Street Design Guidelines

Burlington Transportation Plan

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I. Introduction to the Street Design Guidelines

This section of the Transportation Plan presents specific design guidance for Burlington's streets. The conceptual network of streets and the design recommendations described below advance the goals of the Burlington Master Plan by balancing the transportation needs of all modes, including pedestrians, wheelchairs, bikes, transit, and cars.

The Street Design Guidelines are applicable city-wide. Typical right of way conditions are assumed in the illustrations and examples that follow. For each street type, however, unique situations are encountered that need to be considered on a case-by-case basis as specific street improvement design plans are developed.

Street Design Plan

Overall, Burlington enjoys a network of pleasant pedestrian-scaled streets that contribute to the City's distinctive identity and quality of life. The same intimate scale of the streets that makes them so attractive for pedestrians also requires that decisions be made regarding the allocation of space for various transportation modes. As a practical matter, separate space for cars, buses, bikes, pedestrians and parking cannot be accommodated on every street. The expense of providing these facilities and the extent of paved area would be untenable. The job of the plan is to find a balance between the various modes in the street space.

The street design guidelines also take into consideration the land use context, the function of the street, vehicle speed, and the volume of traffic on the street. Adjoining land uses give form to the street space and the intensity of surrounding activities generates travel demand as well as street design considerations. On single-family residential streets with low traffic volumes, for example, all vehicles can typically share the street space safely and more easily than on a higher speed, higher volume cross-town street. In traditional retail areas, on-street parking is critical; however, parking can conflict with bicycle lanes, transit stops and pedestrian crossings. These elements must all be balanced with overall transportatin goals in mind.

The approach recommended in the plan is to provide all modes a means of efficiently traversing the City and reaching major destinations. The Street Design Plan shown in Figure 1.1 sets forth a street network that provides a balance between the various modes of travel. The designation of the street as a Complete Street, Transit Street, Bicycle Street, or a Slow Street provides the basis for choosing the specific street design elements that apply to each. The Street Design Guidelines include illustrations of recommended design features for each street type; however, each feature must be considered within its specific context to determine its appropriateness to a given situation.

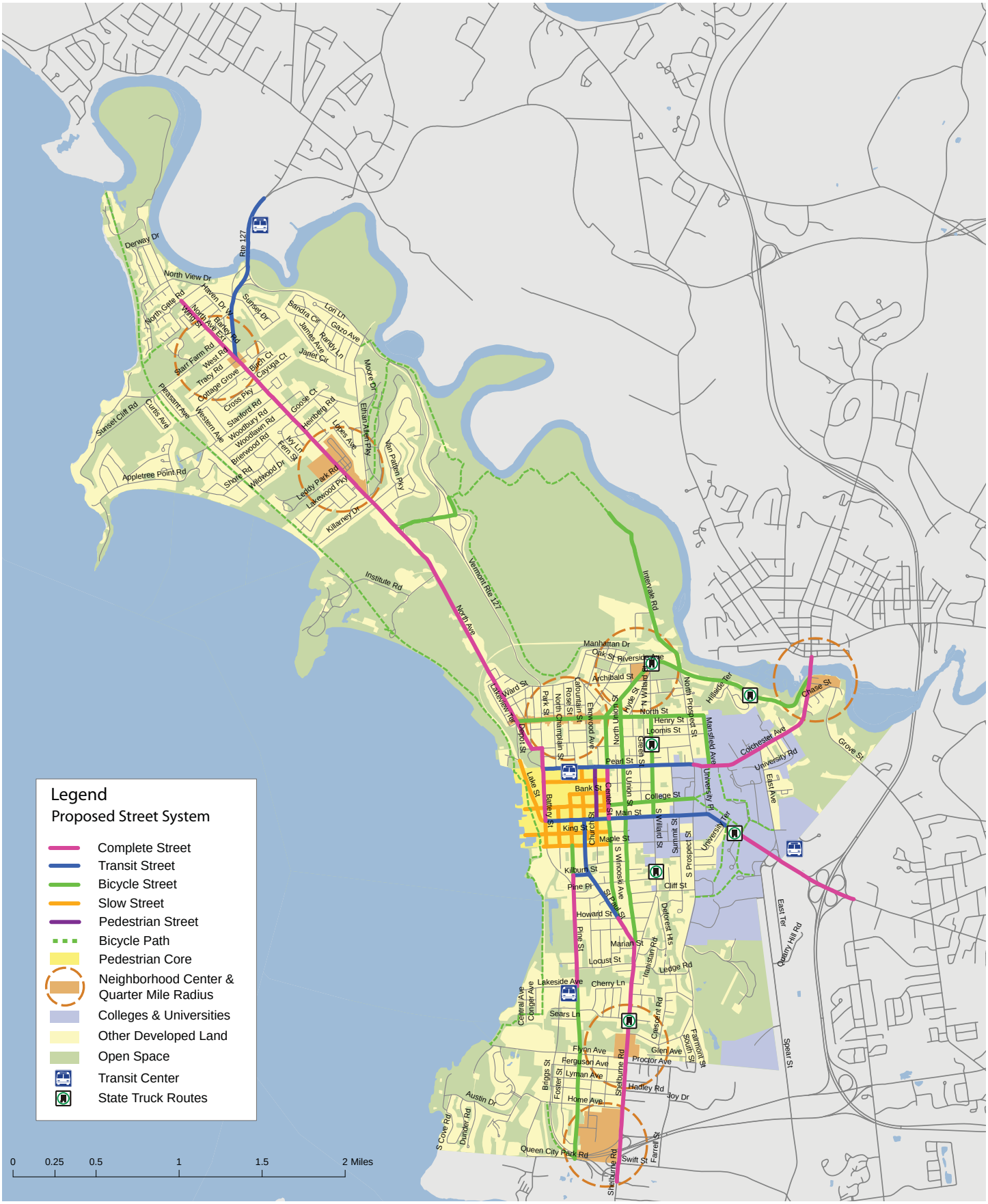


Figure 1.1 Burlington Street Design Plan

The Complete Street

The Complete Streets are the major corridors leading into and out of Burlington. In the current condition, they are typically four-lane arterials dominated by automobile movement, often creating a hostile environment for pedestrians and bicyclists. Given the significance of these corridors in providing access into and through Burlington, the goal of the Complete Street is to accommodate all modes as effectively as possible within the given curb-to-curb dimension.

Depending on the existing configuration of the street, conversion to a Complete Street may involve a reduction from four vehicle lanes to three lanes. The resulting street contains two through lanes and a center turn lane with median refuges, along with one bicycle lane in either direction, transit shelters, and streetscape amenities. In other areas, the conversion may be simpler, involving restriping vehicle lanes, adding bike lanes, and making transit improvements.

Anatomy of a Complete Street

Roadside Zone (Sidewalk and Tree Belt)

Sidewalks

Sidewalks represent the most basic element of pedestrian circulation. The location, configuration, and design of sidewalks should reflect the land use context of the roadway. On Complete Streets, sidewalks should be provided on both sides of the street. Sidewalks should be a minimum of five-feet in width in residential areas and wider where a higher intensity of pedestrian use demands, such as in neighborhood centers, traditional retail areas, and higher density residential zones. However wide a sidewalk is, a 5-foot clear zone must be maintained for circulation needs. All other streetscape amenities, benches, trees, light fixtures should be kept out of this clear zone.

Minimum Width: 5 feet

Tree Belt

The tree belt buffers pedestrians from traffic provides a visual amenity for all. In addition to its visual and psychological benefits, the green strip between the sidewalk and street provides environmental benefits by absorbing and filtering stormwater runoff, providing shade, reducing the urban heat-island effect and absorbing carbon dioxide. Finally, in Burlington's northern climate, tree belts perform the additional important function of snow storage in winter months.

The width of the tree belt is an important design consideration. At a minimum, tree belts should be five-feet wide. Wider belts provide better growing conditions and will result in improved health and vigor of street trees. As an example, the generous tree belts in Burlington's leafy Hill neighborhood range from 8 to 12 feet in width.

In traditional retail areas with on-street parking and higher-intensity pedestrian demands, trees will be planted in prepared beds of structural soil running beneath the sidewalk. Structural soil is an engineered soil mix that serves the dual function of supporting the pavement and accomodating root growth.

In general, trees need a continuous soil volume for healthy growing conditions, and this is easier to achieve in tree belts. In retail areas, a continuous soil volume can be achieved by connecting subsurface planting beds to one another or to nearby landscape areas by using structural soil.

Minimum Width: 5 feet

Street Trees

Street trees provide scale and definition to the street and tremendously improve pedestrian comfort. In addition to the benefits described above, mature street trees reduce the apparent width of the street and contribute economic value to adjoining properties. In general, street trees should be high crowned deciduous species that are tolerant of salt, pollution, soil compaction, and drought. Diversity in the canopy on a citywide basis is important; however, continuity of a single street tree species along stretches of the street provides the most pleasing visual effect.

The City's Urban Forestry Master Plan and Street Tree Planting Plan contains existing conditions information, guidance regarding the choice of street tree species, and planting guidelines for new street trees.

Street Lighting

Street lights provide general illumination for all street users. Due to the expense of light fixtures, most street lighting is utilitarian in nature, with luminaries mounted high on the pole (i.e., 20+ feet) for more coverage per light, and lights are typically scaled and oriented to the motorway. This approach accomplishes the task of lighting the street with fewer fixtures, but does not contribute to the pedestrian-friendliness of the area. On the Complete Street, ornamental light fixtures are recommended at gateways and within high-volume pedestrian zones. Currently, ornamental light fixtures provide an attractive entry image at the heavily-traveled Main Street gateway to Burlington. Extending this treatment to other gateways into the city is recommended. Ornamental pedestrian-scale light fixtures (i.e., 10 to 14 feet in height)

are recommended for areas used in areas with high pedestrian volumes such as neighborhood centers, traditional retail areas, pedestrian promenades, and around the college campuses.

Furniture

Street furniture, such as benches, kiosks and bike racks, adds to the amenity and interest of the street, encourages social activity, and can help contribute to a distinctive identity for a neighborhood or district. Along the Complete Street, street furniture should be primarily used around neighborhood centers, schools and higher volume transit stops. Street furniture cannot obstruct the five-foot 'clear zone' of the sidewalk.

Transit Shelters

Transit shelters protect transit patrons from the elements and ideally provide comfort in the form of benches, schedule and route information. Transit shelters also enhance the general awareness of transit by making it a more prominent visual element along the street.

Recognizing that shelters are costly to install and maintain, a priority should be placed on installing transit shelters on Complete Streets and Transit Streets (see below), particularly at stops with higher levels of transit ridership. The environment of the transit shelter should be as attractive as possible and include benches, lighting, street trees, and clear signage scaled and oriented to the pedestrian. Transit shelters must be located outside of the five-foot 'clear-zone' of the sidewalk.

Waiting for a bus on a cold winter day can be unpleasant. Traditional retail areas with heated shops, places to buy a warm drink, snack bars, and newsstands make for a more agreeable transit waiting environment. In making choices about bus stop locations, consideration should be given to locations that can enhance the experience of waiting, particularly by offering the option to wait in a warm location.

Roadway Zone

The Complete Street includes bike lanes, one in either direction, and accommodates a center lane for left turns and pedestrian refuge medians at intersections.

Parking

Most of the Complete Street network does not currently accommodate on-street parking. There are some exceptions to this, however. Where the Complete Street traverses neighborhood centers, the street ideally will have on-street parking. See the 'Neighborhood Center' special condition, below. In other areas angled parking may be accommodated on the street. Where there is angled parking and bike lanes, reverse (back-in) angled parking is an option to improve driver visibility of bicyclists. Parallel parking requires a minimum five-foot bike lane in addition to an eight-foot parking lane (13 feet total). See also the Bicycle Street.

Bike Lanes

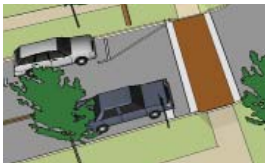
Bike lanes provide dedicated space for bicyclists along the roadway. Striped and signed bicycle lanes make drivers aware that bicycles are a part of the traffic mix and that bicycles are welcome on the roadway. Bicycle lanes are one component of a network that connects to bike paths and routes throughout the City. Bike lanes are typically 4 to 6 feet in width and may be configured on one or both sides of the street. Four-foot lanes are a minimum; 5 to 6 feet is preferable where space is available. Bicycle lanes are best on streets where the volume and/or the speed of traffic warrant separation from traffic for the safety of the cyclist. On streets where traffic volumes and/or speeds are low, such as many residential streets, or where there are no connections to the larger bicycle network, a designated bike lane is not indicated.

In the typical situation on the Complete Street, bike lanes move with the direction of traffic (i.e., one lane in each direction) and are placed on the curb edge of the roadway *without parking*. High visibility treatment of the bike lane, including painting and signage, is encouraged to improve the visibility, safety, and understanding of bikes in the street environment. At a minimum, marking of the bike lane should include a white line, bicycle icon, and directional arrow. Additional treatment might include painting the lane on streets where even higher visibility would be desirable. Integral color pavement is another option for new or reconstructed streets. Bike safe drainage inlet grates should be used.

On state routes, bicycle facility design should meet the requirements of the Vermont Agency of Transportation's *Vermont Pedestrian and Bicycle Facility Planning and Design Manual*.

Minimum Width: 4 feet

Vehicle Lanes



The width of a vehicle lane is a critical dimension that influences vehicular speed. The width of vehicle travel lanes on the Complete Streets typically vary, depending on the given curb-to-curb dimension. Complete Streets can operate effectively with 10 to 11 foot lanes. As a general rule, travel lanes range from a minimum of 9 feet, for low-speed, low-volume streets to a maximum of 12 feet for specific conditions on higher volume and speed streets. Lane widths of 9 feet would not be recommend for the Complete Street in consideration of an adjacent bicycle lanes as well as typical traffic speeds and volumes. Typical lane widths should be 10 to 11 feet.

Minimum Width: 10 feet

Typical Width: 10 to 11 feet

Maximum Width: 12 feet

Two-Way Left Turn Lane

A two-way left turn lane at the center of the Complete Street allows for cars to pull out of the through lane to make turns, thereby allowing more effective use of the street's capacity.

