PUBLIC SQUARE/DOWNTOWN CLEVELAND TRANSPORTATION STUDY

INTRODUCTION

Plan Vision

Public Square is the physical and historic center of Cleveland. The greater Square is crossed by two significant roads (Superior and Ontario Avenues), effectively dividing the place into four smaller squares. These road crossings result in Pubic Square being more about transportation than land use, exactly the opposite of what makes a great downtown focal point.

The City of Cleveland, through the Group Plan Commission Planning, has created a new vision of Public Square that balances land use and transportation, based on the following goals:

- Catalyze Public Square as an attractive, sustainable, green, and extraordinary public park in the heart of our City
- Emphasize people and place rather than cars
- Maximize the connection to The Mall and the diagonal site line from Plaza A (aka Mall A) to Terminal Tower
- Facilitate the successful flow of people, cars, and buses

Nelson\Nygaard translated these goals into the following functional principals to guide a redesign of Public Square:

1. Create a place for all people
2. Activate the Square 18 hours a day
3. Draw people to and through the interior (active internal spaces)
4. Connect neighboring districts/public spaces (supports walking and biking in downtown)
5. Connect the region to the downtown (transit is primary access mode)
6. Accommodate daily activities (sitting, eating, strolling, etc) and large events (e.g., markets, concerts, rallies, etc) without detracting from Mall A
7. Promote infill development and economic activity at the edges and uses that development to draw people to the Square
8. Compliment the new investments occurring throughout Downtown (Casino, restaurants, sports complexes) with a signature public space

Analysis Context

Based on the transportation principles, several scenarios for changes to the streets through and around Public Square were evaluated against a set of preliminary screening criteria. The following four scenarios were selected during this Phase 1 analysis for more detailed analysis of traffic, transit, and other transportation function:

1. full closure of Ontario and continued operation of Superior for general traffic;
2. full closure of Ontario and closure of Superior for general traffic, but maintaining transit throughput;
3. full closure of Ontario and closure of Superior for general traffic except for peak hours, but maintaining transit throughput all day and;
4. full closure of both streets.

Phase 2 analysis of these four scenarios started in September 2014 with a tailored scope to answer the most immediate questions about multimodal operations around the Square, while at the same time data was being collected for 33 relevant intersections throughout downtown Cleveland. Once a baseline of acceptable conditions was identified and a basic design established, a concurrent study for Maintenance of Traffic (MOT) during construction was also initiated.

This report documents the analysis and conclusions of Phase 2 of the Public Square/Downtown Cleveland Transportation Study. Each section includes the technical memorandum submitted to the Agency Working Group (the City of Cleveland, RTA, ODOT, and NOACA) and any conclusions received from that Group.

PHASE 2

Data Collection: Vehicle, Pedestrian, and Bicycle Counts

Phase 1 included analysis of 12 intersections, primarily those directly around and within two to three blocks of Public Square, as they have the greatest potential to be changed due to street and transit modifications around the Square. Phase 2 broadened the study area since diverting traffic from Public Square will extend the range of geographic impact to a broader range of intersections.

Nelson\Nygaard contracted with TMS Engineers to count the following conditions during the AM and PM peak periods:

- Vehicles volumes and turn movements;
- Vehicle classification to determine cars, trucks, and buses;
- Pedestrian and bicycle volumes (for both Phase I and Phase II intersections); and
- Determination of the peak hour and average daily volumes.

Data was counted and analyzed for **33** intersections where existing data was not available or required re-calibration (based on input from the City of Cleveland, RTA, ODOT, and NOACA). This effort also provided an opportunity to collect data for intersections included in the previous analysis where data was borrowed from earlier counts. TMS also verified the physical and operational elements of all of the intersections (both Phase 1 and Phase 2), including observations regarding the flow of traffic and traffic signal operations, measurements of street widths, size of radii, and sight distance measurements.

The following table describes intersections available from Phase 1 and those counted and evaluated Phase 2.

Phase 1 Intersections	Phase 2 Intersections
▪ Superior and Prospect ▪ Superior and East and West Roadway ▪ Superior and Huron ▪ Superior and E 9th ▪ South Roadway and Euclid ▪ North Roadway/Frankfort and Ontario ▪ North Roadway/Frankfort and W. 3rd ▪ Huron and Ontario ▪ Prospect and Ontario ▪ Prospect and E 9th ▪ Prospect and E 14th ▪ Superior and W 3rd	▪ Chester Ave. / Vincent Ave. at E. 9th St. (offset intersection) ▪ Euclid Ave. at E. 9th St. ▪ Euclid Ave. at E. Roadway ▪ Lakeside Ave. at W. 6th St. ▪ Lakeside Ave. at W. 3rd St. ▪ Lakeside Ave. at Ontario St. ▪ Frankfort Ave. at West Roadway ▪ Rockwell Ave. at Ontario St. ▪ Rockwell Ave. at East Roadway ▪ St. Clair Ave. at W. 6th St. ▪ St. Clair Ave. at W. 3rd St. ▪ St. Clair Ave. at Ontario St. ▪ St. Clair Ave. at E. 6th St. ▪ St. Clair Ave. at E. 9th St. ▪ Superior Ave. at Ontario St. ▪ Superior Ave. at E. 6th St. ▪ South Roadway midblock crossing in front of Tower City ▪ South Roadway at Ontario St. ▪ Lakeside and E. 9th St. ▪ St. Clair and W. 9th St. ▪ Carnegie and E. 14th St.

Turning Radii Review (November 11, 2014)

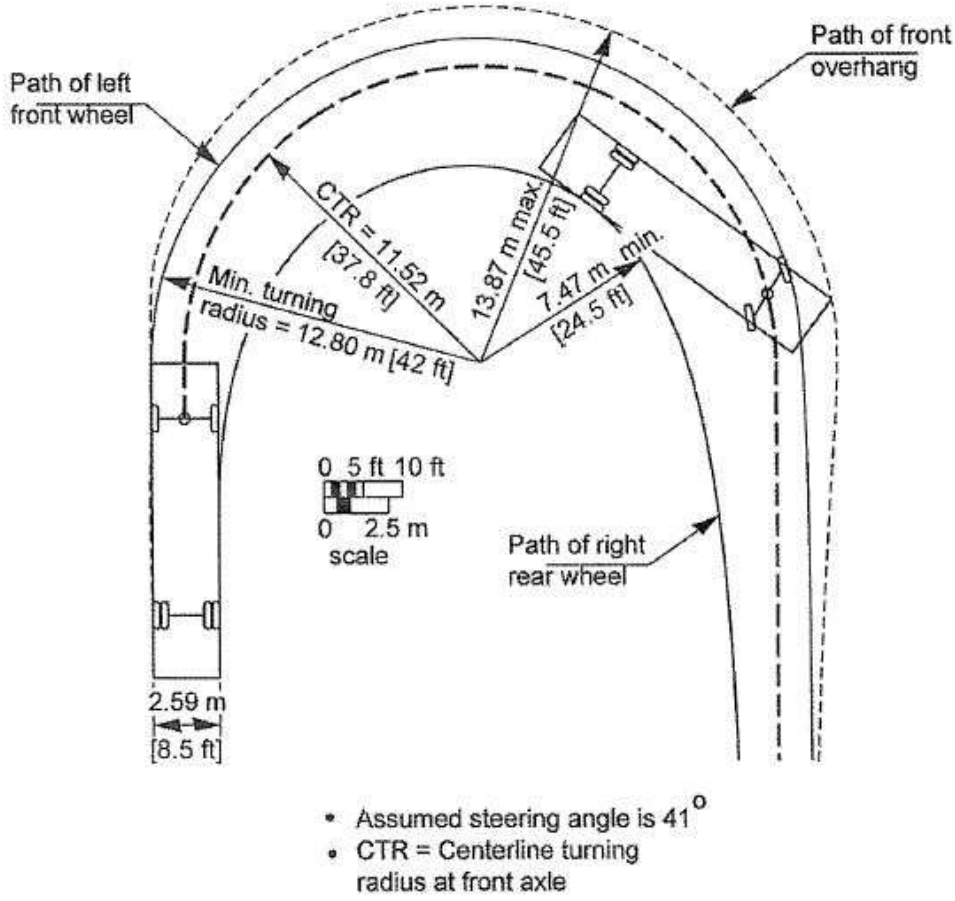
With the on-going roadway and landscape design process of Public Square, this memorandum reviews the turning radii required to accommodate vehicular movements including City buses, articulated buses, and WB-62 semi-trailers (as per AASHTO definitions and as defined as the minimum allowable length limit for the semi-trailer on the Federal National Network) . The primary purpose of this review is to ensure that the turning movements of the design vehicles can be accommodated with the proposed roadway widths and curb radii of Public Square. The secondary purpose of this review is to verify the feasibility of double turning movements that could occur as a worst case scenario (i.e., two buses turning right side-by-side simultaneously).

