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ORCHARD LAKE ROAD, COMMERCE ROAD TO MIDDLEBELT ROAD

Corridor Road Diet Study

Road Commission for Oakland County

Keego Harbor

Orchard Lake Village

Sylvan Lake

West Bloomfield Township

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1. INTRODUCTION

The Road Commission for Oakland County (RCOC) will be performing a rehabilitation project on Orchard Lake Road between Cass Lake Road and the City of Pontiac limits in 2022. As part of this rehabilitation project, the RCOC would like to consider reducing Orchard Lake Road from a four-lane to a three-lane road between Commerce Road and the City of Pontiac limits. This Road Diet Study will analyze alternative cross sections along Orchard Lake Road between Commerce Road and Middlebelt Road. The RCOC will examine a lane reduction between Middlebelt Road and the City of Pontiac limits separately. This analysis will review the operations of the signalized intersection of Commerce Road, Wards Point Drive, Cass Lake Road, Warwick Street, and Middlebelt Road/Inverness Street along Orchard Lake Road.

Orchard Road is in Oakland County, is classified as a principal arterial and is on the NHS as a non-MDOT mainline. It is primarily a four-lane roadway within the study area between Commerce Road and Figa Avenue. The roadway transitions to a five-lane roadway with a two-way center left turn lane between Figa Avenue and Middlebelt Road. Orchard Lake Road has a posted speed limit of 35 mph.

At the signalized T-intersection of **Commerce Road and Orchard Lake Road**, exclusive left and right turn lanes are provided for the eastbound approach. A shared left turn/thru and exclusive thru lane are provided for the northbound movement. Exclusive thru and right turn lanes are provided for the southbound approach. Commerce Road is a two-lane roadway with a posted speed limit of 35 mph.

The intersection of **Wards Point Drive and Orchard Lake Road** forms a signalized T-intersection, with a shared left/right turn lane provided for the eastbound approach, a shared left turn/thru lane and an exclusive thru lane are provided for the northbound approach, and an exclusive thru lane and a shared thru/right turn lane provide for the southbound approach. Wards Point Drive is an unmarked two-lane roadway that serves the Wards Point residential neighborhood with a speed limit of 25 mph.

The eastbound movement at the signalized intersection of **Cass Lake Road and Orchard Road** is provided with an exclusive left turn lane, thru lane, and shared thru/right turn lane. The westbound approach is provided with an exclusive left turn, thru, and right turn lane. The northbound movement is not provided with exclusive lanes, however, the roadway width provides space for an exclusive left turn lane, and shared thru/right turn lane. The southbound approach utilizes an exclusive left turn lane, a shared left turn/thru lane, and an exclusive right turn lane. North of Orchard Lake Road, Cass Lake Road is a three-lane road with a two-way center left turn lane and a posted speed limit of 35 mph. Cass Lake Road becomes a two-lane roadway separated by raised medians south of Orchard Lake Road and provides access to several residential homes with a speed limit of 25 mph.

At the signalized T-intersection of **Warwick Street and Orchard Lake Road**, a shared left turn/thru lane and an exclusive thru lane is provided for the eastbound approach. An exclusive thru lane and shared thru/right turn lane is provided for the westbound approach. A shared left turn/right turn lane is provided for the southbound movement. Warwick Street is an unmarked two-lane roadway with a speed limit of 25 mph.

The signalized intersection of **Middlebelt Road/Inverness Street and Orchard Lake Road** is provided with an exclusive left turn lane, two thru lanes, and an exclusive right turn lane for the eastbound approach. The westbound approach utilizes an exclusive left turn lane, a thru lane and a shared thru/right turn lane. An exclusive left turn, thru, and right turn lane is provided for the northbound movement. The southbound approach is provided with an exclusive left turn lane and a shared thru/right turn lane. South of Orchard



Lake Road, Middlebelt Road transitions from a three-lane road to a two-lane road with a posted speed limit of 40 mph. Inverness Street is an unmarked roadway the aligns with Middlebelt Road and has a speed limit of 25 mph.

This study reviews the traffic capacity and operations of each intersection, traffic safety, basic geometric considerations for the selected alternatives, and access point layout. The traffic projections contained within this study will assist RCOC in determining the final cross section for the upcoming 2022 rehabilitation project on Orchard Lake Road between Cass Lake Road and the City of Pontiac limits. The study will communicate the likely traffic operations if a road diet is to be implemented in 2022, and to provide data for a discussion on long-term opportunities for Orchard Lake Road from Commerce Road to Middlebelt Road between the RCOC and the local communities.

2. TRAFFIC INFORMATION

Traffic data was collected by Traffic Data Collection, LLC (TDC) in September of 2020. The morning peak hour occurs between 7:15am and 8:15 am, and the afternoon peak hour occurs between 4:30 pm and 5:30 pm. Existing traffic volume data can be found in **Appendix A**.

In order to analyze the impacts of future roadway alternatives, traffic data was projected to the horizon year of the study. This study will identify the impacts of these alternates based on 2040 data. Traffic projections were based on consultation with the RCOC. In order to account for the general impacts of traffic growth, a growth factor of 2.5% between current year and the projected year of 2040 (0.12% per year) was used on Orchard Lake Road, and 5% (0.24% per year) on Commerce Road, Cass Lake Road, and Middlebelt Road.

There is one proposed redevelopment in the corridor. The existing Keego Harbor Mobile Home Park located on the north side of Orchard Lake between Wards Point and Cass Lake Road is in the review process for planned redevelopment. The proposed development consists of multiple mixed-use buildings providing residential, commercial and restaurant space. Trip generation calculations associated with this redevelopment plan can be seen in Table 1.

Table 1: Redevelopment Trip Generation

			AM Peak			PM Peak		
			In	Out	Total	In	Out	Total
220 – Multifamily Housing	250	Units	26	89	115	84	49	133
820 – Shopping Center	4000	Sq Ft	2	2	4	7	8	15
932 – Sit Down Restaurant	6000	Sq Ft	33	27	60	36	23	59
210 – Single Family Housing *	93	Units	-18	-53	-71	-60	-35	-95
Total			43	65	108	67	45	112

* Note: Represents the impact of removal of the current land use, supplanted by the new uses.



3. COMMUNITY PLANNING

The study area includes portions of 4 vibrant communities. In September 2020, representatives from these communities met to discuss the challenges and opportunities within this corridor. This collaborative discussion centered on how the corridor was viewed today as well as what the group wanted to see from the corridor in the future.

