

RIVERLANDS SAFETY STUDY

HARRISBURG AREA TRANSPORTATION STUDY
TRI-COUNTY REGIONAL PLANNING COMMISSION

JUNE 2016

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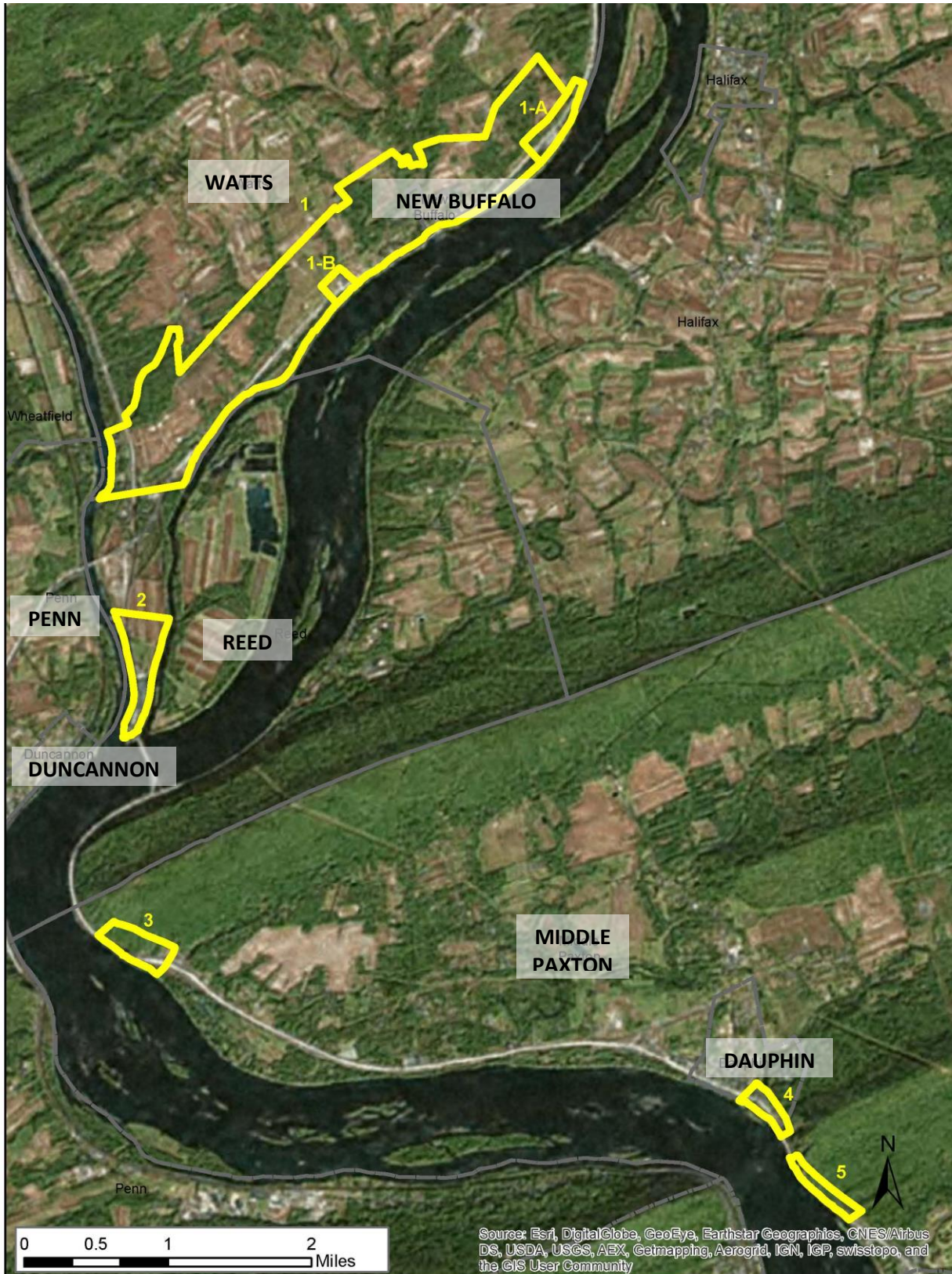
BACKGROUND AND STUDY AREA

The Susquehanna River Valley to the north of Harrisburg has presented transportation obstacles and opportunities since the earliest days of colonial settlement. The Dauphin Narrows through First Mountain is a historical bottleneck and the confluence of the Juniata and Susquehanna Rivers has been the site of ferries, the Pennsylvania Canal, railroads, and highways. Today this area hosts the primary routes north of Harrisburg, US 22/322 and US 11/15 which accommodate over 40,000 vehicles daily. North of Clarks Ferry the two routes join at an interchange at Amity Hall before separating to follow either the Juniata River or Susquehanna River northward. US 22/322 follows the course of the Juniata to the northwest toward Lewistown while US 11/15 exits the Harrisburg Area Transportation Study Metropolitan Planning Organization (HATS) region following the Susquehanna toward Selinsgrove.

Recently municipalities in Dauphin and Perry Counties, as well as the inter-county Cumberland Perry Task Force, have expressed concern about rising numbers of crashes along both of these routes. Preliminary analysis by Tri-County Regional Planning Commission (TCRPC) and its consultants has identified six distinct subareas of concern (See Figure 1).

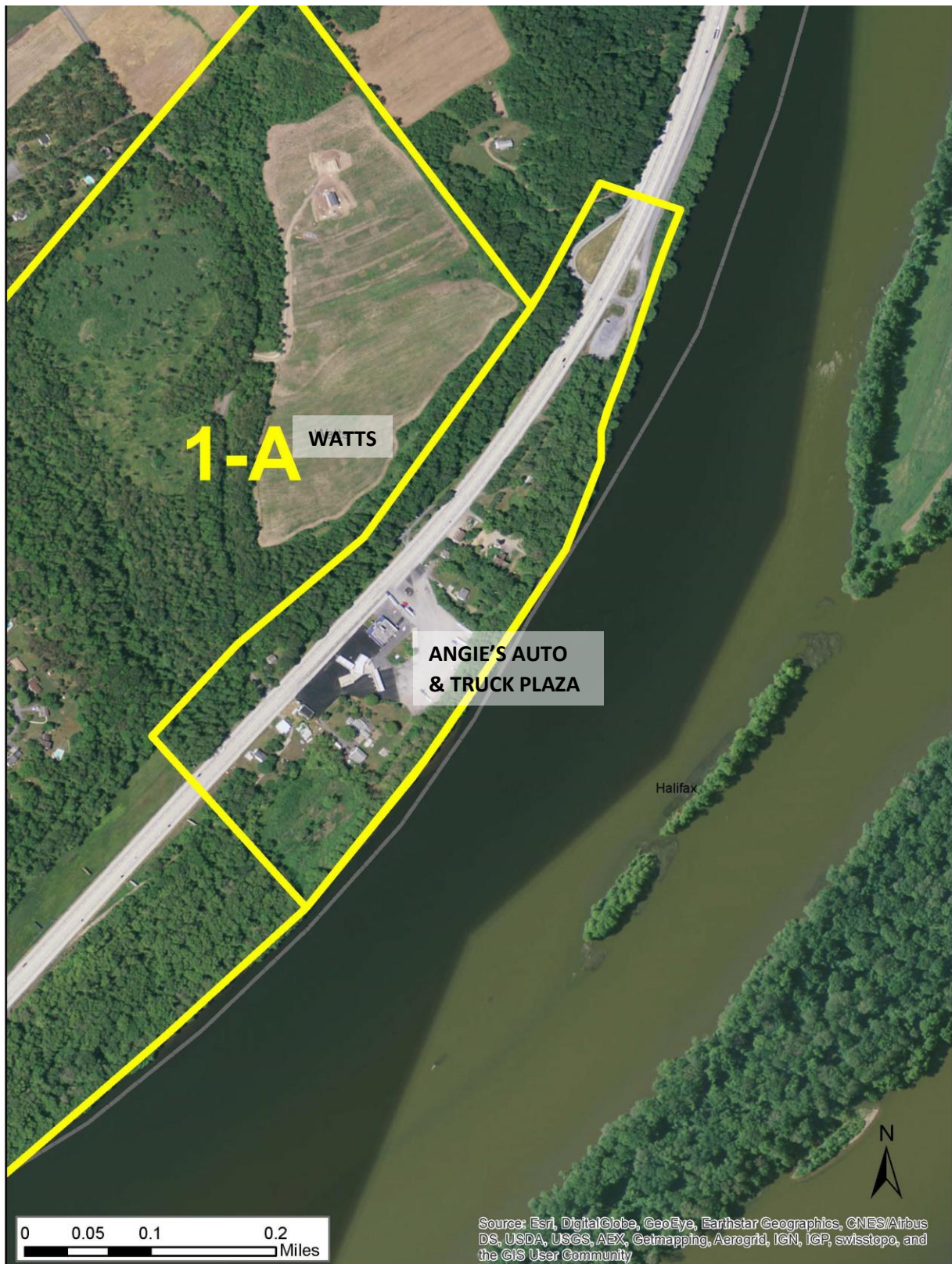
The purpose of this study will be to investigate existing safety and access concerns and, as warranted, develop a suite of improvements to improve safety on these corridors. The study also addresses concerns associated with potential future development along US 11/15 where the greatest amount of developable land along the corridor is found. An office safety review meeting followed by a field view of Area 2 was conducted on April 13, 2016. This meeting was attended by TCRPC, HATS, FHWA, PennDOT District 8-O, Pennsylvania State Police, local municipalities, citizens, etc. All ideas/thoughts/recommendations were summarized and incorporated into this report.

Figure 1 - Overall Study Area



AREA 1-A

Figure 2 - Area 1-A



DESCRIPTION

Area 1-A is a half mile long section of US 11/15 located in Watts Township, Perry County east of the US 22/322 interchange. The corridor has a posted speed limit of 55 MPH with two travel lanes in either direction with a shared center turn lane. There are commercial properties along the eastern side of the roadway.

PROBLEMS

There are major safety concerns leading to problems within Area 1-A including multiple access points throughout the commercial stretch with limited signage, poor lighting, and sudden cross traffic.

Crash data were analyzed between the years 2010 and 2014 and the most common types of reported crashes were found to be angle crashes and motorists hitting fixed objects, each comprising 36% of the total. See the table below of the overall crash breakdown.

Rear-End	Angle	Fixed Object	Unknown	Total	Fatal/Major Injury
3	5	5	1	14	1

The contributing actions for these crashes were also analyzed, with the most common factors being improper turns (27%) and distracted driving (20%). See the table below for the overall breakdown of contributing actions. Note, there may be more than one contributing action per crash.

