



Draft Report

Circleville Norfolk Southern Railroad Crossing Study

Ohio Rail Development Commission
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Circleville, Ohio

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Executive Summary

On December 19, 2012, Norfolk Southern (NS), the Public Utilities Commission of Ohio (PUCO), and the Ohio Rail Development Commission (ORDC) entered into an agreement for a corridor project for the installation of warning devices and railroad-highway grade crossing closures along the NS Heartland Corridor from Columbus to South Point. Under the direction of the ORDC, HDR conducted a study of the 18 NS Heartland Corridor railroad-highway grade crossings in the City of Circleville located in Pickaway County, Ohio. Ten of the crossings are on the Main Line railroad tracks with the eight remaining crossings on Other Lines. The purposes of the study are to evaluate the existing conditions, recommend crossing improvements, and evaluate and make recommendations for possible crossing closures and a grade-separated crossing location. The study area includes the 18 at-grade crossings and 31 adjacent roadway intersections.

Existing Conditions

The data collection and evaluation of the existing conditions in the study area covered turning movement counts at the surface street intersections during the morning and afternoon peak periods, railroad crossing inventory data, roadway and crossing collision data, intersection capacity analyses, travel time data, and research about the ownership of Canal Street. The main traffic routes were found to be Court Street, Pickaway Street, and Washington Street in the north/south direction with High Street, Main Street, and Ohio Street for the east/west direction.

Records of seven collisions involving roadway traffic at the crossings with the presence of a train were found and verified for the study crossings for the ten years from 2004 through 2013. All of the study intersections were found to operate with an acceptable Level of Service (LOS) except for the southbound approach on Canal Street at W. Main Street during the afternoon peak hour for one observed vehicle. No title transfer documentation was found for Canal Street, though a 1938 City map identifies the roadway as abandoned.

Closure Alternatives

Closure alternatives were developed based on a qualitative assessment of the impacts of closure for each of the 18 highway-railroad grade crossings in the City of Circleville for five different impact areas detailed in **Table ES-1**. The crossing closures included in the two alternatives are indicated in the table as well. The closure of Huston Street from S. Court Street to Clinton Street was also included in each of the closure alternatives.

To evaluate the impacts of the proposed closures on traffic operations, the peak hour traffic volumes were diverted based on the existing peak hour turning movement volumes. The capacity analysis models were modified with the new traffic volumes. One location, S. Western Avenue at W. Main Street in the afternoon peak hour for Closure Alternative 1, is expected to experience a degradation of LOS from D to F. This impact would be mitigated with the removal of on-street parking on the north side of the east leg to allow for the addition of a second westbound through travel lane.



Table ES-1: Qualitative Assessment of Impacts of Closure and Alternatives Development

AARDOT	Crossing Location	Areas of Impact					Overall impacts of closure	Closure Alt.
		Traffic volume diverted	Role as main traffic route	Length of diversion	Possibility of adverse safety impacts	City & Emergency Services Feedback (7/21/14)		
481413V	Clinton Street	Medium	Medium	High	Medium	Medium	Medium	-
481414C	S. Washington Street (at Huston St.)	Medium	High	Medium	High	High	High	-
481415J	S. Pickaway Street (at Huston St.)	Medium	High	High	Medium	High	High	-
481416R	S. Court Street	High	High	High	High	High	High	-
481417X	S. Scioto Street (just south of W. Ohio St.)	Low	Low	Low	Medium	Low	Low	Alt. 2
481418E	W. Ohio Street (just west of S. Scioto St.)	Low	Low	Medium	Medium	Low	Low	Alt. 1
481419L	W. Mill Street	Low	Low	High	Low	Low	Low	Alt. 2
481421M	W. Mound Street	Low	Low	High	High	Medium	Medium	Alt. 1
481424H	W. Main Street	High	High	Medium	Low	High	High	-
481426W	W. High Street	Medium	High	High	High	High	High	-
482018P	Huston Street	Low	Low	Low	Low	Low	Low	Alts. 1&2
482021X	S. Scioto Street (just north of Huston St.)	Low	Low	Low	Medium	Low	Low	-
482022E	W. Ohio Street (at Canal Street)	Low	Low	Medium	Medium	Low	Low	-
514837X	S. Washington Street (north of E. Corwin St.)	Medium	High	Medium	Low	High	Medium	-
514838E	E. Corwin Street	Low	Low	Low	Medium	Medium	Low	Alt. 1
514839L	S. Pickaway Street (just south of Corwin St.)	Medium	High	Medium	Low	High	Medium	-
514840F	E. Ohio Street (east of S. Court St.)	Medium	Low	Medium	Medium	Medium	Medium	-
514843B	Harrison Avenue	Medium	Medium	Medium	High	Low	Medium	Alt. 2

Travel time runs were conducted for routes through Huston Street and all but two of crossings being evaluated for closure. The Main Line crossings at S. Scioto Street (#481417X) and W. Ohio Street (#481418E) were estimated based on the traffic model output because they were closed at the time of the site visit in August 2014. The average peak hour travel time increases



per vehicle are 27 seconds in the morning and 20 seconds in the afternoon for Closure Alternative 1. The average peak hour travel time increases per vehicle are six seconds in the morning and 14 seconds in the afternoon for Closure Alternative 2.

Findings and Recommendations

Anticipated impacts of the railroad crossing closures in the two closure alternatives were also evaluated for emergency vehicle services turnaround access, school bus routes, the Circleville Pumpkin Show, the remaining open highway-railroad grade crossings, and relative safety benefits. A third closure alternative, called Revised Closure Alternative 2, was added based on evaluation of Closure Alternatives 1 and 2. This additional alternative is similar to Closure Alternative 2, but instead of having a closure at S. Scioto Street (#481417X) it includes W. Ohio Street (#481418E). **Table ES-2** presents the findings of the alternatives evaluation along with the rankings based on the five categories of selection criteria used to determine a preferred alternative.

Table ES-2: Closure Alternative Evaluation and Decision Matrix

Selection Criteria	Parameter	Evaluation			Ranking		
		Alt. 1	Alt. 2	Revised Alt. 2	Alt. 1	Alt. 2	Revised Alt. 2
Cost	Cost of safety modifications and upgrades to open crossings	\$1,656,000	\$1,745,000	\$1,566,000	3	2	1
	Cost of closures and vehicle turnaround construction	\$380,000	\$243,000	\$239,000			
Capacity Impacts	Number of intersections with a degradation to an unsatisfactory LOS	1	0	0	3	1	1
Travel Time Impacts	Increase in cumulative travel time during peak hours (minutes)	81	40	40	3	1	1
Public Services and Special Events	Number of closures with a medium or high impact to emergency services	2	0	0	3	2	1
	Number of closures on bus routes	1	1	0			
	Number of closures along a main route to Circleville Pumpkin Show	1	0	0			
Safety Impacts	WBAPS total crash risk of crossings to be closed	0.065	0.046	0.039	1	2	3
Total					13	8	7



The recommendations from the closure analysis portion of this study are:

- Closure of the Other Line crossing at Huston Street (#482018P) and the closure of Huston Street from S. Court Street to Clinton Street for an estimated cost of \$15,000;
- Closure of the Main Line crossing at W. Ohio Street (#481418E) which is estimated to cost \$74,000 (including one emergency vehicle turnaround on the west leg);
- Closure of the Main Line crossing at W. Mill Street (#481419L) for an estimated \$15,000 cost; and
- Closure or removal of the Other Line crossing at Harrison Avenue (#514843B) which has an estimated closure cost of \$135,000 (including emergency vehicle turnarounds for both legs.)

Additional items that are recommended for further consideration through diagnostic reviews or supplemental engineering analysis include:

- Circuitry and LED light upgrades for the Main Line crossings that are expected to remain open at W. High Street (#481426W), W. Main Street (#481424H), W. Mound Street (#481421M), S. Scioto Street (#481417X), S. Court Street (#481416R), S. Pickaway Street (#481415J), S. Washington Street (#481414C), and Clinton Street (#481413V) for an estimated cost of \$1,200,000;
- Flashing lights at the Other Lines crossings on S. Scioto Street (#482021X), S. Washington Street (#514837X), S. Pickaway Street (#514839L), and E. Ohio Street (#514840F) for an estimated cost of \$365,000;
- Crossbucks added to the traffic control for the southbound approach and a crossbuck assembly for the northbound approach to the W. Ohio Street Other Line crossing (#482022E);
- Advance preemption for the signalized intersection of Scioto Street and W. Main Street for the W. Main Street Main crossing (#481424H);
- Turn restriction blank-out signs on Canal Street and Western Avenue at the Main Line crossings on W. Mound Street, W. Main Street, W. High Street; and
- Evaluation of the advance warning clearance timing for the S. Court Street crossing (#481416R).



Grade-Separated Railroad Crossing Analysis

Feasibility of a north/south grade-separated crossing location was evaluated for the two existing Main Line at-grade crossings at S. Pickaway Street (#481415J) and Clinton Street (#481413V). An alignment change to Clinton Street would be included in that alternative and allows for a lower number of adjacent properties to be impacted. **Table ES-3** provides the pertinent data of the feasibility assessment. Clinton Street is the recommended location for a possible grade-separated crossing.

Table ES-3: Evaluation Matrix for Grade Separation Location

Evaluation Criteria	Location A – S. Pickaway Street	Location B – Clinton Street
Project Impact and Footprint – Property/ Right of Way (# of Parcel Impacts)	High (22)	Medium (9)
Traffic Volume (AADT)	High (4,126 vpd)	Low (1,094 vpd)
Crossing Safety – Accident Risk of Existing Crossing	Medium	Medium
Bridge Footprint (Span x Width)	High (145' x 64')	Medium (130' x 50')
Roadway Impact (Length North + South)	Medium (575' + 600')	High (625' + 600')



Section 1: Introduction

Under the direction of the Ohio Rail Development Commission (ORDC), HDR conducted a study of the 18 Norfolk Southern (NS) Heartland Corridor railroad-highway grade crossings in the City of Circleville located in Pickaway County, Ohio. Ten of the crossings are on the Main Line railroad tracks with eight remaining Other Line railroad crossings. The purposes of the study are to evaluate the existing conditions, recommend crossing improvements, and evaluate and make recommendations for possible crossing closures and a grade-separated crossing location. The study area includes the 18 at-grade crossings and 31 adjacent roadway intersections. **Figure 1-1** is a location map of the study area.

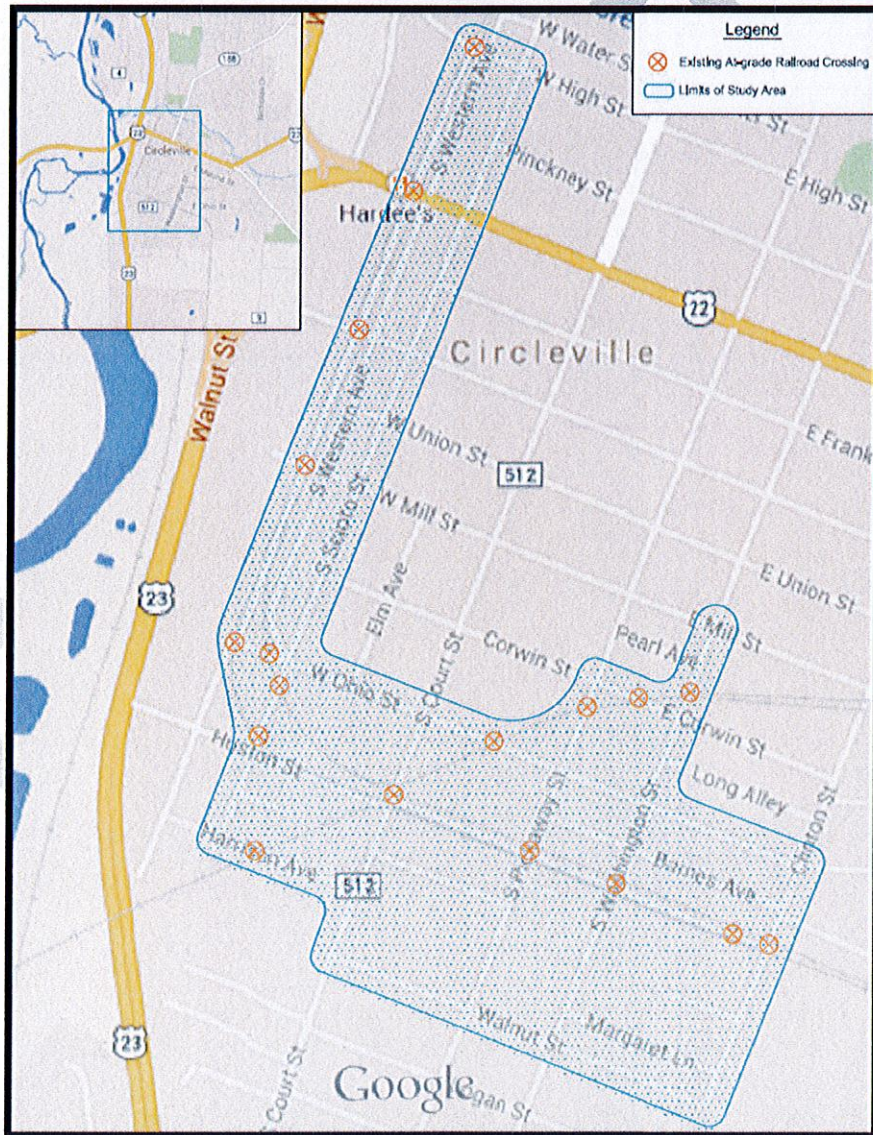


Figure 1-1: Study Area Location Map



Section 2: Background

On December 19, 2012, NS, the Public Utilities Commission of Ohio (PUCO) and ORDC entered into an agreement for a corridor project for the installation of warning devices and railroad-highway grade crossing closures along the NS Heartland Corridor from Columbus to South Point. Most of the corridor has been addressed with only a few communities outstanding. The City of Circleville is one of the outstanding communities. There are ten crossings on the Heartland Corridor Main Line tracks and eight additional Other Lines crossings in this community. The goal of the Heartland Corridor agreement between NS and ORDC is to improve the safety of the travelling public through the elimination of redundant railroad-highway grade crossings and equipment modifications at open crossings.

