TRANSPORTATION ENGINEERING DESIGN STANDARDS

Adopted by City Council Ordinance

City of Lakewood
Traffic Engineering Division
Department of Public Works
480 South Allison-80226-3105

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GLOSSARY OF TERMS

AASHTO: American Association of State Highway and Transportation Officials.

Acceleration Lane: A speed change lane, including tapered areas, for the purpose of enabling a vehicle entering a roadway to increase its speed to a rate at which it can more safely merge with through traffic.

Access: Driveway or other point of access such as a street, road, or highway that connects to the general street system. Where two public roadways intersect, the secondary roadway will be the access.

ADA: Americans with Disabilities Act

Approach: The portion of an intersection leg, which is used by traffic approaching the intersection.

Average Daily Traffic (ADT): The total bi-directional volume of traffic passing through a given point during a given time period, divided by the number of days in that time period.

Band Width: The time in seconds or the percent of cycle between a pair of parallel lines, which delineate progressive movement on a time-space diagram. It is a quantitative measurement of through traffic capacity provided by signal progression.

Capacity: The maximum number of vehicles that have a reasonable expectation of passing over a given roadway or section of roadway in one direction during a given time period under prevailing roadway and traffic conditions.

CDOT: Colorado Department of Transportation.

Connectivity: An interlinked system of streets to reduce travel time by allowing people to make shorter, more direct trips. Connectivity allows people the option of walking or bicycling because the routes to schools, parks, and businesses are shorter. Connectivity allows emergency vehicles like police, fire and ambulances to respond faster and use alternate routes if one is blocked. Connectivity reduces overall vehicles fuel use by shortening trips.

Critical Volume: A volume (or combination of volumes) for a given street, which produces the greatest utilization of capacity for that street in terms of passenger cars or mixed vehicles per hour.

Cycle Time: The time period in seconds required for one complete sequence of signal indications.

Deceleration Lane: A speed change lane, including tapered areas, for the purpose of enabling a vehicle that is to make an exit turn from a roadway to slow to a safe turning speed after it has left the main stream of faster moving traffic.

Delay: Stopped time per approach vehicle, in seconds per vehicle.

Design Hour Volume: Hourly traffic volume used for street design and capacity analysis, usually one or more peak hours during a 24-hour period.

Design Speed: Five to ten miles per hour above the proposed or desired speed limit of the facility under design.

Design Vehicle: Developments intended for public use must be designed for the following types of vehicles:

Residential (excluding single family or duplex)	SU30
Commercial Uses	WB40
Industrial Uses	WB50

For public streets, the following design vehicles must be used:

Commercial/Multi-family Locals and Minor Collectors	SU30
Major Collectors	WB40
Arterials	WB50

Definitions for the above vehicle types are found in AASHTO Geometric Highway Design Standards.

DHV: Design Hour Volume.

Divided Highway: A highway with separated roadways for traffic in opposite directions, such separation being indicated by depressed dividing strips, raised curbing, traffic islands, other physical separations, or by standard pavement markings and other traffic control devices.

D.R.C.O.G.: Denver Regional Council of Governments

Fire Trucks: Must be considered as a WB40 truck with a minimum 25 ft. inside turning radius for design purposes.

Functional Plan: A plan developed by the City to assist staff and the development community in the design and location of public improvements on the City's major street system. This plan is intended to be for planning purposes to ensure that public improvements are constructed in a logical and consistent manner along the City's major streets. Please refer to these documents for specific notes that apply to the use of these plans.

Flow Line: The transition point between the gutter and the face of the curb. For a cross or valley pan, it is the center of the pan. Where no curb exists, the flow line will be considered the edge of the outside traveled lane.

Grade: Rate or percent of change in slope, either ascending or descending from or along the highway. It is measured along the centerline of the highway or access.

Green Time: The length of a green phase plus its change interval, in seconds.

HCM: Highway Capacity Manual.

Hourly Volume: The number of (mixed) vehicles that pass over a given section of a lane or roadway during a time period of one hour.

Level of Service (LOS): A measure of the mobility characteristics of an intersection as determined by the volume/capacity ratio and a secondary factor, vehicle delay.

M.U.T.C.D.: Manual on Uniform Traffic Control Devices, and the Colorado Supplement; as amended.

Roundabouts: A circular intersection with raised center median; islands to separate flows of traffic from each other and pedestrians, yield control on all approaches and geometric features to slow traffic.

R.T.D.: Regional Transportation District

R.T.P. – Regional Transportation Plan, as amended, adopted by DRCOG.

Sight Distance: The length of roadway ahead visible to the driver. The minimum sight distance available should be sufficiently long to enable a vehicle traveling at or near the design speed to stop before reaching a stationary object in its path.

Signal Progression: Progressive movement of traffic at a planned rate of speed through adjacent signalized locations within a traffic control system without stopping.

Speed Change Lane: A separate lane for the purpose of enabling a vehicle entering or leaving a roadway to increase (acceleration lane) or decrease (deceleration lane) its speed to a rate at which it can more safely merge or diverge with through traffic.

Stopping Sight Distance: The distance traveled by a vehicle from the instant the driver of a vehicle sights an object necessitating a stop to the instant the brakes are applied, plus the distance required to stop the vehicle from the instant brake application begins.

Storage Length: Additional lane footage added to a deceleration lane to store the maximum number of vehicles likely to accumulate during a critical period without interfering with the through lanes.

T.D.M.: Travel Demand Model

Time Space Diagram: A chart on which the distance between signals and signal timing is plotted against time. The chart, when completed, indicates signal progression bandwidths and speed of traffic.

T.M.U.: Transit Mixed Use.

T.O.D.: Transit Oriented Development

Traffic Calming: Policies and measures that improve the negative effects of motorized vehicle use on individuals and society in general by changing the design and role of the streets to serve a broad range of social, environmental, and transportation objectives.

Traffic Circle: Raised circular island placed in an intersection that requires a driver to move out of a straight line path and reduce speed.

Trips: One-way trip ends and not two-way round trips.

VC Ratio: Volume/Capacity Ratio

1. FOREWORD

The standards contained herein regulate all improvements and private work to be dedicated to the public and accepted by the City and all work within the public right-of-way. They are intended to provide for adequate, coordinated, modern development with required facilities to serve and protect the potential users of the various areas of the community.

A failure to meet minimum standards creates a deficiency resulting in high user costs and losses. The high costs of maintenance necessitate that the construction of structural sections be done with adequate standards to minimize maintenance costs. These standards are intended to keep operating costs on public facilities at a reasonable level by obtaining proper alignments and structural sections.

It is recognized that certain projects financed in whole or in part with state or federal funds are subject to the standards prescribed by those agencies. Such standards may be greater or less than the City of Lakewood standards.

The Transportation Engineering Design Standards contained herein provide adopted standards for frequently raised construction and development issues. They are aimed at ensuring consistent Transportation Engineering Design practices in new development or redevelopment of land uses in the City of Lakewood. Some of the material contained herein has been drawn from previous City of Lakewood regulations as well as the City of Lakewood Zoning Ordinance, the State Highway Access Code, and nationally established texts and publications listed in the Bibliography.

The standards herein are meant to apply rigidly to new developments that are not constrained by already existing improvements. The standards are not to be applied without qualification to infill development. Infill development in an urban area is often constrained by existing improvements. To the extent deemed feasible by the City, in-fill developments will be required to match these standards. The City may allow modification of these standards when necessary to allow private and public construction that is compatible with surrounding in-place improvements.

These standards will apply to State Highways within the City of Lakewood. Whenever the Standards of the Colorado Department of Transportation and the State Highway Access Code and The City of Lakewood, Transportation Engineering Design Standards conflict, the more stringent standards shall take precedence.

2. CONNECTIVITY AND FUNCTIONAL STREET CLASSIFICATION

2.1 Connectivity

The City requires a connected street system with all new developments, minimizing the use of cul de sacs. Infill parcels will be required to provide future street stubs to adjacent parcels with the potential for development. Retail and office development must provide cross access easements to create circulation patterns to adjacent properties to eliminate multiple accesses to the major street system.

This is to reduce travel time and congestion by allowing people to make shorter and more direct trips. Connectivity allows people the option of walking or bicycling because the routes to schools, parks and businesses are shorter. Connectivity allows emergency vehicles like police, fire and ambulances to respond faster and use alternate routes if one is blocked. Connectivity reduced overall fuel consumption and pollution by shortening trips.

2.2 Functional Street Classification

A map showing the street classification of the City of Lakewood's street network is included in the Appendix, Figure 1. The minimum rights-of-way and pavement width requirements are shown in the Appendix, Figures 2 through 4. These standards are minimums and the City may require wider cross sections depending on traffic impacts from any proposed development in the area. These impacts may create the need for street designs exceeding these minimum standards. Additional geometric design details for collector and arterial streets are available in the City's "Functional Plan" documents located in the Public Works Department. These documents comprise aerial photographs on which the City's anticipated functional design plans for each collector and arterial street in the City are shown at 1 in.=50 ft. scale. Developers will be advised to use these functional plans whenever they are available as the basis for preparing final design drawings for public improvements. In addition to the "Functional Plan," City regulations or the State Highway Access Code may necessitate the provision of speed change lanes as described in sections 4, 5 and 6.

2.2.1 Arterial

An arterial street (See Appendix, Figure 2) is a roadway designed or operating typically with the following characteristics:

a. Posted speed limit greater than or equal to 35 mph.
b. 4-lane minimum width, plus additional turn lanes.
c. 12,000 vehicles per day expected minimum traffic volume when the land that the arterial serves is fully developed.
d. Limited access to adjacent parcels of land.
e. Traffic control at major intersections provided by the traffic signals. Side street control by stop signs.

2.2.2 Major Collector

A major collector (See Appendix, Figure 3) is a roadway designed or operating typically with the following characteristics:

a. Posted speed limit from 30 to 40 mph.
b. Traffic volumes greater than 7,000 vehicles per day when the land that the collector serves is fully developed.
c. Designed to handle traffic volumes loading from and onto local, other collector, and arterial roadways.
d. Traffic control at major intersections provided by roundabouts or traffic signals; side street control by stop signs.
e. No back-out drives are permitted.

2.2.3 Minor Collector

A minor collector (See Appendix, Figure 3) is a roadway designed or operating typically with the following characteristics:

a. Posted speed limit from 25 to 35 mph.
b. Traffic volumes generally less than 7,000 vehicles per day.
c. Designed to handle traffic volumes loading from and onto local, other collector, and arterial roadways.
d. Traffic control on minor collectors generally provided by roundabouts or stop signs.
e. No back-out drives are permitted.

2.2.4 Commercial/Multifamily Local

A Commercial/Multifamily Local (See Appendix, Figure 3) is a roadway designed or operating typically with the following characteristics:

a. Posted speed limit from 25 to 35 mph.
b. Traffic volumes generally less than 5,000 vehicles per day.
c. Designed to handle traffic volumes loading from and onto locals, other collectors, and arterial roadways.
d. Traffic control on commercial/multifamily locals generally provided by roundabouts or stop control.
e. No back-out drives are permitted. In area zoned TMU back-out drives may be considered on a case by case basis.

2.2.5 Local

A local street (See Appendix, Figure 4) is a roadway designed or operating typically with the following characteristics:

a. Posted speed limit from 25 to 30 mph.

b. Traffic volumes up to 2,500 vehicles per day.
c. Designed for the safety of pedestrians and bicyclists and the ease of access to adjacent parcels of land.
d. Traffic control by stop signs, yield signs, or right-of-way rules for uncontrolled intersections.
e. Provide direct access to low density residential land use.

2.2.6 Private Streets

The following conditions apply when private streets are constructed.

a. Private streets may be allowed residential zone districts.

b. Private streets must meet the same Engineering Standards for pavement structural section as a public street in an area of comparable density and traffic volume. Concrete sidewalk, curb and gutter or drainage pans on the edge of the streets will be required.

c. The width of private streets may be varied according to density and traffic impact of each site, after appropriate review by the City's Planning and Engineering staff.

d. Appropriate signs must be permanently maintained at the entrance to the private street system that clearly indicate to the public and to the public and private service providers that the street system is private property.

e. The developer of the private street system must submit the portion of the covenant, declaration and/or by-laws of the homeowner association agreement that clarifies the private responsibilities for the private street system (maintenance, policing, lighting, drainage and signals, and maintenance of common open spaces) for "approval as to form" by the City Attorney's office. This information may alternatively be indicated as a stipulation on the Official Development Plan or the Subdivision Plat. This information must be approved at the time of the approval of the final plat, rezoning, or site plan, as appropriate.

f. Any traffic control devices proposed for the private street systems, such as signs, signals, markings, speed control mechanisms, etc., will be subject to review and approval by the City. The first 50 ft. of a private access approach to an existing or proposed signalized intersection must be dedicated as permanent easement measured from the flowline of the public street to provide for traffic signal loop detector placement, if needed.

g. Street construction plans for private streets will require City approval.

h. Gated private streets are allowed in all residential zone districts. Gated public streets are prohibited.

3. TRAFFIC STUDIES

3.1 Responsibility for Traffic Studies

Traffic studies may be required by the City in order to adequately assess the impacts of a development proposal on the existing and/or planned street system. Unless waived by the City, a written traffic study shall be required for proposed developments with trip generation anticipated to exceed 50 vehicles during any peak hour, as determined by the City. The primary responsibility for assessing the traffic impacts associated with a proposed development will rest with the developer, with the City serving in a review capacity.

The following development proposals or submittals shall require a written study:

a. A rezoning application or an application for annexation into the City.

b. A preliminary map or final plat if the property has already been rezoned for the proposed use and no traffic study was required for the rezoning, or the land use assumptions at the time of platting will result in trip generation increasing by more than 20% compared to trip generation estimates made for the traffic study at the time of rezoning.

c. Prior to issuance of a building permit, if the property has already been zoned and platted and no previous traffic study less than two years old exists.

d. Site access is required off a State Highway. Prior to issuing an access permit, approval from both the City and the Colorado Department of Transportation (CDOT) must be obtained.

e. Additional access off a State Highway to an existing use is being requested.

f. Any change of use affecting access from a State Highway. (For definition of "Change of Use", see section 4.1.1).

g. The applicant will be required to submit a new traffic study if, after submitting the original traffic study for any of the above submittals, the land use intensity is increase by more than 20%, or the land use is changed so that trip generation is increased by more than 20%.

h. The applicant will be required to update the traffic study if previous traffic studies related to the development are more than two years old, unless the City determines the conditions have not changed significantly.

The applicant will be notified at the pre-planning stage if a traffic study will be required, provided sufficient information is available for the City to determine whether the trip generation criterion has been met. If insufficient information is available but the property appears to involve a sufficiently intense land use, the applicant will be informed that a traffic study is required.

Transportation consultants are required to discuss projects with the City prior to starting the study. As a minimum, topics for discussion at such meetings will include trip generation, directional distribution of traffic, trip assignment, definition of the study area, intersections requiring capacity/level of service (LOS) analysis, and methods for projecting build-out volume. This will provide a firm base of cooperation and communications between the City, the owner or developer and the project's consultants in forecasting future traffic characteristics that realistically define traffic impacts associated with the proposed development. Specific requirements will vary depending on the site location and development proposal.

This study will be the responsibility of the applicant and must be prepared by a Professional Engineer registered in the State of Colorado with adequate experience in Transportation Engineering. Upon submission of a draft traffic study, the City will review the study data sources, methods, and findings. Comments will be provided in a written form. The developer and the project engineer will then have an opportunity to incorporate necessary revisions prior to submitting a final report. All studies must be approved by the City before acceptance.

Where access points are not defined or a site plan is not available at the time the traffic study is prepared, additional traffic work may be required when a site plan becomes available or the access points are defined.

3.2 Traffic Study Format

In order to provide consistency and to facilitate staff review of traffic studies, the following format must be followed in the preparation of such studies by transportation consultants.

3.2.1 Introduction

The introduction portion of the report must contain the following:

a. **Project Site and Study Area Boundaries** – A brief description of the size of the land parcel, existing land uses, general terrain features, the locations within the jurisdiction and the region shall be included in this section.

   The exact limits of the study area should be based on engineering judgment, and an understanding of existing traffic conditions surrounding the site. In all instances, however, the developer, his engineer, and the City must mutually agree upon the study area limits. These limits will usually result from initial discussions with staff.

   A vicinity map that shows the site and the study area boundaries, in relation to the surrounding transportation system, must be included.

b. **Proposed Project Description** – The specific proposed land use types(s) and size(s) must be identified, if known. If the project is to be built in a phased manner, the types and sizes of the land use in each phase, as well as the projected completion date of each phase, shall be identified. If specific land uses are not known, the most intense use (in terms of traffic generation) allowed by current or proposed zoning must be assumed for the traffic study.

c. **Project Scope** – The agreed upon scope of the traffic study, in terms of the study intersections, driveways, and roadway segments, time periods and future scenarios to be analyzed, must be briefly described.

3.2.2 Existing Conditions

The current traffic conditions within the study area must be identified.

a. **Roadway Network** – Within the study area, the applicant must describe existing roadways and intersections including geometrics and traffic control as well as improvements contemplated by government agencies or other developments. This would include the nature of the improvement project, its extent, implementation schedule, and the agency or funding source responsible. A map must be provided showing the location of such facilities.

b. **Traffic Volumes** – The current traffic volumes at identified intersections (turning movements) and roadway links for the study time periods must be measured. At a minimum morning and evening (A.M. and P.M.) peak period counts will be required. Turning movement volumes for any other peak period that may be required. Traffic volumes over two years old will not be accepted. A graphic showing these volumes shall be included.

   All raw traffic count data (including average daily traffic volumes and peak hour turning movements) shall be included in the appendices of the report.

c. **Levels of Service (LOS)** – The current traffic operations (LOS) within the study area shall be described during the identified time periods. LOS shall be determined using the operational methodology as detailed in the most recent version of the Highway Capacity Manual (HCM). Both delay and critical volume to capacity ratio (X_c) values shall be reported. The City will provide the appropriate existing traffic signal timing values.

   All calculations must be included in the appendices of the report.

d. **Traffic Safety Analysis** – Traffic crash data for roadway corridors affected by the proposed project may be required for the study. The study period will normally be three years. The City will specify when a traffic safety analysis will be required.

For proposed rezoning, in addition to current traffic volumes and LOS, traffic volumes and LOS generated by land uses allowed under current zoning must be shown.

3.2.3 Site Traffic Projections

a. **Site Trip Generation** – A summary table listing type, size, the Institute of Transportation Engineers (ITE) Trip Generation Manual Land Use Code for each land use in the project, trip generation rates used, and the resultant total trips for each time period analyzed must be provided.

   Trip generation rates from the most current ITE Trip Generation Manual shall be used. In the event that data for the proposed land use is unavailable, trip generation from similar land uses, either from other sources, jurisdictions, or field studies, may be used with City approval. With approval, these sources may be used to supplement ITE Trip Generation Manual data.

   For phased developments, trip generation for each phase, as well as development build-out, shall be provided.

b. **Site Trip Reductions** – Use of the following types of trip reduction factors may be considered with approval of the City.

   - Passerby factors as published in the current ITE Trip Generation Manual. Passerby factors are to be used to reduce the projected additional total daily traffic to street(s) serving a proposed development. They are not to be applied directly to reduce trip generation and turning movement volumes at driveways serving the proposed development.

   - Internal trip assumptions with analytical support.

   - Modal split assumptions with analytical support. For example, when the proposed project is located in a TOD or within a quarter of a mile of a major transit corridor (e.g., the West Corridor Light Rail Transit), a trip reduction may be applicable.

c. **Site Trip Distribution** – The estimates of percentage distribution of trips from the proposed development to destinations in the metro region must be clearly stated in the report using the north, south, east, and west compass points. Market studies and information concerning origin of trip attractions to the proposed development may be used to support these assumptions where available. A graphic showing the percentage of site traffic on each street must be provided as part of the traffic study.

d. **Traffic Assignment** – The direction of approach of site-generated traffic via the area's street system will be presented in this section. The technical analysis steps, basic methods, and assumptions used in this work must be clearly stated and agreed to by the City. The assumed trip distribution and

assignment must represent the most logically traveled routes for drivers accessing the proposed development. These routes can be determined by observation of travel patterns to existing land uses in the study area. A graphic showing the site traffic assignment on the surrounding roadway network must be included.

3.2.4 Background Traffic Growth

Background traffic growth for intersections and roadways within the study must be determined at the proposed project opening (short-term) and in the twenty-year planning horizon or area build-out (long-range), as determined by the City.

a. **Approved Projects** – Traffic from proposed developments within the study area, or having impact on the study area, shall be added to the appropriate planning time frame. Typically this will primarily affect the background traffic at the proposed project opening, however traffic generated by some larger approved projects may not impact the area until after project opening. This traffic should be added into the twenty-year planning horizon.

b. **General Growth** – In addition to approved projects, regional traffic growth will affect background traffic volumes at both analysis scenarios. Future traffic growth shall be developed through accepted means, such as the DRCOG model or CDOT growth factors. The City will approve general traffic growth rates.

c. **Currently Planned Roadway Improvements** – Roadway improvement that are currently planned and funded (i.e., in the current fiscally constrained DRCOG RTP) may be included in the future base conditions, as appropriate.

d. **Background LOS** – The background traffic conditions (LOS) within the study area shall be described during the identified time periods. LOS shall be determined using the operational methodology as detailed in the most recent version of the Highway Capacity Manual (HCM). Both delay and critical volume to capacity ration (X_c) values shall be reported.

   The extent of queuing and its potential impact to adjacent intersections shall be evaluated using a Poisson's distribution methodology (see section 3.5), or other method approved by the City.

   For unsignalized intersections, the current HCM methodology for determining LOS shall be used to identify projected traffic conditions.

   Background traffic volumes shall be shown in graphical format for each analysis scenario analyzed. All LOS calculations shall be included in an Appendix to the report.

3.2.5 Projected Traffic Impacts

Traffic impacts of the proposed project shall be analyzed for the anticipated project opening time frame, including all project phases, and the identified planning horizon.

Short-term

a. **Total Traffic – Project Opening.** The total projected traffic volume at the day of project completion shall be determined by adding the proposed project generated traffic to the short-term background traffic. Total traffic volumes at proposed project opening shall be shown in graphical format.

b. **Level of Service – Project Opening.** The project completion traffic conditions (LOS) within the study area shall be described during the identified time periods. LOS shall be determined using the operational methodology as detailed in the most recent version of the Highway Capacity Manual (HCM). Both delay and critical volume to capacity ratio (X_c) values shall be reported.

   LOS "D" (X_c less than or equal to 0.90) will be the design objective for overall intersection operation. Under no circumstances shall the development cause a drop below LOS "E" (X_c greater than1.00) at signalized intersections for any analysis scenario by the City.

   At unsignalized intersections, the current HCM methodology for determining LOS shall be used to identify projected traffic conditions.

c. **Mitigation – Project Stay Opening.** At intersections with projected LOS "E" (X_c greater than 1.00) or worse, mitigation measures shall be proposed to bring the intersection operation to an acceptable level.

Long-range

a. **Total Traffic – Long-range Projection.** The total projected traffic volume at the day of project opening shall be determined by adding the proposed project generated traffic to the Long-term background traffic. Total traffic volumes at proposed project opening shall be shown in graphical format.

b. **Level of Service – Long-range Projection.** The long-range traffic conditions (LOS) within the study area shall be described during the identified time periods. LOS shall be determined using the operational methodology as detailed in the most recent version of the Highway Capacity Manual (HCM). Both delay and critical volume to capacity ratio (X_c) values shall be reported.

   The design objective for the long-range LOS (X_c) with the project should be no worse than the long-range LOS projections (X_c) without the proposed project.

The extent of queuing and its potential impact to adjacent intersections shall be evaluated using a Poisson's distribution methodology (see section 3.5), or other method approved by the City.

The current HCM methodology for determining LOS shall be used to identify projected traffic conditions at unsignalized intersections.

c. **Mitigation – Long-range Projection.** At intersections with unacceptable projected LOS (as defined in b., above), mitigation measures shall be proposed to bring intersection operation to an acceptable level.

Levels of service values (delay and X_c values) shall be tabulated in a single table for all study intersections, analyzed time periods, and analysis scenarios. All LOS calculations shall be included in the appendices.

3.2.6 Conclusions and Recommendations

This chapter of the report must be a clear, concise description of the study findings and include:

a. **Proposed Improvements.** This section must describe the location, nature, and extent of proposed improvements to assure sufficient roadway capacity and mitigation proposed to reduce the potential for undesirable traffic characteristics. A sketch of each improvement should be provided showing the length, width and other pertinent geometric features of the proposed improvements.

b. **Volume/Capacity Analysis at Critical Points.** Another iteration of the volume/capacity analysis must be described, which demonstrates the anticipated level of service as a result of making the proposed improvements.

c. **Traffic Volume Proportion.** Percentages based on the traffic impact analysis may be required by the City to identify the proportion of traffic using various public improvements (both existing and proposed) from several developments within the study area.

The conclusion chapter will serve as an executive summary.

3.3 Potential Mitigation Measures

Any type of potential mitigation measures, including new roadways, additional traffic lanes on existing roadways, and changes to traffic control will be considered. The City of Lakewood must approve the recommended mitigations.

3.3.1 Roundabouts as Mitigation Measures – At unsignalized intersections of two-lane roadways that are projected to operate at a poor level of service, the City of Lakewood strongly recommends evaluation of a modern roundabout as a mitigation measure over the installation of traffic signals. (Reference: "Roundabouts: An Informational Guide", U.S. Department of Transportation, Federal Highway Administration, Publication No. FHWA-RD-00-067.)

3.3.2 Traffic Signals as Mitigation Measures – The need for new traffic signals will be based on warrants contained in the Manual on Uniform Traffic Control Devices (MUTCD) and any additional warrants established by the National Committee on Uniform Traffic Control Devices. In determining the location of a new signal, traffic progression is of paramount importance. Generally, a spacing of one-half mile for all signalized intersections should be maintained. This spacing is usually desirable to achieve good speed, capacity, and optimum signal progression. Pedestrian movements must be considered in the evaluation and adequate pedestrian clearance provided in the signal cycle split assumptions.

To provide flexibility for existing conditions and ensure optimum two-way signal progression, an approved traffic engineering analysis must be made to properly locate all proposed accesses that may require signalization. The section of roadway to be analyzed for signal progression will be determined by the City and will include all existing and possible future signalized intersections.

The progression pattern calculations must use a cycle consistent with current signal timing policies of the City. A desirable bandwidth of 50% of the signal cycle should be used where existing conditions allow. Where intersections have no signals presently, but are expected to have signals, typically a 60% mainline, 40% cross street cycle split should be assumed. Cycle split assumptions must relate to volume assumptions in the capacity analysis of individual intersections and consider pedestrian clearance times in the development of time/space diagrams.

The green time allocated to the cross street will be no less than the time which is required for a pedestrian to clear the main street using Manual on Uniform Traffic Control Devices standards. Those intersections that would reduce the optimum bandwidth if a traffic signal were installed may be required to remain unsignalized and have turning movements limited by access design or median islands. Refer to section 3 of the State Highways Access Code for signal spacing on State Highways.

3.3.3 Traffic Calming Mitigation Measures – For residential developments, it may be beneficial to propose measures to slow or reduce traffic. The City may require such measures. Potential traffic calming measures to be considered include:

- Electronic Speed Display Devices
- Neighborhood Entry Features
- Raised Intersections/Crosswalks
- Traffic Circles
- Neckdown

- Lane Narrowing
- Medians
- Pedestrian Refuge Islands
- Curvilinear Streets

The City will have final approval of any “proactive” traffic calming measures.

3.4 Queuing Analysis

A 95%-ile (using Poisson’s distribution) queue length will be used as the basis of storage length design and verification of the adequacy of existing storage lengths. Alternative methodologies, such as Synchro™ 95th percentile length calculations may be used with City approval. At signalized intersections, a background cycle length of 120 seconds shall be assumed. Green times for specific movements shall be based on the movement’s proportion of the critical lane volume, subject to phase minimums. Minimum greens shall be assumed to be 10 seconds for through movements and 4 seconds for left turns. Yellow change and red clearance intervals shall be assumed to be 3 seconds and 1 second, respectively for left turn movements and 4 seconds and 1 second, respectively for through movements. For lane groups that have multiple lanes, a lane utilization factor, in accordance with the HCM methodology, shall be applied to the calculation of queue lengths.

