

Road Safety Audit

**Lee Road and
Harvard Avenue
Intersection
City of Cleveland, Ohio**

April 2009

**Prepared By
Northeast Ohio Areawide
Coordinating Agency
1299 Superior Avenue
Cleveland Ohio 44114**



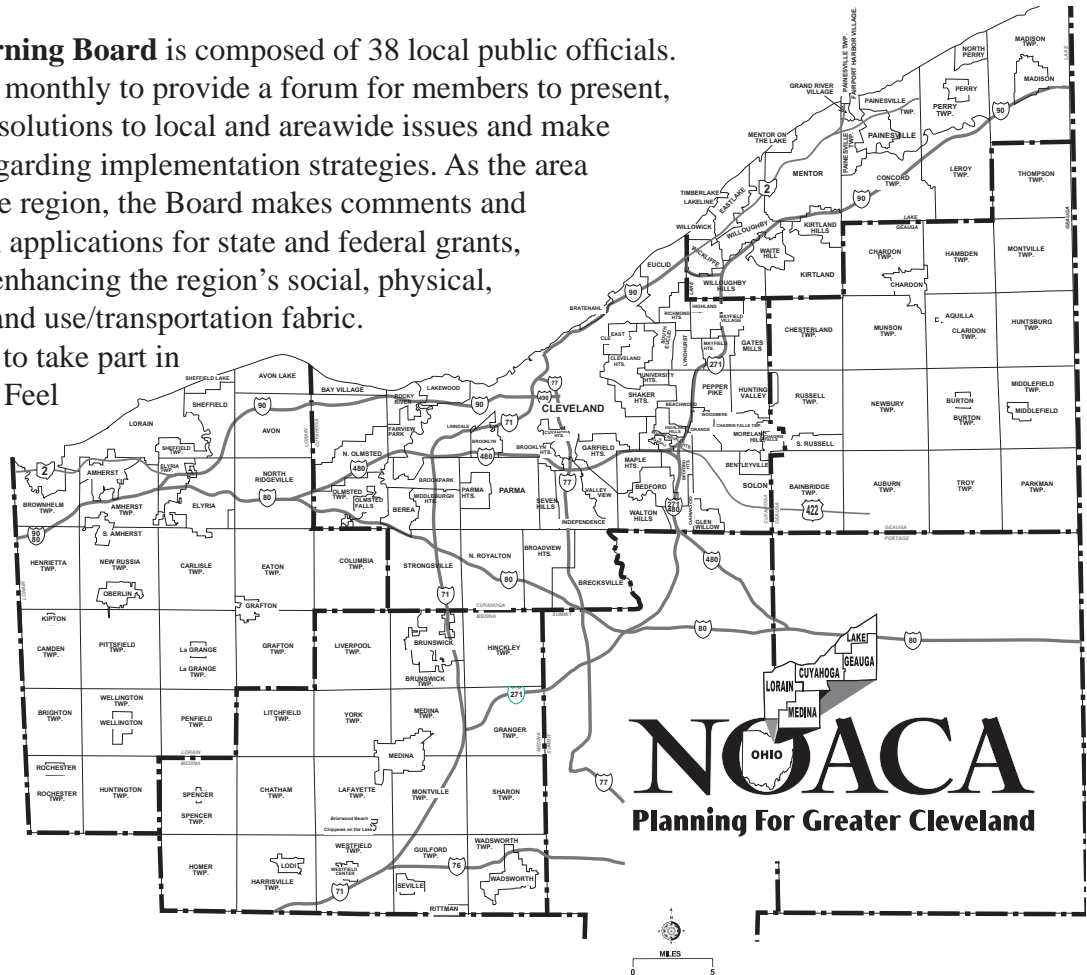
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- Perform continuous water quality, transportation-related air quality and other environmental planning functions.
- Administer the area clearinghouse function, which includes providing local government with the opportunity to review a wide variety of local or state applications for federal funds.
- Conduct transportation and environmental planning and related demographic, economic and land use research.
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- At NOACA Governing Board direction, provide transportation and environmental planning assistance to the 172 units of local, general purpose government.

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12) Abstracts This technical study report, known as a Road Safety Audit (RSA), was conducted for the intersection of Lee Road and Harvard Avenue by an RSA team. The team examined the prevailing physical and traffic conditions in and around the intersection to find opportunities for possible improvements to the intersection, particularly short term, low cost improvements, to reduce or eliminate potential traffic crashes.	
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City Of Cleveland, Ohio

April, 2009

Prepared by

NORTHEAST OHIO AREAWIDE COORDINATING AGENCY

Principal Author
Maher Holozadah,
Senior Transportation Engineer

WILLIAM GRACE
BOARD PRESIDENT

HOWARD R. MAIER
EXECUTIVE DIRECTOR

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<u>Table of Contents</u>	<u>Page</u>
The Roadway Safety Audit Team	7
Executive Summary	8
Background	10
Intersection Layout	11
Crash Analysis (Years 2005-2007 Crash Data)	13
Collision Diagram	17
Pre Audit Meetings	18
The Audit	19
Post audit Meetings	26
Findings and Recommendations	27
Appendices:	29
Appendix A: Glossary	30
Appendix B: Methodology for Ranking High Crash Locations	31
Appendix C: ODOT Improvement Cost and Term Range Categories	32