Positive attributes of the existing corridor:

- There is great interest in developing along the corridor. Existing businesses want to stay here expand and improve
- The corridor is close to the water and the recreational trail access is a huge opportunity
- The corridor has a lively central business district identity
- A well-done project could transform the area and help set the stage for future improvements

Challenges posed by the existing corridor:

- The sharp curve in road is a safety issue
- There are too many driveways which impacts safety
- The corridor has too much traffic and congestion
- Sidewalk gaps, poorly maintained sidewalk, narrow sidewalk, and few opportunities to cross Orchard Lake Road make the corridor feel unsafe and unwelcoming for pedestrians
- No left turn lane which is a safety issue and makes it difficult to access developments

Desired attributes of an improved corridor:

- Complete and walkable streets considering multimodal transportation
- More pedestrian friendly sidewalks that make the most of the trail connection
- Fewer driveways to improve safety, pedestrian accessibility, and the central business district identity of the roadway
- A continuous center left turn lane to allow for safer travel, improved development access and to support the central business district identity of the roadway

Following this meeting, existing planning documents were reviewed allowing the identification of many shared goals.

City of Orchard Lake Village – Master Plan (2018)

The City of Orchard Lake Village completed its recent Master Plan in 2018. Orchard Lake Village is located along the southwestern portion of the study area, between Commerce Rd and Wards Point Dr. The following items related to Orchard Lake Rd and overall transportation policies were included in the Master Plan Document:

- Weekday peak hour traffic congestion on Orchard Lake Rd
- Major transportation challenge is to relieve traffic pressure and improve safety that do not alter the city
- Orchard Lake Rd is only major roadway that is not entirely residential
- Many trips along major roadways, including Orchard Lake Rd, are pass thru trips of residents or others traveling to work
- Considerable traffic on Orchard Lake Rd (19,510 AADT) but very small population (2,375)



- Widening roads to relieve congestion are not acceptable solutions because it would detract from the community character, create additional impervious surfaces and increase runoff to the lakes, and increase traffic speeds thru the city.
- No major road improvements planned other than to resurface roads
- Recommended Strategies
 - Upgrade existing roads with new paving, turn lanes, and corrected geometric deficiencies
 - Improve intersections by adding turn lanes or adding roundabouts
 - Improve traffic management and technology by synchronizing intersections, adding speed controls, and ITS infrastructure
 - Seek regional solutions by working with RCOC, SEMCOG, and the surrounding communities to improve the surrounding network
 - Promote bicycling and walking by adding non-motorized infrastructure to the network
 - Coordinate land use with road capacity to minimize the traffic impact to the city

City of Sylvan Lake – Master Plan (2007)

The City of Sylvan Lake’s Master Plan was completed in 2007. The eastern end of the Orchard Lake Rd study area passes thru Sylvan Lake from Greer Blvd to Middlebelt Rd. The following items related to transportation policy and improvements to Orchard Lake Rd were included in the Master Plan:

- Sylvan Lake has 9.74 miles of streets in the City. 8.74 miles are under the City’s jurisdiction.
- Orchard Lake Rd runs near the southern border of the City with West Bloomfield Twp
- The meandering residential streets influenced by Cass Lake help limit the amount of thru traffic and control speeds on these streets
- Some motorists are using residential streets as bypasses around Orchard Lake Rd
- Although the population base has decreased since 1970, the volume of traffic on primary roads has increased
- Improvements planned to Orchard Lake Rd included a center left turn lane from Cass Lake Rd to Middlebelt
- Few streets have sidewalks which restricts safe pedestrian movement thru the City
- Sidewalk connections along Orchard Lake Rd are intermittent, ped movements are directed to the parking lots
- Establishing a pedestrian walkway system should be made part of an overall design plan for the commercial district. This may be possible with future improvements to Orchard Lake Rd undertaken by RCOC.

Keego Harbor Comprehensive Master Plan (2018)

The City of Keego Harbor completed their most recent Master Plan in 2018. Keego Harbor is located in the center of the Study Area between Wards Point Dr and Maddy Ln. The following items related to transportation policy and Orchard Lake Rd improvements were included in the Master Plan:

- The City has been developed with a traditional grid system of streets and roads. This helps evenly distribute traffic throughout all streets rather than overburdening a single main arterial.
- Plan recommends the continuance of this policy with future development and avoidance of the cul-de-sac road system.
- Orchard Lake Rd is the only east/west arterial in the City and Cass Lake Rd is the only north/south arterial. Significant congestion occurs at this intersection.



- Topographic and land use constraints limit the types of improvements that can be made to this intersection.
- Recently the Cass Lake Rd/Orchard Lake Rd intersections had been improved to facilitate the maximum amount of auto traffic possible. Unfortunately, little consideration was taken to add safe and efficient pedestrian crossing opportunities.
 - Work with RCOC to add a dedicated pedestrian crossing here.
- The intersection of Commerce Rd and Orchard Lake Rd poses challenges to safe and efficient traffic flow.
 - Recommendations include – realigning Commerce Rd to align directly with Millwall for a single signalized intersection OR signalize both intersections and time them to function as a single intersection.
- An access management program should be incorporated into the zoning ordinance to reduce the number of curb-cuts along Orchard Lake Rd. This helps reduce unregulated turning movements, improves traffic flow and safety, improves pedestrian safety, and creates better walking conditions.
- Keego Harbor has a pathway plan that would add complete, connected sidewalks/pathways to Orchard Lake Rd and Cass Lake Rd. These would further connect to internal loops that connect to the residential areas of the City.
- The plan recommends adding gateway treatments at the entry points to the City – including signage, landscaping, or other landmarks. Two gateways at the East and South extents of Orchard Lake Rd were identified.

Keego Harbor Mixed-Use Development Plan

A large mixed-use development is currently being planned along Orchard Lake Rd, at the intersection with Wards Point Dr. The development would be located just after the northeast curve in Orchard Lake Rd. The following are details related to the plans as they exist in December 2020:

- The project would replace the existing mobile home park at this site and add a higher density set of residential buildings, potentially increasing traffic to and from the site.
- The site is requesting reduced parking requirements meaning that residents will have fewer vehicles and reducing the amount of vehicle access to the site.
- The current plans show a total of 250 residential units – with the majority at 2 bedrooms or less. 6 units are designated to have more than 2 bedrooms.
- Additional plans include a slip lane added to Orchard Lake Rd to improve vehicle access into site, and a redesign of Orchard Lake Rd to add a left turn lane into the site.