Crosswalks

Crosswalks greatly assist pedestrian navigation, comfort and safety. Crosswalks assist pedestrian safety by alerting motorists and bicyclists to look for pedestrians and by guiding pedestrians to a safe crossing. Pedestrians must be able to cross streets at regular intervals and cannot be expected to go 300 to 400 ft. out of their way to take advantage of a formal crosswalk.

Along the Complete Street, pedestrian crosswalks should be placed at each intersection. Additional visibility at the intersection can be attained through the use of special paving treatments (i.e., integral colored pavement, special pavers, high visibility painting) at high volume pedestrian crossings, such as traditional retail zones, educational facilities, parks, and employment centers. Texture in the crossing enhances visibility and traffic calming, but texture should be smooth enough so as not to create difficulty for wheelchairs and bicyclists. As an example, brick-like unit pavers and scored asphalt achieve this effect. Mid-block crossings (see below) and crossings at uncontrolled intersections should be high in visibility and combined with other treatments (pedestrian refuge islands, curb extensions, moveable sign cones) to provide for safe crossing of these streets. There are many existing examples of places where Burlington has placed special emphasis on crosswalks for safety and visibility.

Medians and Pedestrian Refuge Islands

Medians are raised islands built within the street that slow and direct traffic, provide a refuge for crossing pedestrians and, when combined with landscaping, make the street more visually attractive. Pedestrian refuge islands are smaller islands placed within the center of the road to facilitate pedestrian crossing of busy thoroughfares.

Along the Complete Street, pedestrian refuge islands are recommended at intersections and mid-block crossings. To be sufficiently large to command attention, islands should be no smaller than 6-feet wide by 20-feet long (ITE) and include a minimum 5-foot walkway crossing. Refuge islands ideally should be landscaped, rather than paved, and include tree planting where room allows.

Minimum Dimensions: 6 feet wide by 20 feet long

Curb Return Radii

Curb return radii, or the 'corners' of the intersection, have a significant influence on the speed of cars turning the corner, and by extension, on the pedestrian environment. Large radius curves facilitate turning for trucks and large vehicles, and allow cars to go around a corner at a faster speed. They also make the crossing distance longer for pedestrians.

Overall, curb return radii should be as small as possible in pedestrian intensive zones, ideally 10 to 15 feet. At other intersections, curb return radii should be a small as possible while still allowing for necessary truck and bus turning movements. On the Complete Street, it is recognized that these major arteries into and out of the City must facilitate transit movements and truck traffic, so curb returns should reflect the mixed traffic flow of these streets.

Green Street Options

Stormwater Planter

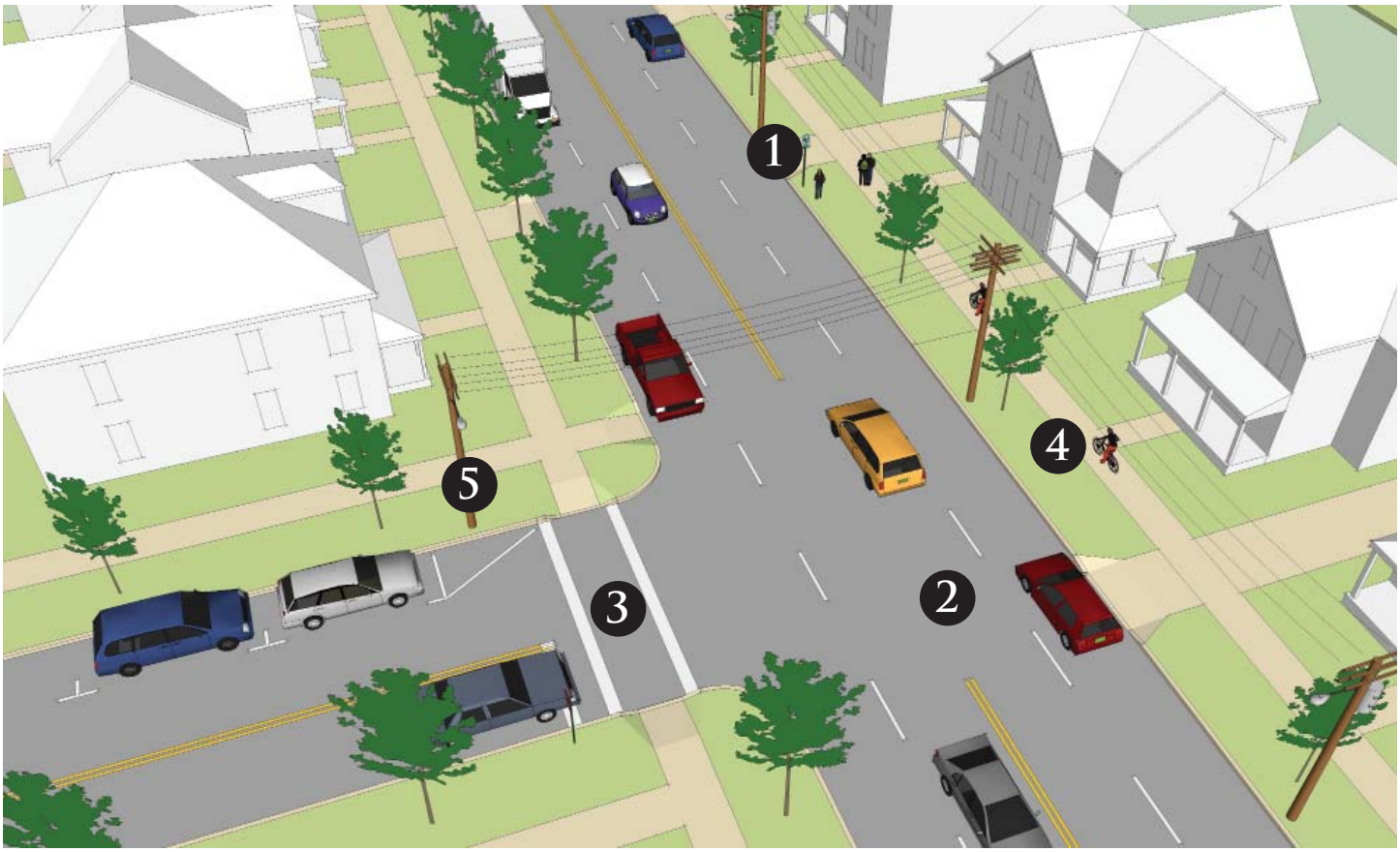
The stormwater planter is an innovative idea for enhancing street design and environmental quality. The planters are streetside landscaped areas, used in place of a tree lawn, that collect, detain, filter and absorb stormwater runoff from the street. These 'bioswales' incorporate specific plant materials and soils that absorb and filter stormwater and sediments, reducing the amount of these elements that are discharged into the city's storm system and eventually Lake Champlain.

Stormwater planters should be located on relatively level streets. Trees may be planted in the stormwater planters, as long as the selected species tolerate both wet and dry cycles and are tolerant of urban conditions. Periodic maintenance of the planters to remove sediment and grit will keep the pollutant removal system functioning well.

Porous Paving

Another stormwater management technique is the use of porous paving in place of traditional paving. Porous paving materials maintain pores or openings that allow stormwater and snowmelt to pass through, thereby improving infiltration, decreasing runoff, and filtering pollutants. On-street parking areas would provide ideal opportunities for porous paving, as they are relatively level areas where water collects. porous paved areas can also narrow the perceived width of the roadway when cars are not present, appearing instead as an extension of the sidewalk space.

The Incomplete Street - Typical Existing Condition



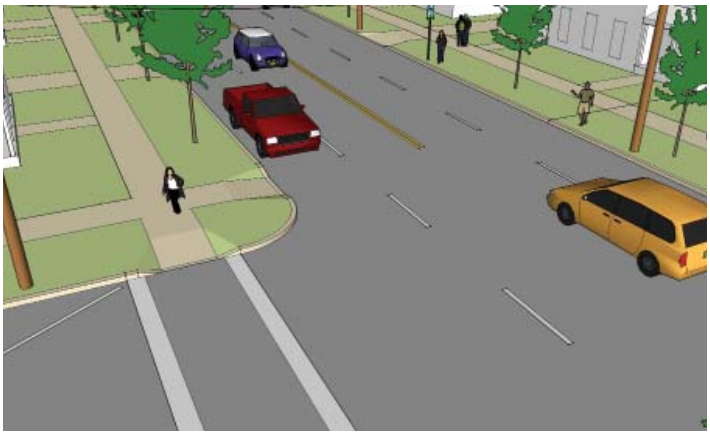
The Incomplete Street Section

1 Basic Transit Stop

Bus stop signs are difficult to distinguish from traffic signs and are virtually invisible to potential users. Transit users are exposed to the elements. Schedule and fare information are absent.

2 Unsafe Lane Allocation

In this four lane roadway, the left lane acts as both a passing lane and a left turn lane, causing potential conflict between drivers accelerating to pass and those slowing to turn.



3 Limited Pedestrian Crossing

Pedestrians must contend with 40' of unbroken pavement and four lanes of traffic. Crosswalks are poorly marked or nonexistent.

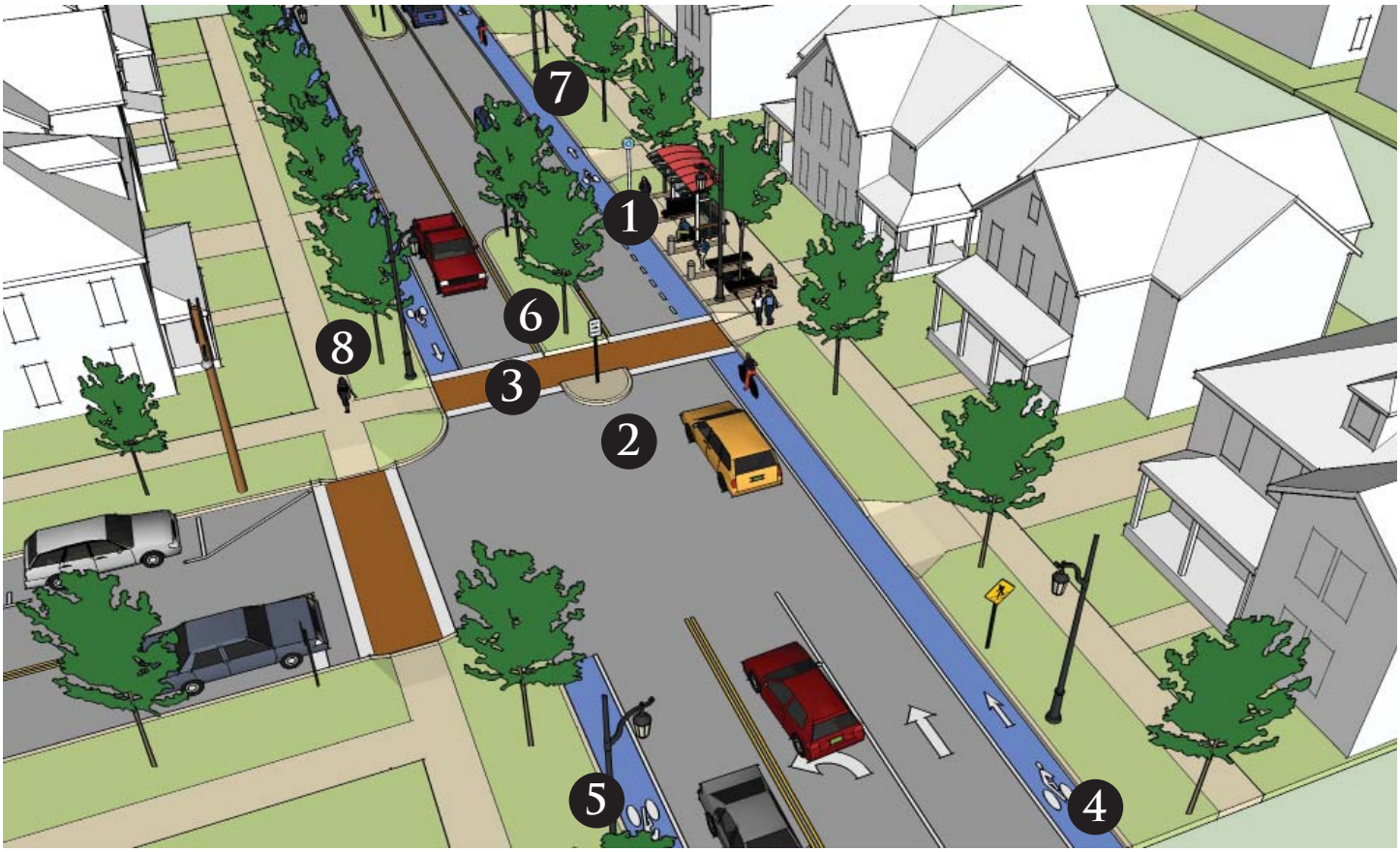
4 Where do Bikes go?

The current four lane roadway configuration allocates no space for bicycles. Cyclists would rather share the sidewalk with pedestrians than take their chances with speeding traffic, even though this is dangerous for pedestrians and also illegal for adults.

5 Unsightly Utilities & Lighting

Overhead utility poles restrict tree planting and are visually unappealing. The cobra head lighting fixtures affixed to the poles present an ad hoc solution to roadway lighting and disregard the lighting of the sidewalk.

The Complete Street - Putting It All Together



The Complete Street Section

1A Curbside Transit Stop

On the Complete Street, buses pull up to the curb. Stops employ a variety of complementary streetscape elements that enhance patron comfort and contribute to the ambience of the street.

1B Improved Transit Shelter

Transit shelters provide patrons with a comfortable place to wait for the bus, ideally displaing real time schedule information, and possibly including automatic ticketing machines.

1C Improved Transit Identity

Clear route signage, system maps, and schedules facilitate the use of transit and enhance the visibility and awareness of transit along the corridor.

1D Transit Stop Furniture

Distinctive street furniture at transit stop locations encourages transit use and contributes to improved identity. Bicycle racks and benches make it easier for a variety of users to benefit from transit.

2 Traffic Calming

By placing this road on a "diet", one full lane of traffic has been eliminated and replaced with bike lanes and landscaped median islands. Textured crosswalks and enhanced street tree plantings contribute to slowing motorists.

