CHAPTER 2

TRANSPORTATION DESIGN

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2.01 General

(A) Intent

The Transportation Design Standards are intended to provide for an integrated transportation system for all transportation modes, including pedestrian, bicycle, transit, and motor vehicle.

(B) Transportation Master Plan

All improvements proposed to the City's transportation system shall conform with the goals~~,~~ and policies~~, and standards adopted~~ in the Transportation Master Plan (TMP).

(C) Reference Standards

Where not specified in these Standards or the B.R.C. 1981, to protect the public health, safety, and welfare, the Director of Public Works will specify the standards to be applied to the design and construction of transportation improvements and may refer to one or more of the references listed in the References Section of these Standards.

(D) Functional Street Classification

Public streets shall be designed and improved to conform to the applicable functional street classification as defined on the "Street Function Class and Proposed Street Facilities" map of the TMP.

2.02 Traffic Study

(A) Traffic Assessment

The Director will require an applicant to submit a Traffic Assessment in order to adequately assess the impacts of any development proposal on the existing and planned transportation system. The Assessment shall include a peak hour trip generation study projection (Refer to 2.03(J)) and may require additional information as determined by the Director.

(B) Traffic Study Requirements

For any development proposal where trip generation from the development during the peak hour of the adjacent street is expected to exceed 100 vehicles for nonresidential applications, or 20 vehicles for residential applications the Director will require an applicant to submit a Traffic Study to evaluate the traffic impacts of the development proposal. The Traffic Study may include the information required in Subsections (A) through (K), of Section 2.03, "Traffic Study Format," of these Standards at the discretion of the Director.

(C) Responsibilities for Traffic Studies

An applicant for construction approval shall be responsible for assessing all traffic impacts associated with a proposed development, with the City serving in a review and approval capacity.

(D) Preparation

A Traffic Study shall be prepared by an Engineer with adequate experience and expertise in transportation engineering. The Engineer shall be identified in the Traffic Study.

(E) Coordination with City

Transportation consultants and Engineers preparing Traffic Studies shall discuss proposed development projects with the Director prior to initiating the study. Issues to be discussed include, without limitation, the TMP, definition of the study area, relevant subarea, area, and subcommunity plans, methods for projecting build-out volumes, background traffic conditions, trip generation, directional distribution of traffic, and trip assignment. These aspects of the Traffic Study shall be approved by the Director prior to study preparation.

(F) Submittal

A Traffic Study shall be prepared in conformance with, and including, the information required in Section 2.03, "Traffic Study Format," of these Standards.

2.03 Traffic Study Format

(A) Study Requirements

The information provided in the Traffic Study shall include the following sections as outlined below. The study shall be typed and bound, and clearly identify the data and information in the appropriate sections. In addition, the study shall contain a table of contents, lists of figures, and tables, and shall identify any map pockets and included drawings.

(B) Introduction

The Traffic Study shall provide an introduction with an overview and discussion of the project or development proposal.

(C) Site Location and Zoning

Include a vicinity map detailing the property location, a conceptual site plan reflecting the boundaries of the project or development, and information detailing the designated zoning district, general terrain and physical features of the site and the surrounding area.

(D) Study Area Boundaries

Include the Study Area Boundaries as determined based on discussions with the Director and include all roadways and transportation routes providing access to the site and the surrounding transportation system.

(E) Existing Area Street System Description

Describe and include roadway orientations, functional classifications and geometries, intersection geometries, and traffic controls, including without limitation signage and striping, speed limits,

parking restrictions, sight distance, transit routes, the presence of bicycle and pedestrian facilities, and any other related traffic operations information and improvements approved or planned by government agencies. For identified improvements scheduled by government agencies, include the nature of the improvements, extent, implementation schedule, and the agency or funding source responsible.

(F) Existing and Projected Roadway and Intersection Traffic Volumes

Include diagrams that map existing traffic volumes, and each variation of projected traffic volumes, for all roadways and intersections within the study area. Also provide diagrams that map the intersection and roadway geometries and traffic control within the study area.

(G) Existing and Proposed Site Uses

Include an identification of the existing land use and proposed land use or the highest potential land use based on zoning and maximum trip generation where a specific use has not been determined. If rezoning is proposed, the study shall provide a comparison between the highest trip generation uses for the existing zoning and the highest trip generation uses for the proposed zoning.

(H) Existing and Proposed Land Uses in Vicinity of the Site

Document any vacant land or potential redevelopment that may result in a change in traffic volume conditions within the study area during each time period studied. Perform and provide trip generation on these parcels and include the trips generated from these parcels in the trip volume diagrams and level of service analyses for each appropriate time period studied.

(I) Transportation Demand Management Strategies

Include an outline of transportation demand management strategies to mitigate traffic impacts created by proposed development and implementable measures for promoting alternate modes of travel, including but not limited to the following:

(1) **Site Design:** Incorporate design features that facilitate walking, biking, and use of transit services to access a proposed development, including features such as transit shelters and benches, site amenities, site design layouts, orientations and connections to increase convenience for alternate modes and reduce multiple trips to and from the site, and direct connections to existing offsite pedestrian, bicycle, and transit systems.

(2) **Programs and Education:** Incorporate alternate modes programs, such as providing transit passes to employees and residents, van pooling to the site by a major employer, ride-sharing, parking pricing, and planned delivery services, and educational measures such, as promoting telecommuting, distributing transit schedules and trails maps, signing alternate travel routes, and providing an onsite transportation coordinator or plan to educate and assist residents, employees, and customers in using alternate modes.

(J) Trip Generation

Traffic estimates for the proposed project and potential developed or redeveloped properties in

the study area shall be obtained by performing trip generation using the procedures outlined in the most current edition of the *Trip Generation Manual* of the Institute of Transportation Engineers (ITE). If adequate *Trip Generation Manual* data is not available for a specific land use, the procedures used to estimate trip generation data shall be approved by the Director. Include the following specific trip generation information:

(1) **Summary Table:** List each land use that requires trip generation analysis, including the project plus developed or redeveloped land uses within the study area. For each trip generation summary include land use type, amount, intensity, average trip generation rates for total daily traffic and peak hour traffic (a.m., noon and/or p.m. peak hour traffic generation may be required), and the resultant total trips generated for each time period and each land use.

(2) **Calculations:** Calculation of projected trip generation for any land use, used to determine study area impacts, shall be based on the following:

(a) Trip generation formulas (or rates, if formulas are not available) published in the most recent version of the *Trip Generation Manual*. Trip generation reports from other industry publications may be considered but are subject to the approval of the Director.

(b) A local trip generation study, following procedures outlined in the most recent version of the *Trip Generation Manual*, if no published rates are available and similar land uses can be studied.

(c) Additional data or studies from other similar jurisdictions. Trip generation obtained in this fashion is subject to the review and approval of the Director.

(3) **Trip Generation Reductions:** Credit for any trip reductions is subject to review and approval in advance by the Director. Anticipated trip reduction assumptions should be discussed and approved by the Director prior to the preparation of the Traffic Study. Trip reductions typically fall into one of two categories: those that reassign some portion of the trip generation from the surrounding roadway network (passerby and diverted trip reductions), and those that remove trips generated from the land use trip generation (internal and modal split reductions).

(a) Use of passerby and diverted trip reductions may be evaluated and considered in reducing the additional estimated total trip generation of a new land use. However, passerby and diverted trip reduction factors are not to be applied directly to reduce trip generation and turning movement volumes at driveways serving the studied land use. These factors are subject to the approval of the Director.

(b) Internal trip reductions and modal split assumptions may reduce the total trip generation of a land use. These factors considered in the Traffic Study shall supply analytical support and detailed documentation to demonstrate how the estimates were derived and incorporated, and are subject to the approval of the Director.

(K) Trip Distribution/Assignment and Modal Split

Trip distribution/assignment of any generated traffic estimates shall be clearly summarized and illustrated for each access route entering and exiting the generating land use, using the study area transportation system as a basis. Include the following specific trip distribution/assignment information:

(1) **Trip Distribution:** The trip distribution for each site shall be identified and illustrated with a graphical figure detailing the percentages making each movement, at each intersection in the study area. The trip distribution shall be logically based upon factors such as the site's location within the City's existing traffic volume data in the study area, market analyses, applied census data, and/or professional engineering judgment. Trip distribution assumptions are subject to the approval of the Director.

(2) **Trip Assignment:** Trip assignment shall be done by applying the trip generation totals for each time period studied, to the trip distribution percentages developed. The trip assignment shall develop anticipated traffic volumes for each of the movements identified by the trip distribution and each of the time periods identified in the analyses. The resulting traffic volumes shall be illustrated with graphical figures detailing the anticipated volumes making each movement, at each intersection in the study area, during each time period studied.

(L) Existing and Projected Traffic Volumes

(1) **Traffic Volume Scenarios:** Five traffic volume scenarios and three separate times of the day may be required to be included in a Traffic Study analysis. The applicant shall meet with the Director to determine the scenarios and time periods to be studied, prior to the development of the Traffic Study. The number of scenarios and time periods to be studied are subject to the approval of the Director. The potential scenarios and time periods include the following:

(a) Scenario 1 - Existing Conditions: An analysis of existing traffic conditions will be required in the Traffic Study. Existing Conditions analysis should attempt to model traffic conditions at the time the Traffic Study is being prepared. Traffic counts that are older than the year the study is being prepared shall be factored up or adjusted to existing year volumes.

(b) Scenario 2 - Anticipated Project Completion Year Without Project Volumes: Include an analysis of the anticipated traffic conditions during the year the project is intended to be finished and traffic is generated. The analysis shall anticipate the increase in background traffic volumes and the generation of other related projects that are not present in the existing condition, but would likely be completed and generating trips in this time period. The trip generation for the proposed project shall not be included in this scenario. If the project is intended to be completed the same year that the Traffic Study is being prepared, then this scenario is the same as Scenario 1 - Existing Conditions.

(c) Scenario 3 - Anticipated Project Completion Year With Project Volumes: This scenario is the same as Scenario 2, except that the project volumes are assigned

to the roadway network and included in the analyses.

(d) Scenario 4 - Future Buildout Conditions Without Project Volumes: An analysis of the anticipated traffic conditions during buildout, using the projected buildout year defined in the City's TMP. The analysis shall anticipate the increase in background traffic volumes and the generation of other related projects that are not present in the existing condition, but would likely be completed and generating trips in this time period. The trip generation for the proposed project should not be included in this scenario.

(e) Scenario 5 - Future Buildout Conditions With Project Volumes: This scenario is the same as Scenario 4, except that the project volumes are assigned to the roadway network and included in the analyses.

(2) **Traffic Volume Projections:** The traffic volume projections shall identify existing and projected daily traffic counts and peak hour turning movement counts for each access point, intersection and street identified in the Traffic Study area for each of the aforementioned scenarios required in the study.

(3) **Time Periods:** Each scenario may be required to look at three different time periods (the a.m., noon and p.m. peak hour conditions). The Director will determine which time periods and scenarios are required for each Traffic Study depending upon the project's size, location, types of land uses and other pertinent factors.

(4) **Raw Traffic Count Data:** Include all raw traffic-count data for average daily and peak hour conditions and traffic analysis worksheets in the appendices of the Traffic Study for reference. Computer techniques and associated printouts may be used for this part of the report.

NOTE: All total daily traffic counts must be actual machine counts, not based on factored peak hour sampling. Latest available machine counts from the City, and other agencies, may be acceptable if not more than 2 years older than the year the Traffic Study is being prepared. Data older than the year the Traffic Study is being prepared shall be factored up to current year numbers, using growth rates approved by the Director.

(M) Transportation Service Standards

Include a discussion and analysis assessing the impacts of the project or development proposal on the existing and planned transportation system in the study area with respect to the following traffic impact and mitigation objectives:

(1) **Transportation Master Plan Objectives:** TMP service standards' objectives include the following:

(a) No long-term growth in auto traffic over current levels described as a 0 percent increase in vehicle miles traveled.

(b) Reduction in single-occupant vehicle travel to 25 percent of total trips.

(c) Continuous reduction in mobile source emission of air pollutants, and no more than 20 percent of roadways congested at LOS F.

(2) **Level of Service Design Guide:** LOS standards objectives include:

(a) Minimum LOS D design guide for peak hour conditions for all movements. Project impacts that maintain LOS D or better for all intersections and street segments may not be required to provide LOS-related traffic mitigation improvements.

(b) LOS E and lower peak hour conditions require the implementation of one or more transportation management strategies consistent with the goals and objectives of the TMP. A transportation management strategy plan required to address and mitigate these conditions may include travel demand management, land use intensity reduction, site design, layout and access modifications, parking reduction measures, or transportation infrastructure improvements.

(N) Level of Service Analysis

(1) The Traffic Study shall provide LOS analyses for all study area intersections (signalized and unsignalized) and mid-block roadway segments using methodologies outlined in the current *Highway Capacity Manual*. The analyses should be performed for Scenarios 1 through 5, described in Section 2.0 3(L), "Existing and Projected Traffic Volumes," and for each time period (a.m., noon and/or p.m. peaks) that is required in the Traffic Study, unless otherwise required by the Director.

(2) Level of service analyses shall consider the appropriate infrastructure, lane usage, traffic control and any other pertinent factors for each scenario to be studied. Intersections with planned improvements, discussed in City planning documents, may have those improvements shown in the level of service analyses.

(3) Signalized intersection level of service analyses shall use the existing timing and phasing of the intersections for all scenarios. If the analyses are to deviate from existing timings or phasing, then a detailed signal progression analyses for the affected corridor shall also be provided.