Distraction	Affected by Physical Condition	Tailgating	Careless	Improper Turn	No Contributing Factor	Improper Driver Actions	Curve
3	1	1	2	4	2	1	1

ALTERNATIVES

RRPM, Pavement Markings and Signage: Due to the changes in roadway characteristics upon entering Area 1-A, it is recommended that there be an increase of signage for both the westbound and eastbound approaches to warn motorists of entering vehicles and upcoming cross traffic. Along with roadway signage, more defined signs at the access points are also required. In addition to signage, recessed reflective pavement markers (RRPM) should be considered throughout the corridor to help keep vehicles in their proper lane and better alert motorists of the travel lane they are utilizing. RRPM are extremely beneficial in poorly lit areas similar to the study location.

Lighting: The entire study area is poorly lit, both the roadway as well as the access driveways. With the volume of cross traffic and amount of motorists utilizing the shared center turn lane, the corridor would greatly benefit from increased lighting.

Consolidation of Access Points: The consolidation of the existing and future access points could provide much more defined access as this portion of the overall corridor develops over time. Hardscaped, channelized turn lanes with adequate storage could be placed within the existing center turn lane. This would not only provide a safer queueing location for vehicles waiting to enter or exit the sites, but also better alert oncoming motorists of clear

locations of cross traffic. It is strongly recommended that the Township consider completing either a comprehensive plan or defined corridor plan that focuses on future development of this area, including allowable uses, zoning districts, and the optimal location of access points. Implementation of this planning effort should then include various tools such as zoning, subdivision/land development standards, an official map, and/or coordinated Highway Occupancy Permit (HOP) policies and procedures.

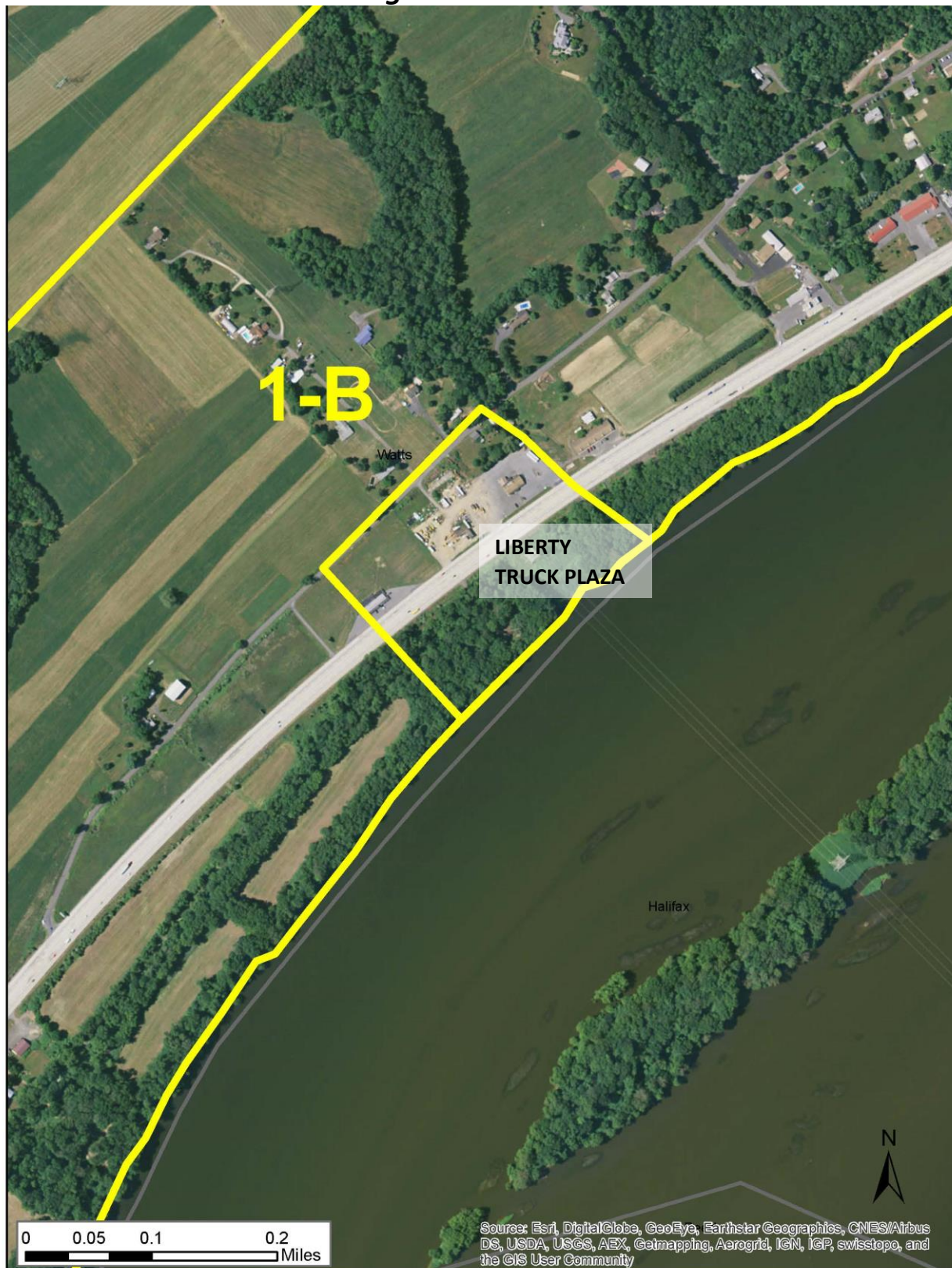
COST ESTIMATE MATRIX

Below is a summary of the costs associated with each of the aforementioned alternatives.

Description	Design Cost	Construction Cost	Total Cost
RRPM, Pavement Markings, & Signage	\$20,000	\$50,000	\$70,000
Lighting	\$20,000	\$200,000	\$220,000
Consolidation of Access Points	\$20,000	\$200,000	\$220,000

AREA 1-B

Figure 3 - Area 1-B



DESCRIPTION

Area 1-B is a 775-foot-long section of US 11/15 located in Watts Township, Perry County 1.5 miles east of the US 22/322 interchange. The corridor has a posted speed limit of 55 MPH with two travel lanes in either direction with a shared center turn lane. There are commercial properties along the western side of the roadway.

PROBLEMS

There are serious safety concerns within Area 1-B including multiple full access points throughout the commercial stretch with limited signage, poor lighting, and sudden cross traffic. The cross traffic comes as a surprise to motorists due to the change in roadway characteristics. There is minimal cross traffic both east and west of this commercial stretch. This can cause motorists to become alarmed when vehicles are entering the roadway.

As a part of the safety study, crash data was analyzed between the years 2010 and 2014. Although there were only 3 reported crashes within the study area, all of these resulted in major injury or fatality. Due to the limited number of collisions there was not a clear trend as to the contributing actions. However, it should be noted that these crashes all occurred prior to the development of the Liberty Travel Plaza.

Rear-End	Angle	Head On	Total	Fatal/ Major Injury
1	1	1	3	3

ALTERNATIVES

Consolidation of Access Points: The consolidation of the existing and future access points as described for Section 1-A could provide much more defined access as this portion of the overall corridor develops over time. Hardscaped, channelized turn lanes with adequate storage could be placed within the existing center turn lane. This will not only provide a safer queueing location for vehicles waiting to enter or exit the sites, but also better alert oncoming motorists of clear locations of cross traffic.

Collector Roadway: Old Trail Road is a local roadway located behind the commercial establishments that is parallel to US 11/15 and provides access to US 11/15 just south of the Liberty Travel Plaza. Upgrading this roadway to accommodate site traffic demand and consolidate access points could help limit the number of serious crashes involving motorists attempting to access the commercial options.

COST ESTIMATE MATRIX

Below is a summary of the costs associated with each of the aforementioned alternatives.

Description	Design Cost	Construction Cost	Total Cost
Consolidation of Access Points	\$35,000	\$350,000	\$385,000
Collector Roadway	\$25,000	\$250,000	\$270,000

AREA 1-A/B, Land Use Management

Land Use Management: A separate effort was undertaken for the broader US 11/15 corridor (Area 1 - See Figures 1, 4 and 5) to determine the approximate number of trips that could be generated if the corridor reached a built-out status. The number of new trips is substantial and would result in significant congestion and safety conditions if not managed as described above and if land use management controls are not implemented. More specifically, there are just under 900 acres of developable land (undeveloped areas outside floodplains and wetlands) with frontage on US 11/15 in Area 1. As indicated in the table below, this area is zoned for agricultural, industrial, residential and commercial development in the order of the available land in each zoning category. Using mid-range trip generation rates from the Institute of Transportation Engineers (ITE) Trip Generation Manual, these areas could reasonably generate nearly 66,000 trips per day when fully developed. This is over three times the current traffic volume on US 11/15.

Zoning	Acres	Lot Size and/or Lot Coverage	Trip Generation Rates	Trips/Day
Agricultural	536.62	2 acre min lot size (single family dwellings used as most likely development type in this zone)	10 trips/day/lot	2,683
Commercial	47.66	0.5 ac w/ public sewer, 50% lot coverage	assume 20% building coverage with 30% parking area, 90 trips/day/1000 s.f. (High quality restaurant as per ITE (mid-range))	37,367
Industrial	202.07	0.5 ac w/o public sewer, 50% lot coverage	assume 20% building coverage with 30% parking area, 13.63 trips/day/1000 s.f. for truck terminals)	23,994
Residential:	97.55			
R1	56.35	1.5 ac w/o public sewer	10 trips/day/lot	376
R2	41.20	10,000 s.f. lots w/ public water & sewer	(4.4 units/ac, with .8 development potential factor)	1,450
Total Acres	883.90			
Total Trip Generation				65,870

Not only should Watts Township consider zoning modifications to both the amount of commercial and industrial lands available, but other controls should be considered such as access management regulations, an Official Map, and other subdivision controls that could have a significant impact to the future operation of traffic along the entire US 11/15 corridor in the Township. As stated above, it is strongly recommended that the township, along with the

MPO, consider a comprehensive or corridor planning exercise that would result in a menu of land use Management controls to help ensure better safety and traffic conditions over the long-term.

