

FINAL REPORT | MAY 15, 2019

I-35/Bayfront Area Traffic Modeling and Special Event Traffic Control Plan

Long-Term Project Recommendations - Event Parking, Traffic, and Wayfinding

Prepared for:



Sponsored by:



Prepared by:



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Executive Summary

The Metropolitan Interstate Council (MIC), a division of Arrowhead Regional Development Commission (ARDC), and Alliant Engineering, Inc. have been leading a planning endeavor to improve the parking, traffic and wayfinding experiences during medium and large-scale events at the Bayfront/DECC/Canal Park area in Duluth, Minnesota. The “I-35/Bayfront/DECC/Canal Park area Traffic Modeling and Special Event Traffic Control Plan” project was initiated by documenting the existing event information and developing a short-term traffic control plan for a pilot test during the 2018 holiday season. The project then concluded an event parking, traffic and wayfinding analysis. This report summarizes the key findings from the analysis as well as recommendations for immediate and long-term strategies/improvements.

Key recommendations are summarized below:

Parking Management and System Improvements

- Use marketing outreach to advertise downtown parking options
- Establish Bayfront Area event parking management committee for planning, operation and system coordination
- Reduce processing time at parking entrances by using multiple entrance lanes and payment points
- Utilize apps to share information on events and parking availability; collaborate with Park Duluth app
- Assign parking at the DECC to reduce entrance queuing into the ramp
- Implement a preferential or prepaid parking strategy
- Upgrade parking systems and coordinate parking management and share facility occupancy

Wayfinding, Parking Access, and Vehicle Traffic Improvements

- Install traffic signs to split Bayfront Park and DECC traffic, utilize Harbor Drive, alternative/multiple parking entrance, and slip ramp
- Utilize apps to share information on events, traffic condition and parking availability; collaborate with Park Duluth app
- Improve signal timing and operations of I-35 ramp terminal intersections at 5th Avenue West and Lake Avenue
- Install Dynamic Message Sign (DMS) on local roadways and develop wayfinding messages and operation plans for events
- Install static freeway & local streets signs for downtown and Canal Park parking
- Separate traffic exiting the NB/EB I-35/5th Avenue ramp to mitigate right turn congestion, by installing dynamic lane assignment sign for the right lane to be either shared through/right or right-turn only
- Reconstruct roadway and sidewalk of 5th Avenue West, potentially add a bike lane, including a potential covered pedestrian walkway along 5th Avenue West
- Reconfigure northbound/eastbound 5th Avenue West exit off I-35 to add an additional right turn lane

Transit-related Improvements

- Use marketing outreach to advertise alternative transportation options
- Add dedicated bus lane via 5th Avenue West and Harbor Drive; Implement Transit Signal Priority (TSP); Add Park and Ride (P&R) shuttle options

Pedestrian-related Improvements

- Use marketing outreach to advertise downtown parking & alternative transportation options
- Install pedestrian access control at Bayfront Park entrance on Harbor Drive
- Improve signal timing and operations of I-35 ramp terminal intersections at 5th Avenue West and Lake Avenue to maximize pedestrian green time
- Use one vehicle lane on 5th Avenue West for pedestrian ingress
- Install permanent/temporary pedestrian wayfinding signs along 5th Avenue West, Harbor Drive and the pedestrian skyway
- Improve pedestrian access in the Bayfront area, including a potential pedestrian amenity upgrade on the portion of the Cross City Trail that connect Bayfront Park (near Railroad Street) and downtown Duluth (near Michigan St)
- Reconstruct the roadway and sidewalk of 5th Avenue West, including a potential covered pedestrian walkway along 5th Avenue West

Bicycle-related Improvements

- Use marketing outreach to advertise downtown parking & alternative transportation options
- Improve bicycle access in the Bayfront area by installing bicycle facilities
- Reconstruct the roadway and sidewalk of 5th Avenue West, potentially add a bike lane

Truck Traffic Considerations

Due to the large present of truck traffic in and around the Rice Point and Bayfront areas, the following should be taken into consideration to ensure that the trucking industry is not negatively impacted by the deployment of the recommendations:

- Turn restriction exemption
 - When a no left turn sign is set up on the looping ramp approach at Railroad Street from Harbor Drive, an “Except Trucks” panel can be added to allow trucks to access local business.
- Accommodate truck turning radius with permanent roadway design and temporary traffic control; maintain truck access during construction and setup/take-down
 - Accommodating the truck turning radius and access is a standard engineering practice and based on a preliminary assessment there appears to be no major constraints for these accommodations under the above strategies.
 - During events that attract large amount of traffic onto Railroad Street (e.g. Bentleyville) and/or draw ingress traffic before the end of business days, additional traffic control agents or traffic controls can be deployed at local business (e.g. Compass Minerals) driveway along Railroad Street to facilitate truck movement entering and exiting the site.
- “Recommended Truck Route”, “Avoid Conflict with Pedestrians and Bicycle” and “Expect Traffic Delay” messages during large-scale events

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- For large-scale and overlapping events, recommended truck routes can be developed and communicated with trucking businesses for trucks to avoid congestion and potential conflicts with event traffic.
- Traffic delay should be expected before and after Bayfront area event if trucks choose to operate during those time windows.
- Truck traffic delay must be considered as a decision-making factor for the dedicated bus lane on 5th Avenue West and Harbor Drive, when it is ready for further evaluation in 5-7 years.

1 Introduction

The Metropolitan Interstate Council (MIC), a division of Arrowhead Regional Development Commission (ARDC), and Alliant Engineering, Inc. have been leading a planning endeavor to improve the parking, traffic and wayfinding experiences during medium and large-scale events at the Bayfront/DECC/Canal Park area (referred to as the Bayfront area) in Duluth, Minnesota. Several stakeholders have been involved with the project and have provided background information and observations on past events that have taken place in the Bayfront area. The stakeholders have also provided input on the final recommendations that are presented in this report. The stakeholders include Bentleyville, the City of Duluth Police and Public Works departments, Duluth Economic Development Authority, Duluth Seaway Port Authority, Duluth Entertainment Convention Center (DECC), Duluth Transit Authority (DTA), Minnesota Department of Transportation (MnDOT), Minnesota State Patrol, Pier B, and the University of Minnesota-Duluth.

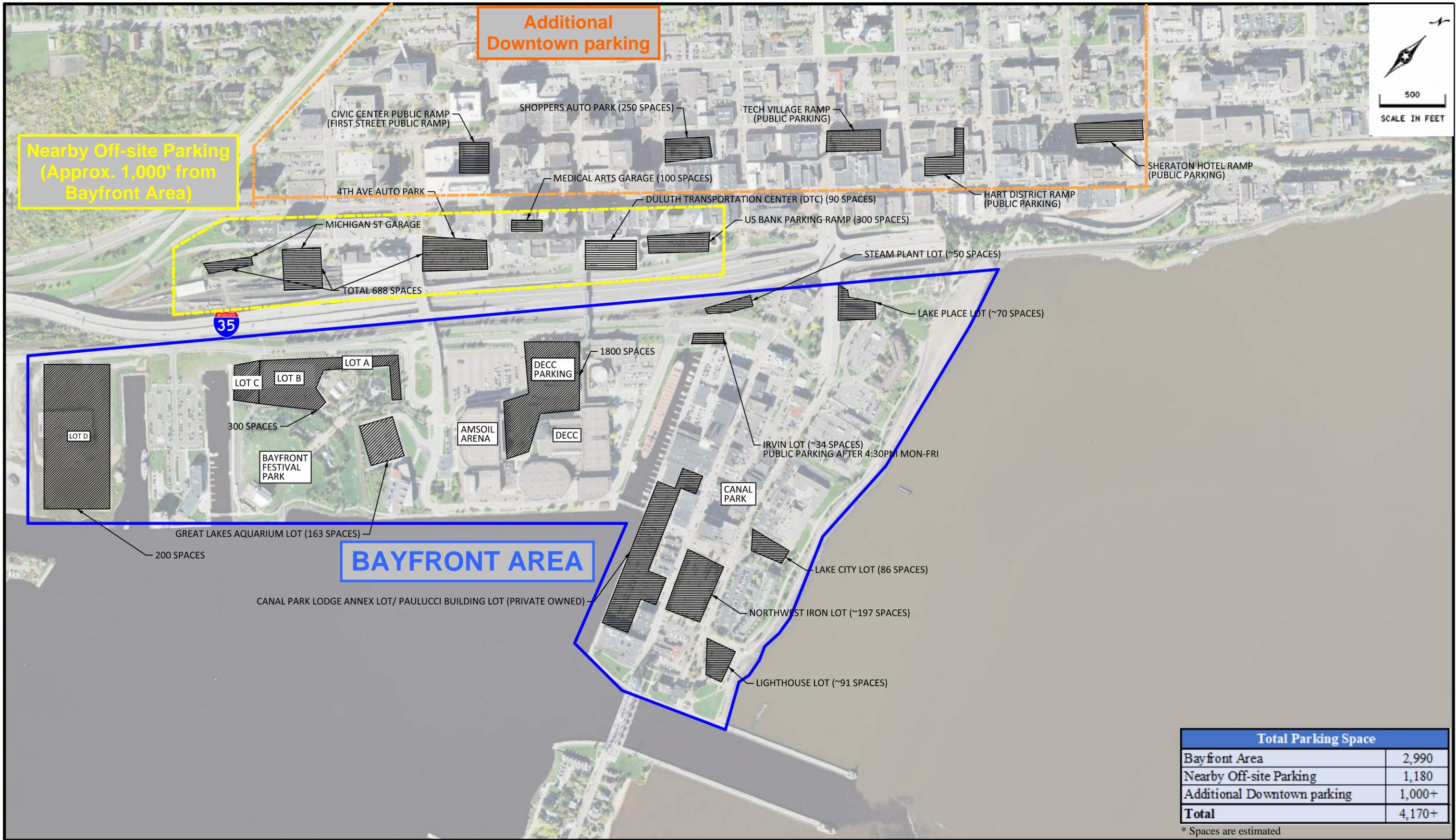
1.1 Project Location

The Bayfront area is located within the City of Duluth in the State of Minnesota. The City of Duluth is a destination for millions of visitors each year accounting for over \$950 million dollars in economic impact. The City is host to numerous of events throughout the year that take place at the Bayfront Festival Park, DECC, and AMSOIL arena. These facilities are all located in the same area and next to Canal Park. Canal Park is another attraction that many people come visit to see the 900 plus ocean-going and Great Lakes freighters coming in or leaving the harbor and visit the local shops and restaurants.

Figure 1 highlights major venues and parking facilities in and around the Bayfront Area.

The Bayfront area is also located adjacent to an industrial area called Rice's Point. Ships from all over the world stop at the Port of Duluth-Superior. Iron, grain, coal and stone combine to make Duluth-Superior a top volume port on the Great Lakes with an estimated total of \$1.4 billion in annual economic impact. The industrial activity at the Port of Duluth-Superior has been increasing steadily over the past several years, which has increased truck and rail traffic in the area. The industrial traffic is mixed in with the commercial/residential traffic at the Bayfront area.

Regionally, the Bayfront area is connected by Interstate Highway 35 and 535, and Trunk Highway 53. The Bayfront area is adjacent to Lake Superior and locally accessible via 5th Avenue West, Lake Avenue, Railroad Street, as well as the Cross City Trail, the Lake walk and the North Shore Scenic Railroad.



Bayfront Area Long-term Project Recommendation

Figure 1 Venue and Parking

1.2 Project Background

During high-turnout events within the Bayfront area, significant congestion and traffic delays at parking facilities and in parking lots along Railroad Street have become more common, along with a corresponding increase in traffic delays and crashes on local streets and I-35. Truck traffic entering and exiting properties along Railroad Street can also experience significant delay during some events as traffic on Railroad Street can back up due to the high demand at the parking lots along Railroad Street and the DECC. The traffic back up typically results in not allowing for a proper gap for trucks to turn out of or into the property. Traffic will commonly back up on the I-35 exits to 5th Avenue/Harbor Drive and Lake Avenue. These streets are the main access points to the Bayfront area and the only street crossings over I-35 that feed into the downtown area and provide direct access to I-35. Railroad street currently terminates at Garfield Avenue, which does not have direct access to I-35 but does have access I-535. Wayfinding to/from I-35 and I-535 is very limited around the Bayfront area.

According to recent observations by large-scale event organizers and patrons, on-site parking facilities are usually quick to fill to their capacities. When this occurred, vehicles were often seen queued up from the parking entrances, involuntarily due to lack of real-time and advanced information or voluntarily due to lack of knowledge/confidence of alternative parking locations. Ironically, nearby off-site parking facilities towards downtown Duluth (shown by Figure 1) were usually observed well underutilized. The overutilization of on-site parking facilities has also exacerbated traffic congestion due to facility queuing and parking circulation.

1.3 Project Approach

This project applied the following strategic and technical steps in order to conclude its recommendations:

- Engaged stakeholders for inputs of background information and existing conditions on events, venues, traffic volumes, parking management, etc.
- Developed a short-term traffic control plan for medium and large-scale events on November 30 and December 1, 2018, as a pilot study for the effectiveness of several preliminary strategies. Further evaluated traffic/parking bottlenecks for future traffic model calibration.
- Developed 30 strategies for potential improvements in event parking, traffic and wayfinding.
- Built a traffic model to analyze the traffic operational benefit of the 30 strategies.
- Concluded a parking and wayfinding analysis of Bayfront area event, including information on potential parking management vendors and technologies as well as two relevant case studies.
- Presented key findings in stakeholder meetings in order to receive feedback and pressure test key recommendations.

This report concludes long-term project recommendations based on the findings throughout the project. An implementation timeline and practical considerations are also prepared based on project interdependencies and relative benefit and cost.

2 Existing Condition and Alternatives Analysis

Four memorandums were completed for the existing conditions and alternatives analysis of Bayfront area event parking, traffic and wayfinding, as listed below:

- Bayfront Area Event Traffic Control Existing Condition Memo (**Attachment A**)
- Bayfront Area Event Traffic Control Plan (Short-term) Memo (**Attachment B**)
- Bayfront Area Event Traffic Forecast and Alternatives Analysis Memo (**Attachment C**)
- Bayfront Area Event Parking and Wayfinding Analysis Memo (**Attachment D**)

Based on the details in **Attachments A, B, C and D**, key conclusions are documented in the sections below.

2.1 Existing Condition Analysis

The Event Traffic Control Existing Condition memo (**Attachment A**) documents the existing event, parking, and traffic conditions of large-scale events and local business activities at the Bayfront Festival Park, DECC, AMSOIL Arena, Canal Park, and other venues around the Bayfront area.

Key Conclusions

Based on the review of existing parking conditions of the Bayfront area, it is concluded that:

- On-site capacity at Bayfront Park and DECC combined is
 - insufficient to accommodate the parking demand of a DECC large event even if no other large event occurs simultaneously.
 - theoretically sufficient to accommodate the parking demand of a Bentleyville event if no other large event occurs simultaneously. However, this requires a high level of coordination for parking facility status and difficulties in finding parking may occur while parking is being turned over (vehicle arriving while others exiting).
- The total capacity of on-site and nearby parking cannot accommodate the parking demand during overlapping large-scale events of Bentleyville and a UMD Men's Hockey game (as well as other smaller concurrent DECC events) without parking demand management (reducing vehicle modal arrivals, encourage remote parking and/or other modes of transportation).
- Parking demand varies by season and is weather dependent.

The traffic congestion observed around the event venues is primarily a result from circulation for parking and is worsened once on-site parking facilities are at capacity. With generally spread-out parking supply throughout the Bayfront park and downtown areas, there is high potential to reduce the circulation congestion with advanced and real-time parking/traffic information. Additionally, opportunities exist to improve the use of alternative transportation modes such as transit and walking by providing amiable and accessible facilities and services.

2.2 Short-term Traffic Control Plan

Attachment B documents the short-term traffic control plan for typical large-scale events during the 2018 holiday season at Bayfront Festival Park, DECC, AMSOIL Arena, Canal Park, or other venues at the Bayfront area.

A short-term traffic control plan for vehicles and pedestrians were developed, implemented and evaluated. The relevant strategies were further discussed as part of the Bayfront Area Event Traffic Forecast and Alternatives Analysis (**Attachment C**).

2.3 Traffic Forecast and Alternative Analysis

Attachment C documents the assumptions and results of the traffic forecast and alternatives analysis for typical large-scale events at the Bayfront area.

This analysis developed a base scenario to represent the typical busy event and tested traffic operation at key intersections throughout the area based on developed strategies. While the actual event situation may differ from the modeled base scenario, the traffic operation evaluation results indicating the difference between base scenario and each alternative are applicable insights to evaluate the 30 strategies.

Key Conclusions

Based on the planning level traffic analysis for the developed strategies to manage Bayfront area event traffic and parking, several key conclusions for vehicle traffic are drawn:

- During typical large-scale Bayfront event ingress, LOS B or above is expected at all study intersections except:
 - I-35 Ramps / 5th Avenue West intersections;
 - I-35 Ramps / Lake Avenue intersection;
 - Bayfront Park Lot Entrance / Railroad Street intersection;
 - Garfield Avenue / Railroad Street intersection.
- These intersections may experience occasional congestion during the peak event ingress hour, resulting overall LOS C or D.
- Since LOS D is considered acceptable traffic operation during peak hour based on Traffic Engineering best practice, even a substantial improvement to it may not be worth the financial and implementation challenges. Therefore, the strategies included in strategy groups 5 and 7 that require significant incremental capital investment are not recommended for further considerations. These include strategies 5b, 5c, 5f, 5g, 5h and 7a (refer to Table 1 and Appendix B of **Attachment C** for strategy details).
- However, some strategies within strategy groups 5 and 7 bear substantial merits based on the traffic and alternative analysis. They may be further analyzed, combined, and/or repackaged during the development of the long-term event management plan. Specifically,
 - Strategy 5a “Reconstruct the roadway and sidewalk of 5th Avenue West, potentially add a bike lane” and strategy 5d “Reconfigure northbound 5th Avenue West exit off I-35” can be repackaged into the future reconstruction of the 5th Avenue West bridge. Impacts to operations of trucks along 5th Avenue West shall be considered when designing and implementing strategies 5a and 5d.
 - Strategy 5e “Improve pedestrian and bicycle access in the area” was further discussed in the Parking and Wayfinding Analysis memo (**Attachment D**). This includes, but not limited to, a potential pedestrian amenity upgrade on the portion of the Cross City Trail that connect Bayfront Park (near Railroad Street) and downtown Duluth (near Michigan St).
 - Strategy 7b “Preferential or prepaid parking strategy” should be further explored for its implementation viability.

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- Strategy 7c “Utilize apps to share information on events, traffic condition and parking availability” should be considered as a strategy for future implementation.
- The strategies within strategy group 1, 2, 3, 4 and 6 should be further refined and evaluated during the development of long-term event management plan. Specifically,
 - If Harbor Drive and/or Lake Avenue / Canal Park Drive pair were to be converted to one-way loop, clockwise direction is more favorable operationally than counter-clockwise direction. However, other factors such as impact to bus/shuttle operation, business access, etc. must be further evaluated in order to determine the favorability of converting Harbor Drive and/or Lake Avenue / Canal Park Drive pair to one-way loop(s).
 - In general, the reduction of roadway capacity along 5th Avenue West for bike lane and wider sidewalk is not expected to create systematic traffic congestion beyond delay at selected movements of selected intersection. However, a detailed traffic impact analysis needs to be conducted in order to identify necessary intersection improvement due to the shift in traffic pattern and reduction in roadway capacity.
 - Strategy 6a “Add dedicated bus lane via 5th Avenue West and Harbor Drive” and strategy 6b “Add P&R shuttle option” can be combined to expand and/or refine the existing shuttle services (routes, frequency, etc.) and related amenities (dedicated bus lane, transit signal priority, etc.).

Since all adjacent intersections already perform at LOS D or better under typical large-scale event traffic demand, the strategies for traffic improvement in this memo are expected to only have moderate impact for traffic operation. Additional analysis on vehicle parking and wayfinding improvements is available in “Bayfront Area Event Parking and Wayfinding Analysis” memo (**Attachment D**).

Based on the traffic and alternative analysis, considerations for pedestrian, transit and bicycles are summarized below:

- Pedestrian
 - Strengthen marketing outreach for alternative transportation (e.g. Park & Walk);
 - Continue pedestrian control at Bayfront Park entrance on Harbor Drive;
 - Utilize one northbound vehicle lane on 5th Avenue West bridge as additional sidewalk space during event ingress; or reconstruct and widen sidewalk on 5th Avenue West bridge;
 - Add permanent/temporary pedestrian wayfinding signs along 5th Avenue West, Harbor Drive and inside the pedestrian skyway.
- Transit
 - Strengthen marketing outreach for alternative transportation (e.g. remote parking shuttles, local transits, etc.);
 - Continue the existing shuttle services for remote parking;
 - Continue the existing train services;
 - Consider adding dedicated bus lane via 5th Avenue West and Harbor Drive;
 - Consider expanding Park & Ride options.
- Bicycle
 - Strengthen marketing outreach for alternative transportation (e.g. bicycle parking locations, bicycle routes, etc.);

- Potentially add a bike lane to 5th Avenue West. Connection to other bike routes from 5th Avenue West should be considered as well.

2.4 Parking and Wayfinding Analysis

The Event Parking and Wayfinding Analysis memo (**Attachment D**) documents the assumptions and results of event parking and wayfinding analysis for the Bayfront area. Selected parking and wayfinding strategies discussed in this memo have been evaluated for traffic operational benefit on adjacent intersections (**Attachment C**).

The Bayfront area event parking study has highlighted three event parking-related issues and challenges:

1. Lack of advanced and real time parking availability information sharing.
2. Parking circulation that creates traffic congestion and customer frustration.
3. Difficulty in coordination among independent parking operations.

Available resources (vendors and technologies) to facilitate event parking management and parking system upgrades are identified for reference. Two case studies are attached to provide relevant best practices and lessons learned.

Key Conclusions

Selected parking improvement efforts below may have immediate positive impacts to event parking experiences and the area traffic congestion:

- Parking Facility Management:
 - When possible and necessary, encourage use of multiple parking entrances, multiple entrance lanes, and multiple payment points to reduce congestion at the main parking entrances.
 - Consider the feasibility, pros and cons of assigning parking (e.g. early customers park at upper level, reserve skyway level, etc.) at the DECC parking ramp and lot during busy events, to reduce in-ramp congestion (when multiple lanes of traffic merge into one).
- Digital Enhancement:
 - Explore the potential to market event parking and alternative parking options (around the Bayfront and adjacent area) on the Park Duluth app.
- Bayfront Area Event Parking Manager:
 - Explore the viability and interests of forming a committee (likely championed by the City of Duluth and funded by stakeholders) with representatives from the City of Duluth, major event operators (Bentleyville Tour of Lights, Bayfront Blues Festival, Bayfront Concerts, UMD Athletics, Grandma's Marathon, Fourth Fest Celebration, Taste of Duluth, Tall Ships Duluth, Canal Park Businesses, etc.), infrastructure operators (Bayfront Park, DECC, Port Authority, local industry representatives, etc.), MnDOT, Duluth-Superior Metropolitan Interstate Council, etc. The committee's responsibilities may include but not limited to:
 - Oversee the coordination of parking information among the various parking garages and lots for large events in the Bayfront area.
 - Oversee the development of infrastructure improvements needed to improve wayfinding to parking for visitors.
 - Oversee the development of infrastructure improvements needed to improve pedestrian wayfinding throughout the Bayfront/Canal Park area for events.

- Pursue funding sources for infrastructure improvements.
- Develop a Protocol and Operations plan for wayfinding and parking for large events in the Bayfront area.

2.5 Further Analysis

Based on recent stakeholder meetings/discussions and combined insights from Traffic Forecast and Alternatives Analysis (**Attachment C**) and Event Parking and Wayfinding Analysis (**Attachment D**), further conclusions were summarized for the following strategies.

Strategy Group #4: Circulation Improvement

Even though the traffic analysis indicates that clockwise direction is more favorable operationally than counter-clockwise direction for potential Harbor Drive one-way loop and Lake Avenue / Canal Park Drive one-way pair, it did not necessarily recommend nor discourage the one-way operation due to following considerations:

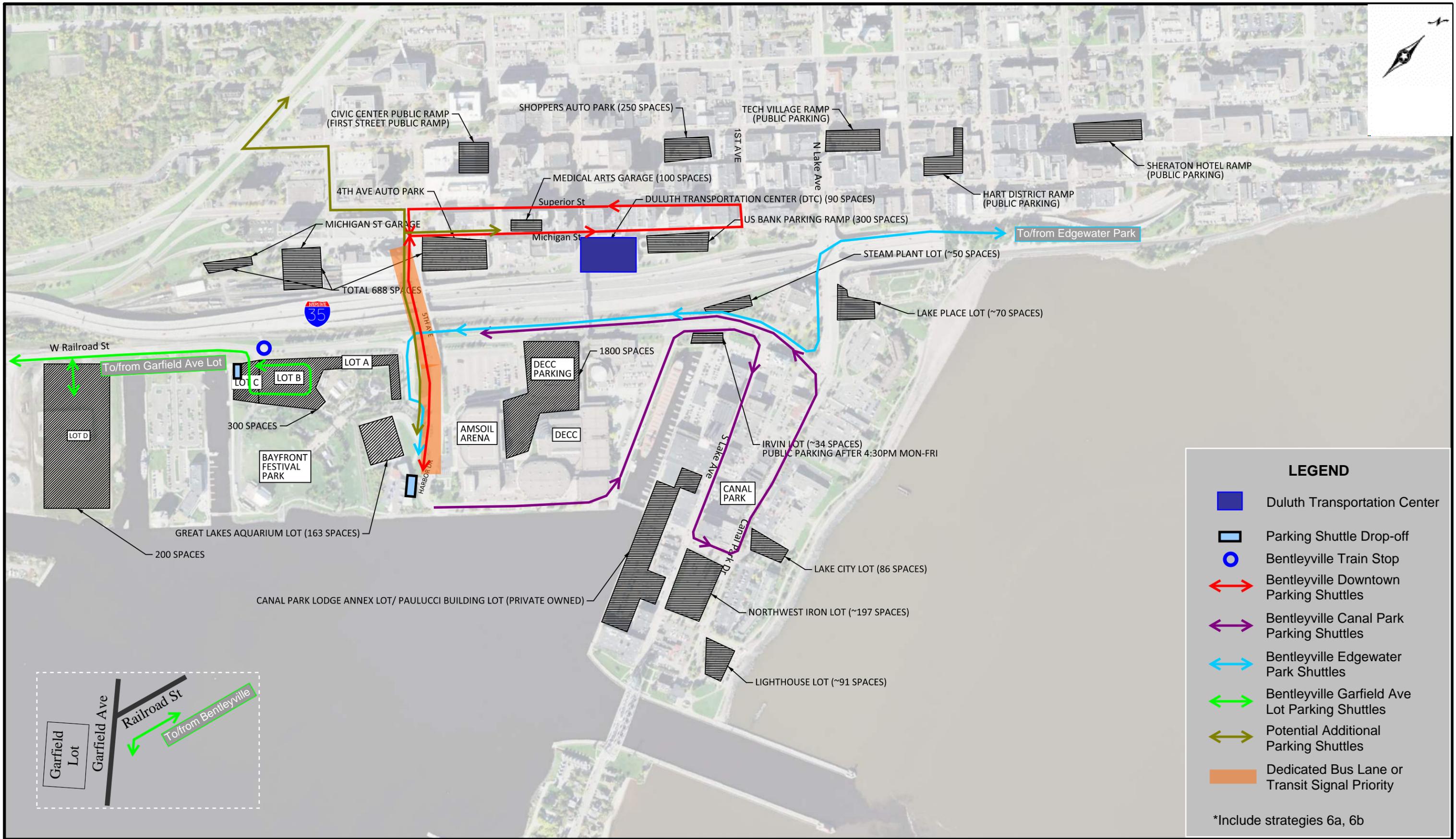
- The one-way conversions do not provide noticeable traffic operation benefit at adjacent intersections.
- The Lake Avenue / Canal Park Drive one-way conversion may elongate the access to local businesses near the end of the one-way loop.
- Bus operations, on-street parking, and pedestrian crossing along Harbor Drive, Lake Avenue and Canal Park Drive may also be affected.
- While both permanent and temporary conversions share most of their pros and cons, the temporary conversion adds another layer of uncertainty and inconsistency to the traffic users.

Therefore, The Strategy Group #4: Circulation Improvement will not be included in the recommendations of this project. If interest persist, further analysis can be done to explore the feasibility, benefit/cost and timeline of converting Lake Avenue / Canal Park Drive to a one-way pair.

Strategy Group #6: Transit Improvement

The traffic analysis concluded even though strategy #6a (Add dedicated bus lane via 5th Avenue West and Harbor Drive) may increase area vehicle traffic delay by reducing capacity of 5th Avenue, strategy #6b (Add Park & Ride (P&R) shuttle option) will conversely reduce vehicle delay by reducing vehicle trips. Therefore, it's the best to view all transit improvement as a package and assess the pro/cons holistically.

Specifically, opportunities may exist along the existing Duluth Transit Authority (DTA) transit routes within and outside the Bayfront area to improve transit travel time, frequency, and reliability by providing transit only lanes, intersection queue jump, TSP, etc. Furthermore, adding P&R shuttles will require additional market research, business plan development, pilot studies, funding discussions, agency meetings, etc. in order to determine the financial feasibility and implementation viability of the increased operation. Therefore, the transit improvement strategies will be recommended for further business analysis and potential implementation in the next several years. Strategy group #6 should also be further evaluated in-regards-to potential impacts to truck traffic that regularly use I-35 and 5th Avenue West ramp interchange to access I-35. An illustration of existing event shuttles and potential related strategies is shown at **Figure 2**.



Bayfront Area Long-term Project Recommendation

Figure 2. Existing and Proposed Shuttles

Strategy 7b: Preferential or Prepaid Parking

The traffic analysis concluded that Strategy 7b Preferential or Prepaid Parking is expected to systematically improve traffic operations at most intersections within the Bayfront area. However, it's acknowledged that institutional and marketing challenges may exist to change parking operation from event-day pay parking to partial/fully prepaid/reserved parking, even though the actual strategy execution does not require lengthy system design or construction. Therefore, this strategy may be recommended after an evaluation of other strategies being implemented in the near term.

3 Recommendations

Based on the existing condition and alternative analysis presented above, recommended strategies are summarized in this section. Recommendations are also further discussed for their potential implementation timeline, costs/complexity, major obstacles and dependencies, and practical considerations.

3.1 Recommended Alternatives

Table 1 on the next page summarizes the recommended strategies for event parking, traffic and wayfinding at the Bayfront Area. It also presents timeline considerations for each strategy as well as any major obstacles or dependencies that may facilitate or hinder the implementation. Project timeline and practical considerations are further discussed in detail in the next section along with estimated project costs.

Table 1. Recommended Strategies, Timeline Considerations and Major Obstacles/Dependency

Strategy Group	Strategy ID	Detailed Strategy	Timeline Consideration		Major Obstacles/Dependency
			Immediate	Future	
#1 Outreach & Minimal Traffic Management*	1a	Dynamic Message Sign (DMS) wayfinding messages and operation plans	X	X	Funding, MnDOT/City approvals
	1b	Marketing outreach for downtown parking options & alternative transportation	X		None
	1c	Southbound left-turn lane on Railroad St at Bayfront Park parking entrance	In-place		None
	1d**	Move the train stop further south near the existing Cross City Trail crossing	In-place		None
	1e**	Pedestrian control at Bayfront Park entrance on Harbor Dr	X		Funding
#2 Integrated Parking & Traffic Circulation Management	2a	Reduce processing time at parking entrances by using multiple entrance lanes and payment points	X		Funding and Staffing
	2b	Assign parking at DECC parking to reduce entrance queuing		X	Logistics and funding
	2c/f	Traffic signs to split Bayfront Park and DECC traffic, utilize Harbor Dr, alternative/multiple parking entrance, and slip ramp	X		Funding
	2d	Establish Bayfront Area event parking management committee for planning, operation and system coordination	X	X	Logistics and leadership
	2e	Static freeway & local streets signs for downtown and Canal Park parking	X		Funding
#3 Traffic Operation Improvement	3a	Separate traffic exiting the NB/EB I-35/5th Avenue ramp to mitigate right turn congestion, by installing dynamic lane assignment sign for the right lane to be either shared through/right or right-turn only		X	Funding, MnDOT approvals
	3b	Add permanent/temporary pedestrian wayfinding signs along 5th Avenue, Harbor Dr and the pedestrian skyway		X	Funding
	3c**	Improve signal timing/operations of I-35 ramp terminal intersections at 5th Ave and Lake Ave	X		Funding/Signal system limitation
#5 Roadway or Network Improvement	5a**	Reconstruct roadway and sidewalk of 5th Ave, potentially add bike lane, including a potential covered pedestrian walkway along 5th Ave		X	Funding
	5d	Reconfigure northbound/eastbound 5th Ave exit off I-35 to add an additional right turn lane		X	
	5e**	Improve pedestrian and bicycle access in the area, including a potential pedestrian amenity upgrade on the portion of the Cross City Trail that connect Bayfront Park (near Railroad St) and downtown Duluth (near Michigan St).		X	Funding
#6 Transit/Pedestrian Improvement	6a/b	Add dedicated bus lane via 5th Ave and Harbor Dr; Implement TSP; Add P&R shuttle option		X	Business viability
	6c**	Use one vehicle lane on 5th Ave for pedestrian ingress	X		Logistics and funding
#7 System or Capacity Improvement	7b	Preferential or prepaid parking strategy	X		Business viability
	7c	Utilize apps to share information on events, traffic condition and parking availability; upgrade parking systems and coordinate parking management and share facility occupancy during overlapping events; collaborate with Park Duluth app	X	X	Logistics and funding

* Group #1 was implemented for 11/30 and 12/1 events as short-term improvement

** Pedestrian-related strategies

Note: Impacts to truck movements shall be considered when designing and implementing strategies 2c/f, 3a, 5a, 5d, 5e, 6a/b, and 6c

To qualify for immediate implementation, a strategy must bear substantial benefit in event parking, traffic or wayfinding with considerations of its total cost and project complexity. To qualify for future implementation, a strategy must still have significant benefit-to-cost ratio but may be either costly/complex or dependent on other major factors such as roadway/bridge reconstruction opportunities or business plan developments.

As an example, DMS wayfinding messages (Strategy 1a) can be implemented immediately on existing Dynamic Message Signs (DMS) by developing a message plan that is approved by the jurisdiction(s). However, if a new DMS needs to be installed for a message to display, a process of funding, bidding, design, construction and testing must be followed, which results in longer timeline and more uncertainty. An overview of existing, planned and proposed DMS on adjacent freeway and highways is documented in **Figure 3**. These DMSs are operated by MnDOT and are for regional use, while additional permanent and temporary DMSs may be deployed on local streets for intelligent parking, traffic and wayfinding management, as shown in **Figure 4**. This figure also illustrates other recommended strategies (1a, 1e, 2c/f, 2e, 3a, and 3c) that will benefit vehicle wayfinding.

Attachment E provides a rendering (**Figure E1**) of what Strategy 1a and 3a may look like at the northbound I-35 exit ramp approaching 5th Avenue West. It also provides an example (**Figure E2**) of a covered pedestrian walkway along Cedar St bridge between East 11th Street and East 12th Street in downtown St Paul that supports the recommendation of Strategy 5a and 5e. A covered pedestrian walkway on 5th Avenue West and/or Lake Avenue will much improve their pedestrian friendliness, which in turn elevate their gateway effect for the Bayfront area. Additionally, **Attachment E** includes a Garfield Lot wayfinding plan (**Figure E3**) that was piloted during the Bentleyville event in November & December 2018. The plan received positive feedback and vehicles were observed to follow the sign to the alternative parking location (Garfield Lot). Therefore, this sign plan is also recommended for future consideration.

Lastly, **Figure 5** highlights recommended strategies (1e, 3b, 5e and 6c) that will benefit pedestrian wayfinding. It's important to note that recommended strategies not highlighted by **Figures 2, 3, 4, 5** or **Attachment E** may also be critical. The importance of each recommended strategies is further evaluated in the next section based on their potential benefit, estimated costs, possible implementation timeline, and practical considerations.



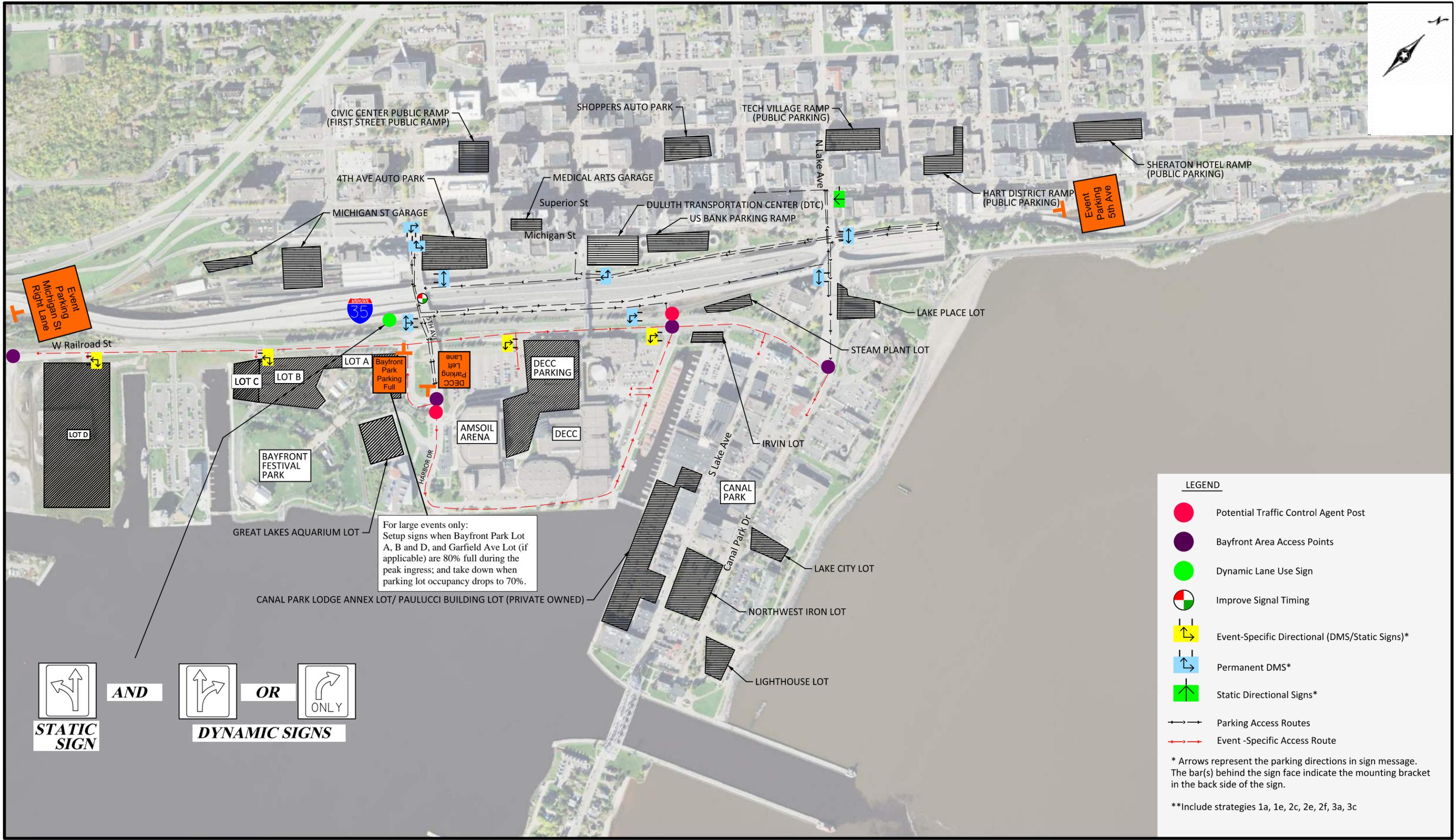
Bayfront Area Long-term Project Recommendation

Legend

-  Existing DMS *
-  Planned DMS *

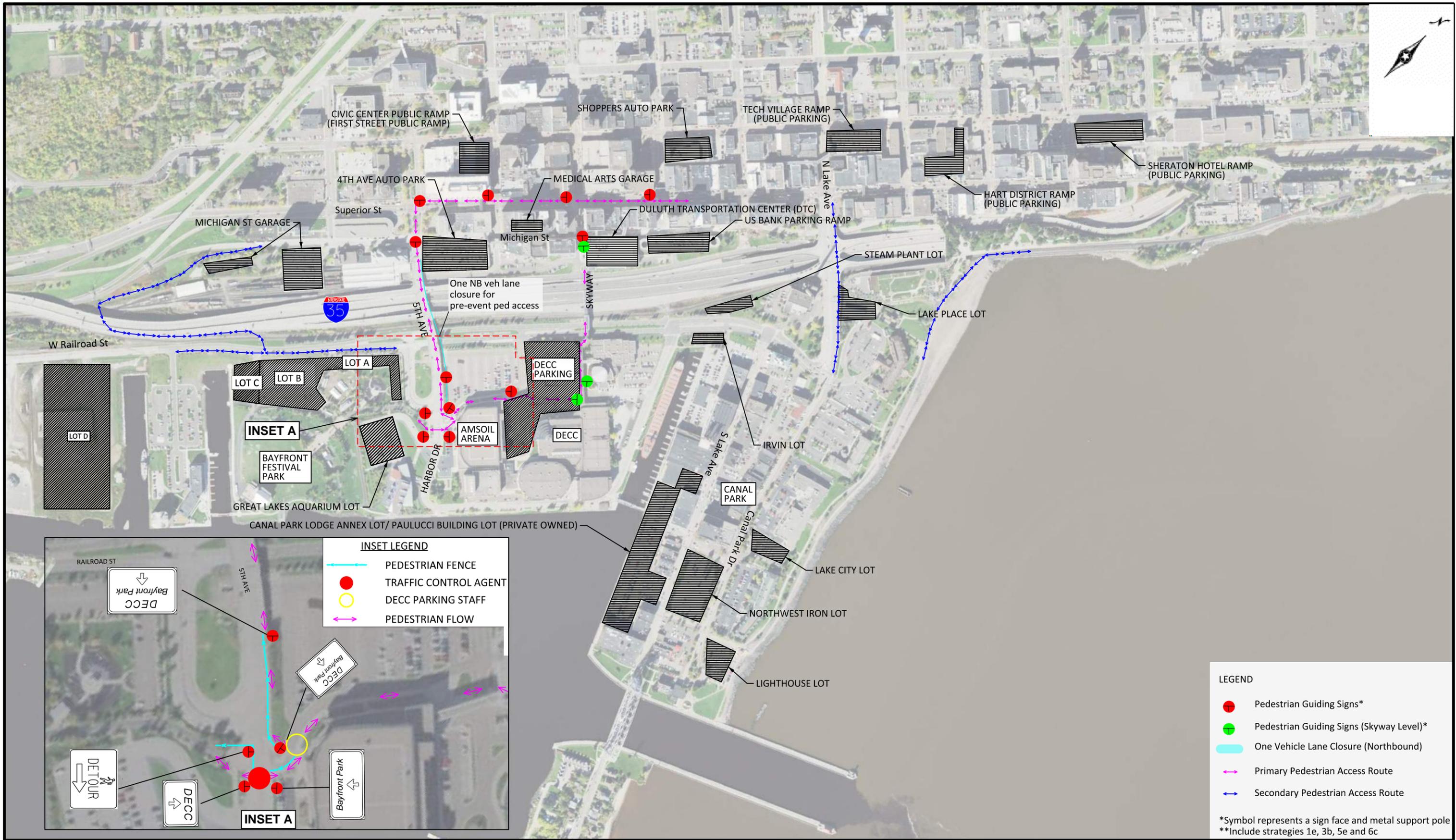
* Strategy 1a
Symbol represents a digital sign face and mounting posts

Figure 3. Regional Freeway Wayfinding



Bayfront Area Long-term Project Recommendation

Figure 4. Vehicle Wayfinding



Bayfront Area Long-term Project Recommendation

Figure 5. Pedestrian Wayfinding

3.2 Cost and Timeline

Table 2 lists the estimated engineering, construction, operation and maintenance costs and 10-year total (without time value of money consideration) of each recommended strategy. These planning-level costs are for comparison purpose only and may not serve as engineering estimates. The engineering and construction costs noted in **Table 2** is assumed to be a one-time cost for each strategy. The engineering cost is assumed to be 18% of the construction cost and is comprised of design and construction administration costs. The Operation and Maintenance (O&M) cost is an annual expense and is based on 30 events per year, as applicable. Although typically there are more than 30 events that take place during the year in the Bayfront area, it is assumed that several of the strategies would only be used for the large scale events. It was also assumed that most events would have a duration of six hours. The 10-year total includes the O&M annual cost multiplied out over 10 years.