For the purposes of this review the analysis utilized the JCFO design files of August 26th, which includes the existing Health Line platforms. The design vehicles reflect the heavy transit usage of the study area and include:

- City Bus: 40ft in length with 25ft wheelbase
- Articulated Bus: 60ft in length with 22ft wheelbase and 21.2ft trailer length
- Semi Trailer (WB-62): 69ft in length with 19.5ft wheelbase and 48ft trailer length

The dimensions that affect roadway and curb design are the minimum center line turning radius, the out-to-out track width, the wheelbase, and the track of the inner rear wheel. The turning paths of each design vehicle for its sharpest turns are established by the outer path of the front body overhang and the path of the inner rear wheel (as shown in Figure 1). The minimum radii of the outside and inside paths for the design vehicles are highlighted below and provide initial guidance of the curb radii required.

Figure 1 Minimum Turning Path for a City Bus



Source: AASHTO – Geometric Design of Highways and Streets

Table 1 AASHTO Design Guidelines

Design Vehicle	City Transit Bus	Articulated Bus	Semitrailer
Symbol	CITY-BUS	A-BUS	WB-62
Minimum Design Turning Radius (ft)	42.0	39.8	45
Centerline Turning Radius (CTR) (ft)	37.8	35.5	41
Minimum Inside Radius (ft)	24.5	21.3	7.9

Source: AASHTO – Geometric Design of Highways and Streets

Proposed Conditions

The design of Public Square currently proposes the following roadway curb radii at the eight (8) area intersections:

Table 2 Proposed Curb Radii

Intersection	Curb Radius	Meets Min. AASHTO Guidelines (as per Design Vehicles)
East Roadway at Superior		
▪ SW	30ft	Yes
▪ SE (effective radius is larger due to bus lane)	25ft	Yes
▪ NE	30ft	Yes
▪ NW	30ft	Yes
West Roadway at Superior		
▪ All corners	30ft	Yes
Ontario at Rockwell		
▪ All corners	30ft	Yes
Ontario at South Roadway		
▪ All corners	20ft	No
West Roadway at Rockwell		
▪ SE	50ft	Yes
East Roadway at Rockwell		
▪ SE	15ft	No
▪ SW	50ft	Yes
South Roadway at Euclid		
▪ NE	33ft	Yes
▪ NW	50ft	Yes
South Roadway at West Roadway		
▪ NW	75ft	Yes

The table above highlights that the proposed curb radii within Public Square all meet the AAHSTO guidelines with the exception of the southeast corner at the intersection of East Roadway and Rockwell. This intersection geometry exists currently and is not proposed to be altered as part of the Public Square project.

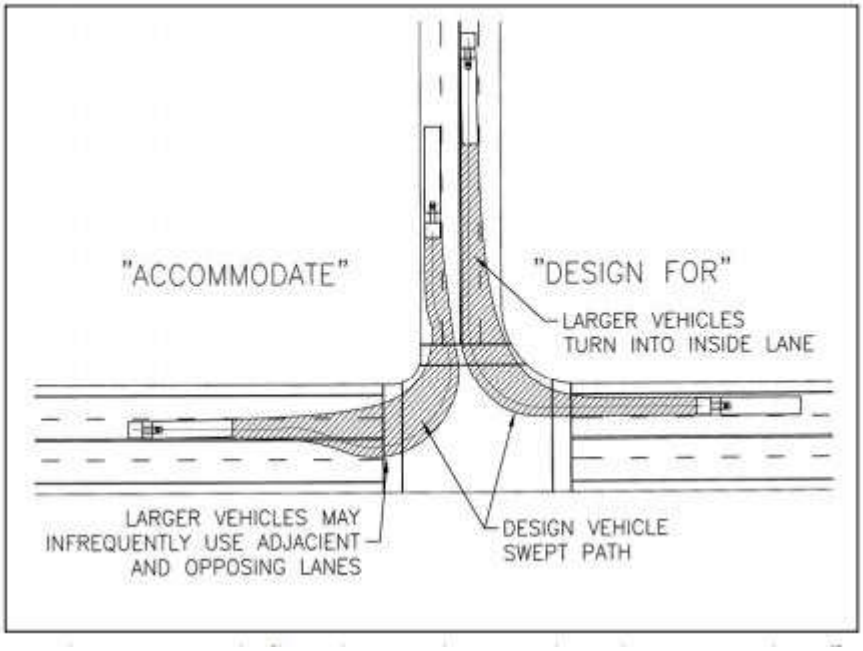
Swept Path Analysis

To simulate the turning movements of the design vehicles, AutoTurn software was utilized to analyze the proposed roadway geometry and swept path maneuvers. Using the proposed Public Square roadway widths and curb radii, each of the eight intersections were reviewed under two different approaches: "Designed for" vs. "Accommodate". Figure 2 below shows these two approaches.

When reviewing designs to fully accommodate vehicular movements through an intersection, a travel path that allows the selected vehicle to remain entirely within its designated lane (or lanes depending on the situation) as it completes its turn is preferred. This is the "Fully Accommodated" or "Designed For" scenario. To accommodate larger vehicles on narrower streets, more latitude for the vehicle path is assumed, including encroachment on adjacent lanes approaching and/or departing the intersection. This is the "Accommodated" scenario.

When accommodating larger vehicles in restricted environments, it is often assumed that a driver will shift to the left, hugging the lane line, before beginning a right turn, and will use all available lanes moving in their direction to begin and complete the turn. This can create interference with other traffic when trucks are turning. This is referred to as "operational accommodation" since the compromise is some loss of operational efficiency of traffic movements.

Figure 2 Accommodation of vehicle movements



The swept path analyses for Public Square have been included as Attachment A and show movements for the three design vehicles at all intersections. The table below summarizes the

analysis results from the perspective of being fully accommodated or accommodated with exceptions.

Table 3 Swept Path Analyses Summary

Intersection	City Bus	Articulated Bus	Semi Trailer	Dual Movements
East Roadway at Superior	Fully Accommodated	Fully Accommodated	Accommodated	Accommodated for all buses with EB Superior stop bar moved.
West Roadway at Superior	Fully Accommodated	Fully Accommodated	Accommodated – with WB stop bar moved.	Accommodated for all buses with WB Superior stop bar moved.
Ontario at Rockwell	Fully Accommodated	Fully Accommodated	Accommodated – with SB stop bar moved	Accommodated for all buses with SB stop bar moved
Ontario at South Roadway	Fully Accommodated	Fully Accommodated	Accommodated – with NB stop bar moved	Accommodated for all buses with NB stop bar moved & 50-ft radii
West Roadway at Rockwell	Fully Accommodated	Fully Accommodated	Accommodated	Accommodated for all buses.
East Roadway at Rockwell	Fully Accommodated	Fully Accommodated	Accommodated	Accommodated for all buses but lane assignment needed.
South Roadway at Euclid	Fully Accommodated	Fully Accommodated	Accommodated	Accommodated for all buses but lane assignment needed.
South Roadway at West Roadway	Fully Accommodated	Fully Accommodated	Accommodated	Accommodated for all buses but lane assignment needed.

*Fully Accommodated = with no restrictions.

** Accommodated = use of full roadway width

As shown in the table and the Attachments, both the City Bus and the Articulated Bus can be fully accommodated by the proposed roadway geometry and curb radii. The larger semi-trailer, although being accommodated, does have some restrictions where opposing stop bars would be required to be moved. These encroachments occur at the intersections of Ontario/Rockwell and Ontario/South Roadway and at the southbound turn onto Superior from West Roadway.

Simultaneous Movements

The secondary element of the swept path analyses was to check the feasibility of two buses/vehicles being able to turn side-by-side simultaneously. The swept paths in Attachment A indicate the following:

- Two City Buses would be able to turn simultaneously at all locations. Although the analyses show that this is feasible, it should be noted that the maneuver would have a risk factor (as is the case with any transit vehicle maneuver in close proximity to another).
- The following locations will require changes to either the existing lane configuration or existing curb radii for dual bus movements.
  - Ontario & Rockwell (change in lane configuration as shown in Attachment A)
  - Ontario & South Roadway (change in SE & SW curb radii to 50-ft)

  As with all situations with buses moving simultaneously there would come with an associated risk factor.
- A semitrailer would not be able to turn with any other vehicle at any location due to the need for the enlarged turning envelope at all intersections.

Design Considerations and Recommendations

The following general principles and recommended practices for intersection size and turning radius design are provided in *the ITE Context Sensitive Solutions in Designing Major Urban Thoroughfares for Walkable Communities* and apply to the Public Square project:

- Intersections should be designed as compact as practical in urban contexts.