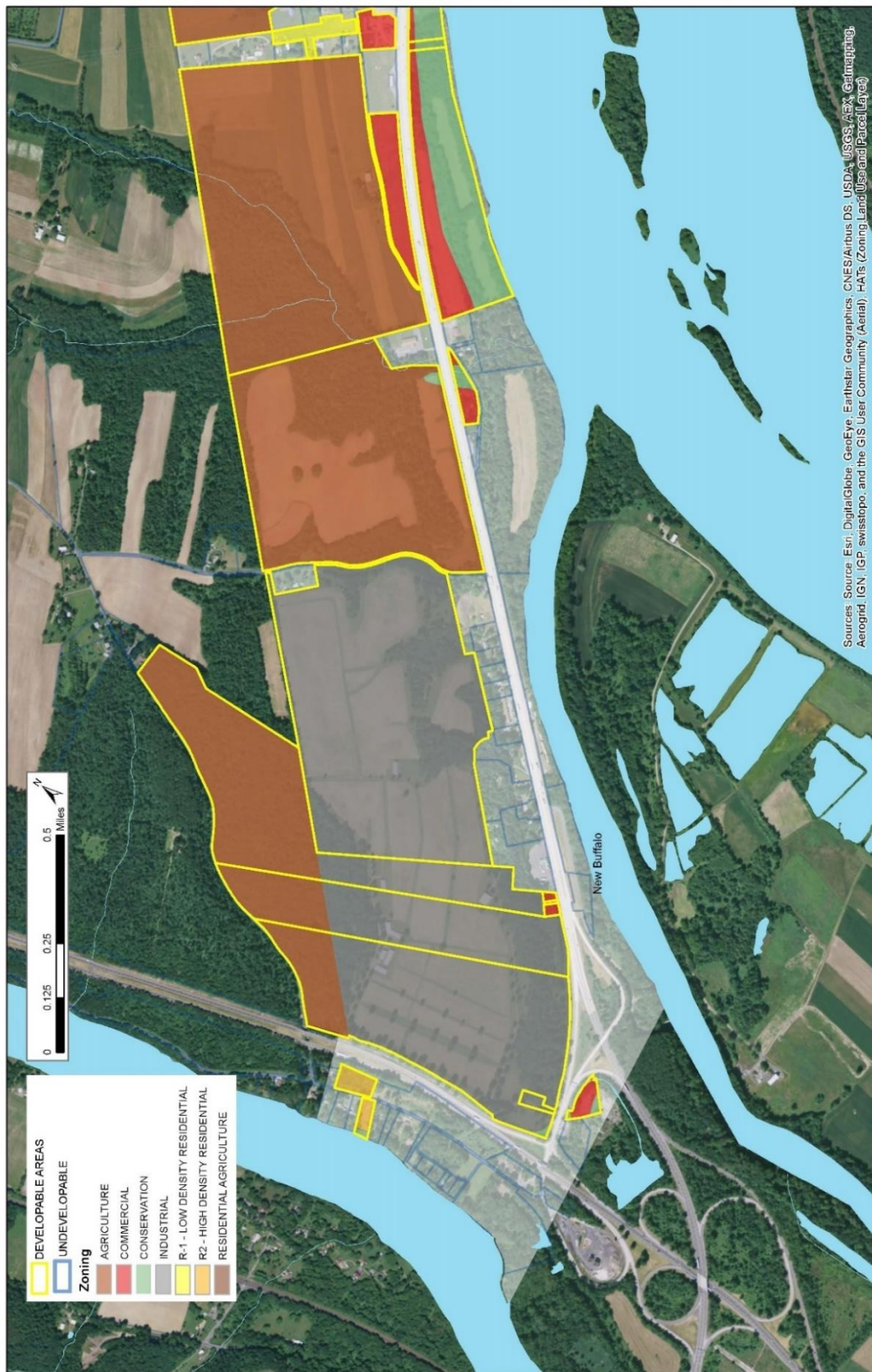


Figure 4 - Development Potential (Area 1 South)

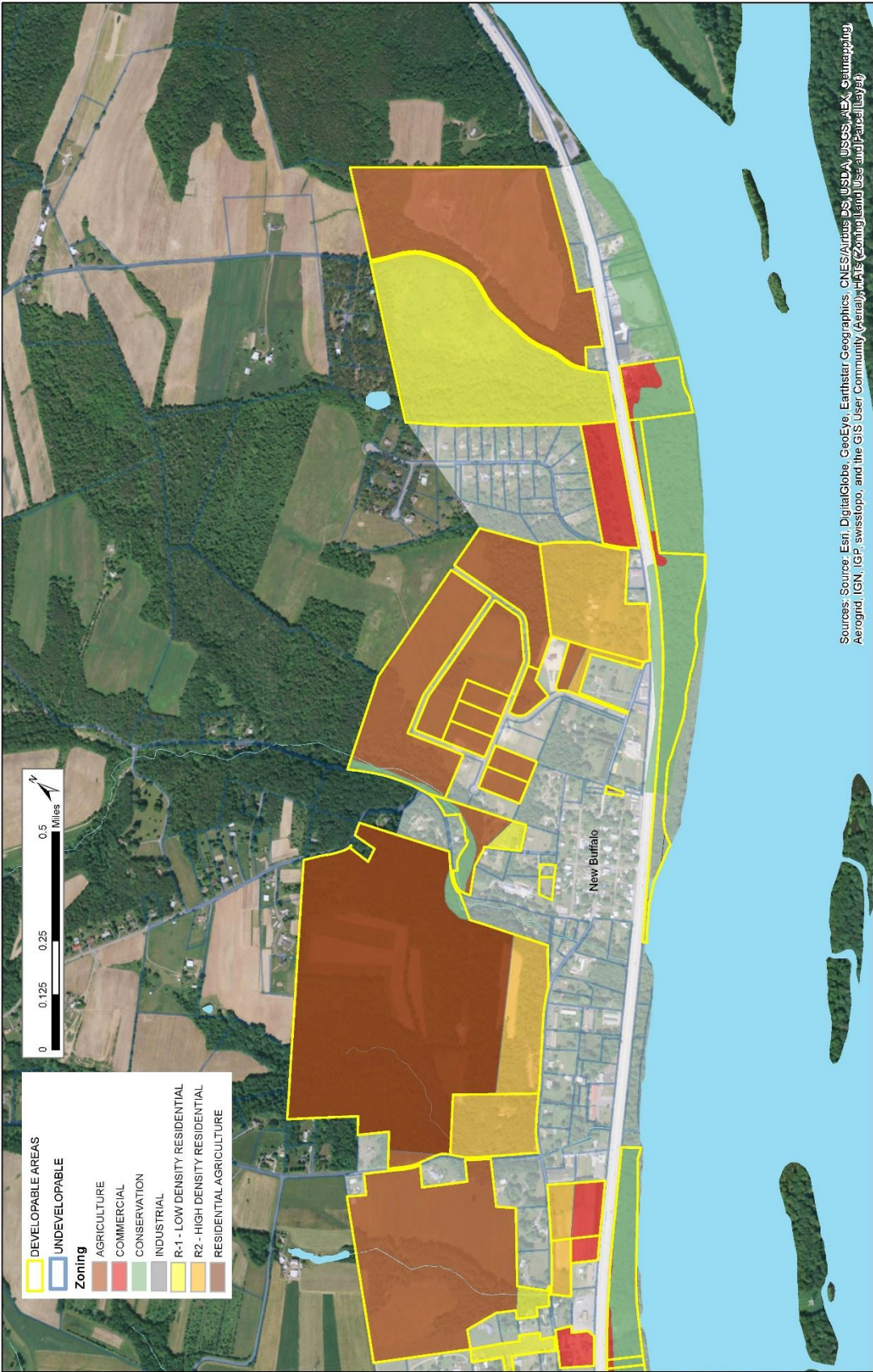


Figure 5 - Development Potential (Area 1 North)

While the analysis of future growth for this project was limited to the Watts Township portion of the study area, Middle Paxton Township participants in the field view expressed concern about similar growth potential originating in northern Dauphin County and entering Area 4 from Routes 147 and 225.

COST ESTIMATE MATRIX

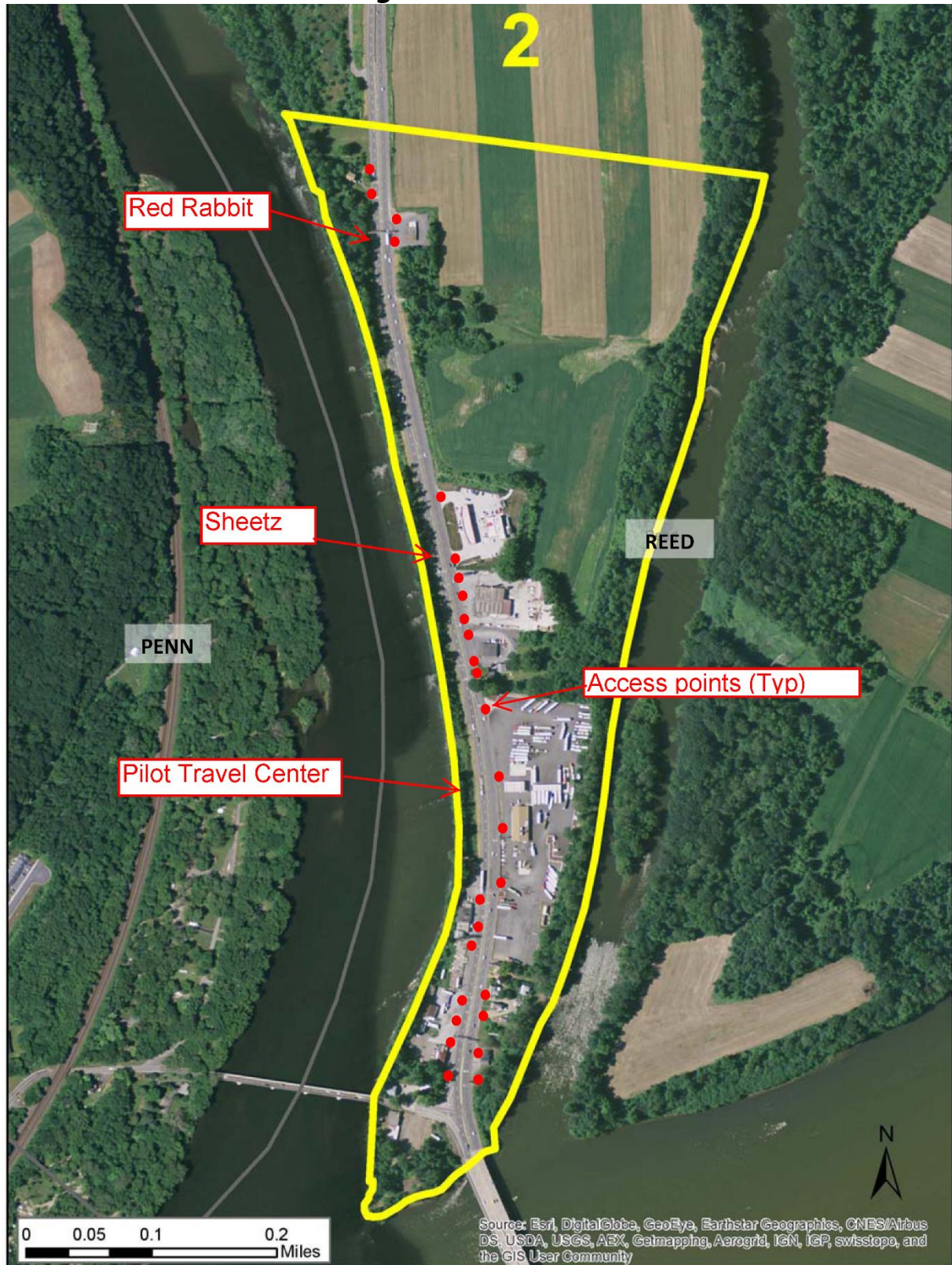
Below is a summary of the costs associated with the aforementioned task.

