



Pearl Street Planning Study– Battery Street to George Street

Burlington, Vermont

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Final Report

Prepared by:



Prepared for:

City of Burlington, Vermont



*Chittenden County Regional
Planning Commission*





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This study is the result of the support and strong interest of the Project Committee Members. Much of the background, history, local input, existing conditions, and consensus documented in the study are attributed to the Committee member's involvement. The study's quality and success is due to their contributions.

Executive Summary

The *Pearl Street Planning Study – Battery Street to George Street* was prepared at the request of the City of Burlington and the Chittenden County Regional Planning Commission (CCRPC) to guide development of Pearl Street as a “complete street”. The project study area extends west along Pearl Street from George Street to and including its intersection with Battery Street. As described in the 2011 City of Burlington Transportation Plan, complete streets effectively serve all travel modes allowing the alternative modes (transit, bike and walking) to compete more successfully with automobiles for the mode of choice. Implementation of the recommended changes in this study will extend the complete street concepts recently constructed along Pearl Street in the vicinity of Church Street westerly to Battery Street creating more consistent accommodations for all roadway users.



Complete Street Concept from the 2011 Burlington Transportation Plan

Existing Conditions

Pearl Street under existing conditions falls short of the City’s design guidelines for a complete street in several respects. Most notably Pearl Street in the study area lacks dedicated accommodations for cyclists. From a pedestrian perspective, sidewalks are provided on both sides of the roadway however, their proximity to vehicular traffic on some sections, barren “greenbelts” and a lack of amenities such as street furniture degrade the pedestrian experience. Likewise, accommodations for pedestrians crossing Pearl Street and Battery Street are very basic even where crossing distances are substantial. At the same time there is excess capacity for vehicular traffic particularly west of North Champlain Street where four travel lanes are provided. Vehicular traffic and abutting businesses are also served by on-street parking east of North Champlain Street. This parking approaches full occupancy during peak periods. The vehicular crash rate on Pearl Street in the study area is quite high and listed as No. 7 on the state’s High Crash Location segment list.

Study Context

The study emphasizes improvements that can be implemented quickly in consideration of one recent project and one proposed project in site vicinity. Immediately east of the study area the City recently constructed streetscape improvements, installed curb extensions (bump outs) at intersections and striped bike lanes on Pearl Street. These improvements have enhanced one section of the pedestrian and bicycle connection between the Church Street Marketplace and Battery Park overlooking Lake Champlain leaving the section from St. Paul Street to Battery Park unimproved. Also, the Chittenden County Transportation Authority has broken ground on a new Downtown Transit Center to be constructed on St. Paul Street. A portion of Pearl Street will be reconstructed and reconfigured at St. Paul Street as part of the Transit Center project. Short-range plans reviewed in this study seek to quickly create a pedestrian and bicycle experience west of St. Paul Street that is reasonably consistent with the existing experience east of St. Paul Street. Longer range strategies to more fully upgrade the Pearl Street corridor west of St. Paul Street are identified in this report and will developed further as part of future planning studies.



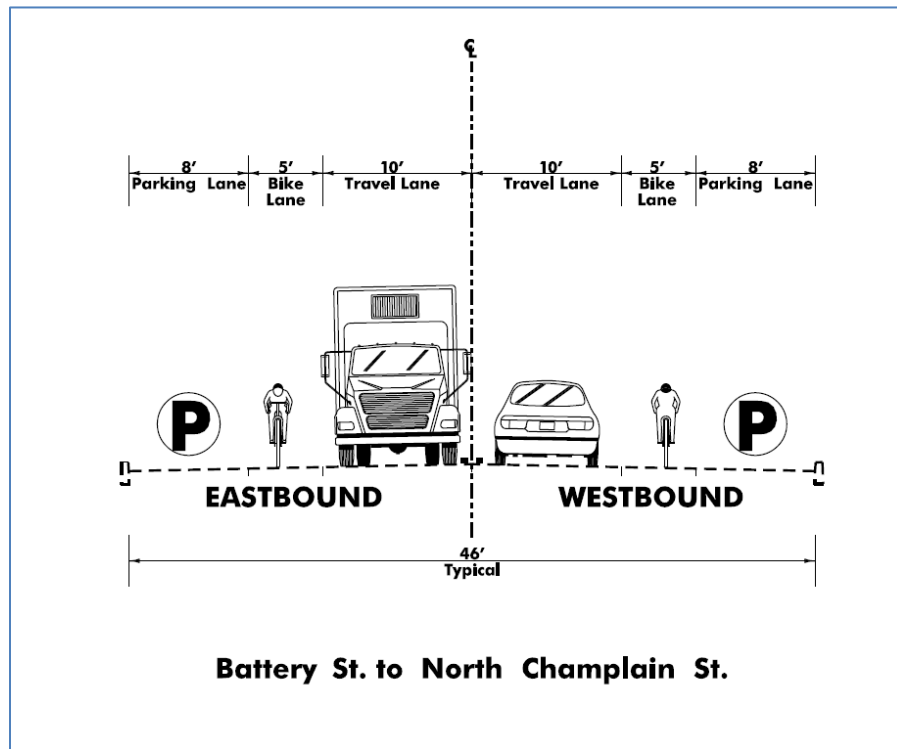
Newly Installed Bike Lane and Curb Extension at St. Paul Street

Short-Range Alternatives

A variety of low-cost, easy to implement actions were considered for Pearl Street to achieve the goal of creating a more complete street. These include “curb-to-curb” treatments, that is, the reallocation of the existing pavement among vehicular travel lanes, parking lanes and bike lanes. Changes to existing crosswalks within the roadway were also considered. Outside the curbs opportunities to enhance the streetscape were defined.

Several curb-to-curb treatments were considered for each of three segments of the roadway and the treatments varied by segment as the travel demands and roadway width vary by location. (The roadway is 40 feet wide in the middle segment and 46 feet wide on the two end segments.) Each treatment considered included at least one vehicular travel lane in each direction and a dedicated bike lane in each direction. Variations related to the provision of on-street parking and/or buffers for the bike lanes. Viable and compatible segment treatments were then combined to create alternative concept plans for detailed evaluation. The evaluations defined impacts on vehicular traffic operations including buses and emergency vehicles, on-street

parking supply, quality of bike accommodations and quality of pedestrian accommodations.



Sample "Curb-to-Curb" Treatment Studied

Recommended Plan

The proposed plans were subjected to stakeholder (multiple City departments, the Chittenden County Transportation Authority and Local Motion) and public review processes. A recommended plan was developed based on the technical evaluation of the initial concept plans and comments received during the review processes. The recommended plan introduces minimum five-foot wide bike lanes in each direction along the roadway. West of Pine Street a minimum two-foot wide buffer is provided between the proposed bike lane and on-street parking. Some of the 28 on-street parking spaces within the study area are relocated with a slight reduction in the parking supply to 27 spaces. Painted curb extensions will be used to shorten pedestrian crosswalks where on-street parking is proposed. The proposed repurposing of the outside right-turn lane from Battery Street to Pearl Street will allow for shorter pedestrian crossings at the Battery Street and Pearl Street intersection as well. Streetscape improvements include replacing some barren and difficult to maintain greenbelt sections with hardscape. Planters, street furniture and public art will be added to the more vital greenbelt sections.



Rendering of Recommended Plan Looking East from Battery Street.

Long-Range Strategies

Potential long-range (and more costly) strategies to further enhance the study corridor have been identified for more detailed evaluation and development in future studies. These strategies include reconstruction of existing sidewalks and wheelchair ramps, converting the proposed painted curb extensions into raised curb extensions and widening the roadway to a consistent 46-foot cross section. A forthcoming, citywide bike and pedestrian master plan will provide a broader context to evaluate these proposals.

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1.0 Introduction

The City of Burlington in conjunction with the Chittenden County Regional Planning Commission (CCRPC) is exploring opportunities to reconfigure Pearl Street between Battery Street and George Street as a complete street, a roadway that effectively accommodates all travel modes. Presently, the roadway serves vehicular and transit traffic with a four-lane cross section west of North Champlain Street and with a two-lane cross section and on-street parking east of North Champlain Street. Sidewalks are provided on both sides of the roadway throughout this section. Missing elements of a complete street are dedicated accommodations for bicycles, comfortable crosswalks for pedestrians, street trees and seating areas.

The City and the CCRPC commissioned this study principally to consider short-range plans for Pearl Street that can be implemented quickly and for low cost. Within the roadway proposed short-range plans primarily consist of changing pavement markings to reallocate the use of space as vehicular travel lanes, parking stalls and/or bike lanes and to enhance crosswalks. Likewise, proposed pedestrian amenities along the roadway include new benches, planters and public art that may be installed without disturbing below-grade utility lines. Proposals that could involve more costly actions such as widening or narrowing the roadway or planting street trees are identified as long range strategies for further consideration as part of the city-wide pedestrian and bike masterplan and the city-wide Street Design Guidelines. This report documents the technical analyses and public review process leading the development of a short-range plan and longer range strategies for Pearl Street.

1.1 Background

Goals and objectives for the Pearl Street corridor have been defined in several recent planning studies. Findings and recommendations from these studies are summarized below.

1.1.1. Plan BTV – Downtown and Waterfront

Recommendations for Pearl Street are presented in *Plan BTV- Downtown and Waterfront* adopted by the City in 2013. This master plan emphasizes the need to enhance pedestrian and bicycle accommodations along Pearl Street. It cites Pearl Street as a barrier between the Old North End (O.N.E.) and the downtown and recommends “strategic infill development, active uses at the street level, and pedestrian improvements to major intersections” as ways to “improve Pearl Street’s appeal and play an important role in providing this enhanced link” between downtown and the O.N.E.. Specific improvements proposed reflect an extension of work recently completed along Pearl Street just east and west of Church Street described in the master plan as follows:

“The master plan calls for streetscape improvements throughout the downtown to improve safety and the user experience for pedestrians and cyclists. Along the Pearl street corridor, sidewalk improvements have been in the works for the past year for the blocks between Winooski Avenue and St. Paul Street. Expansion of this work all the way to Battery Street would ensure continuation of the pedestrian experience. Other improvements are needed for the entire length of Pearl Street, including better lighting,

more street trees, benches, and civic art. Pearl Street, with its connection to Colchester Avenue is one of our main East-West thoroughfares, moving people in and out of the downtown. Therefore, Pearl Street, just like Main Street, can provide a second continuous bike route through the city.” **Plan BTV- Downtown and Waterfront 2013**

Battery Street, at the western limit of the project study area, is identified in *Plan BTV* as a barrier to east-west pedestrian and bike travel in Burlington. The plan notes that “the existing design of Battery Street from Battery Park (Pearl Street) to Maple Street is primarily geared towards the automobile, with very few amenities for cyclists and pedestrians. Because of this auto-oriented focus, the street presents a physical obstacle, conflicting with the City’s desire to better connect Church Street to the waterfront. A road diet or complete street project, reducing the focus on car travel, could increase safety for bikes and pedestrians.”