  Recommendation: Intersections should minimize crossing distance, crossing time, exposure to traffic, encourage pedestrian travel and increase safety.
- Curb return radii should be designed to accommodate the largest vehicle type that will frequently turn the corner (sometimes referred to as the control vehicle).

  Recommendation: Do not design curb radii for the occasional occurrence. Occasional large vehicle can encroach into the opposing travel lane. As outlined in Ohio DOT Location & Design Manual Vol.1 - Intersection Design.
- Curb return radii should be designed to reflect the "effective" turning radius of the corner. The effective turning radius takes into account the wheel tracking of the design vehicle utilizing the width of parking and bicycle lanes. Use of the effective turning radii allows a smaller curb return radius while retaining the ability to accommodate larger design vehicles.
- ***Recommendation:*** Use this design feature where possible. An existing example of this is at the southeast quadrant East Roadway and Superior.
- In urban centers and urban cores where pedestrian activity is intensive, curb return radii should be as small as possible.
- ***Recommendation:*** Proposed curb radii enable City Buses and Articulated Buses to maneuver around the Square with radii ranging between 30-50ft. Enlarged radii would not be beneficial for pedestrian activity.
- On multi-lane thoroughfares, large vehicles may encroach entirely into the adjacent travel lanes (in the same direction of travel).
- ***Recommendation:*** This assumes that larger vehicle can encroach into the adjacent travel lane, which will be required in other instances as buses access stops.

- Apply curb return radii that are compatible with the design vehicle. Occasional turns by vehicles that are larger than the design vehicle could be accomplished by turning more slowly and possibly encroaching into oncoming travel lanes to complete the turn.
- ***Recommendation:*** Designing for the occasional large vehicle (such as interstate semi trailer WB-62/WB-67) is not best practice in urban centers.
  If large vehicles need to encroach into an opposing travel lane, consider placing the stop line for opposing traffic further from the intersection.
- ***Recommendation:*** This is recommended for the Ontario intersections and on the interior Square section of Superior.

The proposed Public Square design meets the principles and recommended practices above and provides a reminder that the project is about public space, interaction, and connection.

The swept path analysis has indicated that the primary design vehicles, the City Bus and Articulated Bus, can be fully accommodated without the need for modifications to the curb radii. Dual movements of buses would need modifications to the existing curb radii at the intersection of Ontario Street and South Roadway and lane configuration at the intersection of Ontario Street and Rockwell Avenue. The larger semi trailer vehicle can be accommodated but with some modifications needed to opposing stop bar locations. By utilizing the proposed design and keeping the intersections as shown, an enhanced pedestrian environment can be provided. Public Square is, and will continue to be a highly active pedestrian location where the reduction of crossing distances and times will not only be beneficial to pedestrians but also to the overall efficiency of the intersection and the vehicular network.

Conclusion: The design accommodates most vehicle turns, however a field test demonstration would be required for buses.

Turning Radii Demonstration (November 17, 2014)

With the on-going roadway and landscape design process of Public Square, memorandum's dated August 28th and a subsequent update dated November 11th reviewed the turning radii required to accommodate vehicular movements including City buses, Articulated buses, and WB-62 semi-trailers (as per AASHTO definitions and as defined as the minimum allowable length limit for the semi-trailer on the Federal National Network) .

In order to confirm that the proposed turn radii would be adequate in the field for the City buses and Articulated buses, particularly for dual movements, a field test at the RTA West Park Station was undertaken on Friday November 14th. The specific purpose of the field demonstration was to ensure that the dual turning movements of the design vehicles could be accommodated at the following locations:

Location	Proposed Curb Radii
East Roadway:	
▪ To Rockwell Avenue	50-Ft
▪ To Ontario Street	30-Ft
Ontario Street:	
▪ To Rockwell Avenue	30-Ft
▪ To West Roadway	50-Ft
South Roadway to/from Ontario Street	50-Ft

The design vehicles utilized for the demonstration included:

- City Bus: 40ft in length (and additional with bike rack in down position)
- Articulated Bus: 60ft in length (and additional with bike rack in down position)
- RTA Health Line Bus: 63ft in length

The proposed dimensions of each roadway section were measured and laid out by Nelson\Nygaard and RTA staff including roadway width, roadway length and curb radii. The three sections were then explained to, and driven with each RTA driver.

The three roadway sections were tested with dual movements of the City buses (two 40-ft vehicles) and the Articulated buses (two 60-ft vehicles). The RTA Health Line vehicle tested the 50-ft radii to ensure that it would be able to perform the turns at Rockwell Avenue and West Roadway and East Roadway respectively, and continue to line up with a left side bus stop location.

All vehicles were able to successfully complete the movements, including dual movements, with no issues or concerns from the drivers. Maneuvers were performed within the proposed roadway widths with adequate distances from both inner and outer curb lines. Both City staff and RTA staff concurred that the vehicles would be able to successfully negotiate the turning movements within Public Square as proposed.

The swept path analysis and demonstration event has therefore shown that that the primary design vehicles, the City Bus and Articulated Bus (both 60-ft and Health Line), can be fully accommodated with the curb radii and stop bar modifications as proposed.

Conclusion: The design accommodates all vehicle turns.

Superior Avenue at West Roadway Intersection Operations (February 9, 2015)

As part of Nelson\Nygaard's continued analysis into the final configuration of Public Square, the turning path of Healthline vehicles and the overall intersection operations at the intersection of Superior Avenue and West Roadway have been reviewed and are outlined in this brief memorandum.

With the proposed closing of Superior Avenue to allow transit traffic only, this provides the opportunity for the Healthline vehicles to utilize Superior Avenue rather than circulate around the

northern half of the Square. Operational considerations for the Healthline vehicle movement from Superior Avenue to West Roadway southbound include the following:

- Turn radii from Superior Avenue into the bus-only lane on West Roadway
- The attached swept path analysis shows that a left-turning articulated bus from westbound Superior Avenue to West Roadway southbound can turn simultaneously as a right-turning vehicle from eastbound Superior to West Roadway southbound.
- Vehicle delay at the Superior Avenue/West Roadway intersection
- The lane configuration for the westbound Superior Avenue approach would include a shared thru and left lane with Healthline buses turning left from that shared lane. The table below shows that delay for the left turn vehicles would be minimal with clearance every cycle.

Table 1: Westbound Level of Service at Superior Ave/West Roadway intersection

Intersection Approach	Level of Service	Vehicle Delay (secs)	Queue Length (95%-tile)	Healthline Vehicles/Hour	Opposing Traffic/Hour
Westbound Approach					
AM Peak Hour	A	5.7	24ft	8	29
PM Peak Hour	C	34.5	57ft	10	31

Based upon the above analysis, the Healthline vehicle movement from Superior Avenue to West Roadway southbound is one that can be safely and efficiently made without the need for a separate or protected signal phase.

Conclusion: RTA decided not to shift the Healthline to Superior Avenue.

Bus Route Operations

Bus Weaving Analysis (February 15, 2015)

Introduction

Following up on lane configuration analysis for Public Square, and per GCRTA's request, the Project Team evaluated locations where buses on Superior must move through more complex weaves against general traffic when crossing Public Square between West 3rd Street and East 3rd Street. There are only two such locations. The two affected locations are entering the square along Superior Avenue, eastbound and westbound. Also, the weaves required for eastbound buses to turn left on East 3rd are unchanged.

Entering the Square Eastbound

Buses traveling eastbound on Superior weave left, while general traffic (including buses headed south) weaves right.

- Routes 20, 22, 26, 35, 45/45A, and 79A/B (20 buses per hour, peak) use stop 18 at nearside West 3rd Street, and have about 300' to West Roadway to effect the weave.
- Routes 55/55F, 81, 246, and 263 (20 buses per hour, peak) use stop 19 at nearside West Roadway and have minimal distance to weave left to continue east.
- Routes 8 and 9 (6 buses per hour, peak) use stop 18 at nearside West 3rd and turn right on West Roadway, with no weave required. Trolleys B, C, and E (12 buses per hour) also use stop 19 at nearside West Roadway.

Entering the Square Westbound

Buses traveling westbound on Superior weave left, while general traffic weaves right.

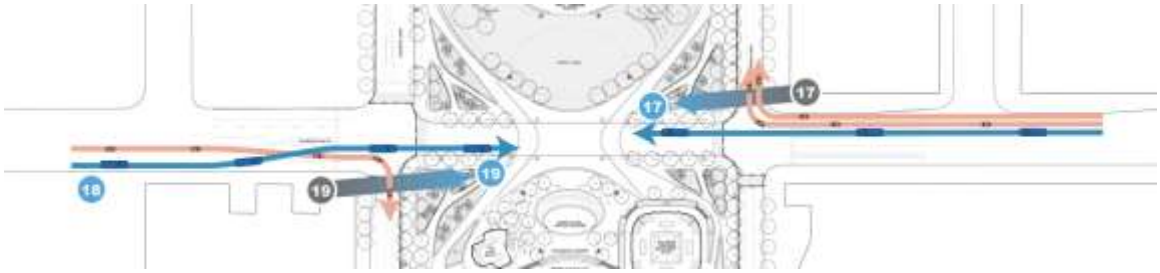
- Routes 3, 20, 22, 26, 35, 38, 39/39F, 45/45A, 55/55F, 239, 246, and 263 (50 buses per hour, peak) use stop 17 at nearside East Roadway and have minimal distance to weave left to continue west.