Description	Design Cost	Construction Cost	Total Cost
Land Use Management	n/a	n/a	\$30,000

AREA 2

Figure 6 – Area 2

● - Access Point



DESCRIPTION

Area 2 is a section of US 22/322 located in Reed Township, Dauphin County beginning at the intersection of Route 849 and US 22/322 (the western end of the Clarks Ferry Bridge) and extending half of a mile west, just past the Red Rabbit restaurant. The corridor has a posted speed limit of 45 MPH with two travel lanes in either direction with a shared center turn lane. Commercial properties are lining the eastern side of the roadway and are also scattered along the western side.

PROBLEMS

There are major safety concerns leading to problems within Area 2 including multiple access points throughout the commercial stretch with limited signage, poor lighting, sudden cross traffic, and accelerated speeds. The study team attempted to contact several property owners (Pilot, Sheetz, Red Rabbit) to ascertain their thoughts about existing safety conditions and any recommendations they may have for improving safety. As of the production of this report, no response has been provided by the property owners.

Although speed adjustment improvements have been completed by PennDOT leading into the corridor, vehicles are coming off of the Clarks Ferry Bridge and the portions of US 22/322 and US 11/15 further to the north travelling at much faster speeds than posted. This, coupled with a sudden change in roadway characteristics, is a large contributing factor to the number and type of collisions.

Crash data analyzed from 2010 through 2014 reveal that of the 78 reported crashes, the most common types are angle (59%) and rear-end (19%). See the table below of the overall crash breakdown.

Rear-End	Angle	Fixed Object	Non Collision	Same Direction Sideswipe	Opposite Direction Sideswipe	Head On	Pedestrian	Total	Fatal/Major Injury
15	46	5	1	4	3	3	1	78	6

The contributing actions for these crashes were also analyzed, with the most common factors being improper turns (59%), careless driving (13%), and speeding (8%). Although the data is not representative of the speeding issue, it is assumed that if the speed were to be monitored more frequently that there would be a decrease in the aforementioned contributing actions. The large number of businesses and access points along this section of roadway does provide a number of potential locations for police to monitor speed conditions, especially for westbound traffic. See the table below for the overall contributing actions breakdown.

Improper Turn	Sudden Stopping	Driving on Wrong Side of the Road	Careless Driving	No Contributing Action	Distracted	Tailgating	Speeding	Improper Driver Actions
46	1	3	10	5	1	5	6	1

ALTERNATIVES

Alternatives were broken up into three different types, short-term, mid-term, and long-term. Short-term alternatives consist of immediately implementable low cost, high benefit options. Mid-term alternatives are more intensive options generally resulting in either higher cost or longer periods of implementation. Any alternative categorized as long-term is a high cost option accompanied with a much longer period of implementation.

Short-Term Alternatives

RRPM, Pavement Markings and Signage: Due to the changes in roadway characteristics upon entering Area 2, it is recommended that there be an increase of signage for both the westbound and eastbound approaches to warn motorists of entering vehicles and upcoming cross traffic. Along with roadway signage, more defined signs at the access points are also needed. In addition to signage, recessed reflective pavement markers (RRPM) should be considered throughout corridor to help keep vehicles in their proper lane and better alert motorists of the travel lane they are using. RRPM are extremely beneficial in poorly lit areas similar to the study location. Although Area 2 was recently repaved and striped (2015), there are many opportunities for increased striping to help further enforce the speed change that occurs entering and exiting the corridor.

Median Barrier: As previously mentioned, the highest percentage of crashes that occur in Area 2 are of the angle type, the majority of which are caused by vehicles turning left to enter or exit business establishments. There are 27 points of access within the approximately 4,000-foot corridor available to motorists via a shared center left turn lane (See Figure 6). While a median barrier would eliminate access to the many businesses in this section for eastbound traffic and force any drivers wishing to exit the businesses travelling eastbound to utilize the nearby interchange, the design and construction of a concrete glare screen barrier would eliminate the left-turn issue and greatly lessen the number of crashes.

Lighting: The entire study area is poorly lit, both the roadway as well as the access driveways. Despite 65% of the crashes in Area 2 occurring during daylight, roadway lighting is strongly recommended. It is common practice to incorporate lighting along corridors that differ from the typical section of roadway, which is the case in this situation. With the volume of cross traffic and amount of motorists utilizing the shared center turn lane, corridor safety would greatly benefit from increased lighting.

Land Use Management: As it stands, Area 2 is not zoned. With the limited amount of available land along the corridor, zoning modifications may have limited impact on the frontage lots except in the case of redevelopment, but could impact the overall corridor by managing growth throughout the remainder of Reed Township. Whether or not zoning controls are considered, access management regulations, an Official Map, and other subdivision controls could have significant impact to the immediate corridor and should be seriously considered as improvements to the existing properties are proposed over time. It is recommended that the Township be made aware of these land use management options and the potential benefits along the corridor and throughout the municipality.

Mid-Term Alternatives

Advanced Congestion Electronic System (ACES): ACES consists of variable message sign activated detectors in the roadway within the study area that alert approaching motorists of excessively slow speeds or congestion ahead. This should assist in lowering the number of rear-end collisions.

Consolidation of Access Points: As mentioned above, there are 27 points of access within the approximately 4,000-foot corridor available to motorists via a shared center left turn lane. The consolidation of these could provide much more defined access to the commercial establishments throughout the corridor. While it would require longer design and construction time than the barrier proposed as a short-term alternative, hardscaped, channelized turn lanes with adequate storage could be placed within the existing center turn lane. This will not only provide a safer queueing location for vehicles waiting to enter or exit the sites, but also better alert oncoming motorists of clear locations of cross traffic. It would also provide some opportunity for eastbound traffic to access the businesses along the east side of the roadway.

Additional Turn Lane: The entrance to the Pilot Travel Center is located in the eastern portion of the study area within close proximity to the Clarks Ferry Bridge. Truck drivers travelling westbound entering the site are forced to decelerate rapidly causing westbound traffic to nearly come to a stop, backing up onto the bridge. There is currently a full width shoulder along the westbound travel lanes. Converting this shoulder into an ingress/egress lane throughout the corridor would provide a deceleration lane for westbound vehicles entering the sites. In addition, it could also function as an acceleration lane for those vehicles exiting and merging with westbound traffic.

Long-Term Alternative

US 22/322 Business: The long-term solution could involve an access road, “US 22/322 Business”, behind the commercial establishments along the eastern side of the roadway with limited access to US 22/322. There are a number of rundown, possibly abandoned, structures at the western end of the Clarks Ferry Bridge. Construction of such an access road would require razing these structures to provide space for an exit ramp for westbound vehicles wishing to access the businesses along the eastern side of the roadway. Reentry for westbound traffic would be provided with a ramp located west of the Sheetz. A conceptual design for this alternative is shown on Figure 7, although a number of alternatives may be developed in a preliminary design stage. Consideration should then be given to modifying or eliminating the existing access points along US 22/322, with a median barrier installed throughout the corridor forcing all local traffic to utilize US 22/322 Business. This alternative may prove challenging to implement from design and environmental perspectives, with floodplains, wetlands, wastewater discharge facilities, and Game Commission ownership of the lands north of Sheetz all posing significant constraints.

COST ESTIMATE MATRIX

Below is a summary of the costs associated with each of the aforementioned alternatives.

Short-Term Improvements			
Description	Design Cost	Construction Cost	Total Cost
RRPM, Pavement Markings, & Signage	\$11,250	\$60,000	\$71,250
Median Barrier	\$45,000	\$250,000	\$295,000
Lighting	\$52,500	\$300,000	\$352,500
Land Use Management	\$100,000	n/a	\$100,000

Mid-Term Improvements			
Description	Design Cost	Construction Cost	Total Cost
ACES	\$55,000	\$250,000	\$305,000
Consolidation of Access Points	\$97,500	\$500,000 - \$750,000 (\$75,000 - \$100,000/Location)	\$597,500 - \$797,500
Turn Lane	\$45,000	\$175,000	\$220,000

Long-Term Improvements			
Description	Design Cost	Construction Cost	Total Cost
US 22/322 Business – Access Road	\$3,100,000	\$31,000,000	\$34,100,000