3 Short Pedestrian Crossings

Refuge islands allow pedestrians to cross the street one lane at a time, breaking what was once a 40' four-lane crossing into two 15' jaunts with a rest in between. See *Special Conditions - Midblock Crossings* for more design options.

4 Bike Lanes

Dedicated bike lanes move bicyclists off the sidewalk. High-visibility striping and lane painting make drivers aware that bikers are a part of the traffic mix and will improve safety and convenience for all.

5 Updated Utilities & Lighting

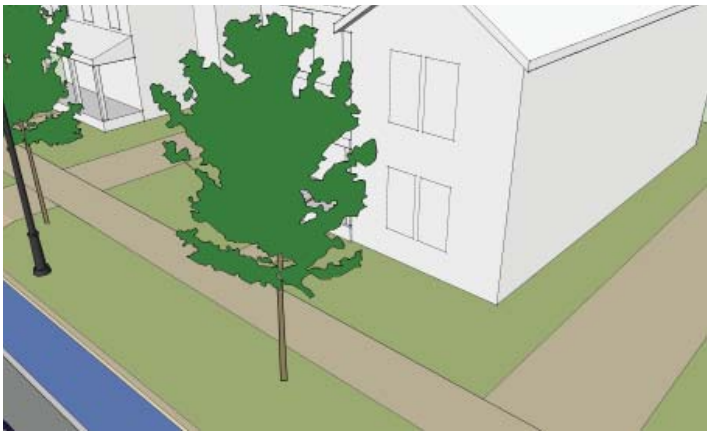
Utilties are placed underground, eliminating the need for unsightly poles and wires. Cobra head fixtures are replaced by ornamental luminaires and poles that cater to all users.

6 Landscaped Median Island & Turn Lane

Landscaped islands can alternate with left turn lanes, where left turns are necessary. The benefits gained include increased greenery, shorter road crossings, reduced traffic speed, and predictable lane usage by vehicles.

7 Stormwater Treatment

Stormwater planters collect runoff from roadway surfaces, using plants and soil to slow, absorb, and cleanse stormwater before it enters municipal storm sewers.



8 Tree Belts

Tree belts provide a buffer between cars and pedestrians, a visual amenity, snow storage, and a place for trees in the city.

Midblock Crossings

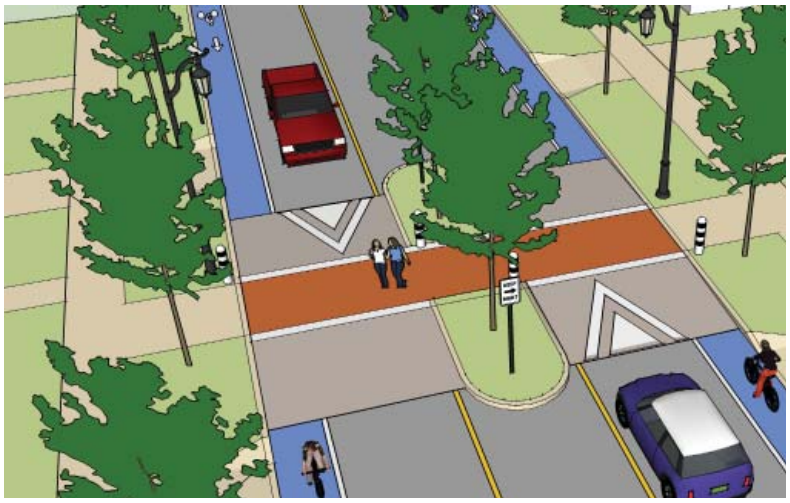
There are places along the street network where pedestrians will opt to cross midblock rather than at the nearest intersection. This may be due to a long distance between intersections, the desire to avoid back tracking, and/or high volumes of pedestrian-generating uses on opposing sides of the street. Formalized midblock crossings improve pedestrian safety and convenience by managing the crossings and channeling them to a safe location. Mid-block crossings can help nearby intersections with capacity problems by allowing pedestrian crossings without taking capacity from the intersection.

Because midblock crossings can be unexpected, they should be made highly visible to drivers. On the Complete Street, pedestrian refuges should be placed in the center of the roadway. The crosswalk should be visually dramatic: ideally 'ladder', 'zebra', or fully painted-out striping for painted crosswalks, or an integrally colored and textured crosswalk bounded by white bars. The crosswalk should be 6 to 10 feet wide. There are a couple of design options for the midblock crossing itself. A "Z" configuration forces pedestrians to look into on-coming traffic as they cross the street. Another option includes a raised crossing, which acts as a traffic calming speed table for cars. Signage or warning lights should be used to warn drivers of an upcoming midblock crossing. Overall, midblock crossings should be placed where sight distances are good and a crossing is warranted by pedestrian volumes.

Application

"Z" Configuration of Midblock Crossing

Raised Midblock Crossing

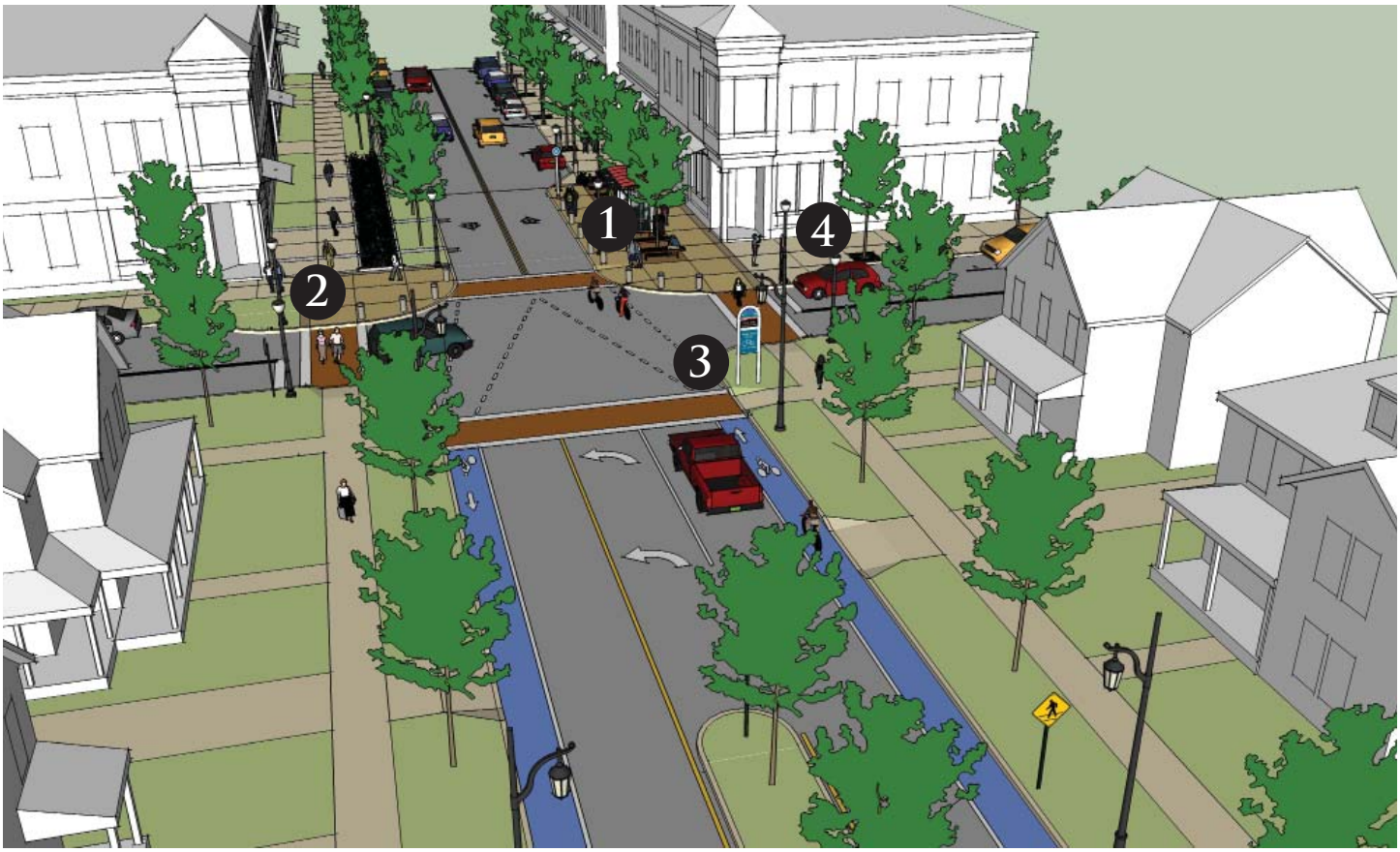


Neighborhood Centers

The City of Burlington encourages Neighborhood Activity Centers in specific locations through the City in order to provide a mixture of uses that would complement surrounding neighborhoods. Such small scale mixed-use centers help support a multi-modal community by providing a place where neighbors can pick up a gallon of milk, purchase a newspaper and a cup of coffee, drop off dry-cleaning, or hop on a bus, all within a close walk or bike ride from home. Existing examples of Neighborhood Activity Centers include North Street in the Old North End and the Fresh Market area on Pine Street.

Most neighborhood centers are located on Complete Streets which support their intended multi-modal character. On-street parking, however, is not part of the Complete Street, but it is an important component of an economically healthy retail center and its pedestrian environment. A transition in street design is therefore required where a Complete Street enters a Neighborhood Center. Conceptually, the street transitions from a Complete Street to a Slow Street: on-street parking and curb extensions replace the bike lanes, and bikes become a part of the mixed traffic flow. The transition in street type should be made clear to motorists and bicyclists through visual cues including signage and pavement marking, and through streetscape design elements such as curb and sidewalk treatment, street lighting, furniture, planting patterns, and sidewalk patterns. Ideally the transition would occur at an intersection where the change in land use occurs and sight distances are good.

The Neighborhood Center Street



The Neighborhood Center Street Section

1A Bus Bulbs

Bus bulbs give additional space to patrons and amenitites and are well suited for crowded urban conditions. They allow buses to continue along their route without the loss of time associated with merging back into traffic (see the Transit Street). Stops employ a variety of complementary streetscape elements that enhance patron comfort and contribute to the ambience of the street.

1B Curbside Transit Stop

Buses pull up to the curb to reach a curbside transit stop. Stops employ a variety of complementary streetscape elements that enhance patron comfort and contribute to the ambience of the street.

2 Curb Extensions

Curb extensions reallocate underutilized roadway space around street crossings to landscaping and widened sidewalks at corners. Through the use of a consistent configuration, surface treatment, and use of furnishings, they contribute to an intersection treatment that unifies the retail area pedestrian system.

3A Bike Transition

As complete streets enter neighborhood centers, bicyclists leave dedicated bike lanes to merge into shared travel lanes. Striping across intersections helps to communicate this transition, as well as changes in streetscape elements, lighting, street furniture and wayfinding signage.

3B Bike Transition Signage

Bicycle signage at the transition from bike lanes to mixed traffic informs bicyclists and motorists that bicyclists are entering the traffic mix and encourages cautious driving. The signage can be incorporated as part of the Citywide way-finding signage program.

4 Trees & Sidewalks

By replacing sidewalk subbases with a special structural soil, street trees can be planted in paved environments.

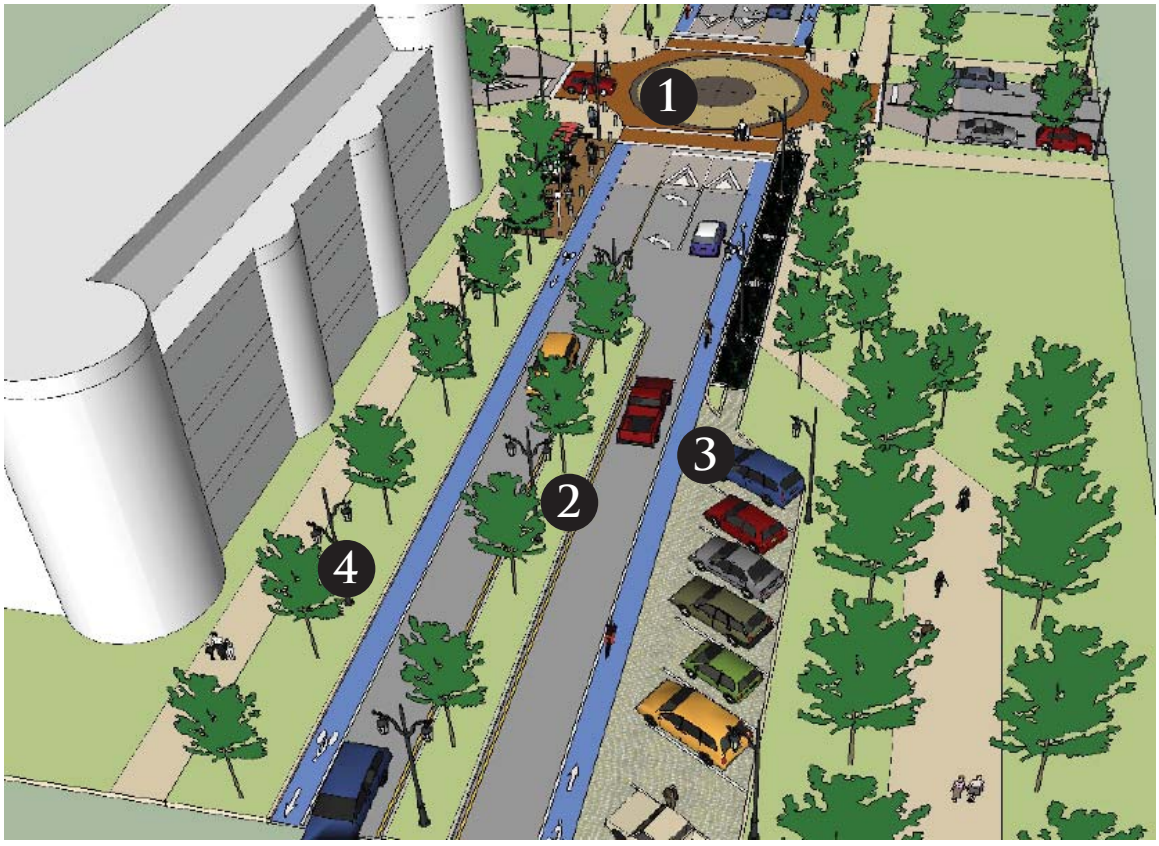
The Complete Battery Street

Battery Street plays a crucial role in Burlington's road network. It is the western boundary of the downtown, and offers sweeping views across Lake Champlain, making visual links both to the Lake and the Adirondacks beyond. Unfortunately, Battery Street currently falls short of its potential as a bridge between the city and its waterfront and as a memorable 'signature' boulevard of Burlington. The street does have the potential to bring city and waterfront together by facilitating movement between them and making the corridor a celebrated public space that is more enticing to pedestrians and bicyclists.