1.1.2. 2011 Burlington Transportation Plan

The emphasis on bicycle accommodations along Pearl Street reflected in *Plan BTV – Downtown and Waterfront*, to some extent, contradicts the recommendations of the *2011 Burlington Transportation Plan*. The *2011 Burlington Transportation Plan* defines and broadly supports Complete Streets however, it specifically identifies Pearl Street as a “Transit Street”. The Plan’s Street Design Guidelines note, “The first priority of the Transit Street is to facilitate efficient transit movement.” In addition the plan notes that, “in the circulation plan, Transit Streets transition from Complete Streets in places where bicycles are diverted to a parallel “Bicycle Street” or path. There are no bicycle lanes on the Transit Street.” The plan however, does not identify a parallel Bicycle Street to accommodate cyclists who would otherwise use Pearl Street.

Consistent with the Transit Street designation for Pearl Street, the City and the Chittenden County Transportation Authority (CCTA) have been developing plans to construct a new Downtown Transit Center on St. Paul Street between Pearl Street and Cherry Street. Some CCTA buses will access the new transit hub by way of Pearl Street and a section of Pearl Street adjacent to St. Paul Street will be used for on-street bus parking.

1.1.3. 2009 Waterfront North Access Scoping Study

The *2009 Waterfront North Access Scoping Study* prepared for the Burlington Department of Public Works examined conditions along Battery Street with the goal of improving pedestrian connections between the downtown area and the waterfront. At Pearl Street, elimination of the outside right-turn lane on Battery Street northbound at Pearl Street was recommended for further study. In response to this recommendation, an internal memorandum prepared by the Burlington Department of Public Works in 2011 examined the operational impacts of the proposed lane reduction. No final recommendations were made however, Public Works concluded that the elimination of a right-turn lane on Battery Street might also allow for a narrowing of Pearl Street thereby shortening pedestrian crossings and improving “pedestrian accessibility and safety across Battery and Pearl Streets”.

The goal of this current study is to explore strategies to better accommodate pedestrians, bicycles and transit vehicles in the Pearl Street corridor and create a truly complete street.

1.2 Project Area

The project study area includes Pearl Street in Burlington, Vermont between Battery Street and George Street. Pearl Street is viewed as the northern limit of the urban core. It's location between Battery Park overlooking Lake Champlain and Church Street, Burlington's pedestrian-only, retail street, is noted in Figure 1. Mixed commercial, institutional and residential uses are located along this segment with retail uses generally more concentrated at the eastern end more proximate to the Church Street Marketplace.

Pearl Street serves as an east-west travel corridor through the downtown area. The segment between Battery Street and North Champlain Street also functions as part of a north-south travel corridor. This segment of Pearl Street and North Champlain Street are designated as Route 127. North Champlain Street is a part of a couplet of one-way streets. North Champlain Street operates in the northbound direction. Park Street, which is west of North Champlain Street is a one-way southbound street and is also designated as Route 127.



Figure 1 Project Study Area

1.3 Study Process

A multi-step planning process was completed that included the following major steps listed below.

- Project Initiation
- Data Collection and Quantification of Existing Conditions
- Future Traffic Forecasts and Analysis
- Development and Evaluation of Alternatives
- Public Meeting
- Selection of Preferred Alternative
- Documentation

During the project initiation phase the study team was assembled and a work plan was developed. Data were then collected to define existing roadway and peak period traffic conditions. Traffic forecasts were then developed and used to evaluate expected roadway operations under future conditions assuming some growth in travel demands. Alternative strategies to accommodate bicycles along Pearl Street were developed and evaluated by the project team. The findings of the alternatives analysis were reviewed at a stakeholders meeting comprised of representatives from various city departments and from the Chittenden County Transportation Authority (CCTA). The findings were then presented to area residents at a public meeting. (Meeting minutes are attached.) At this meeting the expected performance of each alternative in terms of traffic operations, bicycle accommodations, pedestrian experience and parking supply were described. Upon consideration of stakeholder and public comments a preferred alternative was selected.

2.0 Existing Conditions

Field observations and plan research was completed to establish existing roadway, parking and traffic conditions along Pearl Street. The results of these investigations are presented below.

2.1 Existing Roadway Conditions

The project study area includes an approximately one-quarter mile section of Pearl Street between Battery Street and St. Paul Street. An existing conditions base plan was compiled for this area using orthophoto data and ground surveys completed for the proposed Downtown Transit Center on St. Paul Street. Given the source of the data all measurements are approximate and should be verified through a survey in conjunction with the development on any construction plans for the corridor.

The compiled base plan, Figure 2, is attached. As noted, the roadway cross section (curb-to-curb dimension) varies along the segment. West of North Champlain Street where four 11 to 12 foot wide travel lanes are provided the travelway width is approximately 46 feet. A 46-foot cross section is also provided east of Pine Street where a single 15 foot wide travel lane is provided in each direction and on-street parking is provided on both sides of the roadway. The middle section between North Champlain Street and Pine Street is only 40 feet wide but also provides a single 12 foot wide travel lane in each direction and parking on both sides of the road for much of this section. The on-street parking supply includes 16 spaces between North Champlain and Pine Streets and 12 spaces between Pine Street and George Street. To the east of the study area another ten on-street spaces are provided between George Street and St. Paul Street. No on-street parking is permitted west of North Champlain Street. Public off-street parking is provided in a 31-space lot north of Pearl Street between North Champlain Street and George Street.

As noted above there are presently no dedicated bike facilities on Pearl Street between George Street and Battery Street. Bike lanes were recently delineated on Pearl Street east of St. Paul Street. In the study area bicycle traffic must share space with vehicular traffic. (Riding on sidewalks by adults is not permitted in the urban core.)

Sidewalks are present throughout the study area on both sides of Pearl Street and intersecting roadways but several sections are not compliant with the Americans with Disabilities Act (ADA). As assessment of ADA compliance is provided in Appendix A. The minimum sidewalk width is five feet. Wider sections, generally at the eastern end of the study area, range from 8.5 to 14.5 feet. Sections of four to five-foot-wide grass strips or greenbelts are provided in three locations:

- South side of Pearl Street between Battery Street and North Champlain Street
- North side of Pearl Street between North Champlain Street and Pine Street
- South side of Pearl Street between Pine Street and George Street

The section just east of Pine Street and in front of the Pearl Street Diner is heavily compacted and supports very little grass. It is mostly dirt. Similar compaction exists on the north side of the roadway in the middle section adjacent to the Social Security office. In both locations the greenbelts are located adjacent to metered on-street parking suggesting that passengers entering and exiting the vehicles using these spaces impede the growth of grass. There are no street trees planted in any of the greenbelts. There are several trees growing on the roadway right-of-way line or on private property immediately adjacent to the roadway right-of-way as noted in Figure 2. The intersections along Pearl Street in the study area and the adjacent St. Paul Street/Pearl Street intersection are described below.

2.1.1 Battery Street and Pearl Street Intersection

The busiest intersection in the corridor at Pearl Street and Battery Street has full traffic signal control. At this T-type intersection the Pearl Street approach and Battery Street approaches operate during separate signal phases. Battery Street southbound has an advanced green phase to help process left-turns into Pearl Street. Exclusive, pedestrian signal phases, actuated by push buttons are also provided. Two approach lanes are provided on Pearl Street one dedicated for right turns and the other for left turns. The southbound Battery Street approach includes one through lane and a shared through/left-turn lane. The Battery Street northbound approach includes one through lane and two right-turn lanes. The eastbound departure lanes (which receive traffic from the two right-turn lanes) become a dedicated left-turn lane and a through and right-turn approaching North Champlain Street.

2.1.2 North Champlain Street and Pearl Street Intersection

North Champlain Street (Route 127) is a one-way northbound street beginning at Pearl Street. A private driveway, enters Pearl Street from the south opposite North Champlain Street. Traffic control conditions at the North Champlain Street and Pearl Street intersection are somewhat unique. Typically, motorists on Pearl Street will see a flashing yellow signal indication and traffic on a private driveway entering Pearl Street from the south opposite North Champlain Street will see a flashing red signal. When traffic is present on the private driveway a detector will call a green signal phase for the driveway stopping all Pearl Street traffic. Similarly, pushbuttons on the east side intersection corners allow pedestrians to actuate an exclusive “walk” phase allowing pedestrians to cross Pearl Street on the east leg of the intersection while all vehicular traffic is stopped. There is no crosswalk on the west leg of the intersection. Pedestrians headed westbound on Pearl Street and crossing North Champlain Street or the private driveway could use the push buttons to stop traffic. Pushbuttons are not available on the west side of the intersection to assist eastbound pedestrians. At this intersection two approach lanes are provided on Pearl Street eastbound with one designated as an exclusive left-turn lane to North Champlain Street. A single, 20-foot wide lane is provided on Pearl Street westbound. Two 11 foot wide northbound departure lanes are provided on North Champlain Street and parking is provided on the east side of the roadway. As such the North Champlain Street pedestrian crossing is approximately 30 feet.

2.1.3 Pine Street and Pearl Street Intersection

The Pine Street and Pearl Street intersection is also subject to full traffic signal control. Simple two-phase operation allows Pine Street traffic and Pearl Street traffic to operate in separate phases. Concurrent pedestrian phases are provided and crosswalks are provided on all three intersection approaches. Each approach to this

T-type intersection provides a single lane. Eastbound a 12 foot wide lane is provided and a 15 foot wide lane is provided westbound. With on-street parking the pedestrian crossing distance is 40 feet on the west leg of the intersection. On-street parking provided on both sides of Pine Street and 11 foot travel lanes result in a 38 feet crossing distance of Pine Street at Pearl Street.

2.1.4 George Street and Pearl Street Intersection

The George Street and Pearl Street intersection is the only intersection without traffic signal control. George Street is one-way southbound with two approach lanes (left-turn and right-turn) under STOP sign control. Five foot wide sidewalks are provided on both sides of George Street separated from the 26 foot wide roadway by six foot wide greenbelts. A crosswalk is provided across George Street and across Pearl Street on just the west leg of the intersection. On-street parking is provided along both sides of Pearl Street east, west and opposite George Street. With 15- foot wide travel lanes on Pearl Street the Pearl Street pedestrian crossing is 46 feet at this location.