(4) The results of the level of service analyses for each scenario and each time period shall be summarized into one or more tables that illustrate the differences in level of service for each scenario. At a minimum, these tables shall list the level of service results for each intersection to include the level of service for each approach and the total intersection level of service, as well as the appropriate delay values for each approach and the total intersection. These tables shall highlight any locations where the addition of project traffic has caused any approach of any intersection to fall below the LOS D standard for the City.

(O) Traffic Counts and Analyses Worksheets

Provide capacity analysis calculations based on the planning or operational analysis techniques contained in the current *Highway Capacity Manual* or subsequent highway capacity techniques established by the Federal Highway Administration, including the following:

(1) **Raw Traffic Count Data:** Include all raw traffic count data for average daily, hourly Average daily trip (ADT), and peak hour conditions and traffic analysis worksheets in the appendices of the Traffic Study for reference. Computer techniques and associated

printouts may be used for this part of the report.

(2) **Level of Service Analyses:** Include all level of service analyses performed for intersections and roadway links. If signal timing or phasing changes are proposed for traffic mitigation and the signal is currently part of a coordinated system, a progression analysis will be required to ensure that adequate progression is maintained or provided. All progress analysis and assumptions to be used shall be reviewed and approved by the Director.

(P) Traffic Control and Signals

The Traffic Study shall discuss and analyze any traffic control measures that may be necessary to serve a proposed project or development. Any traffic control measures are to be evaluated based on the requirements established in the *Manual on Uniform Traffic Control Devices* (MUTCD) and by the City, and will be applied as necessary to ensure safe and efficient operation of the City's transportation system. The analysis shall demonstrate the need for traffic control measures considering the objectives and policies of the TMP and alternative site designs in order to minimize or mitigate traffic impacts from the proposed project or development. The following traffic control measures are to be addressed:

(1) **Regulatory Signage, Markings and Islands:** These traffic control measures shall be applied as necessary in conformance with the MUTCD and City standards and policies.

(2) **Traffic Signals:** The installation of new traffic signals is not encouraged by the City and all possible alternatives to signalization shall be evaluated before the installation of a new traffic signal will be considered. The need for new traffic signals will be based on warrants contained in the MUTCD and on City policies. In determining the location of a new signal, safety and community traffic circulation and progression will be the primary considerations. If a traffic signal is suggested as part of a mitigation package, and the intersection lies within a series of coordinated traffic signals, then a progression analysis may be required to ensure that adequate progression may still be provided. Generally, a spacing of one-half mile between all signalized intersections is to be maintained, to achieve optimum capacity and signal progression. Pedestrian and bicycle movements shall be considered in all cases and adequate pedestrian clearance is to be provided in the signalization design.

(3) **Intersection and Access Locations:** To provide flexibility and safety for the existing roadway system and to ensure optimum two-way signal progression, an approved traffic engineering analysis shall be made to properly locate all proposed intersections that may require signalization, and any accesses to the proposed development.

(Q) Traffic Crashes

The Traffic Study may need to include crash analyses at one or more locations in the study area. The Director shall specify whether such crash analyses are needed for each Traffic Study. Where required, estimates of increased or decreased crash potential shall be evaluated for the proposed project or development and appropriate safety related mitigation measures are to be included. Traffic crash data is available through the Sate Streets Report and from the City of Boulder's Police Department or from the Director.

(R) Noise Attenuation

If residential development is planned adjacent to a roadway designated collector or greater, the City may require noise attenuation measures. A discussion and analysis of noise attenuation measured using the methods in the *Fundamentals and Abatement of Highway Traffic Noise Textbook* is to be included in all traffic studies for residential developments adjacent to roadways designated collector or greater.

(S) Recommendations

(1) The Traffic Study shall include a section in the report that provides any recommendations of the Engineer. These recommendations shall include the Engineer's recommended location, nature and extent of proposed transportation improvements associated with the project or development to ensure safe and efficient roadway operations and capacity, and compatibility with the City's transportation system and the goals of the TMP.

(2) These recommendations are to be supported with appropriate documentation and discussion of the technical analyses, assumptions and evaluations used to make the determinations and findings applied in the Traffic Study. In the event that any Traffic Study analyses or recommendations indicate unsatisfactory levels of service on any study area roadways, a further description of proposed improvements or mitigation measures to remedy deficiencies shall be included.

(3) These proposed improvements or mitigation measures may include projects by the City or The Colorado Department of Transportation for which funds have been appropriated and obligated. These proposals may also include improvements to be funded and constructed by the applicant as part of project or development construction. Assumptions regarding future roads, widths and lane usages in any analyses are subject to the approval of the Director.

(4) In general, the recommendation section shall include:

(a) Proposed and Recommended Improvements: Provide a detailed description and sketch of all proposed and recommended improvements. Include basic design details showing the length, width and other pertinent geometric features of any proposed improvements. Discuss and ~~abalyze~~analyze whether speed ~~chage~~change lanes are necessary to serve a project of development adjacent to a collector or arterial street. Discuss whether these improvements are necessary because of development traffic or whether they would be necessary due to background traffic. Specify the approximate timing necessary for each improvement.

(b) Level of Service Analysis at Critical Points: Provide another iteration of the LOS analyses that demonstrate the anticipated results of making recommended improvements, such as movement LOS, operational and safety conditions, and conformance with the City's transportation system goals and TMP. In association with LOS analyses for recommended improvements, include a comparison of these results with the background LOS analyses without the proposed project or development. Where appropriate, this step is to be provided

for both near term (year of project completion) and buildout scenarios.

(T) Conclusion

Include a conclusion that serves as the executive study in the report that provides a clear and concise description of the study findings and recommendations~~, and serves as an executive summary~~.

(U) Revisions to Traffic Study

(1) Following City review, the Director may require revisions to a Traffic Study based on the following considerations:

(a) Completeness of the study,

(b) Thoroughness of the level of service and impact analyses and evaluations,

(c) Compatibility of the study with the proposed access design, project or development plan and local transportation system,

(d) Compliance with local and state regulations and design standards, and

(e) An analysis of study deficiencies, errors, or conflicts.

(2) Revisions may also be required ~~as a result of public process with surrounding neighborhoods and land uses or review by City Council or the Planning Board~~ as needed to demonstrate compliance with these Standards. Additional details requiring Traffic Study revisions may include, but are not limited to, the following:

(a) An enlarged study area

(b) Alternative trip generation scenarios

(c) Additional level of service analyses

(d) Site planning and design issues.

2.04 Site Access

(A) Access Requirements

All accesses and curb cuts shall be designed and constructed in compliance with these Standards and the requirements set forth in Section 9-9-5, "Site Access Control," B.R.C. 1981.

(B) Access Permit Required

All accesses and curb cuts proposed and constructed on City streets and alleys require a permit, as set forth in Section 9-9-5, "Site Access Control," B.R.C. 1981.

(C) Location of Access

(1) **Spacing:** Table 2-1, "Access Spacing Requirements," shows the required spacing of access points and curb cuts. Minimum spacing from corners shall be measured from point of intersection of the street flowlines. Minimum spacing between accesses shall be measured at the property line.

Table 2-1: Access Spacing Requirements

Minimum Spacing (measured from edge of access)	Single Family Residential	Other Residential	Commercial	Industrial
Local Streets				
- from property line	7.5'	10'	10'	10'
- from corner	20'	50'	50'	50'
- between accesses	15'	20'	20'	20'
Collector Streets	Permitted only when no other access is available.			
- from property line		10'	10'	10'
- from corner		50'	50'	50'
- between accesses		20'	20'	20'
Arterial Streets	Permitted only when no other access is available.			
- from property line		75'	75'	75'
- from corner		150'	150'	150'
- between accesses		250'	250'	250'

(2) **Alignment:** Accesses shall intersect City streets at a 90-degree angle. Accesses to properties on opposite sides of a collector or arterial, where turning movements are not controlled by a center median or access island, shall either be aligned, or offset by at least 150 feet on collectors, or at least 300 feet on arterials. Greater offsets may be required if left-turn storage lanes are required.

(3) **Relocation of Existing Access Points and Curb Cuts:** Relocation, alteration, or reconstruction of any existing access points and curb cuts shall meet the requirements of these Standards.

(D) Sight Distance

All access points and curb cuts shall provide adequate sight distance as set forth under Section 9-9-7, "Sight Triangles," B.R.C. 1981.

(E) Restriction of Turning Movements

Along streets designated arterial or greater, or where necessary for the safe and efficient movement of traffic, the City will require access points and curb cuts to provide for only limited turning movements, as follows:

(1) **Access With Barrier Island - Left-Turn Restrictions ("**Pork Chop**"):** Where restricted turning movements are required by the City, and where the abutting street does not have a median, a barrier island will be required.

(a) Islands shall have a minimum area of 150 square feet, be bounded by vertical curb, and have an appropriate concrete center surface treatment, approved by the

Director.

(b) Barrier island lanes shall be at least 12 feet wide, have a radius of at least 20 feet, and be designed to accommodate the largest vehicle using the access on a daily basis. The island shall provide congruent curb ramps or cut through for sidewalks. The pedestrian crossing over the barrier island shall be raised. The dimensions of a raised crossing shall be designed considering standards for accessible design and site conditions, including topography, stormwater flow, and location of utilities. The minimum width of the island along the abutting roadway frontage shall be 30 feet for right-in, right-out only islands, and 15 feet for islands allowing right-in, right-out and left-turning movements.

(2) **Access With Median Divider Barriers – Left-Turn Restrictions:** Median barriers may be permitted where a median design can improve traffic circulation and safety, or overall site access. Where permitted, medians shall be at least 4 feet wide, and shall extend at least 25 feet beyond the right-of-way.

(F) Traffic Control

All accesses shall be designed and constructed with appropriate traffic control and signage conforming to the MUTCD, B.R.C. 1981, and these Standards.

(G) One-Way Access Lanes

One-way access lanes may be permitted where restricted access is limited to one turning movement, or where the one-way access improves traffic circulation and safety. One-way access lanes shall be at least 12 feet wide, have at least radius of 20 feet, and be designed to accommodate the largest vehicle using the access on a daily basis.

(H) Speed Change Lanes

Speed change lanes shall be required on Colorado state highways as designated in the Colorado State Highway Access Code in accordance with the standards of Section 4.8 of the Colorado State Highway Access Code. For all collectors or arterials that are not Colorado state highways, the Traffic Study shall make recommendations on the need for speed change lanes, based on the criteria contained in the Colorado State Highway Access Code. When required by the Director based on the criteria in the Colorado State Highway Access Code, design of speed change lanes shall conform with Subsection 2.07(D), "Horizontal Alignment," of these Standards.

(I) Access and Curb Cut Type

(1) **Driveway Ramp and Curb Cut:** All new accesses and curb cuts shall be designed as driveway ramps and curb cuts, using the standard ramp driveway details provided in Chapter 11, except as allowed in Subsection (2), along streets where no curb and gutter exists, or for single family lots where roll-over curbs have been provided.

(2) **Radii Curb Returns:** Radii curb return accesses may be required or permitted by the Director under the following conditions:

(a) The access is located along an arterial or collector.

(b) Access volumes indicate a need for a radii curb return where the ADT exceeds 500 or where speed change lanes would be required.

(c) The access is designed to restrict turning movements, requiring the installation of an access island or center median.

(d) The roadway has no curb and gutter.

(e) The access serves an industrial property, or provides for commercial deliveries, where large truck movements are required.

(f) The Director determines that a radii access is necessary to ensure adequate traffic safety and operation.

(g) The access is for a new public street

Table 2-2: Access Design Specifications

	Single Family Residential	Other Residential	Commercial	Industrial
Width (in feet)				
- Minimum	10	10	15	20
- Maximum	20	35	35	35
- One-Way Lane	N/A	12-18	12-20	14-24
Radii (in feet)				
- Minimum	N/A	15	15	20
- Maximum	N/A	30	30	40
Access Grades				
Initial Grade (to a point 10 ft beyond ROW)				
- Minimum	(+) 3%	(+) 1%	(+) 1%	(+) 1%
- Maximum	(+) 8%	(+) 6%	(+) 6%	(+) 6%
Final Grade (G2)				
- Minimum	(+/-) 3%	(+/-) 1%	(+/-) 1%	(+/-) 1%
- Maximum	(+/-) 14%	(+/-) 8%	(+/-) 8%	(+/-) 8%
Max Grade Break	(+/-) 10%	(+/-) 6%	(+/-) 6%	(+/-) 6%

(J) Access and Curb Cut Width

Access and curb cut widths shall be consistent with Table 2-2, "Access Design Specifications," of these Standards. Access design for Colorado state highways shall conform to the Colorado State Highway Access Code. All other access widths shall be determined using turning templates, as designated by the Director, for a 10 MPH design speed for the largest vehicle expected to use the access on a daily or routine basis. The width of each access shall be the minimum width that is necessary to serve the property and use. No more than 50 percent of the street frontage shall be occupied by the access driveway, except for access to a cul-de-sac or flag lot. All access widths are measured from edge of pavement to edge of pavement (or curb to curb) at the throat of the driveway (or edge of the right-of-way), and are not inclusive of drive cut transitions or curb return radii.

(K) Access and Curb Cut Radii

Access and curb cut radii shall meet the specifications shown in Table 2-2, "Access Design Specifications," of these Standards. All radii are measured from the flowline or from the edge of the pavement where no flowline exists.