Potential Mitigations

Of the above moves, the buses departing eastbound from stop 19 and westbound from stop 17 are recommended for some combination of the following mitigations, to be discussed with GCRTA:

- Move the route stop upstream, to provide at least 300' weaving distance (see **Error! Reference source not found.**).
- Move the route stop onto Superior in the Square (see Figure 4). This curb can accommodate four bays and, with the decision not to route the Health Line here, is undersubscribed.

Maintain the existing stop and reroute the bus around the perimeter of the square (see



- Figure 5).

Figure 3: Weaving Mitigation Option 1 – Moving nearside stops upstream

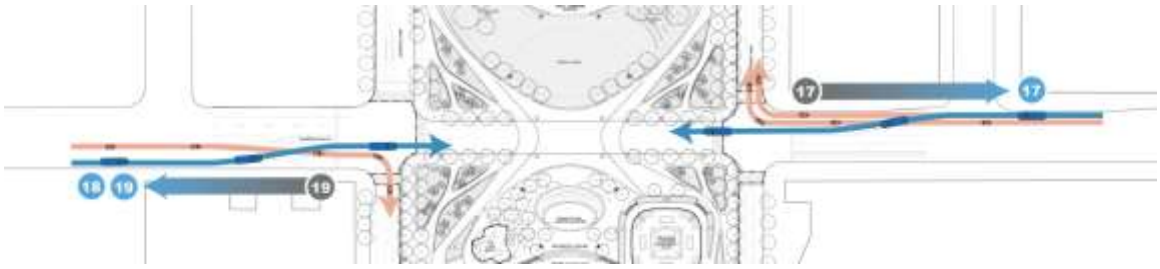


Figure 4: Weaving Mitigation Option 2 – Moving nearside stops into the Square

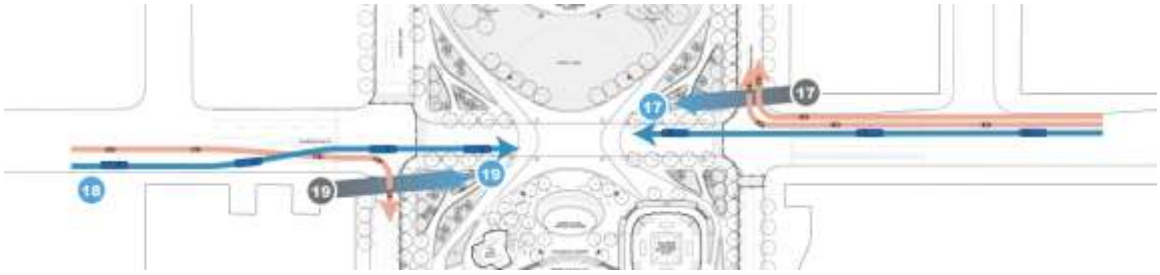


Figure 5: Weaving Mitigation Option 3 – Rerouting the buses around the Square instead of through

Conclusion: RTA to finalize routing plan based on analysis provided.

Bus Stop Location & Sizing

West Roadway, Hotel Stop, and Stop 34/36 Bus Platform (February 27, 2015)

Introduction

This memorandum presents the combined results of capacity analysis of southbound bus stops on West Roadway and southbound Ontario Street.

The recommended allocation of route stops, from north to south, is:

- The north bay of Stop 12 (12N), on West Roadway, far side of Frankfort, with Routes 90F and weekend Trolley L.
- Health Line, unchanged, left handed stop across from Stop 12S.
- The south bay of Stop 12 (12S) on West Roadway, near side of Superior, with Routes 1, 21, 79AB and 81.
- New Stop 0 ("Hotel Stop") on southbound West Roadway, far side of Superior with one bay, serving Routes 8, 19, 76 and 77F.
- Trolley Stop 30, unchanged on South Roadway, nearside Ontario.

- Stops 34 and 36 on southbound Ontario, far side of South Roadway with two bays serving Routes 11, 14 and 15
- Stop 36 on southbound Ontario, midblock, serving Routes 9, 51, 135, 251, and 451.

The loading conditions at these stops is in the range of Level of Service C (15 square feet per waiting passenger) or better without mitigation, except for Stop 34, which would reach Level of Service C with a mitigation, such as an extended curb, and Level of Service D without.

Analysis

The analysis includes the following routes which currently operate around Public Square: #1, 8, 9, 11, 14, and 15, 19, 21, 51, 76, 77F, 79AB, 81, 90F, 135, 251, and 451.

Of these routes, #9, 51, 135, 251, and 451 already use stop 36, which is just south of Stop 34.

Stop 12N is for buses on West Roadway stopping but not turning right into westbound Superior.

Stop 12S is a single bay, 90' stop for buses on West Roadway stopping and turning right into westbound Superior.

Stop 0 is a single bay, 90' stop at the "Hotel Stop".

Stops 34 and 36 are contiguous with 3 bays, and can operate with buses which turn left on Prospect in the two northern bays (Stop 34) and others in Stop 36.

Stop 13 and 26 passenger count data were used for the eight routes serving these eliminated Ontario stops; for routes 135 and 451, this data was not available, so counts from Stop 23 were used as a proxy. For routes 1, 9 and 251, data was not available, so an average of the other routes on similar paths was used.

From the data available, 25% of the day's ridership was assumed as the peak hour ridership.

Methodology

The methodology assigns each route a number of "minutes per hour" it occupies its bus stop. The optimal situation is that a set of routes cumulatively occupy a bus stop for fewer than 36 minutes per hour. This reflects 60 percent of the time in that hour, and is the allowance recommended to offset unevenly spaced arrivals, per Transit Cooperative Highway Research Program (TCRP) Report 165: Transit Capacity and Quality of Service Manual, Third Edition.

TCRP 100 presents a complex methodology for computing bus dwells based on locally collected data, but also quotes earlier work by Herbert Levinson (1983 Transportation Research Record 915) that dwell time is equal to 5 seconds plus 2.75 seconds per boarding or alighting. This research also quoted R. P. Guenthner and K. C. Sinha (1983 Transportation Research Record 915) that there is a 10-20 second penalty for each stop plus a 3-5 second penalty for each passenger boarding or alighting.

Since these data do not require local calibration and since Guenthner and Sinha seem to allow for acceleration and deceleration time, for this analysis, their worst case of 20 seconds per stop penalty plus 5 seconds per passenger was applied. Therefore, the bus stop occupancy per route is 20 seconds for each scheduled trip in the peak hour plus 5 seconds for each passenger in that hour.

Bus Stop Analysis

The results by route are as follows, for routes stopping north of Superior:

Route Number	Trips, Passengers	Minutes of Occupancy per Hour
1	8 trips, 75 passengers	8:55 minutes occupancy per hour
21	2 trips, 23 passengers	2:35 minutes occupancy per hour
79AB	4 trips, 108 passengers	10:20 minutes occupancy per hour
81	5 trips, 101 passengers	10:05 minutes occupancy per hour
L (Weekend)	0 trips, 0 passengers	No peak impact.
90F	3 trips, 67 passengers	6:35 minutes occupancy per hour

For routes stopping south of Superior:

Route Number	Trips, Passengers	Minutes of Occupancy per Hour
8	2 trips, 72 passengers	6:40 minutes occupancy per hour
9	4 trips, 64 passengers	6:40 minutes occupancy per hour
11	3 trips, 145 passengers	13:05 minutes occupancy per hour
14	5 trips, 438 passengers	38:10 minutes occupancy per hour
15	6 trips, 340 passengers	30:20 minutes occupancy per hour
19	4 trips, 214 passengers	19:10 minutes occupancy per hour
51	3 trips, 54 passengers	5:30 minutes occupancy per hour
76	3 trips, 44 passengers	4:40 minutes occupancy per hour
77F	2 trips, 24 passengers	2:40 minutes occupancy per hour
135	3 trips, 10 passengers	1:50 minutes occupancy per hour
251	3 trips, 64 passengers	6:20 minutes occupancy per hour
451	3 trips, 7 passengers	1:35 minutes occupancy per hour

For routes stopping north of Superior, the best way to achieve an acceptable occupancy and expedite turning and straight movements on West Roadway at Superior is to separate the right turning routes (1, 21, 79AB and 81) from the routes that proceed straight, and pull the buses proceeding straight back from the intersection. This creates an average occupancy of 31:55 minutes at the south bay (12S) for turning buses and an occupancy of 6:35 at the north bay (12N) for buses proceeding straight.