2.1.5 St. Paul Street and Pearl Street Intersection

The St. Paul Street and Pearl Street intersection is also a T-type intersection which operates very similar to the Pine Street and Pearl Street intersection. Again, simple two-phase signal operation is provided with concurrent pedestrian phases and crosswalks are provided on all approaches. Each approach to this intersection provides a single lane. Modifications are proposed to this intersection as part of the Downtown Transit Center plans described below.

2.2 Traffic Volumes

Traffic volume data for the study area were collected to establish existing morning and evening peak hour travel demands. Vehicle, bike and pedestrian turning movement counts were conducted by the CCRPC during June and July of 2014 at the Pearl Street intersections with Battery Street, North Champlain Street and Pine Street. Historically, traffic volume levels on Vermont roadways vary seasonally with peak levels occurring in Burlington during the summer months. Surveys were conducted during weekday peak periods, 7 to 9 AM and 4 to 6 PM. AM peak hour volumes were observed from 7:45 to 8:45 AM and the PM peak hour occurred from 4:45 to 5:45 PM. The observed existing traffic flow networks for AM and PM peak hours are shown in Figures 3 and 4. The collected traffic data are included Appendix B. As noted, the highest traffic volume levels in the study area occur along Battery Street which carries more than 1500 vehicles during peak hours. Directional flows are heaviest southbound (towards downtown) in the morning and northbound in the evening. In contrast, volumes on Pearl Street east of North Champlain are relatively balanced by direction and much lower, on the order of 600 to 700 peak hour vehicles. West of North Champlain Street directional volumes are influenced by Pearl Street's designation as the northbound segment of Route 127. During both AM and PM peak hours volumes are heaviest in the eastbound direction on this section as northbound traffic on Battery Street makes "the jog" to continue northbound on Route 127/ North Champlain Street. The left-turn volume from Pearl Street eastbound to North Champlain Street is at its highest level during the PM peak hour with 215 left turns observed.

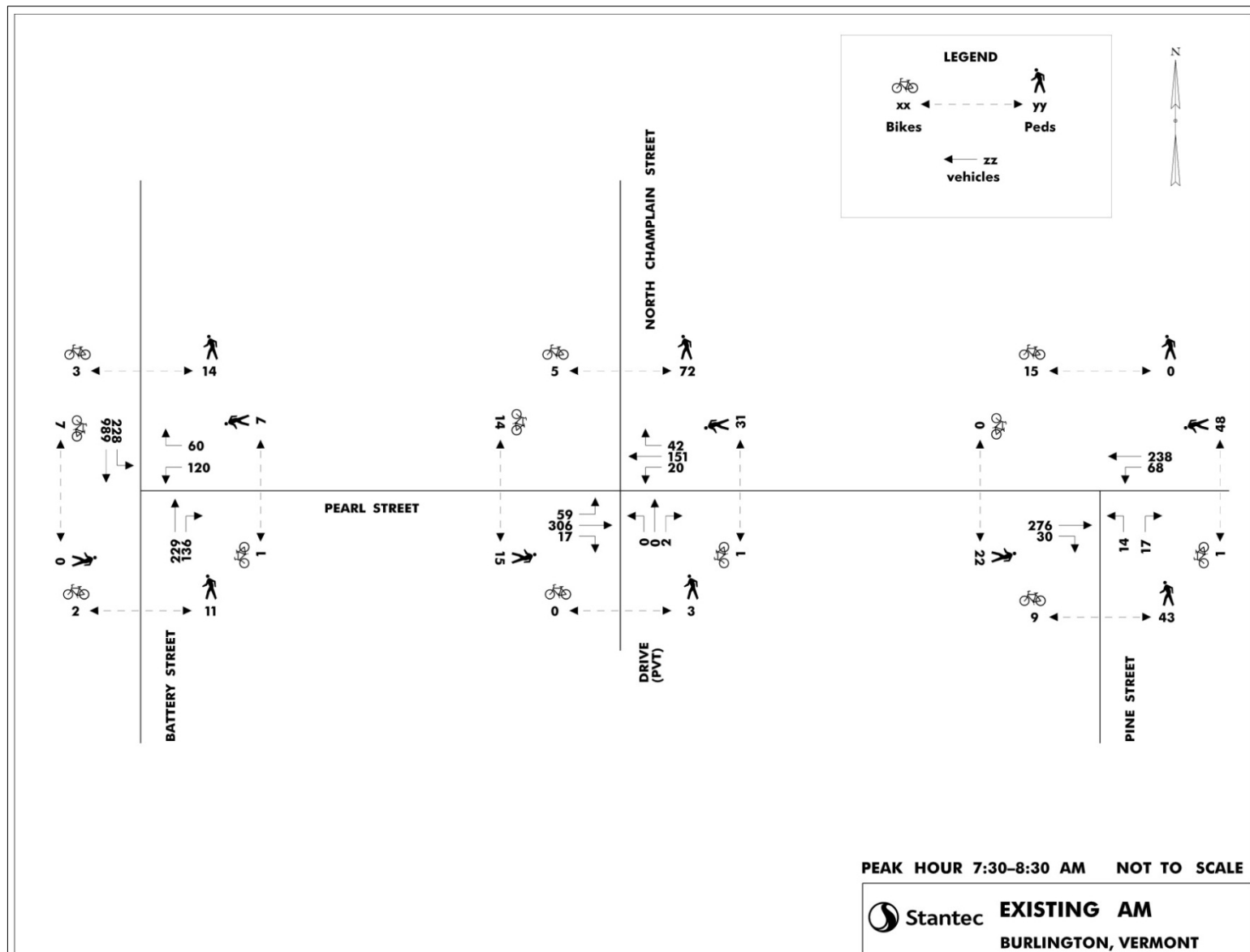


Figure 3 AM Peak Hour Traffic Conditions

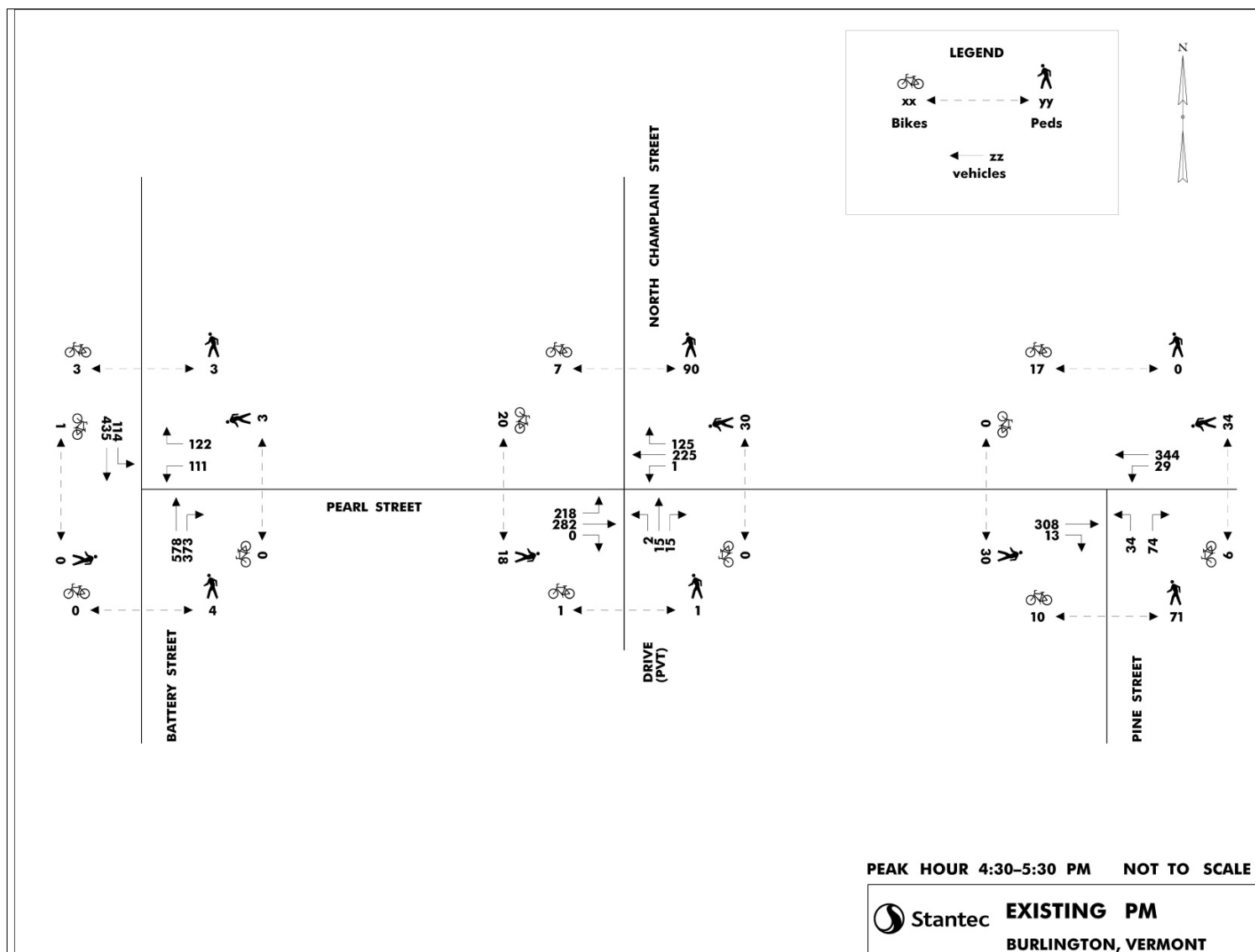


Figure 4 PM Peak Hour Traffic Conditions

Pedestrian and bike activity in the study area is also documented in Figures 3 and 4. Crosswalk counts for movements on the north side of Pearl Street at North Champlain Street and on the south side at Pine Street indicate approximately 115 east-west pedestrian movements during the AM peak hour and 160 movements during the PM peak hour. East-west bicycle traffic along Pearl Street includes approximately 25 cyclists during both AM and PM peak hours. Pedestrian and bicycle counts taken at the Battery Street intersection were conducted during rainy weather and likely are not indicative of peak activity levels.

2.3 Traffic Operations

Intersection and roadway operating levels of service (LOS) are calculated for the study area intersections based on the traffic volume, geometry and traffic control data provided above.

2.3.1 Level of Service Criteria

Level of service is a term used to describe the quality of the traffic flow on a roadway facility at a particular point in time. It is an aggregate measure of travel delay, travel speed, congestion, driver discomfort, convenience, and safety based on a comparison of roadway system capacity to roadway system travel demand. Operating levels of service are reported on a scale of A to F, with A representing the best operating conditions with little or no delay to motorists, and F representing the worst operating conditions with long delays and traffic demands sometimes exceeding roadway capacity.