Monograms contained in the appendices shall be use for unsignalized intersections. (See Figures 5-7)

3.5 Revisions to Traffic Study

Revisions to the traffic study must be provided as required by the City. The need to require revisions will be based on the completeness of the traffic study, the thoroughness of the impact evaluation, the adequacy of proposed improvements and mitigation measures, and the compatibility of the study with the proposed access and development plan.

4. ACCESS MANAGEMENT

4.1 State Highways

The Transportation Commission of Colorado adopted a new State Highway Access Code as of August 31, 1998. Constructing, modifying or closing access to a state highway requires an access permit approved by the City and the Colorado Department of Transportation (CDOT). The Access Code requires property owners of all land adjacent to a State Highway that is being developed or redeveloped to apply for an access permit for each access to the state highway if the use of the property is being changed or the existing access modified. Such application shall be made through the City and not directly to CDOT.

4.1.1 Change in Property Use

When there are changes in property use which result in changes in the access operation, and the access is not in conformance with the State Access Code, the City or State may require reconstruction, relocation or conformance of the access to the State Access Code when any of the following access change criteria occur or will occur as a result of changes in property use:

a) The actual or proposed volume increases by 20% or more.

b) A particular directional characteristic (such as left turns) increases by 20%.

c) The change in use of the property or modifications to the property causes the flow of vehicles entering the property to be restricted or to queue or hesitate on the highway creating a hazard.

d) The use of the access by vehicles exceeding 30,000 pounds gross vehicle weight increases by 20% or by 10 vehicles per day.

e) If a parcel of land with direct highway access has been in a state of non-use for more than four years, recommencement of access use will be considered a change in use.

f) If the renewed use of an access exceeds its design limitations or is nonconforming with the present State Access code, a new permit may be required.

g) Change in property use may include but is not limited to: structural modifications, remodeling, change in type of business, expansion of an existing business, change in zoning, or change in property division creating new parcels. It does not include modifications in advertising, landscaping, general maintenance, or aesthetics that do not affect internal or external traffic flow or safety.

Unless there are identified safety problems, existing legal access to the state highway shall be allowed to remain or be moved or reconstructed under the terms of an access permit in accordance with subsection 2.6 of the State Access Code as long as the total daily trips in and out of this site do not exceed 100.

4.1.2 How to Obtain an Access Permit for State Highways

The State Highway Access Code (The Code) allows local governments to issue access permit applications, or the issuing responsibility may be assumed by the Colorado Department of Transportation. In the City of Lakewood, the City Government is the issuing authority and the following applies (for flow chart, see Appendix, Figure 8).

It is recommended that the applicant apply for the permit at least six months prior to the time when use of the access is desired. This period of time is generally required to process permit documents and approve all necessary plans and reports, prior to the submittal of access permit documents.

Prior to submitting a formal application, interested parties may request a pre-application meeting with the City and CDOT. The purpose of the meeting is to review the preliminary proposal and identify and react to outstanding issues prior to formal application.

Application for access shall include a completed access permit application and any required attachments necessary to review and assess the application or to complete the permit. Attachments necessary may include, but are not limited to plans, maps, traffic study, survey and deeds.

If the permittee or applicant wishes to apply for a waiver from the design standards of the Code, a request can be submitted with the application. An original 2-part CDOT form No. 112 shall be used. See subsection 4.12 of the Access Code.

If the City approves the application, a complete permit form is sent to CDOT, Region 6 Traffic, Access and Utilities Permits. If concurrence is obtained, the State will issue the permit to the applicant.

If the City's decision is that it will not issue the permit, the applicant is notified of the denial and an explanation for the denial is provided. The applicant may appeal the decision of the Public Works Department to the Director of Public Works. If the City approves the application and the Department of Transportation does not concur, the Department will provide an explanation for denial and the applicant may appeal the decision directly to the Transportation Commission of Colorado within 60 days of transmittal of notice of denial. See subsection 2.9 in the State Access Code. Prior to denial the City will meet with the applicant to discuss the reasons for denial and to explore potential alternatives.

When an approved permit is received, it will detail all terms and conditions for the design, construction, and use of the access. These must be read carefully and signed by the property owner. All copies must be returned to CDOT and be accompanied by the appropriate fee.

When ready for construction, the applicant shall request, in writing, a Notice to Proceed from the City. The submittal shall include all required construction drawings, specifications, and any other required documents along with a copy of the access permit. The Notice to Proceed is not a license. It states that the permittee has met the pre-construction and permit submittal requirements and may now begin construction.

The access must be under construction within 12 months of the date of permit issuance or before expiration of any authorized extension (and the inspector noted on the permit must be notified of any change). Otherwise, the City will review the original permit and may request application for a new permit and may require some design modifications to the existing access approach.

For exact details on procedures in obtaining access to State Highways, see Colorado State Highway Access Code, August 31, 1998.

4.1.3 State Highway Access Categories

The State Highway System is divided into eight categories for access control purposes. The number, spacing, type, and location of access and traffic signals have a direct and often significant impact on the capacity, speed and safety of the highway system. The City has only six of the eight categories within the City. The following describes the six categories briefly (for exact access category standards see section 3 of the State Access Code) and a listing of State Highways and categories is listed following this section.

1. **Category F-W:**

   F-W is appropriate for the use on highways that have the capacity for high speed and high traffic volumes over medium and long distances in an efficient and safe manner. Interstate freeways are typical of this category.

2. **Category E-X:**

   E-X is appropriate for use on highways that have the capacity for high speed and relatively high traffic volumes in an efficient and safe manner. Direct access service to abutting land is subordinate to providing service to through traffic movements.

3. **Category NR-A:**

   NR-A is appropriate for the use on non-rural highways that have the capacity for medium and high speeds and provide for medium to high traffic volumes over medium and long distances in an efficient and safe manner. They provide

for interregional, intra-regional, intercity, and intracity travel needs in suburban areas as well as serving as important major arterials in smaller cities and towns. Direct access service to abutting land is subordinate to providing service through traffic movements. This category is normally assigned to National Highway System routes and other routes of regional or state significance.

4. Category NR-B:

NR-B is appropriate for the use on non-rural highways that have the capacity for moderate travel speeds and relatively moderate to high traffic volumes over medium and short distances providing for intercity, and intracity and intercommunity travel needs. These routes are generally not of regional, state or national significance. This category is typically assigned within developed portions of cities and towns where there is established roadside development making the assignment of a higher functional category unrealistic. This category is also appropriate for short sections of regional highway passing through rural communities that may be located along a route of regional, state, and national significance where assignment to higher category is unrealistic. While this category provides service through traffic movements, it allows more direct access to occur.

5. Category NR-C:

NR-C is appropriate for the use on non-rural highways that have the capacity for low to moderate travel speeds and relatively moderate to over medium and short distances providing for intercity, and intracity and intercommunity travel needs. These routes are generally not of regional, state or national significance. This category is typically assigned where there is extensive established roadside development and street systems such as a downtown area, making the assignment of a higher functional category unrealistic. This category provides a reasonable balance between direct access and mobility needs.

6. Category F-R:

Category F-R shall be assigned only to roadways that are designated as frontage or service roads where there is intended purpose of providing for long distance traffic movements. Category F-R may be assigned for high speed rural frontage roads. Access needs will take priority over through traffic movements without compromising the public health, safety, or welfare. Providing access to abutting priority is the primary purpose of this category. At the request of the local authority, the Commission may assign a higher access category when desirable to local transportation plans and needs.

The following table identifies the access category for each State Highway segment in the City.

Table 1: State Highway Access Code Categories in Lakewood

Highway Number	Highway Name	Category	Highway Section Limits
6	6th Avenue	F-W	All
6	6th Avenue Fr Rd	FR	Western City limits to intersection with Kipling Pkwy
8	Morrison Road	NR-A	
8	Morrison Road	NR-B	Kipling Pkwy to Wadsworth Blvd
40	Colfax Avenue	NR-A	Western City limits to Viewpoint St.
40	Colfax Avenue	NR-B	Viewpoint St. to Sheridan
70	Interstate 70	F-W	All
95	Sheridan Blvd.	NR-B	All
121	Wadsworth Blvd.	NR-A	All
285	Hampden Ave.	F-W	All
285	Hampden Fr Rd	FR	All
391	Kipling Street	NR-A	6th Ave to 26th Ave
391	Kipling Parkway/Street	E-X	6th Ave to SH 285

4.2 City Streets

The design, number, and location of access points must be approved by the City when the use of any property or its access operation is changed. A change of use is as defined in section 4.1.1. The number of access points must be kept to a minimum. No access points will be approved without a site plan. The following information is presented as general guidelines for the location of access points to the public street system.

4.2.1 Access Points: Will not be approved for parking or loading areas that require backing maneuvers in a public street right-of-way except for single family or duplex residential uses on local streets.

4.2.2 Provision of Access: If a property has frontage on more than one street, access will be permitted to the lower classification of roadway or only on those street frontages where standards contained herein and other City Regulations can be met. If a property cannot be served by any access point meeting these standards, the City will designate one or more access point(s) based on traffic safety, operational needs and conformance to as many of the requirements of these guidelines as possible.

4.2.3 Restriction of Turning Movements: Where necessary for the safe and efficient movement of traffic, the City may require access points to provide for only limited turning movements. The restriction of turning movements will not affect the number and location of access points as specified elsewhere.

4.2.4 Number of Access Points: One access point per property ownership will be permitted, unless a site plan or traffic study approved by the City shows that additional access points are required to adequately handle driveway volumes and will not be detrimental to traffic flow on adjacent public streets. Temporary access may be granted to undeveloped property prior to development of a final site plan if access is needed for construction or preliminary site access. Temporary accesses are subject to removal, relocation, or redesign after final site plan approval.

4.2.5 Joint Access: Joint access shared by adjacent properties is encouraged and joint access must be considered for two adjacent developments where a proposed new access will not meet the spacing requirement set forth in section 5.1.

4.2.6 Abandoned Accesses: Existing driveways, even if not in use, must not be relocated, altered, or reconstructed without approval from the City.

4.2.7 Speed Change Lanes: For arterial and collector streets, the City may require the provision of speed change lanes if the conditions specified in section 4.3 are met. For design standards, see section 6.7, 6.8.

4.2.8 Access for Special Use Permits

Whenever a property applies for a special use permit which will generate more traffic than the existing residential use, the City will request relocation of the access to a collector or local street frontage where possible. Whenever that is not possible, the City will encourage joint access with adjacent properties in order to minimize arterial access.

Whenever the City determines that access cannot be safely provided or the applicant is not agreeable to implement alternatives proposed by the City aimed at providing safe access, it will be recommended to Planning Commission that the special use permit be denied.

4.3 Criteria for Speed Change Lanes

For both City Streets and State Highways, speed change lanes will be required according to the following unless a variance is obtained from the State and the City waiving these provisions. For design standards, see section 6.8. These provisions may be revised by future amendments to the State Highway Access Code.

4.3.1 Deceleration Lanes for Right Turning Vehicles

A right turn deceleration lane is required when any one or more of the following criteria is met:

a. See Appendix, Figure 7.

b. Where the design hour volume of the right turn into the access is less than five and the outside lane volume exceeds 250 on 45 to 55 mph roadways, 450 on 35 to 40 mph roadways, or 600 on a 25 to 30 mph roadway a right turn lane may be required due to high traffic volumes or other unique site specific safety considerations.

c. When the access volume meets or exceeds 25 design hour volume for roadways with speeds of 25 to 40 mph or 20 design hour volume for roadways with speeds in excess of 40 mph, a right turn deceleration lane will be required.

4.3.2 Acceleration Lanes for Right Turning Vehicles

A right turn acceleration lane is required when any one or more of the following criteria is met:

a. See Appendix, Figure 6.

b. The City or State may require a right turn acceleration lane for any access where a high traffic volume on the roadway and lack of gaps in traffic makes use of an acceleration necessary for vehicles to enter the roadway traffic flow through the use of merging techniques.

c. A right turn acceleration lane will not normally be required when the posted speed is less than 40 mph. The City or the State Highway Department may require an acceleration lane where necessary for public safety and traffic operations based on site specific conditions.

d. Where the design hour volume of the right-turn movement out of the access is less than 15 for roadways with speeds of 45 mph and above or less than 30 for roadways with speeds of 40 mph, no acceleration lane will be required unless specifically necessary due to safety considerations.

4.3.3 Deceleration Lanes for Left Turning Vehicles

A left turn deceleration lane is required when any one or more of the following criteria is met:

a. See Appendix, Figure 5.
b. On State Highways speed change lanes are based on the classification of Highway (See State Access Code).

4.3.4 Acceleration Lanes for Left Turning Vehicles

A left turn acceleration lane is required when any one or more of the following criteria is met:

a. The need for and use of a left turn acceleration lane is site specific. Factors such as highway speed, access volume, nearby access; existing highway auxiliary lanes, traffic control devices, available stopping sight distance, and other topographic and highway design factors are very influential. A left turn acceleration lane may be required if the City or State determines that the lane would be a benefit to roadway safety and operation.

b. Left turn acceleration lanes are not required when: 1) the posted speed is below 40 mph unless required for public safety by the City or the State's District Traffic and Safety Engineer, or 2) the intersection is signalized, or 3) the acceleration lane would interfere with left turn ingress movements to any other access.

4.3.5 General Speed Change Lane Criteria

a. In the Appendix, Figures 5 through 7 are based on less than 7% of the vehicles on the public roadway being trucks exceeding 30,000 pounds gross vehicle weight. If the access will have a larger percentage of vehicles exceeding 30,000 pounds gross vehicle weight, half the values in the Appendix, Figures 5 through 7 will be used to require speed change lanes in the interests of public safety.

b. When higher left turning volumes, safety or traffic operations necessitate, the City or CDOT may require double left turn design.

c. If the design of an access is within two different speed zones, the criteria for the higher speed zone will apply.

d. When traffic safety so requires due to specific site conditions, such as sight distance, a turn lane may be required even though the criteria as described in subsections 4.3 are not met.

e. Where there are three or more through lanes in the direction of travel, the requirement for right turn acceleration and deceleration lanes may be dropped. Each case will be reviewed independently and a decision made based upon site specific conditions. Generally, turn lanes will be required only for a high volume access or where a specific geometric safety problem exists.

f. When calculating the roadway single lane design hour volume, it will be assumed that all lanes have equal volumes.

g. On City arterial streets, accesses will generally require provision of speed change lanes. On collector/commercial local streets, requirement of right turn speed change lanes will be determined on a case-by-case basis. Left turn speed change lanes must be provided on all City streets as required herein.

5. SITE ACCESS DESIGN

5.1 Spacing and Width

Access spacing and width standards are shown in the Appendix, Figure 9. Where accesses are in closer proximity than the distances shown in Figure 1, joint access must be considered. (See 4.2.5) Access spacing on State Highways is subject to the provisions of Section 3 of the State Highway Access Code.

5.2 Alignment

New or relocated accesses shall align with an access on the opposite side of the roadway. Where lots are not large enough to allow accesses on opposite sides of the street to be aligned, the center of driveways not in alignment will normally be offset a minimum of 150 ft. on all collector and commercial/multi-family local streets; 300 ft. on all arterials. Greater distances may be required if left turn storage lanes require such. Minimum sight distance must be provided at all access points as described in Section 6.9, which applies to both public street and private access intersections. Exceptions to this section must be approved by the City Traffic Engineer. Accesses must intersect a public street at 90 degrees or as close to 90 degrees as topography permits (no less than 80 degrees).

5.3 Design

5.3.1 Islands

In the Appendix, Figures 10 through 14 are the recommended minimum design for limited movement accesses. These are based on the turning characteristics of WB40 trucks. Acceleration and deceleration lanes may be required to be incorporated into the designs. The islands must be provided with vertical curb and colored patterned concrete treatment. Additional right of way or easements may be required to accommodate these designs. Typical design details can be referred to in the Roadway Design Manual, Colorado Department of Transportation. The ends of the islands should typically be provided with 2 ft. flowline radii. Where site plans do not permit installation of islands in accesses as shown in the Appendix, Figures 10 through 15, to restrict left turn movements, the City may permit installation of a center median on the adjacent street as an alternative.

5.3.2 Radii and Widths

Generally all new private property accesses will be designed as drive cuts or with curb returns as noted in Table 2, which follows. Drive cuts shall be as illustrated in the Engineering Regulation, Construction Specifications and Design Standards. All radii are quoted in feet as measured along the flowline or edge of pavement where no flow line exists. These standards apply to accesses on State Highways and City streets.

Table 2: Access Design

Road Classification	Land Use		
	Single Family/Duplex	Commercial/Office/ Multi-Family	Industrial
Residential Local	Driveway [1]	Driveway or 15' Radius	Driveway or 30' Radius
Commercial Local/ Multi-Family Local/ Minor Collector	Driveway	15' Radius[3]	30' Radius[3]
Major Collector	N/A [2]	25' Radius[3]	30' Radius[3]
Arterial	N/A [2]	30' Radius[3]	30' Radius[3]

Notes:

1. Rollover curb is acceptable.
2. New single family/duplex accesses shall be to a local public or private street.
3. Curb return radii are required on arterial streets unless site constraints prevent their use.

5.3.3 Maximum Grades

For maximum access grades, see Appendix, Figure 16.

5.4 Vehicle Storage

When a development is located adjacent to a public street, the parking facility must have full internal vehicular, circulation and storage. Vehicular circulation must be located completely within the property and vehicles within one portion of the development must have access to all other portions without using the adjacent street system.

Where a proposed development includes a truck loading operation, and has access to a public street; adequate space must be provided such that all truck maneuvering is performed off street unless waived by the City.

Adequate reservoir capacity must be provided for both inbound and outbound vehicles to facilitate the safe and efficient movement between the street and the development. Inbound vehicle storage areas must be of sufficient size to ensure that vehicles will not obstruct the adjacent street, sidewalk, or circulation within the facility. Outbound vehicle storage areas must be provided to eliminate backup and delay of vehicles within the development.

The following requirements for vehicle storage in parking lots and at drive-up type facilities are based on a typical vehicle length of 20 feet.

5.4.1 For Accesses Serving Off-Street Parking Lots

Recommended distances from the flowline of the street to the first parking stall or aisle for a parking lot design are presented in Lakewood Zoning Ordinance, Article 9 and were developed by the City to provide for a storage area for outbound vehicles exiting a parking lot. Vehicle storage equivalent to the distances shown in Article 9 must be provided at accesses serving the site. The recommended vehicle storage area needed for the entire site may be distributed, proportional to anticipated driver desire, among several accesses if more than one access serves the site. The recommended distance may be further adjusted by the City for accesses with two approach lanes and will be subject to traffic impact study findings, roadway geometry, traffic volumes and site layout.

5.4.2 For Various Commercial Uses

Article 9 in the Zoning Ordinance summarizes the vehicle storage area that must be provided for various commercial uses. These storage areas must be:

a. Based on a vehicle spacing of 12 ft. by 20 ft.
b. Separated from normal parking circulation aisles.
c. Designed using the appropriate design vehicle turning template.

5.5 Mini-storage Warehouse Access Design

Mini-storage warehouse accesses must be designed to permit single unit trucks (SU30) to enter and leave without backing maneuvers. Aisle width between warehouse units must be 25 feet and the turning radius at the ends of the circulation aisles around the ends of warehouse units must be large enough to accommodate fire trucks. Most fire districts require a 25 ft. inside turning radius.

6. GEOMETRIC DESIGN

6.1 Right-of-Way, Street and Lane Widths

The minimum required right-of-way width for a street is based on the required width of paving plus an additional width on each side of the paving to accommodate curbs, sidewalks, and utilities. These are minimum requirements. The City may require additional widths for needed through lanes, turn lanes, speed change lanes, bike lanes and where it is necessary to accommodate slopes and drainage structures. See Appendix, Figures 2 through 4. These standards apply to both City Streets and State Highways.

Table 4 summarizes minimum right-of-way and street widths. All dimensions are in feet.

Table 3: Minimum Right-of-way and Street Widths

Street Classification	Minimum Right-[2] Of-Way Width	Minimum Street[3] Width	See Appendix Figure No.
Arterial street	100	64	2
Minimum collector street with no adjacent driveway access	60	36 [4, 5]	3
Local street for multi-family[2] commercial and industrial areas	60	36 [4,5]	3
Local street[1] for typical single family residential areas	34[4]	27'-4" or 28'	4

[1] For Zone Districts RR, 1R-A,1R, 2R and 3R only. Four off street parking spaces including garages must be provided, or may be used for cul-de-sacs with two off-street parking spaces per dwelling unit including garages. If condition 1 cannot be met, the roadway width must be 32 ft. wide, flowline to flowline.

[2] Temporary construction easements may be needed where there is insufficient right-of-way behind the curb for construction purposes.

[3] Measured between the flow lines of the street.

[4] 12-feet of permanent easement shall be provided on each side for sidewalk, utilities and landscaping, and 14' if bike path is required.

[5] Approaches to signalized intersections must be flared to 44 ft. as shown in the Appendix, Figure 19. In addition, where separate right turn lanes are to be provided, intersections must be designed as shown in the Appendix, Figure 20.

Table 4 summarizes street lane widths to be used in conjunction with the minimum street widths in Table 3. All dimensions are in feet. Measured from center of pavement markings or face of curb.

Table 4: Minimum Street Lane Widths

Lane Type	Collector and Multifamily/ Commercial Locals	Arterials
Curb Parking Lane [1, 2, 3]	8	-
Curb Travel Lane [2, 3]	13	14
Inside Lane[4]	-	12
Left Turn Lane[4]	10	12 [4]
Right Turn Speed Change Lane[3]	13	14
On-Street Bicycle Lane[3]	6	6

[1] Curb parking is not permitted on arterial streets.

[2] If moderate to heavy bicycle traffic is expected in the street, a width of 15 ft. is desirable.

[3] Includes the 2-foot gutter pan.

[4] Add 1-foot when adjacent to raised median sections.

At intersections where double left turn lanes are to be provided, the receiving lanes on the exit portion of the intersection must have a minimum 30 ft. width measured from the outside flowline to the edge of the left turn lane or to the flowline of the center median if one is provided. The length of the transition to match the standard cross section must be determined using the road width transition tapers as specified in section 6.5.

On roadways where no curb and gutter is to be provided, a minimum 4 ft. paved and stabilized shoulder must be provided for disabled vehicle emergency parking.

6.2 Horizontal and Vertical Alignments

6.2.1 Horizontal. Designs must conform to the pattern of thoroughfares designated in the Major Street Plan (see Appendix, Figure 1) and to any future street right-of-way. Proposed streets must be in continuous alignment with existing, planned or platted streets with which they are to connect.

Arterial, collector and local streets (if not ending in a cul-de-sac) must extend to the boundary lines of land being developed. Proposed streets with widths different from existing streets to which they are being connected must be transitioned using City pavement transition taper standards specified in section 6.5. Long straight residential streets over 1300 feet, conducive to high-speed traffic, are strongly discouraged.

Minimum Horizontal Curve Design Criteria are summarized in Table 5. For additional standards on State Highways, see section 4 of the State Access Code.

Table 5: Minimum Horizontal Curve Design Criteria

Design Criteria	Local 27' 4"[1]	Local 28/32[1]	Local 36[1]	Collector 36[1]	Arterial 64[1]
Min. Design Speed (mph)	30	30	30	35	40
Min. Center Line Radius (ft)	150[3]	150[3]	150	300	500
Min. Horiz. Sight Dist. (ft)	200	200	200	250	325
Min. Reverse Curve Tangent (ft)	0	0	0	100	200
Min. Approach Tangent at Intersections[2]	0	0	0	200	300

1 Widths are measured from flowline to flowline of the street. These criteria are to be used without super elevation (see also section 6.3).

2 Where a curved road approaches an intersection, these tangent sections must be provided on the approach to the intersections to provide for adequate sight distance for traffic control devices at the intersection.

3 75' Centerline radius may be used in residential areas where connecting 90° streets.

At the connection of two local streets with 90° alignments where the connecting curve is less than the minimum 150 ft. radius, the outside flowline may be required to be flared as shown in the Appendix, Figure 17. Additional pavement width may be required on horizontal curves on collector and arterial streets to provide for vehicle maneuvers where no super elevation is provided and the minimum horizontal curve design criteria in Table 5 have not been met. The method of calculation for the widening will be as described in the AASHTO "A Policy on Geometric Design of Highways and Street".

6.2.2 Vertical. Grades and vertical sight distance are subject to approval by the City to ensure proper drainage and/or safety for vehicles and pedestrians. Grades of streets must not be less than 0.5%. The maximum vertical grade on all streets is 8% unless waived by the City. For unsignalized intersections, the maximum allowable grade in the intersection is 4%, and extends a minimum of 50 ft. in each direction from the outside edge of traveled way of the intersecting street. At signalized intersections, the maximum grade is 2% within the intersection and for 200 ft. in each direction. Streets must follow the criteria listed in Table 6. For additional standards on State Highways, see the State Highway Access Code. The City Traffic Engineer when matching to existing condition may modify City standards.

Table 6: Minimum Vertical Curve Design Criteria

Design Criteria	Local 24[1]	Local 28/32[1]	Local 36[1]	Collector 36[1]	Arterial 64[1]
Min. Length of Vert. Curves[2](ft.)					
Algebraic difference in grades:					
Less than 0.5%	0	0	0	0	0
0.5% to 1%	50	50	50	50	(3)
1% to 2%	100	100	100	150	(3)
2% to 3%	150	150	150	150	(3)
3% to 4%	150	150	150	220	(3)
4% to 5%	150	150	150	280	(3)
5% or greater	(4)	(4)	(4)	(5)	(3)
Min. Vert. Sight Dist.[6]	150	150	150	200	(3)
Min. Reverse Curve Tangent	0	0	0	100	200

1 Widths are measured from flowline to flowline of the street.

2 All vertical curves must be symmetrical parabolic curves.

3 Reviewed and approved by the City.

4 An additional 30 ft. length of vertical curve must be provided for each additional 1% (or fraction thereof) change in grade above 5%.

5 An additional 50 ft. length of vertical curve must be provided for each additional 1% (or fraction thereof) change in grade above 5%.

6 All minimum stopping sight distances for vertical curves with crests must be shown on the construction plans. Sight distances are based on design speeds listed in Table 14.

6.3 Super elevation on Horizontal Curves

Maximum super elevation rates for major collector and arterial streets of 0.04 to 0.06 ft/ft (4% to 6%) are usually required for use in the City of Lakewood. Super elevation is not usually required for use on minor collector and local street curves. All roadway designs utilizing super elevation are subject to review and approval by the City Engineer. For design details and methodology, it is recommended that the following be consulted: "A Policy on Geometric Design of Highway and Streets," AASHTO, Latest Edition.

6.4 Intersections

6.4.1 Angles

Proposed public streets must intersect one another at 90-degree angles or as close to 90° as topography permits (no less than 80-degrees).

6.4.2 Spacing and Offsets

The standards below will be applied to City streets. Intersection spacing on State Highways is subject to the provisions of the State Highway Access Code, section 4.3.

Arterials: Signalized intersections will normally be spaced at half-mile intervals. Nonsignalized intersections must be spaced at least 600 ft. apart. Nonsignalized four-way intersections may be allowed on arterial streets provided that the design of the intersection precludes left turns onto and through movements across the arterial. If the overlap of left turn storage requirements for two "tee" intersections exceeds 300 ft., the minimum spacing must be increased to provide adequate left turn storage in both directions.

Collectors: Signalized intersections will normally be spaced at half-mile intervals, although the City may approve other locations if adequate signal progression can be maintained. Nonsignalized four legged intersections must be spaced at least 300 ft. apart. When "tee" intersections are used, the center lines of streets not in alignment must normally be offset a minimum of 150 ft. and be 150 ft. from the nearest four legged intersection. If the left turn storage requirements for adjacent intersections overlap, the minimum spacing must be increased to provide adequate left turn storage in both directions.

Commercial/Multifamily Local Streets: Four legged intersections will normally be spaced at least 200 ft. apart. Where "tee" intersections are used, the center lines of streets not in alignment must normally be offset a minimum of 150 ft. and be 150 ft. from the nearest four legged intersection. If the left turn storage requirements for adjacent "tee" intersections overlap, the minimum spacing must be increased to provide for adequate left turn storage in both directions.

Single Family Residential Local Streets: Four legged intersections will normally be spaced at least 200 ft. apart. Where "tee" intersections are used, the center lines of streets not in alignment must normally be offset a minimum of 100 ft.