In addition to illustrating the complete street strategies outlined above, the Complete Battery Street example treats intersections as raised plazas that give prominence to pedestrians. Additional on-street parking adds activity and vitality to the area. In this example, reverse angle diagonal parking is suggested to improve visibility of bicyclists. Because Battery Street has fewer curb cuts than other complete streets, it has the potential to become a more fully realized boulevard and pedestrian promenade overlooking the Lake. As an invitingly landscaped corridor, the street can become a soft edge to the city's Lake side.

Integrating the green street options described earlier in this section will help to protect water quality within Lake Champlain by intercepting and treating stormwater runoff.

The Complete Battery Street



1 College Street Intersection

Raised intersections at Main, Cherry, Pearl, and College Streets could form the basis of a pedestrian "bridge" to the waterfront. Treating intersections as raised plazas, facilitates the best possible pedestrian connection between the city and the Lake. As with all Complete Streets, the proposed concept allows left turn lanes at intersections.

2 Landscaped Median

The section of Battery Street between Main and Pearl Streets offers the opportunity for a more continuous landscaped median than elsewhere in the City. This stretch of roadway, in particular, can attain the character of a boulevard with stately rows of trees along the edges of the roadway and within the landscaped median.

3 Parking & Stormwater

Porous paving, in the form of an open jointed concrete unit paver can be employed in new on-street parking areas along Battery Street to absorb and store stormwater runoff that might otherwise migrate to the Lake. Any runoff that leaves the parking area during heavy rain events will be intercepted by a stormwater planter. Reverse angle parking is suggested for better visibility of bicyclists.

4 Lighting Applications

Lights may be configured in several ways to serve different roadway users. In the image at left, two luminaires are mounted at the same height within the landscaped median to evenly illuminate the roadway. In the tree lawn (right image) a pedestrian level light and roadway light are mounted at different heights.

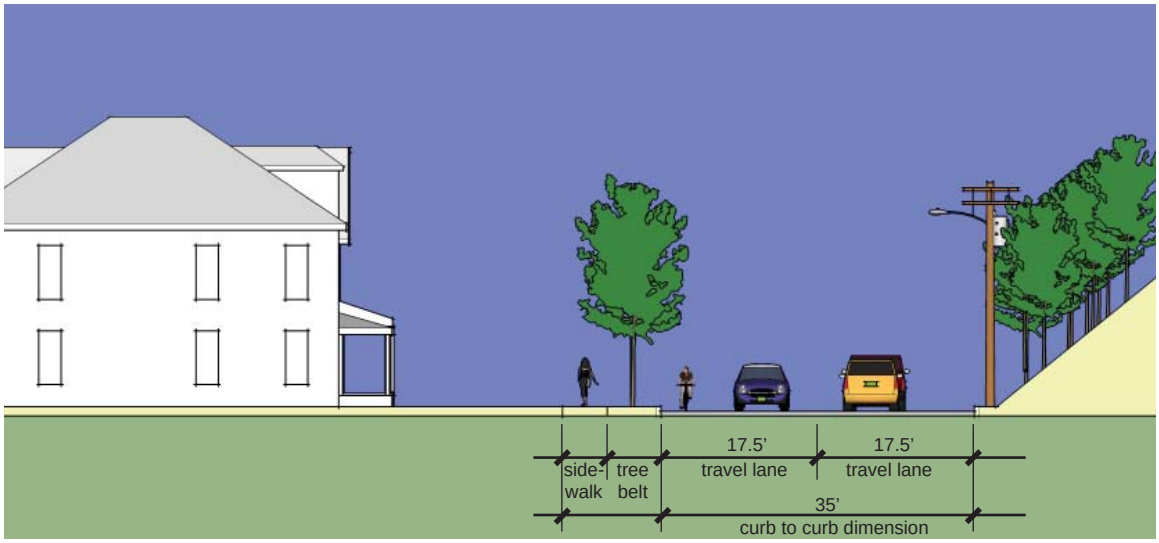
Application

The Complete Colchester Avenue

On Colchester Avenue, the presence of a steep slope initially prevented the inclusion of a sidewalk on both sides of the road. Converting the road to a Complete Street reallocates space within the existing rodway zone to make way for two clearly marked bike lanes, two lanes of traffic, and a new sidewalk. Unsightly utilities are placed underground, and the new standard lighting fixture is installed along both sides of the street.

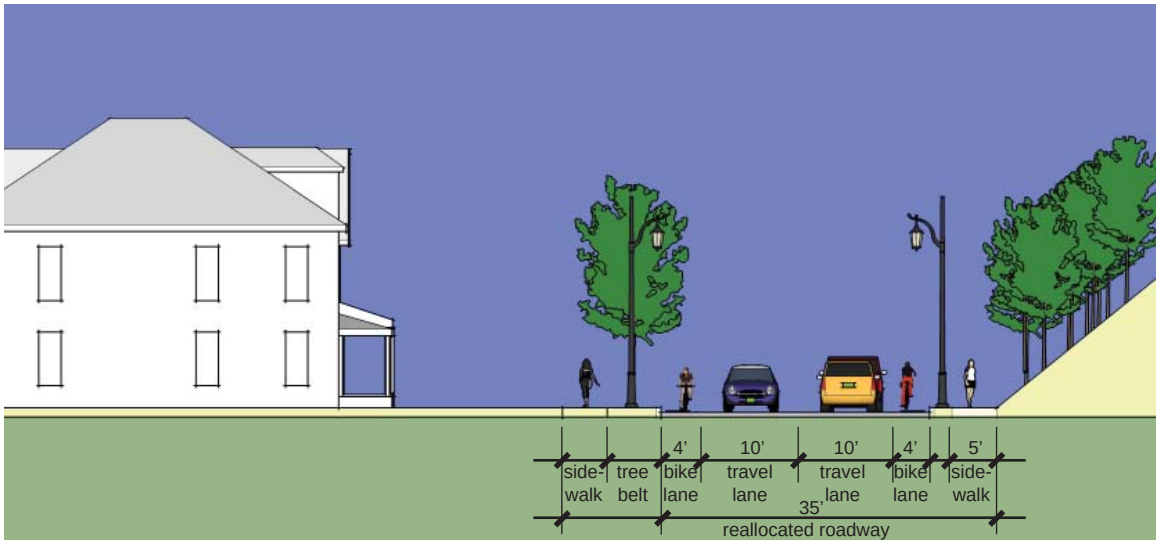
Colchester Avenue

Existing Street Section

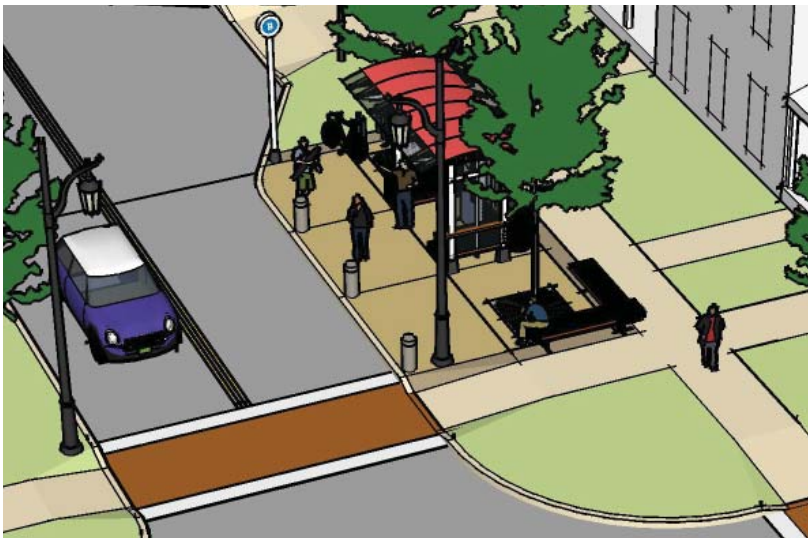


Colchester Avenue

Proposed Street Section



The Transit Street



The first priority of the Transit Street is to facilitate efficient transit movement. Transit Streets respond to curb-to-curb constraints in city streets as well as the need to facilitate transit to and through the City's core. The underlying goal is to give transit buses a 'leg up' on other modes on designated streets, recognizing that time effective transit services pay off in ridership benefits.

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. Two Transit Streets, Main and Pearl, traverse the downtown pedestrian core to expedite transit service through the downtown.

Anatomy of a Transit Street

Roadside Zone (Sidewalk and Tree Belt)

Sidewalks

See Complete Street.

Minimum Width: 5 feet

Tree Belt

See Complete Street.

Minimum Width: 5 feet

Street Trees

Typically around transit stops, adequate hardscape curb space is needed for passenger waiting and bus operations. In light of these considerations, street tree planting around transit stops would be within hardscape and tree grates or in a tree lawn

adapted with hardscape walks.

See Complete Street.

Street Lighting

See Complete Street.

Furniture

See Complete Street.

Transit Shelters

In looking to the future, technologies that may be accommodated at the transit stop include real time passenger and vehicle arrival information, and off-vehicle expedited fare collections systems (smart cards).

See Complete Street.

Transit Stops

Determining transit stop locations involves many decisions regarding vehicle and transit operations, accessibility for mobility impaired passengers, general passenger accessibility, convenience, safety, comfort, and curb-to-curb space constraints. Stops may be located on either side of an intersection or at a mid-block location. Bus stops at the near or far side of the intersection provide the best pedestrian accessibility, but mid-block stops may be warranted for specific conditions such as a long block and/or a high transit trip generator at a mid-block location. The stop may take one of the following configurations:

Curbside Bus Stop Typically, buses pull to the curb to pick up passengers. For streets with on street parking, this results in a loss of curbside spaces. Depending on the dimension of the transit vehicle, bus stops can require about 100 to 140 linear feet of curbside space, (40 foot entry, 60 foot stop, 40 foot pull out) to allow for vehicle maneuvering as well as stopping.

Bus Bulbs A bus bulb is a curb extension that extends from the curb of a parking lane to the edge of a through lane. From an operational standpoint, buses stop in the traffic lane for passenger loading instead of pulling out of traffic, thereby saving time. Bus bulbs create additional space for passengers and amenities and reduce crossing distances. Another advantage of the bus bulb is a reduced street space requirement as no space is needed for pull-in and pull-out. This also reduces the loss of curbside parking along the street.

Bus bulbs are best used in downtown locations where high transit ridership, crowded sidewalks, bus re-entry problems during the peak-hour, and/or inadequate space for transit stop amenities come into play. Bus bulbs should not be used if the average vehicle speeds would create unsafe conditions. Recent research on bus bulbs in downtown locations has found that, contrary

to expectations, bus bulbs resulted in *increased* vehicle and bus speeds. This occurs because in busy congested conditions, buses do not pull out of traffic due to the difficultly of re-entering. (TRB, 2001)

Bus Bulbs are typically 6 feet wide and 35 to 40 feet long.

Bus Turnouts Under certain conditions, bus turnouts may be desirable, but, due to delays caused by re-entering the flow of traffic, they would not be typically anticipated for the Transit Street. In areas where buses have longer dwell times, or where transit or traffic operations warrant an out of lane stopping place, a bus turnout may be appropriate. Like a curbside stop, a bus turnout requires on the order of 100 to 140 linear feet of curbside space per vehicle, to allow for maneuvering in and out of spaces.

Roadway Zone

Parking

The Transit Street traverses busy commercial and mixed use districts within Burlington where on-street parking is a typical condition. On street parking fulfills several important purposes in these zones, including meeting some of the parking demands of adjacent land uses, providing a buffer between pedestrians and traffic, and adding to the activity on the street.

Bus stop areas are typically carved out of the parking lanes in one of several possible configurations, as described above. Bus stops should be posted with no parking signs and appropriately marked on the pavement.

Queue Jump Lanes

Queue Jump Lanes allow buses to bypass congested intersections and improve travel time. In Burlington, where rights of way are limited, Queue Jump Lanes may consist of a right turn lane at the near side of an intersection and a bus stop on the far side of the intersection. At signalized intersections, signal prioritization for buses (an advanced green time for buses) in combination with a queue jump lane could add significantly

to the overall travel time savings of bus transit.

Vehicle Lanes

See Complete Street.

Minimum Width: 10 feet

Maximum Width: 12 feet

Crosswalks

See Complete Street.

Medians and Pedestrian Refuge Islands

See Complete Street.