It should be noted that some of the costs for several strategies could be less as a whole if the strategies are done together. However, it is assumed for cost estimating purposes that each strategy is done independently.

Listed below are the recommended strategies and some additional background information that went into determining the costs shown in **Table 2**.

Strategy 1a (DMS wayfinding messages and operation plans)

The engineering and construction costs are based on the installation of eight DMS on local roadways in and around the Bayfront area and includes the DMS hardware, communications to the DMS, control software to operate the signs, and new infrastructure to mount the signs over the roadway. The engineering cost includes the development of a protocol and operations plan that would define how the DMS are used during events.

The O&M costs is based on two staff members spending approximately 128 hours annually to maintain the DMS and one staff member spending 180 hours annually to manage the DMS during events. The O&M costs also include expenses for materials to maintain the DMS and for power.

Strategy 1b (Marketing outreach for parking options & alternative transportation)

An estimated cost could not be determined for this strategy. However, it is assumed the cost will be relatively low. It should be noted that the University of Minnesota-Duluth and the DECC already send out notifications to Men's and Women's hockey season ticket holders to alert them of bigger events taking place in the Bayfront area and of alternative parking and transportation options when parking is expected to be at a premium at the DECC.

Strategy 1e (Pedestrian control at Bayfront Park entrance on Harbor Drive)

The construction cost includes the purchase of portable metal fencing to control the pedestrian flow along 5th Avenue West/Harbor Drive approximately between the I-35 NB/EB ramp and the DECC parking lot exit. The O&M cost includes two staff members

managing the pedestrians crossing Harbor Drive between the DECC and Bayfront during events, and the set up and take down of the fencing for each event.

Strategy 2a (Reduce processing time at parking entrances)

An estimated cost could not be determined for this strategy as further analysis is needed to determine the most efficient way to reduce the processing time at the parking lot entrances. It is believed that additional staff and/or infrastructure improvements would be needed.

Strategy 2b (Assign parking at DECC parking to reduce entrance queuing)

It is assumed for cost estimating purposes that the most efficient way to reduce entrance queuing into the DECC ramp and/or surface lot is by using staff to direct people to open parking. The O&M cost includes an estimated number of staff that would be needed for this effort.

Strategy 2c/f (Traffic signs to split Bayfront Park and DECC traffic)

The construction cost is based on a one-time expense for temporary signing for events. The O&M cost includes the labor expense to set up and take down the signs for each event. It should be noted that the O&M cost could be split with strategies 2e and/or 3b if these strategies are done together.

Strategy 2d (Establish Bayfront Area event parking management committee)

It is anticipated that there will be no cost associated with forming an event parking management committee. The committee would be comprised of several stakeholders with the purpose of overseeing planning, operation and system coordination for events in the Bayfront area. There may be costs associated with actions the committee takes as part of their role. However, those costs should largely be covered in the recommendations included in **Table 2**.

Strategy 2e (Static freeway & local streets signs for downtown and Canal Park parking)

The construction cost is based on a one-time expense for temporary signing for events. The O&M cost includes the labor expense to set up and take down the signs for each event. It should be noted that the O&M cost could be split with strategies 2c/f and/or 3b if these strategies are done together.

Strategy 3a (Dynamic lane assignment sign for NB/EB I-35/5th Avenue ramp right turn)

The construction cost includes expenses for a dynamic lane assignment sign, mounting, communications, and power. The O&M costs include expenses for power and operating the sign during events.

Strategy 3b (Add permanent/temporary pedestrian wayfinding signs)

The construction cost is based on a one-time expense for temporary signing for events. The O&M cost includes the labor expense to set up and take down the signs for each event. It should be noted that the O&M cost could be split with strategies 2c/f and/or 2e if these strategies are done together.

Strategy 3c (Improve signal timing/operations of I-35 ramps at 5th Avenue and Lake Avenue)

The construction cost includes expenses for the installation of a new video detection system and enhancements to the signal timing and operations for NB/EB I-35 Ramps at 5th Avenue West. The construction cost also includes updates to the signal timing at Lake Avenue as needed. It is assumed no O&M costs for this strategy as there is very little cost associated with maintaining and operating a video detection system. It is assumed that any costs for maintenance will be absorbed into the regular signal O&M for the intersection.

Strategy 5a (Reconstruction of 5th Avenue)

The 5th Avenue West/Harbor Drive roadway from Michigan Street to approximately 100 west of the ramp to Railroad Street is on a steel bridge structure. This bridge structure is different than the I-35 ramps to 5th Avenue West/Harbor Drive. These ramps are comprised of a concrete box bridge. Because of the two separate type of bridge structures, it will be difficult, perhaps impossible, to replace the 5th Avenue West/Harbor structure and include the recommended improvements without impacting the I-35 ramp bridge structures. Therefore, the construction estimate was developed based on the assumption that the entire 5th Avenue West/Harbor Drive bridge structure along with the I-35 ramp bridge structures are completely replaced.

Another factor taken into consideration in determining the construction cost is the type bridge structure that will be used for the new 5th Avenue West/Harbor Drive interchange. It was assumed that the new bridge structure will be the same as the Lake Avenue Interchange. The Lake Avenue interchange (and others as we continue north) is comprised of a concrete box structure. It was assumed that MnDOT, City of Duluth, and the community would want to provide a continued visual flow along I-35 as the harbor and North Shore are major travel destinations. The costs for building a concrete box structure is typically higher due to extra falsework and labor, and additional time for construction.

The construction estimate is based reconstruction approximately 130,000 square feet of bridge structure at a cost of \$249/square foot. The cost per square foot was derived based on information from a Federal Highway Administration website that included the average cost for reconstructing bridges in Minnesota in 2017. It is assumed that no additional O&M costs would be incurred beyond the existing O&M costs for the in-place infrastructure for the 5th Avenue West/Harbor Drive Interchange.

Strategy 5d (Reconfigure northbound/eastbound 5th Avenue West exit off I-35)

This strategy is directly tied to strategy 5a. This strategy is not possible without impacting the existing bridge structures at the 5th Avenue West/Harbor Interchange. Therefore, the engineering, construction and O&M costs for this strategy is included in the cost estimates for strategy 5a.

Strategy 5e (Improve pedestrian and bicycle access in the area)

The construction cost includes adding lighting (approximately 20 lights) and wayfinding signage along the Cross City trail from the trail head at Michigan Street, under I-35 and

to the trail connection at Railroad Street. The O&M costs includes expenses for ongoing power and repairs/re-lamping the light fixtures.

Strategy 6a/b (Add dedicated bus lane via 5th Avenue and Harbor Drive; Implement TSP)

The construction cost includes materials for adding a dedicated bus lane along 5th Avenue West/Harbor Drive from Michigan Street to the DECC and implementing TSP along 5th Avenue West at Michigan and the I-35 ramps. The construction cost for the dedicated bus lane includes temporary signing and delineators. The construction costs for installing TSP includes the equipment and set up.

The O&M cost is mainly related to expenses for the set up and take down of equipment for the dedicated bus lane for each event and some staffing time for managing the lane during events. There is very little to no O&M costs expected with TSP. Adding a P&R shuttle option could not be estimated at this time.

Strategy 6c (Use one vehicle lane on 5th Avenue for pedestrian ingress)

The construction cost includes a one-time purchase of delineators that would be used to separate vehicle traffic and pedestrians. The delineators would be placed along 5th Avenue West/Harbor Drive between Michigan St and the DECC. It is assumed for cost estimating purposes that the delineation would be set up in a way to provide a buffer zone between the pedestrians and vehicles (i.e. two rows of delineators with 2' of separation between the rows). The O&M costs include expenses to set up and remove the delineators for each event.

Strategy 7b (Preferential or prepaid parking strategy)

It is anticipated that there would be very little cost associated with this strategy.

Strategy 7c (Utilize apps to share information on traffic conditions and parking availability)

The costs for this strategy could not be estimated at this time. It is expected to be an extensive cost to upgrade parking systems throughout the Bayfront area to provide real time information on parking availability and incorporate the data into parking apps. It will also require a large marketing campaign to alert visitors that there are apps available that provide real time parking information.

Table 2 Recommended Strategies and Estimated Costs

Strategy Group	Strategy ID	Detailed Strategy	Estimated Project Cost			
			Engineering	Construction	O&M	10yrs Total***
#1 Outreach & Minimal Traffic Management*	1a	Dynamic Message Sign (DMS) wayfinding messages and operation plans	\$216,000	\$1,200,000	\$17,000	\$170,000
	1b	Marketing outreach for downtown parking options & alternative transportation	N/A	N/A	N/A	N/A
	1c**	Pedestrian control at Bayfront Park entrance on Harbor Dr	N/A	\$4,000	\$16,200	\$162,000
#2 Integrated Parking & Traffic Circulation Management	2a	Reduce processing time at parking entrances by using multiple entrance lanes and payment points	N/A	N/A	N/A	N/A
	2b	Assign parking at DECC parking to reduce entrance queuing	N/A	N/A	\$21,600	\$216,000
	2c/f	Traffic signs to split Bayfront Park and DECC traffic, utilize Harbor Dr, alternative/multiple parking entrance, and slip ramp	\$540	\$3,000	\$15,000	\$150,000
	2d	Establish Bayfront Area event parking management committee for planning, operation and system coordination	N/A	N/A	N/A	N/A
	2e	Static freeway & local streets signs for downtown and Canal Park parking	\$2,340	\$13,000	\$15,000	\$150,000
#3 Traffic Operation Improvement	3a	Separate traffic exiting the NB/EB I-35/5th Avenue ramp to mitigate right turn congestion, by installing dynamic lane assignment sign for the right lane to be either shared through/right or right-turn only	\$1,800	\$10,000	\$1,500	\$15,000
	3b	Add permanent/temporary pedestrian wayfinding signs along 5th Avenue, Harbor Dr and the pedestrian skyway	\$396	\$2,200	\$15,000	\$150,000
	3c**	Improve signal timing/operations of I-35 ramp terminal intersections at 5th Ave and Lake Ave	\$5,400	\$30,000	N/A	N/A
#5 Roadway or Network Improvement	5a**	Reconstruct roadway and sidewalk of 5th Ave, potentially add bike lane, including a potential covered pedestrian walkway along 5th Ave	\$5,826,600	\$32,370,000	N/A	N/A
	5d	Reconfigure northbound/eastbound 5th Ave exit off I-35 to add an additional right turn lane	N/A	N/A	N/A	N/A
	5e**	Improve pedestrian and bicycle access in the area, including a potential pedestrian amenity upgrade on the portion of the Cross City Trail that connect Bayfront Park (near Railroad St) and downtown Duluth (near Michigan St).	\$28,800	\$160,000	\$3,000	\$30,000
#6 Transit/Pedestrian Improvement	6a/b	Add dedicated bus lane via 5th Ave and Harbor Dr; Implement TSP; Add P&R shuttle option	\$4,500	\$25,000	\$9,000	\$90,000
	6c**	Use one vehicle lane on 5th Ave for pedestrian ingress	\$4,680	\$26,000	\$9,000	\$90,000
#7 System or Capacity Improvement	7b	Preferential or prepaid parking strategy	N/A	N/A	N/A	N/A
	7c	Utilize apps to share information on events, traffic condition and parking availability; upgrade parking systems and coordinate parking management and share facility occupancy during overlapping events; collaborate with Park Duluth app	N/A	N/A	N/A	N/A

* A portion of Strategy Group #1 was implemented for 11/30 and 12/1 events as short-term improvement. The cost for 1a is for the installation of new DMS on local roads

** Pedestrian-related strategies

*** No time value of money is considered

N/A = Not Applicable/Available

Figure 6 illustrates the relative benefit-to-cost ratio and approximate year of project implementation for each recommended strategy.

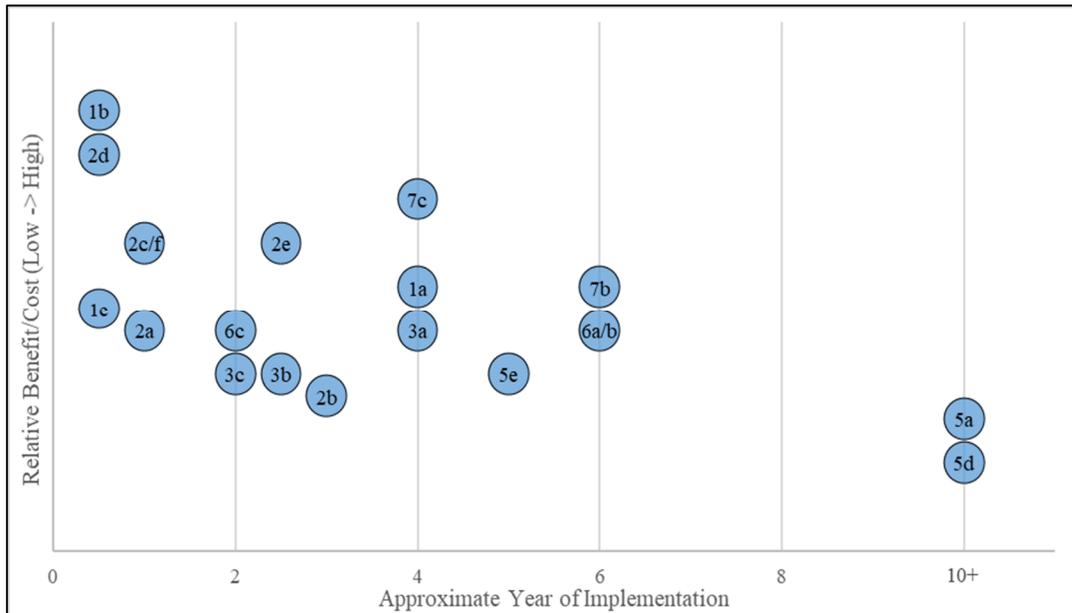


Figure 6. Relative Benefit/Cost and Approximate Year of Projects Implementation

The relative benefit-to-cost ratio is based on quantitative and qualitative assessments of each strategy's benefit as well as their cost estimates. And thus, the ratios in **Figure 6** are relative and not-to-scale. In general, the recommended years of implementation are based on strategy dependency, implementation obstacle and project complexity. They are based on the assumption that critical issues for their implementations are deliberately reviewed and resolved.

Specifically, many strategies within Strategy Groups #1, #2 and #3 (refer to **Tables 1 or 2** in this report or Appendix B of **Attachment C** for strategy details) can be implemented as early as summer 2019 due to their relatively low costs and high benefit. The rest of strategies in groups 1-3 can also be implemented in the near-term (1-4 years). Conversely, strategies 5e, 6a/b and 7b are recommended for implementation in the next 5-8 years due to their clear dependencies on funding and business viability. Finally, strategies 5a and 5d should be considered only in the long-term (10+ years) due to their high costs and dependencies on major roadway/bridge reconstruction.

Furthermore, **Table 3** provides a prioritized list of the originally proposed strategies (including the recommended strategies). The list is ranked based on strategy benefit, financial feasibility and implementation viability. Even though some low-ranking strategies, such as 6a/b, 7b, 5a and 5d, are recommended, they should be considered in the future years and/or based on future evaluations of other implemented strategies and impacts to the truck traffic along 5th Avenue West (more discussion later). Similarly, the non-recommended strategies may be further analyzed and considered when conditions change.

Table 3 Ranked Original Strategies

Strategy ID	Detailed Strategy	Recommended	Priority (1)
1c	Southbound left-turn lane on Railroad St at Bayfront Park parking entrance	In-place	0
1d	Move the train stop further south near the existing Cross City Trail crossing	In-place	0
1b	Marketing outreach for downtown parking options & alternative transportation	Yes	1
1e	Pedestrian control at Bayfront Park entrance on Harbor Dr	Yes	1
2d	Establish Bayfront Area event parking management committee for planning, operation and system coordination	Yes	1
2a	Reduce processing time at parking entrances by using multiple entrance lanes and payment points	Yes	2
2c/f	Traffic signs to split Bayfront Park and DECC traffic, utilize Harbor Dr, alternative/multiple parking entrance, and slip ramp	Yes	2
3c	Improve signal timing/operations of I-35 ramp terminal intersections at 5th Ave and Lake Ave	Yes	3
6c	Use one vehicle lane on 5th Ave for pedestrian ingress	Yes	3
7c	Utilize apps to share information on events, traffic condition and parking availability; upgrade parking systems and coordinate parking management and share facility occupancy during overlapping events; collaborate with Park Duluth app	Yes	4
1a	Dynamic Message Sign (DMS) wayfinding messages and operation plans	Yes	5
2e	Static freeway & local streets signs for downtown and Canal Park parking	Yes	5
3a	Separate traffic exiting the NB/EB I-35/5th Avenue ramp to mitigate right turn congestion, by installing dynamic lane assignment sign for the right lane to be either shared through/right or right-turn only	Yes	5
3b	Add permanent/temporary pedestrian wayfinding signs along 5th Avenue, Harbor Dr and the pedestrian skyway	Yes	5
2b	Assign parking at DECC parking to reduce entrance queuing	Yes	6
5e	Improve pedestrian and bicycle access in the area, including a potential pedestrian amenity upgrade on the portion of the Cross City Trail that connect Bayfront Park (near Railroad St) and downtown Duluth (near Michigan St).	Yes	6
6a/b	Add dedicated bus lane via 5th Ave and Harbor Dr; Implement TSP; Add P&R shuttle option	Yes/Hold	7
7b	Preferential or prepaid parking strategy	Yes/Hold	7
5a	Reconstruct roadway and sidewalk of 5th Ave, potentially add bike lane, including a potential covered pedestrian walkway along 5th Av	Yes/Hold	8
5d	Reconfigure northbound/eastbound 5th Ave exit off I-35 to add an additional right turn lane	Yes/Hold	8
5c	Trailblaze event traffic via 27th Ave, Michigan St, Superior St, Garfield Ave and Railroad St	No	
4a	Change Harbor Dr to one-way flow	No	
4b	Change Canal Park Dr and Lake Ave to a one-way pair	No	
5f	Add additional access to frontage road to improve traffic flow at I-35 and 5th Ave W	No	
5g	Add roadway capacity (thru lane and/or left/right turn lanes) to Railroad St south of Harbor Dr	No (2)	
7a	Construct a parking ramp near the power plant off Railroad St and connect it with shuttle service	No	
5b	Connect Courtland St with Railroad St by a new Courtland St for event access	No	
5h	Dedicated lane from I-35 with direct access to DECC parking ramp	No	

(1) Priority is based on potential benefit, financial feasibility and implementation viability. Smaller numbers indicate higher priority.

(2) Even though strategy 5g is not recommended at this point, as development along Railroad St occurs and area truck traffic increases, it may become a favorable alternative that is worth further evaluation.

Note: Impacts to truck movements shall be considered when designing and implementing strategies 2c/f, 3a, 5a, 5d, 5e, 6a/b, and 6c

3.3 Practical Considerations

In complementary of strategy groupings based on their similarity (**Table 1**) and implementation timeline (**Figure 6**), the recommendations are further evaluated from the practical perspectives of planning commissions, public agencies, business owners, and event organizers. In other words, the strategy recommendations are reorganized based on the logical interests of owners who would carry out the change/development. The following discussion has a focus on what can be done in the next several years for the recommended strategies.

1. Low-hanging Fruits (strategies with high benefit, low cost and/or minimal obstacles)
 - a. Develop a DMS event message plan for the existing and planned DMSs (part of strategy 1a).
 - b. Continue the marketing outreach efforts for downtown parking options and alternative transportation (strategy 1b).
 - c. Formalize traffic sign plans for downtown parking wayfinding (strategy 2e) and pedestrian wayfinding (strategy 3b), as well as temporary traffic control plan to use one northbound vehicle lane on 5th Avenue West as temporary sidewalk during event ingress (strategy 6c). Impacts to truck traffic should be taken into consideration for these strategies, as noted in the next section of this report.
 - d. Continue to implement the pedestrian control plan at Bayfront Park entrance on Harbor Drive for large/applicable events (strategy 1e).
 - e. Improve signal timing and operations and detection reliability at I-35 ramp terminal intersections at 5th Avenue West and Lake Avenue (strategy 3c).
2. Leadership, Stewardship and Management
 - a. Identify the champion and stakeholders of the proposed Bayfront Area event parking management committee, establish the 1st meeting and plan out the future engagements (part of strategy 2d) – this serves as the foundation for the successful implementations of many other strategies.
 - b. Identify project interests and funding sources for the recommended strategies for the next 3 to 5 years.
3. Parking Management and Technology Upgrade
 - a. Increase efficiency at parking entrances during large-scale event ingress by applying a variety of parking management techniques (strategy 2a, 2b, 2c/f, and part of strategy 2d).
 - b. Start to upgrade parking system to enable advance and real-time information sharing (part of strategies 1a, 2d and 7c).
4. Engineering and Construction
 - a. Develop plan with appropriate jurisdiction(s) for DMS and Dynamic Lane Assignment Sign deployment (part of strategy 1a and 3a).
 - b. Identify the funding sources for potential pedestrian amenity upgrade on the portion of the Cross City Trail that connect Bayfront Park (near Railroad Street) and downtown Duluth (near Michigan St) (part of strategy 5e).
 - c. Coordinate with appropriate jurisdiction(s) on the reconstruction plan of 5th Avenue West bridge and adjacent I-35 ramp terminals for potential incorporation of upgraded sidewalk, ADA ramps, bike lanes, turn lanes, etc. (part of strategies 5a and 5d).
5. Back-pocket Strategies
 - a. Identify opportunities (Bus-only lanes, Transit Signal Priority, etc.) to improve the travel time, frequency and reliability of existing DTA transit services for Bayfront area events (part of strategies 6a/b).

Long-term Project Recommendation

- b. Based on the effectiveness of other or previously implemented strategies, develop business plans for
 - i. Increased event shuttle services (part of strategies 6a/b).
 - ii. Preferential or prepaid parking (strategies 7b).

In summary, the practical considerations presented above provide an alternative perspective in organizing the recommended strategies. This, on one hand, highlights the importance and relevancy of each strategies, while, on the other hand, layout an action plan for immediate next steps and project programing.

Truck Traffic Considerations

Due to the presence of the Clure Public Marine Terminal at Rice’s Point, Compass Minerals along Railroad Street and a variety of privately owned/operated cargo facilities nearby, truck traffic is expected throughout the Bayfront area. Access to the freeway system from the Rice Point area is limited. One of the routes typically used by trucks to access I-35 is Railroad Street to 5th Avenue West. Railroad Street is the only connection between Rice’s Point (industrial land use) and the Bayfront Area (mixed land use)¹.

Based on a recent data collection, truck traffic concentration can spike up to 30% of all traffic along Railroad Street during the business hours of a typical weekday, while the annual average daily traffic along Railroad Street is approximate 3,250 per day. Large-scale events often, though not always, occur during weekday evenings or weekends, which generally falls outside of normal peak hours of truck traffic. Opportunities exist for truck operators and event organizers to coordinate timings and avoid unnecessary traffic delay to trucks and minimize intermodal traffic conflicts between trucks and event traffic (passenger vehicles, transit, bicycle and pedestrians).

In general, the recommended strategies have minimal to no impacts to truck movements when compared to the existing condition, or, in some cases, improve traffic conditions for trucks while also improving conditions for event traffic. However, several truck traffic considerations are detailed below:

- Turn restriction exemption
 - When a no left turn sign is set up on the looping ramp approach at Railroad Street (strategy 2c/f), an “Except Trucks” panel can be added to allow trucks to access local business.
- Accommodate truck turning radius with permanent roadway design (strategies 5a and 5d) and temporary traffic control (strategies 6a/b and 6c); maintain truck access during construction and setup/take-down
 - Accommodating the truck turning radius and access is a standard engineering practice and based on a preliminary assessment there appears to be no major constraints for these accommodations under the above strategies.
 - During events that attract large amount of traffic onto Railroad Street (e.g. Bentleyville) and/or draw ingress traffic before the end of business days, additional traffic control agents or traffic controls can be deployed at local

¹ Land Use Zoning. City of Duluth. <http://www.duluthmn.gov/community-planning/land-use-zoning-applications/>

Long-term Project Recommendation

- business (e.g. Compass Minerals) driveway along Railroad Street to facilitate truck movement entering and exiting the site.
- “Recommended Truck Route”, “Avoid Conflict with Pedestrians and Bicycle” and “Expect Traffic Delay” messages during large-scale events
 - For large-scale and overlapping events, recommended truck routes can be developed and communicated with trucking businesses for trucks to avoid congestion and potential conflicts with event traffic.
 - Traffic delay should be expected before and after Bayfront area event if trucks choose to operate during those time windows.
 - Truck traffic delay must be considered as a decision-making factor for strategy 6a/b when it is ready for further evaluation in 5-7 years.

The above items can be one of the key tasks for the proposed Bayfront Area event parking management committee (strategy 2d). The committee should actively reach out to truck operators in the area and engage the trucking industry while the details of each strategy is being finalized. The truck operators within the Rice’s Point area are represented by the newly formed Rice’s Point Business Group.

Attachment A:
Bayfront Area Event Traffic Control Existing Condition Memo



ALLIANT

Memorandum

TO: Ron Chicka
Rondi Watson

FROM: Nick VanGunst, PE, PTOE
Yilun Xu, PE

DATE: February 13, 2019

SUBJECT: Bayfront Area Event Traffic Control Existing Condition Memorandum

This memorandum documents the existing event, parking, and traffic conditions of large-scale events and local business attractions at Bayfront Festival Park, Duluth Entertainment Convention Center (DECC), AMSOIL Arena, Canal Park, and other venues around the Bayfront area in Duluth, MN, as shown in **Figure 1**.

Event Overview

The City of Duluth is a destination for millions of visitors each year accounting for over \$950 million dollars in economic impact. Many events concentrate around the Bayfront area to the interests of this memorandum.

Events and Venues

Numerous events throughout the year take place at the Bayfront Festival Park, Duluth Entertainment Convention Center (DECC), and AMSOIL arena, shown by **Figure 1** located in **Appendix A**. Some of the larger events include the Bayfront Blues Festival, concerts, Bentleyville Tour of Lights, and the University of Minnesota Duluth Men's and Women's hockey. These facilities are all located in the same area and next to Canal Park. Canal Park is another attraction that many people come visit to see the 1,000 plus ocean-going and Great Lakes freighters coming in or leaving the harbor and visit the local shops and restaurants.

Attendance and Timing

In order to assess event parking and traffic impacts, this study focuses on recurring events at the Bayfront area that attract more than 2,000 attendees. A list of these events with estimated typical attendance and timing are listed in **Table 1** based on best knowledge to date.

Table 1 Typical Large Events at the Bayfront Area with Estimated Attendance and Timing

Events	Venue	Estimated Attendance	Typical Event Day/Time
Tall Ships	Canal Park/Bayfront Area	300,000 over four days	One weekend in August/Every three years
Grandma's Marathon	Canal Park/Bayfront Area	18,000 runners & 50,000 additional guests	Friday & Saturday/June
Bentleyville Tour of Lights	Bayfront Park	350,000 annually/29,000 for the peak day	Mid Nov – Dec 26th / Evening
Christmas City Parade	Downtown Duluth	12,000	Friday in November/Evening
Fourth Fest Celebration	Bayfront Park	12,000	Afternoon of July 4 th
Bayfront Blues Festival	Bayfront Park	20,000 in three days	One weekend in August/All-day
Bayfront Concerts	Bayfront Park	Varies	Mostly during the Summer / Evenings
Concerts	DECC	Varies	Varies
Taste of Duluth	Bayfront Park	8,000	One Saturday in July
UMD Men's Hockey	AMSOIL Arena	6,000 per game	Oct – Mar / Fri/Sat 7p.m.
UMD Women's Hockey	AMSOIL Arena	2,000 per game	Sep – Feb / Fri/Sat Afternoon/Evening
High School & College Graduation	DECC	2,000 to 6,500	Fridays-Sundays/May-June
Kia Duluth Drag Races and Car Show	Garfield Avenue	5,100	One weekend in September
Lake Superior Harvest Festival	Bayfront Park	5,000	One day in September
Irvin 5K Run	Bayfront Area	4,600	Friday night before Grandma's Marathon/June
North Shore Inline Skate Marathon	Bayfront Area	4,000	Saturday morning/September
Fitger's 5K Run	Bayfront Area	3,600	3 rd Saturday in April/Morning (9 to 11am)
Grill Wars	Bayfront Park	3,500	One day in August
The Tribune Fest	Bayfront Park	2,500	Three days in August/Evenings
Symphony and Ballet	DECC	500 to 2,200	Varies

* Local businesses at Canal Park attract visitors throughout the year with a concentration in summer.

All-day events like Bayfront Blues Festival and Canal Park local business tend to attract attendees around different times of day, thus its ingress/egress traffic and parking demand are sparse. Conversely, non-all-day events like concerts, hockey games, and Bentleyville Tour of Lights lead to concentrated ingress/egress traffic and parking, which is more easily subject to traffic congestion and parking shortages.

Occasionally, large-scale events may overlap with each other potentially causing even more concentrated ingress and/or egress. For example, the UMD Men's Hockey event at the DECC starting at 7p.m. on

Saturday, December 1st, 2018, overlaps with the Bentleyville Tour of Lights event at Bayfront Festival Park starting at 5p.m. The potential surge of demand during ingress and egress calls for careful parking and traffic management and coordination.

Additionally, there are several smaller events, listed in **Table 2**, that takes place regularly in the Bayfront area. These events alone do not typically generate enough traffic to create congestion on the roadways and at the intersections in the project area. However, it is important to note that the traffic generated by the smaller event could further degrade traffic flow through the project area when the event overlaps with a larger event.

Table 2 Typical Small Events at the Bayfront Area with Estimated Attendance and Timing

Events	Venue	Estimated Attendance	Typical Event Day/Time
Duluth Curling Club	DECC	Varies	October – March/evening
Weddings	DECC	Varies	Varies
Movie	Marcus Duluth Cinema	Varies	Varies
Cruise Ship Arrivals	Canal Park	750/Ship	June-September
Whipper Snapper Races	Bayfront Park	1,200	June/Evening
Park Point 5K	Canal Park	1,700	Thursday evening in July
Walk for Animals	Bayfront Park	100-300	May-June/Afternoon
Thanksgiving Dinner	DECC	500	November/Evening

Parking Demand and Access

Parking Capacity

Parking capacity around the Bayfront area is reviewed and illustrated on **Figure 1**. Theoretically, Bayfront Festival Park, the DECC and AMSOIL Arena area can accommodate a total of approximate 2,400 vehicles with their onsite parking facilities. Throughout Canal Park, approximately 530 public parking and a number of private parking spaces are available with access from Lake Avenue and Canal Park Drive. Furthermore, within 500 feet northwest of I-35, a total of up to approximate 1,000 spaces may be available, in downtown, for event parking. These parking facilities are connected with the Bayfront area by 5th Avenue bridge, a pedestrian skyway, and Lake Avenue bridge for pedestrian access.

However, in addition to the large events of interests (including overlapping large events), smaller events, local businesses, media, special equipment, etc. may demand parking spaces across the facilities within the Bayfront area. Therefore, the available spaces for the large events of interests should be discounted, as footnoted in **Table 3** below. Several assumptions obtained from DECC/Bayfront Park event managers and derived based on engineering judgements are:

- Up to 220 spaces may be taken at DECC parking lot/ramp before the start of DECC large-event.
- Only 375 spaces (excluding Lot D south of the site) may be available on-site at Bayfront Park.
- An average 20% of downtown and Canal parking may be unavailable before the evening event starts due to other businesses and event activities.
- Up to 10% of surface lot parking capacity may be lost if a substantial snow fall happens.

Parking Demand

Based on a recent transportation study¹, 87% of visitors and 47% of residents, or an average of 67% of total trips, to the Bayfront area arrive by vehicles. It is expected that this percentage is much higher during winter months due to weather conditions. The actual parking demand varies based on the type of events, event attendees, time of event, arrival on vehicle percentage, vehicle occupancy, and event overlaps.

A peak parking demand for the Bayfront area is illustrated by the upcoming overlapping events of Bentleyville at Bayfront Park, UMD Men’s Hockey, a symphony concert, wedding and movie at the DECC on Saturday December 1st, as shown in **Table 3**. Expected attendees, vehicle occupancy, and parking turnover information are obtained from Bentleyville and DECC event managers.

Table 3 Parking Demand and Capacity for Typical Peak Overlapping Events

Location		Bayfront Park	DECC	
Peak Events		Bentleyville (Nov 17 - Dec 26)	UMD Men's Hockey (Nov 30 & Dec 1) Symphony, Wedding, and Movie (Dec 1)	
Assumptions (Typical Peak Events) (1)	Attendees	29,000	8,500	
	Vehicle Arrival Percentage	90%	80%	
	Occupancy (person / vehicle)	4.5	2.5	
	Turnover	3	1	
Individual-event Parking Demand		1,933	2,720	
On-site Parking	Capacity	Individual (2)	500	
		Combined	2,080	
	Utilization (3)	Bentleyville or DECC Event (non-concurrent)	93%	131%
Concurrent Events		224%		
Nearby Parking Capacity (4)	Walking Distance	Great Lakes Aquarium Lot	130	
		4th Ave Auto Park, Michigan St Garage and nearby On-street Parking	550	
	Shuttle (Bentleyville) or Walking (DECC)	Duluth Transit Center (DTC) Parking (4a)	70	
		US Bank Parking Ramp	240	
	Shuttle	Canal Park Lots (4b)	400	200
	Garfield Avenue Lot	350	Assume not used	
Combined Parking Capacity		3,820		
Total Capacity Utilization*		122%		

(1) Event attendance information obtained from DECC and Bentleyville event managers; vehicle arrival percentage conservatively derived from "Downtown Duluth Modal Connections Study, Jan 2009." based on engineering judgement.

(2) On-site parking for Bentleyville includes Bayfront Lot A & B (300 available spaces) and Lot D south of the site (200 available spaces); on-site parking for DECC is the DECC parking lot and ramp (1,800 total spaces minus 220 occupied spaces); these capacities have excluded background/employee/media/special parking; sources the same as (1).

(3) Assume Bayfront Park event (Bentleyville) DECC event (Hockey, Symphony, Wedding, Movie, etc.) use each others' on-site parking facilities.

(4) Parking capacity are estimates and are generally discounted by 20% due to background parking.

(4a) DTC has approximately 90 spaces available for public parking, though capacity varies due to contract parking demand. This capacity is discounted by 20% to estimate the available spaces during Bayfront event.

(4b) More Canal Park lots are accessible to Bentleyville event patrons than DECC patrons due to the Bentleyville shuttle.

*Up to 10% of surface parking capacity may be lost after substantial snow falls

Based on the parking demand and capacity calculations in **Table 3**, the Bayfront Park on-site parking facility (Lot A, B and D) is expected to accommodate the Bentleyville average peak parking demand with approximate 93% utilization if parking is actively managed and no other overlapping events occur at the DECC. It’s important to note that factors such as heavy snow fall, surge of vehicle arrival during parking

¹ Duluth-Superior Metropolitan Interstate Council. Downtown Duluth Modal Connections Study. January 2009.

turnover and concurrent events at the DECC can quickly exhaust the rest of its on-site parking capacity with this high utilization rate. Therefore, the nearby parking facilities connected by a variety of Bentleyville shuttles remains relevant and necessary for days with high expected attendees and/or multiple overlapping events.

Comparably, DECC on-site parking facilities (ramp and surface lot) do not have sufficient capacity to accommodate the average peak demand of DECC events even with no concurrent events at Bayfront Park, as shown by the utilization over 100%. Judging from the 131% utilization of DECC on-site parking, it is expected that many other large or median events at the DECC may experience similar on-site parking capacity shortage, especially knowing that smaller concerts and local business are prevalent in the Bayfront Park and Canal Park area throughout the year.

Furthermore, during the overlapping events at Bayfront Park and the DECC as shown by **Table 3**, the total parking demand is expected to well exceed the total on-site capacity, as shown by the 224% utilization. The parking utilization drops to 122% when nearby parking capacities are considered, which is still 22% over total capacity for the on-site and near by parking facilities. Achieving a 90% or higher parking utilization rate is difficult to achieve for several reasons.

1. Event patrons have the tendency to park as close to the venue as possible and are known to underutilize the other nearby parking facilities.
2. Even though a conservative capacity reduction of 20% has been applied in the calculation of nearby facilities' capacities, the actual available capacity is still subject to each facility's own availability depending on downtown events, business day parking, facility maintenance, weather/season, time of day, etc.
3. Nearby parking facilities are spread out throughout the Bayfront and downtown area. Some facilities fill up quicker than others and parking status are not currently shared with patrons seamlessly. In other words, event patrons face increased difficulty to find available parking while total utilization approaches 100%.
4. Snow falls, surge of Bentleyville arrival during parking turnover and local traffic congestions can all aggravate the difficulty of finding parking.

Table 3 illustrate the worst-case scenario that is expected to occur only once or twice during the 2018 holiday season. While traffic/parking control plans will be developed for these large overlapping events, it is important to acknowledge that the total parking capacity in the Bayfront and adjacent downtown area is generally sufficient to accommodate most of its large events provided alternative parking information is well communicated and capacity is actively managed.

Lastly, event attendees and parking demand do fluctuate based on weather condition, time of year, etc. This is especially true for outdoor events such as Bentleyville and concerts.

Parking Access

Access routes to parking facilities near Bayfront Park, DECC, AMSOIL Arena and Canal Park businesses are limited due to the geographic and roadway constraints. Generally, vehicles access the Bayfront area parking via Railroad Street, 5th Avenue, Lake Avenue, and Canal Park Drive as shown in **Figure 2** located in **Appendix A**. There is also a slip-ramp to Railroad Street from the I-35 northbound off-ramp crossing the railroad track. The parking facilities northwest of I-35 can be accessed via 5th Avenue / Lake Avenue ramps from I-35 and local streets such as Michigan Street and Superior Street, as shown in **Figure 2**.

Traffic congestion has been observed at the following locations when event-goers access or circulate for parking, also shown in **Figure 2**:

- Railroad Street in front of Bayfront and DECC parking;
- Right lane (due to right turning vehicles) of I-35 northbound off-ramp to 5th Avenue when upstream 5th Avenue and Railroad Street are congested;
- Lake Avenue and Canal Park Drive.

Parking Management

Currently, parking is managed by individual events, with efforts to provide alternative parking options at nearby sites. For example, Bentleyville highlights several nearby parking facilities on its website in addition to the Bayfront Park on-site parking lot, and DECC advertises its on-site parking and directions while provide adjacent parking information on its website.

“Full” signs may be displayed when parking facility has reached its capacity. However, real time and advance parking information is absent and when parkers realize their intended parking destination is unavailable, they have already joined the congested circulating traffic.

It is understood that event-goers are generally unaware of the parking options towards downtown Duluth northwest of I-35. Limited direct marketing has been implemented to communicate with event-goers to park at alternative parking locations and/or park at specific location depending on their origination to avoid circulating the congested streets near the venue.

Alternative Transportation

Parking Shuttles

Bentleyville currently operates four parking shuttles that connect its venue with Canal Park parking, downtown parking, Edgewater Park and Bentleyville Garfield Avenue remote lot, as shown in **Figure 3**. Canal Park, Garfield lot and Edgewater Park shuttles are well utilized while the downtown shuttles are under-utilized.

Transit

Duluth Transit Center, as shown in **Figure 3** located in **Appendix A**, is located 500 feet west of the Bayfront area and is connected to the DECC by an enclosed pedestrian skyway. The center hosts local (Duluth Transit Authority) and regional (Jefferson Lines) transit routes that connect with downtown Duluth, the UMD campus, Miller Hill Mall, and greater Minnesota, while also providing approximately 90 public parking spaces. Duluth Transit Authority has several routes, such as routes 8, 10, and West Mainline, that service areas around Duluth and stop at the Duluth Transit Center. Some routes operate only on weekdays with hourly services and other routes operate on both weekdays and weekends with 20-30 minutes services.

Other transit options include the Jingle Buses to Bentleyville, Port Town Trolley (summer only) which circulate around downtown Duluth and the Bayfront area, and the Bentleyville train (North Shore Scenic Railroad) which connects Edgewater Hotel, Fitgers and Bayfront Festival Park. Some of these services are detailed in **Appendix A**.

In general, the use of transit for events in the Bayfront area is rare as shown by the recent transportation study² that estimates only 4% of visitors and 13% of residents use transit to access the Bayfront area. This percentage is expected to be less during winter months.

² Duluth-Superior Metropolitan Interstate Council. Downtown Duluth Modal Connections Study. January 2009.

Pedestrian

Primary pedestrian accesses to the Bayfront area are the Cross City Trail, Lakewalk, Duluth Transit Center skyway, 5th Avenue and Lake Avenue, as shown in **Figure 3**. The skyway, as part of the downtown Duluth skyway system, is generally underutilized due to limited knowledge by visitors. 5th Avenue has an 8-foot sidewalk only on the north side and the short actuated pedestrian signal phases at 5th Avenue and I-35 ramp intersections have caused long perceived delays. Sidewalks are present along both sides of Lake Avenue, though they are as narrow as 5 feet at places.

Wayfinding signage during events is often inadequate to confidently guide pedestrians from off-site parking facilities or nearby businesses to the venue.

A known pedestrian safety concern is at the entrance to Bentleyville across the DECC parking lot exit on the other side of Harbor Drive. Vehicle traffic exiting DECC parking, along Harbor Drive and turning from the nearby loop ramp conflict with pedestrians attempting to cross Harbor Drive for parking/event access.

Bicycle

Dedicated bicycle facilities (bike lane or trail) are absent in the Bayfront area. The Lakewalk on the northeast side of Canal Park and the Cross City Trail on the west side of Bayfront Festival Park can be shared between bicycles and pedestrians, as shown in **Figure 3**. Bicycle as a mode of transportation to/from the event is rare due to the unique geographic characters (large slopes) of Duluth. Cyclists around the Bayfront area are expected to be mostly recreational such that they arrive by other transportation modes (vehicle, transit, etc.) and cycle around the area.

Summary

Based on the review of existing parking conditions of the Bayfront area, it is concluded that:

- On-site capacity at Bayfront Park and DECC combined is
 - insufficient to accommodate the parking demand of a DECC large event even if no other large event occurs simultaneously.
 - theoretically sufficient to accommodate the parking demand of a Bentleyville event if no other large event occurs simultaneously. However, this requires a high level of coordination for parking facility status and difficulties in finding parking may occur while parking is being turned over (vehicle arriving while others exiting).
- The total capacity of on-site and nearby parking cannot accommodate the parking demand during overlapping events of Bentleyville and a UMD Men's Hockey game (as well as other smaller concurrent DECC events) without creating substantial difficulties in parking access.
 - Parking demand management (reducing vehicle modal arrivals and/or increasing park-and-ride options) is necessary for overlapping events.
- Parking demand varies by season and is weather dependent.

The traffic congestion observed around the event venues are primarily results from circulation for parking and are worsened once on-site parking facilities are at capacity. With generally spread-out parking supply throughout the Bayfront park and downtown area, there is high potential to reduce the circulation congestion, with advanced and real-time parking/traffic information, preferential parking options and additional shuttle service to/from downtown parking facilities.

Finally, opportunities exist to improve the use of alternative transportation such as transit and walking by providing amiable and accessible facilities and services.