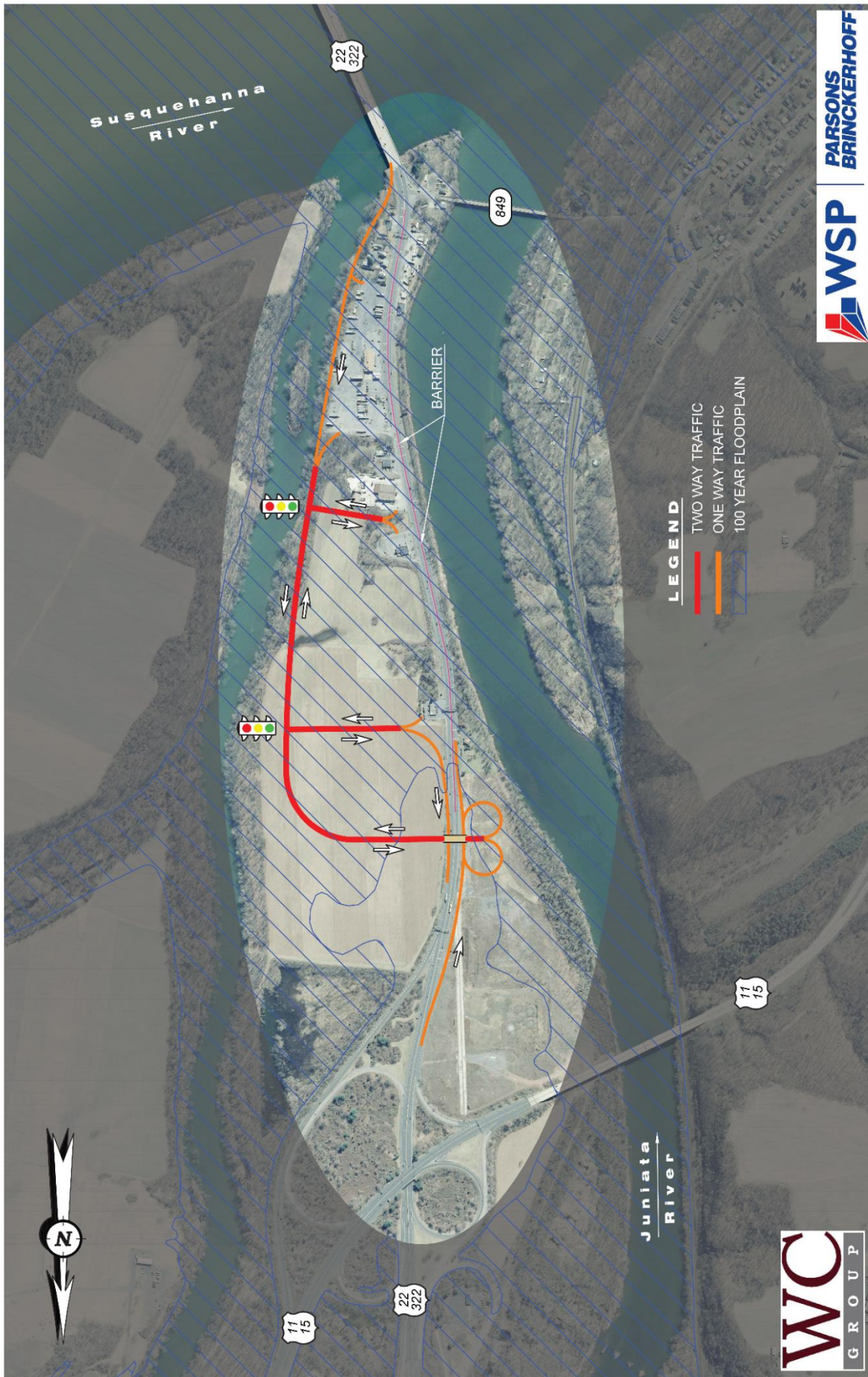


Figure 7 - US 22/322 Business Conceptual Design

AREA 3

Figure 8 - Area 3



DESCRIPTION

Area 3 is a section of US 22/322 located in Middle Paxton Township, Dauphin County. The corridor begins at the US 22/322 overpass of Mountain Road (SR 325) and continues 2,500 feet west. US 22/322 is a divided highway with a two travel lanes in either direction and has a posted speed limit of 55 MPH within the study area.

PROBLEMS

Throughout Area 3, missing lane delineation, overall lack of interchange lighting, and accelerated speeds all contribute to the safety concerns.

Of the 29 reported crashes between the years 2010 to 2014, the most common type is motorists hitting fixed objects (62%). Compared to other segments of US 22/322, the overall volume of collisions is not excessive, however the number of crashes that resulted in a major injury or fatality reach 10% of the total crashes. See the table below for a summary of existing safety conditions.

Rear-End	Angle	Fixed Object	Non Collision	Same Direction Sideswipe	Unknown	Total	Fatal/Major Injury
2	2	18	2	2	3	29	3

The contributing actions for these crashes were also analyzed, the most common factors were speed (41%) and no contributing action (34%). These data indicate that increased speed enforcement in this area could have a significant impact in reducing overall crashes. The Route 325 on-ramp provides the most likely location for westbound speed enforcement in this area, while there is a lane to access a residence immediately north of Area 3 and a pull-off area immediately south of the Middle Paxton Township line that seem to provide the most likely locations for eastbound speed enforcement. See the table below for the overall contributing actions breakdown.

Affected by Physical Condition	Careless	Curve	Distracted	No Contributing Action	Other Improper Driver Actions	Speed	Sudden Slowing/Stopping	Unknown
1	3	1	2	10	3	12	1	1

ALTERNATIVES

RRPM: Due to the curvature in roadway throughout Area 3, it is recommended that recessed reflective pavement markers (RRPM) should be considered throughout corridor to help keep vehicles on the roadway and within their proper lane. RRPM are extremely beneficial in assisting motorists maneuver curves at higher speeds in poorly lit areas similar to the study location. RRPM being implemented within the study area has the potential to decrease the volume of angle and same direction sideswipe collisions in the future.

Reflective Markers: There is a lack of adequate lane delineation within the study area. Very similar to the RRPM, reflective markers placed along the top of the barrier greatly assist motorists to properly traverse the corridor. The implementation of reflective markers should decrease the number of motorists hitting fixed objects.

Lighting: The entire study area is poorly lit, both the roadway as well as entrance and exit ramps. With the location of the exit and entrance ramps in relation to the roadway curvature, increased lighting could greatly increase the safety and operation of the interchange. Poor lighting at the nearby intersection with Gap View Road should also be evaluated alongside the issues associated directly with the interchange.

COST ESTIMATE MATRIX

Below is a summary of the costs associated with each of the aforementioned alternatives.

Description	Design Cost	Construction Cost	Total Cost
RRPM	\$30,000	\$150,000	\$180,000
Reflective Markers	\$7,500	\$50,000	\$57,500
Lighting	\$45,000	\$300,000	\$345,000

AREA 4

Figure 9 - Area 4



DESCRIPTION

Area 4 is a section of US 22/322 located in Dauphin Borough and Middle Paxton Township, Dauphin County. The corridor is 1,600 feet in length beginning 1,000 feet east of the westbound Dauphin Borough exit and continues west just past the exit ramp. Within the study area, US 22/322 is a divided highway with two travel lanes in either direction and has a posted speed limit of 55 MPH.

PROBLEMS

Within Area 4 there is a railroad overpass which creates a tunnel effect for both the west and eastbound traffic. The eastbound motorists are traveling through a curve in the roadway and enter under the ill-lit and poorly delineated railroad overpass. In addition to the lighting and delineation issues there are damaged roadway features throughout the corridor including guiderail terminations and roadway conditions.

As a part of the safety study, crash data were analyzed between the years 2010 and 2014. Of the 44 reported crashes, the most common type are motorists hitting fixed objects (71%). Although a number of crashes occur in the direct vicinity of the overpass there is no indication the clearance height is an issue. It should be noted that 73% of the reported collisions occur in the eastbound travel lanes. See the table below of the overall crash breakdown.

Rear-End	Fixed Object	Non Collision	Same Direction Sideswipe	Head On	Unknown	Total	Fatal/Major Injury
3	31	1	7	1	1	44	2

In addition to the types of crashes, any trending factors within the data were analyzed. It was discovered that 84% of the crashes in Area 4 occurred while the roadway was either wet, icy, slushy or snow covered. This could be a result of poor drainage due to the elevation of the inverts within the stormwater drainage system in reference to the height of the Susquehanna River, especially under flooding conditions. Historically as the river rises, water is pushed back into the drainage system, which then overflows onto the roadway. During the April 2016 field view to discuss this report's preliminary findings, township officials noted that during extreme flooding events that US 22/322 has been completely shut down in this location due to the depth of water on the roadway. The study team reached out to Susquehanna River Basin Commission and they shared the following: "the flooding impacts along 322 at the railroad underpass are due to the crest elevation of the Susquehanna River during a major flood event. A major flood event typically equates to a 100-year storm event. When the Susquehanna River crests above 23.0' the water will begin to flood the railroad underpass along US 22/322. In the past 20 years the Susquehanna River has crested above 23.0' (major flood event) 4 times (1996, 1996, 2004, 2011)." Additionally, the bridge over Stony Creek is not delineated and signed as a bridge and motorists are likely unaware of the potential icing during freezing conditions. Refer to the table below of the overall roadway crash condition breakdown.

Snow	Wet	Ice	Dry	Slush	Water
5	23	6	7	1	2

Of the crashes that occurred when the roadway was wet (icy, slush, snow, water) the majority of them happened during January and November. The table below is monthly breakdown of these collisions.

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
6	3	4	1	2	1	1	1	5	4	6	3

Another trend observed was that speed was a factor in 66% of the crashes. See the table below for an overall breakdown of the contributing factors. These data indicate that increased speed enforcement in this area could have a significant impact in reducing overall crashes. The Route 225 on-ramp to US 22/322 eastbound provides the most likely location for eastbound speed enforcement in this area. The railroad overpass in the southern portion of this area significantly limits westbound speed monitoring opportunities for westbound traffic in the immediate vicinity. Westbound speed monitoring may have to take place as indicated for Area 5.

No Contributing Action	Speed	Driving Wrong Way on 1-Way	Other Improper Driver Actions	Curve	Careless
4	29	1	5	1	4

Lastly, Middle Paxton Township participants in the field view for this project expressed significant concern over existing and possible worsening congestion through the railroad overpass, given significant growth potential from Watts Township and northern Dauphin County. Township officials recommended consideration of the elimination or enlargement of the overpass to provide additional capacity as congestion worsens over time.

ALTERNATIVES

RRPM, Pavement Markings and Signage: Due to the curvature of the roadway and overpass/ramp locations, increased signing, striping and recessed reflective pavement markers (RRPM) could help keep motorists in the correct lane and on the roadway. In addition to pavement markings, signage informing traffic of narrowing roadway conditions and structures could help lower the volume of crashes.

Lighting: The entire study area is poorly lit, both the roadway as well as the westbound exit ramp. With the location of the ramp in relation to the railroad overpass and roadway curvature, increased lighting could greatly improve the safety and operation of the interchange. There was temporary lighting installed at the Dauphin exit which has since been removed. Consideration should be given to the installation of permanent LED lighting in this location.

Guiderail Improvements: The guiderail at the westbound exit into Dauphin Borough, although seemingly reconstructed, could benefit from delineation and a new end treatment. As it stands, 30% (13) of the crashes in the westbound direction are vehicles colliding with the guiderail.

Roadway Improvements: As previously mentioned, there is damaged roadway throughout the corridor. There are issues with the settlement of the roadway in the eastbound and westbound travel lanes causing a rollercoaster effect. Improvements to the subbase layer of roadway would be needed to improve these conditions.

Drainage Assessment: As previously mentioned, 84% of the crashes in Area 4 occurred while the roadway was either wet, icy, slushy or snow covered and could be a result of a poor drainage system. A detailed assessment of existing drainage conditions and alternatives for drainage improvements should be conducted and implemented.

COST ESTIMATE MATRIX

Below is a summary of the costs associated with each of the aforementioned alternatives.

Description	Design Cost	Construction Cost	Total Cost
RRPM, Pavement Markings, & Signage	\$20,000	\$50,000	\$70,000
LED Lighting	\$30,000	\$300,000	\$330,000
Guiderail Improvements	\$5,000	\$10,000	\$15,000
Roadway Improvements	\$57,000	\$570,000	\$627,000
Drainage Assessment	\$75,000	n/a	\$75,000

AREA 5

Figure 10 - Area 5



DESCRIPTION

Area 5 is a section of US 22/322 located in Middle Paxton Township, Dauphin County. The corridor begins at the entrance ramp from Fishing Creek Valley Road (SR 443) to westbound US 22/322 and continues 4,250 feet (approximately 0.8 miles) west. US 22/322 is a divided highway with a two travel lanes in either direction and has a posted speed limit of 55 MPH within the study area.

