ARCADIS Design & Consultancy for natural and built assets

Ohio Department of Transportation
District 8

CORRIDOR STUDY

WAR-U.S. 22-2.00 Corridor Study
PID #101154

March 6, 2018

Corridor Study

WAR-U.S. 22-2.00
PID #101154

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This document, including the information contained herein, is prepared solely for the purpose of identifying, evaluating, and planning safety improvements on public roads that may be implemented utilizing federal aid highway funds and is therefore exempt from discovery or admission into evidence pursuant to 23 U.S.C. 409.

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EXECUTIVE SUMMARY

The Ohio Department of Transportation (ODOT) retained Arcadis U.S., Inc. (Arcadis) to study the overall operation of a 3.1-mile-long segment of U.S. Route 22 (U.S. 22), a 0.6-mile-long portion of State Route (S.R.) 48 and a 1.2-mile-long portion of Old 3C Highway in Warren County, Ohio.

Purpose

In 2005, the Southwest Warren County Transportation Study was undertaken by the Ohio, Kentucky & Indiana Regional Council of Governments (OKI) to improve mobility and safety in southwestern Warren County. An outcome of the study was a recommendation to widen U.S. 22 to provide two lanes in each direction, between Columbia Road and S.R. 48, including the existing high-level bridge over the Little Miami River, as a medium-priority improvement. The cost of improving U.S. 22 was estimated to be $43.9 million (in 2005 dollars), not including right-of-way, utility, engineering, or administrative costs.

Based on the high cost of the recommended improvement, ODOT retained Arcadis to complete this corridor study, considering several options for improving safety and reducing congestion along the U.S. 22 corridor from Landen Drive to West Road.

Existing Conditions

U.S. 22 is an east-west principal urban arterial that approximately parallels Interstate 71. U.S. 22 has a posted speed limit of 45 miles per hour, an average daily traffic volume between 15,000 and 20,000, with 2 percent trucks, and a 60/40 directional split, with the westbound movement being predominant during the a.m. peak hour and the eastbound movement being predominant during the p.m. peak hour. The through traffic volumes during the a.m. and p.m. peak hours result in more than 30 seconds of delay on stop-controlled side streets.

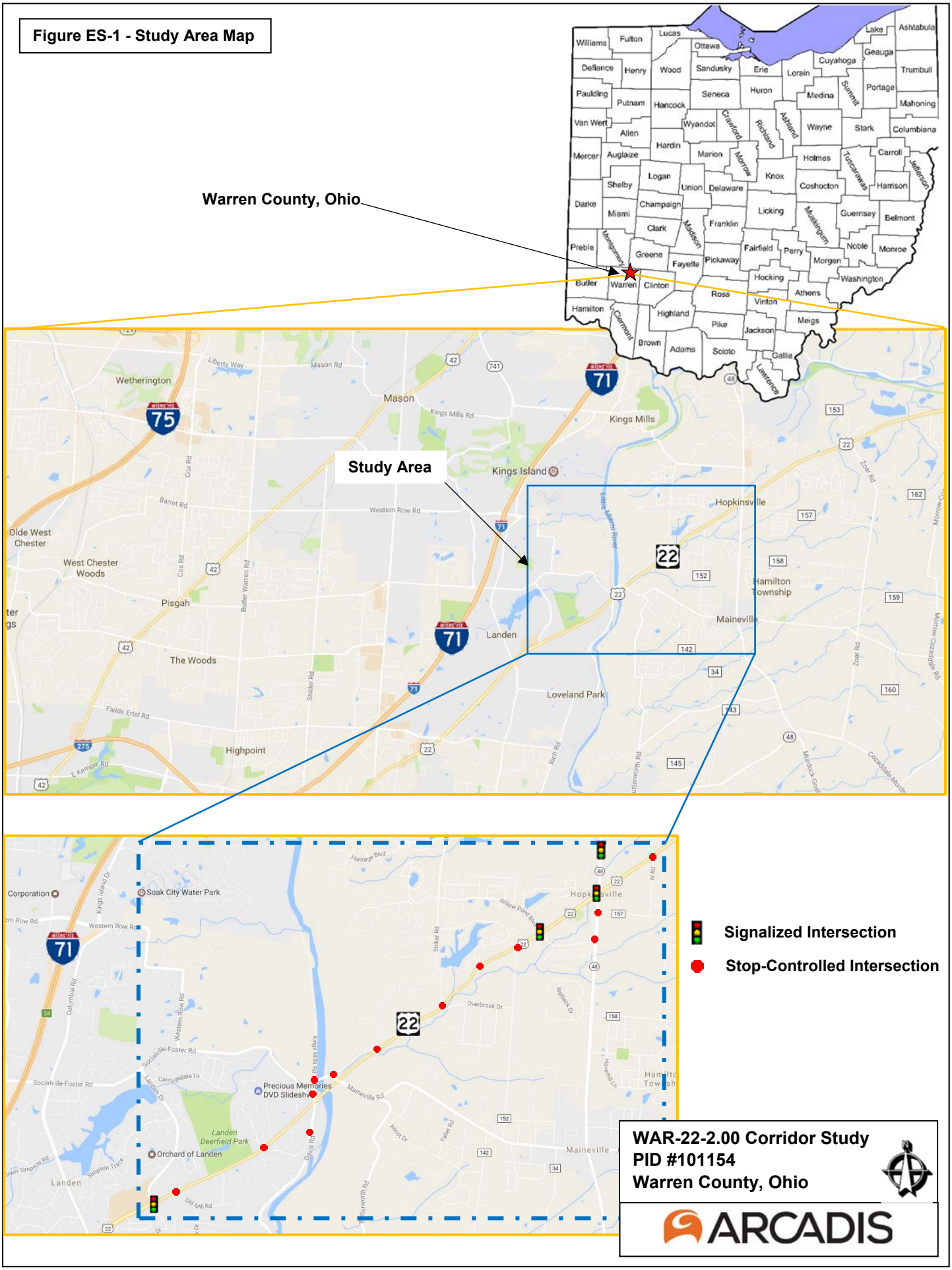
Between Landen Drive and Old Mill Road, U.S. 22 has two westbound lanes, two eastbound lanes, a center two-way left-turn lane, and full shoulders. East of Old Mill Road, U.S. 22 narrows to one westbound lane, one eastbound lane, a center two-way left-turn lane, and full shoulders. East of Creek Woods Place/Old 3C Highway, U.S. 22 narrows again to one westbound lane, one eastbound lane, and narrow shoulders.

Old 3C Highway has one lane in each direction. Old 3C Highway is the remnant of the original lower-level crossing of the Little Miami River and intersects with Davis Road, Socialville Foster Road, Kings Mill Road, and West Foster Maineville Road before reconnecting to U.S. 22 on the other side of the Little Miami River.

S.R. 48 also has one lane in each direction. Traffic on S.R. 48 experiences heavy peak hour congestion at the intersection with U.S. 22. Vehicles traveling northbound on S.R. 48 often use Willow Pond Boulevard as a quadrant roadway to complete a left-turn movement onto U.S. 22 westbound. Vehicles traveling southbound on S.R. 48 encounter a queue north of the Town Center Boulevard intersection during the a.m. and p.m. peak hours. The traffic signal at Town Center Boulevard appears to meter the amount of traffic reaching the intersection of U.S. 22 and S.R. 48.

The study area is illustrated on Figure ES-1.

Figure ES-1 - Study Area Map



Analyses

Arcadis developed planning-level traffic volumes for traffic operational analysis purposes. The opening year for this corridor study is 2019 and the design year is 2039. Arcadis evaluated the feasibility of the following alternatives:

No-Build Alternative

In the no-build alternative, no improvements will be made as a result of this study. The no-build alternative is required for evaluation purposes to serve as a baseline for comparison to an alternative that includes changes to the transportation system network. For the no-build alternative, existing operational conditions were considered with anticipated future traffic volumes.

Alternative 1

In Alternative 1, U.S. 22 will be restriped within the existing pavement to a five-lane roadway between Landen Drive and Creek Woods Place/Old 3C Highway. A pedestrian crossing with a refuge island will be constructed at Landen-Deerfield Park. Between Creek Woods Place/Old 3C Highway and West Road, U.S. 22 will be widened to five lanes with a center two-way left-turn lane. To provide additional capacity over the Little Miami River the existing high-level bridge will either be replaced with a new four-lane-wide structure or it will be supplemented with a second, parallel two-lane structure. A multi-use path will be included on the south side of U.S. 22. The existing retaining wall on the south side of U.S. 22, east of Overbrook Drive, will be extended to accommodate the widening.

Widening alone will not provide traffic operation at all intersections within the study area. Therefore, in addition to widening, improvements are proposed for several intersections along U.S. 22. A roundabout will be constructed at the intersection with Creek Woods Place/Old 3C Highway. No changes, other than prohibiting the southbound left turn during peak hours, are proposed for the intersection with Old 3C Highway east of the high-level bridge. Willow Pond Boulevard will be used as a quadrant roadway and will remain a signalized intersection at U.S. 22. A roundabout will be constructed between S.R. 48 and West Road to provide access to the proposed Hoptown Development roadway, which will connect to S.R. 48 opposite of Town Center Boulevard. No changes are proposed for the intersection with Old Mill Road as part of this alternative. However, based on traffic projections, the Old Mill Road intersection may need to be converted to a Restricted Crossing U-Turn (RCUT) by 2029. Landen Drive and S.R. 48 will also remain signalized intersections. No changes are proposed for the Overbook Drive, Lakeshore Drive, Hopkins Road, and West Road intersections.

Several improvements are proposed for the intersections along S.R. 48. The proposed Hoptown Development roadway will be included as a quadrant roadway serving southbound traffic on S.R. 48 headed to U.S. 22 eastbound and westbound traffic on U.S. 22 headed to S.R. 48 northbound. A traffic signal will be constructed at Willow Pond Boulevard. No changes, other than prohibiting the eastbound through movement during peak hours, are proposed for the UDF Driveway/Nunner Road intersection.

Alternative 2

In Alternative 2, U.S. 22 will be restriped within the existing pavement to a four-lane roadway with a raised median between the Landen Drive and Creek Woods Place/Old 3C Highway intersections. A pedestrian crossing with a refuge island will be constructed at Landen-Deerfield Park. Between Creek Woods Place/Old 3C Highway and West Road, U.S. 22 will be widened to four lanes. The existing retaining wall on the south side of U.S. 22, east of Overbrook Drive, will be extended to accommodate the widening.

However, no changes are proposed for the existing high-level bridge over the Little Miami River, which will remain one lane in each direction.

Improvements are proposed for several intersections along U.S. 22. A roundabout will be constructed at the intersection of Old Mill Road and at the intersection with Creek Woods Place/Old 3C Highway. A raised median will be constructed in the middle of U.S. 22 between these two intersections to convert the driveways to right-in/right-out operation. No changes, other than prohibiting the southbound left turn during peak hours, are proposed for the Old 3C Highway intersection east of the high-level bridge. The Overbrook Drive intersection will be reconfigured into an RCUT. No changes, other than prohibiting the southbound left turn during peak hours, are proposed for the Lakeshore Drive intersection. No changes, other than prohibiting the northbound left turn during peak hours and redirecting traffic to the Overbrook Drive intersection, are proposed for the Hopkins Road intersection. The West Road intersection will be reconfigured into an RCUT. The Landen Drive, Willow Pond Boulevard, and S.R. 48 intersections will remain signalized.

Several improvements are proposed for the intersections along S.R. 48. The Town Center Boulevard intersection will remain a signalized. No changes, other than prohibiting the eastbound through movement during peak hours, are proposed for the UDF Driveway/Nunner Road intersection. No changes, other than prohibiting eastbound left turns during peak hours, are proposed for the Willow Pond Boulevard intersection.

Alternative 2 includes two proposed two-lane true-quadrant roadways located in the northeast and southwest quadrants of the intersection at U.S. 22 and S.R. 48. These proposed quadrant roadways follow the design parameters set forth by the Federal Highway Administrations regarding quadrant roadway design. The quadrant roadways will intersect U.S. 22 and S.R. 48 approximately 500 feet from the intersection of U.S. 22 and S.R. 48. A traffic signal will be constructed at the quadrant roadway intersections along U.S. 22. The quadrant roadway intersections along S.R. 48 will be stop-controlled on the side street.

Alternative 2 Sub Alternative – Peak Hour One-Way Operation on the U.S. 22 Bridge

Alternative 2 includes a sub alternative to address the additional peak hour capacity required on the high-level bridge over the Little Miami River without constructing a new four-lane-wide structure or a supplemental parallel two-lane structure. The existing two-lane high-level bridge will be converted to one-way operation during the peak hour. The lower, non-peak direction volume of traffic, would be diverted off of the existing high-level bridge onto the original Old 3C Highway alignment using the original lower-level crossing of the Little Miami River. This option was considered using the current two-lane configuration of Old 3C Highway and it was also considered if one, reversible, lane is added to Old 3C Highway. The capacity analyses results, the presences of driveways located within the one-way section on U.S. 22, and the presence of the multi-use path below the existing high-level bridge all made this sub alternative not feasible.

Alternative 2 Sub Alternative – Without True-Quadrant Roadways

Alternative 2 includes a sub alternative to provide an option of ODOT elected not to build the two, new true-quadrant roadways. This sub alternative examined the operation of the intersection of U.S. 22 and S.R. 48 without traffic diverted to the two-proposed true-quadrant roadways.

Alternative 3

In Alternative 3, U.S. 22 will be restriped within the existing pavement to a five-lane roadway between the Landen Drive and Creek Woods Place/Old 3C Highway intersections. A pedestrian crossing with a refuge island will be constructed at Landen-Deerfield Park. No widening or restriping is proposed on U.S. 22 between the Creek Woods Place/Old 3C Highway and West Road intersections. In addition, no changes are proposed to the existing high-level bridge over the Little Miami River, which will remain one lane in each direction.

Improvements are proposed at several intersections along U.S. 22. A single lane roundabout will be constructed at the Creek Woods Place/Old 3C Highway intersection. No changes, other than prohibiting the southbound left turn during peak hours, are proposed for the Old 3C Highway intersection east of the high-level bridge. The Overbrook Drive intersection will be reconfigured into an RCUT. No changes, other than prohibiting the southbound left turn during peak hours, are proposed at the Lakeshore Drive intersection. The Hopkins Road intersection will be reconfigured to a Green T intersection to eliminate the conflict between the westbound through movement on U.S. 22 and the northbound left-turn movement from Hopkins Road. The Landen Drive, Willow Pond Boulevard, and S.R. 48 intersections will remain signalized. No changes are proposed for the Old Mill Road intersection.

None of the intersections along S.R. 48 will be changed. The Town Center Boulevard intersection will remain signalized. The eastbound through movement at the UDF Driveway/Nunner Road intersection is prohibited during peak hours. No changes, other than prohibiting eastbound left turns during peak hours, are proposed for the Willow Pond Boulevard intersection.

Alternative 3 Sub Alternative – Peak Hour Movement Restrictions

Alternative 3 includes a short-term sub alternative to address the crash frequency at the intersections of U.S. 22 and Creek Woods Place/Old 3C Highway and at U.S. 22 and Old 3C Highway (east of the high-level bridge over the Little Miami River). This sub alternative examined the operation of these intersections if left turns from Old 3C Highway (at both intersections) were prohibited during the a.m. and p.m. peak hours.

U.S. 22 will be restriped within the existing pavement to a five-lane roadway beginning 1,200 feet east of Landen Drive and extending to Creek Woods Place/Old 3C Highway. The restriping will provide one additional lane with a two-way left-turn lane within the existing pavement. The outside lane on U.S. 22 eastbound will end as a right-turn only lane onto Old 3C Highway (west of the high-level bridge). The outside lane on U.S. 22 westbound will begin as an add lane from Creek Woods Drive.

During the peak hours three movement restrictions will be imposed. First, at the intersection of U.S. 22 and Creek Woods Place/Old 3C Highway, the northbound left turn from Old 3C Highway will be prohibited and the movement redirected to a southbound right turn at the intersection of U.S. 22 and Old 3C Highway (east of the high-level bridge). An overhead flasher will be constructed with lane use signs on the span wires. Second, at the intersection of U.S. 22 and Old 3C Highway (east of the high-level bridge), the southbound left turn from Old 3C Highway to U.S. 22 eastbound will be prohibited and the movement redirected to a northbound right turn at the intersection of Creek Woods Place/Old 3C Highway to U.S. 22 (west of the high-level bridge). Third, at the same intersection, the eastbound left turn from U.S. 22 onto Old 3C Highway will also be prohibited and the movement redirected to an eastbound right turn at the intersection U.S. 22 and Creek Woods Place/Old 3C Highway.

Results

The level of service results for both peak hour capacity analyses demonstrate that, overall, Alternatives 1, 2, and 3 will improve operations and capacity on U.S. 22 within the study area. The capacity analysis for signalized intersections indicates an acceptable level of service in the design year. The capacity analysis for unsignalized intersections where the minor street is stop-controlled indicates that delay will typically be less than 40 seconds in the design year.

Conceptual Opinion of Probable Cost

Conceptual estimates of construction costs for Alternatives 1, 2, and 3 were prepared using the ODOT Estimator program. Estimated construction costs were developed using estimated quantities for items that would be needed or impacted to implement the improvement. The cost estimate assumes a 30 percent contingency, a 7.5 percent inflation rate (to the assumed midpoint of construction), a 0.75 percent performance bond.

The total costs for each alternative includes all of the improvements included in that alternative. It is possible to break each alternative into smaller projects to phase the implementation over several years or to break the improvements into individual projects to implement each improvement separately.

Alternative 1	
Total 2021 Conceptual Estimate of Probable Project Cost (with Inflation)	$93,766,713
(Includes the New 4 Lane Bridge)	
Total Estimated ODOT Right-of-Way Acquisition Cost	$2,175,178
Total Estimated Design Cost	$7,500,000
Total Cost for Alternative 1	$103,441,891
Alternative 1 – New 4 Lane Bridge	$32,297,650
Alternative 1 – New 2 Supplemental Lane Bridge	$23,986,000

Alternative 2	
Total 2021 Conceptual Estimate of Probable Project Cost (with Inflation)	$31,586,068
Total Estimated ODOT Right-of-Way Acquisition Cost	$1,865,024
Total Estimated Design Cost	$2,525,000
Total Cost for Alternative 2	$35,976,092
Alternative 2 Sub-Alternative – Peak Hour One Way Operation on the U.S. 22 Bridge	
Costs were not developed because this alternative was found to not be feasible.	

Alternative 2 Sub-Alternative – Without True Quadrant Roadways	
Total 2021 Conceptual Estimate of Probable Project Cost (with Inflation)	$30,610,678
Total Estimated ODOT Right-of-Way Acquisition Cost	$797,839
Total Estimated Design Cost	$2,450,000
Total Cost for Alternative 2 Sub Alternative	$33,858,517

Alternative 3	
Total 2021 Conceptual Estimate of Probable Project Cost (with Inflation)	$10,513,644
Total Estimated ODOT Right-of-Way Acquisition Cost	$111,340
Total Estimated Design Cost	$845,000
Total Cost for Alternative 3	$11,469,984
Alternative 3 – Creek Woods Place/Old 3C Highway Roundabout	$1,374,255
Alternative 3 Sub-Alternative – Peak Hour Movement Restrictions	
Costs were not developed for this alternative.	

1 INTRODUCTION

The Ohio Department of Transportation (ODOT) retained Arcadis U.S., Inc. (Arcadis) to study the overall operation of a 3.1-mile-long segment of U.S. Route 22 (U.S. 22), a 0.6-mile-long portion of State Route (S.R.) 48 and a 1.2-mile-long portion of Old 3C Highway in Warren County, Ohio. This report summarizes the study methodology, provides an overview of existing conditions, future conditions (no-build alternative) and discusses the feasibility of three build alternatives based on capacity analyses, environmental factors and construction costs.

1.1 Background and Previous Studies

In 2005, the Ohio, Kentucky & Indiana Regional Council of Governments (OKI) completed the Southwest Warren County Transportation Study to improve mobility and safety in southwestern Warren County, the fastest-growing area in the OKI region. OKI recommended 19 transportation improvements, ranked as high, medium, or low priority, at a total cost of just more than $300 million.

One of the medium-priority improvements recommended was the widening of U.S. 22 to provide two lanes in each direction, between Columbia Road and S.R. 48, including widening the existing 1,358-foot-long high-level bridge over the Little Miami River. The cost of improving U.S. 22 was estimated to be $43.9 million (in 2005 dollars), not including right-of-way, utility, engineering, or administrative costs.

In 2010, the Warren County Engineer completed the HopTown Corridor Plan, which proposed a new roadway in the northeast quadrant of the intersection of U.S. 22 and S.R. 48. The proposed roadway would intersect S.R. 48 at Town Center Boulevard, creating a fourth leg. The new roadway would intersect U.S. 22 approximately 550 feet east of the intersection of U.S. 22 and S.R. 48 via construction of a new two-lane roundabout. The proposed roadway would provide improved connectivity and better access to the undeveloped parcels in the northeast quadrant of the intersection of U.S. 22 and S.R. 48, and restrict direct access from the state highways.

Based on the high cost of the OKI recommended improvement to widen U.S. 22, ODOT retained Arcadis to complete a feasibility study, the WAR-22-02.00 Corridor Study, considering several options for improving safety and reducing congestion along the U.S. 22 corridor from Landen Drive to West Road. The WAR-22-02.00 Corridor Study evaluates the feasibility of three alternatives: widening to five lanes; adding capacity utilizing performance-based practical design principles; and implementing targeted improvements at key intersections. The new roadway and roundabout proposed in the HopTown Corridor Plan are included in Alternative 1 of the WAR-22-2.00 Corridor Study. The alternatives are discussed in more detail in Section 1.2.

1.2 Study Purpose and Scope of Work

The purpose of the WAR-U.S. 22-2.00 Corridor Study is to evaluate three build alternatives that address operational, safety, and capacity issues on U.S. 22 within the study area and compare them against the no-build condition. Currently drivers attempting to enter U.S. 22 from one of the minor streets typically wait more than 30 seconds before finding an acceptable gap. By 2039 it is predicted that drivers will wait more than 1 minute of delay, before they find an acceptable gap to enter U.S. 22. Rear-end crashes are the most common crash type at the intersections of U.S. 22 and Creek Woods Place/Old 3C Highway,

Landen Drive, Hopkins Road, Willow Pond Boulevard, and S.R. 48, which is consistent with typical crash patterns on congested corridors and at congested intersections. Future growth in the region is anticipated to cause the existing two-lane high-level bridge over the Little Miami River to be over capacity in 2039.

The alternatives studied are:

- No-Build Alternative: Under the no-build alternative, no improvements will be made as a result of this study. Existing operational conditions were considered with anticipated future traffic volumes.
- Alternative 1: Improvements, including widening the roadway to provide two lanes in each direction, plus a two-way left-turn lane, are provided to add capacity along U.S. 22, including the high-level bridge. The high-level bridge will either be replaced with a new four-lane-wide structure or it will be supplemented with a second, parallel two-lane structure. Improvements also include the development roadway discussed in the 2010 HopTown Corridor Plan.
- Alternative 2: Improvements, utilizing performance-based practical design are provided to add capacity along U.S. 22, excluding the high-level bridge.
    - Alternative 2 includes 2 sub alternatives discussed in Section 6.2.1.
- Alternative 3: Improvements are provided at key intersections within the study area to reduce delay in 2019 and maintain efficient traffic operation until approximately year 2029.
    - Alternative 3 includes 1 sub alternative discussed in Section 6.2.1.

Conceptual diagrams of Alternatives 1, 2, and 3 are provided in Appendix A. Public involvement exhibits illustrating the improvement alternatives at each intersection are included Appendix P.

1.3 Study Area and Existing Conditions

The study area for the WAR-22-2.00 Corridor Study includes a 3.1-mile-long portion of U.S. 22 extending from Landen Drive to West Road. The study area also includes a 0.6-mile-long portion of S.R. 48 and a 1.2-mile-long portion of Old 3C Highway. Old 3C Highway is the remnant of the original low-level crossing of the Little Miami River and intersects U.S. 22 twice, once to the southwest of the U.S. 22 high-level bridge and once to the northeast of the bridge. Between these two intersections, Old 3C Highway intersects Davis Road, Socialville Foster Road, Kings Mill Road, and West Foster Maineville Road.