Appendix A

List of Content:

- Figure 1 Venue and Parking
- Figure 2 Parking Access and Traffic Congestion
- Figure 3 Alternative Transportation Overview
- Duluth Transit Authority Route Maps



Bayfront Area Event Traffic Control

Figure 1 Venue and Parking



Bayfront Area Event Traffic Control

Figure 2 Parking Access and Traffic Congestions



BAYFRONT AREA

LEGEND

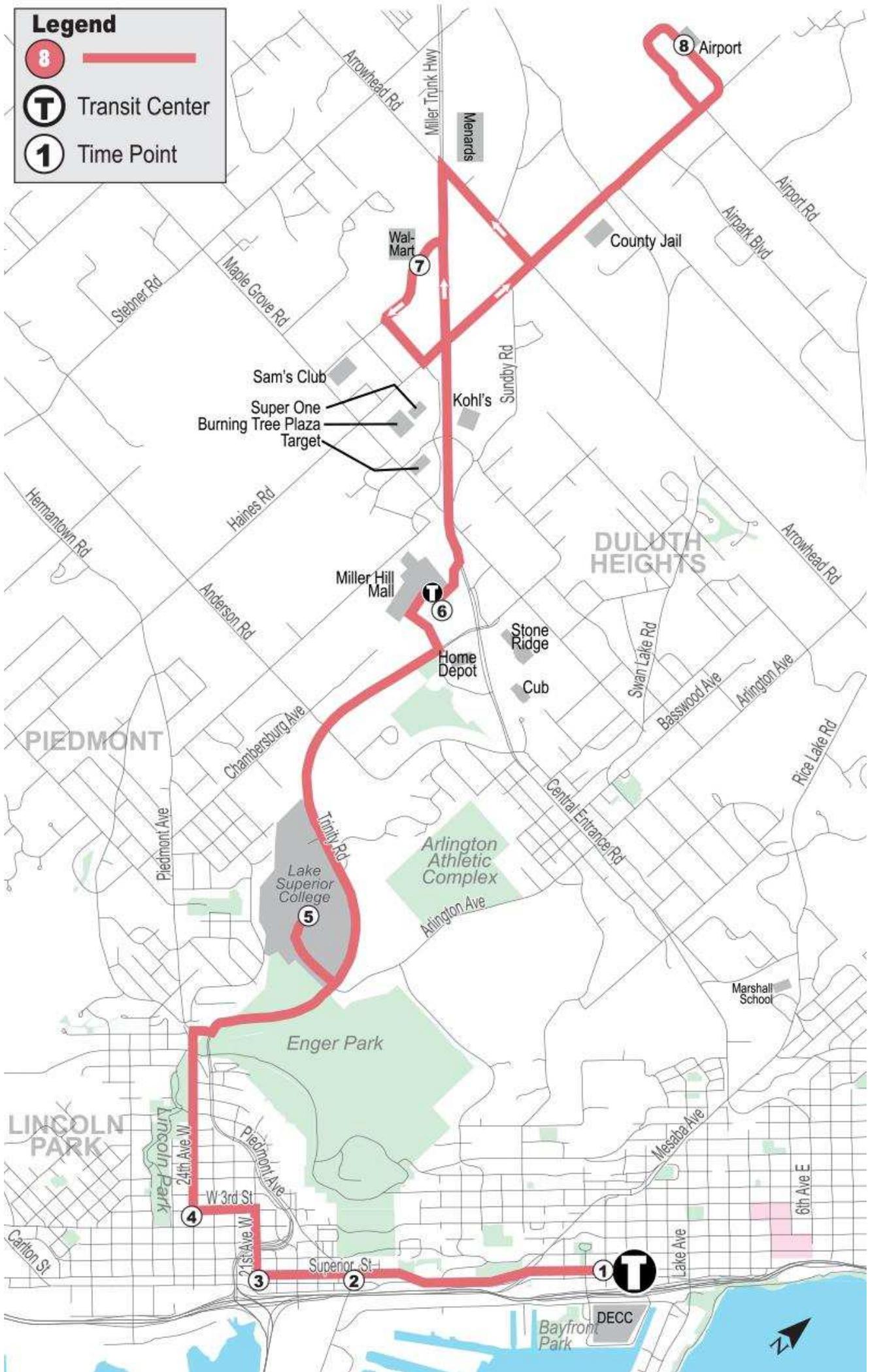
- Duluth Transit Center
- Pedestrian Skyway
- Sidewalk Access
- Trail Access
- Parking Shuttle Drop-off
- Bentleyville Downtown Parking Shuttles
- Bentleyville Canal Park Parking Shuttles
- Bentleyville Edgewater Park Shuttles
- Bentleyville Garfield Ave Lot Parking Shuttles

Bayfront Area Event Traffic Control

Figure 3 Alternative Transportation Overview

Legend

- 8** ———
- T** Transit Center
- 1** Time Point

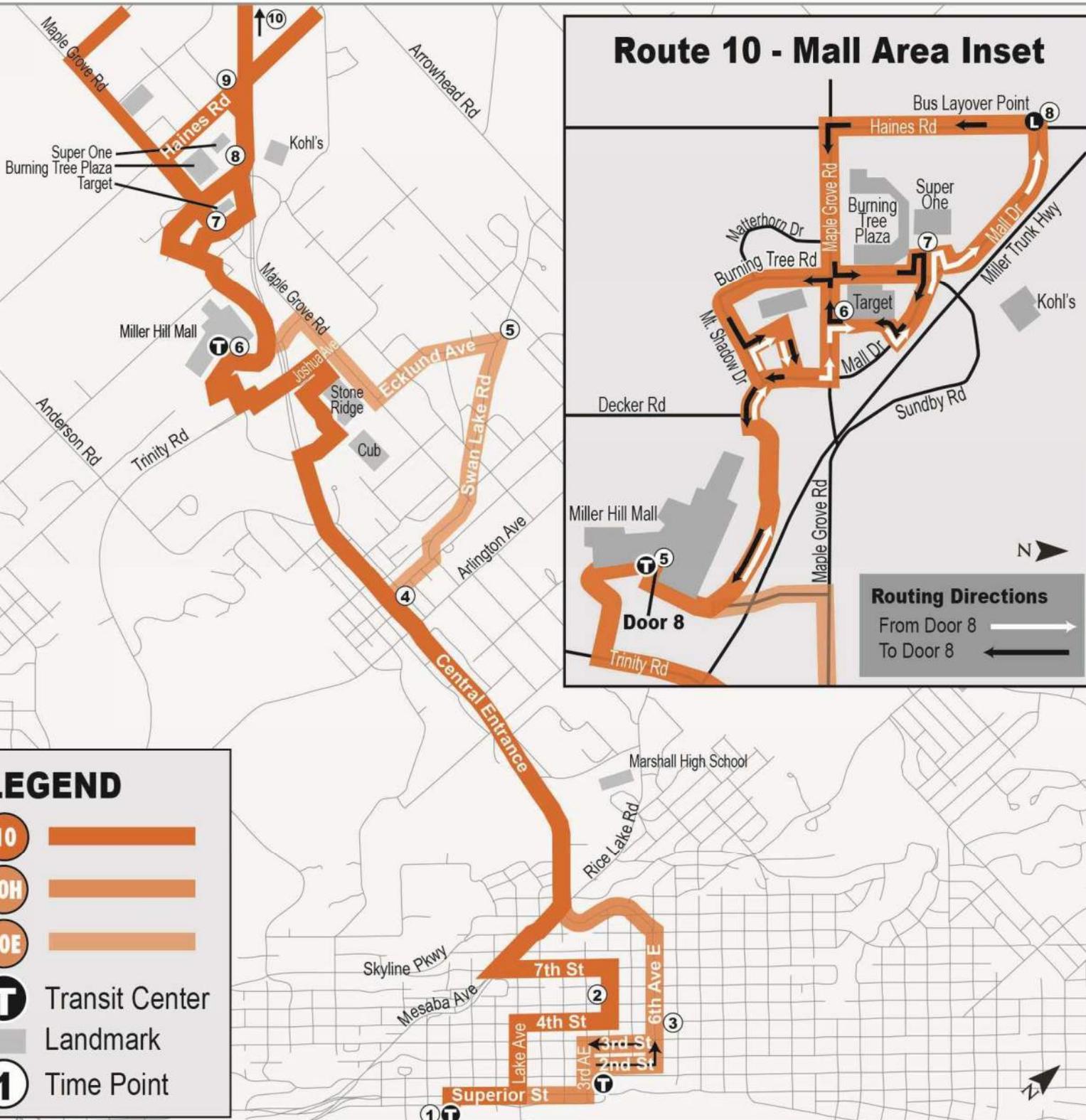


Route 10 - Mall Area Inset



LEGEND

- 10** ———
- 10H** ———
- 10E** ———
- T** Transit Center
- Landmark
- 1** Time Point

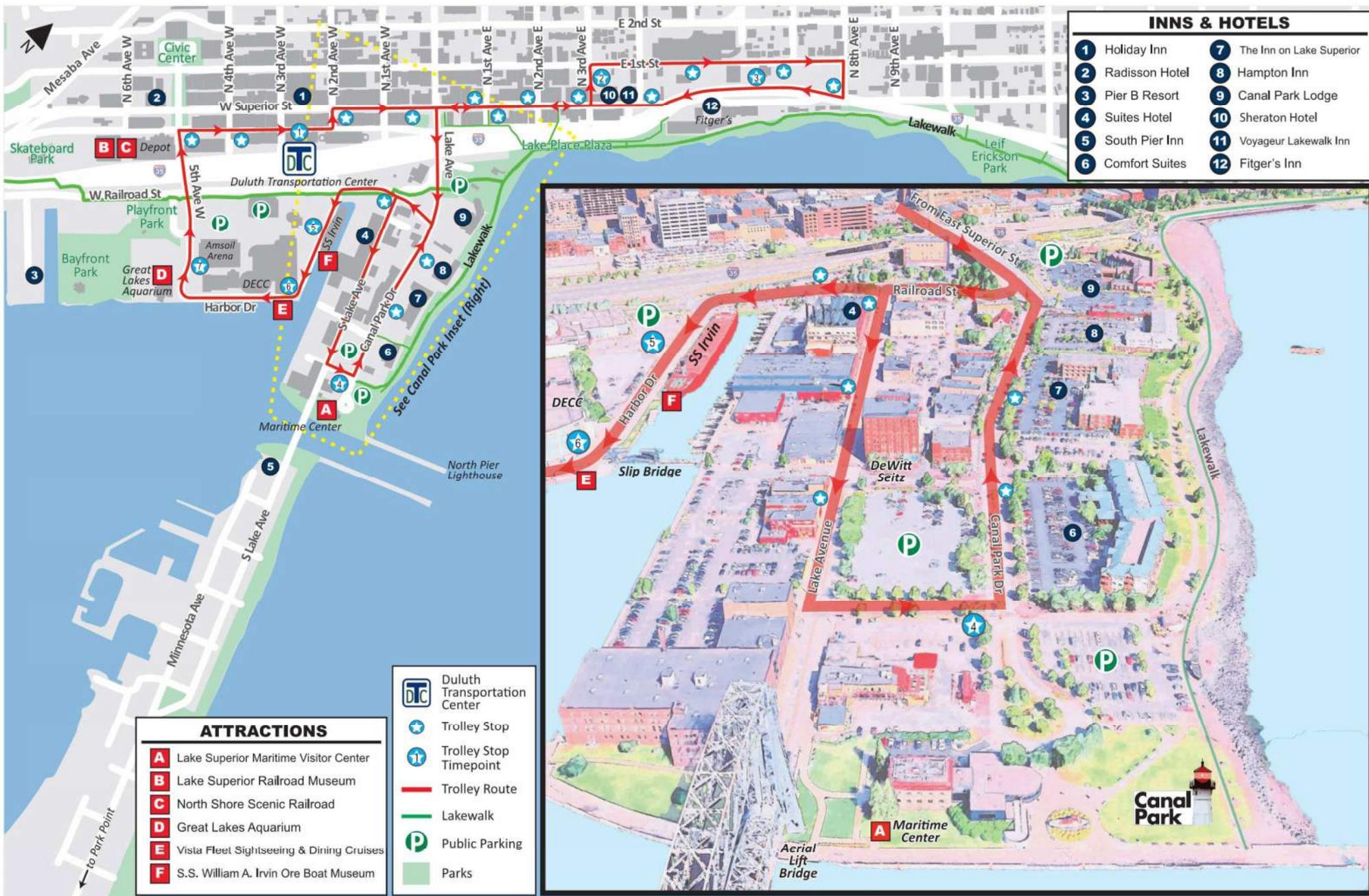




Key

- Skywalks
- Public Parking Area
(There may be a charge)
- Free Parking *(After 5:00 PM)*
 - A - Fourth Ave Auto Park
 - B - US Bank Parking Ramp
 - C - Holiday Inn Parking Ramp
 - D - Shoppers Auto Park
 - E - Medical District Ramp
- ✳ Jingle Bus Stop *(every 20-30 min.)*
 - 1 - Corner of 5th Ave W & Superior St
 - 2 - Holiday Center - Front doors on Superior St
 - 3 - Corner of 3rd Ave E & Superior St
 - 4 - Corner of Buchanan St & Canal Park Dr
- Bentleyville Train
Park at Filger's and ride the Bentleyville Train from Filger's to Bentleyville.
- Meter parking is free in Canal Park and after 5:30 p.m. throughout the Downtown.
- - - Walking Area

DTA Port Town Trolley Route Map



INNS & HOTELS	
1	Holiday Inn
2	Radisson Hotel
3	Pier B Resort
4	Suites Hotel
5	South Pier Inn
6	Comfort Suites
7	The Inn on Lake Superior
8	Hampton Inn
9	Canal Park Lodge
10	Sheraton Hotel
11	Voyageur Lakewalk Inn
12	Fitger's Inn

ATTRACTIONS	
A	Lake Superior Maritime Visitor Center
B	Lake Superior Railroad Museum
C	North Shore Scenic Railroad
D	Great Lakes Aquarium
E	Vista Fleet Sightseeing & Dining Cruises
F	S.S. William A. Irvin Ore Boat Museum

	Duluth Transportation Center
	Trolley Stop
	Trolley Stop Timepoint
	Trolley Route
	Lakewalk
	Public Parking
	Parks

Attachment B:
Bayfront Area Event Traffic Control Plan (Short-term) Memo



ALLIANT

Memorandum

TO: Ron Chicka
Rondi Watson

FROM: Nick VanGunst, PE, PTOE
Yilun Xu, PE
Mike Anderson, PE, PTOE

DATE: November 09, 2018

SUBJECT: Bayfront Area Event Traffic Control Plan (Short-term) Memorandum DRAFT

This memorandum documents the short-term traffic control plan for typical large-scale events during the 2018 holiday season at Bayfront Festival Park, Duluth Entertainment Convention Center (DECC), AMSOIL Arena, Canal Park, or other venues at the Bayfront area in Duluth, MN.

The existing condition of Bayfront area event traffic/parking management has been documented in the “Bayfront Area Event Traffic Control Existing Condition” memorandum (Memo #1) for reference.

Event Overview

Overlapping Events

The overlapping events of Bentleyville Tour of Lights, UMD Men’s Hockey and other concurrent smaller events (Symphony, a wedding and movie theater) at the DECC on Friday, November 30th and Saturday, December 1st are expected to generate the peak parking and traffic demands during the 2018 holiday season, and thus is selected as the basis for short-term traffic control plan development. The expected attendees and parking demand/capacity are documented in **Table 1** below.

Table 1 Parking Demand and Capacity for Typical Peak Overlapping Events

Location		Bayfront Park	DECC	
Peak Events		Bentleyville (Nov 30 & Dec 1)	UMD Men's Hockey (Nov 30 & Dec 1) Symphony, Wedding, and Movie (Dec 1)	
Assumptions (Typical Peak Events) (1)	Busy-day Attendees	29,000	8,500	
	Vehicle Arrival Percentage	90%	80%	
	Occupancy (person / vehicle)	4.5	2.5	
	Turnover	3	1	
Individual-event Parking Demand		1,933	2,720	
On-site Parking	Capacity	Individual (2)	1,580	
		Combined	2,080	
	Utilization (3)	Bentleyville or DECC Event (non-concurrent)	93%	131%
Concurrent Events		224%		
Nearby Parking Capacity (4)	Walking Distance	Great Lakes Aquarium Lot	130	
		4th Ave Auto Park, Michigan St Garage and nearby On-street Parking	550	
	Shuttle (Bentleyville) or Walking (DECC)	Duluth Transit Center (DTC) Parking (4a)	70	
		US Bank Parking Ramp	240	
		Canal Park Lots (4b)	400	200
Shuttle	Garfield Avenue Lot	350	Assume not used	
Combined Parking Capacity		3,820		
Total Capacity Utilization*		122%		

- (1) Event attendance information obtained from DECC and Bentleyville event managers; vehicle arrival percentage conservatively derived from "Downtown Duluth Modal Connections Study. Jan 2009." based on engineering judgement.
- (2) On-site parking for Bentleyville includes Bayfront Lot A & B (300 available spaces) and Lot D south of the site (200 available spaces); on-site parking for DECC is the DECC parking lot and ramp (1,800 total spaces minus 220 occupied spaces); these capacities have excluded background/employee/media/special parking; sources the same as (1).
- (3) Assume Bayfront Park event (Bentleyville) DECC event (Hockey, Symphony, Wedding, Theater, etc.) use each others' on-site parking facilities.
- (4) Parking capacity are estimates and are generally discounted by 20% due to background parking.
- (4a) DTC has approximately 90 spaces available for public parking, though capacity varies due to contract parking demand. This capacity is discounted by 20% to estimate the available spaces during Bayfront event.
- (4b) More Canal Park lots are accessible to Bentleyville event patrons than DECC patrons due to the Bentleyville shuttle.
- *Up to 10% of surface parking capacity may be lost after substantial snow falls

The peak traffic periods would occur around 6:30 PM as Bentleyville opens at 5 PM and the hockey game starts at 7 PM, as well as around 10 PM when Bentleyville is closing (at 10 PM) and hockey game ends (around 9:30 PM). The peak on-site parking would occur between 5 PM and 9 PM when both events are active in session.

Single and Smaller Events

Other smaller events or single large events listed in "Memo #1" located at the Bayfront area and DECC are expected to attract much less traffic/parking demand than the hockey/Bentleyville overlapping events during the 2018 holiday season. Most strategies proposed for the overlapping events will be compatible with these smaller events.

Background Parking and Traffic

Local business and events are active throughout the Bayfront area, during all seasons. Therefore, it is important to understand the background parking/traffic demand and pattern in details, during the development of the short-term traffic control plan for large events.

The relevant background traffic/parking demands, as considered in calculations in **Table 1**, can be categorized into three groups:

1. Canal Park business patrons and employees;
2. Bayfront area large event employees, media, equipment, and special parking;
3. Downtown regular business and event parking and traffic;

First, during the overlapping events of hockey and Bentleyville, the parking supply at Canal Park is expected to serve the entire parking demand for its local business. In fact, it is expected that some parking supply at Canal Park may become readily available for overflow Bayfront Park / DECC event parking.

Moderate traffic circulation to/from Canal Park and along Canal Park Drive and Lake Avenue should still be expected in the evening as people park for dinner and nightlife. Since Canal Park primarily attracts tourism during the summer months, its traffic/parking strategies will be documented in the long-term event traffic plan memo.

Second, during the overlapping large events during the holiday season, expect up to 220 spaces at the DECC on-site parking facilities be occupied by background parking (employees, media, equipment, special parking, nearby business patrons, etc.), which reduces the capacity available for public parking.

Third, a minimal amount of downtown business and event parking is expected during the two overlapping events during the holiday season. However, this number varies daily and is difficult to predict. Thus, conservatively, 20% of spaces at downtown parking facilities can be assumed occupied.

Short-term Management Strategies

Current Issues and Improvement Goals

With the understanding of parking and traffic demand during the overlapping Bentleyville Tour of Lights and UMD Men's Hockey, as well as concurrent smaller events and the background traffic/parking situations, a list of current issues to be addressed or mitigated by the short-term traffic control plan is summarized below:

- Unnecessary parking circulation and traffic congestion near the on-site parking facilities of the DECC and Bayfront Park:
 - Unawareness and underutilization of downtown parking facilities;
 - Lack of advance notices (on the freeway and local streets) for parking wayfinding;
- Traffic congestion at the 5th Avenue / Harbor Drive off-ramp of northbound I-35:
 - Left-lane underutilization;
 - Related to parking access and circulation.
- Opportunities to improve pedestrian access:
 - Lack of effective pedestrian wayfinding system;
 - The narrow sidewalk along 5th Avenue and short pedestrian green time;
 - Known safety concerns at the Bentleyville entrance on Harbor Drive.

Based on the list of current issues and the characteristics of large events during the 2018 holiday season, the short-term traffic control plan aims to achieve the following:

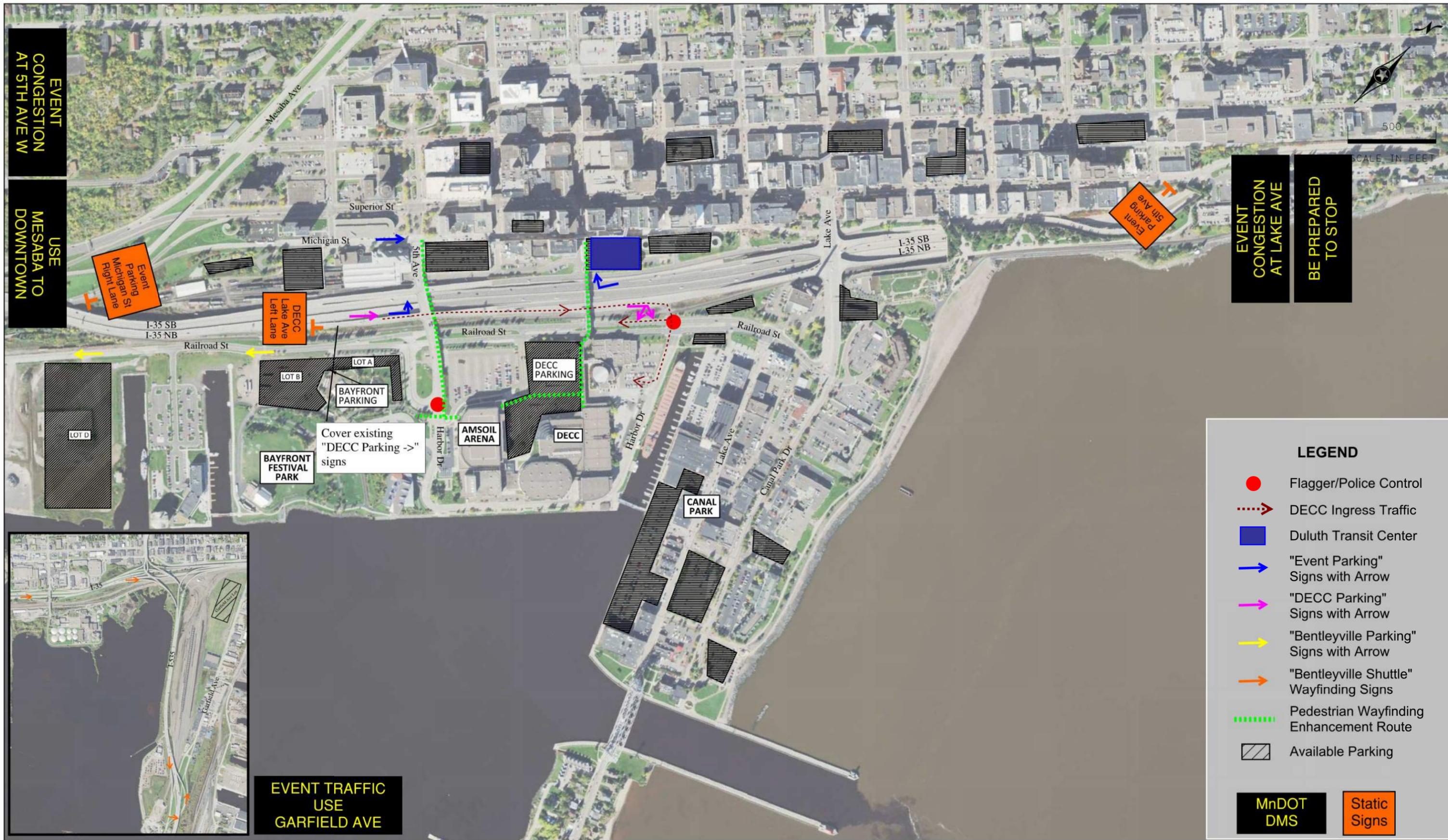
- Efficient use of current on-site and nearby parking facilities with advance parking/wayfinding information sharing and active traffic/parking management.
- Increased use of remote parking options with dedicated shuttles and/or improved pedestrian access and wayfinding.
- Additional use of Traffic Control Agents (TCA) and pedestrian crowd control devices for traffic management.

The unaddressed current issues and other opportunities for improvement will be addressed in long-term improvement recommendations.

Plan Development

Figure 1 provides an overview of the short-term traffic control plan developed based on the overlapping events on Friday, November 30th and Saturday, December 1st. The detailed traffic control plan and cost estimate are documented in **Appendixes A, B, and C**. Five elements are highlighted in achieving the improvement goals:

1. Parking wayfinding and vehicle traffic control plan
2. I-35/5th Avenue traffic signal improvements
3. Remote parking and shuttle services
4. Pedestrian wayfinding and access improvement
5. Preferred/reserved parking strategy



Bayfront Area Event Traffic Control

Figure 1 Short-term Traffic Management Overview

Parking wayfinding and vehicle traffic control plan

As shown by **Figure 1** and detailed in **Appendix A**, the use of existing Dynamic Message Signs (DMS) are proposed on I-35 and I-535 (and US-53 approaching I-535 in Wisconsin) before the 5th / Lake Avenue interchanges of I-35. These DMS are operated by MnDOT. The messages posted on the DMS, along with the “Event Parking” static signs (blue arrows in **Figure 1**) are intended to encourage parkers to use alternative routes, as listed below, to avoid the known traffic congestion.

- Garfield Avenue and Railroad Street, instead of through 5th Avenue interchange, if approaching from the east via I-535;
- Mesaba Avenue exit, Michigan Street and streets to downtown parking, instead of through 5th Avenue interchange, if approaching from the south via I-35;
- Ramp towards 5th Avenue interchange and streets to downtown parking, instead of through Lake Avenue interchange, if approaching from the north via I-35.

Additionally, DECC parkers are encouraged to use the left lane of 5th Avenue exit ramp of northbound I-35, along with traffic towards Lake Avenue, to avoid the known traffic congestion on the right lane (accessing Bentleyville on-site parking). They are then guided to turn left (blue arrow) for downtown parking or proceed straight and exit via the slip ramp (pink arrow) to Railroad Street or Harbor Drive for the DECC on-site parking.

A traffic control agent is recommended at the Railroad Street and Harbor Drive intersection to facilitate efficient traffic movements at this two-way stop-controlled intersection. This post is necessary with the additional traffic volume routed via the slip ramp based on the traffic control plan stated above. Another traffic control agent posted on Harbor Drive at the DECC parking lot exit is primarily for pedestrian crowd control and will be discussed in the section below.

Lastly, the City of Duluth has hired a signing vendor to install temporary static signs along northbound I-35 and eastbound I-535 to alert Bentleyville visitors of the Garfield Avenue parking lot and shuttle service. These signs will be installed the week of November 11th, 2018.

I-35/5th Avenue traffic signal improvements

Alliant staff is currently working with the City of Duluth to investigate the opportunities to improve traffic signal operations at the I-35/5th Avenue interchange. The improvements will specifically be focused on improving the pedestrian crossing at the ramps while hopefully making some improvements to the traffic flow through the intersection. Both signals are operated by one traffic signal controller. This does present limitations to what we can do to improve traffic operations. Alliant will work with the City to identify and make improvements, if available, to the signal operations prior to the start of the 2018 holiday season.

Remote parking and shuttle service

The current Bentleyville parking shuttles to/from the Garfield lot, Canal Park, Edgewater Hotel and Waterpark, and downtown parking should continue as they serve as an effective alternative to on-site parking. Advance marking is necessary to communicate the remote parking options and shuttle route, stops, time, and frequency to event patrons.

Pedestrian wayfinding and access improvement

Pedestrian routes to/from the DECC and Bayfront Park via 5th Avenue bridge and the enclosed skyway between DTC and DECC are supplemented with wayfinding signs as detailed in **Appendix B**. As noted elsewhere in this memo, improvements to the signal operations is also proposed for the I-35 and 5th Avenue interchange to minimize pedestrian wait time to/from the DECC events and Bentleyville.

Additionally, pedestrian fences are proposed at the Bentleyville entrance on Harbor Drive, as detailed in **Appendix B**. This plan aims to corral pedestrians to cross Harbor Drive at a single point away from the DECC parking lot exit, where a Traffic Control Agent (TCA) will manage the conflicts between vehicles and pedestrians. The pedestrian crossing at the DECC parking lot exit, on the other side of Harbor Drive, is routed behind the parking exit gates so that additional queuing space becomes available on the sidewalk as pedestrians wait to cross Harbor Drive. This crossing is proposed to be managed by the DECC parking staff. Coordination between the parking staff and TCA is necessary to allow optimized start and stop of pedestrian flows.

Preferred/reserved parking strategy

A preferred/reserved parking strategy is also recommended for consideration. Specifically, the on-site parking lots (excluding the Garfield Avenue lot and Lot D) of Bentleyville is reserved for those who have pre-purchased parking passes (either at current or higher/premium prices). Therefore, the on-site parking will be unavailable for public parking during the event days which effectively deters the queuing currently observed along Railroad Street (waiting for open spaces during parking turnover).

This strategy is compatible with the rest of the traffic control plan documented above, though it is acknowledged that it requires advanced communication and increased event-day parking management.

Cost Estimates

A cost estimate for the traffic control plan has been developed and documented in **Appendix C**. A total of \$6,000 is estimated for the traffic control plan. The estimate includes costs for providing vehicle and pedestrian wayfinding signs, TCAs, and pedestrian fencing.

Implementation Strategies

To effectively implement the proposed short-term traffic control plan, the following complementary strategies are proposed for event managers:

- Communicate directly with patrons for alternative parking and transportation options (direct mail, reminder emails, TV, phone calls, websites, etc.);
- Communicate with patrons to park based on their direction of travel:
 - If arriving from the east via I-535, exit at Garfield Avenue interchange and use Bentleyville Garfield Avenue lot (Bentleyville only), or exit at Garfield Avenue interchange and follow Railroad Street to the DECC parking (DECC events);
 - If arriving from the south via I-35, exit at Mesaba Avenue, follow Michigan Street or Superior streets and use downtown parking facilities or follow the signs to the Garfield Avenue lot and utilize the shuttles;
 - If arriving from the north via I-35, exit at Lake/5th Avenue, follow ramp towards 5th Avenue and follow signs to turn right to use downtown parking facilities along Michigan Street.
 - If arriving from downtown Duluth, park at downtown facilities along Michigan Street.

- If parked at downtown facilities, follow pedestrian wayfinding signs on 5th Avenue bridge or inside the DTC pedestrian skyway to access the DECC events or Bentleyville;
- Leverage consultant's and agency's knowledge to determine:
 - What, if not all, elements of the proposed traffic control plan can be implemented for the 2018 holiday season.
 - What elements to implement for other large but non-overlapping events during the 2018 holiday season.



Appendix A Detailed Short-term Traffic Control Plan (Vehicle)

List of Content:

- Vehicle Wayfinding Signs
- Vehicle Traffic Control Devices



250

SCALE IN FEET

DMS & PARKING LEGEND	
	TRAFFIC CONTROL AGENT
	TRAFFIC ROUTING STATIC SIGNAGE
	DECC EVENT STATIC SIGNAGE
	EVENT PARKING STATIC SIGNAGE
	DYNAMIC MESSAGE SIGN
	PARKING LOCATION

USE
ALT ROUTE TO
DOWNTOWN

EVENT
CONGESTION
AT 5TH AVE W

I-35 SB
I-35 NB

US HWY 2

11/09/13 PM
11/16/2018
... Projects\2018\180179\DESIGN\Plan Sheets\cd180179_pdr-k1.dgn

NO	DATE	DWN	CKD	REVISIONS
0	10/26/18			



I HEREBY CERTIFY THAT THIS SHEET WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.

PRINT NAME: **DRAFT COPY**
SIGNATURE: **DRAFT COPY**
DATE: _____ LICENSE # _____

SIGNING LAYOUT

BAYFRONT AREA EVENT TRAFFIC CONTROL

SHEET NO. 1 OF 12 SHEETS

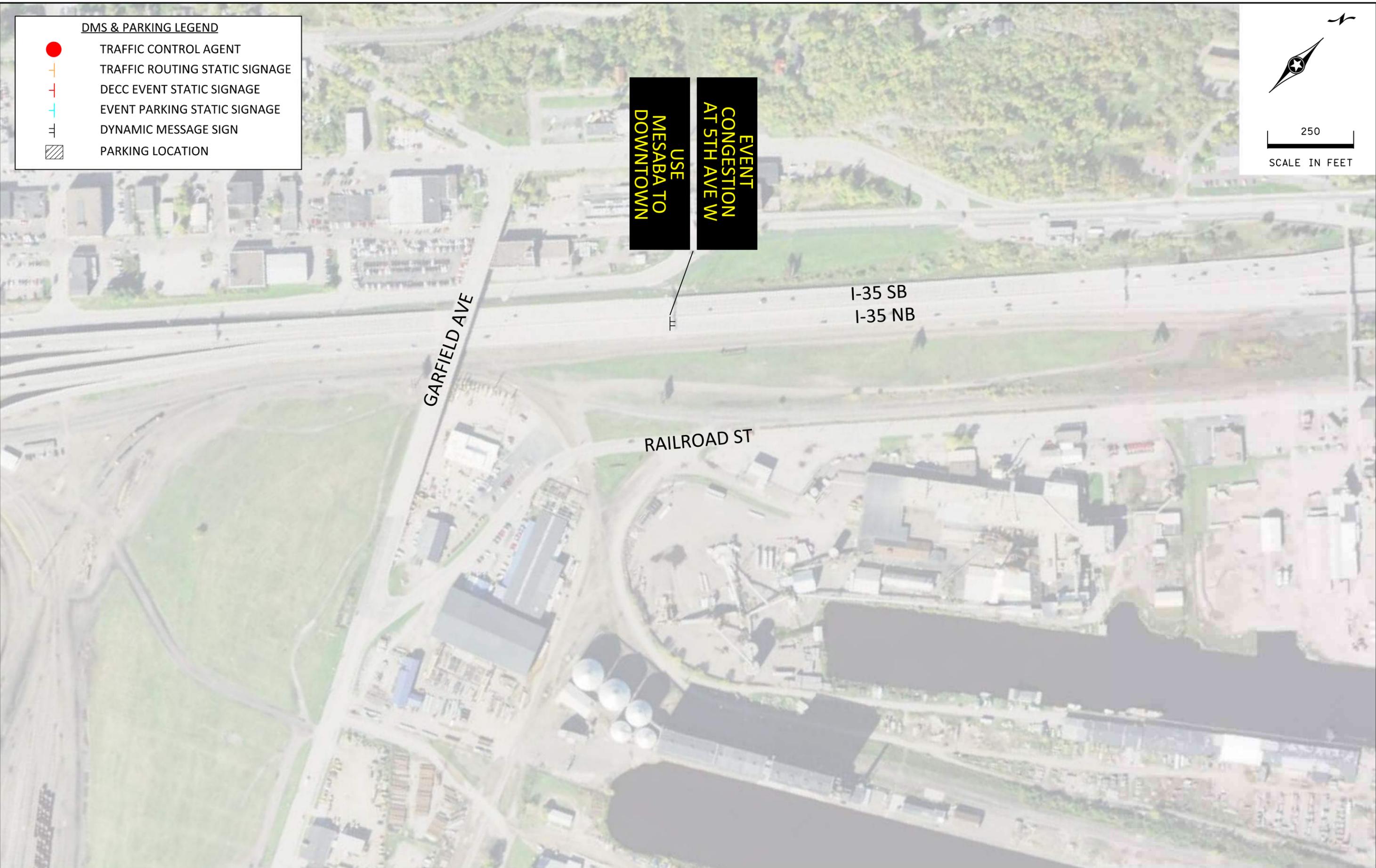


250
SCALE IN FEET

DMS & PARKING LEGEND	
	TRAFFIC CONTROL AGENT
	TRAFFIC ROUTING STATIC SIGNAGE
	DECC EVENT STATIC SIGNAGE
	EVENT PARKING STATIC SIGNAGE
	DYNAMIC MESSAGE SIGN
	PARKING LOCATION

USE
MESA TO
DOWNTOWN

EVENT
CONGESTION
AT 5TH AVE W



GARFIELD AVE

RAILROAD ST

I-35 SB
I-35 NB

11:09:35 PM
11/26/2018
C:\Users\2018\180179\DESIGN\180179_Sheets\cd180179_par-k2.dgn

NO	DATE	DWN	CKD	REVISIONS
0	10/26/18			



I HEREBY CERTIFY THAT THIS SHEET WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.

PRINT NAME: **DRAFT COPY**
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DATE: _____ LICENSE # _____

SIGNING LAYOUT

BAYFRONT AREA EVENT TRAFFIC CONTROL
SHEET NO. 2 OF 12 SHEETS

DMS & PARKING LEGEND

- TRAFFIC CONTROL AGENT
- ┆ TRAFFIC ROUTING STATIC SIGNAGE
- ┆ DECC EVENT STATIC SIGNAGE
- ┆ EVENT PARKING STATIC SIGNAGE
- ┆ DYNAMIC MESSAGE SIGN
- PARKING LOCATION

NOTES:

- ① SIGN MOUNTED ON BACK OF EXISTING SIGN POST.
- ② EXISTING SIGN STRUCTURE. INSTALL SIGN OVER EXISTING DECC PARKING SIGN.
- ③ SIGN TO BE FURNISHED AND INSTALLED BY BENTLEYVILLE.
- ④ INSTALLATION WILL REQUIRE MNDOT PERMIT.

250
SCALE IN FEET

BE PREPARED TO STOP

EVENT CONGESTION AT 5TH AVE W

Event Parking
Michigan St
Right Lane

DECC
Lake Ave
Left Lane

DECC
PKNG

Event
PKNG

Event
PKNG

Event
PKNG

DECC
PKNG

Bentleyville
Parking

Bentleyville
Parking

BAYFRONT
PARKING

DECC
PARKING

DECC
PKNG

LOT D

LOT B

LOT A

BAYFRONT
FESTIVAL
PARK

AMSOIL
ARENA

DECC

HARBOR DR

CANAL
PARK

I-35 SB

I-35 NB

RAILROAD ST

5TH AVE

HARBOR DR

11/09/17 11:09:57 PM
11/16/2018
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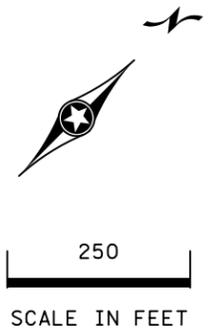


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BAYFRONT AREA EVENT TRAFFIC CONTROL
SHEET NO. 3 OF 12 SHEETS



NOTES:
 ① INSTALLATION WILL REQUIRE MNDOT PERMIT.

DMS & PARKING LEGEND	
	TRAFFIC CONTROL AGENT
	TRAFFIC ROUTING STATIC SIGNAGE
	DECC EVENT STATIC SIGNAGE
	EVENT PARKING STATIC SIGNAGE
	DYNAMIC MESSAGE SIGN
	PARKING LOCATION

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 LICENSE # _____

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BAYFRONT AREA EVENT TRAFFIC CONTROL
 SHEET NO. 4 OF 12 SHEETS



250
SCALE IN FEET

DMS & PARKING LEGEND

	TRAFFIC CONTROL AGENT
	TRAFFIC ROUTING STATIC SIGNAGE
	DECC EVENT STATIC SIGNAGE
	EVENT PARKING STATIC SIGNAGE
	DYNAMIC MESSAGE SIGN
	PARKING LOCATION



EVENT CONGESTION AT LAKE AVE

BE PREPARED TO STOP

I-35 SB
I-35 NB

11:10:39 PM
11/26/2018
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0	10/26/18			
NO	DATE	DWN	CKD	REVISIONS



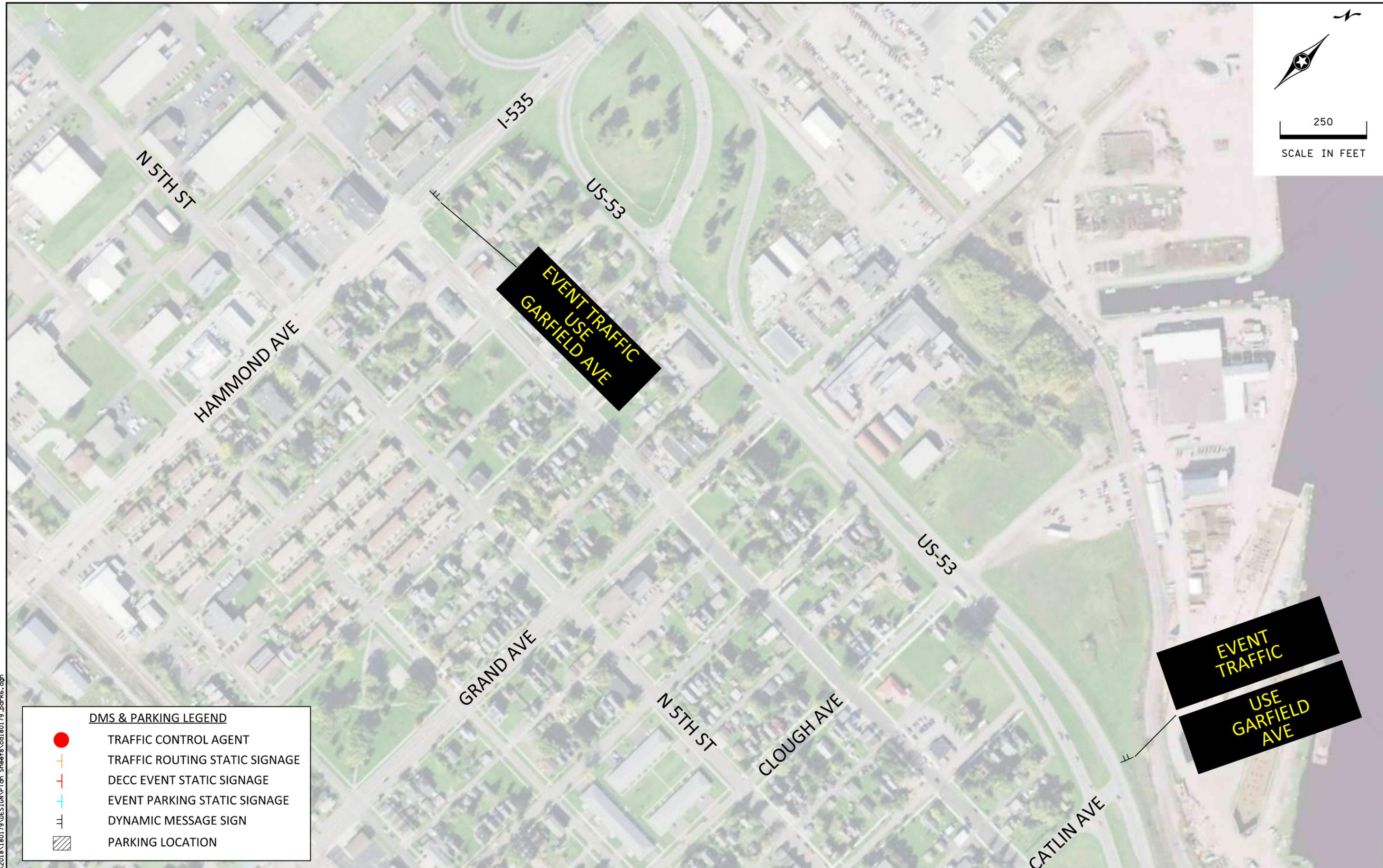
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250
SCALE IN FEET



DMS & PARKING LEGEND

-  TRAFFIC CONTROL AGENT
-  TRAFFIC ROUTING STATIC SIGNAGE
-  DECC EVENT STATIC SIGNAGE
-  EVENT PARKING STATIC SIGNAGE
-  DYNAMIC MESSAGE SIGN
-  PARKING LOCATION

11:11:03 PM
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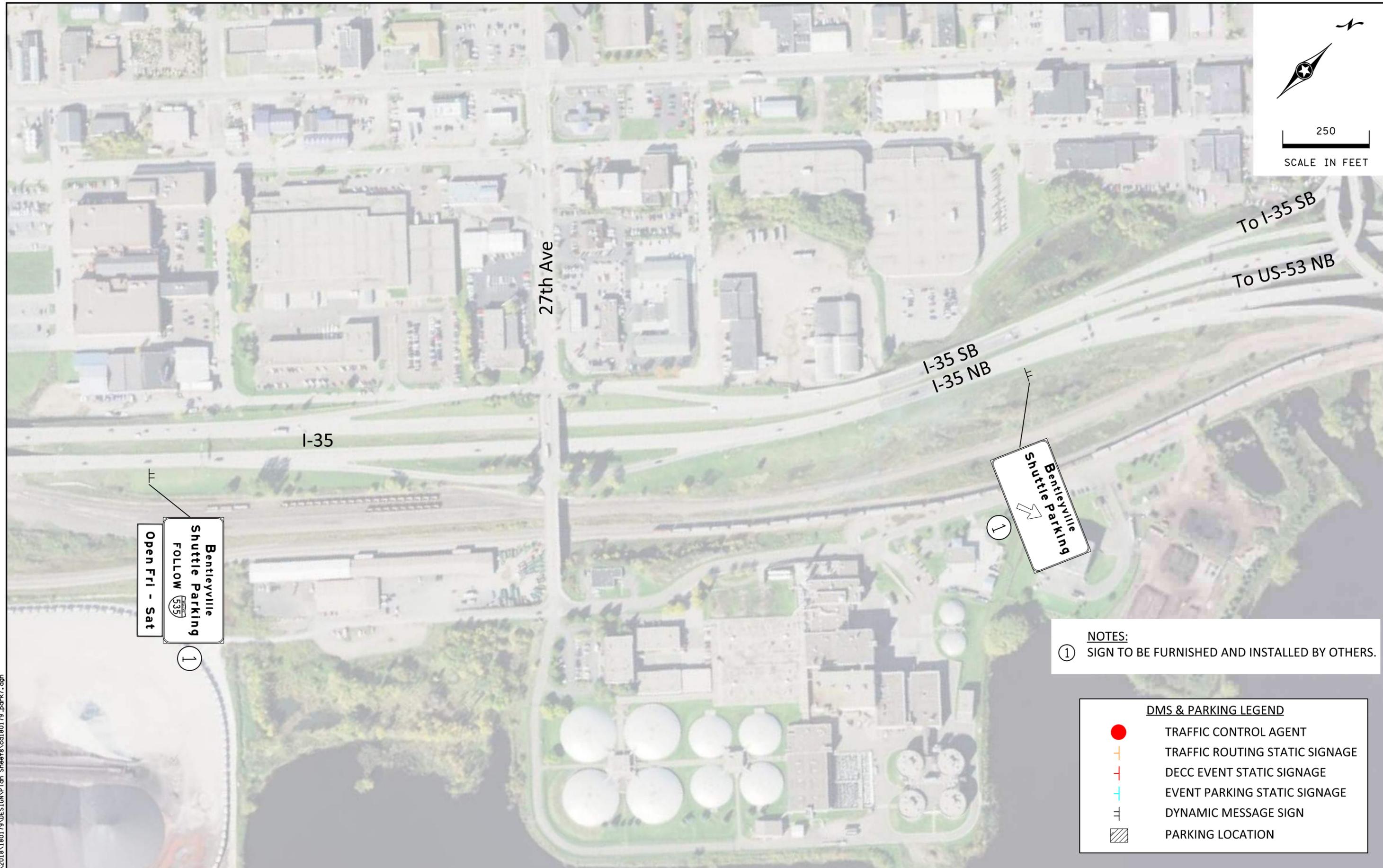
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250
SCALE IN FEET



Open Fri - Sat
Bentleyville
Shuttle Parking
FOLLOW 

1

Bentleyville
Shuttle Parking

1

NOTES:
① SIGN TO BE FURNISHED AND INSTALLED BY OTHERS.