6.4.3 Corner Radii

At public street intersections, the property line corners and minimum flowline radii will be as shown in Table 7. These standards apply to both City streets and State Highways.

The vehicle used for designing intersections must be based on the following:

Commercial/Multi-family Locals and Minor	SU30
Collectors	SU30
Major Collectors	WB40
Arterials	WB50

Table 7: Minimum Intersection Flow line Radii[1]

Type of Intersection	Flow line Radius(ft.)	Property Line Radius (ft.)
Local – Local	15	15 radius
Local – Collector	25	15 radius
Collector - Collector	30	10 radius
Local - Arterial	30	independently designed
Collector - Arterial[2]	30	independently designed
Arterial - Arterial[2]	30	independently designed

[1] Additional right-of-way or easement may be required for intersections where islands are being used to channel traffic and control turning movements.

[2] At signalized intersections where right turn channelization islands are provided (see Appendix, Figures 10 through 13) or high truck and bus volumes may use the access, a larger flowline radius may be required.

6.5 Road Width Transition Tapers

When constructing a roadway that will directly connect with an existing roadway of a different width, it is necessary to install a transition taper between the two. The length of taper depends upon the offset difference between the outside traveled edge of the two sections and the ratios shown in Table 8. These ratios are not to be used in the design of speed change or left turn storage lanes that are covered in sections 6.6 and 6.8 and section 4 of the State Highway Access Code.

Table 8: Minimum Road Width Transition Tapers

Design Speed	Transition Run/Offset (ft/ft)
25	15 / 1
30	15 / 1
35	20 / 1
40	25 / 1
45	30 / 1
50	35 / 1
55	40 / 1
60	45 / 1

6.6 Approach and Bay Tapers for City Streets

The minimum requirements are summarized in Table 9, and striping layouts are illustrated in the Appendix, Figures 18, 19, and 20. The standard collector street cross section is 36 ft. widening to 44 ft. at: a) Signalized intersections, b) Intersections with potential for signalization, or c) Intersections with potential for substantial turning movement volumes. For raised median design standards, see section 6.12. The design for left turn lanes summarized in Table 8 and in the Appendix, Figures 18 and 19, apply to City streets only.

Standards for State Highway right turn and left turn speed change lanes are contained in Tables 10 through 13 in section 6.8.
Although these distances are for straight tapers, reverse curve type tapers may be used. See Colorado Department of Transportation Roadway Design Manual for design details.

Table 9: Minimum Approach and Bay Tapers for City Streets

Design Speed (MPH)	Approach or Departure (ft.)	Bay Taper[1] (ft.)
25	125	100
30	180	120
35	245	140
40	320	160
45	405	180
50	500	200
55	605	220
60	720	240

[1] At existing closely spaced intersections, bay tapers may be shortened to provide adequate storage lengths.

6.7 Left Turn Lane Storage Lengths for City Streets

Left turn lane storage design at both signalized and unsignalized intersections for proposed street design plans can be determined from nomographs (Appendix, Figures 21 and 22). New streets will use the desirable lengths. Minimum design lengths will only be permitted under constraints imposed by geometrics of existing streets. Lengths of dual left turn lanes must be based on a minimum of 60% of the single lane length required.

For State Highways, see section 4 of the State Highway Access Code.

6.7.1 Signalized Intersections

See Appendix, Figure 21.

6.7.2 Unsignalized Intersections

See Appendix, Figure 22. Opposing volumes include only through volumes opposing the left turn movement on the same street for which the left turn channel is being designed.

6.8 Speed Change Lane Design

6.8.1. For Right and Left Turns to Accesses on State Highways & City Streets

When an application for an access permit is approved an important part of the consideration for such approval is highway safety.

Key design elements are:

1. The width and radius of the access must be adequate for the volume and types of vehicles using the access and allow vehicles to turn into the access without going up on the curbs or swinging wide into the highway. This includes emergency vehicles.

2. A hard paved surface on the access must be provided to keep mud off the highway and prevent erosion damage to the highway.

3. A highway volume access must be provided with a turning or speed change lane to allow the driver to maneuver out of the main travel lanes before slowing down. This reduces serious rear-end accidents.

4. Speed change lanes must be provided in the center or median of the road for a high volume access. The left turn is one of the most potentially hazardous turns when not properly provided for. If such lanes cannot be provided, left turns will be restricted.

5. Proper sight distance must be provided to ensure that drivers can see a vehicle entering the highway and still have time to stop. It ensures that the entering driver can look far enough down the road to see oncoming vehicles.
6. Good drainage design must be provided to keep mud, water, and ice off the highway and prevent erosion damage.

7. Sufficient distance must be provided between access points, to allow merging and weaving distances for entering and exiting vehicles and to provide the through vehicle adequate sight distance and time to watch and respond to entering and exiting vehicles.

8. During access construction proper warning signs must be provided for the safety of drivers and pedestrians. These signs must meet State Highway Standards and the standards in the Manual on Uniform Traffic Control Devices.

9. Where acceleration/deceleration lanes must be extended offsite, and there is insufficient right-of-way for off-site construction, the developer will be responsible for the cost of obtaining the necessary right-of-way. If necessary the City will use powers of condemnation to obtain such right-of-way at the developer's cost.

10. When speed change lanes are required, they must be constructed in accordance with the following: For a guide to speed change lane elements, see Appendix, Figure 23.

a. Where two accesses have speed change lanes that overlap, or are in close proximity but do not overlap a continuous lane must be established between the accesses to improve roadway consistency and safety and maintain edge continuity.

b. Speed change lanes must normally be 12 ft. wide exclusive of the gutter pan or shoulder. If existing through travel lanes are less than 12 ft. wide, or if the City standards require it, a lesser width may be used provided a minimum 10 ft. of widening is attained (see Table 4). Speed change lanes on State Highways must be a minimum of 11 ft. where the posted speed limit is above 40 mph and where a high percentage of large trucks use the lane.

c. Table 10 must be used in determining speed change lane lengths.

Table 10: Speed Change Lane Lengths for Right and Left Turn Lanes on State Highways & City Streets

Posted Speed Limit in MPH	25	30	35	40	45	50	55	60	65	70
Deceleration Length in feet [1]	180	250	310	370	435	500	600	700	800	900
Acceleration Length in feet	N/A	190	270	380	550	760	960	1170	1380	1590
Transition Taper Ratio [2]	7.5:1	8:1	10:1	12:1	13.5:1	15:1	18.5:1	25:1	25:1	25:1

[1] These distances apply to both left and right turn deceleration lanes. For details on how the standards in Table 10 are affected by legal/physical constraints, median design, drainage, maintenance and other design elements for speed change lane construction, see section 4.8.2d of the State Highway Access Code.

[2] Ratio between width of lane and length of taper. For left turn lane median island designs, see section 4 of the State Access Code.

[3] For every 15 design hour volume trucks larger than a single unit truck, the length of the average truck plus 10 feet must be added to the storage length required by Table 10.

d. Taper length is included within the stated accel. and decel. length. For left turn deceleration lanes on R-A, R-B and NR-A classification highways storage shall be added to the decel. length. See Table 3-4 of the State Access Code for the complete list of components of a speed change lane.

e. For sight distance requirements, section 6.9 must be complied with for both City streets and State Highways unless the standards contained in section 6.9 are exceeded by the requirements of section 4 of the State Highway Access Code.

f. Additional storage lengths are required for left turn deceleration lanes where vehicle turning movements are in excess of 25 design hour vehicles to accommodate storage of left turning vehicles without shortening the deceleration length. The additional storage lengths are provided in Table 11.

Table 11: Additional Storage Length Requirements for Speed Change Lanes on State Highways

Design Hour Volume (vph)	Additional Storage Length (ft.)
below 30	25
30	40
60	50
100	100
200	200
300	300

g. The speed change lane lengths specified in Table 10 also require adjustments in length to account for grades. Speed change lane lengths must be modified using the multiplication factors in Tables 12 and 13 for all highways with grades in excess of 3%. The lengths in Table 10 excluding the additional storage lengths in Table 11 must be multiplied by the factors in Tables 12 and 13 to adjust for grades where necessary.

Table 12: Factors for the Effect of Grade on Deceleration Lane Lengths on State Highways

Grade	Upgrade Factor	Downgrade Factor
3 – 4.9%	0.90	1.20
5 – 8%	0.80	1.35

Table 13: Factors for the Effect of Grade on Acceleration Lane Lengths on State Highways

Design or Posted Speed (mph)	3-4.9% Upgrade	3-4.9% Downgrade	5-8% Upgrade	5-8% Downgrade
25-45	1.30	0.70	1.50	0.60
50	1.40	0.65	1.80	0.55
55	1.50	0.65	2.00	0.55
60	1.50	0.60	2.30	0.5

6.8.2 Right of Way Requirements to Accesses on City Streets

On City arterial and collector streets, the design of acceleration/deceleration lanes will meet the requirements of section 6.8.1 and the State Highway Access Code, section 4.8, provided sufficient right-of-way is available. If off-site right-of-way is insufficient to construct speed change lanes to these standards, the developer will be responsible for the cost of obtaining the necessary right-of-way. If necessary, the City will use power of condemnation to obtain such right-of-way at the developer's cost. Where driveways have to be located in close proximity to one another in order to provide access to adjacent properties, the City will permit speed change lanes to be combined if the minimum design standards in section 6.8.1, and the State Access Code, section 4, cannot be achieved.

6.9 Sight Distance

Before any access is approved, the City will ensure that vehicles can enter or exit from the proposed access with minimum hazard and disruption of traffic.

6.9.1 Sight Distance Triangles at Public Street Intersections and Private Accesses:

See Appendix, Figure 24 and 25.

6.9.2 At Private Accesses to Public Streets

These sight distance criteria do not apply to single family back out drives where sight distance will be provided based on location of the driver's eye when commencing the back out maneuver.

6.9.3 Minimum Sight Distance

The purpose of the sight distances shown in Table 14 are as follows:

1. When turning left or right, accelerate to the operating speed of the street without causing approaching vehicles to reduce speed by more than 10 miles per hour.

2. When turning left, clear the near half of the street without conflicting with vehicles approaching from the left.

The distance requirements are based on a 3.5 ft. driver eye height and 4.25 ft. object height for passenger cars; a 6.0 ft. driver eye height and 4.25 ft. object height for semi-trailers. See Appendix, Figure 25.

The operating speed on each approach is assumed to be, in order of desirability, a) the 85th percentile speed, b) the posted speed limit, or c) in the case of a new facility, the design speed.

When the criteria for sight distances cannot be met, the City will prohibit turns by exiting vehicles when appropriate or require additional speed change lane length. These standards apply to accesses on State Highways and City streets. They exceed the provisions of section 4 of the State Access Code.

Table 14: Sight Distance (ft.)

Speed (MPH)	Stopping Sight Distance	Safe Turning Sight Distance From Minor Street[1]	Safe Left Turning Sight Distance from Major Street[2]
20	115	170	165
25	155	225	205
30	200	280	245
35	250	335	275
40	305	390	325
45	360	445	365
50	425	500	405
55	495	555	445

1 Measured from the driver's eye twelve feet back of the flowline or edge of pavement. See Figure 25

2 Measured from the point where a left-turning vehicle stops to a vehicle approaching in the outside lane.

In cases where six lane roads exist or high truck traffic is expected the sight distance shall be independently designed according to the latest AASHTO Standards and approved by the Traffic Engineer.

The sight distances in Table 14 apply when highway grades are zero to 3.0% (either up or down). When grades are steeper than 3.0%, adjustments must be made to compensate for the different distances required to reach the speed of highway traffic. Adjustment factors are provided in Table 15.

Table 15: Factors for the Effect of Grade on Sight Distance

Grade	Downgrade[1] Factor	Upgrade[2] Factor
0 – 3%	1.0	1.0
3.1 – 5%	0.6	1.4
5.1 – 8%	0.5	1.7

[1] When the highway in the section to be used for acceleration after leaving the access descends, sight distance in the direction of approaching descending highway traffic should be reduced by these factors.

[2] When the highway in the section to be used for acceleration after leaving the access ascends, then sight distance in the direction of approaching ascending traffic should be increased by these factors.

6.9.4 Stopping Sight Distance

Sight distance is the length of roadway ahead visible to the driver. The minimum stopping sight distance available on a roadway must be sufficiently long to enable a vehicle traveling at or near the roadway design speed to stop before reaching a stationary object in its path or react to a traffic control device such as a stop sign.

Table 14 summarizes the stopping sight distance for vehicles traveling on wet pavement at zero percent grade. All roadway designs in the City must provide the minimum appropriate stopping sight distance shown in Table 14 for level terrain conditions, depending on the design speed of the roadway. These standards apply to both City Streets and State Highways.

Table 14 assumes a driver reaction time of 2.5 seconds; a driver's eye height of 3.5 ft.; an object height of 0.5 ft.

To allow for the effect of grade on stopping sight distance, the factors in Table 16 must be used.

Table 16: Effect of Grade on Stopping Sight Distance

Design Speed	Increase for Down Grades Correction in Stopping Distance (ft.)			Decrease for Upgrades Correction in Stopping Distance (ft.)		
	3%	6%	8%	3%	6%	8%
20-30	10	20	30	10	10	20
31-40	20	40	70	10	20	30
41-50	30	70	110	20	30	40
51-60	50	110	170	30	50	70
61-65	60	130	200	30	60	90

6.10 Bike Path and Sidewalk Clearances, Widths, Grades and Routes

When development occurs on a street where a bike route has been designated by either the Lakewood Bicycle Master Plan or the City's "Functional Plan," the developer will be required to provide a bike path or bike lane along the property frontage.

Sidewalks must be a minimum of 5 ft. in width. Bike paths shall be designed in accordance with AASHTO's Guide for the Development of Bicycle Facilities (latest edition). Maximum detachment of a bike path or sidewalk from the street curb should not exceed 15 ft. This is to avoid pedestrians and bicyclists leaving the alignment of the designated path as a short cut.

If head-in parking is permitted adjacent to the bike path, 2 ft. of additional width will be required on the side of the path adjacent to parking. Fixed objects higher than 6 inches shall not be closer than 2 ft. to the edge of the bike path/sidewalk. All bike paths and walks shall have an adjacent minimum of 2 ft. bench no steeper than 6:1. Objects such as signal or utility poles, signs, bus benches, fire hydrants, etc., must not be located in the sidewalk or bike path. The sidewalk or bike path must normally be detached. Where it is attached, the sidewalk must be a minimum of 8 ft. in width measured from the back of curb. Special lighting treatment may be required for bike paths provided in the middle of developments that are not adjacent to public streets.

On street bike lanes shall be 4 ft. in width, excluding the gutter. Bike lanes shall be marked with an 8 in. white stripe and bike lane symbol marker and signs in accordance with the Manual on Uniform Traffic Control Devices. Where sidewalk and bike paths are located near major RTD bus stops or transfer points, the City may require wider facilities to provide for adequate passenger storage areas. The City may also require bicycle racks at these locations.

Any time a sidewalk or bike path on a street or in a structure having public access is adjacent to a retaining wall having a vertical drop in excess of 30 inches, a pedestrian or bicyclist guardrail with a height of 54 inches must be provided to protect pedestrians and bicyclists.

Sidewalks and bike paths may be required to extend offsite in order to terminate them properly so that pedestrians and bicyclists using such facilities can safely reach adjacent developments.

6.11 Guard Rails

Roadway hazards that may require shielding by a roadside barrier can be placed into five main categories: embankment hazards; fixed objects; non-traversable hazards; end treatments; and ditch sections. Curb and gutter will not be regarded as an adequate barrier for redirecting vehicles. Although the following guardrail criteria have been provided for City streets and State Highways, the City recognizes that the provision of guardrails to redirect errant vehicles may only be necessary on high-speed facilities ($\geq$ 45 mph). On low speed streets (< 45 mph), the need for guardrails will be decided by the City on these criteria as well as engineering judgment, local conditions, and type of roadside hazard. New and modified roadsides shall be designed such that guardrail is not required.

6.11.1 Embankment Criteria:

Height and slope of embankments are the basic factors in determining barrier need for a fill section (for downward slopes). Criteria for fill sections are shown in the Appendix, Figure 26. These criteria are based on studies of the relative severity of encroachments on embankments versus impacts with roadside barriers. Embankments with slope and height combinations below the curve do not warrant protection. Obstacles on the slope may require protection and the criteria in section 6.11.2 and 6.11.3 should be used in such cases. Embankments with slope and height combinations above the curve warrant protection.

6.11.2 Fixed Object Criteria:

A clear unobstructed flat roadside is highly desirable. When these conditions cannot be met, criteria to establish barriers needed for shielding roadside objects are necessary. The removal of fixed objects should be considered as the first alternative. If it is not feasible or possible to remove or relocate a hazard, then a barrier may be necessary. A barrier should be installed only if it is clear that the barrier offers the least hazard potential.

Barrier criteria for fixed objects are a function of the nature of the obstacle and its distance from the edge of the traveled way. In the Appendix, Figure 27 shows the criteria for determining the clear zone on fill and cut sections for three different vehicle-operating speeds. The clear zone is defined as the roadside border area, starting at the edge of the traveled way, available for safe use by an errant vehicle. Fixed objects should be removed, relocated, or shielded by a barrier if they are within the indicated minimum clear zone width. The criteria of Figure 27 are based on two assumptions: a shoulder width of approximately 12 ft. for unrounded sections; that the object is located on the embankment or side slope.

The detailed procedures for using Figure 27 are provided on page 15 of the AASHTO "Guide for Selecting, Locating, and Designing Traffic Barriers." Fixed objects within the clear zone (as defined by using Figure 27) that require protection or removal are:

1. Sign, traffic signal, and luminaire supports with either a breakaway or yielding design greater than 1,100 lb.-sec. (linear impulse) or a concrete base extending 6 in. or more above the ground.

2. Fixed sign bridge supports.

3. Bridge pier and abutments at underpasses.

4. Retaining walls and culverts.

5. Trees with diameters greater than 6 in.

6. Wood poles with a cross-sectional area greater than 50 sq. in.

7. Fire hydrants.

8. Benches that are fixed to the sidewalk.

6.11.3 Nontraversable Hazard Criteria:

Any nontraversable hazard within the clear zone (as defined by in the Appendix, Figure 27) that requires shielding by a barrier should be removed. If this is not practical, a barrier should be provided. Typical nontraversable hazards are:

1. Rough rock cuts.
2. Large boulders.
3. Streams or permanent bodies of water more than 2 ft. in depth.
4. Shoulder drop-offs with slopes steeper than 1:1 and a height greater than 2 ft.

6.11.4 Bridge Rail Ends, Transitions, and End Treatment Criteria:

Most bridge rail approach barrier systems are some type of roadside barrier. For details on warrants for the protection of such roadside hazards, see page 21 of the AASHTO guidebook.

6.11.5 Ditch Section Criteria:

Although specific criteria for barrier protection at ditches do not exist, they can be potential hazards if located near the traveled way and not traversable by an errant vehicle. Preferable front and back slopes for various ditch configurations are provided in the AASHTO guidebook.

6.11.6 Construction Details:

The Colorado Department of Transportation Standard Plans should be consulted for the following guardrail construction details:

1. Lateral clearances from edges of traveled way (typically between 5 & 13 ft.).
2. Height of top of rail above the curb or pavement (typically 25-30 in.).
3. Post spacing (typically 12 ft. 6 in. with 6 ft. 3 in. spacing for the curved, end sections).
4. End treatments (Type 3E).

6.12 Medians

Raised medians may be required on arterial roadways and may be allowed on local roadways. All designs are subject to review and approval by the City and subject to the standards provided in the Roadway Design Manual of the Colorado Department of Transportation and section 4 of the State Access Code.

Widths of raised medians must be a minimum of 4 ft. If left turn lanes are installed in the median, the median must be no less than 16 ft. wide. See Table 17 for recommended median widths. Cuts in existing medians must be approved by the City. In new roadway designs, the minimum spacing of median openings will be 600 ft. Increased storage lengths and tapers may be required as determined by the City based on available turning movement volume data. Median openings that allow left turns in both directions must not be less than 50 ft. nose to nose. For openings that allow left turns in one direction only, see Appendix, Figure 14. All median turn lanes and openings must be designed for at least B-40 trucks. Tapers for left turn lanes in curbed medians should follow the design criteria in Section 6.5 and 6.6.

Fixed objects will not normally be permitted in medians. Plantings must be located so as not to violate the sight distance standards provided in Table 14 of section 6.9.

Table 17: Recommended Median Widths

Function	Minimum Width (ft)	Desired Width (ft)
Separation of Opposing Traffic	4[1]	10
Pedestrian Refuge and Space for Traffic Control Devices	6[1]	14
Left-turn Speed-change and Storage	17	20
Crossing/Entering Vehicle Storage[2]	20	20
U-turns	20	56

[1] Cannot accommodate left-turn lanes, which will be prohibited.

[2] This enables vehicles crossing a street with a median or turning left onto such a street to use the median area for storage so as to negotiate each half of the street separately.

6.13 Vertical Clearance of Structures

A minimum vertical clearance of 16.5 ft. must be provided for all overhead structures measured from the crown of the street (allowing for future overlays) to the lowest portion of the structure on both City Streets and State Highways.

6.14 Cul-de-Sac Lengths & Design

The total street length of a cul-de-sac or a loop cul-de-sac, as shown in the City of Lakewood Engineering Regulations, Construction Specifications and Design Standards, must not be greater than 500 ft. except if one of the following conditions is met.

1. The total cul-de-sac length may be increased to a maximum of 1,000 ft. for RR, R1A, 1R, 2R, and 3R Zone Districts, provided the water supply system for fire protection is approved by the fire protection district.

2. The total length of a cul-de-sac for Zone Districts 4R and 5R may be increased to a maximum of 750 ft. provided the water supply system for fire protection is approved by the fire protection district.

3. It should be noted that for cul-de-sacs serving developments with buildings exceeding 26 ft. in height, the Fire Protection District may require a 45 ft. radius cul-de-sac bulb to permit ladder fire trucks to turn around. The Fire Protection District will determine the exact size required.

4. Standard cul-de-sac design shall be constructed with a 37' min. flowline radius – See Engineering Regulations, Construction Specifications and Design Standards.

   In the Appendix, Figure 28 shows cul-de-sac designs.

6.15 Engineering Regulations, Construction Specifications and Design Standards and Storm Drainage Criteria Manual

For design standards on City facilities, the current edition of the City's Engineering Regulations, Construction Specifications and Design Standards and the Storm Drainage Criteria Manual must be used:

Driveway Construction Designs
Sidewalks and Curbwalks
Pedestrian Ramps
Pavement Design
Ramp Design for the Physically Handicapped
Survey Monuments
Construction Plans
Cul-de-sac Design
Design Details for Curb, Gutter, Manholes, etc.
Drainage

7. TRAFFIC SIGNALS, CONSTRUCTION ZONES, EMERGENCY ACCESS LANES, TRANSIT FACILITIES, NOISE, STRIPING, AND SIGNING

7.1 Traffic Control Device Costs and Associated Easements

When it can be shown that a particular development impacts a street or streets to a point that a traffic signal or other traffic control device is deemed necessary for the safe and efficient movement of vehicles and/or pedestrians, the developer shall be required to install certain traffic control devices or with approval of the City Traffic Engineer, the City may allow or require restricting unsafe movements rather than a traffic signal.

At proposed signalized intersections, the first 50 ft. of a private driveway approach must be dedicated as a permanent easement to the City as measured from the flowline of the cross street to provide for traffic control devices.

Modification or relocation costs of existing traffic control device equipment such as signals on State Highways and City streets will be the responsibility of the developer. Refer to Section 7.8 for specific details on payment for new signals and signal relocation costs via the public improvements agreement.

7.2 Traffic Control in Construction Zones

On State Highways, the Colorado Department of Transportation must approve work area traffic control signing and detour plans. These plans must conform to the Manual on Uniform Traffic Control Devices (MUTCD). On City streets all work must conform to the MUTCD. All work area traffic control plans must be submitted to and approved by the City's Traffic Engineering Division.

7.3 Striping & Signing Plans

In order to facilitate striping and signing of new streets or restriping of existing streets necessitated by development, striping and signing plans must be submitted as part of the construction plans for the public improvements for approval by the City. If the plans require the addition, relocation and removal of pavement markings or signs the cost of these items will be borne by the developer. The striping and signing plans must be based on the lane widths shown in Table 4 of section 6.1, street design standards contained in the Appendix, Figures 2 through 4, 18, 19, 20 sign details contained in Figures 30, 31, 32, 34 and Section 6.6. The plans must be at 1":20' scale and conform to the Manual on Uniform Traffic Control Devices (MUTCD).

All material types must be shown on the plans. New pavement shall have inlaid tape. Existing pavement shall have thermoplastic unless it is known that the road shall be resurfaced within two years. In this case water solvent paint may be used.

7.4 Street Name Signs

Developers are required to provide standard street name signs on public streets in their developments. These must conform to the standards, in the Manual on Uniform Traffic Control Devices. This requirement is specifically addressed in all public improvement agreements. See Appendix, Figures 30 and 31.

7.5 Emergency Access Lanes

The developer is responsible for the installation and the property owner is responsible for maintenance of the signs and markings necessary to designate emergency access lanes. Emergency access lanes must be able to accommodate all emergency vehicles, including fire equipment and must be delineated in a clear and uniform manner. The following is required.

1. Easements for emergency access lanes should allow the shortest practical direct access to points of concern.

2. The emergency access lane will be paved or an alternate surface treatment meeting the requirement of the fire district will be used. The emergency access lane must have a minimum continuous width of 24 ft. unless it is a one-way aisle or for emergency vehicle use only in which case a 18 ft. width will suffice. All corners must have a minimum inside radius of 25 ft. and when a turnaround is employed, the minimum radius must be 37 ft. (See the Appendix, Figure 28 for other designs). Maximum grades must not exceed 8%. Where structures are erected over the lane, vertical clearance must not be less than 13.5 ft.

3. The lanes must be kept free and clear of all obstructions to allow free flow of emergency vehicles.

4. The lanes may be used for the maneuvering of vehicles, but cannot be used for parking or storage of vehicles.

5. In the Appendix, Figure 29 shows the standard sign to be used to designate the emergency access lanes. Directional arrows must be used on the signs to indicate limits of the emergency access lanes. Sign placement shall be on a case by case basis with City approval.

   In addition to standard signs, pavement markings may be necessary to delineate the limits of the emergency access lanes. Whether or not pavement markings are necessary will be decided by the City on an individual basis. When pavement markings are used, they should be installed as shown in the Appendix, Figure 33.

   Traffic Engineering staff must be consulted prior to installation of signs and markings in order to ensure that the designation of the emergency access lane(s) is adequate.

All signs and markings must be inspected and approved by the Traffic Engineering Division. All signs must display a City of Lakewood emblem if the City approves City enforcement.

7.6 Transit Facilities

Collector and arterial roadways may sometimes serve as commuter bus routes with frequent stops that require an increased pavement design. A typical design for this situation is shown in the City's Engineering Regulations, Construction Specifications and Design Standards for bus pads. At existing or planned bus stop locations, additional sidewalk or bike path widths, will be required for bus bench placement. The Regional Transportation District is responsible for the location of all bus stops.

7.7 Noise Attenuation

If an arterial roadway is adjacent to a developed or planned residential area, fencing or noise attenuation measures may be required. Typical designs for noise fences are available in the City Zoning Ordinance. It is recommended that the need for noise attenuation measures be determined using the methods outlined in CDOT's Noise Analysis and Abatement Guidelines, December 2002.

7.8 Installation/Relocation of Traffic Signals via Public Improvement Agreements

New traffic signal installations and relocations of existing signal equipment may be required in public improvement agreements. New signals will be installed only when warranted as specified in the Manual on Uniform Traffic Control Devices and/or any related City of Lakewood or Colorado Department of Transportation standards or criteria in effect at the time. The projected need for a traffic signal will be based on traffic studies submitted by the Developer's Traffic Consultant and approved by the City. The volume studies to determine when a traffic signal needs to be installed will be conducted by the City of Lakewood and/or Colorado Department of Transportation.

City collateral in a form specified in Chapter 14.13 of the Lakewood Municipal Code will be required for total cost of installation for a traffic signal prior to the issuance of building permit for any structure to be built within a development that requires installation of a signal. The actual amount of the collateral, will be determined at the time of application of the first building permit and must be posted before the first building permit can be issued, but no later than one day prior to the issuance of the first building permit. Collateral shall be held by the City until such time as warrants are met for construction.