Minimum Dimensions: 6 feet wide by 20 feet long

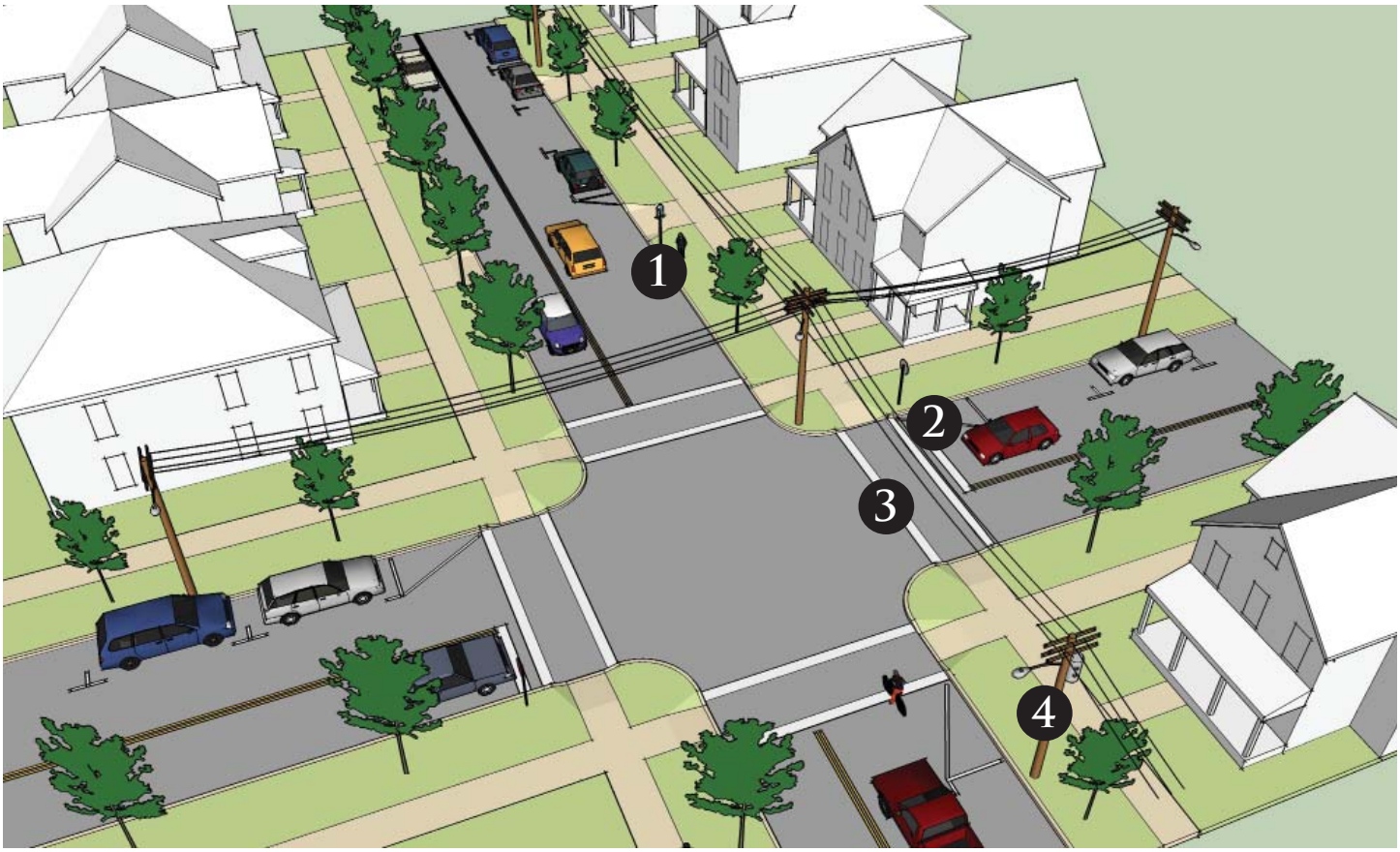
Curb Extensions

Curb extensions are an extension of the sidewalk into the parking lane at intersections and at mid-block crossings that serve a number of purposes for pedestrians and drivers, including: improving visibility for pedestrians and motorists, narrowing the crossing distance for the pedestrians, and calming traffic. Curb extensions typically extend into parking lanes. By bringing pedestrians out from behind parked cars, they manage the conflict between pedestrians and vehicles, making them more visible to one another. They are not compatible with intersections that see a high-volume of right turns made by buses and trucks. Along the Transit Street, consideration must be given to ensuring that buses can maneuver around corners and curb extensions should be designed accordingly.

Curb Return Radii

See Complete Street.

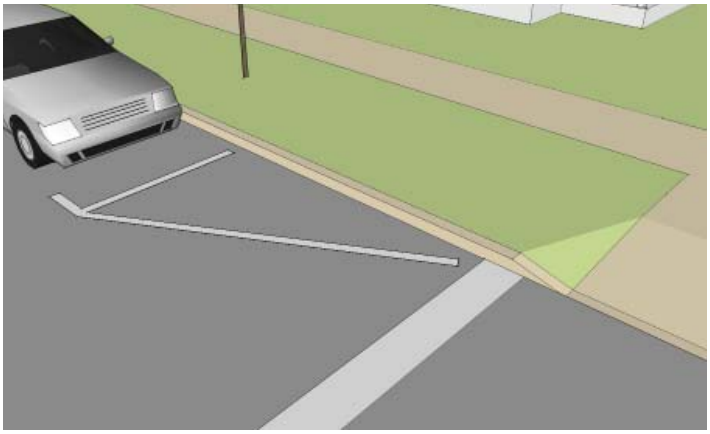
The Existing Street



The Existing Street Section

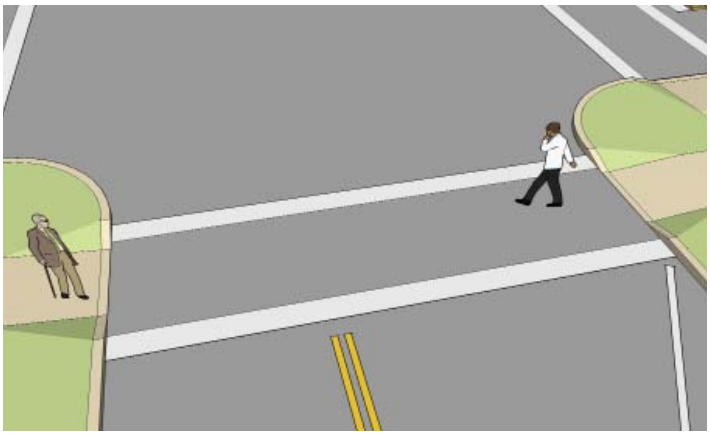
1 Basic Transit Stop

Bus stop signs are difficult to distinguish from traffic signs and are virtually invisible to potential users. Transit users are exposed to the elements. Schedule and fare information are absent.



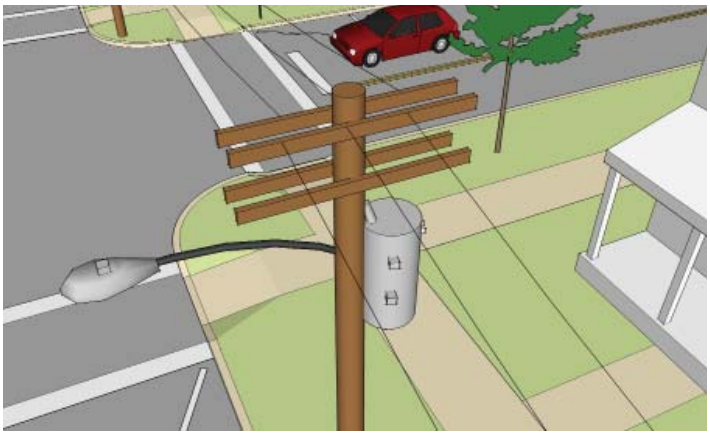
2 Excess Pavement

Underutilzed areas of pavement at crosswalks are the result of providing adequate sight distance around parked cars.



3 Limited Pedestrian Crossing

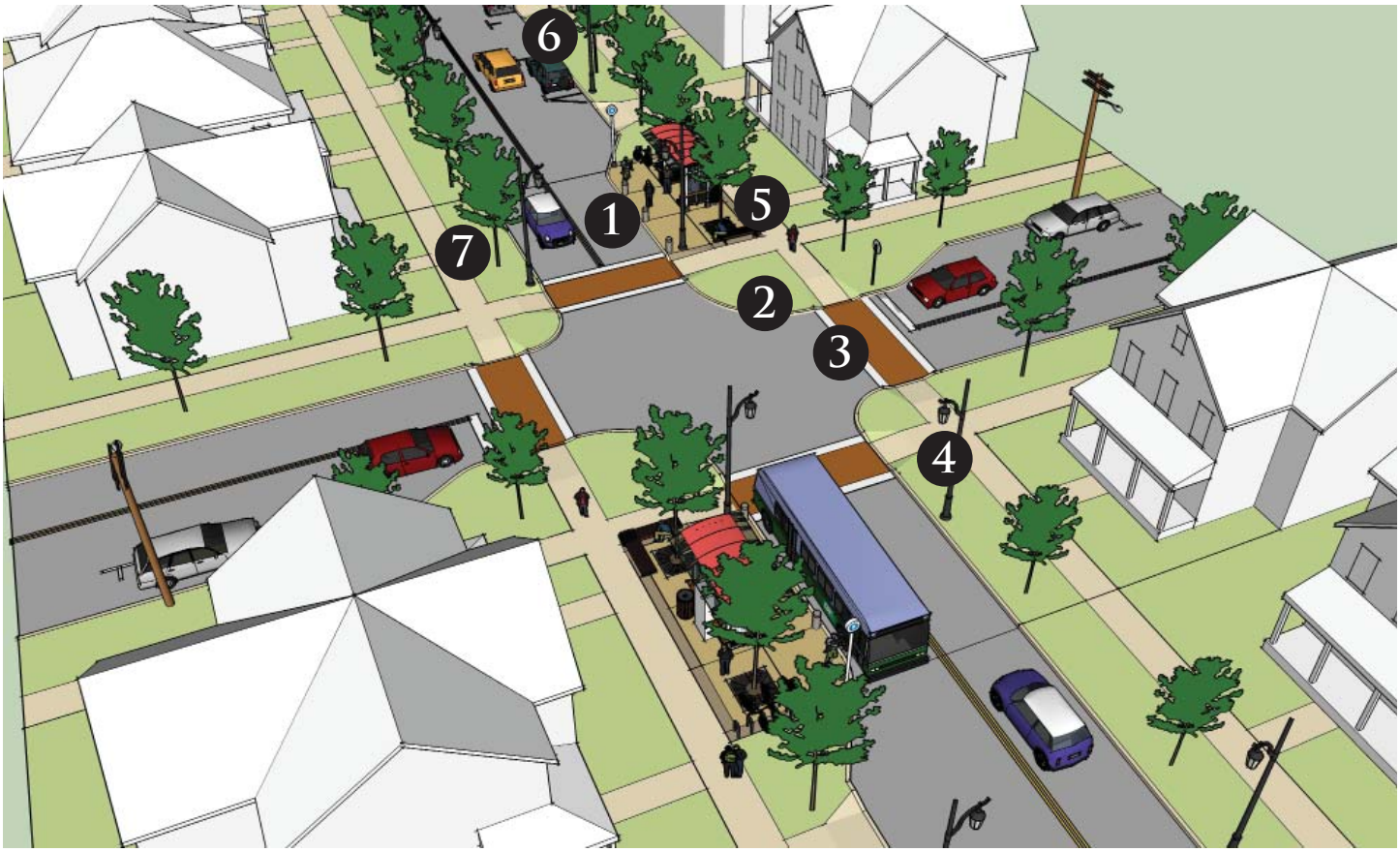
Pedestrians must contend with up to 40' of unbroken pavement. Crosswalks are poorly marked or nonexistent.



4 Unsightly Utilities & Lighting

Overhead utility poles restrict tree planting and are visually unappealing. The cobra head lighting fixtures affixed to the poles present an ad hoc solution to roadway lighting and disregard the pedestrian's lighting needs.

The Transit Street



The Transit Street Section

1A Bus Bulbs

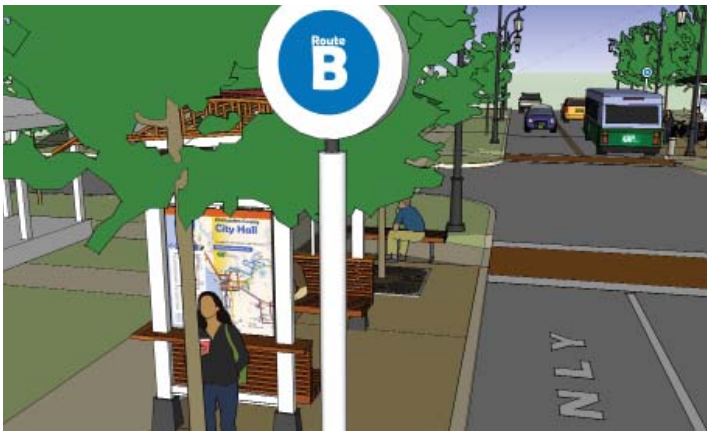
Bus bulbs give additional space to patrons and amenitites and are well suited for crowded urban conditions. They allow buses to continue along their route without the loss of time associated with merging back into traffic. Stops employ a variety of complementary streetscape elements that enhance patron comfort and contribute to the ambience of the street.

1B Curbside Transit Stop

Curbside transit stops require buses to pull into a dedicated idling zone, and are better suited for situations in which wide sidewalks are present, pedestrian and traffic congestion are low, and ridership is not as high.

1C Improved Transit Shelter

Transit shelters provide patrons with a comfortable place to wait for the bus, display real time schedule information, and may include automatic ticketing machines.

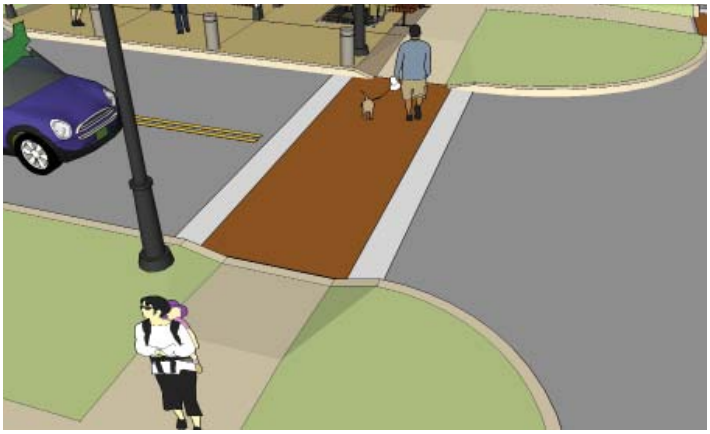


1D Improved Transit Identity

Clear route signage, system maps, and schedules facilitate the use of transit and enhance the visibility and awareness of transit along the corridor.

2 Curb Extensions

Curb extensions reallocate underutilized roadway space around street crossings to landscaping and widened sidewalks at corners. Through the use of a consistent configuration, surface treatment, and use of furnishings, they contribute to an intersection treatment that unifies the downtown pedestrian system.



3 Short Pedestrian Crossings

Curb extensions shorten pedestrian crossings from 40' to a more easily navigated 22'.