DMS & PARKING LEGEND	
	TRAFFIC CONTROL AGENT
	TRAFFIC ROUTING STATIC SIGNAGE
	DECC EVENT STATIC SIGNAGE
	EVENT PARKING STATIC SIGNAGE
	DYNAMIC MESSAGE SIGN
	PARKING LOCATION

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11/8/2018
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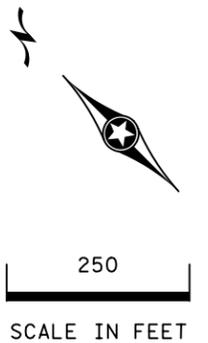


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BAYFRONT AREA EVENT TRAFFIC CONTROL
SHEET NO. 7 OF 12 SHEETS



- DMS & PARKING LEGEND**
- TRAFFIC CONTROL AGENT
 - + TRAFFIC ROUTING STATIC SIGNAGE
 - + DECC EVENT STATIC SIGNAGE
 - + EVENT PARKING STATIC SIGNAGE
 - T DYNAMIC MESSAGE SIGN
 - PARKING LOCATION

NOTES:
 ① SIGN TO BE FURNISHED AND INSTALLED BY OTHERS.

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Appendix B Detailed Short-term Traffic Control Plan (Pedestrian)

List of Content:

- Pedestrian Wayfinding Signs
- Pedestrian-related Traffic Control Devices

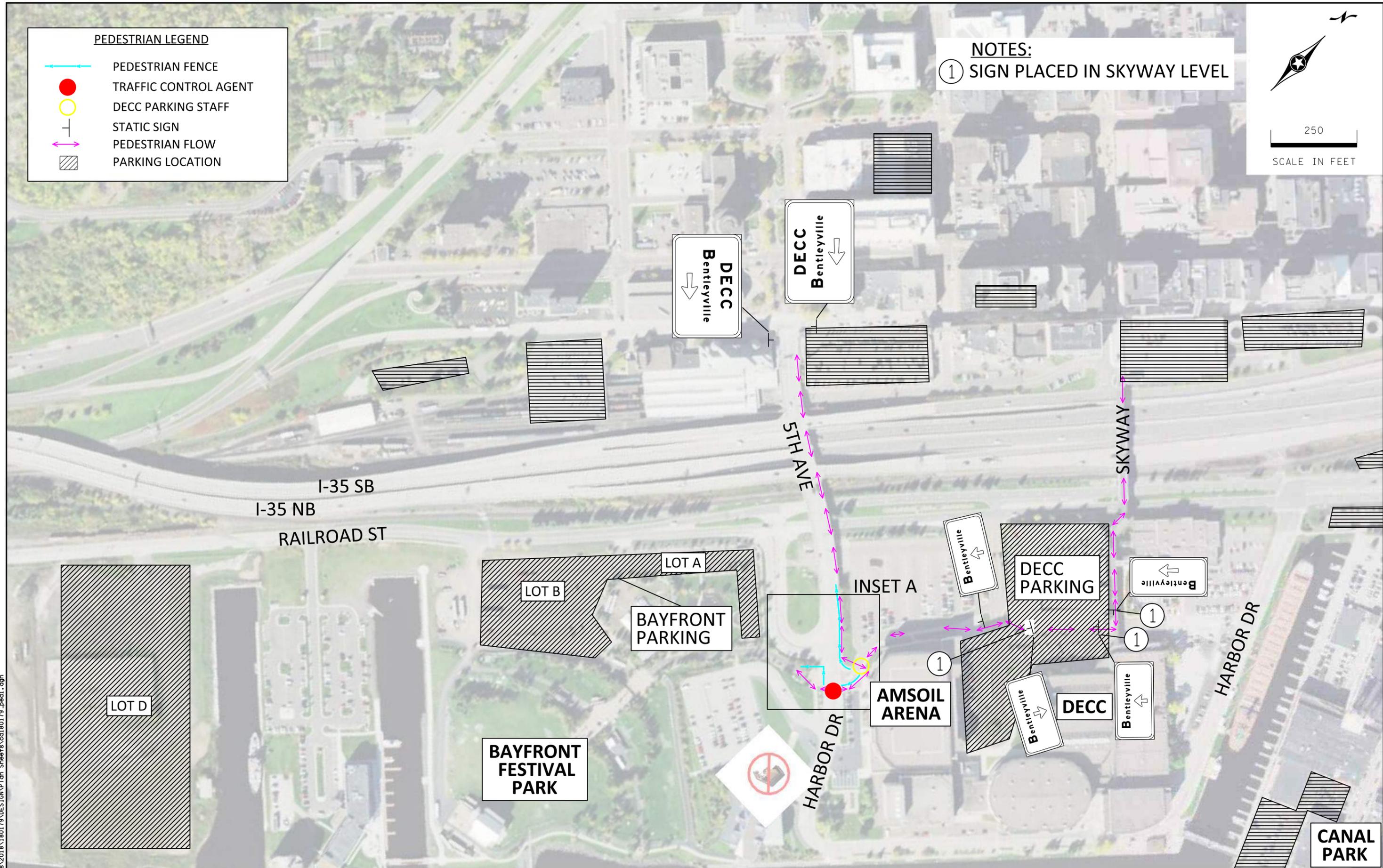


250
SCALE IN FEET

NOTES:
① SIGN PLACED IN SKYWAY LEVEL

PEDESTRIAN LEGEND

- PEDESTRIAN FENCE
- TRAFFIC CONTROL AGENT
- DECC PARKING STAFF
- STATIC SIGN
- PEDESTRIAN FLOW
- PARKING LOCATION



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PEDESTRIAN SIGNING LAYOUT

RAILROAD ST

5TH AVE

PEDESTRIAN LEGEND



PEDESTRIAN FENCE



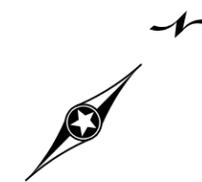
TRAFFIC CONTROL AGENT



DECC PARKING STAFF

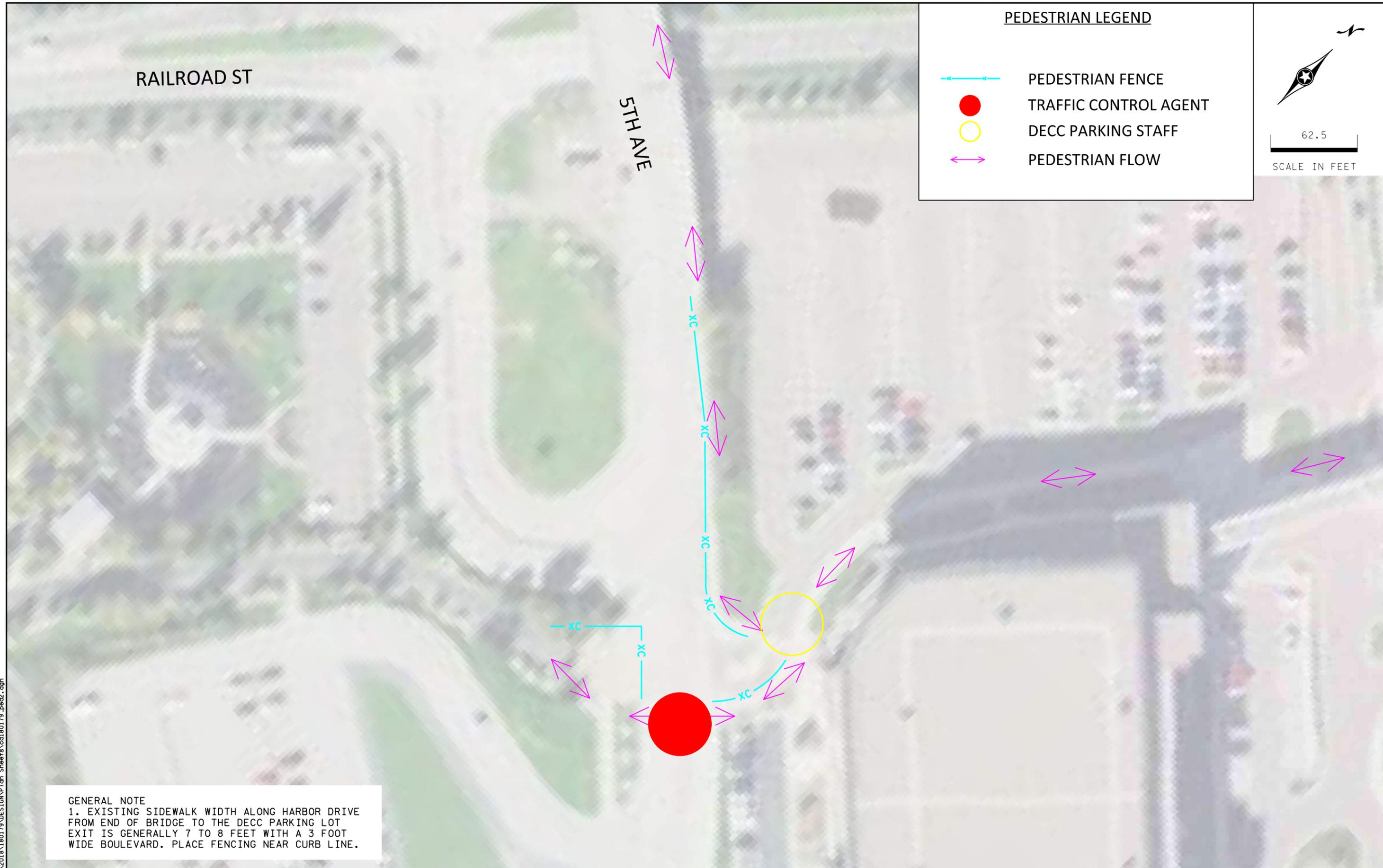


PEDESTRIAN FLOW



62.5

SCALE IN FEET



GENERAL NOTE

1. EXISTING SIDEWALK WIDTH ALONG HARBOR DRIVE FROM END OF BRIDGE TO THE DECC PARKING LOT EXIT IS GENERALLY 7 TO 8 FEET WITH A 3 FOOT WIDE BOULEVARD. PLACE FENCING NEAR CURB LINE.

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PEDESTRIAN SIGNING LAYOUT INSET A

BAYFRONT AREA EVENT TRAFFIC CONTROL SHEET NO. 10 OF 12 SHEETS



Appendix C Sign Tabulation and Cost Estimate

	TITLE	QUANTITY	PANEL LEGEND
①	EVENT PARKING MICHIGAN ST RIGHT LANE	1	
①	DECC LAKE AVE LEFT LANE	1	
①	EVENT PKNG LEFT	1	
①	EVENT PKNG RIGHT	2	
①	EVENT PARKING 5TH AVE	1	
②	BENTLEYVILLE DOWNSTAIRS	1	
①	DECC PKNG RIGHT	2	

	TITLE	QUANTITY	PANEL LEGEND
②	DECC BENTLEYVILLE LEFT	1	
②	DECC BENTLEYVILLE RIGHT	1	
①	DECC PKNG UP	2	
①	EVENT PKNG UP	1	
②	BENTLEYVILLE UP	2	
②	BENTLEYVILLE RIGHT	1	

NOTES:

- ① VEHICLE SIGN
- ② PEDESTRIAN SIGN

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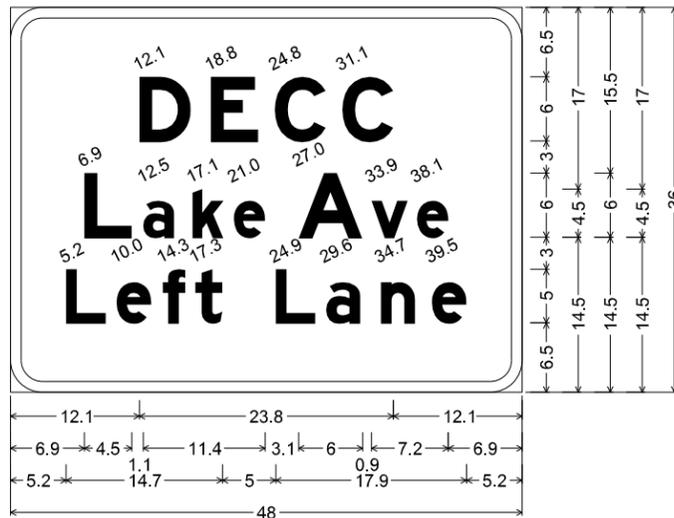
DRAFT COPY **DRAFT COPY**

SIGNING TABULATION

BAYFRONT AREA EVENT TRAFFIC CONTROL
SHEET NO. 11 OF 12 SHEETS



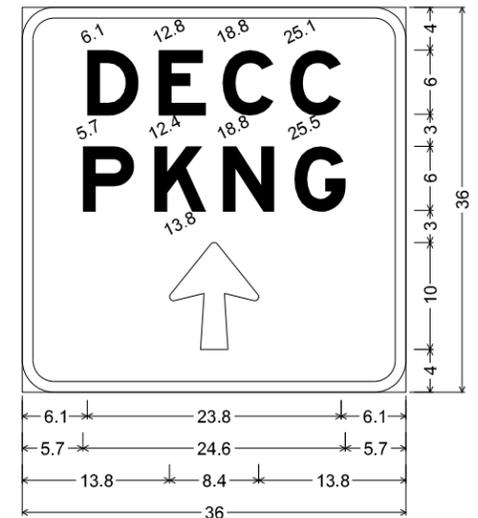
6.0" Radius, 1.3" Border, Black on Orange;
 [Event] E Mod; [Parking] E Mod; [Michigan St] E Mod;
 [Right Lane] E Mod;



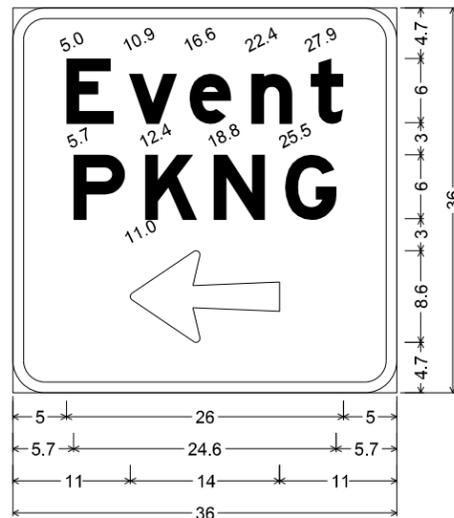
3.0" Radius, 1.0" Border, Black on Orange;
 [DECC] E Mod; [LakeAve] E Mod; [Left Lane] E Mod;



3.0" Radius, 1.0" Border, Black on Orange;
 [Event] E Mod; [Parking] E Mod; [5th Ave] E Mod;



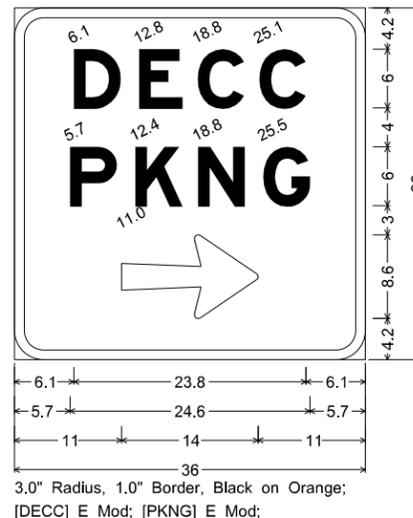
3.0" Radius, 1.0" Border, Black on Orange;
 [DECC] E Mod; [PKNG] E Mod;
 Arrow 3 - 10.0" 90°;



3.0" Radius, 1.0" Border, Black on Orange;
 [Event] E Mod; [PKNG] E Mod;
 Arrow 13 - 14.0" 180°;



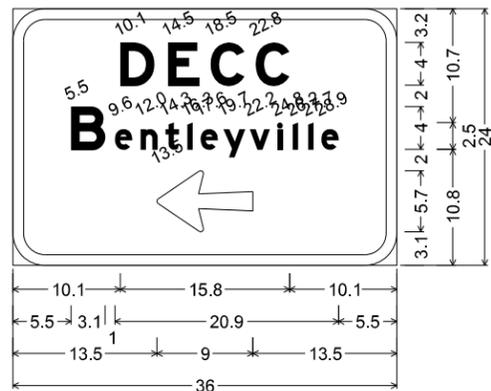
3.0" Radius, 1.0" Border, Black on Orange;
 [Event] E Mod; [PKNG] E Mod;
 Arrow 13 - 14.0" 0°;



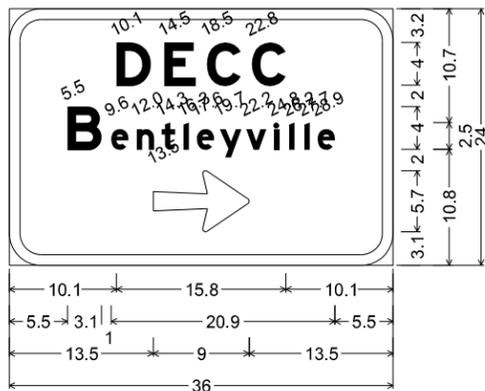
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 [DECC] E Mod; [PKNG] E Mod;
 Arrow 13 - 14.0" 0°;



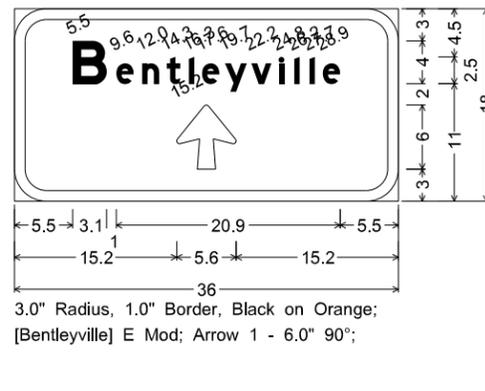
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 [Event] E Mod; [PKNG] E Mod;
 Arrow 3 - 10.0" 90°;



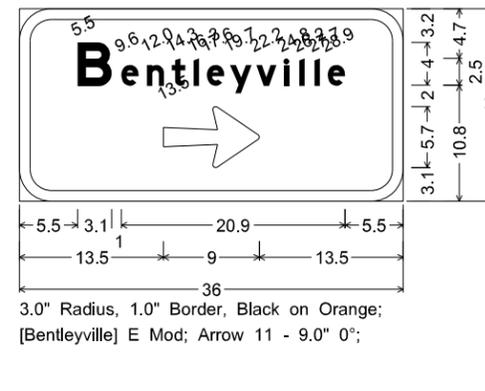
3.0" Radius, 1.0" Border, Black on Orange;



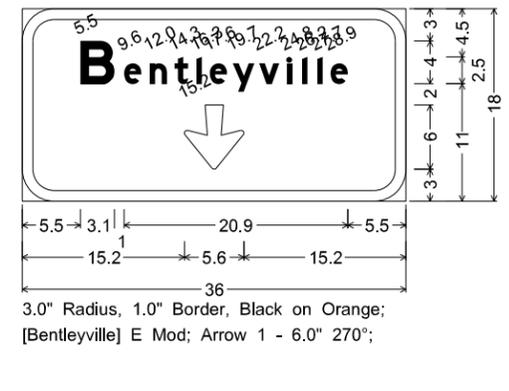
3.0" Radius, 1.0" Border, Black on Orange;



3.0" Radius, 1.0" Border, Black on Orange;
 [Bentleyville] E Mod; Arrow 1 - 6.0" 90°;



3.0" Radius, 1.0" Border, Black on Orange;
 [Bentleyville] E Mod; Arrow 11 - 9.0" 0°;



3.0" Radius, 1.0" Border, Black on Orange;
 [Bentleyville] E Mod; Arrow 1 - 6.0" 270°;

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NO	DATE	DWN	CKD	REVISIONS
0	10/26/18			[Event] E Mod; [Bentleyville] E Mod; Arrow 11 - 9.0" 180°;



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SIGNING SUMMARY

BAYFRONT AREA EVENT TRAFFIC CONTROL

SHEET NO. 12 OF 12 SHEETS

COST ESTIMATE FOR SHORT-TERM TRAFFIC CONTROL PLAN

ITEM NO.	ITEM	UNIT	NOTES	UNIT PRICE	QUANTITY	TOTAL PRICE
1	VEHICLE WAYFINDING SIGNING	LUMP SUM	(1)	\$ 3,405.00	1	\$ 3,405.00
2	PEDESTRIAN WAYFINDING SIGNING	LUMP SUM	(2)	\$ 900.00	1	\$ 900.00
3	TRAFFIC CONTROL AGENT	EACH	(3)	\$ 240.00	2	\$ 480.00
4	PEDESTRIAN FENCING	LUMP SUM	(4)	\$ 1,200.00	1	\$ 1,200.00
						\$ 5,985.00

NOTES:

1. INCLUDES COST OF SIGN MATERIALS, SETUP AND TAKE DOWN FOR THE EVENT (11 SIGNS) (TO BE COMPLETED BY CITY FORCES)
2. INCLUDES COST OF SIGN MATERIALS, SETUP AND TAKE DOWN FOR THE EVENT (6 SIGNS)
3. ASSUMES 6 HOUR SHIFT FOR EACH AGENT
4. ASSUMES EXISTING FENCING IS FURNISHED AND INSTALLED BY POLICE

Attachment C:
Bayfront Area Event Traffic Forecast and Alternatives Analysis Memo



ALLIANT

Memorandum

TO: Ron Chicka
Rondi Watson

FROM: Nick VanGunst, PE, PTOE
Yilun Xu, PE
Mike Anderson, PE, PTOE

DATE: March 29, 2019

SUBJECT: Bayfront Area Event Traffic Forecast and Alternatives Analysis Memorandum

This memorandum documents the assumptions and results of the traffic forecast and alternatives analysis for typical large-scale events at the Bayfront area in Duluth, MN. The alternative analysis is applicable to a variety of Bayfront area events.

The existing condition of the Bayfront area event traffic/parking management has been documented in the “Bayfront Area Event Traffic Control Existing Condition” memorandum (Memo #1). As noted by this memo, the traffic congestion observed around the event venues is primarily a result from circulation for parking.

A short-term event traffic control plan was partially implemented and observed during the overlapping events (typical large-scale events) on November 30, 2018, and December 1, 2018. These events are used to calibrate the Base condition in this traffic and alternative analysis. As documented by the “Bayfront Area Event Traffic Control Plan (Short-term)” memorandum (Memo #2), a list of current known issues/opportunities is summarized below:

- Unnecessary parking circulation and traffic congestion near the on-site parking facilities of the DECC and Bayfront Park:
 - Unawareness and underutilization of downtown parking facilities;
 - Lack of advance notices (on the freeway and local streets) for parking wayfinding;
- Traffic congestion at the 5th Avenue W / Harbor Drive off-ramp of northbound/eastbound I-35:
 - Left-lane underutilization;
 - Related to parking access and circulation.
- Opportunities to improve pedestrian access:
 - Lack of effective pedestrian wayfinding system;
 - The narrow sidewalk along 5th Avenue W and short pedestrian green time;
 - Known safety concerns at the Bentleyville entrance on Harbor Drive.

As part of the alternative analysis, strategies are developed around these known issues/opportunities and attempt to mitigate the parking circulation. Traffic operation performances are screened on a planning level in order to quantify the benefit or impact of a particular strategy. Traffic operation performance,

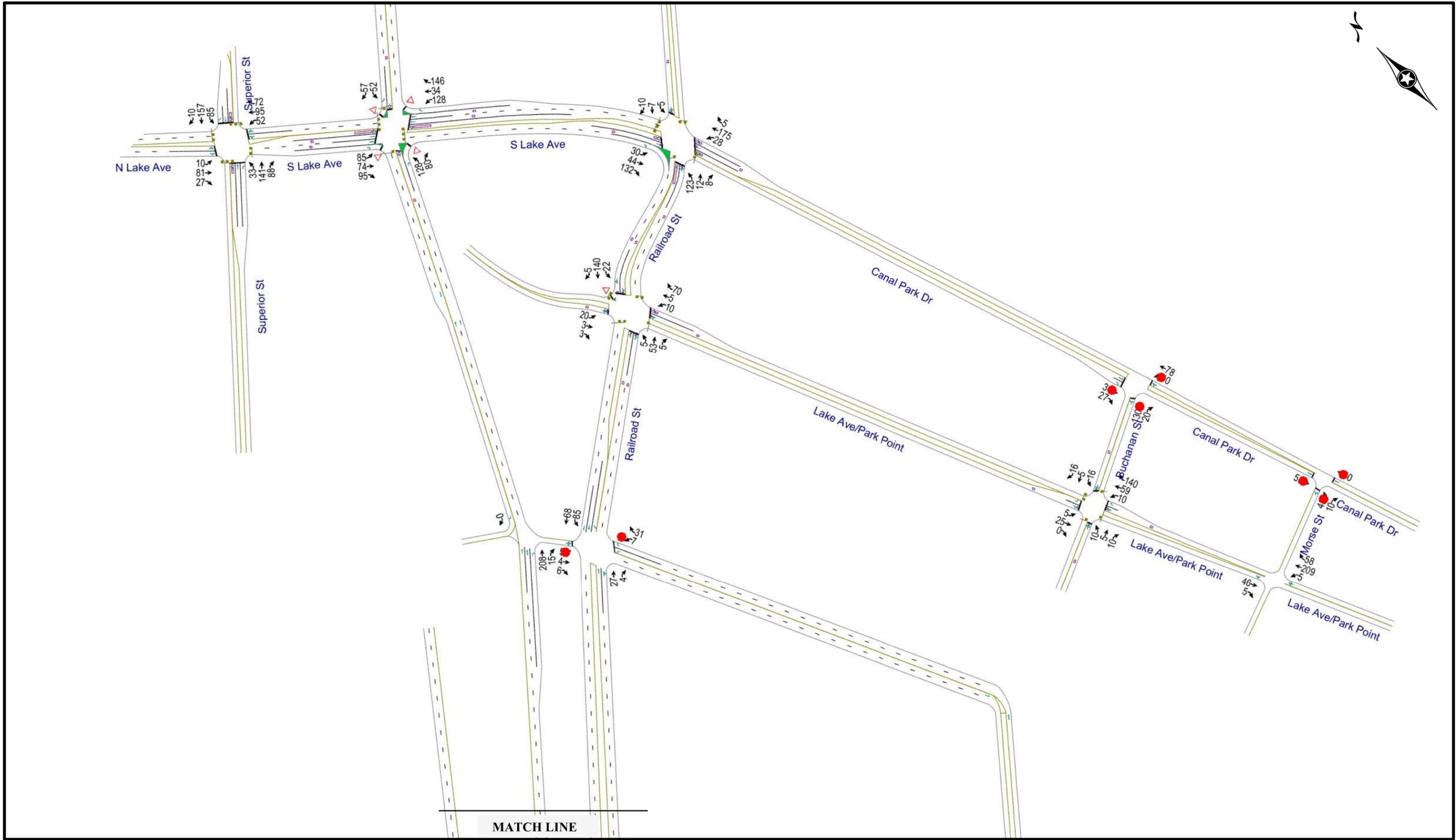
along with other evaluation criteria such as financial feasibility, implementation viability, etc., are used to highlight the overall favorability of alternatives.

Traffic Forecast

A set of representative traffic volumes at key intersections in the Bayfront area is essential to develop models to benchmark alternatives with the Base condition. The key to develop the traffic forecast is to understand the background traffic and event traffic, respectively, during typical large-scale events in the Bayfront area. This study focuses on ingress traffic where parking circulation and access have created congestion. Egress traffic are discussed qualitatively as part of the alternative analysis in this memo.

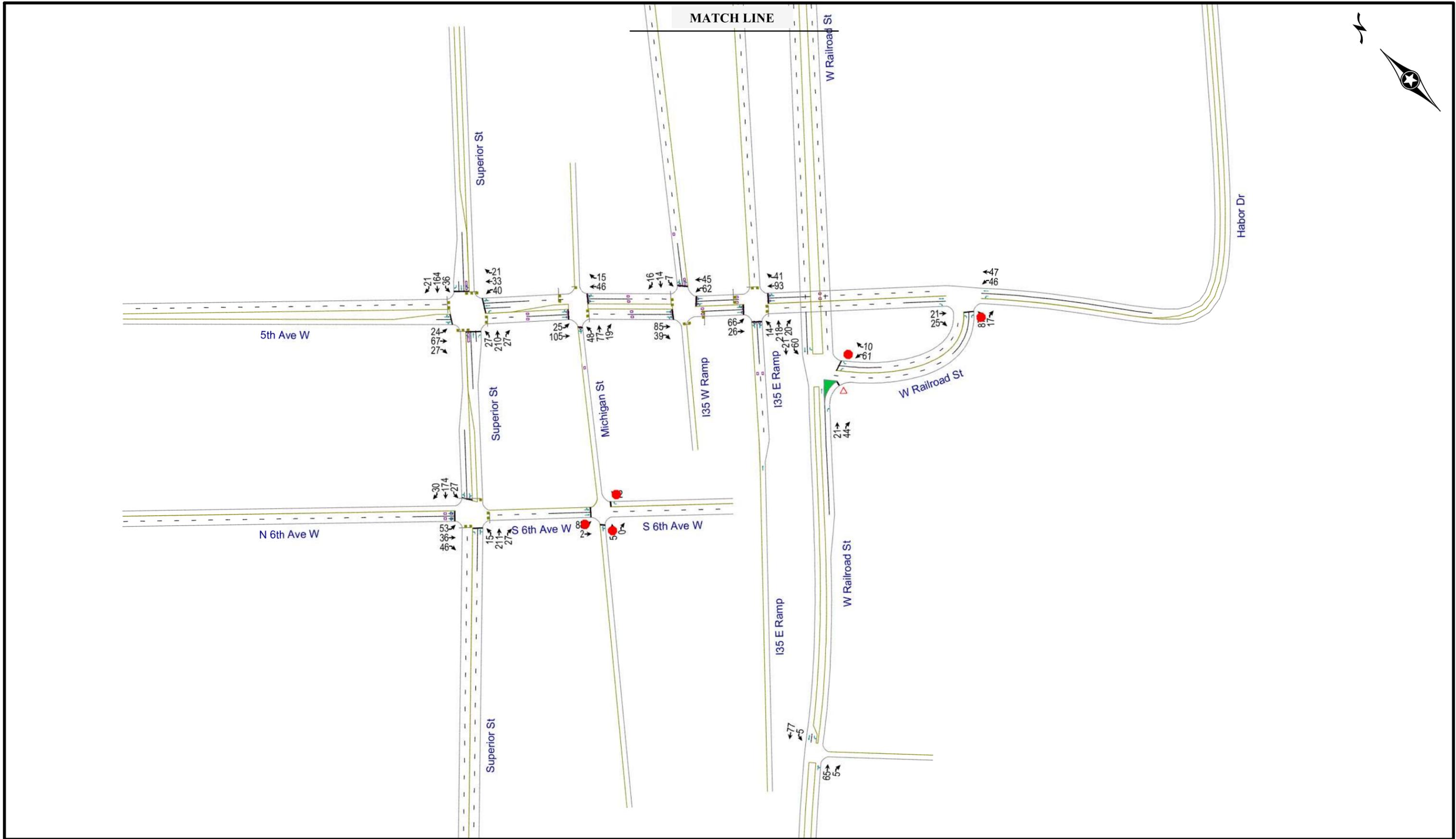
Typical Background Traffic

Background traffic is a result of activities other than the Bayfront area event of interest, and thus unaffected by the traffic/parking mitigation strategies being developed for these events. The background traffic is expected to be low compared to the event-specific traffic. Recent turning movement counts from 2016 to 2018 are generally available at key intersections around the Bayfront area. At intersections with available counts, traffic volumes during a period of 7-8pm on a weekday has been selected to conservatively represent typical background traffic of an event at the Bayfront area. This timeframe coincides with many large-scale events such as Bentleyville Tours of Light, Bayfront Park concerts, etc. A volume-balanced network of key intersections with background traffic is then developed, as shown in **Figure 1**. A volume-balanced network, which is best practice for traffic modeling, means the volume input is the same as the volume output at each intersection within the network.



Bayfront Area Event Traffic Forecast and Alternative Analysis

Figure 1 Key Intersections and Non- event Background Traffic Volume



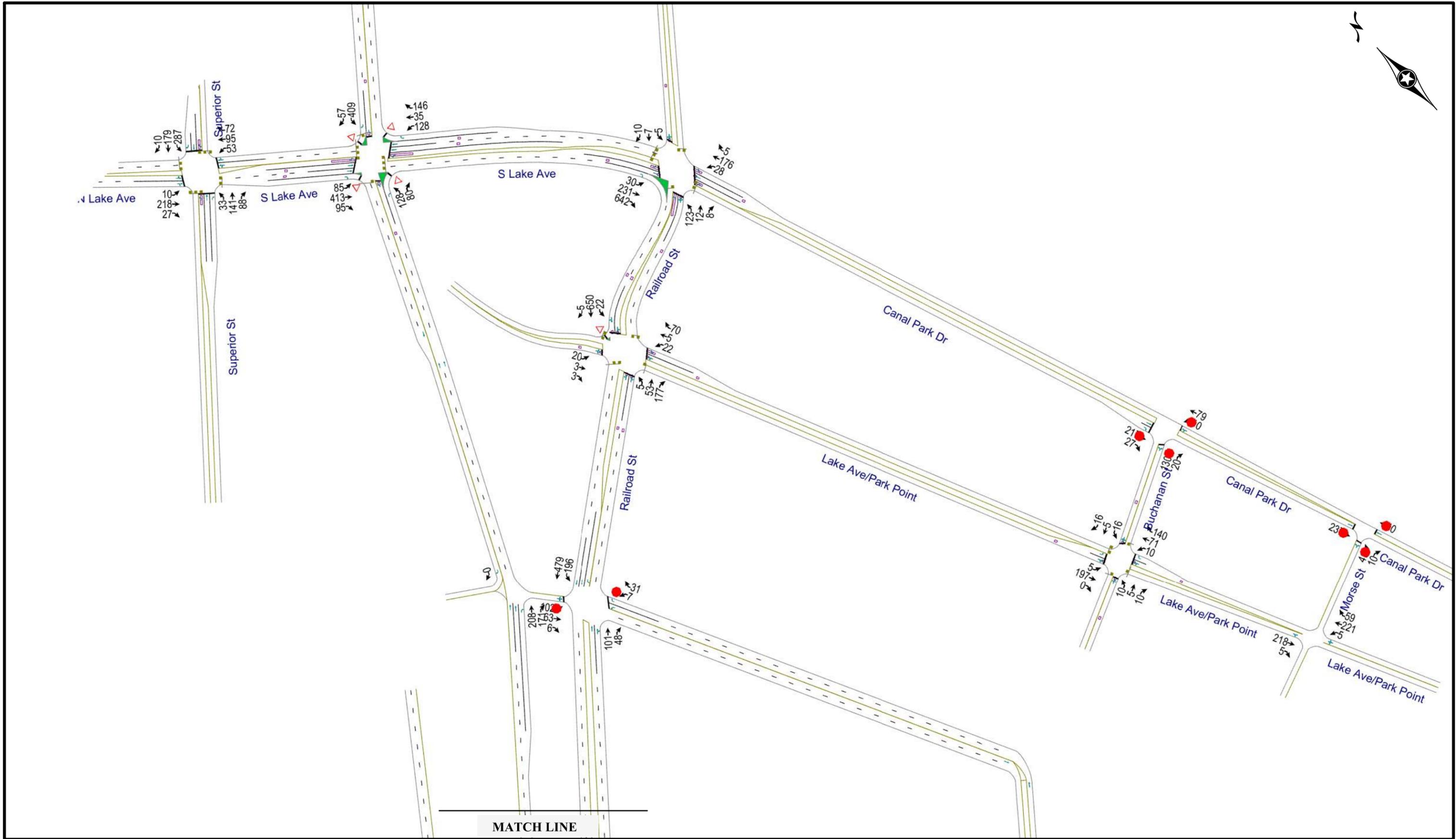
Bayfront Area Event Traffic Forecast and Alternative Analysis

Figure 1 Key Intersections and Non- event Background Traffic Volume Continued

Typical Event Traffic

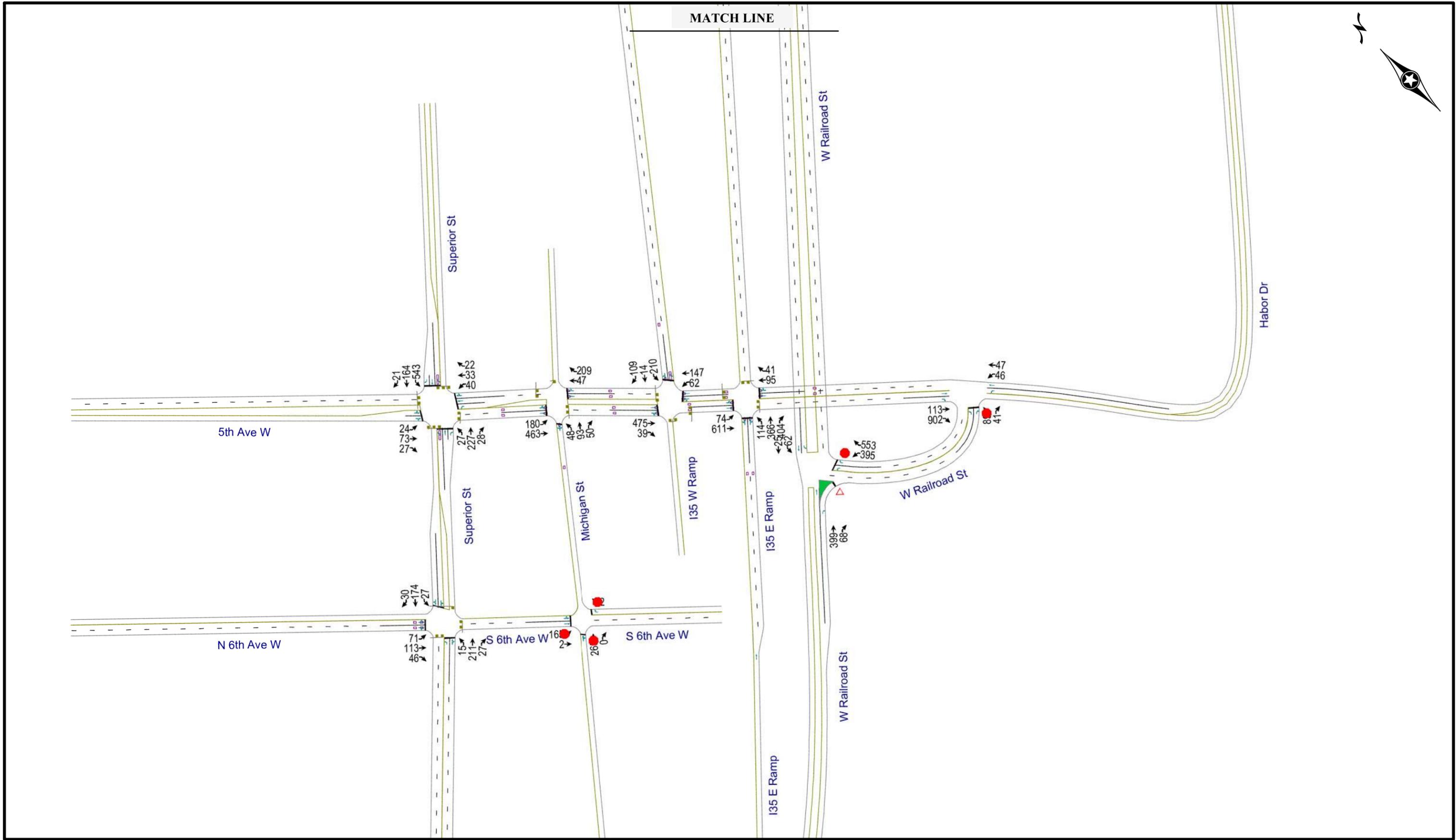
For the purpose of the traffic analysis, a typical event is defined as one that fills 90% capacity (the operational capacity) of all on-site and remote parking facilities at Bayfront Park and the DECC, nearby (within 500 feet northwest of I-35) downtown parking and Canal Park public parking. This translates into 3,438 vehicle trips within the peak hour of the event ingress. Even though the actual vehicle trip demand for large-scale overlapping events, such as the Bentleyville and Men's Hockey on November 30 and December 1, 2018, may be higher than 3,438, the portion beyond the total operational parking capacity would likely diffuse outside the study area. Therefore, the traffic operation in the Bayfront area simulated based on the developed typical event traffic and background traffic are expected to match what has been observed during the overlapping events on November 30 and December 1, 2018.