South of Superior, routes (8, 19, 76, and 77F) can share one bay, with a cumulative occupancy of 33:10 minutes per hour. These are logical candidates for Hotel Stop 0, rather than stops 34 and 36, because routes 8 and 77F turn left as Prospect, and because routes 19 and 76 stop again on Ontario at the far and near sides of Prospect, respectively.

Based exclusively on the criterion to limit cumulative occupancy to 36 minutes per hour per stop (per TCRP Report 165), it would appear that Routes 14 and 15 each require their own stop.

However, RTA has requested that, due to shared destinations, Routes 11, 14, and 15 should share the same stop. Furthermore, the shared destinations should mitigate the dwell time variance, because dwell times will equilibrate as customers take the first bus to arrive, despite the route.

Assigning Routes 11, 14, and 15 to a two-bay bus stop, with an average occupancy of 41:48 minutes occupancy per bay, is a reasonable accommodation. Furthermore, as noted below, the methodology produced conservatively high estimates of boarding loads per trip on these routes, with 49, 88, and 57 passengers boarding each trip, respectively, on Routes 11, 14, and 15. A reduction of 5 boarding passengers per trip would allow this stop to reach the 36 minute per hour occupancy level, and this adjustment seems extremely likely where boarding loads nearly equal or exceed bus capacity.

As Routes 9, 51, 135, 251 and 451 already use Stop 36, these routes add to a cumulative occupancy of 21:55 minutes per hour, and require no further analysis.

This leads to the assignment of routes to stops, as shown in the table below:

Stop	#Bays	Routes	Occupancy per bay per hour
34	2	11, 14, 15	41:48
36	1	9, 51, 135, 251, 451	21:55
0	1	8, 19, 76, 77F	33:10
12 South Bay	1	1, 21, 79AB, 81	31:55
12 North Bay	1	L, 90F	6:35

Stop 12 should be signed as two bays, with bay 12N extending 60' south from Frankfort, and bay 12S occupying the remaining 90' from that point to Superior.

Stop 0 is at the former taxi stand, and should be signed as one bay, but 90' long to provide adequate space for passenger queuing. This requires removing the bulb out at the north end and extending the stop to the point where the building setback for the entrance to Tower City begins.

The bus stops on the west blockface of Ontario south of South Roadway will need to be respaced for optimal usage by buses at stops 34, 36, and 39. The northern 50' of the curb is not useable because the turning bus will require about 75' (the 25' sidewalk plus 50' south of the building line) to reach the curb after the right turn. From north to south, the following is the potential spacing of the northern half of this blockface:

- North building line to 50' south: bus turning clearance
- 50' south to 170' south: Stop 34, 2 bays
- 170' south to 230' south: Stop 36, 1 bay

This layout provides the southernmost bus in Stop 34 with over 200' to transition to the left lane to turn into Prospect.

Finally, the left-handed Health Line stop on West Roadway and Trolley Stop 30 have no change from present.

Sidewalk LOS Analysis

At Stop 12 North Bay, the boarding load per trip is 22 passengers over a bus stop which is 1800 square feet (30' sidewalk x 60' bus stop). This provides 82 square feet per waiting passenger, Level of Service A.

At Stop 12 South Bay, the boarding load per trip, added over all four routes, would add to 68 passengers, over a bus stop which is 2700 square feet (30' sidewalk x 90' bus stop.) This provides approx. 40 square feet per waiting passenger, which is Level of Service A.

At Stop 0, the boarding load per trip, added over all four routes, would add to 117 passengers, over a bus stop which is 1800 square feet (20' sidewalk x 90' bus stop.) This provides approx. 15 square feet per waiting passenger, which is Level of Service C.

At Stop 34, the boarding load per trip, added over the three routes would add to 194 passengers over a bus stop which is 3,400 square feet (20' sidewalk x 170' bus stop, 120 feet plus 50 feet turning clearance to the north, and assumes a widening of the sidewalk.) This provides 17 square feet per waiting passenger, also at Level of Service C. If not widened, the sidewalk provides of 11 square feet per passenger, which is Level of Service D.

At Stop 36 the boarding load per trip, added over all four remaining routes (Route 9 is discontinued), would add to 31 passengers, over a bus stop which is 600 square feet (10' sidewalk x 60' bus stop.) This provides approx. 20 square feet per waiting passenger, which is Level of Service C.

As background, the above analysis is conservative because the peaking methodology produced boarding loads per trip near to and in excess of bus capacity. In fact, conditions are likely much more fluid than Level of Service C because actual boarding loads for most trips are likely much lower.

For the purpose of calculating sidewalk levels of service, the boarding loads per trip are as follows:

Stop 12 South	Trips, Ridership per hour	Ridership Per Trip
Route 1	8 trips, 75 passengers	9 passengers
Route 21	2 trips, 23 passengers	12 Passengers
Route 79AB	4 trips, 108 passengers;	27 passengers
Route 81	5 trips, 101 passengers	20 passengers
Total ridership per trip		68 passengers

Stop12 North	Trips, Ridership per hour	Ridership Per Trip
Route 90F	3 trips, 67 passengers	22 passengers
Route L (Weekend)	0 trips, 0 passengers	No peak impact.
Total ridership per trip		22 passengers

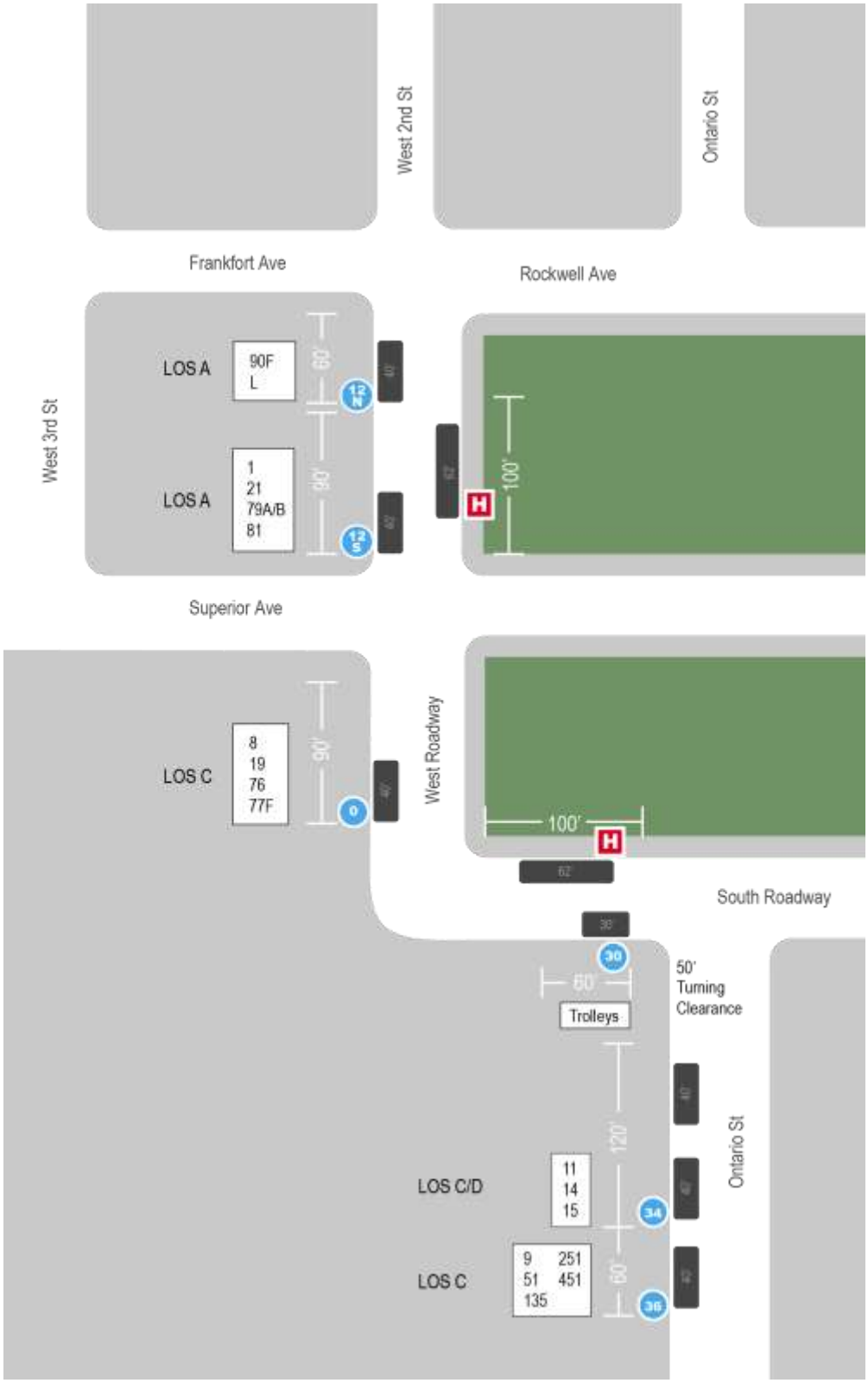
Stop 0	Trips, Ridership per hour	Ridership Per Trip
Route 8	2 trips, 72 passengers	36 passengers
Route 19	4 trips, 214 passengers	54 Passengers
Route 76	3 trips, 44 passengers;	15 passengers
Route 77F	2 trips, 24 passengers	12 passengers
Total ridership per trip		117 passengers

