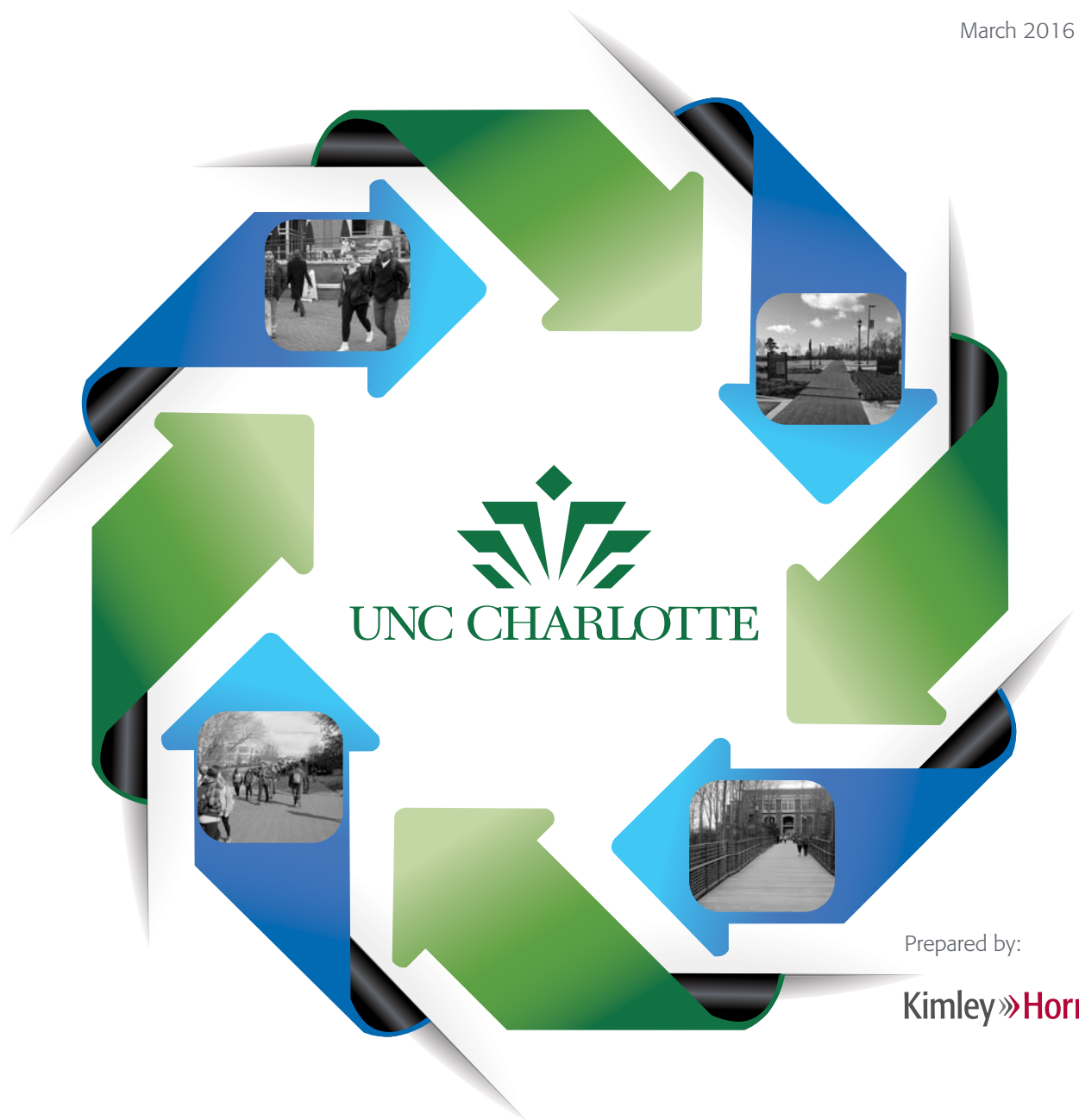




LIGHT RAIL CIRCULATION STUDY

The University of North Carolina at Charlotte

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Prepared by:

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EXECUTIVE SUMMARY

The following Light Rail Circulation Study was prepared for the University of North Carolina at Charlotte (UNC Charlotte) in order to evaluate potential multimodal impacts of two new light rail stations associated with the Charlotte Area Transit System (CATS) Blue Line Extension project. The Blue Line Extension currently is under construction and is scheduled to be operational by 2017. The two new light rail stations will be referred to as the JW Clay Station and the UNC Charlotte Main Station. The JW Clay Station will provide direct access to UNC Charlotte's Charlotte Research Institute (CRI) campus, and the UNC Charlotte Main Station will provide direct access to UNC Charlotte's main campus.

Data was provided to Kimley-Horn by CATS, UNC Charlotte, and the Light Rail Coordinating Committee (LRCC). UNC Charlotte student enrollment data (based on the Fall 2014 Registrar's course schedule) was used to determine the thirty minute period in which the number of students on campus increased the most and in what specific buildings this peak occurs. Zones (two zones on the CRI campus and four zones on the main campus) were created to group the peak enrollment data for analysis.

Data from a 2015 ridership survey conducted by the LRCC was used to approximate the total number of riders daily that could be expected at each station. A total of 2,000 daily riders are anticipated to utilize the JW Clay Station, and 4,000 daily riders are expected to use the UNC Charlotte Main Station. In order to estimate the number of riders that would walk from each station to the analysis zones (and return from the zones to the stations), a percentage of the total ridership was subtracted from the calculated peak alighting (and boarding) volumes. It was estimated that 80% of available seating on shuttles servicing the stations would be used by light rail riders, 2% of the riders would use bicycles, 5% would use vehicular travel for drop-off and pick-up activity, and the remainder would be pedestrians.

The calculated peak pedestrian loading was distributed to pedestrian paths using travel times developed with the UNC Charlotte Interactive Campus Map, field calibration, and route attractiveness criteria. With this information, we analyzed the campus sidewalk and pedestrian facility network. Pedestrians were then assigned to the identified travel routes. A gravity distribution was applied to the pedestrian volumes based on the analysis zone attraction percentages for the determined peak enrollment periods.

The overall Light Rail Circulation Study results were used to provide data to support and inform the future design of potential complementary projects on campus intended to mitigate these impacts. Some of the benefits of addressing these impacts with the recommended projects include safer, more direct access to and from the study light rail stations, reduced pedestrian and vehicular conflicts at key crossing points, and additional walkway capacity and connectivity to the stations.

Based on our findings, the full list of complementary projects, in order of priority listed, is recommended for design and implementation to provide a comprehensive approach to addressing multimodal circulation impacts at each station. The projects should be implemented as budget allows in the recommended order shown in this study, resulting in a potential overall implementation cost of \$1.4 million.





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1.0 STUDY OVERVIEW AND INTENT

The purpose of this study is to assist the UNC Charlotte with determining the potential multimodal impacts of the CATS UNC Charlotte Main Station (“Main”) and the CATS JW Clay Station (“Clay”) at the CRI campus after the LYNX Blue Line Extension becomes operational in 2017.

The intent of the results of the study is to inform the design of “complementary” projects on campus intended to mitigate these impacts.

2.0 DATA SUMMARY

2.1 Provided Data

UNC Charlotte provided Kimley-Horn sections from the 2010 Campus Master Plan covering campus transit circulation, vehicular circulation and pedestrian and bicycle circulation. These sections were provided to inform the study by supporting the existing circulation patterns, the hierarchy of the campus roadway network, and description of the parking facilities on campus.

UNC Charlotte supplied a dashboard summary of the student population that were enrolled during specific times of the day throughout the week. The population estimate was obtained using data from the Registrar’s course schedule from Fall 2014. The data included the number of students enrolled in classes in each building for thirty minute increments during the school week.

All available Geographic Information Systems (GIS) data of UNC Charlotte campus facilities was provided to aid in the analysis of potential pedestrian routes. CATS provided proposed station plans and layouts, proposed service schedule, and the anticipated maximum capacity per train for the Blue Line Extension. The UNC Charlotte LRCC provided results of the 2015 Ridership Study to aid in determining ridership numbers for the study.

2.2 Collected Data

Kimley-Horn conducted site visits to observe existing pedestrian activities and campus facilities. The data collected during these visits was used to assign calculated trips to attractive and commonly used pedestrian routes throughout the CRI and Main campuses. Existing sidewalk widths were measured along various routes that are expected to experience an increase in pedestrian activity due to the light rail.

Using UNC Charlotte’s Interactive Campus Map, pedestrian walk times were collected to identify the most logical route a pedestrian would take from the new light rail station locations. Multiple routes were studied for the buildings on each campus.

Table A on the following page shows the summary of the walk and ride time analysis from the proposed light rail stations.