U.S. 22 is an east-west principal urban arterial that approximately parallels Interstate 71 in southern Warren County. U.S. 22 has a posted speed limit of 45 miles per hour (mph), an average daily traffic (ADT) volume between 15,000 and 20,000, with 2 percent trucks, and a 60/40 directional split, with the westbound movement being predominant during the a.m. peak hour (approximately 7:00 a.m. to 9:00 a.m.) and the eastbound movement being predominant during the p.m. peak hour (approximately 4:30 p.m. to 6:30 p.m.).

Between Landen Drive and Old Mill Road/Island Pines Drive, U.S. 22 has two westbound lanes, two eastbound lanes, a center two-way left turn lane, and full shoulders. U.S. 22 narrows east of Old Mill Road/Island Pines Drive. Between Old Mill Road/Island Pines Drive and Old 3C Highway/Creek Woods Place, U.S. 22 has one westbound lane, one eastbound lane, a center two-way left turn lane, and full shoulders. U.S. 22 narrows again east of Old 3C Highway/Creek Woods Place. Between Riversedge Drive and the bridge over the Little Miami River, U.S. 22 has one westbound lane, one eastbound lane, and narrow shoulders.

At the intersection with Old 3C Highway/Creek Woods Place, U.S. 22 has one westbound lane, one eastbound lane, opposing left turn lanes, and full shoulders. Old 3C Highway has one lane in each direction and enters from the southeast. Creek Woods Place has one lane in each direction and enters from the northwest. Creek Woods Place serves a residential subdivision. The study area is illustrated on Figure 1.

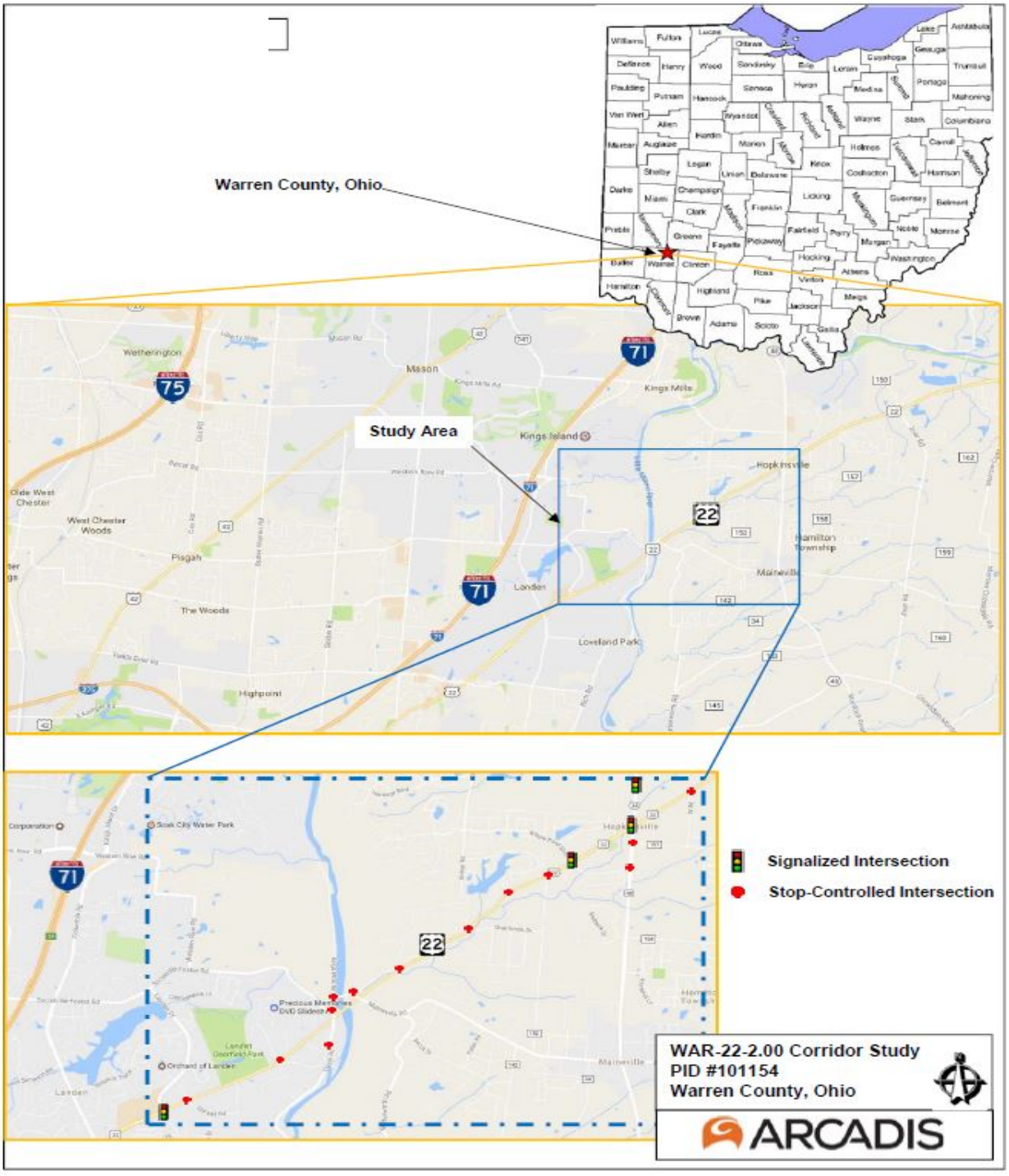


Figure 1. Study Area Map

2 STUDY METHODOLOGY

2.1 Analysis Years

For the purposes of this study the opening year is 2019 and the design year is 2039.

2.2 Methodology

Arcadis evaluated traffic operations in the study area in accordance with the ODOT Traffic Engineering Manual and the ODOT Location and Design Manual Volume 1. The study methodology involved data collection, data analysis, no-build conditions analysis, build conditions analysis, and preparation of a feasibility study report. The data collection and analysis task included gathering historical data (crash rates and traffic volumes), analyzing crash trends, and developing planning-level traffic volumes. Analysis of existing conditions included traffic signal warrant, crash, and capacity analyses. The future conditions analysis task included projecting future-year traffic growth, performing capacity analyses for no-build conditions, and proposing build alternatives based on the capacity issues identified. Alternatives were compared based on results of the capacity analyses and a cost-benefit analysis. Figure 2 presents a flow chart of the study methodology.

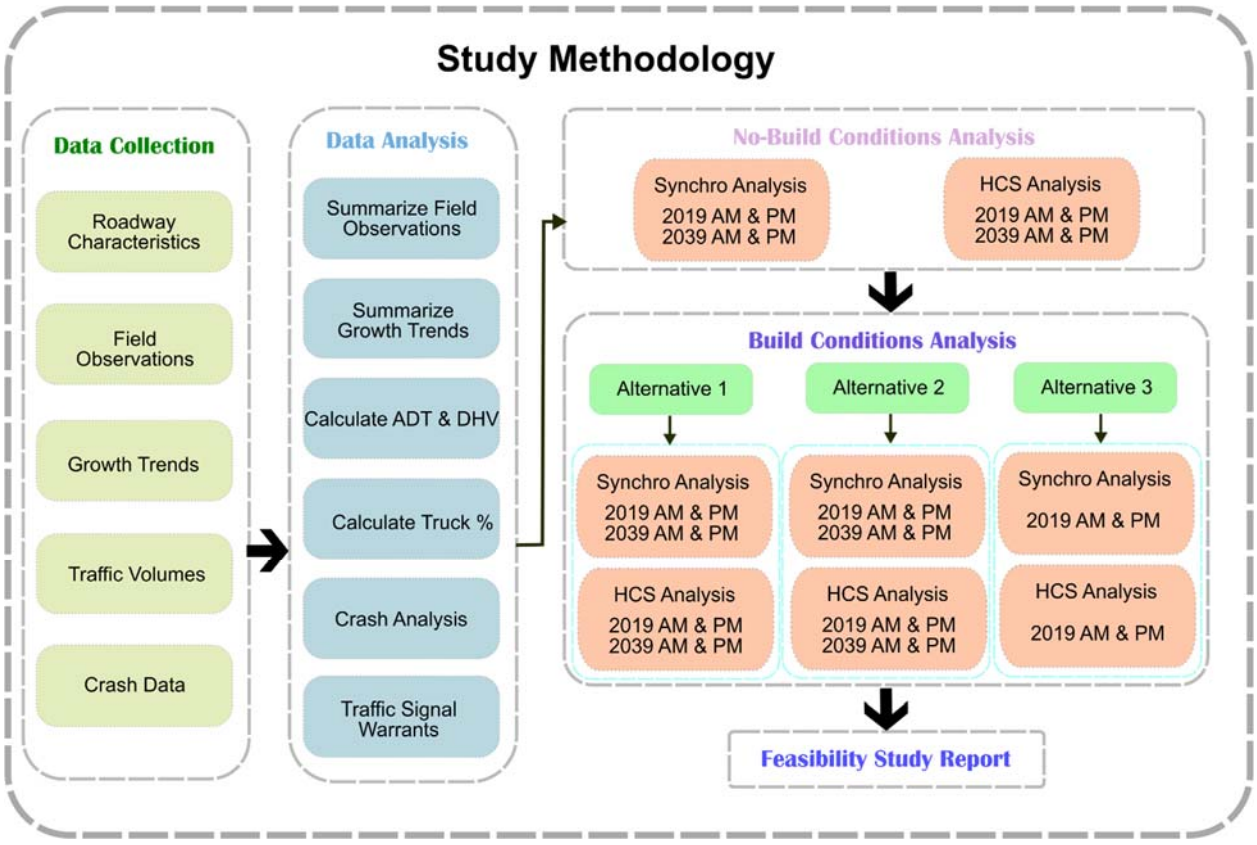


Figure 2. Study Methodology

3 DATA COLLECTION

The data collected at the beginning of the project were used to determine existing traffic volumes and crash characteristics within the study area. The general types of data collected for this study included:

- **Roadway Characteristics:** Roadway geometry information, such as number of lanes, length of turn bays, length of acceleration/deceleration lanes, and intersection control type, was recorded from Google Maps for developing no-build condition Synchro and Highway Capacity Software (HCS) models. Subsequently, a field visit was conducted in January 2017 to visually assess a.m. and p.m. peak period operations and to verify roadway characteristics before developing the no-build condition Synchro and HCS models. In addition to number of lanes and length of turn bays, lane width and sight distance were observed. Videos and photographs were taken to document existing conditions. In addition, any roadway improvements recently implemented within the study area were identified.
- **Growth Factors:** Growth rates for each roadway in the study area were obtained from ODOT District 8 and the OKI travel demand model. ODOT District 8 provided growth factors to Arcadis in October 2016.
- **Traffic Volumes:** ODOT Technical Services performed traffic counts in March and April 2016. ODOT performed ADT and a.m. and p.m. peak hour turning movement counts for the 17 intersections in the study area. ODOT provided raw traffic data, truck percentages, and K factors to Arcadis in June 2016.
- **Crash Data:** The most recent crash data for a three-year period (2013 to 2015) for four intersections within the study area were provided by ODOT. The collected crash data were used to identify the distribution of crashes with relation to type, location, severity, and contributing environmental factors.

4 DATA ANALYSIS

This section summarizes the findings of the field observations performed in the data collection task discussed in Section 3 and results of analyses of the data collected. Growth factors, truck percentages, traffic volumes, crash rates, and traffic signal warrants were analyzed.

4.1 Field Observations

Arcadis visited the study area in January 2017 and used a dashboard camera to document the existing conditions. The site visit documented roadway geometry, the number of lanes, the presence and length of left- and right-turn lanes, intersection control devices, traffic operations, travel patterns, and posted truck restrictions.

Traffic operations observed during the site visit are summarized below.

- A directional split was observed on U.S. 22 with a heavy westbound movement in the a.m. peak hour and a heavy eastbound movement in the p.m. peak hour.
- Vehicles traveling northbound on S.R. 48 use Willow Pond Boulevard as a quadrant roadway (refer to Section 5) to turn left onto U.S. 22 westbound. This route choice is a shorter path and allows motorists to avoid congestion at the signalized intersection of U.S. 22 and S.R. 48.

- Vehicles traveling southbound on S.R. 48 encounter a queue north of the Town Center Boulevard intersection during the a.m. and p.m. peak hours. The traffic signal at Town Center Boulevard appears to meter the traffic reaching the intersection of U.S. 22 and S.R. 48.
- Vehicles traveling southbound on Creek Woods Place conflict with vehicles traveling northbound on Old 3C Highway at the intersection with U.S. 22. The width of U.S. 22 at this intersection makes it difficult for side street vehicles to find a gap when entering U.S. 22.
- Vehicles traveling eastbound on U.S. 22 merge from two lanes to one lane 300 feet east of Old Mill Road. This merge causes eastbound traffic to queue during the p.m. peak hour.
- The posted speed limit increases from 45 mph to 55 mph on the bridge over the Little Miami River.
- The delay at stop-controlled side street approaches can be more than 30 seconds.
- The lane utilization on U.S. 22 eastbound, east of Columbia Road, is poor. During the p.m. peak hour traffic queues from the eastbound outside lane drop on U.S. 22 (west of the intersection at Creek Woods Place/Old 3C Highway) west to Columbia Road.

4.2 Growth Factors

ODOT estimated a 2 percent growth rate for U.S. 22. Growth rates for each side road were estimated using the OKI travel demand model. Future commercial or residential developments within the study area are assumed to be captured in the OKI regional travel demand model growth forecast.

Table 1 shows the growth rate for each road in the study area except for U.S. 22.

4.3 Truck Percentages

Trucks comprise 2 percent of the traffic volumes on U.S. 22. Using the data collected through the sources listed in Section 3, truck traffic was determined to be approximately 1 percent to 3 percent, except for West Road which is 6 percent, during the a.m. and p.m. peak hours.

Table 1 shows the truck percentage for each road except U.S. 22.

Table 1. Intersection Control, Annual Growth Rates, and Truck Percentages

Street		Traffic Control	Annual Growth Rate	Truck Percentage
U.S. 22	Landen Drive	Traffic Signal	0.0%	1.0%
	Old Mill Road	Stop – Side Street	0.0%	3.0%
	Creek Woods Place	Stop – Side Street	1.7%	2.0%
	Old 3C Highway	Stop – Side Street	0.2%	1.0%
	Old 3C Highway	Stop – Side Street	1.7%	0.0%
	Overbrook Drive	Stop – Side Street	0.0%	2.0%
	Lakeshore Drive	Stop – Side Street	0.0%	1.0%
	Hopkins Road	Stop – Side Street	0.6%	2.0%
	Willow Pond Boulevard	Traffic Signal	0.6%	2.0%
	S.R. 48	Traffic Signal	0.3%	2.0%
	West Road	Stop – Side Street	0.0%	6.0%
S.R. 48	Town Center Boulevard	Traffic Signal	0.0%	3.0%
	UDF Driveway/	Stop – Side Street	0.2%	3.0%
	Nunner Road			1.0%
Old 3C Highway	Davis Road	Stop – Side Street	0.7%	1.0%
	Socialville Foster Road	Stop – Side Street	0.7%	1.0%
	Kings Mills Road	Stop – All-Way Stop	0.7%	1.0%
	West Foster Maineville Road	Stop – Side Street	0.0%	1.0%

4.4 Traffic Volumes

The data collected through the sources listed in Section 3 were assessed to develop ADT volumes and peak-hour traffic volumes for use in the traffic study.

4.4.1 Average Daily Traffic Volumes

The existing ADT volumes provided by ODOT Technical Services and the annual growth rate discussed in Section 4.2 were used to determine ADT volumes for 2019 and 2039. The 2019 and 2039 ADT volumes for each segment of U.S. 22, S.R. 48, and Old 3C Highway within the study area are provided in Table 2. Traffic volume diagrams showing ADT volumes for the no-build alternative and Alternatives 1 through 3 are provided in Appendix B.

Table 2. 2019 and 2039 Average Daily Traffic Volumes

Street Segment				2019 ADT	2039 ADT
U.S. 22	Landen Drive	to	Old Mill Road	27,070	38,350
	Old Mill Road	to	Creek Woods Place/ Old 3C Highway	26,020	37,010
	Old 3C Highway (West of the Bridge)	to	Old 3C Highway (East of the Bridge)	22,720	33,260
	Old 3C Highway (East of the Bridge)	to	Overbrook Drive	23,280	34,010
	Overbrook Drive	to	Lakeshore Drive	24,110	34,340
	Lakeshore Drive	to	Hopkins Road	22,950	32,930
	Hopkins Road	to	Willow Pond Boulevard	25,570	33,540
	Willow Pond Boulevard	to	S.R. 48	18,470	27,100
	S.R. 48	to	West Road	21,080	30,330
S.R. 48	Town Center Boulevard	to	S.R. 48	25,340	26,880
	S.R. 48	to	UDF Driveway/Nunner Road	16,040	19,360
	Nunner Road/UDF Driveway	to	Willow Pond Boulevard	14,400	15,320
Old 3C Highway	Old 3C Highway (West of the Bridge)	to	Davis Road	3,270	4,680
	Davis Road	to	Socialville Foster Road	4,170	5,690
	Socialville Foster Road	to	Kings Mills Road	12,010	15,470
	Kings Mills Road	to	West Foster Maineville Road	11,950	15,390
	West Foster Maineville Road	to	Old 3C Highway (East of the Bridge)	2,680	3,820

4.4.2 Peak Hour Volumes

ODOT Technical Services tabulated existing a.m. and p.m. peak period turning movement counts between 6 a.m. and 10 a.m. and between 3 p.m. and 7 p.m. to develop existing design hourly volumes (DHVs). Based on the traffic volumes, the weekday peak periods were determined to be approximately 7:00 a.m. to 8:00 a.m. and 5:30 p.m. to 6:30 p.m.

Open year and design year volumes were developed by applying the growth rates listed in Table 1 to the existing DHVs for the a.m. and p.m. peak hours. Open and design year DHVs are shown on Figure 2.

Traffic volume diagrams showing DHVs for the no-build alternative and Alternatives 1 through 3 are provided in Appendix B.

4.5 Crash Analysis

Crash data for 2013 to 2015 were analyzed for the following intersections:

- U.S. 22 at Landen Drive
- U.S. 22 at Hopkins Road
- U.S. 22 at Willow Pond Boulevard
- U.S. 22 at S.R. 48
- U.S. 22 from Landen Drive to Old 3C Highway east of the high-level bridge (performed by ODOT District 8)

The crash history for each of these intersections is summarized below.

4.5.1 U.S. 22 at Landen Drive

A total of 23 crashes occurred near this signalized four-leg intersection. Fifteen (65 percent) of these crashes were rear-end collisions, and all but one occurred on U.S. 22. Four (17 percent) of these crashes were left-turn crashes, three of which occurred as eastbound drivers turned left to travel north on Landen Drive. Three crashes were angle collisions. One crash was a backing crash that occurred on the northern approach of Landen Drive. No crashes occurred on the southern approach of Landen Drive.

The crash rate per million entering vehicles is 0.72. The ODOT Crash Analysis Module tool excludes intersections from average statewide crash rate calculations. For comparison, the average statewide crash rate for a four-lane undivided principal arterial is 2.71 crashes per million vehicle miles traveled.

4.5.2 U.S. 22 at Hopkins Road

A total of 39 crashes occurred near this stop-controlled T intersection. Thirty (77 percent) of these crashes were rear-end collisions, of which 26 occurred on the eastern approach of U.S. 22. Six (15 percent) of these crashes were fixed object crashes involving vehicles exiting the roadway. The remaining three crashes were sideswipe collisions. Only two crashes occurred on Hopkins Road: one was a rear-end crash and one was a sideswipe crash resulting from a right-turn-on-red movement.

The crash rate per million entering vehicles is 1.60. The ODOT Crash Analysis Module tool excludes intersections from average statewide crash rate calculations. For comparison, the average statewide crash rate for a two-lane undivided principal arterial is 1.68 crashes per million vehicle miles traveled.

4.5.3 U.S. 22 at Willow Pond Boulevard

A total of 25 crashes occurred near this signalized four-leg intersection. Seventeen (68 percent) of these crashes were rear-end collisions, and all but one occurred on U.S. 22. Four (16 percent) of these crashes were left-turn crashes. Two of the left-turn crashes occurred as eastbound drivers turned left to travel north on Willow Pond Boulevard, one occurred as a westbound driver turned left to travel south on Willow

Pond Boulevard, and one occurred when a northbound driver attempted to turn left to travel west on U.S. 22. Four crashes were angle collisions.

The crash rate per million entering vehicles is 0.93. The ODOT Crash Analysis Module tool excludes intersections from average statewide crash rate calculations. For comparison, the average statewide crash rate for a two-lane undivided principal arterial is 1.68 crashes per million vehicle miles traveled.

4.5.4 U.S. 22 at S.R. 48

A total of 92 crashes occurred near this signalized four-leg intersection. Seventy-three (79 percent) of these crashes were rear-end collisions, 32 (44 percent) of which occurred on the northern approach and 23 (33 percent) of which occurred on the western approach. The remaining crashes occurred on the southern and eastern approaches. Nine crashes were angle collisions, and five crashes were left-turn collisions. The remaining five crashes were backing (one), sideswipe-passing (two), fixed-object (one), and pedestrian (one).

The crash rate per million entering vehicles is 2.24. The ODOT Crash Analysis Module tool excludes intersections from average statewide crash rate calculations. For comparison, the average statewide crash rate for a two-lane undivided principal arterial is 1.68 crashes per million vehicle miles traveled.

Rear-end crash data for these four intersections were assessed further. Seventy-five percent of the crashes that occurred at these intersections were rear-end collisions. Fifty-eight percent of the rear-end crashes occurred on a weekday and 25 percent occurred under low-light or dark conditions. Thirteen percent of the crashes resulted in an injury. None of the crashes resulted in a fatality.

Crash diagrams are included in Appendix C.

4.5.5 ODOT Safety Study – U.S. 22 from Landen Drive to Old 3C Highway

ODOT District 8 completed a safety study on U.S. 22 between Landen Drive and Old 3C Highway east of the bridge over the Little Miami River, including the unsignalized four-leg intersection at U.S. 22 and Creek Woods Place/Old 3C Highway. ODOT analyzed crash data for 2014 to 2017.

A total of 95 crashes occurred on U.S. 22 between Landen Drive and Old 3C Highway east of the bridge over the Little Miami River. Sixty-one percent of these crashes were rear end collisions and 18 percent were angle crashes. Almost half (40 percent) of the crashes occurred during the p.m. peak hours. These crashes are attributed to the traffic queue on U.S. 22 that extends from Creek Woods Place/Old 3C Highway west to Columbia Road. Rear end crashes were also observed on U.S. 22 eastbound as drivers stop to turn left onto Old 3C Highway east of the Little Miami River bridge. Approximately 35 percent occurred in wet, snow or icy conditions. Approximability 25 percent of the crashes included an injury.

A total of 10 crashes occurred near the unsignalized four-leg intersection at U.S. 22 and Creek Woods Place/Old 3C Highway. Seven of these 10 crashes were angle collisions occurring as drivers turn left from Old 3C Highway onto U.S. 22. Two of the seven crashes occurred during the a.m. peak hours and four of the seven crashes occurred during the p.m. peak hours. Four of the seven crashes included an injury.

A copy of the safety study completed by ODOT District 8 is included in Appendix C.

4.6 Traffic Signal Warrant Analysis

All new or reconstructed intersections are required to undergo a traffic signal warrant analysis according to the Ohio Manual of Uniform Traffic Control Devices (OMUTCD), Chapter 4c. Intersections within the study area were analyzed using PC Warrants software and in accordance with ODOT Traffic Engineering Manual requirements. Traffic signal warrants 1a, 1b, 1c, 2, 3a, and 3b, which compare peak hour volumes to certain thresholds, were analyzed.