When a new traffic signal becomes warranted, the City will notify the entity that provided collateral in writing, of such a determination. Cash payment must be made within sixty days of receipt of the letter in an amount equal to the City Traffic Engineer's estimate of all costs to install the signal. Upon receiving the cash payment, the City will return the collateral to the entity that provided the collateral, and install the traffic signal(s) within nine months. If the cash payment is not made to the City, the City will use the collateral in order to make cash payment to the City for the installation of a traffic signal. At the time the City receives

payment for the traffic signal(s), signal design plans must be provided to the City within four months of that date. These plans must be at 1 in.:20 ft. scale and meet the Traffic Signal Standards of the City of Lakewood, which can be obtained from the City of Lakewood Traffic Engineering Division or at www.lakewood.org.

In the event that the City of Lakewood and/or the Colorado Department of Transportation determine that a traffic signal is not warranted within five years after receipt of the collateral and will not meet warrants due to land development changes, the collateral will be returned to the Developer.

The developer must pay for the cost of relocation of and any modifications made to existing traffic signals located adjacent to the development made necessary due to the development. Such existing traffic signal improvements may be required to assure:

(1) that signal faces remain in the proper places and
(2) continuation of safe operations.

The developer must provide collateral to the City for improvements to existing traffic signals in accordance with Chapter 14.13 of the Lakewood Municipal Code. Whenever the City receives payment for such signal modifications, signal design plans for the modifications must be submitted to the City or within one month after that date. These plans must be at 1 in.:20 ft. scale and meet the Traffic Signal Standards of the City of Lakewood, which can be obtained from the City of Lakewood Traffic Engineering Division. Signal modifications must be coordinated with public improvements being constructed by the developer.

8. STREET LIGHTING AND UTILITIES

The provisions of this section apply to both City Streets and State Highways.

8.1 Installation of Street Lighting

Arterials:

Lighting units (27,500 lumen-250w) along arterials must be spaced at a minimum of 150 ft. on alternate sides of the street. All intersections must be provided with at least 2 street lights on opposite corners.

Collectors:

Collector lighting units: (27,500' lumen-250w) must be spaced 200 ft. to 250 ft. on alternate sides of the roadway. All intersections must be provided with at least 1 street light.

Locals:

The developer for new developments zoned Residential or like zoned Planned Developments shall install curb or driveway lighting on a photocell for each property instead of streetlights.

Street lighting units along existing local streets will be installed only upon petition of a majority of the adjacent property owners and when the City determines there is a traffic hazard. The City will not install private property lighting.

Installation Procedures:

Proposed street lighting along all public rights-of-way must be coordinated through the City. Streetlight installation orders are issued by the City to Xcel Energy Company to initiate the process and must be requested in writing by the developer through the City as soon as street construction plans are complete. The flow chart in the Appendix, Figure 35 applies to both street lighting installations and the relocation of public utilities. All costs for new street lighting on public streets must be paid for by the developer.

8.2 Breakaway Structures and Lateral Clearances

It is the intent of the City to encourage all fixed objects such as utility, street light poles, fire hydrants, telephone junction boxes, etc. installed in the right-of-way to be of the breakaway type meeting AASHTO construction specifications. Where breakaway type construction cannot be provided, it is the policy of the City to encourage the provision of a minimum of 10 ft. horizontal clearance between the flowline of the street (or the edge of the paved traveled way) and any new or relocated non-breakaway structure in excess of 4 inches in height. If sufficient right-of-way is not available for the 10 foot clear zone, all installations

are encouraged to be placed "as near as practical" to the edge of the public right-of-way. This policy is applicable to all arterial and major collector roadways whose posted speed limit is in excess of 30 miles per hour, and is intended to provide minimum suggested guidelines for the purpose of protecting the public health, safety, and welfare. It is recommended that satisfactory dynamic performance for breakaway objects be evaluated in accordance with current AASHTO specifications. For local streets, the provision of a 5 ft. lateral clearance is recommended.

8.3 Relocation of Xcel Energy Company Utilities

For construction of public improvements in association with new developments, the flow chart provided in the Appendix, Figure 35 illustrates the process that must be followed in order to have utilities relocated ahead of construction. One hundred and sixty days must be allowed for Xcel Energy Company to complete relocation of existing utilities from the date of the relocation request. Relocation orders are issued by the City to Xcel Energy Company to initiate the relocation process and must be requested by the developer through the City as soon as street construction plans have been completed. If the relocated utilities are in an existing easement that was acquired by Xcel Energy Company, there may be a charge levied by the Xcel Energy Company for the relocation of these utilities.

8.4 Utility Easements

Adequate right-of-way or easements must be dedicated to allow for Xcel Energy Company to install streetlights.

Placement of the street lights between the curb and detached sidewalk or bikeway is allowed provided that the requirement for 2 ft. horizontal clearance from the bikeway is met, and the breakaway structure policy for fixed structures along roadways with posted speeds greater than 40 mph. is satisfied.

Where either the bike path or sidewalk is attached to the street curb, streetlights must be placed behind the walk or path in an additional minimum 5 ft. right-of-way or utility easement. Utility easements for street lights are not exclusive, and can be landscaped or used for parking. If there is an exclusive gas easement behind an attached walk or path, the streetlights must be located beyond that easement in an additional five-foot right-of-way or easement or the gas easement relocated.

Easement for water lines must meet the requirements of the appropriate water district and/or Denver Water. Right-of-way must be dedicated for all turning movement channelization islands constructed over water and sewer lines.

8.5 Undergrounding of New and Existing Utilities

It is the policy of the City to require the use and facilitate the installation of underground utilities for initial installation of utilities and for the replacement and relocation of existing utilities. This policy is contained in City Council Resolution 84-256 and may be revised from time to time. It is the policy of the City to promote a reduction in the number of utility poles during the replacement, relocation, upgrade, or maintenance of existing overhead utilities.

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APPENDIX

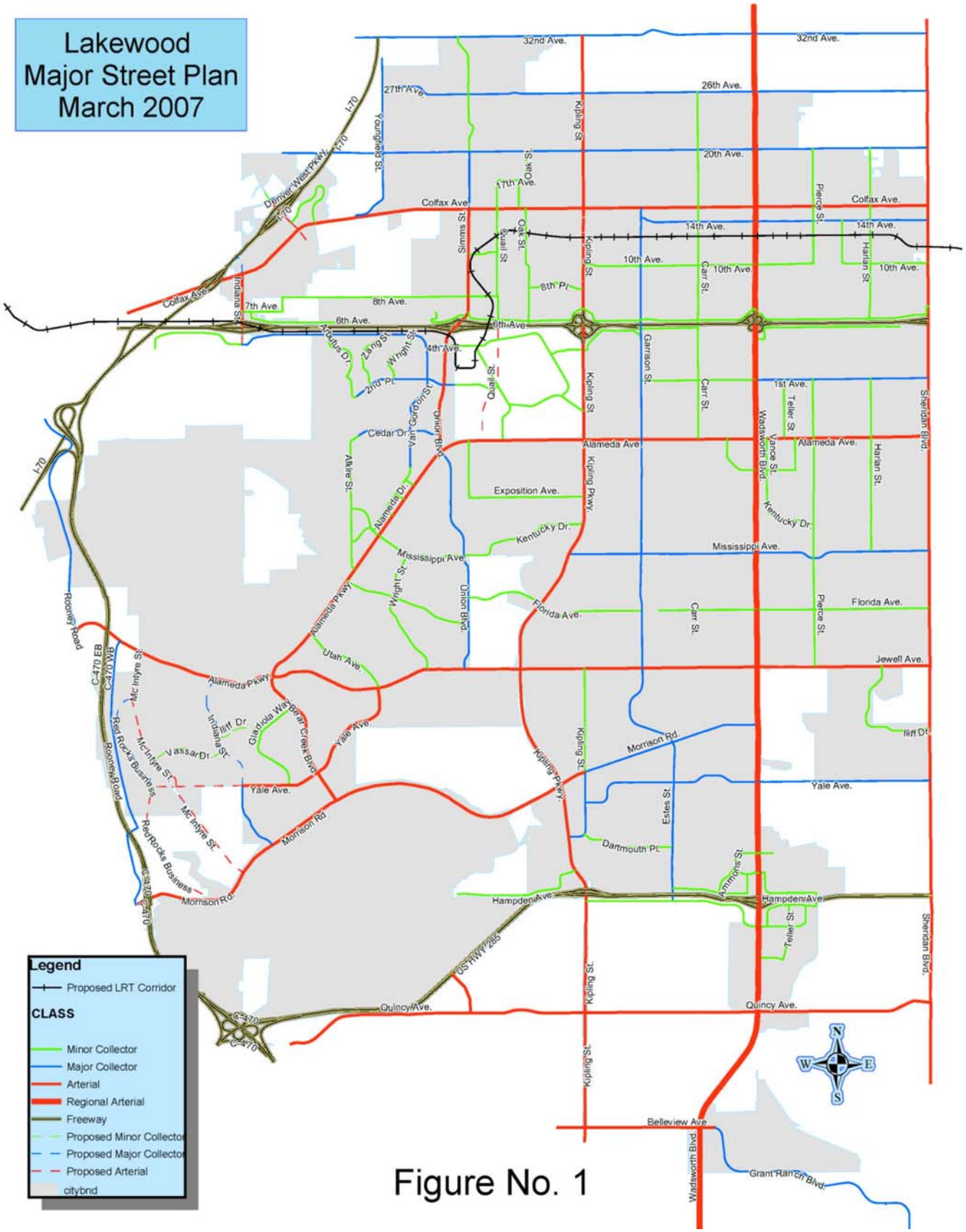
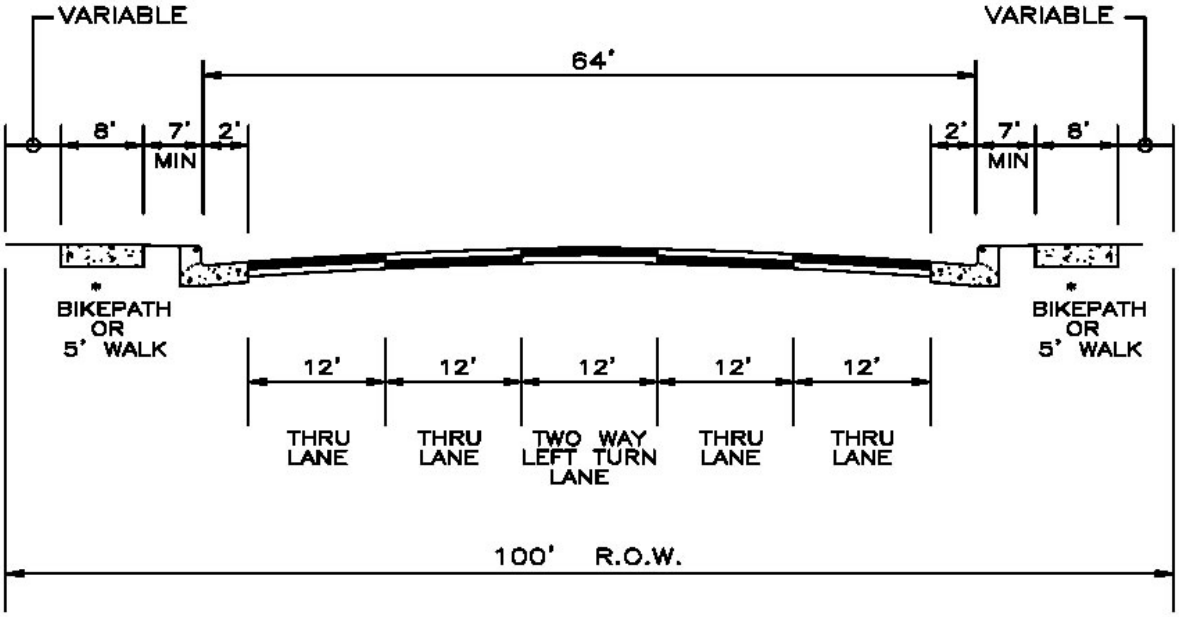

Lakewood
Major Street Plan
March 2007
Legend
Proposed LRT Corridor
CLASS
Minor Collector
Major Collector
Arterial
Regional Arterial
Freeway
Proposed Minor Collector
Proposed Major Collector
Proposed Arterial
citybnd
32nd Ave.
27th Ave.
26th Ave.
20th Ave.
17th Ave.
Colfax Ave.
14th Ave.
10th Ave.
8th Ave.
8th Pl.
7th Ave.
6th Ave.
4th Ave.
2nd Pl.
1st Ave.
Cedar Dr.
Alameda Ave.
Exposition Ave.
Kentucky Dr.
Mississippi Ave.
Florida Ave.
Utah Ave.
Jewell Ave.
Iliff Dr.
Vassar Dr.
Yale Ave.
Morrison Rd.
Dartmouth Pl.
Hampden Ave.
Quincy Ave.
Belleview Ave.
Grant Ranch Blvd.
Youngfield St.
Kipling St.
Oak St.
Simms St.
Quail St.
Garrison St.
Carr St.
Wadsworth Blvd.
Teller St.
Vance St.
Harlan St.
Pierce St.
Sheridan Blvd.
Estes St.
Ammons St.
Indiana St.
Alkire St.
Alameda Dr.
Van Gordon St.
Union Blvd.
Wright St.
Alameda Pkwy.
Kipling Pkwy.
Glaciola Way
Bear Creek Blvd.
Mc Intyre St.
Red Rocks Business
Rooney Road
C-470 EB
C-470 WB
C-470
I-70
US HWY 285
Denver West Pkwy.

Figure No. 1



Notes:

1. Bikepath, bike lanes and walk is determined by the Bicycle Master Plan.

2. Four feet (4') of additional pavement width will be added to each side if bike lanes are required.

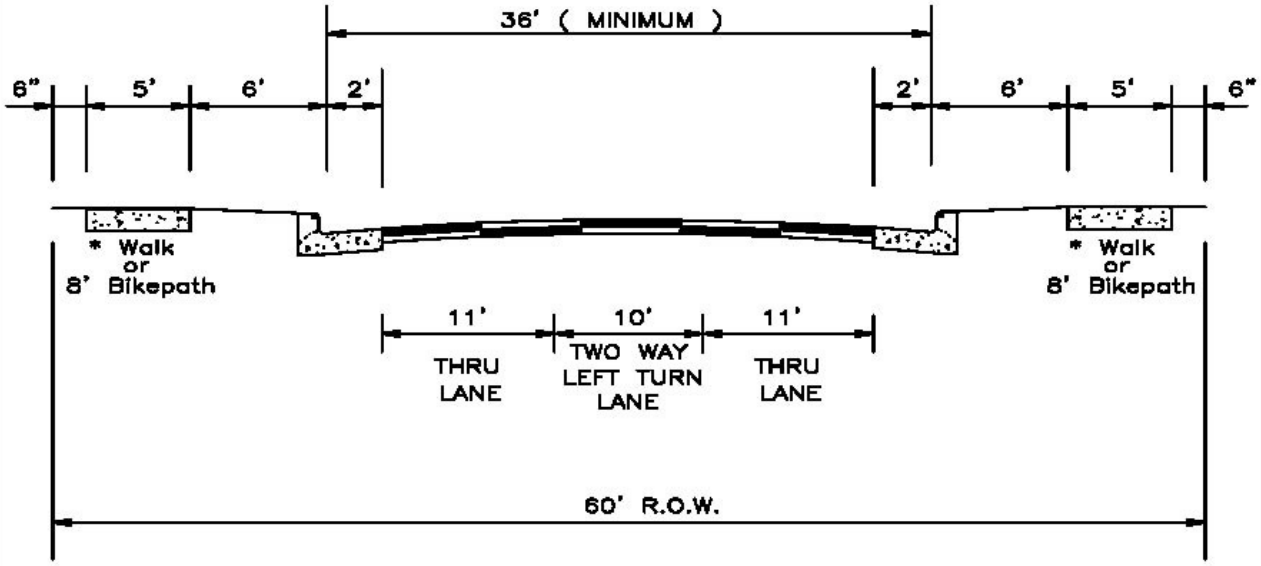
3. Raised or depressed median island are required where necessary to control left turn movements or to provide landscaped areas.

4. See text section 2.2 and 6.

CITY OF LAKEWOOD, COLORADO
DEPARTMENT OF PUBLIC WORKS
DIVISION OF TRAFFIC ENGINEERING

REVISIONS DATE:		FIGURE NO.
October 2006	MINIMUM ARTERIAL ROADWAY	2

D:\upload\Traffic\MINIMUM ARTERIAL ROADWAY



Notes:

1. Bikepath, bike lanes and walk is determined by the Master Bicycle Plan.

2. Four feet (4') of additional pavement width will be added to each side if bike lanes are required.

3. Existing collector street with backout drives must be constructed to a minimum 40' flow line to flow line width.

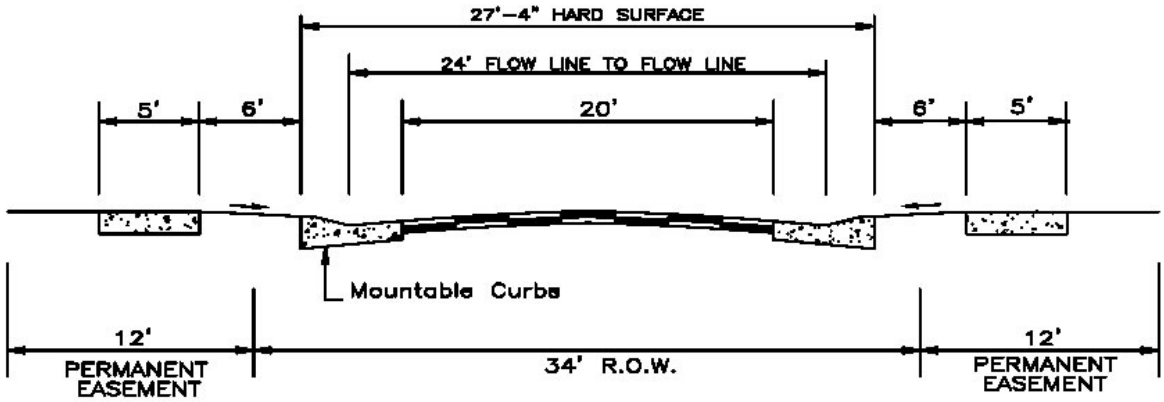
4. See text section 2.2 and 6.

CITY OF LAKEWOOD, COLORADO
DEPARTMENT OF PUBLIC WORKS
DIVISION OF TRAFFIC ENGINEERING

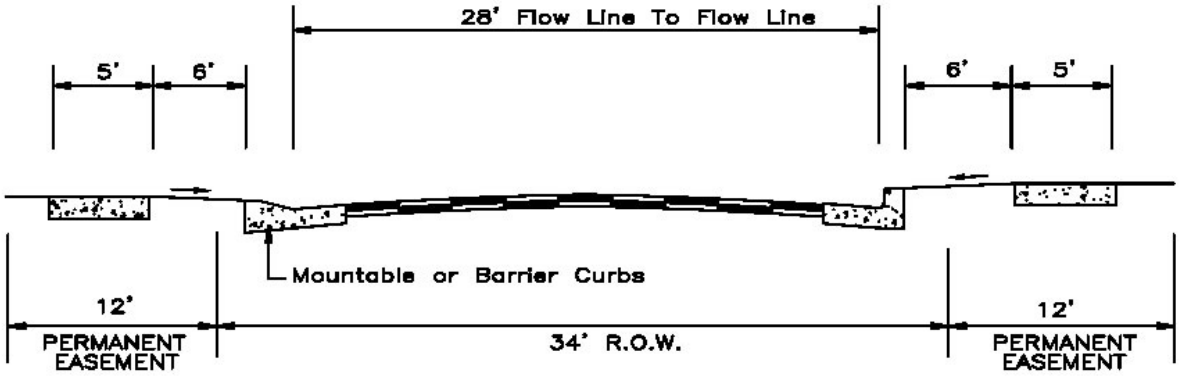
REVISION DATE:		FIGURE NO.
October 2006	COLLECTOR STREET & LOCAL STREET FOR FOR MULTI FAMILY, COMMERCIAL & INDUSTRIAL	3

D:\Lakewood\Traffic\COLLECTOR & LOCAL STREET SECTION

SECTION A



SECTION B



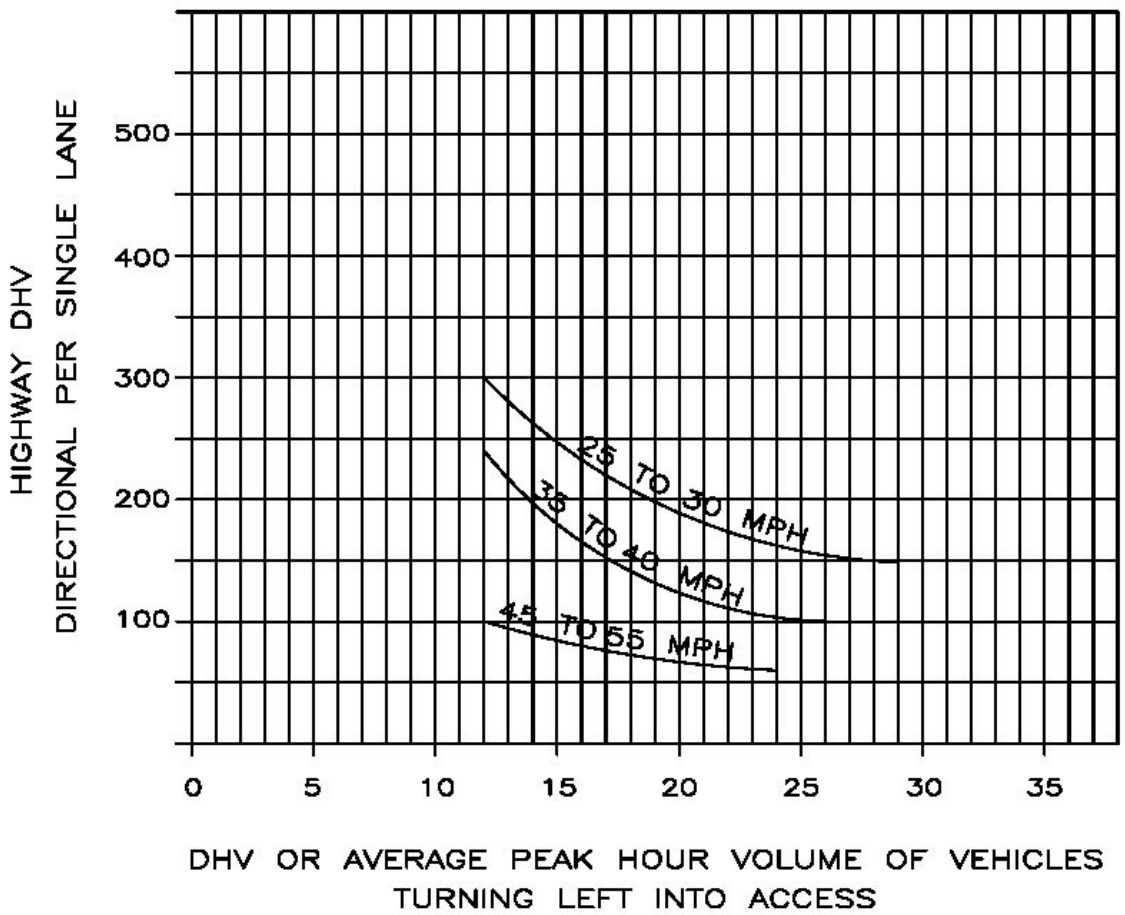
Notes:

1. Section A — Parking allowed only on one side of the street. Parking will b on the opposite side of the street from where the water line is located. Water line to be located under paved portion of street.
2. Section A not available for use in Alameda Water & Sanitation District.
3. Permanent easements shall be for traffic control devices, utilities, pedestrians, construction, maintenance and landscaping.
4. See text section 2.2 and 6.

CITY OF LAKEWOOD, COLORADO

DEPARTMENT OF PUBLIC WORKS
DIVISION OF TRAFFIC ENGINEERING

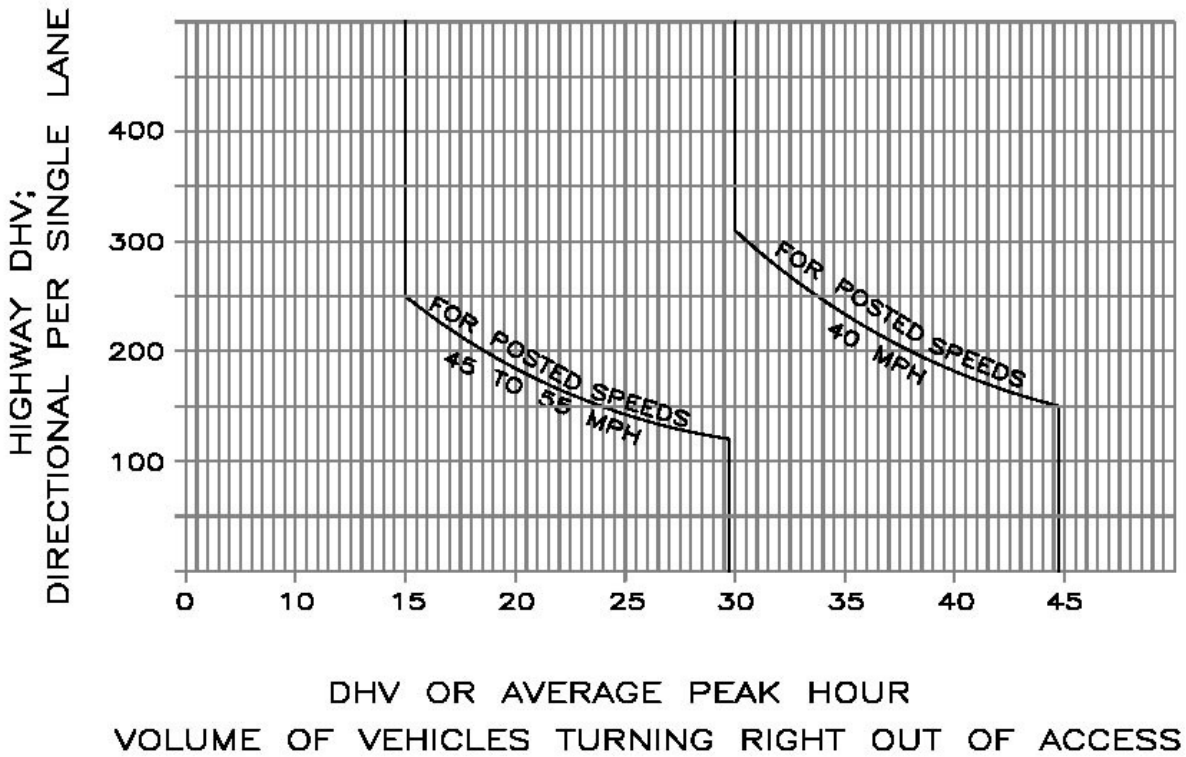
REVISION DATE:		FIGURE NO.
October 2006	LOCAL RESIDENTIAL STREET SERVING R1A, RR, 2R AND 3R LAND USES	4



CITY OF LAKEWOOD, COLORADO

DEPARTMENT OF PUBLIC WORKS
DIVISION OF TRAFFIC ENGINEERING

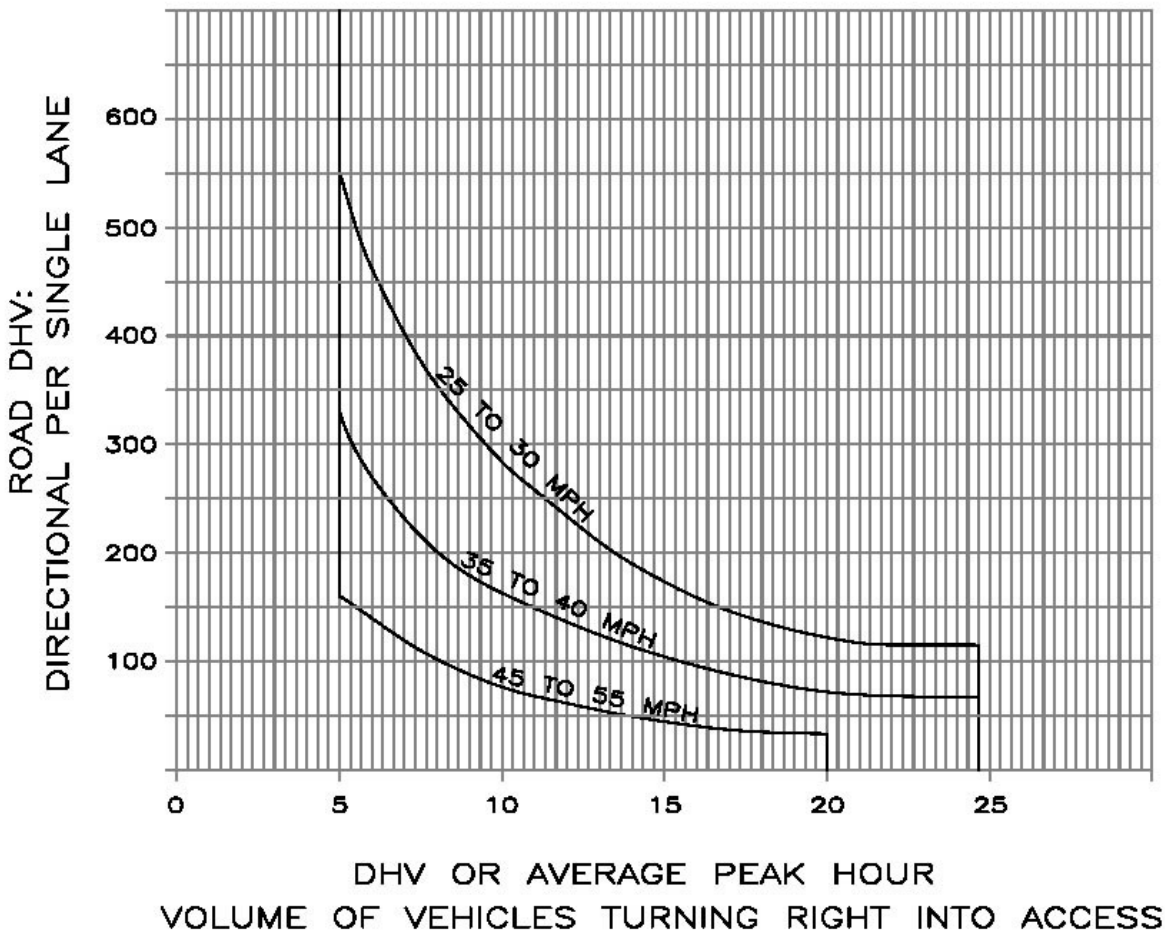
REVISION DATE :		FIGURE NO.
October 2006	VOLUME WARRANTS FOR LEFT–TURN DECELERATION LANES	5



Right turn acceleration lanes not required for posted speed less than 40 mph.

