HOUSTON PUBLIC WORKS

2022-2023 Review Cycle

Infrastructure Design Manual

Redlines

November 2023

City of Houston

Design Manual

Chapter 1

GENERAL REQUIREMENTS

Chapter 1
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Chapter 1

GENERAL REQUIREMENTS

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1.1.01 CHAPTER INCLUDES

1.1.01.A Research and submittal requirements for projects inside the city limits of Houston or within Houston's Extraterritorial Jurisdiction (ETJ).

~~1.1.01.A~~1.1.01.B Tree protection requirements.

1.1.02 REFERENCES

The following references should be reviewed in conjunction with this manual:

1.1.02.A Latest revision of the following City of Houston Code of Ordinances:

1. Chapter 33 - Planning and Development, Article IV - City Surveys.
2. Chapter 33 – Planning and Development, Article V – Trees, Shrubs, and Screening Fences.
3. Chapter 33 – Planning and Development, Article VI – Protection of Certain Trees.

~~1.~~4. Chapter 40 – Streets and Sidewalks, Article V - Excavation in Public Way

~~2.~~5. Chapter 42 - Subdivisions, Developments and Platting.

~~3.~~6. Chapter 47 – Water and Sewers, Article V - Industrial Wastewater.

1.1.02.B Texas Accessibility Standards (TAS) of the Architectural Barriers Act, Article 9102, Texas Civil Statutes.

1.1.02.C City of Houston Standard Specifications and Standard Details, latest revision.

1.1.02.D Rules and Regulations published by Texas Commission on Environmental Quality (TCEQ).

1. Texas Administrative Code Title 30, Part 1, Chapter 290 Public Water Drinking, latest revision.
2. Texas Administrative Code Title 30, Part 1, Chapter 217 Design Criteria for Domestic Wastewater Systems, latest revision.

1.1.02.E Texas Board of Professional Engineers and Land Surveyors (TBPELS) Practice Acts and Rules Concerning Practice and Licensure.

1. Texas Statute, Occupations Code, Title 6, Subtitle A, Chapter 1001 Texas Board of Professional Engineers and Land Surveyors.

2. Texas Statute, Occupations Code, Title 6, Subtitle C, Chapter 1071 Land Surveyors.

3. Texas Administrative Code, Title 22, Part 6 Texas Board of Professional Engineers and Land Surveyors.

1.1.02.F Texas Local Government Code, Title 2, Subtitle C, Chapter 42 Extraterritorial Jurisdiction of Municipalities.

1.1.02.G Storm Water Management Handbook for Construction Activities, Latest Edition as Prepared by Harris County, Harris County Flood Control District (HCFCD), and City of Houston.

1.1.02.H Harris County Public Infrastructure Department's Rules and Regulations.

1.1.02.I City of Houston IDM Chapter 13, Geospatial Data Deliverables.

~~1.1.02.I~~1.1.02.J American Standard for Nursery Stock (ANSI Z60.1).

1.1.03 DEFINITIONS

1.1.03.A As-Built Drawings - Final revised Drawings at completion of the project, submitted by the contractor to the Engineer of Record and City, that captures all changes in work during the construction process shown as revisions on the as-bid Drawings.

1.1.03.B City Engineer - The authorized representative of the City, or the City's designee, having approval authority for Publicly-Funded Projects, Privately-Funded Projects, or having authority for administration of design and construction contracts for the City.

1.1.03.C Conflict Verification - For capital improvement projects requiring the acquisition of fee or easement interest in real property, verification that all existing easements that lie across, along, under, over, through and within the parcel to be acquired will not prevent the construction of the utility or infrastructure or the intended use of the easement.

1.1.03.D Drawings - Plan, profile, details, and other graphic sheets to be used in a construction contract which define character and scope of the project.

1.1.03.E Drip ~~l~~Line - Imaginary circle drawn around a ~~t~~Tree, extending to the ~~t~~Tree's branching limit.

~~1.1.03.E~~1.1.03.F Engineer of Record - A Professional Engineer who seals Drawings, reports or documents for a project.