Stop 34	Trips, Ridership per hour	Ridership Per Trip
Route 11	3 trips, 145 passengers	49 passengers
Route 14	5 trips, 438 passengers	88 passengers
Route 15	6 trips, 340 passengers	57 passengers
Total ridership per trip		194 passengers

Stop 36	Trips, Ridership per hour	Ridership Per Trip
Route 9	To be discontinued	
Route 51	3 trips, 55 passengers	18 passengers
Route 135	3 trips, 10 passengers	3 passengers
Route 251	3 trips, 24 passengers	8 passengers
Route 451	3 trips, 7 passengers	2 passengers
Total ridership per trip		31 passengers

In summary, the above allocation of bus bays and routes should produce acceptable, fluid flow of boarding passengers and buses at bus stops on West Roadway and Ontario Street. All bus stops accommodate level of Service C or better, without mitigation, except Stop 34, which provides level of service D and would provide C with an extended curb. The following diagram summarizes the proposed assignment of bus routes to bays.

Conclusion: With a new Hotel Stop, a bus platform on West Roadway is not needed. RTA to stop locations based on analysis provided.


West 2nd St
Ontario St
Frankfort Ave
Rockwell Ave
West 3rd St
LOS A
90F
L
LOS A
1
21
79A/B
81
100'
Superior Ave
LOS C
8
19
76
77F
West Roadway
100'
South Roadway
50'
Turning
Clearance
Trolleys
LOS C/D
11
14
15
LOS C
9
51
135
251
451
Ontario St

Superior Westbound in the Square (February 1, 2015)

Summary

With the proposed limiting of Superior between East and West Roadways to transit vehicles only, this allows for accommodation of additional transit volumes to provide additional capacity around the outside of the Square for general traffic. The following memorandum presents an evaluation of how buses could stop on Superior within the Square (east and west of the midblock pedestrian crossing). Using conservative dwell per passenger numbers and peaking factors, there is sufficient curb length to accommodate the existing buses plus the Health Line and Route 55 without queuing. The most heavily used bus stop, the 40' bay on the east side of the square in front of the Health Line, would be occupied 31:05 minutes per hour, compared to an acceptable maximum length of 36 minutes per hour.

Methodology

The methodology for capacity analysis of westbound Superior bus stops between East Roadway and West Roadway was the same as for West Roadway, Hotel Stop, and Stop 34/36 Bus Platform (above.)

Where passenger count for stop 16 was available, it was used; otherwise stop 17's count for that route was used as a proxy.

Routes E, 3, 26, 38, 39, 45, 239, 246 and 263 serve westbound Superior nearside of West Roadway. This analysis also adds Route 55 and the Health Line.

The logical array of bays is, from east to west:

- Health Line bay, a 63' bus bay
- The gap at the former path of Ontario
- An articulated 60' bay, also capable of 40' buses
- A bay for 40' buses and trolleys.

This puts the articulated buses in the best position to put all doors on the curb, and the Health Line in the best position to turn left at West Roadway. Some 40' buses should be assigned to the articulated 60' bay to balance occupancy, and the usage of the westernmost standard 40' bus and trolley bay should limited to Trolley E to minimize its use, because this bay cannot easily pull out after loading if the signal is red.

Analysis

The results by route are as follows:

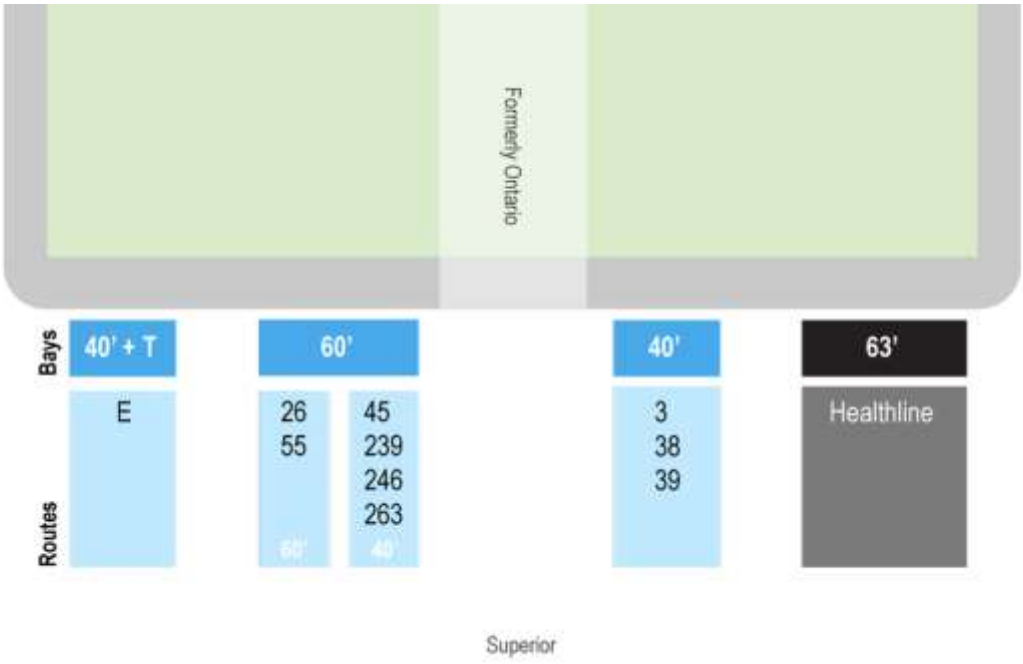
Route Number	Trips, Passengers	Minutes of Occupancy per Hour
E	6 trips, 94 passengers	9:50 minutes occupancy per hour
3	5 trips, 263 passengers	23:35 minutes occupancy per hour
26	4 trips, 89 passengers	9:45 minutes occupancy per hour
38	2 trips, 42 passengers	4:10 minutes occupancy per hour
39	2 trips, 32 passengers	3:20 minutes occupancy per hour
45	2 trips, 102 passengers	9:10 minutes occupancy per hour
55	10 trips, 33 passengers	6:05 minutes occupancy per hour
239	2 trips, 6 passengers	1:10 minutes occupancy per hour
246	4 trips, 11 passengers	2:15 minutes occupancy per hour
263	4 trips, 12 passengers	2:20 minutes occupancy per hour

If the routes are assigned to bays as follows from east to west, they we get the following occupancies:

- The Health Line in the easternmost bay (layover)
- Routes 3, 38, and 39 in the 40' bay on the east side of the square, in front of the Health Line (cumulative 31:05 minutes per hour occupancy)
- All 60' artic buses (Routes 26, 55) plus Routes 45, 239, 246, and 263 in the artic 60' bay on the west side of the square behind the E Trolley (cumulative 31:00 minutes per hour occupancy).
- The E trolley in the westernmost bay (cumulative 9:50 minutes per hour occupancy).

The conclusion, based on these routes and these data, is that the bus stops on westbound Superior will be fluid and not queued. The 40' bay on the east side of the square and the 60' bay on the west side are occupied approximately 31 minutes per hour, compared to an acceptable level of 36 minutes per hour.

Following is a schematic diagram of the proposed bus bays on westbound Superior:



Conclusion: With a decision to maintain the Health Line route on the perimeter of the square, bus stops assignments are more fluid. RTA to determine stop locations based on analysis provided.

Synchro Analysis

Traffic Evaluation Assumptions (July 15, 2014)

The following outlines the proposed assumptions for evaluating changes to traffic operations around Public Square based on current and variations for future conditions.

Traffic Data

- All traffic data counts will include: vehicles, heavy vehicles, pedestrians and bicycles
- Seasonal adjustment factors for Summer ***vehicle counts*** will be applied as per ODOT's guidelines. It is noted however, that these seasonal factors typically apply to AADT's and not peak period counts. If the City of Cleveland utilizes different seasonal factors then they will be used.
- Seasonal adjustment factors for Summer ***pedestrian/bicycle counts*** will be applied to take into account the absence of students (including reduction of students waiting for buses within the Square). Typically summer pedestrian counts are higher than the rest of the year but in locations where students are a high proportion of the walking/bicycle community adjustment factors can be applied. If the City of Cleveland utilizes specific seasonal factors then they will be used. Review of available counts during term-time will determine the adjustment factors.