(L) Access and Curb Cut Grades

Access and curb cut grades shall be consistent with Table 2-2. The initial grade (G1) shall be a positive grade, beginning at the back of the sidewalk, the back of the driveway ramp or pan section, or the edge of the pavement (where no curb and gutter exists), and shall continue at least 10 feet beyond the right-of-way. The final grade (G2) may be positive or negative, depending on the access conditions. The maximum grade break (or change in slope) shall apply at all grade changes. Additional grade changes may occur at intervals of at least 20 feet.

(M) Driveways

(1) **Vehicle Storage:** Adequate driveway storage capacity for both inbound and outbound vehicles to facilitate safe, unobstructed, and efficient traffic circulation and movements from the adjacent roadway and within the development shall be provided, except for single-family or duplex residential driveways on local streets. Adequate driveway length will be subject to approval by the Director and shall extend at least 24 feet beyond the right-of-way before accessing the first off-street parking space or parking lot aisle.

(2) **Internal Circulation:** Developments requiring off-street parking facilities shall provide onsite vehicular circulation allowing access to all portions of the site without using the adjacent street system, unless a joint access or parking easement with one or more of the adjacent property owners has been dedicated.

(3) **Backing Into the Right-of-Way Prohibited:** Driveways shall be designed to contain all vehicle backing movements onsite, except for single family or duplex residential uses on local streets.

(4) **Minimum Back-Up Distance for Detached Single-Family Residential Driveways Accessing Public Alleys: Driveways** shall provide for a minimum distance of 24-feet from the rear of the parking stall or face of garage to the far edge of the adjacent alley right-of-way or turn around area as required by Chapter 9-9-6, "Parking Standards," B.R.C. 1981.

(5) **Shared Driveways (Detached Single-Family Residential Only):** Shared driveways to access detached single-family residential lots may be permitted pursuant to an approved site review or subdivision as set forth in Chapter 9-9-14, "Site Review," B.R.C. 1981 or Chapter 9-12, "Subdivision," B.R.C. 1981, if they meet the following criteria:

(a) A common parking court is provided at a ratio of 0.5 additional spaces per unit if less than two onsite parking spaces, meeting City requirements, are provided on each single-family lot served by the shared driveway.

(b) The shared driveway is no more than 100 feet long, except in districts zoned RL-1 (Residential-Low 1), RE (Residential-Estate), and RR1 (Residential-Rural 1) and RR 2 (Residential-Rural 2), where the shared driveway may extend up to 300

feet long if each lot accessing the shared driveway exceeds 10,000 square feet.

(c) The number of units served shall be no more than three lots or houses that have less than 30 feet of usable frontage on the accessing street.

(d) Adequate turnaround for vehicles is provided either on an individual lot or lots.

(e) The driveway is properly engineered and constructed to mitigate any adverse drainage conditions and is appropriately surfaced for the type of development, usage, and zoning district.

(f) The Driveway is at least 12 feet wide.

(g) For units not fronting on the accessing street, addressing shall be located near the entrance to the shared driveway insuring visibility of the numbering from the street.

(h) A public access easement, a minimum fifteen feet in width, for the benefit and use of all properties and property owners accessing the shared driveway has been dedicated and recorded to ensure legal access rights in perpetuity for each property served.

(i) Driveway spacing conforms with the requirements in Table 2-1, "Access Spacing Requirements," of these Standards.

2.05 Right-of-Way Requirements

Dedication or reservation of public right-of-way required as part of any project or development proposal shall comply with the requirements set forth in Section 9-9-8, "Reservations, Dedication, and Improvement of Rights-of-Way," B.R.C. 1981.

2.06 Base Street and Alley Standards

(A) Base Street Standard

Except for residential streets approved pursuant to Chapter 9-12, "Subdivision," B.R.C. 1981, and Section 2.09, "Residential Streets," all new streets shall provide at a minimum the base street standard components listed in Table 2-3, "Base Street Standard Components."

(B) Base Alley Standard

Except for residential streets approved pursuant to Chapter 9-12, "Subdivision," B.R.C. 1981, and Section 2.09, "Residential Streets," all new alleys shall provide at a minimum the base alley standard components listed in Table 2-4, "Base Alley Standard Components."

Table 2-3: Base Street Standard Components

Street Component	Base Standard
Right-of-Way	60' Minimum Width
Paved Street Section	36' Minimum Width, Curb Face to Curb Face

Travel Lanes	Two Travel Lanes, Two-Way Traffic
Curb and Gutter	Required Both Sides
Parking	Parking Allowed Both Sides
Sidewalks	6’ Preferred Width (5' Minimum), Detached, Required Both Sides
Streetscape Planting Strips*	8’ Width Required Both Sides

*NOTE: In commercial streetside retail zones where 12-foot wide attached sidewalks may be provided, streetscape planting strips may be created using street trees in planting pits with tree grates (15-foot width between back of curb and back of walk).

Table 2-4: Base Alley Standard Components

Alley Component	Base Standard
Right-of-Way	20' Minimum Width
Paved Street Section	18' Minimum Width, Pavement Edge to Pavement Edge
Travel Lanes	Two-Way Traffic Allowed
Parking	Parking on Alley Not Permitted

2.07 Street Geometric Design

(A) Minimum Requirements

Except for State Highways and the geometric design variations allowed for residential streets approved pursuant to Chapter 9-12, “Subdivision,” B.R.C. 1981, and Section 2.09, “Residential Streets,” all city streets shall be designed in conformance with this section. The design standards outlined in this section are minimum design standards, and all street design shall meet or exceed these standards. On streets designated collector or arterial in the TMP, the Director may specify standards to be applied to street design that may exceed the minimum standards in this section based on functional need to ensure safe and efficient operation of the street.

(B) Right-of-Way

The right-of-way width required for new streets shall comply with the requirements of Section 9-9-8, “Reservations, Dedication, and Improvement of Rights-of-Way,” B.R.C. 1981, and shall include without limitation the following elements:

(1) The paved roadway section including without limitation travel lanes, turning and speed change lanes, transit lanes, bicycle lanes, and parking lanes;

(2) Curbs and gutters or drainage swales;

(3) Roadside and median landscaping areas;

(4) Sidewalks and multi-use paths; and

(5) Any necessary utility corridors.

(

C) Lane Width

Street lanes shall meet the minimum width specifications shown in Table 2-5, “~~Minimum and~~ 4/1Preferred Street Lane Widths,” of these Standards.

Table 2-5: ~~Minimum and~~ Preferred Street Lane Widths

Design Criteria		Street Characteristics		
		With Parking Lane	No Parking Lane	With Fixed-Route Bus Transit Service and No Parking Lane
		Preferred	Preferred	Preferred
General Purpose Travel Lanes*		10’	10’	12’ (Outside lane)
Auxiliary Lanes*		10’	9’	10’
Conventional Bike Lanes		7’	6.5’	7’
Contra-Flow Bike Lanes (On One-Way Streets)		7’	6.5’	N/A
Buffered Bike Lanes	Bike Lane	7’	6.5’	6’
	Buffer	3’	3’	2’
Separated Bike Lanes	Bike Lane	7’ (for parking protected bike lanes, a painted 3’ buffer is between curbside of parking lane and bike lane)	7’	7’
	Buffer	3' (with vertical element)	3' (with vertical element)	3' (with vertical element)
Two-Way Separated Bike Lanes	Bike Lane	12’ Two-way bike lane (for parking protected bike lanes, a painted 3’ buffer is between curbside of parking lane and bike lane)	12’ Two-way bike lane (buffer is between curbside of parking lane and bike lane)	N/A
	Buffer	3' (with vertical element)	3' (with vertical element)	N/A
Parking Lanes		8’ (measured from curb face, including gutter pan)	N/A	8’ (measured from curb face, including gutter pan)

*NOTES: Travel, auxiliary lane and bike lane dimensions do not include gutter pan width. Auxiliary lanes include, without limitation, turning and speed change lanes.

Table 2-5: Minimum and Preferred Street Lane Widths

Design Criteria	Travel Lanes *	Auxiliary Lanes*	Conventional Bike LanesOn -Street Bike Lanes	Buffered Bike Lanes	Separated Bike Lanes		Parking Lanes
Parking Lane With Parking Lane	10'	9'	6'	2' buffer plus, 3' preferred, plus 5' bike lane, 6' preferred 5' bike lane	3' horizontal vertical buffer (min. and pref,) between curbside of parking lane and bike lane, plus 6.5' bike lane, (7' preferred)buffer 3' vertical buffer3' vertical buffer plus 5' bike lane, buffer is between curbside of parking lane and bike lane	horizontal (min. and pref,) between curbside of parking lane and bike lane, plus	2' minimum, 8' preferred. M(measured from curb face (inclusive of gutter pan) face)
Without No Parking Lane Parking Lane	10'	9'	6.5' (Mmeasured from curb face (inclusive of gutter pan)6.5' (measured from curb face	2' buffer plus, 3' preferred 6.5' bike lane Measured from curb face (inclusive of gutter pan) (measured from curb face)	3' vertical horizontal buffer (min. and pref,)., Vertical barrier type and dimension may vary. , plus 6.5' bike lane, 7' preferred. Measured from curb face (inclusive of gutter pan)(measured from curb face)	horizontal (min. and pref,). Vertical barrier type and dimension may vary, plus min. and pref.). M (inclusive of gutter pan)	

*NOTES: Travel and auxiliary lane dimensions do not include gutter pan width. Auxiliary lanes include, without limitation, turning and speed change lanes.

(D) Horizontal Alignment

(1) **Conformance to Street Plan:** Horizontal alignment shall conform to the pattern of streets in the Boulder Valley Comprehensive Plan, TMP, and adopted right-of-way plans and shall provide continuous alignment with existing, planned, or platted streets with which they will connect.

(2) **Extension to Property Line:** All streets shall be extended to the property lines across the property to be developed, unless the street to be constructed has been approved by the City as a cul-de-sac or other no-outlet street.

(3) **Minimum Horizontal Curve:** Street curvatures shall meet the minimum specifications shown in Table 2-6, "Minimum Horizontal Street Curve Specifications," of these Standards.

Table 2-6: Minimum Horizontal Street Curve Specifications

Design Criteria	Local Street	Collector Street	Arterial Street
Minimum Design Speed	20 mph	35 mph	40 mph
Minimum Centerline Radius	100 feet	300 feet	500 feet
Minimum Reverse Curve Tangent	50 feet	100 feet	200 feet
Minimum Intersection Approach Tangent	100 feet	200 feet	300 feet

Table 2-6a: Separated Bike Lane Minimum Horizontal Curve Specifications

Design Criteria	Flat, level terrain	Congested, urban area	Intersection approach
Design Speed	15 mph	12 mph	8 mph
Minimum Centerline Radius*	42 feet	27 feet	12 feet

*Radius assumes a 20-deg lean angle of the bicyclist

(4) **Design Horizontal Curve:** The design horizontal street curvature shall meet or exceed the minimum horizontal curvature and be calculated using the following equation:

$$R = V^2 / 15 * (e-f)$$

Where: E = rate of superelevation per foot
F = side friction factor
V = vehicle speed in MPH
R = radius of curve in feet

Side Friction Factors	
Design Speed (mph)	Side Friction Factor (f)
30	0.22
35	0.20
40	0.18
45	0.16

(5) **Intersections and Street Spacing**

(a) **Angles:** All streets shall intersect at right angles (90°).

(b) **Minimum Street Spacing:** Spacing between streets, as measured from centerline

to centerline, shall equal or exceed the minimum distances shown in Table 2-7, "Minimum Street Spacing," of these Standards.

Table 2-7: Minimum Street Spacing

Street Type	Minimum Street Spacing
Local	150 feet
Collector	300 feet
Arterial	500 feet

(c) **Street Spacing for Signalized Intersections:** Signalized intersections, where feasible, shall be spaced at no more than half-mile intervals. Closer signal spacing is generally desired and may be approved by the Director based on context-sensitive design. The Transportation Master Plan and Low-Stress Walk and Bike Network Plan should be consulted when considering placement of signalized intersections to ensure signalized intersections along arterial and collector streets provide controlled crossing opportunities where existing and proposed walking and bicycling network streets cross those arterial and collector streets..

1 The minimum throat width is 20'.

(d) **Corner Radii:** Corner design should take into account the effective turning radius (the curve which vehicles follow when turning, which may be affected by on-street parking, bicycle lanes, medians, and other roadway features) prior to selecting a flowline radius. **The smallest feasible flowline curb radii should be selected for corner designs.** Figure 1~~Figure 1~~ and Figure 2 demonstrate the relationship between the effective radius and the flowline curb radius.

