound on Sixth Street are almost exclusively elementary school students, while students exiting the intersection traveling northbound on Sixth Street are almost exclusively middle school students. While middle school students may take a bus to get to school, many choose to walk instead. There is a grade-crossing guard positioned at the corner of Sixth and Main Street during both the morning and afternoon to guide children safely across the intersection, and thus the grade crossing as well. A significant portion of persons going westbound on Main Street use the Route 11 trolley stop for eastbound trolleys to Philadelphia.

DVRPC staff conducts manual traffic counts at the Main Street crossing. (Source: DVRPC)

Vehicular Counts

DVRPC collects and manages traffic volume counts at over 5,000 locations each year. The majority of the counts are collected by laying pneumatic tubes across the road, with manual counts being completed to supplement the data where necessary (primarily turning movement counts). Because of the presence of trolley tracks on Main Street, it is not possible to conduct a pneumatic tube traffic volume count for the stretch of Main Street near the grade crossing. For the purposes of this study, a manual traffic volume count was conducted at the intersection of Main and Sixth streets. On April 27, 2011, DVRPC staff spent 24 hours at the grade crossing (in four six-hour shifts) conducting a manual count of vehicular traffic. Staff counted through movements along both Main and Sixth streets, as well as all turns between the two roadways. These counts provided a total intersection volume of 11,649 vehicles in the 24-hour period (note: DVRPC also conducted a series of counts using pneumatic tubes at other locations in Darby Borough to validate the manual counts).

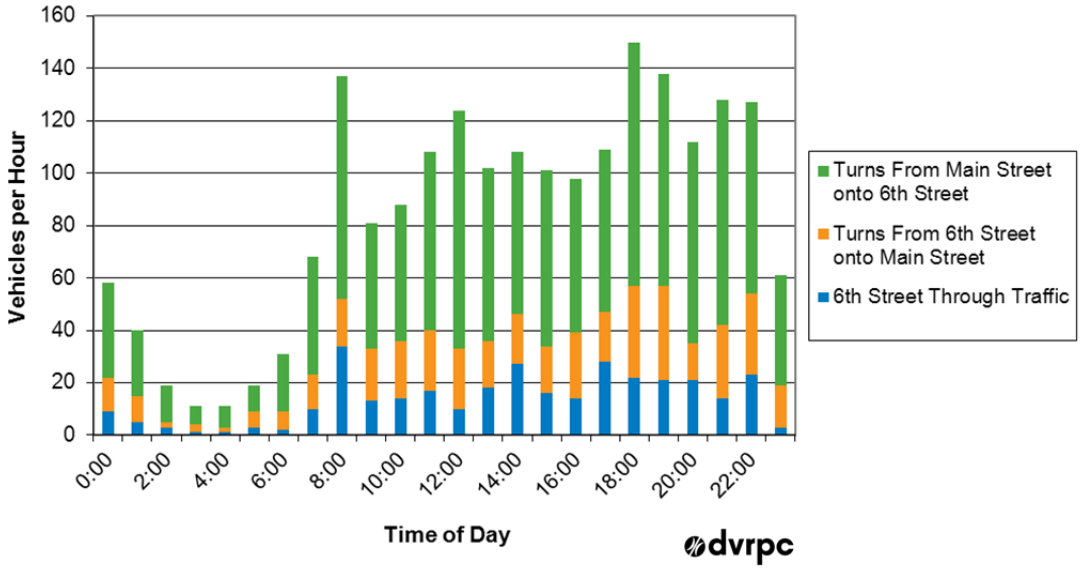
Figure 5: 24-hour Profile of Vehicular Traffic on Main Street by Direction



A total of 9,620 through movements were counted on Main Street at the grade crossing. While westbound and eastbound distribution was close to equal, there were slightly more westbound movements than eastbound movements. The total peak for through movements occurred between 1:00 and 2:00 PM. The observed through movements do not display the type of peak activity during the morning and afternoon rush hours that one may expect; however, there are slight upticks in the distribution during the 9:00 to 10:00 AM period and the 6:00 to 7:00 PM period.

Figure 6 represents the other three types of vehicle movements that were collected using the manual counts: turns from Main Street onto Sixth Street, turns from Sixth Street onto Main Street, and through traffic on Sixth Street. These movements produced a volume of 2,029 vehicles during the 24-hour period. The largest concentration of any of these move types are vehicles turning off of Main Street and onto Sixth Street. While a lot of the traffic distribution in Figure 5 is through traffic in nature, almost all the traffic in Figure 6 likely represents a local movement, with either its origin or destination in Darby Borough. There are distinct peaks in Sixth Street related traffic in the 8:00 AM and 6:00 PM hours, which are likely commuting-related trips. There is also an elevated traffic level from 7:00 to 11:00 PM. This is the time of day when most people are home from work and available for vehicular trips that are more local in nature.

Figure 6: 24-hour profile of Vehicular Traffic on Sixth Street by Turn Type



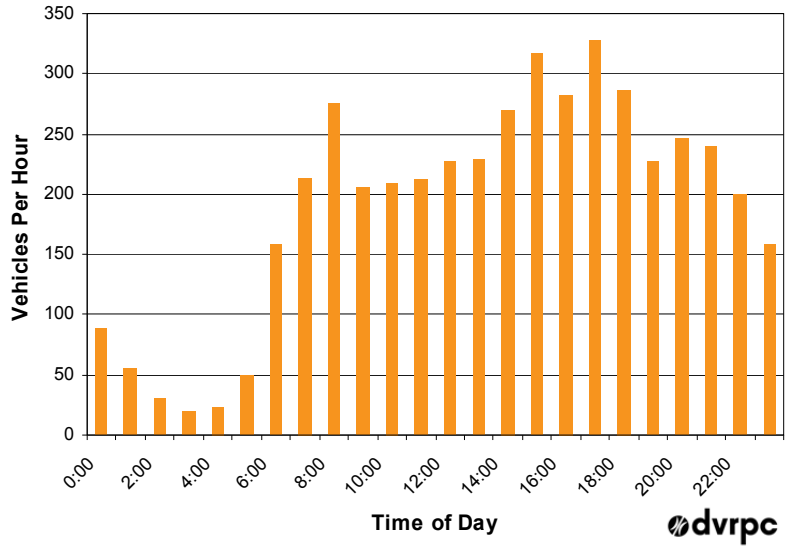
DVRPC also performed informal counts of school buses at both Darby Borough crossings, (note: data collection was focused on vehicle turning movements; school bus totals provide a good estimate. Also, the William Penn School District is moving the school bus depot, which will cause more school buses to traverse the crossings). On April 27, 2011, DVRPC staff noted 51 school buses traveling across the Darby Borough grade crossings during the AM peak period. Additionally, DVRPC staff counted trucks in 15-minute intervals to determine the percentage of truck traffic along Main Street. For the purposes of these counts, trucks were defined as any commercial vehicle that has greater than or equal to six tires. It was determined that the average

truck percentage for Main Street is roughly three percent. The only major trucking operation that regularly uses Main Street was observed to be the United State Postal Service (USPS).

Given the high amount of traffic on Main Street compared to Sixth Street, and given the employment attraction of Philadelphia International Airport (PHL) and airport-related businesses that can be accessed via Main Street, it is clear that Main Street is used as a through route. The USPS truck traffic that was documented is likely due to this trend, as the major Philadelphia area distribution center for USPS is located on Island Avenue near the PHL. Furthermore, DVRPC staff witnessed a high concentration of car drivers wearing safety vests, which would seem to suggest drivers use Main Street to access work sites.

DVRPC also conducted pneumatic tube counts on Sixth Street on either side of the grade crossing, and on Main Street west of the end of the Route 11 trolley tracks, over a 72-hour period from midday on Monday, April 25, to midday on Thursday, April 28. This allowed for a validation of the manual counts, which took place over a 24-hour period. During the manual counts along Sixth Street north of the grade crossing, a total of 1,159 cars were counted by DVRPC staff. Meanwhile, the pneumatic tube counts determined the annual average daily traffic (AADT) for this portion of roadway to be 1,275. This helps DVRPC to verify that there were no major gaps in the manual counts, and to verify that the 24-hour manual counts were accurate.