Table A: Travel Time Summary

From	To	Route	Distance	Estimated Time	Average Time		
Proposed Clay Station	Bioinformatics (Zone 1)	Institute Circle	0.3 miles	5 minutes	Walk Time: 5 minutes		
Proposed Clay Station	Grigg/Duke Centennial Hall (Zone 1)	Institute Circle	0.3 miles	5 minutes	Walk Time: 5 minutes		
Proposed Clay Station	EPIC Building (Zone 2)	JW Clay Boulevard/Epic Lane	0.4 miles	8 minutes	Walk Time: 8.5 minutes		
		Institute Circle/Phillips Road	0.5 miles	9 minutes			
Proposed Main Station	Woodward Hall (Zone 3)	Cameron Boulevard	0.5 miles	9 minutes	9.5 minutes	Walk Time: 8-9 minutes	Ride Time: 3-7 minutes
		On Campus Sidewalks	0.5 miles	10 minutes			
		Green Line	0.5 miles	3 minutes	3 minutes		
Proposed Main Station	College of Education/Health and Human Services (Zone 3)	On Campus Sidewalks	0.4 miles	9 minutes	10 minutes		
		On Campus Sidewalks	0.5 miles	10 minutes			
		On Campus Sidewalks	0.6 miles	11 minutes	4 minutes		
		Green Line	0.6 miles	4 minutes			
Proposed Main Station	Burson (Zone 3)	On Campus Sidewalks	0.4 miles	9 minutes	10 minutes		
		On Campus Sidewalks	0.5 miles	10 minutes			
		On Campus Sidewalks	0.6 miles	11 minutes	4 minutes		
		Green Line	0.6 miles	4 minutes			
Proposed Main Station	Belk Gym (Zone 4)	Cameron Boulevard	0.7 miles	14 minutes	14.5 minutes	Walk Time: 14-9 minutes	Ride Time: 8-7.5 minutes
		On Campus Sidewalks	0.8 miles	15 minutes			
		Green Line	0.8 miles	8 minutes	8 minutes		
Proposed Main Station	Atkins/Cone Center (Zone 4)	On Campus Sidewalks	0.7 miles	14 minutes	14.3 minutes		
		On Campus Sidewalks	0.7 miles	14 minutes			
		On Campus Sidewalks	0.8 miles	15 minutes	7 minutes		
		Green Line	0.6 miles	7 minutes			
Proposed Main Station	Colvard (Zone 4)	On Campus Sidewalks	0.7 miles	14 minutes	14.3 minutes		
		On Campus Sidewalks	0.7 miles	14 minutes			
		On Campus Sidewalks	0.8 miles	15 minutes	8 minutes		
		Green Line	0.7 miles	8 minutes			
Proposed Main Station	Memorial Hall (Zone 4)	Cameron Boulevard	0.8 miles	16 minutes	16.5 minutes		
		On Campus Sidewalks	0.9 miles	17 minutes			
		Green Line	1.8 miles	12 minutes	12 minutes		
Proposed Main Station	Cameron (Zone 5)	On Campus Sidewalks	0.4 miles	9 minutes	9.5 minutes	Walk Time: 11.6 minutes	Ride Time: 6-3 minutes
		On Campus Sidewalks	0.5 miles	10 minutes			
		Green Line	0.5 miles	5 minutes	5 minutes		
Proposed Main Station	McEniry/Smith (Zone 5)	On Campus Sidewalks	0.6 miles	11 minutes	11.7 minutes		
		On Campus Sidewalks	0.7 miles	12 minutes			
		On Campus Sidewalks	0.7 miles	12 minutes	6 minutes		
		Green Line	0.6 miles	6 minutes			
Proposed Main Station	Fretwell/Friday (Zone 5)	On Campus Sidewalks	0.7 miles	13 minutes	13.7 minutes		
		On Campus Sidewalks	0.8 miles	14 minutes			
		On Campus Sidewalks	0.8 miles	14 minutes	8 minutes		
		Green Line	0.7 miles	8 minutes			
Proposed Main Station	Denny/Garinger/Macy/Winningham/Rowe (Zone 6)	On Campus Sidewalks	0.7 miles	14 minutes	14.7 minutes		
		On Campus Sidewalks	0.8 miles	15 minutes			
		On Campus Sidewalks	0.8 miles	15 minutes	9 minutes		
		Green Line	1 mile	9 minutes			
Proposed Main Station	Storrs (Zone 6)	On Campus Sidewalks	0.8 miles	15 minutes	16 minutes		
		On Campus Sidewalks	0.8 miles	16 minutes			
		On Campus Sidewalks	0.9 miles	17 minutes	9 minutes		
		Green Line	1.1 miles	9 minutes			
Proposed Main Station	Robinson Hall (Zone 6)	On Campus Sidewalks	0.8 miles	15 minutes	16.3 minutes		
		On Campus Sidewalks	0.9 miles	17 minutes			
		On Campus Sidewalks	0.9 miles	17 minutes	9 minutes		
		Green Line	1.1 miles	9 minutes			



3.0 FACTS AND ASSUMPTIONS

Facts:

1. CATS provided station plans and platform details for the Main and Clay stations with the following key information for the study.
 - ◆ UNC Charlotte Main Station:
 - Walkway widths: there are multiple paths between 5' and 7' with 24' total width at the crossing to Wallis Hall.
 - There is a stairs and ramp system to Lot 25.
 - There is a bus pull-off which will be used by CATS and UNC Charlotte (per MOU between University and CATS) at Main.
 - ◆ JW Clay Station:
 - The routes are fixed between Clay platform and JW Clay Deck and Campus Tower. There is a pedestrian bridge from the platform to campus with an effective walking width of 11 feet.
 - The platform has access to North Tryon Street to cross at grade at the JW Clay signalized intersection.
2. CATS provided UNC Charlotte with a maximum of 680 passengers per train for a three car train. CATS also provided the following for each station an estimated number of passengers per day:
 - ◆ UNC Charlotte Main Station (Main Campus): 1,946 passengers/day
 - ◆ JW Clay Station (CRI Campus): 1,786 passengers/day
3. CATS provided the following anticipated LRT service plan numbers for headways. The anticipated future peak and off-peak time periods will reflect the current Blue Line LRT service plan periods.
 - ◆ 7.5 minute during peak periods
 - ◆ 15 minute during off-peak periods
4. CATS provided the capacity of each bus/campus shuttle is 32 passengers.
5. CATS and UNC Charlotte provided that specific circulator routes are changing and final routes are not known at time of this study.

Assumptions:

1. It was assumed that half of the Clay Station passengers estimated by CATS would be to/from UNC Charlotte campus. A baseline of 875 passengers per day will be used at the Clay Station.
 - ◆ The 2015 Ridership Survey was conducted by the LRCC in order to help determine commuting patterns, interest in the light rail, and consideration of a bicycle sharing program. The LRCC provided the results of the survey which allowed for the estimation of daily trips generated by light rail. These results were used alongside anecdotal support given the information from CATS and Utah Transit Authority (UTA) that their station ridership expectations were doubled on opening day.
 - In particular, the results [of the Ridership Study] from Question 11 (Q11) ["Yes" comments only] were used to support adjusting the ridership numbers provided by CATS. The question is below:
**Q11. Given this new option for travel, would you be willing to commute using the LYNX light rail:
To and/or from your off campus residence to main campus?**
 - The weighted total of "Yes" respondents (1,112 of 4,882 respondents) from the survey was then extrapolated to the total numbers of campus population (31,641 total students, faculty, and staff).
 - 9,051 people who commute to campus and answered "Yes" to using LYNX.
2. It was assumed that 2/3 would use the Main Station and 1/3 would use the Clay Station (6,027 at Main and 3,023 at Clay).
 - ◆ These numbers were center-massed with CATS numbers (1,950 Main, est. 1,000 Clay) to arrive at 4,000 Main and 2,000 Clay for ridership.
3. The estimated total of daily riders at each station were evenly divided between alighting and boarding (i.e., 4,000 total daily riders at the Main Station would have 2,000 alighting and 2,000 boarding).
 - ◆ In order to determine a baseline number of pedestrians expected to walk from the light rail station to buildings throughout each campus, a percentage of the total calculated peak period alighting and boarding was subtracted for alternative modes of transportation. Peak alighting and boarding periods are discussed in more detail in the Methodology section of this report, starting on the next page.
4. The following are additional reasons supporting the alternative transportation mode subtractions:
 - ◆ Bus/shuttle circulation frequency and routes were not known at the time of the study and are changing as a result of ongoing CATS and UNC Charlotte coordination.
 - ◆ Because drop-off vehicular travel circulation behavior is dependent on variables not part of this study, a conservative percentage (below) was assumed.
 - ◆ Bicycle parking at each station was assumed to be ample and the effect of the light rail stations opening on circulation will need to be studied further. Bicycle ownership was not used as a correlating factor in determining bicycle travel on campus and it was not assumed that just because someone owns a bicycle that he or she would use it to travel to and from the station. A conservative estimate (below) was assumed for bicycle usage.





5. Below are the assumed reductions for other available modes of transportation to and from the light rail stations:
- ◆ 5% of riders will utilize vehicular travel for drop-off and pick-up activity (i.e. privately owned vehicle [POV], taxi, or Uber)
 - ◆ 2% of riders will use a bicycle
 - ◆ Max number of shuttle pick-ups (based on buses being 20% full at time of pick-up)
 - 78 at CRI Campus. This was derived from the current three bus service availability at the CRI deck (32 passengers per bus for three buses = 96 available seats)
 - 104 at Main Campus. This was derived from the current four bus service availability at Wallis Hall on Cameron Boulevard (32 passengers per bus for four buses = 128 available seats)

4.0 METHODOLOGY

4.1 Enrollment Distribution

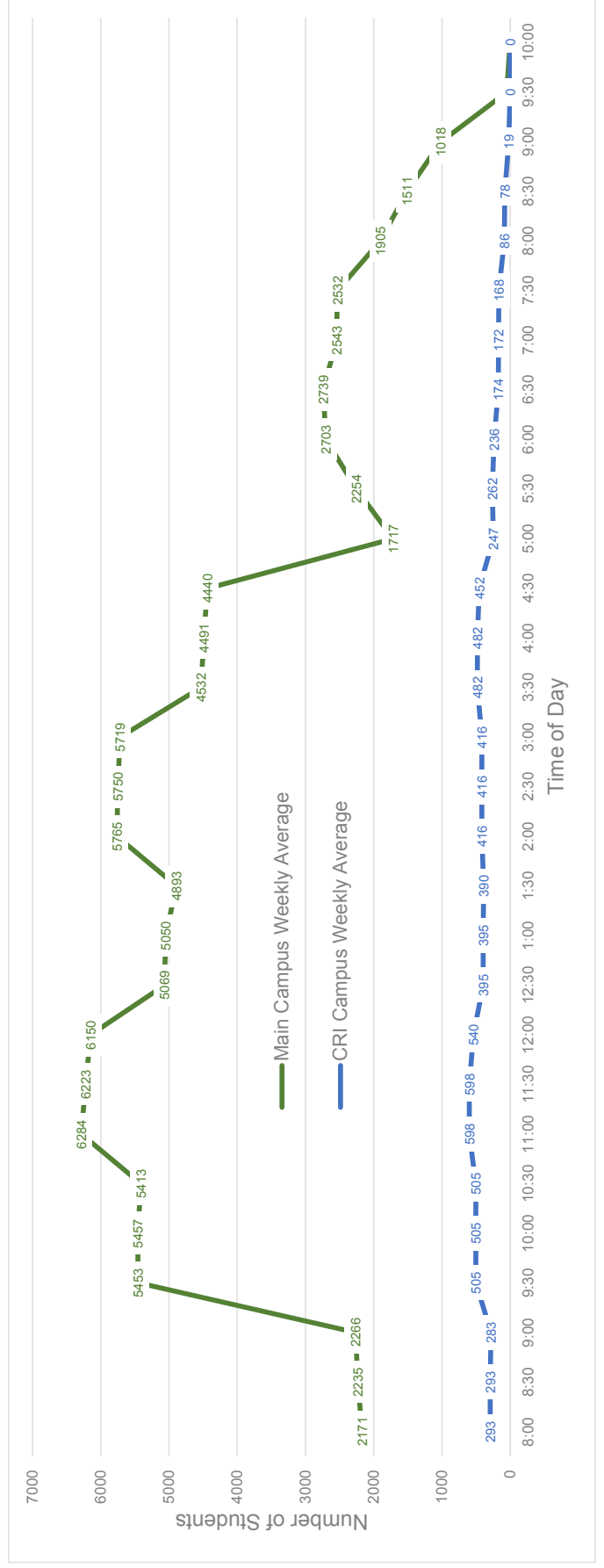
Using the dashboard summary of the student population (via Tableau Reader), enrollment numbers were extracted for all educational buildings on each campus. A daily average was calculated for Monday through Thursday for each 30-minute time period between the hours of 8:00 AM and 10:00 PM. An overall weekly enrollment average was then calculated to identify times throughout an average weekday in which the number of students on campus increased and decreased.