Members of the Roadway Safety Audit Team

The Road Safety Audit team for this intersection consists of the following persons:

Jim Armaline	Senior Planning Engineer	NOACA
Mona Aziz	Senior Transportation Engineer	NOACA
Maher Holozadah	Senior Transportation Engineer	NOACA
Sahar Tawfiq	Transportation Engineer	NOACA
Gary Grano	Senior Transportation Planner	NOACA
Mahmoud Al-Lozi	Principal Planning Engineer	NOACA
Andrew Cross, P.E.	Traffic Engineer	City of Cleveland, Ohio

Executive Summary

This Road Safety Audit (RSA) for the intersection of Lee Road and Harvard Road in Cleveland, Ohio is one of thirteen audits (RSAs) being conducted in the Northeast Ohio Areawide Coordinating Agency's (NOACA) region as part of the Safety Studies program for Fiscal Year 2009. The thirteen RSA locations selected for examination are those that ranked high among a group of high crash locations based on analysis of crash data that NOACA had previously performed for each of the five counties in the NOACA region.

Road safety audits are conducted by independent audit teams assembled for the purpose of examining hazardous or high crash locations to search for and evaluate opportunities for low-cost, short-term safety improvements. The audit team for this RSA consists of technical personnel from NOACA and the City of Cleveland.

The recommendations in this report range from low-cost, short-term remedial actions to intermediate and long range, high cost improvements. When these remedial actions or suggested improvements are implemented, they will improve the level of safety at the subject intersection. The primary improvement recommendations for this intersection are:

- Examine points of access to and from (ingress and egress) the businesses near or around the intersection;
- Work with Cleveland officials and property owners to develop an access management plan for the area surrounding the subject intersection that will be conducive to reducing the number of access points, and minimize potential traffic movement conflicts;
- Reduce the amount of lateral obstructions by removing, relocating or distancing them farther back from the edge of the roadway;
- Re-evaluate the suitability of the locations of bus stops and shelters;
- Re-examine the curvatures and layouts of the driveways serving the businesses adjoining the subject intersection;
- Re-align the North-South legs of the intersection when the time comes for major reconstruction;
- Widen all lanes, particularly the left-turn lanes, to bring the widths to at least the minimum standard;
- Remove all objects and shrubberies presently in quadrants obstructing the line of sight;
- Install a raised barrier or pylons in the center line of Lee Road to prevent left turns into adjoining businesses except at pre-designated access points;
- Reinstall/reinstate channelization islands within the driveways serving Walgreens and the BP gas station to impose right-turn only traffic flow;

- Stagger the stop bars for the left-turn bay and the Through & Right lane to provide more room for on-coming traffic turning from cross street approaches;
- Set stop bars back;
- Educate the owners of adjoining and adjacent businesses about the magnitude of the current crash problems at this location and invite them to work with the City on developing better alternatives to mitigate the current crash problem.

Background

A Road Safety Audit is a formal examination, performed by an independent and unbiased road safety audit (RSA) team, of conditions related to user safety within an existing or future road or intersection. The RSA team takes into consideration the safety of all road users, searches for opportunities for safety improvements, evaluates such opportunities, and writes a report that describes the safety issues the team has observed. The audit team, then, publishes its findings, conclusions, and recommendations.

This audit is part of the Northeast Ohio Areawide Coordinating Agency's (NOACA) safety studies program for fiscal year 2009 to help the Ohio Department of Transportation (ODOT) District 12 office fulfill work requirements concerning roadway improvements to increase safety.

The NOACA safety audit study program for FY 2009 includes thirteen RSAs for select locations throughout the NOACA region. These select locations ranked highest in a listing of high crash locations based on crash data analysis NOACA performed for each county in the NOACA region. The methodology NOACA used to rank the intersections is described in **Appendix B**. Other high crash locations in the listing that have been studied by ODOT or NOACA, or for which improvements have been suggested or implemented, have been precluded from consideration for auditing.

The steps for a road safety audit, taken from Federal Highway Administration (FHWA) Road Safety Audit Guidelines, are:

1. Identify the project or the road-in-service to be audited;
2. Select the RSA team;
3. Conduct pre-audit meeting(s);
4. Conduct field observations under various operating conditions;
5. Conduct audit analysis;
6. Present audit findings to project owner/design team;
7. Project owner/design team will be expected to prepare a formal response to the audit; and
8. Incorporate recommended improvements in the project plans when appropriate.

Intersection Layout and Average Daily Traffic (ADT)

The following aerial photograph shows the intersection of Lee Road and Harvard Avenue, and the prevailing surrounding environment. Lee Road is a 4-lane north-south arterial that stretches between I-480 and Chagrin Boulevard. Harvard Avenue is also a 4-lane east-west arterial that stretches primarily between I-77 and I-271.

The intersection is within the immediate vicinity of high activity commercial establishments. There is a shopping plaza in the south-east quadrant of the intersection anchored by the Walgreens drug store. A Burger King fast-food restaurant is situated in the north-east corner of the intersection. The north-west and south-west quadrants house a BP and a Shell gas station.