A modified CUBE model is used to generate event traffic based on the trip generation and distribution, as explained in detail in **Appendix A**. Also documented in **Appendix A** are the modeling assumptions developed based on the proposed strategies. The forecast event traffic volumes are then added to the background traffic volume in Synchro to create a Base model for typical large-scale event ingress, as shown in **Figure 2**. The Base model is calibrated based on the queue length observations on November 30 and December 1, 2018 at I-35 Ramps / 5th Ave W, I-35 Ramps / Lake Ave and Railroad St / Bayfront Park Lot Entrance intersections.



Bayfront Area Event Traffic Forecast and Alternative Analysis

Figure 2 Key Intersections and Typical Event Traffic Volume



Bayfront Area Event Traffic Forecast and Alternative Analysis

Figure 2 Key Intersections and Typical Event Traffic Volume Continued

Traffic Improvement Strategies

A total of 30 strategies were developed based on discussions, observations, and brainstorming before and during the project. These strategies are categorized, generally based on implementation difficulty, into 7 strategy groups, as shown in **Table 1**. These strategy groups form the basis of the alternative analysis. A detailed description of each strategy is documented in **Appendix B**.

Table 1 Traffic Mitigation Strategies

Strategy Group	Strategy ID	Detailed Strategy
#1 Outreach & Minimal Traffic Management*	1a	Dynamic Message Sign wayfinding messages
	1b	Marketing outreach for downtown parking options & alternative transportation
	1c	Southbound left-turn lane on Railroad St at Bentleyville parking entrance
	1d**	Move the train stop further south near the existing Cross City Trail crossing
	1e**	Pedestrian control at Bentleyville entrance on Harbor Dr
#2 Integrated Parking & Traffic Circulation Management	2a	Reduce processing time at parking entrances
	2b	Assign parking to reduce entrance queuing
	2c	Utilize multiple parking facility (e.g. DECC) entrances
	2d	Coordinate parking management and share facility occupancy during overlapping events
	2e	Static freeway & local streets signs for downtown and Canal Park parking
	2f	Traffic signs to split Bayfront Park and DECC traffic, utilize Harbor Dr, alternative parking entrance, and slip ramp
#3 Traffic Operation Improvement	3a	Separate traffic exiting the NB/EB I-35/5th Avenue ramp to mitigate right turn congestion
	3b	Add permanent/temporary pedestrian wayfinding signs along 5th Avenue, Harbor Dr and the pedestrian skyway
	3c**	Improve signal timing of I-35 ramp terminal intersections at 5th Ave and Lake Ave
#4 Circulation Improvement	4a	Change Harbor Dr to one-way flow
	4b	Change Canal Park Dr and Lake Ave to a one-way pair
#5 Roadway or Network Improvement	5a**	Reconstruct roadway and sidewalk of 5th Ave, potentially add bike lane
	5b	Connect Courtland St with Railroad St by a new Courtland St for event access
	5c	Trailblaze event traffic via 27th Ave, Superior St, Garfield Ave and Railroad St
	5d	Reconfigure northbound/eastbound 5th Ave exit off I-35
	5e**	Improve pedestrian and bicycle access in the area
	5f	Add additional access to frontage road to improve traffic flow at I-35 and 5th Ave W Ramp
	5g	Add roadway capacity (thru lane and/or left/right turn lanes) to Railroad St south of Harbor Dr
	5h	Dedicated lane from I-35 with direct access to DECC parking ramp
#6 Transit/Railroad Improvement	6a	Add dedicated bus lane via 5th Ave and Harbor Dr
	6b	Add P&R shuttle option
	6c**	Use one vehicle lane on 5th Ave for pedestrian ingress
#7 System or Capacity Improvement	7a	Construct a parking ramp near the power plant off Railroad St and connect it with shuttle service
	7b	Preferential or prepaid parking strategy
	7c	Utilize apps to share information on events, traffic condition and parking availability

* Package #1 was implemented for 11/30 and 12/1 events as short-term improvement

** Pedestrian-related strategies

Package #1 had been implemented during the overlapping large-scale events on November 30 and December 1, 2018 and is modeled as the Base condition. Selected strategies are modeled in detail to test their impact on traffic performance of relevant intersections, as documented in the following section.

Traffic Analysis Results

Synchro software package was used to model and measure traffic operations of the proposed strategies. Intersection delay, noted as seconds per vehicle, and Level of Service (LOS) were selected as the measurement of effectiveness (MOE) to represent traffic operations performance at the key intersections on a planning level. The following is the results of the modeling for each proposed strategy as noted in **Table 1**.

Strategy Group #1: Outreach & Minimal Traffic Management

Strategy group #1 includes DMS messages along adjacent freeways and local roadways, marketing outreach for downtown parking & alternative transportation, addition of the left turn lane along Railroad Street into the Bayfront Park lot, moving of the train stop further south near the existing Cross City Trail crossing and pedestrian fencing as part of the recommendations of Memo #2 “Bayfront Area Event Traffic Control Plan (Short-term)”. It should be noted that DMS do not currently exist on the local roadway network and therefore the impact of having DMS on the local roadways was not included in the modeling for Strategy Group #1. The addition of the DMS on local roadways is expected to help further reduce congestion due to traffic circulating around the event area as visitors seek out available parking.

Table 2 below concludes LOS B or above at all study intersections except I-35 Ramps / 5th Ave W, I-35 Ramps / Lake Ave, Bayfront Park Lot Entrance / Railroad St and Garfield Ave / Railroad St intersections. These intersections may experience occasional congestion during the peak event ingress hour, resulting overall LOS C or D.

Table 2 Intersection Delay and LOS based on Strategy Group #1

Intersections	Traffic Control	Delay (sec/veh)	LOS (A-F)	Hourly Entering Volume
5th Ave & I-35 Westbound Ramp	Traffic Signal	37.7	D	1052
5th Ave & I-35 Eastbound Ramp	Traffic Signal	39.4	D	1704
Michigan St & 5th Ave	Traffic Signal	11.3	B	1323
Michigan St & 6th Ave	All-way Stop	7.2	A	422
Railroad St & Ramp to Harbor Dr	Through/Stop	9.0	A	1873
Harbor Dr & Ramp to Railroad St	Through/Stop	6.9	A	1446
Harbor Dr & Railroad St	Through/Stop	2.5	A	1932
Slip Ramp	Through/Stop	2.5	A	699
Bayfront Park Entrance & Railroad St	Through/Stop	19.9	C	1125
Canal Park Dr & Railroad St	Traffic Signal	10.2	B	1265
Lake Ave & Railroad St	Traffic Signal	7.1	A	1040
Lake Ave & I-35 Ramps	Traffic Signal	23.8	C	1565
Canal Park Dr & Buchanan St	All-way Stop	7.7	A	478
Lake Ave & Buchanan St	Traffic Signal	2.9	A	480
Canal Park Dr & Morse St	All-way Stop	7.5	A	335
Garfield Ave & Railroad St	Through/Stop	16.2	C	1044
27th Ave & Courtland St	Through/Stop	1.6	A	28
27th Ave & I-35 Eastbound Ramp	Through/Stop	2.1	A	345
27th Ave & I-35 Westbound Ramp	Through/Stop	2.0	A	618

In general, traffic operations are acceptable in the Bayfront area with typical large-scale event peak hour ingress traffic demand. However, opportunities exist, especially at the above-mentioned intersections, for traffic operation improvements.

Strategy Group #2 Integrated Parking & Traffic Circulation Management

Strategy group #2 calls for additional traffic signs and parking management techniques to more efficiently use the existing roadway network. These strategies are:

- a) Reduce processing time at parking entrances
- b) Assign parking to reduce entrance queuing
- c) Utilize multiple parking facility (e.g. DECC) entrances
- d) Coordinate parking management and share facility occupancy during overlapping events
- e) Static freeway & local streets signs for downtown and Canal Park parking
- f) Traffic signs to split Bayfront Park and DECC traffic, utilize Harbor Dr, alternative parking entrance, and the slip ramp to Railroad St.

Strategies 2c, 2e and 2f may shift the current traffic pattern to achieve a more balanced usage of roadway capacity. As tested, **Table 3** shows that these strategies combined slightly improve traffic operation of intersections adjacent to the parking facilities.

Table 3 Intersection Delay and LOS based on Strategy Group #2

Intersections	Traffic Control	Delay (sec/veh)		LOS (A-F)		Hourly Entering Volume	
		Alt	Base	Alt	Base	Alt	Base
5th Ave & I-35 Westbound Ramp	Traffic Signal	35.2	37.7	D	D	927	1052
5th Ave & I-35 Eastbound Ramp	Traffic Signal	35.7	39.4	D	D	1503	1704
Michigan St & 5th Ave	Traffic Signal	8.1	11.3	A	B	1239	1323
Michigan St & 6th Ave	All-way Stop	7.6	7.2	A	A	452	422
Railroad St & Ramp to Harbor Dr	Through/Stop	7.0	9.0	A	A	1628	1873
Harbor Dr & Ramp to Railroad St	Through/Stop	3.0	6.9	A	A	1420	1446
Harbor Dr & Railroad St	Through/Stop	3.1	2.5	A	A	1859	1932
Slip Ramp	Through/Stop	5.1	2.5	A	A	665	699
Bayfront Park Entrance & Railroad St	Through/Stop	16.5	19.9	C	C	1039	1125
Canal Park Dr & Railroad St	Traffic Signal	10.4	10.2	B	B	1284	1265
Lake Ave & Railroad St	Traffic Signal	7.1	7.1	A	A	1034	1040
Lake Ave & I-35 Ramps	Traffic Signal	20.9	23.8	C	C	1576	1565
Canal Park Dr & Buchanan St	All-way Stop	7.6	7.7	A	A	491	478
Lake Ave & Buchanan St	Traffic Signal	2.3	2.9	A	A	457	480
Canal Park Dr & Morse St	All-way Stop	7.6	7.5	A	A	339	335

Strategies 2a, 2b, 2c and 2d will be further discussed in the “Bayfront Area Event Parking and Wayfinding Analysis Memo” (Memo #4).

Strategy Group #3 Traffic Operation Improvement

The only strategy within strategy group #3 that has been tested to improve traffic operation is 3a) separate traffic exiting the northbound/eastbound I-35/5th Avenue W ramp to mitigate right turn congestion, as shown in **Table 4**. This strategy simply converts the shared through-right lane to exclusive right-turn, which allow drivers to have a clear lane choice regardless of congestion. As a result, LOS for 5th Ave W / I-35 Eastbound Ramp intersection improves from D to C.

Table 4 Intersection Delay and LOS based on Strategy Group #3 (Strategy 3a Only)

Intersections	Traffic Control	Delay (sec/veh)		LOS (A-F)		Hourly Entering Volume	
		Alt	Base	Alt	Base	Alt	Base
5th Ave & I-35 Westbound Ramp	Traffic Signal	38.5	37.7	D	D	1049	1052
5th Ave & I-35 Eastbound Ramp	Traffic Signal	31.0	39.4	C	D	1685	1704

The traffic signals at 5th Ave W / I-35 Ramps intersections are controlled by a single controller with phase overlaps. Though the signal timing has been optimized for events, a few opportunities may still exist to strengthen the operation: 1) adjust signal cabinet wiring so that pedestrian phase time can be maximized with more flexibility; 2) ensure operational vehicle detection to maintain the intended actuated signal operation. The strategy (3b) of adding permanent/temporary pedestrian wayfinding signs along 5th Avenue W, Harbor Dr and the pedestrian skyway is believed to improve pedestrian wayfinding.

Strategy Group #4 Circulation Improvement

Strategy group #4 includes changing Harbor Dr and Lake Ave / Canal Park Dr to one-way loops, either in clockwise or counter-clockwise direction. The intent of the one-way operation is to provide traffic operation benefit to vehicles and transit, and improved parking circulation in the Canal Park area. **Table 5** and **Table 6** show that changing Harbor Dr to one-way does not provide noticeable traffic operation benefit. Additionally, changing it to counter-clockwise one-way street draws additional volumes and delays to 5th Ave W / I-35 Ramps intersections from Lake Ave / I-35 Ramp intersection, resulting in an approximate 15% increase in delay at 5th Ave W / I-35 ramp intersections. This is due to the exit only conversion of Harbor Dr at the Harbor Dr / Railroad St intersection on the northeast side. If one-way street conversion is considered at Harbor Dr, clockwise direction is more favorable in terms of intersection traffic operation.

Table 5 Intersection Delay and LOS based on Strategy Group #4 (Strategy 4a: Harbor Dr Clockwise)

Intersections	Traffic Control	Delay (sec/veh)		LOS (A-F)		Hourly Entering Volume	
		Alt	Base	Alt	Base	Alt	Base
5th Ave & I-35 Westbound Ramp	Traffic Signal	38.0	37.7	D	D	997	1052
5th Ave & I-35 Eastbound Ramp	Traffic Signal	37.1	39.4	D	D	1701	1704
Michigan St & 5th Ave	Traffic Signal	12.0	11.3	B	B	1304	1323
Railroad St & Ramp to Harbor Dr	Through/Stop	10.9	9.0	B	A	2016	1873
Harbor Dr & Ramp to Railroad St	Through/Stop	9.5	6.9	A	A	1440	1446
Harbor Dr & Railroad St	Through/Stop	2.9	2.5	A	A	1948	1932
Slip Ramp	Through/Stop	3.4	2.5	A	A	732	699
Bayfront Park Entrance & Railroad St	Through/Stop	18.3	19.9	C	C	1130	1125
Canal Park Dr & Railroad St	Traffic Signal	10.3	10.2	B	B	1311	1265
Lake Ave & Railroad St	Traffic Signal	7.0	7.1	A	A	1093	1040
Lake Ave & I-35 Ramps	Traffic Signal	27.0	23.8	C	C	1627	1565

Table 6 Intersection Delay and LOS based on Strategy Group #4 (Strategy 4a: Harbor Dr Counter-Clockwise)

Intersections	Traffic Control	Delay (sec/veh)		LOS (A-F)		Hourly Entering Volume	
		Alt	Base	Alt	Base	Alt	Base
5th Ave & I-35 Westbound Ramp	Traffic Signal	43.3	37.7	D	D	1165	1052
5th Ave & I-35 Eastbound Ramp	Traffic Signal	45.3	39.4	D	D	1768	1704
Michigan St & 5th Ave	Traffic Signal	16.7	11.3	B	B	1386	1323
Railroad St & Ramp to Harbor Dr	Through/Stop	13.9	9.0	B	A	2069	1873
Harbor Dr & Ramp to Railroad St	Through/Stop	7.7	6.9	A	A	1269	1446
Harbor Dr & Railroad St	Through/Stop	1.7	2.5	A	A	1882	1932
Slip Ramp	Through/Stop	2.3	2.5	A	A	707	699
Bayfront Park Entrance & Railroad St	Through/Stop	19.1	19.9	C	C	1122	1125
Canal Park Dr & Railroad St	Traffic Signal	10.0	10.2	B	B	1188	1265
Lake Ave & Railroad St	Traffic Signal	6.6	7.1	A	A	955	1040
Lake Ave & I-35 Ramps	Traffic Signal	20.0	23.8	C	C	1476	1565

Table 7 and **Table 8** show that changing Lake Ave / Canal Park Dr to one-way pair does not provide noticeable traffic operation benefit. Additionally, changing it to counter-clockwise one-way pair slows down traffic movement through the Lake Ave / I-35 Ramp intersection, resulting in a delay increase of approximate 17%. With the counter-clockwise one-way ramp conversion, ingress traffic via Lake Ave interchange must make a right turn onto Railroad St and then an immediate left turn onto Lake St for Canal Park area access. If one-way street conversion is considered at Lake Ave / Canal Park Dr, clockwise direction creates a more favorable intersection traffic operation, though either direction of circulation is expected to allow acceptable intersection traffic operation.

Table 7 Intersection Delay and LOS based on Strategy Group #4 (Strategy 4b: Lake Ave / Canal Park Dr Clockwise)

Intersections	Traffic Control	Delay (sec/veh)		LOS (A-F)		Hourly Entering Volume	
		Alt	Base	Alt	Base	Alt	Base
Harbor Dr & Railroad St	Through/Stop	2.5	2.5	A	A	1996	1932
Slip Ramp	Through/Stop	2.5	2.5	A	A	674	699
Canal Park Dr & Railroad St	Traffic Signal	11.6	10.2	B	B	1438	1265
Lake Ave & Railroad St	Traffic Signal	11.1	7.1	B	A	1247	1040
Lake Ave & I-35 Ramps	Traffic Signal	22.1	23.8	C	C	1551	1565
Canal Park Dr & Buchanan St	All-way Stop	8.2	7.7	A	A	503	478
Lake Ave & Buchanan St	Traffic Signal	4.7	2.9	A	A	446	480
Canal Park Dr & Morse St	All-way Stop	8.9	7.5	A	A	493	335

Table 8 Intersection Delay and LOS based on Strategy Group #4 (Strategy 4b: Lake Ave / Canal Park Dr Counter-Clockwise)

Intersections	Traffic Control	Delay (sec/veh)		LOS (A-F)		Hourly Entering Volume	
		Alt	Base	Alt	Base	Alt	Base
Harbor Dr & Railroad St	Through/Stop	2.4	2.5	A	A	1923	1932
Slip Ramp	Through/Stop	2.7	2.5	A	A	736	699
Canal Park Dr & Railroad St	Traffic Signal	10.3	10.2	B	B	1312	1265
Lake Ave & Railroad St	Traffic Signal	6.3	7.1	A	A	1161	1040
Lake Ave & I-35 Ramps	Traffic Signal	27.8	23.8	C	C	1622	1565
Canal Park Dr & Buchanan St	All-way Stop	5.7	7.7	A	A	421	478
Lake Ave & Buchanan St	Traffic Signal	4.3	2.9	A	A	473	480
Canal Park Dr & Morse St	All-way Stop	4.4	7.5	A	A	311	335

In addition to the minor traffic impact, switching Lake Ave / Canal Park Dr to one-way pair may elongate the access to local businesses near the end of the one-way loop. Similar situation exists for parking lot access. However, the one-way loop provides an opportunity for better parking circulation as drivers will be forced to make a right-in and right-out at the parking lot entrances, which makes ingress and egress traffic flow better. It should be noted that other factors, such as bus operation, pedestrian crossing, curb side parking, etc. also factor in the pros and cons of converting Harbor Dr and Lake Ave / Canal Park Dr into one-way streets.

Strategy Group #5 Roadway or Network Improvement

Strategy group #5 includes a suite of strategies that improve roadway geometry and the network in a larger scale than previous packages. Detailed vehicle operation analysis was performed for all strategies individually except e) Improve pedestrian and bicycle access in the area, as discussed below. Additional

analysis on pedestrian/bicycle wayfinding improvement is available in the “Bayfront Area Event Parking and Wayfinding Analysis” memorandum (Memo #4).

Strategy 5a): Reconstruct roadway and sidewalk of 5th Ave W, potentially add bike lane

This strategy requires reduction of vehicle lane(s) along 5th Ave W in order to accommodate wider sidewalk and bike lanes. For modeling purposes, it’s assumed that one vehicle lane each direction is reduced while turn lanes are preserved along 5th Ave W between Superior St and Railroad St.

Table 9 shows that the intersection delay at the 5th Ave W / I-35 Ramp intersections appear to be unaffected by the lane reduction. However, delay along 5th Ave W originally confined around 5th Ave W / I-35 Ramp intersections is now expanded through the Michigan St / 5th Ave W intersection (LOS changes from B to C) and further. It’s noted that due to the reduced capacity, a portion of the traffic demand via 5th Ave W and I-35 ramps may divert via other routes such as Garfield Ave or Lake Ave / I-35 interchange. This diversion may create additional traffic delay especially through the existing two-way stop control at the Garfield Ave / Railroad St intersection.

In general, the reduction of roadway capacity along 5th Ave W for a bike lane and wider sidewalk is not expected to create systematic traffic congestion. However, a detailed traffic impact analysis needs to be conducted to in order to identify necessary intersection improvements due to the shift in traffic pattern and reduction in roadway capacity for vehicles. It’s important to note that more vehicles are expected to park in downtown facilities if the pedestrian access along 5th Ave W is improved. This in turn reduces traffic congestions at the 5th Ave W / I-35 Ramp intersections.

It’s acknowledged that the 5th Ave W bridge will need to be reconstructed at some point. The reconstruction is an opportunity to accommodate wider sidewalk and potentially bicycle lanes (Strategy 5a), and to improve the interchange configuration as part of the Strategy “5d Reconfigure northbound/eastbound 5th Ave W exit off I-35”, which is discussed later in this memo.

Table 9 Intersection Delay and LOS based on Strategy Group #5 (Strategy 5a)

Intersections	Traffic Control	Delay (sec/veh)		LOS (A-F)		Hourly Entering Volume	
		Alt	Base	Alt	Base	Alt	Base
5th Ave & I-35 Westbound Ramp	Traffic Signal	38.0	37.7	D	D	886	1052
5th Ave & I-35 Eastbound Ramp	Traffic Signal	37.2	39.4	D	D	1499	1704
Michigan St & 5th Ave	Traffic Signal	29.2	11.3	C	B	1186	1323
Railroad St & Ramp to Harbor Dr	Through/Stop	6.6	9.0	A	A	1775	1873
Harbor Dr & Ramp to Railroad St	Through/Stop	3.9	6.9	A	A	1277	1446
Lake Ave & Railroad St	Traffic Signal	6.8	7.1	A	A	1017	1040
Lake Ave & I-35 Ramps	Traffic Signal	21.1	23.8	C	C	1615	1565
Garfield Ave & Railroad St	Through/Stop	27.4	16.2	D	C	1081	1044

Strategy 5b): Connect Courtland St with Railroad St by a new Courtland St for event access

Connecting the existing Courtland St and Railroad St with a new Courtland St creates a parallel alternative route for I-35 northbound/eastbound during event ingress. **Table 10** shows that approximately 70 vehicles would travel via the new Courtland St instead of via the 5th Ave W / I-35 Eastbound Ramp intersection. This improves the intersection LOS from D to C. Impacts to other relevant intersections are minimal. During the Twin Ports Interchange preliminary design phase, (2016 - 2018), the concept of Courtland St had been determined infeasible due to the potential disturbance to adjacent contaminated soils and the limited availability of right-of-way needed to construct the roadway.

Even though the overall traffic operation benefit will unlikely outweigh the potential high cost of constructing the new Courtland St, additional event management strategies can be applied to increase the utilization of the new Courtland St. Additionally, the new Courtland St may be utilized for event egress to relieve local congestions near 5th Ave W and Lake Ave interchanges (to I-35).

Table 10 Intersection Delay and LOS based on Strategy Group #5 (Strategy 5b)

Intersections	Traffic Control	Delay (sec/veh)		LOS (A-F)		Hourly Entering Volume	
		Alt	Base	Alt	Base	Alt	Base
5th Ave & I-35 Westbound Ramp	Traffic Signal	38.0	37.7	D	D	1042	1052
5th Ave & I-35 Eastbound Ramp	Traffic Signal	31.9	39.4	C	D	1634	1704
Railroad St & Ramp to Harbor Dr	Through/Stop	8.0	9.0	A	A	1861	1873
Harbor Dr & Ramp to Railroad St	Through/Stop	5.1	6.9	A	A	1388	1446
Harbor Dr & Railroad St	Through/Stop	2.4	2.5	A	A	1899	1932
Slip Ramp	Through/Stop	2.8	2.5	A	A	681	699
Bayfront Park Entrance & Railroad St	Through/Stop	20.5	19.9	C	C	1161	1125
Canal Park Dr & Railroad St	Traffic Signal	10.5	10.2	B	B	1269	1265
Lake Ave & Railroad St	Traffic Signal	6.7	7.1	A	A	1017	1040
Lake Ave & I-35 Ramps	Traffic Signal	25.1	23.8	C	C	1572	1565
Garfield Ave & Railroad St	Through/Stop	17.0	16.2	C	C	1180	1044
27th Ave & Courtland St	Through/Stop	0.7	1.6	A	A	176	28
27th Ave & I-35 Eastbound Ramp	Through/Stop	2.8	2.1	A	A	505	345
27th Ave & I-35 Westbound Ramp	Through/Stop	1.9	2.0	A	A	659	618

Strategy 5c): Trailblaze event traffic via 27th Ave, Superior St, Garfield Ave and Railroad St

Instead of constructing a new Courtland St, Strategy 5c utilizes signs to guide a portion of event ingress traffic on I-35 northbound/eastbound to the Bayfront area via 27th Ave / I-35 interchange. The goal would be to direct visitors north on 27th Ave, to the east on Superior St, to the south on Garfield Ave, and to the east on Railroad St. **Table 11** shows that, similar to Strategy 5b, intersection LOS at 5th Ave W / I-35 Northbound/Eastbound Ramp intersection would increase from D to C. However, this strategy places additional traffic through the southbound left turn movement of Garfield Ave / Railroad St intersection, which conflicts with its heavy northbound right turn movement (channelized right turn). This requires a geometric improvement to convert the channelized northbound right to a traditional right turn lane, or a traffic control upgrade. It should be noted that the traffic analysis did include the new striping configuration along Garfield Ave, which is planned to be completed in 2019.

Table 11 Intersection Delay and LOS based on Strategy Group #5 (Strategy 5c; with geometric change to Garfield Ave / Railroad St intersection)

Intersections	Traffic Control	Delay (sec/veh)		LOS (A-F)		Hourly Entering Volume	
		Alt	Base	Alt	Base	Alt	Base
5th Ave & I-35 Westbound Ramp	Traffic Signal	37.3	37.7	D	D	1049	1052
5th Ave & I-35 Eastbound Ramp	Traffic Signal	32.1	39.4	C	D	1610	1704
Railroad St & Ramp to Harbor Dr	Through/Stop	7.5	9.0	A	A	1870	1873
Harbor Dr & Ramp to Railroad St	Through/Stop	4.4	6.9	A	A	1364	1446
Harbor Dr & Railroad St	Through/Stop	2.4	2.5	A	A	1944	1932
Slip Ramp	Through/Stop	2.3	2.5	A	A	690	699
Bayfront Park Entrance & Railroad St	Through/Stop	11.0	19.9	B	C	1181	1125
Canal Park Dr & Railroad St	Traffic Signal	10.3	10.2	B	B	1270	1265
Lake Ave & Railroad St	Traffic Signal	7.0	7.1	A	A	1032	1040
Lake Ave & I-35 Ramps	Traffic Signal	21.7	23.8	C	C	1567	1565
Garfield Ave & Railroad St*	Through/Stop	14.8	16.2	B	C	1131	1044
27th Ave & Courtland St	Through/Stop	1.7	1.6	A	A	29	28
27th Ave & I-35 Eastbound Ramp	Through/Stop	2.1	2.1	A	A	359	345
27th Ave & I-35 Westbound Ramp	Through/Stop	1.9	2.0	A	A	632	618

* The channelized northbound right is converted to traditional right turn

Strategy 5d): Reconfigure northbound/eastbound 5th Ave W exit off I-35

Strategy 5d adds one additional right turn lane to the eastbound 5th Ave W exit off I-35. This increases the right turn capacity from the existing shared through-right lane. **Table 12** indicates that this strategy substantially improves intersection delay (and LOS from D to C), especially at the 5th Ave W / I-35 Ramp intersections. However, this strategy is expected to be high in cost due to bridge construction and right-of-way constraints.

Table 12 Intersection Delay and LOS based on Strategy Group #5 (Strategy 5d)

Intersections	Traffic Control	Delay (sec/veh)		LOS (A-F)		Hourly Entering Volume	
		Alt	Base	Alt	Base	Alt	Base
5th Ave & I-35 Westbound Ramp	Traffic Signal	32.7	37.7	C	D	1033	1052
5th Ave & I-35 Eastbound Ramp	Traffic Signal	22.8	39.4	C	D	1678	1704
Michigan St & 5th Ave	Traffic Signal	9.9	11.3	A	B	1318	1323
Railroad St & Ramp to Harbor Dr	Through/Stop	9.3	9.0	A	A	1879	1873
Harbor Dr & Ramp to Railroad St	Through/Stop	6.1	6.9	A	A	1441	1446
Bayfront Park Entrance & Railroad St	Through/Stop	19.6	19.9	C	C	1124	1125

Strategy 5f): Add additional access to frontage road to improve traffic flow on I-35 at 5th Ave W Ramp

Strategy 5f adds an additional exit ramp from I-35 eastbound (before 5th Ave W exit) to Railroad St, which reduces traffic volume via the 5th Ave W / I-35 Eastbound Ramp intersection. This strategy slightly improves traffic operation of the intersections along 5th Ave W and Railroad St, as shown by **Table 13**. This strategy is expected to be high in cost due to right-of-way constraints. Also, the Federal Highway Administration will likely not approve of a new connection directly off of I-35 due to the current spacing between interchanges in the project area.

Table 13 Intersection Delay and LOS based on Strategy Group #5 (Strategy 5f)

Intersections	Traffic Control	Delay (sec/veh)		LOS (A-F)		Hourly Entering Volume	
		Alt	Base	Alt	Base	Alt	Base
5th Ave & I-35 Westbound Ramp	Traffic Signal	37.1	37.7	D	D	1023	1052
5th Ave & I-35 Eastbound Ramp	Traffic Signal	31.0	39.4	C	D	1565	1704
Railroad St & Ramp to Harbor Dr	Through/Stop	7.6	9.0	A	A	1843	1873
Harbor Dr & Ramp to Railroad St	Through/Stop	4.9	6.9	A	A	1378	1446
Harbor Dr & Railroad St	Through/Stop	2.5	2.5	A	A	1933	1932
Slip Ramp	Through/Stop	2.7	2.5	A	A	687	699
Bayfront Park Entrance & Railroad St	Through/Stop	17.2	19.9	C	C	1123	1125
Canal Park Dr & Railroad St	Traffic Signal	10.5	10.2	B	B	1279	1265
Lake Ave & Railroad St	Traffic Signal	6.9	7.1	A	A	1037	1040
Lake Ave & I-35 Ramps	Traffic Signal	21.8	23.8	C	C	1588	1565
Garfield Ave & Railroad St	Through/Stop	6.7	16.2	A	C	941	1044

Strategy 5g): Add roadway capacity (thru lane and/or left/right turn lanes) to Railroad St south of Harbor Dr

Strategy 5g adds roadway capacity to Railroad St between Garfield Ave and Harbor Dr, by adding either turn lanes in front of parking facilities or a full westbound/southbound lane. **Table 14** and **Table 15** show that both versions of this strategy have minimal impact to traffic operations of adjacent intersections. It is important to note that a westbound/southbound left turn lane from Railroad St to Bayfront Park lot was added as part of strategy group #1 (the Base condition) and this addition was observed to be effective during the large-scale events on November 30 and December 1, 2018.

Additionally, adding a full westbound/southbound lane along Railroad St may better facilitate the egress traffic via Railroad St towards Garfield Ave. However, the limited availability of right-of-way, adjacent railroad tracks and potential contaminated soils may place constraints or drastically increase the cost of construction.

Table 14 Intersection Delay and LOS based on Strategy Group #5 (Strategy 5g: Add Turn Lanes along Railroad St)

Intersections	Traffic Control	Delay (sec/veh)		LOS (A-F)		Hourly Entering Volume	
		Alt	Base	Alt	Base	Alt	Base
Railroad St & Ramp to Harbor Dr	Through/Stop	9.0	9.0	A	A	1874	1873
Harbor Dr & Ramp to Railroad St	Through/Stop	5.5	6.9	A	A	1450	1446
Harbor Dr & Railroad St	Through/Stop	2.4	2.5	A	A	1916	1932
Slip Ramp	Through/Stop	2.7	2.5	A	A	703	699
Bayfront Park Entrance & Railroad St	Through/Stop	19.4	19.9	C	C	1133	1125
Canal Park Dr & Railroad St	Traffic Signal	10.6	10.2	B	B	1266	1265

Table 15 Intersection Delay and LOS based on Strategy Group #5 (Strategy 5g: Add One Westbound Lane along Railroad St south of Harbor Dr)

Intersections	Traffic Control	Delay (sec/veh)		LOS (A-F)		Hourly Entering Volume	
		Alt	Base	Alt	Base	Alt	Base
Railroad St & Ramp to Harbor Dr	Through/Stop	9.5	9.0	A	A	1878	1873
Harbor Dr & Ramp to Railroad St	Through/Stop	5.6	6.9	A	A	1454	1446
Harbor Dr & Railroad St	Through/Stop	2.5	2.5	A	A	1916	1932
Slip Ramp	Through/Stop	3.0	2.5	A	A	711	699
Bayfront Park Entrance & Railroad St	Through/Stop	18.1	19.9	C	C	1129	1125
Canal Park Dr & Railroad St	Traffic Signal	9.9	10.2	A	B	1244	1265

Strategy 5h): Dedicated lane from I-35 with direct access to DECC parking ramp

Strategy 5h adds a dedicated bridge/ramp from I-35 (near 5th Ave W / Lake Ave exit) to the DECC parking ramp. For modelling purposes, it's assumed that the traffic towards the DECC parking ramp still has to travel through the 5th Ave W / I-35 Eastbound Ramp intersection. **Table 16** shows that the dedicated DECC parking access attracts traffic from Lake St interchange and Garfield Ave to 5th Ave W interchange. This results in intersection LOS improvements to the Lake Ave / I-35 Ramp, Garfield Ave / Railroad St, and adjacent intersections, while worsens the operation of 5th Ave W / I-35 Ramp intersections (LOS changes from D to E at 5th Ave W / I-35 Eastbound Ramp intersection). If this strategy were to be implemented, signal timing and/or geometric improvements at 5th Ave W / I-35 Eastbound Ramp intersection are necessary.

Table 16 Intersection Delay and LOS based on Strategy Group #5 (Strategy 5h)

Intersections	Traffic Control	Delay (sec/veh)		LOS (A-F)		Hourly Entering Volume	
		Alt	Base	Alt	Base	Alt	Base
5th Ave & I-35 Westbound Ramp	Traffic Signal	46.4	37.7	D	D	1028	1052
5th Ave & I-35 Eastbound Ramp	Traffic Signal	59.7	39.4	E	D	1836	1704
Michigan St & 5th Ave	Traffic Signal	36.0	11.3	D	B	1116	1323
Michigan St & 6th Ave	All-way Stop	12.3	7.2	B	A	453	422
Railroad St & Ramp to Harbor Dr	Through/Stop	8.1	9.0	A	A	1061	1873
Harbor Dr & Ramp to Railroad St	Through/Stop	2.9	6.9	A	A	872	1446
Harbor Dr & Railroad St	Through/Stop	2.7	2.5	A	A	1002	1932
Slip Ramp	Through/Stop	1.9	2.5	A	A	1328	699
Bayfront Park Entrance & Railroad St	Through/Stop	11.3	19.9	B	C	901	1125
Canal Park Dr & Railroad St	Traffic Signal	9.4	10.2	A	B	1141	1265
Lake Ave & Railroad St	Traffic Signal	6.3	7.1	A	A	943	1040
Lake Ave & I-35 Ramps	Traffic Signal	18.5	23.8	B	C	1345	1565
Garfield Ave & Railroad St	Through/Stop	3.0	16.2	A	C	786	1044

Strategy Group #6 Transit/Railroad Improvement

Strategy group #6 includes the following strategies:

- a) Add dedicated bus lane via 5th Ave W and Harbor Dr
- b) Add Park & Ride (P&R) shuttle option
- c) Use one vehicle lane on 5th Ave W for pedestrian ingress

Strategy 6a has similar traffic operational impacts to that of strategy 5a that reduces one lane each direction along 5th Ave W. It is anticipated that strategy 6c will have a minimal impact to ingress traffic along 5th Ave W and at the 5th Ave W Ramp intersections. It would also help improve the pedestrian crossing along 5th Ave W over I-35. However, the egress traffic from the DECC would be impacted if the

dedicated lane for pedestrians is not reopened to vehicles prior to the event ending at the DECC. It's important to note that the dedicated bus lane may make transit options more amenable, which in turn potentially reduce vehicle traffic and congestion.

Strategy 6b refers to adding Park & Ride (P&R) shuttles to/from the Bayfront area. Potential P&R locations include the Miller Hill Mall, University of Minnesota Duluth Campus and downtown parking ramps. Existing regular route transit can also be utilized for the P&R strategy. As documented in **Appendix A**, the modeling assumes 5% vehicle modal reduction, while the actual modal reduction will depend on the P&R service scope and acceptance. **Table 17** shows that if the P&R strategy were to be implemented, systematic delay reduction can be expected from the entire Bayfront area.

Table 17 Intersection Delay and LOS based on Strategy Group #6 (Strategy 6b)

Intersections	Traffic Control	Delay (sec/veh)		LOS (A-F)		Hourly Entering Volume	
		Alt	Base	Alt	Base	Alt	Base
5th Ave & I-35 Westbound Ramp	Traffic Signal	37.1	37.7	D	D	1038	1052
5th Ave & I-35 Eastbound Ramp	Traffic Signal	34.7	39.4	C	D	1638	1704
Michigan St & 5th Ave	Traffic Signal	13.5	11.3	B	B	1316	1323
Michigan St & 6th Ave	All-way Stop	7.4	7.2	A	A	428	422
Railroad St & Ramp to Harbor Dr	Through/Stop	7.4	9.0	A	A	1817	1873
Harbor Dr & Ramp to Railroad St	Through/Stop	5.1	6.9	A	A	1374	1446
Harbor Dr & Railroad St	Through/Stop	2.2	2.5	A	A	1868	1932
Slip Ramp	Through/Stop	2.3	2.5	A	A	667	699
Bayfront Park Entrance & Railroad St	Through/Stop	18.5	19.9	C	C	1072	1125
Canal Park Dr & Railroad St	Traffic Signal	10.2	10.2	B	B	1245	1265
Lake Ave & Railroad St	Traffic Signal	6.6	7.1	A	A	986	1040
Lake Ave & I-35 Ramps	Traffic Signal	18.8	23.8	B	C	1544	1565
Canal Park Dr & Buchanan St	All-way Stop	7.5	7.7	A	A	469	478
Lake Ave & Buchanan St	Traffic Signal	2.2	2.9	A	A	462	480
Canal Park Dr & Morse St	All-way Stop	7.6	7.5	A	A	319	335
Garfield Ave & Railroad St	Through/Stop	10.0	16.2	A	C	996	1044
27th Ave & Courtland St	Through/Stop	1.5	1.6	A	A	28	28
27th Ave & I-35 Eastbound Ramp	Through/Stop	2.1	2.1	A	A	359	345
27th Ave & I-35 Westbound Ramp	Through/Stop	2.0	2.0	A	A	629	618

If one vehicle lane on northbound 5th Ave W is closed to allow better pedestrian inbound access (effectively wider sidewalk), minimal traffic operation impact is expected to adjacent intersection, as shown by **Table 18**. This lane is expected to open for the egress traffic. It's important to note that more vehicles are expected to park in downtown facilities if the pedestrian access along 5th Ave W is improved. This in turn reduces traffic congestions at the 5th Ave W / I-35 Ramp intersections.

Table 18 Intersection Delay and LOS based on Strategy Group #6 (Strategy 6c)

Intersections	Traffic Control	Delay (sec/veh)		LOS (A-F)		Hourly Entering Volume	
		Alt	Base	Alt	Base	Alt	Base
5th Ave & I-35 Westbound Ramp	Traffic Signal	38.9	37.7	D	D	1024	1052
5th Ave & I-35 Eastbound Ramp	Traffic Signal	40.5	39.4	D	D	1679	1704
Michigan St & 5th Ave	Traffic Signal	13.0	11.3	B	B	1319	1323
Railroad St & Ramp to Harbor Dr	Through/Stop	8.8	9.0	A	A	1891	1873
Harbor Dr & Ramp to Railroad St	Through/Stop	6.2	6.9	A	A	1432	1446
Harbor Dr & Railroad St	Through/Stop	2.5	2.5	A	A	1932	1932
Slip Ramp	Through/Stop	3.1	2.5	A	A	690	699
Bayfront Park Entrance & Railroad St	Through/Stop	19.7	19.9	C	C	1124	1125

If strategies 6a, 6b and 6c are combined, the traffic operations of adjacent intersections are expected to be similar to that of strategy 6a alone. Additionally, area traffic congestions are expected to be confined to the 5th Ave W / I-35 Ramp intersections mostly due to strategy 6b.

Strategy Group #7 System or Capacity Improvement

Strategy group #7 proposes big-picture strategies such as:

- a) Construct a parking ramp near the power plant off Railroad St and connect it with shuttle service
- b) Preferential or prepaid parking strategy
- c) Utilize apps to share information on events, traffic condition and parking availability

Strategy 7a constructs a 3-level parking ramp with approximately 170 spaces on the north/west side of Railroad St between Lake Ave and Harbor Dr. Minor traffic operation impacts to adjacent intersections are expected with this parking capacity addition, as shown by **Table 19**.

Table 19 Intersection Delay and LOS based on Strategy Group #7 (Strategy 7a)

Intersections	Traffic Control	Delay (sec/veh)		LOS (A-F)		Hourly Entering Volume	
		Alt	Base	Alt	Base	Alt	Base
5th Ave & I-35 Westbound Ramp	Traffic Signal	37.7	37.7	D	D	1031	1052
5th Ave & I-35 Eastbound Ramp	Traffic Signal	40.1	39.4	D	D	1688	1704
Michigan St & 5th Ave	Traffic Signal	13.6	11.3	B	B	1302	1323
Railroad St & Ramp to Harbor Dr	Through/Stop	8.3	9.0	A	A	1853	1873
Harbor Dr & Ramp to Railroad St	Through/Stop	5.5	6.9	A	A	1418	1446
Harbor Dr & Railroad St	Through/Stop	2.7	2.5	A	A	2000	1932
Slip Ramp	Through/Stop	3.6	2.5	A	A	725	699
Bayfront Park Entrance & Railroad St	Through/Stop	19.1	19.9	C	C	1120	1125
Canal Park Dr & Railroad St	Traffic Signal	9.9	10.2	A	B	1318	1265
Lake Ave & Railroad St	Traffic Signal	6.7	7.1	A	A	1106	1040
Lake Ave & I-35 Ramps	Traffic Signal	23.0	23.8	C	C	1626	1565
Garfield Ave & Railroad St	Through/Stop	18.4	16.2	C	C	1034	1044

Strategy 7b reserves the on-site parking capacity of Bayfront Park and DECC to prepaid customers and shifts a large percentage of parking demand (day-of-event parking circulation) from on-site parking to remote and downtown parking alternatives. **Table 20** indicates that this substantially improves traffic operations at most intersections in the Bayfront area.

Table 20 Intersection Delay and LOS based on Strategy Group #7 (Strategy 7b)

Intersections	Traffic Control	Delay (sec/veh)		LOS (A-F)		Hourly Entering Volume	
		Alt	Base	Alt	Base	Alt	Base
5th Ave & I-35 Westbound Ramp	Traffic Signal	28.8	37.7	C	D	887	1052
5th Ave & I-35 Eastbound Ramp	Traffic Signal	27.5	39.4	C	D	1320	1704
Michigan St & 5th Ave	Traffic Signal	8.3	11.3	A	B	1285	1323
Michigan St & 6th Ave	All-way Stop	8.1	7.2	A	A	484	422
Railroad St & Ramp to Harbor Dr	Through/Stop	4.2	9.0	A	A	1167	1873
Harbor Dr & Ramp to Railroad St	Through/Stop	2.9	6.9	A	A	959	1446
Harbor Dr & Railroad St	Through/Stop	2.3	2.5	A	A	1272	1932
Slip Ramp	Through/Stop	2.3	2.5	A	A	724	699
Bayfront Park Entrance & Railroad St	Through/Stop	11.6	19.9	B	C	779	1125
Canal Park Dr & Railroad St	Traffic Signal	10.0	10.2	B	B	990	1265
Lake Ave & Railroad St	Traffic Signal	6.4	7.1	A	A	765	1040
Lake Ave & I-35 Ramps	Traffic Signal	14.7	23.8	B	C	1277	1565
Canal Park Dr & Buchanan St	All-way Stop	7.7	7.7	A	A	470	478
Lake Ave & Buchanan St	Traffic Signal	2.3	2.9	A	A	456	480
Canal Park Dr & Morse St	All-way Stop	7.5	7.5	A	A	333	335
Garfield Ave & Railroad St	Through/Stop	3.3	16.2	A	C	819	1044

Even though it's difficult to quantify, Strategy 7c is expected to have a positive impact on the event traffic circulation at Bayfront area as well as the customer experience of parking.