[Table B](#) and [Figure A](#) on the next page show the average weekly enrollment numbers for the CRI and Main Campuses.

Table B: Average Daily Enrollment Data

Standard Time	8:00	8:30	9:00	9:30	10:00	10:30	11:00	11:30	12:00	12:30	1:00	1:30	2:00	2:30	3:00	3:30	4:00	4:30	5:00	5:30	6:00	6:30	7:00	7:30	8:00	8:30	9:00	9:30	10:00	
Main Campus																														
Mon.	1,664	1,764	1,788	4,800	4,765	4,724	5,307	5,320	5,251	4,327	4,343	4,157	4,902	4,890	4,850	4,134	4,135	4,009	1,607	2,311	2,999	2,954	2,623	2,612	2,101	1,635	1,023	99	0	0
Tues.	2,380	2,439	2,440	5,591	5,607	5,577	6,814	6,654	6,627	5,135	5,067	4,996	6,369	6,369	6,388	4,819	4,766	4,730	1,993	2,375	2,872	3,194	3,126	3,097	2,388	2,011	1,409	7	0	0
Wed.	2,277	2,377	2,485	5,975	5,959	5,903	6,338	6,339	6,208	5,747	5,757	5,445	5,711	5,672	5,661	4,670	4,616	4,521	1,731	2,136	2,742	2,901	2,845	2,844	2,060	1,680	1,126	100	0	0
Thurs.	2,361	2,361	2,352	5,447	5,498	5,448	6,578	6,578	6,512	5,068	5,031	4,973	6,077	6,070	5,997	4,504	4,447	4,499	1,537	2,194	2,197	1,906	1,577	1,573	1,160	719	514	7	0	0
Weekly Avg.	2,171	2,235	2,266	5,453	5,457	5,413	6,223	6,223	6,150	5,069	5,050	4,893	5,765	5,750	5,719	4,532	4,491	4,440	1,717	2,254	2,703	2,739	2,543	2,532	1,905	1,511	1,018	53	0	
CRI Campus																														
Mon.	269	269	229	666	666	666	627	627	510	571	571	571	395	395	401	499	499	439	180	215	160	75	75	64	21	21	0	0	0	0
Tues.	335	335	335	416	416	416	560	560	560	267	267	267	468	468	458	498	498	498	247	274	279	83	74	70	17	17	12	0	0	0
Wed.	252	252	252	541	541	541	644	644	528	527	527	527	361	361	367	471	471	411	277	290	235	127	127	127	48	29	29	0	0	0
Thurs.	316	316	316	397	397	397	560	560	560	214	193	193	438	438	438	459	459	459	256	268	268	411	411	411	257	245	14	0	0	0
Weekly Avg.	293	293	283	505	505	505	598	598	540	395	390	390	416	416	416	482	482	452	247	262	236	174	172	168	86	78	19	0	0	

Figure A: Weekly Average Enrollment Totals





4.2 Peak Occupancy

Once the daily enrollment data was compiled and analyzed, the average 30 minute enrollment data between 8:00 AM and 5:00 PM for each building was used to determine the peak period in which the number of students on campus increased and decreased the most. Based on the enrollment data in Section 4.1, the peak period for the CRI Campus was estimated to occur between 7:30 AM and 8:00 AM and between 9:00 AM and 9:30 AM for the Main Campus.

Figures B and C show the general occupancy trends on the CRI and Main Campuses, respectively. It was assumed that the majority of students would remain on campus during typical lunch hours for afternoon classes.

Figure B: CRI Campus General Occupancy

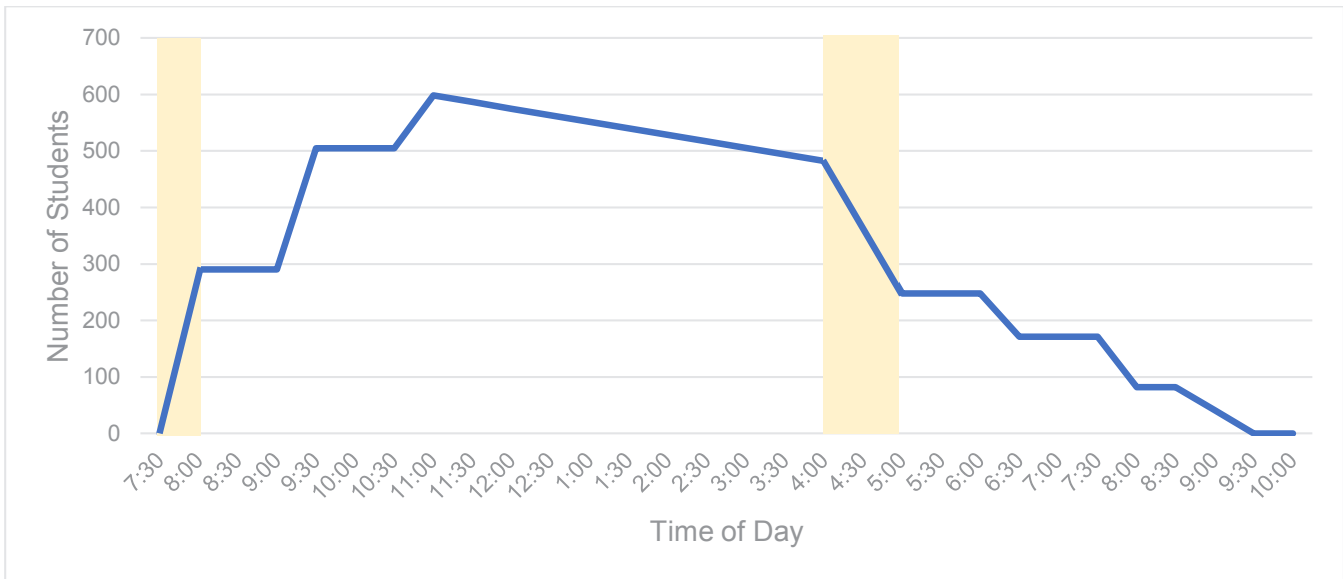
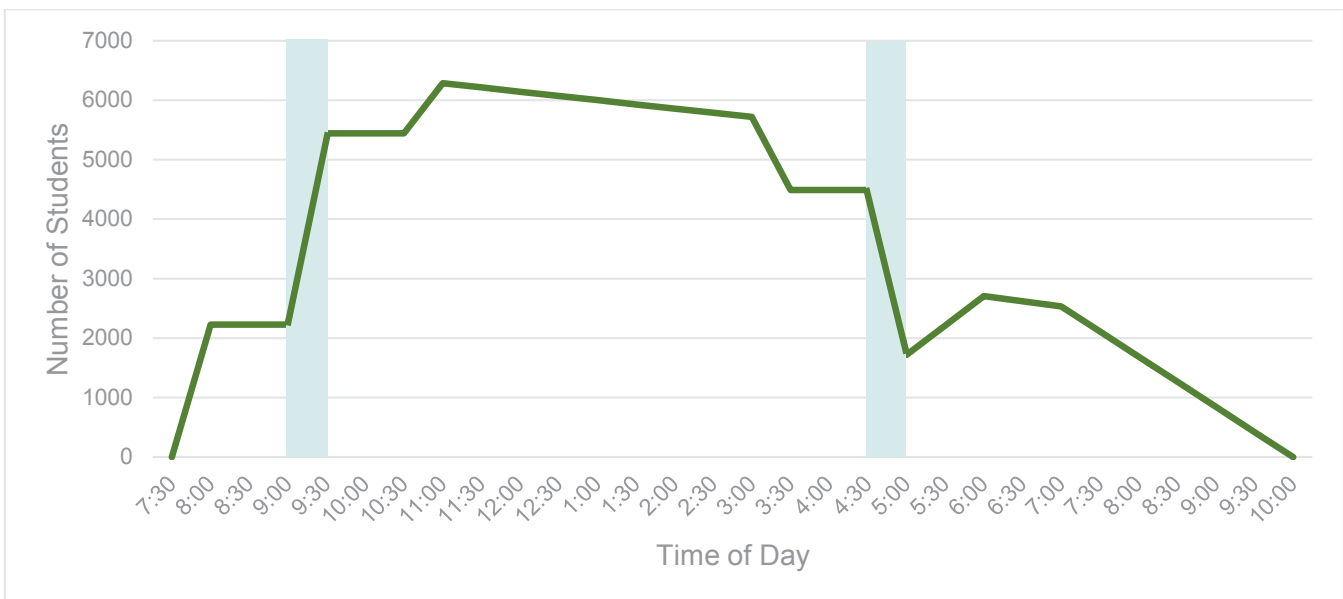


Figure C: Main Campus General Occupancy



4.3 Mode Split

Table C below shows the estimated number of pedestrians using various modes of transportation based on the applied reduction percentages discussed in Section 3.0.

Table C: Peak Hour Mode Totals

	CRI Campus		Main Campus	
	AM Peak (7:30-8:00 AM)	PM Peak (4:00-5:00 PM)	AM Peak (9:00-9:30 AM)	PM Peak (4:30-5:00 PM)
Alighting and Boarding	485	391	885	762
Vehicular	24	20	44	38
Bicycle	10	8	18	15
Bus	78	78	104	104
Pedestrian	373	286	719	605

According to the analysis performed, the highest pedestrian volumes are anticipated to occur during the AM peak hours for both campuses. These calculated pedestrian volumes were used for further analysis.

4.4 Analysis Zones

Educational buildings on the CRI and Main Campuses were combined into analysis zones based on their location and proximity to other buildings. Two analysis zones were identified for the CRI Campus, and four analysis zones were identified for the Main Campus. Analysis zones are shown in Figure D and E.