The existing intersection geometry is suitable for the various traffic movements. The intersection is clearly marked and lane assignments were properly made. The speed limit is 25 mph as the area is classified commercial. Bus routes are present on both Lee Road and Harvard Avenue. Bus stop shelters are available at 2 corners of the intersection on Lee Road and bus stops are present near the intersection on Harvard Avenue. Pedestrian facilities are adequate as there are well marked crosswalks, ADA ramps, pedestrian buttons, and truncated domes. Lane widths, however, are narrow due to the need to provide left-turn storage bays on all legs of the intersection within a tight right of way. Turn lane storage length or capacity should be evaluated to make sure there is sufficient storage capacity, particularly during peak periods. The signal operation is well designed with phasing and timing that cater well to the traffic demands. Turning radii at the corners, however, appear inadequate.

All commercial establishments have multiple access driveways in proximity of the intersection. The area is heavily travelled with average daily traffic of about 23,000 vehicles per day (VPD) on Lee Road and about 21,000 vehicles per day (VPD) on Harvard Avenue, noted on the aerial photograph shown below.



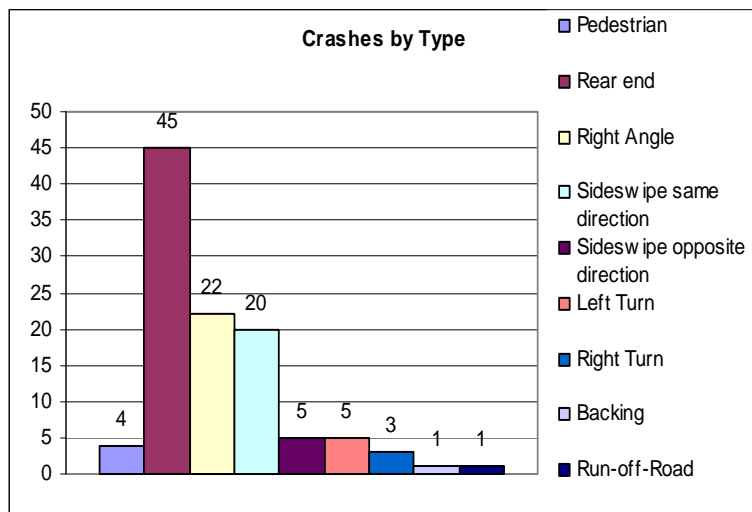
Crash Analysis (3-Year Crash Data for Years 2005-2007)

It is evident from the following bar charts that the predominant type of crash among the various types of crashes is the rear end collision. This signifies that there may be a high number of abrupt or sudden stops or slowdowns, unpredictable by other drivers that cause trailing vehicles to collide with vehicles in front of them. Field observations reveal that these sudden stops are mainly due to the following actions:

- a) Abrupt, split-second decisions made by motorists without giving adequate advanced notice of intent when entering or exiting driveways close to the intersection;
- b) Attempts to turn left on permissive left turn phases and then abort such attempts when trying to take advantage of gaps that appear sufficient but in fact are not; and
- c) Sudden stop-and-go actions as some pedestrians may cross the street at non crossing locations.

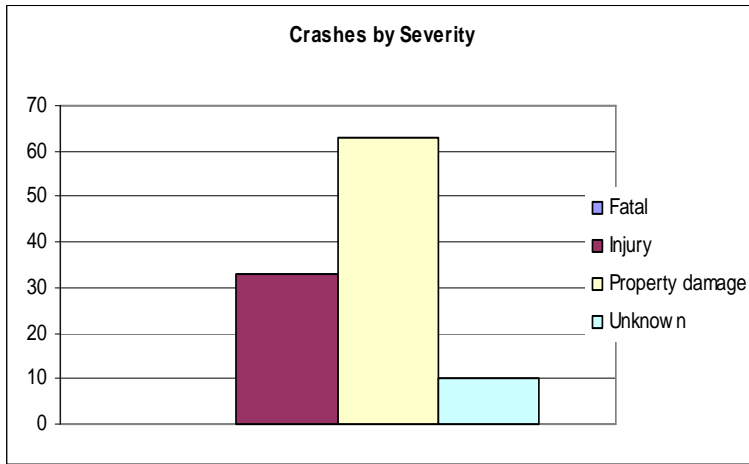
Crashes occur during daylight and on dry pavement conditions. This indicates that visibility and surface conditions are not contributing factors. It is, therefore, reasonable to conclude that human factors manifested by heavy traffic volumes, congestion, and uncontrolled ingress and egress points of access are primary contributing causes to these crashes.

Figure 1



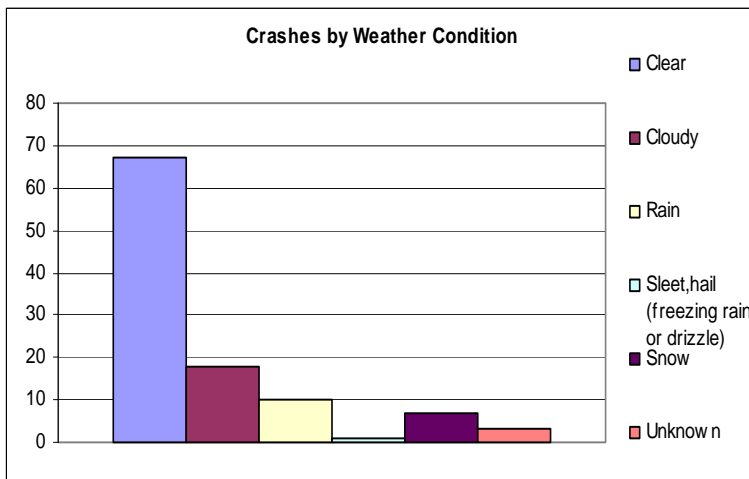
Collision Type	No. of Crashes
Pedestrian	4
Rear end	45
Right Angle	22
Sideswipe same direction	20
Sideswipe opposite direction	5
Left Turn	5
Right Turn	3
Backing	1
Run-off-Road	1
Total	106