West Bloomfield Township – Master Plan (2010)

The West Bloomfield Township Master Plan was completed in 2010 but is currently being updated as of December 2020. West Bloomfield Township touches the Orchard Lake Rd study area toward the eastern end, between the Clinton River Trail and Middlebelt Rd. The Township also borders the southern edges of Keego Harbor and Sylvan Lake. The following items are the related transportation policy and improvements included in the Master Plan:

- Orchard Lake Rd is a principal arterial that runs thru most of West Bloomfield Township
- The Township looks to stay up to date on proposed changes to the roadway system in order to ensure resident’s voices are heard in the design process.



- In a public opinion survey regarding future road improvements, participants ranked maintenance and improvements to neighborhood streets highest.
- West Bloomfield Twp. does not have jurisdiction over the road system and needs to work with SEMCOG, RCOC, and MDOT to ensure improvements are made correctly.
- West Bloomfield is recommending that future roadway projects integrate complete street designs to promote multi-modal transportation in the Township.
- The Township is recommending working with RCOC to add traffic calming measures as these measures make streets feel more comfortable and improve safety for residents.
 - The Township identified the following traffic calming measures:
 - Speed bumps, chokers, chicanes, & road narrowing.
- The Township is also interested in adding access management policies to the streets under RCOC control to minimize congestion, crash potential, and improve safety for non-motorized users.

Oakland County Commission – Complete Streets Resolution

In 2011, the Oakland County Board of Commissioners passed a resolution supporting Complete Streets and requested the Road Commission of Oakland County to adopt Complete Streets into the planning process. Additional resolutions are as follows:

- Request for RCOC to develop Non-Motorized Transportation Plan
- Request for RCOC to plan for, design, and construct all transportation projects (both new and retrofit) to provide appropriate accommodations for bicyclists, pedestrians, transit users, and persons of all ages and abilities.
- Request for RCOC to report progress in implementing the Non-Motorized Transportation Plan.

4. SAFETY ANALYSIS

A safety analysis was performed to explore the recent crash history at the five study intersections, as well as the corridor segments. The primary focus of this analysis was to summarize and identify crash patterns. These patterns help identify safety concerns, some of which may be reduced by the proposed intersection improvements included in the remaining sections of this study. Particular attention was given to head-on and angle crashes, which tend to result in more serious injuries and greater property damage.

Crash data for the analysis was obtained from the Traffic Improvement Association’s (TIA) Traffic Crash Analysis Tool (TCAT) in the form of a crash summary report. Detailed traffic crash reports (UD-10s) for the most severe including any crashes with pedestrian or bicyclist involvement were downloaded and reviewed in detail. The crash data encompassed a period of three full years spanning January 1, 2017 thru December 31, 2019. Historical Crash Data can be found in **Appendix B**.

Intersection Crash Analysis

A summary of the intersection crash data is shown in Table 2, and a summary of the segment crash data is presented in Table 3.



Table 2: Intersection Crash Summary – Orchard Lake Road, Commerce Road to Middlebelt Road

Intersection	Crash Type								Injuries			
	Side Swipe Sm	Head On	Head On Left Turn	Angle	Rear End	Single Vehicle	Other	TOTAL	Fatal	A-Level (Incapacitating)	B-Level (Non-Incapacitating)	C-Level (Possible)
Commerce	10	0	0	10	31	0	1	52	0	0	3	7
Wards Point	10	0	1	2	15	5	1	34	0	1	2	2
Cass Lake	8	0	1	4	17	1	3	34	0	0	2	1
Warwick	3	0	0	5	9	1	2	20	0	0	0	5
Middlebelt	15	0	2	14	27	2	1	61	0	0	1	5
TOTAL	46	0	4	35	99	9	8	201	0	1	8	20
% TOTAL	22.9%	0.0%	2.0%	17.4%	49.3%	4.5%	4.0%	100.0%	0.0%	0.5%	4.0%	10.0%

Table 3: Segment Crash Summary – Orchard Lake Road, Commerce Road to Middlebelt Road

Intersection	Crash Type								Injuries			
	Side Swipe Sm	Head On	Head On Left Turn	Angle	Rear End	Single Vehicle	Other	TOTAL	Fatal	A-Level (Incapacitating)	B-Level (Non-Incapacitating)	C-Level (Possible)
Commerce to Wards Point	7	0	3	9	10	2	2	33	0	1	2	4
Wards Point to Cass Lake	5	0	0	4	12	0	2	23	0	1	3	1
Cass Lake to Warwick	14	1	3	19	26	3	5	71	0	1	5	4
Warwick to Middlebelt	12	0	4	16	24	3	2	61	0	0	3	14
TOTAL	38	1	10	48	72	8	11	188	0	3	13	23
% TOTAL	20.2%	0.5%	5.3%	25.5%	38.3%	4.3%	5.9%	100.0%	0.0%	1.6%	6.9%	12.2%

There were 201 total crashes at the five study intersections and 188 total crashes along the Orchard Lake Road segments from Commerce Road to Middlebelt Road during the study period. The prominent crash type, at both the intersections and along the corridor, was rear-end collisions, accounting for 49% and 38% of all crashes, respectively. Side Swipe collisions were the second most prominent collision type at the study intersections accounting for 23% of all crashes. Angle collisions were the second most common crash type along the corridor segments, making up 26% of all crashes. The rear-end crashes tended to occur at the intersections where vehicles were stopped a signal or when vehicles were turning left or right onto various side streets along Orchard Lake Road.



During the analysis period, there were no crashes which resulted in a fatality, however, a total of four crashes resulted in an A-level (incapacitating) injury. A total of 21 B-level (non-incapacitating) injuries and 43 C-level (possible) injury crashes occurred during the analysis period. The balance of the crashes resulted in property damage only (PDO). Of the A-level injuries, half involved a pedestrian crossing Orchard Lake Road. One of the pedestrian crashes occurred at Prynne Street and the second occurred near Wards Point Drive. The other A-level injury crashes included a rear end collision near Willow Beach Street, in which Unit 1 had stopped and indicated they were turning left into a store parking lot when Unit 2 rear-ended Unit 1. The final A-level injury crash involved a signal vehicle traveling northbound along Orchard Lake Road. The vehicle failed to navigate the curve at Wards Point Drive and struck a light pole on the side of the road. Of the 21 B-level injury crashes, one involved a pedestrian that was hit while crossing Orchard Lake Road as South Bay Drive, which serves a mobile home community. No crashes were reported that involved a bicyclist.