~~1.1.03.F~~1.1.03.G Extraterritorial Jurisdiction (ETJ) - The unincorporated territory extending beyond the corporate boundaries of the City established pursuant to Chapter 42 of the Texas Local Government Code, as may be amended from time to time.

1.1.03.H Parkway - Area lying between the street curb or edge of roadway paving and the adjacent property line.

~~1.1.03.G~~1.1.03.I Privately-Funded Projects - Projects that are funded by an individual or private entity and do not have a design contract with the City.

~~1.1.03.H~~1.1.03.J Publicly-Funded Projects - Projects that are funded by a public entity, but do not have a design contract with the City.

~~1.1.03.I~~1.1.03.K Professional Engineer - An engineer currently licensed and in good standing with the Texas Board of Professional Engineers and Land Surveyors (TBPELS).

~~1.1.03.J~~1.1.03.L Project Manager - An authorized representative of the City of Houston who manages the project or the Engineer of Record for private development.

1.1.03.M Protected Tree - Corridor ~~t~~Tree, designated ~~t~~Tree, green corridor ~~t~~Tree or ~~p~~Parkway ~~t~~Tree as defined by Chapter 33 of the City of Houston Code of Ordinances.

~~1.1.03.K~~1.1.03.N Record Drawings - Final revised Drawings prepared by the Engineer of Record on the original as-bid Drawings documenting significant changes in work based solely upon the marked-up As-Built Drawings, addenda, revisions, change orders and other data furnished by the contractor.

~~1.1.03.L~~1.1.03.O Registered Professional Land Surveyor (RPLS) - A surveyor currently registered and in good standing with State of Texas Board of Professional Engineers and Land Surveyors (TBPELS).

~~1.1.03.M~~1.1.03.P Review Authorities - The authorized representatives of City departments, divisions, branches or sections responsible for reviewing and approving calculations and Drawings for Publicly-Funded Projects, Privately-Funded Projects and for design and construction contracts with the City.

1.1.03.Q Specifications - City of Houston Standard Specifications plus project-specific narrative descriptions of procedures, requirements, and materials for a particular project.

1.1.03.R Tree - ~~a~~Any evergreen or deciduous ~~t~~Tree which at the time of planting has a caliper equal to or greater than 1 1/2 inches as measured six inches above the root collar, which is not less than six feet in height as measured from the root collar, and which meets the Standard for Nursery Stock Specifications.

1.1.04 PLAT AND CONSTRUCTION DRAWING REVIEW PROCESS

1.1.04.A Review of plat and construction Drawings by Houston Public Works is a required part of the overall platting process under purview of the City Planning Commission and the Planning and Development Department of the City of Houston.[1]

1.1.04.B The process to be followed in submitting documents for review and approval of water, wastewater, storm drainage, and street paving is described by the flowchart depicted in Figure 4.1, Class III Preliminary Plat.

1.1.04.C For projects requiring a subdivision plat, construction of utilities and paving is not permitted until the plat has been recorded.

1.1.04.D For projects not requiring a subdivision plat, construction of utilities and paving is not permitted until final design Drawings are approved and signed by the Director of Houston Public Works, or the Director's designee.

1.1.04.E Signature of the Director of Houston Public Works, or the Director's designee, on final design Drawings for utilities which are intended to remain private, does not indicate acceptance of the City for ownership or maintenance or operation of facilities indicated on the Drawings.

[1] Refer to weblink for City requirements: http://www.houstontx.gov/planning/Commissions/commiss_plan.html

SECTION 2 - GERNERAL DESIGN REQUIREMENTS

1.2.01 DESIGN REQUIREMENTS

1.2.01.A Preliminary Design.

1. Publicly/Privately-Funded Projects:

    a. Prior to preliminary design submittal, City reviewers are available to discuss alternate solutions for project elements where alternate designs may be considered.

    b. Provide the Office of City Engineer with Drawings in sufficient detail to describe the proposed improvements. Include proposed materials, if different from materials approved by the City. Identify any problems or conflicts associated with the project. Information furnished must be in sufficient detail for the City Engineer to assess whether the design meets current City design standards.

    c. Provide rights-of-way and easement requirements for the project.