Figure 2



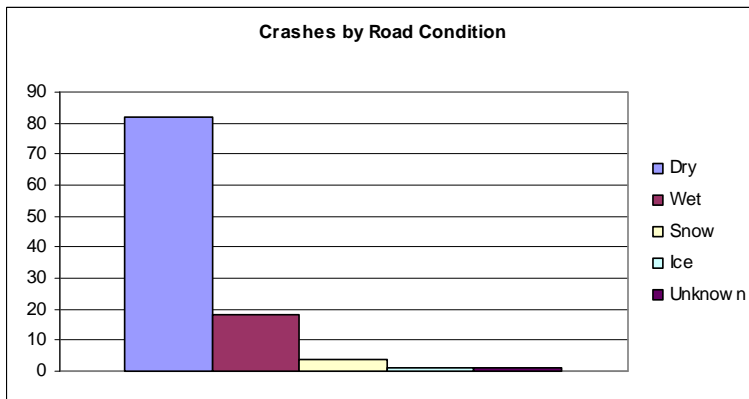
Crash Severity	No. of Crashes
Fatal	0
Injury	33
Property damage	63
Unknown	10
Total	106

Figure 3



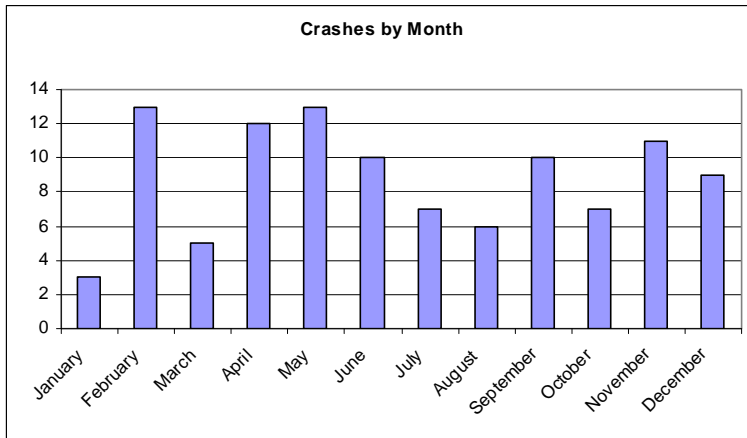
Weather	No. of Crashes
Clear	67
Cloudy	18
Rain	10
Sleet or hail (freezing rain or drizzle)	1
Snow	7
Unknown	3
Total	106

Figure 4



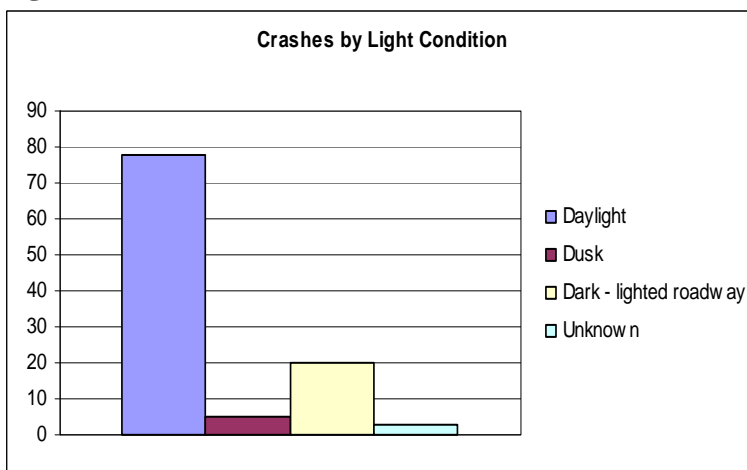
Road Condition	No. of Crashes
Dry	82
Wet	18
Snow	4
Ice	1
Unknown	1
Total	106

Figure 5



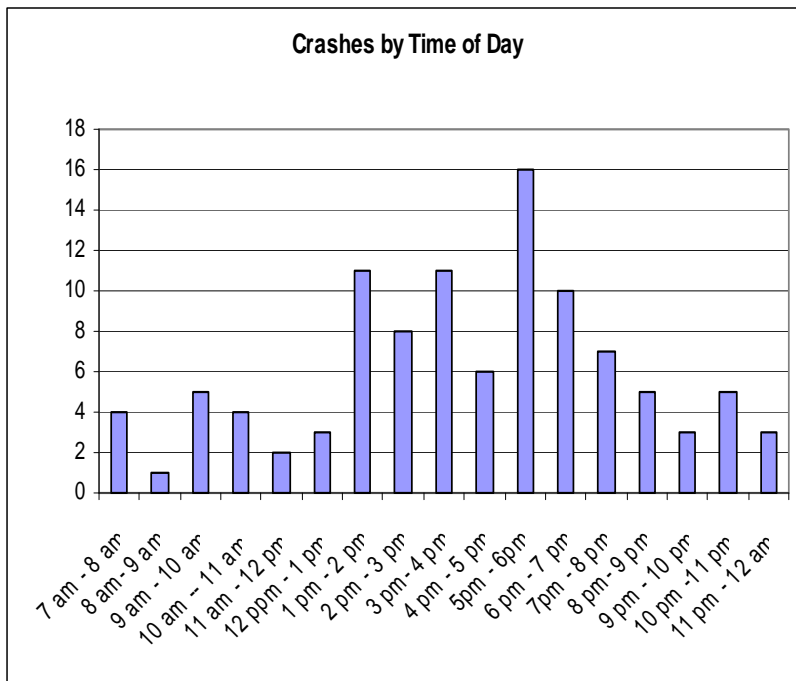
Month	No. of Crashes
January	3
February	13
March	5
April	12
May	13
June	10
July	7
August	6
September	10
October	7
November	11
December	9
Total	106