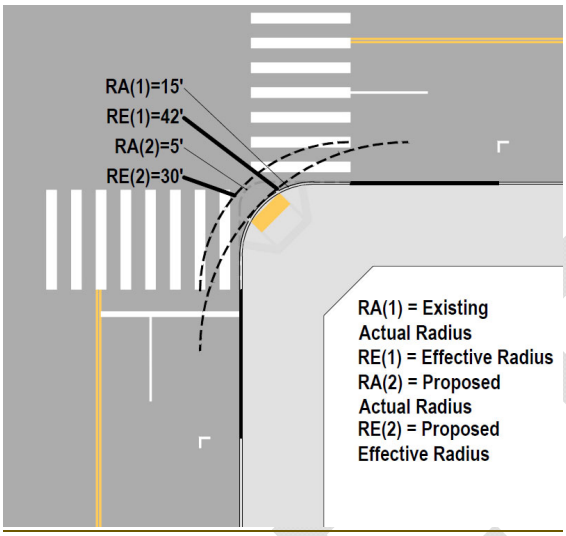

Figure 1. Actual and Effective Radius At A Conventional Intersection Corner

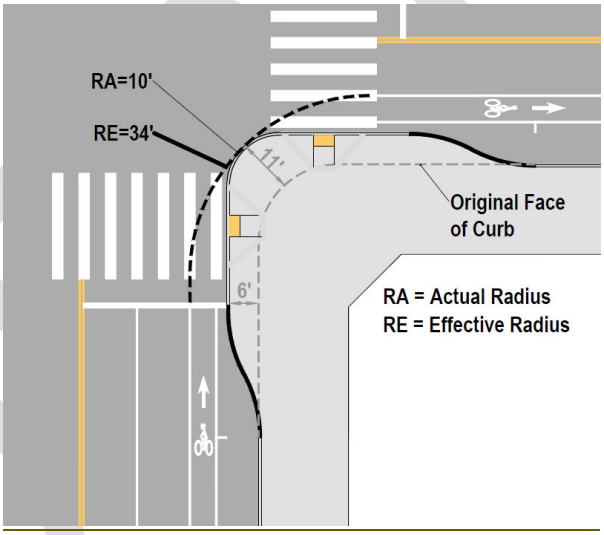

Figure 2. Actual and Effective Radius At An Intersection Corner With A Curb Extension

The effective radius should be analyzed for the design vehicle; **the default design vehicle is the SU-30 for all intersections.** In some instances, a different design vehicle may be warranted (i.e., a bus on transit routes, a semi-truck on industrial streets).

An important companion to understanding the effective radius and selecting the flowline curb radius is the allowable encroachment. While

the default design vehicle is the SU-30, encroachment is allowable to different degrees based on the street type(s). The following should be considered when selecting the radii:

- At turns onto Local streets (from Arterials, Collectors, or Locals), the design vehicle can use the entire width of the departing and receiving lanes, including oncoming travel lanes, to negotiate the turn.
- At intersections where the minor leg is stop controlled and the major leg is uncontrolled, the design vehicle can use the entire width of the departing (if minor leg) or receiving (if minor leg) lanes, including oncoming travel lanes, to negotiate the turn.
- At signalized intersections where the design vehicle can utilize multiple lanes on the receiving street to complete their turn; in this scenario it may be necessary to implement a "No Right on Red" restriction.
- The "throat width", or the curb-to-curb width at the block end, should be considered when selecting the curb radius, as it may decrease the space available for encroachment.

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In addition to encroachment for the design vehicle, the following should be considered for other types of vehicles:

- It is assumed that emergency vehicles are able to use the entire street right-of-way to negotiate turns, including all adjacent and oncoming travel lanes.
- Large trucks are assumed to be able to use adjacent lanes on the departing and receiving streets at all intersections; large trucks may use the entire street right-of-way on Local streets.
- It may be necessary to recess a stop bar on the intersecting street if large vehicles make regular turns at the intersection; this practice should be limited for use as a strategy only at locations where vehicle encroachment over a stop line would occur regularly and presents operational or safety issues if not corrected.
- A dashed centerline may be used if large vehicles make infrequent turns at an intersection but require space from an oncoming lane to negotiate the turn.
- Restricting turns may be necessary, especially with considering the use of traffic calming elements on Local streets; for instance, the planning and placement of traffic circles may require restricting turns for larger vehicles.

- A mountable truck apron may be considered in instances where large trucks turn infrequently, but there is limited space for encroachment. The truck apron provides a smaller effective radius for the design vehicle but makes a larger effective radius available to accommodate larger vehicle off-tracking. Figure 3 below shows an example of this potential scenario.

Figure 3. Example of A Mountable Truck Apron At An Intersection Corner

The minimum property line corner and flowline radii at intersections shall meet or exceed the minimum radii specifications shown in Table 2-8, "Minimum Intersection Radii," of these Standards.

Table 2-8: Minimum Intersection Radii

Street Type	Minimum Flowline Radius	Minimum Property Radius
Local	5 feet	15 feet
Collector	15 feet	15 feet
Arterial	20 feet	10 feet

Table 2-8a: Relationship between Effective and Actual Radius for the Default Design Vehicle (SU-30)

			Street B			
		Parking	No	No	Yes	Yes
		Bike Lane	No	Yes	No	Yes
Street A	Parking	Bike Lane				
	No	No	RA = 30' (RE = 30')	RA = 25' (RE = 30')	RA = 25' (RE = 30')	RA < 10' (RE = 30')
	No	Yes	RA = 25' (RE = 30')	RA = 15' (RE = 30')	RA < 10' (RE = 30')	RA < 5' (RE = 30')
	Yes	No	RA = 25' (RE = 30')	RA < 10' (RE = 30')	RA < 5' (RE = 30')	RA < 5'' (RE = 35')
	Yes	Yes	RA < 10' (RE = 30')	RA < 5' (RE = 30')	RA < 5' (RE = 35')	RA < 5' (RE = 45')

~~(d)~~(e) **when the difference between the effective and actual corner radii becomes larger, or when the effective radius cannot be reduced to what is necessary for the control vehicle, the design should consider using a curb extension*

(6) **Road Width Transition Tapers:** Where two street sections or different widths are to be connected, a transition taper is required between the outside traveled edge of the two sections. The length of the transition taper shall be calculated using the following equation:

$$L = WS$$

Where: S = Speed in MPH
L = Length in feet
W = Width of offset in feet

This transition is not to be used in the design of left turn storage lanes or speed change lanes.

Design of tapers for on-street bike lanes should use a minimum length as calculated using the formula below:

$$L = \frac{WS^2}{60}$$

Where: L = Longitudinal lane shift (ft), minimum 20 ft

W = Lateral width of offset (ft)

S = Target bicyclists operating speed (mph)

If the bikeway is delineated by paint-only, and if the off-tracking of a bicycle pulling a trailer would not put the trailer into a motor vehicle lane, a maximum taper ratio of 2:1 (longitudinal:lateral) may be considered.

(7) **Left Turn Lanes**

(a) **Storage Length:** Left turn lane storage length shall be determined based on traffic volumes using the Leisch nomographs provided in the ITE "Guidelines for Major Urban Street Design." ~~The left turn lane storage length shall not be less than 50 feet.~~ Lengthening single left turn lanes to the maximum extent feasible should be exhausted before including dual turn lanes. Where dual left turn lanes are provided, the lane storage length shall be based on at least 60 percent of the single lane storage length. The left turn lane storage length of any single or dual left turn lanes shall not be less than 80 feet. Triple left turn lanes are only allowed with Director approval.

(b) **Lane Change Taper:** Left turn lane change tapers shall be calculated using the equation for bay tapers in Subsection (8).

(8) **Speed Change Lanes:** Speed change lanes required for transitional access to turning lanes shall be designed according to the design standards provided in the ITE "Guidelines for Major Urban Street Design," as follows:

(a) **Bay Tapers:** Bay tapers are required for the lane transition from the travel lane into a turn lane. The bay taper length shall be calculated using the following equation:

$$\mathbf{L = WS / 3}$$

Where: S = Speed in MPH
L = Length in feet
W = Width of offset in feet

(b) **Approach Tapers:** Approach tapers are required to transition the position of travel lanes to accommodate turn lanes. The approach taper length shall be calculated using the following equation:

$$\mathbf{L = WS^2 / 60}$$

Where: S = Speed in MPH
L = Length in feet
W = Width of offset in feet

(9) **Cul-de-sacs:** Where allowed, cul-de-sacs shall have a minimum pavement diameter of 90 feet, curb face to curb face, and a minimum right-of-way diameter of 115 feet, except for residential streets approved pursuant to Chapter 9-12, "Subdivision," B.R.C. 1981, and Section 2.09, "Residential Streets." Cul-de-sacs are prohibited on arterial and collector streets, and are strongly discouraged on local and residential streets. The Director may permit cul-de-sacs where there is no other possible street or driveway access to a property from a public right-of-way, or if a cul-de-sac would avoid direct property access to a collector or arterial.

(E) Vertical Alignment

(1) **Minimum Street Grade:** All street grades shall equal or exceed the minimum street grade of 0.5 percent.

(2) **Maximum Street Grade:** Street grades shall not exceed the maximum street grades shown in Table 2-9, "Maximum Street Grades," of these Standards.

Table 2-9: Maximum Street Grades

Street Type	Maximum Street Grade
Local	8%
Collector	6%
Arterial	5%
Intersection Approach (Minimum 50')	4%
Signalized Intersection Approach (Min. 50')	2%

(3) **Design Controls for Vertical Curves:** Design control for sag and crest vertical curves, (based on a design speed of 30 mph) shall meet the specifications shown in Table 2-10, "Vertical Curve Design Control," of these Standards. For design speeds in excess of 30 mph, design control shall be in accordance with the current edition of "A Policy on Geometric Design of Highways and Streets,", prepared by the American Association of State Highway and Transportation Officials.

Table 2-10: Vertical Curve Design Control

Algebraic Difference in Grades	Sag Curve Minimum Vertical Curve Length	Crest Curve Minimum Vertical Curve Length
0.5 - 1.0 %	50 feet	100 feet
1.0 - 3.0 %	100 feet	100 feet
3.0 - 5.0 %	200 feet	150 feet
5.0 - 7.0 %	300 feet	200 feet
7.0 - 8.0 %	300 feet	300 feet
Min. Vert. Sight Distance	N/A	250 feet

(4) **Vertical Sight Distance:** Vertical curve sight distance shall equal or exceed 250 feet. Greater vertical sight distance may be required by the Director to ensure safe travel and street crossings for all transportation modes.

(F) Sight Distance

All streets and alleys shall provide adequate sight distance as set forth under Section9-9-7, "Sight Triangles," B.R.C. 1981.

(1) **Design Sight Distance for Separated Bike Lanes**: On streets with separated bike lanes that provide a parking lane between the outside motor vehicle travel lane and the separated bike lane, parking should be restricted within 20 feet of driveways to provide adequate sight distance where motor vehicles turn across the separated bike lane. Additionally, where side streets intersect the separated bike lane, intersections should be designed for a two-stage crossing scenario where the motorist will first assess the separated bike lane conflicts, then move forward and assess motor vehicle conflicts. The equation in Table 2-XX can be used to calculate the departure sight triangle between a

passenger vehicle and the bikeway using a time gap (t_g) of 5.5 seconds for the motorist to clear the bikeway. This time gap uses an assumption that the vertex (decision point) of the departure sight triangle is 10 ft from the edge of bikeway and the bikeway width is no wider than 14 ft. The appropriate AASHTO *Green Book* Case B sight distance can then be used to calculate departure sight triangle between the motorist and the intersecting motorist travel lanes. Designers should reference *Table 2.6a: Separated Bike Lane Minimum Horizontal Curve Specifications* earlier in this chapter to establish the V_{bike} of a given project.

Table 2-XX: Separated Bike Lane Intersection Sight Distance

$ISD_{bike} = 1.47\, V_{bike}\, t_g$		
Where:		
ISD_{bike}	=	intersection sight distance (length of the leg of sight triangle along the bikeway) (ft)
V_{bike}	=	design speed of bikeway (mph)
t_g	=	time gap for passenger vehicle to cross bikeway (s)

(G) Medians

Raised medians are required on new arterial streets. Raised medians, where feasible, shall extend past the pedestrian crosswalk to allow for a pedestrian refuge zone.

(1) **Median Widths:** Medians shall be at least 4 feet wide, curb face to curb face. If left turn lanes are installed in the median, the median width adjacent to the left turn storage lanes shall be 4 feet and the median width at the start of the left turn lane bay taper shall be at least 14 feet wide, curb face to curb face. Median design widths shall conform to Table 2-11, "Median Width Design Standards," of these Standards.

Table 2-11: Median Width Design Standards

Function	Minimum Width	Recommended Width
Separation of Opposing Traffic	4 feet*	10 feet*
Pedestrian Refuge or Traffic Control Device Location	6 feet*	14 feet
Medians Separating Left Turn Lanes	14 feet	20 feet

* NOTE: Cannot accommodate left-turn lanes

(2) **Landscaping in Medians:** Landscaping in medians shall comply with the requirements of Chapter 3, "Streetscaping," of these Standards.

(H) Vertical Clearance of Structures

At least 17.5 feet of vertical clearance shall be provided for all overhead structures. Vertical clearance is measured from the crown of the street to the lowest portion of the structure on all streets and alleys.

2.08 Sidewalks

(A) Required

Sidewalks are required on both sides of all new streets, except for residential streets that were approved without required sidewalks pursuant to Chapter 9-12, "Subdivision," B.R.C. 1981, and Section 2.09, "Residential Streets."

(B) Conformance with the Transportation Master Plan

Off-street sidewalks may be required as part of any project or development proposal in conformance with the TMP.

(C) Compliance with Americans with Disabilities Act (ADA)

All public sidewalks shall comply with the requirements of the ADA's "Standards for Accessible Design," which includes without limitation sidewalk widths, grades, locations, markings, surface treatments, and access ramps.

(D) Minimum Widths

Sidewalk widths shall conform to the dimensions shown in Table 2-12, "Minimum Sidewalk Widths," of these Standards.

Table 2-12: Minimum Sidewalk Widths

Minimum Sidewalk Width			
	Adjacent Land Use		
Street Type	Commercial/Retail	Commercial/Industrial	Residential
Local	12	5	4
Collector	12	5	5
Arterial	12	8	8

Note: All off-street multi-use/bike paths designated in the Transportation Master Plan shall be 12 feet wide.

(E) Vertical Grades

The vertical grade of a sidewalk shall not exceed 8.33 percent, a ratio of 12 feet horizontal to 1 foot vertical (12:1).