Figure D: CRI Campus Analysis Zones

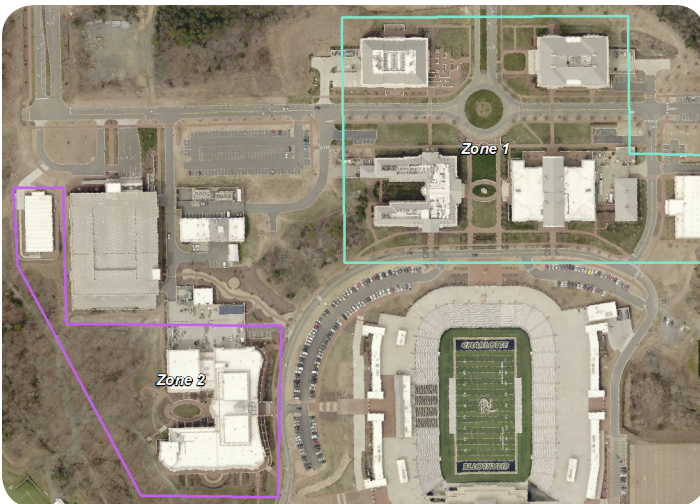
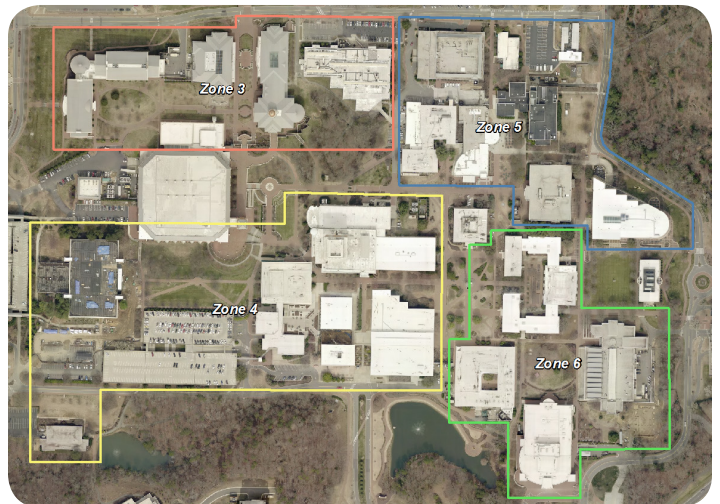


Figure E: Main Campus Analysis Zones





4.5 Zone Distribution

The number of students enrolled daily in the identified analysis zones was used to calculate distribution percentages for each analysis zone during each 30-minute period between 8:00 AM and 5:00 PM.

Table D and E below show the calculated pedestrian distributions for each analysis zone.

Table D: CRI Campus Enrollment and Distribution

CRI Campus	Time of Day																		
	8:00	8:30	9:00	9:30	10:00	10:30	11:00	11:30	12:00	12:30	1:00	1:30	2:00	2:30	3:00	3:30	4:00	4:30	5:00
Zone 1 Enrollment	124	124	114	248	248	248	299	299	240	204	204	199	229	229	226	231	231	231	111
Zone 1 Distribution	42%	42%	40%	49%	49%	49%	50%	50%	45%	52%	52%	51%	55%	55%	54%	48%	48%	51%	45%
Zone 2 Enrollment	169	169	169	257	257	256	299	299	299	191	191	191	187	187	190	251	251	221	136
Zone 2 Distribution	58%	58%	60%	51%	51%	51%	50%	50%	55%	48%	48%	49%	45%	45%	46%	52%	52%	49%	55%

Table E: Main Campus Enrollment and Distribution

Main Campus	Time of Day																		
	8:00	8:30	9:00	9:30	10:00	10:30	11:00	11:30	12:00	12:30	1:00	1:30	2:00	2:30	3:00	3:30	4:00	4:30	5:00
Zone 3 Enrollment	676	676	694	1,725	1,726	1,750	1,911	1,849	1,828	1,639	1,645	1,644	1,974	1,976	1,974	1,230	1,218	1,165	630
Zone 3 Distribution	31%	30%	31%	31%	29%	32%	30%	30%	30%	32%	33%	34%	34%	34%	35%	27%	27%	26%	37%
Zone 4 Enrollment	288	302	304	549	523	516	537	532	532	500	505	483	628	622	618	410	408	403	99
Zone 4 Distribution	13%	13%	13%	10%	9%	9%	9%	9%	9%	10%	10%	10%	11%	11%	11%	9%	9%	9%	6%
Zone 5 Enrollment	1,015	1,021	1,008	2,128	2,129	2,112	2,309	2,308	2,258	2,043	2,043	1,880	2,117	2,117	2,095	2,037	2,031	2,011	716
Zone 5 Distribution	47%	46%	44%	38%	36%	38%	37%	37%	37%	40%	40%	38%	37%	37%	37%	45%	45%	45%	42%
Zone 6 Enrollment	187	237	261	1,131	1,610	1,109	1,528	1,534	1,532	880	854	883	1,042	1,039	1,033	854	845	861	272
Zone 6 Distribution	9%	11%	12%	20%	27%	20%	24%	25%	25%	17%	17%	18%	18%	18%	18%	19%	19%	19%	16%

4.6 Pedestrian Paths

Using calculated walk times from UNC Charlotte’s Interactive Campus Map, pedestrians were distributed among existing paths based on the likelihood that a pedestrian would use the various routes that were studied. The estimated pedestrian path percentages were then used to establish a total number of students traversing a particular link along the existing sidewalk network.

Figure F shows the major pedestrian routes that were analyzed for deficiencies on the CRI Campus. Routes along North Tryon Street, JW Clay Boulevard, and Robert D. Snyder Road are anticipated to carry the majority of the pedestrian traffic generated from the new light rail station.

Figure F: CRI Campus Pedestrian Links



Table F provides more detail on the individual links that were analyzed.

Table F: CRI Campus Pedestrian Link Descriptions

Link	Description	Additional Peds	Deficiencies
NN	From proposed Clay Station to CRI Deck	236	Multiple road/driveway crossings
OO	From CRI Deck to RUP2 Lane	63	Road/driveway crossings and stairs
RR	From proposed Clay Station to Institute Circle	137	Adjacent to high volume road (North Tryon Street)
TT	From North Tryon Street along Institute Circle	63	Missing sidewalk
UU	Along Institute Circle to Phillips Road	43	Multiple sets of stairs
VW	Along Epic Lane	173	Relatively steep grade





Figure G shows the major pedestrian routes that were analyzed for deficiencies on the Main Campus. Routes between Cameron Boulevard and Craver Road are anticipated to carry the majority of the pedestrian traffic generated from the new light rail station.

Figure G: Main Campus Pedestrian Links

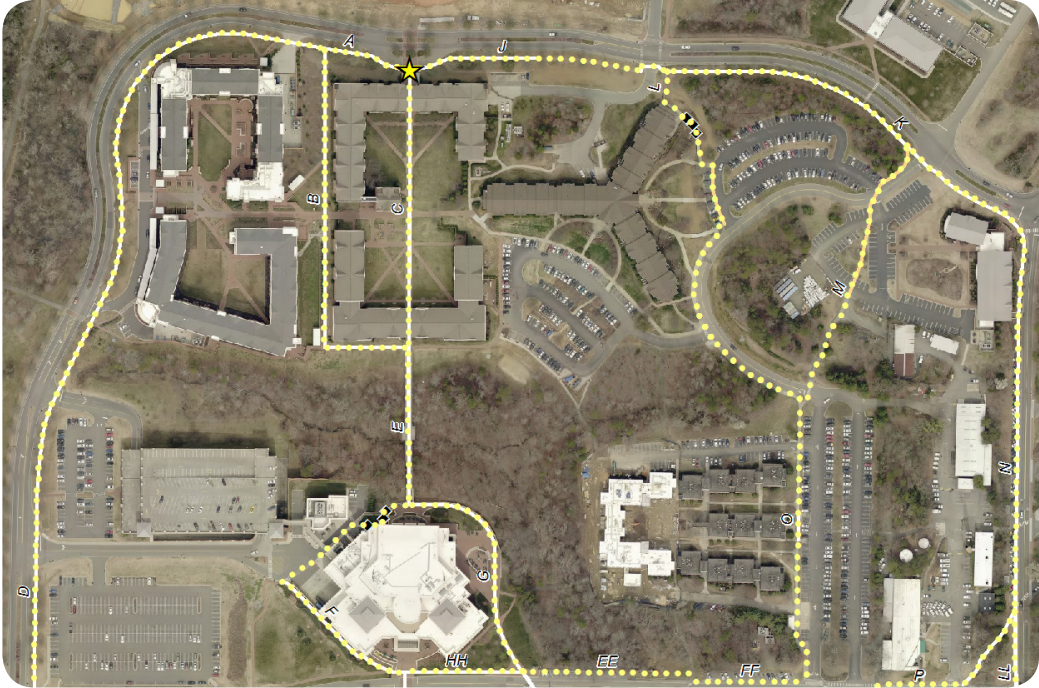


Table G provides more detail on the individual links that were analyzed.

Link	Description	Additional Peds	Deficiencies
A	From proposed Main Station to Wallis/Miltimore Hall	103	Potential vehicular interaction
B	Between Walls/Miltimore Hall to elevated boardwalk	59	Narrow sidewalk
C	From proposed Main Station to elevated boardwalk	305	Cuts through residence hall courtyard
D	From Walls/Miltimore Hall to Craver Road	44	Long route
E	Elevated Boardwalk to Student Union	364	Heavily traveled route
F	Around Student Union towards parking deck	15	Multiple sets of stairs and narrow sidewalks
G	Around Student Union to Craver Road	349	Heavily traveled route
J	From proposed Main Station to Poplar Lane	311	Narrow and steep sidewalk
K	From Poplar Lane to Poplar Terrace Drive	205	Narrow sidewalk
L	From Cameron Boulevard towards Witherspoon Hall	106	Multiple sets of stairs and missing sidewalk
M	From Cameron Boulevard towards Pine/Elk/Oak Halls	106	Missing sidewalks
N	Along Cameron Boulevard from Poplar Terrace Drive	99	Long route
O	In front of Pine/Elm/Oak Halls	212	Adjacent to parking lot
P	From Mary Alexander Road to Craver Road	7	Recently upgraded
EE	Along Craver Road from Student Union to Library Lane	33	Recently upgraded
FF	Along Craver Road from Library Lane to Lot 16	14	Recently upgraded
HH	Along Craver Road in front of Student Union	166	Recently upgraded
LL	Along Mary Alexander Road	92	Recently upgraded

4.7 Pedestrian Signal Warrant Analysis

Signal warrant analysis were calculated based on Figure 4C-7, Warrant 4 for the expected pedestrian and vehicular volumes at an existing crosswalk on Cameron Boulevard near Wallis Hall and a proposed crosswalk at JW Clay Boulevard/Robert D. Snyder Road near the CRI Deck. The pedestrian volumes described in Section 4.3 were used for this analysis. The AM and PM peak hour of pedestrian volumes expected at the light rail stations were compared with the vehicular volumes at each crosswalk location.