Figure 7: 24-hour profile of Vehicular Traffic on Fifth Street (both directions)



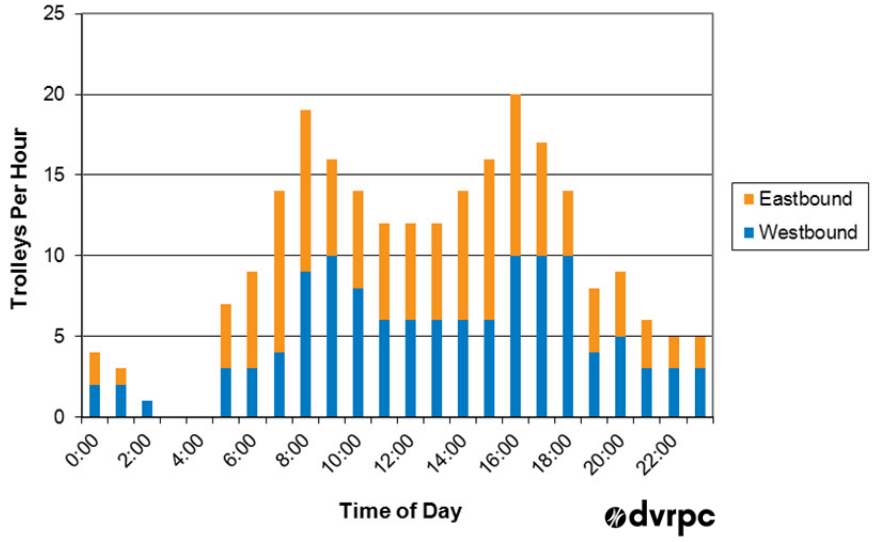
The traffic on Fifth Street carries a similar distribution to Sixth Street, with a morning peak between 8:00 and 9:00 AM, and generally more evening traffic than morning traffic. As with Sixth Street, Fifth Street serves a higher proportion of local traffic

than Main Street does. Traffic is less dictated by travel to work and more by local trips. Using the traffic volumes collected for a 72-hour period from Monday, April 25, 2011, to Thursday, April 28, 2011, and adjusted for seasonality, it was determined that the AADT for Fifth Street is 4,146.

Trolley Counts

Figure 8 shows the distribution of scheduled trolley traffic at the crossing throughout a weekday. There are clearly two peaks of scheduled trolley traffic during the morning and afternoon rush hours. Trolleys tend to run in equal amounts in each direction during the day and night, but during the two peak periods, directional distribution is varied. The standard schedule for midday trolley traffic is one trolley every 10 minutes in each direction. In the morning peak hours from 6:00 to 9:00 AM, 26 trolleys travel eastbound (to Center City) over the crossing, while 16 travel westbound (to Darby Transportation Center). This trend is reversed in the afternoon from 4:00 to 7:00 PM. Thirty trolleys travel westbound and 21 travel eastbound (note: the time interval directly after the morning peak has more westbound trolley traffic because the additional trolleys from the peak period need to be redistributed at Darby Transportation Center. This also occurs before the afternoon peak, but in reverse fashion).

Figure 8: Number of Scheduled Route 11 Trolleys at the Main Street Grade Crossing (Weekdays)



A Route 11 Trolley drives over the crossing at Main Street. (Source: DVRPC)

On the weekends, the trolleys have significantly abbreviated schedules. On Saturdays, 65 Route 11 trolleys travel eastbound across the Main Street grade crossing to Center City, and 66 run westbound to the Darby Transportation Center. Both directions peak at roughly one trolley every 15 minutes, but that peak activity schedule is from 9:30 AM to 6:00 PM traveling to Center City, and 11:00 AM to 7:00 PM traveling to the Darby Transportation Center. On Sundays, there are 54 trolleys to Center City, peaking at one every 20 minutes between 10:00 AM and 10:00 PM, and 54 trolleys to the Darby Transportation Center, peaking at one every 20 minutes from 11:00 AM to 11:00 PM.

In addition to the scheduled trolleys, there are both Route 11 and Route 13 trolleys that cross the intersection deadheading to the trolley depot and service station at the corner of Island and Elmwood avenues. These deadheading trolleys create additional wear and tear on the grade crossing surface and increase maintenance costs, but, since they do not stop to serve passengers, they do not affect the efficiency of vehicular traffic through the grade crossing in the same way that the scheduled Route 11 trolleys do.

Train Counts and Gate Closures

The freight rail line through Darby Borough is owned by CSX, which is the only carrier that operates along the line. DVRPC staff used manual traffic counts to count the number of cars on each train, and noted a number of other pieces of information (note: while all data in this section was collected at the Main Street grade crossing, because of their close proximity, it is logical to deduce that much of the data would have been virtually the same if collected at the Fifth Street grade crossing). The following is a list of all the data that was collected for each train observed during the field views:

- Direction of the train;
- Train speed (in MPH, captured using DVRPC radar gun); and
- Number of carloads for each train.

A CSX tank car travels over the grade crossing at Main Street. (Source: DVRPC)

In addition to this train-specific information, DVRPC also collected data that documented gate closure information. This data included:

- Time the gate goes down (to the second);
- Number of auto violations (i.e., cars that circumvent the gates when down);

- Number of pedestrian violations (i.e., persons that cross the rail line when gates are down);
- Time the gate goes up (to the second); and
- Estimated number of queued cars traveling in each direction on Main Street created by gate closure.

Table 1 summarizes the observed train and gate closure information over five time periods.

Table 1: Train Activity along the CSX Philadelphia Subdivision in Darby Borough on April 27, 2011

Time Period	Number of Freight Trains	Number of Switch Trains and Other Gate Closures	Average Number of Cars per Freight Train	Average Time Gates are Closed per Closure	Average Estimated Stacked Vehicles on Main Street WB	Average Estimated Stacked Vehicles on Main Street EB
12 midnight – 6 A.M.	3	2	72	2:23	1	1
6 A.M. – 9 A.M.	1	1	82	1:51	11	7
9 A.M – 3 P.M.	4	1	50	1:59	10	12
3 P.M. – 6 P.M.	2	0	63	2:23	17	11
6 P.M. – 12 midnight	3	2	51	2:00*	10	7

** One train stopped prior to the grade crossing for testing due to an earlier incident; this gate closure information was not consistent and was not included in the average for this time period. (Source: DVRPC)*

Train traffic through the Darby Borough grade crossings is spread out relatively evenly throughout the day. The average time of closure in the chart represents the time the gates closed during DVRPC's field work, be it a long freight train, a short switching train, or just for testing. In terms of longer freight trains, the average time that the gates were closed was approximately two minutes and 30 seconds. The longest the gates were closed was roughly five minutes, but this was between 3:00 A.M. and 4:00 A.M. and resulted in only one stacked car in each direction. Stacked cars along Main Street were the greatest during the afternoon peak period between 3:00 and 6:00 P.M. In general, the gate closures did not seem to cause any major traffic delays, as the entire queue was able to clear out and return to free-flow conditions within approximately one minute after each closure ended.

On one occasion it was noted by DVRPC staff that a southbound train came through Darby Borough within five minutes of the passing of a northbound train. This is due to the fact that the Philadelphia Subdivision has two tracks approximately 1,000 feet north of the Fifth Street grade crossing. Southbound trains wait at this location until northbound trains pass through Darby Borough, and then proceed. DVRPC also witnessed that during these occurrences, the gates might malfunction and open and close when no train was present.