On October 31, 2013, the City of Circleville, NS, and the ORDC met to discuss grade crossing safety along with the shared goals of traffic flow and economic development. The intent and scope of this traffic study were discussed including a 25% closure goal, Canal Street ownership status, signal preemption, and a proposed grade-separated crossing location.

A project kick-off meeting was held on May 8, 2014 with the City of Circleville, HDR, NS, and ORDC in attendance. Information received and discussion included contact information for City service providers and the new school location. A copy of the Memorandum of Understanding between NS and ORDC and the meeting notes are provided in **Appendix A**.



Section 3: Existing Conditions

In order to develop railroad crossing safety improvements, analyze locations for railroad crossing closures, and determine the feasibility of a grade-separated railroad crossing, the current traffic, railroad crossing, safety and operating conditions must be assessed.

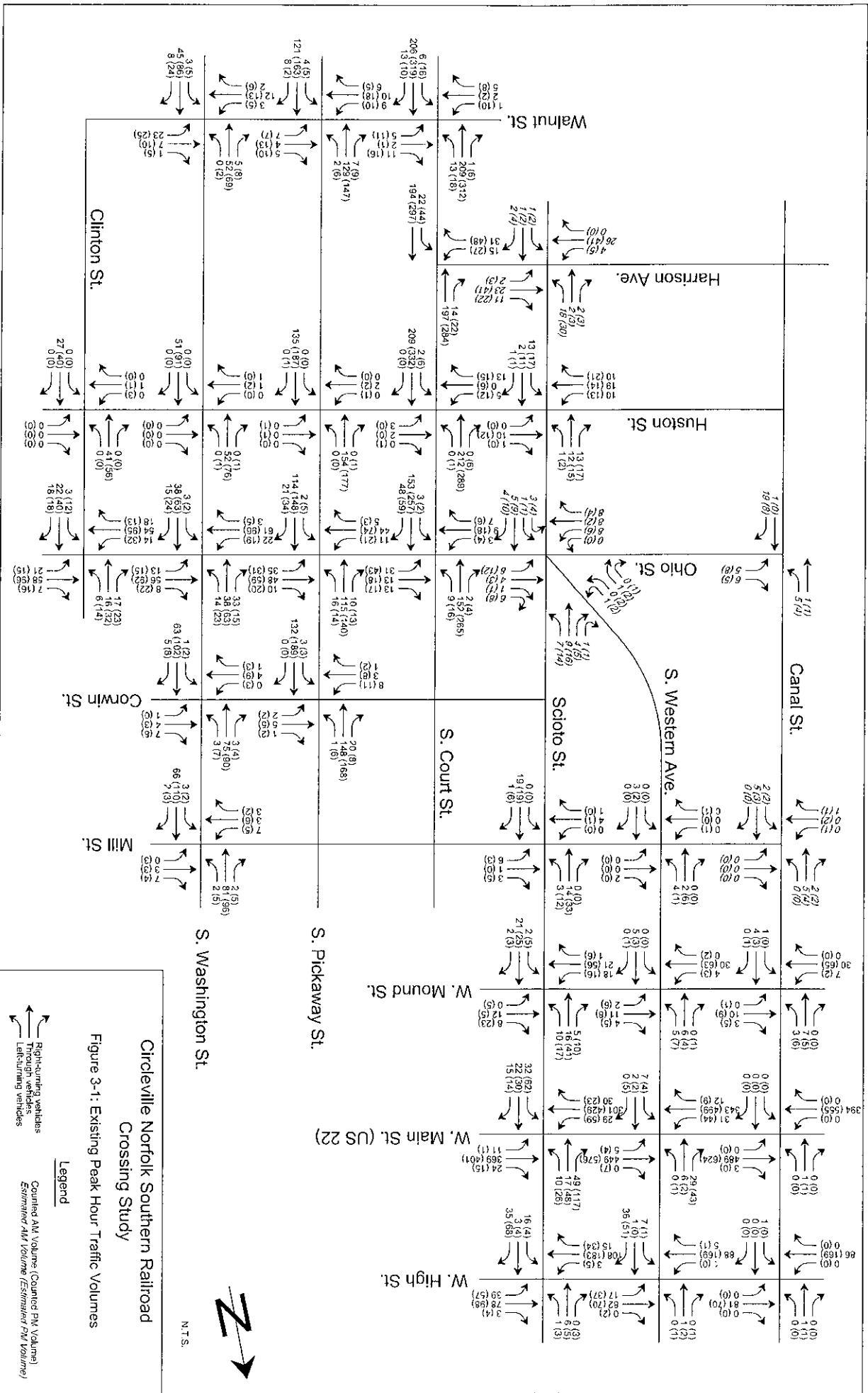
Traffic Data

Morning and afternoon peak period turning movement counts were collected at 27 intersections adjacent to the 18 at-grade railroad crossings in the City of Circleville. The counts were collected on Thursdays May 15th and May 22nd of 2014 from 7 a.m. to 9 a.m. and from 4 p.m. to 6 p.m. A supplemental 24-hour bidirectional volume count was collected for the W. Mound Street railroad crossing on Friday, July 11th, 2014 to verify the 2014 Average Annual Daily Traffic (AADT) volume for this crossing that was calculated from the adjacent turning movement counts. For the purpose of evaluating vehicle queues at the intersection of W. Ohio Street and S. Western Avenue at S. Scioto Street, a peak period turning movement count was collected on Wednesday, January 7, 2015 when the two adjacent railroad crossings had reopened. The traffic count data is provided in **Appendix B**. Traffic signal timing plan data was obtained for the two signal-controlled intersections in the 31-intersection study area from the City of Circleville Transportation Department, for Scioto Street at W. Main Street, and from the controller, for S. Court Street at Ohio Street.

The counts were summarized in 15-minute intervals so that the peak hour within each period could be determined along with the peak hour factor that is used in the capacity analysis to calculate the maximum flow of traffic during the hour. The counted vehicles were classified as lights, mediums and trucks so that the percentage of heavy vehicles for each movement could be determined. The light vehicle classification was comprised of motorcycles, cars, and light goods vehicles. The medium vehicle classification included buses and single-unit trucks. Articulated trucks made up the truck category.

Four intersections that were included in the existing conditions analysis were not counted in May of 2014 because of railroad crossing and roadway closures that altered the flow of traffic through those intersections. Therefore, the analysis turning movements at the intersections of Canal Street and W. Mill Street, Canal Street and W. Ohio Street, S. Scioto Street and W. Ohio Street, and S. Scioto Street and Harrison Avenue were estimated based on the count data collected at adjacent intersections.

The area-wide peak hours were found to be from 8:00 a.m. to 9:00 a.m. and from 4:15 p.m. to 5:15 p.m. for the morning and afternoon, respectively. **Figure 3-1** represents the morning and afternoon peak hour turning movement volumes for the 31 intersections in the study area. As mentioned previously, four of the intersections were not able to be counted in May 2014 so the volumes were estimated based on the adjacent counted intersections. Though the intersection of W. Mill Street and Canal Street has reopened as a three-leg intersection, the intersection geometry used in this report was the four-leg geometry in place prior to the closure of this intersection.





The percentage of heavy vehicles for the movements, ranged from zero to 100 percent. The City of Circleville identified the main north/south vehicular traffic routes as Court Street, Pickaway Street and Washington Street. The main east/west routes were identified as Main Street, Mound Street and High Street. The peak hour traffic counts collected in May 2014 were consistent with this identification of the main routes, except for Mound Street as a main east/west route. The volumes on Ohio Street, not Mound Street, were the third highest of the east/west corridors. The 2014 AADT on Mound Street between the US 23 ramp and Western Avenue was calculated to be 808 vehicles per day (vpd,) while the 2014 AADT on E. Ohio Street between S. Court Street and S. Pickaway Street was found to be 1,981 vpd.

Circleville City Schools (CCS) bus routes for the 2014-2015 school year were obtained from the CCS Department of Transportation webpage on September 18th, 2014 and are included in **Appendix C**. The crossing locations along the routes were determined and verified with the CCS Transportation Coordinator over the phone. The number of school buses using each crossing was determined assuming all 18 crossings in the study area are open. The school bus crossing tally for each Heartland Corridor crossing in the City of Circleville is provided in **Table 3-1**.

At-Grade Railroad Crossings

Along the Heartland Corridor, in the study area, there are eight at-grade railroad crossings on Other Lines and ten Main Line at-grade railroad crossings. The location, jurisdiction, and AARDOT number for each of the crossings is shown in **Figure 3-2**. The AARDOT number is also known as the inventory number and is part of a uniform numbering system for all at-grade crossings in the United States.

Sources for the data collection effort pertaining to the railroad crossings included the ORDC, the Federal Railroad Administration (FRA,) CCS Transportation Department, and site visits on Wednesday, August 6 and Thursday, August 7, 2014. Data collected includes number of tracks, number of roadway lanes, warning devices, train volumes, daily school bus crossings, FRA Web Based Accident Prediction Systems (WBAPS) scores, and photographs. **Table 3-1** summarizes the data collected and modified, as appropriate based on the site visit, for each of the 18 railroad crossings in the study area. **Appendix D** includes year 2014 photographs of the railroad crossings, data obtained from the FRA's inventory, and the PUCO railroad inventories.

In **Table 3-1**, the number of lights identified as crossing warning devices is the number of pairs of lights, unique to an approach direction at a particular location. The daily train count data was collected on March 19, 2013 or April 16, 2014 for each crossing, as reported in the PUCO/ORDC database. Based on conditions observed in the field and from conversations with Circleville service providers it is believed, subject to NS confirmation, that the Harrison Avenue crossing (#514843B) was not being used by train traffic at the time of the field visit in August 2014. Additionally, the Other Line track that has four crossings from E. Ohio Street (#514840F) to S. Washington Street (#514837X) does not appear to be used for daily train traffic but is routinely used for railroad storage. The year 2014 AADTs were calculated using the peak period volume counts collected in May and July of 2014 and January 2015, 24-hour count data from an ODOT count station in the study area, and ODOT seasonal adjustment factors.