The vehicular volumes along Cameron Boulevard were calculated using vehicular turning movement counts from previous UNC Charlotte studies and by applying a 2% growth rate to develop horizon-year volumes.

Vehicular volumes on JW Clay Boulevard/Robert D. Snyder Road were developed using empty space counts from spring 2014 at the CRI deck and CRI 2. The number of vehicles that were expected at the AM and PM peak hours then were assigned to JW Clay Boulevard and Robert D. Snyder Road to develop vehicular volumes at the proposed crosswalk location. A 2% annual growth rate was applied to the 2014 volumes to calculate the 2016 and 2020 volumes.





5.0 STUDY RESULTS

Based on the performed analysis for the various modes of transportation, multiple recommendations were identified for existing pedestrian facilities. Some of the recommendations include new sidewalk connections, widening of existing sidewalks, and signalized pedestrian crosswalks.

Potential pedestrian facility enhancements are briefly summarized in Section 6.

Bus circulator route results and subsequent recommendations are not included in this study.

5.1 Pedestrian Volumes

Based on the calculated pedestrian distribution for each route, higher pedestrian volumes are anticipated along main connections in close proximity to the proposed light rail stations.

Pedestrian volumes along the main sidewalks studied on the CRI Campus can be handled without widening any of them. However, additional sidewalks could be constructed to increase connectivity and reduce volumes along the existing routes.

Pedestrian volumes along the major sidewalks studied on the Main Campus show that additional capacity is needed near the proposed Main Station in order to handle the predicted pedestrian loads during peak times. The anticipated increase in pedestrians on the Cameron Boulevard sidewalk between Wallis Hall and Poplar Terrace Drive negatively impacts the Pedestrian Level of Service during peak times.

[Appendix A](#) contains figures displaying the calculated link volumes.

5.2 Pedestrian Signals

Based on the expected vehicular and pedestrian volumes at the proposed crosswalk locations along Cameron Boulevard and JW Clay Boulevard/Robert D. Snyder Road, installing pedestrian activated high-intensity activated crosswalk (HAWK) signals at both locations is warranted. With the influx of pedestrian volume expected with the light rail during the AM and PM peak hours, a HAWK signal will allow pedestrian to cross Cameron Boulevard and Robert D. Snyder Road safely and efficiently. [Figures H and I](#) on the following page show the signal warrant analysis that was performed for each proposed crosswalk location.

Figure H: Crosswalk Analysis over Robert D. Snyder Road

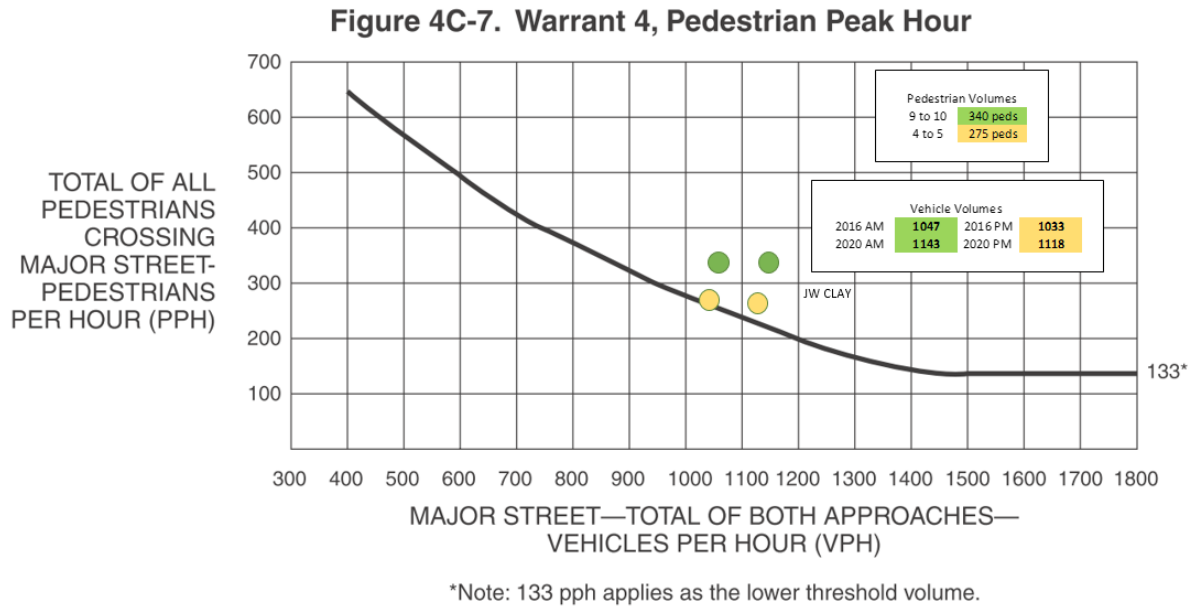
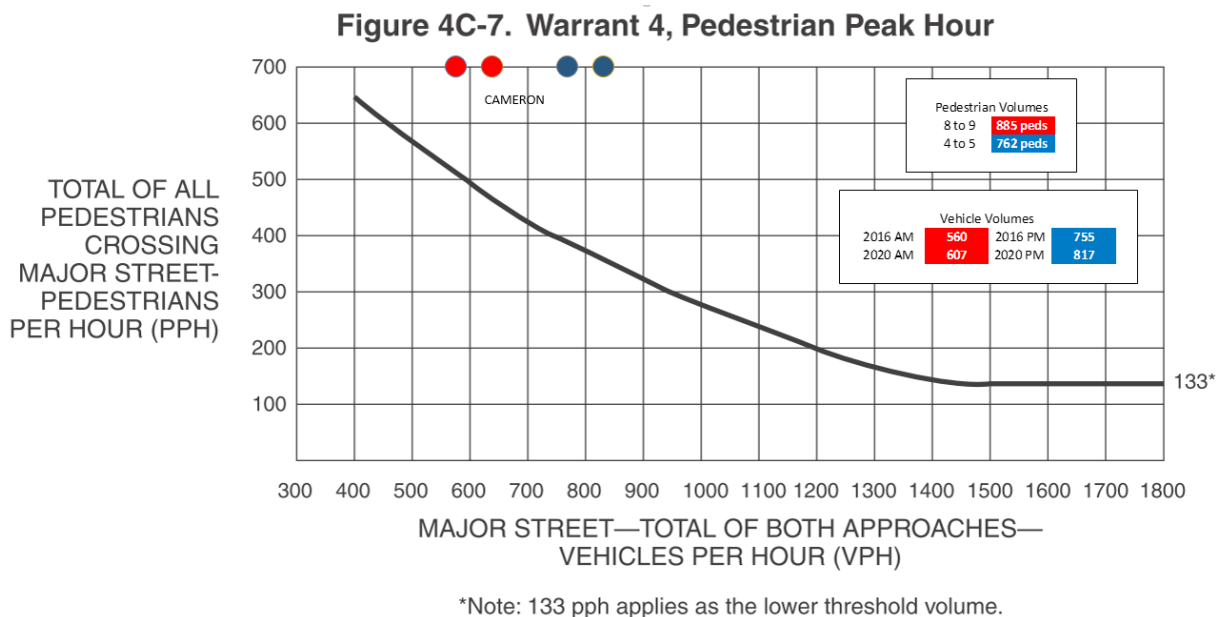


Figure I: Crosswalk Analysis over Cameron Boulevard





The pedestrian crosswalk time is typically developed with a 7-second walk time plus the crosswalk length divided by 3.5 feet/second per the MUTCD. Using this methodology, the timing at Cameron Boulevard at the light rail station would be a 7-second walk time plus a 13-second flash time, yielding a 20-second cycle length for the HAWK signal. At the proposed light rail crosswalk along Robert D. Snyder Road, the same methodology would apply a 7-second walk time plus a 10-second flash time, yielding a 17-second cycle length for the HAWK signal.

The HAWK signals can be coordinated with the signal at Cameron Boulevard at Mary Alexander Road and JW Clay Boulevard at US 29. The coordination will need to be monitored and, if the HAWK signals are limiting the platooning and progression of traffic volume along the corridor, they will need to be switched out of coordination and run strictly on pedestrian activation. Another advantage of running on pedestrian activation versus coordination is pedestrians will not be waiting for a downstream signal. If pedestrians are waiting and no vehicles are causing conflict, pedestrians are likely to disobey the HAWK signal and cross the street outside the walk and flash times.

Cameron Boulevard at Mary Alexander Road and Phillips Road/Craver Road at Cameron Boulevard do not need to be coordinated because they are too far apart. Coordinating these two signals may cause undesirable progression through campus.

From field observations and Synchro queueing analysis, the eastbound queue along Cameron Boulevard at Mary Alexander Road nearly extends to Poplar Lane during the peak time for class dismissal. The length of this queue is not expected to affect the HAWK signal operations at Cameron Boulevard and the light rail station stop. If the queue were to spill back into the HAWK signal crossing at Cameron Boulevard, the pedestrians would still maintain right-of-way and should be able to cross Cameron Boulevard safely.

5.3 POV Analysis

Based on the total anticipated Privately Owned Vehicle (POV) users at each station, existing facilities are expected to be able to handle all POV activity. Approximately 12 POVs are predicted during the most intense 15-minute period at the JW Clay Station. This estimate shows that ample parking is provided in the CRI Deck. If needed, available space along Robert D. Snyder Road can be utilized to add a POV drop off lane in the future. Approximately 22 POVs are predicted during the most intense 15-minute period at the UNC Charlotte Main Station. This estimate shows that ample parking is provided in Lot 25 without any modifications to existing circulation.

5.4 Bicycle Analysis

Based on the total anticipated bicycle users at each station, proposed bicycle parking is expected to be more than enough. The users modeled for the study are commuters using the train to get to campus. This study does not reflect an estimate of bicycle use or parking by area residents using the light rail to leave the University, as this activity will likely differ and needs to be studied further to understand the impact to the bike parking at the stations and surrounding residence halls. Therefore, the study does not recommend modifying or increasing the bicycle parking that is to be provided at each station.

In terms of bicycle circulation, current bicycle facilities on Cameron Boulevard are adequate for the calculated number of additional users at the UNC Charlotte Main Station. For CRI Campus bicycle users, the addition of bicycle lanes on Robert D. Snyder Road can be evaluated during future development phases. The study does not justify widening Robert D. Snyder Road to add bicycle lanes.