CITY OF LAKEWOOD, COLORADO
DEPARTMENT OF PUBLIC WORKS
DIVISION OF TRAFFIC ENGINEERING

REVISION DATE:		FIGURE NO.
October 2006	VOLUME WARRANTS FOR RIGHT TURN ACCELERATION LANES	6



Right turn deceleration lane is required when on or above the relevant curve. Also see section 4.3.

CITY OF LAKEWOOD, COLORADO
DEPARTMENT OF PUBLIC WORKS
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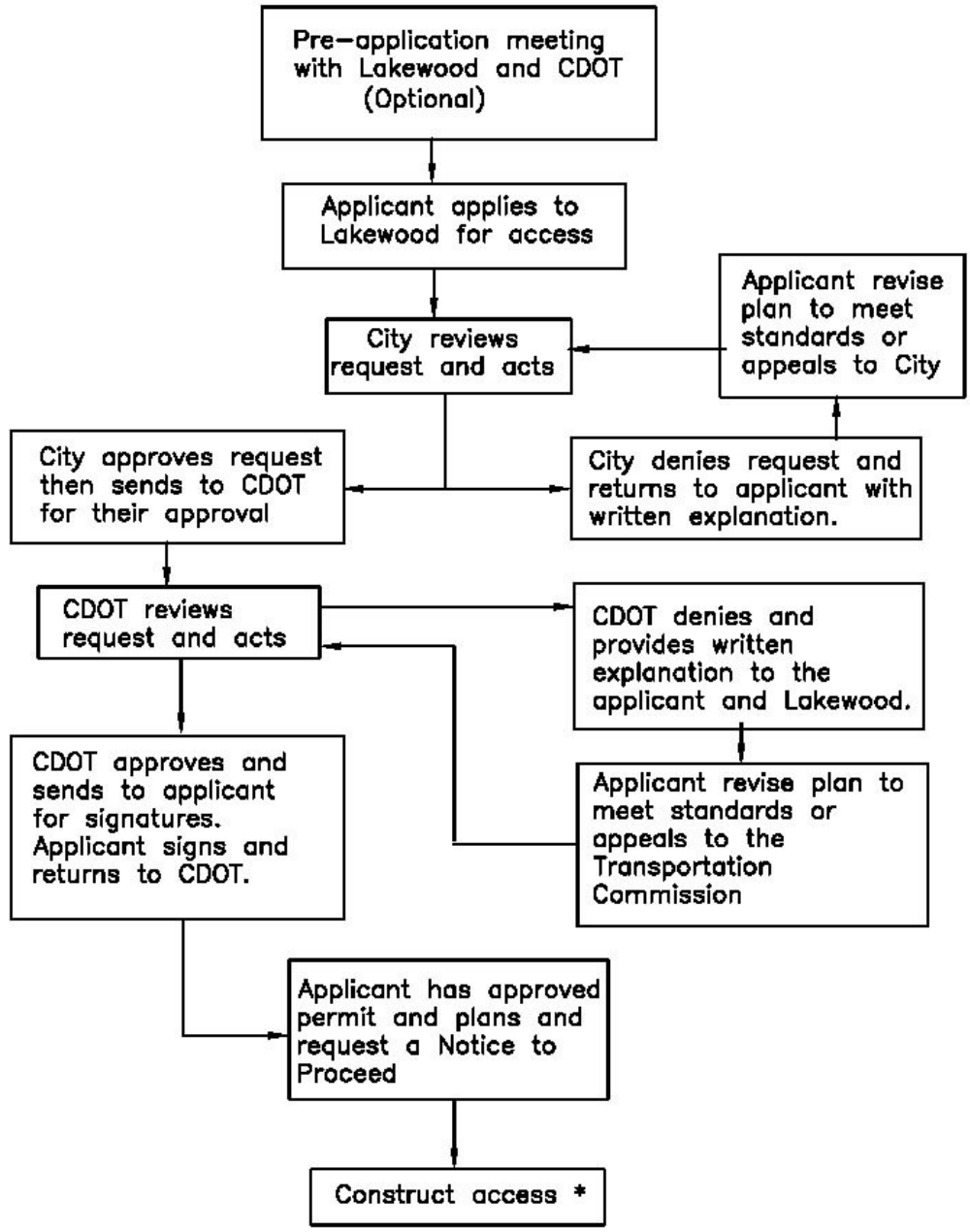
REVISION DATE:		FIGURE NO.
October 2006	VOLUME WARRANTS FOR RIGHT–TURN DECELERATION LANES	7



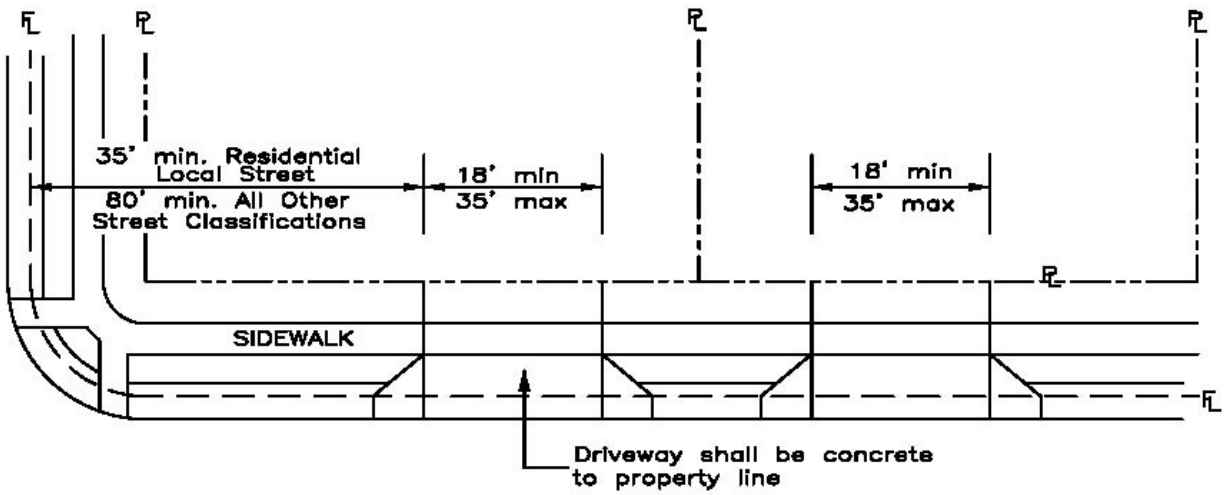
* If access is not under construction within one year of permitting then the access permit will expire.

See State Access Code for exact procedures.

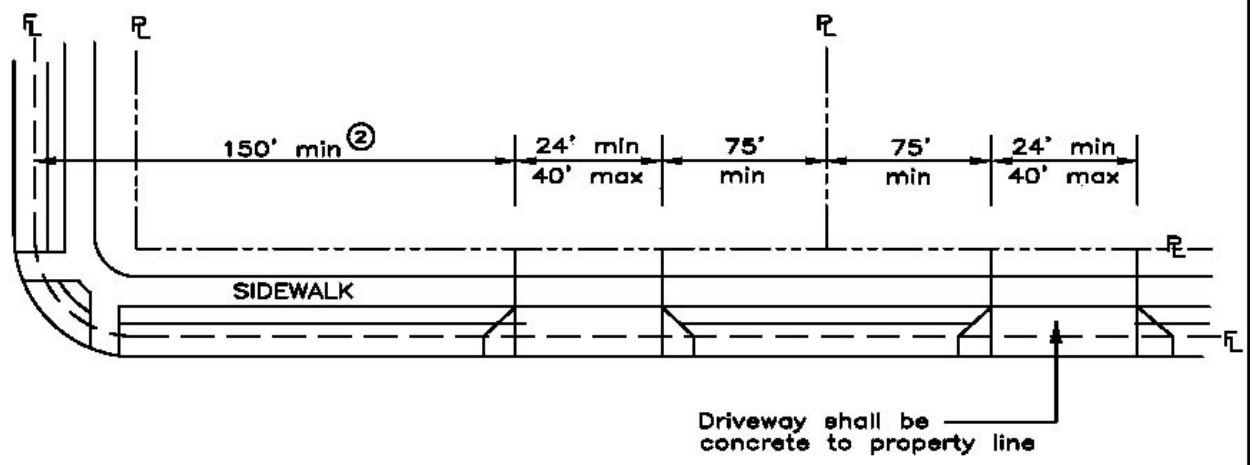
CITY OF LAKEWOOD, COLORADO

DEPARTMENT OF PUBLIC WORKS
DIVISION OF TRAFFIC ENGINEERING

REVISION DATE:	STATE HIGHWAY ACCESS PERMIT PROCEDURE	FIGURE NO.
October 2006		8



SINGLE FAMILY/DUPLEX ACCESS ①

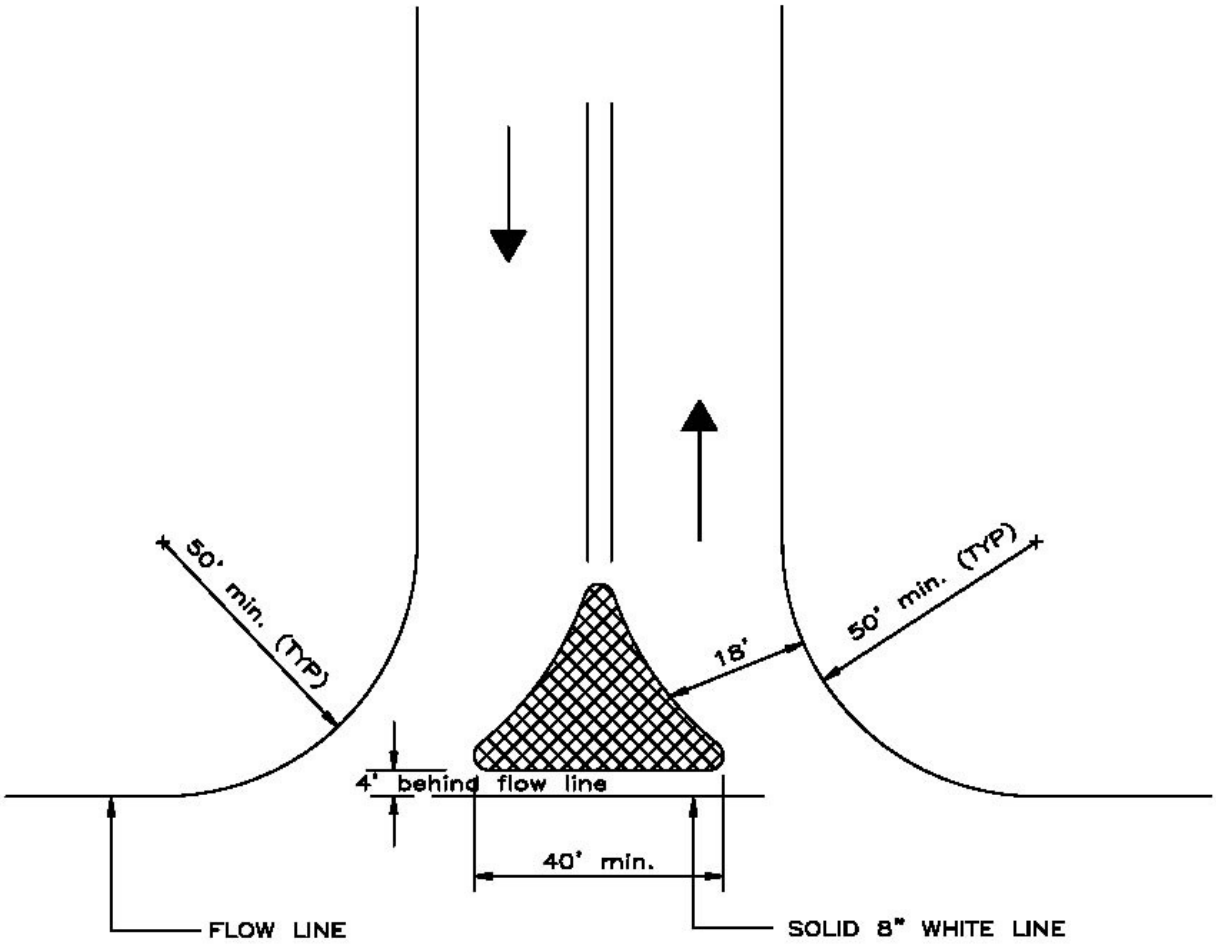


COMMERCIAL/OFFICE/MULTI—FAMILY/INDUSTRIAL ACCESS ①

1. This standard applies to all street classifications.
2. The 150' dimension from the corner may be increased to provide additional left—turn storage.
3. New and relocated accesses shall align with an access on the opposite side of the street or staggered by 150'.

CITY OF LAKEWOOD, COLORADO
DEPARTMENT OF PUBLIC WORKS
DIVISION OF TRAFFIC ENGINEERING

REVISION DATE :		FIGURE NO.
October 2006	ACCESS SPACING AND WIDTHS	9

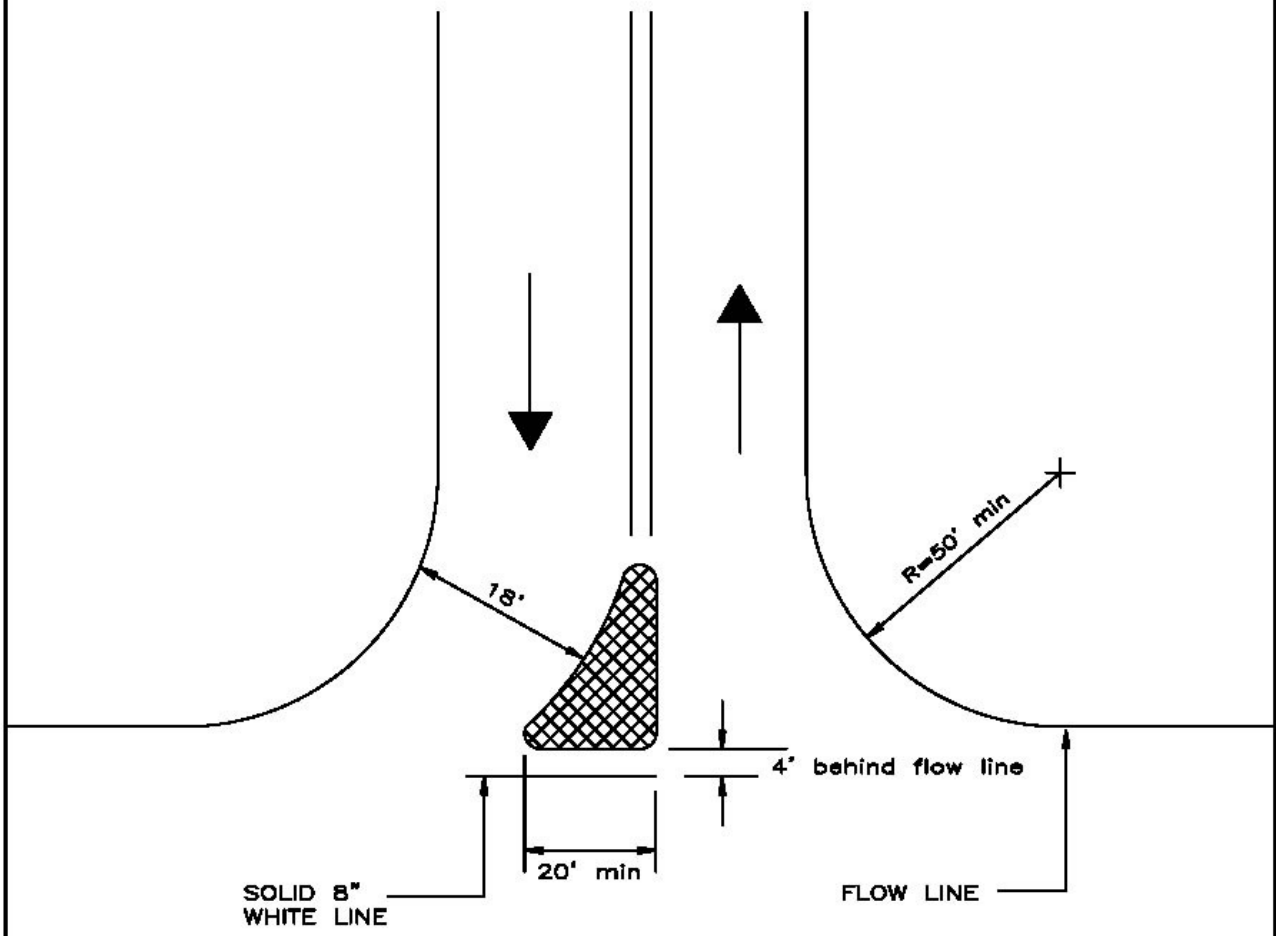


1. A center median island may be required rather than this design.

2. See section 5.3

CITY OF LAKEWOOD, COLORADO
DEPARTMENT OF PUBLIC WORKS
DIVISION OF ENGINEERING

REVISION DATE:	RIGHT–IN, RIGHT–OUT ACCESS DESIGN	FIGURE NO.
October 2006		10

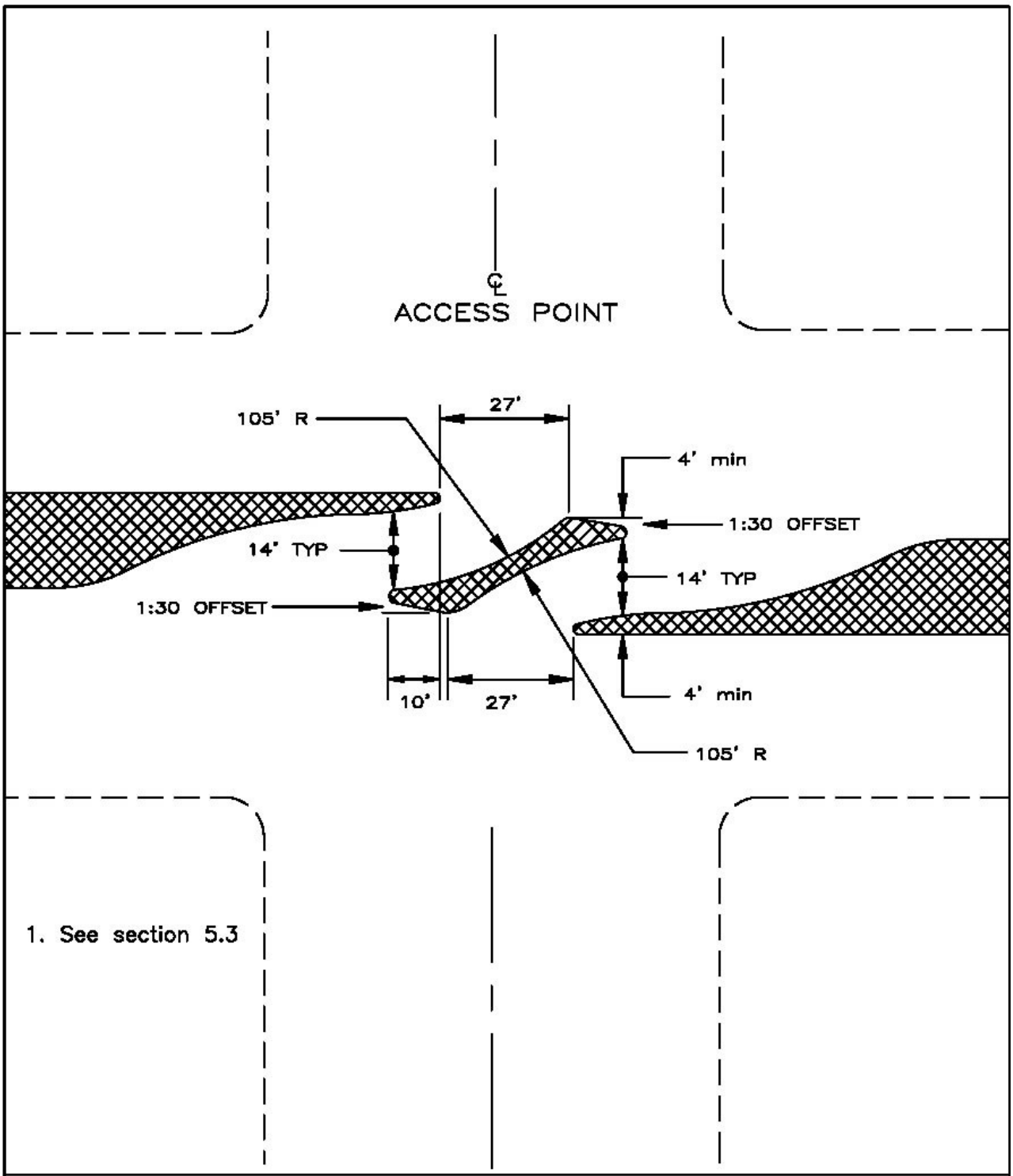


1. A center median island may be required rather than this design.

2. See section 5.3

CITY OF LAKEWOOD, COLORADO
DEPARTMENT OF PUBLIC WORKS
DIVISION OF TRAFFIC ENGINEERING

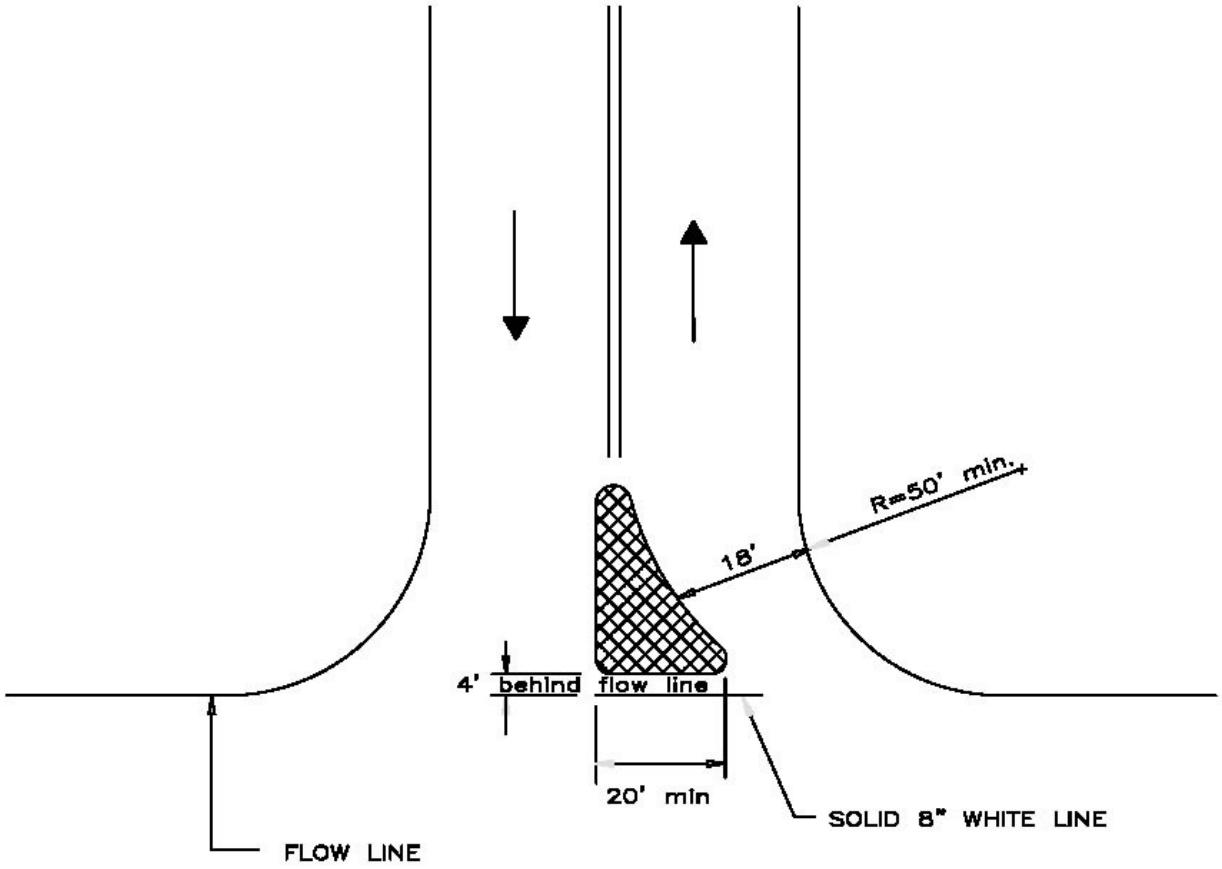
REVISION DATE:		FIGURE NO.
October 2006	RIGHT–IN, RIGHT–OUT, LEFT–IN ACCESS DESIGN	11