Accidents/Incidents

Accidents Reported to the Federal Railroad Administration

The Federal Railroad Administration maintains a database containing reported cases of impacts between on-track equipment and any user of a public or private highway-railroad intersection dating back to 1975. The database contains seven accident reports for the Main Street crossing, which are summarized below, starting with the most recent:

- September 11, 2012, at 12:52 PM, a train that was 101 cars long struck a truck stopped on the crossing. The driver was not in the vehicle and was not injured. The estimated damage to the truck was $2,000.
- November 30, 2011, at 8:10 AM, a train that was 23 cars long struck a vehicle that had stopped on the tracks after the gates had come down. The driver had exited the vehicle before impact and was not injured. The estimated damage to the car was $2,000.
- December 29, 2010, at 6:00 PM, a train that was 37 cars long struck a pedestrian who was trying to beat the train through the crossing. The teenage pedestrian was injured, but not killed.
- January 24, 2006, at 7:28 AM, a train that was 81 cars long struck a pedestrian who was trying to beat the train through the crossing. The pedestrian was injured, but not killed.
- December 14, 1987, at 9:51 PM, a train that was 52 cars long struck an automobile that was moving over the crossing. The driver of the automobile was injured, but not killed, and the estimated damage to the car was $4,000.
- June 9, 1986, at 1:50 PM, a train that was 14 cars long stuck a pedestrian who was stopped on the crossing. The pedestrian was injured, but not killed.
- June, 23, 1982, at 12:05 AM, a train that was 34 cars long struck an automobile that was moving over the crossing. The driver was not injured and the accident only caused an estimated $400 in damage.

While none of these accidents were major, the Main Street crossing had more accident reports than any other individual crossing in the region (although more serious accidents have occurred at other crossings). The Fifth Street grade crossing had no reported accidents in the FRA database.

Community Incidents

As detailed in this section, the Main Street crossing has significant activity in the form of pedestrians, automobiles, trolleys, and trains. Compounding the problem, and possibly because of the high activity levels, there is a high concentration of undesirable activity near the crossing as well. According to the Darby Borough Police Department, there have been 131 documented reports at the intersection of Sixth and Main streets between January 1, 2007, and April 15, 2011. The crimes include, but are not limited to, public drunkenness, fighting, drug sales, theft, disorderly conduct, curfew violations, and motor vehicle accidents.

Field Observations

While not expressly part of the more comprehensive data collection efforts, notable observations about the operations and goings-on in the vicinity of the subject grade crossings were made in conjunction with the scheduled field work. The most significant and prevalent of these, which have direct tie-ins to transportation and safety considerations, are described below.

- **Citizen/pedestrian trespassing on and along railroad right-of-way**
  At various times, individuals were observed walking along the railroad tracks (sometimes, "inside the tracks") in either direction for significant distances, presumably as a type of short cut to reach their final destination.

- **Dislodging of grade crossing gates by vehicles in transit on the intersecting streets**
  This occurred when vehicles temporarily stopped "on top of" the grade crossing, backed up into a descended gate due to the approach of a train, or when the gate came down on top of a vehicle as the train approached the grade crossing. In two observed cases, the railroad gates were rendered inoperable and railroad personnel had to be summoned to the scene to repair the gates.

- **"False alarm" episodes created by the descent of grade crossing gates and the activation of grade crossing lights and bells, but without the appearance of an actual train passing through the grade crossings**
  These observed grade crossing closures and train warnings each lasted a relatively short period of time.

Activity Overview

The Darby Borough grade crossings are a series of complicated moving parts. Below is a summary of some of the numbers that were collected in DVRPC's data collection effort. These numbers represent observed totals from one 24-hour period, and are believed to be in the range of what an average day at the grade crossing would yield.

- **11,649** total vehicles were counted on both Main and Sixth streets at the grade crossing
- **4,146** was determined to be the AADT of Fifth Street at the grade crossing
- **13** freight trains moved through Darby Borough
- **763** carloads worth of goods moved through Darby Borough
- **323** total pedestrians traversed the grade crossing at Main and Sixth streets between 7:00 and 9:00 A.M
- **237** SEPTA Route 11 trolleys are scheduled to cross the Main Street on a weekday

Figure 9: All Modes of Transportation at the Main Street Grade Crossing

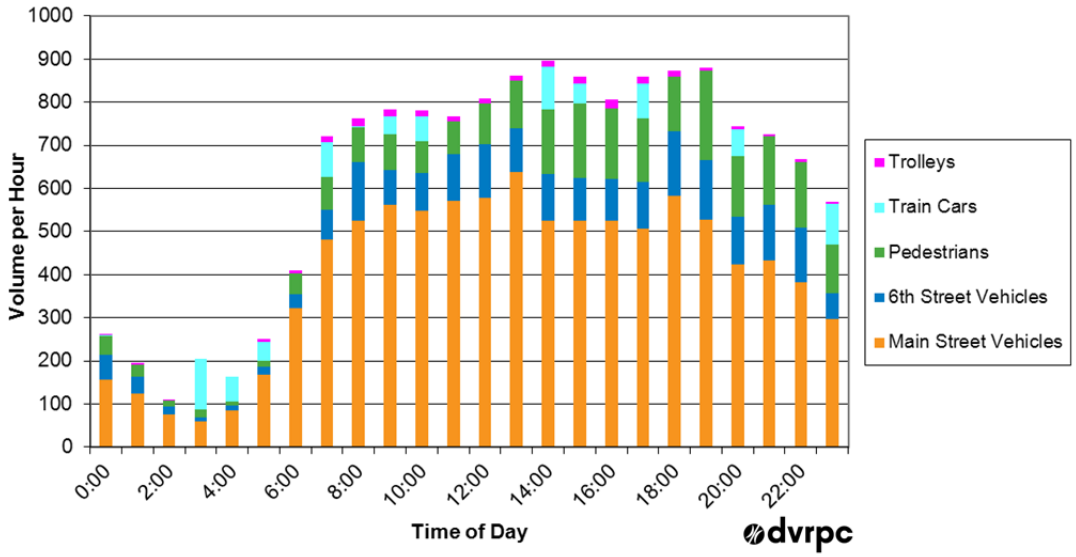


Figure 9 shows all modes of traffic at the Main Street grade crossing in one summary chart. It shows that from 7:00 A.M. to 10:00 P.M., the total traffic, when considering all these different modes, maintains a comparable level from hour to hour. Sixth Street traffic is defined as all turning movements at the intersection of Main and Sixth streets, as well as all through movements on Sixth Street. Pedestrian traffic does not show the impact of students traveling to and from school using Sixth Street. Train traffic is represented in terms of total train cars per hour.

Summary of Issues

The majority of the key issues that exist are at the Main Street grade crossing, but given the proximity of the Fifth Street grade crossing, it remains important to view the two crossings as closely related. Below is a summary of the major issues at the Main Street grade crossing.

The safety issue is of primary importance to pedestrians and motorists. The Main Street grade crossing creates a possible dangerous situation for both motorists and pedestrians. Over the past 30 years, there have been seven incidents reported to the Federal Railroad Administration (FRA); three involving pedestrians, and four involving vehicles. However, upon conducting the field views and talking with the Delaware County Planning Department and Darby Borough officials, safety concerns may be greater than the reported incidents suggest. For example, traffic at the intersection of Main and Sixth streets occasionally queues within the grade crossing due to the traffic light at 5th and Main Street and/or the trolley stop. This creates a potentially dangerous situation if a train is coming and a driver may be put in a precarious situation.

An operations issue is caused when trains block vehicular traffic, which creates delays for motorists, obstacles for emergency vehicles, and emissions concerns due to the idling cars. On April 27, 2011, 13 freight trains traversed the Main Street grade crossing, leading to a total gate closure time of approximately 32 minutes and 30 seconds. This blockage led to roughly 219 total cars queued along Main Street at the gate, for various lengths of time, throughout the course of the day. The operations issue also exists for Fifth Street, although in a lesser sense, purely due to the fact that the Fifth Street grade crossing has less vehicular activity.

Lastly, there is a maintenance issue because the Main Street grade crossing does not hold up well over time and needs regular, ongoing reconstruction. Highway-railroad grade crossings can be constructed of many different materials. In the DVRPC region, Class I grade crossings utilize various construction materials including timber, asphalt, rubber, and concrete to solidify the roadway around the railroad. The Main Street grade crossing in Darby Borough represents a unique grade crossing surface because of the presence of the trolley line. For many years, the grade crossing had to be regularly replaced because the pounding exerted by the trolleys and trains would wear down the pavement quickly, creating potholes and generally unsafe pavement conditions.