4 Updated Utilities & Lighting

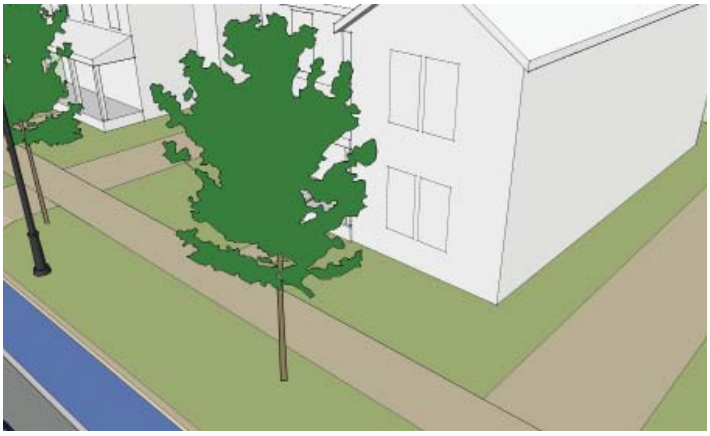
Utilties are placed underground, eliminating the need for unsightly poles and wires. Cobra head fixtures are replaced by ornamental luminaires and poles that cater to all users.

5 New Street Furniture

Distinctive street furniture at transit stop locations encourages transit use and contributes to improved identity. Bicycle racks and benches make it easier for a variety of users to benefit from transit.

6 Stormwater Treatment

Stormwater planters collect runoff from roadway surfaces, using plants and soil to slow, absorb, and cleanse stormwater before it enters municipal storm sewers.



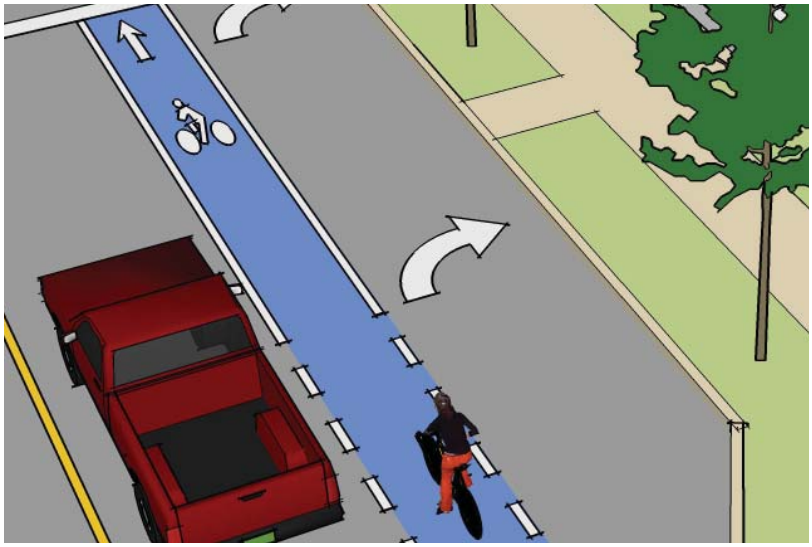
7 Tree Belts

Tree belts provide a buffer between cars and pedestrians, a visual amenity, snow storage, and a place for trees in the city.

Midblock Crossing

See Complete Street

The Bicycle Street



The Bicycle Street gives bicycles priority treatment through street improvements intended to enhance bicycle convenience and safety. The Bicycle Streets, together with the Complete Streets, Slow Streets and off-road paths, provide a bike network that will traverse the city. It is the intention of the plan to implement design changes, specifically through the marking of the pavement and an improved system of wayfinding signage oriented exclusively to bicyclists, to heighten the awareness of bicycling in general, an on these streets in particular, in effect 'branding' them as a Bicycle Street.

Anatomy of a Bicycle Street

Roadside Zone (Sidewalk and Tree Belt)

Sidewalks

See Complete Street.

Minimum Width: 5 feet

Tree Belt

See Complete Street.

Minimum Width: 5 feet

Street Trees

See Complete Street.

Street Lighting

See Complete Street.

Furniture

See Complete Street.

Transit Shelters

See Complete Street.

Roadway Zone

Parking

On street parking exists along the Bicycle Street as parallel or angled parking. Due to potential conflicts between parked cars and bicyclists, the treatment of parking and bicycle lanes requires special consideration. Where a bike lane runs parallel to parallel parking the bike lane should be as wide as space allows, but no less than a combined width (with parking) of 13 feet. In areas where bike lanes are combined with angled parking, reverse angle (back-in) parking spaces should be considered.

Bike Lanes

Bike lanes provide dedicated space for bicyclists along the roadway. Striped and signed bicycle lanes make drivers aware that bicycles are welcome and a part of the traffic mix that they must navigate. The lanes are planned as part of a network that connects to separate paths and bike routes throughout the City. They are typically 4 to 6 feet in width and may be configured on one or both sides of the street. Bicycle lanes are best on streets where the volume and/or the speed of traffic warrant some separation or designation. On streets where traffic volumes and/or speeds are low, such as many residential streets, or where there are no connections to the larger bicycle network, a designated bike lane is not needed.

Depending on the configuration of the street space, Bicycle Streets can accommodate bicycle lanes in a number of ways, as described below. The variables at work include the right-of-way width, one-way versus two-way streets, parking, and bicycle lanes themselves. Whichever configuration is chosen, continuity along the route is important to eliminate confusion for drivers and bicyclists. The configuration options for the Bicycle Street are described below, beginning with 30 foot curb-to-curb dimensions and moving to 40 foot curb-to-curb dimensions:

Single Direction Bike Lane on a Two-Way Street with Parking: 30-foot street. This option allows for parking on one side of the street, a four-foot bike lane on the other side of the street, and two-way vehicular traffic. This option should be implemented as a 'Bicycle Street Couplet' paired with a single direction bike lane running in the other direction. To obtain adequate space for bikes, cars and parking, this option will require widening the street by two feet.

Bike Lanes on a One-Way Street with Parking: 30-foot street. This option is the inverse of the previous option with bike lanes accommodated in both directions, combined with one-way vehicular traffic and parking on one side of the street. The advantage to this approach is that it accommodates two-way bike travel, while maintaining parking on one side of the street, all within the existing 30 foot curb-to-curb distance. The use of a contra-flow bike lane in this option should be carefully considered as drivers do not expect bicycle travel in the opposite direction on a one-way street. If possible, lanes should be demarcated in a visually dramatic fashion and intersecting streets should be signed to help drivers understand the flow of traffic. Converting a street to a one-way direction requires a parallel street accommodating travel in the opposite direction. A further consideration is that the speed of traffic will likely increase on a one-way street, and this is not a desirable outcome on most streets.

Bike Lanes on a Two-Way Street with No Parking: 30-foot street. The last option for a 30-foot curb-to-curb distance involves removing on-street parking and accommodating two way traffic and a bike lane in either direction. While bicycle and vehicular traffic are well-accommodated within the existing curb-to-curb street space, the loss of on-street parking would be a hardship for adjoining land uses.

Two-Way Bike Lanes and Two-Way Street: 40-foot street. Within a 40-foot curb-to-curb dimension, bicycle traffic and vehicular traffic can be handily accommodated with bike lanes in each direction, parking on one side of the street and two-way traffic.

High visibility treatment of the bike lane, including painting and signage, is encouraged to improve the visibility, safety, understanding, and entitlement of bikes on the street. At a minimum, marking of the bike lane should include a solid white line, bicycle icon, and directional arrow. Additional treatment might include painting the lane on streets where even higher visibility would be desirable. Integral color pavement is another option for new or reconstructed streets. Bike safe drainage inlet grates should be employed.

On state routes, bicycle facility design should meet the requirements of the Vermont Agency of Transportation's *Vermont Pedestrian and Bicycle Facility Planning and Design Manual*.

The following recommended bike lane dimensions are recommended (ITE, 2005).

Minimum Bike Lane Width: 4 feet (outside of gutter pans, if applicable)

Minimum Combined Bike and Parking Lane Width: 13 feet

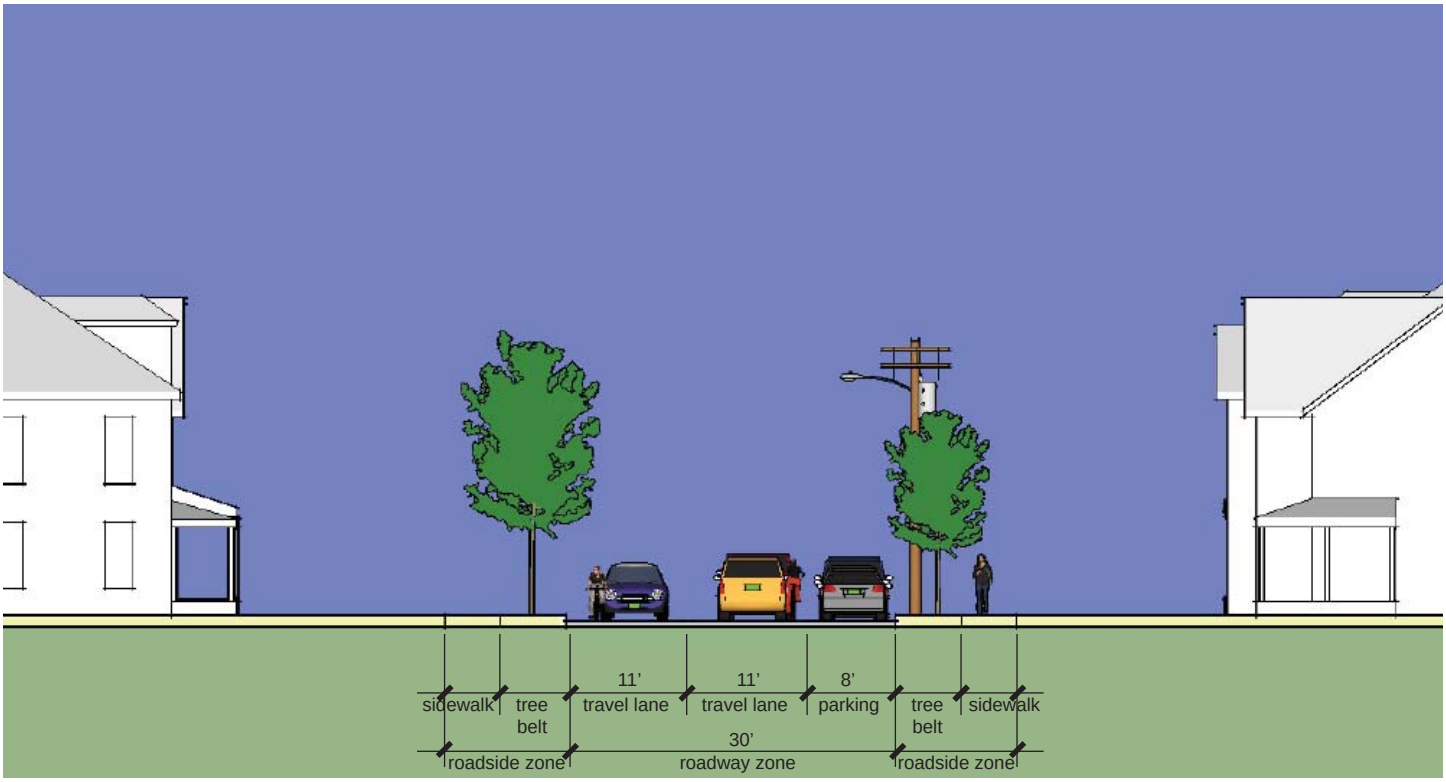
Vehicle Lanes

See Complete Streets.