Conclusions

The Bayfront Area event traffic analysis developed a base scenario to represent the typical busy event and test traffic operation at key intersections throughout the area based on developed strategies. While the actual event situation may differ from the modeled base scenario, the traffic operation evaluations based on the difference between base scenario and alternatives are applicable insights to evaluate the strategies.

Based on the planning level traffic analysis for the developed strategies to manage Bayfront area event traffic and parking, several key conclusions for vehicle traffic are drawn below:

- During typical large-scale Bayfront event ingress, LOS B or above is expected at all study intersections except:
 - I-35 Ramps / 5th Ave W intersections;
 - I-35 Ramps / Lake Ave intersection;
 - Bayfront Park Lot Entrance / Railroad St intersection;
 - Garfield Ave / Railroad St intersection.
- These intersections may experience occasional congestion during the peak event ingress hour, resulting overall LOS C or D.
- Since LOS D is considered acceptable traffic operation during peak hour based on Traffic Engineering best practice, even a substantial improvement to it may not be worth the financial and implementation challenges, as illustrated in **Table 21**. Therefore, the strategies included in strategy groups 5 and 7 that require significant incremental capital investment are not recommended for further considerations. These include strategies 5b, 5c, 5f, 5g, 5h and 7a.
- Some strategies within strategy groups 5 and 7 bear substantial merits based on the traffic and alternative analysis. They may be further analyzed, combined, and/or repackaged during the development of the long-term event management plan. Specifically,
 - Strategy 5a “Reconstruct roadway and sidewalk of 5th Ave W, potentially add bike lane” and strategy 5d “Reconfigure northbound 5th Ave W exit off I-35” can be repackaged into the future reconstruction of the 5th Ave W bridge.
 - Strategy 5e “Improve pedestrian and bicycle access in the area” will be further discussed in Memo #4. This includes, but not limited to, a potential pedestrian amenity upgrade on the portion of the Cross City Trail that connect Bayfront Park (near Railroad St) and downtown Duluth (near Michigan St).
 - Strategy 7b “Preferential or prepaid parking strategy” should be further explored for its implementation viability.
 - Strategy 7c “Utilize apps to share information on events, traffic condition and parking availability” should be considered as a long-term strategy.
- The strategies within strategy group 1, 2, 3, 4 and 6 should be further refined and evaluated during the development of long-term event management plan. Specifically,
 - If Harbor Dr and/or Lake Ave / Canal Park Dr pair were to be converted to one-way loop, clockwise direction is more favorable operationally than counter-clockwise direction. However, other factors such as impact to bus/shuttle operation, business access, etc. must be further evaluated in order to determine the favorability of converting Harbor Dr. and/or Lake Ave / Canal Park Dr pair to one-way loop(s).
 - In general, the reduction of roadway capacity along 5th Ave W for bike lane and wider sidewalk is not expected to create systematic traffic congestion beyond delay at selected movements of selected intersection. However, a detailed traffic impact analysis needs to be conducted in order to identify necessary intersection improvement due to the shift in traffic pattern and reduction in roadway capacity.

- Strategy 6a “Add dedicated bus lane via 5th Ave W and Harbor Dr” and strategy 6b “Add P&R shuttle option” can be combined to expand and/or refine the existing shuttle services (routes, frequency, etc.) and related amenities (dedicated bus lane, transit signal priority, etc.).

Since all adjacent intersections already perform at LOS D or better under typical large-scale event traffic demand, the strategies for traffic improvement in this memo are expected to only have moderate impact for traffic operation. Additional analysis on vehicle parking and wayfinding improvements is available in “Bayfront Area Event Parking and Wayfinding Analysis” memorandum (Memo #4).

Based on the traffic and alternative analysis, considerations for pedestrian, transit and bicycles are summarized below:

- Pedestrian
 - Strengthen marketing outreach for alternative transportation (e.g. Park & Walk);
 - Continue pedestrian control at Bayfront Park entrance on Harbor Dr;
 - Utilize one northbound vehicle lane on 5th Ave W bridge as additional sidewalk space during event ingress; or reconstruct and widen sidewalk on 5th Ave W bridge;
 - Add permanent/temporary pedestrian wayfinding signs along 5th Avenue W, Harbor Dr and inside the pedestrian skyway.
- Transit
 - Strengthen marketing outreach for alternative transportation (e.g. remote parking shuttles, local transits, etc.);
 - Continue the existing shuttle services for remote parking;
 - Continue the existing train services;
 - Consider adding dedicated bus lane via 5th Ave W and Harbor Dr;
 - Consider expanding Park & Ride options.
- Bicycle
 - Strengthen marketing outreach for alternative transportation (e.g. bicycle parking locations, bicycle routes, etc.);
 - Potentially add bike lane to 5th Ave W. Connection to other bike routes from 5th Ave W should be considered as well.

Additional analysis on pedestrian/bicycle wayfinding improvements is available in the “Bayfront Area Event Parking and Wayfinding Analysis” memorandum (Memo #4).

Bayfront Area Event Traffic Forecast and Alternatives Analysis Memorandum

March 29, 2019

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Table 21 Strategies and Their Favorability

Strategy Group	Strategy ID	Detailed Strategy	Evaluations		
			Traffic Improvement	Financial Feasibility	Implementation Viability
#1 Outreach & Minimal Traffic Management*	1a	Dynamic Message Sign wayfinding messages	Minimum	High	High
	1b	Marketing outreach for downtown parking options & alternative transportation			
	1c	Southbound left-turn lane on Railroad St at Bentleyville parking entrance			
	1d**	Move the train stop further south near the existing Cross City Trail crossing			
	1e**	Pedestrian control at Bentleyville entrance on Harbor Dr			
#2 Integrated Parking & Traffic Circulation Management	2a	Reduce processing time at parking entrances	Minimum	Moderate	High
	2b	Assign parking to reduce entrance queuing			
	2c	Utilize multiple parking facility (e.g. DECC) entrances			
	2d	Coordinate parking management and share facility occupancy during overlapping events			
	2e	Static freeway & local streets signs for downtown and Canal Park parking			
	2f	Traffic signs to split Bayfront Park and DECC traffic, utilize Harbor Dr, alternative parking entrance, and slip ramp			
#3 Traffic Operation Improvement	3a	Separate traffic exiting the NB/EB I-35/5th Avenue ramp to mitigate right turn congestion	Minimum	High	High
	3b	Add permanent/temporary pedestrian wayfinding signs along 5th Avenue, Harbor Dr and the pedestrian skyway			
	3c**	Improve signal timing of I-35 ramp terminal intersections at 5th Ave and Lake Ave			
#4 Circulation Improvement	4a	Change Harbor Dr to one-way flow	Minimum	High	Moderate
	4b	Change Canal Park Dr and Lake Ave to a one-way pair			
#5 Roadway or Network Improvement	5a**	Reconstruct roadway and sidewalk of 5th Ave, potentially add bike lane	Moderate	Low	Low
	5b	Connect Courtland St with Railroad St by a new Courtland St for event access			
	5c	Trailblaze event traffic via 27th Ave, Superior St, Garfield Ave and Railroad St			
	5d	Reconfigure northbound/eastbound 5th Ave exit off I-35			
	5e**	Improve pedestrian and bicycle access in the area			
	5f	Add additional access to frontage road to improve traffic flow at I-35 and 5th Ave W Ramp			
	5g	Add roadway capacity (thru lane and/or left/right turn lanes) to Railroad St south of Harbor Dr			
5h	Dedicated lane from I-35 with direct access to DECC parking ramp				
#6 Transit/Railroad Improvement	6a	Add dedicated bus lane via 5th Ave and Harbor Dr	Moderate	Moderate	Low
	6b	Add P&R shuttle option			
	6c**	Use one vehicle lane on 5th Ave for pedestrian ingress			
#7 System or Capacity Improvement	7a	Construct a parking ramp near the power plant off Railroad St and connect it with shuttle service	Significant	Low	Low
	7b	Preferential or prepaid parking strategy			
	7c	Utilize apps to share information on events, traffic condition and parking availability			

* Package #1 was implemented for 11/30 and 12/1 events as short-term improvement

** Pedestrian-related strategies



Appendix A Traffic Forecast with a Modified Travel Demand Model



MEMORANDUM

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Yilun Xu, PE
Alliant Engineering, Inc

From: Haifeng Xiao, PE, PTOE
HFTE Inc

Date: March 18, 2019

Subject: Traffic Circulation, Modeling & Control Plan for I-35/Bayfront/DECC/Canal Park Study
Traffic Forecast with a Modified Travel Demand Model

OVERVIEW

The Canal Park is one of the major attractions for visitors to the City of Duluth each year. In its immediate vicinity, the Duluth Entertainment Convention Center (DECC), Bayfront Festival Park, AMSOIL arena, and Great Lakes Aquarium host numerous events throughout the year. During high-turnout events, significant congestion and traffic delay have become increasingly common on the roadways and in nearby parking facilities.

The main goal of this study is to reduce congestion and delays for the traffic into and out of the area during such events by using technology, traffic control and potential geometric changes to the local roadway system. Both short-term and long-term strategic scenarios have been developed and analyzed to help identify and address the issues in the area. **Figure 1** illustrates the study area location.

The Metropolitan Interstate Council (MIC) Travel Demand Model was used to develop traffic forecasts for strategic scenarios that would result in traffic route changes in the study area. The purpose of this memorandum is to document the traffic forecast assumptions, methodology and results.

STUDY INTERSECTIONS

Below is the list of the study intersections. They are also illustrated in **Figure 1**.

- Lake Avenue/Superior Street
- Lake Avenue/I-35 Single Point Interchange Ramps
- Canal Park Drive/Rail Road Street
- Canal Park Drive/Buchanan Street
- Canal Park Drive/Morse Street
- Lake Avenue/Railroad Street
- Lake Avenue/Buchanan St
- Lake Avenue/Morse St

- Harbor Drive/Northbound I-35 CD Road Slip Ramp
- Harbor Drive/Railroad Street
- 5th Avenue/Superior Street
- 5th Avenue/Michigan Street
- 5th Avenue/Southbound I-35 Ramps
- 5th Avenue/Harbor Drive/Northbound I-35 CD Road
- Harbor Drive/Railroad Street-Harbor Road Loop Connection
- Railroad Street/Railroad Street-Harbor Road Loop Connection
- 6th Avenue/Superior Street
- 6th Avenue/Michigan Street
- Railroad Street/Bayfront Parking Lot
- Garfield Avenue/Railroad Street
- 27th Avenue/Southbound I-35 Ramps
- 27th Avenue/Northbound I-35 Ramps
- 27th Avenue/Courtland Street

LONG-TERM STRATEGIES AND MIC MODELING SCENARIOS

Based on the strategies recommended in the RFP, the project team developed a few long-term strategy groups with detailed strategies including, but not limited to, new roadway connections, lane/road closures, one-way lane configurations, parking capacity changes and/or redistributions within the study area. **Table 1** summarizes the long-term strategy groups and detailed strategies. The strategies were re-grouped into a number of scenarios for traffic forecast analysis using the MIC model. The rightmost column in **Table 1** includes the modeling scenarios with the numbers indicating modeling ranking priorities with #1 as the highest. It is noted that a few strategies are not applicable for quantitative analysis using the MIC model and thus are not included in this traffic forecast memorandum.

Table 1
Long-Term Strategies and MIC Modeling Scenarios

Strategy Group	Strategy ID	Detailed Strategy	MIC Modeling Assumption	MIC Modeling Scenarios*
#1 Outreach & Minimal Traffic Management	1a	Freeway DMS wayfinding messages	The "Event Base" scenario	S00
	1b	Marketing outreach for downtown parking options & alternative transportation		
	1c	Southbound left-turn lane on Railroad St at Bentleyville parking entrance		
	1d	Move the train stop further south near the existing Superior Hiking Trail crossing		
	1e	Pedestrian control at Bentleyville entrance on Harbor Dr		
#2 Integrated Parking & Traffic Circulation Management	2a	Reduce processing time at parking entrances		
	2b	Assign parking to reduce entrance queuing		
	2c	Utilize multiple parking facility (e.g. DECC) entrances		
	2d	Coordinate parking management and share facility occupancy during overlapping events		
	2e	Static freeway & local streets signs for downtown and Canal Park parking	10% parking reduction @ Bayfront Park and DECC lots, which only applies to routes via I-35 (both directions) and SB 5th Ave	S10
	2f	Traffic signs to split Bayfront Park and DECC traffic, utilize Harbor Dr, alternative parking entrance, and slip ramp	Increase the utilization of east DECC parking entrance to 40% and decrease the north to 60% - compared to 80/20 now	
#3 Traffic Operation Improvement	3a	Separate traffic exiting the NB/EB I-35/5th Avenue ramp to mitigate right turn congestion		
	3b	Add permanent/temporary pedestrian wayfinding signs along 5th Avenue, Harbor Dr and the pedestrian skyway		
	3c	Improve signal timing of I-35 ramp terminal intersections at 5th Ave and Lake Ave		
#4 Circulation Improvement	4a	Change Harbor Dr to one-way flow	Have two sets of volumes based on two directions of one way Harbor Dr.	S01-clockwise, S02-counterclockwise
	4b	Change Canal Park Dr and Lake Ave to a one-way pair	Have two sets of volumes based on two directions of one way Lake/Canal Park Dr.	S03-clockwise, S04-counterclockwise
#5 Roadway or Network Improvement	5a	Reconstruct roadway and sidewalk of 5th Ave, add bike lane potentially	Change 5th Ave to one lane each direction to accommodate bike lane and wider sidewalks	S05
	5b	Connect Courtland St with Railroad St by a new Courtland St for event access	Add this link	S12
	5c	Trailblaze event traffic via 27th Ave, Michigan St, Superior St, Garfield Ave and Railroad St	Shift 5% of "EB I-35 to 5th Ave" route to this route	
	5d	Reconfigure northbound/eastbound 5th Ave exit of I-35		
	5e	Improve pedestrian and bicycle access in the area		
	5f	Add additional access to frontage road to improve traffic flow between I-35	Add this link for EB I-35	S06
	5g	Add roadway capacity (thru lane and/or left/right turn lanes) to Railroad St south of Harbor Dr		
	5h	Dedicated lane from I-35 with direct access to DECC parking ramp	Add this link	S07
#6 Transit/Railroad Improvement	6a	Add dedicated bus lane via 5th Ave and Harbor Dr		same as #S05
	6b	Add P&R shuttle option	Reduce all parking demand by 5%	S11
	6c	Use one vehicle lane on 5th Ave for pedestrian ingress		same as #S05
#7 System or Capacity Improvement	7a	Construct a parking ramp near the power plant off Railroad St and connect it with shuttle service	Add one special generator of 170 capacity. Reduce all other parking capacity by 5%	S08
	7b	Preferential or prepaid parking strategy	Reduce DECC and Bayfront Park (excluding Garfield lot) parking by 50%; increase the downtown parking by 20%	S09
	7c	Utilize apps to share information on events, traffic condition and parking availability		

*Strategies not applicable for MIC analysis are left blank

MIC MODELING ASSUMPTIONS, METHODOLOGY AND STEPS

The latest MIC model in Cube as of 9/15/2018 was used for traffic forecast analysis for this study. It is noted that the MIC model is designed for daily traffic forecasts and is calibrated and validated using the average daily traffic volumes while this study is intended to analyze traffic conditions during events in the study area. The event trips are not included in the current MIC model. Therefore, a few assumptions would need to be made in order to use the MIC model for this study. The major assumptions are summarized below:

- It is acknowledged that the MIC model is not directly applicable for peak hour traffic forecasts. It was assumed the daily traffic route changes and relative volume changes due to different long-term strategies were comparable to peak hour results, and thus the relative daily changes in MIC model were used to estimate the peak hour traffic changes for this study.
- All the traffic, including the event trips, would be on their shortest paths when assignment equilibrium was achieved for all the modeling scenarios that were analyzed in this study.
- The parking lots available for the events in the study area were added to the MIC model as special generators. The parking spaces available for event trips were used for the trip generations entering and exiting the parking lots. The existing parking facilities in the study area were combined and grouped into seven special generators and a new special generator was added for the modeling Scenario 8 (S8). **Figure 2** illustrates the special generator locations coded in the MIC model. **Table 2** below summarizes the available event parking spaces at those locations for all the twelve scenarios.

Table 2
Available Event Parking Spaces for Different MIC Modeling Scenarios

#	Location	Available Event Parking Spaces				
		S1	S2	S3	S4	S5
1	DECC Ramp	1,422	1,351	712	1,280	1,351
2	Bayfront Park Lot	450	428	225	405	428
3	Aquarium Lot	117	111	117	117	111
4	Michigan St Garage/Vicinity	495	470	594	495	470
5	Transit Center Lot	279	265	335	279	265
6	Canal Park Lots	360	342	360	360	342
7	Garfield Ave Lot	315	299	315	315	299
8*	New Lot in NW of Lake/Railroad		170			
Total available parking spaces for events		3,438	3,436	2,658	3,251	3,266
Applicable modeling scenarios		S1-S7 & S12	S8	S9	S10	S11

*Proposed new parking lot, only applicable for S8

- The distributions of the event vehicular trips were not available. Therefore, the event trips distributions were estimated based on the distributions of the household data in the MIC model. The TAZs (Traffic Analysis Zones) within 1.5 miles of the DECC were excluded in the process assuming that these event trips wouldn't drive and park to participate the events. The event trip distributions are illustrated in **Figure 2** as well.

Based on the assumptions, a Cube application was developed in the current MIC model to develop traffic forecasts under the base conditions and different long-term strategies conditions. **Figure 3** illustrates the

flowchart for the DECC study application based on the current MIC model. The traffic forecasts for the base and build scenarios during the event were developed following the steps below:

- The MIC 2018 and 2045 model inputs were reviewed. The review revealed that there was not much growth in the MIC area, and therefore the 2018 model was used for this study.
- The PM peak hour traffic from the MIC model under the base No Build conditions were validated by comparing the queues in the Synchro model using the MIC model results and the actual queues observed during the events in December 2018.
- The twelve long-term modeling scenarios and corresponding networks were developed based on the strategies previously described. The models were run and the background daily traffic and event traffic assignment results were reported separately in Cube.
- The daily traffic relative percentile changes between the build and base scenarios were applied to the actual peak hour non-event counts to develop background traffic forecasts under different modeling scenarios. The traffic forecasts were developed at the segment level at this level of analysis.
- The forecasted background traffic volumes were ultimately combined with the event trip assignment results to develop the final event traffic forecasts under different long-term strategy scenarios.

TRAFFIC FORECAST RESULTS

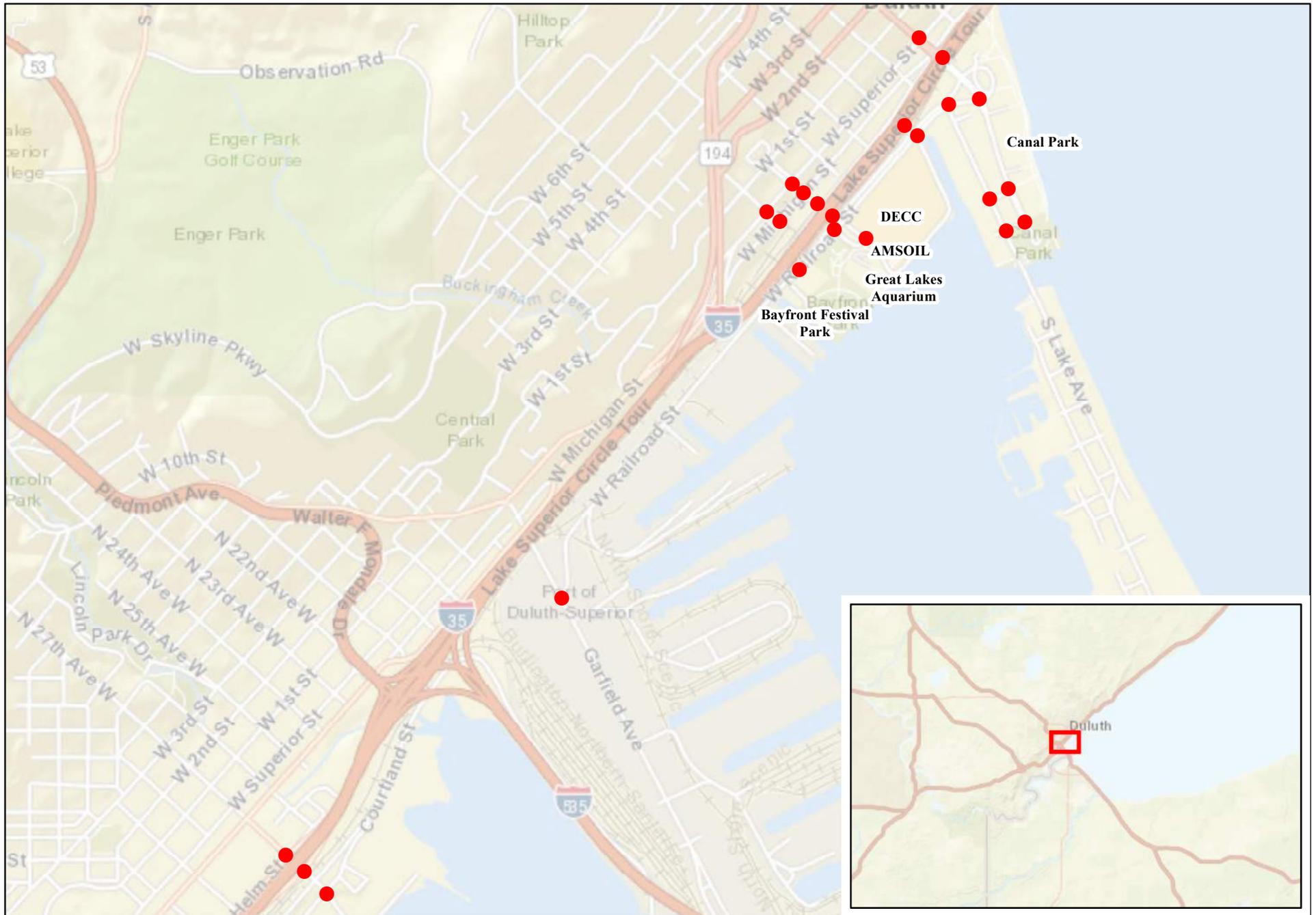
Based on the assumptions, methodology and steps described in the previous section, the traffic forecasts were developed for the base scenario at the turning movement level and for the twelve long-term build scenarios at segment level.

Appendix 0_1 summarizes the existing PM peak hour traffic TM counts at the key study intersections without events.

Appendix 0_2 summarizes the event inbound traffic TM assignment results at the key study intersections in the MIC model.

Appendix 0_3 summarizes the combined background and event traffic TMs during peak hour. They are also summarized at segment levels used as the base for build traffic forecasts.

Appendices 1 through 12 summarize the segment level traffic forecasts at the study intersections respectively for the Build Scenarios 1 through 12 and the ratios to the base No Build.

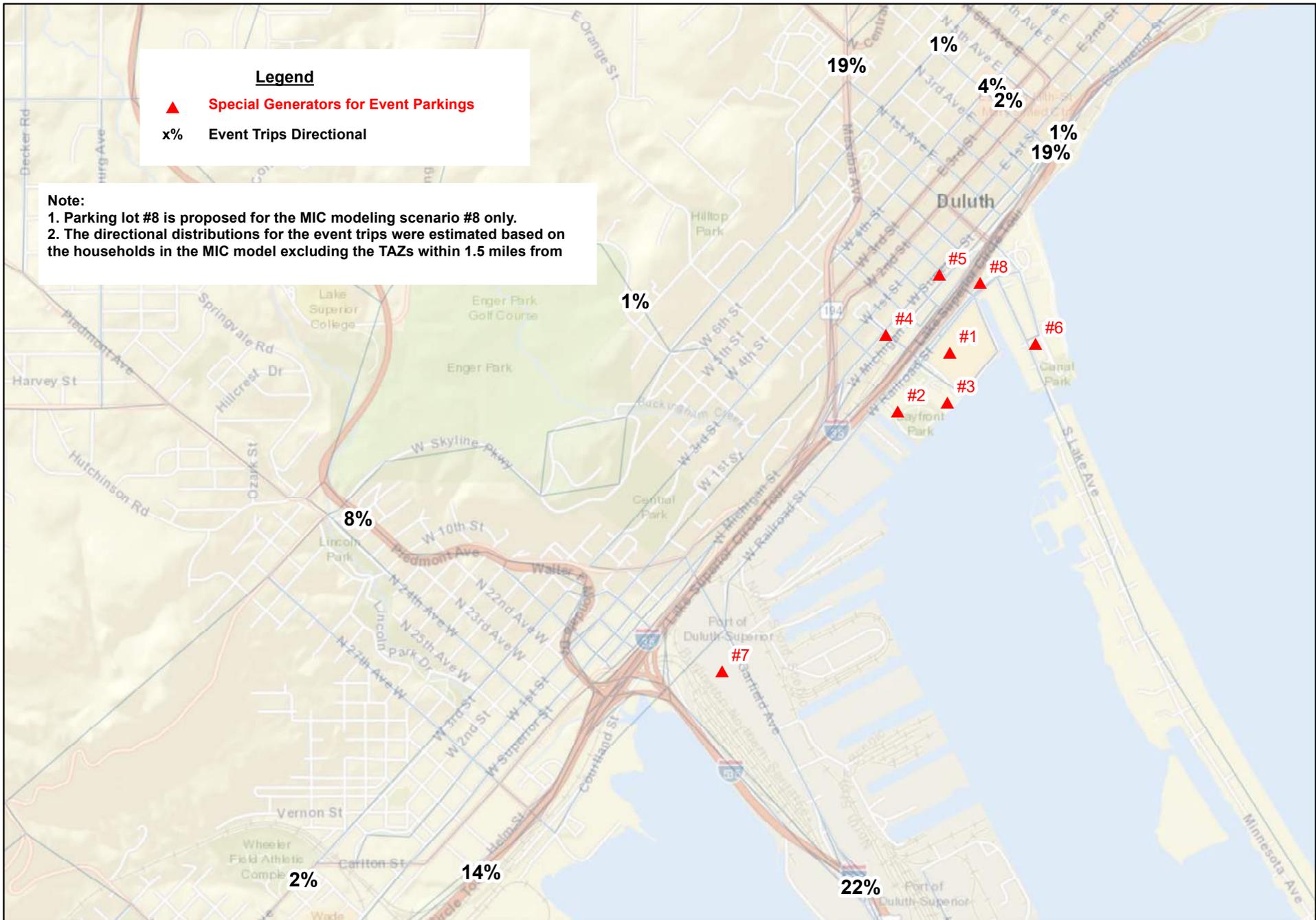


Author: :HXIAO
 Date: 1/30/2019

Study Location in MIC and Study Intersections

**I-35/Bayfront Area/DECC/Canal Park Traffic Circulation and Modeling Study
 City of Duluth, MN**

**Figure
 1**

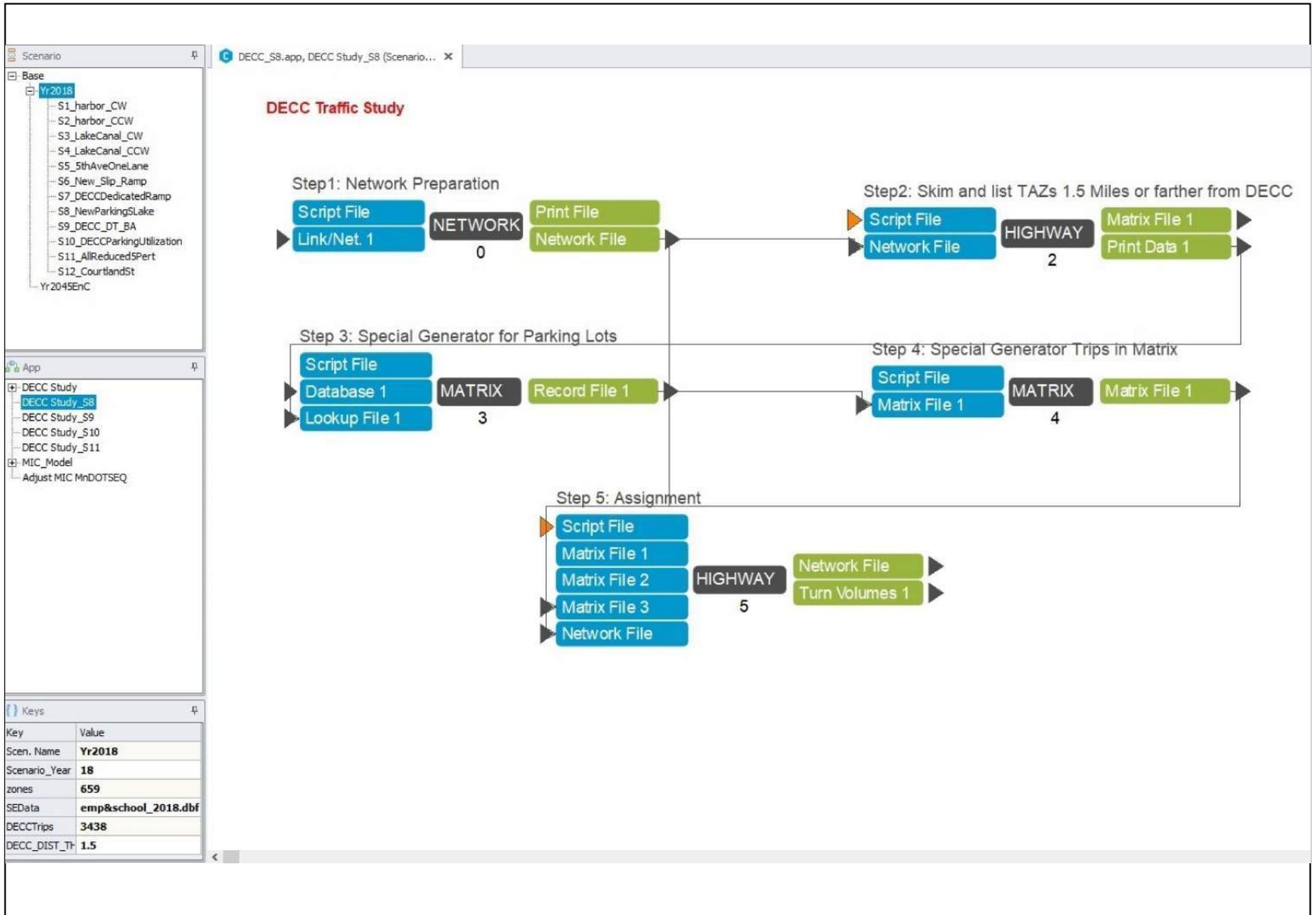


Author: :HXIAO
Date: 1/30/2019

Event Trips Parking Locations and Directional Distributions

**I-35/Bayfront Area/DECC/Canal Park Traffic Circulation and Modeling Study
City of Duluth, MN**

**Figure
2**



Author: :HXIAO
 Date: 1/30/2019

DECC Event Trips Distribution and Assignment Application in Cube

**I-35/Bayfront Area/DECC/Canal Park Traffic Circulation and Modeling Study
 City of Duluth, MN**

**Figure
 3**

Appendix 0_1
Non Event Peak Hour Actual Counts

Intersection	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR
Lake Avenue/Superior Street	52	95	72	10	81	27	33	141	88	85	157	10
Lake Avenue/I-35 Single Point Intersection	128	34	146	85	74	95	128		80	52		57
Canal Park Drive/Rail Road Street	28	175	5	30	44	132	123	12	8	5	7	10
Canal Park Drive/Buchanan Street	10	78			30	27	130		20			
Canal Park Drive/Morse Street		40			50		48		10			
Lake Avenue/Railroad Street	10	5	70	20	3	3	5	53	5	22	140	5
Lake Avenue/Buchanan St	10	59	140	5	25		10	5	10	16	5	16
Lake Avenue/Morse St	5	209	58		46	5						
Harbor Drive/Northbound I-35 CD Road Slip Ramp								208	15			
Harbor Drive/Railroad Street	7		31	5	4	6		27	4	85	68	
5th Avenue/Superior Street	40	33	21	24	67	27	27	210	27	36	164	21
5th Avenue/Michigan Street		46	15	25	105		48	77	19			
5th Avenue/Southbound I-35 Ramps	62	45			85	39				7	14	16
5th Avenue/Harbor Drive/Northbound I-35 CD Road		93	41	66	26		14	218	20			
Harbor Drive/Railroad Street-Harbor Road Loop Connection	46	47			21	25	87		17			
Railroad Street/Railroad Street-Harbor Road Loop Connection	61		10					21	44	60	21	
6th Avenue/Superior Street				53	36	46	15	211	27	27	174	30
6th Avenue/Michigan Street			2	88	2			54				
Railroad Street/Bayfront Parking Lot								65	5	5	77	
Garfield Avenue/Railroad Street	1	5	4	133	5	1	58	2	3	2		1
27th Avenue/Southbound I-35 Ramps	7	78			184	105				10	12	168
27th Avenue/Northbound I-35 Ramps		4	4	187	7		81	2	3			
27th Avenue/Courtland Street	1	1	2	3	2	5	5		1	1	1	2

Appendix 0_2

Event Inbound Traffic Assignment in Base Scenario

Intersection	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR
Lake Avenue/Superior Street	1	0	0	0	107	0	0	0	0	202	22	0
Lake Avenue/I-35 Single Point Intersection	0	1	0	0	309	0	0	0	0	357	0	0
Canal Park Drive/Rail Road Street	0	1			187	480	0		0			
Canal Park Drive/Buchanan Street	0	1			187	0	0		0			
Canal Park Drive/Morse Street	0	0	0	0	187	0	1	0	0	0	0	0
Lake Avenue/Railroad Street	12		0					0	172	0	480	
Lake Avenue/Buchanan St		12	0	0	172					0		0
Lake Avenue/Morse St	0	12	1	0	172	0	0	0	0	0	0	0
Harbor Drive/Northbound I-35 CD Road Slip Ramp								0	156			
Harbor Drive/Railroad Street	0		0	97	59	0	0	74	44	111	381	
5th Avenue/Superior Street	0	0	1	0	6	0	0	17	1	537	0	0
5th Avenue/Michigan Street		1	194	155	388		0	16	31			
5th Avenue/Southbound I-35 Ramps	0	102			420	0				203	0	93
5th Avenue/Harbor Drive/Northbound I-35 CD Road		2	0	8	615		100	148	384			
Harbor Drive/Railroad Street-Harbor Road Loop Connection	0	0			92	907	2		24			
Railroad Street/Railroad Street-Harbor Road Loop Connection	334		573					378	24	2	4	
6th Avenue/Superior Street	0	0	0	18	77	0	0	0	0	0	0	0
6th Avenue/Michigan Street		0	0	77	0		0	211	0			
Railroad Street/Bayfront Parking Lot	0	0	0	0	0	0	0	403	178	272	66	0
Garfield Avenue/Railroad Street		0	500	81	177					66		0
27th Avenue/Southbound I-35 Ramps	0	0			64	0				0	0	0
27th Avenue/Northbound I-35 Ramps		0	0	64	0		0	0	0			
27th Avenue/Courtland Street				0		0	0	0			0	0

Appendix 0_3

Combined Background + Event Traffic for the Base Scenario

Intersection	NBL			NBT			NBR			SBL			SBT			SBR			EBL			EBT			EBR			WBL			WBT			WBR			South Leg		North Leg		West Leg		East Leg	
	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR	NB_in	SB_out	SB_in	NB_out	EB_in	WB_out	WB_in	EB_out																								
Lake Avenue/Superior Street	53	95	72	10	188	27	33	141	88	287	179	10	220	563	225	138	262	259	476	223																								
Lake Avenue/I-35 Single Point Intersection	128	35	146	85	383	95	128		80	409		57	309	872	563	220	208	223	466	231																								
Canal Park Drive/Rail Road Street	28	176	5	30	231	612	123	12	8	5	7	10	209	244	873	309	143	647	22	47																								
Canal Park Drive/Buchanan Street	10	79			217	27	130		20				89	237	244	209	150	37																										
Canal Park Drive/Morse Street		40			237		49		10				40	247	237	89	59																											
Lake Avenue/Railroad Street	22	5	70	20	3	3	5	53	177	22	620	5	97	202	26	15	235	645	647	143																								
Lake Avenue/Buchanan St	10	71	140	5	197		10	5	10	16	5	16	221	223	202	97	25	15	37	150																								
Lake Avenue/Morse St	5	221	59		218	5							285	218	223	221		10		59																								
Harbor Drive/Northbound I-35 CD Road Slip Ramp								208	171					171			379			208																								
Harbor Drive/Railroad Street	7		31	102	63	6		101	48	196	449		38	307	171		149	462	645	234																								
5th Avenue/Superior Street	40	33	22	24	73	27	27	227	28	573	164	21	95	674	124	81	282	231	758	273																								
5th Avenue/Michigan Street		47	209	180	493		48	93	50				256	543	673	95	191			482																								
5th Avenue/Southbound I-35 Ramps	62	147			505	39				210	14	109	209	715	544	256		115	333	0																								
5th Avenue/Harbor Drive/Northbound I-35 CD Road		95	41	74	641		114	366	404				136	1045	715	209	884			481																								
Harbor Drive/Railroad Street-Harbor Road Loop Connection	46	47			113	932	89		41				93	154	1045	136	130	978																										
Railroad Street/Railroad Street-Harbor Road Loop Connection	395		583					399	68	62	25		978	130			467	420	87	982																								
6th Avenue/Superior Street				71	113	46	15	211	27	27	174	30		167	230	45	253	220	231	282																								
6th Avenue/Michigan Street			2	165	2			265					2	2	167		265			432																								
Railroad Street/Bayfront Parking Lot								468	183	277	143			460			651	143	420	468																								
Garfield Avenue/Railroad Street	1	5	504	214	182	1	58	2	3	68		1	510	253	397	64	63	2	69	720																								
27th Avenue/Southbound I-35 Ramps	7	78			248	105				10	12	168	85	258	353	246		124	190	0																								
27th Avenue/Northbound I-35 Ramps		4	4	251	7		81	2	3				8	10	258	85	86			257																								
27th Avenue/Courtland Street	1	1	2	3	2	5	5		1	1	1	2	4	4	10	8	6	7	4	5																								

Appendix 1

Segment Level Peak Hour Traffic Forecasts for S1: Harbor Drive One-Way (Clockwise)

Intersection	Build combined Non Event + Event Inbound Traffic								Build/Base Ratio							
	South Leg		North Leg		West Leg		East Leg		South Leg		North Leg		West Leg		East Leg	
	NB_in	SB_out	SB_in	NB_out	EB_in	WB_out	WB_in	EB_out	NB_in	SB_out	SB_in	NB_out	EB_in	WB_out	WB_in	EB_out
Lake Avenue/Superior Street	221	605	244	135	263	258	497	228	1.00	1.07	1.09	0.98	1.00	0.99	1.04	1.02
Lake Avenue/I-35 Single Point Intersection	307	934	604	221	209	225	490	230	0.99	1.07	1.07	1.00	1.00	1.01	1.05	1.00
Canal Park Drive/Rail Road Street	206	244	934	307	145	708	22	47	0.98	1.00	1.07	0.99	1.01	1.09	1.00	1.00
Canal Park Drive/Buchanan Street	86	237	244	206	150	37			0.96	1.00	1.00	0.98	1.00	1.00		
Canal Park Drive/Morse Street	40	247	237	86	56				1.00	1.00	1.00	0.96	0.95			
Lake Avenue/Railroad Street	100	202	26	15	233	706	708	145	1.03	1.00	1.00	1.00	0.99	1.09	1.09	1.01
Lake Avenue/Buchanan St	224	223	202	100	25	15	37	150	1.01	1.00	1.00	1.03	1.00	1.00	1.00	1.00
Lake Avenue/Morse St	285	218	223	224		10		56	1.00	1.00	1.00	1.01		1.01		0.95
Harbor Drive/Northbound I-35 CD Road Slip Ramp		203			412			209		1.19			1.09			1.00
Harbor Drive/Railroad Street	0	425	203		173	462	707	232	0.00	1.38	1.19		1.16	1.00	1.10	0.99
5th Avenue/Superior Street	99	641	123	81	280	231	730	278	1.04	0.95	0.99	1.00	0.99	1.00	0.96	1.02
5th Avenue/Michigan Street	243	511	641	100	209			482	0.95	0.94	0.95	1.05	1.09			1.00
5th Avenue/Southbound I-35 Ramps	198	654	512	243		118	305	0	0.95	0.92	0.94	0.95		1.03	0.92	
5th Avenue/Harbor Drive/Northbound I-35 CD Road	138	952	654	198	874			516	1.01	0.91	0.92	0.95	0.99			1.07
Harbor Drive/Railroad Street-Harbor Road Loop Connection	95	0	952	138	105	982			1.02	0.00	0.91	1.01	0.81	1.00		
Railroad Street/Railroad Street-Harbor Road Loop Connection	982	105			467	419	87	1012	1.00	0.81			1.00	1.00	1.00	1.03
6th Avenue/Superior Street		165	227	41	253	220	231	280		0.99	0.99	0.90	1.00	1.00	1.00	0.99
6th Avenue/Michigan Street	2	2	165		283			452	1.00	1.00	0.99		1.07			1.05
Railroad Street/Bayfront Parking Lot		460			650	142	419	467		1.00			1.00	0.99	1.00	1.00
Garfield Avenue/Railroad Street	511	253	398	66	63	2	68	719	1.00	1.00	1.00	1.03	1.00	1.00	0.98	1.00
27th Avenue/Southbound I-35 Ramps	85	258	353	246		124	190		1.00	1.00	1.00	1.00		1.00	1.00	
27th Avenue/Northbound I-35 Ramps	8	10	258	85	86			257	1.00	1.00	1.00	1.00	1.00			1.00
27th Avenue/Courtland Street	4	4	10	8	6	7	4	5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

*Highlighted if ratio is equal or less than 1.00

Appendix 2

Segment Level Peak Hour Traffic Forecasts for S2: Harbor Drive One-Way (Counter-Clockwise)

Intersection	Build combined Non Event + Event Inbound Traffic								Build/Base Ratio							
	South Leg		North Leg		West Leg		East Leg		South Leg		North Leg		West Leg		East Leg	
	NB_in	SB_out	SB_in	NB_out	EB_in	WB_out	WB_in	EB_out	NB_in	SB_out	SB_in	NB_out	EB_in	WB_out	WB_in	EB_out
Lake Avenue/Superior Street	218	507	209	137	263	262	437	222	0.99	0.90	0.93	0.99	1.00	1.01	0.92	1.00
Lake Avenue/I-35 Single Point Intersection	311	765	508	218	205	232	424	233	1.00	0.88	0.90	0.99	0.99	1.04	0.91	1.01
Canal Park Drive/Rail Road Street	206	244	765	311	148	539	22	47	0.98	1.00	0.88	1.00	1.03	0.83	1.00	1.00
Canal Park Drive/Buchanan Street	86	237	244	206	150	37			0.96	1.00	1.00	0.98	1.00	1.00		
Canal Park Drive/Morse Street	40	247	237	86	56				1.00	1.00	1.00	0.96	0.95			
Lake Avenue/Railroad Street	100	202	26	15	237	537	539	148	1.03	1.00	1.00	1.00	1.01	0.83	0.83	1.03
Lake Avenue/Buchanan St	224	223	202	100	25	15	37	150	1.01	1.00	1.00	1.03	1.00	1.00	1.00	1.00
Lake Avenue/Morse St	285	218	223	224		10		56	1.00	1.00	1.00	1.01		1.00		0.95
Harbor Drive/Northbound I-35 CD Road Slip Ramp		112			317			205		0.65			0.84			0.99
Harbor Drive/Railroad Street	40	0	112		105	466	537	236	1.04	0.00	0.65		0.70	1.01	0.83	1.01
5th Avenue/Superior Street	103	728	128	81	281	231	809	281	1.08	1.08	1.03	1.00	1.00	1.00	1.07	1.03
5th Avenue/Michigan Street	252	599	727	103	200			477	0.98	1.10	1.08	1.08	1.05			0.99
5th Avenue/Southbound I-35 Ramps	206	826	600	253		113	386	0	0.98	1.15	1.10	0.99		0.98	1.16	
5th Avenue/Harbor Drive/Northbound I-35 CD Road	134	1214	825	206	879			419	0.99	1.16	1.15	0.98	0.99			0.87
Harbor Drive/Railroad Street-Harbor Road Loop Connection	0	368	1214	134	179	977			0.00	2.39	1.16	0.99	1.37	1.00		
Railroad Street/Railroad Street-Harbor Road Loop Connection	977	180			468	421	93	937	1.00	1.38			1.00	1.00	1.07	0.95
6th Avenue/Superior Street		165	227	37	253	220	231	280		0.99	0.99	0.81	1.00	1.00	1.00	0.99
6th Avenue/Michigan Street	2	2	165		269			443	1.00	1.00	0.99		1.02			1.03
Railroad Street/Bayfront Parking Lot		460			651	143	420	468		1.00			1.00	1.00	1.00	1.00
Garfield Avenue/Railroad Street	507	252	396	61	63	2	69	720	0.99	1.00	1.00	0.95	1.00	1.00	1.00	1.00
27th Avenue/Southbound I-35 Ramps	85	258	353	246		124	190		1.00	1.00	1.00	1.00		1.00	1.00	
27th Avenue/Northbound I-35 Ramps	8	10	258	85	86			257	1.00	1.00	1.00	1.00	1.00			1.00
27th Avenue/Courtland Street	4	4	10	8	6	7	4	5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