A close-up of the grade crossing surface on Main Street in Darby Borough.
(Source: DVRPC)

Recently, double-frogged flange, was installed at the Main Street grade crossing. The trolley tracks are situated at a slightly higher elevation than the railroad tracks. This allows the trolley to virtually pass over the rail line without making as much contact and without creating as much wear and tear on the surrounding pavement. While the double-frogged flange has

provided some improvements, the surrounding pavement is still deteriorating and will still need regular maintenance in the future. This regular maintenance is expensive, and any major project at the crossing should seek to continue to improve the surface conditions.

Additionally, the grade crossing has a history of drainage issues. Main Street is slightly sloped, so that running water in each direction moves toward the grade crossing. When there is a surge in the water system, like with a heavy rain storm, a large puddle can be found on the east side of the rail line all along the land between the Main Street and Fifth Street grade crossings. It is not totally clear how much this lack of drainage is contributing to the need for maintenance, but if resolved, it is possible that it could create an improved situation. Additionally, the excess water is unattractive and detracts from economic activity along Main Street.

The maintenance of grade crossings is the responsibility of the railroad that owns that particular rail line, in this case, CSX. Meanwhile, the roadway leading up to the grade crossing is the responsibility of the roadway owner, in this case, the Pennsylvania Department of Transportation. This creates a complex situation in Darby Borough along Main Street because it is not totally clear who is responsible for issues of drainage around the Main Street grade crossing.

CHAPTER 4

Possible Improvements

This chapter details a list of possible improvements that could be made to improve safety and traffic conditions at grade crossings. This chapter is designed to put forward a range of different options for improving grade crossings, but does not make any recommendation as to which would best fit for either the Main Street or Fifth Street grade crossings. This range of improvement options provides a sound basis for identifying appropriate "next steps" for the study.

Improvements at the Grade Crossings

The grade crossings at Main Street and Fifth Street in Darby Borough are furnished with standard safety features: bells, lights, gates, and signage. When looking to improve a grade crossing that already has this equipment, possible improvements fall into three categories:

- Upgrades to existing equipment;
- Supplementary Safety Measures (SSMs); and
- Grade separation.

Each of these possible improvements is presented in three parts:

- Overview: what is the improvement and how it is typically applied
- Possible Application: what this improvement would achieve at the Darby Borough grade crossings
- Considerations: what needs to be considered and overcome before this improvement can be advanced

In addition, this chapter will discuss other possible improvements (e.g., modified traffic patterns) and community-based improvements (e.g., a public education campaign).

Upgrades to Existing Equipment

A first step in identifying potential improvements is to explore opportunities to improve existing passive devices, active control systems, and roadway and grade crossing surfaces. Upgrades to existing equipment can be made to a single piece of equipment or to all aspects of the existing equipment.

Above: A cross buck sign is obscured by a "Trolley Stop" sign and "Do Not Block Intersection" sign on the eastbound approach to the grade crossing on Main Street. (Source DVRPC)

Passive Devices

Overview

Passive Devices refer to the signage and striping at a grade crossing and the advanced signage and striping leading up to a grade crossing. In many rural areas or on seldom-used rail lines, passive devices are the only safety measure present at a grade crossing. Advanced passive devices play an important role in warning vehicular traffic, which is especially important for drivers unfamiliar with the area. Passive devices at a crossing usually consist of a cross buck railroad sign and striping to let motorists know exactly where the train crosses.

Figure 10: Examples of Popular Passive Warning Devices

Left: An Advanced grade crossing warning sign.
Center: Advanced grade crossing warning striping in pavement.
Right: Grade crossing cross bucks.
(Source: Operation Lifesaver)

Possible Application

All signage at the Main Street grade crossing and advanced signage leading up to the Main Street crossing could be replaced with new passive devices. When placing the signs, it is important to have sufficient sight distance and visibility so that the signs can be easily seen. Striping could be improved at the crossing by providing advanced warning signs. Stop bars should be

refreshed well before the crossing gate on Main Street. Currently, the stop bars on eastbound Main Street bisect the train tracks. At Fifth Street, the posted cross bucks are clearly visible, but there are no advanced warning signs or striping in the pavement to warn drivers.

Considerations

Given the location of the crossings in a mature community, the placement of signage should be well coordinated to ensure the prominence of signs, the coordination of information and messages, and the minimization of visual clutter.

Active Control Systems

Overview

Active Control Systems alert drivers and pedestrians of the presence of a train by using flashing lights, bells, crossing gates, or any combination of the three.

Possible Application

In Darby Borough, both the Main Street and Fifth Street crossings have the three major active control systems. Complete reinstallment of these systems with new equipment would allow for a reassessment of the best placement for both lights and gates. Additionally, newer LED lights are brighter and more energy efficient than the lights currently in use. Also, some grade crossings now use LED lights on the gate arms to act as an extra deterrent for pedestrians and motorists circumventing the gates.

Considerations

Installing new gates is expensive, costing anywhere from $100,000 to $300,000 depending on the crossing. Adding LED lights and making other small, less expensive upgrades to the existing gate infrastructure would require much less funding.

Roadway and Grade Crossing Surfaces

Overview

All grade crossing surfaces are periodically reinstalled to keep the rail line and roadway smooth and “bump-free.” Accelerating that process and possibly using a different material (be it established or new) to strengthen the grade crossing will hopefully reduce the need for future maintenance.

Possible Application

At Main Street, frequent resurfacing of the crossing has been necessary due to the additional wear and tear caused by trolley traffic. While the new double-frogged flange has been a major upgrade over the previous crossing mechanism, new technologies may be discovered that provide an even better solution. Additionally, a new water drainage system for the crossing and the surrounding roadway and railroad bed has the possibility of lessening future maintenance needs and making the area around the crossing more visually appealing. At Fifth Street, the resurfacing could focus on the roadway leading up to and proceeding away from the crossing to create a smoother change of grade instead of the severe ramp that currently exists on either side.

The primary purposes of a paved surface are to protect the subgrade by limiting vertical compressive stresses at the surface of the native soil (known as the subgrade layer) and to keep water and debris out in order to ensure the structural integrity and safety of the system. Within the pavement structure, the subbase layer functions primarily as a structural support for the system. This layer evenly distributes the loads onto the subgrade layer.

The subbase and subgrade layers can be improved by a few methods. First, if the native soil is poor, it may be excavated out. Higher-quality fill may then be placed and compacted to remedy the poor subgrade conditions. Second, an adequate drainage system can be provided. This will aid in directing water away from the pavement system. Third, the subgrade may be treated with certain materials, such as asphalt binder, cement lime, and fly ash. These materials will help to stabilize the subgrade by increasing its stiffness. They primarily fill in any air voids that may trap water, which will weaken the system. Fourth, the thickness of the base and subbase layers may be increased. Finally, additional base layers may be included in the system in order to protect the integrity of the subgrade layer.

Considerations

As mentioned earlier, the ownership of the area at and around crossings is varied, and it would require extensive coordination to fund a new water drainage system. The recent double-frogged flange mechanism at the Main Street crossing has provided great benefit.

Supplementary Safety Measures (SSMs)

Supplementary Safety Measures (SSMs) are defined as traffic-control measures that help prevent unsafe movements over a crossing. According to US Code Title 49: Transportation Appendix A to Part 222, there are many types of approved SSMs, but this report will focus on the two that have the most potential for Darby Borough:

- Four-Quadrant Gate System; and
- Highway Medians or Channelization Devices.

These SSMs were originally developed to be used for "Exception to the Use of the Locomotive Horn" code, otherwise referred to as quiet zones. Quiet zones are grade crossings where the local municipalities have opted to finance SSMs and the railroad in turn agrees to not blow the locomotive horn at the crossing. The quiet zone classification can only be achieved through close coordination with the FRA and other stakeholders. While SSMs are typically used to support quiet zones, there is no reason that their effectiveness would not also pertain to improving safety, and in some cases efficiencies, at grade crossings where the train still blows the horn.

In addition to these SSMs, there are a series of technological improvements, referred to as intelligent transportations systems (ITS), or an intelligent grade crossing, that may also be grouped under the SSMs category.