Beyond the results and recommendations of this study, one approach to addressing bicycle circulation on the CRI Campus may involve a holistic approach to the street design. A complete street approach, one geared towards all users, motorists, pedestrians, bicyclists and transit, could be assessed and potentially implemented on Robert D. Snyder Road. Reallocation of the street lane widths and markings and studying the addition of shared lane markings (or "sharrows") could result in an approach that would address the discontinuity of bicycle facilities from Institute Circle to JW Clay Boulevard along Robert D. Snyder Road.

6.0 RECOMMENDATIONS

Results and subsequent recommendations are based on regularly occurring, weekday peak campus hours. Results and recommendations are not based on off-peak hours, events, or nights and weekends.

According to the performed analysis, the following complementary projects, shown in [Figures J](#) and [K](#), are recommended to offset the estimated increase in pedestrian traffic on UNC Charlotte's facilities after the Blue Line Extension opens in 2017.

Project costs are outlined in [Table H](#). A recommended project prioritization is shown in [Table I](#). The prioritization considers reduced walk distance, safety, reduced pedestrian/vehicular conflicts, coordination with future campus facility projects in the vicinity of the stations and impacted pedestrian links, as well as overall cost of each project.

The full list of complementary projects, in order of priority listed, is recommended for design and implementation to provide a comprehensive approach to addressing circulation impacts at each station. The projects should be implemented as budget allows in the recommended order shown in [Table I](#).

[Figures J](#) and [K](#) show the approximate locations for the complementary projects on the CRI and Main Campuses, respectively. The CRI Campus complementary projects should address the Blue Line Extension infrastructure along North Tryon and the future streetscape along JW Clay north of North Tryon. Future coordination with City of Charlotte Engineering & Property Management, CDOT and CATS will be necessary during design and implementation of the complementary projects.

Figure J: CRI Campus Complementary Projects

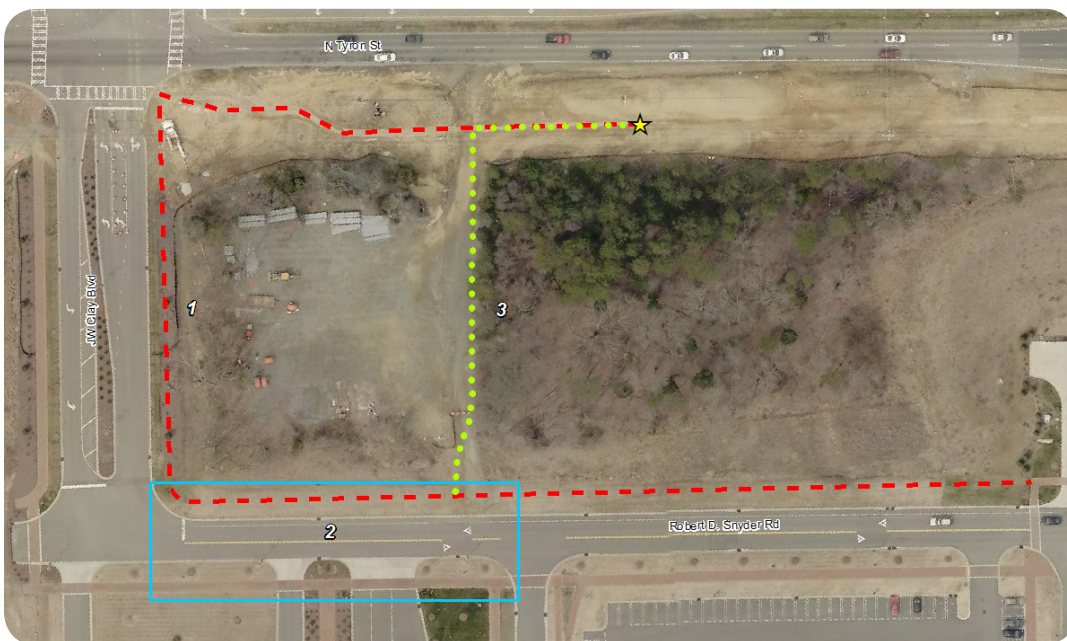




Figure K: Main Campus Complementary Projects

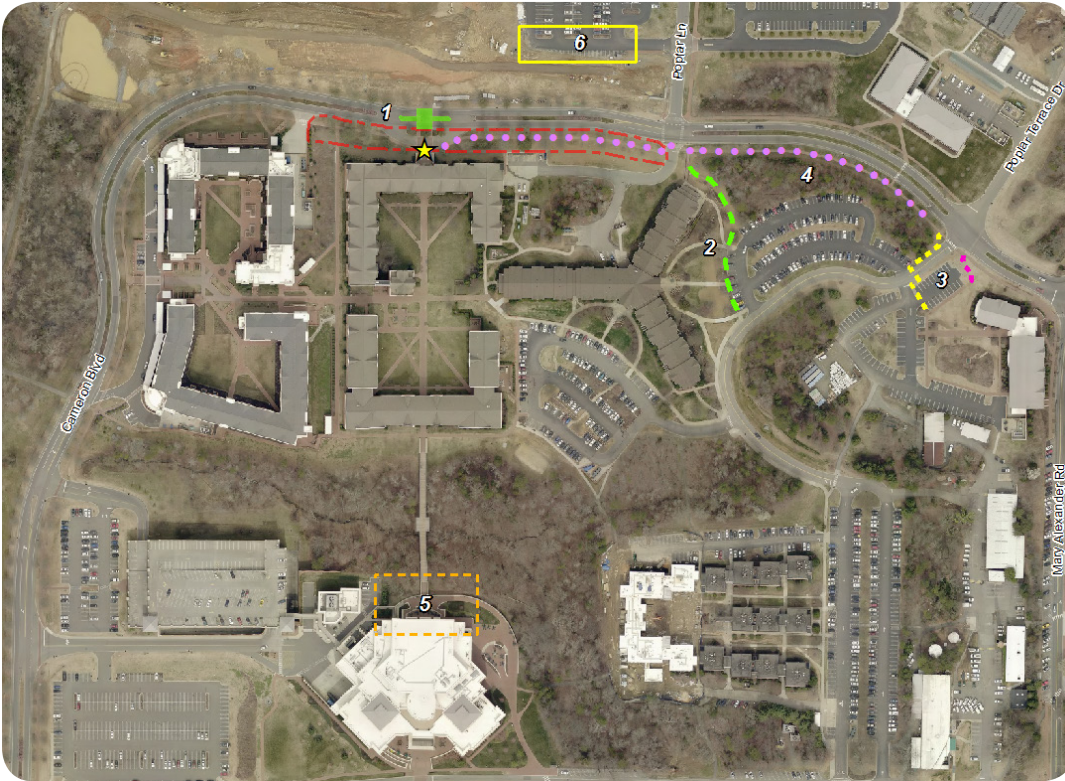


Table H shows an estimated cost summary for the recommended complementary projects.

Table H: Complementary Project Cost Breakdown

Project	Description	Construction Cost	Project Cost
CRI 1	Sidewalk connection on JW Clay (N) and Robert D. Snyder Road	\$240,000	\$320,000
CRI 2	Crosswalk from Robert Snyder; new sidewalk to CRI Deck	\$60,000	\$80,000
CRI 3	New connection from Clay Station to Robert D. Snyder Road	\$310,000	\$410,000
Main 1	Main Station crosswalk improvements and plaza/drop off improvements	\$420,000	\$550,000
Main 2	Witherspoon new sidewalk from Cameron Boulevard to Poplar Terrace Lane	\$80,000	\$110,000
Main 3	Sidewalk connection to future counseling center	\$60,000	\$80,000
Main 4	Sidewalk widening on Cameron (EB) from Wallis Hall to Poplar Terrace Lane	\$100,000	\$130,000
Main 5	Access improvements behind Student Union	\$80,000	\$110,000
Main 6	Lot 25 POV Signage	\$8,000	\$11,000

Table I shows an estimated cost summary for combinations of the recommended complementary projects.

Table I: Complementary Project Prioritization

Priority Number	Project Name	Project Cost	Cumulative Cost	Project Importance
1	Main 1	\$550,000	\$550,000	Safer access to Main Campus
2	CRI 1	\$320,000	\$870,000	Reduces pedestrian/vehicular conflicts
3	CRI 2	\$80,000	\$950,000	Provides safe roadway crossing
4	Main 4	\$130,000	\$1,080,000	Increases sidewalk capacity
5	Main 2	\$110,000	\$1,190,000	Minimizes obstacles
6	Main 6	\$11,000	\$1,201,000	Designates POV parking
7	Main 3	\$80,000	\$1,281,000	Constructs missing sidewalk
8	Main 5	\$110,000	\$1,391,000	Improves pedestrian access

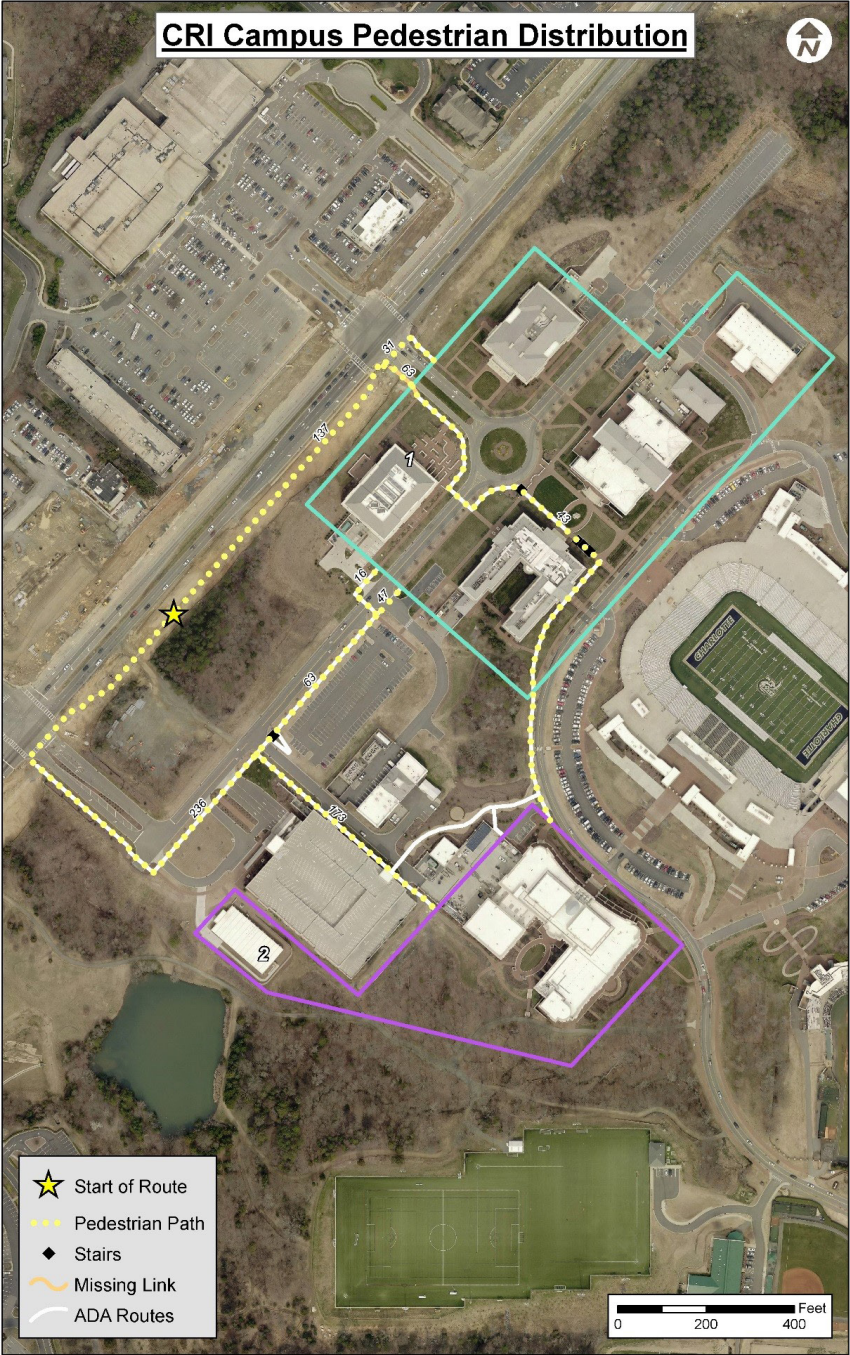
Appendix B contains more detailed information for each of the recommended complementary projects.