Synchro Modeling

The following settings and assumptions will be used for traffic evaluation using Synchro:

- A "peak hour factor" is used to adjust traffic volumes observed over multiple hours for analysis. Existing traffic volumes are divided by the peak hour factor for analysis purposes.
- For future analysis, the peak hour factor will be set in Synchro as per the existing intersection approaches for all future scenarios.
- To evaluate capacity impacts of transit routes within the network, the Synchro setting for bus volumes will be inserted as "bus blockages".
- For roadways with transit-only lanes, these lanes were not included in the Synchro model as they do not impact the regular travel lanes. At intersections where signal timings include "hold" phases for transit lanes, the applicable timings were incorporated.
- Synchro enables multiple signal timing optimizations; for existing conditions signal timings will be provided by the City. For future scenarios, signal timings will be optimized as appropriate and reviewed by the City.
- Since this analysis is for the area in and around Public Square, the "area type" selected for analysis will "CBD" for "central business district".
- Pedestrian volumes from the traffic counts will be included as "conflicting pedestrians" volumes in the model.
- Pedestrian desire lines will be reviewed for each scenario to enable volume adjustments at critical intersection and crossing locations.
- Traffic volumes entering the study area will be based on existing counts and the NOACA 2030 Regional Demand Travel Model for future scenarios. Assignment of volumes will be reviewed by both the City and NOACA.
- The baseline Synchro model will be provided to the City for review and feedback.

Existing Conditions

Utilizing the Phase 2 traffic count data, the existing signal timing data and the modeling assumptions, a Synchro model was developed for existing conditions of the study area. This model scenario underwent review by both the City and ODOT whose comments were incorporated into the final model. The most notable feedback from ODOT and subsequent addition to the model was an growth rate of 12% too account for the seasonal traffic factor with the traffic counts being collected during the summer. The Synchro results for the existing conditions are shown in Figure 6.

Figure 6: Existing Public Square Level of Service Results

Existing Intersection	AM	AM	AM	AM	PM	PM	PM	PM
	Intersection LOS	Average Signal Delay (seconds)	50th %-tile Queue Length (ft)	95th %-tile Queue Length (ft)	Intersection LOS	Average Signal Delay (seconds)	50th %-tile Queue Length (ft)	95th %-tile Queue Length (ft)
Ontario St & S. Roadway	E	65	NBT 392	NBT 465	E	59.8	SBT 448	SBT 508
Ontario St & Superior Ave	F	94	EBT 831	EBT 973	F	125.1	WBT 1015	WBT 930
Ontario St & Frankfort/Rockwell	E	61.1	NBT 444	NBT 515	E	58.1	SBT 235	SBT 298
West Roadway & Superior Ave	D	47.3	EBT 320	EBT 463	D	46.8	WBT 299	WBT 167
East Roadway & Superior Ave	E	71.8	EBL 727	EBT 268	D	53.5	WBT 529	WBT 608
West Roadway & Frankfort/Rockwell	Unsignalized	n/a			Unsignalized	n/a		
East Roadway & Frankfort/Rockwell	Unsignalized	n/a			Unsignalized	n/a		
South Roadway/Euclid & East Roadway	D	41.3	EBT 359	EBT 77	A	3.3	EBT 22	EBT 36

Future Conditions

In order to assess future conditions within the Phase 2 study area, the Synchro model was modified to reflect the proposed design of the Square with Ontario Street completely closed and Superior Avenue open to only transit vehicles. Under future conditions, it was assumed that there would be no vehicular traffic growth rate as per discussions with NOACA (November 12, 2014), "Currently for downtown, our growth rates are flat and we're assuming 0% growth." As such, the existing traffic volumes with the 12% seasonal factor were used for the future conditions.

1. The future conditions were initially modeled for the immediate area of the Square to assess the capacity impacts of the design and to confirm that Superior Avenue could be closed to all but transit vehicles from a capacity perspective. These scenarios included three models based on potential rates of traffic diversion around the Square. Base Volumes: No reduction in traffic around the Square from the existing conditions (i.e., all northbound Ontario St traffic use South Roadway to East Roadway to Rockwell Ave to Ontario Street).
2. 25% Volume Reduction in traffic around the Square from the existing conditions. This assumes that there will be a 25% reduction based upon diversion rates to other roadways within the study area as well as changes in travel patterns (i.e., change in trip time, reduction in discretionary trips etc).
3. 50% Volume Reduction in traffic around the Square from the existing conditions. This assumes that there will be a 50% reduction based upon diversion rates to other roadways within the study area as well as changes in travel patterns (i.e., change in trip time, reduction in discretionary trips etc). This scenario also includes pedestrian only phases at all intersections.

The three future condition scenarios have been reviewed by the City, ODOT and RTA with additional analysis of the diversion rate to be performed on the wider study area upon detailed review of the traffic patterns under the demolition Maintenance of Traffic plan. The decision was made however, to enable Superior Avenue to be open to transit vehicles only. The Synchro results for the future condition scenarios are shown below in Figure 7 through Figure 9.

Conclusion: Superior Avenue to be open to transit vehicles only.

Figure 7: Future Public Square Level of Service Results with no vehicle diversion

Future Intersection - Base Scenario: Superior closed, no veh reduction	AM Intersection LOS	AM Average Signal Delay (seconds)	AM 50th %-tile Queue Length (ft)	AM 95th %-tile Queue Length (ft)	PM Intersection LOS	PM Average Signal Delay (seconds)	PM 50th %-tile Queue Length (ft)	PM 95th %-tile Queue Length (ft)
Ontario St & S. Roadway	F	155.9	NBR 622	NBR 814	F	309.8	EBT 1043	EBT 663
Ontario St & Superior Ave	n/a	n/a			n/a	n/a		
Ontario St & Frankfort/Rockwell	C	27.7	SBR 24	SBR 37	F	214.2	WBT 1070	WBT 867
West Roadway & Superior Ave	F	89.9	EBR 826	EBR 937	F	495	SBT 1839	SBT 1453
East Roadway & Superior Ave	F	198.9	NBT 1279	NBT 322	F	302	NBT 1060	NBT 948
West Roadway & Frankfort/Rockwell	B	12	WBT 145	WBT 92	E	66.3	WBL 926	WBL 1
East Roadway & Frankfort/Rockwell	E	58.3	NBL 577	NBL 136	F	89.7	WBT 502	WBT 533
South Roadway/Euclid & East Roadway	F	501.6	EBL 2351	EBL 1864	F	62.6	EBL 438	EBL 110
West Roadway & South Roadway	D	52.6	SBL 10	SBL 0	F	165.7	SBL 1767	SBL 0

Figure 8: Future Public Square Level of Service Results with 25% vehicle diversion

Future Intersection - Base Scenario: Superior closed, 25% veh reduction	AM Intersection LOS	AM Average Signal Delay (seconds)	AM 50th %-tile Queue Length (ft)	AM 95th %-tile Queue Length (ft)	PM Intersection LOS	PM Average Signal Delay (seconds)	PM 50th %-tile Queue Length (ft)	PM 95th %-tile Queue Length (ft)
Ontario St & S. Roadway	E	65.8	EBT 408	EBT 502	F	96.5	EBT 422	EBT 115
Ontario St & Superior Ave	n/a	n/a			n/a	n/a		
Ontario St & Frankfort/Rockwell	A	5.8	WBT 91	WBT 31	F	80.3	WBT 662	WBT 711
West Roadway & Superior Ave	C	23.6	EBR 174	EBR 707	F	104.3	SBT 991	SBT 587
East Roadway & Superior Ave	E	55.2	NBT 578	NBT 702	D	46.4	NBT 302	NBT 329
West Roadway & Frankfort/Rockwell	B	18.7	WBT 106	WBT 157	B	19.5	WBT 41	WBT 1
East Roadway & Frankfort/Rockwell	A	8.3	WBT 51	WBT 93	E	65.5	WBT 295	WBT 321
South Roadway/Euclid & East Roadway	F	249.7	EBL 1571	EBL 1702	D	46.6	EBL 248	EBL 166
West Roadway & South Roadway	A	5.4	SBL 42	SBL 22	D	53.6	SBL 1086	SBL 39

Figure 9: Future Public Square Level of Service Results with 50% vehicle diversion (inc. Pedestrian only phasing)