Figure 6



Light Condition	No. of Crashes
Daylight	78
Dusk	5
Dark - lighted roadway	20
Unknown	3
Total	106

Figure 7

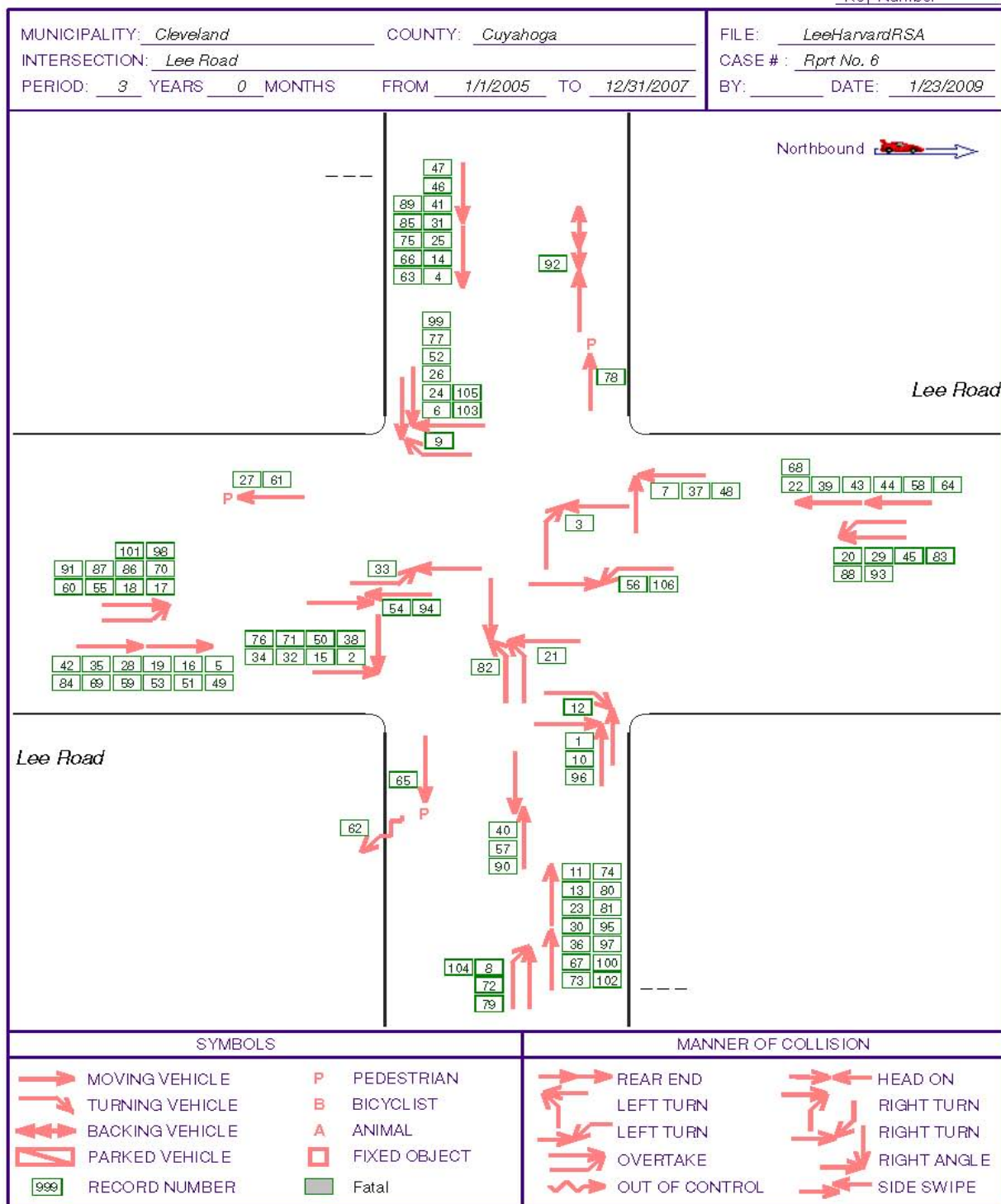


Time of day	No. of Crashes
12 am - 1 am	1
1 am - 2 am	1
2 am - 3 am	0
3 am - 4 am	0
4 am - 5 am	0
5 am - 6 am	0
6 am - 7 am	0
7 am - 8 am	4
8 am - 9 am	1
9 am - 10 am	5
10 am -- 11 am	4
11 am - 12 pm	2
12 pm - 1 pm	3
1 pm - 2 pm	11
2 pm - 3 pm	8
3 pm- 4 pm	11
4 pm - 5 pm	6
5 pm - 6 pm	16
6 pm - 7 pm	10
7 pm - 8 pm	7
8 pm- 9 pm	5
9 pm - 10 pm	3
10 pm -11 pm	5
11 pm - 12 am	3
Total	106

Collision Diagram

This collision diagram depicts the type, frequency, and relative location of the crashes that occurred in the most recent 3-year period of the crash data. It is intended to further aid the reader to understand the nature of the crash problems at this intersection.