Four-Quadrant Gate System

Overview

Traditional grade crossing gates, like those at both Fifth and Main streets, use a two-gate system, where an arm blocks only the traffic lane on which vehicles approach the grade crossing. Four-quadrant gates provide one gate for each direction of traffic at a grade crossing, both entering and exiting. When a train is approaching, all gates close and prevent a vehicle from circumventing the gates to proceed through the grade crossing. Because of the lack of exit lanes, four-quadrant gate systems must have a built-in delay between when the entrance lanes are closed and when the exit lanes are closed. This allows any queued traffic to exit the grade crossing before all the gates come down. The timing of the four-quadrant gate system should be established by a qualified traffic engineer to determine the specific timing. Additionally, the engineer may determine that it is necessary to have a vehicle presence detector that would keep the exit gates open until all cars are clear of the grade crossing.

Possible Application

Both the Main Street and Fifth Street grade crossings are candidates for four-quadrant gates. At Main Street seven gates would be required due to the two additional approaches created by Sixth Street.

Considerations

Typical grade crossings involve just a single intersecting highway. If installing a four-quadrant gate system at the Main Street crossing, at least seven gates would be needed to reach the desired effect. In general, four-quadrant gates have a price range of $150,000 to $500,000, but this is likely a low cost estimate considering the amount of gates needed for Main Street.

Figure 11: Example of Four-Quadrant Gate System

Left: A four-quadrant gate in North Carolina (note: the gates to the entrances are already closed, but the gates for the exits are in the process of closing). (Source: North Carolina Department of Transportation)

Additionally, gates are mechanical devices that are exposed to weather and tampering and thus, are subject to a small degree of malfunction. With additional gates, there is an additional risk of malfunction. Generally speaking, gate systems are designed to close if any gate is malfunctioning. Closed gates at all approaches on Main Street due to a nonworking gate would create a substantial traffic flow problem in Darby Borough.

Medians or Channelization Devices

Overview

Medians or channelization devices are designed to deny vehicles the possibility of circumventing closed gates. It is advised that these devices extend 100 feet from the gates on each highway approach to the crossing. There are three potential types that could serve the function of a channelization device:

- **Barrier wall systems** are full concrete medians that create a barrier. These are the most successful form of preventing traffic from circumventing the gates, but they take up a wide section of the roadway between the lanes. Also, barrier wall systems leave little wiggle room in the event of an emergency and can increase the risk of a car accident, as well as the severity of car accidents.

- **Nonmountable curb islands** are usually about six inches high and about two feet in width. Nonmountable curb islands can be very appealing for a community because they can be filled with landscaping to enhance the streetscape of the road. Like barrier wall systems, curb islands require a wide section of the roadway and pose the same risks in terms of increased traffic accidents and severity.

- **Mountable raised curbs** are short curbs that have raised vertical panels on top of them. They are designed to create a visual deterrent to circumventing a lowered gate. They have the benefit of allowing cars to drive over them, albeit by knocking over the panels, in case of emergency. The raised vertical panels need to be frequently monitored to replace broken elements.

Possible Application

Both Main Street and Fifth Street could be viable candidates for medians or channelization devices. Typically, these improvements cost a total of $10,000 to $15,000 per crossing. While this SSM does not provide any direct pedestrian safety benefit, the raised vertical panels bring additional visible attention to the crossing, which may improve driver awareness of pedestrians at the crossing.

Figure 12: Example of Mountable Raised Curb Channelization Device

Left: A mountable raised curb with vertical panels in North Carolina. (Source: North Carolina Department of Transportation)

Considerations

As mentioned above, there is an increased potential for vehicular accidents around channelization devices. This is especially true with nonmountable devices. Also, these devices require a variable amount of the roadway space depending on which alternative is chosen. Space may also be an issue in configuring a system that allows the SEPTA trolleys to pass without obstruction. It is possible that the trolley lines would need to be moved to accommodate a channelization system.

With any of the channelization alternatives, it is possible that parking would no longer be possible along Main Street near the crossing, and with some of the alternatives, Main Street may need to be widened. Due to the commercial aspect of the land use along Main Street, these alternatives may not be favorable to local businesses.

Intelligent Grade Crossings

Overview

Intelligent Transportation Systems (ITS) represent an array of new technologies that monitor travel conditions and convey information to travelers. For grade crossings, ITS-type projects are referred to by many names, but for the purposes of this report, they will be referred to as Intelligent Grade Crossings. They include a host of different improvements, with the common theme being a use of technology to improve both safety at the crossing and the flow of traffic. Traditional railroad systems sense a train, which triggers a gate, whereas an Intelligent Grade Crossing provides continuous information of train location and speed. Below is a list of sample Intelligent Grade Crossing projects.

- **Preemption of Traffic Signals near Railroad Crossings**
  The U.S. DOT's guidelines state, "where a signalized highway intersection exists in close proximity to a railroad crossing, the railroad and traffic signal control equipment should be interconnected, and normal operation of the traffic signals controlling the intersection should be preempted to operate in a special control mode when trains are approaching." (*Railroad-Highway Grade Crossing Handbook, U.S. Department of Transportation, Revised Second Edition, August 2007).* A traffic engineer would be needed to design the preemption system in consultation with CSX in order to optimize the safe flow of traffic along Main Street in Darby. Any system that is designed would also include the Fifth Street grade crossing.

- **Automated Enforcement of Lowered Crossing Gates**
  These systems use photo technology to capture the license plate number of motorists who circumvent closed railroad gates.

- **Advanced Warning for Railroad Delays**
  These systems provide real-time information about upcoming delays to variable message signs and emergency personal. Variable message signs can be placed along the roadway to let drivers know about upcoming delays, approximate time of delays, and possible alternative routes. Likewise, these systems can be tied into emergency personnel switchboards so that ambulance, fire, and police activity can anticipate an upcoming crossing closure.

- **Second Train Coming Warning Systems**
  If a second train is going to pass through the crossing shortly after the first one has (e.g., in the opposite direction where the train line has two sets of tracks), this system will light up signs letting drivers know to anticipate the second train. This prevents anyone from assuming that the gates are not functional.

- **In-Vehicle Alert System**
  This system can broadcast over the radio and let drivers know whether to expect a closure and how long it will be.

- **Stalled Automobile Detection**
  This system can sense if a vehicle is stalled on the railroad tracks and transmit a signal to the train operator. This system can be tied in with four-quadrant gates, and if the rail line has Positive Train Control (PTC), the system can override the railroad engineer so the train stops before the crossing (if possible given the train's speed and distance from the crossing).

Possible Application

Given the proximity of the traffic signal at Fifth and Main streets, a traffic signal that is interconnected with the grade crossing should be designed and installed in accordance to the federal guidelines. Other Intelligent Grade Crossing improvements presented here are applications that could be also used to improve efficiency and reduce queuing.

Considerations

Currently, the State of Pennsylvania does not allow for photo enforcement beyond Automated Red Light Enforcement, which has limited deployment in Pennsylvania. If this law changes, then Intelligent Grade Crossing systems could be installed to photograph vehicles that attempt to circumvent the gates.

The cost of implementing any sort of Intelligent Grade Crossing can vary a great deal. It is also possible that some of the queuing problems along Main Street could be lessened by the installation of a traffic signal at Sixth and Main streets at far less cost.

Grade Separation

One way to completely remove any conflict between vehicles and railroads at grade crossings is to grade separate the crossing. This section will lay out the different possible grade separation configurations in general and how they may or may not be applied in Darby Borough. Because of traffic volumes, the focus will be on separating vehicle and train traffic on Main Street.

Benefits of a Grade Separation

One of the most successful freight corridor programs in the country is located in the Everett-Seattle-Tacoma area in the State of Washington. Organized as the Freight Action Strategy (FAST) Corridor, this partnership between local cities, counties, ports, federal, state, and regional transportation agencies, railroads, and trucking interests has worked collaboratively to fund regionally significant freight projects. Of the 24 projects they have identified, half of them are grade separations.

As an example of how impactful a grade separation can be, below are the identified benefits of completing a grade separation on M Street in Auburn, Washington, as part of the FAST Corridor program:

- Removing the conflict of rail and vehicle traffic (currently this grade crossing has about 16 to 24 trains per day, with roughly five minutes of closure per train);
- Improving freight mobility for trains and trucks;
- Improving emergency vehicle access;
- Increasing the capacity to accommodate 2030 traffic volumes;
- Improving air quality through emissions reduction from waiting vehicles;
- Reducing neighborhood cut-through traffic on residential streets; and
- Improving safety (project will ensure the safety of the 53 daily school bus grade crossings).

Alignment Types

Grade separations modify the elevation of either the road or the rail line. This prevents major disruptions to both modes during construction and normally lessens the cost of the overall project. This section will discuss the considerations for changing the grade of the road versus changing the grade of the rail line and provides examples of each.

Change Elevation of the Roadway

Overview

There are two basic ways to change the elevation of the road; either build a highway bridge over the rail line, or tunnel the road under the rail line. Changing the elevation of the road is often chosen as the means to create a grade separation because cars can climb and descend at a much steeper grade than a train can.

Possible Application

Since the issues at Main Street overshadow the issues at Fifth Street, this alignment scenario assumes that the Main Street grade crossing would be separated but that the Fifth Street grade crossing would not. Generally, when confronted with a scenario of two grade crossings in close proximity to each other, where one is being grade separated, the other will be closed and traffic rerouted over the now separated grade crossing. Due to some of the considerations noted below, this may be

difficult in Darby Borough, but closure or upgrade of the Fifth Street grade crossing should be strongly considered if this scenario is ultimately advanced.

Considerations

There are a number of factors to consider when analyzing a scenario where the elevation of Main Street would change in order to create a separated grade crossing. They include, but are not limited to:

- Building a bridge on Main Street may require an extended right-of-way along the road which does not currently exist. It is possible that eminent domain powers would have to be exercised to remove some buildings on either side of Main Street. Even if the buildings are able to remain, the road will no longer be at grade, and may not be flush with sidewalks and parking locations. The potential loss of parking could be detrimental to Darby Borough businesses.
- Sixth Street would have to be shut down to both vehicular and pedestrian traffic at Main Street, which would cause extra traffic to flow over the Fifth Street grade crossing. It would also remove Sixth Street as a pedestrian throughway, so pedestrian traffic would need to be rerouted as well. There is a concern that trespassing along the rail line would increase because it would be a more direct route than rerouting pedestrian traffic over another street.
- The presence of the Route 11 trolley would mean that the trolley tracks and overhead electrical lines would need to be either diverted to a different road or be rebuilt as part of the new Main Street Alignment, or the trolley would have to have a terminal east of the Main Street crossing and then use shuttle buses to access the Darby Transportation Center.
- In addition to the trolley adding to the cost of the project, any roadway elevation change would likely result in the removal of the Sixth Street trolley stop, and possibly the Fifth Street trolley stop as well. Accommodations would need to be made to create new trolley stops in Darby Borough to facilitate the grade separation.
- A grade separation creates an underpass that has the possibility to serve as a breeding ground for crime and other unwanted activity.
- With either a highway bridge or tunnel, any vehicular accident at or near the crossing would likely be more difficult to clear in a timely fashion, and it would create more of a backup on Main Street than the current configuration. Additionally, accidents may affect the integrity of the grade separation (i.e., a truck that is too tall striking the rail bridge over the road), which forces additional funds to be spent to repair the grade separation infrastructure.
- In the case of a highway bridge over the railroad, there is a concern that the bridge would create a darker, less attractive corridor along Main Street. In a disadvantaged community such as Darby Borough, steps should be taken to make roadways brighter and more attractive, not the opposite.

Road over Rail Example

Creating a grade separation by bridging the highway over the rail line is the most common grade separation approach. One example is on Iowa Avenue in Riverside, California. Iowa Avenue has an AADT of 16,000 cars, and the Burlington Northern Santa Fe currently operates about 90 freight trains and 10 passenger trains per day on the rail line. The project will construct a four-lane highway bridge along Iowa Avenue and change local circulation patterns. The total cost will be $31.64 million for construction and is expected to start in August 2012 and take 16 months to complete. The project will cost the local government about $1.58 million, and the remainder will come from a combination of county, state, federal, and railroad dollars.

Figure 13: Example of Road over Rail Grade Separation Project

Left: Present conditions at Iowa Avenue in Riverside, CA. Right: A rendering of a planned roadway bridge over the railroad tracks. (Source: Riverside California, Public Works Department)

Road under Rail Example

The FAST Corridor project on M Street in Auburn, Washington, is designed to be grade separated by tunneling the road under the existing rail line. The project is in close proximity to the local high school. The Burlington Northern Santa Fe Railroad operates 16 to 24 trains per day through the crossing, each of which stops traffic for roughly five minutes. The project is expected to cost $22,250,000, and will also widen the roadway from two to four lanes and build new pedestrian walkways and bike lanes.

Figure 14: Example of Road under Rail Grade Separation Project

Left: Present at-grade conditions at M Street in Auburn, WA. Right: A rendering of a planned roadway tunnel under the rail line in Auburn, WA. (Source: Puget Sound Regional Council)

Change Elevation of the Rail Line

Overview

There are two basic scenarios for changing the elevation of the rail line: dropping the rail line under the highway, or building a rail bridge over the road. The ascent or descent for the train must be gradual, so either of these scenarios would require changes to the rail lines well beyond the actual crossing.

Possible Application

In Darby Borough, creating a grade separated crossing at Main Street by changing the elevation of the rail line would undoubtedly lead to a grade separated crossing at Fifth Street given the proximity of the grade crossings. When dealing with a long rail corridor with multiple grade crossings, such as the Philadelphia Subdivision in Delaware County, changing the elevation of the rail line is often chosen. By changing the elevation of the rail throughout the entire corridor, the grade crossings can be separated through a single project, instead of tackling each grade crossing individually.

Changing the elevation of the rail would likely be much less disruptive to the Darby Borough community than changing the elevation of the roadway. It would not greatly affect the Main Street businesses and it is possible that the trolley tracks could be more easily accommodated given this alternative.

Considerations

While modifying the elevation of the railway would be less disruptive to local traffic patterns, there are still considerations that would need to be worked out in order for this alternative to be advanced.

The largest consideration is the surrounding railroad infrastructure. Any change in elevation of the rail line would have to start a substantial distance from the grade crossing and extend a long way after the grade crossing. Existing rail bridges and tunnels would likely have to be modified as part of the project. Below is a list, from north to south, of notable railroad infrastructure within a mile from the Darby Borough grade crossings (note: the project may require going beyond a mile, in which case additional infrastructure would have to be dealt with):

- 68th Street, Philadelphia: rail line goes under the roadway;
- 70th Street, Philadelphia: rail line goes over the roadway;
- Cobbs Creek Parkway, Philadelphia: rail line goes over the roadway;
- Cobbs Creek, Yeadon Borough and Philadelphia: rail line goes over the water;
- Darby Creek, Darby Borough: rail line goes over the water and Walnut Street;
- Pine Street, Darby Borough: rail line goes under the road; and
- Chester Pike, Sharon Hill and Collingdale boroughs: rail line goes under the road.

A project to change the elevation of the rail line, either for the entire corridor, or for just Darby Borough, will have a major impact on rail traffic during construction. Normally, when major rail construction is undertaken along a main line, the rail line keeps at least one track open for segments of the day to allow for train operations to occur. It is difficult to imagine how trains could remain operative during this type of construction.

Lastly, given documented criminal activity and the trespassing witnessed during field views, these aspects of the Darby Borough grade crossings are a concern under this improvement scenario. A rail bridge through Darby Borough would create significant additional poorly lit spaces that may lead to increases in crime underneath the superstructure that holds the rail. Additionally, trespassing has already been witnessed on the rail bridge over Darby Creek, so it is logical to assume that trespassing would occur on any new bridge or tunnel. This trespassing would be especially dangerous given the few options trespassers would have when trains traveled through Darby Borough.

Rail over Road Example

In City of Industry, California, a 1.6 mile concrete-walled flyover structure with steel railroad bridges spanning Sunset and Orange avenues was recently completed. The flyover structure is 45 feet wide and reaches a height of 32 feet. The bridge over Sunset Avenue is 132 feet long and the Orange Avenue Bridge is 66 feet long. The project cost $95,200,000 and took four years to complete.