Based on the traffic signal warrant analysis for the study area, traffic signals are warranted at the following intersections:

- U.S. 22 at Landen Drive (currently signalized)
- U.S. 22 at Old 3C Highway (east of the high-level bridge)
- U.S. 22 at Willow Pond Boulevard (currently signalized)
- U.S. 22 at S.R. 48 (currently signalized)
- S.R. 48 at Town Center Boulevard (currently signalized)
- Old 3C Highway at Socialville Foster Road

Based on the traffic signal warrant analysis for the study area, traffic signals are not warranted at the following intersections:

- U.S. 22 at Old Mill Road
- U.S. 22 at Creek Woods Place/Old 3C Highway
- U.S. 22 at Overbrook Drive
- U.S. 22 at Lakeshore Drive
- U.S. 22 at Hopkins Road
- U.S. 22 at West Road
- S.R. 48 at UDF Driveway/Nunner Road
- S.R. 48 at Willow Pond Boulevard
- Old 3C Highway at West Foster Maineville Road
- Old 3C Highway at Kings Mills Road
- Old 3C Highway at Davis Road

The results of the warrant analysis conducted in accordance with ODOT Traffic Engineering Manual requirements for the 17 intersections studied along U.S. 22 are summarized in Table 3. The PC Warrants reports are provided in Appendix D.

Table 3. Summary of Traffic Signal Warrant Analysis

Intersection		Existing Control	Warrant 1 Eight-Hour Vehicular Volumes			Warrant 2 Four-Hour Volumes	Warrant 3 Peak Hour Volumes	
			1A	1B	1C		3A	3B
U.S. 22	Landen Drive	Signal	Y	Y	N	Y	N	Y
	Old Mill Road	Stop	N	N	N	N	N	N
	Creek Woods Place/Old 3C Highway	Stop	N	N	N	N	N	N
	Old 3C Highway	Stop	N	N	N	Y	N	N
	Overbrook Drive	Stop	N	N	N	N	N	N
	Lakeshore Drive	Stop	N	N	N	N	N	N
	Hopkins Road	Stop	N	N	N	N	N	N
	Willow Pond Boulevard	Signal	Y	Y	Y	Y	N	Y
	S.R. 48	Signal	Y	Y	Y	Y	N	Y
	West Road	Stop	N	N	N	N	N	N
S.R. 48	Town Center Boulevard	Signal	N	N	N	N	N	Y
	UDF Driveway/Nunner Road	Stop	N	N	N	N	N	N
	Willow Pond Boulevard	Stop	N	N	N	N	N	N
Old 3C Highway	West Foster Maineville Road	Stop	N	N	N	N	N	N
	Kings Mills Road	Stop	N	N	N	N	N	N
	Socialville Foster Road	Stop	N	N	N	N	N	Y
	Davis Road	Stop	N	N	N	N	N	N

5 POTENTIAL INNOVATIVE IMPROVEMENTS

Arcadis evaluated five potential innovative treatments as part of this study: performance based practical design, a roundabout intersection, a restricted crossing U-turn (RCUT) intersection, Green T intersection, and a quadrant roadway.

5.1 Performance-Based Practical Design

ODOT has adopted performance-based practical design as a flexible approach to transportation planning. Performance-based practical design allows ODOT to make informed, risk-based decisions regarding how to select investments based on community needs, funding constraints, site impacts, and transportation needs without compromising safety. A key component of ODOT's approach to performance-based

practical design is use of the American Association of State Highway and Transportation Officials' Highway Safety Manual to compare and select improvements that may not be realized in a 20-year planning horizon but rather may be realized incrementally.

The Federal Highway Administration (FHWA) recognizes performance-based practical design as a valuable tool for making incremental improvements to existing conditions in an environment that is constrained by available funding, timing, environmental impacts, and property impacts.

5.2 Roundabout Intersection

A roundabout intersection allows for left-turn, thru, and right-turn movements, similar to a regular intersection. A roundabout intersection differs from a conventional intersection in that a roundabout is a circular intersection where all traffic moves counterclockwise around a circular center island. Vehicles entering the roundabout must yield to vehicles in the roundabout. Vehicles entering the roundabout are not required to stop unless they will conflict with a vehicle in the roundabout. Vehicle speeds are low through the roundabout.

According to the Transportation Research Board's (TRB's) National Cooperative Highway Research Program Report 672, a roundabout intersection is a preferred safety treatment, despite having a high frequency of rear-end and angle crashes because vehicles are traveling in the same direction and are not required to stop. The report indicates that roundabouts provide more time for drivers entering the intersection to adjust their speed and safely merge, and roundabouts reduce the potential for crashes within the intersection by reducing the number of conflict points compared to a traditional intersection (TRB 2010b).

A photograph of a roundabout intersection is provided on Figure 3.

Figure 3. Roundabout Intersection

5.3 Restricted Crossing U-Turn Intersection

An RCUT intersection differs from a traditional intersection by eliminating and rerouting the left-turn and through movements from minor street approaches. To accommodate the left-turn and through movements, drivers must turn right from the side street onto the main road and then make a U-turn maneuver at a one-way median opening approximately 400 feet after the intersection. An RCUT intersection can be signalized, stop-controlled, or merge/yield-controlled. This study addresses only stop-controlled RCUT intersections.

The FHWA Restricted Crossing U-Turn Intersection Informational Guide indicates that a stop-controlled RCUT intersection is a preferred safety treatment for isolated intersections on a four-lane arterial roadway. It also indicates that in some cases, a stop-controlled RCUT intersection is later converted to a signalized RCUT intersection as traffic volumes increase (FHWA 2014). However, this study examined only stop-controlled RCUT intersections and recommends potentially signalizing the U-turn opening if traffic volumes on U.S. 22 increase.

A schematic layout of an RCUT intersection is provided on Figure 4.

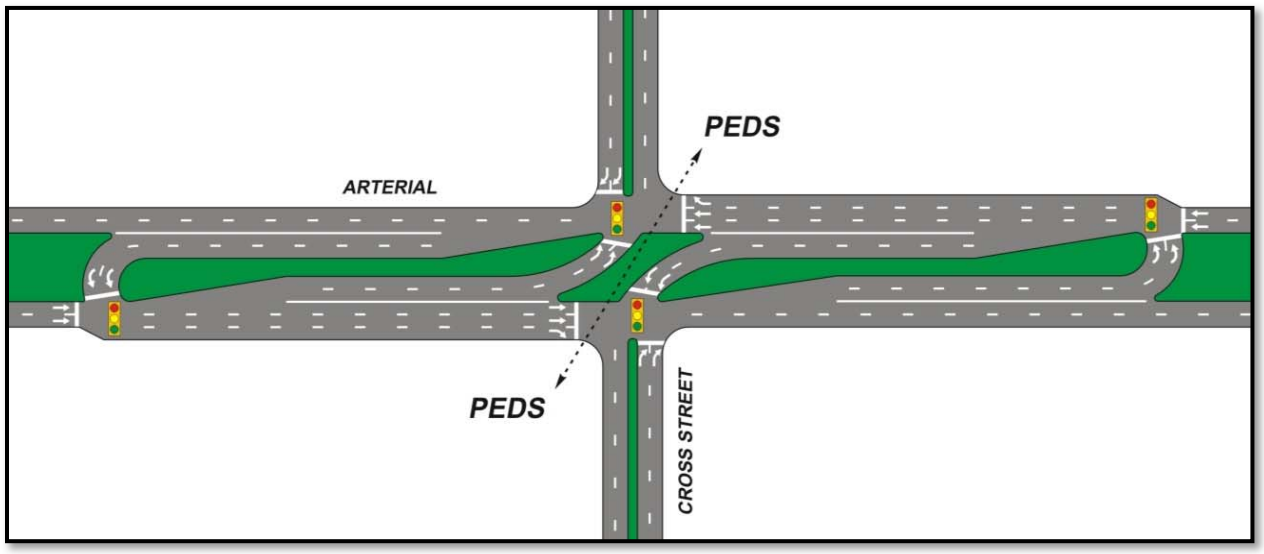


Figure 4. RCUT Intersection

5.4 Green T Intersection

A green T intersection differs from a typical intersection by eliminating the conflict between the through movement (in one direction) and the left-turn movement from minor street approaches. Mainline through traffic passes through the green T intersection without stopping, providing a continuous through movement at all times. Access to the side street is provided by a dedicated left-turn lane with a deceleration lane. The left-turn lane and deceleration lane are separated from the through lane by a concrete median or pavement markings. Side street traffic wishing to turn left onto the mainline must yield to oncoming traffic and enter the channelized left-turn lane (the same lane providing left-turn access from the mainline to the side street). Left-turn traffic has a dedicated acceleration lane allowing motorists the opportunity to increase their speed before merging with mainline traffic after the channelized median ends. Side street traffic wishing to turn right onto the mainline can make a traditional right-turn movement.

The FHWA Continuous Green T-Intersection Safety Case Study indicates a Green T intersection is a preferred safety treatment at isolated intersections where heavy through movements cause significant delay on minor street approaches. It also indicates fuel savings and economic benefits can be associated with a green T intersection treatment because of the reduced delay experienced by motorists (FHWA 2010).

A photograph of a green T intersection is provided on Figure 5.

Figure 5. Green T Intersection

5.5 Quadrant Roadway

A quadrant roadway differs from a typical intersection by rerouting left-turn movements at a four-leg intersection onto a road that connects the two intersecting roads. The design prohibits left turns and right turns at the main intersection, allowing the traffic signal to be operated using two phases. At a quadrant roadway intersection, drivers turning left must make two left-turn movements, using the connector road, approximately 500 feet away from the main intersection. Similarly, drivers turning right must make two right turn movements, using the connector road.

The FHWA Quadrant Roadway Tech Brief indicates that a quadrant roadway is a favorable improvement at a congested intersection in a developing area. The quadrant roadway improves intersection capacity

by reducing the number of traffic signal phases and, therefore, reducing control delay. Traffic simulation shows up to a 15 percent decrease in delay compared to conventional intersections (FHWA 2009).

A schematic layout of a quadrant roadway is provided on Figure 6.

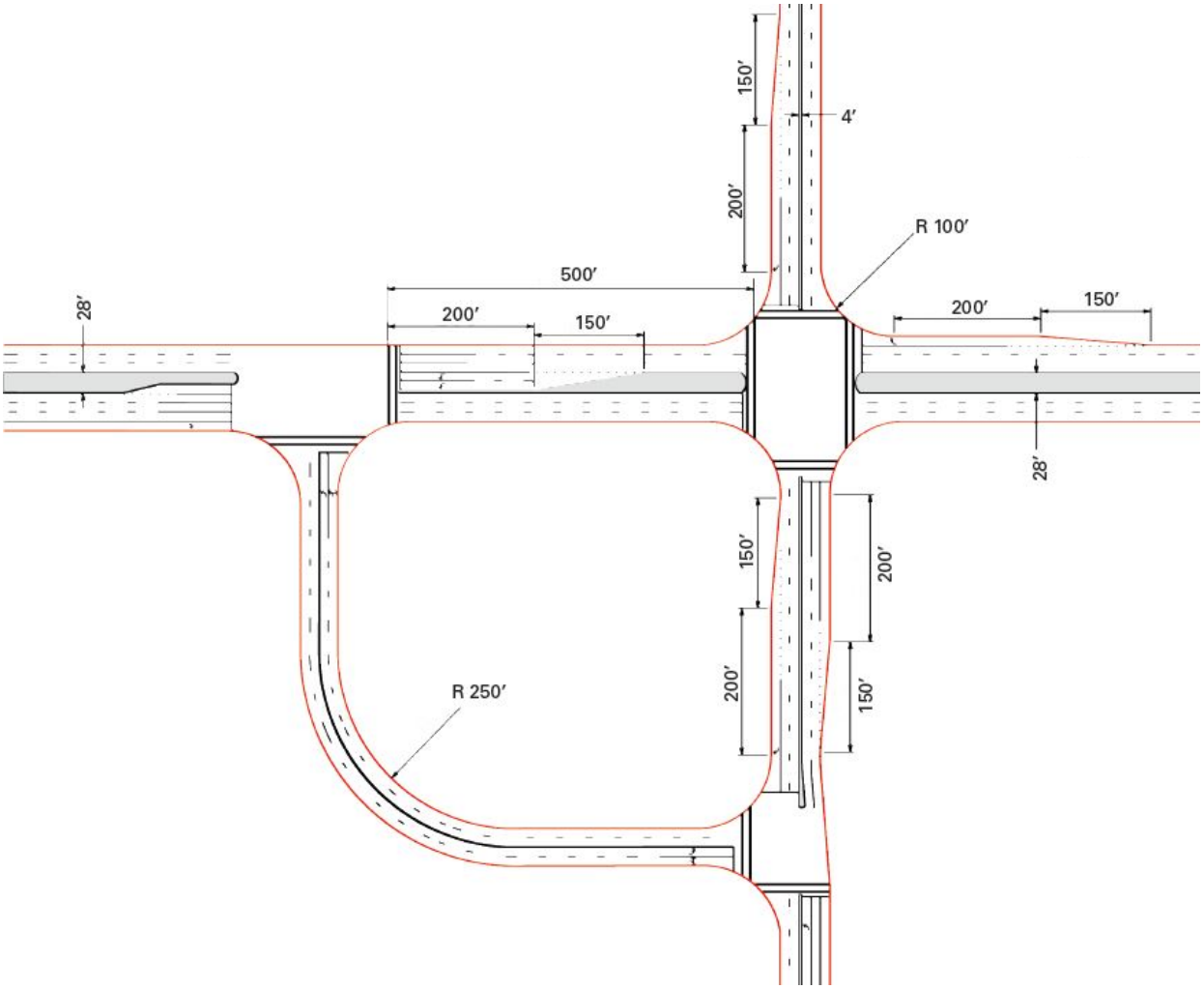


Figure 6. Quadrant Roadway Intersection Schematic

6 ALTERNATIVES CONSIDERED

Three build alternatives and the no-build alternative were considered and are described below.

6.1 No-Build Alternative

Under the no-build alternative, no improvements will be made as a result of this study. The no-build alternative is required for evaluation purposes to serve as a baseline for comparison to an alternative that

includes changes to the transportation system network. For the no-build alternative, existing operational conditions were considered with anticipated future traffic volumes.

6.2 Build Alternatives

The build alternatives include the following improvements along U.S. 22:

- Alternative 1: Improvements, including restriping and widening the roadway to provide two lanes in each direction, plus a two-way left-turn lane, are provided to add capacity along U.S. 22. The high-level bridge will either be replaced with a new four-lane-wide structure or it will be supplemented with a second, parallel two-lane structure. Improvements also include the development roadway discussed in the 2010 HopTown Corridor Plan.
- Alternative 2: Improvements, including restriping and widening the roadway to provide two lanes in each direction, are provided to add capacity along U.S. 22, excluding the high-level bridge. The restriping and widening utilized performance-based practical design.
    - Alternative 2 includes one sub alternative discussed below.
- Alternative 3: Improvements are provided at key intersections within the study area to maintain efficient traffic operation until approximately year 2029.
    - Alternative 3 includes one sub alternative discussed below.

The build alternatives also considered improvements at each intersection within the study area. For each build alternative, future operational conditions were considered with implementation of the improvements proposed in each alternative. The design year is 2039. However, improvements included in Alternative 3 are designed to operate in 2019 and continue operating efficiently until approximately 2029.

6.2.1 U.S. 22

Alternative 1, U.S. 22 will be restriped within the existing pavement to a five-lane roadway between the Landen Drive and Creek Woods Place/Old 3C Highway intersections. The restriping will provide one additional lane with a two-way left-turn lane within the existing pavement. Beginning 300 feet east of Creek Woods Place/Old 3C Highway and extending east to West Road, U.S. 22 will be widened to five lanes with a center two-way left-turn lane. To provide additional capacity over the Little Miami River the existing high-level bridge will either be replaced with a new four-lane-wide structure with a multi-use path on the south side of U.S. 22 or it will be supplemented with a second, parallel two-lane structure. The existing retaining wall on the south side of U.S. 22, east of Overbrook Drive, will be extended to accommodate the widening.

Alternative 2, U.S. 22 will be restriped within the existing pavement to a four-lane roadway with a raised median between the Landen Drive and Creek Woods Place/Old 3C Highway intersections. The restriping will provide one additional lane within the existing pavement and the raised median will allow all access points between Old Mill Road and Creek Woods Place/Old 3C Highway to be right-in right out. Beginning 300 feet east of Creek Woods Place/Old 3C Highway and extending east to West Road, U.S. 22 will merge to two lanes to cross the existing high-level bridge over the Little Miami River. Beginning on the east side of the existing high-level bridge, U.S. 22 will be widened to provide one additional lane utilizing performance-based practical design principles. The existing retaining wall on the south side of U.S. 22,

east of Overbrook Drive, will be extended to accommodate the widening. Alternative 2 does not provide additional capacity to the existing high-level bridge over the Little Miami River.

Alternative 2 Sub Alternative – Without True-Quadrant Roadways, Improvements along U.S. 22 will be exactly as discussed in the Alternate 2 section discussed above.

This sub alternative was included to provide an option if ODOT elected not to build the two, new true-quadrant roadways at the intersection of U.S. 22 and S.R. 48. This sub alternative examined the operation of the intersection of U.S. 22 and S.R. 48 without traffic diverted to the two-proposed true-quadrant roadways.

Alternative 3, U.S. 22 will be restriped within the existing pavement to a five-lane roadway between the Landen Drive and Creek Woods Place/Old 3C Highway intersections. The restriping will provide one additional lane with a two-way left-turn lane within the existing pavement. Beginning 300 feet east of Creek Woods Place/Old 3C Highway, U.S. 22 will merge to two lanes to cross the existing high-level bridge over the Little Miami River. Alternative 3 will not provide additional capacity on U.S. 22 east of the intersection with Creek Woods Place/Old 3C Highway or to the existing high-level bridge over the Little Miami River.

It is anticipated that to maintain an acceptable level of service (LOS) along the U.S. 22 corridor, one additional lane will be required on U.S. 22 after 2029. This additional capacity is included in Alternatives 1 and 2 beginning east of the intersection with Creek Woods Place/Old 3C Highway and extending to West Road intersection.

Alternative 3 Sub Alternative – Peak Hour Movement Restrictions, Alternative 3 includes a sub alternative to address the crash frequency at the intersections of U.S. 22 and Creek Woods Place/Old 3C Highway and at U.S. 22 and Old 3C Highway (east of the high-level bridge). This sub alternative examined the operation of these intersections if left turns from Old 3C Highway were prohibited during the a.m. and p.m. peak hours.

U.S. 22 will be restriped within the existing pavement to a five-lane roadway beginning 1,200 feet east of Landen Drive and extending to Creek Woods Place/Old 3C Highway. The restriping will provide one additional lane with a two-way left-turn lane within the existing pavement. The outside lane on U.S. 22 eastbound will end as a right-turn only lane onto Old 3C Highway. The outside lane on U.S. 22 westbound will begin as an add lane from Creek Woods Drive.

6.2.2 U.S. 22 at Landen Drive

The intersection of U.S. 22 and Landen Drive will remain a signalized intersection in all three alternatives. Alternatives 1 and 2 include two intersection improvements. A northbound left-turn lane and a westbound right-turn lane will be added to reduce the queue length and improve overall intersection operation during peak hours. Alternative 3 does not include any intersection improvements.

6.2.3 U.S. 22 at Old Mill Road

In Alternative 1 the intersection of U.S. 22 and Old Mill Road will remain stop-controlled with full access. However, in 2029, delay on Old Mill Road may require that this intersection be reconfigured into an RCUT with a U-turn opening east of the intersection. In Alternative 2 a roundabout will be constructed at the intersection. In Alternative 3, the intersection will remain stop- controlled with full access.

6.2.4 U.S. 22 at Creek Woods Place/Old 3C Highway

In Alternatives 1 and 2 a roundabout will be constructed at the intersection of U.S. 22 at Creek Woods Place/Old 3C Highway. The roundabout will provide 2 lanes in each direction on U.S. 22 and one lane on Creek Woods Place and Old 3C Highway. In Alternative 3 a single lane roundabout will be constructed. The roundabout will have an eastbound right turn slip lane and a southbound right turn add lane.

Alternative 3 Sub Alternative – Peak Hour Movement Restrictions, Improvements along U.S. 22 are discussed above in Section 6.2.1.

Improvements at the intersection of U.S. 22 and Creek Woods Place/Old 3C Highway are included to address crash frequency. At the intersection of U.S. 22 and Creek Woods Place/Old 3C Highway the northbound left turn from Old 3C Highway will be prohibited and the movement redirected to a southbound right turn at the intersection of U.S. 22 and Old 3C Highway (east of the high-level bridge). An overhead flasher will be constructed with lane use signs on the span wires.

6.2.5 U.S. 22 at Old 3C Highway (East of the Bridge)

U.S. 22 and Old 3C Highway east of the high-level bridge will remain a full-access intersection during most of the day. During the a.m. and p.m. peak hours, the southbound left turn from Old 3C Highway to U.S. 22 eastbound will be prohibited and the movement redirected to a northbound right turn at the intersection of Creek Woods Place/Old 3C Highway to U.S. 22 (west of the high-level bridge). In Alternative 3, the eastbound left turn from U.S. 22 onto Old 3C Highway will also be restricted during the a.m. and p.m. peak hours.

Alternative 3 Sub Alternative – Peak Hour Movement Restrictions, Improvements along U.S. 22 are discussed above in Section 6.2.1.

Improvements at the intersection of U.S. 22 and Old 3C Highway are included to address crash frequency. At the intersection of U.S. 22 and Old 3C Highway (east of the high-level bridge) the southbound left turn from Old 3C Highway to U.S. 22 eastbound will be prohibited and the movement redirected to a northbound right turn at the intersection of Creek Woods Place/Old 3C Highway to U.S. 22 (west of the high-level bridge). The eastbound left turn from U.S. 22 onto Old 3C Highway will also be prohibited and the movement redirected to an eastbound right turn at the intersection U.S. 22 and Creek Woods Place/Old 3C Highway.

6.2.6 U.S. 22 at Overbrook Drive

U.S. 22 and Overbrook Drive will remain a full-access intersection in Alternative 1. However, in 2029, delay on the stop-controlled approach may exceed 40 seconds. Therefore, in Alternative 2, the intersection was reconfigured into an RCUT with a U-turn opening east of the intersection. The U-turn may need to be signalized during the a.m. peak hour in the design year depending on traffic growth. In Alternative 3, the intersection will be reconfigured into an RCUT with a yield-controlled U-turn.

6.2.7 U.S. 22 at Lakeshore Drive

U.S. 22 and Lakeshore Drive will remain a full-access intersection in Alternative 1. In Alternative 2, the intersection will remain full access except during peak hours. Southbound left turns will be prohibited during the a.m. and p.m. peak hours and the movement redirected to the north on Striker Road and

Willow Pond Boulevard. In Alternative 3, the intersection will also remain full access except during peak hours. In the a.m. and p.m. peak hours, southbound left turns will be prohibited (similar to Alternative 2), although the heavy a.m. movement on U.S. 22 may cause delay to exceed 40 seconds for southbound right-turn traffic. U.S. 22 will have to be widened to two lanes in each direction, or approximately half of the southbound right-turn traffic during the a.m. peak hour may need to be redirected to the north on Striker Road and Willow Pond Boulevard.

6.2.8 U.S. 22 at Hopkins Road

U.S. 22 and Hopkins Road will remain a full-access intersection in Alternative 1. In Alternative 2, northbound left turns will be prohibited during the a.m. and p.m. peak hours and the movement redirected to the RCUT at Overbrook Drive. In Alternative 3, U.S. 22 and Hopkins Road will be reconfigured to a Green T intersection.

6.2.9 U.S. 22 at Willow Pond Boulevard

U.S. 22 and Willow Pond Boulevard will remain a signalized intersection in all three alternatives. Alternative 1 will use Willow Pond Boulevard as a quadrant roadway serving northbound traffic on S.R. 48 wishing to travel westbound on U.S. 22 and serving eastbound U.S. 22 traffic wishing to travel southbound on S.R. 48. Northbound left-turn traffic at the intersection of U.S. 22 and S.R. 48 will be rerouted (via signage) to make a left turn at the intersection of S.R. 48 and Willow Pond Boulevard and another left turn at the intersection of U.S. 22 and Willow Pond Boulevard. Eastbound right-turn traffic at the intersection of U.S. 22 and S.R. 48 will be rerouted (via signage) to make a right turn on Willow Pond Boulevard and another right turn from Willow Pond Boulevard to S.R. 48.

The distance between the intersection of U.S. 22 and Willow Pond Boulevard and the intersection of U.S. 22 and S.R. 48 is approximately 2,300 feet. The distance between the intersection of S.R. 48 and Willow Pond Boulevard and U.S. 22 and S.R. 48 is approximately 1,700 feet. The optimal separation between the intersections of a quadrant roadway and the main intersection is approximately 500 feet to optimize and coordinate traffic signals, to provide storage between the intersections, to avoid driveways located between quadrant roadways having an indirect path through the intersection, and to prevent drivers from ignoring the quadrant roadway paths and choosing to make their movements in the main intersection. Therefore, Alternative 2 proposes constructing a new true-quadrant roadway in the southwest quadrant of the intersection of U.S. 22 and S.R. 48 that is located within the 500-foot threshold.

Alternatives 1 and 2 include an intersection capacity improvement on the south approach. A second northbound left-turn lane will be added to reduce the queue length and improve overall intersection operation in the peak hours.

Alternative 3 proposes revised traffic signal timing but no intersection capacity improvements.

6.2.10 U.S. 22 at S.R. 48

The intersection of U.S. 22 and S.R. 48 will remain signalized in all three alternatives. Alternative 1 will use Willow Pond Boulevard and the proposed HopTown Development Roadway as quadrant roadways in the southwest and northeast quadrants of the intersection. Alternative 2 proposes two new true-quadrant roadways in the southwest and northeast quadrants of the intersection. These quadrant roadways will reduce traffic volumes at the intersection. Alternative 3 does not include any intersection improvements.

6.2.10.1 Alternative 2 Sub Alternative – Without True-Quadrant Roadways

As discussed in Section 6.2.1 the operation of the intersection of U.S. 22 and S.R. 48 was examined if ODOT elected not to build the two, new true-quadrant roadways. The analysis considered the operation of the intersection of U.S. 22 and S.R. 48 without traffic diverted to the two-proposed true-quadrant roadway

6.2.11 U.S. 22 at West Road

In Alternative 1, U.S. 22 and West Road will remain a full-access intersection except during peak hours. During the a.m. and p.m. peak hours, northbound left turns will be prohibited, and the movement redirected to Nunner Road. In Alternative 2, the intersection will be reconfigured into an RCUT. The U-turn may need to be signalized during the peak hours in the design year depending on traffic growth. Alternative 3 does not include any intersection improvements.

6.2.12 S.R. 48 at Town Center Boulevard

The intersection of U.S. 22 and Town Center Boulevard will remain signalized in all three alternatives. In Alternative 1, the development roadway proposed in the HopTown Corridor Plan discussed in Section 1 will be included as a quadrant roadway serving southbound traffic on S.R. 48 wishing to travel east on U.S. 22 and westbound traffic on U.S. 22 wishing to travel north on S.R. 48. Southbound left-turn traffic will be rerouted to make a left turn at the intersection of S.R. 48 and Town Center Boulevard and another left turn at the proposed roundabout with U.S. 22. Westbound right-turn traffic will be rerouted to make a right turn at the proposed roundabout and another right turn at the intersection of S.R. 48 and Town Center Boulevard.

The distance between the intersection of U.S. 22 and the proposed roundabout and the intersection of U.S. 22 and S.R. 48 is approximately 1,600 feet. The distance between the intersection of S.R. 48 and Town Center Boulevard and U.S. 22 and S.R. 48 is approximately 1,400 feet. The optimal separation between the intersections of a quadrant roadway and the main intersection is approximately 500 feet to optimize and coordinate traffic signals, to avoid driveways located between quadrant roadways having an indirect path through the intersection and to prevent drivers from ignoring the quadrant roadway paths and choosing to make their movements in the main intersection. Therefore, Alternative 2 proposes constructing a new true-quadrant roadway in the northeast quadrant of the intersection of U.S. 22 and S.R. 48 that is located within the 500-foot threshold. Alternative 3 propose revised traffic signal timing but no intersection capacity improvements.

6.2.13 S.R. 48 at UDF Driveway/Nunner Road

The intersection of S.R. 48 and the UDF Driveway/Nunner Road will remain unsignalized in all three alternatives. In Alternatives 1 and 2, the peak hour through traffic volumes on S.R. 48 will be reduced compared to the no-build condition. This is because northbound traffic on S.R. 48 wishing to travel westbound on U.S. 22 and eastbound traffic on U.S. 22 wishing to travel southbound on S.R. 48 will be rerouted to Willow Pond Boulevard (in Alternative 1) and to the proposed true-quadrant roadway (in Alternative 2). By redirecting this traffic, S.R. 48 at the UDF Driveway/Nunner Road will be able to operate with full access most of the time. During the a.m. and p.m. peak hours, the eastbound through movement from the UDF Driveway to Nunner Road may need to be restricted depending on traffic growth. In

Alternative 3, the intersection will be reconfigured into a Green T intersection, which will prohibit eastbound through and eastbound left-turn movements from the UDF Driveway.

6.2.14 S.R. 48 at Willow Pond Boulevard

A traffic signal will be constructed at the intersection of S.R. 48 at Willow Pond Boulevard in Alternative 1. To satisfy signal warrant requirements, Willow Pond Boulevard will be used as a quadrant roadway serving northbound traffic on S.R. 48 wishing to travel westbound on U.S. 22 and serving eastbound U.S. 22 traffic wishing to travel southbound on S.R. 48. In Alternative 2, S.R. 48 at Willow Pond Boulevard will be reconfigured into a right-in/right-out intersection. In Alternative 3, eastbound left turns will be prohibited during the a.m. and p.m. peak hours.

The three build alternatives are summarized in Table 4 and shown on Figure 7. Conceptual diagrams of the three build alternatives are provided in Appendix A. Public involvement exhibits illustrating the improvement alternatives at each intersection are included Appendix P.

Table 4. Build Alternative Summary

	Road	Alternative 1	Alternative 2	Alternative 3
Corridors	U.S. 22	2 Lanes in Each Direction with a Two-Way Left-Turn Lane	2 Lanes in Each Direction (except over the Little Miami River)	2 Lanes west of the Little Miami River and 1 Lane in Each Direction
	S.R. 48	-	-	-
	Old 3C Highway	-	-	-
U.S. 22 at	Landen Drive	Traffic Signal	Traffic Signal	Traffic Signal
	Old Mill Road	Full Access **(RCUT by 2029)**	Roundabout	Full Access
	Creek Woods Place Old 3C Highway	Roundabout	Roundabout	Roundabout
	Old 3C Highway	Redirect Southbound Left Turn	Redirect Southbound Left Turn	Redirect Southbound Left Turn and Restrict Eastbound Left Turn
	Overbrook Drive	Full Access	RCUT	Full Access
	Lakeshore Drive	Full Access	Redirect Peak Hour Southbound Left Turn	Redirect Peak Hour Southbound Left Turn Redirect Peak Hour Southbound Right Turn without Widening
	Hopkins Road	Full Access	Redirect Peak Hour Northbound Left Turn	Green T Intersection
	Willow Pond Boulevard	Traffic Signal	Traffic Signal	Traffic Signal
	S.R. 48	Traffic Signal	Traffic Signal	Traffic Signal
	West Road	Redirect Peak Hour Northbound Left Turn	RCUT	Full Access
S.R. 48 at	Town Center Boulevard	Traffic Signal	Traffic Signal	Traffic Signal
	UDF Driveway/Nunner Road	Restrict Peak Hour Eastbound Turn	Restrict Peak Hour Eastbound Turn	Green T Intersection
	Willow Pond Boulevard	Traffic Signal	Right-In/Right-Out	Restrict Peak Hour Left Turns
Old 3C Highway at	Davis Road	-	-	-
	Socialville Foster Road	-	-	-
	Kings Mills Road	-	-	-
	West Foster Maineville Road	-	-	-

FIGURE 7 - Alternatives Summary

Alternative 1 - Full Access (RCUT by 2029)
Alternative 2 - Roundabout
Alternative 3 - Full Access

Alternative 1 - Redirect SBLT
Alternative 2 - Redirect SBLT
Alternative 2 Sub Alternative - Peak Hour One-Way Operation on the U.S. 22 Bridge
Alternative 3 - Redirect SBLT & Redirect EBLT
Alternative 3 Sub Alternative - Peak Hour Movement Restrictions

Alternative 1 - Traffic Signal
Alternative 2 - Traffic Signal
Alternative 2 Sub Alternative - Without True-Quadrant Roadways
Alternative 3 - Traffic Signal

Alternative 1 - Traffic Signal
Alternative 2 - Traffic Signal
Alternative 3 - Traffic Signal

Alternative 1 - Roundabout
Alternative 2 - Traffic Signal

Alternative 1 - Traffic Signal
Alternative 2 - Traffic Signal
Alternative 3 - Traffic Signal

Alternative 1 - Full Access
Alternative 2 - Redirect Peak Hour SBLT
Alternative 3 - Redirect Peak Hour SBLT & Peak Hour SBRT

Alternative 1 - Traffic Signal
Alternative 2 - Traffic Signal
Alternative 3 - Traffic Signal

Alternative 2 - Traffic Signal

Alternative 2 - Stop Control

SR 48
Towne Center Boulevard
Northeast Quadrant Roadway
Southwest Quadrant Roadway
Nunner Road
West Road
Willow Pond Boulevard
Willow Pond Boulevard
US 22
US 22
US 22
US 22
Kings Mills Road
Maineville Road
Old 3C Highway
Socialville-Foster Road
Bridge over Little Miami River
Old 3C Highway
Old 3C Highway
Creek Woods Place
Landen Drive
Old Mill Road
Davis Road
Lakeshore Drive
Overbrook Drive
Hopkins Road

Alternative 1 - 5 Lane Section
Alternative 2 - 4 Lane Section
Alternative 3 - 2 Lane Section (4 Lane by 2029)

Alternative 1 - Full Access
Alternative 2 - Redirect Peak Hour NBLT
Alternative 3 - Green T

Alternative 2 - Stop Control

Alternative 1 - Redirect Peak Hour NBLT
Alternative 2 - RCUT
Alternative 3 - Full Access

Alternative 1 - Roundabout
Alternative 2 - Roundabout
Alternative 2 Sub Alternative - Peak Hour One-Way Operation on the U.S. 22 Bridge
Alternative 3 - Roundabout
Alternative 3 Sub Alternative - Peak Hour Movement Restrictions

Alternative 1 - Full Access
Alternative 2 - RCUT
Alternative 3 - Full Access (RCUT by 2024)

Alternative 1 - Traffic Signal
Alternative 2 - Right In/Right Out
Alternative 3 - Restrict Peak Hour EBLT

Alternative 1 - Restrict Peak Hour EBT
Alternative 2 - Restrict Peak Hour EBT
Alternative 3 - Green T

Legend

- Signalized Intersection
- Stop-Controlled Intersection
- Proposed Road for Alternative 1
- Proposed Road for Alternative 2

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7 BUILD ALTERNATIVES NOT RECOMMENDED

Arcadis evaluated several build alternatives that were not recommended to be advanced.

7.1 Alternative 1

Alternative 1 included four intersection treatments that were not recommended.

7.1.1 U.S. 22 at Creek Woods Place/Old 3C Highway

The feasibility of constructing a RCUT was considered at the intersection of U.S. 22 and Creek Woods Place/Old 3C Highway. The RCUT alternative was eliminated because the U-turn opening east of the intersection would need to be signalized during the a.m. peak hour. The U-Turn traffic signal resulted in significant queues on U.S. 22 westbound and increased the probability of rear-end crashes while the U-Turn movement was being served.

7.1.2 U.S. 22 at Hopkins Road

The feasibility of constructing a RCUT was considered at the intersection of U.S. 22 and Hopkins Road. The RCUT alternative was eliminated because the U-turn movement east of the intersection would need to occur at the existing traffic signal at U.S. 22 and Willow Pond Boulevard and would negatively impact traffic signal operation.

7.1.3 U.S. 22 at Willow Pond Boulevard

The feasibility of converting the existing traffic signal to a multi lane roundabout was considered at the intersection of U.S. 22 and Willow Pond Boulevard. The roundabout would provide 2 lanes in each direction on U.S. 22 and one lane, with right turn bypass lanes, on both approaches of Willow Pond Boulevard. The roundabout is not recommended. Once U.S. 22 is widened to 2 lanes in each direction the traffic signal will operate efficiently. Also, the roundabout would impact the parcels adjacent to the intersection.

7.1.4 U.S. 22 at S.R. 48

The feasibility of converting the existing traffic signal to a multi lane roundabout was considered at the intersection of U.S. 22 and S.R. 48. The roundabout would provide 2 lanes in each direction on U.S. 22 and on S.R. 48. The roundabout was eliminated because the capacity analysis indicated the roundabout would not operate efficiently in 2039 and because the properties adjacent to the roundabout would be adversely impacted.

7.2 Alternative 2

Alternative 2 included one improvement on U.S. 22 and two intersection treatments that were not recommended. The improvement on U.S. 22 is referred as the Alternative 2 Sub Alternative – Peak Hour One Way Operation on the U.S. 22 Bridge.

7.2.1 Alternative 2 Sub Alternative – Peak Hour One Way Operation on the U.S. 22 Bridge

This sub alternative was included to address the additional peak hour capacity required in the design year on the high-level bridge over the Little Miami River without widening or constructing a new bridge. The 60/40 directional split on U.S. 22 makes it viable to consider converting the existing two-lane high-level bridge to one-way operation during the peak hour. The lower, non-peak direction volume of traffic, would be diverted off of the existing high-level bridge onto the original Old 3C Highway alignment using the original lower-level crossing of the Little Miami River. In the a.m. peak hour, westbound traffic on U.S. 22 would use both lanes on the existing high-level bridge. Eastbound traffic on U.S. 22 would be diverted at the intersection of Creek Woods Place/Old 3C Highway, cross the Little Miami River using the existing low-level crossing, and join U.S. 22 again at the intersection with Old 3C Highway on the east side of the high-level bridge. Similarly, in the p.m. peak hour, eastbound traffic on U.S. 22 would use both lanes on the existing high-level bridge. Westbound traffic on U.S. 22 would be diverted from U.S. 22 at the intersection of Old 3C Highway east of the bridge, cross the Little Miami River using the existing low-level crossing, and join U.S. 22 again at the intersection with Creek Woods Place/Old 3C Highway. This alternative would provide both directions with two lanes over the Little Miami River without widening the existing high-level bridge. Traffic signals would be constructed at both intersections of U.S. 22 and Old 3C Highway. Old 3C Highway would remain bi-directional. This option was considered using the current two-lane configuration on Old 3C Highway and the option was considered if a second, reversible, lane was constructed on Old 3C Highway.

A capacity analysis for the intersections along Old 3C Highway was performed for this sub alternative to Alternative 2. The capacity analysis results, shown in Section 8.3.1, show the intersections along Old 3C Highway will operate at LOS E or F when traffic traveling in the non-peak direction is diverted from U.S. 22 to Old 3C Highway. Therefore, this sub alternative was determined to not be feasible.

7.2.2 U.S. 22 at Creek Woods Place/Old 3C Highway

The feasibility of constructing a traffic signal was considered at the intersection of U.S. 22 and Creek Woods Place/Old 3C Highway.

The traffic signal warrant analysis for this intersection was initially performed using existing traffic pattern and the traffic signal was not warranted. A second traffic signal warrant analysis was subsequently performed using an adjusted traffic pattern in which southbound left turns from Old 3C Highway to U.S. 22 eastbound (east of the high-level bridge) are prohibited and the movement redirected to a northbound right turn from Old 3C Highway to U.S. 22 (west of the high-level bridge). Based on the analysis performed using the adjusted traffic pattern, the intersection satisfied Warrant 2 (Four Hour Volumes) and Warrant 3b (Peak Hour Volumes). The traffic signal alternative was eliminated the probability of rear-end crashes on U.S. 22 increased significantly after the traffic signal was constructed.

7.2.3 U.S. 22 at Old 3C Highway (East of the Bridge)

The feasibility of constructing a traffic signal was considered at the intersection of U.S. 22 and Old 3C Highway.

As discussed in Section 4.6 all reconstructed intersections are required to undergo a traffic signal warrant analysis according to the Ohio Manual of Uniform Traffic Control Devices (OMUTCD), Chapter 4c. The

intersection of U.S. 22 and Old 3C Highway was analyzed using PC Warrants software and in accordance with ODOT Traffic Engineering Manual requirements. This intersection satisfied traffic signal Warrant 2. The traffic signal was eliminated because the heavy volume of through traffic on U.S. 22 significantly increased the probability of rear end crashes after the signal was constructed.

Table 5. Build Alternatives Not Recommended Summary

	Road	Alternative 1	Alternative 2	Alternative 3
Corridors	U.S. 22	-	-	-
	S.R. 48	-	-	-
	Old 3C Highway	-	One-Way Pair	-
U.S. 22 at	Landen Drive	-	-	-
	Old Mill Road	-	-	-
	Creek Woods Place Old 3C Highway	RCut	Traffic Signal	-
	Old 3C Highway	-	Traffic Signal	-
	Overbrook Drive	-	-	-
	Lakeshore Drive	-	-	-
	Hopkins Road	RCut	-	-
	Willow Pond Boulevard	Roundabout	-	-
	S.R. 48	Roundabout	-	-
	West Road	-	-	-
S.R. 48 at	Town Center Boulevard	-	-	-
	UDF Driveway/Nunner Road	-	-	-
	Willow Pond Boulevard	-	-	-
Old 3C Highway at	Davis Road	-	One-Way Pair	-
	Socialville Foster Road	-	One-Way Pair	-
	Kings Mills Road	-	One-Way Pair	-
	West Foster Maineville Road	-	One-Way Pair	-

8 CAPACITY ANALYSES

A capacity analysis is the primary method for evaluating the efficiency of a roadway or intersection. The Highway Capacity Manual 2010 (HCM 2010), published by TRB, outlines capacity analysis procedures and criteria for evaluating the operations of unsignalized and signalized intersections. The criteria for evaluating the operation of an intersection as defined in the HCM 2010 are measured in terms of LOS, a qualitive measure, and control delay per vehicle. The HCM 2010 defines six levels of service, designated by the letters A through F. LOS A represents the best operating conditions, and LOS F represents the worst operating conditions. LOS criteria are listed in Table 6.

Table 6. LOS Criteria for Signalized and Unsignalized Intersections

Level of Service	Signalized Intersection Delay (Seconds)	Unsignalized Intersection Delay (Seconds)
A	≤ 10	≤ 10
B	> 10-15	> 10-20
C	> 15-25	> 20-35
D	> 25-35	> 35-55
E	> 35-50	> 55-80
F	> 50 or Volume/Capacity Ratio > 1.0	> 80 or Volume/Capacity Ratio > 1.0

Source: Highway Capacity Manual (TRB 2010a)

The no-build and build alternatives were analyzed to determine the LOS for each intersection in the study area. Traffic analyses were completed in HCS and Synchro for stop-controlled, signalized, RCUT, and Green T intersections. Roundabouts were analyzed using Sidra 7. The analyses were conducted for the open year and design year a.m. and p.m. peak hour conditions.

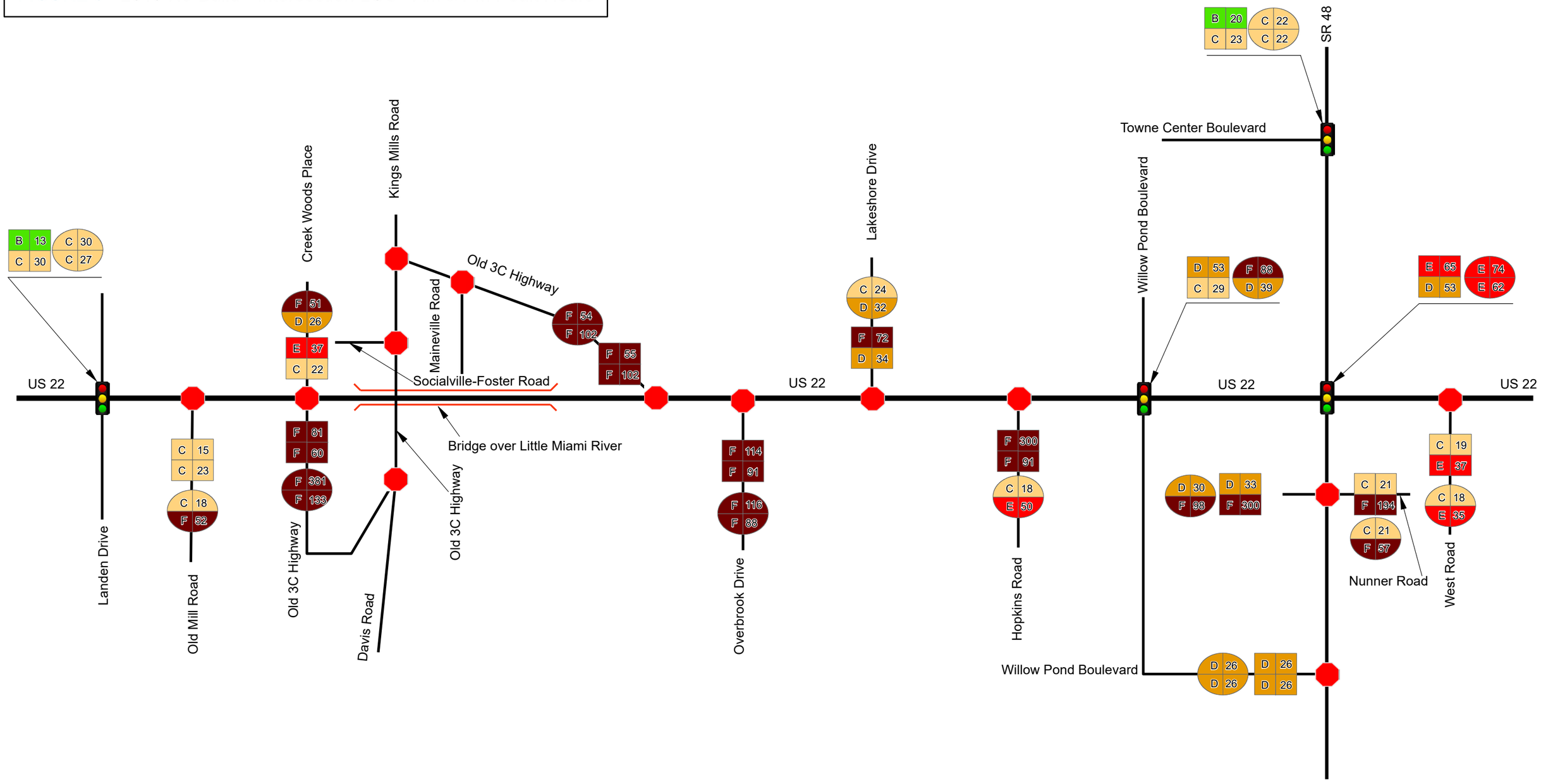
8.1 No-Build Alternative

For the no-build alternative, existing operational conditions were analyzed using anticipated future traffic volumes. In the no-build alternative, many unsignalized side streets will operate at LOS E or F in the a.m. and p.m. peak hours. In general, unsignalized side street delay will range from 30 seconds to more than 3 minutes.

Table 7 presents a comparison of the results of the 2039 no-build alternative capacity analysis to the build alternative capacity analyses for Alternatives 1 and 2. Table 8 presents a comparison of the results of the 2019 no-build alternative capacity analysis to the build alternative capacity analysis for Alternative 3. These tables compare traffic operations if no improvements are implemented, to traffic operations if Alternative 1, 2, or 3 (but not the sub alternatives) is implemented. Figures 8 and 9 present the no-build alternative capacity analysis results for 2019 and 2039, respectively.

The HCS and Synchro analysis results for 2019 and 2039 are included in Appendix E and Appendix F, respectively.

FIGURE 8 - 2019 No-Build - Intersection LOS - AM & PM Peak Hours



Legend

- Signalized Intersection
- Stop-Controlled Intersection
- LOS A
- LOS B
- LOS C
- LOS D
- LOS E
- LOS F
- Synchro LOS and Delay at Intersections
- HCS LOS and Delay at Intersections

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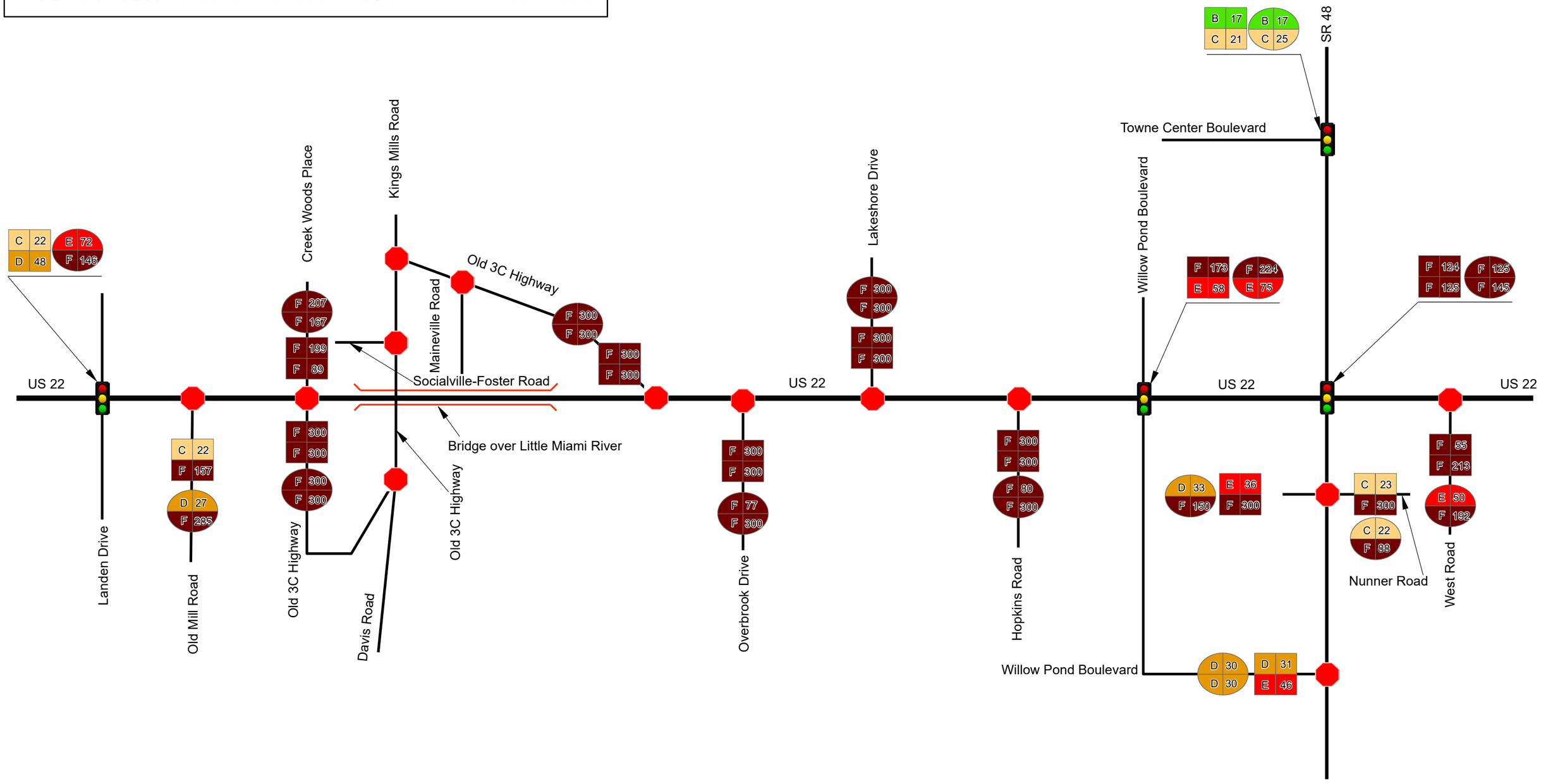
FIGURE 9 - 2039 No-Build - Intersection LOS - AM & PM Peak Hours



Legend

- Signalized Intersection
- Stop-Controlled Intersection
- LOS A
- LOS B
- LOS C
- LOS D
- LOS E
- LOS F
- Synchro LOS and Delay at Intersections
- HCS LOS and Delay at Intersections

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8.2 Alternative 1

In Alternative 1, all but three intersections are anticipated to operate at an acceptable LOS in the design year during both the a.m. and p.m. peak hours. The widening proposed in Alternative 1 will not improve peak hour traffic operation at Overbrook Drive, Lakeshore Drive and the UDF Driveway. Left-turn movements from Overbrook Drive will operate at LOS E during the p.m. peak hour and left turn movements from Lakeshore Drive will operate at LOS E during the a.m. peak hour. The UDF Driveway will operate at LOS E during the p.m. peak hour.

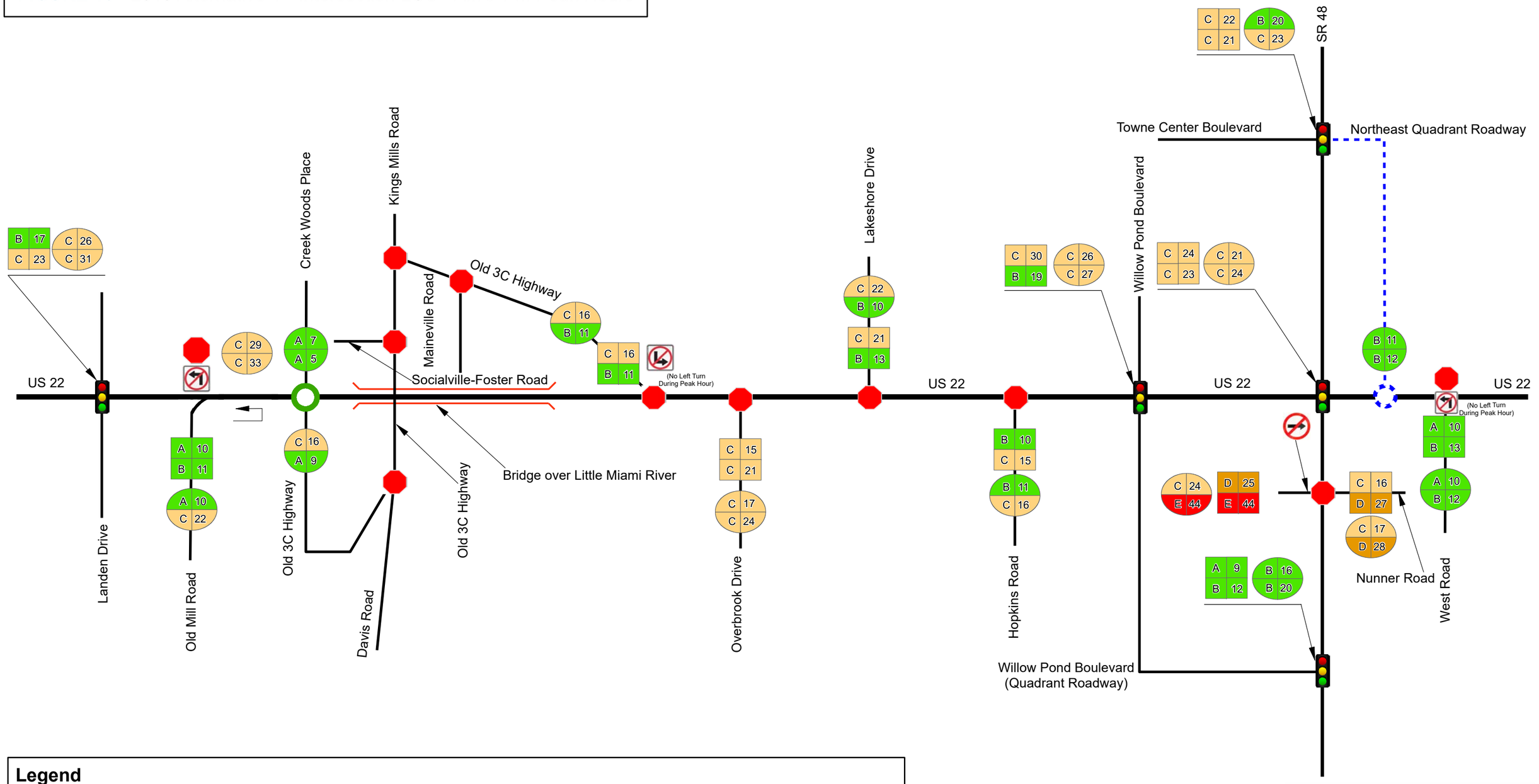
Therefore, in addition to widening U.S. 22 Alternative 1 includes three peak hour movement restrictions. The southbound left-turn movement from Old 3C Highway to U.S. 22 (east of the high-level bridge) will be prohibited and the movement redirected to an eastbound right turn from Old 3C Highway to U.S. 22 (west of the high-level bridge). The northbound left-turn movement at West Road will be prohibited and the movement redirected as a right turn at the intersection of S.R. 48 and Nunner Road. The eastbound through movement from the UDF Driveway will be prohibited during the p.m. peak hour at the intersection of S.R. 48 and the UDF Driveway/Nunner Road.

The capacity analysis demonstrates that Alternative 1 will improve mobility on U.S. 22, reduce delay at stop-controlled side streets, and provide the additional capacity needed in 2039.

A comparison of traffic operations if no improvements are implemented to traffic operations if Alternative 1 is implemented is presented in Table 7. Figures 10 and 11 present the Alternative 1 capacity analysis results for 2019 and 2039, respectively.

Conceptual diagrams of Alternative 1 and the RCUT intersection at Old Mill Road are provided in Appendix A. The HCS and Synchro analysis results for 2019 and 2039 are included in Appendix G and Appendix H, respectively.

FIGURE 10 - 2019 Alternative 1 - Intersection LOS - AM & PM Peak Hours



Legend

- Signalized Intersection
- Stop-Controlled Intersection
- Proposed Road
- Roundabout Intersection
- RCUT Intersection
- Synchro LOS and Delay at Intersections
- HCS LOS and Delay at Intersections
- Sidra LOS and Delay at Intersections
- LOS A
- LOS B
- LOS C
- LOS D
- LOS E
- LOS F

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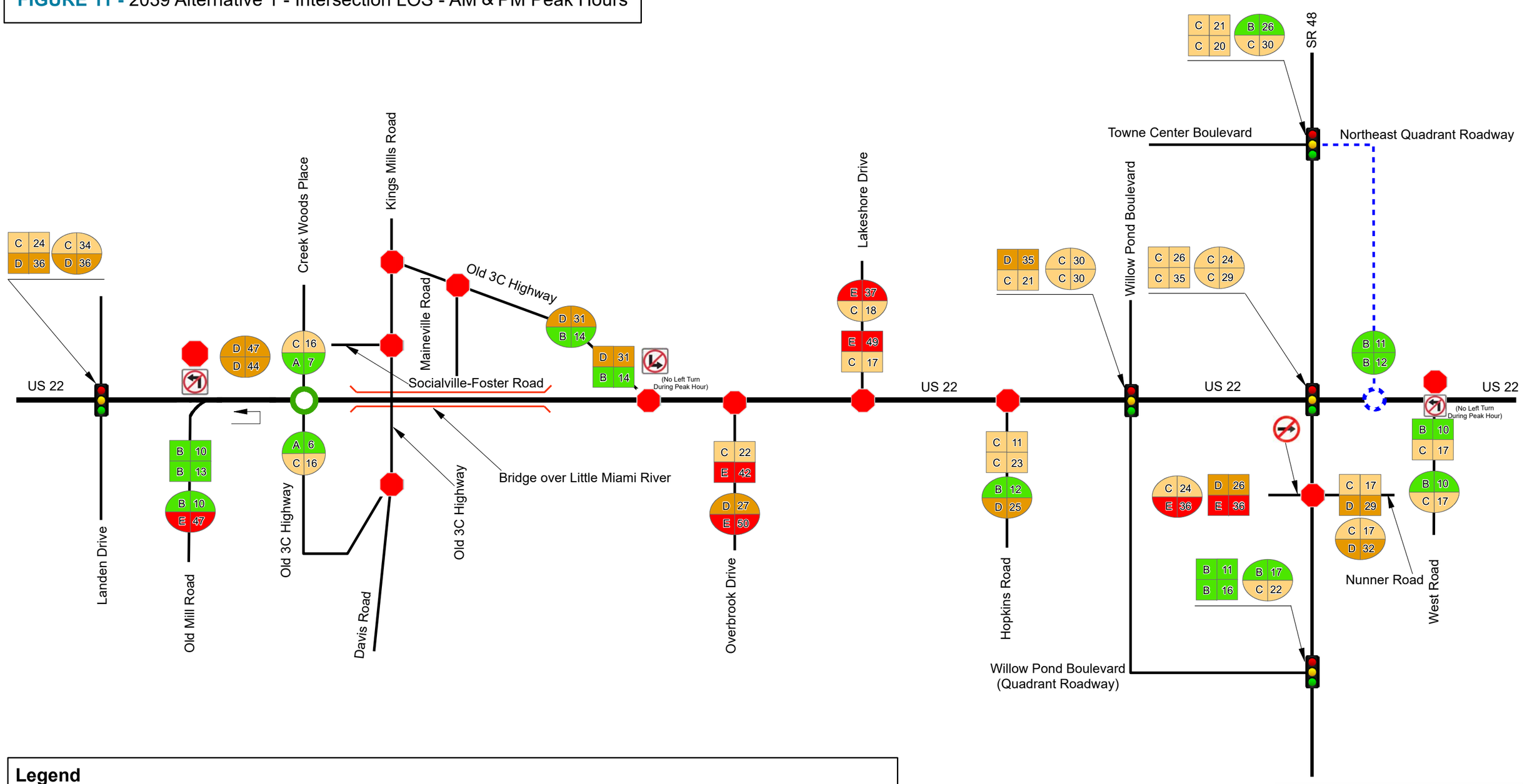
FIGURE 11 - 2039 Alternative 1 - Intersection LOS - AM & PM Peak Hours



Legend

- Signalized Intersection
- Stop-Controlled Intersection
- Proposed Road
- Roundabout Intersection
- RCUT Intersection
- Synchro LOS and Delay at Intersections
- HCS LOS and Delay at Intersections
- Sidra LOS and Delay at Intersections
- LOS A
- LOS B
- LOS C
- LOS D
- LOS E
- LOS F

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8.3 Alternative 2

In Alternative 2, all but two intersections are anticipated to operate at an acceptable LOS in the design year during both the a.m. and p.m. peak hours. The RCUT at West Road will operate at LOS E unless U.S. 22 is widened to two lanes east of the intersection. The UDF Driveway will operate at LOS E during the p.m. peak hour, even with the through movement prohibited.

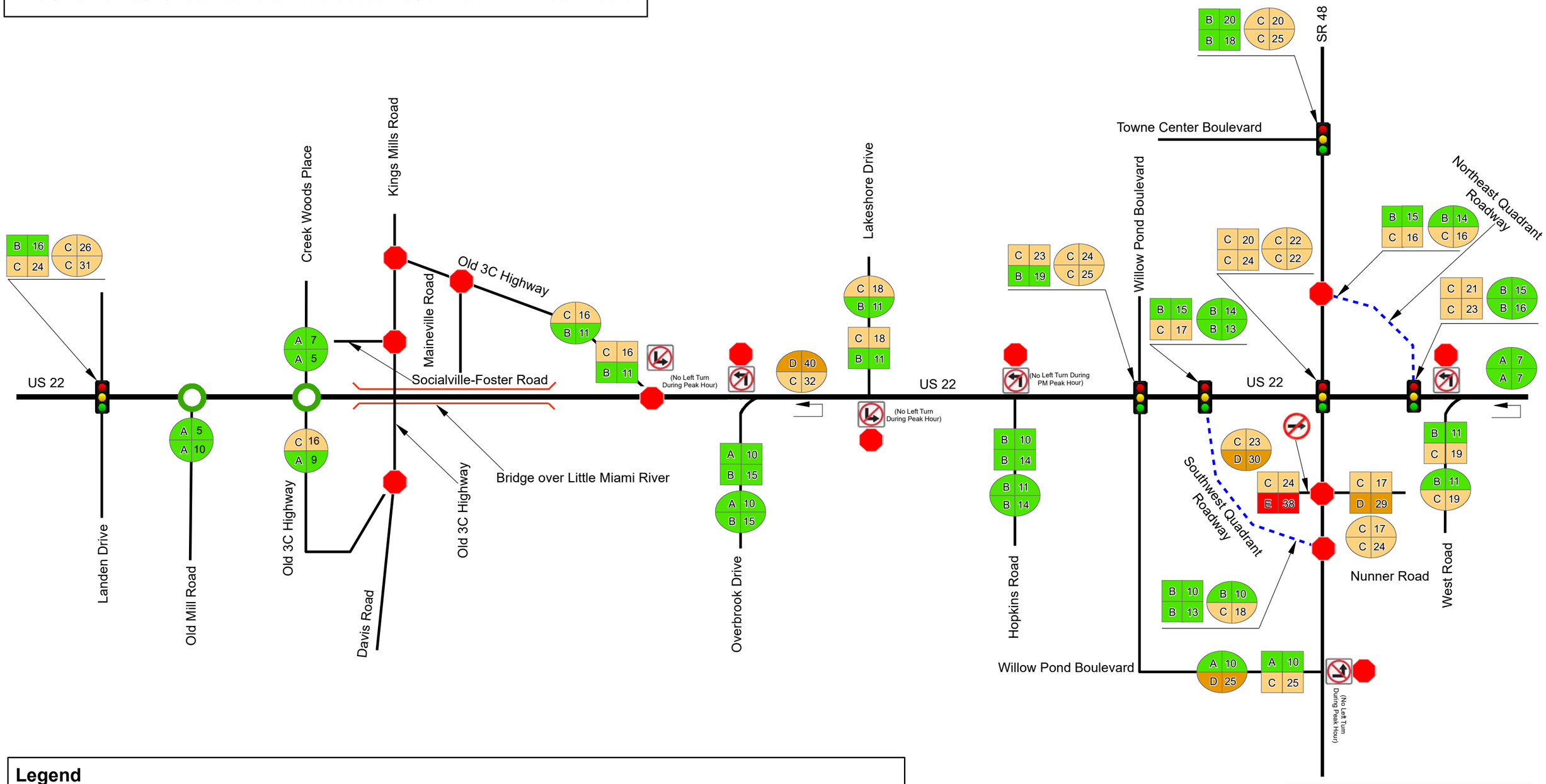
Alternative 2 includes four peak hour movement restrictions. The southbound left-turn movement from Old 3C Highway to U.S. 22 (east of the high-level bridge) will be prohibited and the movement redirected to an eastbound right turn from Old 3C Highway to U.S. 22 (west of the high-level bridge). The southbound left-turn movement at Lakeshore Drive will be prohibited and the movement redirected to the north on Striker Road and as a left turn at the intersection of U.S. 22 and Willow Pond Boulevard. The northbound left turn at Hopkins Road will be prohibited during the p.m. peak hour and the movement redirected east on Overbrook Drive and through the RCUT intersection at Overbrook Drive and U.S. 22. The eastbound through movement from the UDF Driveway will be prohibited during the p.m. peak hour at the intersection of S.R. 48 and the UDF Driveway/Nunner Road.

The capacity analysis demonstrates that Alternative 2 will improve mobility on U.S. 22, reduce delay at stop-controlled side streets, and, except on the existing high-level bridge, provide the additional capacity needed in 2039.

A comparison of traffic operations if no improvements are implemented to traffic operations if Alternative 2 is implemented is presented in Table 7. Figures 12 and 13 present the Alternative 2 capacity analysis results for 2019 and 2039, respectively.

Conceptual diagrams of Alternative 2 and the RCUT intersection at Old Mill Road are provided in Appendix A. The HCS and Synchro analysis results for 2019 and 2039 are included in Appendix I and Appendix J, respectively.

FIGURE 12 - 2019 Alternative 2 - Intersection LOS - AM & PM Peak Hours



Legend

- Signalized Intersection
- Stop-Controlled Intersection
- Proposed Road
- Roundabout Intersection
- RCUT Intersection
- Synchro LOS and Delay at Intersections
- HCS LOS and Delay at Intersections
- Sidra LOS and Delay at Intersections
- LOS A
- LOS B
- LOS C
- LOS D
- LOS E
- LOS F

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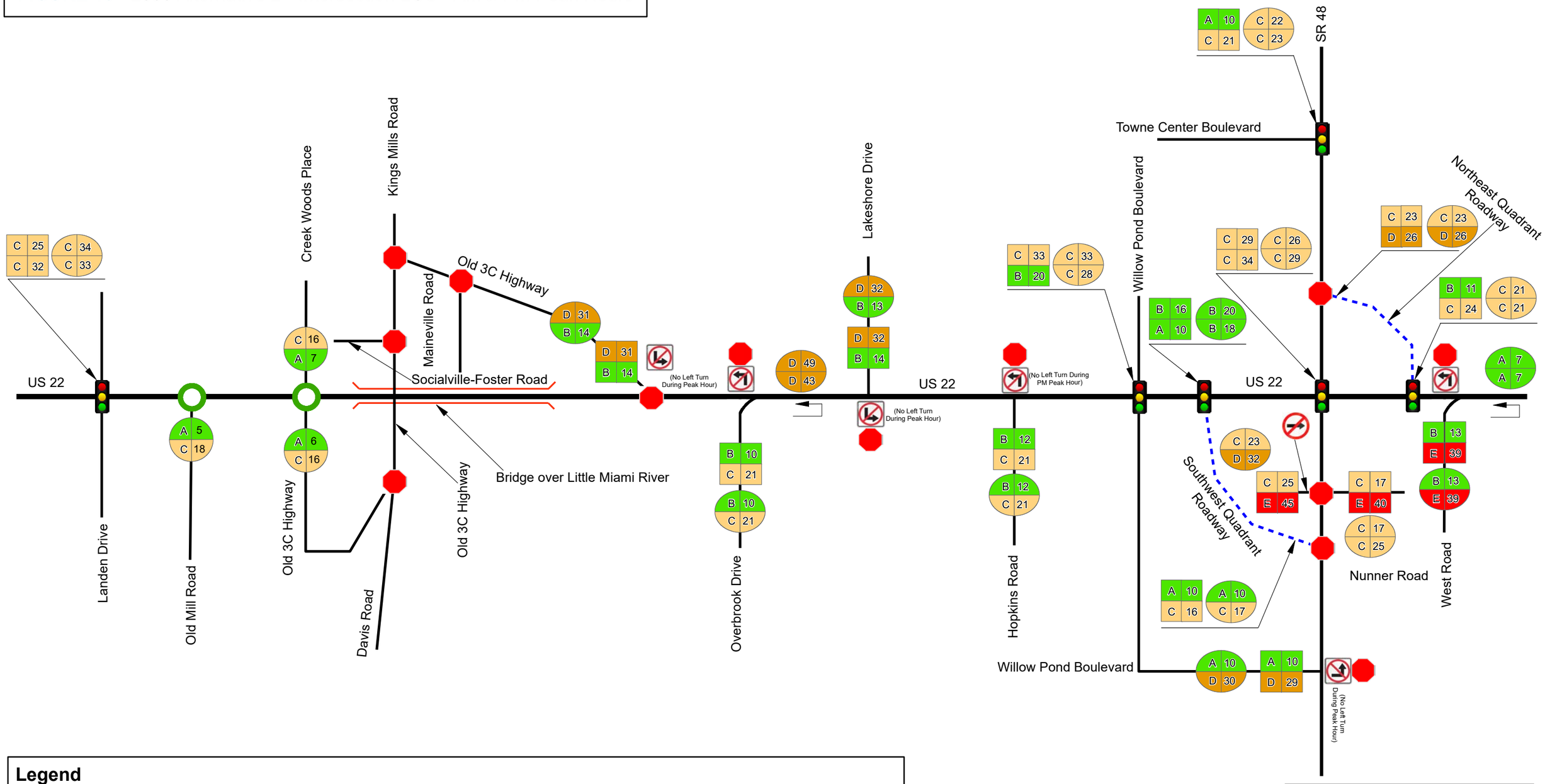
FIGURE 13 - 2039 Alternative 2 - Intersection LOS - AM & PM Peak Hours



Legend

- Signalized Intersection
- Stop-Controlled Intersection
- Proposed Road
- Roundabout Intersection
- RCUT Intersection
- Synchro LOS and Delay at Intersections
- HCS LOS and Delay at Intersections
- Sidra LOS and Delay at Intersections
- LOS A
- LOS B
- LOS C
- LOS D
- LOS E
- LOS F

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Table 7. Alternatives 1 & 2 Intersection Capacity Analysis

Intersection			No-Build (2039)				Alternative 1 (2039)				Alternative 2 (2039)			
			EB	WB	NB	SB	EB	WB	NB	SB	EB	WB	NB	SB
U.S. 22	Landen Drive	AM	B	F	E	F	B	D	D	D	B	D	D	D
		PM	F	E	D	F	D	B	D	E	D	B	D	D
	Old Mill Road	AM			D				B / D		A	B	A	
		PM			F				E / D		C	A	C	
	Creek Woods Place/Old 3C Highway	AM			F	F	A	C	A	C	A	C	A	C
		PM			F	F	B	A	C	A	B	A	C	A
	Old 3C Highway	AM				F				D				D
		PM				F				B				B
	Overbrook Drive	AM			F				D				B / D	
		PM			F				E				C / D	
	Lakeshore Drive	AM				F				E				D
		PM				F				C				B
	Hopkins Road	AM			F				B				B	
		PM			F				D				C	
	Willow Pond Boulevard	AM	C	F	F	F	B	C	C	D	C	D	C	D
		PM	F	C	F	E	D	C	C	D	C	C	C	C
	True-Quadrant Roadway	AM											C	
		PM											C	
	S.R. 48	AM	F	E	F	F	C	C	C	B	C	C	C	B
		PM	F	E	F	F	C	C	B	C	C	C	B	C
	Development Road/True-Quadrant Roadway	AM					A	A		B				C
		PM					B	A		B				C
	West Road	AM			E				B				B / A	
		PM			F				C				E / A	
S.R. 48	Town Center Boulevard	AM	B		B	B	C	C	C	B	C		C	B
		PM	D		A	D	C	D	B	D	D		A	D
	UDF Driveway/Nunner Road	AM	D	C			C	C			C	C		
		PM	F	F			E	D			D	C		
	Willow Pond Boulevard	AM	D				B		B	B	A			
		PM	D				C		B	C	D			

8.3.1 Alternative 2 Sub Alternative – Peak Hour One Way Operation on the U.S. 22 Bridge

A capacity analysis for the intersections along Old 3C Highway was performed for this sub alternative to Alternative 2. The capacity analysis shows that under the current two-lane configuration the intersections along Old 3C Highway will operate at LOS E or F when traffic traveling in the non-peak direction is diverted from U.S. 22 to Old 3C Highway. Similarly, under the optional reversible lane configuration the intersections along Old 3C Highway will operate at LOS E or F when traffic traveling in the non-peak direction is diverted from U.S. 22 to Old 3C Highway.

A comparison of traffic operations if the lower, non-peak direction volume of traffic is diverted off of the existing high-level bridge onto the original Old 3C Highway alignment using the original lower-level crossing of the Little Miami River is shown in Figure 15. The capacity analysis demonstrates that Alternative 2 Sub Alternative – Peak Hour One Way Operation on the U.S. 22 Bridge will not improve mobility on U.S. 22 over the Little Miami River. Therefore, this sub alternative was determined to not be feasible.

8.3.2 Alternative 2 Sub Alternative – Without True-Quadrant Roadways

A capacity analysis for the intersection of U.S. 22 and S.R. 48 without diverting traffic onto the two-proposed true-quadrant roadways was performed for this Alternative 2 sub alternative. If traffic is not rerouted, the intersection at U.S. 22 and S.R. 48 will need to be widened to provide a dual left turn lane on each approach except the westbound approach. Similarly, if traffic is not rerouted, the intersection of S.R. 48 and the UDF Driveway/Nunner Road will operate at LOS F in the design year. Operations at the S.R. 48 and the UDF Driveway/Nunner Road will have to be evaluated regularly to determine if a traffic signal warrant is satisfied.

The results of the capacity analysis were used to create a schematic of the necessary lane configuration if no traffic is diverted away from the intersection of U.S. 22 and S.R. 48 onto the true-quadrant roadways. The improvements shown illustrate the widening necessary to maintain LOS E (or better) operation in 2039.

A conceptual diagram Alternative 2 Sub Alternative – Without True-Quadrant Roadways is provided in Appendix A.

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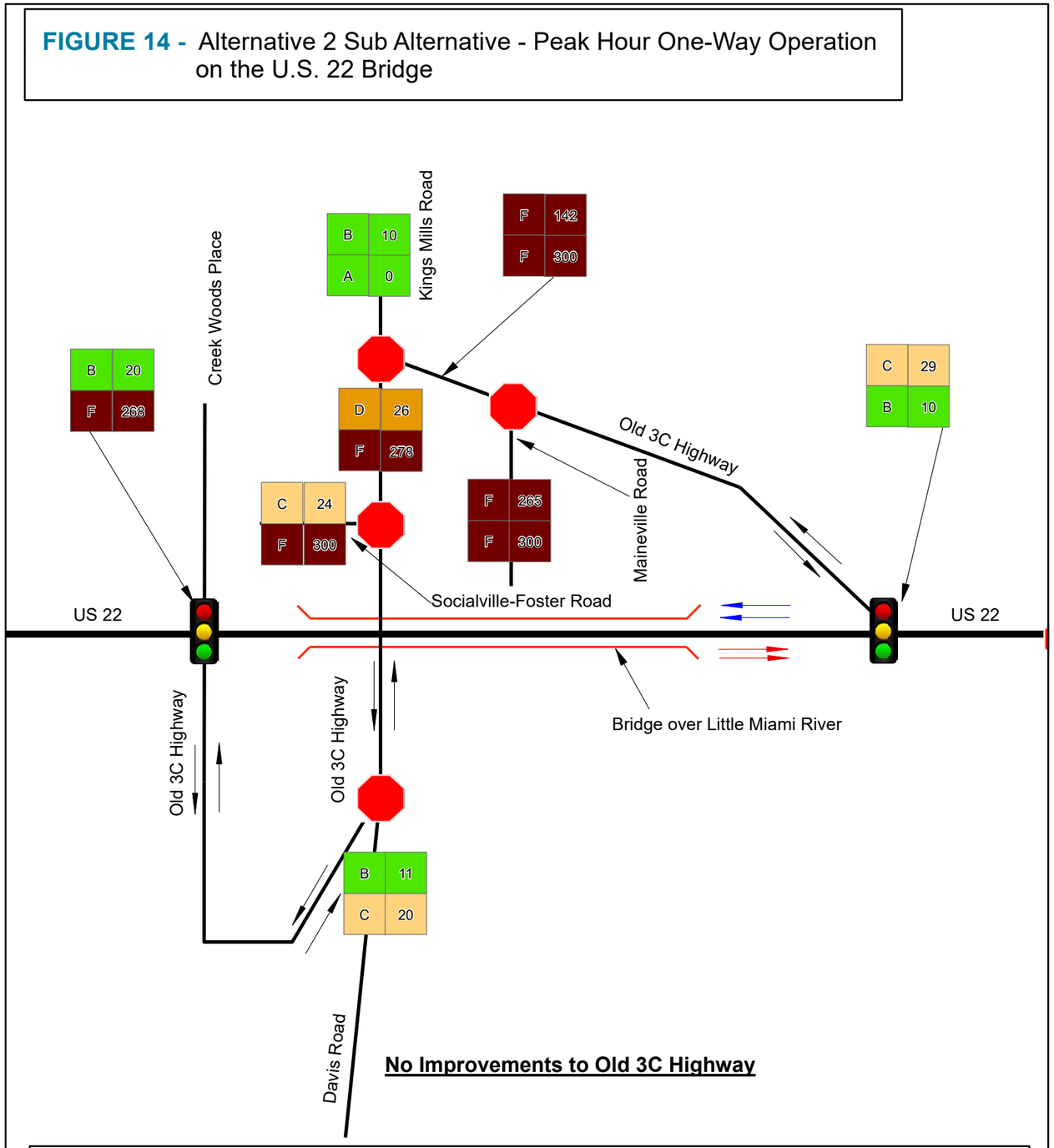
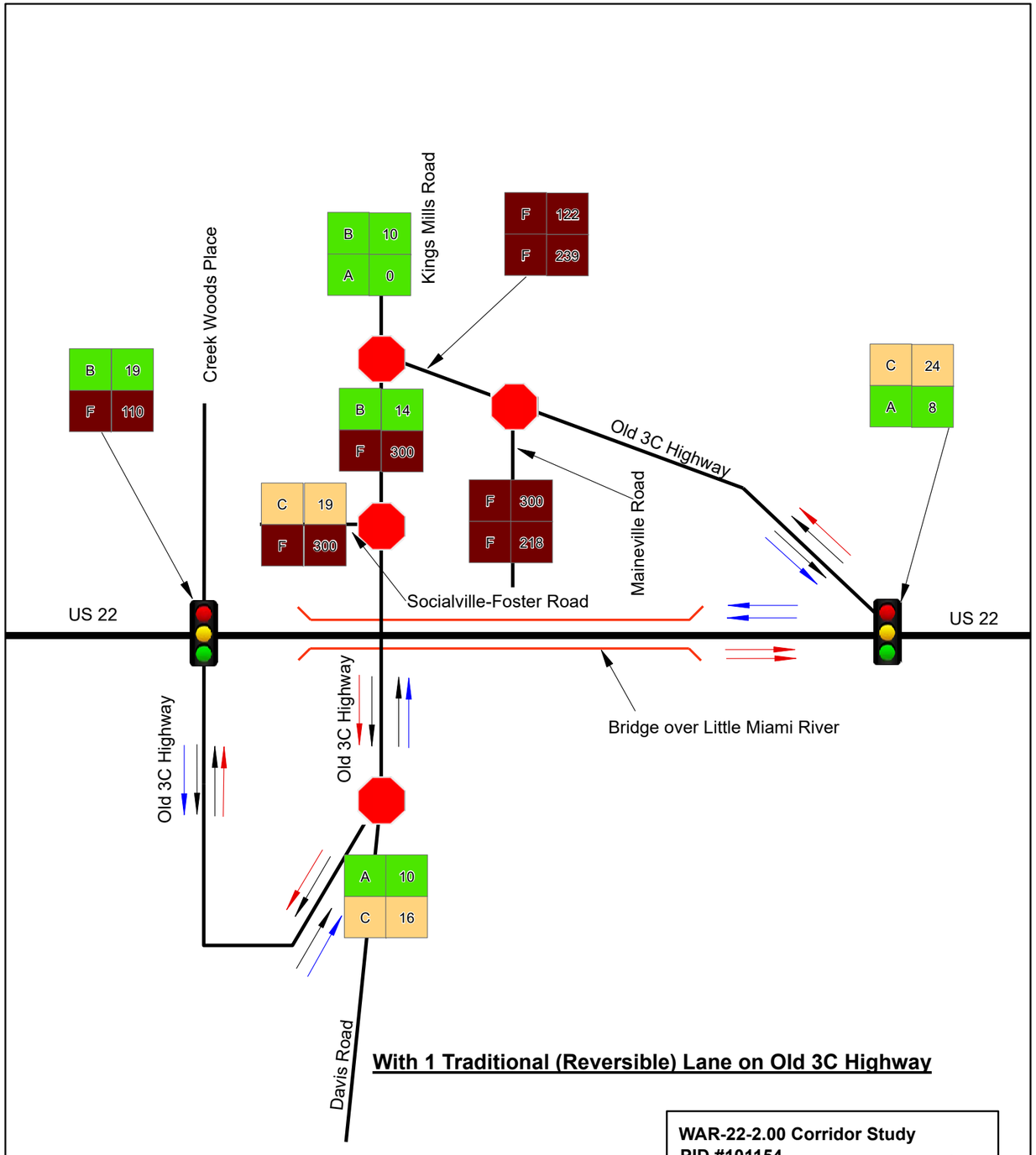
FIGURE 14 - Alternative 2 Sub Alternative - Peak Hour One-Way Operation on the U.S. 22 Bridge



No Improvements to Old 3C Highway



With 1 Traditional (Reversible) Lane on Old 3C Highway

Legend

2039 AM / 2039 PM — Intersection LOS

AM LOS / AM Delay / PM LOS / PM Delay — Approach LOS and Delay at Unsignalized Intersection

LOS A, LOS B, LOS C, LOS D, LOS E, LOS F

Signalized Intersection

Stop-Controlled Intersection

Existing Lane

Reversible Lane (AM)

Reversible Lane (PM)

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8.4 Alternative 3

Alternative 3 provides incremental improvements designed to reduce delay at several intersections along U.S. 22 in 2019 and continue operating efficiently until approximately 2029. However, in Alternative 3, several intersections are anticipated to continue operating at LOS E or F in the open year during both the a.m. and p.m. peak hours.

The southbound right-turn movement at Old 3C Highway east of the high-level bridge will operate at LOS E unless U.S. 22 is widened to two lanes west of the intersection. The Overbrook Drive U-turn movement will operate at LOS E during the a.m. peak hour unless U.S. 22 is widened to two lanes or the U-turn is signalized. The southbound right-turn movement from Lakeshore Drive may operate at LOS E or F unless U.S. 22 is widened to two lanes west of the intersection. The traffic signals at Willow Pond Boulevard and S.R. 48 will continue to operate at LOS E and LOS F, respectively. Because capacity improvements are needed at these two intersections, they will operate with approximately the same level of delay as they currently experience. West Road will operate at LOS E in the p.m. peak hour. As traffic volumes increase approaching the design year, the intersection of U.S. 22 and West Road will need a movement restriction or will need to be reconfigured into an RCUT intersection. The left-turn movement from Willow Pond Boulevard onto S.R. 48 will operate at LOS E. Alternative 3 does not provide the improvements necessary for acceptable levels of service in the design year.

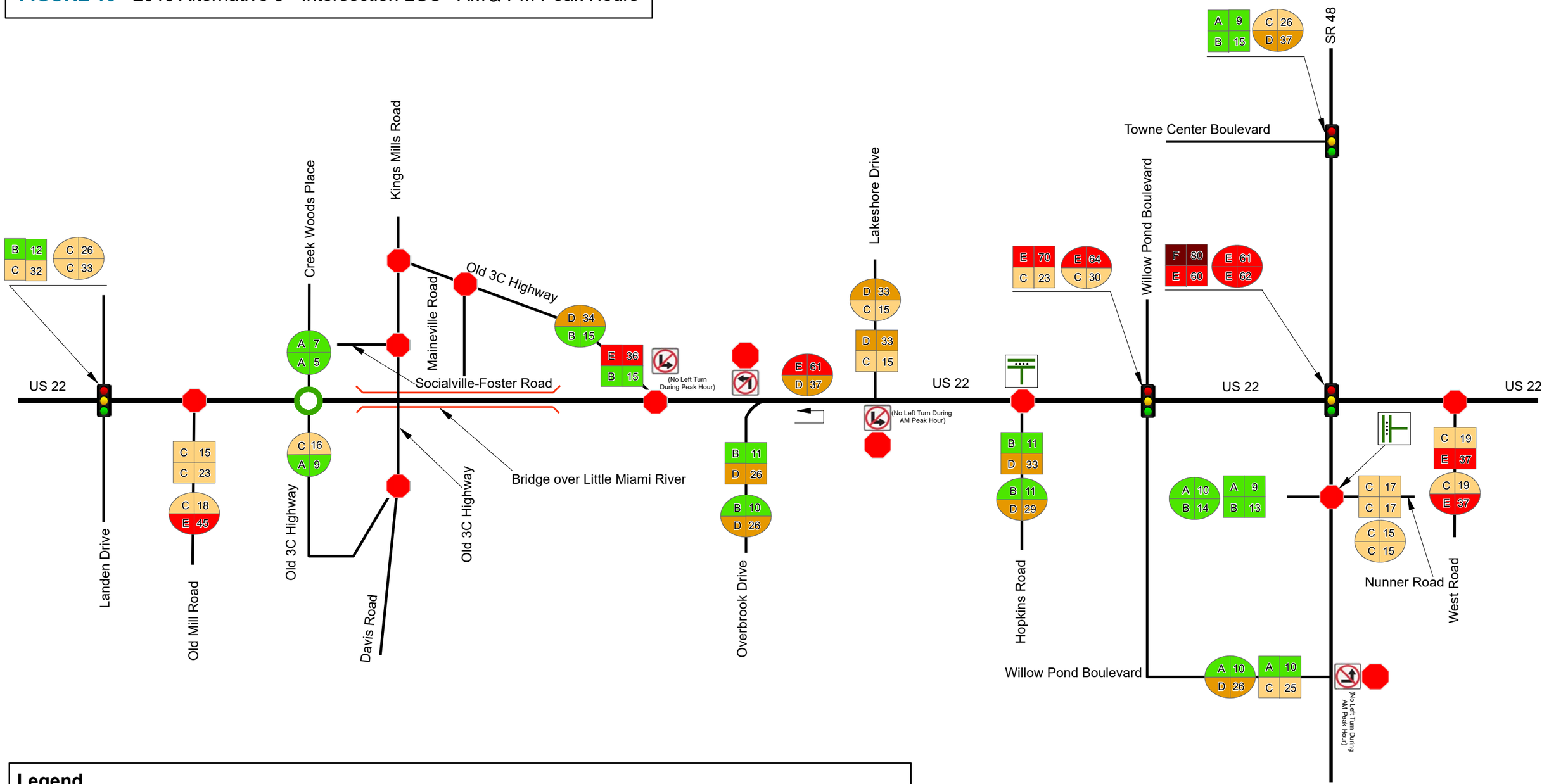
Alternative 3 includes three peak hour movement restrictions. The southbound left-turn movement from Old 3C Highway to U.S. 22 (east of the high-level bridge) will be prohibited and the movement redirected to an eastbound right turn from Old 3C Highway to U.S. 22 (west of the high-level bridge). The southbound left-turn movement at Lakeshore Drive will be prohibited and the movement redirected to the north on Striker Road and as a left turn at the intersection of U.S. 22 and Willow Pond Boulevard. The eastbound left-turn movement at the intersection of S.R. 48 and Willow Pond Boulevard will be prohibited during the peak hours.

The capacity analysis demonstrates that Alternative 3 will improve mobility on U.S. 22 and will reduce delay at stop-controlled side streets but **will not** provide the additional capacity needed in 2039. If Alternative 3 is implemented, U.S. 22 will not operate at an acceptable LOS in the design year. Alternative 3 provides improvements necessary to maintain acceptable operation of U.S. 22 until 2029.

A comparison of traffic operations if no improvements are implemented to traffic operations if Alternative 3 is implemented is presented in Table 8. Figure 15 presents the Alternative 3 capacity analysis results for 2019.

A conceptual diagram of Alternative 3 is provided in Appendix A. The HCS, Synchro, and Sidra analysis results for 2019 and 2039 are included in Appendix K, Appendix L, and Appendix M, respectively.

FIGURE 15 - 2019 Alternative 3 - Intersection LOS - AM & PM Peak Hours



Legend

- Signalized Intersection
- Stop-Controlled Intersection
- Roundabout Intersection
- RCUT Intersection
- Synchro LOS and Delay at Intersections
- HCS LOS and Delay at Intersections
- Sidra LOS and Delay at Intersections
- LOS A
- LOS B
- LOS C
- LOS D
- LOS E
- LOS F
- Green T Intersection

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Table 8. Alternative 3 Intersection Capacity Analysis

Intersection			No-Build (2019)				Alternative 3 (2019)			
			EB	WB	NB	SB	EB	WB	NB	SB
U.S. 22	Landen Drive	AM	B	C	C	C	C	C	C	C
		PM	C	C	C	C	D	C	C	D
	Old Mill Road	AM			C				C	
		PM			F				E	
	Creek Woods Place/Old 3C Highway	AM			F	F	A	C	A	C
		PM			F	D	B	A	C	A
	Old 3C Highway	AM				F				D
		PM				F				B
	Overbrook Drive	AM			F				B / E	
		PM			F				D / D	
	Lakeshore Drive	AM				C				D
		PM				D				C
	Hopkins Road	AM			C				B	
		PM			E				D	
	Willow Pond Boulevard	AM	B	F	F	F	B	E	E	E
		PM	D	B	D	D	D	B	C	D
	True-Quadrant Roadway	AM								
		PM								
	S.R. 48	AM	E	E	F	D	E	E	E	D
		PM	E	D	E	E	E	D	E	E
	Development Road/True-Quadrant Roadv	AM								
		PM								
	West Road	AM			C				C	
		PM			E				E	
S.R. 48	Town Center Boulevard	AM	C		C	B	C		C	B
		PM	D		A	C	E		B	D
	UDF Driveway/Nunner Road	AM	D	C			A	C		
		PM	F	F			B	C		
	Willow Pond Boulevard	AM	D				A			
		PM	D				D			

8.4.1 Alternative 3 Sub Alternative – Peak Hour Movement Restrictions

A capacity analysis for the intersections at U.S. 22 and Creek Woods Place/Old 3C Highway and at U.S. 22 and Old 3C Highway east of the high-level bridge was performed for this sub alternative to Alternative 3. A comparison of traffic operations if left turn movements from Old 3C Highway are redirected during the a.m. and p.m. peak hours is shown in Figure 16.

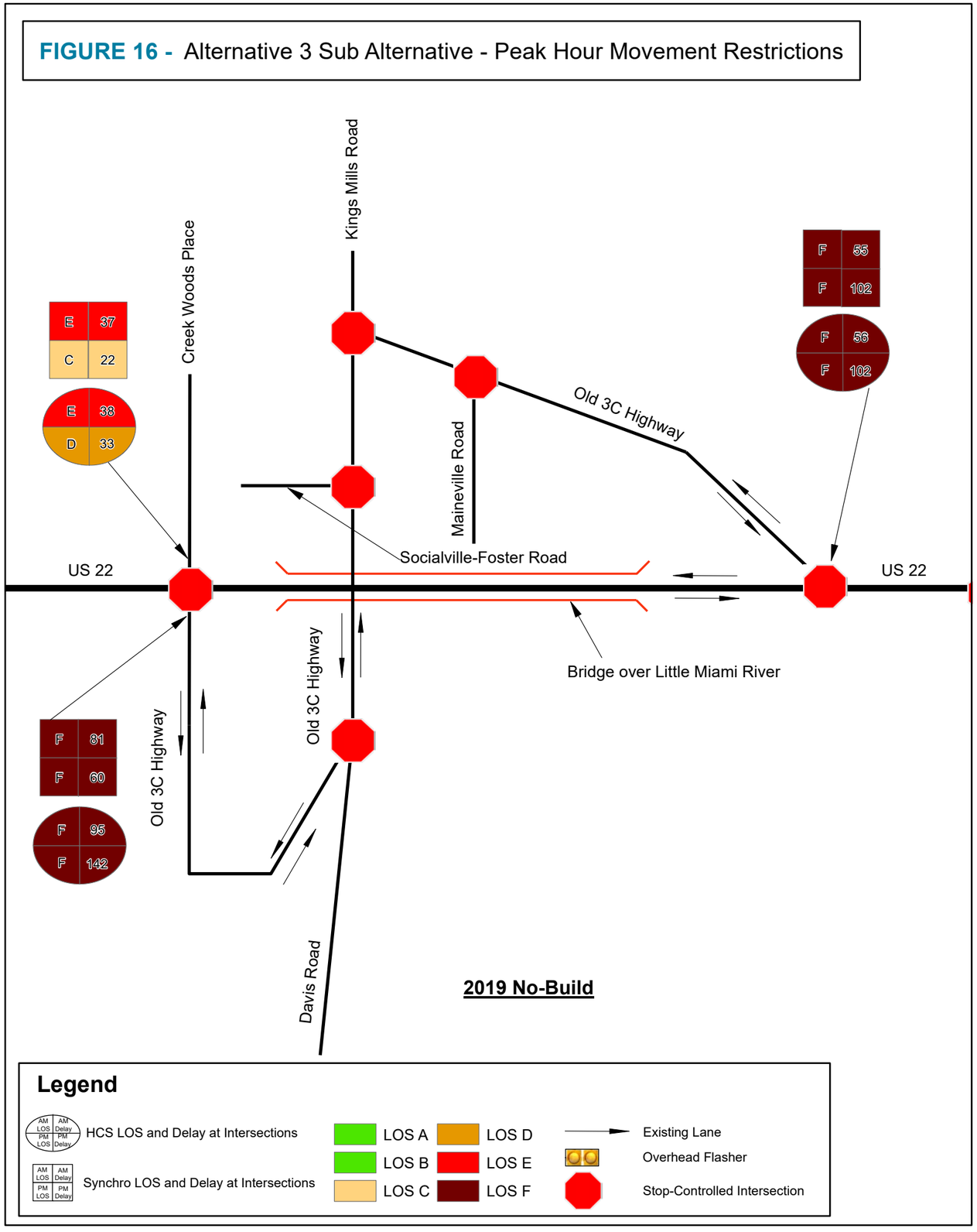
The Synchro capacity analysis shows the north approach (Creek Woods Place) at the intersection of U.S. 22 and Creek Woods Place/Old 3C Highway will operate at the same a.m. and p.m. peak hour LOS after these peak hour movement restrictions are imposed. The LOS during the a.m. peak hour is E and the LOS during the p.m. peak hour is C. The delay reduces 1 second during the a.m. peak hour and 3 seconds during the p.m. peak hour.

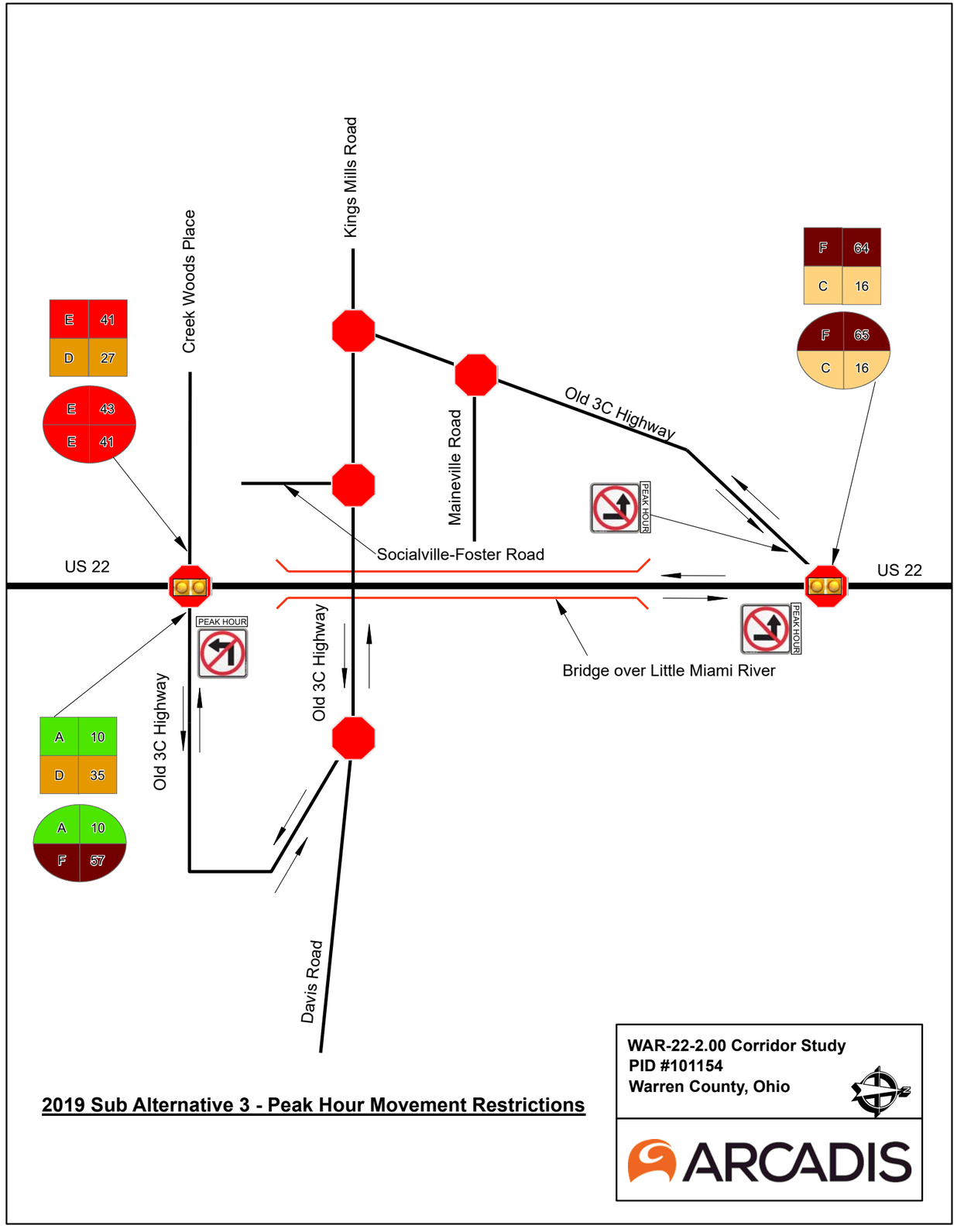
The Synchro capacity analysis shows the south approach (Old 3C Highway) at the intersection of U.S. 22 and Creek Woods Place/Old 3C Highway will operate at a significantly better peak hour LOS after these peak hour movement restrictions are imposed. The LOS during the a.m. peak hour improves from F to A and the LOS during the p.m. peak hour improves from F to D. The delay reduces 70 seconds during the a.m. peak hour and 25 seconds during the p.m. peak hour.

The Synchro capacity analysis shows the north approach (Old 3C Highway) at the intersection of U.S. 22 and Old 3C Highway will operate at the same a.m. peak hour LOS and a better p.m. peak hour LOS after these peak hour movement restrictions are imposed. The LOS during the a.m. peak hour remains F. The delay increases 10 seconds. The LOS during the p.m. peak hour improves from LOS F to LOS C and the delay decreases 90 seconds.

A Conceptual diagram of Alternative 3 Sub Alternative – Peak Hour Movement Restrictions is provided in Appendix A. The HCS and Synchro analysis results for 2019 and 2039 are included at the end of Appendix K and Appendix L, respectively.

FIGURE 16 - Alternative 3 Sub Alternative - Peak Hour Movement Restrictions





9 LANE CONFIGURATION DIAGRAMS

Diagrams showing the lane configuration for the no-build and build alternatives have been developed.

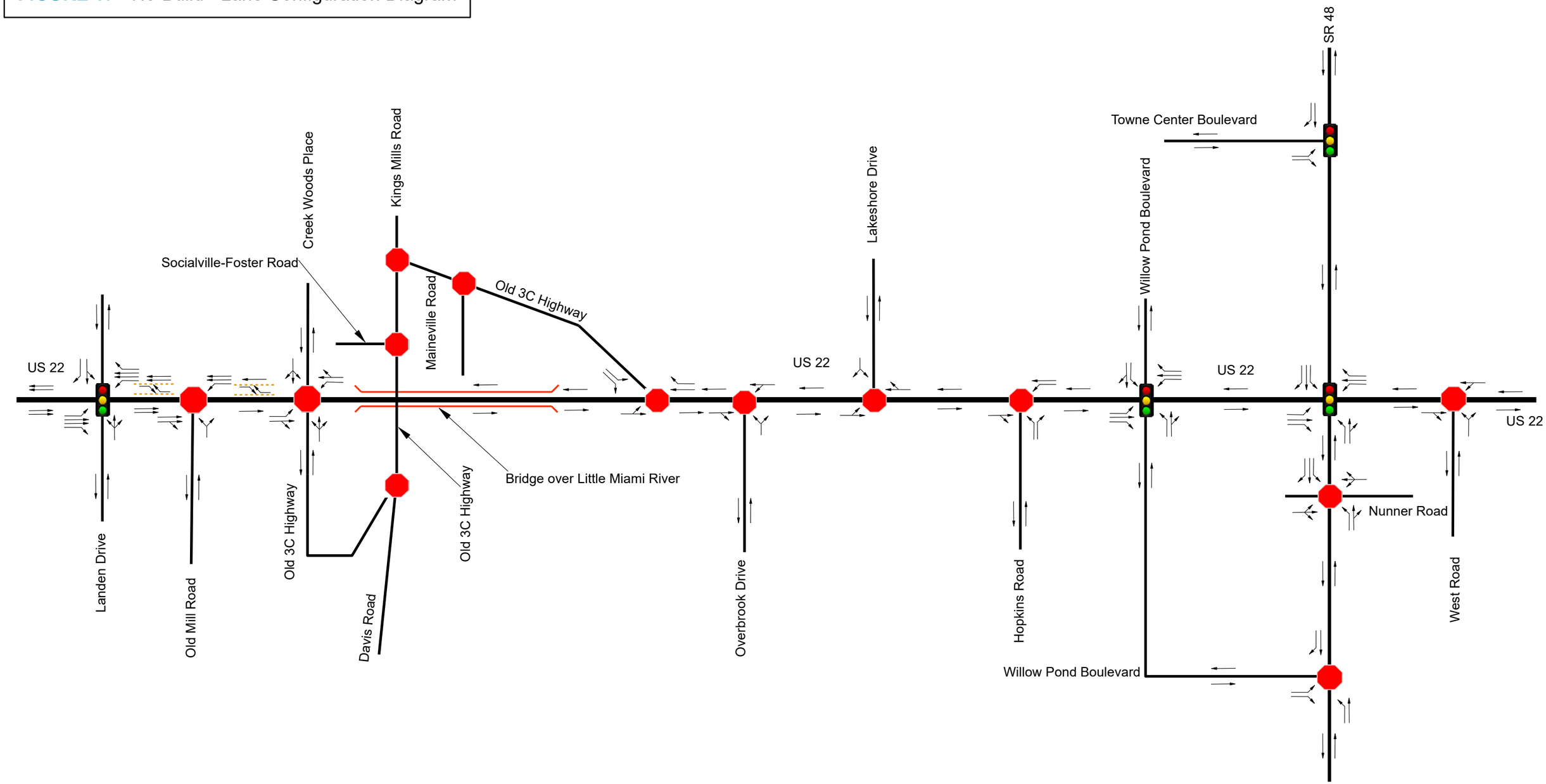
In Alternative 1, U.S. 22 will be five lanes with a center two-way left-turn lane between Landen Drive and West Road. S.R. 48 will remain one lane in each direction except for the northbound direction between U.S. 22 and Town Center Boulevard.

In Alternative 2, U.S. 22 will be four lanes with a raised median between Landen Drive and Creek Woods Place/Old 3C Highway. Between Creek Woods Place/Old 3C Highway and West Road, U.S. 22 will be four lanes except on the bridge. No changes are proposed to the existing high-level bridge over the Little Miami River. S.R. 48 will remain one lane in each direction except for the northbound direction between U.S. 22 and Town Center Boulevard.

In Alternative 3, U.S. 22 will be five lanes with a center two-way left-turn lane between Landen Drive and Creek Woods Place/Old 3C Highway. Between Creek Woods Place/Old 3C Highway and West Road U.S. 22 will remain two lanes. No changes are proposed on S.R. 48.

Figures 17 to 20 show the lane configurations for the U.S. 22 and S.R. 48 corridors.

FIGURE 17 - No-Build - Lane Configuration Diagram



Legend

- Signalized Intersection
- Stop-Controlled Intersection
- Through Lane
- Left-Turn Lane
- Right-Turn Lane
- Shared Left-Turn Lane
- Shared Right-Turn Lane
- Center Two-Way-Left-Turn Lane

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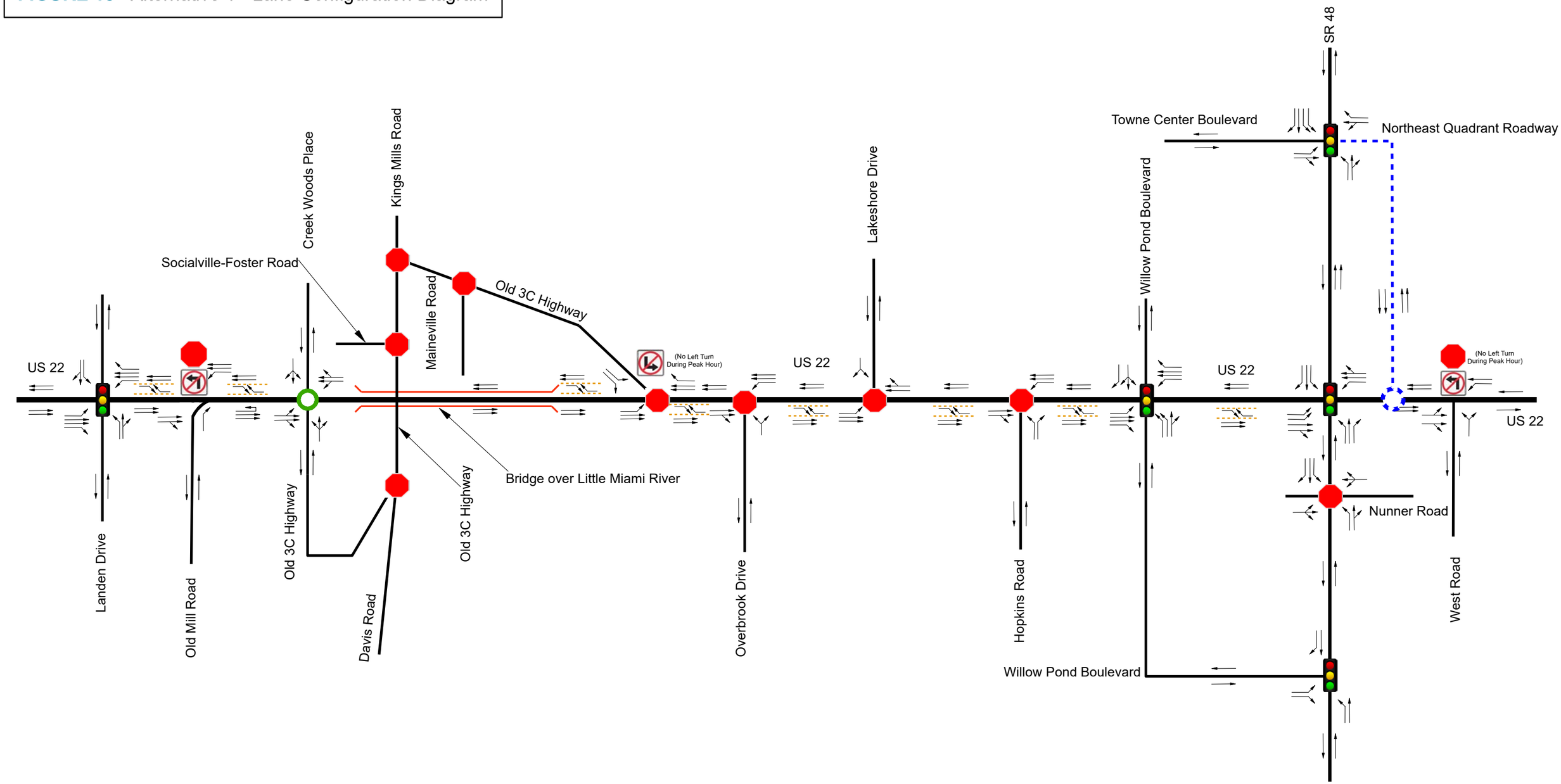
FIGURE 18 - Alternative 1 - Lane Configuration Diagram



Legend

- Signalized Intersection
- Stop-Controlled Intersection
- Through Lane
- Left-Turn Lane
- Right-Turn Lane
- Shared Left-Turn Lane
- Shared Right-Turn Lane
- Center Two-Way-Left-Turn Lane
- Proposed Road
- RCUT Intersection
- Roundabout Intersection

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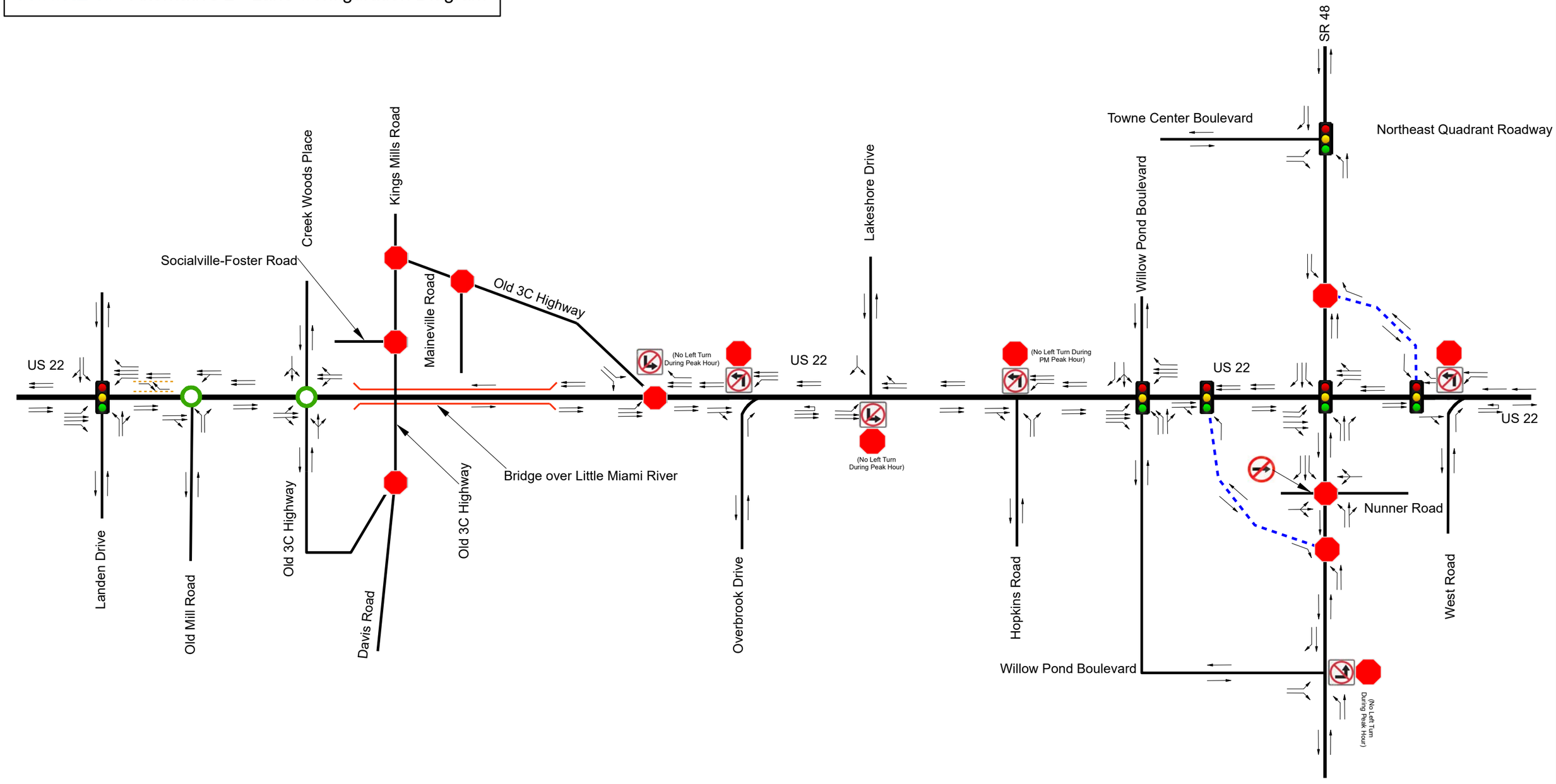
FIGURE 19 - Alternative 2 - Lane Configuration Diagram



Legend

- Signalized Intersection
- Stop-Controlled Intersection
- Through Lane
- Left-Turn Lane
- Right-Turn Lane
- Shared Left-Turn Lane
- Shared Right-Turn Lane
- Center Two-Way-Left-Turn Lane
- Proposed Road
- RCUT Intersection
- Roundabout Intersection

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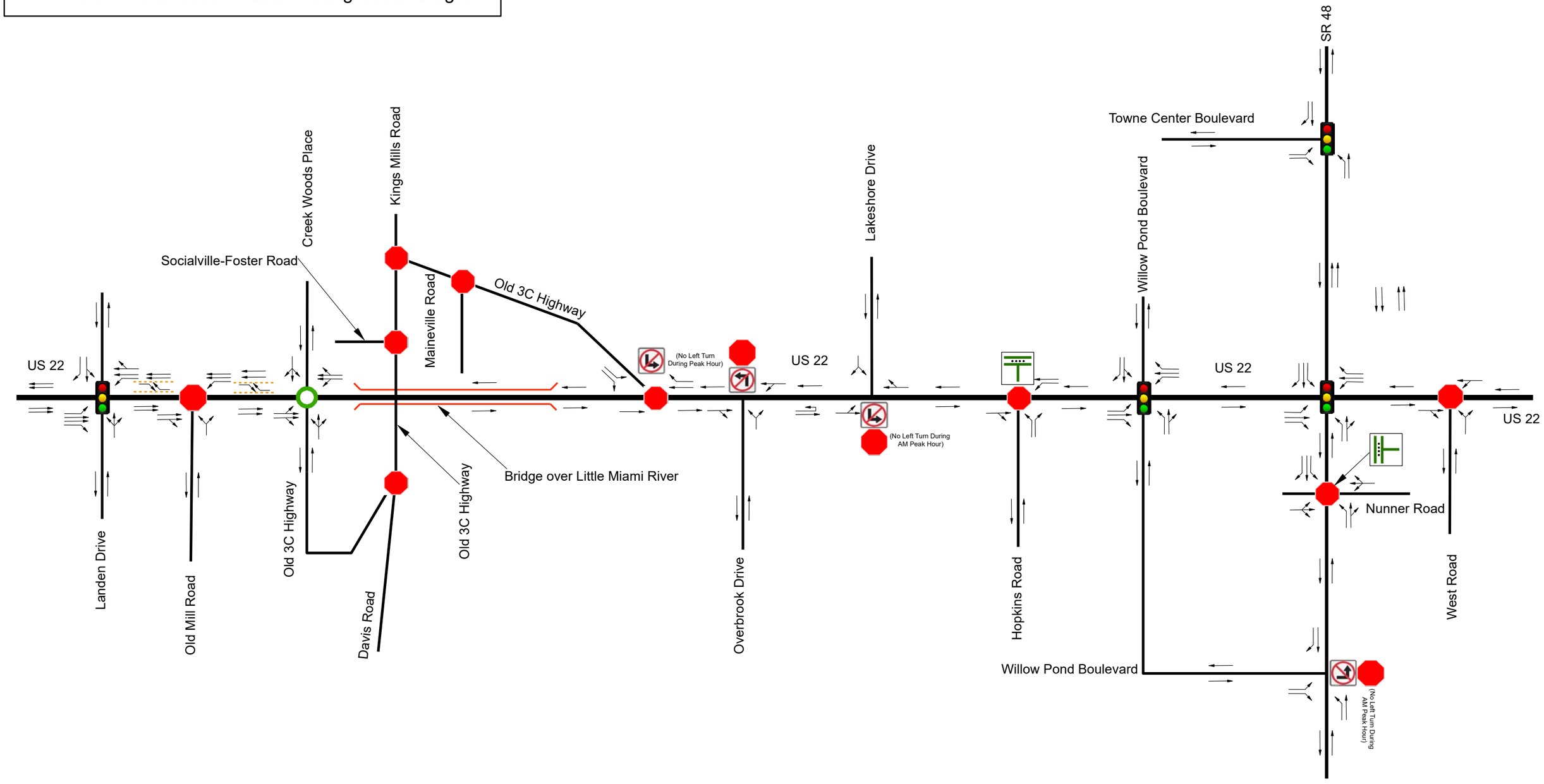
FIGURE 20 - Alternative 3 - Lane Configuration Diagram



Legend

- Signalized Intersection
- Stop-Controlled Intersection
- Through Lane
- Left-Turn Lane
- Right-Turn Lane
- Shared Left-Turn Lane
- Shared Right-Turn Lane
- RCUT Intersection
- Center Two-Way-Left-Turn Lane
- Roundabout Intersection

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10 CONCEPTUAL OPINION OF PROBABLE COST

A conceptual estimate of construction costs for the three build alternatives was prepared using the ODOT Estimator program. Estimated construction costs were developed using estimated quantities for items that would be needed or impacted to implement the required safety improvements.

The following assumptions were utilized in estimating construction costs:

- Unit prices for non-standard items were estimated based on ODOT's Summary of Contracts Awarded for 2015, Procedures for Budget Estimating, and prior bid tabs.
- A 30 percent contingency was selected based on the Procedures for Budget Estimating.
- The rate of inflation was calculated using the ODOT Office of Estimating Fiscal Year 2017–2021 Business Plan Inflation Calculator. Based on a construction midpoint of August 2019, a 7.5 percent rate of inflation (to the assumed midpoint of construction) was assumed.
- The performance bond cost was estimated to be 0.75 percent of the construction cost before adding the contingency.
- The cost for construction layout stakes was estimated to be 0.75 percent of the construction cost before adding the contingency.
- Maintenance of traffic costs were estimated to be slightly less than 10 percent of the construction cost before adding the contingency.
- The pedestrian crossing on U.S. 22 at Landen Deerfield Park will include warning signs, LED flashers, support, and solar power service.
- A 30 percent contingency was assumed for filling of the pedestrian refuge island in all three build alternatives based on the multiple options and wide range of costs to implement this improvement.

The total 2019 conceptual estimate of probable project cost (with inflation) for each alternative is summarized below and included in Appendix N.

10.1 Alternative 1

The conceptual estimate of probable project cost for Alternative 1 with a new four-lane-wide structure is as follows:

Total 2021 Conceptual Estimate of Probable Project Cost (with Inflation)	$93,766,713
Total Estimated ODOT Right-of-Way Acquisition Cost	$2,175,178
Total Estimated Design Cost	$7,500,000
Total Cost for Alternative 1 – New Bridge	$103,441,891

10.1.1 Alternative 1 – 4 Lane Bridge

The conceptual estimate of probable project cost to construct only the new 4 lane wide high level bridge is as follows:

Total 2021 Conceptual Estimate of Probable Project Cost (with Inflation)	$32,297,650

10.1.2 Alternative 1 – Supplemental 2 Lane Bridge

In lieu of replacing the existing two-lane high-level bridge with the new four lane wide bridge costs were developed if a second, supplemental, two-lane wide bridge is built adjacent to the existing bridge.

The new supplemental bridge could be constructed on the north or south side of the existing bridge. Shifting the alignment will have additional impacts to the surrounding parcels. To minimize the impacts, retaining walls were assumed for approximately 1,100 feet on either side of the new structure. Additional parcel takes would also be required in this scenario. The northern option would have the more significant right of way impact with a structure being removed. The total cost of the new two-lane bridge to the north or south would have an estimated cost of $23,986,000. This cost would include the additional roadway widening required for the alignment shift, retaining walls added and additional property impacts. The estimated cost assumed no rehabilitation of the existing structure that is 82 years old and was last rehabilitated in 1990. The total replacement of the existing two-lane bridge to four lanes would cost an estimated $32,297,650. The higher cost was included in the overall estimate.

The conceptual estimate of probable project cost to construct a second, supplemental, 2 lane bridge, on the north or south side of the existing two-lane high level structure is as follows:

Total 2021 Conceptual Estimate of Probable Project Cost (with Inflation)	$23,986,000

10.2 Alternative 2

The conceptual estimate of probable project cost for Alternative 2 is as follows:

Total 2021 Conceptual Estimate of Probable Project Cost (with Inflation)	$31,586,068
Total Estimated ODOT Right-of-Way Acquisition Cost	$1,865,024
Total Estimated Design Cost	$2,525,000
Total Cost for Alternative 2	$35,976,092

10.2.1 Alternative 2 Sub Alternative – Peak Hour One Way Operation on the U.S. 22 Bridge

Costs were not developed because this alternative was found to not be feasible.

10.2.2 Alternative 2 Sub Alternative – Without True-Quadrant Roadways

The conceptual estimate of probable project cost for Alternative 2 without the true-quadrant roadways is as follows:

Total 2021 Conceptual Estimate of Probable Project Cost (with Inflation)	$30,610,678
Total Estimated ODOT Right-of-Way Acquisition Cost	$797,839
Total Estimated Design Cost	$2,450,000
Total Cost for Alternative 2 without the true quadrant roadways	$33,858,517

10.3 Alternative 3

The conceptual estimate of probable project cost for Alternative 3 is as follows:

Total 2021 Conceptual Estimate of Probable Project Cost (with Inflation)	$10,513,644
Total Estimated ODOT Right-of-Way Acquisition Cost	$111,340
Total Estimated Design Cost	$845,000
Total Cost for Alternative 3	$11,469,984

10.3.1 Alternative 3 – Creek Woods Place/Old 3C Highway Roundabout

The conceptual estimate of probable project cost to construct only the roundabout at the intersection of U.S. 22 and Creek Woods Place/Old 3C Highway is as follows:

Total 2021 Conceptual Estimate of Probable Project Cost (with Inflation)	$1,374,255
Total Estimated ODOT Right-of-Way Acquisition Cost	$111,340
Total Estimated Design Cost	$150,000
Total Cost for Alternative 3 – Creek Woods Place/Old 3C Highway Roundabout	$2,955,579

11 ENVIRONMENTAL OVERVIEW

During preliminary development of the proposed alternatives potential environmental issues to be addressed in the National Environmental Policy Act (NEPA) document were evaluated. Based on the level of impacts anticipated, a Categorical Exclusion type document is likely to be approved for the project. The team did not identify any potential environmental impacts that would significantly affect the decision regarding the preferred alternative. Following is a summary of key issues identified:

Ecological Resources

There are six streams in the study area, including the Little Miami River. The Little Miami River is a Group 2 stream under the Ohio Mussel Survey Protocol and a State and National Scenic River. U.S. 22 crosses the Little Miami River from approximately miles 3.14 to 3.2. Observations of mussels at the Little Miami River crossing have been recorded: *Epioblasma triquetra* (federally endangered), *Truncilla truncata* (state species of concern), and *Truncilla donaciformis* (state threatened species). Another named stream, Bear Run, crosses the study area in multiple locations and runs parallel to U.S. 22 in some locations in the study area.

Areas of potential wetlands are mainly anticipated within or adjacent to streams. Specifically, the wide riparian corridor/floodplain of the Little Miami River likely contains large wetland areas. Other low-lying or depressed areas may also be potential wetland locations. The United States Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) depicts two ponds approximately 200 feet south of U.S. 22 at mile 2.43. The NWI also maps riverine wetlands that cross U.S. 22 at miles 2.63, 3.59, 4.22, and 5.32. Hydric soils are mapped along U.S. 22 from mile 2.00 to 2.04, from the Little Miami River eastward to mile 4.28, from miles 4.78 to 4.83, and from miles 5.24 to 5.31.

Suitable wooded habitat for the Indiana bat *(Myotis sodalist)* and northern long-eared bat *(Myotis septentrionalis)* is located throughout the study area.

The topography of the study area includes some steep grades, especially along the river banks, and to the north and south of U.S. 22 from the river eastward to approximately mile 4.40.

Cultural Resources

A search of the Ohio Historic Preservation Office (OHPO) database indicates that the area west of the Little Miami River has been included in a previous Phase I archaeological survey and the intersection of U.S. 22 and S.R. 48 was included in a previous Phase I History/Architecture survey. According to the database, Hopkinsville Cemetery adjoins the south side of U.S. 22 from mile 5.16 to 5.23. The U.S. 22 bridge over the Little Miami River, built in 1937 and reconstructed in 1990, is eligible for listing in the National Register of Historic Places. In addition, there are a number of “historic” properties (inventoried and more than 50 years of age, although not necessarily eligible for listing) and mapped archaeological sites in the study area.

Section 4(f)/Section 6(f) Resources

The study area includes several parks, including local- and state-managed parks. The parks are concentrated west of the Little Miami River.

Landen-Deerfield Park is a 95-acre park owned and managed by the Warren County Park District. Landen-Deerfield Park is located immediately adjacent to the north side of U.S. 22 from miles 2.25 to 2.62. Sports facilities include soccer, baseball, softball, and football fields and tennis, basketball, and sand volleyball courts. Additional park amenities include a natural area, hiking trails, mountain bike trails, fishing areas, shelters, restrooms, a concession stand, picnic tables, and grills. Landen-Deerfield Park is protected under Section 6(f). The Warren County Park District received $401,383 in funding from the Land and Water Conservation Fund in 1980 for the development of Landen-Deerfield Park.

The Little Miami State Park is a linear park that follows the Little Miami State and National Scenic River. The park averages 66 feet in width and runs for approximately 50 miles through Greene, Warren, Clermont, and Hamilton Counties. U.S. 22 crosses the Little Miami Scenic Trail, a component of the Little Miami State Park, at mile 3.25. The trail is a proposed U.S. Bike Route carrying shared pedestrian and bicycle traffic.

Carl Rahe Park, formerly known as Glenn Island State Canoe Access, is located adjacent to U.S. 22 from mile 3.09 to the western riverbank, with the exception of a residential property immediately under the bridge. Access to the park is provided from Old 3C Highway. The park has a parking area, shelters, a fire pit, open fields, and watercraft launch access points and is maintained by ODNR.

Other parks in proximity to U.S. 22 include Foster’s Crossing and Foster’s Landing Park (local parks) on the river banks north of U.S. 22.

Environmental Hazards

Environmental hazards in the study area include regulated underground storage tanks at 2669 W U.S. 22 (United Dairy Farmers), 2219 W U.S. 22 (Cincy Tool Rental), 424 E U.S. 22 (Thorton Landscape), 1860 W U.S. 22 (Tri County Tree & Turf), 6643 S.R. 48 (United Dairy Farmers), and U.S. 22/West Road (Cincinnati Bell Telephone); a Resources Conservation and Recovery Act site at 68 W U.S. 22 (Walgreens); and a spill/emergency response location at 200 U.S. 22.

Land Use

Existing land use, based on Warren County parcel data, consists primarily of residential development, much of it new. Many of the residential areas include common areas. There are a few small clusters of commercial parcels, including several along U.S. 22 from miles 2.00 to 2.86, and around the intersection of U.S. 22 and S.R. 48. West of the Little Miami River, much of the land consists of publicly owned parcels, including the aforementioned parks. At miles 3.20 to 3.30, a large parcel belonging to a Girl Scout organization (Camp Butterworth) crosses U.S. 22.

The eastern section of the study area consists of residential and agricultural parcels, several of which are vacant. Two churches own property (including Hopkinsville Cemetery) from miles 5.16 to 5.28; churches also own property on both sides of the road from miles 5.57 to 5.78.

Deerfield Township's 2015 Comprehensive Plan prioritizes pedestrian and bicycle trails, particularly connections that would contribute to completing the Deerfield Township portion of the Miami to Miami Trail, as well as trails that provide connections between neighborhoods, parks, schools, and commercial areas. The Plan identifies a proposed Miami to Miami route that crosses the Little Miami River within the study area.

The Comprehensive Plan characterizes the area along the river's western banks as low- or medium-density rural neighborhoods. The plan sets guidelines for this portion of the study area that emphasize its rural character by recommending low- to medium-density residential development, recreation, and agricultural uses of the land. The plan also identifies an existing residential area south of U.S. 22 that consists of older homes on very small lots. The plan recommends the consolidation of small lots to create buildable sites for single-family development.

The Comprehensive Plan describes the area immediately along U.S. 22 as neighborhood mixed-use, consisting of a mix of higher-density residential, small commercial, and large big-box-type uses. The plan emphasizes the importance of maintaining cohesiveness with the surrounding neighborhoods, providing connectivity for vehicles and pedestrians, and including landscaping, signage, and lighting designed to a pedestrian scale.

The Hamilton Township Land Use Plan, adopted in April 2006, specifically identifies widening of U.S. 22 as a goal. The plan discusses the high intensity of growth in the township, especially residential growth, as water and wastewater facilities have extended into formerly rural, undeveloped areas. The plan identifies the intersection of U.S. 22 and S.R. 48 as a central business district. The plan also indicates the need to seek a balance between preserving the area's rural and residential characteristics and an increase in commercial activity, discouraging the conversion of commercial or industrial property to other uses. As in Deerfield Township, Hamilton Township's plan emphasizes the importance of walkability and access to open space and recreation when considering new development.

A red flag summary map is included in Appendix O.

12 SUMMARY

In 2005, the Southwest Warren County Transportation Study was undertaken by OKI to improve mobility and safety in southwestern Warren County. Widening U.S. 22 to provide two lanes in each direction, between Columbia Road and S.R. 48, including the existing 1,358-foot-long high-level bridge over the Little Miami River, was recommended at an estimated cost $43.9 million, not including right-of-way, utilities, engineering, or administrative costs.

Based on the high cost, ODOT retained Arcadis to study the overall operation of a 3.1-mile-long segment of U.S. 22 and to consider options for improving safety and reducing congestion between Landen Drive and West Road. The study area also includes a 0.6-mile-long portion of S.R. 48 and a 1.2-mile-long portion of Old 3C Highway. Old 3C Highway is the remnant of the original low-level crossing of the Little Miami River and intersects U.S. 22 twice, once to the southwest of the U.S. 22 bridge over the Little Miami River and once to the northeast of the bridge.

The WAR-22-2.00 Corridor Study provides an overview of existing conditions, future conditions (no-build alternative) and discusses the feasibility of three build alternatives: widening to five lanes; adding capacity utilizing performance-based practical design principles; and implementing targeted improvements at key intersections.

The purpose of this corridor study is twofold. First, ODOT anticipates that future growth in the region will lead to overcapacity on the existing two-lane bridge over the Little Miami River. Second, unsignalized intersections where the minor street is stop-controlled currently experience a high amount of delay and high crash frequency, indicating side street traffic has a difficult time finding a gap to enter U.S. 22. This study demonstrates and documents how each of the build alternatives will improve mobility along U.S. 22 and reduce delay on stop-controlled side streets.

The no-build alternative and three build alternatives analyzed are summarized below.

No-Build Alternative

Under the no-build alternative, no improvements will be implemented as a result of this study.

Alternative 1

In Alternative 1, U.S. 22 will be restriped within the existing pavement to a five-lane roadway between the Landen Drive and Creek Woods Place/Old 3C Highway intersections. The restriping will provide one additional lane with a two-way left-turn lane within the existing pavement. Beginning 300 feet east of Creek Woods Place/Old 3C Highway and extending east to West Road, U.S. 22 will be widened to five lanes with a center two-way left-turn lane. To provide additional capacity over the Little Miami River the existing high-level bridge will either be replaced with a new four-lane-wide structure with a multi-use path on the south side of U.S. 22 or it will be supplemented with a second, parallel two-lane structure. The existing retaining wall on the south side of U.S. 22, east of Overbrook Drive, will be extended to accommodate the widening.

In addition to widening, improvements are proposed for several intersections along U.S. 22. A roundabout will be constructed at the intersection with Creek Woods Place/Old 3C Highway. No changes, other than prohibiting the southbound left turn during peak hours, are proposed for the intersection with Old 3C Highway east of the high-level bridge. Willow Pond Boulevard will be used as a quadrant roadway and will remain a signalized intersection. A two-lane roundabout will be constructed between S.R. 48 and

West Road to provide access to the proposed Hoptown Development roadway, which will connect to S.R. 48 opposite of Town Center Boulevard. No changes are proposed for the intersection with Old Mill Road as part of this alternative. However, based on traffic projections, the Old Mill Road intersection will need to be converted to a Restricted Crossing U-Turn (RCUT) by 2029. Landen Drive and S.R. 48 will also remain signalized intersections. No changes are proposed for the Overbook Drive, Lakeshore Drive, Hopkins Road, and West Road intersections.

Several improvements are proposed for the intersections along S.R. 48. The proposed Hoptown Development roadway will be included as a quadrant roadway serving southbound traffic on S.R. 48 headed to U.S. 22 eastbound and westbound traffic on U.S. 22 headed to S.R. 48 northbound. A traffic signal will be constructed at Willow Pond Boulevard. No changes, other than prohibiting the eastbound through movement during peak hours, are proposed for the UDF Driveway/Nunner Road intersection.

Alternative 1 will increase capacity on U.S. 22, including the existing high-level bridge, and will reduce delay on the unsignalized side streets when compared to the design no-build alternative.

As part of the Southwest Warren County Transportation Study, OKI stressed the regional importance of adding capacity over the Little Miami River. An outcome of the study was a recommendation to widen the existing high-level bridge on U.S. 22. The study also recommended the Western Row Road Extension project, which would provide a new high-level crossing over the Little Miami River north of the U.S. 22 high-level bridge. The new high-level crossing would improve mobility and connectivity between southwestern Warren County and Interstate 71. In 2005, the Western Row Road Extension was estimated to cost $40 million. Recent estimates provided by the Warren County Engineer predict the cost of the Western Row Road Extension to be close to $300 million.

Alternative 2

In Alternative 2, U.S. 22 will be restriped within the existing pavement to a four-lane roadway with a raised median between the Landen Drive and Creek Woods Place/Old 3C Highway intersections. The restriping will provide one additional lane within the existing pavement and the raised median will allow all access points between Old Mill Road and Creek Woods Place/Old 3C Highway to be right-in right out. Beginning 300 feet east of Creek Woods Place/Old 3C Highway and extending east to West Road, U.S. 22 will merge to two lanes to cross the existing high-level bridge over the Little Miami River. Beginning on the east side of the existing high-level bridge, U.S. 22 will be widened to provide one additional lane utilizing performance-based practical design principles. The existing retaining wall on the south side of U.S. 22, east of Overbrook Drive, will be extended to accommodate the widening. Alternative 2 does not provide additional capacity to the existing high-level bridge over the Little Miami River.

Improvements are proposed for several intersections along U.S. 22. A roundabout will be constructed at the intersection of Old Mill Road and at the intersection with Creek Woods Place/Old 3C Highway. No changes, other than prohibiting the southbound left turn during peak hours, are proposed for the Old 3C Highway intersection east of the high-level bridge. The Overbrook Drive intersection will be reconfigured into an RCUT. No changes, other than prohibiting the southbound left turn during peak hours, are proposed for the Lakeshore Drive intersection. No changes, other than prohibiting the northbound left turn during peak hours and redirecting traffic to the Overbrook Drive intersection, are proposed for the Hopkins Road intersection. The West Road intersection will be reconfigured into an RCUT. The Landen Drive, Willow Pond Boulevard, and S.R. 48 intersections will remain signalized.

No configuration changes are proposed for the intersections along S.R. 48. The Town Center Boulevard intersection will remain a signalized. No changes, other than prohibiting the eastbound through movement during peak hours, are proposed for the UDF Driveway/Nunner Road intersection. No changes, other than prohibiting eastbound left turns during peak hours, are proposed for the Willow Pond Boulevard intersection.

Alternative 2 includes two proposed two-lane true-quadrant roadways located in the northeast and southwest quadrants of the intersection. These proposed quadrant roadways follow the design parameters set forth by the Federal Highway Administrations regarding quadrant roadway design. The quadrant roadways will intersect U.S. 22 and S.R. 48 approximately 500 feet from the intersection of U.S. 22 and S.R. 48. A traffic signal will be constructed at the quadrant roadway intersections along U.S. 22. The quadrant roadway intersections along S.R. 48 will be stop-controlled on the side street.

Alternative 2 will increase capacity on U.S. 22, except on the existing high-level bridge, and will reduce delay on the unsignalized side streets when compared to the design year no-build alternative.

Alternative 2 Sub Alternative – Without True-Quadrant Roadways

Alternative 2 includes a sub alternative to provide an option of ODOT elected not to build the two, new true-quadrant roadways. This sub alternative examined the intersection lane configuration required to maintain acceptable traffic operation in 2039 if no traffic is diverted away from the intersection of U.S. 22 and S.R. 48 onto the true-quadrant roadways. This sub alternative also noted that if traffic is not rerouted, the intersection of S.R. 48 and the UDF Driveway/Nunner Road will operate at LOS F in the design year. Operations at the S.R. 48 and the UDF Driveway/Nunner Road will have to be evaluated regularly to determine if a traffic signal warrant is satisfied.

Alternative 3

In Alternative 3, U.S. 22 will be restriped within the existing pavement to a five-lane roadway between the Landen Drive and Creek Woods Place/Old 3C Highway intersections. The restriping will provide one additional lane with a two-way left-turn lane within the existing pavement. Beginning 300 feet east of Creek Woods Place/Old 3C Highway, U.S. 22 will merge to two lanes to cross the existing high-level bridge over the Little Miami River. Alternative 3 will not provide additional capacity on U.S. 22 east of the intersection with Creek Woods Place/Old 3C Highway or to the existing high-level bridge over the Little Miami River.

Improvements are proposed at several intersections along U.S. 22. A single lane roundabout will be constructed at the Creek Woods Place/Old 3C Highway intersection. No changes, other than prohibiting the southbound left turn during peak hours, are proposed for the Old 3C Highway intersection east of the high-level bridge. The Overbrook Drive intersection will be reconfigured into an RCUT. No changes, other than prohibiting the southbound left turn during peak hours, are proposed at the Lakeshore Drive intersection. The Hopkins Road intersection will be reconfigured to a Green T intersection to eliminate the conflict between the westbound through movement on U.S. 22 and the northbound left-turn movement from Hopkins Road. The Landen Drive, Willow Pond Boulevard, and S.R. 48 intersections will remain signalized. No changes are proposed for the Old Mill Road intersection.

None of the intersections along S.R. 48 will be changed. The Town Center Boulevard intersection will remain signalized. The eastbound through movement at the UDF Driveway/Nunner Road intersection is prohibited during peak hours. No changes, other than prohibiting eastbound left turns during peak hours, are proposed for the Willow Pond Boulevard intersection.

It is anticipated that to maintain an acceptable level of service (LOS) along U.S. 22 one additional lane will be required on U.S. 22 after 2029. Alternative 3 does not add this capacity on U.S. 22 but it will reduce delay on the unsignalized side streets when compared to the 2019 no-build alternative.

Alternative 3 Sub Alternative – Peak Hour Movement Restrictions

Alternative 3 includes a sub alternative to address the crash frequency at the intersections of U.S. 22 and Creek Woods Place/Old 3C Highway and at U.S. 22 and Old 3C Highway (east of the high-level bridge).

U.S. 22 will be restriped within the existing pavement to a five-lane roadway beginning 1,200 feet east of Landen Drive and extending to Creek Woods Place/Old 3C Highway. The restriping will provide one additional lane with a two-way left-turn lane within the existing pavement. The outside lane on U.S. 22 eastbound will end as a right-turn only lane onto Old 3C Highway. The outside lane on U.S. 22 westbound will begin as an add lane from Creek Woods Drive.

At the intersection of U.S. 22 and Creek Woods Place/Old 3C Highway the northbound left turn from Old 3C Highway will be prohibited and the movement redirected to a southbound right turn at the intersection of U.S. 22 and Old 3C Highway (east of the high-level bridge). An overhead flasher will be constructed with lane use signs on the span wires.

At the intersection of U.S. 22 and Old 3C Highway (east of the high-level bridge) the southbound left turn from Old 3C Highway to U.S. 22 eastbound will be prohibited and the movement redirected to a northbound right turn at the intersection of Creek Woods Place/Old 3C Highway to U.S. 22 (west of the high-level bridge). The eastbound left turn from U.S. 22 onto Old 3C Highway will also be prohibited and the movement redirected to an eastbound right turn at the intersection U.S. 22 and Creek Woods Place/Old 3C Highway.

The capacity analysis shows the north approach (Creek Woods Place) at the intersection of U.S. 22 and Creek Woods Place/Old 3C Highway will operate at the same a.m. and p.m. peak hour LOS after these peak hour movement restrictions are imposed. The LOS during the a.m. peak hour is E and the LOS during the p.m. peak hour is C. The delay reduces 1 second during the a.m. peak hour and 3 seconds during the p.m. peak hour. The number of conflicts motorist exiting Creek Woods Place will be reduced however these motorists may continue to experience a similar amount of delay.

The capacity analysis shows the south approach (Old 3C Highway) at the intersection of U.S. 22 and Creek Woods Place/Old 3C Highway will operate at a significantly better peak hour LOS after these peak hour movement restrictions are imposed. The capacity analysis shows the north approach (Old 3C Highway) at the intersection of U.S. 22 and Old 3C Highway will operate at the same a.m. peak hour LOS and a better p.m. peak hour LOS after these peak hour movement restrictions are imposed. The LOS during the a.m. peak hour remains F while the LOS during the p.m. peak hour improves from LOS F to LOS C.

Conclusion: The results of the analyses indicate that each of the build alternatives will improve mobility on U.S. 22 and reduce stop-controlled side street delay. However, only build Alternative 1 addresses capacity issues related to the existing 1,358-foot-long high-level bridge over the Little Miami River.

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APPENDICES A THROUGH P

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