1. See section 5.3

CITY OF LAKEWOOD, COLORADO
DEPARTMENT OF PUBLIC WORKS
DIVISION OF TRAFFIC ENGINEERING

REVISION DATE:		FIGURE NO.
October 2006	RIGHT–IN, RIGHT–OUT, LEFT–IN MEDIAN DESIGN	12



1. A center median island may be required rather than this design.

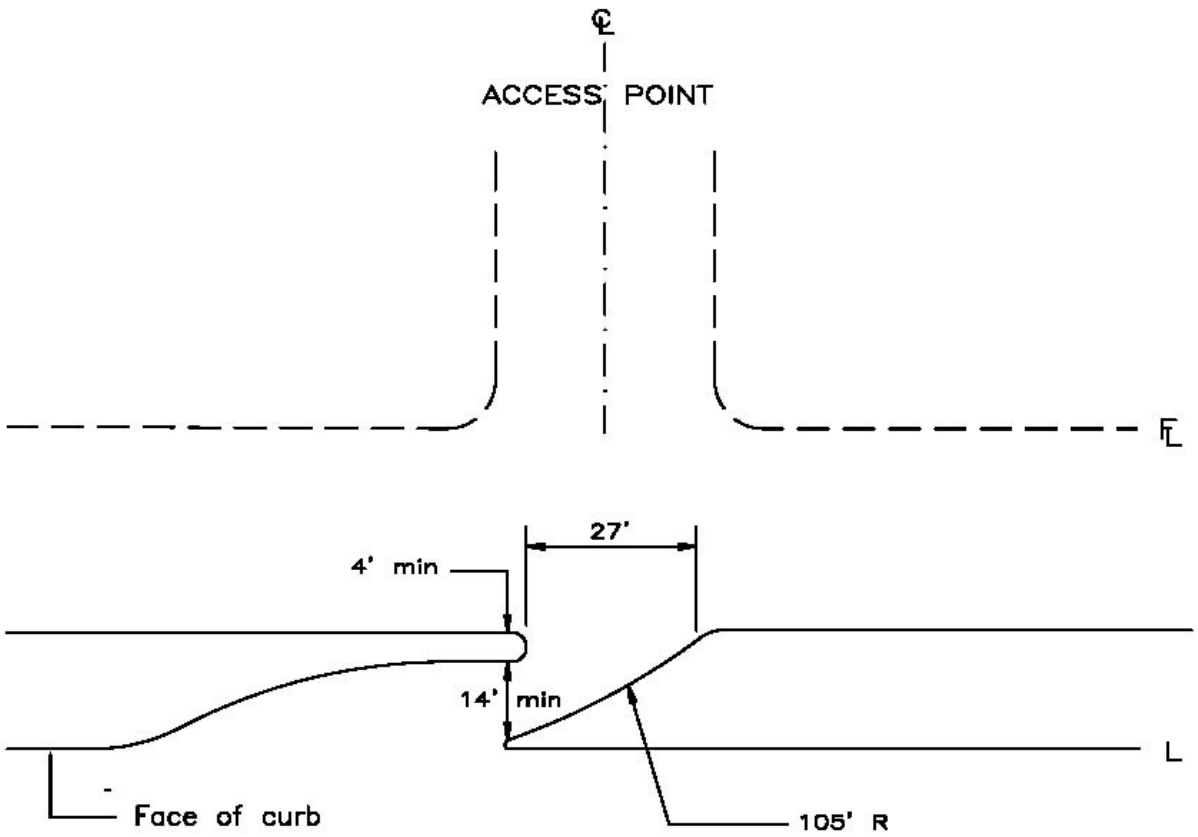
2. See section 5.3

CITY OF LAKEWOOD, COLORADO

DEPARTMENT OF PUBLIC WORKS
DIVISION OF TRAFFIC ENGINEERING

REVISION DATE:		FIGURE NO.
october 2006	RIGHT–IN, RIGHT–OUT, LEFT–OUT ACCESS DESIGN	13

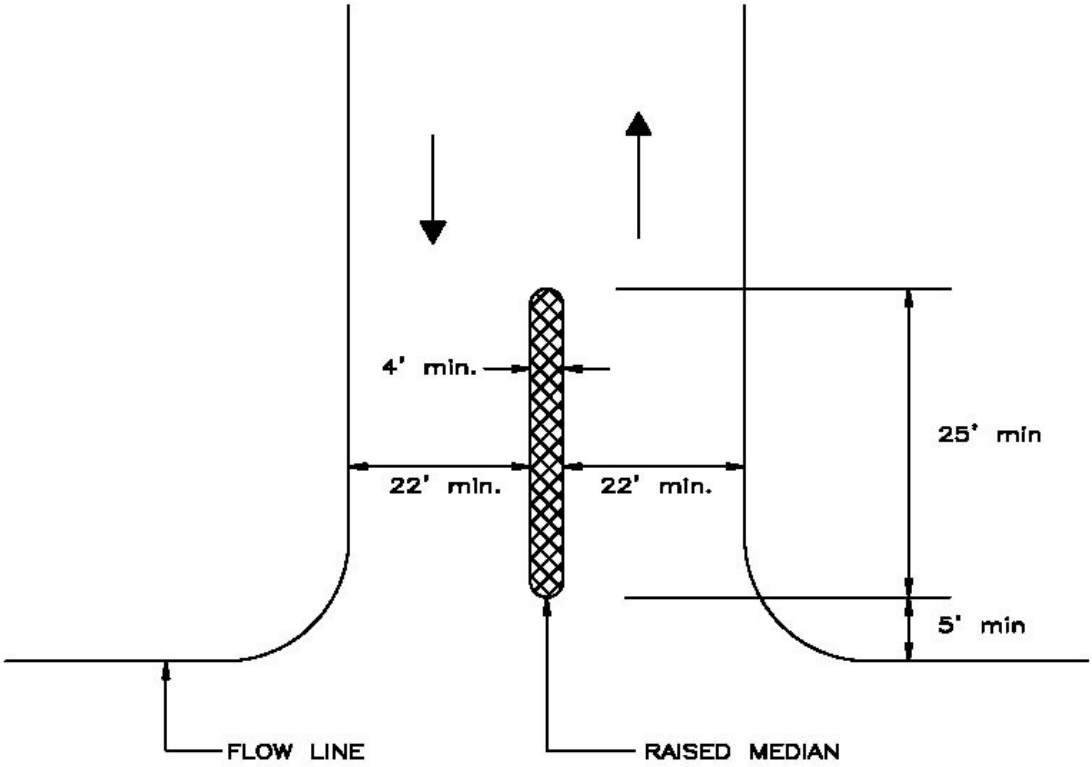
Access Design RI In Out, LT Out



1. See section 5.3

CITY OF LAKEWOOD, COLORADO
DEPARTMENT OF PUBLIC WORKS
DIVISION OF TRAFFIC ENGINEERING

REVISION DATE:		FIGURE NO.
October 2006	MEDIAN DESIGN TO RESTRICT EXITING LEFT TURNS	14



1. This access design cannot be used for signalized intersection approaches where left—turn have to be aligned.
2. See section 5.3

CITY OF LAKEWOOD, COLORADO
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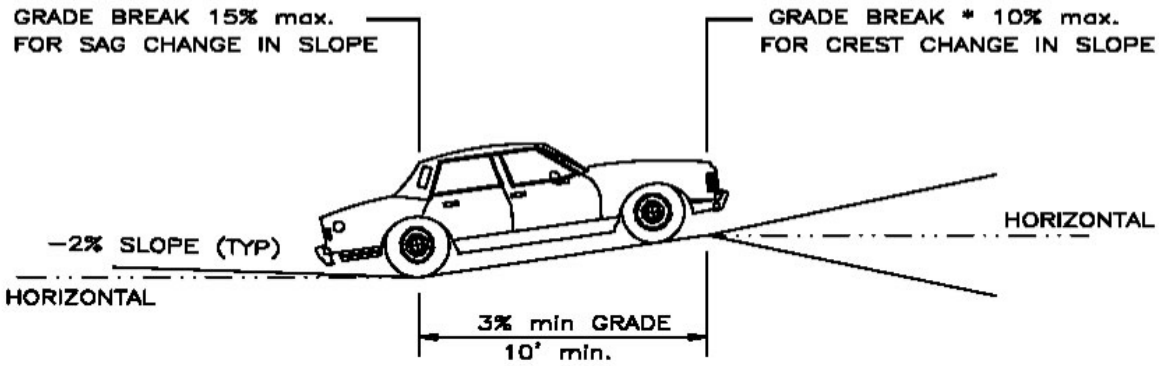
DIVISION OF TRAFFIC ENGINEERING

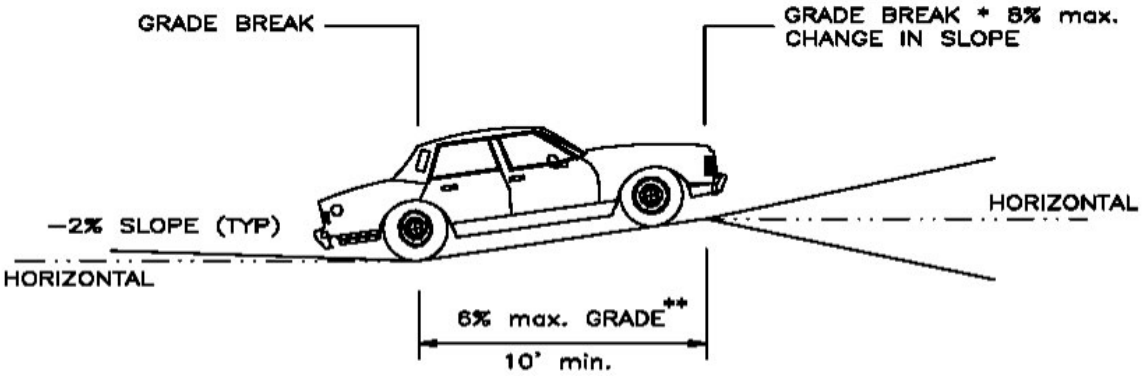
REVION DATE:		FIGURE NO.
October 2006	ACCESS DESIGN WITH MEDIAN DIVIDER	15



LOW DENSITY RESIDENTIAL DRIVEWAYS

* DRIVEWAY GRADES NOT TO EXCEED 14%

ANY VARIANCE TO BE APPROVED BY CITY ENGINEER



HIGH DENSITY RESIDENTIAL & COMMERCIAL DRIVEWAYS

* DRIVEWAY GRADES NOT TO EXCEED 8%

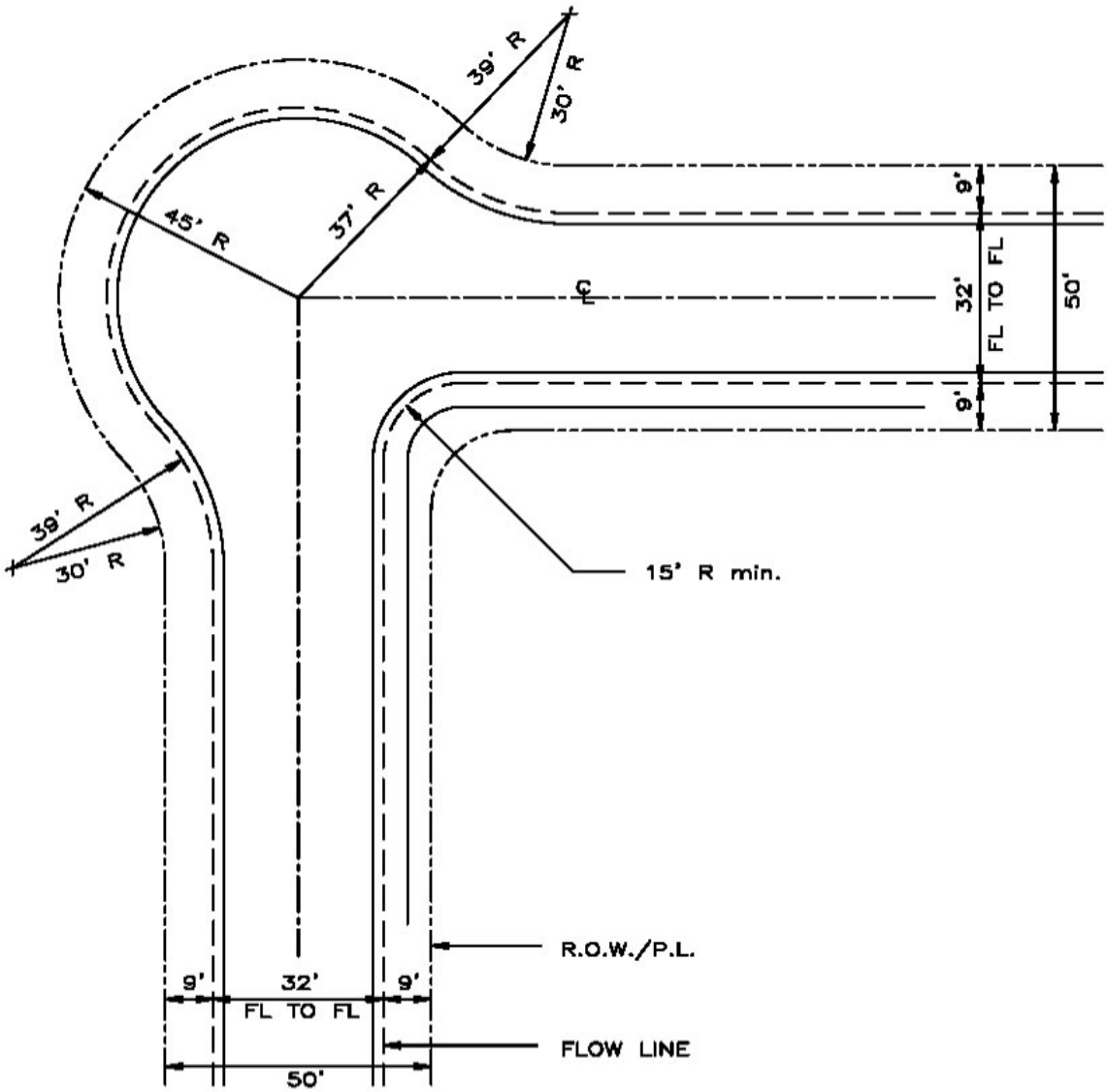
** THE 10' DISTANCE WITH ATTACHED WALKS, SHALL BEGIN AT THE BACK OF WALK

ANY VARIANCE TO BE APPROVED BY CITY ENGINEER

CITY OF LAKEWOOD, COLORADO

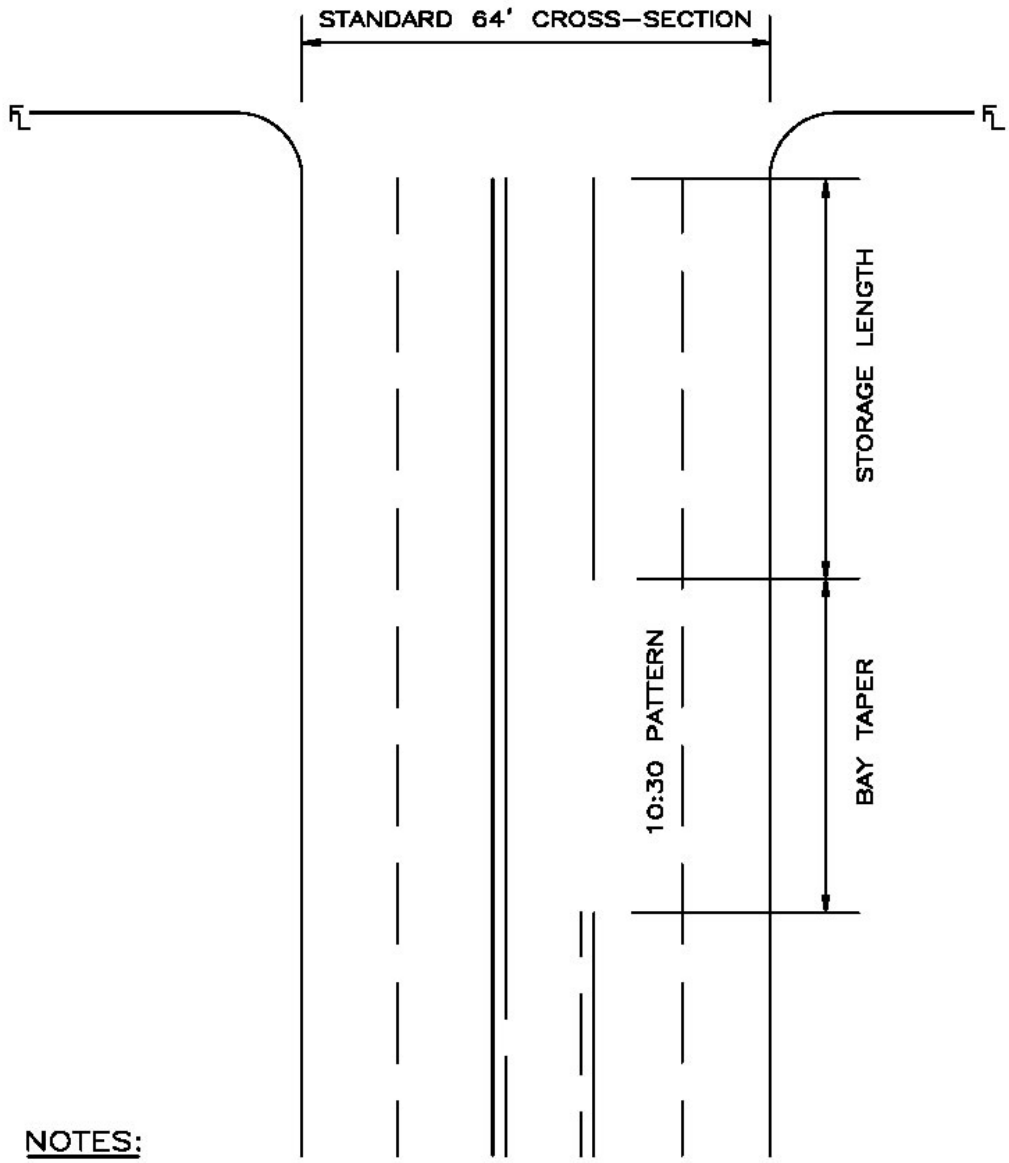
DEPARTMENT OF PUBLIC WORKS
DIVISION OF TRAFFIC ENGINEERING

REVISION DATE:		FIGURE NO.
October 2006	ACCESS GRADES	16



CITY OF LAKEWOOD, COLORADO
DEPARTMENT OF PUBLIC WORKS
DIVISION OF TRAFFIC ENGINEERING

REVISION DATE:		FIGURE NO.
October 2006	EYE BROW TYPE CUL–DE–SAC BULB	17



NOTES:

1. For bay and approach taper lengths see section 6.6. for lane widths see Figure 2.

2. On arterial roadways with raised medians, taper design should conform to the roadway design manual of the Colorado Department of Transportation.

CITY OF LAKEWOOD, COLORADO
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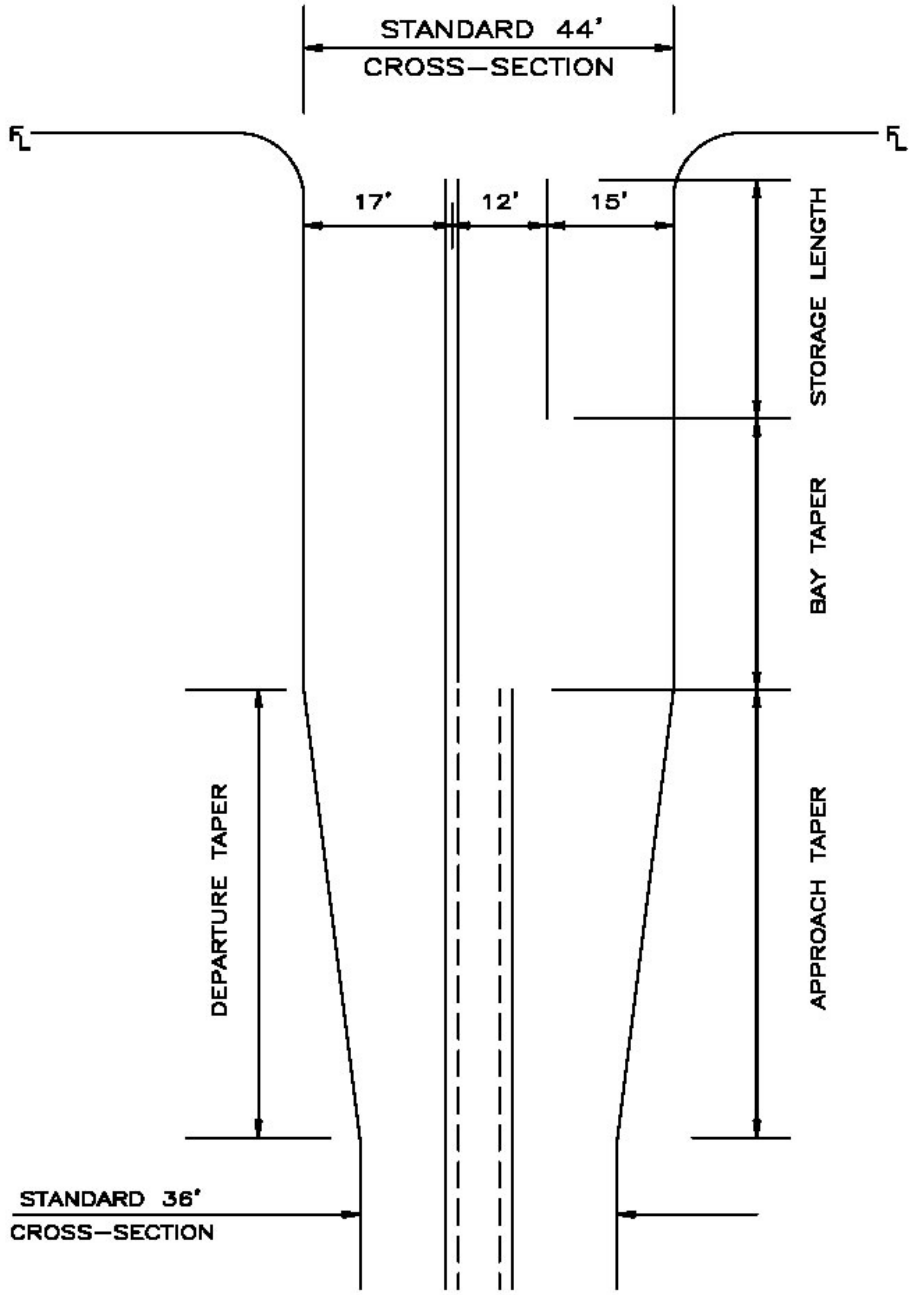
DIVISION OF TRAFFIC ENGINEERING

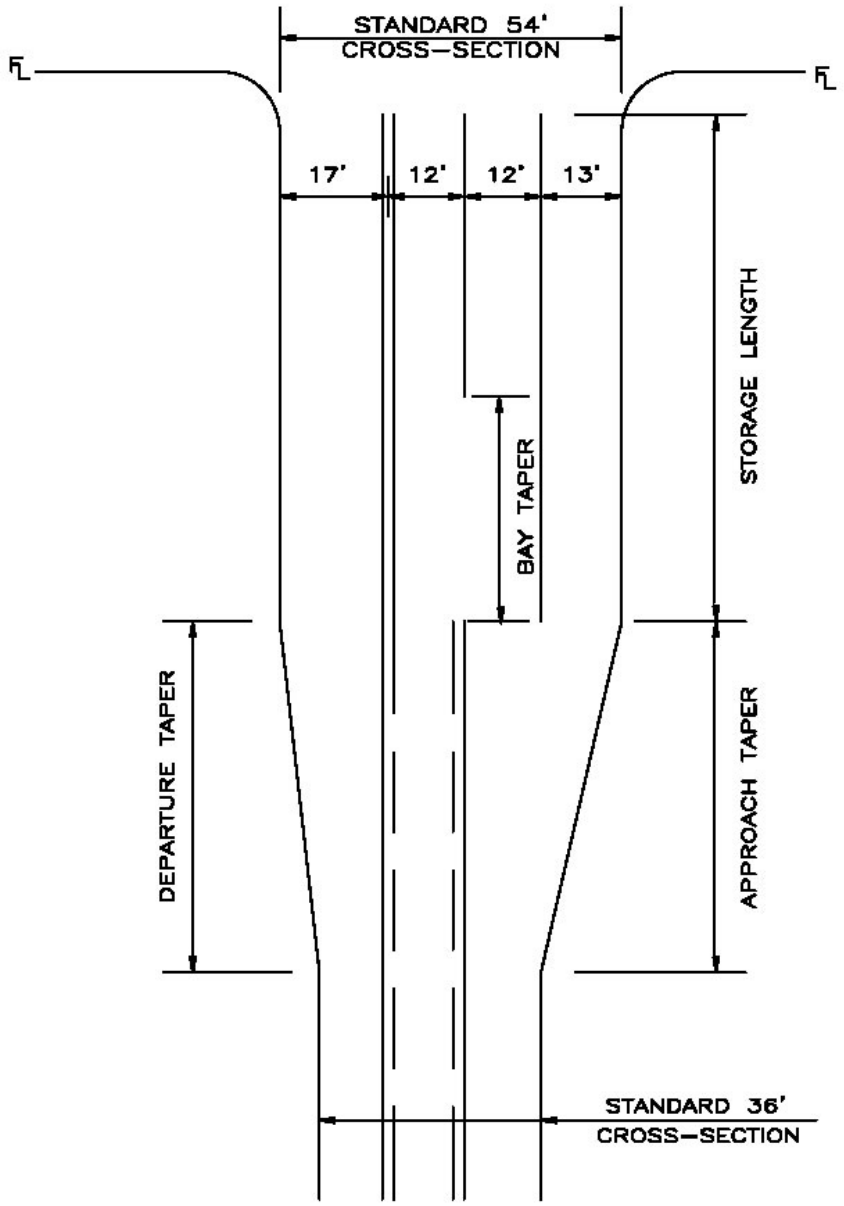
REVISION DATE:		FIGURE NO.
October 2006	LEFT TURN APPROACH AND BAY TAPERS FOR ARTERIALS	18



FOR BAY AND APPROACH TAPERS SEE SECTION 6.6

CITY OF LAKEWOOD, COLORADO
DEPARTMENT OF PUBLIC WORKS
DIVISION OF TRAFFIC ENGINEERING

REVISION DATE:		FIGURE NO.
October 2006	LEFT TURN APPROACH AND BAY TAPERS FOR COLLECTORS	19



NOTES:

1. This full intersection design is assymetrical. Left turn and thru lane must align with opposite intersection approach.
2. For bay and approach tapers see Section 6.6.