A Policy on the Geometric Design of Highway and Streets published by the American Association of State Highway and Transportation Officials provides guidance relative to the selection of an appropriate level of service for roadway design. In selecting an appropriate level of service the traveling public's tolerance for traffic congestion and the resources available to provide high performing facilities should be considered. It recommends Level of Service (LOS) C or better for most conditions but acknowledges that LOS D may be appropriate for urban settings where trip lengths are shorter and driver tolerance for delays are greater. Also, the cost of building wider, higher capacity roadways in urban settings are typically much greater than elsewhere. In addition to the cost/vehicular capacity tradeoff, greater traffic capacity generally means less convenience and safety for pedestrians as roadways become wider and pedestrian crossings become longer.

Intersection operating levels of service are calculated following procedures defined in the *Highway Capacity Manual*, published by the Transportation Research Board. For signalized intersections the operating level of service is based on travel delays. Delays can be measured in the field but generally are calculated as a function of traffic volume; peaking characteristic of traffic flow; percentage of heavy vehicles in the traffic stream; type of traffic control; number of travel lanes and lane use; intersection approach grades; and, pedestrian activity. Through this analysis, volume-to-capacity ratios can be calculated for individual movements or for the intersection as a whole. A volume-to-capacity ratio of 1.0 indicates that a movement or intersection is operating at its theoretical capacity. The specific delay criteria applied per the *2000 Highway Capacity Manual* to determine operating levels of service are summarized in Table 1.

Signalized Intersections	
Level of Service	Average Delay per Vehicle (Seconds)
A	≤10.0
B	10.1 to 20.0
C	20.1 to 35.0
D	35.1 to 55.0
E	55.1 to 80.0
F ¹	>80.0

Table 1: Intersection Level of Service Criteria

¹Level of Service F is also assigned to individual lane groups if the volume-to-capacity ratio exceeds 1.0.

Source: *2010 Highway Capacity Manual*, Transportation Research Board, National Academy of Sciences, Washington, DC, 2010.

2.3.2 Calculated Operating Levels of Service

Capacity analyses for the study area intersections were conducted following the procedures of the *Highway Capacity Manual* using the Synchro software package. For conservatism, the North Champlain Street/Pearl Street intersection was analyzed as if it had a fully operational signal when in fact it typically is on “flash” mode. (Analyses were not conducted for the St. Paul Street/Pearl Street intersection as operations at this location were addressed in studies done for the proposed new Downtown Transit Center at this location.) The analysis results are presented in Table 2. The capacity analysis worksheets are included in Appendix C. It was found that each of the three intersections analyzed experience peak hour traffic demands that are well below the capacities of each intersection. The Battery Street/Pearl Street intersection is the busiest of the three and it operates at LOS B during the more critical morning peak hour with a volume-to-capacity (V/C) ratio of 0.72. This V/C ratio indicates that the intersection is accommodating traffic demands that are 28 percent below the capacity of the intersection.

		Existing (2014)		
		LOS ¹	Delay ²	V/C ³
Location	Peak Hour			
Battery Street/Pearl Street				
	AM	B	15	0.72
	PM	B	17	0.64
N. Champlain Street/Pearl Street				
	AM	A	3	0.22
	PM	A	6	0.35
Pine Street/Pearl Street				
	AM	A	7	0.34
	PM	A	8	0.41

¹ LOS= Level of Service

² Delay = Average delay expressed in seconds per vehicle

³ V/C = Volume-to-capacity ratio for critical movements

⁴ For conservatism, the North Champlain Street/Pearl Street intersection was analyzed as if it had a fully operational signal when in fact it typically is on “flash” mode.

Table 2: Existing Intersection Capacity Analysis Results

2.3.3 Field Observations

Field observations confirm the capacity analysis results. During peak hours vehicles queue on Battery Street approaching Pearl Street. The queues typically clear within a single signal cycle consistent with the calculated LOS B operations. Queues were very limited the Pearl Street approach to Battery Street and at the other study intersections.

Field observations were also made of bus turning movements from northbound Battery Street to Pearl Street. Buses were observed turning right from the leftmost right-turn lane and using most of the two eastbound lanes on Pearl Street to complete the turn. Some passenger cars turning right from the rightmost lane were also observed encroaching on the inside eastbound lane of Pearl Street.

2.4 Safety

The crash history for the study area was investigated using the Vermont Agency of Transportation (VTrans) crash database. High Crash Locations (HCL's) experience crash rates that are significantly higher than the statewide average crash rate for comparable locations. The HCL intersection list for the 2008 through 2012 reporting period does not identify any high crash intersections in the study area. However, the 0.3 mile long Pearl Street segment extending east from Battery Street to approximately Church Street is listed as #7 on the HCL roadway segment list. During this five-year period 101 crashes were reported on this segment. Of these 62 crashes occurred between Battery Street and St. Paul Street. Within this segment the greatest concentration of crashes occurred between Pine Street and St. Paul Street. The severity of crashes on the entire 0.3 mile segment is low, perhaps due to the low travel speeds on this segment. Fewer than seven percent of the crashes resulted in personal injuries and no fatalities were reported. The most common crash type reported was “same direction sideswipe” (37 crashes) followed by “rear end” collisions (33 crashes).

2.5 Transit Services

The Chittenden County Transportation Authority's (CCTA) downtown transit center is located on Cherry Street one block south of Pearl Street. As noted above, the new Downtown Transit Center will be built on St. Paul Street between Pearl Street and Cherry Street. Presently, multiple bus routes follow Pearl Street as shown in Figure 5. However, only one route, Route 8-City Loop, has a designated bus stop and shelter on Pearl Street. It is located on the north side of the road east of North Champlain Street.

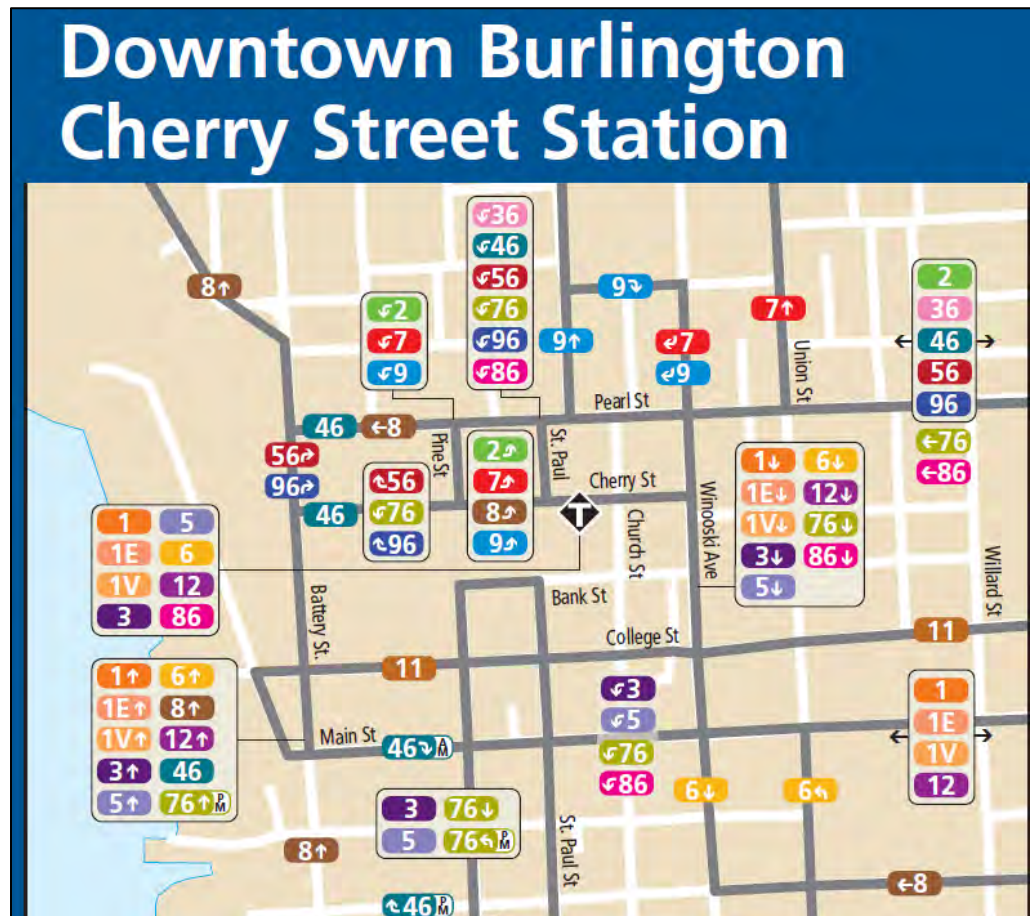


Figure 5 CCTA Bus Routes in Downtown Burlington

2.6 Parking Utilization

Parking conditions in the study area were monitored on several weekdays and weekend days in the summer and fall of 2014 as part of a separate study of downtown parking conditions being conducted by the City. The parking study area limits do not exactly match the limits of this study. The parking surveys considered on-street and off-street spaces along Pearl Street between Battery Street and St. Paul Street with the exception of spaces on the north side of Pearl Street east of George Street. Data for one of the summer weekday observations, Friday, July 18, 2014, is presented in Table 3. The daytime, on-street peak demand occurs at 1 PM when 25 (76 percent) of the 33 on-street spaces surveyed are in use. Up to 31 spaces were occupied at 6 PM or later. Off-street parking demand also reached its highest level during the evening hours with 26 (84 percent) of the 31 public occupied after 6 PM.

Combined, the on-street and off-street parking facilities operate at 80 percent of capacity during the day and 92 percent of capacity during the evening.

Parking Type	Spaces Provided	Vehicles Parked	
		1PM	7 PM
Off-Street	31	26	28
On-Street	33	25	31
Total	64	51	59

Table 3 Existing Parking Utilization

Note: Data for Friday, July 18, 2014. Data collected as part of the 2014 Burlington Downtown Parking Study

4.0 *Future Conditions*

Traffic volume and roadway conditions in the project study area were developed to reflect future conditions. These forecasts consider anticipated future traffic growth and planned roadway improvements in the project area. The future travel demand conditions were later used to evaluate and compare alternative roadway improvement strategies. Travel demand and roadway improvement factors are described below.

4.1 *Future Traffic Growth*

A 2034 future “design year” for the study was selected. The future traffic conditions assume a five percent increase in traffic volumes above existing levels. This reflects an annual growth rate of 0.25 percent per year consistent growth rates applied in other recent traffic studies of City streets.