Figure 3-2: Existing Railroad Crossing Locations and AARDOT Number



Table 3-1: Railroad Crossing Existing Conditions Data

AARDOT	Crossing Location	Railroad & Crossing Data					Roadway Data			FRA WBAPS Accident Prediction Value
		No. of Tracks	Warning Device		Daily Trains	Max. Train Speed (mph)	No. of Lanes	2014 AADT	Daily School Buses	
			Type	No.						
481413V	Clinton Street	3	Crossbucks	3	37	40	2	1,094	2	0.023829
			Lights	5						
			Gates	2						
481414C	S. Washington Street (at Huston St.)	4	Crossbucks	4	37	40	2	1,922	5	0.016542
			Lights	8						
			Gates	3						
481415J	S. Pickaway Street (at Huston St.)	4	Crossbucks	4	33	25	2	4,126	8	0.027519
			Lights	10						
			Gates	3						
481416R	S. Court Street	5	Crossbucks	4	33	25	4	6,820	7	0.04865
			Lights	6						
			Gates	2						
481417X	S. Scioto Street (just south of Ohio St.)	2	Crossbucks	2	32	25	2	461	2	0.020061
			Lights	4						
			Gates	2						
481418E	W. Ohio Street (just west of Scioto St.)	2	Crossbucks	2	32	25	2	110	0	0.01364
			Lights	5						
			Gates	2						
481419L	W. Mill Street	2	Crossbucks	2	32	25	2	10	0	0.010099
			Lights	6						
481421M	W. Mound Street	4	Crossbucks	3	32	25	2	808	0	0.038327
			Lights	8						
			Gates	2						
481424H	W. Main Street	3	Crossbucks	3	32	25	3	14,105	8	0.093428
			Lights	6						
			Gates	3						
481426W	W. High Street	3	Crossbucks	3	28	25	2	2,610	7	0.0669
			Lights	6						
			Gates	2						
482018P	Huston Street	1	Crossbuck Assembly	1	4	15	2	24	0	0.005203
482021X	S. Scioto Street (just north of Huston St.)	1	Crossbuck Assembly	2	6	15	2	461	2	0.014473
482022E	W. Ohio Street (at Canal Street)	2	Crossbuck Assembly	1	16	15	2	110	0	0.011498



Table 3-1: Railroad Crossing Existing Conditions Data

AARDOT	Crossing Location	Railroad & Crossing Data					Roadway Data			FRA WBAPS Accident Prediction Value
		No. of Tracks	Warning Device		Daily Trains	Max. Train Speed (mph)	No. of Lanes	2014 AADT	Daily School Buses	
			Type	No.						
514837X	S. Washington Street (north of Corwin St.)	1	Crossbuck Assembly	2	1	10	2	2,351	3	0.013586
514838E	E. Corwin Street	1	Crossbuck Assembly	2	1	10	2	288	1	0.007948
514839L	S. Pickaway Street (just south of Corwin St.)	1	Crossbuck Assembly	2	1	10	2	4,067	7	0.017948
514840F	E. Ohio Street (east of Court St.)	1	Crossbuck Assembly	2	1	10	2	1,981	3	0.011869
514843B	Harrison Avenue	2	Crossbuck Assembly	2	1	10	2	1,478	0	0.010309

Crash Data

A crash analysis of the 31 adjacent intersections, and the 18 railroad-highway grade crossings, selected as the study area was completed. The analysis included collection of crash data from applicable sources, review of the crash history, and identification of possible deficiencies.

Intersection crash data

The last three years, 2011 through 2013, of historical crash data for the 31 intersections in the study area, was obtained from ODOT's GIS Crash Analysis Tool and the Ohio Department of Public Safety's (ODPS) Crash Extracts. There were a total of 38 reported crash events during the three year period at the study intersections. In 2011, there were nine crashes while the year 2012 had 13 crashes and the year 2013 had a crash count of 16. **Table 3-2** provides the crash count for each intersection by year and severity. The highest severity of crashes, one where a human fatality occurs, is omitted from the table because there were no fatal crashes in the study area from 2011 through 2013. The next highest severity is a crash where a person is injured, followed by the least severe crashes that are identified as Property Damage Only (PDO) where only physical property is damaged.

The crash rate for each intersection was calculated based on the crash count data and from the 2014 turning movement counts. The crash rate gives the number of crashes occurring at that location for every 1 million vehicles that enter the intersection and is also included in **Table 3-2**. The statewide average crash rate and crash frequency for each intersection were determined based on the total number of approach lanes, area type (rural or urban) and traffic control (nonsignalized or signalized) from ODOT data for the three year period from 2007 to 2009. This is the most recent data available since ODOT has moved away from using this particular type of safety data.



Table 3-2: Intersection Crash Summary by Year and Severity

Intersection / Year/ Severity	2013		2012		2011		Total	Crash Rate (Crashes / MEV)	Above State Avg.
	Inj.	PDO	Inj.	PDO	Inj.	PDO			
Canal St. at High St.	0	0	0	0	0	0	0	0	
Canal St. at W. Main St.	2	0	0	0	0	0	2	0.14	
Canal St. at W. Mound St.	0	0	0	0	0	0	0	0	
Canal St. at W. Mill St.	0	0	0	0	0	0	0	0	
Canal St. at W. Ohio St.	0	0	0	0	0	0	0	0	
S. Western Ave. at W. High St.	0	0	1	0	0	0	1	0.24	X
S. Western Ave. at W. Main St.	1	3	0	1	1	1	7	0.47	X
S. Western Ave. at W. Mound St.	0	0	0	0	0	0	0	0	
S. Western Ave. at W. Mill St.	0	0	0	0	0	1	1	7.31	X
N. Scioto St. at W. High St.	0	1	0	0	0	0	1	0.17	
Scioto St. at W. Main St.	0	0	0	2	0	0	2	0.13	
S. Scioto St. at W. Mound St.	0	0	0	0	0	0	0	0	
S. Scioto St. at W. Mill St.	0	0	0	0	0	0	0	0	
S. Scioto St. at W. Ohio St. & S. Western Ave.	0	0	0	0	0	0	0	0	
S. Scioto St. at Huston St.	0	1	0	0	0	0	1	0.65	X
S. Scioto St. at Harrison Ave.	0	0	0	0	0	0	0	0	
S. Court St. at Ohio St.	0	0	3	0	0	0	3	0.34	
S. Court St. at Huston St.	0	0	0	0	1	2	3	0.36	X
S. Court St. at Harrison Ave.	1	0	0	0	0	0	1	0.11	
S. Court St. at Walnut St.	0	1	0	0	0	0	1	0.11	
S. Pickaway St. at Corwin St.	0	0	1	0	0	0	1	0.20	X
S. Pickaway St. at E. Ohio St.	1	2	1	1	0	1	6	0.86	X
S. Pickaway St. at Huston St.	0	0	0	0	0	0	0	0	
S. Pickaway St. at Walnut St.	0	1	0	1	0	0	2	0.41	X
S. Washington St. at E. Mill St.	0	0	0	0	0	0	0	0	
S. Washington St. at E. Corwin St.	0	0	1	0	0	0	1	0.34	X
S. Washington St. at E. Ohio St.	0	1	0	0	1	0	2	0.37	X
S. Washington St. at Huston St.	0	0	0	0	0	0	0	0	
S. Washington St. at Walnut St.	1	0	0	0	0	0	1	0.31	X
Clinton St. at E. Ohio St.	0	0	0	1	0	1	2	0.40	X
Clinton St. at Huston St.	0	0	0	0	0	0	0	0	
Total	6	10	7	6	3	6	38	-	-

Twelve of the 31 intersections had a crash rate for the years 2011-2013 that was greater than the statewide average for the years 2007-2009. Low vehicular roadway volumes, like those in the City of Circleville, will inflate crash rates causing them to not be an accurate parameter for comparison to statewide averages. The average yearly crash frequency for each intersection was also compared to the ODOT statewide average based on each intersection type. The



average crash frequency is the total raw count of crashes over the three-year data collection time divided by three for the number of years and represents the number of crashes that occurred over a one-year time period. None of the intersections had an average crash frequency that was greater than the statewide average.

Of the 12 locations with crash rates greater than the statewide average, the two intersections that averaged two or more crashes per year were selected as high-crash locations for further analysis as part of this study. These locations are S. Western Avenue at W. Main Street which had an average of 2.3 crashes per year and S. Pickaway Street at E. Ohio Street which had an average of 2.0 crashes per year. A detailed analysis of each of these locations follows.

S. WESTERN AVENUE AT W. MAIN STREET (US 22)

The intersection of S. Western Avenue and W. Main Street (US Highway 22) is a four-leg intersection located just east of the W. Main Street Main Line crossing (#481424H.) **Figure 3-3** shows an aerial view of this intersection. The centerline of S. Western Avenue is located 45 feet east of the nearest track edge of the W. Main Street crossing. The intersection control is minor-street stop control for the S. Western Avenue approaches and free-flowing on W. Main Street unless there is a train approaching the crossing and the warning devices are activated. There is a stop bar on the westbound approach on W. Main Street at the intersection with S. Western Avenue indicating where vehicular traffic should stop in the presence of a train. There is a signalized intersection in close proximity to the study intersection at W. Main Street and S. Scioto Street. The stop bar for the eastbound approach at this adjacent signalized intersection is 170 feet east of the centerline of S. Western Avenue. The intersection of W. Main Street with Canal Street is located between the railroad tracks is approximately 90 feet west, centerline-to-centerline, of S. Western Avenue.

As can be seen in **Figure 3-3**, the laneage of the westbound, northbound and southbound approaches is one lane. The eastbound approach is striped for one through lane and one continuous left-turn lane west of the railroad crossing. There is no approach striping across the railroad tracks or within 150 feet of the centerline of S. Western Avenue. Review of traffic operations for this intersection showed that the left-turn lane is used as a through lane on the eastbound approach of W. Main Street at S. Western Avenue 33 to 40 percent of the time during the morning and afternoon peak periods, respectively. There are two receiving lanes for both the eastbound and westbound departure legs. There is on-street parking marked on both sides of the east leg and on-street parking is used on the departure side of the south leg.



Figure 3-3: S. Western Avenue at W. Main Street (US 22) Aerial

There were seven vehicle crashes in the years 2011, 2012, and 2013 that occurred at the intersection of S. Western Avenue and W. Main Street or on a leg immediately adjacent to the intersection that did not occur on the railroad crossing with the presence of a train. **Figure 3-4** is a collision diagram showing the crash locations and details on an aerial image of the intersection. **Table 4-3** identifies important details of the seven crashes. A review of the crash reports for these crashes was conducted and the reports are included in **Appendix E**.

Circleville Norfolk Southern Railroad Crossing Study
 Figure 3-4: S. Western Avenue at W. Main Street 2011-2013 Collision Diagram



Legend

	Rear End
	Angle
	Backing Vehicle
	Fixed Object
	Injury/Crash

Diagram Label Key
 Date/Hour/Road Cond



Table 3-3: Crash Details for S. Western Avenue at W. Main Street

Crash Type	Road Surface	Wet		Dry	
	Severity/ Light Cond.	Light	Dark	Light	Dark
Angle	Injury	-	1	-	-
	PDO	-	-	-	-
Backing	Injury	-	-	-	-
	PDO	1	-	1	-
Fixed Object	Injury	-	-	-	-
	PDO	-	-	-	2
Rear End	Injury	1	-	-	-
	PDO	-	-	1	-

Backing, fixed object, and rear end crash types each had two crashes in the last three years at this intersection. Both backing collisions and one of the fixed object collisions, involved backing out of or into the on-street parking on W. Main Street and S. Western Avenue, so location and/or signing of parking areas could warrant further evaluation. Vehicle queues extending from the signalized intersection with Scioto Street through the intersection with S. Western Avenue on W. Main Street were observed during the afternoon peak hour. Vehicles will also queue in the westbound direction when a train is present on the railroad tracks. Both of these queuing instances will contribute to the occurrence of backing and rear end collisions. Changes to the signal timing during the afternoon peak period could be considered to reduce the queuing in the eastbound direction.

S. PICKAWAY STREET AT E. OHIO STREET

The intersection of S. Pickaway Street and E. Ohio Street is a four-leg intersection that has one approach lane and one departure lane per leg and operates under all-way stop control. **Figure 3-5** shows an aerial view of this intersection. There are three railroad crossings whose nearest track edge is within 435 feet of this intersection. The Other Lines crossing on E. Ohio Street (#514840F) is located approximately 400 feet west of the center of the intersection. The Other Lines crossing on S. Pickaway Street (#514839L) is located about 360 feet north of the intersection, while the Main Line crossing on S. Pickaway Street (#481415J) is approximately 435 feet south of the intersection.



Figure 3-5: S. Pickaway Street at E. Ohio Street Aerial

There were six vehicle crashes in the three-year study period that occurred at the intersection of S. Pickaway Street and E. Ohio Street or on an approach to the intersection. **Figure 3-6** is a collision diagram showing the crash locations and details on an aerial image of the intersection. **Table 3-4** identifies important details of the six crashes. A review of the crash reports for these crashes was conducted and the reports are included in **Appendix E**.

Creleville Norfolk Southern Railroad Crossing Study
 Figure 3-6: S. Pickaway Street at E. Ohio Street 2011-2013 Collision Diagram





Table 3-4: Crash Details for S. Pickaway Street at E. Ohio Street

Crash Type	Road Surface Severity/ Light Cond.	Wet		Dry	
		Light	Dark	Light	Dark
Angle	Injury	-	-	1	1
	PDO	-	1	2	-
Rear End	Injury	-	-	-	-
	PDO	-	-	1	-

Five of the six collisions, during the years 2011, 2012, and 2013, at the intersection of S. Pickaway Street and E. Ohio Street were angle collisions. The contributing circumstances for these collisions were drivers who did not follow the traffic control and stop at the intersection, or stopped and then proceeded into the intersection without ensuring that there were no other vehicles in the intersection. An analysis to determine the appropriateness of all-way stop control at this intersection is recommended. Additionally, an evaluation of the signage at this intersection and an upgrade to current sign standards, if necessary, and restriping of pavement markings is recommended.