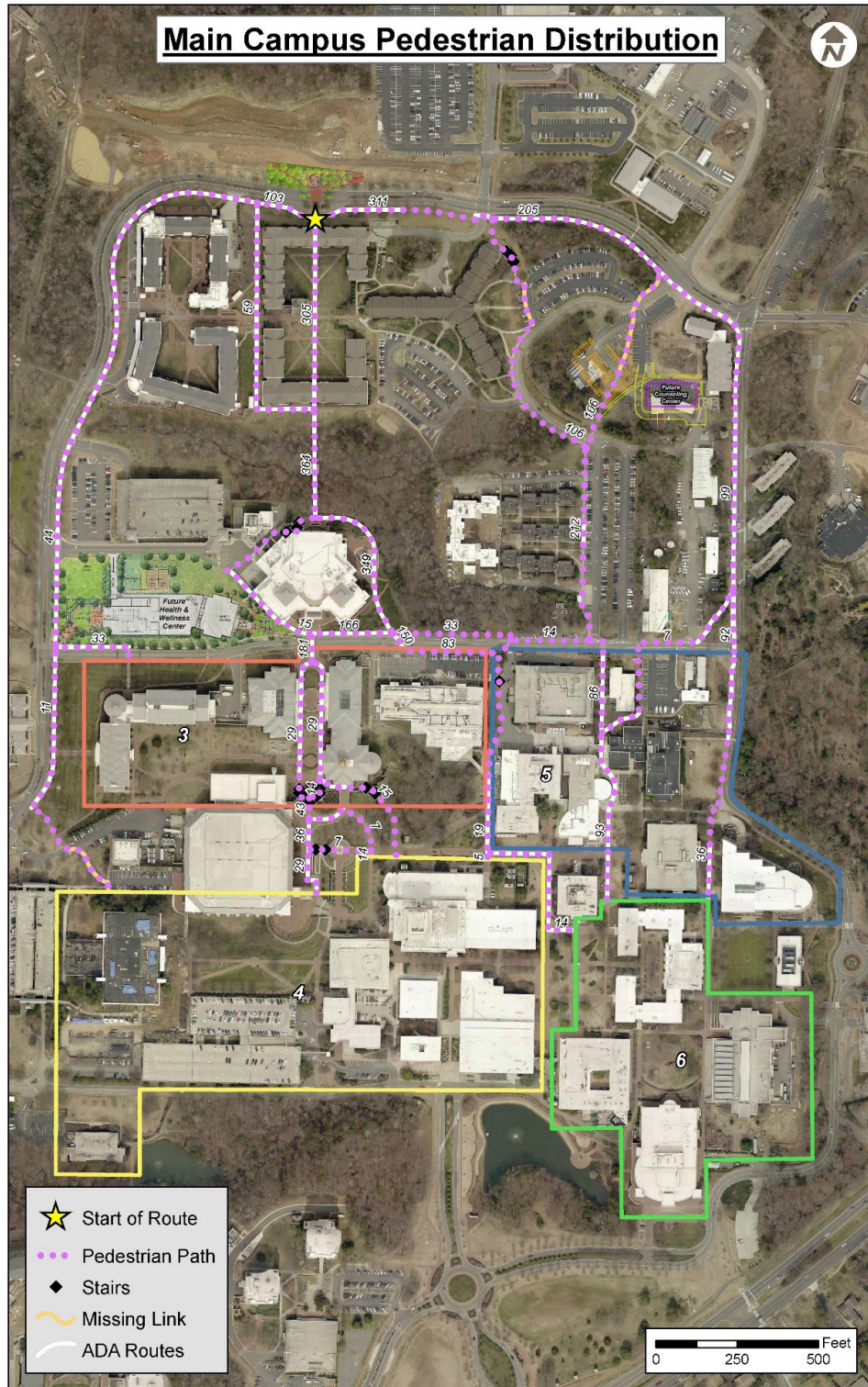




APPENDIX A: PEDESTRIAN LINK VOLUMES

The following Pedestrian Link Volumes reflect **ONLY** the anticipated increase in link volumes due to the impact of the light rail. These volumes are in addition to the existing link volumes.







APPENDIX B: COMPLEMENTARY PROJECTS

Project Location: CRI Campus (Proposed JW Clay Station)

Project Name: CRI 1

Project Description: JW Clay Boulevard and Robert D. Snyder Road sidewalk connection

Estimated Cost: \$320,000 total project cost (\$80,000 for administrative costs + \$240,000 for construction costs)

Project Benefits:

- ◆ Provides additional route for students to access CRI Campus
- ◆ Reduces conflict points with vehicular traffic



Project Location: CRI Campus (Proposed JW Clay Station)

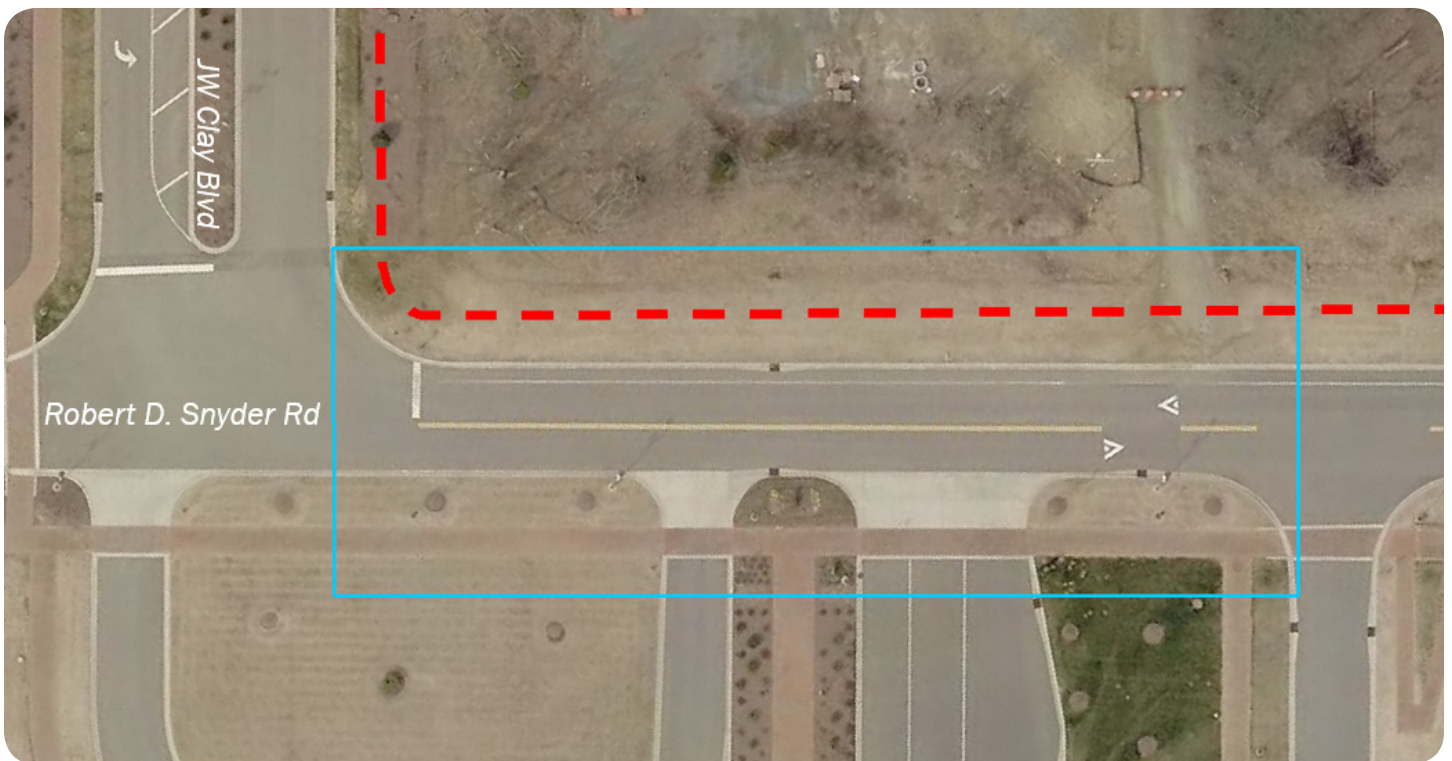
Project Name: CRI 2

Project Description: Crosswalk over Robert D. Snyder Road — specific location to be determined

Estimated Cost: \$80,000 total project cost (\$20,000 for administrative costs + \$60,000 for construction costs)

Project Benefits:

- ◆ Provides designated crossing for students to access CRI Campus





Project Location: CRI Campus (Proposed JW Clay Station)

Project Name: CRI 3

Project Description: New pedestrian connection

Estimated Cost: \$410,000 total project cost (\$100,000 for administrative costs + \$310,000 for construction costs)