4.2 *Proposed Transportation System Improvements*

A new Downtown Transit Center is being constructed on St. Paul Street just south of Pearl Street. Figure 6 illustrates the proposed layout of the Transit Center. As shown, a center median/bus loading platform accommodating ten bus berths will be provided on St. Paul Street. The median/platform will essentially create one-way streets on either side of the platform. Additional bus staging areas will be provided on Pearl Street. The bus parking stalls will be 9.5 feet wide compared to the eight-foot-wide stalls now provided on Pearl Street.

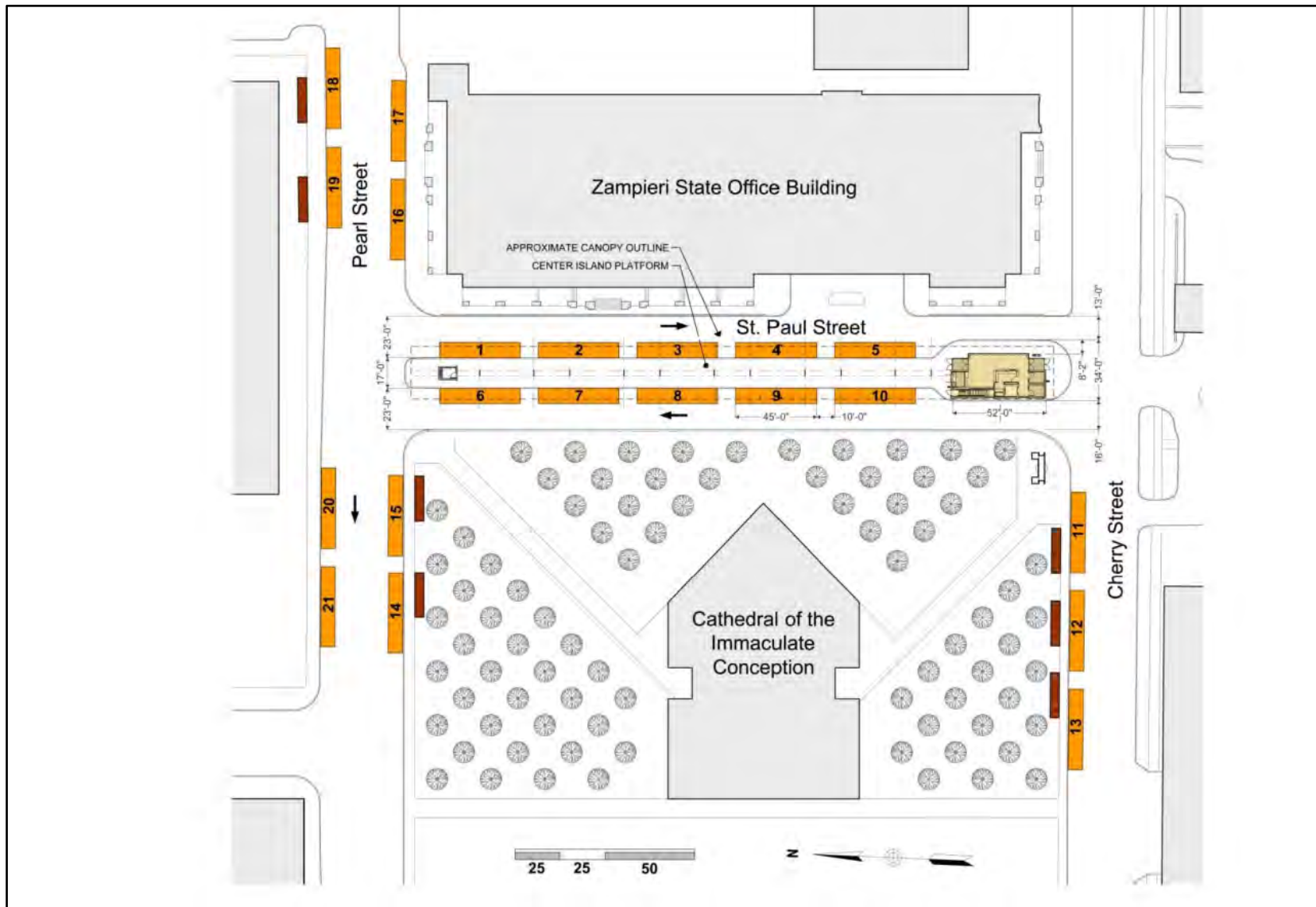


Figure 6 Proposed Downtown Transit Center Plan

4.3 Future Traffic Operations

Capacity analysis results for the study area intersections are compared in Table 4 for Existing and Future conditions. As shown, little change is anticipated in the intersection level of service ratings. Calculated volume-to-capacity ratios for the intersections increase by approximately five percent consistent with the assumed five percent growth in traffic volumes over the next 20 years. Capacity analysis worksheets can be found in Appendix C.

		Existing (2014)			Future (2034) No Build		
Location	Peak Hour	LOS ¹	Delay ²	V/C ³	LOS	Delay	V/C
Battery Street/Pearl Street							
	AM	B	15	0.72	B	16	0.76
	PM	B	17	0.64	B	18	0.68
N. Champlain Street/Pearl Street							
	AM	A	3	0.22	A	3	0.23
	PM	A	6	0.35	A	6	0.37
Pine Street/Pearl Street							
	AM	A	7	0.34	A	8	0.36
	PM	A	8	0.41	A	9	0.43

¹ LOS= Level of Service

² Delay = Average delay expressed in seconds per vehicle

³ V/C = Volume-to-capacity ratio for critical movements

⁴ For conservatism, the North Champlain Street/Pearl Street intersection was analyzed as if it had a fully operational signal when in fact it typically is on “flash” mode.

Note: Future conditions reflect a five percent increase in volumes relative to existing conditions.

Table 4 Future Intersection Capacity Analysis Results

5.0 Short-Range Alternatives

Alternative short-range improvement plans were developed and analyzed for the study area. These alternatives would enhance accommodations and improve connectivity for people walking and bicycling along Pearl Street. The alternatives generally assume that the existing Pearl Street curb lines remain in their present location. However, changes are proposed in how the pavement between the curbs will be used. Within the existing curb lines vehicular travel lanes, vehicular turn lanes, parking lanes, and bike lanes were balanced.

5.1 Bicycle/Cross Section Considerations

Various “curb to curb” cross section treatments were considered to better accommodate bikes within the roadway by adding bike lanes or buffered bike lanes.. The viable alternatives vary by location as the existing curb to curb roadway width varies by location as well. Design criteria used in developing the cross sections are noted in Table 5. These cross sections were used as the building blocks for conceptual improvement plans covering the entire study area.

Roadway Element	Minimum Width (feet)
Bike Lane	5
Vehicular Travel Lane	10
Car Parking Lane	8

Table 5 Roadway Design Criteria

5.1.1 Alternatives West of North Champlain Street

Alternative treatments for Pearl Street west of North Champlain Street respect the existing 46 feet curb to curb width of Pearl Street in this area. Figure 7 illustrates the existing four lane cross section which as noted does not include any on-street parking or bike accommodations. Alternative treatments explore how a reduction in the number of travel lanes might allow for better bicycle accommodations. Figure 8 shows that with only three travel lanes buffered bike lanes could be included in the roadway. Figure 9 shows how reducing the number of travel lanes to only two allows for both bike lanes and parking lanes on Pearl Street. This cross section matches the cross section on the recently reconstructed section of Pearl Street just east of the study area. Figure 10 illustrates how modifying the two-lane concept by eliminating parking from one side of the roadway would allow for buffered bike lanes.