Railroad crossing crash data

A Ten Year Collision History report was obtained for each of the 18 railroad crossings from WBAPS on June 12th and 13th, 2014. Reports for these incidents were obtained from the FRA Office of Safety Analysis website, as available. In addition to the FRA data, crash records for the five most recent years of available data, 2009 – 2013, were obtained from ODPS. Crashes located at railroad crossing in the study area were identified from the ODPS data and then those officer crash reports were reviewed to determine if each incident had involved the presence of a train.

Details for the identified crashes from FRA and ODPS are provided in **Table 3-5**. Incidents recorded in the ODPS data that did not involve the collision of a highway user and train, but occurred when a train was approaching the crossing, are included in **Table 3-5** because they were near misses that could have resulted in a collision with a train under slightly different circumstances. The collision history report and available crash reports obtained from FRA and the crash reports for the events identified through ODPS data are included in **Appendix F**.



Table 3-5: Railroad Crossing Crash History (2004-2013)

AARDOT	Crossing Location	Collision Date / Time	Operational Warning Device	Circumstances	# Killed / # Injured	Data Source
481414C	S. Washington Street	9/6/2006 7:30 AM	Gates	Train struck automobile	0 / 0	FRA
481416R	S. Court Street	10/19/2011 7:26 PM	Gates	Automobile drove onto tracks when blocked by train and gates	0 / 0	ODPS
481418E	W. Ohio Street	3/23/2005 12:15 AM	Gates	Train struck automobile	0 / 0	FRA
481419L	W. Mill Street	9/24/2004 10:00 AM	Flashing Lights	Train struck automobile	0 / 0	FRA
481421M	W. Mound Street	1/24/2011 12:09 PM	Flashing Lights	Automobile struck train	0 / 2	ODPS
481424H	W. Main Street	10/4/2013 11:20 AM	Gates	Semi-truck struck gates to clear the tracks with oncoming train	0 / 0	ODPS
		1/24/2011 12:10 AM	Flashing Lights	Automobile struck train	0 / 0	FRA*
481426W	W. High Street	1/26/2011 6:55 PM	Gates	Train struck automobile that had driven around the gates	0 / 0	FRA

*The details for this crash in the description record indicate that it occurred at W. Mound Street.

Based on a review of the FRA crash report for the collision on W. Main Street on January 24, 2011, it appears that this collision was not coded to the correct crossing and is the same collision as that which occurred at the W. Mound Street crossing, on the same day and hour, and was reported by the Circleville Police Department to ODPS. This conclusion was made based on, 1) the warning devices mentioned in the FRA report are not consistent with what was in place at that time on W. Main Street, 2) Mound Street is mentioned in the FRA report, and 3) the same train number is provided in each report. When the crash at the W. Mound Street crossing occurred, the warning devices in place were flashing lights, bells, and crossbucks. At the time of the field visit in August 2014, the W. Mound Street crossing had one gate for each approach in operation.

The crashes detailed in **Table 3-5** do not include crashes that involved the railroad tracks and/or the railroad crossing warning devices without an approaching train and activated warning devices. There were four crashes identified in the ODPS data from 2009 through 2013 that fell into this situation. Two of the crashes occurred at the W. Main Street crossing. The first of these was a hit-and-run where a vehicle hit a raised gate and it rotated so that it would lower over the tracks when activated. The second W. Main Street crash resulted from a driver of an eastbound vehicle that desired to go south on S. Western Avenue, but drove onto the tracks thinking they were the intersecting roadway. A crash at the S. Court Street crossing involved a vehicle driving onto the tracks instead of staying on Huston Street across the offset intersection.



The last crash was on Mound Street where electrical wires to the flashing lights were snagged by a truck which damaged the apparatus.

Items for possible railroad crossing safety improvement, based on the crash occurrences mentioned previously, include:

- Installation of advance preemption capabilities for the traffic signal at Scioto Street and W. Main Street;
- Evaluation of the clearance time, for highway traffic to clear tracks that is provided by the crossing warning devices for the S. Court Street crossing;
- Installation of signage for Huston Street at S. Court Street notifying about the offset intersection (if the east leg remains open); and
- Updating crossbuck assembly signage that lists the number of tracks so that the appropriate number of tracks for each crossing is displayed, as needed.

An evaluation of safety conditions at the railroad crossings in the City of Circleville was also completed by CTC, Inc. for the ORDC. Comments received on November 14, 2014 are listed here in *italics* along with any applicable HDR input:

- *Permanently prohibit the eastbound Main St left turn on to Western Avenue. A left turning vehicle will stop on the tracks to wait for a gap in the traffic and could potentially cause other vehicles to stop on the tracks while a train is approaching. The left turn prohibition should also be considered for Mound Street.* Observation of left-turning vehicle behavior from W. Main Street to the north leg of S. Western Avenue was conducted with the aid of the turning movement count data collection videos. Most vehicles slowed down or stopped past the tracks while waiting for a gap. An instance of a second-in-queue left-turning vehicle stopping on the tracks was observed during the morning peak hour data collection. Synchro 8 traffic analysis software reports the Highway Capacity Manual (HCM) control delay, the delay that is experienced from the left-turning vehicles having to yield to westbound traffic, for this movement as 9.1 seconds per vehicle. The 95th percentile queue length, the length of queue that is expected to be exceeded only 5% of the time, is determined by Synchro 8 to be less than one vehicle length in the morning and afternoon peak hours. At the intersection of Mound Street and S. Western Avenue, the peak hour queue lengths were also found to be less than one vehicle length for the eastbound left-turn movement based on the May 2014 traffic volumes.
- *During railroad activations, turn restriction blank-out signs should be considered for Canal Street, Huston Street, and Western Avenue. It is recommended that the turn restriction symbol sign (MUTCD R3-1 and R3-2) be utilized. On Canal Street at Main Street, there are existing turn restriction signs as part of the railroad warning system. It should be determined if these signs will remain as part of the project or upgraded to the turn restriction symbol. Maintenance and operation of the signs must be determined.*
- *Evaluate the traffic control devices at Ohio Street and Scioto Street to ensure vehicles are not forced to stop on the tracks to abide by the stop sign condition. The stop bar for the eastbound approach at this intersection is approximately 55 feet from the railroad*



track dynamic envelope. This will provide storage space for two vehicles outside the influence area of the tracks. A peak period turning movement count was conducted on Wednesday, January 7, 2015 at this intersection. Synchro 8 software was used to evaluate the 95th percentile queue length for the eastbound approach during the morning and afternoon peak hours. For the traffic conditions at the time of the count data collection for this intersection, the 95th percentile queue length was 0 vehicles and 0.1 vehicles in the morning and afternoon peak hours, respectively. Video taken at the time of the count data collection was observed and did not show more than one vehicle at a time stopped on the eastbound approach waiting to enter the intersection.

- *Evaluate the traffic control devices at High Street and Scioto Street to ensure vehicle queues are not extending over the tracks as are [sic] result of the all-way stop condition.* The HCM control delay and 95th percentile queue length for the eastbound movement at this intersection is evaluated through Synchro 8 to be 9.8 seconds per vehicle and 1.6 vehicles, respectively, during the afternoon peak hour. The count data collection video at the intersection of High Street and S. Western Avenue was observed for the afternoon peak hour to see if there were any queues extending for the eastbound travel direction from the stop-control at Scioto Street to the railroad tracks. A vehicle queue headed in the eastbound direction that was released following a train at the W. High Street crossing did not extend to the intersection with S. Western Avenue.
- *Advance Preemption operation should be considered at the Main St and Scioto St crossing (481424H).*
- *The traffic signal controller at Main St and Scioto operates the mid-block pedestrian signal located east of the intersection. The mid-block pedestrian signal operation must be considered when determining the preemption programming of the traffic signal controller.*

Capacity Analysis

A capacity analysis of the 31 intersections in the study area was completed for the existing conditions using Synchro 8 traffic analysis software and HCM reporting criteria, as feasible. The geometric and traffic control parameters along with the collected and estimated turning movement count data for the morning and afternoon peak hours, as described previously, were used to develop the analysis model. The percentage of trucks for each movement and peak hour factor for each approach, calculated from the count data, were also coded into the analysis software.

Level of Service (LOS) is the parameter used to qualify intersection performance based on the capacity and quality of service provided to road users. As shown in **Table 3-6**, LOS is divided into six different levels, ranging from A (the best) to F (the worst), based on the average stopped delay experienced by users at unsignalized or signalized intersections. LOS A through C is satisfactory for rural areas and LOS A through D is generally considered acceptable for urban areas, such as the City of Circleville.



Table 3-6: Level of Service Definitions

Level of Service	Control Delay (seconds/vehicle)	
	Unsignalized	Signalized
A	<10	<10
B	10-15	10-20
C	15-25	20-35
D	25-35	35-55
E	35-50	55-80
F	>50 (or V/C>1.0)	>80 (or V/C>1.0)

In **Table 3-6**, LOS A through C are shaded green to indicate a LOS well within the satisfactory range. LOS D is shaded orange to indicate an acceptable LOS but is on the border of being unacceptable for the urban area type. LOS E and F are shaded red to indicate an unsatisfactory LOS. **Table 3-7** summarizes the results of the capacity analysis for the existing conditions morning and afternoon peak hours, 8:00 a.m. to 9:00 a.m. and 4:15 p.m. to 5:15 p.m., respectively. For unsignalized intersections, the worst approach LOS is reported. For signalized intersections, the overall intersection LOS is reported. The Synchro 8 capacity analysis reports for the 2014 existing condition are included in **Appendix G**.

Table 3-7: Existing Conditions Capacity Analysis Results (AM and PM Peak)

Intersection	Traffic Control	Peak Hour	
		AM	PM
Canal Street at High Street	Two-Way Stop	B	B
Canal Street at W. Main Street	Two-Way Stop	D	F
Canal Street at W. Mound Street	Two-Way Stop	A	A
Canal Street at W. Mill Street	Two-Way Stop	A	A
Canal Street at W. Ohio Street	Two-Way Stop	A	A
S. Western Avenue at W. High Street	Two-Way Stop	B	B
S. Western Avenue at W. Main Street	Two-Way Stop	C	D
S. Western Avenue at W. Mound Street	Two-Way Stop	A	A
S. Western Avenue at W. Mill Street	Two-Way Stop	A	A
N. Scioto Street at W. High Street	All-Way Stop	A	A
Scioto Street at W. Main Street	Signalized	A	B
S. Scioto Street at W. Mound Street	All-Way Stop	A	A
S. Scioto Street at W. Mill Street	All-Way Stop	A	A
S. Scioto St. at W. Ohio St. & S. Western Ave.	Multi-Way Stop	A	A
S. Scioto Street at Huston Street	Two-Way Stop	A	A
S. Scioto Street at Harrison Avenue	Two-Way Stop	A	A
S. Court Street at Ohio Street	Signalized	A	B
S. Court Street at Huston Street	Two-Way Stop	B	B
S. Court Street at Harrison Avenue	One-Way Stop	B	B
S. Court Street at Walnut Street	Two-Way Stop	B	B
S. Pickaway Street at Corwin Street	Two-Way Stop	B	B



Table 3-7: Existing Conditions Capacity Analysis Results (AM and PM Peak)

Intersection	Traffic Control	Peak Hour	
		AM	PM
S. Pickaway Street at E. Ohio Street	All-Way Stop	A	A
S. Pickaway Street at Huston Street	Two-Way Stop	B	B
S. Pickaway Street at Walnut Street	Two-Way Stop	B	B
S. Washington Street at E. Mill Street	Two-Way Stop	B	B
S. Washington Street at E. Corwin Street	Two-Way Stop	B	B
S. Washington Street at E. Ohio Street	All-Way Stop	A	A
S. Washington Street at Huston Street	Two-Way Stop	A	B
S. Washington Street at Walnut Street	All-Way Stop	A	A
Clinton Street at E. Ohio Street	All-Way Stop	A	A
Clinton Street at Huston Street	Two-Way Stop	B	A

The worst-approach leg LOS is listed for stop-controlled intersections.

As detailed in **Table 3-7**, the intersections in the study area all operate with acceptable LOS with the exception of the southbound approach on Canal Street at W. Main Street during the afternoon peak hour. It should be noted that the volumes on Canal Street are very low and the excessive delay at this intersection is experienced by one vehicle on Canal Street during the afternoon peak hour. There were no other vehicles going to or from Canal Street during the afternoon peak hour.