Future Intersection - Base Scenario: Superior closed, 50% veh reduction, with separate Ped Phases	AM	AM	AM	AM	PM	PM	PM	PM
	Intersection LOS	Average Signal Delay (seconds)	50th %-tile Queue Length (ft)	95th %-tile Queue Length (ft)	Intersection LOS	Average Signal Delay (seconds)	50th %-tile Queue Length (ft)	95th %-tile Queue Length (ft)
Ontario St & S. Roadway	C	23.7	EBT 122	EBT 189	C	21.5	EBY 128	EBT 475
Ontario St & Superior Ave	n/a	n/a			n/a	n/a		
Ontario St & Frankfort/Rockwell	C	27.1	WBT 230	WBT 231	C	24	WBT 224	WBT 437
West Roadway & Superior Ave	B	17	SBT 101	SBT 143	E	60.1	SBT 508	SBT 417
East Roadway & Superior Ave	D	47.7	NBT 426	NBT 385	C	24.3	NBT 238	NBT 295
West Roadway & Frankfort/Rockwell	C	24.5	WBT 77	WBT 114	B	11.8	WBT 71	WBT 89
East Roadway & Frankfort/Rockwell	A	6	NBL 17	NBL 193	C	33.8	WBT 203	WBT 216
South Roadway/Euclid & East Roadway	E	55.6	EBL 534	EBL 573	A	9.2	EBL 26	EBL 69
West Roadway & South Roadway	A	0.8	SBL 7	SBL 0	A	0.3	SBL 0	SBL 0

Lane Configuration (Sept 4, 2014 with updates)

With the on-going roadway and landscape design process of Public Square, this memorandum reviews the lane configurations of the adjacent roadways and intersections required to accommodate vehicular movements and to ensure sufficient vehicular capacity. This memorandum utilizes the previous Traffic Analysis Summary dated April 16, 2012 (updated with 2014 traffic analysis) and the Curb Radii Review and Turning Demonstration memoranda (August, 2014 and November, 2014). The purpose of this review is to ensure that the proposed Public Square design team assigns the travel lanes to the roadway and intersections with appropriate widths and configurations.

For the purposes of the September, 2014 review the analysis utilized the JCFO design files of August 26th which included the existing Health Line platforms. The Curb Radii Review, dated August 28th, 2014 concluded that the curb radii proposed in the current roadway design were able to accommodate design vehicles of a City Bus, Articulated Bus, and a Semi-Trailer (WB-62).

2014 Traffic Analysis

The 2014 traffic analysis focused on the current design scenario which includes the following:

- Ontario Street is closed completely between Rockwell Ave and South Roadway, allowing for the creation of two large public areas that could be programmed for large events.
- Superior Avenue is closed to general purpose traffic, but retains two lanes in each direction dedicated to transit.
- Two traffic lanes around the Square are maintained at all times. Some locations include a bus lane and a general travel lane only.

Given the expanded role of Rockwell Avenue, a new signal at East Roadway and Rockwell Avenue was assumed in the 2012 analysis that would aid drivers and pedestrians navigating the intersection. This new signal would be in combination with the mitigation measures highlighted in the 2012 summary report, which primarily included signal timing optimization and can be viewed in more detail in the report.

Existing and Proposed Roadway Widths

The figure below compares the existing and proposed Public Square roadway widths (curb to curb) and lane configurations, with changes noted in bold. The proposed lane configurations are discussed in the section following:

Figure 10: Existing and Proposed Roadway Widths

Roadway	Existing		Proposed
	Width	Configuration	Width
Rockwell Ave	38'-6"'	3 lanes (inc. bus lane)	same
South Roadway W. of Ontario E. of Ontario	 45'-8" 34'-8"	 2 lanes (inc. bus lane) 3 lanes (inc. bus lane)	 same same
West Roadway **N. of Superior** **S. of Superior**	 **41'** 37'-10"	 **3 lanes (inc. bus lane)** 2 lanes (inc. bus lane)	 **41'** 37'-10"
East Roadway	39'-3"	3 lanes (inc. bus lane)	same
Superior Ave (within the Square)	**78'**	**4 lanes (inc. median and 2 bus lanes)**	**48'**
Ontario Street N. of Superior S. of Superior	 64'-10" 66'-3"	 6 lanes	 same same
Euclid Ave	62'-9"	4 lanes (2 bus lanes and BRT platform)	same

The table above highlights that the proposed roadway widths within Public Square would be comparable to the existing conditions with the exception of Superior Avenue (within the Square) which has a reduced roadway width with removal of median

Proposed Lane Configuration

The traffic analysis performed in 2012 concluded that the proposed design of Public Square with the appropriate mitigation measures would have enough capacity to accommodate the daily traffic volumes.

In reviewing the required lane configurations based on the proposed roadway widths the following elements are considered:

- Ohio DOT lane width criteria
- Existing and proposed bus only lanes
- Proposed location of bus stops

In particular the Ohio DOT lane width criteria is essential as these roadways receive Federal program funding and as per Ohio DOT "Location & Design Manual section 300 – "On all Federal Aid Primary (FAP) roadways at least one 12 ft. lane in each direction is required". Figure 6 shows the urban roadway criteria for lanes and shoulder widths.

Figure 11: ODOT Urban Roadway Criteria

URBAN ROADWAY CRITERIA LANE & SHOULDER WIDTHS (A)	301-4E REFERENCE SECTIONS 301.1.2, 301.2.2, 301.2.3 & 304.2.2

Functional Classification	Locale	Minimum Lane Width (ft.)	Minimum Curbed Shoulder Width (ft.) (F)	
			w/o Parking Lane	with Parking Lane (E)
Interstate, Other Freeways and Expressways	All	12	12 Rt. Paved (H) 4 Med. Paved (D)	
Arterial Streets	50 mph or more	12	8 Each Side Paved (G)	
	Less than 50 mph	11 (B)	1-2 Paved	7-10 Paved
Collector Streets (I)	Commercial / Industrial	11	1-2 Paved	8 - 11 Paved
	Residential	10	1-2 Paved	7 - 8 Paved
Local Streets (I)	Commercial / Industrial	11	1-2 Paved	8 Paved
	Residential	10 (C)	1-2 Paved	7 Paved

Source: Ohio Department of Transportation - Location & Design Manual Volume I – Section 300

Considering the prior and 2014 analysis, the proposed Public Square design and Ohio DOT criteria, Figure 12 describes the proposed lane configuration for the adjacent roadways.

Figure 12: Proposed Lane Configuration and Widths

Roadway	Proposed		
	Roadway Width	Configuration	Lane Widths
Rockwell Ave	38'-6"	3 lanes (inc. bus lane)	Bus Lane = 14' Center Through Lane = 12' Right Turn Lane = 13' (Curb Lane)
South Roadway W. of Ontario	45'-8"	2 lanes (inc. bus lane)	Same as existing roadway
South Roadway E. of Ontario	34'-8"	3 lanes (inc. bus lane)	Bus Lane = 12' Left Turn Lane = 11' (Center Lane) Left/Right Turn Lane = 12' (Curb Lane)
West Roadway N. of Superior	41'	3 lanes (inc. bus lane)	Bus Lane = 15' Through/Right Turn Lane = 13' (Center Lane) Right Turn Lane = 13' (Curb Lane)
West Roadway S. of Superior	37'-10"	2 lanes (inc. bus lane)	Same as existing roadway
East Roadway	39'-3"	3 lanes (inc. bus lane)	Bus Lane = 14' Right Turn Lane = 12' Right Turn Lane = 13' (Curb Lane)
Superior Ave (within the Square)	48'	4 lanes (inc. 2 bus lanes)	Two lanes in each direction Bus Lane = 12' Through Lane = 12'
Superior Ave (approaching the Square)	76' WB 91' EB	4 lanes (inc. 2 bus lanes)	Same as existing roadway
Ontario Street	64' to 66'	4-6 lanes	Right Turn Lane = 13' Right Turn Lane = 13'
Euclid Ave	62'-9"'	4 lanes (2 bus lanes and BRT platform)	Same as existing roadway

The lane configurations described above are included diagrammatically in Attachment B.

Conclusion: Roadway lane configurations as per above table.

Proposed Traffic Signals

With the proposed lane configuration around the Square, two intersections which are now stop-sign controlled would now include multiple left turn lanes. Upon review of the traffic analysis and

in concurrence with the City, the following intersections will be signalized under the future conditions:

1- East Roadway at Rockwell Avenue

2- West Roadway at Rockwell Avenue

The signalization of these intersections provides the opportunity for signal priority for the Heatlthline BRT vehicles as well as designated pedestrian phases to aid pedestrian safety.

Additionally, the greater emphasis on pedestrian activity within the Square and its environs means that connections between the Square and adjacent demand centers are a crucial element to be addressed. With this in mind and the potential for both higher vehicle and pedestrian volumes in front of Tower City, a pedestrian signal is proposed to provide a dedicated crossing to the interior of the Square.

Conclusion: New traffic signals along Rockwell Ave at West Roadway and East Roadway. New pedestrian signal in front of Tower City.