Project Benefits:

- ◆ Provides more direct route for students to access CRI Campus
- ◆ Reduces conflict points with vehicular traffic
- ◆ Reduces walk time



Path	Distance	Walk Time*
Red	910 feet	~3.8 minutes
Green	415 feet	~1.7 minutes

**Average walking speed of 4 feet/second*

Project Location: Main Campus (Proposed UNC Charlotte Main Station)

Project Name: Main 1

Project Description: Main Station crosswalk improvements with potential plaza/drop-off improvements

Estimated Cost:

- ◆ Main Station crosswalk improvements: \$300,000 total project cost (\$70,000 for administrative costs + \$230,000 for construction costs)
- ◆ Main Station crosswalk improvements plus plaza/drop-off improvements: \$550,000 total project cost (\$130,000 for administrative costs + \$420,000 for construction costs)

Project Benefits:

- ◆ Provides designated crossing for students to access CRI Campus





Project Location: Main Campus (Proposed UNC Charlotte Main Station)

Project Name: Main 2

Project Description: Witherspoon sidewalk

Estimated Cost: \$110 total project cost (\$30,000 for administrative costs + \$80,000 for construction costs)

Project Benefits:

- ◆ Provides unimpeded route for students (i.e. no stairs and parking lot)



Project Location: Main Campus (Proposed UNC Charlotte Main Station)

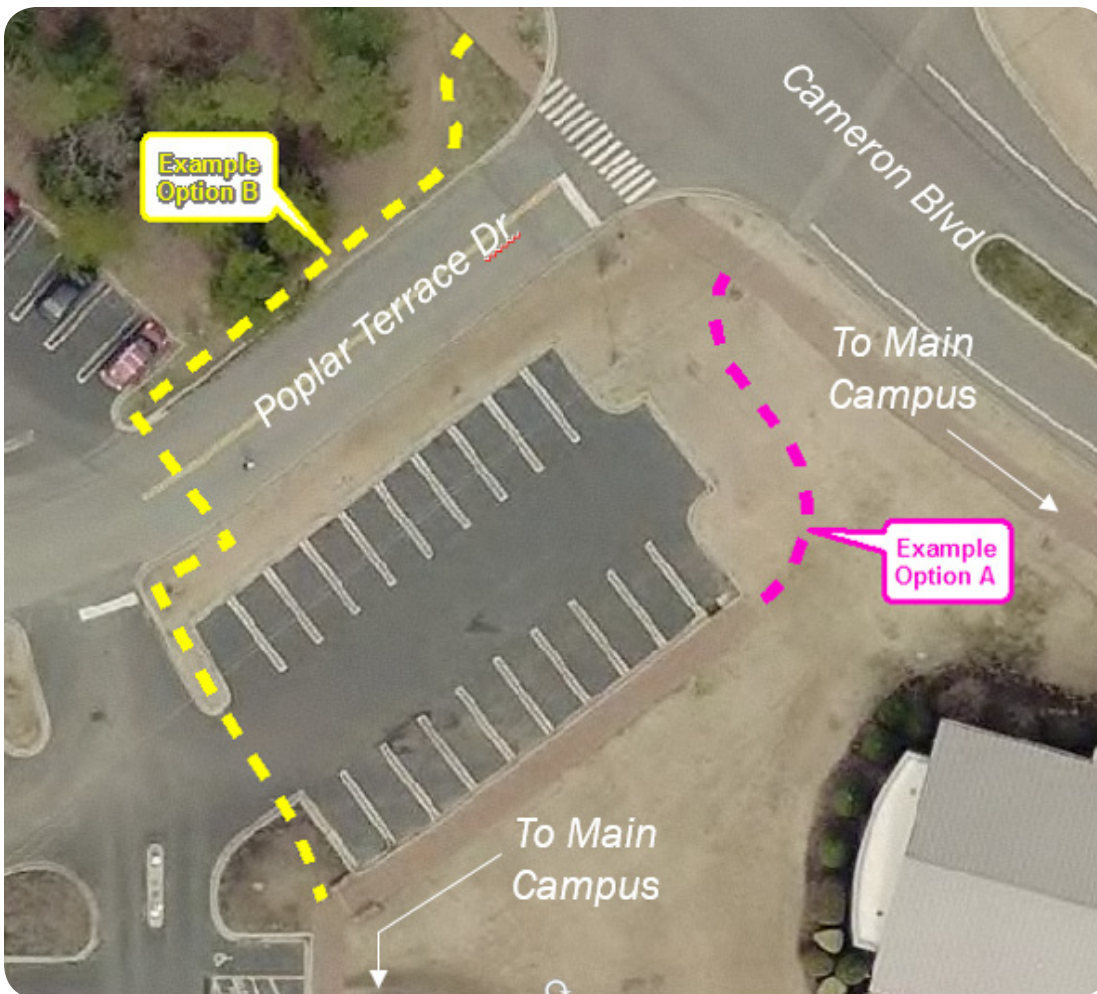
Project Name: Main 3

Project Description: Counseling Center sidewalk connection

Estimated Cost: \$80,000 total project cost (\$20,000 for administrative costs + \$60,000 for construction costs)

Project Benefits:

- ◆ Provides direct connection for students
- ◆ Reduces vehicular conflicts



It was assumed that a complete walkway connection will be constructed as part of the Student Counseling Center addition project.





Project Location: Main Campus (Proposed UNC Charlotte Main Station)

Project Name: Main 4

Project Description: Cameron Boulevard sidewalk widening

Estimated Cost: \$130,000 total project cost (\$30,000 for administrative costs + \$100,000 for construction costs)

Project Benefits:

- ◆ Provides increased sidewalk capacity for students



Main Station to Poplar Lane	Poplar Lane to Poplar Terrace Drive
Baseline Pedestrian Volume (5' sidewalk) — 750	Baseline Pedestrian Volume (5' sidewalk) — 750
Total Pedestrian Volume — 1,061	Total Pedestrian Volume — 955
Exceeds LOS C	Approaches LOS C
Increase to 8' wide sidewalk	Increase to 8' wide sidewalk

Project Location: Main Campus (Proposed UNC Charlotte Main Station)

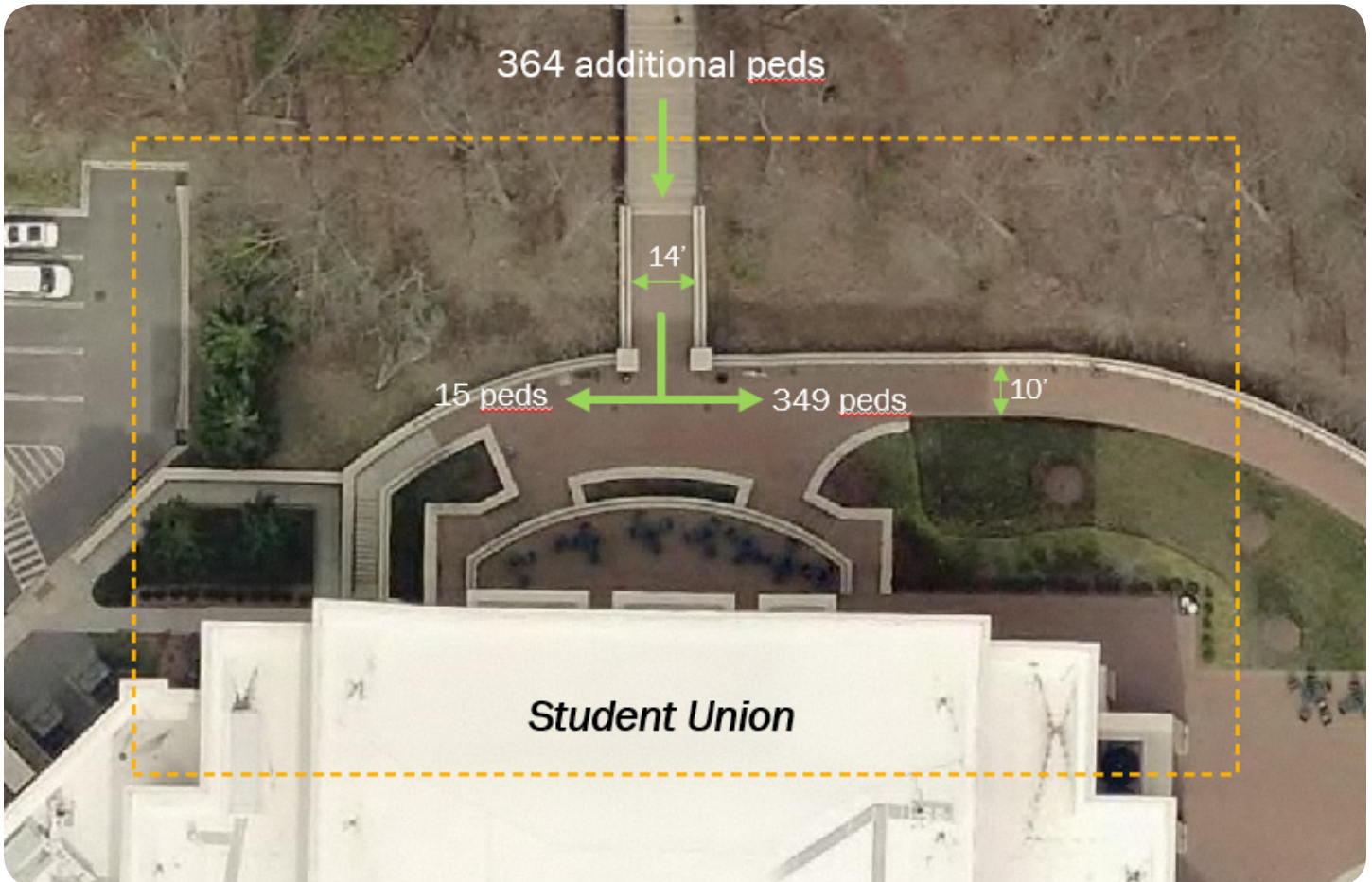
Project Name: Main 5

Project Description: Access improvements behind Student Union

Estimated Cost: \$110,000 total project cost (\$30,000 for administrative costs + \$80,000 for construction costs)

Project Benefits:

- ◆ Provides better accessibility to the Student Union





Project Location: Main Campus (Proposed UNC Charlotte Main Station)

Project Name: Main 6

Project Description: Lot 25 POV Signage

Estimated Cost: \$11,000 total project cost (\$3,000 for administrative costs + \$8,000 for construction costs)

Project Benefits:

- ◆ Provides designated area for POV users






UNC CHARLOTTE