Queue Length Analysis

As shown in **Table 3-7**, two of the study intersections operate under traffic signal control. The intersection of Scioto Street and W. Main Street is located approximately 211 feet east of the Main Line crossing on W. Main Street (#481424H.) The intersection of S. Court Street and Ohio Street is located approximately 313 feet north of the Main Line crossing on S. Court Street (#481416R.) These distances were measured from the railroad dynamic envelope to the downstream stop bar at the signalized intersection, effectively the length of queuing space available at the signalized intersection that is safely outside of the crossing area.

A comparison of the expected queue lengths at these intersections to the available queuing space has been conducted to determine if advance preemption would be beneficial at these locations. The 95th percentile queue lengths for the applicable approaches were determined from the existing condition peak hour Synchro 8 models. The afternoon peak hour is expected to have the longest queues for each intersection. For the eastbound through movement on W. Main Street the 95th percentile queue length is 194 feet. The 95th percentile queue length for the northbound approach on S. Court Street is 49 feet for the afternoon peak hour.

Thus, the modeled 95th percentile queue length for the eastbound direction on W. Main Street is within one car length of the railroad crossing. Taking into the account the location of the Western Avenue intersection with W. Main Street, the presence of on-street parallel parking on the eastbound approach to Scioto Street, and pedestrian activity in the area, the actual queue



length can be expected to exceed the modeled queue length for the eastbound approach to Scioto Street. The existing condition Synchro 8 Queues reports are included in **Appendix G**.

Travel Time Data

Travel time data was collected on Wednesday, August 6th and Thursday, August 7th of 2014 for use in evaluation of closure scenarios that are discussed in **Section 5: Railroad-Highway Grade Crossing Closure Analysis**. The Main Line crossings at W. Ohio Street (#481418E) and S. Scioto Street (#481417X) were closed at that time, so travel time information related to those crossings were determined from the Synchro 8 traffic analysis model output. During the travel time runs, delay was experienced at the northbound approaches to W. Main Street (US 22) on S. Western Avenue and S. Scioto Street during the afternoon peak period due to the traffic volumes on W. Main Street. The collected travel time data is included in **Appendix H** and the analysis of the data is presented in **Section 5**.

Canal Street

Research regarding the ownership of Canal Street, the north-south roadway between the Norfolk Southern railroad tracks from W. Ohio Street to W. High Street, was conducted as part of this study. The Pickaway County Historical and Genealogical Library located city ordinances and newspaper clippings stating that Canal Street was a city street at the time that the railroad tracks were laid. A 1935 City of Circleville map, that was revised on February 14, 1938, identifies Canal Street as abandoned. Copies of these documents are included in **Appendix I**.

A records search was conducted at the Pickaway County Recorder's Office for any documentation pertaining to the transfer of Canal Street from the City of Circleville to the railroad companies. Records were found for the purchase of canal property from the State of Ohio by the railroads. Title transfers for alleys between the City and Railroad were found, but no records related to the abandonment nor transfer of Canal Street were found in the search. These titles are on record in the Pickaway County Recorder's Office and notes from the search are included in **Appendix I**.



Section 4: Crossing Safety Modifications

Safety modifications to the warning devices at each of the 18 existing railroad-highway grade crossings in the study area were developed based on the existing warning device, number of trains per day, and highway AADT volume, all detailed in **Table 3-1**, along with the crossing geometry. The Ohio Manual of Uniform Traffic Control Devices (2012 Edition) was referenced in the development of these modifications. Circuitry and LED light upgrades are also included for each of the Main Line crossing locations. As of the date of this report, no diagnostic team reviews had been conducted for the crossing locations in the study area, so these modification recommendations are for planning purposes only. **Table 4-1** provides the category of existing warning device present at the time of the site visit, the recommended modifications, the characteristics that led to the recommendation, and the estimated cost of construction.

Table 4-1: Recommended Railroad Crossing Warning Device Modifications

AARDOT	Crossing Location	Highest Level of Warning Device	Daily Trains	Existing Highway AADT	Modification	Reason for Modification	Estimated Cost
481413V	Clinton Street	Gates	37	1,094	Circuitry & LEDs	Standard upgrade	\$150,000
481414C	S. Washington Street (at Huston St.)	Gates	37	1,922	Circuitry & LEDs	Standard upgrade	\$150,000
481415J	S. Pickaway Street (at Huston St.)	Gates	33	4,126	Circuitry & LEDs	Standard upgrade	\$150,000
481416R	S. Court Street	Gates	33	6,820	Circuitry & LEDs, grade crossing pavement marking	Standard upgrade, EB approach on Huston does not have crossing symbol	\$150,000
481417X	S. Scioto Street (just south of W. Ohio St.)	Gates	32	1,058	Circuitry & LEDs	Standard upgrade	\$150,000
481418E	W. Ohio Street (just west of S. Scioto St.)	Gates	32	217	Circuitry & LEDs	Standard upgrade	\$150,000
481419L	W. Mill Street	Lights	32	57	Circuitry & LEDs	Standard upgrade	\$150,000
481421M	W. Mound Street	Gates	32	808	Circuitry & LEDs	Standard upgrade	\$150,000
481424H	W. Main Street	Gates	32	14,105	Circuitry & LEDs, grade crossing pavement marking	Standard upgrade, 2 nd EB lane used as through lane	\$150,000



Table 4-1: Recommended Railroad Crossing Warning Device Modifications

AARDOT	Crossing Location	Highest Level of Warning Device	Daily Trains	Existing Highway AADT	Modification	Reason for Modification	Estimated Cost
481426W	W. High Street	Gates	28	2,610	Circuitry & LEDs	Standard upgrade	\$150,000
482018P	Huston Street	Crossbuck Assembly	4	24	Signage	No crossbucks/ yield sign on one approach	\$1,000
482021X	S. Scioto Street (just north of Huston St.)	Crossbuck Assembly	6	1,439	Lights	Highway AADT & limited site distance	\$95,000
482022E	W. Ohio Street (at Canal Street)	Crossbuck Assembly	16	396	Signage	No crossbucks one approach	\$1,000
514837X	S. Washington Street (north of E. Corwin St.)	Crossbuck Assembly	1	2,351	Lights	Highway AADT	\$90,000
514838E	E. Corwin Street	Crossbuck Assembly	1	288	Grade crossing pavement marking	Not present on EB approach	\$1,000
514839L	S. Pickaway Street (just south of Corwin St.)	Crossbuck Assembly	1	4,067	Lights	Highway AADT	\$90,000
514840F	E. Ohio Street (east of S. Court St.)	Crossbuck Assembly	1	1,981	Lights	Highway AADT	\$90,000
514843B	Harrison Avenue	Crossbuck Assembly	1	1,478	Lights	Highway AADT	\$90,000

The cost estimated for the addition of flashing lights at the railroad crossings specified above includes \$15,000 for mobilization and demobilization and \$75,000 for the lights, circuitry and installation. The additional \$5,000 in the estimate for the S. Scioto Street (#482021X) crossing is for removal of the tree that is closest to the tracks on the north leg. The total cost of the safety modifications described in **Table 4-1** is \$1,957,000.



Section 5: Railroad-Highway Grade Crossing Closure Analysis

Based on the ORDC/NS goal of closing 25% of redundant crossings, closure alternatives were developed that included closure of four of the 18 crossings in the study area. This section details the development of the alternatives that were analyzed and the assessment of impacts to capacity, travel time, emergency services, and school transportation services.

Development of Alternatives

A qualitative assessment of the impacts of closure for each of the 18 railroad crossings in the City of Circleville was conducted in order to develop the alternative closure scenarios. The relative impact of closing each crossing was rated (Low, Medium, or High) based on (1) the roadway volume that would be diverted, (2) the importance of the route as a main traffic route, (3) the additional distance that traffic would have to travel with closure compared to the crossing remaining open, (4) safety implications of diverting traffic to other crossings based on the difference in WBAPS Accident Prediction scores, and (5) the importance of the crossings to the operations of City of Circleville services, including emergency services. The feedback from the City of Circleville was received on July 21, 2014. CCS bus route data was not available at the time of the qualitative assessment because new routes were being developed due to the consolidation of the elementary schools at the new main campus near Clark Drive at Brookhill Lane, northeast of the study area.

The relative overall impact of closure for each crossing was then assessed based on the impacts in five categories: (1) roadway volume that would be diverted, (2) the importance of the route as a main traffic route, (3) the additional distance that traffic would have to travel with closure compared to the crossing remaining open, (4) safety implications of diverting traffic to other crossings based on the difference in WBAPS Accident Prediction scores, and (5) the importance of the crossings to the operations of City of Circleville services, including emergency services. Two closure scenarios were then developed with the goal of not having adjacent or nearby crossings included in the same scenario. Both scenarios include the closure of the Other Line crossing at Huston Street (#482018P) and Huston Street from S. Court Street to Clinton Street. This section of Huston Street is located between two sets of railroad tracks and does not provide any access to land uses. The other crossing closures included in Scenario 1 are W. Ohio Street (#481418E) just west of S. Scioto Street, W. Mound Street (#481421M), and E. Corwin Street (#514838E). In addition to Huston Street, the Scenario 2 closures are S. Scioto Street (#481417X) just south of W. Ohio Street, W. Mill Street (#481419L), and Harrison Avenue (#514843B). The qualitative assessment and development of alternative scenarios is detailed in **Table 5-1**.



Table 5-1: Qualitative Assessment of Impacts of Closure and Alternatives Development

AARDOT	Crossing Location	Areas of Impact					Overall impacts of closure	Closure Alt.
		Traffic volume diverted	Role as main traffic route	Length of diversion	Possibility of adverse safety impacts	City & Emergency Services Feedback (7/21/14)		
481413V	Clinton Street	Medium	Medium	High	Medium	Medium	Medium	-
481414C	S. Washington Street (at Huston St.)	Medium	High	Medium	High	High	High	-
481415J	S. Pickaway Street (at Huston St.)	Medium	High	High	Medium	High	High	-
481416R	S. Court Street	High	High	High	High	High	High	-
481417X	S. Scioto Street (just south of W. Ohio St.)	Low	Low	Low	Medium	Low	Low	Alt. 2
481418E	W. Ohio Street (just west of S. Scioto St.)	Low	Low	Medium	Medium	Low	Low	Alt. 1
481419L	W. Mill Street	Low	Low	High	Low	Low	Low	Alt. 2
481421M	W. Mound Street	Low	Low	High	High	Medium	Medium	Alt. 1
481424H	W. Main Street	High	High	Medium	Low	High	High	-
481426W	W. High Street	Medium	High	High	High	High	High	-
482018P	Huston Street	Low	Low	Low	Low	Low	Low	Alts. 1&2
482021X	S. Scioto Street (just north of Huston St.)	Low	Low	Low	Medium	Low	Low	-
482022E	W. Ohio Street (at Canal Street)	Low	Low	Medium	Medium	Low	Low	-
514837X	S. Washington Street (north of E. Corwin St.)	Medium	High	Medium	Low	High	Medium	-
514838E	E. Corwin Street	Low	Low	Low	Medium	Medium	Low	Alt. 1
514839L	S. Pickaway Street (just south of Corwin St.)	Medium	High	Medium	Low	High	Medium	-
514840F	E. Ohio Street (east of S. Court St.)	Medium	Low	Medium	Medium	Medium	Medium	-
514843B	Harrison Avenue	Medium	Medium	Medium	High	Low	Medium	Alt. 2

Capacity Impacts

To quantify the impacts of the two alternative closure scenarios to the existing traffic operations at the 31 intersections in the study area, the Synchro 8 models were modified to represent traffic



conditions with the applicable railroad crossings closed. Existing vehicle traffic using the roadways and crossings affected by the closures were manually diverted and assigned to nearby roadways and crossings, as appropriate, for the morning and afternoon peak hours individually. **Figures 5-1** and **5-2** show the locations of closed railroad crossings for each of the two closure alternatives along with the detour vehicle paths that were determined based on the existing turning movement count data on the adjacent roadways and used for the assignment of diverted traffic volumes.



Figure 5-1: Closure Alternative 1 Detour Routes



Figure 5-2: Closure Alternative 2 Detour Routes

ODOT historical count data in the City of Circleville near the study area was assembled and evaluated to determine the historical rate of traffic growth in the area. Between the years 2011 and 2012, volumes on W. Main Street between the railroad crossing and Court Street decreased by four percent. Between the years 2007 and 2011, the count data on W. Main Street decreased by five percent per year. Due to the historical trends of decreasing traffic volumes, a growth rate was not applied to the existing traffic volumes to represent anticipated changes when the closures would take effect. Given the historical trend of decreasing traffic in the area, this is a conservative approach for the capacity analysis. Additionally, the alternative capacity analysis does not include any other modifications to the network such as lane configuration or signal phasing. **Table 5-2** lists the LOS for each intersection during the



morning peak hour, 8:00 a.m. to 9:00 a.m., for the Existing Condition, Closure Alternative 1, and Closure Alternative 2.