PROBLEMS

One of the biggest issues in Area 5 is the deteriorated state of a retaining wall along the westbound travel lanes. Beneath the crumbling stone wall is a lateral drainage system stretching the length of the wall. The existing wall is not properly protecting the drainage system from debris such as branches, leaves and other material sliding down the slope towards the roadway. This debris causes drainage problems and could be effecting the functionality of the entire drainage system, potentially causing safety hazards for motorists and cyclists. Additionally, rocks and other debris are periodically found on and along the roadway, potentially contributing to fixed object and other crashes.

Crash data analyzed between the years 2010 and 2014 indicates that the most common types of crashes are motorists hitting fixed objects (62%) and rear-end collisions (17%). See the table below of the overall breakdown of crash data.

Rear-End	Angle	Fixed Object	Non Collision	Same Direction Sideswipe	Opposite Direction Sideswipe	Unknown	Total	Fatal/Major Injury
10	2	36	1	6	1	2	58	1

Of the aforementioned crashes, speed was considered the top contributing action (52%), while “No Contributing Action” made up 17%. See the table below for the overall breakdown of contributing actions. These data indicate that increased speed enforcement in this area could have a significant impact in reducing overall crashes. The Route 443 on-ramp provides the most likely location for westbound speed enforcement in this area. The steep riverbank that restricts the possible shoulder width limits the opportunities for eastbound speed enforcement in the immediate area, so monitoring may be restricted to the Route 225 location as described for Area 4.

Lastly, participants in the field view noted that poorly lit and limited signage in the area of North Front Street has led to some drivers inadvertently entering Route 22/322 in the wrong direction in the eastbound lanes.

Speed	30
No Contributing Action	10
Affected by Physical Condition	4
Driving Wrong Way on 1-Way	1
Tailgating	1
Curve	1
Careless	4
Distracted	2
Unknown	1
Other Improper Driver Actions	3
Sudden Slowing/Stopping	1

ALTERNATIVES

Reconstruction of Retaining Wall: Due to the state of the retaining wall, it is proposed to reconstruct the approximately 2,000 linear foot wall. It is also recommended that a rock catch fence be constructed on top of the retaining wall which could provide a higher level of protection from debris falling onto the roadway. Being that the most common crash type within the study area is the hitting of fixed objects, this percentage is anticipated to decrease by limiting the amount of objects in the travel lanes.

Drainage Assessment/Improvement: As previously mentioned, the linear drainage system is currently covered with debris from the hillside, which slopes down to the retaining wall. Therefore, the exact condition of the drainage system is unknown. It is recommended that the drainage system be cleaned out after the retaining wall is reconstructed and its condition evaluated and improved as necessary. Of the reported crashes within Area 5, 53% occurred when the roadway was either wet, slushy, icy or snow covered.

RRPM, Delineation, Glare Screen: Recessed reflective pavement markers (RRPM) should be considered throughout the corridor to help keep vehicles in their proper lane and better alert motorists of the travel lane they are using. In conjunction with RRPM, given the nature of the majority of the collisions, side mounted delineation is recommended, as well as the addition of a vertical blade glare screen.

Lighting: The entire study area is poorly lit, most notably at the exit for North Front Street in Area 5. Increased lighting and possibly increased or improved signage could greatly improve the safety and operation in this area. Consideration should be given to the installation of permanent LED lighting in this location.

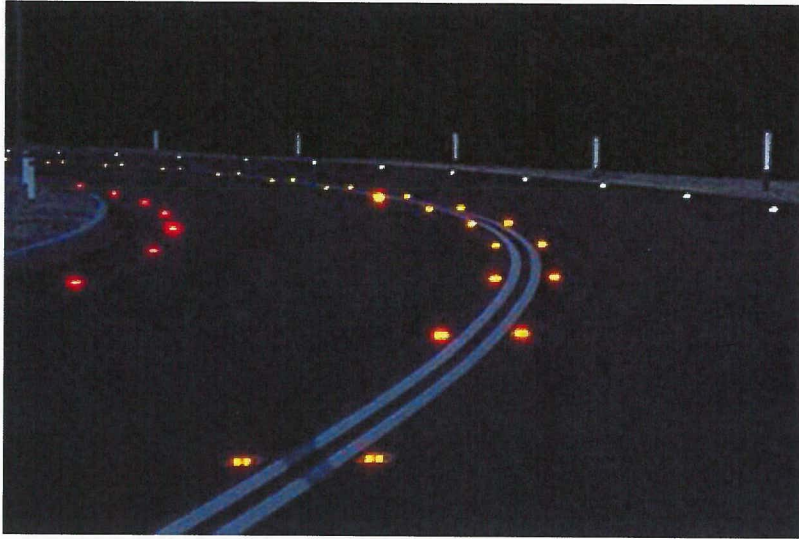
COST ESTIMATE MATRIX

Below is a summary of the costs associated with each of the aforementioned alternatives.

Description	Design Cost	Construction Cost	Total Cost
Clean Up Debris and Tree Trimming	n/a	n/a	\$20,000
Shotcrete Existing Wall Face	\$7,500	\$75,000	\$82,500
Reconstruction of Retaining Wall	\$52,500	\$525,000	\$577,500
Drainage Assessment/Improvement	\$75,000	TBD	TBD
RRPM, Delineation, Glare Screen	\$20,000	\$50,000	\$70,000
LED Lighting	\$30,000	\$300,000	\$330,000

Appendix A:

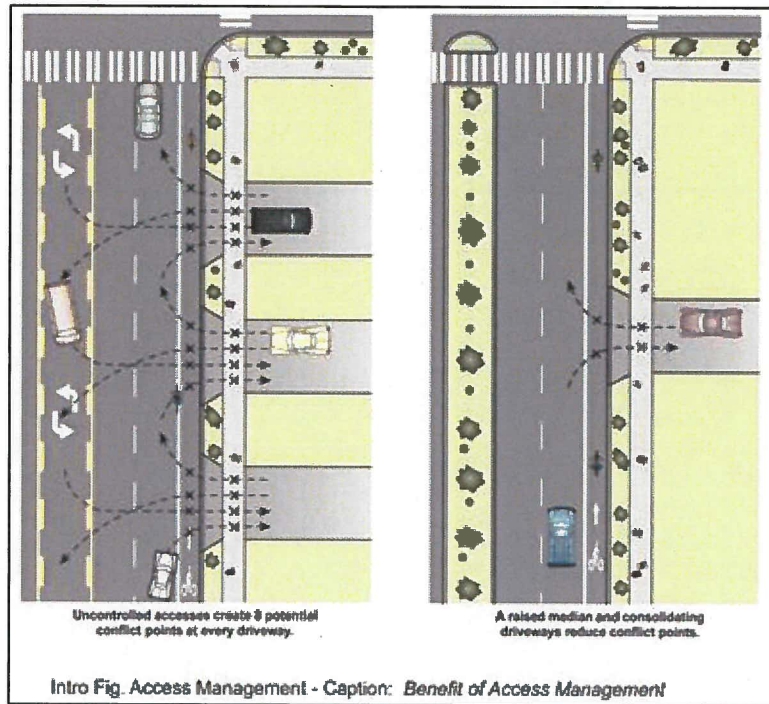
Exhibits of Proposed Improvements



Recessed Reflective Pavement Markings (RRPM)



Example of LED Lighting - Before & After



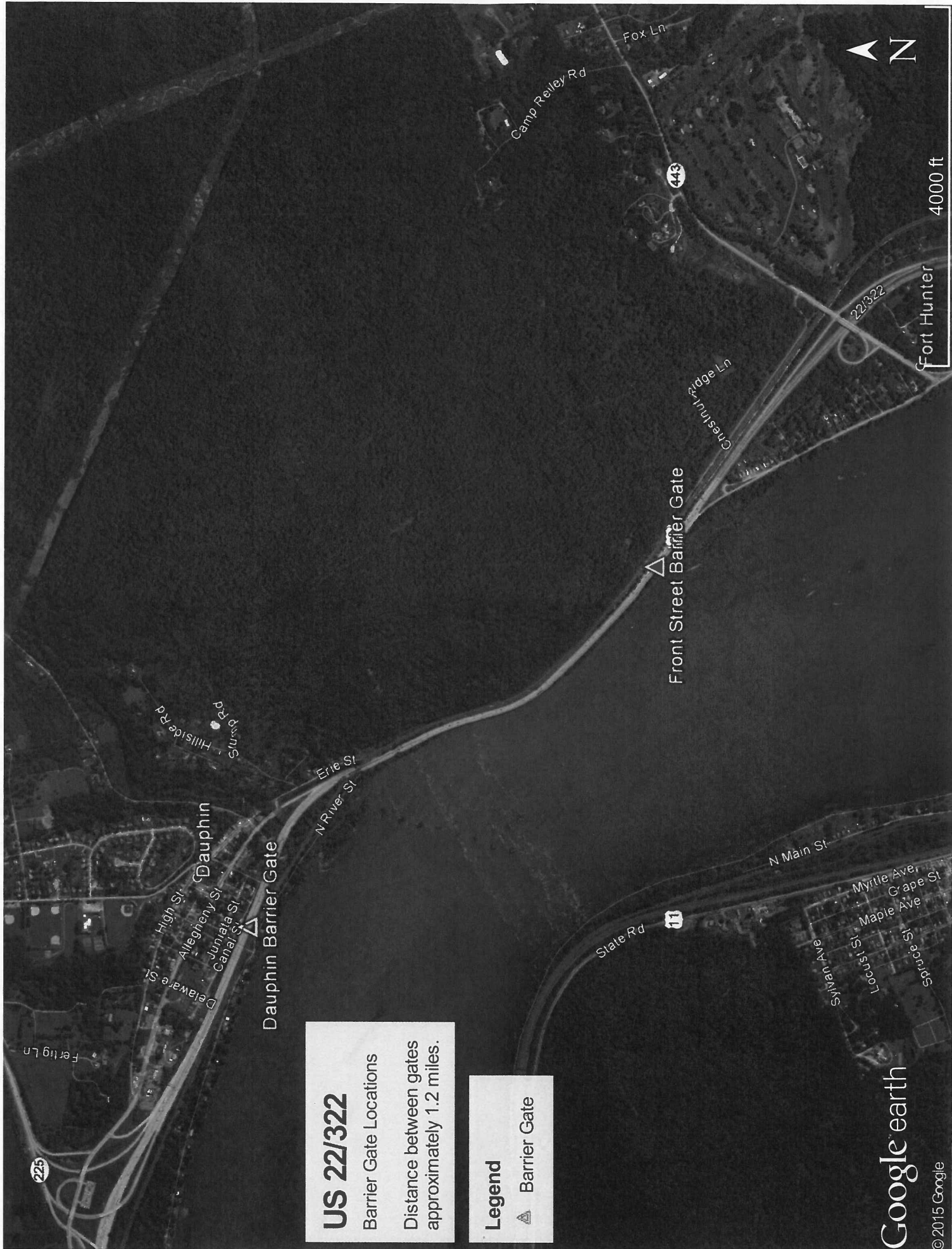
Example of Consolidation of Access Points



Example of Proper Guiderail End Treatment

Appendix B:

Contraflow Improvements



US 22/322

Barrier Gate Locations

Distance between gates approximately 1.2 miles.