Minimum Width: 10 feet

The Existing 30' Street

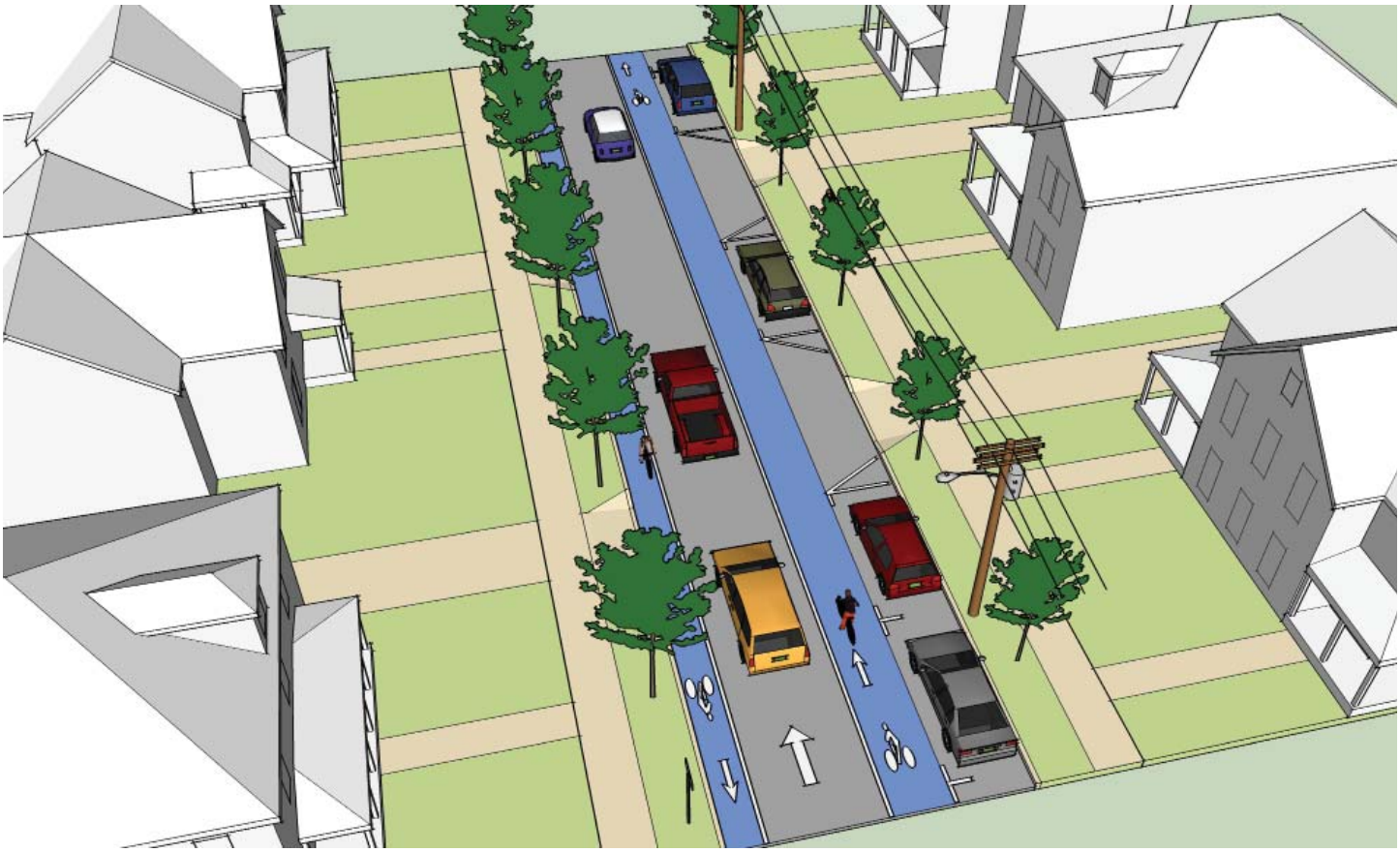
The Existing 30' Street Section



The Bicycle Street - 32' Street With a Single Direction Bike Lane

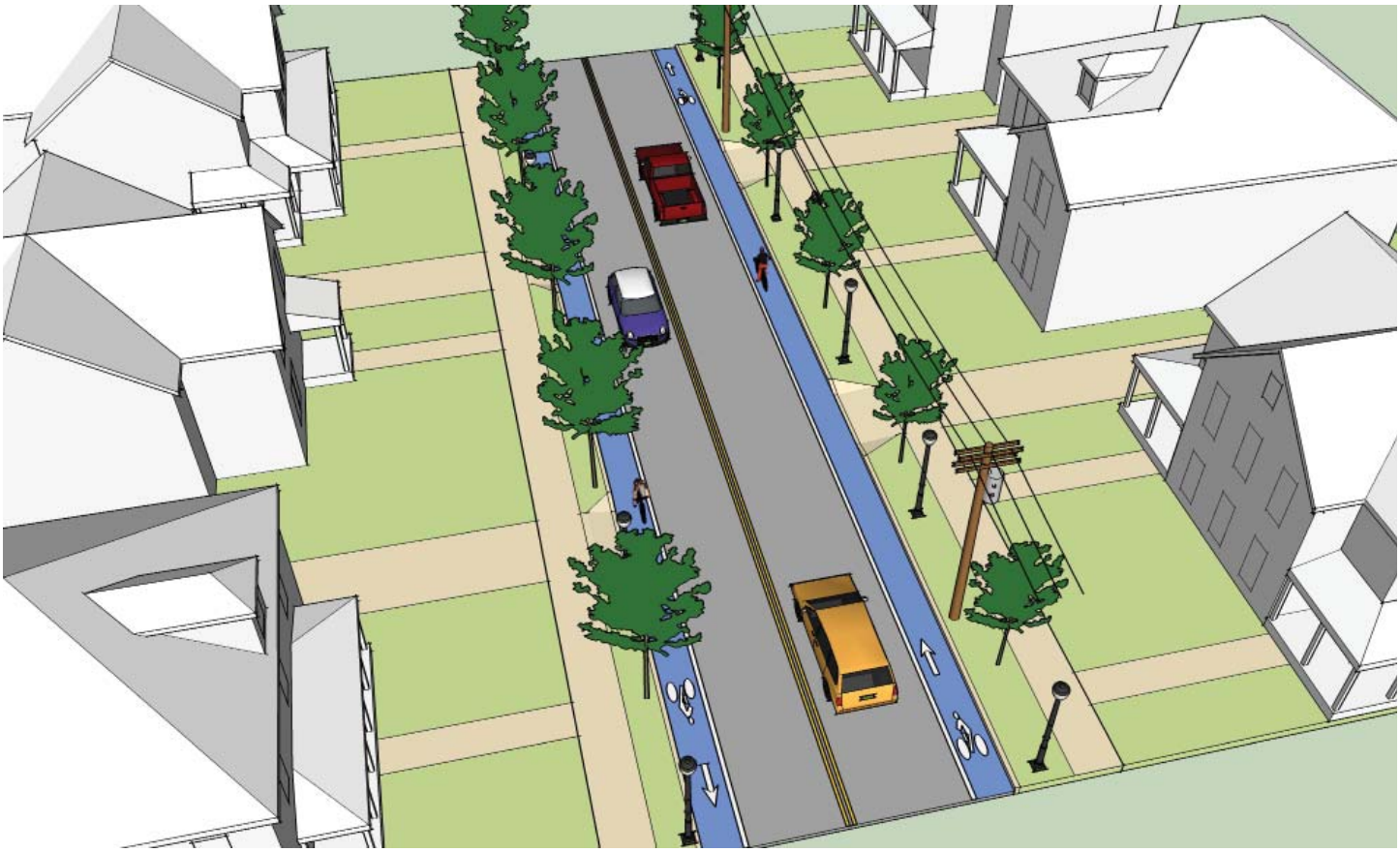
The Bicycle Street Section

The Bicycle Street - 30' with Two Bike Lanes & One Way Street



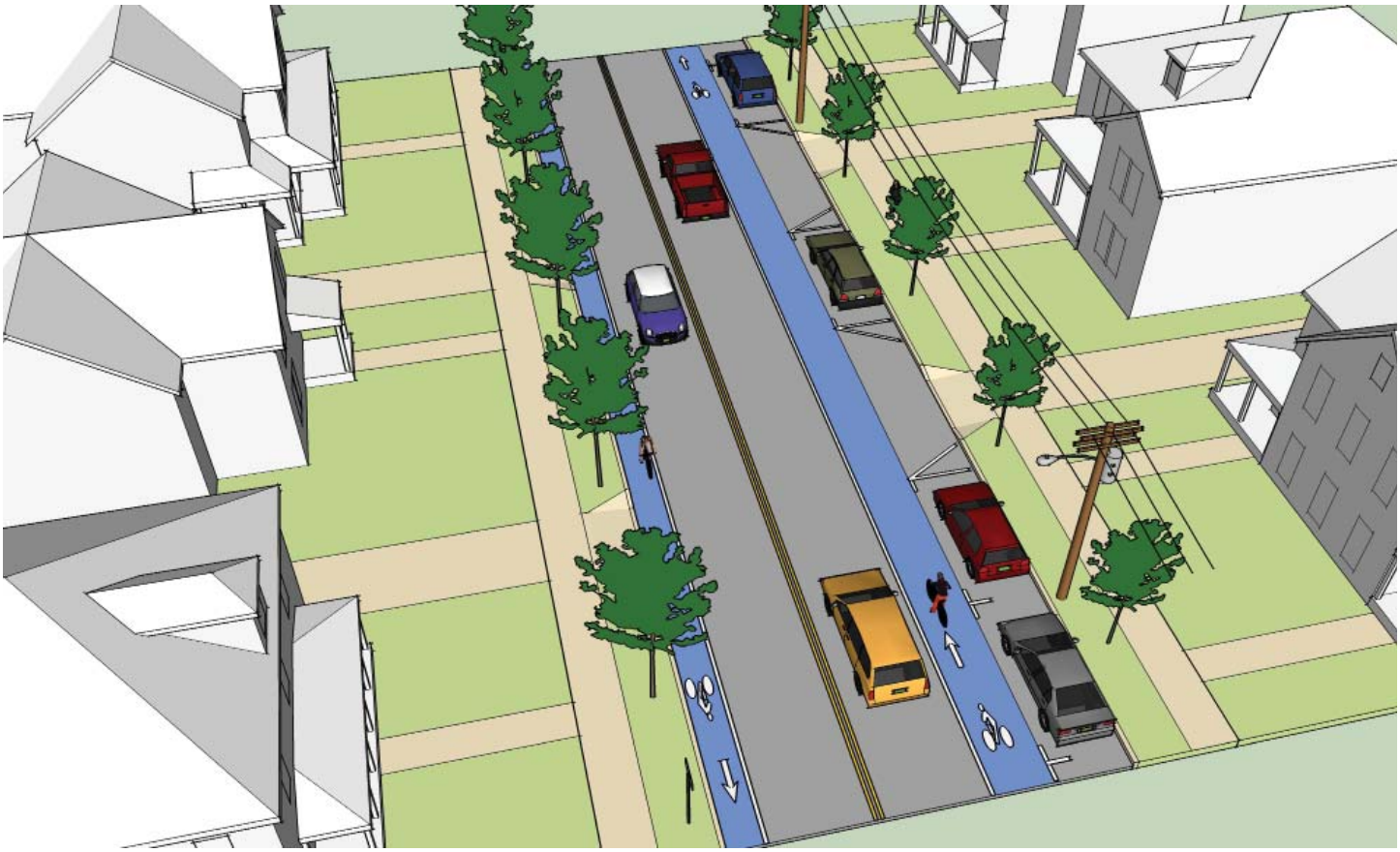
The Bicycle Street Section

The Bicycle Street - 30' with Two Bike Lanes & Two Way Street



The Bicycle Street Section

The Bicycle Street - 40' with Two Bike lanes & Two Way Street



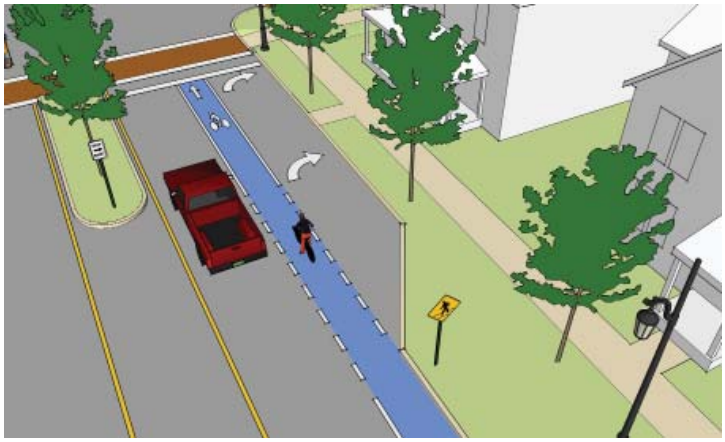
The Bicycle Street Section

Bike Lane Treatment at Intersections

In general, bike lanes should stop behind the stop bar or crosswalk. Lanes should not cross the intersection. However, where intersections involve a complex array of movements, a broken lane may be used to improve clarity for cyclists.

Right Turn Lanes

If an exclusive right turn lane exists within the bicycle network, a through bike lane to the left of the turn lane should be striped within the roadway.



The Slow Street

The Slow Streets are located within the pedestrian-oriented downtown core bounded by South Winooski Street, Maple Street, the waterfront and Pearl Street. Within this area, all modes of transportation are in high demand and vehicular traffic must proceed at slow speeds for safety. Cars, buses and bicycles all share the right of way. Pedestrian convenience is of the utmost importance and crossings are frequent. Cars easily pull in and out of curbside spaces. The rich mix of activity is facilitated by the slow speed of traffic on these streets.

Anatomy of a Slow Street

Roadside Zone (Sidewalk and Tree Belt)

Sidewalks

In this high volume pedestrian environment,sidewalks are typically much wider than in other areas and would be anticipated to remain as such. In a vibrant downtown, sidewalk function as social gathering spaces as well as a conveyance for pedestrians. Street furniture, sidewalk cafes, transit stops, bicycle parking are all functions that would be expected along the sidewalks of the Slow Street. Whatever functions are accommodated a five-foot clear zone for pedestrian movement must be maintained. While this five foot width forms an absolute minimum width for passage, it is anticipated that a minimum width is more on the order of 8 to 10 feet.

See Complete Street.

Minimum Width: 5 feet

Tree Belt

See Complete Street.

Minimum Width: 5 feet

Street Trees

See Complete Street.

Street Lighting

See Complete Street.

Ornamental pedestrian scale fixtures should be 10 to 14 feet in height.

Furniture

See Complete Street.

Transit Shelters

See Complete Street.

Roadway Zone

Parking

See Transit Street.

Parking Meters and Pay Stations

Parking meters at the edge of the curb have been identified as a problem due to incompatibility with snow storage during the winter months. Parking meters should be located behind the tree belt at the edge of the pedestrian clear zone to improve accessibility during the winter months.

Centralized pay stations for parking are another option that improves accessibility for patrons during snowy conditions and provides expanded payment options.

Vehicle Lanes

Vehicle travel lanes vary in terms of width, depending on availability within the right-of way. The Slow Street is typically characterized by 12 foot lanes due to the mixture of bikes, buses and cars in the roadway. Vehicle Lanes should be no less than 10 feet in width.

Minimum Width: 10 feet

Maximum Width: 12 feet

Crosswalks

See Complete Street.

Curb Extensions

See Transit Street.

Curb Return Radii

See Complete Street.

Green Street Options

Stormwater Planter

See Complete Street.

Porous Paving

See Complete Street.

The Existing Street

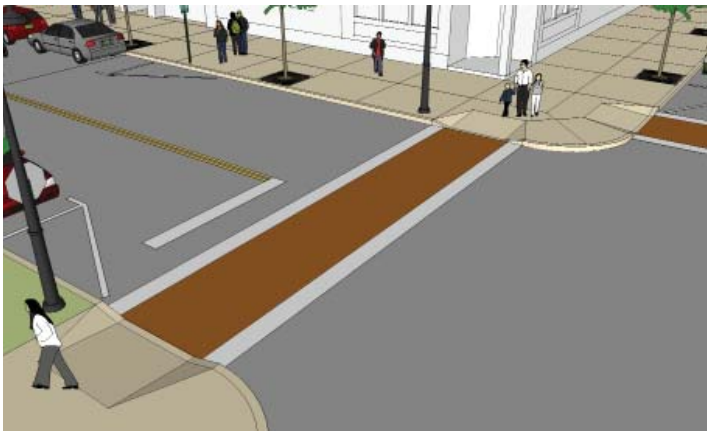
The Existing Street Section

1 Basic Transit Stop

Bus stop signs are difficult to distinguish from traffic signs and are virtually invisible to potential users. Transit users are exposed to the elements. Schedule and fare information are absent.

2 Excess Pavement

Underutilzed areas of pavement at crosswalks are the result of providing adequate sight distance around parked cars.