Further Considerations

The majority of the crashes that occurred during the analysis period were rear-end collisions. A change in the roadway cross-section such as the addition of a two-way center left turn lane may help lessen the observed crash patterns. Any changes in geometry should include verification that the clearance intervals are appropriate and that the signal timing “dilemma zones” suit driver expectations, which may also help reduce the observed crash tendencies.

5. ROADSIDE DESIGN

In addition to the 5 signalized intersections, the study area includes 21 unsignalized minor street intersections and nearly 100 driveways. Each of the access points represents opportunity for safety conflicts and operational friction. Many of the commercial driveways are wider than typical, increasing pedestrian exposure time and adding to both onsite and roadway congestion. Reduction of the total number of access points will allow for more predictable driver behavior, improving safety throughout the roadway. Locations where driveway consolidation may be considered are identified in **Appendix F**. There are also multiple sites where paved parking areas are located at least partially in the right-of-way. Future redevelopment along the corridor should prioritize good access management practices.

Non-motorized facilities in the corridor include an inconsistent sidewalk along both sides of the roadway. Prioritization should be given to filling sidewalk gaps and upgrading existing walks that are narrow or in poor condition. In some locations the sidewalk is located without separation from adjacent parking areas. Any redevelopment in the corridor should prioritize pedestrian facilities consistent with the communities’ master plans. Locations where sidewalk improvements should be considered are identified in the **Appendix F**.

6. EXISTING OPERATIONAL ANALYSIS

The study intersections were analyzed according to the methodologies published in the Highway Capacity Manual, 2010 edition. For this project, Synchro Version 11 software was used to conduct the analysis for traditional intersections. Software printouts for the evaluations of intersections have been included in **Appendix C** and **Appendix D**. These software packages computes delay values based on factors such as number and type of lanes, intersection controls such as STOP signs or traffic signals, traffic volumes, pedestrian volumes, geometric characteristics, signal timing characteristics, roadway grade, speed limit, etc. This analysis determines the average delay experienced by vehicles. This value is an average across the entire peak hour, vehicles arriving during the busiest portion of the peak hour or arriving in a clustered



group of vehicles instead of in a random pattern could experience longer delays. On the other hand, vehicles arriving during a lighter portion of the peak hour could experience a shorter delay. The average delay is used to determine the corresponding level of service (LOS) values for each intersection movement, as well as the intersection as a whole.

The LOS of an intersection is based on factors such as number and types of lanes, intersection controls such as STOP signs or traffic signals, traffic volumes, pedestrian volumes, etc. LOS is expressed as a letter grade, in a range from A thru F. In this context, 'A' represents the best conditions, with very little or no average delay to vehicles. LOS 'F' is the worst of conditions, equated with very large average delays and few gaps of acceptable length. The following tables identify level of service criteria for signalized and unsignalized intersections.

Table 4: Level of Service Criteria For Signalized Intersections

Level of Service	Average Delay/Vehicle (seconds)	Description
A	Less than or equal to 10	Most vehicles do not stop at all. Most arrive during the green phase. Little or no delay.
B	> 10 to 20	More vehicles stop than for LOS A. Still good progression thru lights. Short traffic delays.
C	> 20 to 35	Significant numbers of vehicles stop, although many pass thru without stopping.
D	> 35 to 55	Many vehicles stop. Individual signal cycle failures are noticeable. Progression is intermittent.
E	> 55 to 80	Considered to be the limit of acceptable delay. Individual cycle failures are frequent and progression is poor.
F	>80	Extreme and unacceptable traffic delays.

SOURCE: Transportation Research Board, Highway Capacity Manual 2010.

Table 5: Level of Service Criteria For Unsignalized Intersections

Level of Service	Average Delay/Vehicle (seconds)	Description
A	0 to 10	Little or no delay, very low main street traffic
B	> 10 to 15	Short traffic delays, many acceptable gaps
C	> 15 to 25	Average traffic delays, frequent gaps still occur
D	> 25 to 35	Longer traffic delays, limited number of acceptable gaps
E	> 35 to 50	Very long traffic delays, very small number of acceptable gaps
F	>50	Extreme traffic delays, virtually no acceptable gaps in traffic

An intersection LOS 'D' is considered by many traffic safety professionals to be the minimum acceptable condition in an urban/suburban area. For rural areas, most highway agencies consider LOS 'C' the minimum. Given the location of the study intersections, on the edge of an urbanized area, LOS 'D' was utilized as the study goal.



The five signalized intersections were evaluated under the existing conditions during both peak periods. Table 6 shows the intersection LOS and corresponding delays during the AM Peak Hour. Table 7 shows the intersection LOS and corresponding delays during the PM Peak Hour.

Table 6: 2020 AM Peak Delay and Level of Service – Existing Conditions

	Northbound		Southbound		Eastbound		Westbound		Intersection	
	Delay (Sec.)	LOS	Delay (Sec.)	LOS	Delay (Sec.)	LOS	Delay (Sec.)	LOS	Delay (Sec.)	LOS
Commerce Road @ Orchard Lake Road	10.0	B*	21.5	C*	68.8	E	N/A	N/A	31.3	C
Wards Point Drive @ Orchard Lake Road	5.4	A*	N/A	N/A	43.4	D	9.5	A**	8.0	A
Cass Lake Road @ Orchard Lake Road	42.6	D	34.3	C	44.8	D**	46.7	D**	41.4	D
Warwick Street @ Orchard Lake Road	N/A	N/A	53.8	D	3.7	A**	2.1	A**	3.6	A
Middlebelt Road @ Orchard Lake Road	27.9	C	32.2	C	23.7	C**	12.2	B**	20.0	B

* Orchard Lake Road is considered Northbound / Southbound at this intersection

** Orchard Lake Road is considered Eastbound / Westbound at this intersection

Table 7: 2020 PM Peak Delay and Level of Service – Existing Conditions

	Northbound		Southbound		Eastbound		Westbound		Intersection	
	Delay (Sec.)	LOS	Delay (Sec.)	LOS	Delay (Sec.)	LOS	Delay (Sec.)	LOS	Delay (Sec.)	LOS
Commerce Road @ Orchard Lake Road	11.8	B*	7.0	A*	58.2	E	N/A	N/A	18.1	B
Wards Point Drive @ Orchard Lake Road	4.0	A*	N/A	N/A	40.5	D**	4.5	A	4.6	A
Cass Lake Road @ Orchard Lake Road	50.0	D	39.1	D	31.1	C**	143.6	F**	85.0	F
Warwick Street @ Orchard Lake Road	N/A	N/A	36.5	D	1.3	A**	1.9	A**	1.9	A
Middlebelt Road @ Orchard Lake Road	34.3	C	22.1	C	32.5	C**	24.4	C**	28.9	C

* Orchard Lake Road is considered Northbound / Southbound at this intersection

** Orchard Lake Road is considered Eastbound / Westbound at this intersection

The corridor experiences congestion during both peak periods. The eastbound approach of Commerce Road experiences excessive delay during both peak periods. During the afternoon peak period, the intersection of Orchard Lake at Cass Lake Road experiences lengthy delays, most notably in the westbound Orchard Lake Road direction. Delay at these intersections contributes to congestion throughout the corridor.