Legend

 Barrier Gate

Google earth

© 2015 Google

Appendix C:

2040 Travel Demand Model

HATS Travel Demand Model Growth Rates for Riverlands Safety Study Corridors

Route 22/322												
	Route 443 (Fishing Creek Valley Rd) to 225 (Peters Mountain Rd)			Route 225 (Peters Mountain Rd) to Route 325 (Mountain Rd)			Route 325 (Mountain Rd) to Route 147 (River Rd)			Route 147 (River Rd) to Route 849 (Market St)		
	EB	WB	Total	EB	WB	Total	EB	WB	Total	EB	WB	Total
% Change 2017 to 2040	11.0%	7.9%	9.5%	15.1%	10.2%	12.7%	14.8%	10.4%	12.7%	19.6%	15.6%	17.6%
% Change Per Year	0.5%	0.3%	0.4%	0.7%	0.4%	0.6%	0.6%	0.5%	0.6%	0.9%	0.7%	0.8%

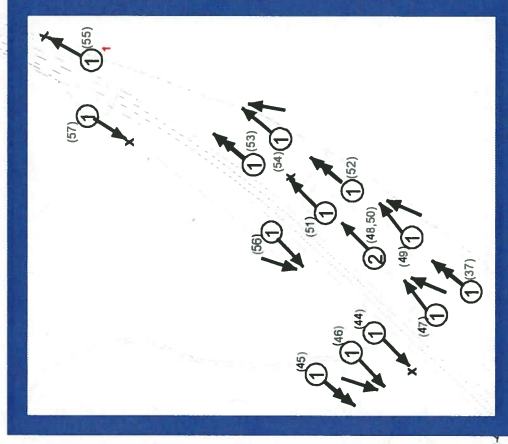
Route 11/15				
Route 22/322 to Route 1023 (Market St)		Route 1023 (Market St) to Jug Handle		
NB	SB	NB	SB	Total
24.6%	25.0%	25.7%	26.1%	25.9%
1.1%	1.1%	1.1%	1.1%	1.1%

Appendix D:

Crash Diagrams

FOR INTERNAL USE ONLY

AREA 1-A



LEGEND

(1) Crash Record Identifier

○ # crashes

1 - Count of Fatal and Major Injury Crashes

→ Rear End

↗ Angle

→ Hit Fixed Object

↔ Non Collision

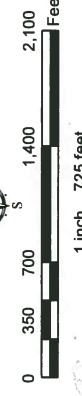
↗ Same Direction Sideswipe

↘ Opposite Direction Sideswipe

→ Head On

→ Hit Pedestrian

→ Unknown

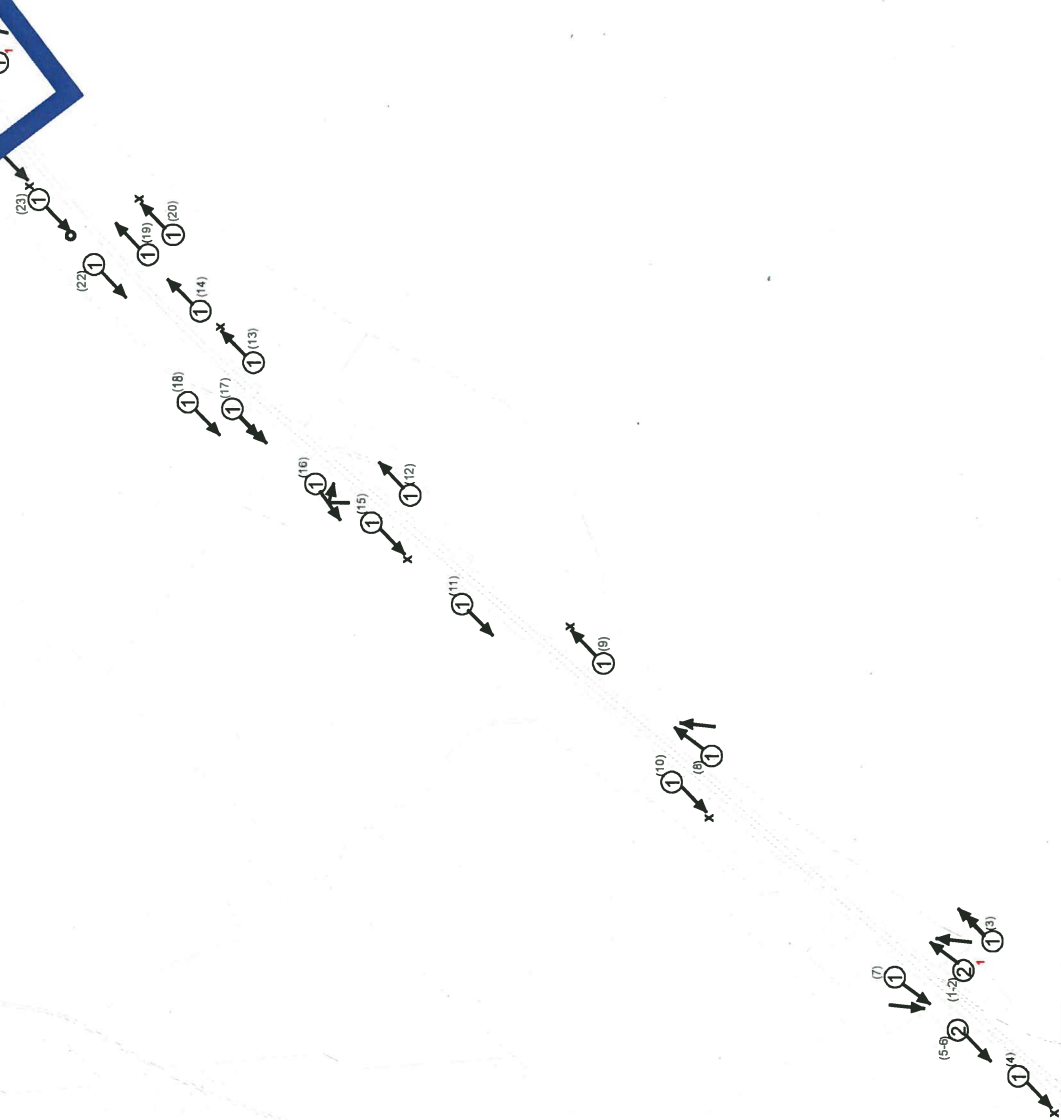
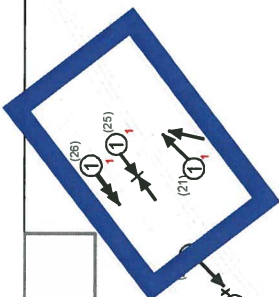


HATS

Data Source: PennDOT 2010-2014

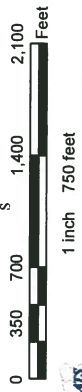
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AREA 1-B



LEGEND

- (1) Crash Record Identifier
- # crashes
- 1 - Count of Fatal and Major Injury Crashes
- Rear End
- Angle
- Hit Fixed Object
- Non Collision
- Same Direction Sideswipe
- Opposite Direction Sideswipe
- Head On
- Hit Pedestrian
- Unknown

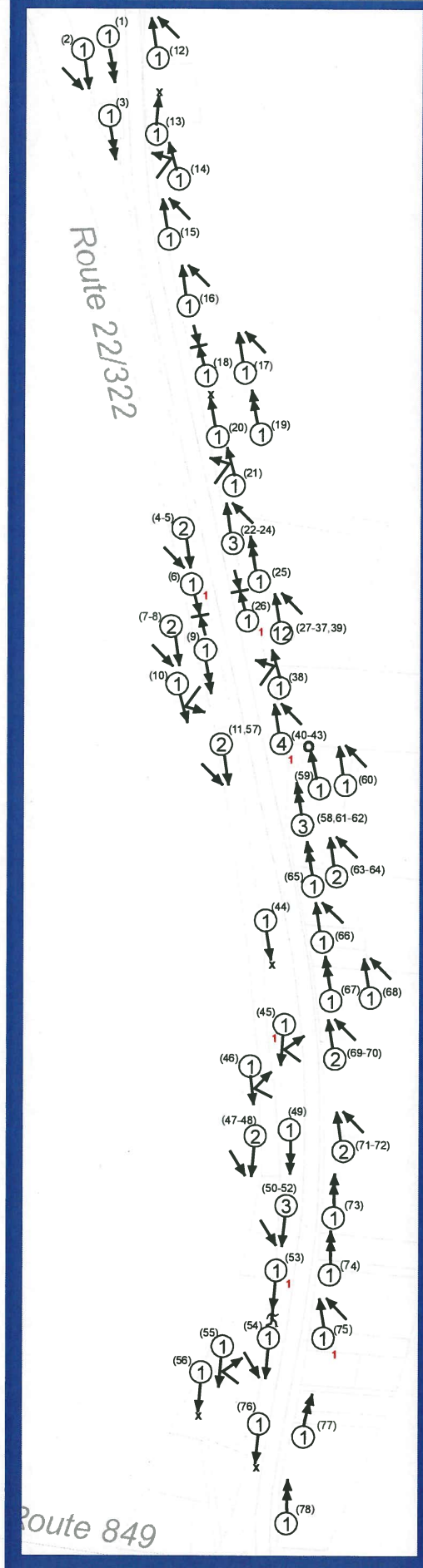
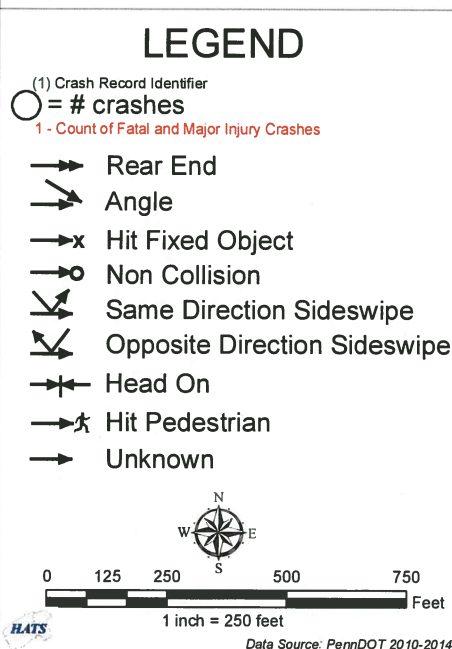