CITY OF LAKEWOOD, COLORADO
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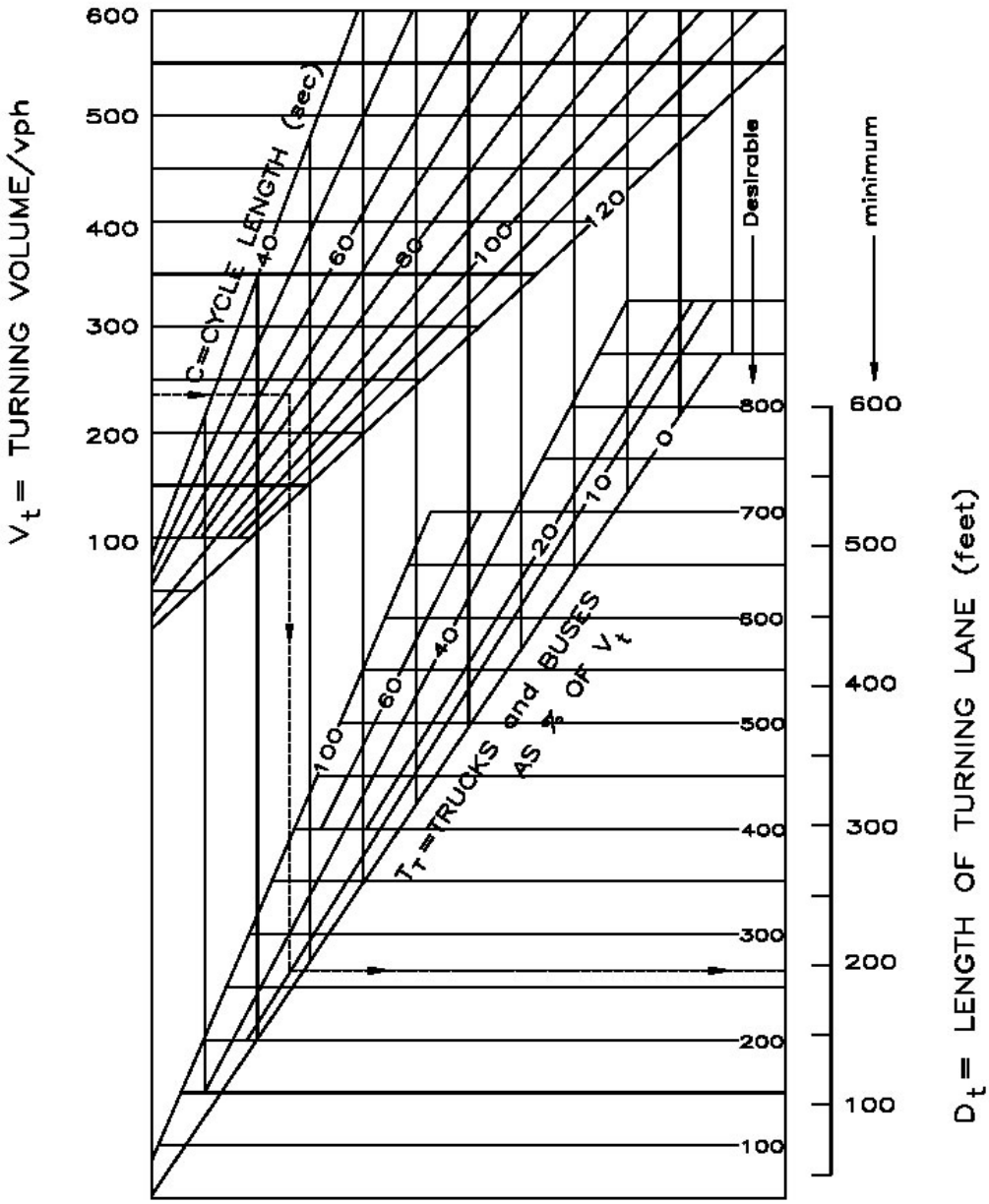
REVISION DATE:		FIGURE NO.
October 2006	54' COLLECTOR STREET APPROACH WITH RIGHT TURN LANE	20

D:\Signals\Traffic\Collector Right Turn Approach



1. Use 120 second cycle length for arterial streets.
2. T_T =2% minimum.

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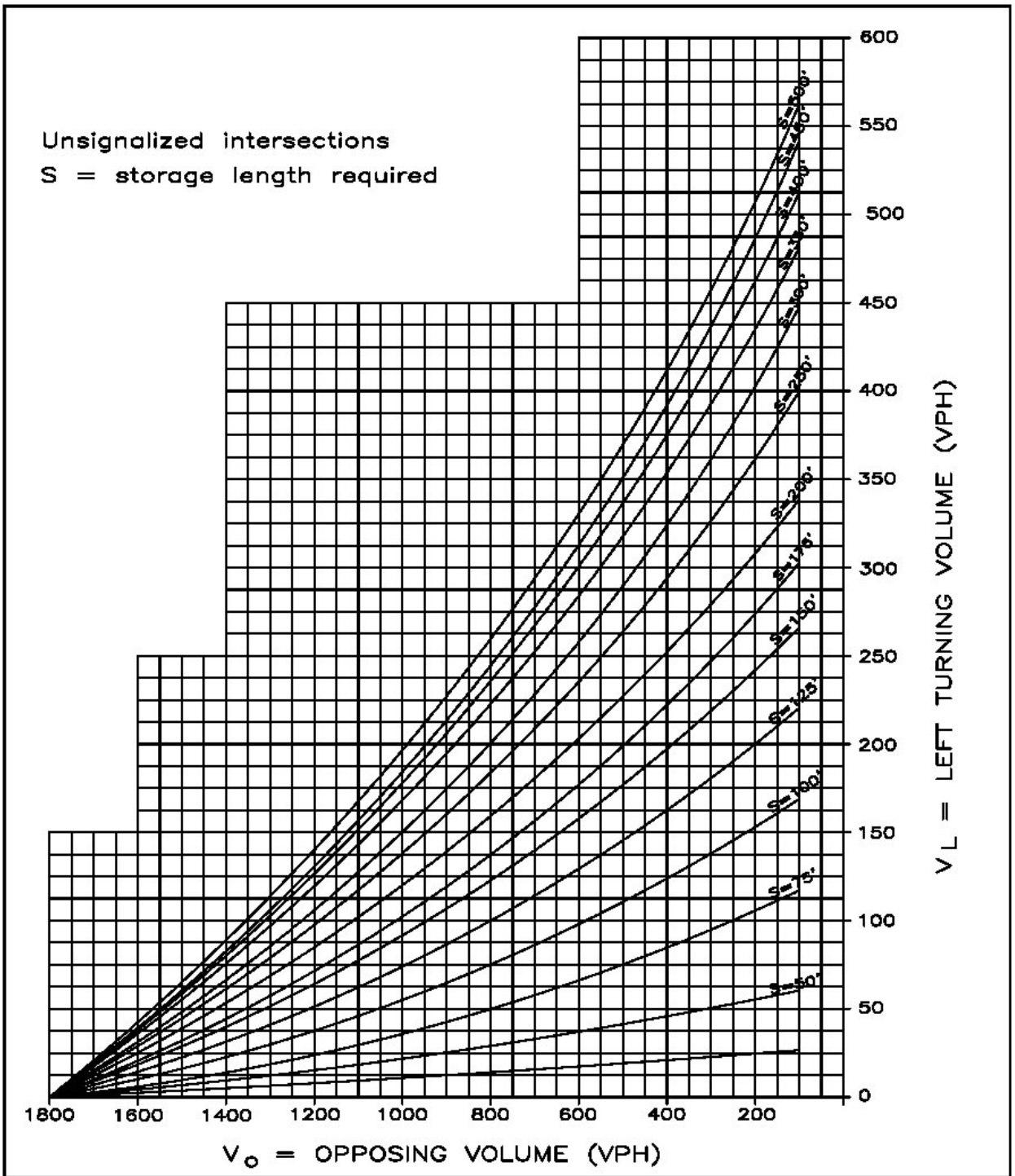
REVISION DATE:	DESIGN OF LEFT TURN STORAGE LENGTH VOLUME–BASED NOMOGRAPH FOR AT–GRADE SIGNALIZED INTERSECTIONS	FIGURE NO.
October 2006		21



CITY OF LAKEWOOD, COLORADO

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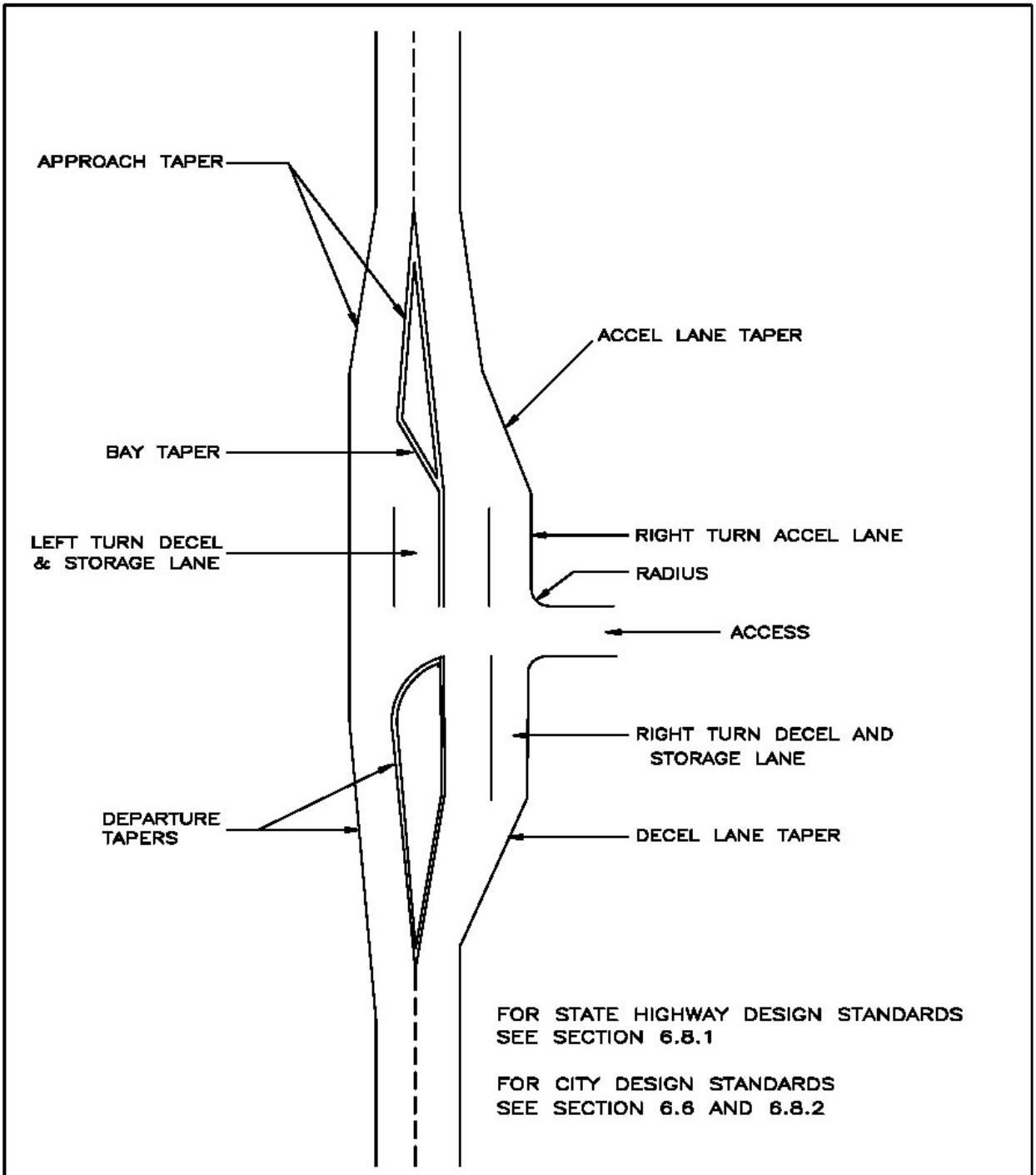
DIVISION OF TRAFFIC ENGINEERING

REVISION DATE:	DESIGN OF LEFT TURN STORAGE LENGTH VOLUME–BASED CHART FOR AT–GRADE UNSIGNALIZED INTERSECTIONS ON ON FOUR LANE ROADWAYS	FIGURE NO.
October 2006		22

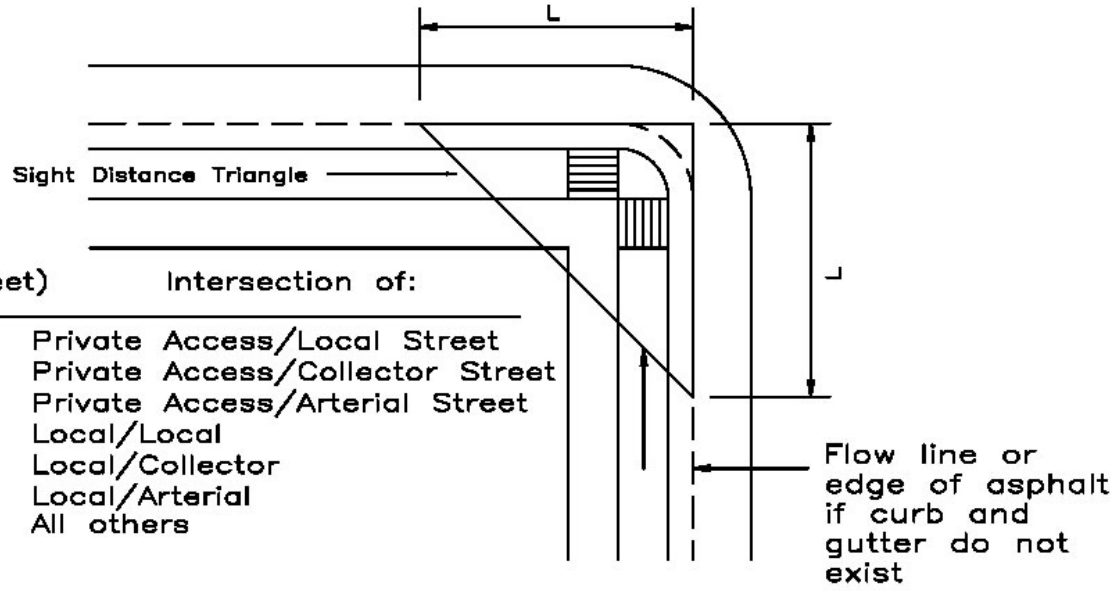
D:\Signal\Trans\Volume Base Design Left Turn Storage Chart



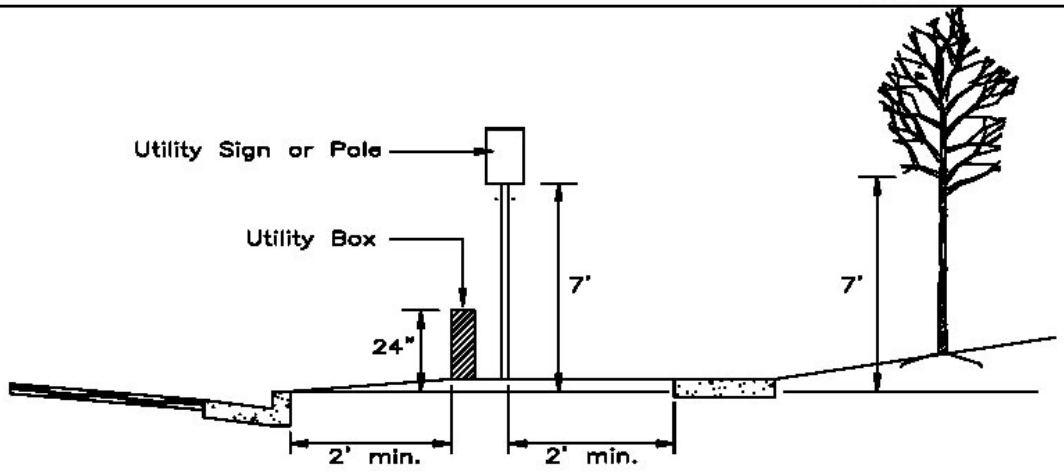
CITY OF LAKEWOOD, COLORADO

DEPARTMENT OF PUBLIC WORKS
DIVISION OF TRAFFIC ENGINEERING

REVISION DATE:		FIGURE NO.
October 2006	SPEED CHANGE LANE DESIGN ELEMENTS	23



L (feet)	Intersection of:
30	Private Access/Local Street
40	Private Access/Collector Street
55	Private Access/Arterial Street
30	Local/Local
40	Local/Collector
40	Local/Arterial
55	All others



OBJECTS WITHIN SIGHT DISTANCE TRIANGLE

NOTE:

1. The Transportation Engineering Design Standards define additional areas in which sight distance triangle criteria apply.
2. Items within the sight triangle must be lower than 24" or above 7'. The height is measured from the top of curb.
3. Safety devices such as fire hydrants and traffic signals may be located within the sight distance triangle with approval of the City Traffic Engineer.
4. Distance dependent on street classification. See section 6.9.

CITY OF LAKEWOOD, COLORADO

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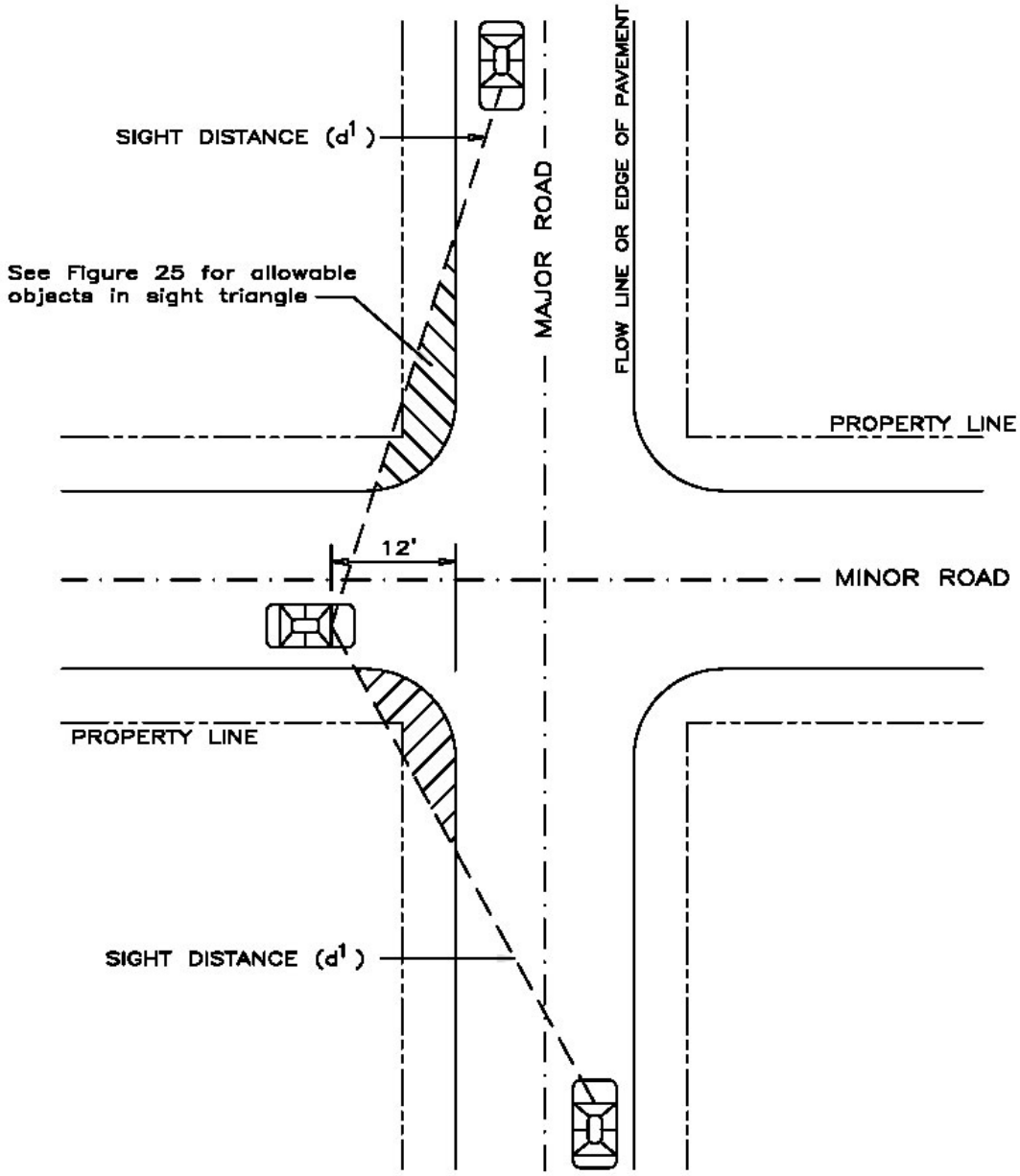
DIVISION OF TRAFFIC ENGINEERING

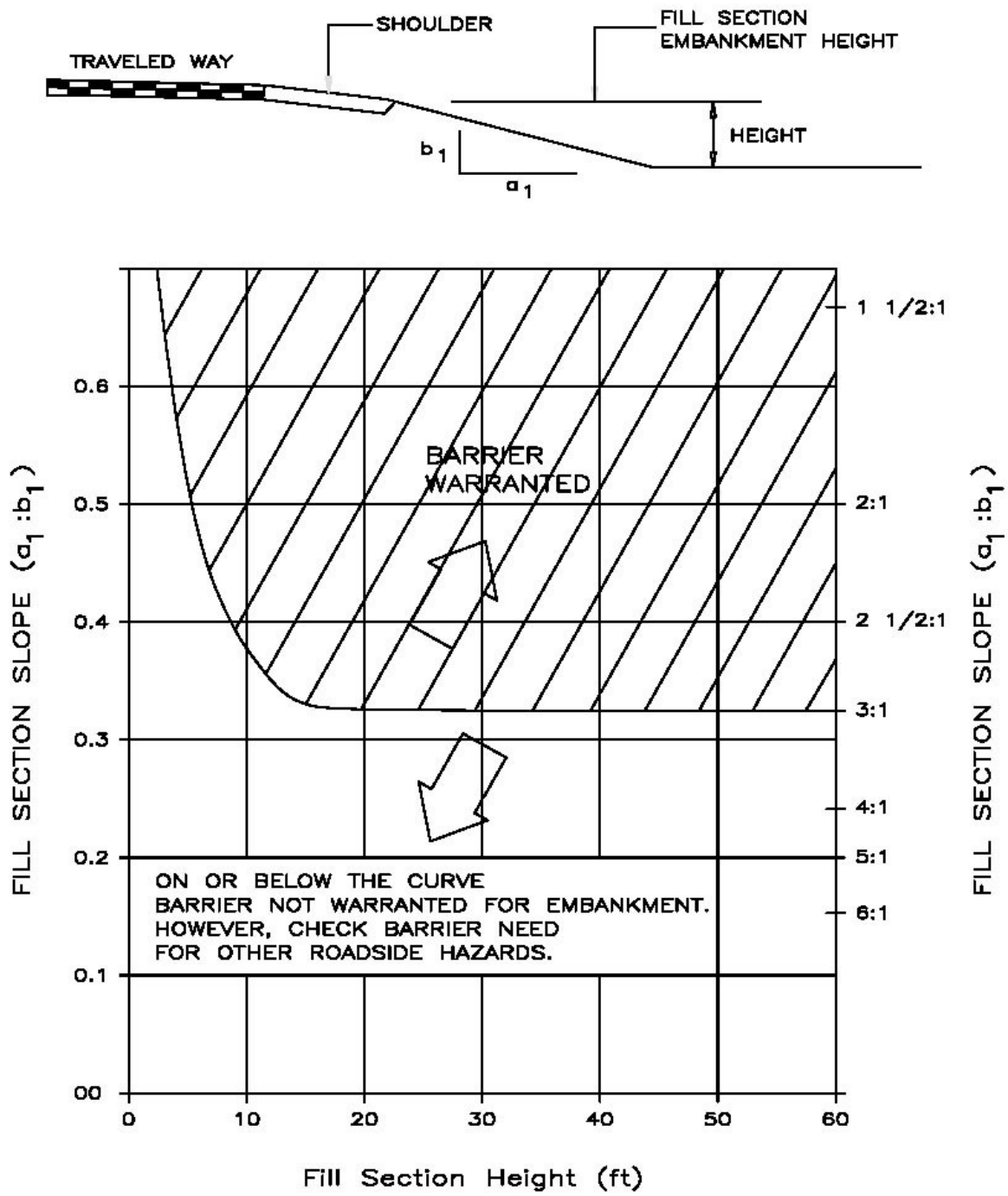
REVISION DATE:		FIGURE NO.
October 2006	SIGHT DISTANCE TRIANGLE	24



FOR SIGHT DISTANCE LENGTHS SEE SECTION 6.9.3

CITY OF LAKEWOOD, COLORADO
DEPARTMENT OF PUBLIC WORKS
DIVISION OF TRAFFIC ENGINEERING

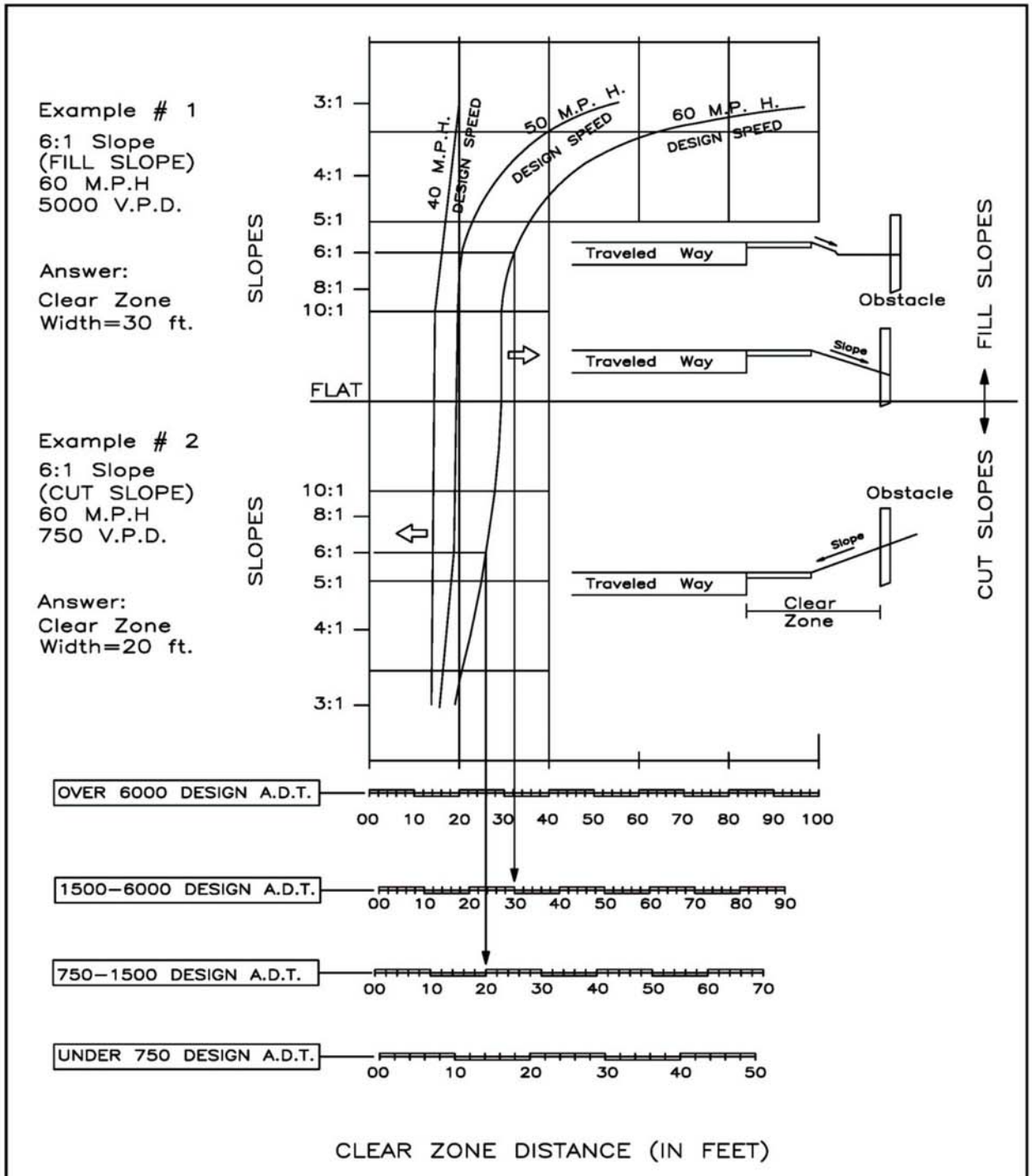
REVISION DATE:		FIGURE NO.
October 2006	DEPARTURE SIGHT DISTANCE	25



CITY OF LAKEWOOD, COLORADO

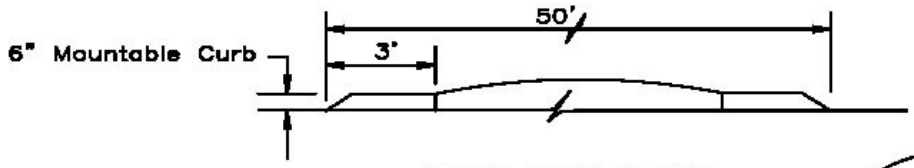
DEPARTMENT OF PUBLIC WORKS
DIVISION OF TRAFFIC ENGINEERING

REVISION DATE:		FIGURE NO.
October 2006	GUARD RAIL WARRANT CHART FOR FILL SECTION EMBANKMENTS	26

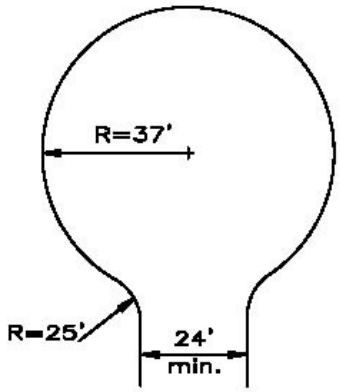


CITY OF LAKEWOOD, COLORADO
DEPARTMENT OF PUBLIC WORKS
DIVISION OF TRAFFIC ENGINEERING

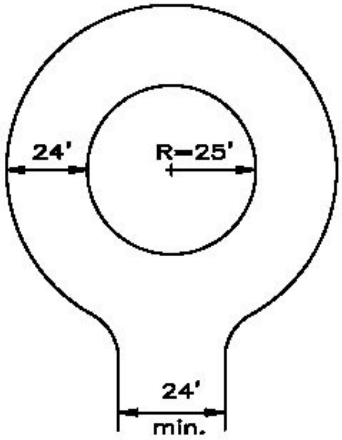
REVISION DATE:		FIGURE NO.
October 2006	GUARD RAIL WARRANT CHART FOR CLEAR ZONE WIDTH, SPEED AND SLOPE CRITERIA	27



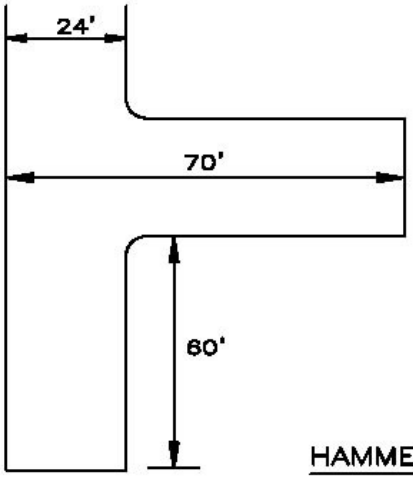
INSIDE CURB DESIGN

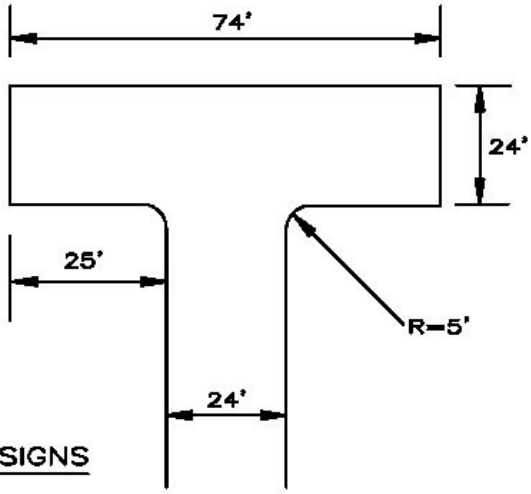


STANDARD CUL–DE–SAC
NO MEDIAN



CUL–DE–SAC
WITH CENTER MEDIAN





HAMMERHEAD DESIGNS

NOTES:

1. All measurements are to flow line if curb and gutter exist. If curb and gutter does not exist, measurments are to edge of asphalt.
2. Cul de sac with center medians shall have a minimum of 24' of driving surface with no parking. If parking is allowed the driving surface will be a minimum of 32'.
3. Hammerhead design will only be used on private streets or where existing condition will not permit a cul–de–sac.