COLLISION DIAGRAM



Pre-Audit Meeting

A pre-audit meeting of the audit team was held on November 13, 2008. An aerial photo of the intersection and surrounding area was presented to the audit team to discuss their views, experiences, and knowledge of the location. The team discussed at length the various characteristics of the intersection and the prevailing conditions. The audit team also reviewed the 3-year crash data for years 2005-2007 and existing Average Daily Traffic (ADT) data to assess the level of activities in and around the intersection.

The Audit

The audit team conducted an on-site Road Safety Audit (RSA) for the intersection of Lee Road and Harvard Avenue in Cleveland, Ohio in November, 2008. The team spent considerable time on-site making observations, recording notes, and establishing an inventory of prevailing conditions and physical characteristics of the intersection and surrounding environment. These observations are summarized below and corroborated with photographs to illustrate the descriptions:

- A shopping plaza, anchored by a Walgreens drug store, exists on the eastern side of Lee Road in the south-east quadrant of the intersection. Although the plaza is serviced by two major driveways off of Lee Road and Harvard Avenue, another driveway off of Lee Road in proximity to the intersection, intended to provide additional access to service the Walgreens drug store, appears to exacerbate the already complex traffic movement conflicts and contribute to the number of crashes. The driveway, evidently, was designed to allow only right-in/right-out traffic bound for the shopping plaza. The island within the driveway that regulates the flow of traffic was deleted and traffic enters and exits the driveway in any direction. Some southbound traffic entering the shopping plaza through this driveway by turning left causes traffic conflicts, interference with traffic flow, and turbulence in traffic platoons. Exiting the driveway onto Lee Road to head in the southbound direction causes further traffic movement conflicts and interference with the ordinary flow of traffic on Lee Road in both the northbound and southbound directions. There was no evident reason as to why the island that controlled traffic movement and limited it to right-in/right-out only was removed. It might have been ignored by drivers and that resulted in problems to those who intentionally or inadvertently tried to circumvent it in their attempt to exit the driveway to head south onto Lee Road or enter the driveway when turning left onto it from Lee Road in the southbound direction. If closing the driveway altogether is not considered a reasonable option, then restoring the island is thought to be a reasonable measure to reinstate the intended control that the island provided when it was first opened.



5707t





- The Shell gas station driveway, off of Lee Road, is too close to the corner of the intersection. Traffic entering the gas station through this driveway, especially when deciding to do so at the spur of the moment, forces trailing traffic to suddenly slow down and hence causes or creates the potential for rear end crashes. Traffic entering the gas station at this driveway comes mainly from two traffic streams. One stream is from Harvard Avenue westbound turning left onto Lee Road southbound. The other is through traffic from Lee Road southbound.



- Objects or structures situated too closely to the side of the road present an obstruction in the lateral clearance area. These objects or structures should be set back further from the edge of the roadways so as not to pose a real or perceived obstruction. The photos below show how close this information or poster kiosk is to the side of the road, causing trucks or larger vehicles to veer away from it, especially if they have protruding mirrors. This problem is exacerbated when the travel lanes are also narrow or have sub-standard widths.



- The ‘No Parking on Sidewalk or Tree Lawn’ signs appear to be ignored, as vehicles are obviously parked on the sidewalk. While there may be no discernible correlation between crashes and parking on sidewalks and tree lawns, recording this observation as part of the audit was considered appropriate as it may affect pedestrian safety.



- In the southwest quadrant, within the premises of the Shell gas station, the shrubbery present is a problem to the line of sight. In that same quadrant, within the public right of way, physical obstructions, such as the traffic control signal pole and the light pole, present a more constrictive environment that makes it difficult for right turning traffic movements. The sharp curvature at that same corner makes it difficult for larger or longer vehicles, such as trucks, to negotiate the turns easily. Collision between turning vehicles and these obstructions, evidenced by the physical damage to the traffic control signal pole, indicates that increasing the turning radius, setting back the poles, and removing outgrown shrubberies would help reduce the potential for such mishaps.



Sharp curvature, and objects within the lateral clearance area



Unightly, overgrown, and excessively tall shrub

- The pedestrian crossing phase appears inadequate. The pedestrian crossing interval, for example, for crossing Lee Road was measured to be 7 seconds. A review of current pedestrian movements and consultation of the ITE guidelines are suggested. Missing pedestrian crossing actuation buttons and crossing orientation signs call for attention to providing these auxiliary equipments.



Missing pedestrian crossing actuation button and crossing orientation signs



Damage to poles due to collision with turning vehicles

- This brick wall, within the northeast quadrant of the intersection, is too high and overly close to the curb and sidewalk of the intersection. It presents an obstruction to the line of sight, by both being situated too closely to the intersection and by being more than the customary 36 inches tall in order to be below the height of driver's eye.