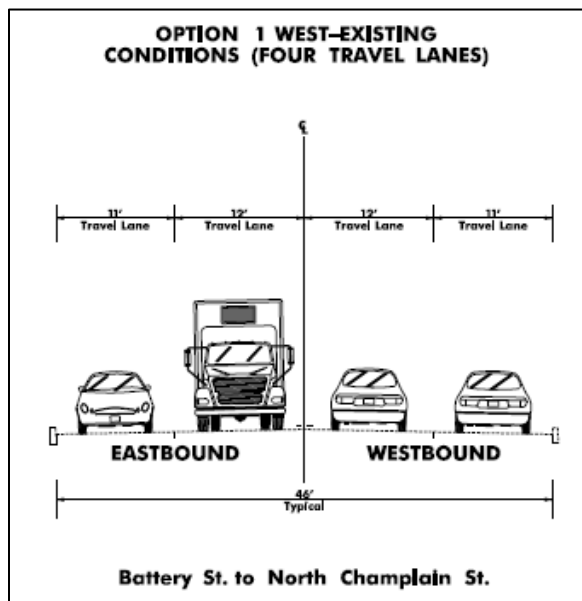


Figure 7 Existing Four-Lane Roadway Cross Section – West

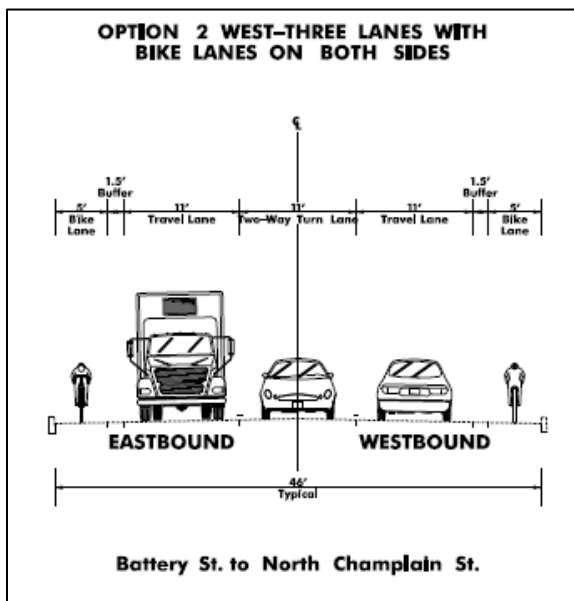


Figure 8 Three-Lane Roadway Cross Section - West

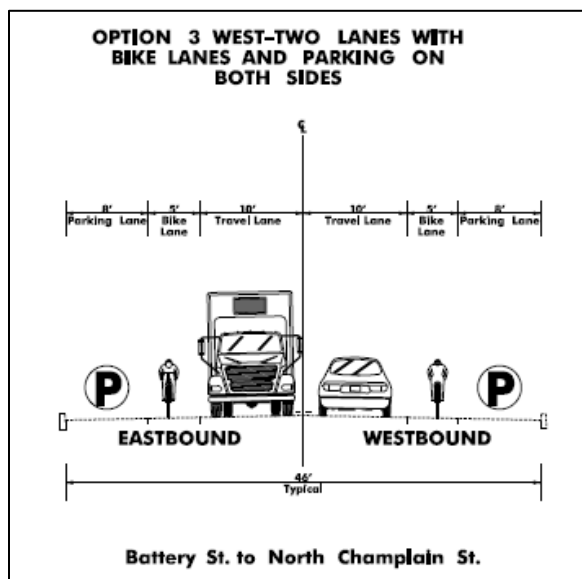


Figure 9 Two-Lane Roadway Cross Section – West

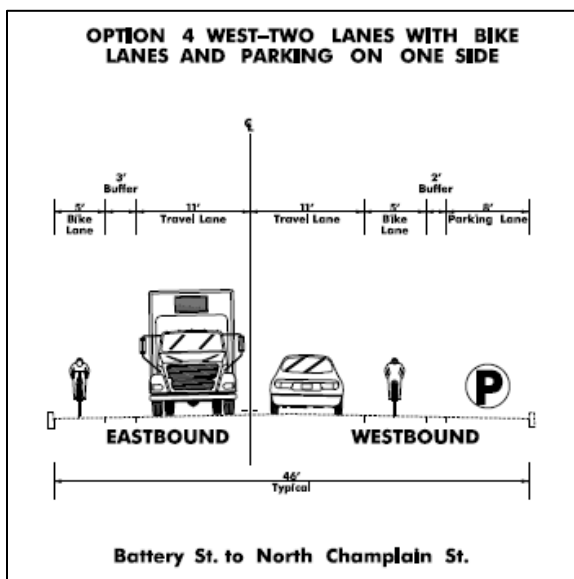


Figure 10 Two-Lane Roadway Cross Section with Parking on One Side West

5.1.2 Alternatives East of North Champlain Street and West of Pine Street (Middle Section)

The middle section of the study area, Pearl Street east of North Champlain Street and west of Pine Street, is 40 feet wide curb to curb. It provides two travel lanes and on-street parking under existing conditions as shown in Figure 11. Figure 12 shows how bike lanes could be added by maintaining parking on one side of the roadway. Figure 13 shows how the 40 feet wide roadway could be used to provide buffered bike lanes.

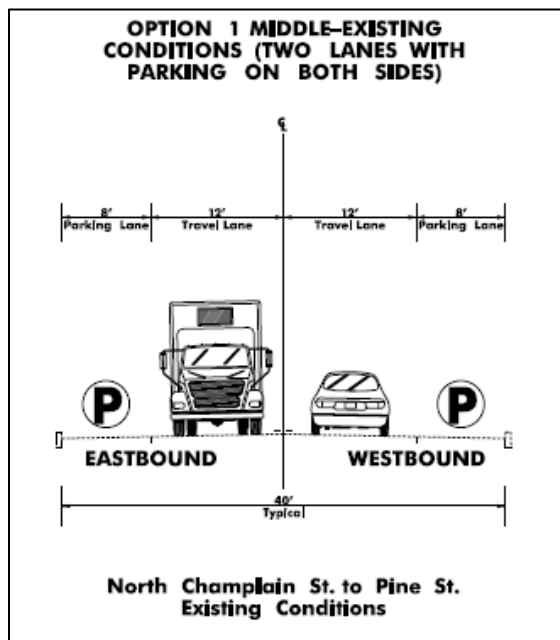


Figure 11 Two-Lane Roadway Cross Section with Parking on Both Sides – Middle

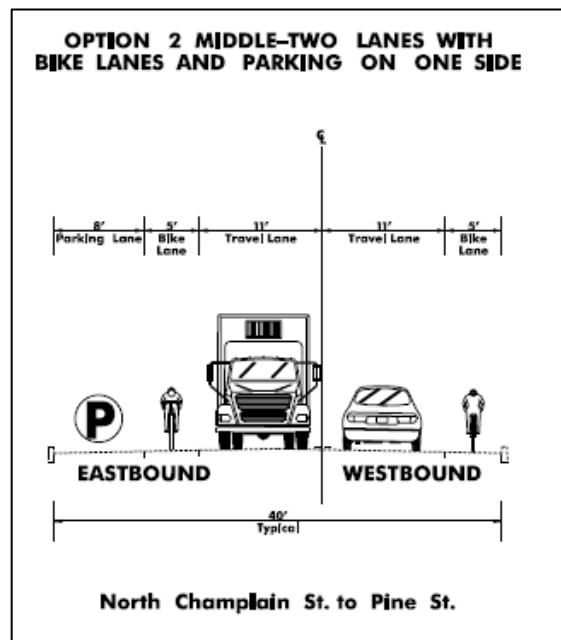


Figure 12 Two-Lane Roadway Cross Section with Bike Lanes on Both Sides and Parking on One Side -- Middle

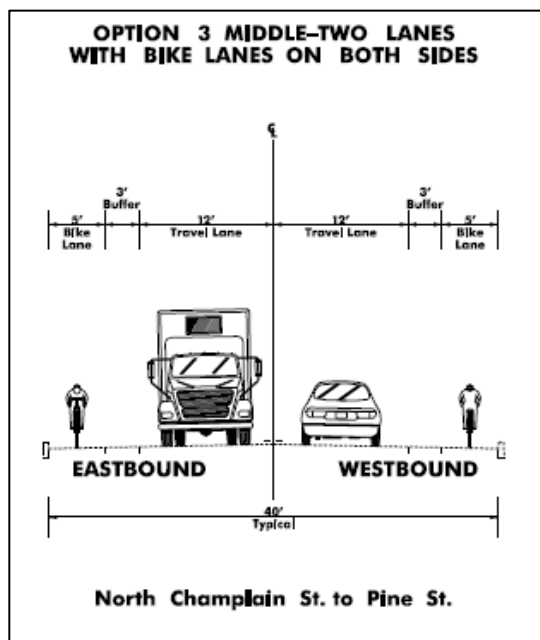


Figure 13 Two-Lane Roadway Cross Section with Bike Lanes on Both Sides – Middle

5.1.3 Alternatives East of Pine Street

Alternative treatments for Pearl Street east of Pine Street Pine Street are similar to those applicable to the west end of the study area since a 46 feet wide roadway is provided in both sections. Existing conditions shown in Figure 14 indicate two 15-foot-wide travel lanes with on-street parking on both sides. Similar to Figure 9 above, Figure 15 shows how the 15-foot wide travel lanes could be restriped to provide 10-foot wide travel lanes and 5-foot wide bike lanes. Likewise, Figure 16 is similar to Figure 10 in showing how maintaining parking on just one side of the roadway would create space to provide buffered bike lanes.

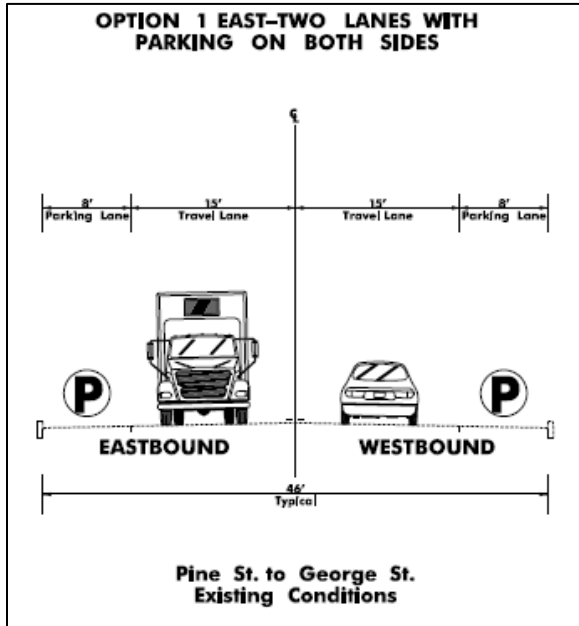


Figure 14 Two-Lane Roadway Cross Section with Parking on Both Sides – East

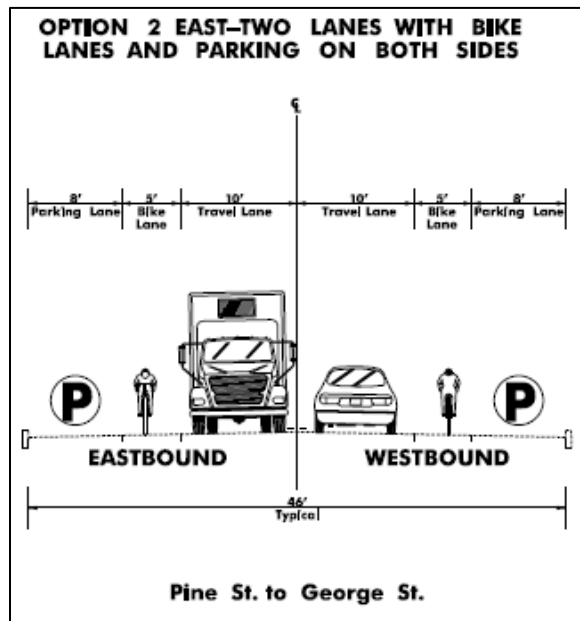


Figure 15 Two-Lane Roadway Cross Section with Bike Lanes and Parking on Both Sides – East

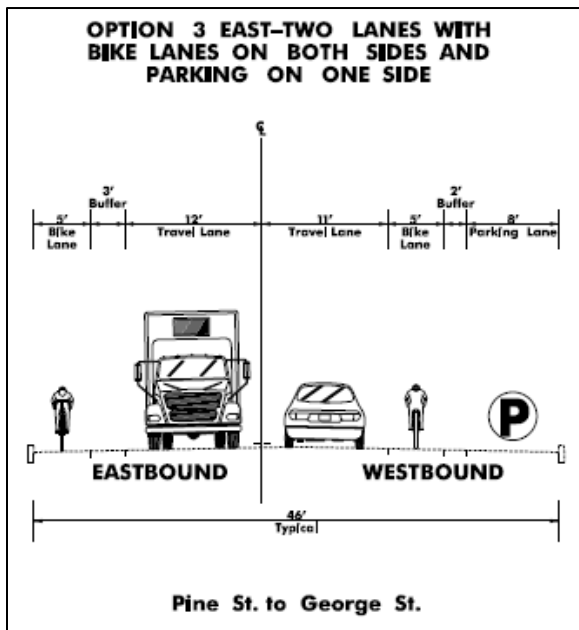


Figure 16 Two-Lane Roadway Cross Section with Bike Lanes on Both Sides and Parking on North Side – East

5.2 Concept Plans

Three conceptual improvement plans for Pearl Street were developed by combining alternative treatments for the west, middle and east sections of the study roadway segment. Three concepts, A, B and C were initially developed assuming that the new Downtown Transit Center would not impact Pearl Street west of St. Paul Street. However, plans for the Transit Center were finalized as this study was being prepared. Consequently, revised concept plans A1, B1 and C1 were developed to align with new Pearl Street curb lines associated with the Transit Center.