3 Long Pedestrian Crossing

Pedestrians are exposed to oncoming traffic for a distance of 40 feet when crossing streets.

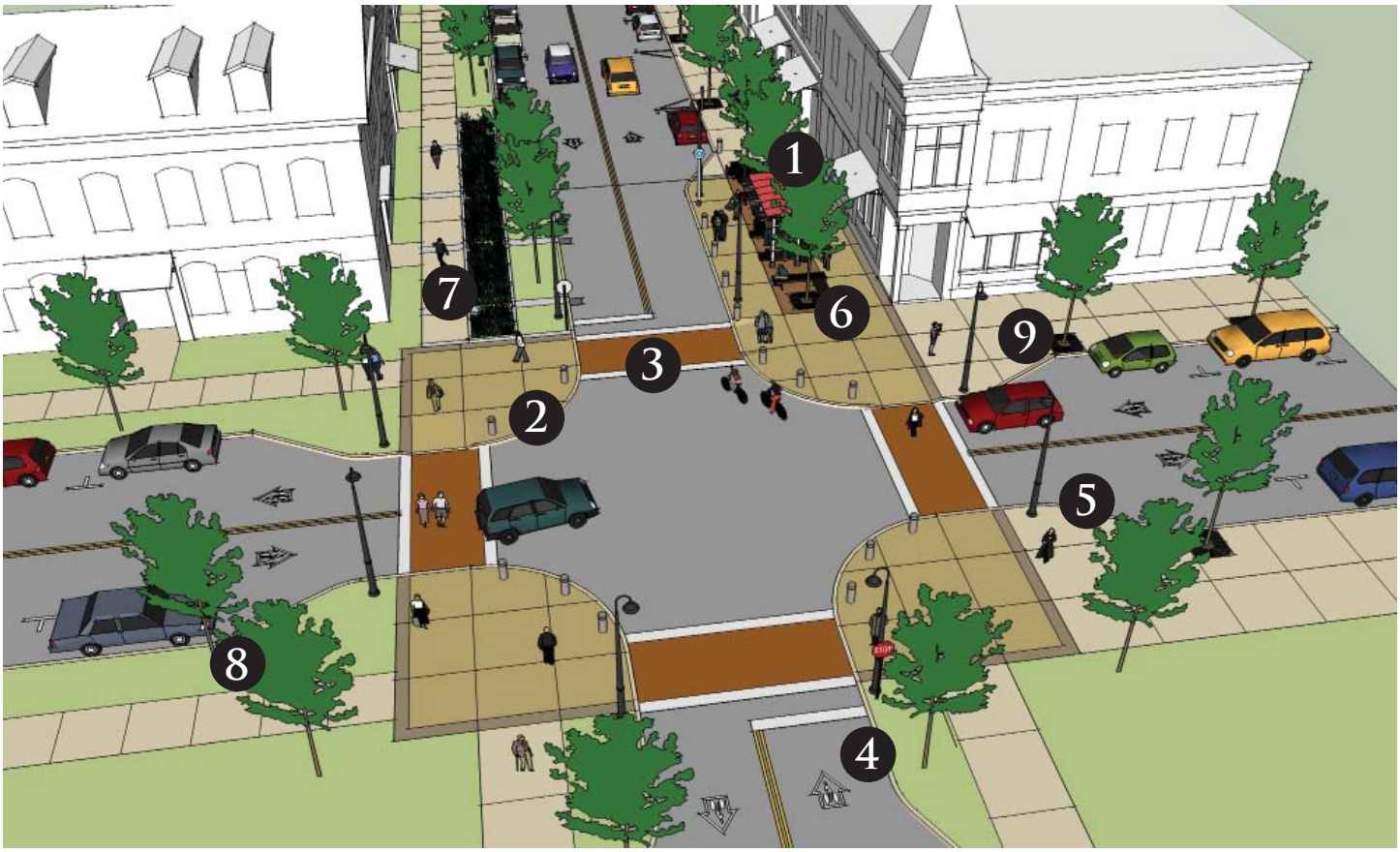
4 Where do Bikes go?

Without a clear expression of intent, it is not apparent that bicyclists are expected to share the roadway with motorists.

5 Mix of Street Lights

Street lights are uncoordinated within districts, contributing to a hodgepodge of street furnishings and detracting from neighborhood identity.

The Slow Street



The Slow Street Section

1A Bus Bulbs

Bus bulbs give additional space to patrons and amenitites and are well suited for crowded urban conditions. They allow buses to continue along their route without the loss of time associated with merging back into traffic. Stops employ a variety of complementary streetscape elements that enhance patron comfort and contribute to the ambience of the street.

1B Curbside Transit Stop

Curbside transit stops require buses to pull into a dedicated idling zone, and are better suited for situations in which wide sidewalks are present, pedestrian and traffic congestion are low, and ridership is not as high.

1C Improved Transit Shelter

Transit shelters provide patrons with a comfortable place to wait for the bus, display real time schedule information, and may include automatic ticketing machines.

1D Improved Transit Identity

Clear route signage, system maps, and schedules facilitate the use of transit and enhance the visibility and awareness of transit along the corridor.

2 Curb Extensions

Curb extensions reallocate underutilized roadway space around street crossings to landscaping and widened sidewalks at corners. They also allow pedestrians to see and be seen around parked cars before leaving the curb. Through the use of a consistent configuration, surface treatment, and use of furnishings, they contribute to an intersection treatment that unifies the downtown pedestrian system.

3 Short Pedestrian Crossings

Curb extensions shorten pedestrian crossings from 40' to a more easily navigated 24'.

4 Bike markings

Bicycle arrows within the traveled way indicate to bicyclists and motorists that the road is to be shared by both.

5 Updated Street Lighting

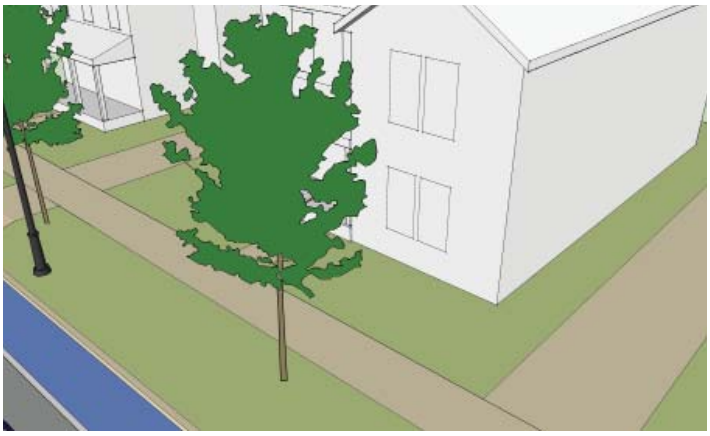
Existing street lights are replaced with a luminaire and pole specific to slow streets.

6 New Street Furniture

Distinctive street furniture at transit stop and other key locations encourages transit use and contributes to improved identity. Bicycle racks and benches make it easier for a variety of users to benefit from transit.

7 Stormwater Treatment

Stormwater planters collect runoff from roadway surfaces, using plants and soil to slow, absorb, and cleanse stormwater before it enters municipal storm sewers. Curb extensions are appropriate locations for stormwater facilities.



8 Tree Belts

Tree belts provide a buffer between cars and pedestrians, a visual amenity, snow storage, and a place for trees in the city.

9 Trees & Sidewalks

By replacing sidewalk subbases with a special structural soil, street trees can be planted in paved environments.

Enhanced Intersection Treatment

At certain key intersections, where pedestrian volumes are particularly heavy and connections between sidewalks and/or pedestrian promenades are desired, special treatment of the intersection can visually connect pedestrian zones and calm traffic. The intersection may be raised to sidewalk level and incorporate special paving treatment, creating a slow intersection and strong visual connections between pedestrian zones. Curb extensions protected with bollards extend the sidewalk space into the intersection allowing drivers and pedestrians to see each other more clearly. This treatment also works well as extended sidewalk space for festivals and special celebrations.

The Enhanced Intersection

The Enhanced Intersection Section

1 Raised Intersection

Raising the intersection to the level of surrounding sidewalks creates a continuous pedestrian environment from curb to curb. The intersection acts as a large speed table, causing drivers to slow down as they approach it.

2 Surface Materials & Bollards

Surfacing materials such as smooth granite setts, concrete unit pavers resembling brick, and textured or colored concrete can be used to give more visual prominence to the intersection and create a "paved carpet" underfoot. Granite bollards help to further distinguish pedestrian-only zones from the mixed flow zones.

Midblock Crossing

See Complete Street.

VI. Traffic Calming

Traffic Calming

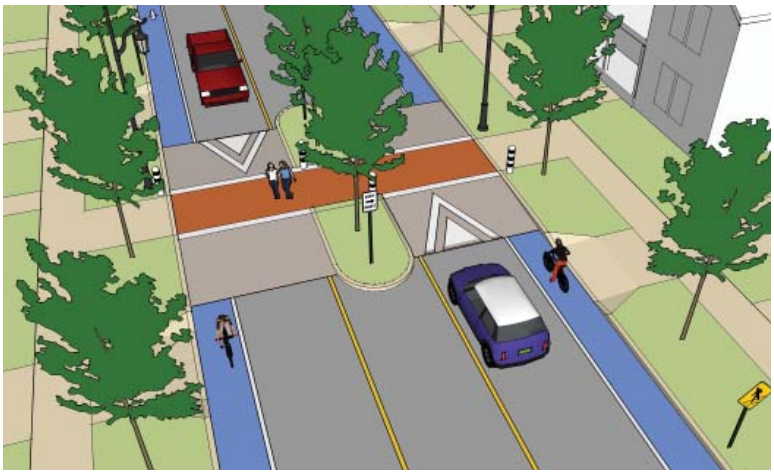
The design of the street network has a great influence on the livability, vitality and character of Burlington. Growth in Burlington and the surrounding region coupled with overall growth in automobile ownership and vehicle miles traveled, have seen attendant growth in traffic volume, speed and congestion. Much of the focus of street design in past decades has been on facilitating and expediting automobile circulation. Due to these various circumstances, many residents feel that their neighborhoods have become overwhelmed with speeding and cut-through traffic that erodes their quality of life.

The following section describes traffic calming approaches that are used to reduce speed, improve safety, and enhance the livability of the street environment while still accommodating through traffic. Traffic calming measures that address speed are typically grouped into the following categories: vertical deflections such as speed tables, textured pavement, raised crosswalks, and intersections; horizontal deflections such as chicanes and neighborhood traffic circles; and roadway narrowings such as center medians and curb extensions. Many of these measures are used in combination with one another in the street design guidelines to calm traffic and make environments more pedestrian and bicycle friendly. Other methods may be applied to streets that are not specifically addressed in the Street Design Guidelines.

For neighborhoods, implementing traffic calming measures should begin with an assessment of the problem that identifies the sources of the problem and includes neighborhood participation. Many communities have adopted traffic calming policies and a process for neighborhoods to study and adopt neighborhood traffic management plans and set priorities for funding and implementation.

Speed Tables and Raised Crosswalks

Speed tables are raised platforms of pavement placed within a traffic lane. They are typically used in mid-block locations and work well as raised crosswalks in those areas. Dynamic painting and textured paving help to increase visibility and driver awareness of pedestrians.



Speed tables that are 22 feet in length have been effective at reducing speed by an average of 18% (from an average of 36.7 to 30.1 miles per hour) and reducing accidents by an average of 45% (from an average of 6.7 to 3.7 accidents per year).

Raised Intersections

Raised intersections are flat raised areas covering the entire intersection. The intersection often employs colored and textured paving as well to demarcate the intersection as part of the pedestrian zone. Applied at an intersection, raised intersections calm two streets at once.

Raised intersections have been observed to result in a 1% reduction in speed (from an average of 34.6 to 34.3 mph).

Textured Pavement

Colored and textured pavement treatments are used to heighten the visual and tactile sense of prominent pedestrian zones. They are used in combination with raised crosswalks and intersections, and are sometime used along entire blocks. There is currently no data available that describes the effectiveness of textured pavement with respect to reducing speed.

Horizontal Deflection Measures

Neighborhood Traffic Circles or Intersection Island

Neighborhood traffic circles are raised islands placed within an intersection. They are not to be confused with modern roundabouts, which are applied to a different set of circumstances. Traffic circles require drivers to slow down in order to go around the circle. Like raised intersections, they have the advantage of calming traffic on two streets at once.

Neighborhood traffic circles are very effective at reducing speed and frequency of collisions, and with landscaping can be an attractive addition to the street environment. They should not be used where there is a high volume of buses and large vehicles.

Burlington has a neighborhood traffic circle at the intersection of Strong and Blodgett in the Old North End.

Neighborhood traffic circles have resulted in an average reduction of speed by 11% (from 34.1 to 30.2 miles per hour) and a 70% reduction in intersection collisions - a 28% reduction in collisions overall.

Chicanes

Chicanes are curb extensions that intrude into the street space and alternate from one side of the street to another. Chicanes can also be created by alternating on-street parking from one side of the street to another. Chicanes are applied in mid-block locations.

Chicanes must be designed carefully to ensure that drivers cannot cut a speed path through the center of the road. On a typical residential street chicanes will have an impact on on-street parking and driveways.

Data on chicanes' effecteness in reducing speed and collisions is limited. Experience in the City of Seattle has found chicanes to be effective in reducing speeds from 18 to 35% overall.

Horizontal Narrowings

Pedestrian Refuges or Center Islands

Pedestrian refuges or center islands are raised medians at the center of the road that narrow travel lanes at a particular location and provide a place for pedestrians to seek refuge from traffic as they cross a street. If they are not part of a pedestrian crossing they can be a visual amenity or gateway that narrows travel lanes and slows traffic at a specific location.

Islands without any vertical deflection result in an average speed reduction of 7%, or from an average of 34.9 to 32.3 mph.

Curb Extensions or Chokers

Curb extensions are areas of sidewalk or landscape islands that extend into the intersection or roadway. At intersections, curb extensions have several benefits for pedestrians including greater visibility, shortened crossing distances, and slower vehicle turning speeds.

Curb extensions without vertical or horizontal deflection have been effective in reducing speeds 7% (from 34.9 to 32.3 miles per hour).

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