2. Design Contracts with the City:

    a. Participate in preliminary conferences with the City's Project Manager outlining the scope of work and extent of the preliminary report.

    b. Prepare preliminary engineering studies and designs based upon the scope of work and as outlined in the professional engineering services contract with the City.

    c. Prepare the contractually specified number of copies of preliminary layouts, sketches, reports, and calculations supporting the preliminary layouts. Prepare alternate solutions, where applicable to the project, and include the engineer's specific recommendations.

    d. Prepare preliminary cost estimates for primary and alternate solutions of the proposed construction.

    e. Participate in conferences with the City to determine final design.

    f. When required by the professional services contract, provide detailed soils and geotechnical investigations and environmental investigations to support proposed construction of utilities and paving.

    g. Provide required real estate, rights-of-way, and easement

1.2.01.A.2.g continued

requirements for the project.

1.2.01.B Final Design.

1. Publicly/Privately-Funded Projects:

   a. Revise design to reflect comments of the City Engineer and Review Authorities. Include design calculations to support proposed improvements.

   b. Provide electronic Drawings to the City Engineer and Review Authorities for verification and compliance with prior review comments.

   c. Obtain required signatures from governmental agencies (other than the City of Houston) and private utility companies prior to requesting signature by the City.

   d. Include the following note on construction Drawings - "Contractor shall notify the City of Houston, Houston Public Works (832-394-9098), 48 hours before starting work on this project."

2. Design Contracts with the City:

   a. Furnish the City, where applicable, engineering data necessary for applications for routine permits required by local, state, and federal authorities.

   b. Prepare detailed final design Drawings and Specifications in compliance with comments received from the City subsequent to the review of the preliminary design.

   c. Prepare detailed cost estimates and proposal forms for the authorized project.

   d. Provide estimated construction duration. Include all back up calculations and assumptions. Provide assumed number of holidays, weekends, severe weather and other non-working days as applicable.

1.2.02 SUBMITTALS

1.2.02.A Submittal Procedures.

1. For Publicly/Privately-Funded Projects:

   a. To obtain review of final design Drawings for both Publicly-Funded and Privately-Funded Projects, first submit Drawings to the Houston

1.2.02.A.1.a continued

Public Works, Office of the City Engineer for assignment of a project number before review will commence. The project number will remain in effect for one year.

b. Once a project number is assigned, reference the number in all correspondence relating to that project.

c. Obtain and complete electronic plan review assigned tasks for each phase of the review process. The same project number will be used for all review phases of each project unless review of a subsequent phase is delayed by over one year.

d. Office of the City Engineer personnel will process reviews through appropriate review teams in Houston Public Works.

e. If a project has begun the review process but becomes inactive for a period of 12 months from the date of the last correspondence, the project will be considered stopped and the project number inactivated.

f. The City has a weekly one-day walk-through procedure for the signature of revisions and updates of plans approved through the hard copy review. Instruction sheets for this procedure may be obtained from the Office of the City Engineer.

g. Projects involving construction of privately owned facilities require review and approval of any connection to a public water line, sanitary sewer, or storm sewer or to a public street, using the process defined in this manual.

2. For Design Contracts with the City:

a. Submit documents in accordance with requirements of the professional engineering services contract.

1.2.02.B Preliminary Design.

1. Publicly-Funded and Privately-Funded Projects: Submit set of the design Drawings and supporting documents through the electronic plan review system. Provide supporting evidence as described in Article 1.2.01 and Article 1.2.04. All Drawings submitted through the electronic plan review system to the Office of the City Engineer are considered to be in the final design stage and ready for signature.

2. Design contracts with the City: Submit documents in accordance with requirements of the professional engineering services contract.

1.2.02.C Final Design.

1. Publicly/Privately-Funded Projects:

   a. Plans submitted through the electronic plan review system to the Office of the City Engineer must comply with Article 1.2.02.B.1.

2. Design Contracts with the City:

   a. Submit documents in accordance with requirements of the professional engineering services contract.

   b. Submit a copy of the City review comments on the preliminary Drawings.

1.2.02.D Signature Stage.