*Highlighted if ratio is equal or less than 1.00

Appendix 3

Segment Level Peak Hour Traffic Forecasts for S3: Lake Ave/Cannal Dr. One-Way (Clockwise)

Intersection	Build combined Non Event + Event Inbound Traffic								Build/Base Ratio							
	South Leg		North Leg		West Leg		East Leg		South Leg		North Leg		West Leg		East Leg	
	NB_in	SB_out	SB_in	NB_out	EB_in	WB_out	WB_in	EB_out	NB_in	SB_out	SB_in	NB_out	EB_in	WB_out	WB_in	EB_out
Lake Avenue/Superior Street	220	567	225	139	263	259	479	222	1.00	1.01	1.00	1.01	1.00	1.00	1.01	1.00
Lake Avenue/I-35 Single Point Intersection	279	875	567	220	208	194	467	232	0.90	1.00	1.01	1.00	1.00	0.87	1.00	1.01
Canal Park Drive/Rail Road Street	0	541	876	279	619	645	22	47	0.00	2.22	1.00	0.90	4.33	1.00	1.00	1.00
Canal Park Drive/Buchanan Street	0	497	541	0	75	75			0.00	2.10	2.22	0.00	0.50	2.02		
Canal Park Drive/Morse Street	40	418	497	0	0				1.00	1.69	2.10	0.00	0.00			
Lake Avenue/Railroad Street	311	0	26	15	229	673	645	619	3.20	0.00	1.00	1.00	0.98	1.04	1.00	4.33
Lake Avenue/Buchanan St	359	0	0	311	25	15	112	112	1.63	0.00	0.00	3.20	1.00	1.00	3.02	0.75
Lake Avenue/Morse St	285	46	0	359		10		0	1.00	0.21	0.00	1.62		1.00		0.00
Harbor Drive/Northbound I-35 CD Road Slip Ramp		165			373			208		0.97			0.99			1.00
Harbor Drive/Railroad Street	38	306	165		149	490	673	229	1.00	1.00	0.97		1.00	1.06	1.04	0.98
5th Avenue/Superior Street	99	675	123	81	282	231	762	279	1.04	1.00	0.99	1.00	1.00	1.00	1.01	1.02
5th Avenue/Michigan Street	237	541	676	99	209			482	0.93	1.00	1.00	1.04	1.09			1.00
5th Avenue/Southbound I-35 Ramps	221	712	541	236		149	335	0	1.06	1.00	1.00	0.92		1.30	1.01	
5th Avenue/Harbor Drive/Northbound I-35 CD Road	166	1049	712	221	867			475	1.22	1.00	1.00	1.06	0.98			0.99
Harbor Drive/Railroad Street-Harbor Road Loop Connection	93	154	1049	166	160	982			1.00	1.00	1.00	1.22	1.23	1.00		
Railroad Street/Railroad Street-Harbor Road Loop Connection	982	160			466	420	117	985	1.00	1.23			1.00	1.00	1.34	1.00
6th Avenue/Superior Street		161	223	32	254	220	231	283		0.96	0.97	0.71	1.01	1.00	1.00	1.00
6th Avenue/Michigan Street	2	2	161		278			452	1.00	1.00	0.96		1.05			1.05
Railroad Street/Bayfront Parking Lot		460			649	142	419	466		1.00			1.00	0.99	1.00	1.00
Garfield Avenue/Railroad Street	514	252	397	70	63	2	68	718	1.01	1.00	1.00	1.09	1.00	1.00	0.99	1.00
27th Avenue/Southbound I-35 Ramps	85	257	352	246		124	190		1.00	1.00	1.00	1.00		1.00	1.00	
27th Avenue/Northbound I-35 Ramps	8	10	257	85	86			256	1.00	1.00	1.00	1.00	1.00			1.00
27th Avenue/Courtland Street	4	4	10	8	6	7	4	5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

*Highlighted if ratio is equal or less than 1.00

Appendix 4

Segment Level Peak Hour Traffic Forecasts for S4: Lake Ave/Cannal Dr. One-Way (Counter-Clockwise)

Intersection	Build combined Non Event + Event Inbound Traffic								Build/Base Ratio							
	South Leg		North Leg		West Leg		East Leg		South Leg		North Leg		West Leg		East Leg	
	NB_in	SB_out	SB_in	NB_out	EB_in	WB_out	WB_in	EB_out	NB_in	SB_out	SB_in	NB_out	EB_in	WB_out	WB_in	EB_out
Lake Avenue/Superior Street	213	563	231	138	263	259	470	216	0.97	1.00	1.03	1.00	1.00	1.00	0.99	0.97
Lake Avenue/I-35 Single Point Intersection	355	874	563	213	201	265	467	233	1.15	1.00	1.00	0.97	0.97	1.19	1.00	1.01
Canal Park Drive/Rail Road Street	315	0	874	355	141	1074	22	47	1.51	0.00	1.00	1.15	0.98	1.66	1.00	1.00
Canal Park Drive/Buchanan Street	182	0	0	315	164	5			2.04	0.00	0.00	1.51	1.10	0.14		
Canal Park Drive/Morse Street	40	60	0	182	161				1.00	0.24	0.00	2.04	2.73			
Lake Avenue/Railroad Street	0	569	26	15	236	602	1074	141	0.00	2.82	1.00	1.00	1.00	0.93	1.66	0.98
Lake Avenue/Buchanan St	0	538	569	0	25	15	23	201	0.00	2.41	2.82	0.00	1.00	1.00	0.61	1.34
Lake Avenue/Morse St	285	404	538	0		10		161	1.00	1.85	2.41	0.00		1.00		2.73
Harbor Drive/Northbound I-35 CD Road Slip Ramp		172			373			201		1.00			0.98			0.97
Harbor Drive/Railroad Street	38	306	172		149	419	602	236	1.00	1.00	1.00		1.00	0.91	0.93	1.01
5th Avenue/Superior Street	103	672	124	81	279	231	761	283	1.09	1.00	1.00	0.99	0.99	1.00	1.00	1.04
5th Avenue/Michigan Street	246	543	672	104	212			484	0.96	1.00	1.00	1.09	1.11			1.01
5th Avenue/Southbound I-35 Ramps	159	714	543	247		76	335	0	0.76	1.00	1.00	0.97		0.66	1.01	
5th Avenue/Harbor Drive/Northbound I-35 CD Road	90	1041	713	158	871			475	0.67	1.00	1.00	0.76	0.99			0.99
Harbor Drive/Railroad Street-Harbor Road Loop Connection	93	154	1042	90	84	975			1.00	1.00	1.00	0.67	0.65	1.00		
Railroad Street/Railroad Street-Harbor Road Loop Connection	975	84			467	419	41	980	1.00	0.65			1.00	1.00	0.48	1.00
6th Avenue/Superior Street		168	229	35	253	220	231	280		1.01	1.00	0.78	1.00	1.00	1.00	0.99
6th Avenue/Michigan Street	2	2	168		278			455	1.00	1.00	1.01		1.05			1.05
Railroad Street/Bayfront Parking Lot		460			651	142	419	468		1.00			1.00	0.99	1.00	1.00
Garfield Avenue/Railroad Street	520	253	398	74	63	2	68	720	1.02	1.00	1.00	1.16	1.00	1.00	0.98	1.00
27th Avenue/Southbound I-35 Ramps	85	258	353	246		124	190		1.00	1.00	1.00	1.00		1.00	1.00	
27th Avenue/Northbound I-35 Ramps	8	10	258	85	86			257	1.00	1.00	1.00	1.00	1.00			1.00
27th Avenue/Courtland Street	4	4	10	8	6	7	4	5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

*Highlighted if ratio is equal or less than 1.00

Appendix 5

Segment Level Peak Hour Traffic Forecasts for S5: 5th Avenue One-lane in each direction between Michigan Street and Harbor Drive Loop

Intersection	Build combined Non Event + Event Inbound Traffic								Build/Base Ratio							
	South Leg		North Leg		West Leg		East Leg		South Leg		North Leg		West Leg		East Leg	
	NB_in	SB_out	SB_in	NB_out	EB_in	WB_out	WB_in	EB_out	NB_in	SB_out	SB_in	NB_out	EB_in	WB_out	WB_in	EB_out
Lake Avenue/Superior Street	283	567	229	182	259	260	477	239	1.29	1.01	1.02	1.32	0.99	1.00	1.00	1.07
Lake Avenue/I-35 Single Point Intersection	309	875	567	283	276	224	466	235	1.00	1.00	1.01	1.29	1.33	1.01	1.00	1.02
Canal Park Drive/Rail Road Street	209	243	875	309	144	650	22	47	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Canal Park Drive/Buchanan Street	89	236	243	209	150	37			1.00	1.00	1.00	1.00	1.00	1.00		
Canal Park Drive/Morse Street	40	246	236	89	59				1.00	1.00	1.00	1.00	0.99			
Lake Avenue/Railroad Street	97	202	26	15	235	648	650	144	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Lake Avenue/Buchanan St	221	223	202	97	5	5	37	150	1.00	1.00	1.00	1.00	0.20	0.33	1.00	1.00
Lake Avenue/Morse St	285	218	223	221		10		59	1.00	1.00	1.00	1.00		1.00		0.99
Harbor Drive/Northbound I-35 CD Road Slip Ramp		171			447			276		1.00				1.18		1.33
Harbor Drive/Railroad Street	38	307	171		149	465	648	234	1.00	1.00	1.00		1.00	1.01	1.00	1.00
5th Avenue/Superior Street	68	696	124	81	290	231	783	257	0.71	1.03	1.00	1.00	1.03	1.00	1.03	0.94
5th Avenue/Michigan Street	148	540	695	68	305			471	0.58	0.99	1.03	0.71	1.60			0.98
5th Avenue/Southbound I-35 Ramps	80	710	540	148		118	309	0	0.38	0.99	0.99	0.58		1.03	0.93	
5th Avenue/Harbor Drive/Northbound I-35 CD Road	135	1043	710	80	807			549	0.99	1.00	0.99	0.38	0.91			1.14
Harbor Drive/Railroad Street-Harbor Road Loop Connection	93	155	1044	135	130	977			1.00	1.01	1.00	1.00	1.00	1.00		
Railroad Street/Railroad Street-Harbor Road Loop Connection	977	130			465	419	87	980	1.00	1.00			1.00	1.00	1.00	1.00
6th Avenue/Superior Street		170	233	5	260	220	231	290		1.02	1.02	0.11	1.03	1.00	1.00	1.03
6th Avenue/Michigan Street	2	2	170		330			547	1.00	1.00	1.02		1.24			1.27
Railroad Street/Bayfront Parking Lot		460			648	142	419	465		1.00			1.00	0.99	1.00	0.99
Garfield Avenue/Railroad Street	542	253	398	100	63	2	70	716	1.06	1.00	1.00	1.56	1.00	1.00	1.01	1.00
27th Avenue/Southbound I-35 Ramps	85	255	350	246		124	190		1.00	0.99	0.99	1.00		1.00	1.00	
27th Avenue/Northbound I-35 Ramps	8	10	255	85	86			254	1.00	1.00	0.99	1.00	1.00			0.99
27th Avenue/Courtland Street	4	4	10	8	6	7	5	5	1.00	1.00	1.00	1.00	1.00	1.00	1.25	1.00

*Highlighted if ratio is equal or less than 1.00

Appendix 6

Segment Level Peak Hour Traffic Forecasts for S6: Northbound I-35 New Slip Ramp/Railroad Street Connection South of Bayfront Park

Intersection	Build combined Non Event + Event Inbound Traffic								Build/Base Ratio							
	South Leg		North Leg		West Leg		East Leg		South Leg		North Leg		West Leg		East Leg	
	NB_in	SB_out	SB_in	NB_out	EB_in	WB_out	WB_in	EB_out	NB_in	SB_out	SB_in	NB_out	EB_in	WB_out	WB_in	EB_out
Lake Avenue/Superior Street	218	567	239	138	262	259	466	221	0.99	1.01	1.06	1.00	1.00	1.00	0.98	0.99
Lake Avenue/I-35 Single Point Intersection	309	871	567	218	206	227	467	232	1.00	1.00	1.01	0.99	0.99	1.02	1.00	1.00
Canal Park Drive/Rail Road Street	206	243	871	309	146	646	22	47	0.99	1.00	1.00	1.00	1.02	1.00	1.00	1.00
Canal Park Drive/Buchanan Street	86	236	243	206	150	37			0.96	1.00	1.00	0.98	1.00	1.00		
Canal Park Drive/Morse Street	40	246	236	86	56				1.00	1.00	1.00	0.97	0.95			
Lake Avenue/Railroad Street	100	202	26	15	235	644	646	146	1.03	1.00	1.00	1.00	1.00	1.00	1.00	1.02
Lake Avenue/Buchanan St	224	223	202	100	5	5	37	150	1.01	1.00	1.00	1.03	0.20	0.33	1.00	1.00
Lake Avenue/Morse St	285	218	223	224		10		56	1.00	1.00	1.00	1.01		1.00		0.95
Harbor Drive/Northbound I-35 CD Road Slip Ramp		171			377			206		1.00			0.99			0.99
Harbor Drive/Railroad Street	38	307	171		149	461	644	234	1.00	1.00	1.00		1.00	1.00	1.00	1.00
5th Avenue/Superior Street	99	674	124	81	280	231	762	280	1.05	1.00	1.00	1.00	0.99	1.00	1.01	1.02
5th Avenue/Michigan Street	237	545	674	99	219			486	0.93	1.00	1.00	1.05	1.15			1.01
5th Avenue/Southbound I-35 Ramps	193	717	545	237		116	332	0	0.92	1.00	1.00	0.93		1.01	1.00	
5th Avenue/Harbor Drive/Northbound I-35 CD Road	136	998	717	193	817			479	1.00	0.96	1.00	0.92	0.92			1.00
Harbor Drive/Railroad Street-Harbor Road Loop Connection	93	154	997	136	130	930			1.00	1.00	0.95	1.00	1.00	0.95		
Railroad Street/Railroad Street-Harbor Road Loop Connection	930	130			467	370	87	984	0.95	1.00			1.00	0.88	1.00	1.00
6th Avenue/Superior Street		166	228	31	253	220	231	280		0.99	0.99	0.69	1.00	1.00	1.00	0.99
6th Avenue/Michigan Street	2	2	166		283			463	1.00	1.00	0.99		1.07			1.07
Railroad Street/Bayfront Parking Lot		460			699	143	371	467		1.00			1.07	1.00	0.88	1.00
Garfield Avenue/Railroad Street	496	253	317	59	63	2	71	631	0.97	1.00	0.80	0.93	1.00	1.00	1.03	0.88
27th Avenue/Southbound I-35 Ramps	85	269	364	246		124	190		1.00	1.04	1.03	1.00		1.00	1.00	
27th Avenue/Northbound I-35 Ramps	8	10	269	85	86			268	1.00	1.00	1.04	1.00	1.00			1.04
27th Avenue/Courtland Street	4	4	10	8	6	7	5	5	1.00	1.00	1.00	1.00	1.00	1.00	1.25	1.00

*Highlighted if ratio is equal or less than 1.00

Appendix 7

Segment Level Peak Hour Traffic Forecasts for S7: Dedicated Ramp Connection from 5th Avenue/CD Road to DECC Garage

Intersection	Build combined Non Event + Event Inbound Traffic								Build/Base Ratio							
	South Leg		North Leg		West Leg		East Leg		South Leg		North Leg		West Leg		East Leg	
	NB_in	SB_out	SB_in	NB_out	EB_in	WB_out	WB_in	EB_out	NB_in	SB_out	SB_in	NB_out	EB_in	WB_out	WB_in	EB_out
Lake Avenue/Superior Street	218	383	174	140	264	277	364	219	0.99	0.68	0.77	1.02	1.01	1.07	0.76	0.98
Lake Avenue/I-35 Single Point Intersection	309	630	383	218	206	235	419	233	1.00	0.72	0.68	0.99	0.99	1.06	0.90	1.01
Canal Park Drive/Rail Road Street	209	244	630	309	143	404	22	47	1.00	1.00	0.72	1.00	1.00	0.62	1.00	1.00
Canal Park Drive/Buchanan Street	89	237	244	209	150	37			1.00	1.00	1.00	1.00	1.00	1.00		
Canal Park Drive/Morse Street	40	247	237	89	59				1.00	1.00	1.00	1.00	1.00			
Lake Avenue/Railroad Street	97	202	26	15	235	402	404	143	1.00	1.00	1.00	1.00	1.00	0.62	0.62	1.00
Lake Avenue/Buchanan St	221	223	202	97	5	5	37	150	1.00	1.00	1.00	1.00	0.20	0.33	1.00	1.00
Lake Avenue/Morse St	285	218	223	221		10		59	1.00	1.00	1.00	1.00		1.00		1.00
Harbor Drive/Northbound I-35 CD Road Slip Ramp		112			318			206		0.65			0.84			0.99
Harbor Drive/Railroad Street	38	95	112		105	329	403	234	1.00	0.31	0.65		0.70	0.71	0.62	1.00
5th Avenue/Superior Street	104	798	175	81	283	231	829	281	1.09	1.18	1.41	1.00	1.00	1.00	1.09	1.03
5th Avenue/Michigan Street	237	676	799	105	230			484	0.93	1.24	1.19	1.11	1.20			1.00
5th Avenue/Southbound I-35 Ramps	188	964	676	237		105	442	0	0.90	1.35	1.24	0.93		0.91	1.33	
5th Avenue/Harbor Drive/Northbound I-35 CD Road	138	472	965	188	1156			1599	1.02	0.45	1.35	0.90	1.31			3.32
Harbor Drive/Railroad Street-Harbor Road Loop Connection	93	154	472	138	132	405			1.00	1.00	0.45	1.02	1.02	0.41		
Railroad Street/Railroad Street-Harbor Road Loop Connection	405	133			166	420	87	105	0.41	1.02			0.36	1.00	1.00	0.11
6th Avenue/Superior Street		175	239	28	253	220	231	283		1.05	1.04	0.63	1.00	1.00	1.00	1.00
6th Avenue/Michigan Street	2	2	175		281			472	1.00	1.00	1.05		1.06			1.09
Railroad Street/Bayfront Parking Lot		460			349	143	420	166		1.00			0.54	1.00	1.00	0.36
Garfield Avenue/Railroad Street	227	253	391	77	63	2	71	418	0.45	1.00	0.98	1.20	1.00	1.00	1.03	0.58
27th Avenue/Southbound I-35 Ramps	85	257	352	246		124	190		1.00	1.00	1.00	1.00		1.00	1.00	
27th Avenue/Northbound I-35 Ramps	8	10	257	85	86			256	1.00	1.00	1.00	1.00	1.00			1.00
27th Avenue/Courtland Street	4	4	10	8	6	7	5	5	1.00	1.00	1.00	1.00	1.00	1.00	1.25	1.00

*Highlighted if ratio is equal or less than 1.00

Appendix 8

Segment Level Peak Hour Traffic Forecasts for S8: New 170-Space Parking Lot in Southwest of Lake Avenue/Railroad Street

Intersection	Build combined Non Event + Event Inbound Traffic								Build/Base Ratio							
	South Leg		North Leg		West Leg		East Leg		South Leg		North Leg		West Leg		East Leg	
	NB_in	SB_out	SB_in	NB_out	EB_in	WB_out	WB_in	EB_out	NB_in	SB_out	SB_in	NB_out	EB_in	WB_out	WB_in	EB_out
Lake Avenue/Superior Street	215	601	255	140	263	258	482	215	0.98	1.07	1.13	1.02	1.00	1.00	1.01	0.96
Lake Avenue/I-35 Single Point Intersection	309	929	601	215	203	220	483	233	1.00	1.06	1.07	0.98	0.97	0.99	1.04	1.01
Canal Park Drive/Rail Road Street	211	234	929	309	141	713	22	47	1.01	0.96	1.06	1.00	0.99	1.10	1.00	1.00
Canal Park Drive/Buchanan Street	91	227	234	211	150	37			1.02	0.96	0.96	1.01	1.00	1.00		
Canal Park Drive/Morse Street	40	237	227	91	61				1.00	0.96	0.96	1.02	1.04			
Lake Avenue/Railroad Street	95	193	26	15	226	711	713	141	0.98	0.96	1.00	1.00	0.96	1.10	1.10	0.99
Lake Avenue/Buchanan St	219	214	193	95	5	5	37	150	0.99	0.96	0.96	0.98	0.20	0.33	1.00	1.00
Lake Avenue/Morse St	285	209	214	219		10		61	1.00	0.96	0.96	0.99		1.00		1.04
Harbor Drive/Northbound I-35 CD Road Slip Ramp		209			412			203		1.22			1.09			0.97
Harbor Drive/Railroad Street	38	295	209		179	445	622	308	1.00	0.96	1.22		1.20	0.96	0.96	1.32
5th Avenue/Superior Street	103	647	123	81	280	231	733	281	1.09	0.96	0.99	1.00	0.99	1.00	0.97	1.03
5th Avenue/Michigan Street	240	524	647	104	208			467	0.94	0.97	0.96	1.09	1.09			0.97
5th Avenue/Southbound I-35 Ramps	201	684	524	241		118	318	0	0.96	0.96	0.96	0.94		1.02	0.95	
5th Avenue/Harbor Drive/Northbound I-35 CD Road	136	994	685	201	889			515	1.00	0.95	0.96	0.96	1.01			1.07
Harbor Drive/Railroad Street-Harbor Road Loop Connection	93	148	994	136	129	932			1.00	0.96	0.95	1.00	0.99	0.95		
Railroad Street/Railroad Street-Harbor Road Loop Connection	931	129			482	402	87	969	0.95	0.99			1.03	0.96	1.00	0.99
6th Avenue/Superior Street		165	226	35	253	220	231	279		0.99	0.98	0.78	1.00	1.00	1.00	0.99
6th Avenue/Michigan Street	2	2	165		263			438	1.00	1.00	0.99		0.99			1.01
Railroad Street/Bayfront Parking Lot		438			657	138	402	483		0.95			1.01	0.96	0.96	1.03
Garfield Avenue/Railroad Street	519	240	385	63	63	2	66	726	1.02	0.95	0.97	0.99	1.00	1.00	0.96	1.01
27th Avenue/Southbound I-35 Ramps	85	259	354	246		124	190		1.00	1.00	1.00	1.00		1.00	1.00	
27th Avenue/Northbound I-35 Ramps	8	10	259	85	86			258	1.00	1.00	1.00	1.00	1.00			1.00
27th Avenue/Courtland Street	4	4	10	8	6	7	5	5	1.00	1.00	1.00	1.00	1.00	1.00	1.25	1.00

*Highlighted if ratio is equal or less than 1.00

Appendix 9

Segment Level Peak Hour Traffic Forecasts for S9: Balanced Parking between DECC and Downtown Parking Lots

Intersection	Build combined Non Event + Event Inbound Traffic								Build/Base Ratio							
	South Leg		North Leg		West Leg		East Leg		South Leg		North Leg		West Leg		East Leg	
	NB_in	SB_out	SB_in	NB_out	EB_in	WB_out	WB_in	EB_out	NB_in	SB_out	SB_in	NB_out	EB_in	WB_out	WB_in	EB_out
Lake Avenue/Superior Street	218	464	198	130	262	258	403	230	0.99	0.82	0.88	0.94	1.00	1.00	0.85	1.03
Lake Avenue/I-35 Single Point Intersection	309	632	464	218	205	222	325	231	1.00	0.72	0.82	0.99	0.99	1.00	0.70	1.00
Canal Park Drive/Rail Road Street	206	244	632	309	146	406	22	47	0.99	1.00	0.72	1.00	1.02	0.63	1.00	1.00
Canal Park Drive/Buchanan Street	86	237	244	206	150	37			0.97	1.00	1.00	0.99	1.00	1.00		
Canal Park Drive/Morse Street	40	247	237	86	56				1.00	1.00	1.00	0.97	0.95			
Lake Avenue/Railroad Street	97	202	26	15	235	401	406	146	1.00	1.00	1.00	1.00	1.00	0.62	0.63	1.02
Lake Avenue/Buchanan St	221	223	202	97	5	5	37	150	1.00	1.00	1.00	1.00	0.20	0.33	1.00	1.00
Lake Avenue/Morse St	282	218	223	221		10		56	0.99	1.00	1.00	1.00		1.00		0.95
Harbor Drive/Northbound I-35 CD Road Slip Ramp		142			347			205		0.83			0.92			0.99
Harbor Drive/Railroad Street	38	201	142		127	273	401	234	1.00	0.65	0.83		0.85	0.59	0.62	1.00
5th Avenue/Superior Street	104	525	122	81	283	231	610	282	1.09	0.78	0.98	1.00	1.00	1.00	0.81	1.03
5th Avenue/Michigan Street	287	354	526	104	202			556	1.12	0.65	0.78	1.09	1.06			1.15
5th Avenue/Southbound I-35 Ramps	218	470	354	287		119	304	0	1.04	0.66	0.65	1.12		1.04	0.91	
5th Avenue/Harbor Drive/Northbound I-35 CD Road	137	625	470	218	685			449	1.01	0.60	0.66	1.04	0.78			0.93
Harbor Drive/Railroad Street-Harbor Road Loop Connection	93	154	625	137	131	558			1.00	1.00	0.60	1.01	1.01	0.57		
Railroad Street/Railroad Street-Harbor Road Loop Connection	558	131			316	284	87	546	0.57	1.01			0.68	0.68	1.00	0.56
6th Avenue/Superior Street		161	225	41	253	220	231	283		0.96	0.98	0.91	1.00	1.00	1.00	1.00
6th Avenue/Michigan Street	2	2	161		326			492	1.00	1.00	0.96		1.23			1.14
Railroad Street/Bayfront Parking Lot		235			410	142	283	316		0.51			0.63	0.99	0.67	0.68
Garfield Avenue/Railroad Street	311	252	356	65	63	2	70	479	0.61	1.00	0.90	1.02	1.00	1.00	1.01	0.67
27th Avenue/Southbound I-35 Ramps	85	244	339	247		124	190		1.00	0.95	0.96	1.00		1.00	1.00	
27th Avenue/Northbound I-35 Ramps	8	10	244	85	86			243	1.00	1.00	0.95	1.00	1.00			0.95
27th Avenue/Courtland Street	4	4	10	8	6	7	5	5	1.00	1.00	1.00	1.00	1.00	1.00	1.25	1.00

*Highlighted if ratio is equal or less than 1.00

Appendix 10

Segment Level Peak Hour Traffic Forecasts for S10: Balanced Parking in Bayfront and DECC Parking Lots

Intersection	Build combined Non Event + Event Inbound Traffic								Build/Base Ratio							
	South Leg		North Leg		West Leg		East Leg		South Leg		North Leg		West Leg		East Leg	
	NB_in	SB_out	SB_in	NB_out	EB_in	WB_out	WB_in	EB_out	NB_in	SB_out	SB_in	NB_out	EB_in	WB_out	WB_in	EB_out
Lake Avenue/Superior Street	217	607	265	138	263	259	480	221	0.99	1.08	1.18	1.00	1.00	1.00	1.01	0.99
Lake Avenue/I-35 Single Point Intersection	309	889	606	217	206	221	439	232	1.00	1.02	1.08	0.99	0.99	0.99	0.94	1.00
Canal Park Drive/Rail Road Street	208	244	890	309	144	664	22	47	1.00	1.00	1.02	1.00	1.00	1.03	1.00	1.00
Canal Park Drive/Buchanan Street	88	237	244	208	150	37			0.99	1.00	1.00	1.00	1.00	1.00		
Canal Park Drive/Morse Street	40	247	237	89	59				1.00	1.00	1.00	0.99	0.99			
Lake Avenue/Railroad Street	96	202	26	15	235	661	664	143	0.99	1.00	1.00	1.00	1.00	1.02	1.03	1.00
Lake Avenue/Buchanan St	221	223	202	97	5	5	37	150	1.00	1.00	1.00	1.00	0.20	0.33	1.00	1.00
Lake Avenue/Morse St	284	218	223	221		10		58	1.00	1.00	1.00	1.00		1.01		0.99
Harbor Drive/Northbound I-35 CD Road Slip Ramp		253			459			206		1.48			1.21			0.99
Harbor Drive/Railroad Street	38	606	253		211	324	662	234	1.00	1.97	1.48		1.42	0.70	1.03	1.00
5th Avenue/Superior Street	99	575	123	81	283	231	659	277	1.04	0.85	0.99	1.00	1.00	1.00	0.87	1.01
5th Avenue/Michigan Street	246	442	574	99	202			481	0.96	0.81	0.85	1.04	1.06			1.00
5th Avenue/Southbound I-35 Ramps	197	603	443	245		116	324	0	0.94	0.84	0.81	0.96		1.01	0.97	
5th Avenue/Harbor Drive/Northbound I-35 CD Road	136	811	603	197	831			562	1.00	0.78	0.84	0.94	0.94			1.17
Harbor Drive/Railroad Street-Harbor Road Loop Connection	93	154	810	136	130	743			1.00	1.00	0.77	1.00	1.00	0.76		
Railroad Street/Railroad Street-Harbor Road Loop Connection	743	130			435	392	87	743	0.76	1.00			0.93	0.93	1.00	0.76
6th Avenue/Superior Street		163	225	41	255	220	231	283		0.98	0.98	0.91	1.01	1.00	1.00	1.00
6th Avenue/Michigan Street	2	2	163		277			445	1.00	1.00	0.98		1.05			1.03
Railroad Street/Bayfront Parking Lot		415			600	142	392	435		0.90			0.92	0.99	0.93	0.93
Garfield Avenue/Railroad Street	481	253	388	75	63	2	70	669	0.94	1.00	0.98	1.18	1.00	1.00	1.01	0.93
27th Avenue/Southbound I-35 Ramps	85	255	350	246		124	190		1.00	0.99	0.99	1.00		1.00	1.00	
27th Avenue/Northbound I-35 Ramps	8	10	255	85	86			254	1.00	1.00	0.99	1.00	1.00			0.99
27th Avenue/Courtland Street	4	4	10	8	6	7	5	5	1.00	1.00	1.00	1.00	1.00	1.00	1.25	1.00

*Highlighted if ratio is equal or less than 1.00

Appendix 11

Segment Level Peak Hour Traffic Forecasts for S11: Add P&R shuttle to reduce parking demand by 5%

Intersection	Build combined Non Event + Event Inbound Traffic								Build/Base Ratio							
	South Leg		North Leg		West Leg		East Leg		South Leg		North Leg		West Leg		East Leg	
	NB_in	SB_out	SB_in	NB_out	EB_in	WB_out	WB_in	EB_out	NB_in	SB_out	SB_in	NB_out	EB_in	WB_out	WB_in	EB_out
Lake Avenue/Superior Street	224	557	225	140	263	257	468	226	1.02	0.99	1.00	1.02	1.00	0.99	0.98	1.02
Lake Avenue/I-35 Single Point Intersection	309	845	557	224	212	227	450	231	1.00	0.97	0.99	1.02	1.02	1.02	0.97	1.00
Canal Park Drive/Rail Road Street	208	234	844	309	144	628	22	47	0.99	0.96	0.97	1.00	1.01	0.97	1.00	1.00
Canal Park Drive/Buchanan Street	88	227	234	208	150	37			0.99	0.96	0.96	0.99	1.00	1.00		
Canal Park Drive/Morse Street	40	237	227	88	58				1.00	0.96	0.96	0.99	0.98			
Lake Avenue/Railroad Street	98	193	26	15	226	626	628	144	1.01	0.96	1.00	1.00	0.96	0.97	0.97	1.01
Lake Avenue/Buchanan St	222	214	193	98	5	5	37	150	1.01	0.96	0.96	1.01	0.20	0.33	1.00	1.00
Lake Avenue/Morse St	285	209	214	222		10		58	1.00	0.96	0.96	1.01		1.00		0.98
Harbor Drive/Northbound I-35 CD Road Slip Ramp		163			375			212		0.95			0.99			1.02
Harbor Drive/Railroad Street	38	295	163		144	449	626	227	1.00	0.96	0.95		0.97	0.97	0.97	0.97
5th Avenue/Superior Street	105	641	124	81	283	231	726	285	1.10	0.95	1.00	1.00	1.01	1.00	0.96	1.05
5th Avenue/Michigan Street	237	518	640	105	207			462	0.93	0.95	0.95	1.10	1.09			0.96
5th Avenue/Southbound I-35 Ramps	194	679	518	236		119	322	0	0.93	0.95	0.95	0.92		1.04	0.97	
5th Avenue/Harbor Drive/Northbound I-35 CD Road	136	991	679	194	847			477	1.00	0.95	0.95	0.93	0.96			0.99
Harbor Drive/Railroad Street-Harbor Road Loop Connection	93	148	990	136	129	928			1.00	0.96	0.95	1.00	0.99	0.95		
Railroad Street/Railroad Street-Harbor Road Loop Connection	928	129			448	403	87	931	0.95	0.99			0.96	0.96	1.00	0.95
6th Avenue/Superior Street		160	221	31	255	220	231	282		0.96	0.96	0.68	1.01	1.00	1.00	1.00
6th Avenue/Michigan Street	2	2	160		264			437	1.00	1.00	0.96		0.99			1.01
Railroad Street/Bayfront Parking Lot		438			622	139	403	448		0.95			0.96	0.97	0.96	0.96
Garfield Avenue/Railroad Street	482	240	384	61	63	2	67	691	0.95	0.95	0.97	0.96	1.00	1.00	0.97	0.96
27th Avenue/Southbound I-35 Ramps	85	255	350	246		124	190		1.00	0.99	0.99	1.00		1.00	1.00	
27th Avenue/Northbound I-35 Ramps	8	10	255	85	86			254	1.00	1.00	0.99	1.00	1.00			0.99
27th Avenue/Courtland Street	4	4	10	8	6	7	5	5	1.00	1.00	1.00	1.00	1.00	1.00	1.25	1.00

*Highlighted if ratio is equal or less than 1.00

Appendix 12

Segment Level Peak Hour Traffic Forecasts for S12: Extend Courtland Street to Garfield Avenue

Intersection	Build combined Non Event + Event Inbound Traffic								Build/Base Ratio							
	South Leg		North Leg		West Leg		East Leg		South Leg		North Leg		West Leg		East Leg	
	NB_in	SB_out	SB_in	NB_out	EB_in	WB_out	WB_in	EB_out	NB_in	SB_out	SB_in	NB_out	EB_in	WB_out	WB_in	EB_out
Lake Avenue/Superior Street	224	566	228	143	263	259	476	223	1.02	1.00	1.01	1.04	1.00	1.00	1.00	1.00
Lake Avenue/I-35 Single Point Intersection	309	873	566	224	212	225	467	232	1.00	1.00	1.01	1.02	1.02	1.01	1.00	1.00
Canal Park Drive/Rail Road Street	208	243	873	309	144	648	22	47	0.99	1.00	1.00	1.00	1.01	1.00	1.00	1.00
Canal Park Drive/Buchanan Street	88	236	243	208	150	37			0.98	1.00	1.00	0.99	1.00	1.00		
Canal Park Drive/Morse Street	40	246	236	88	58				1.00	1.00	1.00	0.98	0.98			
Lake Avenue/Railroad Street	98	202	26	15	235	646	648	144	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.01
Lake Avenue/Buchanan St	222	223	202	98	5	5	37	150	1.01	1.00	1.00	1.01	0.20	0.33	1.00	1.00
Lake Avenue/Morse St	285	218	223	222		10		58	1.00	1.00	1.00	1.01		1.00		0.98
Harbor Drive/Northbound I-35 CD Road Slip Ramp		171			383			212		1.00			1.01			1.02
Harbor Drive/Railroad Street	38	307	171		149	463	646	234	1.00	1.00	1.00		1.00	1.00	1.00	1.00
5th Avenue/Superior Street	106	673	124	81	280	231	758	283	1.12	1.00	1.00	1.00	0.99	1.00	1.00	1.04
5th Avenue/Michigan Street	237	544	673	106	222			481	0.93	1.00	1.00	1.12	1.16			1.00
5th Avenue/Southbound I-35 Ramps	187	716	544	237		115	338	0	0.89	1.00	1.00	0.93		1.00	1.01	
5th Avenue/Harbor Drive/Northbound I-35 CD Road	134	998	716	187	821			487	0.98	0.95	1.00	0.89	0.93			1.01
Harbor Drive/Railroad Street-Harbor Road Loop Connection	93	154	998	134	128	931			1.00	1.00	0.95	0.98	0.98	0.95		
Railroad Street/Railroad Street-Harbor Road Loop Connection	930	128			465	372	87	982	0.95	0.98			0.99	0.88	1.00	1.00
6th Avenue/Superior Street		165	227	33	253	220	231	280		0.99	0.99	0.74	1.00	1.00	1.00	0.99
6th Avenue/Michigan Street	2	2	165		285			463	1.00	1.00	0.99		1.08			1.07
Railroad Street/Bayfront Parking Lot		460			700	147	372	465		1.00			1.08	1.03	0.88	0.99
Garfield Avenue/Railroad Street	510	254	346	46	143	2	73	769	1.00	1.00	0.87	0.72	2.27	1.00	1.06	1.07
27th Avenue/Southbound I-35 Ramps	107	255	353	246		146	187		1.25	0.99	1.00	1.00		1.17	0.98	
27th Avenue/Northbound I-35 Ramps	26	108	255	107	187			254	3.29	10.83	0.99	1.25	2.18			0.99
27th Avenue/Courtland Street	4	4	108	26	6	7	22	103	1.00	1.00	10.83	3.29	1.00	1.00	5.58	20.67

*Highlighted if ratio is equal or less than 1.00



Appendix B Detailed Explanation of Traffic Improvement Strategies



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The following includes the description, intent, and expected result of each strategy that is listed in Table 1 on page 8 of the Bayfront Area Event Traffic Forecast and Alternatives Analysis Memorandum

- 1a. Dynamic Message Sign wayfinding messages
 - Play digital messages on freeway Dynamic Message Signs (DMS) in the area to alert drivers of congestion and alternative access routes to the event
 - Play digital messages on local road DMS (currently not installed) to alert drivers of available parking in real time
 - Intent to reduce congestion caused by drivers circulating around the event area looking for parking
 - Expect to redirect a large portion of vehicles to alternative parking options
- 1b. Marketing outreach for downtown parking options & alternative transportation
 - Outreach to public for alternative downtown parking options near I-35, as well as alternative transportation options such as park & ride, walking, bicycle, etc.
 - Intent to promote alternative parking and mode of transportation
 - Expect to shift a small portion of parking demand towards downtown facilities; shift a small portion of vehicle travels to other modes
- 1c. Southbound left-turn lane on Railroad St at Bentleyville parking entrance
 - Install a left turn lane on southbound Railroad St at Bayfront Park lot entrance; close the left turn lane once the lot is approaching its capacity
 - Intent to provide some queuing storage and the option for southbound thru vehicles to get around left turn vehicles
 - Expect to reduce southbound delay and improve parking lot operation
- 1d. Move the train stop further south near the existing Superior Hiking Trail crossing
 - Move the train stop further south near the existing Superior Hiking Trail crossing
 - Intent to reduce the conflict between street-crossing pedestrians and the vehicles entering Bayfront Parking lot
 - Expect to reduce the above-mentioned conflict and improve vehicle flow
- 1e. Pedestrian control at Bentleyville entrance on Harbor Dr
 - Use temporary fencing to guide pedestrian to cross Harbor Dr at a single point near the Bayfront Park entrance (on Harbor Dr)
 - Intent to separate pedestrian crossing from vehicle turning from/onto the looping ramp
 - Expect to reduce the above-mentioned conflict, improve pedestrian safety and vehicle flow
- 2a. Reduce processing time at parking entrances
 - Reduce payment processing time at parking entrances by having multiple agents for each entrance lane, offer prepaid parking pass, etc.
 - Intent to reduce processing time at parking entrances where at times this is the bottleneck to getting vehicles off the roadway and into the parking lot
 - Expect to improve customer experience and reduce queuing back onto the street
- 2b. Assign parking to reduce entrance queuing



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- Manage early-arriving visitors to park on upper levels or spots more difficult to get to (by coning off other spaces)
 - Intent to reduce queuing out of DECC parking ramp due to parking activities
 - Expect to improve parking capacity utilization as well as reducing queuing from parking facility during busy ingress
- 2c. Utilize multiple parking facility (e.g. DECC) entrances
 - Sign, and encourage the use of, multiple entrances for DECC parking
 - Intent to guide more vehicles to use the east entrance of DECC parking on Harbor Dr
 - Expect to reduce the queuing at the north entrance of DECC parking on Railroad St
- 2d. Coordinate parking management and share facility occupancy during overlapping events
 - Coordinate parking management via planning meetings, regular check-ins, other information sharing activities, and share facility occupancy during overlapping events via radio, messaging, or other digital means
 - Intent to enhance collaboration across agencies and business and improve information intelligence
 - Expect to reduce parking circulation and area traffic congestion
- 2e. Static freeway & local streets signs for downtown and Canal Park parking
 - Static signs on freeway and local streets to complement the DMS wayfinding messages (strategy 1a)
 - Intent to alert drivers of congestion, alternative access route and alternative parking
 - Expect to redirect a large portion of vehicles to alternative parking and/or through alternative route
- 2f. Traffic signs to split Bayfront Park and DECC traffic, utilize Harbor Dr, alternative parking entrance, and slip ramp
 - Static signs to encourage use of the east entrance (Harbor Dr) of DECC parking by looping around Harbor Dr, or via the slip ramp
 - Intent to increase the use of east entrance of DECC parking and the slip ramp
 - Expect to reduce the queuing at the north entrance of DECC parking on Railroad St and reduce right-turn congestion from eastbound I-35 ramp to eastbound 5th Ave W
- 3a. Separate traffic exiting the NB/EB I-35/5th Avenue ramp to mitigate right turn congestion
 - Convert the shared through-right lane on eastbound I-35 ramp at 5th Ave W to exclusive right-turn
 - Intent to allow drivers to have a clear lane choice regardless of congestion
 - Expect to reduce right-turn congestion from eastbound I-35 ramp
- 3b. Add permanent/temporary pedestrian wayfinding signs along 5th Avenue, Harbor Dr and the pedestrian skyway
 - Add permanent/temporary pedestrian wayfinding signs along 5th Avenue, Harbor Dr and the pedestrian skyway – further details to be developed in Memo 5: Final Recommendation
 - Intent to enhance pedestrian wayfinding and overall experience



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- Expect to improve pedestrian experience and encourage visitors to park in the downtown area knowing they will have signing to help guide them from the parking lot to the event area
- 3c. Improve signal timing of I-35 ramp terminal intersections at 5th Ave and Lake Ave
 - Adjust signal timing, phasing, detection or other design elements of I-35 ramp terminal intersections at 5th Ave and Lake Ave
 - Intent to improve traffic operation through the intersections
 - Expect to reduce vehicle and pedestrian delay
- 4a. Change Harbor Dr to one-way flow
 - Permanently or temporarily change Harbor Dr to one-way street clockwise or counterclockwise
 - Intent to provide traffic operation benefit to vehicles and transit on Harbor Dr
 - Expect to improve traffic flow on Harbor Dr and adjacent intersections
- 4b. Change Canal Park Dr and Lake Ave to a one-way pair
 - Permanently or temporarily change Canal Park Dr and Lake Ave to one-way street pair clockwise or counterclockwise
 - Intent to provide traffic operation benefit to vehicles and transit on Canal Park Dr and Lake Ave
 - Expect to improve traffic flow and parking circulation on Canal Park Dr, Lake Ave and through adjacent intersections
- 5a. Reconstruct roadway and sidewalk of 5th Ave, potentially add bike lane
 - Reconstruct roadway and sidewalk of 5th Ave W, add bike lane potentially
 - Intent to provide wider sidewalk on both side of 5th Ave W, ADA ramps, potential bike lanes and maintain the existing two vehicle lanes
 - Expect to improve pedestrian and bicycle experience and encourage visitors to park in the downtown area and walk across the 5th Ave bridge to access the event area
- 5b. Connect Courtland St with Railroad St by a new Courtland St for event access
 - Construct a new Courtland St between the existing Courtland St and Railroad St
 - Intent to provide an alternative local route in parallel to I-35 for Bayfront area access
 - Expect to reduce congestion at 5th Ave W / I-35 Ramp intersections
- 5c. Trailblaze event traffic via 27th Ave, Michigan St, Superior St, Garfield Ave and Railroad St
 - Setup trailblazing signs along 27th Ave, Michigan St, Superior St, Garfield Ave and Railroad St, a route as an alternative to I-35
 - Intent to provide an alternative local route in parallel to I-35 for Bayfront area access
 - Expect to reduce congestion at 5th Ave W / I-35 Ramp intersections
- 5d. Reconfigure northbound/eastbound 5th Ave exit of I-35
 - Add one additional right turn lane to the eastbound 5th Ave W exit of I-35 as part of the reconfiguration
 - Intent to separate right-turn traffic from through traffic
 - Expect to reduce intersection traffic congestion
- 5e. Improve pedestrian and bicycle access in the area



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- Modernize and improve pedestrian facilities (sidewalk, ramps, crossing treatment, lighting, etc.) and bicycle infrastructures (bike lanes/trails, bike parking, etc.) in Bayfront area
 - Intent to improve pedestrian and bicycle traffic level of services
 - Expect to improve pedestrian/bicycle experience, and potentially increase use of walking/cycling as modes of transportation
- 5f. Add additional access to frontage road to improve traffic flow on I-35 at 5th Ave W Ramp
 - Add additional exit ramp from I-35 eastbound (before 5th Ave W exit) to Railroad St
 - Intent to reduce traffic volume via the 5th Ave W / I-35 Eastbound Ramp intersection
 - Expect to improve traffic operation of the 5th Ave W / I-35 Eastbound Ramp intersection
- 5g. Add roadway capacity (thru lane and/or left/right turn lanes) to Railroad St south of Harbor Dr
 - Add roadway capacity to Railroad St between Garfield Ave and Harbor Dr, by adding either turn lanes in front of parking facilities or a full westbound/southbound lane
 - Intent to increase roadway capacity and relieve bottlenecks
 - Expect to improved traffic flow along Railroad St and adjacent intersections
- 5h. Dedicated lane from I-35 with direct access to DECC parking ramp
 - Construct a dedicated bridge/ramp from I-35 (near 5th Ave W / Lake Ave exit) to the DECC parking ramp
 - Intent to reduce traffic delay at the 5th Ave W/I-35 Eastbound Ramp and on Railroad St
 - Expect to improve traffic operation of the 5th Ave W / I-35 Eastbound Ramp intersection and on Railroad St
- 6a. Add dedicated bus lane via 5th Ave and Harbor Dr
 - Temporarily convert one existing vehicle lane on 5th Ave W and Harbor Dr to bus only lane
 - Intent to reduce bus delay, improves its reliability and capacity, and attract additional users for the mode of transportation
 - Expect to improve bus operation and schedule reliability, and potentially impact vehicle traffic operation
- 6b. Add P&R shuttle option
 - Add additional park & ride shuttles by using remote parking locations
 - Intent to reduce use of vehicle as a mode of transportation
 - Expect to reduce area traffic congestion
- 6c. Use one vehicle lane on 5th Ave for pedestrian ingress
 - Temporarily close one northbound vehicle lane on 5th Ave W to provide a wider “sidewalk” during event ingress
 - Intent to improve pedestrian traffic level of services
 - Expect to improve pedestrian experience, encourage the use of downtown parking facilities, and slightly impact vehicle traffic operations at adjacent intersections
- 7a. Construct a parking ramp near the power plant off Railroad St and connect it with shuttle service



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- Construct a 3-level parking ramp with approximately 170 spaces on the north/west side of Railroad St between Lake Ave and Harbor Dr.
- Intent to increase parking capacity for events in Bayfront area
- Expect to reduce parking circulation and alleviate parking shortage during busy and overlapping events
- 7b. Preferential or prepaid parking strategy
 - Reserve the on-site parking capacity of Bayfront Park and DECC to prepaid customers.
 - Intent to shift a large percentage of parking demand (day-of-event parking circulation) from on-site parking to remote and downtown parking alternatives
 - In the short-term, result in customer dissatisfaction, increased parking circulation and traffic congestion, and in the long-term, substantially reduce traffic congestion and parking circulation in the area
- 7c. Utilize apps to share information on events, traffic condition and parking availability
 - Utilize apps (sponsored by agency or vendors) to share information on events, traffic condition and parking availability
 - Intent to share information in advance and in real-time
 - Expect to reduce parking circulation, improve parking capacity utilization and traffic operation in the area, and improved visitor satisfaction.