Table 5-2: AM Peak Hour Intersection Capacity Analysis

Intersection	Traffic Control	Condition		
		Existing	Alt. 1	Alt. 2
Canal Street at High Street	Two-Way Stop	B	B	B
Canal Street at W. Main Street	Two-Way Stop	D	D	D
Canal Street at W. Mound Street	Two-Way Stop	A	A	A
Canal Street at W. Mill Street	Two-Way Stop	A	A	A
Canal Street at W. Ohio Street	Two-Way Stop	A	A	A
S. Western Avenue at W. High Street	Two-Way Stop	B	B	B
S. Western Avenue at W. Main Street	Two-Way Stop	C	D	C
S. Western Avenue at W. Mound Street	Two-Way Stop	A	A	A
S. Western Avenue at W. Mill Street	Two-Way Stop	A	A	A
N. Scioto Street at W. High Street	All-Way Stop	A	A	A
Scioto Street at W. Main Street	Signalized	A	A	A
S. Scioto Street at W. Mound Street	All-Way Stop	A	A	A
S. Scioto Street at W. Mill Street	All-Way Stop	A	A	A
S. Scioto St. at W. Ohio St. & S. Western Ave.	Multi-Way Stop	A	A	A
S. Scioto Street at Huston Street	Two-Way Stop	A	A	A
S. Scioto Street at Harrison Avenue	Two-Way Stop	A	A	A
S. Court Street at Ohio Street	Signalized	A	A	A
S. Court Street at Huston Street	Two-Way Stop	B	A	B
S. Court Street at Harrison Avenue	One-Way Stop	B	B	B
S. Court Street at Walnut Street	Two-Way Stop	B	B	B
S. Pickaway Street at Corwin Street	Two-Way Stop	B	B	B
S. Pickaway Street at E. Ohio Street	All-Way Stop	A	A	A
S. Pickaway Street at Huston Street	Two-Way Stop	B	-	-
S. Pickaway Street at Walnut Street	Two-Way Stop	B	B	B
S. Washington Street at E. Mill Street	Two-Way Stop	B	B	B
S. Washington Street at E. Corwin Street	Two-Way Stop	B	A	B
S. Washington Street at E. Ohio Street	All-Way Stop	A	A	A
S. Washington Street at Huston Street	Two-Way Stop	A	-	-
S. Washington Street at Walnut Street	All-Way Stop	A	A	A
Clinton Street at E. Ohio Street	All-Way Stop	A	A	A
Clinton Street at Huston Street	Two-Way Stop	B	A	A

With the closure of Huston Street between S. Court Street and Clinton Street in the closure alternatives, the intersections of Huston Street with S. Pickaway Street and S. Washington Street would no longer exist and are shown blank in the capacity analysis table. As shown in **Table 5-2**, the only intersection to experience degradation in LOS from the Existing Condition to an Alternative Condition is S. Western Avenue at W. Main Street which goes from LOS C to D in



the morning peak hour with Closure Alternative 1. LOS D is a satisfactory LOS for this area type. None of the other intersections in the study area are expected to experience a decrease in LOS during the morning peak hour due to the evaluated railroad crossing closures.

Table 5-3 provides the capacity analysis results for the afternoon peak hour, 4:15 p.m. to 5:15 p.m., for the Existing Condition, Closure Alternative 1, and Closure Alternative 2.

Table 5-3: PM Peak Hour Intersection Capacity Analysis

Intersection	Traffic Control	Condition		
		Existing	Alt. 1	Alt. 2
Canal Street at High Street	Two-Way Stop	B	B	B
Canal Street at W. Main Street	Two-Way Stop	F	F	F
Canal Street at W. Mound Street	Two-Way Stop	A	A	A
Canal Street at W. Mill Street	Two-Way Stop	A	A	A
Canal Street at W. Ohio Street	Two-Way Stop	A	A	A
S. Western Avenue at W. High Street	Two-Way Stop	B	B	B
S. Western Avenue at W. Main Street	Two-Way Stop	D	F	D
S. Western Avenue at W. Mound Street	Two-Way Stop	A	A	A
S. Western Avenue at W. Mill Street	Two-Way Stop	A	A	A
N. Scioto Street at W. High Street	All-Way Stop	A	A	A
Scioto Street at W. Main Street	Signalized	B	B	B
S. Scioto Street at W. Mound Street	All-Way Stop	A	A	A
S. Scioto Street at W. Mill Street	All-Way Stop	A	A	A
S. Scioto St. at W. Ohio St. & S. Western Ave.	Multi-Way Stop	A	A	A
S. Scioto Street at Huston Street	Two-Way Stop	A	A	A
S. Scioto Street at Harrison Avenue	Two-Way Stop	A	A	A
S. Court Street at Ohio Street	Signalized	B	B	B
S. Court Street at Huston Street	Two-Way Stop	B	B	C
S. Court Street at Harrison Avenue	One-Way Stop	B	B	B
S. Court Street at Walnut Street	Two-Way Stop	B	B	B
S. Pickaway Street at Corwin Street	Two-Way Stop	B	B	B
S. Pickaway Street at E. Ohio Street	All-Way Stop	A	A	A
S. Pickaway Street at Huston Street	Two-Way Stop	B	-	-
S. Pickaway Street at Walnut Street	Two-Way Stop	B	B	B
S. Washington Street at E. Mill Street	Two-Way Stop	B	B	B
S. Washington Street at E. Corwin Street	Two-Way Stop	B	A	B
S. Washington Street at E. Ohio Street	All-Way Stop	A	A	A
S. Washington Street at Huston Street	Two-Way Stop	B	-	-
S. Washington Street at Walnut Street	All-Way Stop	A	A	A
Clinton Street at E. Ohio Street	All-Way Stop	A	A	A
Clinton Street at Huston Street	Two-Way Stop	A	A	A



During the evening peak hour, the intersection of S. Western Avenue at W. Main Street also experiences a decrease in the reported LOS for Closure Alternative 1 compared to the Existing Condition. However, with a LOS D in the Existing Condition, the LOS is degraded into the unacceptable range (LOS F) with the diversion of traffic from the W. Mound Street closure in Alternative 1. The drop in LOS for the northbound approach on S. Western Avenue to W. Main Street can be mitigated with a second westbound through lane. This laneage modification requires the removal of the five on-street parking spots on the north side of the east leg. There are two receiving lanes on the west leg which extend to the US Highway 23 overpass. This additional capacity would result in LOS D for the northbound approach on S. Western Avenue to W. Main Street during the afternoon peak hour for Closure Alternative 1 which is the same as the existing LOS.

As shown in **Table 5-3**, the intersection of S. Court Street at Huston Street shows a LOS decrease from B to C from the Existing Condition to Closure Alternative 2 during the afternoon peak hour, which is within the acceptable range. The other 29 intersections in the study area do not exhibit any degradation in LOS due to the analyzed railroad crossing closures in the afternoon peak hour.

Travel Time Impacts

As mentioned in **Section 4**, travel time runs were completed along two routes for each of the railroad crossings included in the Closure Alternatives except for W. Ohio Street (#481418E) and S. Scioto Street (#481417X) whose closure impacts were estimated based on count data and the Synchro 8 analysis model. These two Main Line crossings were temporarily closed in August 2014 at the time of travel time data collection. To estimate the impacts of closure, two alternate routes that would be used by vehicles with the crossing closed were run for each crossing. Due to minimal congestion in the majority of the study area during the peak periods, multiple directions were not run for each route. Travel time impacts associated with the closures of each crossing were determined for each crossing and each scenario for both peak periods. The data is summarized in **Table 5-4**.

Table 5-4: Summary of Travel Time Data

AARDOT	Crossing Location	Peak Hour	Route	Increase in Travel Time with closure (sec/veh)	Number of vehicles diverted	Total Increase in Travel Time (min)
481417X	S. Scioto Street	AM	Scioto/Harrison to Scioto/Mill	24*	13	2.7*
			Court/Ohio to US 23/Huston	2*		
			Average	13*		
		PM	Scioto/Harrison to Scioto/Mill	27*	38	9.3*
			Court/Ohio to US 23/Huston	2*		
			Average	15*		



Table 5-4: Summary of Travel Time Data

AARDOT	Crossing Location	Peak Hour	Route	Increase in Travel Time with closure (sec/veh)	Number of vehicles diverted	Total Increase in Travel Time (min)
481418E	W. Ohio Street	AM	Court/Ohio to Maplewood/Huston	-3*	6	-0.8*
			Canal/Mill to Court/Ohio	-13*		
			Average	-8*		
		PM	Court/Ohio to Maplewood/Huston	-4*	8	-1.3*
			Canal/Mill to Court/Ohio	-15*		
			Average	-9*		
481419L	W. Mill Street	AM	Canal (N of Ohio) to Western/Main	3	0	0
			Scioto/Mill to Canal (N of Ohio)	67		
			Average	35		
		PM	Canal (N of Ohio) to Western/Main	16	2	1.3
			Scioto/Mill to Canal (N of Ohio)	65		
			Average	40		
481421M	W. Mound Street	AM	Canal/Main to Court/Mound	56	54	34.5
			Court/Mound to Main/US 23 Ramp	20		
			Average	38		
		PM	Canal/Main to Court/Mound	56**	89	42.6**
			Court/Mound to Main/US 23 Ramp	2		
			Average	29**		
482018P	Huston Street	AM	Clinton/Ohio to Pickaway/Edison	14	7	-2.0
			Court/Huston to Clinton/Ohio	-48		
			Average	-17		
		PM	Clinton/Ohio to Pickaway/Edison	-5	9	-0.2
			Court/Huston to Clinton/Ohio	3		
			Average	-1		
514838E	E. Corwin Street	AM	Corwin (E of Court) to Clinton/Corwin	35	13	3.8
			Washington/Ohio to Pickaway/Mill	1		
			Average	18		
		PM	Corwin (E of Court) to Clinton/Corwin	18	24	2.8
			Washington/Ohio to Pickaway/Mill	-4		
			Average	7		
514843B	Harrison Avenue	AM	Harrison (W of Court) to Maplewood/Huston	13	74	8.9
			Court/Huston to Maplewood/Harrison	2		
			Average	7		
		PM	Harrison (W of Court) to Maplewood/Huston	31	128	32.2
			Court/Huston to Maplewood/Harrison	-1		
			Average	15		

*Travel times estimated based on the existing condition peak hour Synchro 8 traffic analysis models.

**Due to high traffic volumes and a lack of gaps on W. Main Street at Canal Street during the afternoon peak period, travel time data was not collected for this route during that time period. The increase in travel time is estimated as at least equal to the morning peak periods increase because there was more congestion in evening peak periods.



Summing the individual crossing travel time data for each of the crossings in Closure Alternative 1 and Closure Alternative 2 yields the anticipated time impacts for the morning and afternoon peak periods and can be used as a comparison tool between the two scenarios. The closures included in Alternative 1 are W. Ohio Street (#481418E), W. Mound Street (481421M), Huston Street (#482018P), and E. Corwin Street (514838E). The cumulative travel time impacts for all vehicles that will be diverted due to Closure Alternative 1 is 36 minutes for 80 vehicles in morning peak hour and estimated at 44 minutes for 130 vehicles in afternoon peak hour. Thus, the average travel time increases are 27 seconds per vehicle and 20 seconds per vehicle in the morning and afternoon peak hours, respectively.

Closure Alternative 2 analyzes the impacts of closure to the crossings at S. Scioto Street (#481417X), W. Mill Street (#481419L), Huston Street (#482018P), and Harrison Avenue (#514843B.) The cumulative travel time impacts for all vehicles that will be diverted due to Closure Alternative 2 is 10 minutes for 94 vehicles in morning peak hour and 43 minutes for 177 vehicles in afternoon peak hour. Therefore, the average travel time increases are six seconds per vehicle and 14 seconds per vehicle in the morning and afternoon peak hour, respectively.

Circleville Services and Special Event Impacts

Emergency and School Bus Service

Impacts to City of Circleville emergency services and CCS bus transportation services were determined based on feedback from the City of Circleville, shown in **Table 5-1**, and the railroad crossings used by buses to complete the school year 2014-2015 bus routes, shown in **Table 3-1**. For Alternative 1, closure of two of the four crossing closure locations were rated to be of Medium impact to the City of Circleville's police and fire operations with the other two rated as Low impact. One of the crossings included in this alternative serves bus traffic for the 2014-2015 school year; E. Corwin Street (#514838E) is crossed by one bus on a typical school day.