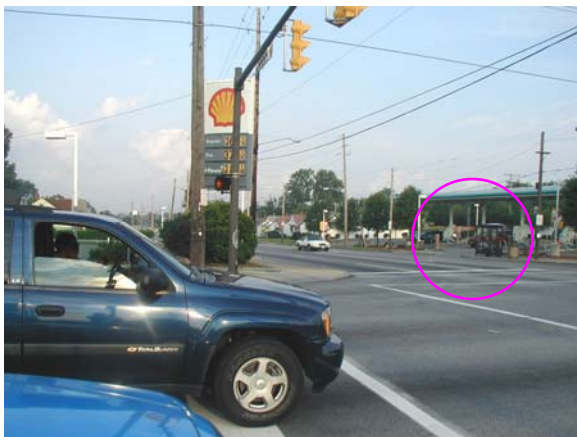


- This structure, within the northwest quadrant of the intersection, is rather high and is close to the curb and sidewalk of the intersection. It presents an obstruction to the line of sight, by both being situated too closely to the intersection and its height more than the customary acceptable 36” maximum in order to be below the height of the driver’s eye specified by AASHTO manual “A Policy on Geometric Design of Highways and Streets”.





- There are two driveways for the BP gas station to and from Harvard Avenue. The first driveway is supposed to be a right-in, right-out driveway equipped with a small island to regulate such movement. The island is rather small, and the lanes demarcated by the island are too narrow. The island is most likely not clearly visible, especially at night. Tire marks on the island and chipping due to collision between the underside of vehicles and the island indicate infringement on the raised island. The driveway and the island within it should be widened, enlarged, and designed better for more visibility and less damage to vehicles and island.



The location of the 1st driveway of the BP gas station on Harvard Avenue, and how close it is to the corner of the intersection



The 1st driveway of the BP gas station, on Harvard Avenue, showing an island designed for right-in/right-out only traffic movements. See next photograph.



Raised island within the driveway of the BP gas station fronting Harvard Avenue to regulate right-in/right-out traffic movements

- This bus stop on Harvard Avenue, serving eastbound buses, is located at a reasonable distance east of Lee Road. The location opposite from it, on the other side of Harvard Avenue westbound would be a much better location for a bus stop and shelter to serve westbound buses instead of that located in front of the BP gas station at short distance west of Lee Road, or within feet of the intersection. When buses stop at that location, through traffic either gets trapped behind them or drivers attempt to avoid them, to get out of that trap, by abruptly maneuvering to the left, which increases the potential for sideswipe collisions.



Bus stop and shelter on Harvard Avenue, eastbound, satisfactorily located at a reasonable distance east of Lee Road



Suggested location for a bus stop and shelter on Harvard Avenue for westbound buses, opposite that on the other side

- The sidewalks and pedestrian ramps seem to have been recently refurbished. Truncated domes for the blind and ramps for the disabled have been incorporated in the new reconstruction.



Truncated Domes on freshly laid concrete

Post-audit Meeting

Post-audit meetings and caucuses were convened on and off site to discuss the observations made by the members of the audit team to formulate a collective opinion and view of the prevailing conditions and site characteristics that appear to contribute to the acuity of the crash problem at this location. The audit team made a summary of the field observations, shown below, upon which the team based its findings, conclusions, and recommendations.

Findings and Recommendations

- Lane markings and assignments on Lee Road and Harvard Avenue are appropriately placed and allocated. Turn bay storage sufficiency, however, should be re-evaluated to determine whether their storage capacities are adequate in light of existing traffic volumes. Level of service analysis should be performed to determine the adequacy of the traffic signal timing and phasing to rule out any possible problems with the operation of the traffic control signal plan.
- The area around the intersection is heavily travelled and is active with various commercial offerings. The commercial establishments, particularly those near the intersection, are served with multiple access points that increase the potential for traffic conflicts. Access management, therefore, should be employed and evaluated for a better circulation of traffic in and around the intersection. Driveways serving gas stations located at the corners of the intersection should be re-examined so that those closest to the corners could be eliminated or re-configured. The driveway into the Walgreens drug store located on Lee Road should be restored to its original configuration to limit ingress and egress to right-in/right-out traffic, or be closed entirely. Traffic southbound on Lee Road entering the driveway by turning left from the inner lane near the center line causes trailing traffic to slow down, stop, or get involved in rear end collisions. Furthermore, traffic exiting that driveway and turning left onto Lee Road to head south interferes with oncoming through traffic on Lee Road in both the northbound and southbound directions. This interference increases the potential for angle collisions.
- The bus stop in front of the BP gas station, west of Lee Road, is too close to the intersection. Traffic trailing westbound buses that stop at the bus stop to drop off or pick up passengers gets trapped behind these buses and the flow of through traffic to their left. This causes erratic behaviors by drivers behind the buses. Drivers make sudden lane changes to avoid being stopped or trapped behind a bus. These maneuvers increase the potential for sideswipe collisions. This bus stop would be better suited if moved upstream of the intersection and located opposite that on Harvard Avenue which serves eastbound buses. The bus stop could also be equipped with a bus shelter, as one does not presently exist, which would be consistent with what is presently available across the street on Harvard Avenue.