CITY OF LAKEWOOD, COLORADO

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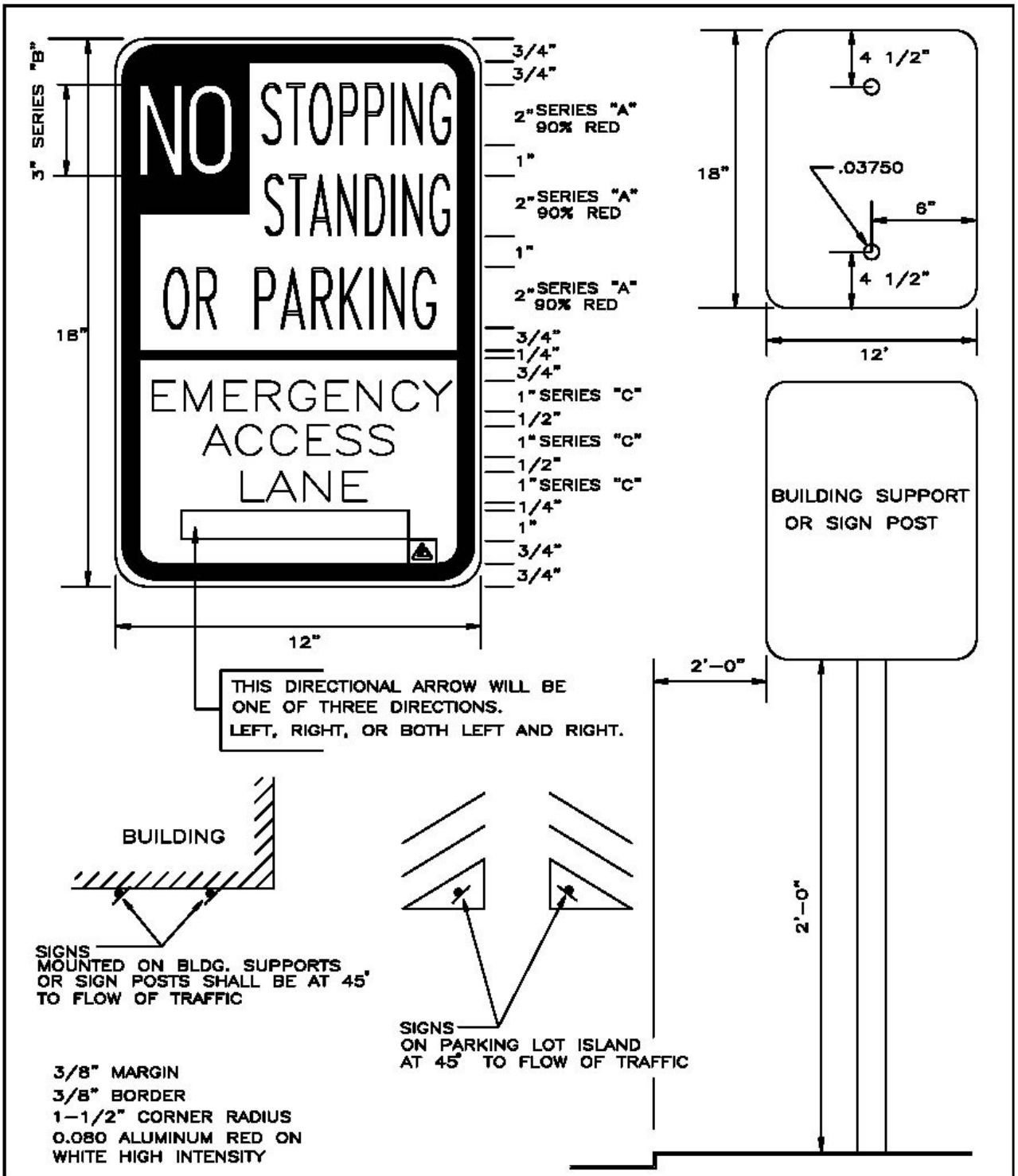
DIVISION OF TRAFFIC ENGINEERING

REVISION DATE:		FIGURE NO.
October 2006	FIRE DEPARTMENT APPROVED TURNAROUNDS	28

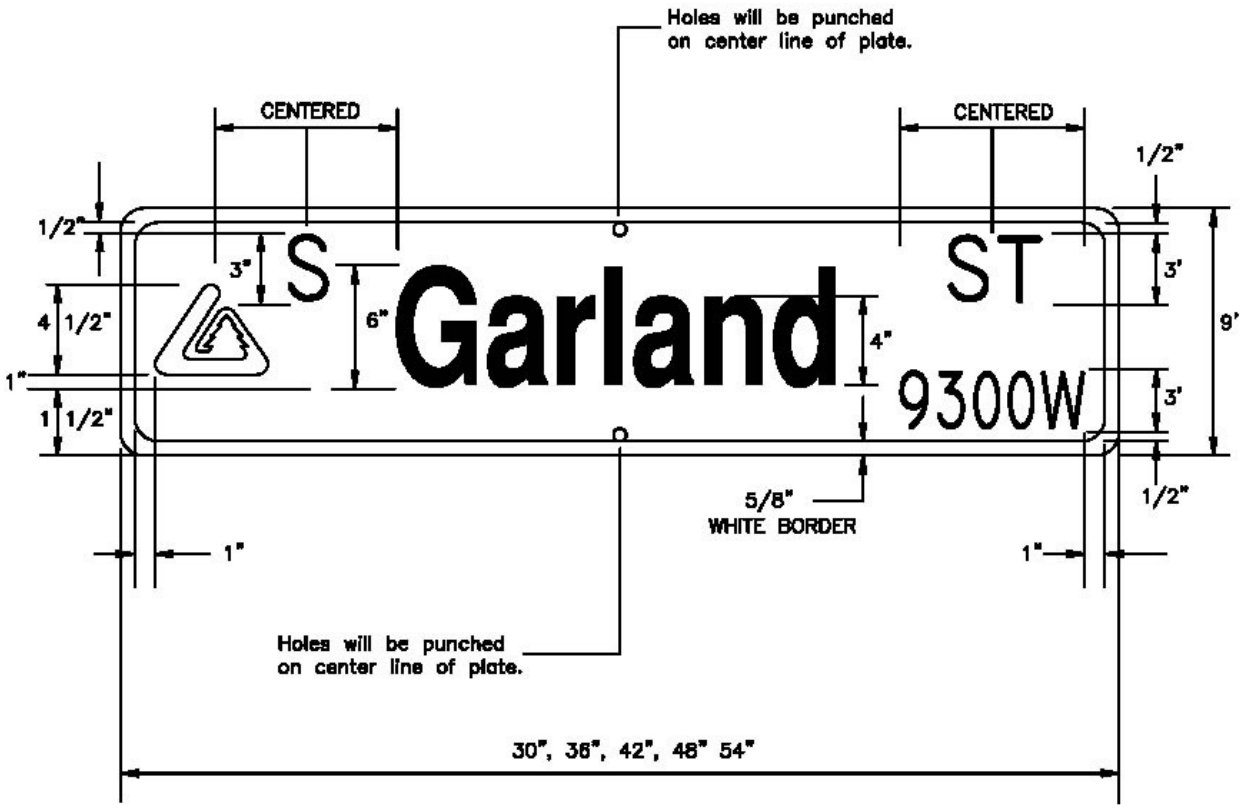
D:\Digital\Traffic\Fire Department Turnaround



CITY OF LAKEWOOD, COLORADO

DEPARTMENT OF PUBLIC WORKS
DIVISION OF TRAFFIC ENGINEERING

REVISION DATE:		FIGURE NO.
October 2006	EMERGENCY ACCESS LANE	29



NOTES :

1) This standard shall be used on all non-signalized intersections.
2) Sign blanks shall be 0.080 gauge aluminum.
3) Sheeting material shall be white 3M Dimond grade VIP overlayed with blue 3M E.C. film or DG^3.
4) Sign shall be placed on one side of the blank only.
5) Holes shall be 3/8 inch diameter free of burrs and sharp edges.
6) 1 1/2" radii.
7) Private streets shall conform to this specification except the Lakewood logo shall not be used.
8) All letters and numbers shall be series " C ".
9) All numbered streets shall be as shown: 6" 3rd 6" Lowercase

CITY OF LAKEWOOD, COLORADO
DEPARTMENT OF PUBLIC WORKS
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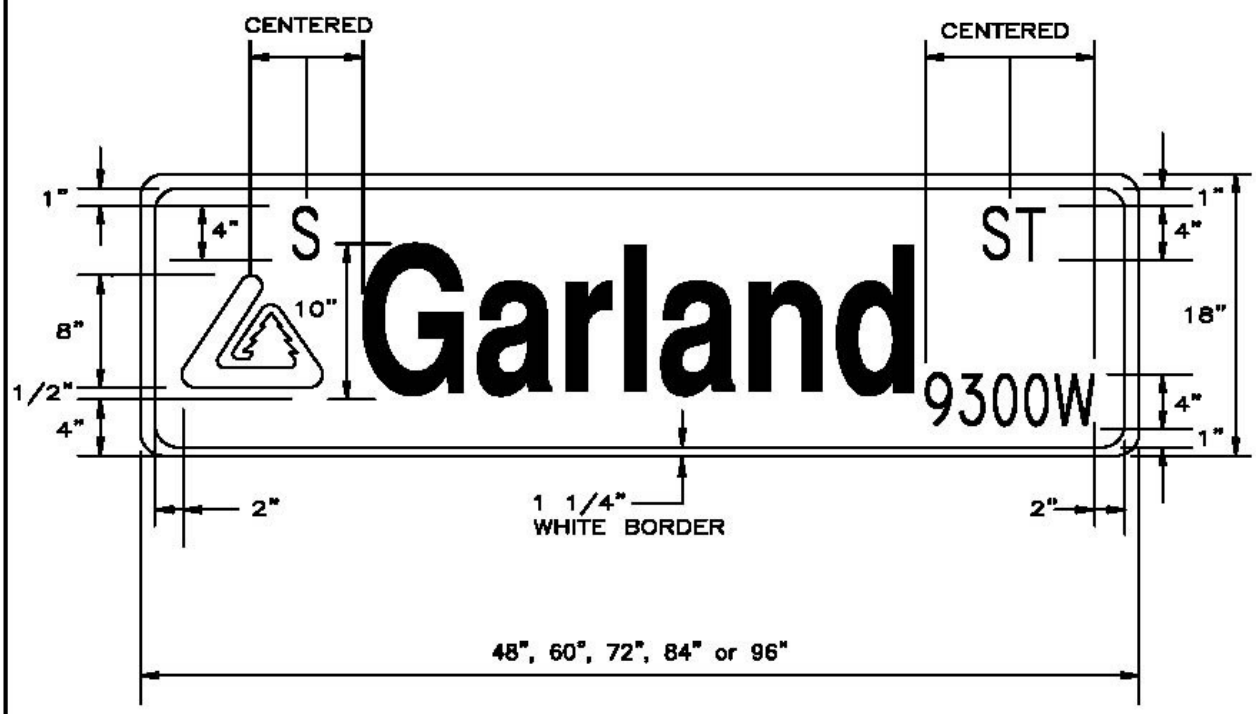
REVISION DATE:	STREET NAME SIGN DESIGN NON SIGNALIZED INTERSECTIONS	FIGURE NO.
October 2006		30

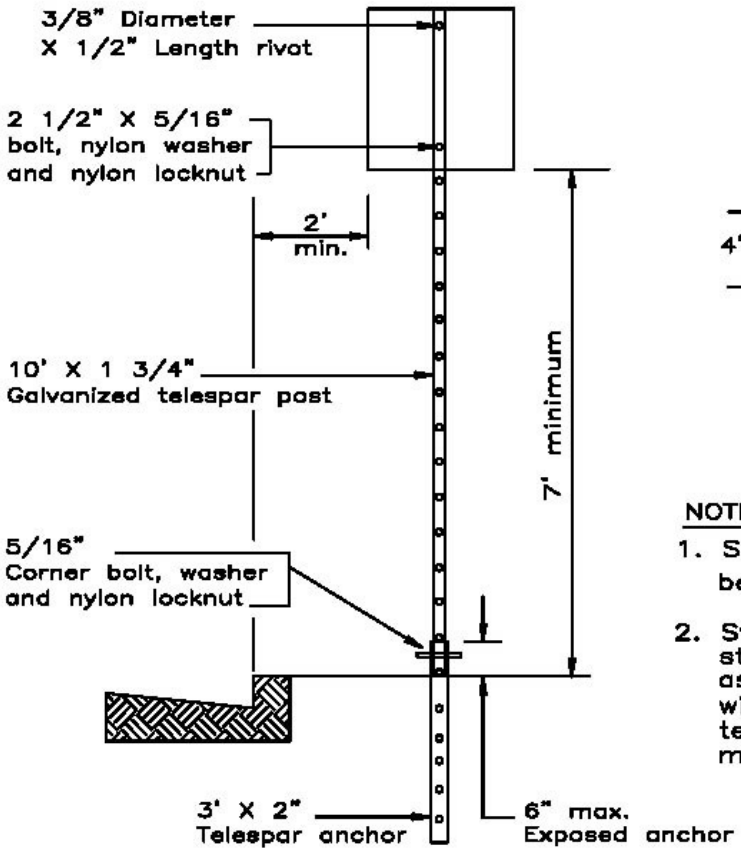


NOTES:

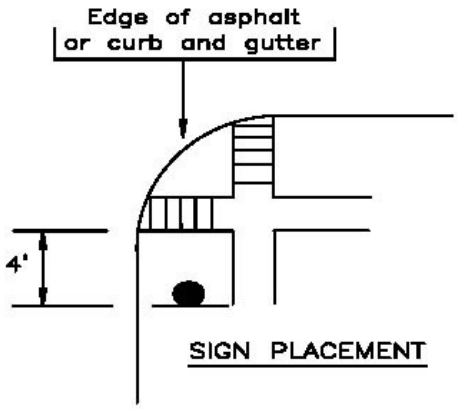
1) This standard shall be used on all signalized intersections.
2) Sign blanks shall be 0.080 gauge aluminum.
3) Sheeting material shall be white 3M Dimond grade VIP overlayed with blue 3M E.C. film or DG^3.
4) Sign shall be placed on one side of the blank only.
5) Holes shall be 3/8 inch diameter free of burrs and sharp edges.
6) 1 1/2" Corner radii.
7) Private streets shall conform to this specification except the Lakewood logo shall not be used.
8) All letters and numbers shall be series " C ".
9) All numbered streets shall be as shown: 10" 3rd 10" or 6" Lowercase.

CITY OF LAKEWOOD, COLORADO
DEPARTMENT OF PUBLIC WORKS
DIVISION OF TRAFFIC ENGINEERING

REVISION DATE:		FIGURE NO.
October 2006	STREET NAME SIGN DESIGN SIGNALIZED INTERSECTIONS	31



TYPICAL SIGN INSTALLATION
W/CURB AND GUTTER



TYPICAL PLACEMENT
OF STOP SIGN

NOTES:

1. Sign shall be placed 4' behind curb ramp or cross walk.
2. Stop sign installation with street name signs shall be as the typical sign installation with a 3' x 1 1/2" telespar extension for the mounting of street name signs.

NOTES:

1. All telespar shall be 12 gauge steel, square tubing, with 7/16" holes plus or minus 1/64" on 1" centers on all sides for the entire length.
2. Stop sign and street name signs shall be diamond grade material, all others shall be high intensity.
3. "No parking" signs shall be mounted on 8' post at a 45 degree angle facing traffic.
4. Signs larger than 48" in width shall be double posted.
5. All signs shall conform to the current issue of the Manual on Uniform Traffic Control Devices.

CITY OF LAKEWOOD, COLORADO
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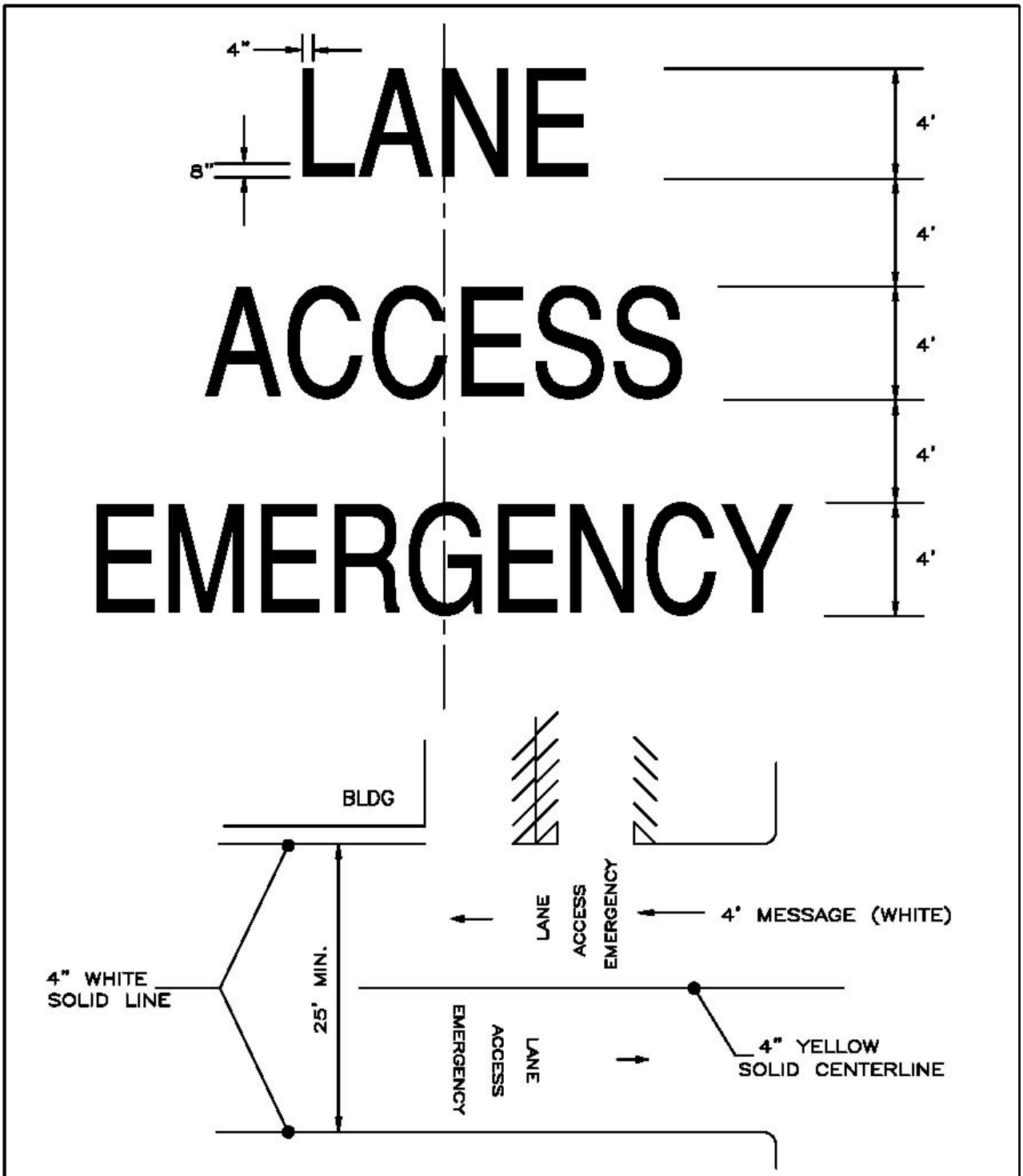
REVISION DATE:		FIGURE NO.
October 2006	POST MOUNT ROADSIDE SIGN DETAIL	32



CITY OF LAKEWOOD, COLORADO

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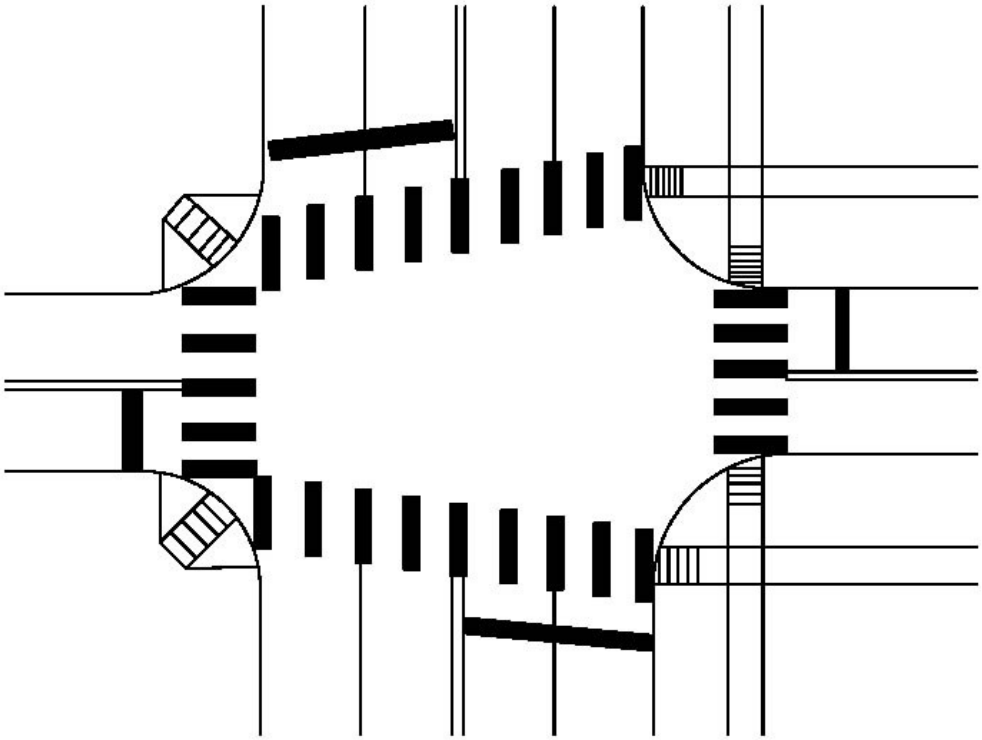
DIVISION OF TRAFFIC ENGINEERING

REVISION DATE:		FIGURE NO.
October 2006	EMERGENCY ACCESS LANE PAVEMENT MESSAGE LAYOUT	33



NOTES:

1. All bars shall be 1'x8', except on State Highway then 2'x8' bars required with a posted speed limit of 40 m.p.h. or greater.
2. Bars shall be centered in the travel lane and on lane lines.
3. Lanes wider than 12' shall have bars spaced at 6' center to center.
4. Bars shall be centered on the pedestrian ramps.
5. Stop bars shall be 24" in width and installed in compliance with the M.U.T.C.D.
6. All materials shall be thermoplastic or 3M Intersection grade tape or equivalent.

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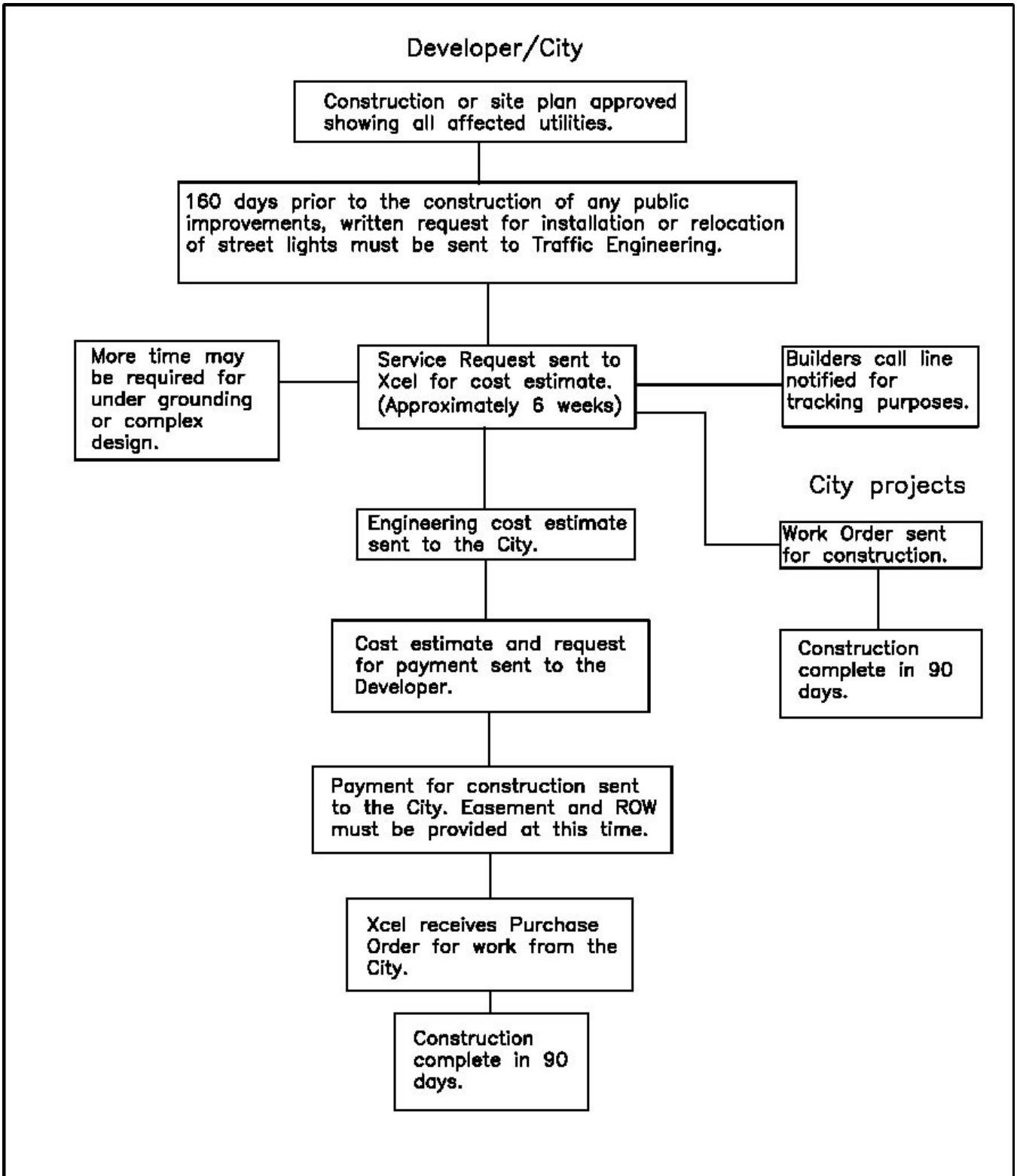
REVISION DATE:		FIGURE NO.
October 2006	CROSSWALK INSTALLATION	34



CITY OF LAKEWOOD, COLORADO

DEPARTMENT OF PUBLIC WORKS
DIVISION OF TRAFFIC ENGINEERING

REVISION DATE :	XCEL ENERGY COMPANY INSTALLATION AND RELOCATION PROCEDURES	FIGURE NO.
October 2006		35