7. IMPROVEMENT CONCEPTS PRELIMINARY ANALYSIS

Within the corridor there is an opportunity for modifications to the existing roadway. Conversion of the existing 4-lane section to a section providing a two-way center-left turn lane would help address some of



the observed safety and operational concerns. To provide additional understanding on how this type of a change would impact operations, three versions of a road diet were considered for further evaluation.

3 Lane Road Diet

This traditional road diet would use the existing pavement limits to provide one lane in each direction and a two-way center left-turn lane. The 3-lane cross section would be consistent without the addition of auxiliary lanes at intersections. Additional paved space not needed for vehicular lanes would be used as a paved shoulder with the potential for future projects to adjust the curb line to narrow the roadway.

This option would provide the needed two-way center left-turn lane to address some of the safety concerns in the corridor. It would also provide the most opportunity for reuse of the space currently dedicated to vehicle lanes. The existing operations at the signalized intersection indicate that congestion is already significant at numerous locations in the study area. Without the additional auxiliary turn lanes, operations are expected to further deteriorate. Due to anticipated poor operations, this alternative was eliminated from further consideration.

3 Lane Road Diet with Auxiliary Lanes

Building on the 3-lane road diet, this alternative would also provide one lane in each direction and a two-way center left-turn lane within the existing pavement limits. The majority of the study area would have a constant 3-lane cross section. Auxiliary turn lanes would be added at signalized intersections, staying within the constraints of the existing pavement. Portions of the roadway would have additional paved space not needed for vehicular lanes. Near some intersections, the entire road width would be utilized for travel lanes. Additional paved space not needed for vehicular lanes would be used as a paved shoulder with the potential for future projects to adjust the curb line to narrow the roadway.

This option would provide the needed two-way center left-turn lane to address some of the safety concerns in the corridor. It would also provide some opportunity for reuse of the space currently dedicated to vehicle lanes. It is anticipated that the use of auxiliary turn lanes will help reduce the operational impacts of the change in cross section. **A detailed operational analysis was completed for this alternative.**

Unbalanced 4 Lane

This alternative provides a continuous two-way center left-turn lane, a single eastbound lane and two westbound lanes on Orchard Lake Road. The unbalanced lanes address the additional capacity needs of westbound Orchard Lake Road in the evening peak period while still providing the safety benefits of a more traditional road diet. Auxiliary turn lanes would be added at signalized intersections, staying within the constraints of the existing pavement.

This option would provide the needed two-way center left-turn lane to address safety some of the concerns in the corridor. It minimizes capacity concerns for westbound vehicles by maintaining two travel lanes. The use of auxiliary turn lanes is expected to further reduce the operational impacts of the change in cross section. **A detailed operational analysis was completed for this alternative.**

8. CONCEPT OPERATIONAL ANALYSIS

The five signalized intersections were evaluated for the selected alternatives. The 3 Lane with Auxiliary Lanes and the Unbalanced 4 Lane alternatives were analyzed during both peak periods for the 2020 and 2040 study years. Renderings of these alternatives are included in **Appendix E**.



Commerce Road at Orchard Lake Road

At this intersection Orchard Lake Road is a 4-lane roadway. The southbound Orchard Lake Road approach lanes are used as designated right turn only lane and a thru lane. The northbound Orchard Lake Road lanes are used as a thru lane and a shared thru/right lane. Commerce Road is a two-lane roadway with a 500-foot-long auxiliary left turn lane. The intersection is a three-legged intersection with schools on the west side of the intersection and commercial development on the east side.

The three-lane with auxiliary turn lane alternative modifies the lanes on Orchard Lake Road to only provide one thru lane in each direction and reallocate space for a center two-way left-turn lane. At this intersection, the southbound Orchard Lake Road approach will include an auxiliary right turn lane with 450 feet of storage. The northbound approach will include a designated left turn lane with 150 feet of storage. The Commerce Road approach maintains the existing geometry.

The unbalanced 4 lane alternative modifies the lanes on Orchard Lake Road to replace one of the eastbound (northbound) lanes with a center two-way left-turn lane. Two westbound (southbound) lanes are maintained to accommodate the heavy volumes during the PM Peak period. At this intersection, the southbound Orchard Lake Road approach lanes are used as designated right turn only lane and a thru lane. The northbound approach will include a designated left turn lane with 150 feet of storage. The Commerce Road approach maintains the existing geometry.

Table 8: Commerce Road at Orchard Lake Road

		Orchard Lake Northbound		Orchard Lake Southbound		Commerce Eastbound		Intersection	
		Delay (Sec.)	LOS	Delay (Sec.)	LOS	Delay (Sec.)	LOS	Delay (Sec.)	LOS
2020 AM	Existing Conditions	10.0	B	21.5	C	68.8	E	31.3	C
	3 – Lane w/ Aux	12.7	B	26.8	C	60.9	E	32.7	C
	Unbalanced 4 - Lane	14.3	B	32.1	C	49.1	D	32.8	C
2040 AM	Existing Conditions	10.3	B	23.9	C	75.1	E	34.5	C
	3 – Lane w/ Aux	13.3	B	29.3	C	63.2	E	34.9	C
	Unbalanced 4 - Lane	14.2	B	33.6	C	53.3	D	34.8	C
2020 PM	Existing Conditions	11.8	B	7.0	A	58.2	E	18.1	B
	3 – Lane w/ Aux	19.4	B	15.7	B	60.3	E	25.2	C
	Unbalanced 4 - Lane	22.3	C	24.8	C	33.9	C	25.6	C
2040 PM	Existing Conditions	12.5	B	7.8	A	59.2	E	19.1	B
	3 – Lane w/ Aux	21.2	C	16.6	B	60.1	E	26.4	C
	Unbalanced 4 - Lane	25.3	C	29.6	C	33.0	C	28.6	C



Under existing conditions, the intersection experiences lengthy delay for the Commerce Road approach during both peak periods. This contributes to substantial queuing near the adjacent school properties. At this location both alternatives provide the opportunity for signal retiming to help alleviate a small portion of this delay. The 3-lane with Auxiliary turn lanes only provides modest improvements to the Commerce Road movement, with both peak hours operating at a LOS E. The unbalanced 4-lane alternative provides some opportunity for operational improvements at this location.