- Lateral clearance is a matter that often times is overlooked. Clutter, and objects situated too closely to the curbs affect the perception of safety. Larger vehicles or drivers that shy away from being too close to adjacent curbside fixtures tend to move away and distance their vehicles from such objects or fixture, thereby driving closer to the lane divider markings. This movement, sub-conscious as it may be, leaves little room for vehicles in the inner or adjacent lanes to move freely. Therefore, the slightest reaction to a real or perceived need for avoidance causes or increases the potential for opposite direction or passing sideswipe collisions. An inventory and review of existing objects and fixtures located near the curbs should be made, and a plan of action to set them back as far away from the curbs as possible should be established in order to increase the area of lateral clearance.
- The section of Lee Road, north of Harvard Avenue, is somewhat misaligned with the section south of the intersection by approximately 6 inches. The lane widths are therefore narrower, where the through lanes are about 10 feet wide and the left-turn bays are about 9 feet wide. Reconstruction of the roadway in the future should take into consideration the need to widen these lanes and make them as close as possible to the standard width of 12 feet each.
- Driver behavior appears to be rather aggressive at times, especially during periods of heavy travel or congestion. Driver frustrations or impatience might be a cause for a propensity to take potentially hazardous actions. Occasional policing or the installation of monitoring cameras with added driver education might help reduce such propensity and hence reduce the potential for crashes.
- An in depth crash analysis might be helpful to check whether any of the crashes were alcohol related crashes.
- Stop bars are too close to the intersection. Set stop bars back a little farther from the intersection and offset all stop bars for the left-turn bays by placing them in advance of the stop bars for the through lanes to provide more clearance for larger or longer vehicles negotiating left turn movements.
- Improve the curb curvatures at all corners of the intersection by increasing the turning radii and removing obstructions within the lateral clearance areas and within the spaces at all corners of the intersection. All shrubberies and landscaping features must be made or kept below 36" high.
- There were instances of pedestrians crossing the streets within mid-block instead of at the designated crossing locations.

The City of Cleveland may use this report to request safety funding from the Ohio department of Transportation (ODOT) to address some or all the recommendations provided in this report.

APPENDICES

Appendix A: Glossary

Appendix B: Methodology for Ranking High Crash Locations

Appendix C: Improvement Cost and Term Range Categories

Appendix A: Glossary

Backplate: A thin metal or plastic plate, affixed behind the traffic signal head or beacon, that extends outward from and parallel to the signal face on all sides of the signal housing to shield the sun glare and to provide a background for improved visibility of the signal indications.

Capacity: Traffic carrying ability of a facility over a range of defined operational conditions. Capacity analysis provides tools to assess facilities and to plan and design improved facilities.

Clearance Interval: The yellow plus all-red interval that occurs between the phases of a traffic signal to provide for clearance of the intersection before conflicting movements are released.

Crash Reduction Factor: The percentage of crash reduction expected after implementing the recommended countermeasure.

Detector: A device that detects the presence of a vehicle and actuates the demand for a green signal.

Gore: A location where one or more lanes of the road diverge away from their direction of travel.

Green Time: The duration of the green indication for a given movement at a signalized intersection.

Island: Area between traffic lanes used for the control of vehicular movements or for pedestrian refuge. Within an intersection area, a median or an outer separation shall be an island. An island may be designated by pavement markings, channelizing devices, curbs, pavement edges, or other devices.

Pedestrian Crossing Countdown Signal: Displays flashing numbers that count down the time remaining until the end of the flashing “DON’T WALK” (FDW) interval.

Queue: The length of vehicular traffic accumulating in a traffic storage bay (left, right, or through lanes) awaiting the start of the green interval to begin moving.

Signal Phasing: The way in which the right of way is allocated among conflicting traffic movements that seek to use the same space.

Truncated Domes: Detectable warning system aids the visually impaired, which comply with the detectable warnings on the walking surfaces section of the Americans with Disabilities Act.

Appendix B: Methodology for Ranking High Crash Locations

Crash locations are ranked according to one of four criteria:

1. Frequency of crashes

Rank 1 means that the location has the highest number of crashes or crash frequency.

2. Equivalent Property Damage Only (EPDO) Index:

This index is based on a formula where crashes of all severities are converted to the equivalent of property damage only crashes. ODOT uses this formula in their crash analysis. It is similar to NOACA's severity index. The formula is:

EPDO Index = (No. of fatal crashes X 90.14) + (No. of injury crashes X 5.50) + (No. of property damage only crashes) + (No. of crashes of unknown severity)

Rank 1 means that the location has the highest EPDO.

3. Crash Rate (Crashes per million entering vehicles):

CR = (No. of crashes X 1,000,000) / (No. of data years X 365 days X approach volume)

Rank 1 means that the location has the highest crash rate.

4. Composite Ranking:

Composite Ranking = Rank based on Frequency + Rank based on EPDO + Rank based on Crash Rate.

Rank 1 means that the location has the highest Composite Ranking.

Appendix C: Improvement Cost and Term Range Categories

Cost Category	Cost Range
Low Cost	Less than \$100,000
Medium Cost	\$100,000-\$5,000,000
High Cost	Greater than \$5,000,000

Time Range Category	Time Range
Low Range	One year or less
Medium Range	One year -5 years
High Range	More than 5 years

Example of Possible Combinations:

