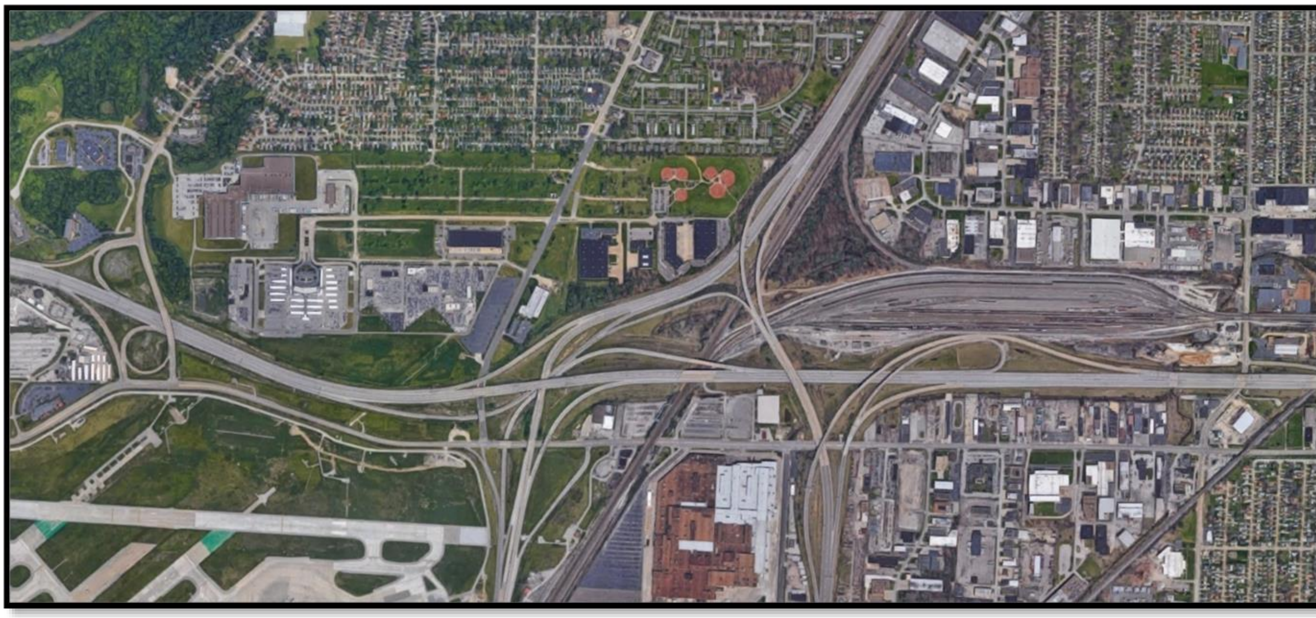
CUY-480-7.14 WB

Performance Based Project Development Report

PID 108482



The environmental review, consultation, and other actions required by applicable federal environmental laws for these projects are being, or have been, carried out by ODOT pursuant to 23 U.S.C. 327 and a memorandum of understanding dated December 11, 2015, and executed by FHWA and ODOT.

July 2019

Prepared by

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GPD GROUP

OHIO DEPARTMENT OF TRANSPORTATION

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1. Introduction

1.1 Project Background

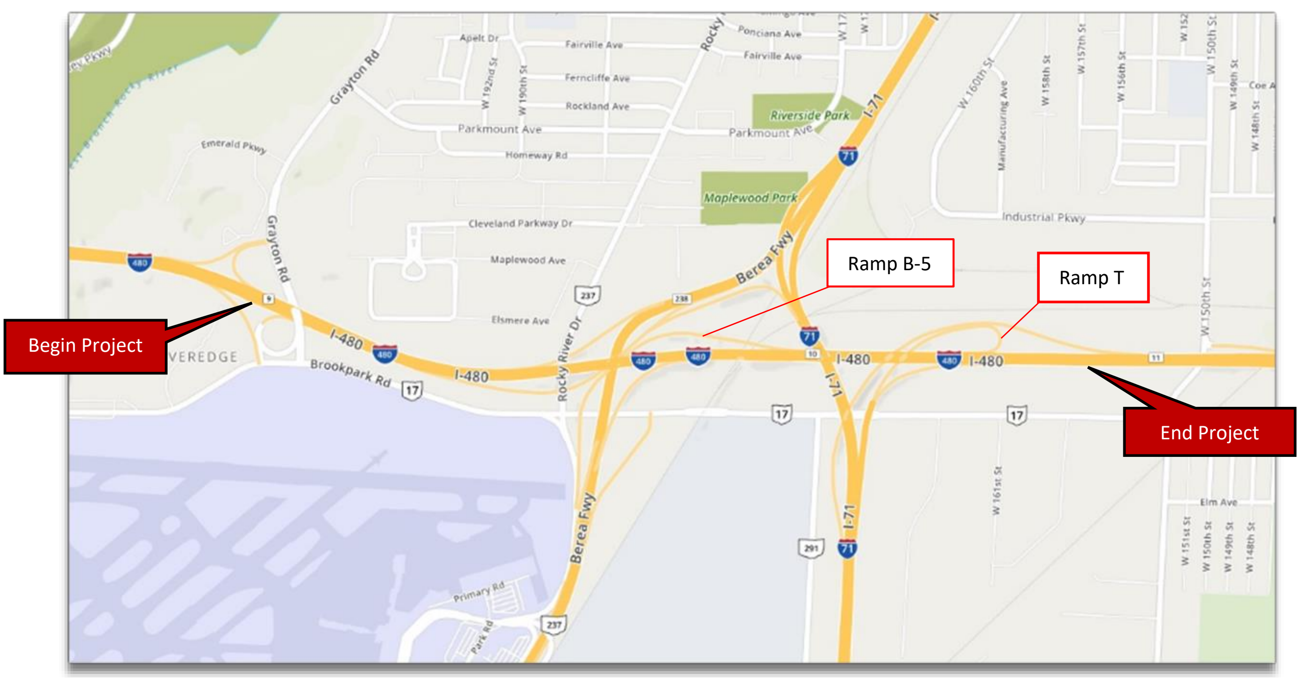
The purpose of this report is to investigate the use of Performance Based Project Development (PBPD) criteria to reconfigure the westbound I-480 lane assignments through the I-71/SR 237/Grayton Road interchanges to provide 3 through lanes of traffic on the existing 2-lane section. A map of the study area is shown in **Figure 1** on this page. The use of reduced shoulder widths would enable the existing roadway to accommodate an additional through lane without the need for roadway or bridge widening. The proposed project will increase capacity for this segment of I-480 and will improve the operation and therefore safety between the I-71 NB to I-480 WB entrance ramp (Ramp T) to the I-480 exit ramp to SR 237 (Ramp B-5).

A preliminary review of design constraints was previously developed to confirm the feasibility of applying reduced PBPD criteria and a memo was submitted on 1/10/19 and included the following:

- Investigated shifting the crown location due to proposed lane shifts
- Developed proposed lane and shoulder configuration
- Investigated existing bridge deck drainage
- Determined vertical and horizontal clearances

The preliminary design investigation is included in **Appendix A** and concludes the construction of the project using PBPD design criteria is feasible. District 12 review comments and the disposition is also provided in **Appendix A**.

Figure 1 – Project Location



1.2 Existing Conditions

The I-480 westbound roadway consists of 3 lanes east of the I-480 westbound exit ramp to southbound SR 237 (Ramp B-5); 2 lanes between Ramp B-5 and the I-71 southbound ramp to I-480 westbound; and 4 lanes through the Grayton Road interchange. The westbound roadway of I-480 consists of 12' wide lanes with paved shoulder widths of 10' on the outside and 11' on the inside. Existing typical sections are shown in **Appendix A**. The posted speed limit on I-480 within the project is 60 mph. Per the ODOT Traffic Monitoring Management System (TMMS), the 2018 Annual Average Daily Traffic (AADT) on westbound I-480 are as follows:

- 37,600 east of the entrance ramp from northbound I-71
- 51,400 between the entrance ramp from northbound I-71 and the SR-237 SB exit ramp
- 61,300 between the southbound I-71 entrance ramp and the Grayton Road exit ramp

There is 1°00'00" horizontal curve between the bridge over the NS RR/RTA and the bridge over the Berea Freeway/ramps that has a superelevation rate of 0.024 and meets 56 mph design speed. A 1°28'00" horizontal curve begins just west of the mainline bridge over SR 237 has a superelevation rate of 0.036 and meets 60 mph design speed.

Presently the I-71 northbound ramp to westbound I-480 (Ramp T) merges into the outside third lane on I-480 which subsequently becomes a drop lane at the exit ramp to southbound SR 237 (Ramp B-5), thus creating a significant weave movement between traffic wishing to continue on westbound I-480 and I-480 traffic exiting on Ramp B-5 to the airport. Another weave movement is located between the southbound I-71 ramp to westbound I-480 and the westbound exit ramp to Grayton Road. Currently there are 2 lanes on I-480 westbound and the 2-lane ramp from I-71 southbound enters as 2 add lanes on I-480 prior to the Grayton Road deceleration lane. This forces westbound I-480 traffic to cross over two lanes of entering traffic from I-71 southbound to access the exit ramp to Grayton Road. The existing weaves and lane assignments are shown in **Figure 2 and 3.**

2. Performance Based Project Development

Performance Based Project Development (PBPD) is a planning and design philosophy with a general premise that proposed improvements should be targeted based on project-specific needs. The emphasis is on safety and operational performance, not strict adherence to standards. The goal of the PBPD is to fix what is broken and not spend scarce resources solely for the purpose of meeting published design standards.

Recognizing that existing geometric deficiencies and lane continuity issues are resulting in higher than normal crash occurrences, the District requested this corridor be evaluated using PBPD strategies. PBPD criteria that are to be considered for this project include the following:

- Reconfigure the existing WB lane assignments through the I-71/SR 237/Grayton Rd. interchanges to provide 3 lanes on the existing 2-lane section and improve existing weaves. The proposed lane assignments compared to the existing lane assignments are shown in **Figure 2 and 3.**

- Provide reduced shoulder widths to avoid any widening of the westbound roadway and the mainline bridge over SR 237. Proposed paved shoulder widths are 5' on the inside and 4' on the outside.

Figure 2 – I-480 WB from I-71 NB to SR 237 SB Weave (Not to Scale)

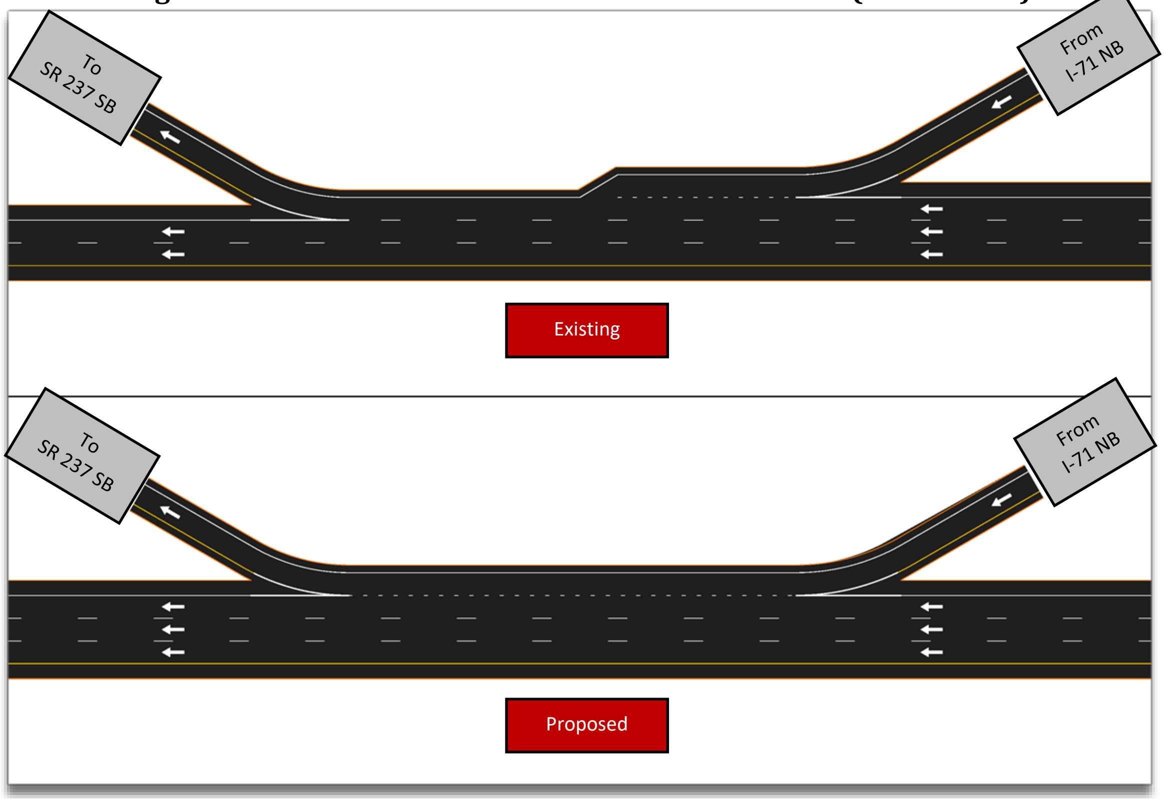
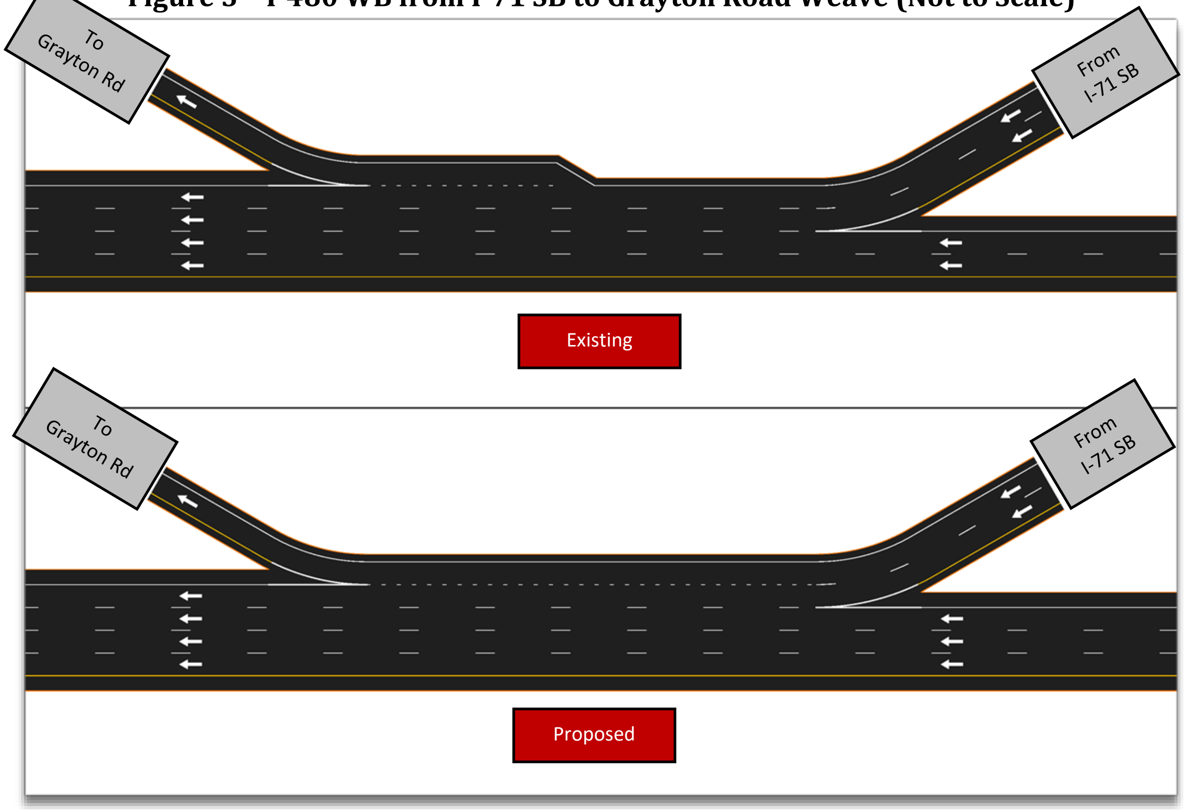


Figure 3 – I-480 WB from I-71 SB to Grayton Road Weave (Not to Scale)



3. Alternatives Considered

The alternatives considered to provide a third continuous through lane on westbound I-480 are:

1.) Build using standard criteria
2.) Build using Reduced PBPD criteria

The two Build alternatives are summarized as follows:

3.1 Build using Standard Criteria

The *Build using Standard Criteria* alternative provides a three-lane section on westbound I-480 meeting current design criteria. In order to provide the additional lane and meet all current design standards, the following improvements are needed:

- Current design criteria require 12 ft. lanes with 10 ft. paved shoulders on both sides. The westbound roadway would need to be widened by 12 feet on the outside.
- The CUY-480-0791 bridge would need to be reconstructed and widened by 12 feet since the structure is less than 200 ft. in length and needs to have standard 10 ft. shoulders on both sides.
- Four overhead bridges (CUY-480-0727, CUY-71-1008, CUY-480-0869 and CUY-480-0873) would need to be reconstructed to move the outside piers north to accommodate the widening on I-480 to provide standard shoulder widths.

Operations and safety are expected to be improved through the proposed addition of capacity and reduction in congestion. However, the improvements listed above would obviously require significant funding in order to construct the *Build using Standard Criteria* condition which meets current design standards.

3.2 Build using Reduced PBPD Criteria

The *Build using Reduced PBPD Criteria* alternative utilizes the existing 2-lane westbound roadway width (lanes and shoulders) to provide 3 through lanes of traffic using reduced shoulder widths. The improvements would include the following:

- Provide three 12 ft. lanes with 5 ft. paved inside shoulder and 4 ft. paved outside shoulder on the westbound roadway, see Proposed Typical Sections in **Appendix A**. The option of 11 ft. lanes with 8 ft. paved inside shoulder could be investigated further. However, the analysis in this study assumes the 12 ft. lanes option.
- Requires a design exception for shoulder width – left and right side on the roadway, and right side for one mainline bridge that is less than 200 ft. in length. The other two mainline bridges are over 200 feet in length and will have shoulders exceeding the minimum of 3.5 feet allowed per L&D Volume 1 Figure 302-2.
- Requires the crown location to shift, thus resulting in variable mill/fill on the roadway and hydrodemoliton and variable overlays on the 3 mainline bridges.

Pavement coring on the existing shoulders should be performed to determine if the buildup is adequate to carry traffic. Construction costs have been estimated for the option that uses the existing shoulders as well as the option that replace the shoulders. See Section 6 for cost estimates. Operations and safety are expected to be improved through the proposed addition of capacity and reduction in congestion. See Sections 4 and 5 for safety and capacity analysis.

4. Safety Analysis

4.1 Crash Rankings

Segments of I-480 in the study area have the following rankings (shown in **Table 1**) on the ODOT 2017 HSIP Urban Freeway List:

Table 1 – ODOT 2017 HSIP Rankings

Straight Line Mileage	Location on I-480 WB	HSIP Ranking
7.17 – 2.27	Just east of Grayton Rd exit	#2075
7.37 – 7.47	Between Grayton Rd exit & I-71 SB entrance	#1756
7.86 – 7.96	Just east of I-71 SB entrance	#567
8.44 – 8.54	Just east of SR 237 exit	#265
8.74 – 8.84	Just west of I-71 NB entrance	#1758

4.2 Crash Data

Crash data was obtained from ODOT Transportation Information Mapping System (TIMS) for I-480 westbound and associated ramps in the study area for three complete years of available data (2016-2018). A total of 99 crashes were obtained. The OH-1 report for each documented crash was reviewed to correct information, where necessary, and locate crashes properly within the study limits. A summary of the crash data is provided in **Table 2**. Crash data for the study area was plotted on an aerial to identify crash patterns and probable causes. The crash diagrams for the study area are provided in **Appendix B**.

Table 2 - Crash Data Summary

Crash Year	Number	Percent
2016	33	33.3%
2017	35	35.4%
2018	31	31.3%

Hour of Day	Number	Percent
1:00 AM	2	2.0%
3:00 AM	3	3.0%
6:00 AM	3	3.0%
7:00 AM	6	6.1%
8:00 AM	7	7.1%
9:00 AM	5	5.1%
10:00 AM	3	3.0%
11:00 AM	4	4.0%
12:00 PM	2	2.0%
1:00 PM	2	2.0%
2:00 PM	4	4.0%
3:00 PM	4	4.0%
4:00 PM	15	15.2%
5:00 PM	19	19.2%
6:00 PM	8	8.1%
7:00 PM	4	4.0%
8:00 PM	2	2.0%
9:00 PM	2	2.0%
10:00 PM	3	3.0%
11:00 PM	1	1.0%

Crash Severity	Number	Percent
Injury Crash	21	21.2%
Property Damage Crash	78	78.8%

Crash Type	Number	Percent
Rear End	44	44.4%
Sideswipe – Passing	34	34.3%
Fixed Object	18	18.2%
Other Non-Collision	2	2.0%
Angle	1	1.0%

Day of Week	Number	Percent
Tuesday	23	23.2%
Friday	20	20.2%
Monday	18	18.2%
Wednesday	15	15.2%
Thursday	11	11.1%
Sunday	7	7.1%
Saturday	5	5.1%

Road Condition	Number	Percent
Dry	72	72.7%
Wet	17	17.2%
Snow	8	8.1%
Water (Standing, Moving)	1	1.0%
Ice	1	1.0%

4.3 Crash Trends

Noteworthy crash patterns in the study area have been summarized with supporting details and probable causes:

- **Rear End Crashes**
  Rear end crashes were the most prevalent crash type in the study area. A total of 44 rear end crashes were reported, nine resulting in injury. Rear end crashes represent 44.4 percent of the crashes reported within the study area, higher than the statewide average of 29.9 percent. Twenty-seven of the rear end crashes occurred between the I-71 northbound entrance ramp and the SR-237 exit ramp, seven occurred between the SR-237 exit ramp and the I-71 southbound entrance ramp, and seven occurred between I-71 southbound entrance ramp and the Grayton Road exit ramp. Most (77.3 percent) of the rear end crashes occurred during dry pavement conditions and most (79.5 percent) occurred during daylight. The crashes were concentrated during the PM peak (77.3 percent taking place from 3:00-7:00 PM). These crashes are likely due to congestion and erratic movements from the weaves in the study area.

- **Sideswipe-Passing Crashes**
  Sideswipe-passing crashes were the second most prevalent crash type in the study area. A total of 34 sideswipe-passing crashes were reported, four resulting in injury. Sideswipe-passing crashes represent 34.3 percent of the total crashes reported in the study area, higher than the statewide average of 18.6 percent. Fourteen of the sideswipe-passing crashes occurred between the I-71 northbound entrance ramp and the SR-237 exit ramp, seven occurred between the SR-237 exit ramp and the I-71 southbound entrance ramp, and 11 occurred between I-71 southbound entrance ramp and the Grayton Road exit ramp. Of the sideswipe-passing crashes, most (79.4 percent) occurred during dry pavement conditions and most (70.6 percent) occurred during daylight. The crashes were concentrated during the AM peak (20.6 percent taking place from 7:00-10:00 AM) and PM peak (44.1 percent taking place from 3:00-7:00 PM). These crashes are likely due to congestion and erratic movements from the weaves in the study area.

- **Fixed Object Crashes**
  Fixed object crashes were the third most prevalent crash type in the study area. A total of 18 fixed object crashes were reported, six resulting in injury. Fixed object crashes represent 18.2 percent of the total crashes reported in the study area, lower than the statewide average of 26.1 percent. Five of the fixed object crashes occurred between the I-71 northbound entrance ramp and the SR-237 exit ramp, four occurred between the SR-237 exit ramp and the I-71 southbound entrance ramp, and four occurred between I-71 southbound entrance ramp and the Grayton Road exit ramp. About half (44.4 percent) of the fixed object crashes occurred during wet pavement conditions and about half (44.4 percent) occurred in the dark. The crashes were concentrated during the AM peak (44.4 percent taking place from 7:00-10:00 AM). It is suspected that many of the fixed object crashes are due to inclement weather and/or a vehicle attempting to avoid a rear end or sideswipe-passing crash.

4.4 Highway Safety Manual Analysis

A crash analysis was performed using the ODOT Economic Crash Analysis Tool (ECAT) and Highway Safety Manual (HSM) methodology for freeway segments to determine the safety implications of constructing the *Build using Reduced PBPD Criteria* alternative. The crash analysis is a conceptual comparison based on the change in typical section in the *Build using Reduced PBPD Criteria* compared to existing conditions. Crash data for the entire study area was not imported into ECAT for this analysis, only the predicted average crash frequency output of ECAT was utilized.

The predicted frequency of crashes/year was used to estimate how the crash frequency would change as a result of this project. Since a full ECAT analysis was not completed, the crash frequencies should not be compared to other locations, and conclusions should not be made about these frequencies versus known trends or data. These results are for a conceptual comparison of the alternatives only. The ECAT input and output reports are provided in **Appendix C** and the crash frequencies and percent change in crash frequency for the different crash severities are listed in **Table 3** below.

Table 3 – Predicted Crash Frequency Comparison (Crashes/Year)

I-480 Between	Alternative	Fatal or Incapacitating Injury	Non-Incapacitating Injury	Possible Injury	Property Damage Only	Total
I-71 SB & Grayton Rd.	Ex. Conditions	0.8526	2.9262	3.3136	19.1011	**26.1935**
	Build w/ PBPD	0.8283	2.6702	2.9510	9.9099	**16.3594**
	Percent Change	-2.9%	-8.7%	-10.9%	-48.1%	**-37.5%**
I-71 NB & I-71 SB	Ex. Conditions	0.4239	1.4382	1.6215	11.5567	**15.0403**
	Build w/ PBPD	0.6243	1.9143	2.0713	9.5571	**14.1670**
	Percent Change	47.3%	33.1%	27.7%	-17.3%	**-5.8%**
I-71 N & SR 237	Ex. Conditions	0.4095	1.4646	1.6827	8.3382	**11.8950**
	Build w/ PBPD	0.6038	1.9467	2.1512	10.7945	**15.4962**
	Percent Change	47.4%	32.9%	27.8%	29.5%	**30.3%**

The results of the above crash frequency comparison shows a range in percent changes between the predicted crashes for the existing conditions compared to the implementation of the *Build using Reduced PBPD Criteria* alternative solely based on HSM methodology. This HSM analysis compares predicted crashes, which reflects how a site would be expected to perform relative to 1,000 similar sites. The crash history shows that most of the crashes are directly related to weaving and congestion (sideswipe-passing and rear end crashes) and are not a typical distribution of crash types and crash characteristics. So the predicted crashes shown for the existing conditions may not be representative of the site. Based on engineering judgement, the implementation of the *Build using Reduced PBPD Criteria* alternative, which specifically improves weaving and congestion, is expected to improve safety, even though that is not shown by HSM analysis.

5. Capacity Analysis

Weave volumes were collected for the two weaves in the study area from 6-10 AM and 3-7 PM on Thursday, March 28, 2019. The peak hours were determined to be from 7:15 – 8:15 AM and 4:30 – 5:30 PM. Northeast Ohio Areawide Coordinating Agency (NOACA) provided a linear annual growth rate of 0.04% for the study area. The growth rate was applied to the count data to calculate Design Year 2040 volumes. Count data, NOACA correspondence, and traffic volume calculations are provided in **Appendix D**.

Weave capacity was evaluated using HCS7 to assess existing conditions compared to the *Build using Reduced PBPD Criteria* alternative using 2019 and 2040 traffic volumes. Levels of service (LOS) and density are summarized in **Table 4**. Detailed capacity analysis results are provided in **Appendix E**.

Table 4 – Weave Capacity Analysis Results – Existing and Build Scenarios

I-480 WB Weave	Scenario	2019		2040	
		AM	PM	AM	PM
I-71 NB to SR-237 SB	Ex. Conditions	D/31.6	E/41.7	D/32.0	E/42.1
	Build w/ PBPD	C/24.7	D/33.0	C/25.1	D/33.4
I-71 SB to Grayton Rd	Ex. Conditions	C/26.0	F/* (V/C=1.26)	C/26.3	F/* (V/C=1.27)
	Build w/ PBPD	C/20.4	F/* (V/C=1.26)	C/20.7	F/* (V/C=1.27)

Letter/Number – LOS/ Density (pc/mi/ln)
Red indicates failing LOS/Density
**Density was non-computable, so V/C ratio was listed instead*

Capacity is failing during the PM peak at the weave between I-71 SB and Grayton Road in the existing conditions. The *Build using Reduced PBPD Criteria* alternative will improve capacity compared to the existing conditions at both weave locations in the study area, but it will not bring the failing weave between I-71 SB and Grayton Road to acceptable capacity during the PM peak. The AM peak analysis shows the weave between I-71 SB and Grayton Road will be improved with the *Build using Reduced PBPD Criteria* alternative, even though this improvement cannot be seen in the PM peak results since the density was non-computable. It is anticipated that the proposed improvements will greatly improve operations and reduce congestion by improving the existing weave, even though the HCS analysis does not show this. Additionally, capacity on I-480 westbound between the two weaves will be improved by the addition of another through lane, changing from a 2-lane section to a 3-lane section.

HCS support was contacted to inquire about the analysis in this study. They confirmed the analysis of the proposed conditions. However, their direction was that the existing conditions should be analyzed as separate merge and diverge facilities, as opposed to a weave. Weaving movements exist in both the existing and proposed conditions. Analyzing these existing movements as a merge and diverge may not adequately account for the weaving movements and will likely show that the facility operates better than it does in the field. This will also make it difficult to compare to the *Build using Reduced PBPD Criteria* alternative analysis. HCS may not have the capability to analyze these existing atypical weaves as desired. For this reason, the weave analysis of the existing conditions shown in this report may not represent exactly what is occurring in the field, but it serves as a way of directly comparing the existing weave configuration to the *Build using Reduced PBPD Criteria* alternative weave configuration.

Analysis of the existing conditions as separate merge and diverge facilities was conducted for documentation purposes. Levels of service (LOS) and density are summarized in **Table 5**. Detailed capacity analysis results are provided in **Appendix E**.

Table 5 – HCS Support Recommended Analysis Results – Existing Conditions

Facility	2019		2040	
	AM	PM	AM	PM
I-71 NB to I-480 WB Merge	C/25.9	D/33.6	C/26.1	D/33.9
I-480 WB to SR 237 SB Diverge	C/22.7	F/31.7 (V/C = 1.04)	C/23.0	F/32.0 (V/C = 1.04)
I-71 SB to I-480 WB Merge	F/32.5 (V/C = 1.03)	F/52.7 (V/C = 1.61)	F/32.8 (V/C = 1.04)	F/53.2 (V/C = 1.63)
I-480 WB to Grayton Rd. Diverge	B/17.4	C/27.3	B/17.6	C/27.5

Letter/Number – LOS/ Density (pc/mi/ln)
Red indicates failing LOS/Density

6. Cost Estimates

Conceptual construction cost estimates were developed for two scenarios of the *Build using Reduced PBPD Criteria* reduced shoulder widths; one estimate assumes the pavement for the existing shoulders is retained and the second estimate includes full replacement of the shoulder pavement. It has been assumed a design exception for shoulder width will be required for the roadway and one mainline bridge that is less than 200 ft. in length (CUY-480-0791). Estimates of probable construction costs were determined with conceptual quantities using Estimator. A summary of estimated construction costs is provided in **Table 6.** The construction cost estimates are in 2019 dollars and include a design contingency of 20%.

Table 6 – Estimated Cost of Construction in 2019 Dollars

Category	PBPD without Shoulder Replacement	PBPD with Shoulder Replacement
Roadway	-	$190,000
Pavement	$541,000	$1,857,000
Maintenance of Traffic	$28,000	$285,000
Structures (CUY-480-0791)	$135,000	$135,000
Structures (CUY-480-0800)	$383,000	$383,000
Structures (CUY-480-0831)	$286,000	$286,000
Traffic Control	$99,000	$99,000
Incidentals	$70,000	$172,000
Sub-Total =	$1,542,000	$3,407,000
Design Contingency (20%)	$309,000	$682,000
Grand Total =	$1,851,000	$4,089,000

7. Conclusion

Utilizing reduced shoulder widths to reconfigure the existing 2-lane westbound I-480 roadway to a 3-lane section has been investigated and determined to be a feasible design option and a cost effective solution to improving capacity and safety on this section of heavily traveled I-480. The estimated cost to construct the reconfiguration of the westbound roadway with milling and resurfacing will be *significantly* less than the cost for the 12 ft. widening of the existing roadway and one mainline bridge, and relocation of the outside piers for 4 overhead bridges required to meet all current design criteria.

The results of the HSM analysis shows a range in percent changes between the predicted crashes for the existing conditions compared to the implementation of the *Build using Reduced PBPD Criteria* alternative solely based on HSM methodology. This HSM analysis compares predicted crashes only. The crash history shows that most of the crashes are not a typical distribution of crash types and crash characteristics. So the predicted crashes may not be representative of the site. Based on engineering judgement, the implementation of the *Build using Reduced PBPD Criteria* alternative, which specifically improves weaving and congestion, is expected to improve safety, even though that is not shown by HSM analysis.

The *Build using Reduced PBPD Criteria* alternative will improve capacity compared to the existing conditions at both weave locations in the study area, but it will not bring the failing weave between I-71 SB and Grayton Road to acceptable capacity during the PM peak. Capacity on I-480 westbound between the two weaves will be improved by the addition of another through lane, changing from a 2-lane section to a 3-lane section.

Based on engineering judgement, the existing weaves will be improved at both locations. These improvements will likely lead to a reduction in the high frequency of sideswipe-passing and rear end crashes shown in the crash history. **Figure 2** shows that vehicles traveling from I-71 NB to I-480 WB have to merge and then change one lane in the existing conditions compared to only changing one lane in the proposed conditions. **Figure 3** shows that vehicles traveling from I-480 WB to Grayton Road have to weave through two lanes from I-71 SB then diverge compared to only changing two lanes in the proposed conditions. Capacity in the segment between the two weaves will be greatly improved by changing from the existing 2-lane section to the proposed 3-lane section.

The results of the HSM and capacity analyses are not overwhelmingly conclusive. However, it is questionable whether they are truly representative of the existing and *Build using Reduced PBPD Criteria* alternative conditions. It is anticipated that the proposed improvements will improve operations and reduce congestion in the I-480 WB study area, therefore reducing crashes related to these existing issues. It is recommended that full ECAT analysis and IMS-style capacity analysis with supplemental microsimulation be conducted to verify the findings of this study and better understand the full impacts of the proposed *Build using Reduced PBPD Criteria* alternative before implementation.

Appendix A

Preliminary Design Memo, Schematic Plan, Typical Sections, Review Comments and Disposition

Memo

RE: Preliminary Review of Design Constraints Summary for CUY-480-7.14 WB
Date: January 10, 2019; **Revised July 30, 2019**

Background

Carpenter Marty Transportation (CM) was retained to investigate and produce a Performance Based Project Development (PBPD) analysis and report of IR-480 WB from the IR-71 NB to IR-480 WB entrance ramp to the Grayton Road exit ramp. Before the PBPD analysis and report is produced, a preliminary review of design constraints was completed. The review includes the investigation of shifting crown location due to lane shifts, development of proposed lane and shoulder configuration, investigation of existing bridge deck drainage, and determination of vertical and horizontal clearances. The findings of this review are summarized in this Memo.

Roadway Design

A preliminary layout of the proposed lane and shoulder configuration is provided in **Attachment A**, and the existing and proposed typical sections are provided in **Attachment B**. At this time, the only controlling criteria design exception anticipated for this project is for shoulder width. From Table 301-3 in the ODOT L&D Volume 1, the median and right side graded shoulder width should be 15', and the treated (paved) shoulder width should be 10'. The minimum barrier offset is 4', which is being met. The layout as shown provides a 5' paved shoulder on the median side and 4' paved on the outside.

No design exceptions are required for two of the existing mainline structures (CUY-480-0800 and 0831) since they are over 200' in length. From Table 302-2 in the ODOT L&D Volume 1, the minimum lateral clearance for an urban interstate bridges with a length exceeding 200' is 3.5'. 5' is being provided on the median, and a minimum of 4' provided on the right side. Structure CUY-480-0791 is less than 200' in length and will require a design exception for the outside shoulder width since proposed is 4' and required is 10'.

The tapers/shifts at the begin and end of project are adequate for 70+ MPH.

Pavement cores will be required on the existing shoulders to determine if they are adequate to carry traffic, or if they will require full depth replacement. Full depth replacement of the shoulders will greatly increase the project cost due to not only the pavement removal and replacement itself, but MOT costs as well.

CM is assuming a variable thickness milling and overlay will be required to shift the crown of the existing roadway to align with the proposed innermost lane line.

If there are funds available to widen the outside shoulders, relocate/replace the existing guardrail and complete grading work, it is recommended. With only 5' of inside shoulder and 4' of outside shoulder provided, any disabled vehicle or crash would not have sufficient width to pull over without encroaching on the adjacent travel lane. The shoulders can be tapered down to existing at the structures to eliminate the need for modifications to the bridges.

Impacts to the existing signage along the corridor would be minimal and would consist of only a few overhead truss/mast arm mounted signs needing to be reset to align with the proposed lanes.

Mainline Bridge Drainage

The bridge deck drainage was analyzed using the methods described in the Location & Design Manual Volume 2. A 10-year frequency event was used per Section 1103.2 and allowable spread was determined assuming no spread into the lanes per Table 1103-1. CDSS was utilized to determine inlet pass by flow for the right shoulder of all bridges.

<u>CUY-480-0791</u>
The existing bridge has three scuppers on the left side and five scuppers on the right side of the bridge.

Location	Maximum Spread (ft.)	Allowable Spread (ft.)
Left Shoulder	5.41	4.25
Right Shoulder	4.37	5.50

The scuppers are not adequate for the proposed lane configuration on the left side of the bridge. More scuppers can be added to decrease the spread below allowable limits. The scuppers on the right side of the bridge are adequate for the proposed lane configuration.

<u>CUY-480-0800</u>
The existing bridge has 13 scuppers on the left side and 17 scuppers on the right side of the bridge.

Location	Maximum Spread (ft.)	Allowable Spread (ft.)
Left Shoulder	6.71	4.00
Right Shoulder	5.10	5.50

The scuppers on the left side of the bridge are not adequate for the proposed lane configuration. New scuppers as well as a drainage collection system would need to be added due to lane configuration under the bridge to improve drainage conditions on the bridge. The scuppers on the right side of the bridge are adequate for the proposed lane configuration.

CUY-480-0831
The existing bridge has five scuppers on the left side and seven scuppers on the right side of the bridge.

Location	Maximum Spread (ft.)	Allowable Spread (ft.)
Left Shoulder	6.52	5.25
Right Shoulder	6.70	5.25

The scuppers on both sides of the bridge are not adequate for the proposed lane configuration. New scuppers as well as a drainage collection system would need to be added to both sides due to lane configuration under the bridge to improve drainage conditions on the bridge.

Overhead Bridge Clearances

The vertical and horizontal clearances for each bridge were determined using existing plans, BR-191 reports, and aerial maps.

Bridge	Controlling Location	Existing Minimum Horizontal Clearance (ft.)	Proposed Minimum Horizontal Clearance (ft.)	Allowable Minimum Horizontal Clearance (ft.)
CUY-480-0727	Right Shoulder	10.25	4.75	4.0
CUY-71-1008	Left Shoulder	10.0	4.0	4.0
CUY-480-0869	Left Shoulder	10.0	4.0	4.0
CUY-480-0873	Left Shoulder	10.0	4.0	4.0

Bridge	Controlling Location	Existing Minimum Vertical Clearance (ft.)	Allowable Minimum Vertical Clearance (ft.)
CUY-480-0727	Ex. centerline WB lanes	16.4	14.5
CUY-71-1008	Left edge of lane	17.5	14.5
CUY-480-0869	Ex. centerline WB lanes	17.7	14.5
CUY-480-0873	Left edge of lane	16.3	14.5

Bridge Overlays

The crown location on the mainline bridge decks will need to be modified. Per BDM 404.2, maximum overlay thickness is 2½ inches. Crown shift will not be able to be accomplished with an overlay without an approved deviation to BDM 404.2. The proposed maximum overlay thickness would be approximately 3½ inches not including any hydrodemolition of the existing deck.

Conclusion

Overall CM believes that the construction of the project is feasible and would provide a substantial improvement to the traffic flow by providing an additional travel lane and reducing the weaves throughout the corridor.

This design memo was reviewed, and comments provided by District 5 in an email dated 2/4/19. A disposition of comments was provided via email on 2/18/19. See **Attachment C** for the comments and disposition.

Attachment A

Schematic Plan

CARPENTER MARTY transportation

Attachment A

SCHEMATIC PLAN

CUY-480-7.14 WB

CALCULATED KAM
CHECKED MDW

0 25 50 100
HORIZONTAL SCALE IN FEET

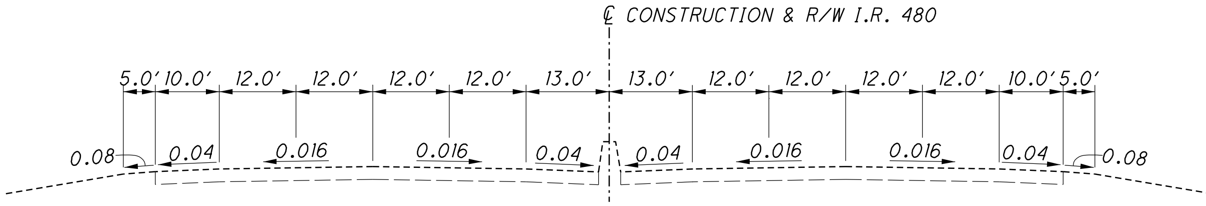
N

1/1

Attachment B

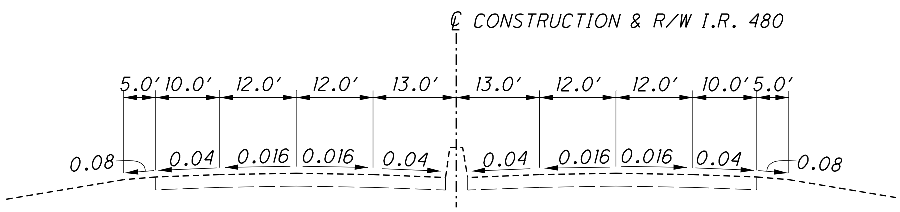
Typical Sections

Attachment B



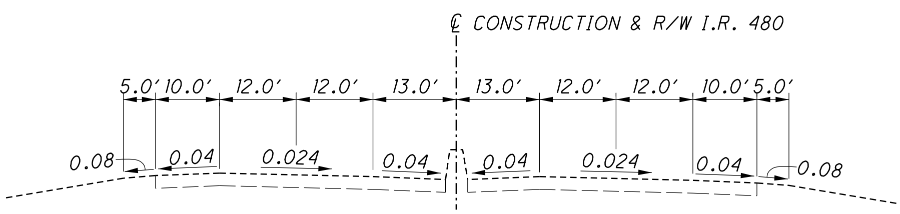
SECTION OF EXISTING PAVEMENT - I.R. 480

SECTION APPLIES:
STA. 491+00



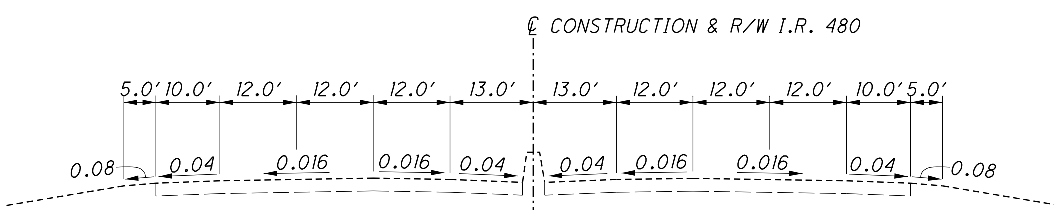
SECTION OF EXISTING PAVEMENT - I.R. 480

SECTION APPLIES:
STA. 446+00



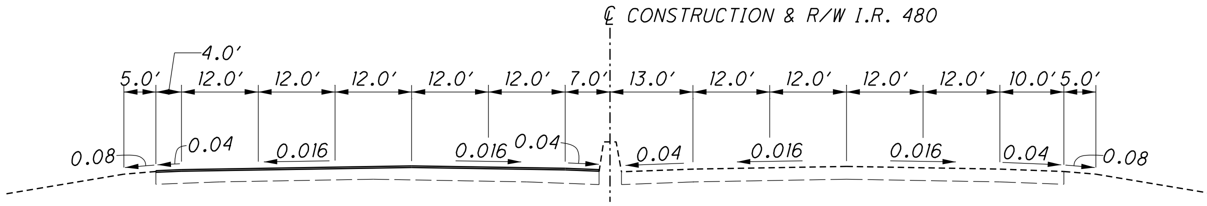
SECTION OF EXISTING PAVEMENT - I.R. 480

SECTION APPLIES:
STA. 457+00



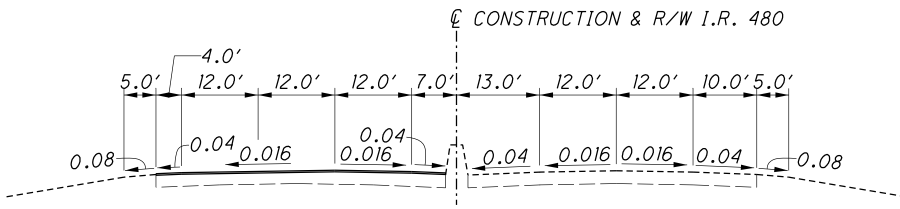
SECTION OF EXISTING PAVEMENT - I.R. 480

SECTION APPLIES:
STA. 481+00



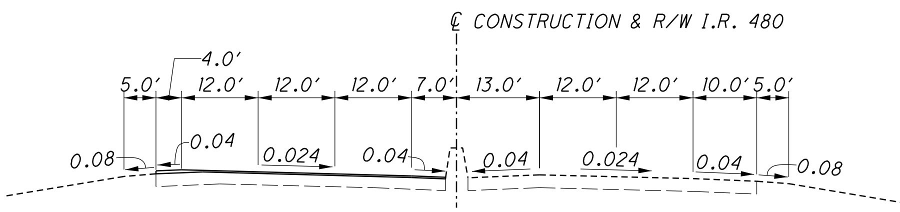
<u>SECTION OF PROPOSED PAVEMENT - I.R. 480</u>

SECTION APPLIES:
STA. 491+00



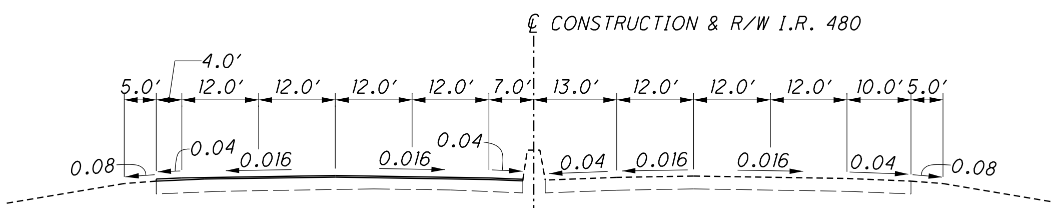
<u>SECTION OF PROPOSED PAVEMENT - I.R. 480</u>

SECTION APPLIES:
STA. 446+00



<u>SECTION OF PROPOSED PAVEMENT - I.R. 480</u>

SECTION APPLIES:
STA. 457+00



<u>SECTION OF PROPOSED PAVEMENT - I.R. 480</u>

SECTION APPLIES:
STA. 481+00

Attachment C

Design Memo Review Comments and Disposition

Attachment C

Mike Weeks

From: Westbrooks, Kevin <kwestbrooks@gpdgroup.com>
Sent: Monday, February 18, 2019 2:21 PM
To: Keri.Welch@dot.ohio.gov
Cc: Gina Balsamo; John Gallagher; Eric.Kallio@dot.ohio.gov; Keith.Hamilton@dot.ohio.gov; Anthony.Toth@dot.ohio.gov
Subject: RE: CUY IR 480 07.14 WB - PBPD Preliminary Review

Keri,

As we discussed the other day, the document that was reviewed by ODOT was not intended to be a final product. It was intended to be more of a status memo to make sure that ODOT was still in support of continued progress on the project. A final, much more detailed report will be submitted on this project. As such, some of the comments will be incorporated into the final document. Below are the responses to the comments from Carpenter Marty.

1. Please reference PID#108482 on the review.
   - This will be included in the PBPD report.
2. Include an existing typical section and proposed typical section in the report showing the lane and shoulder widths.
   - This will be included in the PBPD report.
3. Can the lane width configuration be taken down to 2-11' lanes and 1-12' lane to increase the shoulder widths to help with the drainage issues?
   - The two lanes could be taken down to 11', but a design exception for lane width would be required.
4. The I-71 southbound ramp onto I-480 westbound will create the potential of a weave for the Grayton exit. Please note in the memo that this should be studied further in the IOS.
   - This will be studied as part of the PBPD.
5. The report indicates that a crown shift on the mainline bridges is necessary. What is the total cover with the 3 ½" overlay?
   - This would depend on how much hydrodemolition is performed. SS 848.20 specifies a minimum depth of 1" of hydrodemolition. This would leave 1.5" of cover over the top mat of reinforcing steel plus the overlay. Overlays are typically not accounted for in cover over reinforcing steel since the deck concrete and overlay are not monolithic.

   Can this be accommodated with the bridge overlay being constructed part width?
   - The variable thickness portion of the overlay would only occur within the location of where the crown currently is and where the proposed crown will be, 6'. If you placed a construction joints at the limits of the crown shift, one joint would be in the middle of a proposed lane and the other joint would be at the lane line.

   How far is the crown shift?
   - The crown shift would be 6' with the 3-12' lanes.

   Is this feasible?
   - Per the BDM the below are the following maximum uniform thicknesses of rigid overlays.
     - Latex Modified (LMC) – 2.5"
     - Micro-Silica Modified (MSC) – 3"
     - Superplasticized Dense (SDC) – No limit
   - Another idea may be to overlay the bridges with asphalt overlays. The original bridge decks had 2.5" asphalt overlays on them. In 1999, a constant 2.5" micro-silica overlay was placed after the 2.5" asphalt overlay was removed. The longevity of the asphalt overlay would not be what a rigid overlay would be.

If you have any questions regarding this, please let me know.

Kevin Westbrooks, PE, PTOE
Project Manager / Traffic Engineer
Licensed in OH

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5595 Transportation Blvd, Suite 100, Cleveland, OH 44125
gpdgroup.com

From: Keri.Welch@dot.ohio.gov [mailto:Keri.Welch@dot.ohio.gov]
Sent: Monday, February 4, 2019 12:12 PM
To: Westbrooks, Kevin <kwestbrooks@gpdgroup.com>
Cc: Gina Balsamo <gbalsamo@cmtran.com>; John Gallagher <jgallagher@cmtran.com>; Eric.Kallio@dot.ohio.gov; Keith.Hamilton@dot.ohio.gov; Anthony.Toth@dot.ohio.gov
Subject: RE: CUY IR 480 07.14 WB - PBPD Preliminary Review

Kevin,

The District has reviewed the preliminary review for the I-480 WB PBPD Project and offers the following comments:

1. Please reference PID#108482 on the review.
2. Include an existing typical section and proposed typical section in the report showing the lane and shoulder widths.
3. Can the lane width configuration be taken down to 2-11' lanes and 1-12' lane to increase the shoulder widths to help with the drainage issues?
4. The I-71 southbound ramp onto I-480 westbound will create the potential of a weave for the Grayton exit. Please note in the memo that this should be studied further in the IOS.
5. The report indicates that a crown shift on the mainline bridges is necessary. What is the total cover with the 3 ½" overlay? Can this be accommodated with the bridge overlay being constructed part width? How far is the crown shift? Is this feasible?

Please incorporate these comments into the report.

Thanks,
Keri

Keri J. Welch, PE
Traffic Planning Engineer
ODOT District 12: Cuyahoga, Geauga & Lake counties
5500 Transportation Blvd., Garfield Heights, Ohio 44125
(p) 216.584.2166
transportation.ohio.gov

OHIO DEPARTMENT OF TRANSPORTATION

From: Westbrooks, Kevin <kwestbrooks@gpdgroup.com>
Sent: Monday, January 14, 2019 10:38 AM
To: Hamilton, Keith <Keith.Hamilton@dot.ohio.gov>
Cc: Welch, Keri <Keri.Welch@dot.ohio.gov>; Gina Balsamo <gbalsamo@cmtran.com>; John Gallagher <jgallagher@cmtran.com>
Subject: CUY IR 480 07.14 WB - PBPD Preliminary Review

Keith,

Below is a link to Carpenter Marty's preliminary review of the I-480 WB PBPD project. Please let us know if you have any questions or comments. Upon ODOT's acceptance/concurrence, CM will move on to the full PBPD analysis and report.

https://cmtran-my.sharepoint.com/:f:/p/gbalsamo/EhL7X6bV9hFCsImcvYiL9ywB0LgYVBrT-_JpMXU-qPDCFA?e=AsJINm

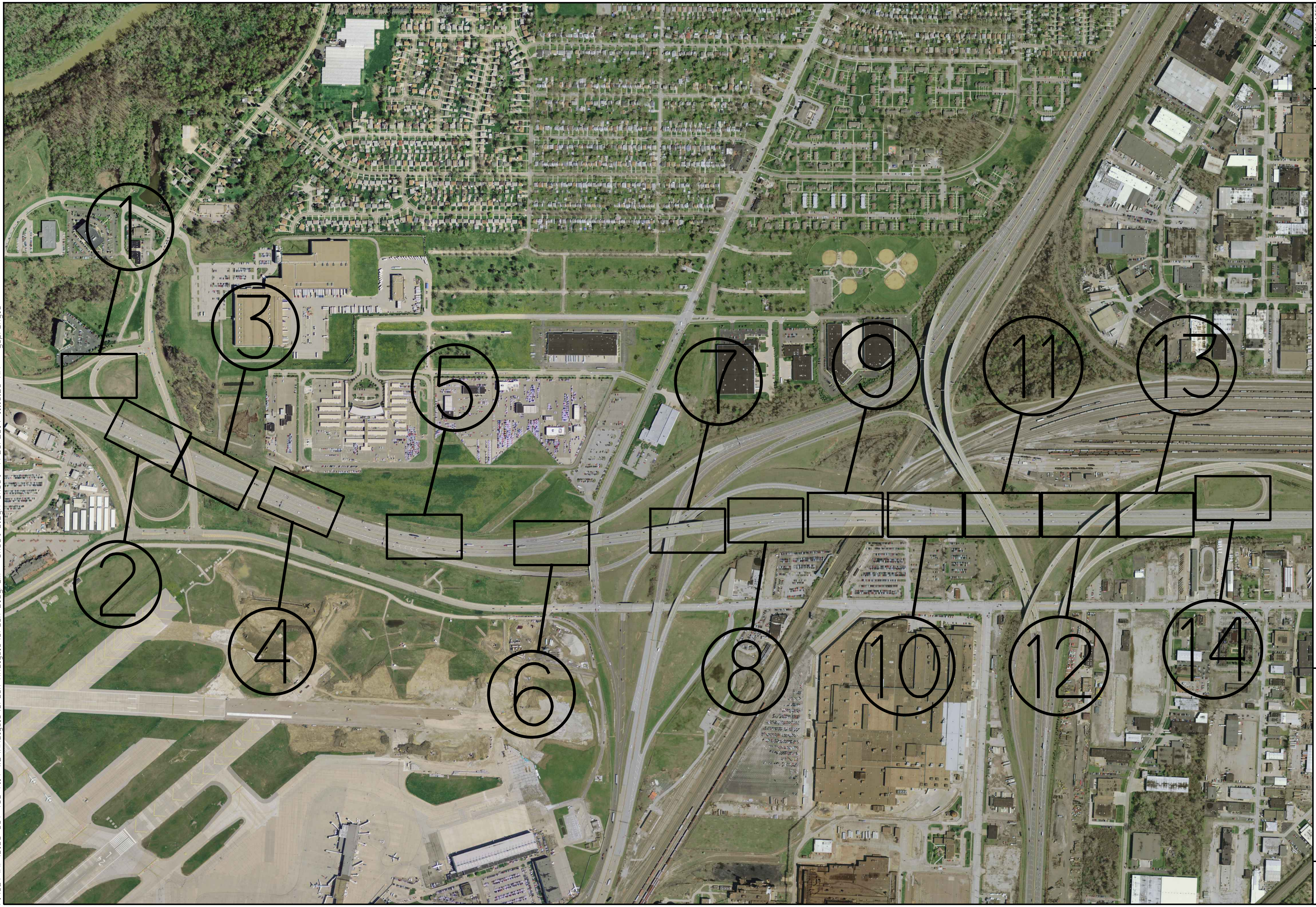
Thanks,

Kevin Westbrooks, PE, PTOE
Project Manager / Traffic Engineer

GPD GROUP
Glaus, Pyle, Schomer, Burns & DeHaven, Inc.
5595 Transportation Blvd, Suite 100 Cleveland, OH 44125 gpdgroup.com
tel / 216.927.8688 cel / 330.697.1856 fax / 216.518.5545

Appendix B

Crash Diagrams



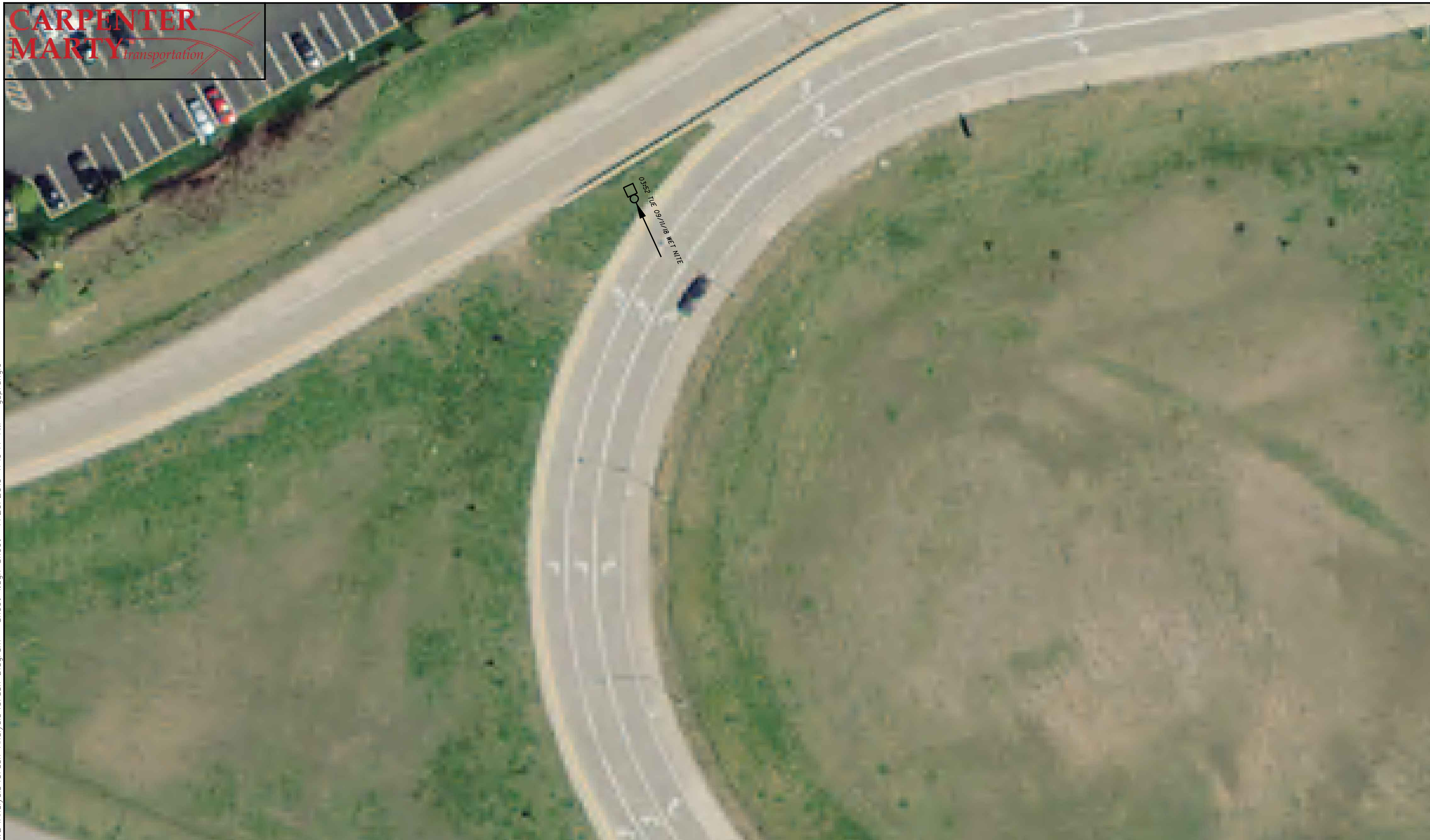
CALCULATED GMB
CHECKED JJG

N

Crash Diagram Legend

CUY-480-7.14 WB

0
14



Crash Totals

0	Property Damage Only
1	Injury or Fatal
1	Total Crashes

Symbols

Angle

Rear End

Fixed Object

Sideswipe Passing

Injury

Crash Text

1. Time, day, date
2. Road condition
3. NITE - dark outside

HORIZONTAL SCALE IN FEET 0 10 20 40

CALCULATED GMB

CHECKED JJG

Crash Diagram 2016 to 2018 Crash Data

CUY-480-7.14 WB

1 / 14

CARPENTER MARTY transportation

Crash Totals

7	Property Damage Only
3	Injury or Fatal
10	Total Crashes

Symbols

Angle

Rear End

Fixed Object

Sideswipe Passing

Injury

Crash Text

1. Time, day, date
2. Road condition
3. NITE - dark outside

0 10 20 40 HORIZONTAL SCALE IN FEET

CALCULATED GMB

CHECKED JJG

Crash Diagram 2016 to 2018 Crash Data

CUY-480-7.14 WB

CARPENTER MARTY transportation

HORIZONTAL SCALE IN FEET (0, 10, 20, 40)

CALCULATED GMB

CHECKED JJG

Crash Diagram
2016 to 2018 Crash Data

CUY-480-7.14 WB

Crash Totals

3	Property Damage Only
2	Injury or Fatal
5	Total Crashes

Symbols

- Angle
- Rear End
- Fixed Object
- Sideswipe Passing
- Injury

Crash Text

1. Time, day, date
2. Road condition
3. NITE - dark outside

CARPENTER MARTY transportation

Crash Diagram
2016 to 2018 Crash Data

CUY-480-7.14 WB

HORIZONTAL SCALE IN FEET: 0 10 20 40

CALCULATED GMB

CHECKED JJG

Crash Totals

1	Property Damage Only
1	Injury or Fatal
2	Total Crashes

Symbols

Angle

Rear End

Fixed Object

Sideswipe Passing

Injury

Crash Text

1. Time, day, date
2. Road condition
3. NITE - dark outside

0 10 20 40
HORIZONTAL SCALE IN FEET

CALCULATED GMB
CHECKED JJG

Crash Diagram 2016 to 2018 Crash Data

Crash Totals

6 Property Damage Only

0 Injury or Fatal

6 Total Crashes

Symbols

Angle

Rear End

Fixed Object

Sideswipe Passing

Injury

Crash Text

1. Time, day, date
2. Road condition
3. NITE - dark outside

CUY-480-7.14 WB

CARPENTER MARTY transportation

N

0 10 20 40
HORIZONTAL SCALE IN FEET

CALCULATED GMB
CHECKED JJG

Crash Diagram 2016 to 2018 Crash Data

CUY-480-7.14 WB

Crash Totals

3 Property Damage Only

2 Injury or Fatal

5 Total Crashes

Symbols

Angle

Rear End

Fixed Object

Sideswipe Passing

Injury

Crash Text

1. Time, day, date
2. Road condition
3. NITE - dark outside

Crash Diagram
2016 to 2018 Crash Data

HORIZONTAL SCALE IN FEET: 0 10 20 40

CALCULATED GMB
CHECKED JJG

Crash Totals

1	Property Damage Only
2	Injury or Fatal
3	Total Crashes

Symbols

- Angle
- Rear End
- Fixed Object
- Sideswipe Passing
- Injury

Crash Text

1. Time, day, date
2. Road condition
3. NITE - dark outside

CUY-480-7.14 WB

7 / 14

P:\ODT\MP\0108 CUY-480-7.14 WB\Analysis\Crash Analysis\Crash Diagram - Sheet 7.dgn Sheet 7/26/2019 11:16:26 AM gsprungle

CARPENTER MARTY transportation

N

HORIZONTAL SCALE IN FEET
0 10 20 40

CALCULATED GMB
CHECKED JJG

Crash Diagram 2016 to 2018 Crash Data

CUY-480-7.14 WB

Crash Totals	
2	Property Damage Only
0	Injury or Fatal
2	Total Crashes

Symbols

Angle

Rear End

Fixed Object

Sideswipe Passing

Injury

Crash Text

1. Time, day, date
2. Road condition
3. NITE - dark outside

CARPENTER MARTY transportation

N

0 10 20 40
HORIZONTAL SCALE IN FEET

CALCULATED GMB
CHECKED JJG

Crash Diagram 2016 to 2018 Crash Data

CUY-480-7.14 WB

Crash Totals

4 Property Damage Only
0 Injury or Fatal
4 Total Crashes

Symbols

Angle
Rear End
Fixed Object
Sideswipe Passing
Injury

Crash Text

1. Time, day, date
2. Road condition
3. NITE - dark outside

CARPENTER MARTY transportation

Crash Totals

5 Property Damage Only

4 Injury or Fatal

9 Total Crashes

Symbols

Angle

Rear End

Fixed Object

Sideswipe Passing

Injury

Crash Text

1. Time, day, date
2. Road condition
3. NITE - dark outside

N

HORIZONTAL SCALE IN FEET
0 10 20 40

CALCULATED GMB
CHECKED JJG

Crash Diagram
2016 to 2018 Crash Data

CUY-480-7.14 WB

P:\ODOT\MP\0108 CUY-480-7.14 WB\Analysis\Crash Analysis\Crash Diagram - Sheet 10.dgn Sheet 7/26/2019 11:16:31 AM gsprungle

CARPENTER MARTY transportation

N

HORIZONTAL SCALE IN FEET
0 10 20 40

CALCULATED GMB
CHECKED JJG

Crash Diagram
2016 to 2018 Crash Data

CUY-480-7.14 WB

Crash Totals

20	Property Damage Only
2	Injury or Fatal
22	Total Crashes

Symbols

Angle

Rear End

Fixed Object

Sideswipe Passing

Injury

Crash Text

1. Time, day, date
2. Road condition
3. NITE - dark outside

Crash Diagram 2016 to 2018 Crash Data

CUY-480-7.14 WB

HORIZONTAL SCALE IN FEET: 0 10 20 40

CALCULATED: GMB
CHECKED: JJG

Crash Totals

11	Property Damage Only
1	Injury or Fatal
12	Total Crashes

Symbols

- Angle
- Rear End
- Fixed Object
- Sideswipe Passing
- Injury

Crash Text

1. Time, day, date
2. Road condition
3. NITE - dark outside

CARPENTER MARTY transportation

Crash Totals

6	Property Damage Only
3	Injury or Fatal
9	Total Crashes

Symbols

Angle

Rear End

Fixed Object

Sideswipe Passing

Injury

Crash Text

1. Time, day, date
2. Road condition
3. NITE - dark outside

N

HORIZONTAL SCALE IN FEET: 0 10 20 40

CALCULATED GMB

CHECKED JJG

Crash Diagram 2016 to 2018 Crash Data

CUY-480-7.14 WB

CARPENTER MARTY transportation

N

HORIZONTAL SCALE IN FEET

0 10 20 40

CALCULATED GMB

CHECKED JJG

Crash Diagram 2016 to 2018 Crash Data

Crash Totals

9	Property Damage Only
0	Injury or Fatal
9	Total Crashes

Symbols

Angle

Rear End

Fixed Object

Sideswipe Passing

Injury

Crash Text

1. Time, day, date
2. Road condition
3. NITE - dark outside

CUY-480-7.14 WB

Appendix C

ECAT Input and Output Reports

Project Information

General Information

Project Name	CUY-480-7.14 WB	Contact Email	Gsprungle@cmtran.com
Project Description	Performance Based Project Development Report Safety Analysis	Contact Phone	614-656-2419
Reference Number	PID 108482	Date Performed	7/31/2019
Analyst	Greg Sprungle	Analysis Year	2018
Agency/Company	Carpenter Marty Transportation		
Perform Benefit Cost Analysis?	No		

**Do the proposed improvements fundamentally change the conditions of the base safety performance function (SPF),
Or is crash data unavailable for the analysis condition,
Or is only predicted (and not expected) analysis needed for the existing or proposed condition?** **Yes**

(Examples: unsignalized to signalized, undivided to divided, increase or decrease in the number of lanes, change the number of approaches to an intersection, significant realignment of the roadway)

If Yes, are you analyzing the existing or proposed conditions? **Existing**

Project Elements Description Table

Project Element ID (Must be Unique)	Site Type	Intersection Control Type	Location Information: NLFID	Begin Logpoint/ Intersection Midpoint	End Logpoint *(Leave blank for Intersection)*	Length (mi) OR Intersection Radius Buffer (mi)	Cross Route NLFID(s)	Common Name
IR480N; 8.479-8.863	Freeway Segment		SCUYIR00480**N	8.479	8.863	0.384		I-480 WB between 71N and 237
IR480N; 7.174-7.753	Freeway Segment		SCUYIR00480**N	7.174	7.753	0.579		I-480 WB between 71S and Grayton
IR480N; 7.753-8.479	Freeway Segment		SCUYIR00480**N	7.753	8.479	0.726		I-480 WB between 71N and 71S

Existing Conditions: General Information and Data for Freeway Segment

General Information		Location Information	
Analyst	Greg Sprungle	Route	IR480*
Agency or Company	Carpenter Marty Transportation	Logpoints	7.174 to 7.753
Date Performed	07/31/19	Common Name	I-480 WB between 71S and Grayton
Segment for Analysis	IR480N; 7.174-7.753	Analysis Year	2018

Input Data		Existing Conditions			Base Conditions
Basic Roadway Data					
Area Type		Urban	Copy From:		
Segment length L (mi)		0.579			
Cross Section Data	Cross Section Help				
Number of through lanes n		4			
Lane width W_l (ft)		12			12
Outside shoulder width W_s (ft)		10			10
Inside shoulder width W_{is} (ft)		11			6
Median width W_m (ft)		26			60
Clear zone width W_{hc} (ft)		30			30
Presence of rumble strips on outside shoulder		Yes			No
Presence of rumble strips on inside shoulder		No			No
Freeway Segment Volume Data					
Freeway segment AADT, $AADT_{fs}$ (veh/day)		74,206	(Note: this is only for the one side of freeway being analyze.)		
	Maximum Allowable AADT =	*135,000*			
Proportion of AADT during high-volume hours P_{hv}		0.57			
Ramp Access Data			*Begin Station (feet)*	*End Station (Feet)*	
Entrance Ramp	Distance from begin milepost to upstream entrance ramp gore $X_{b,ent}$ (mi)				
	Length of s-c lane in segment $L_{en,seg}$ (mi)				
Exit Ramp	Distance from end milepost to downstream exit ramp gore $X_{e,ext}$ (mi)				
	Length of s-c lane in segment $L_{ex,seg}$ (mi)				
Weave	Length of Type B weaving section $L_{wev,}$ (mi) Weave Help	0.5196			
	Length of Type B weaving section in segment $L_{wev,seg,inc}$ (mi)	0.5196			
Curve and Barrier Characteristics					
Horizontal Curve Data			Add Curve Data		
Total Curve Length (mi)		0.316287879			Go to Curve Details
Median Barrier Summary					
Length of Median Barrier (mi)		0.579	Add Barrier Data		
Roadside Barrier Summary					
Length of Roadside Barrier (mi)		0.052083333			Go to Barrier Details

Existing Segment: Summary Results (Without Animal Crashes) (Crashes/Year)					
	KA	B	C	O	Total
$N_{predicted}$	0.8526	2.9262	3.3136	19.1011	**26.1935**
$N_{expected}$ - Existing Condtions	0.0000	0.0000	0.0000	0.0000	**0.0000**
$N_{potential\ for\ improvement}$ - Existing Conditions	0.0000	0.0000	0.0000	0.0000	**0.0000**

Existing Conditions: General Information and Data for Freeway Segment

General Information		Location Information	
Analyst	Greg Sprungle	Route	IR480*
Agency or Company	Carpenter Marty Transportation	Logpoints	7.753 to 8.479
Date Performed	07/31/19	Common Name	I-480 WB between 71N and 71S
Segment for Analysis	IR480N; 7.753-8.479	Analysis Year	2018

Input Data		Existing Conditions			Base Conditions
Basic Roadway Data					
Area Type		Urban	Copy From:		
Segment length L (mi)		0.726			
Cross Section Data	Cross Section Help				
Number of through lanes n		2			
Lane width W_l (ft)		12			12
Outside shoulder width W_s (ft)		10			10
Inside shoulder width W_{is} (ft)		11			6
Median width W_m (ft)		26			60
Clear zone width W_{hc} (ft)		12			30
Presence of rumble strips on outside shoulder		Yes			No
Presence of rumble strips on inside shoulder		No			No
Freeway Segment Volume Data					
Freeway segment AADT, $AADT_{fs}$ (veh/day)		52,855	(Note: this is only for the one side of freeway being analyze.)		
	Maximum Allowable AADT =	*55,000*			
Proportion of AADT during high-volume hours P_{hv}		0.84			
Ramp Access Data			*Begin Station (feet)*	*End Station (Feet)*	
Entrance Ramp	Distance from begin milepost to upstream entrance ramp gore $X_{b,ent}$ (mi)				
	Length of s-c lane in segment $L_{en,seg}$ (mi)				
Exit Ramp	Distance from end milepost to downstream exit ramp gore $X_{e,ext}$ (mi)	0.03			
	Length of s-c lane in segment $L_{ex,seg}$ (mi)				
	AADT of exit ramp $AADT_{e,ext}$ (veh/day)	9,237			
Weave	Length of Type B weaving section $L_{wev,}$ (mi) Weave Help				
	Length of Type B weaving section in segment $L_{wev,seg,inc}$ (mi)				
Curve and Barrier Characteristics					
Horizontal Curve Data			Add Curve Data		
	Total Curve Length (mi)	0.079734848			Go to Curve Details
Median Barrier Summary					
	Length of Median Barrier (mi)	0.579	Add Barrier Data		
Roadside Barrier Summary					
	Length of Roadside Barrier (mi)	0.579			Go to Barrier Details

Existing Segment: Summary Results (Without Animal Crashes) (Crashes/Year)					
	KA	B	C	O	Total
$N_{predicted}$	0.4239	1.4382	1.6215	11.5567	**15.0403**
$N_{expected}$ - Existing Condtions	0.0000	0.0000	0.0000	0.0000	**0.0000**
$N_{potential\ for\ improvement}$ - Existing Conditions	0.0000	0.0000	0.0000	0.0000	**0.0000**

Existing Conditions: General Information and Data for Freeway Segment

General Information		Location Information	
Analyst	Greg Sprungle	Route	IR480*
Agency or Company	Carpenter Marty Transportation	Logpoints	8.479 to 8.863
Date Performed	07/31/19	Common Name	I-480 WB between 71N and 237
Segment for Analysis	IR480N; 8.479-8.863	Analysis Year	2018

Input Data	Existing Conditions			Base Conditions
Basic Roadway Data				
Area Type	Urban	Copy From:		
Segment length L (mi)	0.384			
Cross Section Data (Cross Section Help)				
Number of through lanes n	3			
Lane width W_l (ft)	12			12
Outside shoulder width W_s (ft)	10			10
Inside shoulder width W_{is} (ft)	11			6
Median width W_m (ft)	26			60
Clear zone width W_{hc} (ft)	30			30
Presence of rumble strips on outside shoulder	Yes			No
Presence of rumble strips on inside shoulder	No			No
Freeway Segment Volume Data				
Freeway segment AADT, $AADT_{fs}$ (veh/day)	62,092	(Note: this is only for the one side of freeway being analyze.)		
Maximum Allowable AADT =	*90,000*			
Proportion of AADT during high-volume hours P_{hv}	0.67			
Ramp Access Data		*Begin Station (feet)*	*End Station (Feet)*	
Entrance Ramp: Distance from begin milepost to upstream entrance ramp gore $X_{b,ent}$ (mi)				
Entrance Ramp: Length of s-c lane in segment $L_{en,seg}$ (mi)				
Exit Ramp: Distance from end milepost to downstream exit ramp gore $X_{e,ext}$ (mi)				
Exit Ramp: Length of s-c lane in segment $L_{ex,seg}$ (mi)				
Weave: Length of Type B weaving section $L_{wev,}$ (mi) (Weave Help)	0.373			
Weave: Length of Type B weaving section in segment $L_{wev,seg,inc}$ (mi)	0.373			
Curve and Barrier Characteristics				
Horizontal Curve Data		Add Curve Data		
Total Curve Length (mi)	0			Go to Curve Details
Median Barrier Summary				
Length of Median Barrier (mi)	0.384	Add Barrier Data		
Roadside Barrier Summary				
Length of Roadside Barrier (mi)	0.271780303			Go to Barrier Details

Existing Segment: Summary Results (Without Animal Crashes) (Crashes/Year)					
	KA	B	C	O	Total
$N_{predicted}$	0.4095	1.4646	1.6827	8.3382	**11.8950**
$N_{expected}$ - Existing Condtions	0.0000	0.0000	0.0000	0.0000	**0.0000**
$N_{potential\ for\ improvement}$ - Existing Conditions	0.0000	0.0000	0.0000	0.0000	**0.0000**

Project Information

General Information

Project Name	CUY-480-7.14 WB	Contact Email	Gsprungle@cmtran.com
Project Description	Performance Based Project Development Report Safety Analysis	Contact Phone	614-656-2419
Reference Number	PID 108482	Date Performed	7/31/2019
Analyst	Greg Sprungle	Analysis Year	2018
Agency/Company	Carpenter Marty Transportation		
Perform Benefit Cost Analysis?	No		

Do the proposed improvements fundamentally change the conditions of the base safety performance function (SPF), Or is crash data unavailable for the analysis condition, Or is only predicted (and not expected) analysis needed for the existing or proposed condition?	**Yes**

(Examples: unsignalized to signalized, undivided to divided, increase or decrease in the number of lanes, change the number of approaches to an intersection, significant realignment of the roadway)

If Yes, are you analyzing the existing or proposed conditions?	**Proposed**

Project Elements Description Table

Project Element ID (Must be Unique)	Site Type	Intersection Control Type	Location Information					
			NLFID	Begin Logpoint/ Intersection Midpoint	End Logpoint *(Leave blank for Intersection)*	Length (mi) OR Intersection Radius Buffer (mi)	Cross Route NLFID(s)	Common Name
IR480N; 8.479-8.863	Freeway Segment		SCUYIR00480**N	8.479	8.863	0.384		I-480 WB between 71N and 237
IR480N; 7.174-7.753	Freeway Segment		SCUYIR00480**N	7.174	7.753	0.579		I-480 WB between 71S and Grayton
IR480N; 7.753-8.479	Freeway Segment		SCUYIR00480**N	7.753	8.479	0.726		I-480 WB between 71N and 71S

Proposed Conditions: General Information and Data for Freeway Segment

General Information		Location Information	
Analyst	Greg Sprungle	Route	IR480*
Agency or Company	Carpenter Marty Transportation	Logpoints	7.174 to 7.753
Date Performed	07/31/19	Common Name	I-480 WB between 71S and Grayton
Segment for Analysis	IR480N; 7.174-7.753	Analysis Year	2018

Input Data		Proposed Conditions			Base Conditions
Basic Roadway Data					
Area Type		Urban	Copy From:		
Segment length L (mi)		0.579			
Cross Section Data Cross Section Help					
Number of through lanes n		5			
Lane width W_l (ft)		12			12
Outside shoulder width W_s (ft)		4			10
Inside shoulder width W_{is} (ft)		5			6
Median width W_m (ft)		20			60
Clear zone width W_{hc} (ft)		30			30
Presence of rumble strips on outside shoulder		Yes			No
Presence of rumble strips on inside shoulder		No			No
Freeway Segment Volume Data					
Freeway segment AADT, $AADT_{fs}$ (veh/day)		74,206	(Note: this is only for the one side of freeway being analyze.)		
Maximum Allowable AADT =		*155,000*			
Proportion of AADT during high-volume hours P_{hv}		0.32			
Ramp Access Data			*Begin Station (feet)*	*End Station (Feet)*	
Entrance Ramp	Distance from begin milepost to upstream entrance ramp gore $X_{b,ent}$ (mi)				
	Length of s-c lane in segment $L_{en,seg}$ (mi)				
Exit Ramp	Distance from end milepost to downstream exit ramp gore $X_{e,ext}$ (mi)				
	Length of s-c lane in segment $L_{ex,seg}$ (mi)				
Weave	Length of Type B weaving section $L_{wev,}$ (mi) Weave Help	0.5196			
	Length of Type B weaving section in segment $L_{wev,seg,inc}$ (mi)	0.5196			
Curve and Barrier Characteristics					
Horizontal Curve Data			Add Curve Data		
Total Curve Length (mi)		0.316287879			Go to Curve Details
Median Barrier Summary					
Length of Median Barrier (mi)		0.579	Add Barrier Data		
Roadside Barrier Summary					
Length of Roadside Barrier (mi)		0.035			Go to Barrier Details

Proposed Segment: Summary Results (Without Animal Crashes) (Crashes/Year)					
	KA	B	C	O	Total
$N_{predicted}$	0.8283	2.6702	2.9510	9.9099	**16.3594**
$N_{predicted}$ - Proposed Conditions All CMFs	0.8283	2.6702	2.9510	9.9099	**16.3594**

Proposed Conditions: General Information and Data for Freeway Segment

General Information		Location Information	
Analyst	Greg Sprungle	Route	IR480*
Agency or Company	Carpenter Marty Transportation	Logpoints	7.753 to 8.479
Date Performed	07/31/19	Common Name	I-480 WB between 71N and 71S
Segment for Analysis	IR480N; 7.753-8.479	Analysis Year	2018

Input Data		Proposed Conditions			Base Conditions
Basic Roadway Data					
Area Type		Urban	Copy From:		
Segment length L (mi)		0.726			
Cross Section Data	Cross Section Help				
Number of through lanes n		3			
Lane width W_l (ft)		12			12
Outside shoulder width W_s (ft)		4			10
Inside shoulder width W_{is} (ft)		5			6
Median width W_m (ft)		20			60
Clear zone width W_{hc} (ft)		12			30
Presence of rumble strips on outside shoulder		Yes			No
Presence of rumble strips on inside shoulder		No			No
Freeway Segment Volume Data					
Freeway segment AADT, $AADT_{fs}$ (veh/day)		52,855	(Note: this is only for the one side of freeway being analyze.)		
	Maximum Allowable AADT =	*90,000*			
Proportion of AADT during high-volume hours P_{hv}		0.52			
Ramp Access Data			*Begin Station (feet)*	*End Station (Feet)*	
Entrance Ramp	Distance from begin milepost to upstream entrance ramp gore $X_{b,ent}$ (mi)				
	Length of s-c lane in segment $L_{en,seg}$ (mi)				
Exit Ramp	Distance from end milepost to downstream exit ramp gore $X_{e,ext}$ (mi)	0.03			
	Length of s-c lane in segment $L_{ex,seg}$ (mi)				
	AADT of exit ramp $AADT_{e,ext}$ (veh/day)	9,237			
Weave	Length of Type B weaving section $L_{wev,}$ (mi) Weave Help				
	Length of Type B weaving section in segment $L_{wev,seg,inc}$ (mi)				
Curve and Barrier Characteristics					
Horizontal Curve Data			Add Curve Data		
	Total Curve Length (mi)	0.079734848			Go to Curve Details
Median Barrier Summary					
	Length of Median Barrier (mi)	0.726	Add Barrier Data		
Roadside Barrier Summary					
	Length of Roadside Barrier (mi)	0.296212121			Go to Barrier Details

Proposed Segment: Summary Results (Without Animal Crashes) (Crashes/Year)					
	KA	B	C	O	Total
$N_{predicted}$	0.6243	1.9143	2.0713	9.5571	**14.1670**
$N_{predicted}$ - Proposed Conditions All CMFs	0.6243	1.9143	2.0713	9.5571	**14.1670**

Proposed Conditions: General Information and Data for Freeway Segment

General Information		Location Information	
Analyst	Greg Sprungle	Route	IR480*
Agency or Company	Carpenter Marty Transportation	Logpoints	8.479 to 8.863
Date Performed	07/31/19	Common Name	I-480 WB between 71N and 237
Segment for Analysis	IR480N; 8.479-8.863	Analysis Year	2018

Input Data		Proposed Conditions			Base Conditions
Basic Roadway Data					
Area Type		Urban	Copy From:		
Segment length L (mi)		0.384			
Cross Section Data	Cross Section Help				
Number of through lanes n		4			
Lane width W_l (ft)		12			12
Outside shoulder width W_s (ft)		4			10
Inside shoulder width W_{is} (ft)		5			6
Median width W_m (ft)		20			60
Clear zone width W_{hc} (ft)		30			30
Presence of rumble strips on outside shoulder		Yes			No
Presence of rumble strips on inside shoulder		No			No
Freeway Segment Volume Data					
Freeway segment AADT, $AADT_{fs}$ (veh/day)		62,092	(Note: this is only for the one side of freeway being analyze.)		
	Maximum Allowable AADT =	*135,000*			
Proportion of AADT during high-volume hours P_{hv}		0.38			
Ramp Access Data			*Begin Station (feet)*	*End Station (Feet)*	
Entrance Ramp	Distance from begin milepost to upstream entrance ramp gore $X_{b,ent}$ (mi)				
	Length of s-c lane in segment $L_{en,seg}$ (mi)				
Exit Ramp	Distance from end milepost to downstream exit ramp gore $X_{e,ext}$ (mi)				
	Length of s-c lane in segment $L_{ex,seg}$ (mi)				
Weave	Length of Type B weaving section $L_{wev,}$ (mi) Weave Help	0.373			
	Length of Type B weaving section in segment $L_{wev,seg,inc}$ (mi)	0.373			
Curve and Barrier Characteristics					
Horizontal Curve Data			Add Curve Data		
	Total Curve Length (mi)	0			Go to Curve Details
Median Barrier Summary					
	Length of Median Barrier (mi)	0.384	Add Barrier Data		
Roadside Barrier Summary					
	Length of Roadside Barrier (mi)	0.281818182			Go to Barrier Details

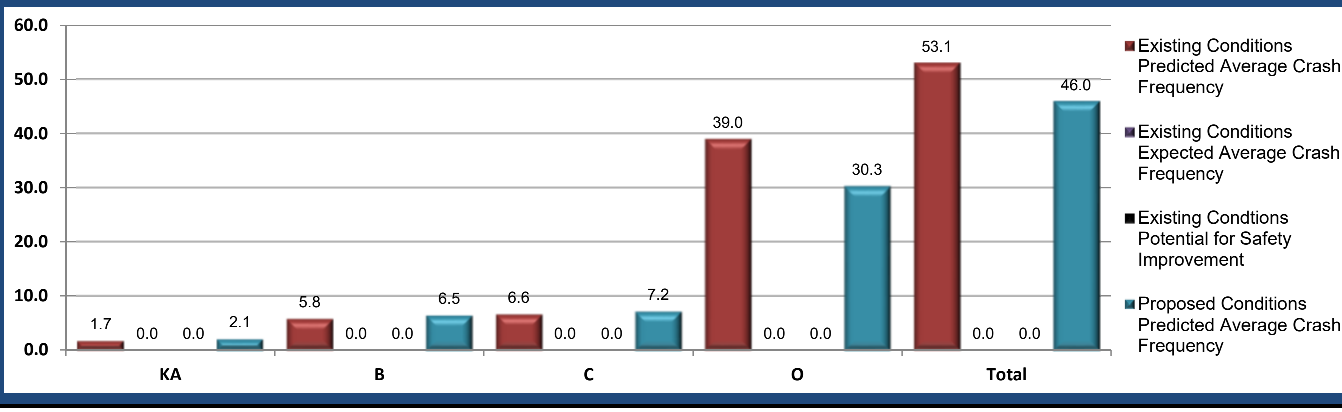
Proposed Segment: Summary Results (Without Animal Crashes) (Crashes/Year)					
	KA	B	C	O	Total
$N_{predicted}$	0.6038	1.9467	2.1512	10.7945	**15.4962**
$N_{predicted}$ - Proposed Conditions All CMFs	0.6038	1.9467	2.1512	10.7945	**15.4962**

Project Safety Performance Report

General Information

Project Name	CUY-480-7.14 WB	Contact Email	Gsprungle@cmtran.com
Project Description	Performance Based Project Development Report Safety Analysis	Contact Phone	614-656-2419
Reference Number	PID 108482	Date Performed	7/31/2019
Analyst	Greg Sprungle	Analysis Year	2018
Agency/Company	Carpenter Marty Transportation		

Summary of Anticipated Safety Performance of the Project (average crashes/year)



Project Summary Results (Without Animal Crashes)

	KA	B	C	O	Total
$N_{predicted}$ - Existing Conditions	1.6860	5.8290	6.6178	38.9960	53.1288
$N_{expected}$ - Existing Conditions	0.0000	0.0000	0.0000	0.0000	0.0000
$N_{potential\ for\ improvement}$ - Existing Conditions	0.0000	0.0000	0.0000	0.0000	0.0000
$N_{predicted}$ - Proposed Conditions	2.0564	6.5312	7.1735	30.2615	46.0226

Project Safety Performance Report

General Information

Project Name	CUY-480-7.14 WB	Contact Email	Gsprungle@cmtran.com
Project Description	Performance Based Project Development Report Safety Analysis	Contact Phone	614-656-2419
Reference Number	PID 108482	Date Performed	7/31/2019
Analyst	Greg Sprungle	Analysis Year	2018
Agency/Company	Carpenter Marty Transportation		

Existing Conditions Project Element Predicted Crash Summary (Without Animal Crashes)

Project Element ID	Common Name	Crash Severity Level				
		KA	B	C	O	Total
IR480N; 8.479-8.863	I-480 WB between 71N and 237	0.4095	1.4646	1.6827	8.3382	11.895
IR480N; 7.174-7.753	I-480 WB between 71S and Grayton	0.8526	2.9262	3.3136	19.1011	26.1935
IR480N; 7.753-8.479	I-480 WB between 71N and 71S	0.4239	1.4382	1.6215	11.5567	15.0403

Existing Conditions Project Element Expected Crash Summary (Without Animal Crashes)

Project Element ID	Common Name	Crash Severity Level				
		KA	B	C	O	Total
IR480N; 8.479-8.863	I-480 WB between 71N and 237	0	0	0	0	0
IR480N; 7.174-7.753	I-480 WB between 71S and Grayton	0	0	0	0	0
IR480N; 7.753-8.479	I-480 WB between 71N and 71S	0	0	0	0	0

Existing Conditions Project Element Potential for Safety Improvement Summary (Without Animal Crashes)

Project Element ID	Common Name	Crash Severity Level				
		KA	B	C	O	Total
IR480N; 8.479-8.863	I-480 WB between 71N and 237					0
IR480N; 7.174-7.753	I-480 WB between 71S and Grayton					0
IR480N; 7.753-8.479	I-480 WB between 71N and 71S					0

Proposed Conditions Project Element Predicted Crash Summary (Without Animal Crashes)

Project Element ID	Common Name	Crash Severity Level				
		KA	B	C	O	Total
IR480N; 8.479-8.863	I-480 WB between 71N and 237	0.6038	1.9467	2.1512	10.7945	15.4962
IR480N; 7.174-7.753	I-480 WB between 71S and Grayton	0.8283	2.6702	2.951	9.9099	16.3594
IR480N; 7.753-8.479	I-480 WB between 71N and 71S	0.6243	1.9143	2.0713	9.5571	14.167

Summary by Crash Type

Crash Type	Existing			Proposed
	Predicted Crash Frequency	Expected Crash Frequency	PSI	Predicted Crash Frequency
Unknown	0.1137			0.1137
Head On	0.0972			0.0972
Rear End	21.3072			21.3072
Backing	0.2308			0.2308
Sideswipe - Meeting	0.4378			0.4378
Sideswipe - Passing	14.0934			14.0934
Angle	0.5469			0.5469
Parked Vehicle	0.3636			0.3636
Pedestrian	0.0668			0.0668
Animal	2.1589			2.1589
Train	0.0000			0.0000
Pedalcycles	0.0000			0.0000
Other Non-Vehicle	0.0000			0.0000
Fixed Object	6.3787			6.3787
Other Object	0.7478			0.7478
Overturning	0.4112			0.4112
Other Non-Collision	1.0720			1.0720
Left Turn	0.1555			0.1555
Right Turn	0.0000			0.0000

Appendix D

Count Data, NOACA Correspondence, and Traffic Volume Calculations

Quality Counts
DATA THAT DRIVES COMMUNITIES

Location: I-480 WB between I-71 NB Off-Ramp and SR-237 SB Off-Ramp
Date: 3/28/2019
Time: 6:00 AM - 10:00 AM

	Westbound											
	I-480 WB to I-480 WB			I-480 WB to SR-237 SB			I-71 NB to I-480 WB			I-71 NB to SR-237 SB		
Time	Passanger Vehicles	Heavy Vehicles	**Total**	Passanger Vehicles	Heavy Vehicles	**Total**	Passanger Vehicles	Heavy Vehicles	**Total**	Passanger Vehicles	Heavy Vehicles	**Total**
6:00 AM	172	27	**199**	84	0	**84**	81	7	**88**	3	1	**4**
6:15 AM	230	25	**255**	92	3	**95**	124	5	**129**	4	1	**5**
6:30 AM	360	33	**393**	114	3	**117**	158	2	**160**	5	0	**5**
6:45 AM	347	39	**386**	117	4	**121**	190	7	**197**	9	0	**9**
7:00 AM	366	35	**401**	117	8	**125**	226	7	**233**	11	0	**11**
7:15 AM	455	30	**485**	131	5	**136**	284	11	**295**	9	0	**9**
7:30 AM	573	33	**606**	122	8	**130**	302	10	**312**	11	1	**12**
7:45 AM	481	51	**532**	131	10	**141**	253	12	**265**	9	0	**9**
8:00 AM	476	30	**506**	120	9	**129**	227	12	**239**	10	1	**11**
8:15 AM	434	42	**476**	114	6	**120**	273	18	**291**	11	2	**13**
8:30 AM	424	47	**471**	110	5	**115**	245	11	**256**	7	2	**9**
8:45 AM	405	49	**454**	93	9	**102**	217	15	**232**	8	1	**9**
9:00 AM	314	43	**357**	90	7	**97**	176	10	**186**	5	0	**5**
9:15 AM	363	45	**408**	112	9	**121**	193	23	**216**	4	0	**4**
9:30 AM	351	50	**401**	95	6	**101**	189	9	**198**	8	0	**8**
9:45 AM	334	47	**381**	90	12	**102**	140	8	**148**	8	0	**8**
Total	6085	626	**6711**	1732	104	**1836**	3278	167	**3445**	122	9	**131**

Location: I-480 WB between I-71 NB Off-Ramp and SR-237 SB Off-Ramp
Date: 3/28/2019
Time: 3:00 PM - 7:00 PM

	Westbound											
	I-480 WB to I-480 WB			I-480 WB to SR-237 SB			I-71 NB to I-480 WB			I-71 NB to SR-237 SB		
Time	Passanger Vehicles	Heavy Vehicles	**Total**	Passanger Vehicles	Heavy Vehicles	**Total**	Passanger Vehicles	Heavy Vehicles	**Total**	Passanger Vehicles	Heavy Vehicles	**Total**
3:00 PM	604	29	**633**	131	8	**139**	243	6	**249**	9	0	**9**
3:15 PM	606	34	**640**	148	7	**155**	243	4	**247**	14	1	**15**
3:30 PM	669	40	**709**	143	5	**148**	226	3	**229**	6	0	**6**
3:45 PM	737	31	**768**	152	7	**159**	240	8	**248**	8	1	**9**
4:00 PM	715	21	**736**	142	9	**151**	294	5	**299**	9	0	**9**
4:15 PM	769	31	**800**	133	2	**135**	262	6	**268**	14	1	**15**
4:30 PM	764	29	**793**	126	7	**133**	278	6	**284**	19	1	**20**
4:45 PM	782	29	**811**	179	1	**180**	260	4	**264**	17	1	**18**
5:00 PM	801	27	**828**	135	3	**138**	270	2	**272**	15	0	**15**
5:15 PM	788	22	**810**	184	11	**195**	271	4	**275**	15	1	**16**
5:30 PM	727	18	**745**	143	3	**146**	263	1	**264**	22	0	**22**
5:45 PM	643	29	**672**	112	3	**115**	250	4	**254**	9	0	**9**
6:00 PM	561	20	**581**	127	2	**129**	233	1	**234**	2	0	**2**
6:15 PM	516	19	**535**	117	4	**121**	194	2	**196**	13	0	**13**
6:30 PM	506	27	**533**	103	2	**105**	183	4	**187**	9	0	**9**
6:45 PM	428	14	**442**	127	7	**134**	185	0	**185**	6	0	**6**
Total	10616	420	**11036**	2202	81	**2283**	3895	60	**3955**	187	6	**193**

Location: I-480 WB between I-71 SB Off-Ramp and Grayton Rd Off-Ramp
Date: 3/28/2019
Time: 6:00 AM - 10:00 AM

	Westbound											
	I-480 WB to I-480 WB			I-480 WB to Grayton Rd			I-71 to I-480 WB			I-71 to Grayton Rd		
Time	Passanger Vehicles	Heavy Vehicles	**Total**	Passanger Vehicles	Heavy Vehicles	**Total**	Passanger Vehicles	Heavy Vehicles	**Total**	Passanger Vehicles	Heavy Vehicles	**Total**
6:00 AM	183	24	**207**	58	1	**59**	44	5	**49**	25	2	**27**
6:15 AM	277	19	**296**	78	4	**82**	66	11	**77**	24	0	**24**
6:30 AM	408	36	**444**	71	3	**74**	86	12	**98**	32	0	**32**
6:45 AM	449	36	**485**	107	3	**110**	117	8	**125**	57	2	**59**
7:00 AM	465	29	**494**	104	6	**110**	111	4	**115**	38	2	**40**
7:15 AM	559	34	**593**	162	3	**165**	160	15	**175**	37	0	**37**
7:30 AM	671	35	**706**	167	3	**170**	188	8	**196**	43	1	**44**
7:45 AM	519	59	**578**	219	8	**227**	216	14	**230**	48	3	**51**
8:00 AM	529	38	**567**	159	4	**163**	180	8	**188**	43	3	**46**
8:15 AM	529	48	**577**	158	4	**162**	162	14	**176**	38	0	**38**
8:30 AM	539	52	**591**	129	4	**133**	150	16	**166**	51	2	**53**
8:45 AM	508	54	**562**	126	5	**131**	135	13	**148**	42	2	**44**
9:00 AM	363	51	**414**	112	2	**114**	127	16	**143**	42	2	**44**
9:15 AM	444	65	**509**	93	4	**97**	126	15	**141**	35	4	**39**
9:30 AM	438	51	**489**	105	3	**108**	136	13	**149**	24	4	**28**
9:45 AM	372	48	**420**	97	6	**103**	143	14	**157**	25	1	**26**
Total	7253	679	**7932**	1945	63	**2008**	2147	186	**2333**	604	28	**632**

Quality Counts
DATA THAT DRIVES COMMUNITIES

Location: I-480 WB between I-71 SB Off-Ramp and Grayton Rd Off-Ramp
Date: 3/28/2019
Time: 3:00 PM - 7:00 PM

	Westbound											
	I-480 WB to I-480 WB			I-480 WB to Grayton Rd			I-71 to I-480 WB			I-71 to Grayton Rd		
Time	Passanger Vehicles	Heavy Vehicles	**Total**	Passanger Vehicles	Heavy Vehicles	**Total**	Passanger Vehicles	Heavy Vehicles	**Total**	Passanger Vehicles	Heavy Vehicles	**Total**
3:00 PM	692	28	**720**	117	4	**121**	352	20	**372**	58	1	**59**
3:15 PM	688	34	**722**	141	1	**142**	411	23	**434**	58	0	**58**
3:30 PM	794	42	**836**	91	3	**94**	421	19	**440**	69	1	**70**
3:45 PM	808	31	**839**	141	1	**142**	481	10	**491**	50	5	**55**
4:00 PM	846	23	**869**	131	3	**134**	463	9	**472**	42	1	**43**
4:15 PM	868	31	**899**	136	4	**140**	597	12	**609**	51	0	**51**
4:30 PM	884	34	**918**	139	2	**141**	543	16	**559**	57	0	**57**
4:45 PM	929	32	**961**	115	2	**117**	514	14	**528**	75	3	**78**
5:00 PM	890	28	**918**	120	1	**121**	569	15	**584**	58	0	**58**
5:15 PM	921	26	**947**	157	0	**157**	547	17	**564**	53	1	**54**
5:30 PM	861	17	**878**	134	1	**135**	497	11	**508**	49	0	**49**
5:45 PM	756	28	**784**	128	1	**129**	428	13	**441**	41	1	**42**
6:00 PM	652	27	**679**	108	1	**109**	355	5	**360**	25	2	**27**
6:15 PM	580	20	**600**	124	2	**126**	292	7	**299**	25	0	**25**
6:30 PM	567	25	**592**	113	2	**115**	295	10	**305**	37	0	**37**
6:45 PM	525	11	**536**	87	1	**88**	224	5	**229**	28	0	**28**
Total	12261	437	**12698**	1982	29	**2011**	6989	206	**7195**	776	15	**791**

Gina Balsamo

From: Ali Makarachi <AMakarachi@mpo.noaca.org>
Sent: Wednesday, April 24, 2019 12:10 PM
To: Gina Balsamo; Chelsea Cousins
Cc: Mike Kubek
Subject: RE: CUY-480-7.14 WB PBPD Growth Rate Request

Follow Up Flag: Flag for follow up
Flag Status: Completed

Gina,

Yes I agree with 0.04% for both periods. The future year is 22 years out and we should see some growth. Please note that 0.04% is annual growth.

Regards,

Ali Makarachi, PhD, PE
Northeast Ohio Areawide Coordinating Agency (NOACA)
Transportation Modeling & Data Integration Manager
1299 Superior Avenue E
Cleveland, OH 44114
(216) 241- 2414, Ext. 370
www.noaca.org
amakarachi@mpo.noaca.org

From: Gina Balsamo <gbalsamo@cmtran.com>
Sent: Wednesday, April 24, 2019 10:26 AM
To: Ali Makarachi <AMakarachi@mpo.noaca.org>; Chelsea Cousins <ccousins@cmtran.com>
Cc: Mike Kubek <MKubek@mpo.noaca.org>
Subject: RE: CUY-480-7.14 WB PBPD Growth Rate Request

Ali,

Thank you for the model outputs. Typically, we use the same growth rate for AM and PM peak analysis. Would you recommend using 0.04% for the all segments in the study area for the both peaks? We want to make sure we are being conservative but also realistic in our analysis.

Thanks for your help,

Gina Balsamo, PE
Traffic Engineer
CARPENTER MARTY
614.656.2429 | www.cmtran.com

From: Ali Makarachi <AMakarachi@mpo.noaca.org>
Sent: Monday, April 22, 2019 11:56 AM
To: Chelsea Cousins <ccousins@cmtran.com>
Cc: Gina Balsamo <gbalsamo@cmtran.com>; Mike Kubek <MKubek@mpo.noaca.org>
Subject: RE: CUY-480-7.14 WB PBPD Growth Rate Request

Chelsea,

The requested NOACA travel forecasting model outputs are attached. The CAGR value for the I-480 WB for the AM peak period is zero and for the PM peak period is 0.04%.

Please let me know if you have any questions.

Regards,

Ali Makarachi, PhD, PE
Northeast Ohio Areawide Coordinating Agency (NOACA)
Transportation Modeling & Data Integration Manager
1299 Superior Avenue E
Cleveland, OH 44114
(216) 241- 2414, Ext. 370
www.noaca.org
amakarachi@mpo.noaca.org

From: Chelsea Cousins [mailto:ccousins@cmtran.com]
Sent: Tuesday, April 16, 2019 8:41 AM
To: Ali Makarachi <AMakarachi@mpo.noaca.org>
Cc: Gina Balsamo <gbalsamo@cmtran.com>; Mike Kubek <MKubek@mpo.noaca.org>
Subject: CUY-480-7.14 WB PBPD Growth Rate Request

Good Morning,

We would like to request growth rates for the following locations. We are conducting a Performance Based Project Development analysis for ODOT District 12 of the IR-71 NB to IR-480 WB entrance ramp to the Grayton Road exit ramp. Please see attached count data. Analysis will be conducted on the existing count data (2019) and the horizon year, which will be 2040. The report will be reviewed by ODOT District 12.

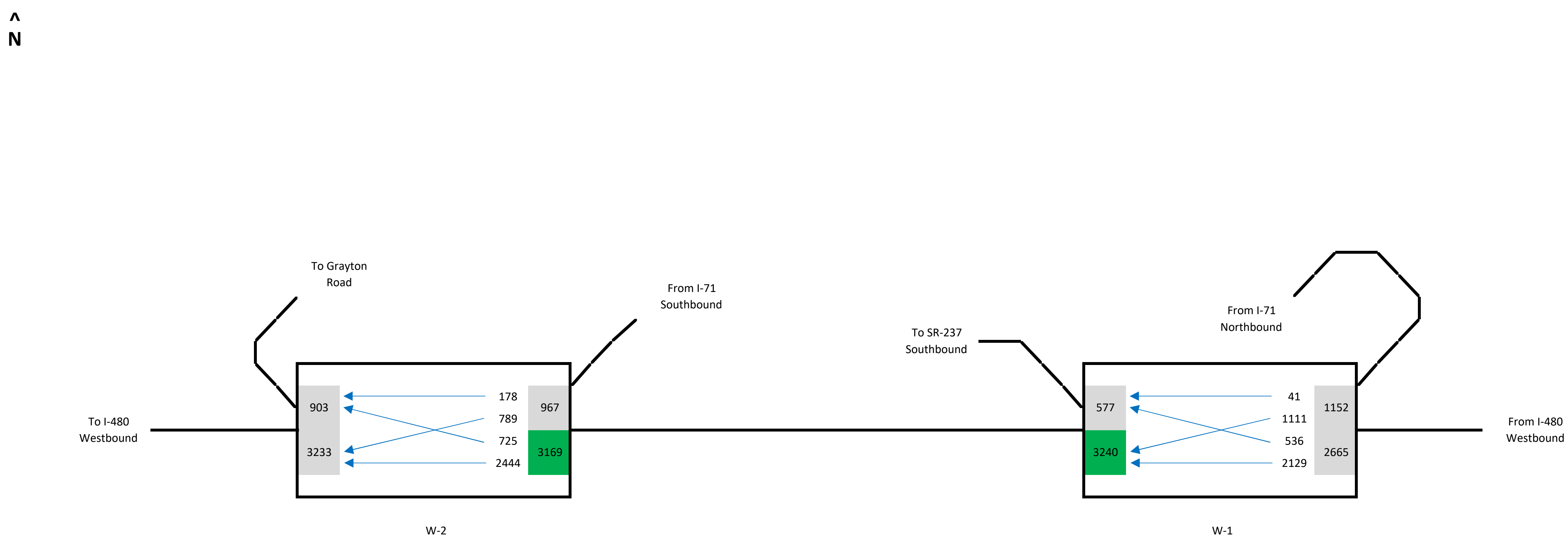
Please let me know if you need any further information.

Thanks,

Chelsea Cousins, EIT
Project Engineer
CARPENTER MARTY
614.656.2418 | www.cmtran.com

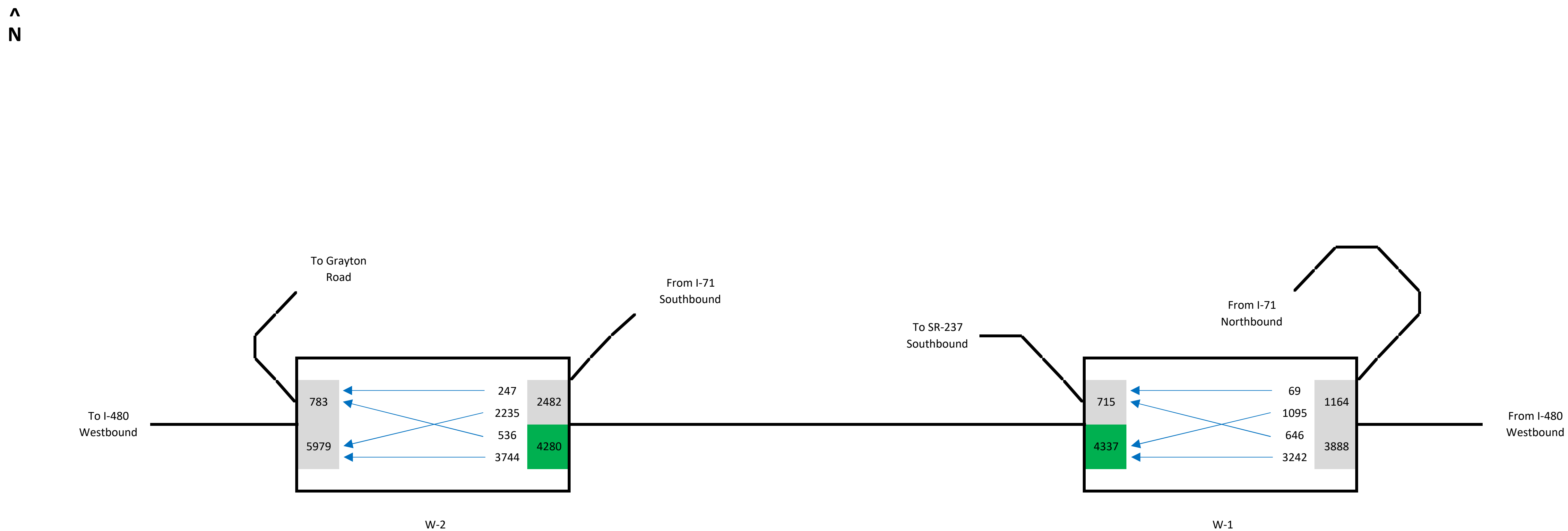
CUY-480-7.14 PBPD
Traffic Volume Calculations

Year	Period	Scenario	Plate
2019	AM	Count Data	A



CUY-480-7.14 PBPD
Traffic Volume Calculations

CARPENTER MARTY transportation	Year	Period	Scenario	Plate
	2019	PM	Count Data	B

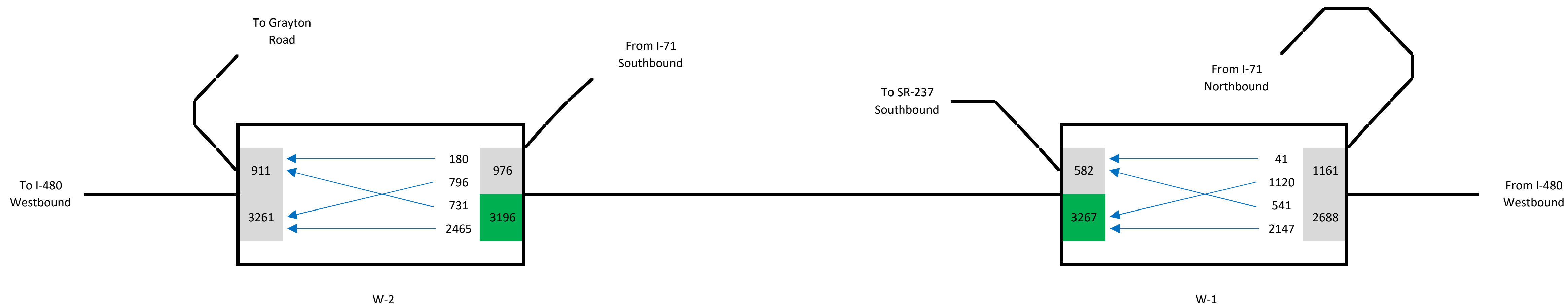


CUY-480-7.14 PBPD
Traffic Volume Calculations

CARPENTER MARTY transportation	Year	Period	Scenario	Plate
	2040	AM	Design Year	A

^
N

Growth Rate/Yr 0.04%

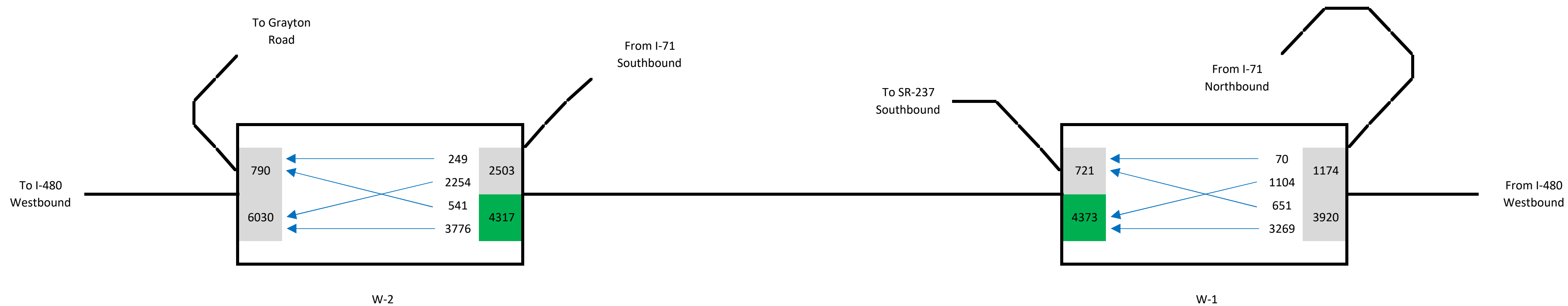


CUY-480-7.14 PBPD
Traffic Volume Calculations

CARPENTER MARTY transportation	Year	Period	Scenario	Plate
	2040	PM	Design Year	B

^
N

Growth Rate/Yr 0.04%



Appendix E

Capacity Analysis Results

HCS7 Freeway Weaving Report

Project Information

Analyst	CMC	Date	4/25/19
Agency	CMTran	Analysis Year	2019
Jurisdiction	ODOT District 12	Time Period Analyzed	AM
Project Description	IR-480 WB between IR-71 NB and SR-237 SB - Existing Conditions		

Geometric Data

Number of Lanes (N), ln	3	Segment Type	Freeway
Segment Length (L_S), ft	1275	Number of Maneuver Lanes (N_{WL}), ln	2
Weaving Configuration	One-Sided	Ramp-to-Freeway Lane Changes (LC_{RF}), lc	1
Terrain Type	Level	Freeway-to-Ramp Lane Changes (LC_{FR}), lc	0
Percent Grade, %	-	Ramp-to-Ramp Lane Changes (LC_{RR}), lc	0
Interchange Density (ID), int/mi	0.50	Cross Weaving Managed Lane	No

Adjustment Factors

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

	FF	RF	RR	FR
Demand Volume (V_i), veh/h	2129	1111	41	536
Peak Hour Factor (PHF)	0.94	0.94	0.94	0.94
Total Trucks, %	9.33	4.85	6.87	5.66
Heavy Vehicle Adjustment Factor (f_{HV})	0.915	0.954	0.936	0.946
Flow Rate (v_i), pc/h	2475	1239	47	603

Weaving Flow Rate (v_W), pc/h	1842	Freeway Max Capacity (c_{IFL}), pc/h/ln	2300
Non-Weaving Flow Rate (v_{NW}), pc/h	2522	Density-Based Capacity (c_{IWL}), pc/h/ln	1867
Total Flow Rate (v), pc/h	4364	Demand Flow-Based Capacity (c_{IW}), pc/h	5687
Volume Ratio (VR)	0.422	Weaving Segment Capacity (c_W), veh/h	5212
Minimum Lane Change Rate (LC_{MIN}), lc/h	1239	Adjusted Weaving Area Capacity, pc/h	5601
Maximum Weaving Length (L_{MAX}), ft	6929	Volume-to-Capacity Ratio (v/c)	0.78

Speed and Density

Non-Weaving Vehicle Index (I_{NW})	161	Average Weaving Speed (S_W),mi/h	49.0
Non-Weaving Lane Change Rate (LC_{NW}), lc/h	633	Average Non-Weaving Speed (S_{NW}), mi/h	44.1
Weaving Lane Change Rate (LC_W), lc/h	1391	Average Speed (S), mi/h	46.0
Weaving Lane Change Rate (LC_{All}), lc/h	2024	Density (D), pc/mi/ln	31.6
Weaving Intensity Factor (W)	0.325	Level of Service (LOS)	D

HCS7 Freeway Weaving Report

Project Information

Analyst	CMC	Date	4/25/19
Agency	CMTran	Analysis Year	2019
Jurisdiction	ODOT District 12	Time Period Analyzed	PM
Project Description	IR-480 WB between IR-71 NB and SR-237 SB - Existing Conditions		

Geometric Data

Number of Lanes (N), ln	3	Segment Type	Freeway
Segment Length (L_S), ft	1275	Number of Maneuver Lanes (N_{WL}), ln	2
Weaving Configuration	One-Sided	Ramp-to-Freeway Lane Changes (LC_{RF}), lc	1
Terrain Type	Level	Freeway-to-Ramp Lane Changes (LC_{FR}), lc	0
Percent Grade, %	-	Ramp-to-Ramp Lane Changes (LC_{RR}), lc	0
Interchange Density (ID), int/mi	0.50	Cross Weaving Managed Lane	No

Adjustment Factors

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

	FF	RF	RR	FR
Demand Volume (V_i), veh/h	3242	1095	69	646
Peak Hour Factor (PHF)	0.94	0.94	0.94	0.94
Total Trucks, %	3.81	1.52	3.11	3.55
Heavy Vehicle Adjustment Factor (f_{HV})	0.963	0.985	0.970	0.966
Flow Rate (v_i), pc/h	3581	1183	76	711

Weaving Flow Rate (v_W), pc/h	1894	Freeway Max Capacity (c_{IFL}), pc/h/ln	2300
Non-Weaving Flow Rate (v_{NW}), pc/h	3657	Density-Based Capacity (c_{IWL}), pc/h/ln	1936
Total Flow Rate (v), pc/h	5551	Demand Flow-Based Capacity (c_{IW}), pc/h	7038
Volume Ratio (VR)	0.341	Weaving Segment Capacity (c_W), veh/h	5623
Minimum Lane Change Rate (LC_{MIN}), lc/h	1183	Adjusted Weaving Area Capacity, pc/h	5808
Maximum Weaving Length (L_{MAX}), ft	6028	Volume-to-Capacity Ratio (v/c)	0.96

Speed and Density

Non-Weaving Vehicle Index (I_{NW})	233	Average Weaving Speed (S_W),mi/h	48.4
Non-Weaving Lane Change Rate (LC_{NW}), lc/h	867	Average Non-Weaving Speed (S_{NW}), mi/h	42.6
Weaving Lane Change Rate (LC_W), lc/h	1335	Average Speed (S), mi/h	44.4
Weaving Lane Change Rate (LC_{All}), lc/h	2202	Density (D), pc/mi/ln	41.7
Weaving Intensity Factor (W)	0.348	Level of Service (LOS)	E

HCS7 Freeway Weaving Report

Project Information

Analyst	CMC	Date	4/25/19
Agency	CMTran	Analysis Year	2040
Jurisdiction	ODOT District 12	Time Period Analyzed	AM
Project Description	IR-480 WB between IR-71 NB and SR-237 SB - Existing Conditions		

Geometric Data

Number of Lanes (N), ln	3	Segment Type	Freeway
Segment Length (L_S), ft	1275	Number of Maneuver Lanes (N_{WL}), ln	2
Weaving Configuration	One-Sided	Ramp-to-Freeway Lane Changes (LC_{RF}), lc	1
Terrain Type	Level	Freeway-to-Ramp Lane Changes (LC_{FR}), lc	0
Percent Grade, %	-	Ramp-to-Ramp Lane Changes (LC_{RR}), lc	0
Interchange Density (ID), int/mi	0.50	Cross Weaving Managed Lane	No

Adjustment Factors

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

	FF	RF	RR	FR
Demand Volume (V_i), veh/h	2147	1120	41	541
Peak Hour Factor (PHF)	0.94	0.94	0.94	0.94
Total Trucks, %	9.33	4.85	6.87	5.66
Heavy Vehicle Adjustment Factor (f_{HV})	0.915	0.954	0.936	0.946
Flow Rate (v_i), pc/h	2496	1249	47	608
Weaving Flow Rate (v_W), pc/h	1857	Freeway Max Capacity (c_{IFL}), pc/h/ln		2300
Non-Weaving Flow Rate (v_{NW}), pc/h	2543	Density-Based Capacity (c_{IWL}), pc/h/ln		1867
Total Flow Rate (v), pc/h	4400	Demand Flow-Based Capacity (c_{IW}), pc/h		5687
Volume Ratio (VR)	0.422	Weaving Segment Capacity (c_W), veh/h		5212
Minimum Lane Change Rate (LC_{MIN}), lc/h	1249	Adjusted Weaving Area Capacity, pc/h		5601
Maximum Weaving Length (L_{MAX}), ft	6929	Volume-to-Capacity Ratio (v/c)		0.79

Speed and Density

Non-Weaving Vehicle Index (I_{NW})	162	Average Weaving Speed (S_W),mi/h	48.9
Non-Weaving Lane Change Rate (LC_{NW}), lc/h	637	Average Non-Weaving Speed (S_{NW}), mi/h	44.0
Weaving Lane Change Rate (LC_W), lc/h	1401	Average Speed (S), mi/h	45.9
Weaving Lane Change Rate (LC_{All}), lc/h	2038	Density (D), pc/mi/ln	32.0
Weaving Intensity Factor (W)	0.327	Level of Service (LOS)	D

HCS7 Freeway Weaving Report

Project Information

Analyst	CMC	Date	4/25/19
Agency	CMTran	Analysis Year	2040
Jurisdiction	ODOT District 12	Time Period Analyzed	PM
Project Description	IR-480 WB between IR-71 NB and SR-237 SB - Existing Conditions		

Geometric Data

Number of Lanes (N), ln	3	Segment Type	Freeway
Segment Length (L_S), ft	1275	Number of Maneuver Lanes (N_{WL}), ln	2
Weaving Configuration	One-Sided	Ramp-to-Freeway Lane Changes (LC_{RF}), lc	1
Terrain Type	Level	Freeway-to-Ramp Lane Changes (LC_{FR}), lc	0
Percent Grade, %	-	Ramp-to-Ramp Lane Changes (LC_{RR}), lc	0
Interchange Density (ID), int/mi	0.50	Cross Weaving Managed Lane	No

Adjustment Factors

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

	FF	RF	RR	FR
Demand Volume (V_i), veh/h	3269	1104	70	651
Peak Hour Factor (PHF)	0.94	0.94	0.94	0.94
Total Trucks, %	3.81	1.52	3.11	3.55
Heavy Vehicle Adjustment Factor (f_{HV})	0.963	0.985	0.970	0.966
Flow Rate (v_i), pc/h	3611	1192	77	717

Weaving Flow Rate (v_W), pc/h	1909	Freeway Max Capacity (c_{IFL}), pc/h/ln	2300
Non-Weaving Flow Rate (v_{NW}), pc/h	3688	Density-Based Capacity (c_{IWL}), pc/h/ln	1936
Total Flow Rate (v), pc/h	5597	Demand Flow-Based Capacity (c_{IW}), pc/h	7038
Volume Ratio (VR)	0.341	Weaving Segment Capacity (c_W), veh/h	5623
Minimum Lane Change Rate (LC_{MIN}), lc/h	1192	Adjusted Weaving Area Capacity, pc/h	5808
Maximum Weaving Length (L_{MAX}), ft	6028	Volume-to-Capacity Ratio (v/c)	0.96

Speed and Density

Non-Weaving Vehicle Index (I_{NW})	235	Average Weaving Speed (S_W),mi/h	48.3
Non-Weaving Lane Change Rate (LC_{NW}), lc/h	873	Average Non-Weaving Speed (S_{NW}), mi/h	42.5
Weaving Lane Change Rate (LC_W), lc/h	1344	Average Speed (S), mi/h	44.3
Weaving Lane Change Rate (LC_{All}), lc/h	2217	Density (D), pc/mi/ln	42.1
Weaving Intensity Factor (W)	0.350	Level of Service (LOS)	E

HCS7 Freeway Merge Report

Project Information

Analyst	GMB	Date	7/31/2019
Agency	CMTran	Analysis Year	2019
Jurisdiction	ODOT District 12	Time Period Analyzed	AM
Project Description	IR-480 WB and IR-71 NB merge - Existing Conditions		

Geometric Data

	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	60.0	25.0
Segment Length (L) / Acceleration Length (L_A),ft	1500	700
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

Adjustment Factors

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity

Demand Volume (V_i)	2665	1152
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	8.54	4.92
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f_{HV})	0.921	0.953
Flow Rate (v_i),pc/h	3078	1286
Capacity (c), pc/h	6900	1900
Volume-to-Capacity Ratio (v/c)	0.63	0.68

Speed and Density

Upstream Equilibrium Distance (L_{EQ}), ft	149.7	Density in Ramp Influence Area (D_R), pc/mi/ln	25.9
Distance to Upstream Ramp (L_{UP}), ft	2310	Speed Index (M)	0.386
Downstream Equilibrium Distance (L_{EQ}), ft	3518.0	Flow Outer Lanes (v_{OA}), pc/mi/ln	1120
Distance to Downstream Ramp (L_{DOWN}), ft	1965	On-Ramp Influenece Area Speed (S_R), mi/h	53.1
Prop. Freeway Vehicles in Lane 1 and 2 (P_M)	0.636	Outer Lanes Freeway Speed (S_O), mi/h	57.8
Flow in Lanes 1 and 2 (v_{12}), pc/h	1958	Ramp Junction Speed (S), mi/h	54.2
Flow Entering Ramp-Infl. Area (v_{R12}), pc/h	3244	Average Density (D), pc/mi/ln	26.8
Level of Service (LOS)	C		

HCS7 Freeway Merge Report

Project Information			
Analyst	GMB	Date	7/31/2019
Agency	CMTran	Analysis Year	2019
Jurisdiction	ODOT District 12	Time Period Analyzed	PM
Project Description	IR-480 WB and IR-71 NB merge - Existing Conditions		

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	60.0	25.0
Segment Length (L) / Acceleration Length (L_A),ft	1500	700
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

Adjustment Factors		
Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (V_i)	3888	1164
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	8.54	4.92
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f_{HV})	0.921	0.953
Flow Rate (v_i),pc/h	4491	1299
Capacity (c), pc/h	6900	1900
Volume-to-Capacity Ratio (v/c)	0.84	0.68

Speed and Density			
Upstream Equilibrium Distance (L_{EQ}), ft	454.9	Density in Ramp Influence Area (D_R), pc/mi/ln	33.6
Distance to Upstream Ramp (L_{UP}), ft	2310	Speed Index (M)	0.556
Downstream Equilibrium Distance (L_{EQ}), ft	4267.4	Flow Outer Lanes (v_{OA}), pc/mi/ln	1554
Distance to Downstream Ramp (L_{DOWN}), ft	1965	On-Ramp Influenece Area Speed (S_R), mi/h	50.0
Prop. Freeway Vehicles in Lane 1 and 2 (P_M)	0.654	Outer Lanes Freeway Speed (S_O), mi/h	56.2
Flow in Lanes 1 and 2 (v_{12}), pc/h	2937	Ramp Junction Speed (S), mi/h	51.5
Flow Entering Ramp-Infl. Area (v_{R12}), pc/h	4236	Average Density (D), pc/mi/ln	37.5
Level of Service (LOS)	D		

HCS7 Freeway Merge Report

Project Information

Analyst	GMB	Date	7/31/2019
Agency	CMTran	Analysis Year	2040
Jurisdiction	ODOT District 12	Time Period Analyzed	AM
Project Description	IR-480 WB and IR-71 NB merge - Existing Conditions		

Geometric Data

	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	60.0	25.0
Segment Length (L) / Acceleration Length (L_A),ft	1500	700
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

Adjustment Factors

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity

Demand Volume (V_i)	2688	1161
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	8.54	4.92
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f_{HV})	0.921	0.953
Flow Rate (v_i),pc/h	3105	1296
Capacity (c), pc/h	6900	1900
Volume-to-Capacity Ratio (v/c)	0.64	0.68

Speed and Density

Upstream Equilibrium Distance (L_{EQ}), ft	157.6	Density in Ramp Influence Area (D_R), pc/mi/ln	26.1
Distance to Upstream Ramp (L_{UP}), ft	2310	Speed Index (M)	0.389
Downstream Equilibrium Distance (L_{EQ}), ft	3548.4	Flow Outer Lanes (v_{OA}), pc/mi/ln	1130
Distance to Downstream Ramp (L_{DOWN}), ft	1965	On-Ramp Influenece Area Speed (S_R), mi/h	53.0
Prop. Freeway Vehicles in Lane 1 and 2 (P_M)	0.636	Outer Lanes Freeway Speed (S_O), mi/h	57.7
Flow in Lanes 1 and 2 (v_{12}), pc/h	1975	Ramp Junction Speed (S), mi/h	54.1
Flow Entering Ramp-Infl. Area (v_{R12}), pc/h	3271	Average Density (D), pc/mi/ln	27.1
Level of Service (LOS)	C		

HCS7 Freeway Merge Report

Project Information

Analyst	GMB	Date	7/31/2019
Agency	CMTran	Analysis Year	2040
Jurisdiction	ODOT District 12	Time Period Analyzed	PM
Project Description	IR-480 WB and IR-71 NB merge - Existing Conditions		

Geometric Data

	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	60.0	25.0
Segment Length (L) / Acceleration Length (L_A),ft	1500	700
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

Adjustment Factors

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity

Demand Volume (V_i)	3920	1174
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	8.54	4.92
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f_{HV})	0.921	0.953
Flow Rate (v_i),pc/h	4528	1311
Capacity (c), pc/h	6900	1900
Volume-to-Capacity Ratio (v/c)	0.85	0.69

Speed and Density

Upstream Equilibrium Distance (L_{EQ}), ft	465.4	Density in Ramp Influence Area (D_R), pc/mi/ln	33.9
Distance to Upstream Ramp (L_{UP}), ft	2310	Speed Index (M)	0.567
Downstream Equilibrium Distance (L_{EQ}), ft	4303.2	Flow Outer Lanes (v_{OA}), pc/mi/ln	1562
Distance to Downstream Ramp (L_{DOWN}), ft	1965	On-Ramp Influenece Area Speed (S_R), mi/h	49.8
Prop. Freeway Vehicles in Lane 1 and 2 (P_M)	0.655	Outer Lanes Freeway Speed (S_O), mi/h	56.2
Flow in Lanes 1 and 2 (v_{12}), pc/h	2966	Ramp Junction Speed (S), mi/h	51.4
Flow Entering Ramp-Infl. Area (v_{R12}), pc/h	4277	Average Density (D), pc/mi/ln	37.9
Level of Service (LOS)	D		

HCS7 Freeway Diverge Report

Project Information

Analyst	GMB	Date	7/31/2019
Agency	CMTran	Analysis Year	2019
Jurisdiction	ODOT District 12	Time Period Analyzed	AM
Project Description	IR-480 WB to SR 237 SB diverge - Existing Conditions		

Geometric Data

	Freeway	Ramp
Number of Lanes (N), ln	2	1
Free-Flow Speed (FFS), mi/h	60.0	55.0
Segment Length (L) / Deceleration Length (L_A),ft	1500	1500
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

Adjustment Factors

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity

Demand Volume (V_i)	3240	577
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	7.81	5.75
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f_{HV})	0.928	0.946
Flow Rate (v_i),pc/h	3714	649
Capacity (c), pc/h	4600	2200
Volume-to-Capacity Ratio (v/c)	0.81	0.30

Speed and Density

Upstream Equilibrium Distance (L_{EQ}), ft	-	Density in Ramp Influence Area (D_R), pc/mi/ln	22.7
Distance to Upstream Ramp (L_{UP}), ft	-	Speed Index (D)	0.226
Downstream Equilibrium Distance (L_{EQ}), ft	-	Flow Outer Lanes (v_{OA}), pc/mi/ln	-
Distance to Downstream Ramp (L_{DOWN}), ft	-	Off-Ramp Influenece Area Speed (S_R), mi/h	55.9
Prop. Freeway Vehicles in Lane 1 and 2 (P_D)	1.000	Outer Lanes Freeway Speed (S_O), mi/h	-
Flow in Lanes 1 and 2 (v_{12}), pc/h	3714	Ramp Junction Speed (S), mi/h	55.9
Flow Entering Ramp-Infl. Area (v_{R12}), pc/h	-	Average Density (D), pc/mi/ln	33.2
Level of Service (LOS)	C		

HCS7 Freeway Diverge Report

Project Information			
Analyst	GMB	Date	7/31/2019
Agency	CMTran	Analysis Year	2019
Jurisdiction	ODOT District 12	Time Period Analyzed	PM
Project Description	IR-480 WB to SR 237 SB diverge - Existing Conditions		

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	2	1
Free-Flow Speed (FFS), mi/h	60.0	55.0
Segment Length (L) / Deceleration Length (L_A),ft	1500	1500
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

Adjustment Factors		
Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (V_i)	4337	715
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	3.20	3.51
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f_{HV})	0.969	0.966
Flow Rate (v_i),pc/h	4761	787
Capacity (c), pc/h	4600	2200
Volume-to-Capacity Ratio (v/c)	1.04	0.36

Speed and Density			
Upstream Equilibrium Distance (L_{EQ}), ft	-	Density in Ramp Influence Area (D_R), pc/mi/ln	31.7
Distance to Upstream Ramp (L_{UP}), ft	-	Speed Index (D)	-
Downstream Equilibrium Distance (L_{EQ}), ft	-	Flow Outer Lanes (v_{OA}), pc/mi/ln	-
Distance to Downstream Ramp (L_{DOWN}), ft	-	Off-Ramp Influenece Area Speed (S_R), mi/h	55.7
Prop. Freeway Vehicles in Lane 1 and 2 (P_D)	1.000	Outer Lanes Freeway Speed (S_O), mi/h	-
Flow in Lanes 1 and 2 (v_{12}), pc/h	4761	Ramp Junction Speed (S), mi/h	-
Flow Entering Ramp-Infl. Area (v_{R12}), pc/h	-	Average Density (D), pc/mi/ln	-
Level of Service (LOS)	F		

HCS7 Freeway Diverge Report

Project Information

Analyst	GMB	Date	7/31/2019
Agency	CMTran	Analysis Year	2040
Jurisdiction	ODOT District 12	Time Period Analyzed	AM
Project Description	IR-480 WB to SR 237 SB diverge - Existing Conditions		

Geometric Data

	Freeway	Ramp
Number of Lanes (N), ln	2	1
Free-Flow Speed (FFS), mi/h	60.0	55.0
Segment Length (L) / Deceleration Length (L_A),ft	1500	1500
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

Adjustment Factors

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity

Demand Volume (V_i)	3267	582
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	7.81	5.75
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f_{HV})	0.928	0.946
Flow Rate (v_i),pc/h	3745	654
Capacity (c), pc/h	4600	2200
Volume-to-Capacity Ratio (v/c)	0.81	0.30

Speed and Density

Upstream Equilibrium Distance (L_{EQ}), ft	-	Density in Ramp Influence Area (D_R), pc/mi/ln	23.0
Distance to Upstream Ramp (L_{UP}), ft	-	Speed Index (D)	0.227
Downstream Equilibrium Distance (L_{EQ}), ft	-	Flow Outer Lanes (v_{OA}), pc/mi/ln	-
Distance to Downstream Ramp (L_{DOWN}), ft	-	Off-Ramp Influenece Area Speed (S_R), mi/h	55.9
Prop. Freeway Vehicles in Lane 1 and 2 (P_D)	1.000	Outer Lanes Freeway Speed (S_O), mi/h	-
Flow in Lanes 1 and 2 (v_{12}), pc/h	3745	Ramp Junction Speed (S), mi/h	55.9
Flow Entering Ramp-Infl. Area (v_{R12}), pc/h	-	Average Density (D), pc/mi/ln	33.5
Level of Service (LOS)	C		

HCS7 Freeway Diverge Report

Project Information

Analyst	GMB	Date	7/31/2019
Agency	CMTran	Analysis Year	2040
Jurisdiction	ODOT District 12	Time Period Analyzed	PM
Project Description	IR-480 WB to SR 237 SB diverge - Existing Conditions		

Geometric Data

	Freeway	Ramp
Number of Lanes (N), ln	2	1
Free-Flow Speed (FFS), mi/h	60.0	55.0
Segment Length (L) / Deceleration Length (L_A),ft	1500	1500
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

Adjustment Factors

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity

Demand Volume (V_i)	4373	721
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	3.20	3.51
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f_{HV})	0.969	0.966
Flow Rate (v_i),pc/h	4801	794
Capacity (c), pc/h	4600	2200
Volume-to-Capacity Ratio (v/c)	1.04	0.36

Speed and Density

Upstream Equilibrium Distance (L_{EQ}), ft	-	Density in Ramp Influence Area (D_R), pc/mi/ln	32.0
Distance to Upstream Ramp (L_{UP}), ft	-	Speed Index (D)	-
Downstream Equilibrium Distance (L_{EQ}), ft	-	Flow Outer Lanes (v_{OA}), pc/mi/ln	-
Distance to Downstream Ramp (L_{DOWN}), ft	-	Off-Ramp Influenece Area Speed (S_R), mi/h	55.7
Prop. Freeway Vehicles in Lane 1 and 2 (P_D)	1.000	Outer Lanes Freeway Speed (S_O), mi/h	-
Flow in Lanes 1 and 2 (v_{12}), pc/h	4801	Ramp Junction Speed (S), mi/h	-
Flow Entering Ramp-Infl. Area (v_{R12}), pc/h	-	Average Density (D), pc/mi/ln	-
Level of Service (LOS)	F		

HCS7 Freeway Weaving Report

Project Information

Analyst	CMC	Date	4/25/19
Agency	CMTran	Analysis Year	2019
Jurisdiction	ODOT District 12	Time Period Analyzed	AM
Project Description	IR-480 WB between IR-71 NB and SR-237 SB - Proposed Conditions		

Geometric Data

Number of Lanes (N), ln	4	Segment Type	Freeway
Segment Length (L_S), ft	1515	Number of Maneuver Lanes (N_{WL}), ln	2
Weaving Configuration	One-Sided	Ramp-to-Freeway Lane Changes (LC_{RF}), lc	1
Terrain Type	Level	Freeway-to-Ramp Lane Changes (LC_{FR}), lc	1
Percent Grade, %	-	Ramp-to-Ramp Lane Changes (LC_{RR}), lc	0
Interchange Density (ID), int/mi	0.50	Cross Weaving Managed Lane	No

Adjustment Factors

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

	FF	RF	RR	FR
Demand Volume (V_i), veh/h	2129	1111	41	536
Peak Hour Factor (PHF)	0.94	0.94	0.94	0.94
Total Trucks, %	9.33	4.85	6.87	5.66
Heavy Vehicle Adjustment Factor (f_{HV})	0.915	0.954	0.936	0.946
Flow Rate (v_i), pc/h	2475	1239	47	603
Weaving Flow Rate (v_W), pc/h	1842	Freeway Max Capacity (c_{IFL}), pc/h/ln		2300
Non-Weaving Flow Rate (v_{NW}), pc/h	2522	Density-Based Capacity (c_{IWL}), pc/h/ln		1886
Total Flow Rate (v), pc/h	4364	Demand Flow-Based Capacity (c_{IW}), pc/h		5687
Volume Ratio (VR)	0.422	Weaving Segment Capacity (c_W), veh/h		5292
Minimum Lane Change Rate (LC_{MIN}), lc/h	1842	Adjusted Weaving Area Capacity, pc/h		5687
Maximum Weaving Length (L_{MAX}), ft	6929	Volume-to-Capacity Ratio (v/c)		0.77

Speed and Density

Non-Weaving Vehicle Index (I_{NW})	191	Average Weaving Speed (S_W),mi/h	48.1
Non-Weaving Lane Change Rate (LC_{NW}), lc/h	570	Average Non-Weaving Speed (S_{NW}), mi/h	41.5
Weaving Lane Change Rate (LC_W), lc/h	2143	Average Speed (S), mi/h	44.1
Weaving Lane Change Rate (LC_{All}), lc/h	2713	Density (D), pc/mi/ln	24.7
Weaving Intensity Factor (W)	0.358	Level of Service (LOS)	C

HCS7 Freeway Weaving Report

Project Information

Analyst	CMC	Date	4/25/19
Agency	CMTran	Analysis Year	2019
Jurisdiction	ODOT District 12	Time Period Analyzed	PM
Project Description	IR-480 WB between IR-71 NB and SR-237 SB - Proposed Conditions		

Geometric Data

Number of Lanes (N), ln	4	Segment Type	Freeway
Segment Length (L_S), ft	1515	Number of Maneuver Lanes (N_{WL}), ln	2
Weaving Configuration	One-Sided	Ramp-to-Freeway Lane Changes (LC_{RF}), lc	1
Terrain Type	Level	Freeway-to-Ramp Lane Changes (LC_{FR}), lc	1
Percent Grade, %	-	Ramp-to-Ramp Lane Changes (LC_{RR}), lc	0
Interchange Density (ID), int/mi	0.50	Cross Weaving Managed Lane	No

Adjustment Factors

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

	FF	RF	RR	FR
Demand Volume (V_i), veh/h	3242	1095	69	646
Peak Hour Factor (PHF)	0.94	0.94	0.94	0.94
Total Trucks, %	3.81	1.52	3.11	3.55
Heavy Vehicle Adjustment Factor (f_{HV})	0.963	0.985	0.970	0.966
Flow Rate (v_i), pc/h	3581	1183	76	711

Weaving Flow Rate (v_W), pc/h	1894	Freeway Max Capacity (c_{IFL}), pc/h/ln	2300
Non-Weaving Flow Rate (v_{NW}), pc/h	3657	Density-Based Capacity (c_{IWL}), pc/h/ln	1955
Total Flow Rate (v), pc/h	5551	Demand Flow-Based Capacity (c_{IW}), pc/h	7038
Volume Ratio (VR)	0.341	Weaving Segment Capacity (c_W), veh/h	6814
Minimum Lane Change Rate (LC_{MIN}), lc/h	1894	Adjusted Weaving Area Capacity, pc/h	7038
Maximum Weaving Length (L_{MAX}), ft	6028	Volume-to-Capacity Ratio (v/c)	0.79

Speed and Density

Non-Weaving Vehicle Index (I_{NW})	277	Average Weaving Speed (S_W),mi/h	47.4
Non-Weaving Lane Change Rate (LC_{NW}), lc/h	804	Average Non-Weaving Speed (S_{NW}), mi/h	39.7
Weaving Lane Change Rate (LC_W), lc/h	2195	Average Speed (S), mi/h	42.0
Weaving Lane Change Rate (LC_{All}), lc/h	2999	Density (D), pc/mi/ln	33.0
Weaving Intensity Factor (W)	0.387	Level of Service (LOS)	D

HCS7 Freeway Weaving Report

Project Information

Analyst	CMC	Date	4/25/19
Agency	CMTran	Analysis Year	2040
Jurisdiction	ODOT District 12	Time Period Analyzed	AM
Project Description	IR-480 WB between IR-71 NB and SR-237 SB - Proposed Conditions		

Geometric Data

Number of Lanes (N), ln	4	Segment Type	Freeway
Segment Length (L_S), ft	1515	Number of Maneuver Lanes (N_{WL}), ln	2
Weaving Configuration	One-Sided	Ramp-to-Freeway Lane Changes (LC_{RF}), lc	1
Terrain Type	Level	Freeway-to-Ramp Lane Changes (LC_{FR}), lc	1
Percent Grade, %	-	Ramp-to-Ramp Lane Changes (LC_{RR}), lc	0
Interchange Density (ID), int/mi	0.50	Cross Weaving Managed Lane	No

Adjustment Factors

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

	FF	RF	RR	FR
Demand Volume (V_i), veh/h	2147	1120	41	541
Peak Hour Factor (PHF)	0.94	0.94	0.94	0.94
Total Trucks, %	9.33	4.85	6.87	5.66
Heavy Vehicle Adjustment Factor (f_{HV})	0.915	0.954	0.936	0.946
Flow Rate (v_i), pc/h	2496	1249	47	608
Weaving Flow Rate (v_W), pc/h	1857	Freeway Max Capacity (c_{IFL}), pc/h/ln		2300
Non-Weaving Flow Rate (v_{NW}), pc/h	2543	Density-Based Capacity (c_{IWL}), pc/h/ln		1886
Total Flow Rate (v), pc/h	4400	Demand Flow-Based Capacity (c_{IW}), pc/h		5687
Volume Ratio (VR)	0.422	Weaving Segment Capacity (c_W), veh/h		5292
Minimum Lane Change Rate (LC_{MIN}), lc/h	1857	Adjusted Weaving Area Capacity, pc/h		5687
Maximum Weaving Length (L_{MAX}), ft	6929	Volume-to-Capacity Ratio (v/c)		0.77

Speed and Density

Non-Weaving Vehicle Index (I_{NW})	193	Average Weaving Speed (S_W),mi/h	48.1
Non-Weaving Lane Change Rate (LC_{NW}), lc/h	575	Average Non-Weaving Speed (S_{NW}), mi/h	41.3
Weaving Lane Change Rate (LC_W), lc/h	2158	Average Speed (S), mi/h	43.9
Weaving Lane Change Rate (LC_{All}), lc/h	2733	Density (D), pc/mi/ln	25.1
Weaving Intensity Factor (W)	0.360	Level of Service (LOS)	C

HCS7 Freeway Weaving Report

Project Information

Analyst	CMC	Date	4/25/19
Agency	CMTran	Analysis Year	2040
Jurisdiction	ODOT District 12	Time Period Analyzed	PM
Project Description	IR-480 WB between IR-71 NB and SR-237 SB - Proposed Conditions		

Geometric Data

Number of Lanes (N), ln	4	Segment Type	Freeway
Segment Length (L_S), ft	1515	Number of Maneuver Lanes (N_{WL}), ln	2
Weaving Configuration	One-Sided	Ramp-to-Freeway Lane Changes (LC_{RF}), lc	1
Terrain Type	Level	Freeway-to-Ramp Lane Changes (LC_{FR}), lc	1
Percent Grade, %	-	Ramp-to-Ramp Lane Changes (LC_{RR}), lc	0
Interchange Density (ID), int/mi	0.50	Cross Weaving Managed Lane	No

Adjustment Factors

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

	FF	RF	RR	FR
Demand Volume (V_i), veh/h	3269	1104	70	651
Peak Hour Factor (PHF)	0.94	0.94	0.94	0.94
Total Trucks, %	3.81	1.52	3.11	3.55
Heavy Vehicle Adjustment Factor (f_{HV})	0.963	0.985	0.970	0.966
Flow Rate (v_i), pc/h	3611	1192	77	717
Weaving Flow Rate (v_W), pc/h	1909	Freeway Max Capacity (c_{IFL}), pc/h/ln		2300
Non-Weaving Flow Rate (v_{NW}), pc/h	3688	Density-Based Capacity (c_{IWL}), pc/h/ln		1955
Total Flow Rate (v), pc/h	5597	Demand Flow-Based Capacity (c_{IW}), pc/h		7038
Volume Ratio (VR)	0.341	Weaving Segment Capacity (c_W), veh/h		6814
Minimum Lane Change Rate (LC_{MIN}), lc/h	1909	Adjusted Weaving Area Capacity, pc/h		7038
Maximum Weaving Length (L_{MAX}), ft	6028	Volume-to-Capacity Ratio (v/c)		0.80

Speed and Density

Non-Weaving Vehicle Index (I_{NW})	279	Average Weaving Speed (S_W),mi/h	47.4
Non-Weaving Lane Change Rate (LC_{NW}), lc/h	810	Average Non-Weaving Speed (S_{NW}), mi/h	39.5
Weaving Lane Change Rate (LC_W), lc/h	2210	Average Speed (S), mi/h	41.9
Weaving Lane Change Rate (LC_{All}), lc/h	3020	Density (D), pc/mi/ln	33.4
Weaving Intensity Factor (W)	0.389	Level of Service (LOS)	D

HCS7 Freeway Weaving Report

Project Information

Analyst	CMC	Date	4/25/19
Agency	CMTran	Analysis Year	2019
Jurisdiction	ODOT District 12	Time Period Analyzed	AM
Project Description	IR-480 WB between IR-71 SB and Grayton Rd - Existing Conditions		

Geometric Data

Number of Lanes (N), ln	4	Segment Type	Freeway
Segment Length (L_S), ft	2740	Number of Maneuver Lanes (N_{WL}), ln	2
Weaving Configuration	One-Sided	Ramp-to-Freeway Lane Changes (LC_{RF}), lc	0
Terrain Type	Level	Freeway-to-Ramp Lane Changes (LC_{FR}), lc	2
Percent Grade, %	-	Ramp-to-Ramp Lane Changes (LC_{RR}), lc	0
Interchange Density (ID), int/mi	0.50	Cross Weaving Managed Lane	No

Adjustment Factors

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

	FF	RF	RR	FR
Demand Volume (V_i), veh/h	2444	789	178	725
Peak Hour Factor (PHF)	0.94	0.94	0.94	0.94
Total Trucks, %	8.56	7.97	4.43	3.14
Heavy Vehicle Adjustment Factor (f_{HV})	0.921	0.926	0.958	0.970
Flow Rate (v_i), pc/h	2823	906	198	795

Weaving Flow Rate (v_W), pc/h	1701	Freeway Max Capacity (c_{IFL}), pc/h/ln	2300
Non-Weaving Flow Rate (v_{NW}), pc/h	3021	Density-Based Capacity (c_{IWL}), pc/h/ln	2033
Total Flow Rate (v), pc/h	4722	Demand Flow-Based Capacity (c_{IW}), pc/h	6667
Volume Ratio (VR)	0.360	Weaving Segment Capacity (c_W), veh/h	6212
Minimum Lane Change Rate (LC_{MIN}), lc/h	1590	Adjusted Weaving Area Capacity, pc/h	6667
Maximum Weaving Length (L_{MAX}), ft	6236	Volume-to-Capacity Ratio (v/c)	0.71

Speed and Density

Non-Weaving Vehicle Index (I_{NW})	414	Average Weaving Speed (S_W),mi/h	50.6
Non-Weaving Lane Change Rate (LC_{NW}), lc/h	1337	Average Non-Weaving Speed (S_{NW}), mi/h	42.9
Weaving Lane Change Rate (LC_W), lc/h	2016	Average Speed (S), mi/h	45.4
Weaving Lane Change Rate (LC_{All}), lc/h	3353	Density (D), pc/mi/ln	26.0
Weaving Intensity Factor (W)	0.265	Level of Service (LOS)	C

HCS7 Freeway Weaving Report

Project Information

Analyst	CMC	Date	4/25/19
Agency	CMTran	Analysis Year	2019
Jurisdiction	ODOT District 12	Time Period Analyzed	PM
Project Description	IR-480 WB between IR-71 SB and Grayton Rd - Existing Conditions		

Geometric Data

Number of Lanes (N), ln	4	Segment Type	Freeway
Segment Length (L_S), ft	2740	Number of Maneuver Lanes (N_{WL}), ln	2
Weaving Configuration	One-Sided	Ramp-to-Freeway Lane Changes (LC_{RF}), lc	0
Terrain Type	Level	Freeway-to-Ramp Lane Changes (LC_{FR}), lc	2
Percent Grade, %	-	Ramp-to-Ramp Lane Changes (LC_{RR}), lc	0
Interchange Density (ID), int/mi	0.50	Cross Weaving Managed Lane	No

Adjustment Factors

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

	FF	RF	RR	FR
Demand Volume (V_i), veh/h	3744	2235	247	536
Peak Hour Factor (PHF)	0.94	0.94	0.94	0.94
Total Trucks, %	3.44	2.86	1.90	1.44
Heavy Vehicle Adjustment Factor (f_{HV})	0.967	0.972	0.981	0.986
Flow Rate (v_i), pc/h	4119	2446	268	578

Weaving Flow Rate (v_W), pc/h	3024	Freeway Max Capacity (c_{IFL}), pc/h/ln	2300
Non-Weaving Flow Rate (v_{NW}), pc/h	4387	Density-Based Capacity (c_{IWL}), pc/h/ln	1992
Total Flow Rate (v), pc/h	7411	Demand Flow-Based Capacity (c_{IW}), pc/h	5882
Volume Ratio (VR)	0.408	Weaving Segment Capacity (c_W), veh/h	5710
Minimum Lane Change Rate (LC_{MIN}), lc/h	0	Adjusted Weaving Area Capacity, pc/h	5883
Maximum Weaving Length (L_{MAX}), ft	6771	Volume-to-Capacity Ratio (v/c)	1.26

Speed and Density

Non-Weaving Vehicle Index (I_{NW})	-	Average Weaving Speed (S_W),mi/h	-
Non-Weaving Lane Change Rate (LC_{NW}), lc/h	-	Average Non-Weaving Speed (S_{NW}), mi/h	-
Weaving Lane Change Rate (LC_W), lc/h	-	Average Speed (S), mi/h	-
Weaving Lane Change Rate (LC_{All}), lc/h	-	Density (D), pc/mi/ln	-
Weaving Intensity Factor (W)	-	Level of Service (LOS)	F

HCS7 Freeway Weaving Report

Project Information

Analyst	CMC	Date	4/25/19
Agency	CMTran	Analysis Year	2040
Jurisdiction	ODOT District 12	Time Period Analyzed	AM
Project Description	IR-480 WB between IR-71 SB and Grayton Rd - Existing Conditions		

Geometric Data

Number of Lanes (N), ln	4	Segment Type	Freeway
Segment Length (L_S), ft	2740	Number of Maneuver Lanes (N_{WL}), ln	2
Weaving Configuration	One-Sided	Ramp-to-Freeway Lane Changes (LC_{RF}), lc	0
Terrain Type	Level	Freeway-to-Ramp Lane Changes (LC_{FR}), lc	2
Percent Grade, %	-	Ramp-to-Ramp Lane Changes (LC_{RR}), lc	0
Interchange Density (ID), int/mi	0.50	Cross Weaving Managed Lane	No

Adjustment Factors

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

	FF	RF	RR	FR
Demand Volume (V_i), veh/h	2465	796	180	731
Peak Hour Factor (PHF)	0.94	0.94	0.94	0.94
Total Trucks, %	8.56	7.97	4.43	3.14
Heavy Vehicle Adjustment Factor (f_{HV})	0.921	0.926	0.958	0.970
Flow Rate (v_i), pc/h	2847	914	200	802

Weaving Flow Rate (v_W), pc/h	1716	Freeway Max Capacity (c_{IFL}), pc/h/ln	2300
Non-Weaving Flow Rate (v_{NW}), pc/h	3047	Density-Based Capacity (c_{IWL}), pc/h/ln	2033
Total Flow Rate (v), pc/h	4763	Demand Flow-Based Capacity (c_{IW}), pc/h	6667
Volume Ratio (VR)	0.360	Weaving Segment Capacity (c_W), veh/h	6212
Minimum Lane Change Rate (LC_{MIN}), lc/h	1604	Adjusted Weaving Area Capacity, pc/h	6667
Maximum Weaving Length (L_{MAX}), ft	6236	Volume-to-Capacity Ratio (v/c)	0.71

Speed and Density

Non-Weaving Vehicle Index (I_{NW})	417	Average Weaving Speed (S_W),mi/h	50.5
Non-Weaving Lane Change Rate (LC_{NW}), lc/h	1342	Average Non-Weaving Speed (S_{NW}), mi/h	42.7
Weaving Lane Change Rate (LC_W), lc/h	2030	Average Speed (S), mi/h	45.2
Weaving Lane Change Rate (LC_{All}), lc/h	3372	Density (D), pc/mi/ln	26.3
Weaving Intensity Factor (W)	0.266	Level of Service (LOS)	C

HCS7 Freeway Weaving Report

Project Information

Analyst	CMC	Date	4/25/19
Agency	CMTran	Analysis Year	2040
Jurisdiction	ODOT District 12	Time Period Analyzed	PM
Project Description	IR-480 WB between IR-71 SB and Grayton Rd - Existing Conditions		

Geometric Data

Number of Lanes (N), ln	4	Segment Type	Freeway
Segment Length (L_S), ft	2740	Number of Maneuver Lanes (N_{WL}), ln	2
Weaving Configuration	One-Sided	Ramp-to-Freeway Lane Changes (LC_{RF}), lc	0
Terrain Type	Level	Freeway-to-Ramp Lane Changes (LC_{FR}), lc	2
Percent Grade, %	-	Ramp-to-Ramp Lane Changes (LC_{RR}), lc	0
Interchange Density (ID), int/mi	0.50	Cross Weaving Managed Lane	No

Adjustment Factors

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

	FF	RF	RR	FR
Demand Volume (V_i), veh/h	3776	2254	249	541
Peak Hour Factor (PHF)	0.94	0.94	0.94	0.94
Total Trucks, %	3.44	2.86	1.90	1.44
Heavy Vehicle Adjustment Factor (f_{HV})	0.967	0.972	0.981	0.986
Flow Rate (v_i), pc/h	4154	2467	270	584

Weaving Flow Rate (v_W), pc/h	3051	Freeway Max Capacity (c_{IFL}), pc/h/ln	2300
Non-Weaving Flow Rate (v_{NW}), pc/h	4424	Density-Based Capacity (c_{IWL}), pc/h/ln	1992
Total Flow Rate (v), pc/h	7475	Demand Flow-Based Capacity (c_{IW}), pc/h	5882
Volume Ratio (VR)	0.408	Weaving Segment Capacity (c_W), veh/h	5710
Minimum Lane Change Rate (LC_{MIN}), lc/h	0	Adjusted Weaving Area Capacity, pc/h	5883
Maximum Weaving Length (L_{MAX}), ft	6771	Volume-to-Capacity Ratio (v/c)	1.27

Speed and Density

Non-Weaving Vehicle Index (I_{NW})	-	Average Weaving Speed (S_W),mi/h	-
Non-Weaving Lane Change Rate (LC_{NW}), lc/h	-	Average Non-Weaving Speed (S_{NW}), mi/h	-
Weaving Lane Change Rate (LC_W), lc/h	-	Average Speed (S), mi/h	-
Weaving Lane Change Rate (LC_{All}), lc/h	-	Density (D), pc/mi/ln	-
Weaving Intensity Factor (W)	-	Level of Service (LOS)	F

HCS7 Freeway Merge Report

Project Information

Analyst	GMB	Date	7/31/2019
Agency	CMTran	Analysis Year	2019
Jurisdiction	ODOT District 12	Time Period Analyzed	AM
Project Description	IR-480 WB and IR-71 SB merge - Existing Conditions		

Geometric Data

	Freeway	Ramp
Number of Lanes (N), ln	2	2
Free-Flow Speed (FFS), mi/h	60.0	55.0
Segment Length (L) / Acceleration Length (L_A),ft	1500	1500
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

Adjustment Factors

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity

Demand Volume (V_i)	3169	967
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	7.46	7.22
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f_{HV})	0.931	0.933
Flow Rate (v_i),pc/h	3621	1103
Capacity (c), pc/h	4600	4400
Volume-to-Capacity Ratio (v/c)	1.03	0.25

Speed and Density

Upstream Equilibrium Distance (L_{EQ}), ft	-	Density in Ramp Influence Area (D_R), pc/mi/ln	32.5
Distance to Upstream Ramp (L_{UP}), ft	2310	Speed Index (M)	-
Downstream Equilibrium Distance (L_{EQ}), ft	-	Flow Outer Lanes (v_{OA}), pc/mi/ln	-
Distance to Downstream Ramp (L_{DOWN}), ft	1965	On-Ramp Influenece Area Speed (S_R), mi/h	49.3
Prop. Freeway Vehicles in Lane 1 and 2 (P_M)	1.000	Outer Lanes Freeway Speed (S_O), mi/h	-
Flow in Lanes 1 and 2 (v_{12}), pc/h	3621	Ramp Junction Speed (S), mi/h	-
Flow Entering Ramp-Infl. Area (v_{R12}), pc/h	4724	Average Density (D), pc/mi/ln	-
Level of Service (LOS)	F		

HCS7 Freeway Merge Report

Project Information			
Analyst	GMB	Date	7/31/2019
Agency	CMTran	Analysis Year	2019
Jurisdiction	ODOT District 12	Time Period Analyzed	PM
Project Description	IR-480 WB and IR-71 SB merge - Existing Conditions		

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	2	2
Free-Flow Speed (FFS), mi/h	60.0	55.0
Segment Length (L) / Acceleration Length (L_A),ft	1500	1500
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

Adjustment Factors		
Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (V_i)	4280	2482
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	3.17	2.77
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f_{HV})	0.969	0.973
Flow Rate (v_i),pc/h	4699	2714
Capacity (c), pc/h	4600	4400
Volume-to-Capacity Ratio (v/c)	1.61	0.62

Speed and Density			
Upstream Equilibrium Distance (L_{EQ}), ft	-	Density in Ramp Influence Area (D_R), pc/mi/ln	52.7
Distance to Upstream Ramp (L_{UP}), ft	2310	Speed Index (M)	-
Downstream Equilibrium Distance (L_{EQ}), ft	-	Flow Outer Lanes (v_{OA}), pc/mi/ln	-
Distance to Downstream Ramp (L_{DOWN}), ft	1965	On-Ramp Influenece Area Speed (S_R), mi/h	0.0
Prop. Freeway Vehicles in Lane 1 and 2 (P_M)	1.000	Outer Lanes Freeway Speed (S_O), mi/h	-
Flow in Lanes 1 and 2 (v_{12}), pc/h	4699	Ramp Junction Speed (S), mi/h	-
Flow Entering Ramp-Infl. Area (v_{R12}), pc/h	7413	Average Density (D), pc/mi/ln	-
Level of Service (LOS)	F		

HCS7 Freeway Merge Report

Project Information

Analyst	GMB	Date	7/31/2019
Agency	CMTran	Analysis Year	2040
Jurisdiction	ODOT District 12	Time Period Analyzed	AM
Project Description	IR-480 WB and IR-71 SB merge - Existing Conditions		

Geometric Data

	Freeway	Ramp
Number of Lanes (N), ln	2	2
Free-Flow Speed (FFS), mi/h	60.0	55.0
Segment Length (L) / Acceleration Length (L_A),ft	1500	1500
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

Adjustment Factors

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity

Demand Volume (V_i)	3196	976
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	7.46	7.22
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f_{HV})	0.931	0.933
Flow Rate (v_i),pc/h	3652	1113
Capacity (c), pc/h	4600	4400
Volume-to-Capacity Ratio (v/c)	1.04	0.25

Speed and Density

Upstream Equilibrium Distance (L_{EQ}), ft	-	Density in Ramp Influence Area (D_R), pc/mi/ln	32.8
Distance to Upstream Ramp (L_{UP}), ft	2310	Speed Index (M)	-
Downstream Equilibrium Distance (L_{EQ}), ft	-	Flow Outer Lanes (v_{OA}), pc/mi/ln	-
Distance to Downstream Ramp (L_{DOWN}), ft	1965	On-Ramp Influenece Area Speed (S_R), mi/h	48.9
Prop. Freeway Vehicles in Lane 1 and 2 (P_M)	1.000	Outer Lanes Freeway Speed (S_O), mi/h	-
Flow in Lanes 1 and 2 (v_{12}), pc/h	3652	Ramp Junction Speed (S), mi/h	-
Flow Entering Ramp-Infl. Area (v_{R12}), pc/h	4765	Average Density (D), pc/mi/ln	-
Level of Service (LOS)	F		

HCS7 Freeway Merge Report

Project Information			
Analyst	GMB	Date	7/31/2019
Agency	CMTran	Analysis Year	2040
Jurisdiction	ODOT District 12	Time Period Analyzed	PM
Project Description	IR-480 WB and IR-71 SB merge - Existing Conditions		

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	2	2
Free-Flow Speed (FFS), mi/h	60.0	55.0
Segment Length (L) / Acceleration Length (L_A),ft	1500	1500
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

Adjustment Factors		
Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (V_i)	4317	2503
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	3.17	2.77
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f_{HV})	0.969	0.973
Flow Rate (v_i),pc/h	4739	2737
Capacity (c), pc/h	4600	4400
Volume-to-Capacity Ratio (v/c)	1.63	0.62

Speed and Density			
Upstream Equilibrium Distance (L_{EQ}), ft	-	Density in Ramp Influence Area (D_R), pc/mi/ln	53.2
Distance to Upstream Ramp (L_{UP}), ft	2310	Speed Index (M)	-
Downstream Equilibrium Distance (L_{EQ}), ft	-	Flow Outer Lanes (v_{OA}), pc/mi/ln	-
Distance to Downstream Ramp (L_{DOWN}), ft	1965	On-Ramp Influenece Area Speed (S_R), mi/h	0.0
Prop. Freeway Vehicles in Lane 1 and 2 (P_M)	1.000	Outer Lanes Freeway Speed (S_O), mi/h	-
Flow in Lanes 1 and 2 (v_{12}), pc/h	4739	Ramp Junction Speed (S), mi/h	-
Flow Entering Ramp-Infl. Area (v_{R12}), pc/h	7476	Average Density (D), pc/mi/ln	-
Level of Service (LOS)	F		

HCS7 Freeway Diverge Report

Project Information

Analyst	GMB	Date	7/31/2019
Agency	CMTran	Analysis Year	2019
Jurisdiction	ODOT District 12	Time Period Analyzed	AM
Project Description	IR-480 WB to Grayton Rd diverge - Existing Conditions		

Geometric Data

	Freeway	Ramp
Number of Lanes (N), ln	4	1
Free-Flow Speed (FFS), mi/h	60.0	30.0
Segment Length (L) / Deceleration Length (L_A),ft	1500	630
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

Adjustment Factors

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity

Demand Volume (V_i)	3233	903
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	8.43	3.45
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f_{HV})	0.922	0.967
Flow Rate (v_i),pc/h	3730	993
Capacity (c), pc/h	9200	1900
Volume-to-Capacity Ratio (v/c)	0.41	0.52

Speed and Density

Upstream Equilibrium Distance (L_{EQ}), ft	-	Density in Ramp Influence Area (D_R), pc/mi/ln	17.4
Distance to Upstream Ramp (L_{UP}), ft	-	Speed Index (D)	0.582
Downstream Equilibrium Distance (L_{EQ}), ft	-	Flow Outer Lanes (v_{OA}), pc/mi/ln	772
Distance to Downstream Ramp (L_{DOWN}), ft	-	Off-Ramp Influenece Area Speed (S_R), mi/h	49.5
Prop. Freeway Vehicles in Lane 1 and 2 (P_D)	0.436	Outer Lanes Freeway Speed (S_O), mi/h	65.8
Flow in Lanes 1 and 2 (v_{12}), pc/h	2186	Ramp Junction Speed (S), mi/h	55.2
Flow Entering Ramp-Infl. Area (v_{R12}), pc/h	-	Average Density (D), pc/mi/ln	16.9
Level of Service (LOS)	B		

HCS7 Freeway Diverge Report

Project Information			
Analyst	GMB	Date	7/31/2019
Agency	CMTran	Analysis Year	2019
Jurisdiction	ODOT District 12	Time Period Analyzed	PM
Project Description	IR-480 WB to Grayton Rd diverge - Existing Conditions		

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	4	1
Free-Flow Speed (FFS), mi/h	60.0	30.0
Segment Length (L) / Deceleration Length (L_A),ft	1500	630
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

Adjustment Factors		
Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (V_i)	5979	783
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	3.23	1.57
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f_{HV})	0.969	0.985
Flow Rate (v_i),pc/h	6564	846
Capacity (c), pc/h	9200	1900
Volume-to-Capacity Ratio (v/c)	0.71	0.45

Speed and Density			
Upstream Equilibrium Distance (L_{EQ}), ft	-	Density in Ramp Influence Area (D_R), pc/mi/ln	27.3
Distance to Upstream Ramp (L_{UP}), ft	-	Speed Index (D)	0.569
Downstream Equilibrium Distance (L_{EQ}), ft	-	Flow Outer Lanes (v_{OA}), pc/mi/ln	1613
Distance to Downstream Ramp (L_{DOWN}), ft	-	Off-Ramp Influenece Area Speed (S_R), mi/h	49.8
Prop. Freeway Vehicles in Lane 1 and 2 (P_D)	0.436	Outer Lanes Freeway Speed (S_O), mi/h	63.4
Flow in Lanes 1 and 2 (v_{12}), pc/h	3339	Ramp Junction Speed (S), mi/h	55.7
Flow Entering Ramp-Infl. Area (v_{R12}), pc/h	-	Average Density (D), pc/mi/ln	29.5
Level of Service (LOS)	C		

HCS7 Freeway Diverge Report

Project Information			
Analyst	GMB	Date	7/31/2019
Agency	CMTran	Analysis Year	2040
Jurisdiction	ODOT District 12	Time Period Analyzed	AM
Project Description	IR-480 WB to Grayton Rd diverge - Existing Conditions		

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	4	1
Free-Flow Speed (FFS), mi/h	60.0	30.0
Segment Length (L) / Deceleration Length (L_A),ft	1500	630
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right
Adjustment Factors		
Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000
Demand and Capacity		
Demand Volume (V_i)	3261	911
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	8.43	3.45
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f_{HV})	0.922	0.967
Flow Rate (v_i),pc/h	3763	1002
Capacity (c), pc/h	9200	1900
Volume-to-Capacity Ratio (v/c)	0.41	0.53

Speed and Density			
Upstream Equilibrium Distance (L_{EQ}), ft	-	Density in Ramp Influence Area (D_R), pc/mi/ln	17.6
Distance to Upstream Ramp (L_{UP}), ft	-	Speed Index (D)	0.583
Downstream Equilibrium Distance (L_{EQ}), ft	-	Flow Outer Lanes (v_{OA}), pc/mi/ln	779
Distance to Downstream Ramp (L_{DOWN}), ft	-	Off-Ramp Influenece Area Speed (S_R), mi/h	49.5
Prop. Freeway Vehicles in Lane 1 and 2 (P_D)	0.436	Outer Lanes Freeway Speed (S_O), mi/h	65.8
Flow in Lanes 1 and 2 (v_{12}), pc/h	2206	Ramp Junction Speed (S), mi/h	55.2
Flow Entering Ramp-Infl. Area (v_{R12}), pc/h	-	Average Density (D), pc/mi/ln	17.0
Level of Service (LOS)	B		

HCS7 Freeway Diverge Report

Project Information

Analyst	GMB	Date	7/31/2019
Agency	CMTran	Analysis Year	2040
Jurisdiction	ODOT District 12	Time Period Analyzed	PM
Project Description	IR-480 WB to Grayton Rd diverge - Existing Conditions		

Geometric Data

	Freeway	Ramp
Number of Lanes (N), ln	4	1
Free-Flow Speed (FFS), mi/h	60.0	30.0
Segment Length (L) / Deceleration Length (L_A),ft	1500	630
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

Adjustment Factors

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity

Demand Volume (V_i)	6030	790
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	3.23	1.57
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f_{HV})	0.969	0.985
Flow Rate (v_i),pc/h	6620	853
Capacity (c), pc/h	9200	1900
Volume-to-Capacity Ratio (v/c)	0.72	0.45

Speed and Density

Upstream Equilibrium Distance (L_{EQ}), ft	-	Density in Ramp Influence Area (D_R), pc/mi/ln	27.5
Distance to Upstream Ramp (L_{UP}), ft	-	Speed Index (D)	0.570
Downstream Equilibrium Distance (L_{EQ}), ft	-	Flow Outer Lanes (v_{OA}), pc/mi/ln	1627
Distance to Downstream Ramp (L_{DOWN}), ft	-	Off-Ramp Influenece Area Speed (S_R), mi/h	49.7
Prop. Freeway Vehicles in Lane 1 and 2 (P_D)	0.436	Outer Lanes Freeway Speed (S_O), mi/h	63.4
Flow in Lanes 1 and 2 (v_{12}), pc/h	3367	Ramp Junction Speed (S), mi/h	55.6
Flow Entering Ramp-Infl. Area (v_{R12}), pc/h	-	Average Density (D), pc/mi/ln	29.8
Level of Service (LOS)	C		

HCS7 Freeway Weaving Report

Project Information

Analyst	CMC	Date	4/25/19
Agency	CMTran	Analysis Year	2019
Jurisdiction	ODOT District 12	Time Period Analyzed	AM
Project Description	IR-480 WB between IR-71 SB and Grayton Rd - Proposed Conditions		

Geometric Data

Number of Lanes (N), ln	5	Segment Type	Freeway
Segment Length (L_S), ft	2885	Number of Maneuver Lanes (N_{WL}), ln	2
Weaving Configuration	One-Sided	Ramp-to-Freeway Lane Changes (LC_{RF}), lc	0
Terrain Type	Level	Freeway-to-Ramp Lane Changes (LC_{FR}), lc	2
Percent Grade, %	-	Ramp-to-Ramp Lane Changes (LC_{RR}), lc	0
Interchange Density (ID), int/mi	0.50	Cross Weaving Managed Lane	No

Adjustment Factors

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

	FF	RF	RR	FR
Demand Volume (V_i), veh/h	2444	789	178	725
Peak Hour Factor (PHF)	0.94	0.94	0.94	0.94
Total Trucks, %	8.56	7.97	4.43	3.14
Heavy Vehicle Adjustment Factor (f_{HV})	0.921	0.926	0.958	0.970
Flow Rate (v_i), pc/h	2823	906	198	795

Weaving Flow Rate (v_W), pc/h	1701	Freeway Max Capacity (c_{IFL}), pc/h/ln	2300
Non-Weaving Flow Rate (v_{NW}), pc/h	3021	Density-Based Capacity (c_{IWL}), pc/h/ln	2044
Total Flow Rate (v), pc/h	4722	Demand Flow-Based Capacity (c_{IW}), pc/h	6667
Volume Ratio (VR)	0.360	Weaving Segment Capacity (c_W), veh/h	6212
Minimum Lane Change Rate (LC_{MIN}), lc/h	1590	Adjusted Weaving Area Capacity, pc/h	6667
Maximum Weaving Length (L_{MAX}), ft	6236	Volume-to-Capacity Ratio (v/c)	0.71

Speed and Density

Non-Weaving Vehicle Index (I_{NW})	436	Average Weaving Speed (S_W),mi/h	50.6
Non-Weaving Lane Change Rate (LC_{NW}), lc/h	1223	Average Non-Weaving Speed (S_{NW}), mi/h	44.0
Weaving Lane Change Rate (LC_W), lc/h	2276	Average Speed (S), mi/h	46.2
Weaving Lane Change Rate (LC_{All}), lc/h	3499	Density (D), pc/mi/ln	20.4
Weaving Intensity Factor (W)	0.263	Level of Service (LOS)	C

HCS7 Freeway Weaving Report

Project Information

Analyst	CMC	Date	4/25/19
Agency	CMTran	Analysis Year	2019
Jurisdiction	ODOT District 12	Time Period Analyzed	PM
Project Description	IR-480 WB between IR-71 SB and Grayton Rd - Proposed Conditions		

Geometric Data

Number of Lanes (N), ln	5	Segment Type	Freeway
Segment Length (L_S), ft	2885	Number of Maneuver Lanes (N_{WL}), ln	2
Weaving Configuration	One-Sided	Ramp-to-Freeway Lane Changes (LC_{RF}), lc	0
Terrain Type	Level	Freeway-to-Ramp Lane Changes (LC_{FR}), lc	2
Percent Grade, %	-	Ramp-to-Ramp Lane Changes (LC_{RR}), lc	0
Interchange Density (ID), int/mi	0.50	Cross Weaving Managed Lane	No

Adjustment Factors

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

	FF	RF	RR	FR
Demand Volume (V_i), veh/h	3744	2235	247	536
Peak Hour Factor (PHF)	0.94	0.94	0.94	0.94
Total Trucks, %	3.44	2.86	1.90	1.44
Heavy Vehicle Adjustment Factor (f_{HV})	0.967	0.972	0.981	0.986
Flow Rate (v_i), pc/h	4119	2446	268	578

Weaving Flow Rate (v_W), pc/h	3024	Freeway Max Capacity (c_{IFL}), pc/h/ln	2300
Non-Weaving Flow Rate (v_{NW}), pc/h	4387	Density-Based Capacity (c_{IWL}), pc/h/ln	2003
Total Flow Rate (v), pc/h	7411	Demand Flow-Based Capacity (c_{IW}), pc/h	5882
Volume Ratio (VR)	0.408	Weaving Segment Capacity (c_W), veh/h	5710
Minimum Lane Change Rate (LC_{MIN}), lc/h	0	Adjusted Weaving Area Capacity, pc/h	5883
Maximum Weaving Length (L_{MAX}), ft	6771	Volume-to-Capacity Ratio (v/c)	1.26

Speed and Density

Non-Weaving Vehicle Index (I_{NW})	-	Average Weaving Speed (S_W),mi/h	-
Non-Weaving Lane Change Rate (LC_{NW}), lc/h	-	Average Non-Weaving Speed (S_{NW}), mi/h	-
Weaving Lane Change Rate (LC_W), lc/h	-	Average Speed (S), mi/h	-
Weaving Lane Change Rate (LC_{All}), lc/h	-	Density (D), pc/mi/ln	-
Weaving Intensity Factor (W)	-	Level of Service (LOS)	F

HCS7 Freeway Weaving Report

Project Information

Analyst	CMC	Date	4/25/19
Agency	CMTran	Analysis Year	2040
Jurisdiction	ODOT District 12	Time Period Analyzed	AM
Project Description	IR-480 WB between IR-71 SB and Grayton Rd - Proposed Conditions		

Geometric Data

Number of Lanes (N), ln	5	Segment Type	Freeway
Segment Length (L_S), ft	2885	Number of Maneuver Lanes (N_{WL}), ln	2
Weaving Configuration	One-Sided	Ramp-to-Freeway Lane Changes (LC_{RF}), lc	0
Terrain Type	Level	Freeway-to-Ramp Lane Changes (LC_{FR}), lc	2
Percent Grade, %	-	Ramp-to-Ramp Lane Changes (LC_{RR}), lc	0
Interchange Density (ID), int/mi	0.50	Cross Weaving Managed Lane	No

Adjustment Factors

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

	FF	RF	RR	FR
Demand Volume (V_i), veh/h	2465	796	180	731
Peak Hour Factor (PHF)	0.94	0.94	0.94	0.94
Total Trucks, %	8.56	7.97	4.43	3.14
Heavy Vehicle Adjustment Factor (f_{HV})	0.921	0.926	0.958	0.970
Flow Rate (v_i), pc/h	2847	914	200	802

Weaving Flow Rate (v_W), pc/h	1716	Freeway Max Capacity (c_{IFL}), pc/h/ln	2300
Non-Weaving Flow Rate (v_{NW}), pc/h	3047	Density-Based Capacity (c_{IWL}), pc/h/ln	2044
Total Flow Rate (v), pc/h	4763	Demand Flow-Based Capacity (c_{IW}), pc/h	6667
Volume Ratio (VR)	0.360	Weaving Segment Capacity (c_W), veh/h	6212
Minimum Lane Change Rate (LC_{MIN}), lc/h	1604	Adjusted Weaving Area Capacity, pc/h	6667
Maximum Weaving Length (L_{MAX}), ft	6236	Volume-to-Capacity Ratio (v/c)	0.71

Speed and Density

Non-Weaving Vehicle Index (I_{NW})	440	Average Weaving Speed (S_W),mi/h	50.6
Non-Weaving Lane Change Rate (LC_{NW}), lc/h	1228	Average Non-Weaving Speed (S_{NW}), mi/h	43.9
Weaving Lane Change Rate (LC_W), lc/h	2290	Average Speed (S), mi/h	46.1
Weaving Lane Change Rate (LC_{All}), lc/h	3518	Density (D), pc/mi/ln	20.7
Weaving Intensity Factor (W)	0.264	Level of Service (LOS)	C

HCS7 Freeway Weaving Report

Project Information

Analyst	CMC	Date	4/25/19
Agency	CMTran	Analysis Year	2040
Jurisdiction	ODOT District 12	Time Period Analyzed	PM
Project Description	IR-480 WB between IR-71 SB and Grayton Rd - Proposed Conditions		

Geometric Data

Number of Lanes (N), ln	5	Segment Type	Freeway
Segment Length (L_S), ft	2885	Number of Maneuver Lanes (N_{WL}), ln	2
Weaving Configuration	One-Sided	Ramp-to-Freeway Lane Changes (LC_{RF}), lc	0
Terrain Type	Level	Freeway-to-Ramp Lane Changes (LC_{FR}), lc	2
Percent Grade, %	-	Ramp-to-Ramp Lane Changes (LC_{RR}), lc	0
Interchange Density (ID), int/mi	0.50	Cross Weaving Managed Lane	No

Adjustment Factors

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

	FF	RF	RR	FR
Demand Volume (V_i), veh/h	3776	2254	249	541
Peak Hour Factor (PHF)	0.94	0.94	0.94	0.94
Total Trucks, %	3.44	2.86	1.90	1.44
Heavy Vehicle Adjustment Factor (f_{HV})	0.967	0.972	0.981	0.986
Flow Rate (v_i), pc/h	4154	2467	270	584

Weaving Flow Rate (v_W), pc/h	3051	Freeway Max Capacity (c_{IFL}), pc/h/ln	2300
Non-Weaving Flow Rate (v_{NW}), pc/h	4424	Density-Based Capacity (c_{IWL}), pc/h/ln	2003
Total Flow Rate (v), pc/h	7475	Demand Flow-Based Capacity (c_{IW}), pc/h	5882
Volume Ratio (VR)	0.408	Weaving Segment Capacity (c_W), veh/h	5710
Minimum Lane Change Rate (LC_{MIN}), lc/h	0	Adjusted Weaving Area Capacity, pc/h	5883
Maximum Weaving Length (L_{MAX}), ft	6771	Volume-to-Capacity Ratio (v/c)	1.27

Speed and Density

Non-Weaving Vehicle Index (I_{NW})	-	Average Weaving Speed (S_W),mi/h	-
Non-Weaving Lane Change Rate (LC_{NW}), lc/h	-	Average Non-Weaving Speed (S_{NW}), mi/h	-
Weaving Lane Change Rate (LC_W), lc/h	-	Average Speed (S), mi/h	-
Weaving Lane Change Rate (LC_{All}), lc/h	-	Density (D), pc/mi/ln	-
Weaving Intensity Factor (W)	-	Level of Service (LOS)	F