Wards Point Road at Orchard Lake Road

At this intersection Orchard Lake Road is a 4-lane roadway with two thru lanes provided in each direction. There are no additional auxiliary turn lanes provided at the intersection. Wards Point Road is a two-lane roadway. The intersection is a three-legged intersection with commercial and residential development adjacent to the roadway.

At this intersection, the three-lane with auxiliary turn lane alternative provides a single lane on each approach. The Wards Point approach and the operations of the intersection remain unchanged.

The unbalanced 4 lane alternative provides two westbound lanes. The Wards Point approach and the operations of the intersection remain unchanged.

Table 9: Wards Point Road at Orchard Lake Road

		Orchard Lake Northbound		Orchard Lake Westbound		Wards Point Eastbound		Intersection	
		Delay (Sec.)	LOS	Delay (Sec.)	LOS	Delay (Sec.)	LOS	Delay (Sec.)	LOS
2020 AM	Existing Conditions	5.4	A	9.5	A	43.4	D	8.0	A
	3 – Lane w/ Aux	3.9	A	18.1	B	43.2	D	12.3	B
	Unbalanced 4 - Lane	3.1	A	1.7	A	15.6	B	2.4	A
2040 AM	Existing Conditions	5.4	A	9.9	A	43.4	D	8.2	A
	3 – Lane w/ Aux	4.1	A	18.6	B	43.2	D	12.7	B
	Unbalanced 4 - Lane	2.9	A	1.5	A	17.8	B	2.2	A
2020 PM	Existing Conditions	4.0	A	4.5	A	40.5	D	4.6	A
	3 – Lane w/ Aux	8.9	A	24.9	C	40.5	D	17.0	B
	Unbalanced 4 - Lane	8.1	A	2.0	A	23.1	C	5.3	A
2040 PM	Existing Conditions	4.0	A	4.9	A	40.5	D	4.8	A
	3 – Lane w/ Aux	9.7	A	25.1	C	40.5	D	17.0	B
	Unbalanced 4 - Lane	8.1	A	1.9	A	24.9	C	5.2	A



Under existing conditions, this intersection operates with acceptable delay during both peak periods. The three-lane with auxiliary turn lane alternative is anticipated to operate with similar delay as the existing intersection. The unbalanced 4 lane alternative provides some additional capacity relief and is expected to operate at a LOS C or better for all approaches during both peak periods.

Cass Lake Road at Orchard Lake Road

At this intersection, Orchard Lake Road is a 4-lane roadway with auxiliary turn lanes provided at the intersection. Eastbound Orchard Lake Road has an auxiliary Left turn lane with 190 feet of storage. Westbound Orchard lake has an auxiliary left turn lane with 100 feet of storage and an auxiliary right turn lane with 435 feet of storage. The southbound Cass Lake approach has an auxiliary left turn lane with 300 feet of storage, an auxiliary right turn lane with 125 feet of storage and a shared thru/left lane. The northbound Cass Lake Road approach is divided roadway with a 22' wide median and a single approach lane approximately 22' wide. The dual turn lanes and the differences between the Cass Lake Road approaches require the intersection to operate as under split. Adjacent development is commercial.

The three-lane with auxiliary turn lane alternative modifies the lanes on Orchard Lake Road to only provide one thru lane in each direction and reallocate space for a center two-way left-turn lane. At this intersection, the westbound Orchard Lake Road approach will an auxiliary right turn lane with 435 feet of storage. Eastbound Orchard Lake Road has an auxiliary right turn lane with 100 feet of storage. The southbound Cass Lake Road approach maintains the same geometry but modifies the lane usage to provide a single left turn lane, a single thru lane and the auxiliary right turn lane. The northbound approach maintains the existing geometry. Operationally the change to a single left turn lane for the southbound approach allows for the Cass Lake approaches to run concurrently. Some minor geometric adjustments may be required to provide left turn alignment for the Cass Lake Road approaches.

The unbalanced 4 lane alternative modifies the lanes on Orchard Lake Road to replace one of the eastbound lanes with a center two-way left-turn lane. Two westbound lanes are maintained to accommodate the heavy volumes during the PM Peak period. At this intersection, the westbound Orchard Lake Road approach has an auxiliary right turn lane with 435 feet of storage. Eastbound Orchard Lake Road has an auxiliary right turn lane with 100 feet of storage. The southbound Cass Lake Road approach maintains the same geometry but modifies the lane usage to provide a single left turn lane, a single thru lane and the auxiliary right turn lane. The northbound approach maintains the existing geometry. Operationally the change to a single left turn lane for the southbound approach allows for the Cass Lake approaches to run concurrently. Some minor geometric adjustments may be required to provide left turn alignment for the Cass Lake Road approaches.



Table 10: Cass Lake Road at Orchard Lake Road

		Cass Lake Northbound		Cass Lake Southbound		Orchard Lake Eastbound		Orchard Lake Westbound		Intersection	
		Delay (Sec.)	LOS	Delay (Sec.)	LOS	Delay (Sec.)	LOS	Delay (Sec.)	LOS	Delay (Sec.)	LOS
2020 AM	Existing Conditions	42.6	D	34.3	C	44.8	D	46.7	D	41.4	D
	3 – Lane w/ Aux	42.6	D	206.9	F	120.9	F	265.6	F	195.8	F
	Unbalanced 4 - Lane	49.0	D	48.2	D	53.2	D	42.3	D	48.0	D
2040 AM	Existing Conditions	42.6	D	35.4	D	45.3	D	47.9	D	42.3	D
	3 – Lane w/ Aux	42.6	D	228.0	F	131.9	F	284.3	F	212.8	F
	Unbalanced 4 - Lane	49.5	D	57.7	E	53.4	D	38.9	D	50.6	D
2020 PM	Existing Conditions	50.0	D	39.1	D	31.1	C	143.6	F	85.0	F
	3 – Lane w/ Aux	50.4	D	50.1	D	208.3	F	357.7	F	249.6	F
	Unbalanced 4 - Lane	43.6	D	67.8	E	30.6	C	30.5	C	37.0	D
2040 PM	Existing Conditions	50.3	D	39.1	D	31.9	C	152.4	F	89.2	F
	3 – Lane w/ Aux	51.0	D	53.7	D	232.8	F	372.2	F	264.7	F
	Unbalanced 4 - Lane	51.7	D	77.0	E	31.2	C	28.9	C	38.2	D