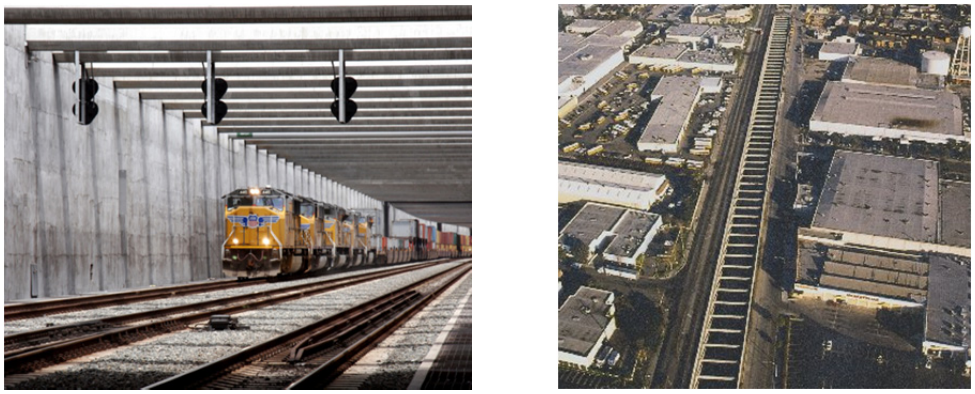
Figure 15: Example of a Rail over Road Grade Separation Project

A railroad bridge over Sunset Avenue in the City of Industry, CA. (Source: Alameda Corridor-East Construction Authority)

Rail under Road Example

One of the most famous grade separation projects took place in Los Angeles, California, along what is called the Alameda Corridor. The project's centerpiece is the Mid-Corridor Trench, which carries freight trains in an open trench that is 10 miles long, 33 feet deep, and 50 feet wide between State Route 91 in Carson and 25th Street in Los Angeles. The total cost of the 20-mile project was $2,400,000,000. Construction began in April 1997 and operations began in April 2002. The need for the corridor was driven by the container cargoes moving through the ports of Long Beach and Los Angeles. It was paid for by a mixture of public and private funds and the railroads pay a user fee to retire debts. In March 2011, the corridor averaged 38.4 trains per day, 10,245 TEUs (i.e., twenty-foot equivalent units) per day, and generated $7,000,000 in revenue.

Figure 16: Example of Rail under Road Grade Separation Project



Left: A train passes through the Alameda Corridor's Mid-Corridor Trench.
Right: An overhead view of the Alameda Corridor's Mid-Corridor Trench.
(Source: Alameda Corridor Transportation Authority)

Other Possible Improvements

There are additional ways to improve operations at grade crossings that do not require physical changes to the grade crossings. This section will explore some of those possibilities. Everything presented in this section could be done as a stand-alone improvement, or as part of a package of improvements.

Traffic Patterns

Changing the traffic patterns of vehicles, trains, and/or trolleys represents a possible strategy at the Darby Borough grade crossings. The initiatives identified in this section are all relatively low cost, but have many considerations due to potential disturbances in traditional traffic patterns. These disturbances can cause a backlash from the local community and other unforeseen traffic issues, which may require further study.

Temporary Closure of a Public Highway

Overview

A temporary closure entails closing the crossing to highway traffic during specific periods of time, often at night and during other off-peak highway hours. The closure system (which can take multiple forms from hand-laid cones to automated gates) must

completely block highway traffic on all approach lanes to the grade crossing. Daily activation and deactivation of the system is the responsibility of the public authority, which is responsible for maintenance of the street crossing the rail line. A successful system would seek to have as many trains as possible operate during this time frame and as few as possible during the time when the grade crossing is open.

Possible Application

Temporary closure of a public highway is generally more common in a rural area than in an urbanized area such as Darby Borough. Main Street has far too much through traffic to recommend any temporary closure; however, it would be a possibility for Fifth Street. A temporary closure is often deemed a good solution because it requires very little in the way of capital costs.

Considerations

The rail line through Darby Borough does not operate in a condensed window, and it is doubtful that a temporary closure would result in a significant difference for Darby Borough in general. Additionally, any temporary closure of the Fifth Street grade crossing would likely funnel more traffic to the Main Street grade crossing.

One-way Street(s) with Gates

Overview

This initiative consists of taking a two-way street and changing the traffic to exclusively one-way. Once the one-way street is created, a new gate is installed that completely blocks both lanes. This can be done by installing one extra-long gate, or two gates on either side of the roadway.

Possible Application

Traffic volumes on Main Street are far too high to contemplate changing traffic patterns to create a one-way road. However, this is a viable possibility for both Fifth and Sixth streets. South of Main Street, both Fifth and Sixth streets are one way, with Fifth Street running northbound and Sixth Street running southbound. Below are three options for consideration:

- Option 1: Change Sixth Street between Main and Greenway to one-way northbound. This would make all vehicle movements involving Sixth Street proceed away from the crossing at Sixth and Main streets, which is anticipated to improve safety. This option does not affect Fifth Street at all and will not eliminate turns from eastbound Main Street onto northbound Sixth Street. Individuals making these turns often stop on the CSX tracks until there is a break in westbound Main Street traffic.

- Option 2: Change Sixth Street between Main Street and Greenway to one-way southbound and change Fifth Street between Main Street and Greenway to one-way northbound. This would extend the existing one-way zones on Fifth and Sixth streets

to Greenway instead of stopping them on Main. This allows for one-way traffic on Sixth and Fifth streets at both grade crossings and eliminates cars making left turns from eastbound Main Street onto northbound Sixth Street. By eliminating southbound Fifth Street traffic, there is likely to be a major increase in southbound Sixth Street traffic, the consequences of which would need to be analyzed.

- Option 3: Change Sixth Street between Main Street and Greenway Avenue to one-way southbound and leave Fifth Street unchanged. This would eliminate cars making the turn from eastbound Main Street onto northbound Sixth Street, but would not make any safety improvement to the Fifth Street crossing. By leaving Fifth Street unchanged, there should be very little change to the total Sixth Street traffic volumes.

Considerations

A full traffic plan would need to be conducted by a traffic engineer in order to decide the best reconfiguration for traffic movement and safety. Additionally, any change along Fifth Street would require modifications to the signal placements and timing at the corner of Fifth and Main streets.

Vehicular Traffic Patterns

Overview

Diverting vehicular traffic so that fewer vehicles travel over the Darby Borough grade crossings each day would lessen safety concerns at the grade crossing and improve operations. The route used to divert vehicles would need to be improved to be made more appealing and well-signed to encourage use.

Possible Application

There are two possible applications to divert vehicular traffic in Darby Borough. The first possibility is a local diversion, where nonlocal Main Street traffic would be directed to take a different route through Darby Borough that did not involve traveling over either the Fifth or Main street grade crossings. For example, this route could travel via either Walnut Street or Pine Street.

The other possibility is a more regional diversion. For some of the surrounding communities, such as Lansdowne and Clifton Heights, the most direct route to the Philadelphia Airport and I-95 is to travel through Main Street in Darby Borough to access Island Avenue. There are multiple alternative routes that are similar in length, so with signage and improvements to those routes, diverting some of the through traffic off of Main Street is a possibility.

Considerations

Diverting vehicular traffic may create some negative side effects to the community of Darby Borough. The first is that Main Street in Darby Borough is a commercial corridor with multiple businesses. Taking vehicular traffic off of Main Street has the possibility of negatively affecting those businesses.

Besides this concern, there are logistical obstacles that would have to be overcome in order for this solution to be put into effect. Even after the other roads are improved and signs erected, it may be difficult to modify people's driving habits, so the desired results are not guaranteed. Also, there is likely to be strong opposition to the traffic diversion from any neighborhood through which the new traffic flows. Any diversion project would need extensive public outreach to ensure the support of the local communities.

Train Traffic Patterns

Overview

Diverting train traffic is a regular practice for railroads because of construction projects, and in some instances can provide a solution to a grade crossing issue.