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AREA 2



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AREA 3

LEGEND

(1) Crash Record Identifier

○ # crashes

1 - Count of Fatal and Major Injury Crashes

→ Rear End

↗ Angle

→x Hit Fixed Object

→○ Non Collision

↗ Same Direction Sideswipe

↘ Opposite Direction Sideswipe

→ Head On

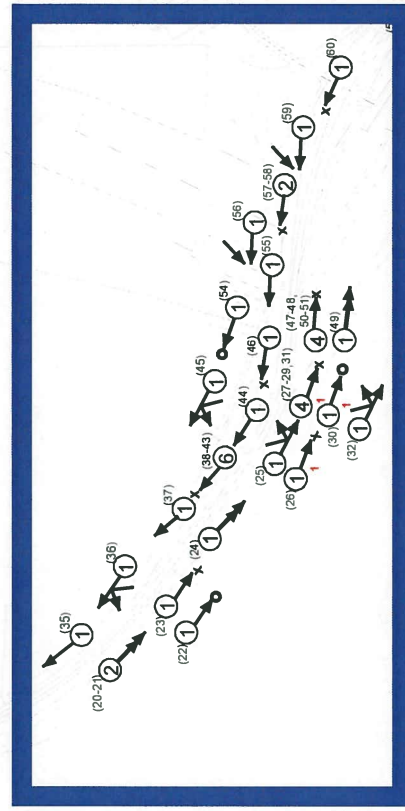
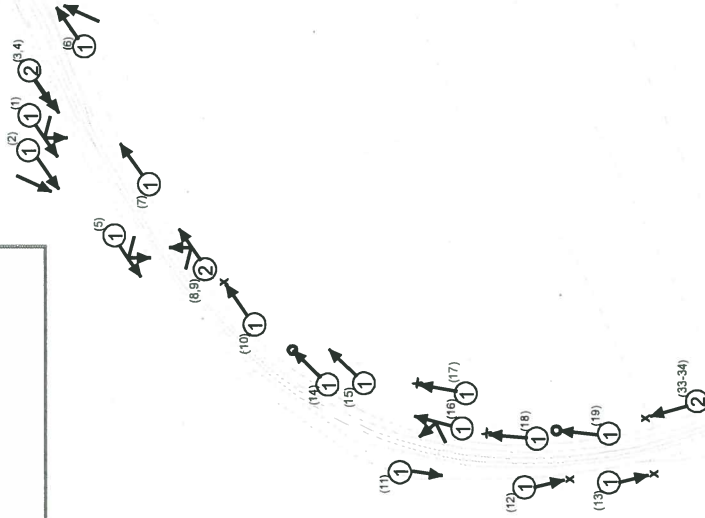
→x Hit Pedestrian

→ Unknown



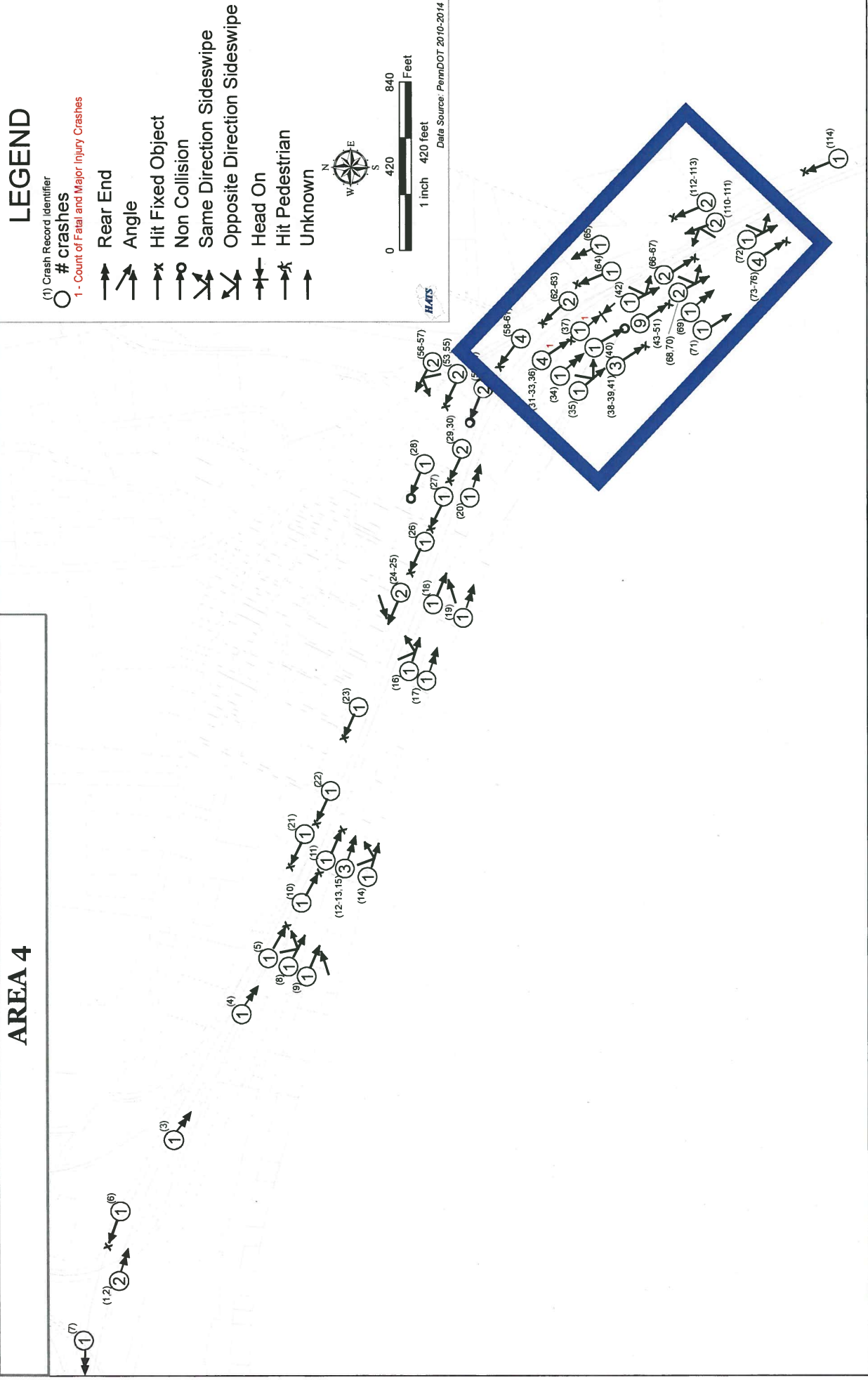
HATS

Data Source: PennDOT 2010-2014



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AREA 4



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AREA 5

LEGEND

(1) Crash Record Identifier

○ # crashes

1 - Count of fatal and Major Injury Crashes

→ Rear End

↘ Angle

→x Hit Fixed Object

→o Non Collision

↘ Same Direction Sideswipe

↗ Opposite Direction Sideswipe

→ Head On

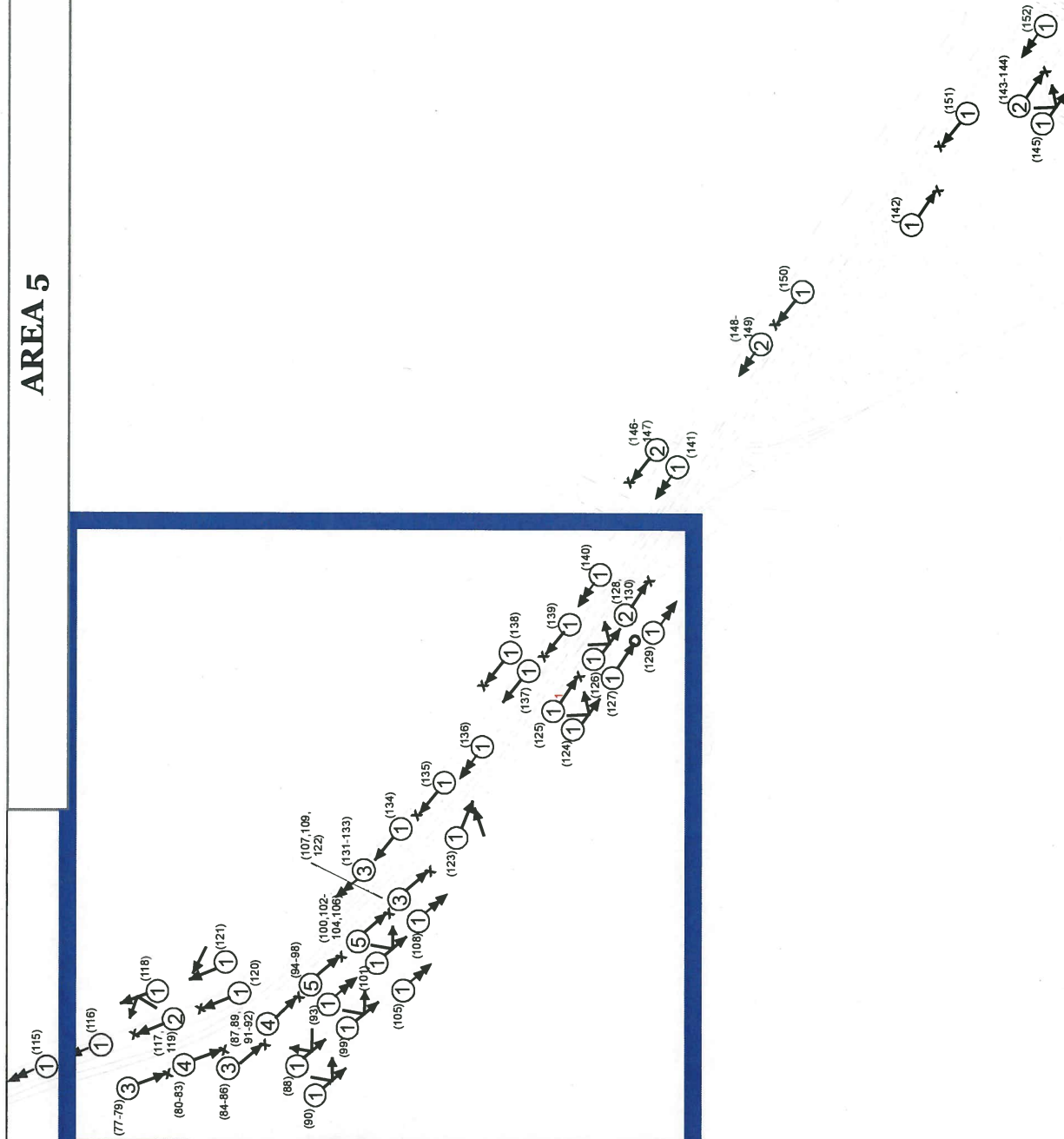
→* Hit Pedestrian

→ Unknown



HAATS

Data Source: PennDOT 2010-2014



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