Under existing conditions, this intersection experiences lengthy delay for multiple approaches during both peak periods. Delay is particularly lengthy for westbound Orchard Lake Road drivers in the PM Peak hour. The delay contributes to the substantial congestion in the vicinity of the intersection. At this location, the 3-lane with auxiliary lanes alternative reduces the number of eastbound and westbound thru lanes and eliminates the dual southbound Cass Lake Road left turn replacing it with a single left turn lane. These changes negatively impact the approach delay and result in an intersection LOS F during both peak periods. The unbalanced 4-lane alternative also reduces the number of eastbound thru lanes and eliminates the dual southbound left turn replacing it with a single left turn lane. These lane configuration changes are balanced with the signal phasing adjustments to remove the northbound and southbound split phase operations to minimize negative impacts to intersection delay. The unbalanced 4-lane alternative has an overall reduction in delay, but the southbound approach experiences an increase in delay and operates at the LOS E during the PM Peak period.

Warwick Street at Orchard Lake Road

At this intersection Orchard Lake Road is a 4-lane roadway with two thru lanes provided in each direction. There are no additional auxiliary turn lanes provided at the intersection. Warwick is a two-lane roadway. The intersection is a three-legged intersection with commercial and residential development adjacent to the roadway.



At this intersection, the three-lane with auxiliary turn lane alternative provides a single lane on each approach. The Warwick Street approach and the operations of the intersection remain unchanged.

The unbalanced 4 lane alternative provides two westbound lanes. The Warwick Street approach and the operations of the intersection remain unchanged.

Table 11: Warwick Street at Orchard Lake Road

		Warwick Northbound		Warwick Southbound		Orchard Lake Eastbound		Orchard Lake Westbound		Intersection	
		Delay (Sec.)	LOS	Delay (Sec.)	LOS	Delay (Sec.)	LOS	Delay (Sec.)	LOS	Delay (Sec.)	LOS
2020 AM	Existing Conditions	N/A	N/A	53.8	D	3.7	A	2.1	A	3.6	A
	3 – Lane w/ Aux	N/A	N/A	54.6	D	10.8	B	1.5	A	7.8	A
	Unbalanced 4 - Lane	N/A	N/A	54.6	D	16.5	B	3.6	A	12.1	B
2040 AM	Existing Conditions	N/A	N/A	53.8	D	4.1	A	2.1	A	3.8	A
	3 – Lane w/ Aux	N/A	N/A	54.6	D	12.3	B	1.6	A	8.7	A
	Unbalanced 4 - Lane	N/A	N/A	54.6	D	16.6	B	1.8	A	11.4	B
2020 PM	Existing Conditions	N/A	N/A	36.5	D	1.3	A	1.9	A	1.9	A
	3 – Lane w/ Aux	N/A	N/A	38.2	D	6.7	A	36.8	D	24.2	C
	Unbalanced 4 - Lane	N/A	N/A	28.7	C	9.6	A	3.5	A	6.2	A
2040 PM	Existing Conditions	N/A	N/A	36.5	D	1.7	A	1.9	A	2.0	A
	3 – Lane w/ Aux	N/A	N/A	38.2	D	7.0	A	48.7	D	31.1	C
	Unbalanced 4 - Lane	N/A	N/A	28.7	C	10.6	B	3.7	A	6.7	A

Under existing conditions, this intersection operates with acceptable delay during both peak periods. Both alternatives provide similarly acceptable operations during the AM Peak period. Although all alternatives produce an acceptable level of delay in the PM Peak hour, the Unbalanced 4-lane alternative provides additional capacity relief and is expected to operate at a LOS C or better for all approaches.

Middlebelt Road at Orchard Lake Road

At this intersection Orchard Lake Road is a 5-lane roadway with auxiliary turn lanes provided at the intersection. Eastbound Orchard Lake Road has an auxiliary right turn lane with 200 feet of storage. The southbound Inverness St approach has an auxiliary left turn lane with 50 feet of storage and a shared thru/left lane. The northbound Middlebelt approach has an auxiliary left turn lane with 100 feet of storage and an auxiliary right turn lane with 500 feet of storage. Adjacent development is commercial.

The three-lane with auxiliary turn lane alternative modifies the lanes on Orchard Lake Road to only provide one thru lane in each direction west of this intersection and retains space for a center two-way left-turn



lane. At this intersection, the outside lane of the westbound Orchard Lake Road approach will become a right turn only lane at the intersection. Eastbound Orchard Lake Road has an auxiliary right turn lane with 200 feet of storage. The Middlebelt Road and Inverness Road approaches and the operations of the intersection remain unchanged.

The unbalanced 4 lane alternative assumes that the one eastbound lane west of the intersection will be added. It will then connect with the existing 5-lane section. At the intersection, geometrics and operations are the same as existing with some minor adjustments to the signal timing.

Table 12: Middlebelt Road at Orchard Lake Road

		Middlebelt Northbound		Middlebelt Southbound		Orchard Lake Eastbound		Orchard Lake Westbound		Intersection	
		Delay (Sec.)	LOS	Delay (Sec.)	LOS	Delay (Sec.)	LOS	Delay (Sec.)	LOS	Delay (Sec.)	LOS
2020 AM	Existing Conditions	27.9	C	32.2	C	23.7	C	12.2	B	20.0	B
	3 – Lane w/ Aux	31.9	C	32.3	C	50.8	D	20.5	C	37.1	D
	Unbalanced 4 - Lane	28.0	C	32.1	C	9.6	A	6.9	A	10.9	B
2040 AM	Existing Conditions	27.9	C	31.8	C	24.7	C	12.9	B	20.8	C
	3 – Lane w/ Aux	34.5	C	31.9	C	59.0	E	21.5	C	41.8	D
	Unbalanced 4 - Lane	20.0	B	17.2	B	15.9	B	12.2	B	15.0	B
2020 PM	Existing Conditions	34.3	C	22.1	C	32.5	C	24.4	C	28.9	C
	3 – Lane w/ Aux	123.4	F	32.1	C	31.7	C	54.7	D	58.2	E
	Unbalanced 4 - Lane	34.4	C	21.0	C	20.0	B	19.9	B	22.5	C
2040 PM	Existing Conditions	34.7	C	21.7	C	33.8	C	25.6	C	29.9	C
	3 – Lane w/ Aux	138.2	F	32.1	C	33.7	C	64.2	E	66.1	E
	Unbalanced 4 - Lane	30.6	C	14.1	B	18.5	B	22.7	C	22.5	C