Concept A1, with the exception of the Transit Center related curb line change, reflects existing conditions and is used as baseline to evaluate the other two alternatives. Concept A1 is shown in the attached Figure 17.

Concept B1, shown in the attached Figure 18, was developed by first assuming that the west end of Pearl Street would be restriped to include three rather than four vehicular lanes and that a right-turn lane from Battery Street to Pearl Street eastbound would also be discontinued. The treatment, shown earlier in Figure 8, allows buffered bike lanes on the west end of Pearl Street by also restriping Pearl Street for only two travel lanes at North Champlain Street. Here on-street parking, relocated from the north side of the street just west of Pine Street, is shown on the south side of Pearl Street. The bike lanes, without buffering, continue east from North Champlain Street past George Street. On-street parking is maintained on both sides of the roadway east of Pine Street. Minimum ten-foot travel lanes are provided throughout the study area. Wider lanes, 11 to 12 feet wide, are shown where space permits.

Concept C1, shown in Figure 19, was developed by first assuming that the west end of Pearl Street would be restriped for two vehicular travel lanes and that a right-turn lane from Battery Street to Pearl Street eastbound would also be discontinued. The treatment shown in Figure 10 was applied to this section adding buffered bike lanes and adding parking on the north side of the roadway. Continuing to the east parking was generally maintained on the north side of the roadway west of Pine Street and on both sides of the roadway east of Pine Street. The bike lanes are continued to the east (without buffering) past George Street. Minimum ten-foot travel lanes are provided throughout the study area. Wider lanes, 11 to 12 feet wide, are shown where space permits. An approximate 1.5 feet widening of the roadway to the south just west of George Street is shown in order to directly align travel lanes on Pearl Street east and west of George Street.

5.3 Concept Plan Evaluations

The concepts were each evaluated with respect to several quantitative and qualitative performance measures. These include:

- Intersection operations (peak hour operating level of service, volume-to-capacity ratios and vehicle queues)
- On-street parking supply
- Pedestrian accommodations (presence and/or quality of buffers and crossing distances)

- Bicycle accommodations (presence and/or buffering of bike lanes)

Each of the performance criteria are discussed below with respect to the alternatives considered.

5.3.1 Traffic Operations Comparison

As noted above (Section 4.3), the three intersections controlled by traffic signals operate at Level of Service (LOS) B or better under existing conditions and under future “No Build” conditions. (Future No Build conditions assume that traffic volumes grow by five percent relative to existing conditions over the next 20 years.) The three concept plans were evaluated with the projected No Build traffic volumes. Concept A1 generally represents existing roadway conditions and anticipated traffic operations with Concept A1 are consistent with the future No Build traffic analysis results presented earlier. However, Concepts B1 and C1 reduce the number vehicular travel lanes west of North Champlain Street impacting traffic operations at the Pearl Street intersections with Battery Street and with North Champlain Street.

5.3.1.1 Battery Street/Pearl Street Intersection Operations

As shown in Table 6 the changes proposed at Battery Street under Concept B1, discontinuing a northbound right-turn lane on Battery Street, has negligible impact on overall intersection operations and very little impact on delays for the northbound right-turn movement. Combining all of the right-turn demand into a single lane does result in a significant increase in the expected vehicle queues. Vehicle queues in the northbound right-turn lane on Battery Street may occasionally spill back to Cherry Street located 250 feet to the south with Concept B1. However, the analysis results show that the northbound through lane might also extend to Cherry Street under Concept A1.

Table 6 also identifies the consequences of providing only a single westbound approach lane to Battery Street as proposed under Concept C1. For Concept C1 the overall operating level of service decreases from LOS B to LOS C during both AM and PM peak hours relative to No Build conditions. Longer vehicle queues are associated with the projected longer traffic delays. The the westbound (Pearl Street) westbound 95th percentile vehicle queue during the PM peak hour is 285 feet. The separation between Battery Street and North Champlain Street along Pearl Street is approximately 340 feet. Consequently, the vehicle queues spilling back from Battery Street are not expected to restrict access to North Champlain Street under Concept C1.

		Concept A1 – Existing Conditions plus Transit Center Changes				Concept B1 – Bike Lanes Added, Parking Favored on South Side of Pearl Street				Option C1 – Bike Lanes Added, Parking Favored on North Side of Pearl Street			
Peak Hour	Approach Lane Group	Level of Service ¹	Delay ²	V/C Ratio ³	Queue (ft.) ⁴	Level of Service	Delay	V/C Ratio	Queue	Level of Service	Delay	V/C Ratio	Queue
AM	NB Through	B	13.0	0.36	149	B	13.0	0.36	149	B	14.6	0.38	156
	NB Right	B	10.8	0.14	48	B	12.0	0.25	94	B	13.4	0.27	98
	SB Through/Left	B	12.9	0.80	393	B	12.9	0.80	394	B	16.2	0.84	453
	WB Left	D	49.8	0.80	158	D	49.8	0.80	158	n/a	n/a	n/a	n/a
	WB Right	C	27.6	0.05	28	C	27.6	0.05	28	n/a	n/a	n/a	n/a
	WB Left/Right	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	E	67.0	0.92	210
	Overall	B	16.1	0.76	n/a	B	16.2	0.76	n/a	C	21.5	0.82	n/a
PM	NB Through	C	21.5	0.79	516	C	21.5	0.79	516	D	37.4	0.92	575
	NB Right	B	11.3	0.34	125	B	16.0	0.60	283	C	22.6	0.70	352
	SB Through/Left	A	6.3	0.43	113	A	6.3	0.43	113	A	9.3	0.51	132
	WB Left	E	71.6	0.88	173	E	71.6	0.88	173	n/a	n/a	n/a	n/a
	WB Right	C	29.7	0.10	54	C	29.7	0.10	54	n/a	n/a	n/a	n/a
	WB Left/Right	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	F	102.1	1.04	285
	Overall	B	18.4	0.67	n/a	B	19.4	0.68	n/a	C	34.4	0.81	n/a

¹LOS= Level of Service

²Delay = Average delay expressed in seconds per vehicle

³V/C = Volume-to-capacity ratio for critical movements

⁴95th Percentile vehicle queue

Table 6 Future Battery Street/Pearl Street Intersection Operations

5.3.1.2 North Champlain Street/Pearl Street Intersection Operations

Traffic operations for the Pearl Street intersection with North Champlain Street are shown in Table 7. Here again Concept A1 reflects existing intersection conditions in terms of travel lanes provided. For Concepts B1 and C1 the eastbound Pearl Street approach includes just a single lane rather the two lanes provided under existing conditions. This change has only a nominal impact during the AM peak hour. During the PM peak hour when there is a higher left-turn demand on the eastbound approach the overall intersection delay increases modestly from six to nine seconds. The delay increase does not change the overall level of service which is LOS A in all cases. With all eastbound traffic is combined into a single lane the 95th percentile eastbound vehicle queue length is 278 feet. This is less than the 340 feet of separation between Battery Street and North Champlain Street indicating that the queue should not spill back to the point where it may impact Battery Street operations. The calculated queue length is much less than 278 feet when the intersection is analyzed as an unsignalized location. (As noted previously this intersection has been analyzed as if it were fully signalized as a worst case scenario when, in fact, the signal operates on flash mode most of the time.)

Peak Hour	Approach Lane Group	Concept A1 – Existing Conditions plus Transit Center Changes				Concept B1 – Bike Lanes Added, Parking Favored on South Side of Pearl Street				Option C1 – Bike Lanes Added, Parking Favored on North Side of Pearl Street			
		Level of Service ¹	Delay ²	V/C Ratio ³	Queue (ft.) ⁴	Level of Service	Delay	V/C Ratio	Queue	Level of Service	Delay	V/C Ratio	Queue
AM	NB All	D	41.3	0.01	0	D	40.6	0.01	0	D	40.6	0.01	0
	EB Left	A	1.3	0.07	16	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	EB Through/Right	A	1.7	0.25	73	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	EB All	n/a	n/a	n/a	n/a	A	2.1	0.32	94	A	2.1	0.32	94
	WB Through/Right	A	1.6	0.20	48	A	1.6	0.20	49	A	1.6	0.20	49
	Overall	A	2.5	0.23	n/a	A	2.7	0.29	n/a	A	2.7	0.29	n/a
PM	NB All	D	40.4	0.53	19	D	40.4	0.53	19	D	40.4	0.53	19
	EB Left	A	3.2	0.35	64	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	EB Through/Right	A	2.1	0.25	67	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	EB All	n/a	n/a	n/a	n/a	A	9.1	0.74	278	A	9.1	0.74	278
	WB Through/Right	A	2.1	0.26	67	A	2.1	0.26	67	A	2.1	0.26	67
	Overall	A	5.9	0.37	n/a	A	9.4	0.72	n/a	A	9.4	0.72	n/a

¹LOS= Level of Service

²Delay = Average delay expressed in seconds per vehicle

³V/C = Volume-to-capacity ratio for critical movements

⁴95th Percentile vehicle queue

Note: this intersection was analyzed as if it had a fully operational signal when in fact it typically is on “flash” mode.

Table 7 Future North Champlain Street/Pearl Street Intersection Operations

Both Concepts B1 and C1 will provide operational benefits not reflected in the intersection capacity analysis results. As noted in the Existing Conditions discussion, conflicts are observed with traffic attempting to turn simultaneously from the two right-turn lanes from Battery Street. Also, some traffic weaving occurs on Pearl Street eastbound as motorists move into their proper lanes approaching North Champlain Street. The changes proposed under Concepts B1 and C1 will eliminate these conflicts potentially resulting in safer and more efficient traffic flow.

5.3.2 On-Street Parking

On-street parking supplies to serve local businesses and residents vary for each concept as noted in Table 8. Presently there is no on-street parking west of North Champlain Street and 28 spaces are provided between North Champlain Street and George Street. Concepts A1 and B1 maintain the existing supply of 28 spaces. Concept C1 results in a reduction to 24 spaces.