Attachment D:
Bayfront Area Event Parking and Wayfinding Analysis Memo



ALLIANT

Memorandum

TO: Ron Chicka
Rondi Watson

FROM: Nick VanGunst, PE, PTOE
Yilun Xu, PE
Mike Anderson, PE, PTOE

DATE: March 29, 2019

SUBJECT: Bayfront Area Event Parking and Wayfinding Analysis Memorandum

This memorandum documents the assumptions and results of event parking and wayfinding analysis for the Bayfront area in Duluth, MN. Selected parking and wayfinding strategies discussed in this memo have been evaluated for traffic operational benefit on adjacent intersections, as documented in the “Bayfront Area Event Traffic Forecast and Alternatives Analysis memorandum (Memo #3)”.

Parking Overview

A parking study was recently completed by HKGI to establish a framework for implementing a district-wide parking approach for Downtown Duluth and Canal Park¹. Even though this study does not include the majority of Bayfront area (except Canal Park), it summarizes the current parking utilization in downtown Duluth and Canal Park and provides insights into the future of area parking management.

The HKGI study confirmed that downtown parking facilities close to the Bayfront area, such as Duluth Transportation Center ramp, US Bank ramp, Library/Depot upper ramp, etc., are well underutilized during typical evenings. The assumption used in the Bayfront parking study that 80% capacity of these facilities is ready for event use is consistent with this finding from HKGI study. Furthermore, the HKGI study points out that 350 to 989 spaces may be available throughout the Canal Park area depending on time of day and day of week, which is also generally consistent with the assumptions in the Bayfront area parking study.

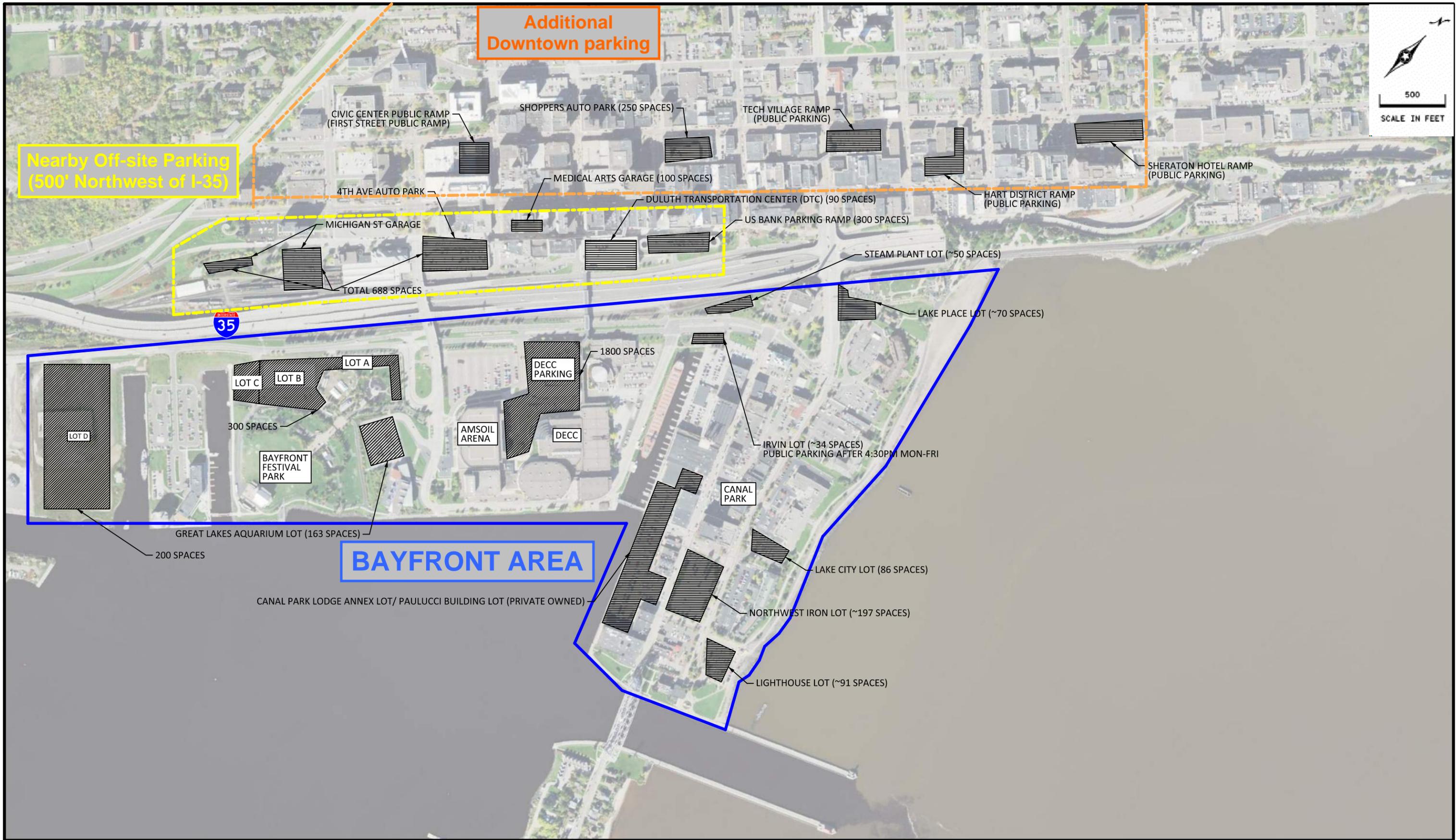
¹ Hoisington Koegler Group Inc. 2018 Downtown Duluth Parking Study. November 8, 2018.

Many strategies developed in the HKGI study have resonated with those being developed for the Bayfront area. These include:

- Collect parking utilization information
- Enhance wayfinding system
- Use parking fee as parking management leverage
- Improve customer services
- Adopt travel demand management methods
- Develop shared parking agreement among parking facilities owners

Current Parking Operation and Systems in the Bayfront Area

The following sections summarize the current parking operations and systems at major parking facilities throughout the Bayfront area. These parking facilities, as well as their estimated capacities for event parking, are shown in **Figure 1**.



Bayfront Area Event Parking and Wayfinding Analysis

Figure 1 Parking Location and Capacity

Bayfront Festival Park

Bayfront Festival Park hosts a suite of outdoor events all-year round such as Bentleyville Tours of Lights, Fourth Fest Celebration, summer concerts, etc. On-site parking facilities include Lot A, B and C that have combined available spaces of 300. Adjacent parking facilities include Lot D (southwest of the pier) and Great Lakes Aquarium lot.

Lot A, B, C and D are unmanned and ungated facilities that utilize event parking management staff to collect parking payment at entry. Great Lakes Aquarium lot is a manned and gated facility that usually supply additional parking capacity to Bayfront Park events. Payments are collected by a parking attendant.

In the example of the Bentleyville Tours of Lights event, when Lot A, B, C and D are approaching their capacity, event parking operation staff setup “Full” signs at parking lot entrances, close the westbound left-turn lane on Railroad St to the entrance, and have a person stationed at the closed left-turn lane to direct attendees to a remote parking lot (Garfield Lot) near Garfield Ave / Railroad St intersection or at the DECC.

The Garfield lot is on railroad property on the west side of Garfield Ave south of Railroad St. During Bentleyville events, parking staff flag down event traffic traveling northbound on Garfield Ave to park at the Garfield Lot. This lot is connected with the Bentleyville site by a 10-minute shuttle ride. It’s important to note that the Garfield Lot is not intended for ongoing parking uses and the City of Duluth intends to develop Lot D in the near future and its parking capacity is expected to be lost.

During other Bayfront Park events, parking operations are similar since no automatic parking system (gate, pay station, automatic payment machine, etc.) currently exist at these surface parking lots. Therefore, the current parking operation at Bayfront Park relies heavily on event parking management staff.

DECC, Amsoil Arena and Symphony Hall

The DECC, Amsoil Arena and Symphony Hall area has an on-site parking ramp and surface lots with a combined total number of parking spaces of 1,800, of which 1,580 spaces are assumed to be available during events (220 spaces assumed unavailable for events due to use by theater patrons and others). The DECC parking has two entrances/exits gates (north and east sides; with attendant booths) and one exit-only gate (west side; no attendant booth). The north gate off Railroad St is most heavily used compared to the east gate off Harbor Dr. These gates do not currently have automatic pay machines and event parking payments are collected by attendants at entrances. During busy events such as UMD Hockey games, etc., all lanes may be used for entry which is managed by additional event parking staff. After entry at the northern gate, the left two lanes must merge into one while traveling up the DECC ramp while traffic in the right lane is directed to park in the surface lot if space is available.

Canal Park Area

Parking systems throughout Canal Park includes on-street meters, ungated (manually gated) parking lots (with pay stations), gated lots and reserved parking near businesses. They are managed by the City of Duluth or diverse private owners. Some parking spaces throughout Canal Park have time limit of 2-3 hours to encourage turnover. This study estimates a total of 400 parking spaces at Canal Park is available for a typical busy Bayfront Area event.

Nearby Downtown Parking

Within 500 feet northwest of I-35 adjacent to Bayfront Park and the DECC, there exists parking facilities that are often available for event parking. These facilities, including 4th Ave Auto Park, Michigan St Garage, Duluth Transportation Center (DTC) Parking Ramp, US Bank Parking Ramp and Michigan St on-street parking, provides an estimated total available capacity of 860 spaces (approximately 80% of total capacity) for event parking, assuming business activities have largely dissipated before event ingress. Most of these facilities are gated parking ramps (except the parking meters along Michigan St) with automatic pay stations/machines and “space available”, “open” or “full” indications. “P” parking symbols are visible (mostly along Michigan St) outside the facet of the facilities. An enclosed pedestrian skyway is directly connected with the DTC Parking Ramp and DECC ramp (and subsequently the DECC).

Issues and Challenges

Three main issues and challenges have been identified for the current event parking situation at Bayfront area:

1. Lack of advanced and real time parking availability information sharing.
2. Parking circulation that creates traffic congestion and customer frustration.
3. Difficulty in coordination among independent parking operations.

Parking Information Sharing

As highlighted under the “Parking Overview” section above, parking space availability information is generally unavailable to event attendees before they reach the parking entrance. Due to the roadway capacity and network constraints, these customers may have already experienced traffic congestion and/or directional confusion.

Even though “Full” signs are set up at parking facility entrances and parking staff are actively redirecting customers when the facilities are full, the message cannot effectively reach those who just join the slow queue towards the intended parking facility. The lack of real-time and advanced parking information sharing is a missed opportunity to improve customer experience and reduce area traffic congestion.

Parking Circulation

When event attendees are turned away from their intended parking facility, usually the one closest to the venue and sometimes the only one they are aware of, they start to search for alternative parking. This creates additional traffic congestion that can be largely avoided if they were presented multiple parking options and availability information in advance and in real time.

Furthermore, the turned-away customers may be redirected to an alternative parking that is also full, just because the parking staff at one event do not have the information on adjacent parking availability. In other cases, the turned-away customers may be redirected to an unfamiliar location and be frustrated by the lack of directional assistance to the event. In either case, the parking circulation creates additional stress and area traffic congestion that ultimately translate into diminished event experiences.

Operation Coordination

From event parking operators’ standpoint, it’s difficult, or sometimes unnecessary to coordinate with other operators for real time sharing of parking capacity and information. This is mainly because the

operators are employed by or as part of individual event management. They serve the best business interests to the specific event and accommodate customer parking at the closest vicinity or designated overflow parking. This model has generally worked well and is still the most efficient way, in terms of cost/benefit, to manage parking for most small or median sized events that do not overlap with other events in the Bayfront area.

The logistics and unique needs of each event outweigh the perceived benefit of crossing organizational barriers to manage area parking capacity and information collaboratively. This is especially the case when customer frustration due to area traffic congestion, lack of parking information sharing, and parking circulation, is difficult to measure. Furthermore, it gradually becomes an economic externality (similar to air pollution) that stays out of the cost equations of individual businesses as overlapping events becomes more and more common and that the customer frustration is just others' (or everyone's) fault.

Because of this, the collaboration requires a champion that consistently coordinates with multiple stakeholders for the best interests of all affected. This requires a great deal of stewardship and financial resources (staff time, budget commitment, legal paperwork, organizational changes, etc.) that is currently absent in the budget.

Parking Management Techniques

This section summarizes current techniques for parking management that has been proven successful for large-scale events. **Table 1** and **Table 2** lists possible vendors for event parking management (strategy, planning, and operation) and parking control system upgrades (full/open signs, detections, gate equipment, payment machines, vehicle detections, software, etc.).

Table 1 Potential Vendors for Event Parking Management

Vendors	Type of Services	Relevant Benefits	Cost
Various Parking Management Software (ease parking software, glideparcs, parkalot, netpark, etc.)	Parking rules development Prepaid reservation website module Loyalty program Parking spaces assessment Validation system	Quick implementation; customized services	Cost depends on scope, event types and frequency.
Allied parking, Inc	Event Parking Valet Staffing & Security Facility Maintenance (Snow Removal, Sweeping and Pressure Washing) Striping & Painting	Locally located, event parking service provided.	
Parking Management Company (PMC)	Event Parking Management	PMC handles 1000s of events across the country every year; provides special event with a seasoned site manger to oversee the event.	

*Sources:

<https://www.capterra.com/parking-management-software/>

<https://www.alliedparkinginc.com/>

<https://parkingmgt.com/services/specialevents/>

Table 2 Potential Vendors for the Event Parking Control System

Vendors	Type of Services	Relevant Benefits	Cost
WPS Parking System	Provide software managing a single or multiple parking lots, hardware products for off-street parking, and online service that manages multiple parking lots.	Provide products and/or online service to manage multiple parking lots - allow parking information sharing	Estimated \$80k-160k capital cost per parking facility for including system planning, design & development, electronic/static signs, communication lines, parking facility equipment, and system software. Estimated \$2-3k/month O&M cost per facility.
Amano Parking Solutions	Provide hardware such as pay stations, ticket dispenser, entrance and exit gates, proximity readers, fee computers, license plate identification systems, etc.	Integrated parking hardware solution	
Nedap	Vehicle identification and access control through one dedicated platform. People Identification for parking facility access and vehicle detection for real-time vehicle occupancy.	Various products to provide the services. Services are provided as soon as the products are installed. Parking information may be shared with the vehicle detection service.	

*Sources:

<http://www.parking-net.com/parking-industry/wps-parking-systems#company-info>

<http://www.sasaccess.com/amano/>

<https://www.nedapidentification.com/solutions/>

<https://www.itscosts.its.dot.gov/ITS/benecost.nsf/ID/F1112FA098133F3C85256DB100458923?OpenDocument&Query=CApp>

Table 3 highlights methods or technology of real-time parking information sharing potentially applicable to the Bayfront area.

Table 3 Methods or Technologies of Applicable Real-time Parking Information Sharing

Uses	Methods	Description of Services	Relevant Benefits	Typical Cost Items
Collect Parking Information	Manual Estimation	Staff manually estimate parking occupancy	Inexpensive option for small parking lots that don't require timely information sharing	Staff time
	Facility in/out counts	Manually or automatically count vehicles enter/exit to derive the parking availability	Relatively inexpensive option that provides real-time parking occupancy estimate	Staff time, system installation, operation and maintenance
	Individual vehicle identification in parking spaces	Detectors at each parking spot collectively derive facility occupancy information	Real-time and accurate facility occupancy information; potential for parking data analytics	Staff time, system installation, operation and maintenance
Communicate Parking Information	Parking Mobile App	Offer drivers/passengers real-time and/or general parking information and notifications	Allow users to obtain rich parking information anywhere, interactively and in real-time or in advance	App development cost and information feeds management
	Dynamic Message Signs	Display parking facility status at entrance or key decision points	Allow users to obtain real-time parking information to make informed navigation decisions.	System installation, operation and maintenance
Capitalize Parking Information	Parking Payment Apps	Expand payment options and provide the ability to park in any space and pay through apps, as well as display parking facility status	Allow drivers to park at underutilized facilities, resulting potentially more balanced parking capacity use in Bayfront area. Provide a potential business case to cover costs.	App development cost, business and information feeds management
	Parking Coupon Programs	Provide parking coupons at nearby businesses (with parking); redeemable in multiple ways	Incentivize parking at remote locations, resulting potentially more balanced parking capacity use in Bayfront area. Provide a potential business case to cover costs.	Program management related costs

*Sources:

<http://www.duluthparking.com/services>

<https://en.parkopedia.com/parking/duluth/?arriving=201901281130&leaving=201901281330>

Parking Management Case Studies

To illustrate the substantial positive impacts on customer experience and area traffic congestion by advanced parking management and control systems, two case studies are documented in **Appendix A**.

Mall of America Parking Wayfinding Strategies and Techniques

This case study showcases its recent parking wayfinding system upgrades and the proven improvements on attendee's ingress experiences and overall use of infrastructure. It also highlights the collaboration between multiple public agencies and private business, such as the Bloomington Port Authority, City of Bloomington Public Works and Police Department, Mall of America Operations, and MnDOT.

The Mall of America attracts visitors throughout the year, but the demand surges around special occasions such as holidays and events. This is similar to the Bayfront area that attracts visitors all-year-round with surges of demand during large-scale events. The case of the Mall of America parking wayfinding strategy development involves multiple agencies, which is similar to the situation of the Bayfront area.

Therefore, the Mall of America case is highly relevant to the Bayfront area in terms of incorporating the best practices and lessons learned in parking wayfinding strategy development and technology application.

If Bayfront area events begin to adopt the best practices learned from the Mall of America case, the following results are expected:

- Noticeably improved customer parking experiences that is consistent across major events
 - If stakeholders develop and operate a parking information sharing system that is accurate, timely and consistent.
- Noticeably improved stakeholder relationship and shared-vision
 - If all stakeholders meet proactively and regularly to develop and review the operation plan, and discuss each other's priority, concerns, goals and wish lists.

University of Minnesota (Twin Cities) Event Parking Ingress/Egress Management

This case study summarizes an event management plan that evolved over the years since the opening of TCF Bank Stadium at the University of Minnesota east bank campus. The plan includes a suite of Dynamic Message Signs (DMS), static traffic sign plans, event signal timing, parking management and process improvements. It accommodates traffic/parking demand of events, sometimes overlapping events, with attendance ranging from 7,000 to 60,000 at TCF Bank Stadium, Mariucci Arena and Williams Arena (all in close proximity).

The University of Minnesota (Twin Cities) is located in an urban setting, with limited major accesses to/from the campus. The TCF Bank stadium, as well as the adjacent sports arenas, are geographically segregated from the north by railroad properties and to the west by the Mississippi River. These features make the area similar to the situation of Bayfront area where multiple venues are connected with limited roadways and experiencing geographic constraints.

Therefore, the University of Minnesota case is highly relevant to the Bayfront area in terms of venues and geographic locations. The parking management case illustrates some possible future for the Bayfront Area event management, while putting forward best practices and lesson-learned from similar endeavors.

If Bayfront area events begin to adopt the best practices learned from the University of Minnesota (Twin Cities) case, the following results are expected:

- Parking capacity utilization at major facilities can reach beyond 90% with noticeably improved parking access efficiency
 - If major parking facilities actively manage ingress demand by first loading the spaces that are most difficult to get to, and;
 - If parking facilities share occupancy status with each other in real time and intelligently (using information, DMS, marketing channels, etc.) redirect traffic to the best alternative facility when reaching capacity themselves.
- Noticeably reduce parking circulation and area traffic congestions during major events
 - If parking facilities share occupancy status with each other in real time and intelligently (using information, DMS, marketing channels, etc.) redirect traffic to the best alternative facility when reaching capacity themselves.

Wayfinding Strategies

Based on the event traffic and parking study of the Bayfront area, wayfinding strategies are developed for short-term and long-term implementations. In the short-term, when real-time parking availability information is largely unavailable, the philosophy of wayfinding is to promote the awareness and use of alternative parking locations (e.g. remote parking, nearby downtown ramps, Canal Park, etc.), as well as the wayfinding for walking and/or shuttle connections to/from the alternative parking. Marketing outreach campaign, static signs, freeway DMS, and local DMS can be deployed to encourage the use of alternative parking (see locations and routing in **Figure 2**). The scale of implementation may be fine-tuned up or down depending on the nature of events and concurrent events.

In the long-term, when real-time parking availability systems are systematically implemented throughout the Bayfront area, permanent static signs and DMS can be deployed at strategic locations (shown in **Figure 2**) on both freeway and local streets to timely and dynamically direct ingress traffic to selected parking locations that minimize parking circulation and mitigate known traffic congestion and parking shortage.

The implementation of wayfinding strategies also requires a clean-up of existing directional static parking signs throughout the area to ensure compatibility with the overall wayfinding goals and philosophy. For example, the “DECC Parking” sign (with static right arrow) on northbound I-35 ramp at 5th Avenue W will need to be replaced with dynamic messages that direct traffic to right (DECC, etc. parking) or left (downtown parking). It is also important to ensure that the deployment is applicable to events of different scales. The final wayfinding plan will be included as part of the long-term recommendation as the final deliverable of this project.

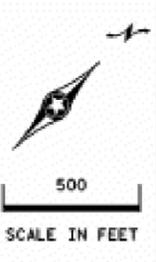
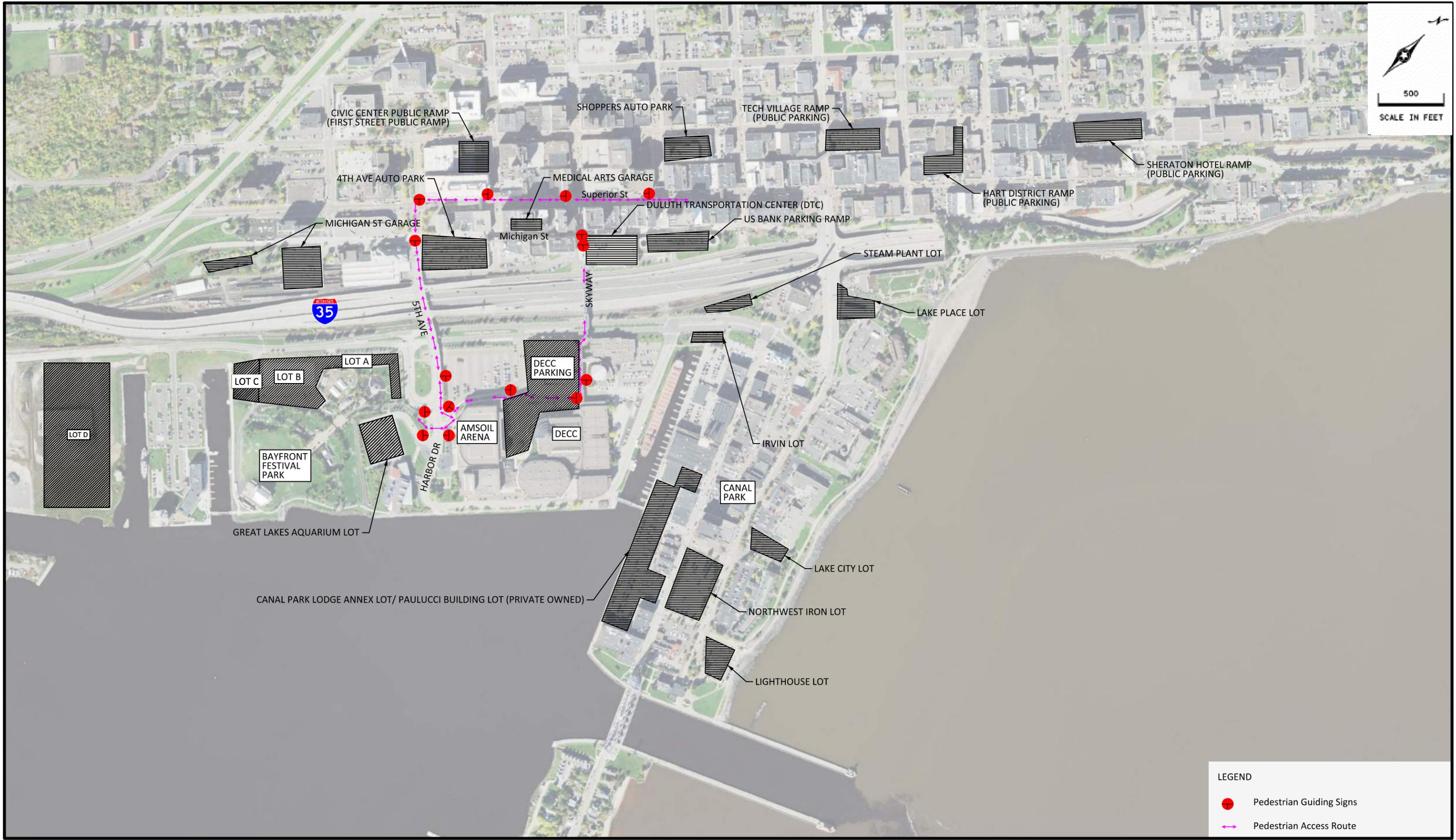


Bayfront Area Event Traffic Control

Figure 2 Wayfinding Overview

Pedestrian and Bicycle Wayfinding Considerations

The philosophy of pedestrian event ingress wayfinding (from parking or adjacent businesses to the venue) focuses on 1) capturing pedestrians from downtown parking facilities and along Michigan St, and 2) directing pedestrians over the 5th Ave and Lake Ave bridges, and the pedestrian skyway from the Duluth Transportation Center. Permanent and temporary signs should be deployed to guide, funnel and direct the pedestrian flows, as shown by **Figure 3**. Since the only dedicated ingress bicycle route is the Cross City Trail along Railroad St, bicyclists, either on the trail or sharing lane with vehicles, may follow wayfinding messages for vehicles and/or pedestrians. As new bicycle facilities are being planned throughout the Bayfront area, bicycle wayfinding elements for events should be considered.



- LEGEND**
- Pedestrian Guiding Signs
 - - - Pedestrian Access Route

Bayfront Area Event Parking and Wayfinding Analysis

Figure 3 Pedestrian Wayfinding Overview



Conclusions

In conclusion, the Bayfront area event parking study has highlighted three event parking-related issues and challenges:

1. Lack of advanced and real time parking availability information sharing.
2. Parking circulation that creates traffic congestion and customer frustration.
3. Difficulty in coordination among independent parking operations.

Available resources (vendors) to facilitate event parking management and parking system upgrades are identified for reference. Two case studies are attached to provide relevant best practices and lesson-learned. While the wayfinding strategies are being finalized as part of the long-term event management plan towards the end of this project, selected parking improvement efforts may commence as outlined below. These efforts are expected to have immediate positive impacts to event parking experiences and the area traffic congestion.

- Parking Facility Management:
 - When possible and necessary, encourage use of multiple parking entrances, multiple entrance lanes, and multiple payment points to reduce congestion at the main parking entrances.
 - Consider the feasibility, pros and cons of assigning parking (e.g. early customers park at upper level, reserve skyway level, etc.) at the DECC parking ramp and lot during busy events, to reduce in-ramp congestion (when multiple lanes of traffic merge into one).
- Digital Enhancement
 - Explore the potential to market event parking and alternative parking options (around the Bayfront and adjacent area) on the Park Duluth app.
- Bayfront Area Event Parking Manager
 - Explore the viability and interests of forming a committee (likely championed by the City of Duluth and funded by stakeholders) with representatives from the City of Duluth, major event operators (Bentleyville Tour of Lights, Bayfront Blues Festival, Bayfront Concerts, UMD Athletics, Grandma's Marathon, Fourth Fest Celebration, Taste of Duluth, Tall Ships Duluth, Canal Park Businesses, etc.), infrastructure operators (Bayfront Park, DECC, Port Authority, etc.), MnDOT, Duluth-Superior Metropolitan Interstate Council, etc. The committee's responsibilities may include but not limited to:
 - Oversee the coordination of parking information among the various parking garages and lots for large events in the Bayfront area.
 - Oversee the development of infrastructure improvements needed to improve wayfinding to parking for visitors.
 - Oversee the development of infrastructure improvements needed to improve pedestrian wayfinding throughout the Bayfront/Canal Park area for events.
 - Pursue funding sources for infrastructure improvements.
 - Develop a Protocol and Operations plan for wayfinding and parking for large events in the Bayfront area.

Appendix A Case Studies

List of Content:

- Mall of America (MOA) Parking Wayfinding Strategies and Techniques
- University of Minnesota (Twin Cities) Event Parking Ingress/Egress Management

Case Study 1: Mall of America (MOA) Parking Wayfinding Strategies and Techniques

Since opening its doors in 1992, Mall of America® (MOA), located in the South Loop District in City of Bloomington, MN, has revolutionized the shopping experience and become a leader in retail, entertainment and attractions. It hosts more than 400 events a year, ranging from concerts, to celebrity appearances and fashion shows. Each year, 40 million people from around the world visit the mall, generating nearly \$2 billion each year in economic impact for the state².

With the growth of the MOA, congestion had become a significant problem as traffic was known to overflow from the MOA parking ramps onto the local roadway system, and from there onto the interstate during peak times. The City of Bloomington got together with the MOA and MnDOT to develop a long term plan to improve traffic flow in and around the South Loop District area. This plan included a series of wayfinding improvement projects that have been completed to facilitate intelligent information sharing of parking capacity and management of traffic flow. The improvements include:

- Freeway (completed 2011): Dynamic Message Signs (DMS) (**Figure A-1**) on the interstate system surrounding the South Loop District direct drivers to MOA access points.
- South Loop District Local Road (completed 2015): DMS (**Figure A-2**) on local roads direct motorists away from congested roadways and closed parking facilities.
- Mall of America Onsite (completed 2016): DMS located at parking ramps and on the circulating roads surrounding the MOA to further direct motorists to available parking, and to direct egress traffic to alternative exit points in the event the local roadway is congested or closed due to an accident.



Figure A-1 Example of Wayfinding DMS on Freeway for MOA

² Mall of America website. <https://www.mallofamerica.com/about>.



Figure A-2 Example of Wayfinding DMS on Local Streets for MOA

The philosophy of the wayfinding systems on multiple types of roadway facilities (freeway, local streets and parking access roads on the MOA property) is to promptly provide customers with the least-congested parking ingress route and most easily accessible parking spaces, which translate into improvements of overall customer experience, area traffic operation and parking facility utilization. It directly impacts public perception of the South Loop area by providing real-time information and a better overall visitor experience, while reduces fuel consumption and improves air quality as the overall number of vehicles circulating looking for parking is reduced.

In late 2018, the Mall of America (MOA) started to operate a new camera-based parking system (provided by Park Assist) that detects vehicle occupancy at each parking stall in its parking ramps and feeds the space availability information onto displays along the parking drive aisle (**Figure A-3**).



Figure A-3 Example of the Parking Information Sharing at Mall of America (MOA) (credit: Elizabeth Flores – Star Tribune)

This system further improves the MOA parking wayfinding experience by adding information intelligence right before parking, after the intelligence during earlier processes of parking ingress (DMS on freeway, local streets and parking circulating roads). A recent Star Tribune article³ also highlights some direct positive customer feedbacks since the opening of the parking system.

In operation, when the MOA parking ramps (east, west or both) are reaching capacity or experiencing significant backup, MOA parking management team notifies Bloomington Police Department and MnDOT staff of the status. At this point, the MOA team, Police Department, and MnDOT promptly and simultaneously change messages on DMSs within their respective jurisdictions, based on the specific parking situation (observed/estimated by MOA team) and according to the predefined protocols in the operation plan. The stakeholder group meets regularly to review the operation plan and any lessons learned from the latest operations.

While the \$3.4 million cost of installing Park Assist camera system was funded by The Bloomington Port Authority by using MOA tax increment financing, this project demonstrates the tremendous results achieved from collaborations between multiple public agencies and private organizations such as the Bloomington Port Authority, City of Bloomington Public Works, Police Department, Mall of America Operation, and MnDOT.

³ Star Tribune. No more circling: Mall of America lights the way to open parking spots. November 2018.

Case Study 2: University of Minnesota (Twin Cities) Event Parking Ingress/Egress Management

The University of Minnesota – Twin Cities has developed event traffic/parking management plans to assist parking ingress and egress for variety of large/median-scale events at the TCF Bank Stadium, Mariucci arena and Williams arena (in close vicinity). These events typically draw 7,000 to 60,000 attendees and may overlap with each other.

Key elements of the event parking/traffic management at University events include:

- Reserve parking at premium locations for pre-paid pass-only access, while allow day-of-event cash parking at multiple locations
 - Encourage attendees, through multiple marketing channels, to select parking location based on their direction of travel (**Figure A-3**);
 - Provide Park & Ride options with complimentary shuttles.
- Use parking count system, event management staff and traffic management center technologies (traffic camera, DMS, etc.) to gather real-time parking and traffic information for event-day management.
 - Use static and dynamic messages to direct and redirect parking demand based on parking facility status.
- Coordinate with multiple internal and external departments/agencies to collectively carry out the parking and traffic management plan elements. For examples:
 - I-394 reversible lane depending on the direction of event traffic;
 - Event traffic signal timing plans along University Ave and 4th St;
 - Towing of illegal on-street parking;
 - Internal process of traffic/parking management plan improvement.



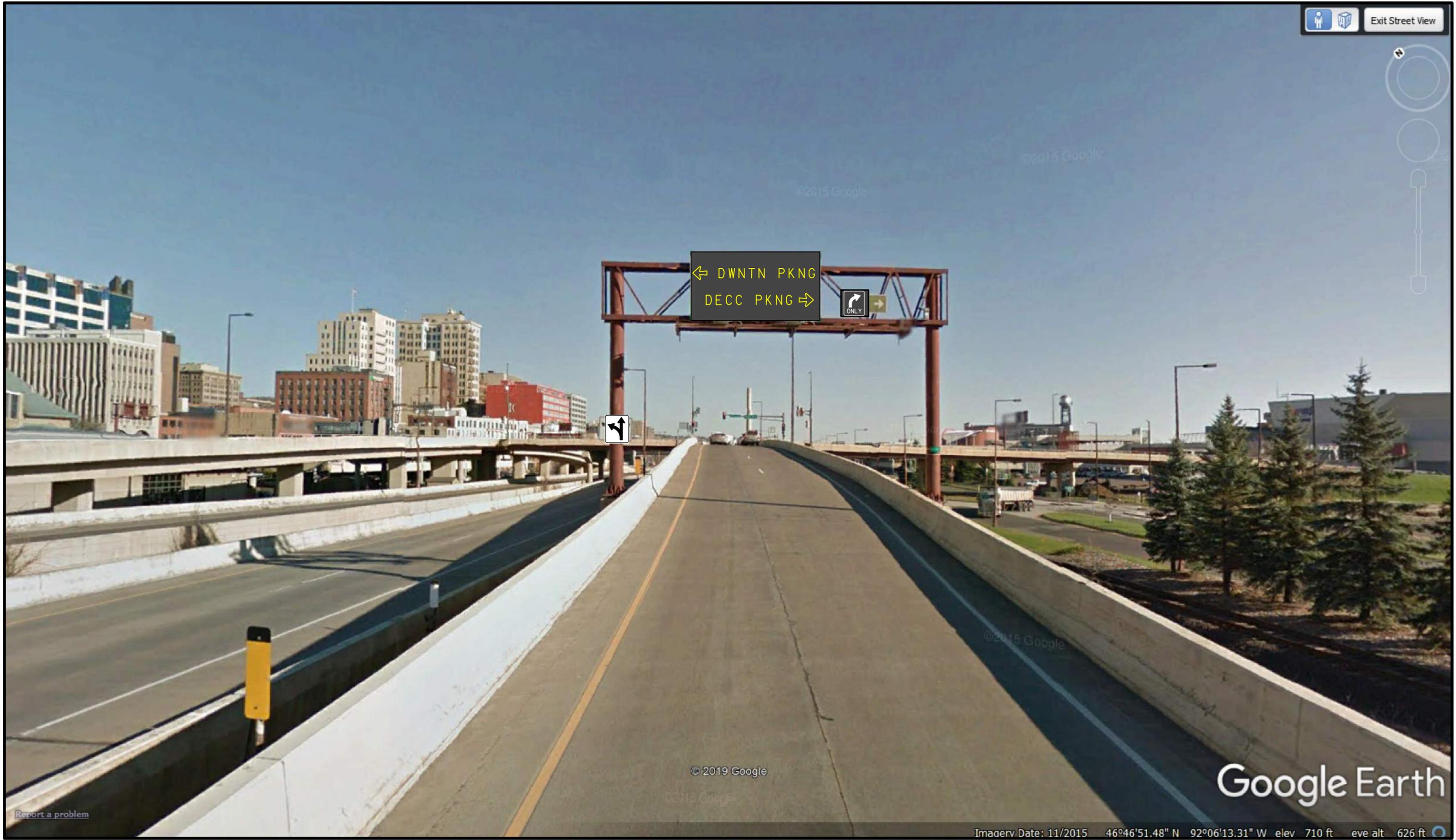
Figure A-3 Recommended Ingress/Egress Routes to/from Event Parking

As a result, the University often achieves beyond 92% parking occupancy in major parking facilities (with spaces over 1,000) during recent large-scale events and accommodates event parking demand at its campus facilities with minimal parking entry declines⁴. The parking circulation is also limited thanks to the guided parking access routes, contingency/redirection plans when facility is reaching capacity, and reservation of cash parking capacity at key locations.

The University uses a checklist to coordinate parking/traffic management plan executions on the event day. The original event traffic/parking management plan has been continuously reviewed by internal and external experts and evolved to adapt for different types and scales of events, such as (Vikings Football, Basketball, Hockey, concerts, United FC games, etc.), on the University of Minnesota – Twin Cities campus.

⁴ Anonymous. Former essential employee insights. 2017.

Attachment E:
Renderings and Examples of Select Strategies



Bayfront Area Long-term Project Recommendation

Figure E1 DMS and Dynamic Lane Assignment Sign for I-35 Northbound Exit Ramp at 5th Ave W



Bayfront Area Long-term Project Recommendation

Figure E2 Covered Pedestrian Walkway in Saint Paul



Note:
 These event parking static signs were installed by the City of Duluth for Bentleyville event in November & December 2018, which can continue for future years if deemed effective.

Legend

-  **Event Parking Static Signage***
-  **Parking Location**
-  **Route to Event Parking Lot**

* Symbol represents a sign face and mounting posts

Figure E3 Garfield Lot Wayfinding
 (Piloted for Bentleyville Event in 2018)