Under existing conditions, this intersection operates with acceptable delay during both peak periods. The Unbalanced 4-lane alternative operations are nearly identical to the existing conditions. The lane reductions required for the 3-lane with auxiliary lanes alternative result in a substantial increase in delay and unacceptable level of service values in the PM Peak period.

9. CONCEPT DISCUSSION AND CONCLUSION

Under existing conditions there are identified operational and safety concerns within the Orchard Lake Corridor. Crash data indicates that the lack of a center left turn lane is contributing to crash patterns, especially in locations with a high concentration of driveways. Peak hour congestion on the roadway further contributes to these safety concerns. Under existing conditions some approaches to signalized intersections have excessive delays and a poor level of service during the peak hour. Delays are most



significant at the intersection of Orchard Lake Road and Cass Lake Road. Traffic volumes in this area are expected to increase, further decreasing the operational safety performance of the existing configuration.

With the operational and safety performance of the existing corridor, consideration of improvements to the corridor is prudent. Multiple alternatives were explored for potential improvements to the corridor. The most promising alternatives are a 3 Lane Road Diet with Auxiliary Lanes and an Unbalanced 4 Lane.

3 Lane Road Diet with Auxiliary Lanes

This alternative would provide one lane in each direction and a two-way center left-turn lane within the existing pavement limits. The majority of the study area would have a constant 3-lane cross section. Auxiliary turn lanes would be added at signalized intersections, staying within the constraints of the existing pavement. Portions of the roadway would have additional paved space not needed for vehicular lanes. Near some intersections, the entire road width would be utilized for travel lanes. Additional paved space not needed for vehicular lanes would be used as a paved shoulder with the potential for future projects to adjust the curb line to narrow the roadway.

This option would provide the needed two-way center left-turn lane to address safety concerns in the corridor. It would also provide some opportunity for reuse of the space currently dedicated to vehicle lanes. The inclusion of auxiliary turn lanes helps reduce negative operational impacts, however, there operations at some locations are still significant. The intersections at Cass Lake Road and Middlebelt Road experience substantial delays and poor approach level of service values in the peak periods, with these intersections performing worse under this alternative than the existing geometry.

Unbalanced 4 Lane

This alternative provides a continuous two-way center left-turn lane, a single eastbound lane and two westbound lanes. The unbalanced lanes address the additional capacity needs of westbound Orchard Lake Road in the evening peak period while still providing the safety benefits of a more traditional road diet. Auxiliary turn lanes would be added at signalized intersections, staying within the constraints of the existing pavement.

This option would provide the needed two-way center left-turn lane to address safety concerns in the corridor. It minimizes capacity concerns for westbound vehicles by maintaining two travel lanes. The use of auxiliary turn lanes further reduces the operational impacts of the change in cross section. The majority of intersections in the corridor have acceptable operations during both peak hours. The intersection of Orchard Lake Road and Cass Lake Road has an overall reduction in delay, but the southbound approach experiences an increase in delay and operates at the LOS E during the PM Peak period.

Community Outreach

The findings of the study were provided to the project stakeholder group in March 2021. A findings meeting was held to review the study data and discuss opportunities for implementation. Community representatives also provided updates to their respective community boards and departments, including emergency services. OHM Advisors, on behalf of the RCOC, prepared a recorded video presentation to summarize the study elements and findings. The recorded presentation and a series of questions to solicit feedback was made available in a web-based format for public review and comment. **Appendix G** includes the list of questions, a quantitative breakdown of the responses, and a brief qualitative summary.



Input from both the stakeholder team members and public responses reflect the wide variety of road users. While many expressed concern at any change that could have a negative impact on capacity, others would like to see changes to the automotive focus of the corridor. The competing visions of this corridor were reflected in suggestions to explore a five-lane roadway and suggestions to explore a lower speed three lane roadway with bike lanes. As discussed above, the study was limited to exploring alternatives that could be accomplished within the existing roadway pavement. Widening required to provide either additional travel lanes or continuous bike lanes of adequate width would have substantial impacts on the adjacent properties and the existing pedestrian facilities. This type of work is outside what was planned to be accomplished with the current project.

Road user respondents were asked to identify which transportation problems they currently experienced along the corridor. Traffic congestion was the most often cited transportation problem. Other concerns experienced by a majority of responders were difficulty turning and speeding vehicles. These experiences align with the stakeholder teams priorities of improved safety and mobility in the corridor.

Conclusion

The existing road section and adjacent development contribute to the operational and safety concerns along the Orchard Lake Road corridor. The substantial number and concentration of access points combined with the lack of a center left turn lane results in driveway related crash patterns along the entire corridor. Consolidation of access points will minimize operational friction and safety concerns along the corridor.

Non-motorized facilities in the corridor include an inconsistent sidewalk along both sides of the roadway. Access point consolidation and modifications to parking areas located in the right-of-way may provide opportunity to fill sidewalk gaps increase pedestrian visibility along the corridor. The modification of the road section to add a center left turn lane plus elimination of access points could provide the opportunity to add pedestrian refuge islands at mid/block crossings of Orchard Lake Road. Any redevelopment in the corridor should prioritize pedestrian facilities consistent with the communities' master plans.

Both evaluated alternatives provide the safety and operational benefit of a center left turn lane. This provides a space for vehicles to wait to complete left turns into driveways and side streets along the corridor. The alternatives minimize abrupt lanes changes and vehicles stopping in thru lanes. The inclusion of auxiliary turn lanes under both alternatives helps minimize the operational impacts of the proposed lane change. The addition of an additional westbound thru lane allows the unbalanced 4-lane alternative to provide less operational disruption.

The unbalanced 4-lane alternative is the most promising solution corridor section as it addresses safety concerns while providing optimal reallocation of the existing pavement to minimize negative operational impacts.