Possible Application

In Darby Borough, there are three general ways that through train traffic could be diverted (note: local trains serving facilities and customers along the line would still be needed). The Philadelphia Subdivision, which runs through Darby Borough, is a vital segment of the CSX main rail line connecting Florida to North Jersey. Any successful diversion project would not significantly affect CSX from a business point of view.

The first option would be to construct a freight-only track within the right-of-way of the AMTRAK Northeast Corridor, which CSX would use to divert through trains off of the Philadelphia Subdivision, thus, out of Darby Borough. This project was first proposed in the Mid Atlantic Rail Operations Study as a way of reducing conflicts between Norfolk Southern and Amtrak. The cost of the project could approach $1,000,000,000.

A second option would be to build a rail bypass around Darby Borough. Given the dense urban nature of the communities surrounding Darby Borough, there is no clear, viable bypass alternative. Further research could be done to look into this possibility, but given the potential cost and lack of a clear route, it probably is not feasible.

Considerations

There is a significant concern that any diversion of train traffic could negatively impact train traffic, which could be detrimental to the DVRPC region. Furthermore, given the high costs of the two diversion scenarios, it is likely that all 12 grade crossings

along the Philadelphia Subdivision in the DVRPC region could be grade separated (or closed) for the same cost, and with less impact than any of the proposed train diversion scenarios.

Trolley Traffic Patterns

Overview

Diverting trolley traffic out of the Main Street grade crossing would alleviate some of the maintenance concerns and costs that surrounded the grade crossing. Any change to a trolley route or elimination of a trolley stop must be closely coordinated with both SEPTA and the local neighborhoods being affected.

Possible Application

In order to remove the trolley tracks from the Main Street grade crossing, the Route 11 could be terminated east of the grade crossing; and shuttle buses would then be used to connect the termination point with the Darby Transportation Center. One possible termination point is the trolley yard on Island Avenue, where trolleys would be able to conveniently turn around. This is already done whenever track work is performed between Island Avenue and the Darby Transportation Center.

The trolley stops at Sixth Street do not have any major effects on traffic operations, but they do increase the amount of pedestrian traffic around the Main Street grade crossing. Trolleys stopped at Fifth Street occasionally back up eastbound Main Street vehicular traffic to the point where cars are queued into the Main Street grade crossing. If removing trolley stops is considered, the most logical solution would be to remove the Sixth Street stop traveling westbound, and the Fifth Street stop going eastbound.

Considerations

Moving the termination point of the Route 11 trolley would necessitate major capital costs, including building a new turnaround for the Route 11 and removing the existing trolley tracks along Main Street in Darby Borough. Additionally, the shuttle bus to trolley connection may disincentivize some Darby Borough residents from using public transportation. The Route 13 trolley could still terminate at the Darby Transportation Center, but would need a new route for deadheading to and from the trolley yard on Island Avenue.

Relocating the trolley stops would be a small capital cost, but would require extensive community participation to ensure that the new locations served the community to the same extent, while improving traffic operations and safety.

Community-Based Improvements

As mentioned in chapter 2, there is a high level of activity; vehicular, pedestrian, and criminal, around the crossing. This activity can lead to increased safety risks at the crossing. This section will detail some community-based actions that could counteract these forces and create safer grade crossings in Darby Borough.

- **Create Continuing Public Education Campaign.** Operation Lifesaver is a nationwide, non-profit public awareness program that is designed to draw attention to grade crossing safety. Through Operation Lifesaver, certified presenters meet with school children and other groups to outline safe practices at grade crossings. The Federal Highway Administration estimates that safety awareness initiatives through Operation Lifesaver have saved 10,000 lives in 30 years. This emphasis on safety is critical, particularly given the fact that both train and highway volumes are on the rise.

- **Pedestrian Improvements.** The two grade crossings in question are largely traversed by pedestrians who are travelling to or from the elementary and middle schools in the nearby area. Therefore, a primary goal is to improve the safety within the area for these pedestrians. As part of the Phase II Report, the initiative Safe Routes to School (SRTS) will be covered in detail. This program focuses on improving children's safety while walking and bicycling to and from school. It looks to actively engage the children, as well as the community, in discovering potential hazards surrounding the schools and neighborhoods.

  SRTS incorporates education, encouragement, enforcement, and engineering into its goal of increasing the number of children walking to and from school. Educational activities instruct students, parents, and the community about pedestrian safety. SRTS encourages schools and communities to generate excitement about walking and biking to and from school. Enforcement activities can help to improve driver behavior, as well as bicyclist and pedestrian behavior. Finally, the engineering aspect of SRTS aids in transforming the community, through maintenance, operation, and construction projects, into a safe and pedestrian-friendly environment.

  One suggestion to encourage students and their families to walk to school is to begin a walking school bus. A walking school bus is an organized group of children walking to and from school with one or more adults. This allows children to walk to school even if their parents are unable to walk with them. It enables parents to feel that their children are safe when walking to school.

CHAPTER 5

Next Steps

The contents of this report provide a summary of the work conducted as Phase I of the Darby Borough Grade Crossing Study. As a follow-up, a number of tasks will be undertaken in Phase II of the study. Phase II will focus on public outreach in Darby Borough, an identification of the most applicable short-, medium-, and long-term grade crossing improvements, and a fleshing out of the most preferred improvements.

Walkability Audits

Walkability audits are an exercise that provides technical assistance to assess walking conditions for school children and to create a plan for improving them. The walkability audit process is led by an engineer, with the help of a team of local school officials, municipal staff, law enforcement officials, and other community members. After a two-day assessment, the school is presented with a final report that includes recommendations for improving safety and increasing student participation along the walking routes.

Walkability audits are conducted as part of the Safe Routes to School (SRTS) program. SRTS programs are efforts by parents, schools, and governments to improve the health and safety of children by enabling and encouraging them to walk and bicycle to school. SRTS programs examine conditions around schools and seek to improve safety and accessibility in the vicinity of schools. The goal of these programs is to help make bicycling and walking to school safer and more appealing.

In coordination with the William Penn School District, DVRPC hosted walkability audits for both the Penn Wood Middle School and the Walnut Street Elementary School as part of Phase II activities. Both audits covered the grade crossing at Sixth and Main streets, and the Penn Wood Middle School Audit additionally cov ered the grade crossing at Fifth and Main streets. The audits provide additional information and insight to help identify potential improvements for the grade crossings.

Open House and Transportation Expo

DVRPC also conducted a public outreach event in the Darby Borough Recreation Center as part of Phase II activities. The event featured a number of stations for various transportation agencies, such as SEPTA, CSX, and Operation Lifesaver. The focal point of the Open House was four poster boards, which displayed background information and possible improvements for the two

grade crossings. Possible improvements were organized into three categories: short-term intiatives, medium-term intiatives, and long-term intiatives.

Short-term initiatives are projects that take six months to two years to implement and cost less than $250,000. Medium-term initiatives are projects that are likely to take two to 10 years to implement and cost between $1,000,000 and $6,000,000. Long-term initiatives are projects that take over 10 years to implement or cost over $50,000,000.

At the Open House, Darby Borough residents were given a chance to provide comments on a variety of potential recommendations, which will be included in the Phase II report. The public comments will be summarized and used as an additional guide to select future improvements.

Possible Initiative Follow-Up

Following the Open House, DVRPC will follow up on the short-, medium-, and long-term options for the Darby Borough grade crossings. One example of this work may be to perform a traffic signal warrant analysis for the intersection of Sixth and Main if that is a preferred alternative identified by Darby Borough and the steering committtee. DVRPC will continue to hold meetings of the steering committee as needed to follow-up on commitments made by all stakeholders.

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Abstract:

This study examines two highway-railroad grade crossings in Darby Borough, Delaware County, Pennsylvania. The purpose is to document existing conditions at the grade crossings and provide background to possible grade crossing improvement or separation scenarios, which will be explored in greater depth in the Phase II report.

This report is divided into six chapters: an introduction and study purpose; general background information about Darby Borough, the two grade crossings, and Class I grade crossings in general; a summary of data collected for this study; an examination of possible improvements based on the Federal Railroad Administration guidelines and example projects from around the country; and some of the key next steps that will be undertaken in Phase II.

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