Street Section	Location	Parking Provided (Car Spaces)		
		Concept A1	Concept B1	Concept C1
Battery to North Champlain	North Side	0	0	7
	South Side	0	4	0
	Total	0	4	7
North Champlain to Pine	North Side	4	0	7
	South Side	12	12	0
	Total	16	12	7
Pine to George	North Side	6	6	6
	South Side	6	6	4
	Total	12	12	10
Total	North Side	10	6	20
	South Side	18	22	4
	Total	28	28	24

Table 8 On-Street Parking Supply – Pearl Street

5.3.3 Pedestrian Accommodations

The “curb-to-curb” concepts offer limited changes to pedestrian accommodations as pedestrian travel generally occurs on the sidewalks except for street crossings. Impacts to pedestrian crossings are described here as are buffers provided between pedestrians on the sidewalk and moving vehicles on Pearl Street. Both of these factors are influenced by proposed on-street parking supplies.

As noted above, the short-range alternatives considered in this study do not involve significant construction such as the installation of curb extensions that would potentially shorten pedestrian crossings. However, the City is proposing to provide painted curb extensions where pedestrians can be on the edge of the roadway and “shielded” from vehicular traffic by on-street parking. Planters may also be placed in the roadway where space permits to better identify the painted curb extensions. Painted curb extensions could be provided at up to five locations along Pearl Street with Concept A1. Similar opportunities are available along Pearl Street for Concepts B1 and C1. These two concepts also allow for a painted curb extension on Battery Street at Pearl Street.

For pedestrians walking along Pearl Street the pedestrian experience can be influenced by the nature of the buffer between the sidewalk and moving vehicular traffic. Separation (distance) and the presence or absence of vehicles parked along the curb affect the quality of the buffer. Separation can be provided by greenbelts, parking and/or bike lanes.

Sidewalk buffer conditions are summarized by in Table 9. Green shading is provided to identify most favorable conditions, that is, where the separation is ten feet or greater or where on-street parking is provided. Generally, Concepts B1 and C1 offer improved buffer conditions on the west end of the corridor. In the narrower, middle, section of the corridor, a bike lane replaces parking as the buffer on one side of the roadway.

		Concept A1		Concept B1		Concept C1	
		Separation (feet)	Parking	Separation (feet)	Parking	Separation (feet)	Parking
Battery to North Champlain	North Side	0	No	6.5-10	No	16	Yes
	South Side	4-7	No	10.5-20	Some	12-15	No
North Champlain to Pine	North Side	14	Yes	11	No	19	Yes
	South Side	8	Yes	13	Yes	5	No
Pine to George	North Side	8-9.5	Yes	13-14.5	Yes	13.5-14.5	Yes
	South Side	11.5-13	Yes	16.5-18	Yes	16.5	Yes

Table 9 Sidewalk Buffer Conditions – Pearl Street

5.3.4 Bicycle Accommodations

Among the three conceptual plans four levels of bicycle treatment are represented. These include, listed from worst (highest stress level for cyclist) to best (lowest level of stress for cyclist):

- Shared Lane (a single travel lane less than 15 feet wide shared by bikes and vehicles)
- Bicycle Accommodation (a minimum 15-foot-wide lane that can accommodate bicycles and vehicles side by side)
- Bike Lane (minimum 5 feet wide) adjacent to parking
- Bike Lane with Buffer (minimum 5-foot-wide lane and minimum 1.5-foot-wide striped buffer) or no adjacent parking

The Bike Lane with Buffer condition is considered the least stressful for cyclists as there is virtually no risk of a car door unexpectedly opening into the cyclist's travel path. Physical barriers were not pursued within the buffer area to create protected bike lanes, accounting for concerns regarding CCTA and Fire Department access adjacent to the 10' travel lanes.

The proposed bicycle treatments are illustrated in the conceptual plans and also summarized schematically in Figure 20. As shown, the lowest level of accommodation for bicycles is reflected in Concept A1 as no dedicated bike facilities are proposed. For most of the study area cyclists must share 11 or 12 foot-wide travel lanes with moving vehicles. East of Pine Street wider (15-foot) travel lanes are shared however, the car door risk is also present due to on-street parking. Concepts B1 and C1 provide continuous bike lane striping throughout the corridor with "buffered" conditions at the west end of the corridor and on one side of the roadway within the middle section. Of the approximate 2340 linear feet of bike lanes proposed, 58 percent are buffered for Concept B1 and 42 percent are buffered for Concept C1.

Proposed Bike Treatments



LEGEND



- Shared Lane (< 15' wide)
- Bike Accomodation Lane (shared lane ≥ 15' wide)
- Bike Lane (adjacent to parking)
- Buffered Bike Lane (buffer provided or no adjacent parking)

CONCEPT A1



CONCEPT B1



CONCEPT C1



Figure 20 Proposed Bicycle Treatments

5.3.5 Evaluation Summary

Analysis results are summarized in an evaluation matrix, Table 10. For Concepts B1 and C1 cells in the table are color coded to indicate performance relative to Concept A1, the baseline condition. Cells shaded green indicate performance that is significantly better than the performance of Concept A1 for that metric. Cells shaded red indicate performance that is significantly worse than the performance of Concept A1. Key highlights include:

- All three concepts perform satisfactorily from a traffic operations perspective using Level of Service C to define acceptable traffic operations.
- Concept B1 maintains more on-street parking than Concept C1.
- Concepts B1 and C1 both improve conditions for pedestrians.
- Concepts B1 and C1 both improve conditions for bicyclists.

Performance Measure	Concept A1	Concept B1	Concept C1
Traffic Operations			
Battery Street/Pearl Street Intersection - PM Peak Hour Delay (sec/veh)	18 seconds	19 seconds	34 seconds
N. Champlain Street/Pearl Street Intersection - PM Peak Hour Delay (sec/veh)	6 seconds	9 seconds	9 seconds
Parking (# of on-street spaces)			
West of N. Champlain Street	0	4	7
Between N. Champlain and Pine	16	12	7
East of Pine Street	12	12	10
Total	28	28	24
Pedestrian Experience – Sidewalk Buffer (P, G, and/or B)¹			
West of N. Champlain Street	North - None South - G	North - B South – P, G, B	North – P, B South – G, B
Between N. Champlain and Pine	North – P, G South - P	North – B, G South – P, B	North – P, B, G South - B
East of Pine Street	North - P South – P, G	North – P, B South – P, B, G	North – P, B South – P, B, G
Pedestrian Experience - Crossings			
Crossing Pearl Street at Battery Street (Crosswalk length in feet)	46 feet	46 feet	38 feet
Crossing Battery Street at Pearl Street (Crosswalk length in feet)	59 feet	47 feet	47 feet
Bicycle Accommodations			
“Protected” Bike Lane (%)²	0%	44%	58%
Shared Lane (%)	56%	0%	0%

¹P=Parking Lane; G=Greenbelt; B=Bike Lane

²Protected=Bike lane does not directly abut on-street parking

Table 10 Evaluation Matrix

5.4 *Public/Stakeholder Evaluations*

The conceptual improvement plans for Pearl Street were presented to stakeholders, (representatives of various City departments, Local Motion and the CCTA) and to City residents at separate meetings. Meeting participants were mixed in their support for the concept of adding bike lanes to Pearl Street with concerns were expressed relative to bike lanes located immediately adjacent to parking lanes and bus parking. Additionally, there were concerns that the proposed ten-foot-wide vehicular travel lanes were too narrow to safely accommodate buses and fire trucks adjacent to bike lanes especially if any barrier was placed between the bike lane and the vehicular travel lane. Buses and fire apparatus will need regular access through the Battery Street/Pearl Street intersection so their movements should not be restricted. As a relatively flat street that connects continuously across the city, Pearl Street was also mentioned for inclusion in longer range plans to create a north-south bike route through Burlington. Residents also cited general concerns regarding the accommodation of mobility challenged pedestrians in the area especially at crosswalks along Pearl Street. Finally, it was suggested that a portion of the wide sidewalk area on the south side of the roadway just east of Pine Street might be used by adjacent restaurants for outdoor seating and dining. Minutes from these meetings are included in Appendix D.

In response to the comments received on the conceptual plans a vehicle turning analysis was conducted for the Battery Street/Pearl Street intersection. The analysis considered the ability of a CCTA bus to turn right from Battery Street to Pearl Street for each concept plan. (A city fire truck would have similar space requirements for turning.) The analysis concluded that with some adjustments to the curb radius for the southeast corner of the intersection, city buses and fire trucks will be able to execute right-turns into Pearl Street under proposed Concepts B1 and C1 without conflicting with westbound traffic on Pearl Street. For the larger, intercity (Link Express) buses, the STOP bar on the Pearl Street intersection approach would need to be shifted to the east to accommodate turns from Battery Street northbound. A more detailed account of this analysis is included in Appendix E.

6.0 Recommendations

Based on the information presented above the City Department of Public Works recommends a short-range plan that combines elements of Concepts B1 and C1 with additional enhancements for pedestrians. Longer range strategies to improve the corridor are also proposed.

6.1 Short-Range Plan

The recommended plan is illustrated in the attached Figure 21. Similar to Concepts B1 and C1 it adds bike lanes to Pearl Street while maintaining much of the existing on-street parking supply. The plan also includes:

- A single northbound right-turn lane from Battery Street to Pearl Street allowing for a shorter pedestrian crossing on Battery Street;
- Generally, two vehicular travel lanes on Pearl Street west of North Champlain Street where there are now four;
- Painted “bump outs” or curb extensions on Pearl Street where crosswalks are shielded by on-street parking to shorten pedestrian crossings distances;
- Raised planters and/or civic art in the greenbelt west of North Champlain Street where the presence of underground utilities precludes the opportunity to plant trees;
- A converted greenbelt east of Pine Street, which presently supports very limited vegetation, to hardscape;
- Benches on the wider sidewalk section east of Pine Street that may be used by pedestrians and by patrons of restaurants on this block; and,
- Provision of 27 on-street parking spaces compared to 28 spaces under existing conditions.

6.2 Long-Range Strategies

Long-range strategies recommended for development as part of future planning efforts are listed below.

- Widening the roadway into the greenbelt(s) between North Champlain Street and Pine Street to create a consistent 46-foot-wide cross section throughout the study corridor. (This section is only 40 feet wide now and adjacent segments are 46 feet wide.) The extra width could allow for additional on-street parking and/or enhanced bike lane buffering.
- Converting painted curb extensions proposed as part of the short-range plan into raised extensions protected by curbing.

- Rebuilding wheelchair ramps, driveway aprons and sidewalk segments where deteriorated to enhance mobility for pedestrians.
- Reevaluating the roadway design and function in the context of the proposed city-wide pedestrian and bicycle master plan.
- Advancing streetscape improvements identified in the forthcoming citywide Street Design Guidelines. Improvements may include more street trees and/or rain gardens for stormwater management.