All four crossings included in Closure Alternative 2 were indicated to be of Low impact to City of Circleville police and fire services. Similarly to Alternative 1, one crossing in Alternative 2 is along a CCS bus route. S. Scioto Street (#481417X), though closed at the beginning of the 2014-2015 school year, serves two school buses on a typical school day when open.

Emergency Vehicle Turnaround Access

With the closure of any railroad crossing, the two roadway legs that were connected across the railroad tracks will become dead end locations. The City of Circleville requires that newly constructed streets that dead end to have turnaround space in order to accommodate emergency vehicles. Similarly, space for emergency vehicles to turn around is desired by the City for the approaches to a closed railroad crossing if there are land uses present which would be served by emergency vehicles. For Closure Alternative 1, the locations that emergency vehicles would serve are the west leg of W. Ohio Street at #481418E, the west leg of W. Mound Street at #481421M, and both legs of Corwin Street at #514838E.

For Closure Alternative 2, the south leg on S. Scioto Street at #481417X and both approaches on Harrison Avenue at #514843B could need emergency vehicle turnaround space if the



crossings are closed. There are alley connections off the west legs of both Corwin Street and Harrison Avenue just before the railroad tracks that should be evaluated by the Circleville Fire Department to determine if they could provide a sufficient route for emergency vehicle access as opposed to the construction of a circular turnaround.

The estimated cost for closing a crossing and constructing a cul-de-sac with a 47-foot radius for one approach is \$55,000. The cost for a crossing that requires both approaches have a cul-de-sac is estimated at \$95,000 for closure and roadway construction. Locations that have no turnaround construction needs have an estimated crossing closure cost of \$15,000. The cost for right-of-way acquisition to construct the cul-de-sacs was also estimated. Property value data was obtained from the Pickaway County Auditor's website in January 2015 and the property acquisition costs were estimated assuming a 50% increase in the land value of the affected properties. **Table 5-5** details the total estimated cost for each potential turnaround location.

Table 5-5: Cost of Emergency Vehicle Turnarounds

AARDOT	Crossing Location	Leg	Estimated Cost		
			ROW	Construction	Total
481417X	S. Scioto Street	South	\$23,000	\$55,000	\$78,000
481418E	W. Ohio Street	West	\$19,000	\$55,000	\$74,000
481421M	W. Mound Street	West	\$24,000	\$55,000	\$79,000
514838E	E. Corwin Street	West	\$113,000	\$95,000	\$212,000
		East	\$4,000		
514843B	Harrison Avenue	West	\$19,000	\$95,000	\$135,000
		East	\$21,000		

The estimated total cost for potential emergency vehicle turnaround locations is \$365,000 for Closure Alternative 1 and \$213,000 for Closure Alternative 2.

Circleville Pumpkin Show

Impacts of railroad crossing closures to the Circleville Pumpkin Show were explored. The parade route from 2013 indicates that the parade does not travel on any of the railroad crossings in the City of Circleville, nor are any other Circleville Pumpkin Show attractions located adjacent to the crossings included in the Closure Alternatives. Based on the locations of the Circleville Pumpkin Show events, the crossings on W. High Street, W. Main Street and W. Mound Street will likely be part of main ingress/egress routes for the event's vehicular traffic.

Railroad Crossing Impacts

With closure of any of the 18 highway-railroad grade crossings in the City of Circleville and a section of Huston Street, vehicular traffic using those crossings will be diverted to other adjacent roadways and, in many instances, other railroad crossings. The crossing AADT for each of the railroad crossings in the study was estimated for Closure Alternatives 1 and 2 based on the diversion of peak hour traffic developed for the capacity analysis. These volumes along with the Existing Condition volumes are detailed in **Table 5-6**.



Table 5-6: Impacts on Highway AADTs (vpd) at Railroad Crossings

AARDOT	Crossing Location	Condition		
		Existing	Alt. 1	Alt. 2
481413V	Clinton Street	1,094	1,094	1,094
481414C	S. Washington Street (at Huston St.)	1,922	1,922	1,922
481415J	S. Pickaway Street (at Huston St.)	4,126	4,141	4,141
481416R	S. Court Street	6,820	6,859	7,795
481417X	S. Scioto Street (just south of W. Ohio St.)	461	454	Closed
481418E	W. Ohio Street (just west of S. Scioto St.)	110	Closed	334
481419L	W. Mill Street	10	69	Closed
481421M	W. Mound Street	808	Closed	813
481424H	W. Main Street	14,105	14,834	14,105
481426W	W. High Street	2,610	2,610	2,610
482018P	Huston Street	24	Closed	Closed
482021X	S. Scioto Street (just north of Huston St.)	461	454	6
482022E	W. Ohio Street (at Canal Street)	110	26	395
514837X	S. Washington Street (north of E. Corwin St.)	2,351	2,429	2,351
514838E	E. Corwin Street	288	Closed	288
514839L	S. Pickaway Street (just south of Corwin St.)	4,067	4,153	4,067
514840F	E. Ohio Street (east of S. Court St.)	1,981	2,024	2,024
514843B	Harrison Avenue	1,478	1,478	Closed

For Closure Alternative 1, the largest increase in highway crossing traffic would be experienced by W. Main Street due to the closure of W. Mound Street. For Closure Alternative 2, the S. Court Street crossing would serve the greatest volume of diverted traffic due to the crossing closures on S. Scioto Street and Harrison Avenue.

Warning Device Modifications

The railroad crossing safety modifications presented in **Section 5** are recommended for all but two of the open crossings in the two closure alternatives detailed in this section. These locations are S. Scioto Street (#482021X) and W. Ohio Street (#482022E) in Closure Alternative 2. The highway volume travelling on the S. Scioto Street (#482021X) crossing will be very low (estimated at less than 10 vehicles per day) in Alternative 2 due to the closure of the crossing immediately to the north, so installation of flashing lights at this location may not be appropriate.



As shown in **Table 5-6**, the highway AADT for W. Ohio Street (#482022E) is expected to increase by 285 vehicles per day in Closure Alternative 2 compared to the existing condition. All of the 285 vehicles diverted to this crossing result from the closure of S. Scioto Street (#481417X) that was included in Closure Alternative 2. Due to this 259% increase in the crossing volume, upgrading the warning devices at this crossing to gates and lights is recommended.

The estimated cost of upgrading the W. Ohio Street crossing (#482022E) to active warning devices is \$275,000 with \$25,000 for mobilization and demobilization and \$250,000 for the equipment, circuitry and installation of the gates and lights. Thus, the total cost of the recommended safety modifications and proposed standard materials upgrades at the 14 crossings that will remain open is \$1,656,000 for Closure Alternative 1 and \$1,745,000 for Closure Alternative 2.

Crossing Safety

The collision risk reductions due to the closures are estimated based on the WBAPS Accident Prediction Values. The total reduction with Closure Alternative 1 is 0.065 and for Closure Alternative 2 the risk reduction is 0.046.



Section 6: Grade-Separated Railroad Crossing Analysis

Replacement of a north/south oriented at-grade crossing with a grade separation bridge was investigated in an effort to improve overall railroad crossing safety in the City of Circleville. Several existing at-grade crossing locations were initially evaluated for possible reconstruction with grade separation: S. Court Street (#481416R), S. Pickaway Street (#481415J), S. Washington Street (#481414C) and Clinton Street (#481413V), all by Huston Street. It was assumed, for this analysis, that Huston Street would be closed from S. Court Street east to Clinton Street.

The four crossing locations were reduced to two locations for further investigation. Clinton Street was identified as one of the alternatives for analysis from the City of Circleville because of a planned development, Pickaway Progress Park, south of the railroad off Clinton Street. The crossing located on S. Court Street was eliminated due to the associated increase in construction cost that would be required to tie in Huston Street to the west of the grade separation. This connection would require additional retaining walls to raise Huston Street to the elevated profile of S. Court Street. The second location eliminated was S. Washington Street. Daily traffic volumes on S. Washington Street are approximately half of the volume on S. Pickaway Street, thereby making the location at S. Pickaway Street a more desirable location for this improvement to railroad crossing safety. The S. Pickaway Street crossing also serves the greatest number of school buses on a typical school day of the four crossings considered.

Further investigation of the two selected alternatives, Location A – S. Pickaway Street and Location B – Clinton Street, required preliminary assumptions to establish a project impact and associated construction costs for each location. The assumptions are:

- Each crossing would be a simple span bridge with abutments supported on mechanically stabilized earth (MSE) walls. This arrangement eliminates the need to place piers in between the sets of railroad tracks and also reduces the overall footprint of the bridge.
- The abutments were set at the required minimum clear distance from the centerline of the outer most tracks. According to the Public Project Manual of Norfolk Southern, the minimum required vertical clearance window over the railroad has a height of 23 feet and a width set 6 feet off the centerline of each of the outermost tracks.
- Roadway widths were determined by either maintaining the existing width or meeting the minimum requirements of the ODOT Location and Design Manual.
- Grades were held to a six percent maximum based on the requirements of the ODOT Location and Design Manual and past project experience.
- MSE walls would be used to reduce the impacts to surrounding houses and businesses. Where property would be impacted even with the use of MSE walls, the use of grading was investigated in lieu of retaining walls to reduce the construction cost.

The required structure span at crossing Location A – S. Pickaway Street is approximately 145 feet. The existing roadway pavement width, which provides one travel lane and on-street



parking in each direction, will be maintained along with sidewalks on either side of the road. The overall width of the road and the bridge was determined to be approximately 64 feet. The required distance needed to raise the road to span the minimum vertical clearance window over the tracks was calculated to be approximately 575 feet to the north and 600 feet to the south. **Figure 6-1** shows the approximate roadway and bridge plan limits along with the impacts to the surrounding properties for grade separation on S. Pickaway Street.

The crossing at Location B – Clinton Street requires a structure span length of approximately 130 feet. A preliminary roadway width including sidewalks on both sides of the road was assumed to be approximately 50 feet. The required distance needed to raise the road to span the minimum vertical clearance window over the tracks was calculated to be approximately 625 feet to the north and 600 feet to the south. The location of the grade separation was also assumed to have an alignment shift to the east. Shifting the alignment would reduce the impact to the surrounding houses and businesses. The crossing at this location will require additional site work for the parcel drive located southeast of the Barnes Avenue and Clinton Street intersection. This drive provides access for a number of organizations: Pickaway Area Rural Transit, Pickaway County Early Head Start, Haven House and a food pantry. **Figure 6-2** shows the approximate roadway and bridge plan limits along with the impacts to the surrounding properties.

For both S. Pickaway Street and Clinton Street, the intersections with E. Ohio Street will be impacted by the proposed grade separation. The extent of the impact has not been investigated as part of this report. However, for the purpose of this study, the impact is assumed to be equivalent for both locations. **Table 6-1** provides the preliminary construction cost for each grade separation alternative and **does not include costs associated with property and right of way acquisition nor modifications to the intersections with E. Ohio Street.**

Table 6-1: 2014 Cost Summary for Grade-Separated Railroad Crossing

Cost	Location A – S. Pickaway Street	Location B – Clinton Street
Structure	\$1,624,000	\$1,138,000
Retaining Walls	\$1,353,000	\$2,310,000
Roadway	\$742,000	\$512,000
Contingency (30%)	\$1,116,000	\$1,190,000
Total	\$4,835,000	\$5,150,000