At sidewalk locations adjacent to transit stops or transfer points, the Director may require wider sidewalk sections to provide for adequate passenger storage areas.

(F) Vertical Clearance

A minimum ~~8~~ 10 foot vertical clearance shall be provided between all sidewalk and multi-use

path surfaces and any overhead encroachments.

2.09 Residential Streets

(A) Purpose

(1) The residential street standards were developed to allow a variety of choices in the creation of new transportation corridors within the urban environment under conditions that will not compromise the safety and function of the city street system. Traditionally streets have provided the following:

(a) Corridors for pedestrian, bicycle, transit, and motor vehicle movement;

(b) Parking for vehicles;

(c) Fire, police, and emergency access;

(d) Locations for public utilities networks including water supply, sewage, electricity, telecommunications and gas services, and refuge disposal; and

(e) Postal and other delivery services.

(2) These standards recognize that streets, if appropriately designed, may provide additional community amenities including landscape buffers, attractive public gathering spaces, opportunities for neighborhood interaction, public art, view corridors, and potential avenues for new technologies.

(B) Scope

(1) **Location of Streets**

(a) These standards are intended to be used for new streets in undeveloped areas of the city.

(b) Where infill development in the existing developed portions of the city requires the creation of new streets, these alternative standards may be used if the Director finds, after completing the review process described in Section (C) below, that the new streets will not impair the functions of the surrounding transportation system nor negatively impact the character of the surrounding existing development.

(c) Further, the Director may determine that these standards are appropriate for redesigning and reconfiguring existing streets. Because the public cost of retrofitting, reconfiguring, or redesigning existing streets is often expensive, decisions about reconstruction of individual streets in accordance with these standards shall be made pursuant to the city's Capital Improvements Program process.

(2) **Methods of Review**

(a) Permitted: The following street types may be developed without review:

(i) Residential collector street

(ii) Residential street

(iii) Residential alley

(b) By Director Review: Residential streets listed in paragraph (B)(2)(a) and the street types listed below may be developed upon approval by the Director under the criteria outlined in Section (C) below.

(i) Rural residential street

(ii) Access street

(iii) Access lane

(c) By Site Review: Those underlined criteria and specifications in the following residential street standards may be appropriate for modification under certain limited circumstances. Developments requesting such modifications shall meet all of the requirements of Section 9-2-14, "Site Review," B.R.C. 1981, in addition to the criteria outlined in Subsection (C), "Director Review," below.

(3) **Cumulative Standards:** These street standards are intended to be used in combination with Section 2.07, "Street Geometric Design," of these Standards. Where the standards in this section are silent, the criteria or specifications contained in Section 2.07 shall control.

(C) Director Review

(1) **Application:** As part of a subdivision application, the applicant for residential street construction approval shall include plans that depict the building envelopes of all proposed structures, and the location of proposed trees, street furniture, fire hydrants, meter pits, utility cabinets, or pedestrians in the right-of-way.

(2) **Criteria:** The Director will consider the following factors in determining whether an alternative street design is appropriate in a particular location:

(a) Urban Design: The street should contribute to the creation of an attractive community and to a clearly defined sense of place. Streets shall be designed with due attention to building spacing and setbacks, green spaces, attractive materials, plantings, and landscaping. Pavement and right-of-way widths that are less than the Residential Street standard should provide a benefit to the community that includes improved safety, improved site design, the creation of street canopies through landscaping, and secondary lot access through the use of alleys. Rural Residential streets shall be consistent with the existing character of the area, or with an approved subcommunity or area plan.

(b) Street Function: The street should be designed according to its function. This may require a diversity of street types, each serving a role in a hierarchical system. The street pattern and any reduced pavement or right-of-way widths should provide acceptable levels of accessibility, safety and convenience for all street users, including emergency service providers. The pattern shall discourage residential streets from operating as pass through traffic routes for externally generated traffic, while minimizing the length of time local drivers need to spend in a low-speed environment.

(c) Connectivity: The neighborhood street pattern should be simple, and logical, with the following characteristics:

(i) "No outlet" streets will be highly discouraged and allowed only when street connectivity is unachievable:

(ii) The street pattern provides for safe and convenient movements for pedestrians, bicycles, and motor vehicles, including transit.

(d) Design Speed: The design of the streets will control vehicular speeds under normal driving conditions to that specified in the residential street standards, while maintaining reasonable access for emergency vehicles.

(e) Minimize Maintenance Costs: The street will not create additional city obligations for maintenance and repair that exceed a standard street section.

(f) Adequate Parking: The site design provides for adequate on-street and off-street parking to serve the area.

(g) Infill Streets: In the case of infill development, the residential street design will not impair the functioning of, and will have a compatible transition to, the surrounding street system and will not negatively impact the character of the surrounding existing development. No additional density may result from approval of the reduced rights-of-way provided for in the case of Access Streets, Access Lanes, or Residential Alleys.

(D) Residential Street Sections

Five residential street sections and a residential alley may be applied to the design of residential neighborhoods as part of subdivisions approved pursuant to Chapter 9-12, "Subdivision," B.R.C. 1981. Residential streets shall be designed in compliance with the standards outlined in Table 2-13, "Residential Street Design Standards," "Technical Drawings 2.63 - 2.68," Chapter 11, of these Standards, and the requirements of this Section.

(1) **Residential Collector Street:** The residential collector street collects and distributes neighborhood traffic from residential streets to community collector and arterial transportation systems, and provides access to individual properties. The residential collector street is designed for residential streets where anticipated traffic volumes range from 1,000 to 2,500 vehicle trips per day. In addition to the requirements outlined in Table 2-13, "Residential Street Design Standards," and "Technical Drawing 2.63," Chapter 11, the residential collector street shall be designed to meet the following minimum standards:

(a) Parking: On-street parking is allowed on both sides.

(b) Bicycle Facilities: Additional street and right-of-way width shall be provided where on street bicycle lanes are required by a City-adopted subcommunity or area plan, the TMP, or the BVCP.

(c) Provision of Alleys: Where alleys are provided or required to be provided under a City-adopted subcommunity or area plan, onsite parking spaces shall be accessed from the alley and not the street.

(d) Emergency Response: Residential collectors exceeding 500 feet in length from any intersection shall provide a secondary emergency access at 500-foot intervals.

(2) **Residential Street:** The residential street is designed to provide access to individual properties as well as access to the higher classification street network. The residential street provides for neighborhood circulation and may carry neighborhood traffic and through movements. The residential street shall be designed to meet the minimum standards shown in Table 2-13, "Residential Street Design Standards," and "Technical Drawing 2.64," Chapter 11, of these Standards.

Table 2-13: Residential Street Design Standards

Design Standards	Residential Collector	Residential Street	Rural-Type Residential Street	Access Street	Access Lane	Residential Alley
Design Speed	25 mph	25 mph	20 mph	15 mph	10 mph	10 mph
Design Traffic Volumes (Vehicle Trips Per Day)	1,000 -2,500	500 - 1,000	500 - 1,000	400	250	N/A
Minimum Right-of-Way	60'	60'	60'	40'	30'	16'
Minimum Pavement Section	32'	30'	22' plus 2' gravel shoulders	26'	20'	12'
Sidewalk	5'	4'	4' where required	4'	N/A	N/A
Streetscape Planting Strip	8'	8'	N/A	N/A	N/A	N/A
Minimum Centerline Radius	300'	150'	150'	100'	100'	100'
Minimum Curb Radius	20'	20'	20'	10'	10'	10'
Maximum Length Between Connecting Streets	500'	500'	500'	350'	350'	N/A
Maximum Street Length - No Outlet	500'	500'	500'	150'	150'	500'
Maximum Street Length - Loop or Circle Street	500'	500'	500'	500'	500'	500'
Minimum Turn-Around Area	35' Radius	35' Radius	30' Radius or "Y" or "T" Turn	30' Radius or "Y" or "T" Turn	25' Radius or "Y" or "T" Turn	25' Radius or "Y" or "T" Turn
Emergency Response Set Up Area Intervals	N/A	N/A	N/A	150'	150'	N/A
Sidewalk Placement	Detached Required	Detached Required	Adjacent to Property Line Where Required	Attached	N/A	N/A
Curb and Gutter	Required	Required	N/A	Required	N/A	N/A
On-Street Parking	Allowed	Allowed	Allowed	Allowed	Allowed	Not Allowed
Minimum Lot Frontages	N/A	N/A	60' no alley 40' w/ alley	60' no alley 40' w/alley	60'	N/A
Maximum Number of Units to be Accessed	N/A	N/A	N/A	25 single family	15 single family	N/A

NOTE: Residential street standards that are underlined may be varied through Section 9-2-14, "Site Review," B.R.C. 1981.

(a) Parking: Parking is allowed both sides or, on residential streets where parking is restricted or prohibited, off-street parking courts providing parking spaces at a ratio of 0.5 spaces per dwelling unit shall be provided.

(b) Bicycle Facilities: Additional street and right-of-way width shall be provided where on-street bicycle lanes are required by a City-adopted subcommunity or area plan, the TMP, or the BVCP.

(c) Provision of Alleys: Where alleys are provided or required to be provided under a City-adopted subcommunity or area plan, onsite parking spaces shall be accessed from the alley and not the street.

(d) Emergency Response: Residential streets exceeding 500 feet from any intersection shall provide a secondary emergency access at 500-foot intervals.

(3) **Rural Residential Street:** The rural residential street is designed to provide access to individual properties as well as access to the higher classification street network. The rural residential street provides for neighborhood traffic and through movements, and is designed to carry traffic volumes in the range of 500 to 1,000 vehicles per day. The rural residential street shall be provided where prescribed by a City-adopted subcommunity or area plan to maintain the rural character of an area or neighborhood. The rural residential street is a curbless paved street section, with gravel shoulders for parking and open roadside ditches for drainage. In addition to the requirements outlined in Table 2-13, "Residential Street Design Standards," and "Technical Drawing 2.65," Chapter 11, the rural residential street shall be designed to meet the following standards:

(a) Parking: Allowed on both sides of the street.

(b) Turnaround Standard (No Outlet Streets): If a "Y" or "T" turnaround is proposed in place of a standard cul-de-sac bulb turnaround, the "Y" or "T" turnaround shall be designed 60 feet long and 20 feet wide. The turnaround area (including sidewalks if required) shall be contained within the dedicated right-of-way.

(c) Provision for Future Sidewalks: If sidewalks are not required at the time of initial street construction, adequate space in the right-of-way shall be reserved for a future sidewalk and commitments from adjacent property owners to participate in assessment districts shall be obtained, so that sidewalks can be added and funded in the future when they are appropriate.

(d) Sidewalk Placement (Where Required): Sidewalks shall be required where vehicular traffic volumes are anticipated to exceed 1,000 trips per day, on routes to school, and as prescribed by a City-adopted subcommunity or area plan. Sidewalks shall be placed outside of the paved roadway and drainage ditch, and inside the right-of-way line.

(e) Roadside Drainage Ditches: Sideslopes along roadside drainage ditches shall be 4:1, and driveway culverts, at least 12 inches in diameter with flared end sections or headwalls, shall be installed by owners at driveways.

(f) Land Use Requirements: Lot frontages shall be at least 60 feet wide, unless alley access is provided. Lot frontages with alley access shall be at least 40 feet wide. Two onsite parking spaces, meeting all City requirements, shall be provided on each single-family lot.

(g) Provision of Alleys: Where alleys are provided or required to be provided under a City-adopted subcommunity or area plan, onsite parking spaces shall be accessed from the alley and not the street.

(h) Emergency Response: Rural residential streets exceeding 500 feet from any intersection shall provide a secondary emergency access at 500-foot intervals.

(4) **Access Street:** The access street provides public access to no more than 25 single-family dwelling units, where anticipated vehicular volumes would not exceed 400 trips per day. The access street is narrow, to ensure slower speeds for vehicular travel, and provides sidewalks along both sides of the street. In addition to the requirements outlined in Table 2-13, "Residential Street Design Standards," and "Technical Drawing 2.66," Chapter 11, the access street shall comply with the following minimum standards:

(a) Parking: Parking is allowed on both sides of the street or, if parking is not provided on-street, a parking court at a ratio of 0.5 spaces per dwelling unit is required.

(b) "L" Intersections: "L" intersections may be permitted as part of subdivision, and are subject to approval by the Director. Where permitted, "L" intersections shall have at least a 150-foot-long tangent street section from the intersection to the closest curvature and a minimum corner radius of 50 feet.

(c) Circle or Loop Street: If a circle or loop street is proposed as part of subdivision, the street shall connect to a higher classification street, or connect to two separate perpendicular or offset higher classification streets.

(d) Turnaround Standard (No outlet streets): If a "Y" or "T" turnaround is proposed in place of a standard cul-de-sac bulb turnaround, the "Y" or "T" turnaround shall be designed with a 60 foot length, 20 foot width. The turnaround area (including sidewalks if required) shall be contained within dedicated right-of-way.

(e) Land Use Requirements: A residential access street shall connect to a higher classification street. Lot frontages shall be at least 60 feet wide, unless alley access is provided. Lot frontages with alley access shall be at least 40 feet wide. Two onsite parking spaces, meeting all City requirements, shall be provided on each single-family lot.

(f) Provision of Alleys: Where alleys are provided or required to be provided under a City-adopted subcommunity or area plan, onsite parking spaces shall be accessed from the alley and not the street.

(g) Emergency Response: Access streets exceeding 175 feet from any intersection shall provide a fire apparatus setup area at 150 foot intervals. The setup area shall provide at least 30 foot long, 25 foot wide clear zone, and is subject to approval

by the Fire Department.

(5) **Access Lane:** The access lane provides public access to no more than 15 single family dwelling units, where anticipated vehicular traffic volumes would not exceed 250 trips per day. The access lane is a narrow "shared street" for all modes of travel (vehicular, bicycle, and pedestrian), without curb and gutter or sidewalks, and must connect with a higher classification street. In addition to the requirements outlined in Table 2-13, "Residential Street Design Standards," and "Technical Drawing 2.67," Chapter 11, the access lane shall comply with the following minimum standards:

(a) Parking: Parking is allowed.

(b) "L" Intersections: "L" intersections shall have a minimum 150-foot long tangent street section from the intersection to the closest curvature and a minimum corner radius of 50 feet.

(c) Circle or Loop Street: A circle or loop street shall connect to a higher classification street, or connect to two separate perpendicular or offset higher classification streets.

(d) Turnaround Standard (No outlet streets): A "Y" or "T" turnaround shall be designed with a 60 foot length, 20 foot width. The turnaround area (including sidewalks if required) shall be contained within dedicated right-of-way.

(e) Land Use Requirements: An access lane shall connect to a higher classification street. Lot frontages shall be at least 60 feet wide. Two onsite parking spaces, meeting all City requirements, shall be provided on each single-family lot. If the minimum lot frontage requirement is not met, additional parking spaces shall be provided at a ratio of 0.5 spaces per dwelling unit as a part of the subdivision. These required spaces shall be located on private property.

(f) Right-of-Way Landscaping: Landscaping other than ground cover or low shrubbery shall be placed outside of the right-of-way.

(g) Emergency Response: Access streets exceeding 175 feet from any intersection shall provide a fire apparatus setup area at 150 foot intervals. The setup area shall provide a minimum 30-foot long, 25 foot wide clear zone, and is subject to approval by the Fire Department.

(6) **Residential Alley:** The residential alley is to provide secondary vehicular access to the rear of lots in detached single-family dwelling subdivisions with narrow street frontages, in order to limit curb cuts from the street and increase on-street parking. Alleys are most beneficial when lot widths are narrower than 50 feet. In addition to the requirements outlined in Table 2-13, "Residential Street Design Standards," and "Technical Drawing 2.68," Chapter 11, the residential alley shall be designed to meet the following minimum land use requirements: Backup distance for parking and garage access from the alley shall be 24 feet, including the 16-foot alley right-of-way width, and the remaining backup distance shall be provided on the lot being served.

2.10 Emergency Access Lanes

(A) Emergency Access Required

All industrial, commercial, and residential developments shall provide adequate emergency vehicle access. Adequate emergency access is a minimum 20 foot wide unobstructed fire apparatus access road with an unobstructed vertical clearance of 15 feet, and meets all applicable standards as set forth in Chapter 10-8, "Fire Prevention Code," B.R.C. 1981.

(B) When Emergency Access Lane is Required

When adequate emergency access is not available from a public street, an applicant for construction approval shall construct an emergency access lane. Emergency access lanes must accommodate all emergency vehicles, including fire equipment.

(C) Secondary Emergency Access

Secondary emergency access lanes shall be provided to structures whenever the distance to the nearest public street equals or exceeds 500 feet. Secondary access lanes shall conform to all design requirements specified for emergency access lanes.

(D) Local Emergency Access Lane Standards

In addition to the emergency access standards set forth in Chapter 10-8, "Fire Prevention Code," B.R.C. 1981., an emergency access lane shall equal or exceed the following standards:

(1) **Direct Route:** Emergency access lanes shall provide the shortest practical direct access to points of concern, and be entirely contained within a minimum, continuous 20 foot wide emergency access easement or public right-of-way.

(2) **Distance From Structure:** Emergency access lanes shall be provided whenever a structure is located more than 150 feet from fire apparatus access.

(3) **Surface:** An emergency access lane shall consist of either of the following:

(a) Two concrete strips at least 4 feet wide, with a 4-foot separation between them. Vegetation other than grass shall not be permitted in the separation area.

(b) A minimum continuous paved surface width of 12 feet.

(4) **Radius:** An emergency access lane shall provide a minimum turning radius of 25 feet, or the radius needed to accommodate an SU-30 vehicle.

(5) **Turnarounds:** If the length of the emergency access lane exceeds 150 feet (without an outlet accessible to emergency vehicles), then a turnaround with a minimum radius of 45 feet shall be provided.

(6) **Grade:** The grade for an emergency access lane shall not exceed five percent. Exceptions may be allowed with specific approval from the City of Boulder Fire Chief where this standard cannot be met due to topographical conditions.

(7) **Vertical Clearance:** Vertical clearance from the surface of the emergency access lane shall be at least 15 feet.

(E) Unobstructed Access

Emergency access lanes shall be kept free and clear of all obstructions. If the Director or Fire Chief determines that barriers are needed to prevent automobile traffic from using an emergency access lane, then the applicant for construction approval shall install traffic bollards. Traffic bollard designs shall provide for immediate access of emergency vehicles, without requiring these vehicles to stop and maneuver around, or unlock, any structures. The Director and Fire Chief shall have final approval of all bollard designs.

(F) Access Identification

Signs and pavement markings will be required if necessary by the Director and Fire Chief to delineate and identify emergency access lanes. All signage for emergency access lanes shall conform with the specifications in the MUTCD.

2.11 Bicycle Facilities and Multi-Use Path Design

(A) Conformance with Low-Stress Walk and Bike Network Plan

The arrangement, type, and location of all bike lane and multi-use path facilities and routes shall conform with the "Low-Stress Walk and Bike Network Plan" section in the TMP. The Director shall specify the standards for design and construction of new bike lane and multi-use path facilities consistent with these Standards and considering public health, safety, and welfare and generally accepted engineering principles. The Director may refer to the Transportation References in these Standards.

(B) On-Street Bike Lanes - Streets Without On-Street Parking

An on-street bike lane is separated from the motor vehicle travel lane by a single white line. On-street bike lanes on new streets without on-street parking shall be at least 5 feet wide, exclusive of the curb pan, or 6.5 feet from the face of any curb. On existing streets where on-street bike lanes are being added and available right-of-way or improvements space is restricted, the Director of Public Works may approve a reduced width of the bike lane; the reduced width shall be at least 5 feet wide, inclusive of the curb pan.

(C) On-Street Bike Lanes - Streets With On-Street Parking

An on-street bike lane on a street with on-street parking is separated from the motor vehicle travel lane or parking lane by a single white line. On-street bike lanes on new streets with on-street parking shall be at least 6 feet wide, exclusive of the parking lane. On existing streets where on-street bike lanes are being added and available right-of-way or improvements space is restricted, the Director of Public Works may approve a reduced width of the bike lane; the reduced width shall be at least 5 feet wide, exclusive of the parking lane.

(D) Buffered Bike Lanes

A buffered bike lane is separated from the motor vehicle travel lane by a painted buffer space

creating a greater separation between the bike lane and adjacent travel lane. The buffer shall be marked with 2 solid white lines, and the markings shall otherwise conform with MUTCD standards. The buffered space shall be at least 2 feet wide. On streets without on-street parking the bike lane shall be at least 5 feet wide, or 6.5 feet from the face of the curb. Bike lanes on new streets with on-street parking shall be at least 5 feet wide, exclusive of the parking lane. On existing streets where buffered bike lanes are to be added and right-of-way or improvement space is limited, the Director may modify this standard considering safety concerns or approve an on-street bike lane..

(E) Separated Bike Lanes (One-Way and Two-Way)

A separated bike lane is physically separated from the motor vehicle travel lane through vertical or horizontal elements and is distinct from the sidewalk. Separated bike lanes have different forms but all share common elements. Where on-street parking is allowed, the separated bike lane shall be located to the curb side of the parking (in contrast to on-street and buffered bike

lanes). Separated bike lanes may be one-way or two-way and may be at street level, at sidewalk level, or at an intermediate level. If located at sidewalk level, a curb or median shall separate the separated bike lane from the motor vehicle travel lane, and different pavement color or type shall separate the separated bike lane from the sidewalk. If located at sidewalk level, the separation may include a landscaped area. If located at street level, the separated bike lane shall be separated from the motor vehicle travel lane by raised medians, on-street parking, or flexible delineators. Flexible delineators shall conform with MUTCD standards. Raised medians shall conform to "Technical Drawing 2.42C," Chapter 11 of these Standards. The Director may require additional markings, signage, and other improvements to ensure safe and efficient operation of the City's transportation system.

On streets without on-street parking, a vertical separation shall create a buffer between the bike lane and the travel lane that is at least 3 feet wide, and the bike lane shall be at least 5 feet wide, or 6.5 feet from the face of the curb. On streets with on-street parking, the separation shall be a 3-foot-wide horizontal buffer between the bike lane and the parking lane, and the bike lane shall be at least 5 feet wide.

On existing streets where separated bike lanes are to be added and right-of-way or improvement space is limited, the Director may modify this standard considering safety concerns and the efficient operation of the City's transportation system.

Examples of one-way separated bike lanes at driveways are shown in the figures below:

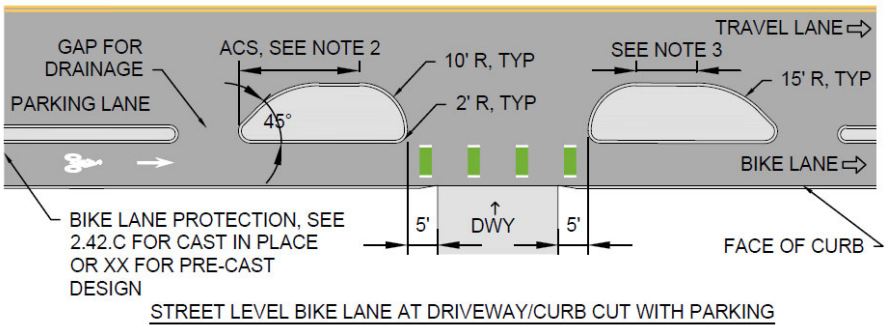


Figure 4 - Typical Layout for One-way Street Level Separated Bike Lanes at Driveways

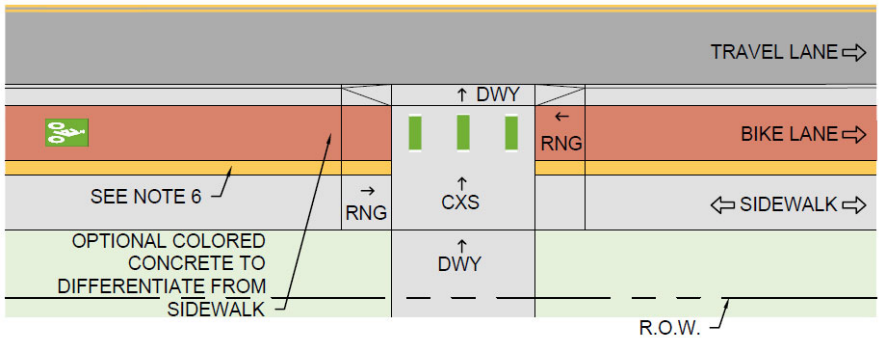


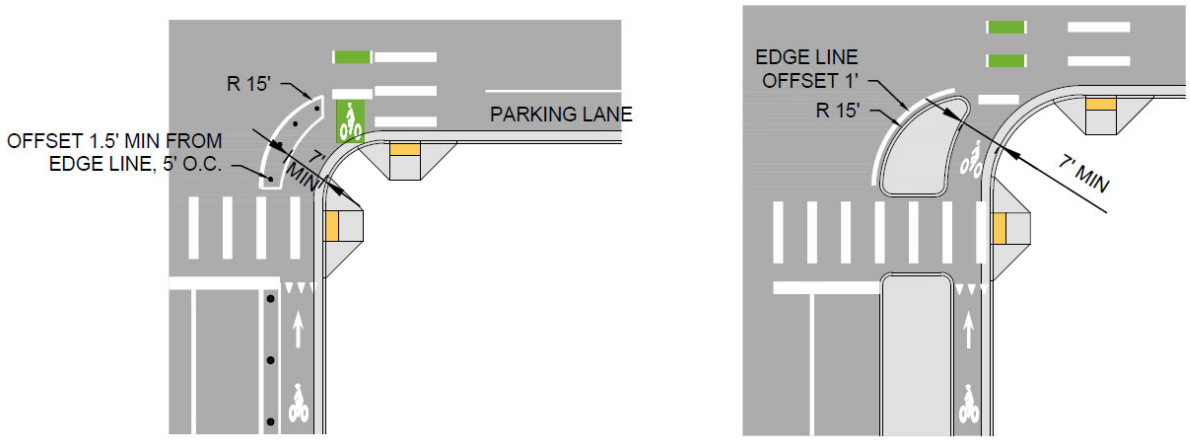
Figure 5 - Typical Layout for Sidewalk Level One-way Separated Bike Lanes at Driveways

Notes:

1. Design plans should be consulted for variations
2. Typical approach clear space (ACS) for driveways and alleys should be 20' as shown. in constrained locations the approach clear space may be measured from edge of driveway
3. In constrained locations the far-side buffer tangent may be reduced to 5'
4. See city of boulder design and construction standards, section 2.07, table 2.5 for standard lane widths
5. Bike lane tapers preferred at 7:1 shift, minimum 3:1 shift in constrained locations where speed is ≤ 13 mph
6. For bike lanes at sidewalk elevation without buffer treatment, 1' minimum directional indicator strip required within the sidewalk; typically located 1' from the edge of the bike lane.
7. Accessible ramp slope (RMP) = 7.8% (8.3% max)
8. Accessible cross slope (CXS) = 0.5-1.5% (2% max)
9. Accessible running slope (RNG) = 5% max
10. Driveway slope (DWY) = 12% max