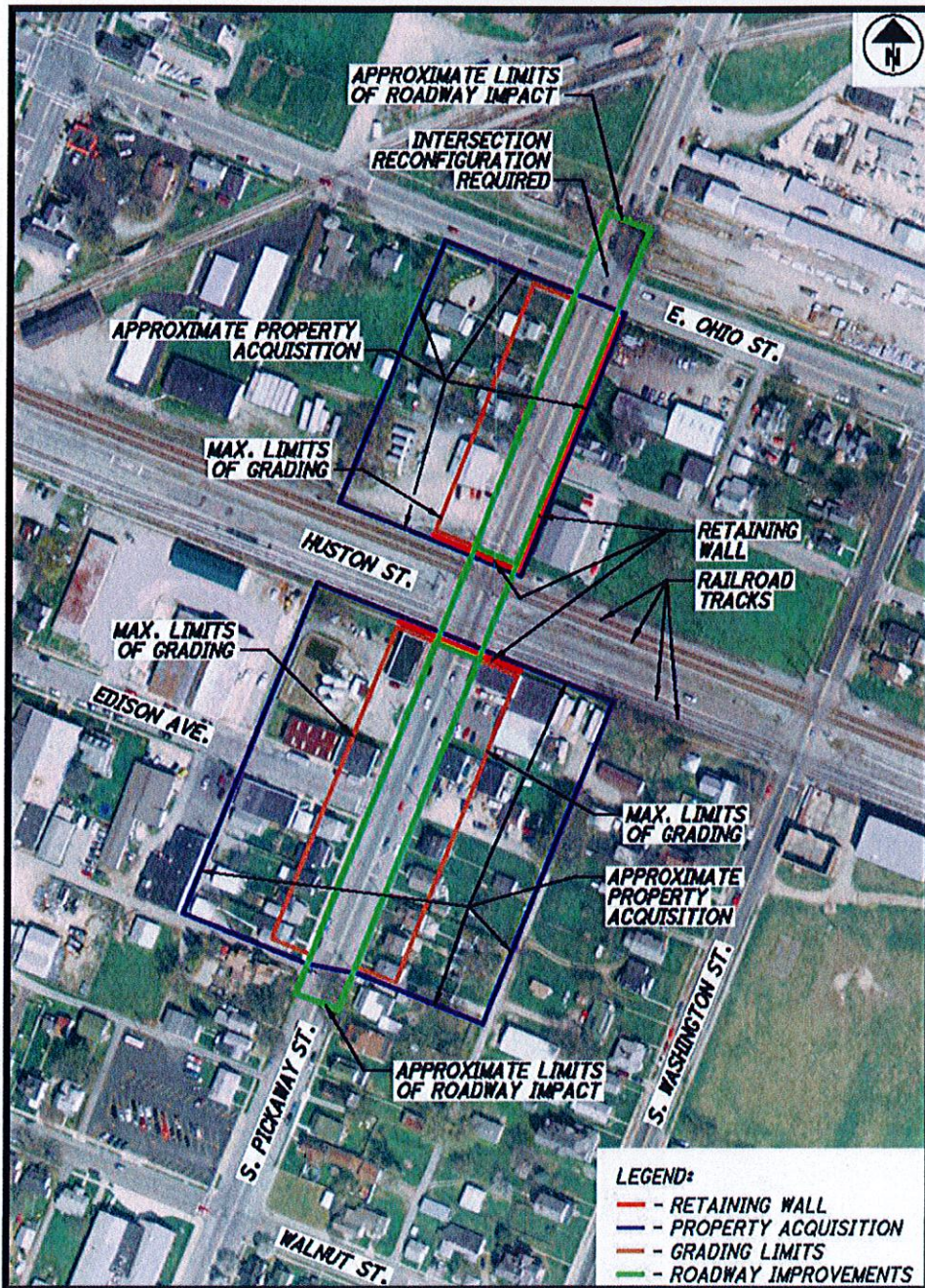


Figure 6-1: Location A – S. Pickaway Street Grade-Separated Crossing Concept

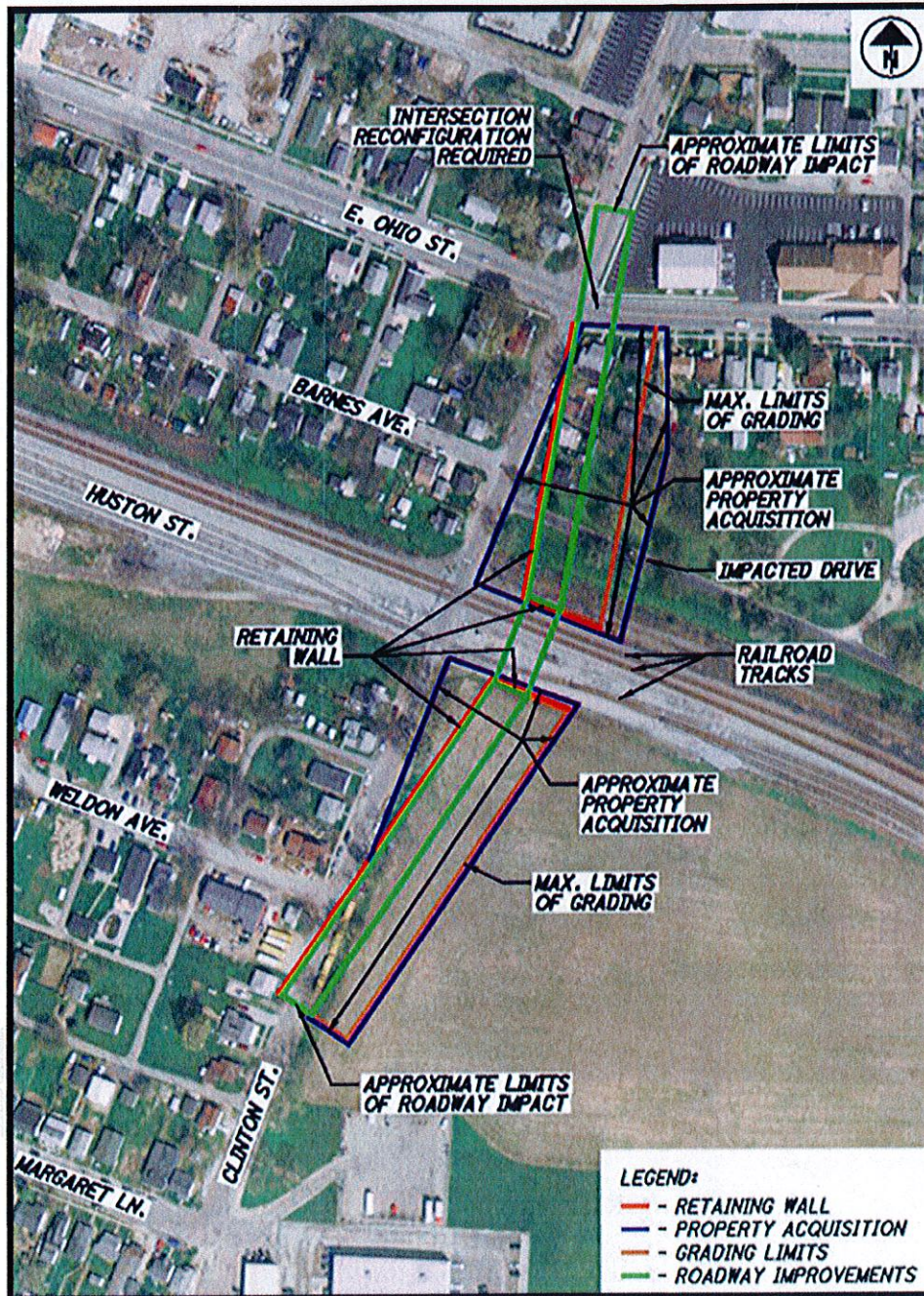


Figure 6-2: Location B – Clinton Street Grade-Separated Crossing Concept



Following a comparison of the two potential crossing locations, the recommended location for a north/south grade-separated crossing is Location B – Clinton Street. Though the construction cost for this location has been determined to be 6.5% greater and it is on a route that carries a lower traffic volume, the impact to and associated acquisition cost of the surrounding properties would be significantly less than the impact from Location A – S. Pickaway Street. Location B would provide the desired grade-separated north/south access for emergency crews and school buses along with potential for future connection to the redeveloped Pickaway Progress Park.

Table 6-2: Evaluation Matrix for Grade Separation Location

Evaluation Criteria	Location A – S. Pickaway Street	Location B – Clinton Street
Project Impact and Footprint – Property/ Right of Way (# of Parcel Impacts)	High (22)	Medium (9)
Traffic Volume (AADT)	High (4,126 vpd)	Low (1,094 vpd)
Crossing Safety – Accident Risk of Existing Crossing	Medium	Medium
Bridge Footprint (Span x Width)	High (145' x 64')	Medium (130' x 50')
Roadway Impact (Length North + South)	Medium (575' + 600')	High (625' + 600')



Section 7: Findings and Recommendations

Following the collection of data, evaluation of existing conditions, development of alternative closure scenarios, and evaluation of the closure alternatives, a recommendation for the closure of at-grade railroad crossings will be determined. The criteria used for the selection of the preferred alternative are: (1) cost, (2) capacity impacts, (3) travel time impacts, (4) Circleville services and special event impacts, and (5) relative safety benefits. Closure Alternatives 1 and 2, along with an additional closure alternative that has been added based on the analysis completed in **Section 5**, are ranked 1 to 3 for each criterion. The alternative with the lowest impacts is ranked first with a value of 1 and the alternative with the greatest impacts was ranked third with an assigned value of 3. Thus, the lowest total value indicates the alternative that minimizes the overall impacts.

Called the Revised Closure Alternative 2, the supplemental alternative is based on Closure Alternative 2 but includes closure of W. Ohio Street (#481418E) instead of S. Scioto Street (#481417X). The S. Scioto Street crossing (#481417X) has been replaced to make up this revised alternative due to its location along two school bus routes and the implications of its closure to the Other Line W. Ohio Street crossing (#482022E). All criteria were assumed to have equal weight. **Table 7-1**, the Closure Alternative Evaluation and Decision Matrix, presents this information.

As presented in **Table 7-1**, Revised Closure Alternative 2 has the lowest total impact score followed by Closure Alternative 2 and then Closure Alternative 1 as evaluated for the five selection criteria. The closure locations evaluated in Revised Alternative 2 are W. Ohio Street (#481418E), W. Mill Street (#481419L), Huston Street from S. Court Street to Clinton including the crossing (#482018P), and Harrison Avenue (#514843B).



Table 7-1: Closure Alternative Evaluation and Decision Matrix

Selection Criteria	Parameter	Evaluation			Ranking		
		Alt. 1	Alt. 2	Revised Alt. 2	Alt. 1	Alt. 2	Revised Alt. 2
Cost	Cost of safety modifications and upgrades to open crossings	\$1,656,000	\$1,745,000	\$1,566,000	3	2	1
	Cost of closures and vehicle turnaround construction	\$380,000	\$243,000	\$239,000			
Capacity Impacts	Number of intersections with a degradation to an unsatisfactory LOS	1	0	0	3	1	1
Travel Time Impacts	Increase in cumulative travel time during peak hours (minutes)	81	40	40	3	1	1
Public Services and Special Events	Number of closures with a medium or high impact to emergency services	2	0	0	3	2	1
	Number of closures on bus routes	1	1	0			
	Number of closures along a main route to Circleville Pumpkin Show	1	0	0			
Safety Impacts	WBAPS total crash risk of crossings to be closed	0.065	0.046	0.039	1	2	3
Total					13	8	7

Based on the appearance of the Other Line tracks and crossing on Harrison Avenue (#514843B), it is recommended that removal of the crossing be considered also. This section of tracks was not being used at the time of the field visit in August 2014 and there are no land uses or tracks southwest of the crossing that the spur tracks are serving. Closure of the crossing at Harrison Avenue (#514843B) would divert an estimated 875 vehicles per day to the crossing at S. Court Street (#481416R) and the intersection with Huston Street which is in within that crossing.

Thus, the recommendations from the closure analysis portion of this study are:

- Closure of the Other Line crossing at Huston Street (#482018P) and the closure of Huston Street from S. Court Street to Clinton Street for an estimated cost of \$15,000;



- Closure of the Main Line crossing at W. Ohio Street (#481418E) which is estimated to cost \$74,000 (including one emergency vehicle turnaround on the west leg;)
- Closure of the Main Line crossing at W. Mill Street (#481419L) for an estimated \$15,000 cost; and
- Closure or removal of the Other Line crossing at Harrison Avenue (#514843B) which has an estimated cost for closure of \$135,000 (including emergency vehicle turnarounds for both legs.)

Additional items that are recommended for further consideration through diagnostic reviews or supplemental engineering analysis include:

- Circuitry and LED light upgrades for the Main Line crossings that are expected to remain open at W. High Street (#481426W), W. Main Street (#481424H), W. Mound Street (#481421M), S. Scioto Street (#481417X), S. Court Street (#481416R), S. Pickaway Street (#481415J), S. Washington Street (#481414C), and Clinton Street (#481413V) for an estimated cost of \$1,200,000;
- Flashing lights at the Other Line crossings on S. Scioto Street (#482021X), S. Washington Street (#514837X), S. Pickaway Street (#514839L), and E. Ohio Street (#514840F) for an estimated cost of \$365,000;
- Crossbucks added to the traffic control for the southbound approach and a crossbuck assembly for the northbound approach to the W. Ohio Street Other Line crossing (#482022E);
- Advance preemption for the signalized intersection of Scioto Street and W. Main Street for the W. Main Street crossing (#481424H);
- Turn restriction blank-out signs on Canal Street and Western Avenue at the HC crossings on W. Mound Street, W. Main Street, W. High Street; and
- Evaluation of the advance warning clearance timing for the S. Court Street crossing (#481416R).

No records were found indicating the transfer of Canal Street from the City of Circleville to any of the railroad companies that have operated in this study area. A City map that was revised in 1938 indicates that Canal Street was abandoned which supports the consensus of Canal Street as private property.

The Clinton Street crossing (#481413V) was determined to be the most feasible location for a north/south grade-separated crossing. The property impacts are expected to be the least for this location compared to S. Pickaway Street, the other north/south crossing location that was evaluated.