Examples of one-way separated bike lanes at intersections with protected corners are shown in

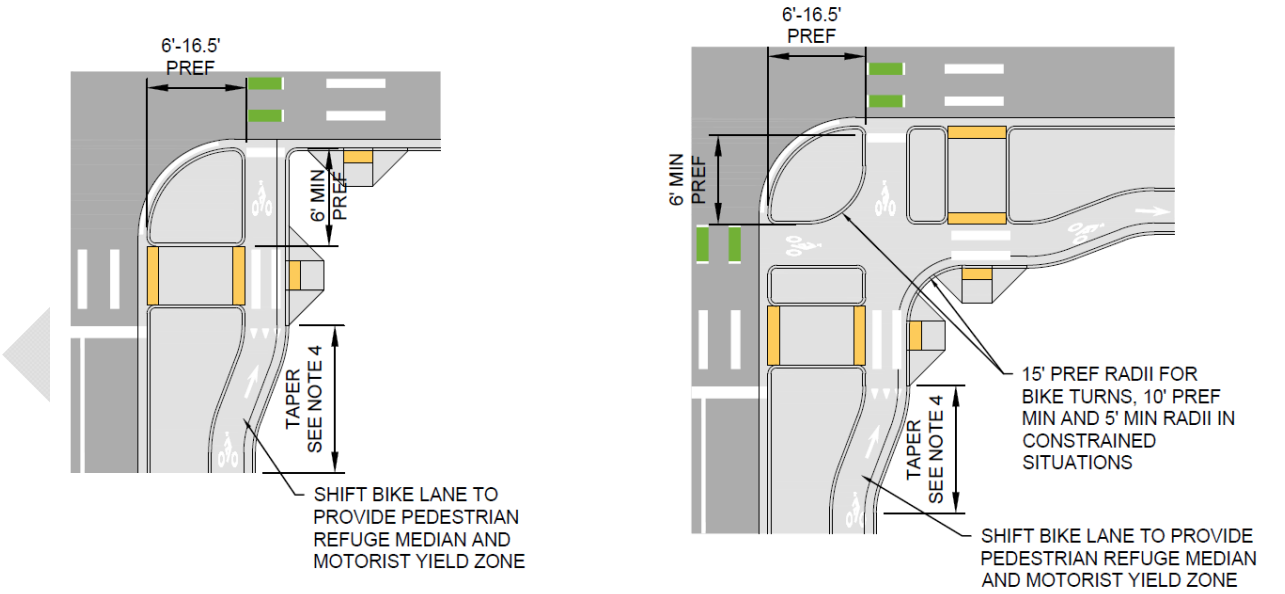
the figures below:



RETROFIT PROTECTED CORNER TREATMENT WITH PAINT AND POST

RETROFIT PROTECTED CORNER TREATMENT WITH CONCRETE

Figure 6 - Typical Layout of Street Level Separated Bike Lanes at Intersection in Retrofit Conditions



RECONSTRUCTED PROTECTED CORNER TREATMENT WITH CONCRETE

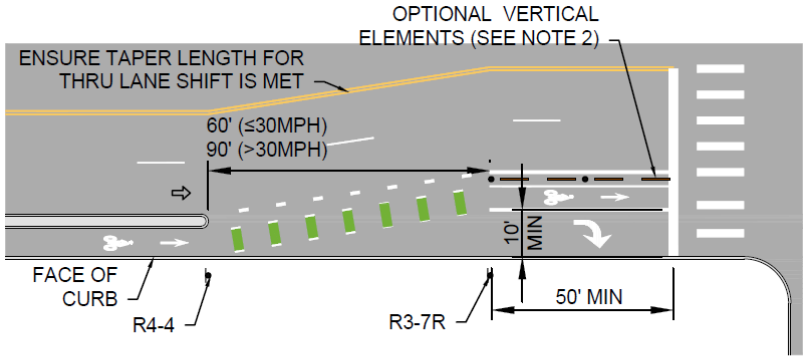
RECONSTRUCTED PROTECTED CORNER TREATMENT WITH CONCRETE (INTERSECTION BIKE FACILITIES)

Figure 7 - Typical Layout of Street Level Separated Bike Lanes at Intersections in Reconstructed Condition

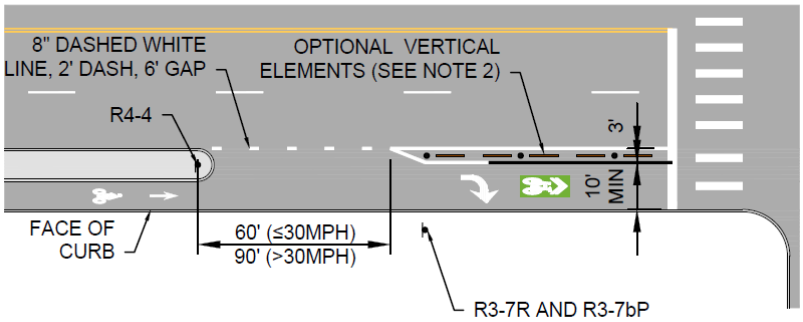
Notes:

1. Design plans should be consulted for variations
2. Size and shape of corner treatments are dependent on intersection characteristics
3. See city of boulder design and construction standards, section 2.07, table 2.5 for standard lane widths
4. Bike lane tapers preferred at 7:1 shift, minimum 3:1 shift in constrained locations where speed is ≤ 13 mph

Examples of one-way separated bike lanes at intersections with non-protected corners are shown in the figures below:



BIKE/TURN LANE - EXCLUSIVE TREATMENT (NO PARKING)



BIKE/TURN LANE - MIXING ZONE TREATMENT (NO PARKING)

Figure 8 - Typical Layout of One-way Separated Bike Lane and Right Turn Lane

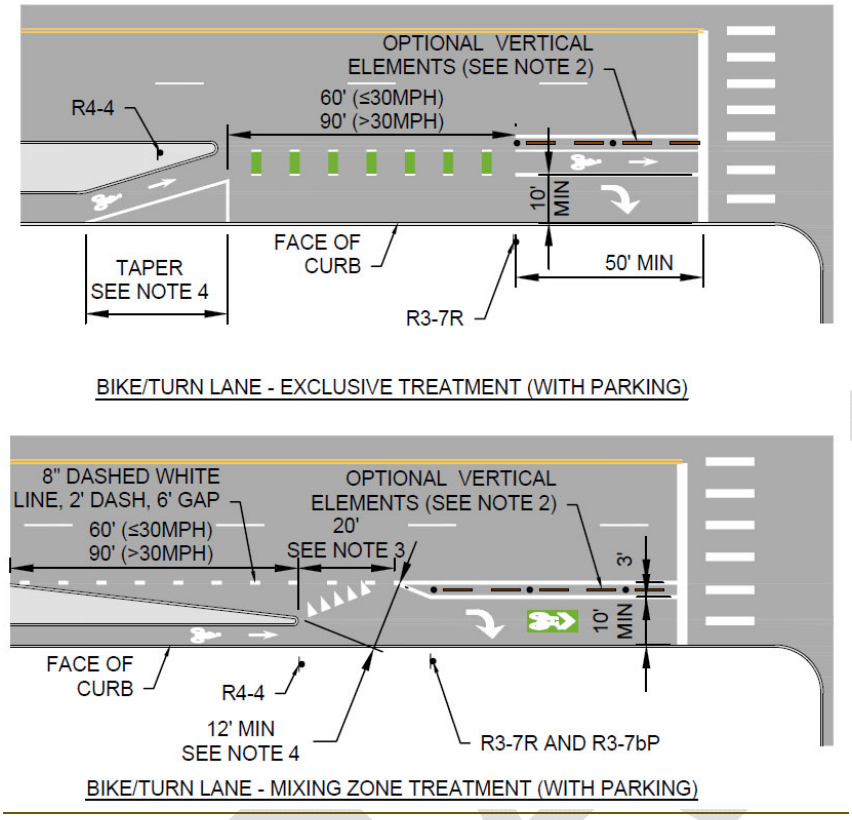


Figure 9 - Typical Layout of One-way Separated Bike Lane and Right Turn Lane

Notes:

1. Design plans should be consulted for variations
2. Vertical elements may be excluded or modified as needed to accommodate truck and/or transit vehicles
3. 25' minimum where high bus volume is anticipated
4. 13' minimum where high bus volume is anticipated
5. Bike lane tapers preferred at 7:1 shift, minimum 3:1 shift in constrained locations where speed is ≤ 13 mph
6. See city of boulder design and construction standards, section 2.07, table 2.5 for standard lane widths
7. A ramp up to sidewalk may be provided for people on bicycles prior to vehicular mixing zone to provide a low stress alternative

(F) Off-Street Multi-Use Paths

Design for off-street multi-use paths shall conform to Chapter 5 of the AASHTO Guide for the Development of Bicycle Facilities, 4th edition. The paths shall be at least 10 feet wide with an

inside edge radius of at least 15 feet and shall conform to "Technical Drawing 2.02D," Chapter 11, of these Standards.

(G) Bicycle Parking

Bicycle parking should be located in a visible and prominent location that is lit at night and physically separated from automobile parking to prevent vehicles from intruding into the bike parking area. All bicycle parking constructed in the City of Boulder shall conform to the provisions in the Section 9-9-6(g), "Bicycle Parking," B.R.C. 1981 or as adopted in any subcommunity or area improvement plan.

(1) **Bicycle Parking in Sidewalk Area of Public Right-of-Way:** Bicycle parking racks located in the sidewalk area of the public right-of-way shall be designed using either the inverted "U" rack standard or the inverted "U" racks on rails standard. A minimum aisle of 5 feet shall be provided for bikes to maneuver in when accessing the rack. All racks shall be attached to a concrete base using a high security tamper proof anchor such as a mushroom head carbon steel expansion anchor "spike" #5550 as manufactured by Rawl or an equivalent theft-proof device.

(a) Inverted "U" Rack: The inverted U rack is designed to park two bicycles, facing opposite directions, parallel to the rack. For the rack to meet its design specification of parking two bikes, it must be installed according to the specifications below, otherwise it will be considered to provide parking for one bike. The inverted "U" standard may be installed with the following conditions:

(i) Where the "U" rack is installed oriented parallel to a wall or curb, at least 3.0 feet shall be provided between the parallel wall or curb and the center of the rack. Where a bike rack is located near a curb with "head-in" automobile parking, a minimum distance of 5 feet from the curb to the center of the rack is required to avoid damage to bicycles or racks by automobiles extending across the curb over the sidewalk.

(ii) Where the "U" rack is installed oriented perpendicular to a wall or curb, a minimum distance of 4 feet from the wall or curb to the center of the rack will be provided to allow two bikes to access and use the rack.

(iii) Where placed side-by-side, "U" racks shall be placed at least 3.5 feet apart to accommodate ease of access to the racks.

(iv) Where placed in a series of 2 or more and parallel to a wall, inverted "U" racks will be separated by a minimum distance of 10 feet between the centers of the racks to allow access to both sides of the rack.

(v) The location of a bike rack shall maintain a minimum unobstructed sidewalk width of 6 feet from any bicycle parked properly in the rack.

(vi) The location of a "U" rack shall maintain a minimum unobstructed

distance of 3 feet from any pedestrian curb ramp to any bicycle parked properly in the rack.

(b) Inverted "U" Racks on Rails: The inverted "U" racks on rails are designed to park four to ten bicycles, with two bikes facing opposite directions parked on either side and parallel to each inverted "U" rack. These racks allow locking of frame and wheel with a U-lock and support bikes with two points of contact. For the rack to meet its design specifications of parking bikes from both sides, it must be installed according to the conditions of the inverted "U" rack listed above; otherwise it will be considered to provide no more than half of its designed parking capacity.

(2) **Onsite Bicycle Parking:** Bicycle parking should generally be provided within 50 feet of the main building entrance. Racks must be installed according to the guidelines in (1) above to reach their designed parking capacity. Otherwise, they shall be credited with no more than half their design capacity. Bicycle parking racks or lockers located on development or project sites or in parking lots outside of public right-of-way shall generally be selected from the following standards:

(a) Inverted "U" Rack: The inverted "U" rack is recommended for most bike rack installations and is one of the standards for bicycle parking in public rights-of-way as required in Subsection (1) above. Each rack provides space for two bicycles and allows flexibility in parking by providing two supports for attaching locks. The "U" rack may be used individually where space is limited, or, in circumstances requiring a larger amount of bike parking, inverted "U" racks on rails may be used to park four to ten bikes. Inverted "U" racks and inverted "U" racks on rails shall meet the specifications for the dimensions and installation shown in Chapter 11, "Technical Drawings," of these Standards

(b) Other Bike Rack Styles: Another rack style may be approved by the Director of Public Works if it meets the following criteria:

(i) Provides at least two contact points between the rack and the bike to securely support the bike;

(ii) Provides at least a 2 foot by 6 foot parking space for each bike without the need to lift the handlebars of one bike over those of another to park;

(iii) Allows the frame and one wheel to be locked to the rack with a standard high security, U-shaped shackle lock; and

(iv) The rack is uncomplicated and intuitively simple for the bicyclist to use.

(c) Lockers: Bicycle lockers provide secure weatherproof storage for bike parking. Lockers are recommended for employee and longer-term parking and require adequate space, since they require more area than bicycle racks.

(3) **On-Street Bike Parking (Bike Parking Corrals)**: The Director may approve on-street bike corrals in commercial areas where sidewalk space is limited and in locations with high pedestrian volumes. In approving the design and construction of bike corrals, the Director shall consider public safety and the efficient operation of the City's transportation system.

2.12 Street Lighting

(A) Scope

The provisions of this section shall apply to public streets, and are subject to the restrictions outlined in the Section 9-9-16, "Lighting, Outdoor," B.R.C. 1981.

(B) Guidelines for Street Lighting

(1) **Street Light Requests**

(a) Public Service Company (PSC) of Colorado is responsible for providing street lighting as requested by the City.

(b) Before considering new or additional local street light requests, the City will require unanimous consent of all affected owners of property within 100 feet of proposed street light locations and the support of at least 51 percent of the total number of owners of properties within 500 feet of proposed locations.

(2) **Costs:** The installation costs of street light fixtures, excluding those that provide a demonstrated safety need, shall be paid by the applicant requesting the installation. The City will assume continued maintenance and energy costs associated with new installations.

(3) **Priorities for Installation:** Streetlights may be provided on the basis of identified traffic need with priorities established as follows:

(a) Reduction of an identified night time traffic accident problem correctable through street light installation.

(b) Major traffic corridors with significant turning movement conflicts and night time pedestrian activity.

(c) Major traffic corridors with significant night-time turning movement conflicts.

(d) Arterial and collector intersections and/or horizontal or vertical alignment changes.

(e) Residential street lighting.

(f) Commercial alleys with significant night-time pedestrian activity.

(4) **Design:** Street lights installed in public rights-of-way shall be an energy efficient lighting source (LED unless otherwise approved by the Director) with a minimum of ambient or reflected light (full cut-off fixtures). Poles shall be located so that the center

of the pole is three feet behind the face of the curb. The Director may approve a different pole location that is between three feet and six feet behind the face of the curb where necessary to accommodate the needs of other public right-of-way uses in the sidewalk area. The City has adopted the Illuminating Engineering Society's (IES) American National Standard Practice for Roadway Lighting as the design standard for all city streets, with the following modifications:

(a) Expressway and Arterial: Street lighting shall be based on IES standards.

(b) Other Streets: Street lighting may be provided at intersections and identified pedestrian crossings only. Lighting may be considered at locations with demonstrated needs based on changes in horizontal or vertical alignments. Fixtures shall have 29-watt LED lighting unless street width or other conditions justify higher wattage.

(c) Alleys: Except for alleys in commercial areas with significant night time pedestrian activity, the city will not provide alley lighting.

(d) Private Driveways: Street lighting installed at the intersection of private driveways and city streets shall be installed using City standards, be located outside of the public right-of-way, and all costs for installation, maintenance, and continued energy expenditures shall be the responsibility of the applicant requesting the lighting installation.

(C) Easements

Adequate rights-of-way or utility easements shall be dedicated to the City to allow PSC of Colorado to install street lights. Facilities with detached bike paths or sidewalks may use a combined signage, utility, and pedestrian easement for placement of the street lights between the curb and bikeway provided that the requirement for 2 feet of horizontal clearance from the sidewalk or bike path is met. Where a bike path or sidewalk is attached to the street curb and gutter, street lights shall be placed behind the sidewalk or path within a minimum 3-foot wide utility easement. Utility easements for street lights are not exclusive, and may be landscaped or used for parking subject to City approval. If there is an exclusive gas easement behind an attached walk or path, the street lights shall be located beyond that easement in an additional three-foot wide easement or the gas easement shall be relocated.

2.13 Transit Stop Facilities

New transit stops and enhancements to existing transit stops shall be designed in accordance with RTD's "Bus Infrastructure Standard Drawings" and with consideration of NACTO's "Transit Street Design Guide."

2.14 Traffic Calming Design

(A) Scope

Xxxxx

(B) Neighborhood Traffic Circle

Xxxxx

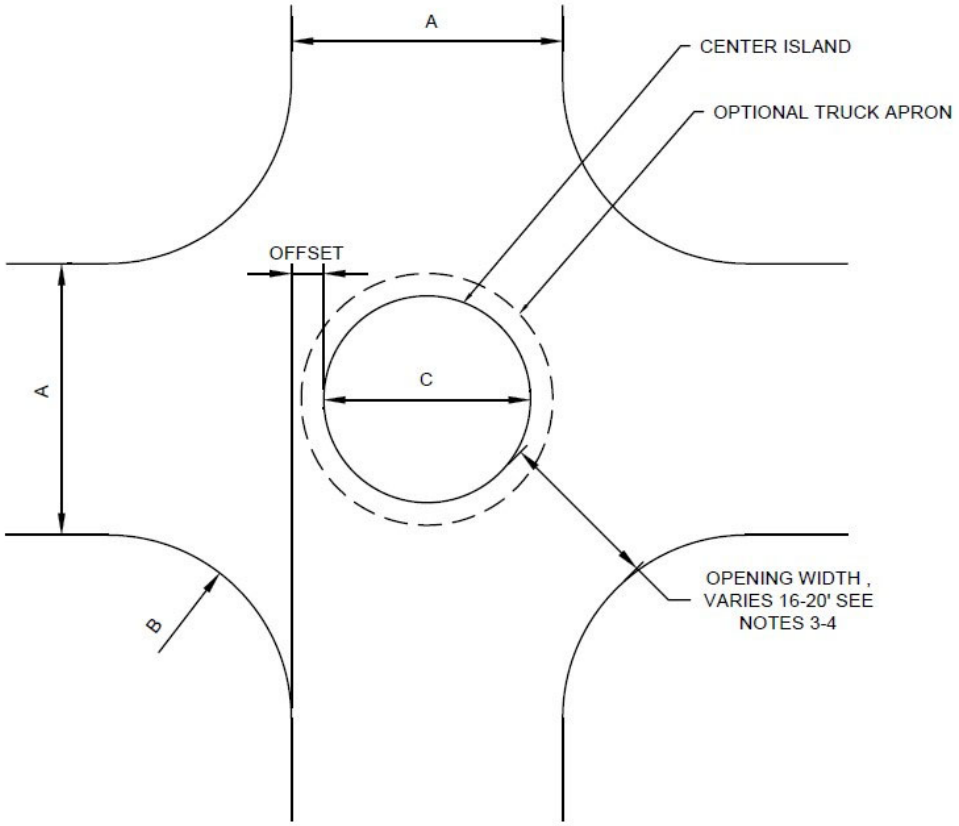


Figure 10 – Typical Layout and Standard Dimensions of Neighborhood Traffic Circle

Table 1. Offset and Opening Width Dimensions

Offset	Opening Width
5.5’ (Max)	16’ (Min)
5.0’	17’
4.5’	18’
4.0’	19’
3.5’ or less	20’ (Max)

Table 2. Center Island Diameter Dimension for Different Street Widths and Curb Return Radii

A Street Width	B Curb Return Radius	C Center Island Diameter
28’	15’ 20’ 25’	18’ 20’ 22’
30’	15’ 20’ 25’	20’ 22’ 24’
36’	15’ 20’ 25’	27’ 29’ 33’
40’	15’ 20’ 25’	32’ 34’ 38’

Notes:

1. Use dimension schedule as a design guide. Final dimensions to be determined by the engineer.
2. Where crossing streets are not the same width, consider curb extensions on wider street to create consistent approach widths.
3. For locations with non-standard street widths, the relationship between the offset and the opening width is determined by the opening width table.
4. Where the circulating width is less than 20 feet wide, a mountable truck apron may be required.
5. Landscaping requires streets landscape architect review and approval. Plantings and trees must not inhibit intersection sight distances by ensuring a clear zone of visibility between 36 inches high and 80 inches high from the pavement elevations.
6. Intersections with more or less than 4 legs require engineer approval.

(C) Raised Crossing

xxxx

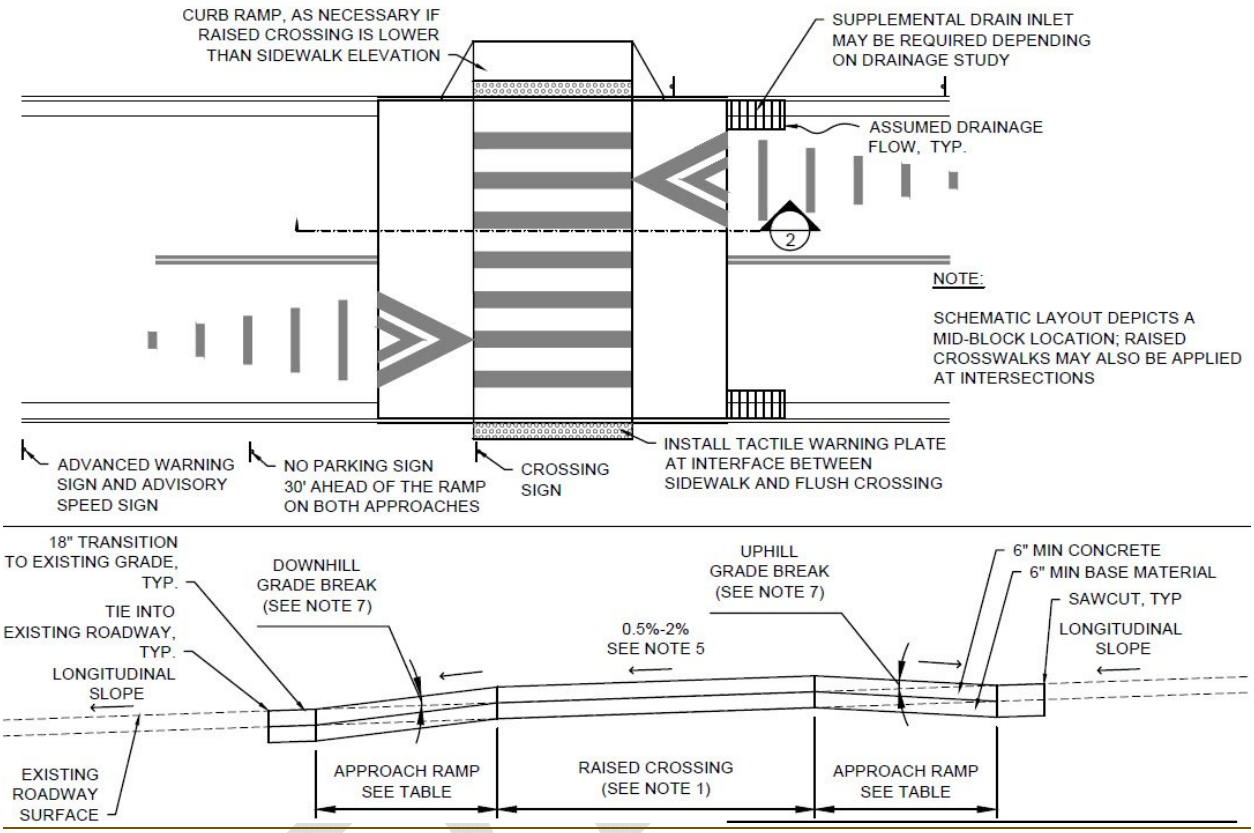


Figure 11 - Typical Layout of Raised Crossing at Mid-Block Location

Table 3. Dimensions of Approach Ramp Length For Various Roadway Longitudinal Slopes and Target Grade Breaks

Roadway Longitudinal Slope	Approach Ramp Length			
	5-6% Grade Break		8-10% Grade Break	
	Uphill	Downhill	Uphill	Downhill
0%	5.0-5.5' (3.0'-4.0')	5.0-5.5' (3.0'-4.0')	3.0-3.5' (2.0'-2.5')	3.0-3.5' (2.0'-2.5')
2%	5.0-5.5' (3.0'-4.0')	5.0-5.5' (3.0'-4.0')	3.0-3.5' (2.0'-2.5')	3.0-3.5' (2.0'-2.5')
4%	5.0-5.5' (3.0'-4.0')	8.0-10.0' (6.5'-7.5')	3.0-3.5' (2.0'-2.5')	5.0'-6.0' (4.0'-5.0')
6%	5.0-5.5' (3.0'-4.0')	11.0-13.5' (9.5'-11.5')	3.0-3.5' (2.0'-2.5')	6.5'-8.5' (5.5'-7.0')
Note: Primary ramp lengths assume a 6-inch tall raised crossing. Ramp lengths in parenthesis assume a 4-inch tall raised crossing.				

Table 4. Target Grade Breaks For Different Roadway Classifications

Roadway Classification	Grade Break Range	
	Min	Max
Local	8%	10%
Collector	5%	6%
Arterial	5%	6%

Notes:

1. The width of the top of raised crosswalks should match the width of the connecting sidewalk, shared use path, or desired crosswalk, but not less than 10' in width.
2. Modifications to existing street paving, cold plane and overlay asphalt, or reconstruction of paving required as necessary to restore a smooth transition and street crown, match paving materials and thickness, and warp new gutter to join invert at inlet.
3. Where positive drainage cannot be achieved, install supplemental drain inlet and connect to existing stormwater conveyance system.
4. Place crosswalk 2' (min) from poles, hydrants, or other vertical obstructions.
5. Crosswalk cross slopes should be no greater than 2%, however, at mid-block locations the cross slope may match the existing street grade. Cross slope may be 0% if longitudinal slope is sufficient to self drain
6. Crosswalk longitudinal slope should not exceed 5%
7. Grade breaks should be determined based on existing roadway speeds and desired speed reduction, generally higher grade breaks corresponds to higher speed reduction