1. Publicly/ Privately-Funded Projects:

   a. This stage is only applicable for submittals that comply with Article 1.2.02.A.1.f. Submit previously approved Drawings for signatures.

   b. Plans submitted through the electronic plan review system to the Office of the City Engineer must comply with Article 1.2.02.B.1.

2. Design Contracts with the City:

   a. Submit original tracings with prints containing previous review comments.

   b. Specification submittals: Submit final design Specifications for review.

   c. Submit final computer-generated drawing files in acceptable electronic media including vicinity maps, right-of-way Drawings, construction Drawings, or other information pertinent to the project.

   d. Submit surveyor's field book and electronic data in accordance with Chapter 2, Survey Requirements.

1.2.02.E Construction.

1. For design contracts with the City, refer to construction submittal requirements in the professional engineering services contract.

2. Record Drawings:

   a. Provide Record Drawings in the format requested by the City.

1.2.02.E.2 continued

b. For design contracts with the City, submit Record Drawings in accordance with requirements of the professional engineering services contract.

c. For Publicly-Funded and Privately-Funded Projects, submit Record Drawings to the Office of the City Engineer no later than two weeks following final acceptance of the project.

d. For projects involving waterlines, refer to Chapter 7 for specific requirements.

3. Geospatial Data Deliverables: Provide GIS datasets in accordance with Chapter 13 – Geospatial Data Deliverables for projects that are proposing or modifying assets identified in Chapter 13 that are or will be operated and/or maintained by the City. In addition, provide GIS datasets in accordance with Chapter 13 – Geospatial Data Deliverables for projects that are proposing or modifying the privately owned and operated telecommunications assets described in Chapter 13.

1.2.02.F Provide additional submittals as required in applicable chapters of the City of Houston Infrastructure Design Manual (IDM).

1.2.03 QUALITY ASSURANCE

1.2.03.A Have surveying and platting accomplished under direction of a RPLS.

1.2.03.B Have recording documents sealed, signed, and dated by a RPLS.

1.2.03.C Have calculations prepared by or under the direct supervision of a Professional Engineer trained and licensed in disciplines required by the project scope.

1.2.03.D Have final design Drawings sealed, signed, and dated by the Professional Engineer responsible for development of the Drawings.

1.2.04 RESEARCH REQUIREMENTS

1.2.04.A Research existing utility and right-of-way information with the City departments listed below. Present and discuss the concept of the project with these same departments.

1. Houston Airport System

2. Houston Public Works

a. Capital Projects

b. Customer Account Services

1.2.04.A.2 continued

c. Financial Management Services

d. Houston Permitting Center

e. Houston Water

f. Transportation & Drainage Operations

3. Planning and Development Department

4. Parks and Recreation Department

5. Finance Department, Franchise Administration

1.2.04.B Research existing utilities and rights-of-way or easements for conflicts with the following public and private organizations:

1. Texas Department of Transportation

2. Harris County Public Infrastructure Department

3. Harris County Toll Road Authority

4. Metropolitan Transit Authority of Harris County

5. Harris County Flood Control District

6. Other City and County Governments

7. Franchise Holders:

   a. CenterPoint Energy - Gas

   b. AT & T Company

   c. CenterPoint Energy - Electric

8. Cable television and data communications companies

9. Other utility companies:

   a. Utility districts

   b. Private utilities/franchises

   c. Railroad companies

   d. Pipeline companies

1.2.04.C Verify that no restrictions or conflicts exist that will prevent approval and permitting of the project.

1. For capital improvement projects requiring the acquisition of real property, a Conflict Verification is required.

1.2.05 APPROVED DRAWINGS

1.2.05.A Approved Drawings for projects within the city limits and within the ETJ will be assigned a City drawing number and will be filed by the City prior to release back to the Engineer of Record. Record files for facilities within public rights-of-way will be available to the public. Record files associated with plants, buildings and other facilities outside public rights-of-way will be restricted pended security constraints.

SECTION 3 - TREE PROTECTION

1.3.01 TREE PROTECTION

1.3.01.A Tree Protection Requirements

1. Tree protection requirements ~~is~~ are designed to protect ~~t~~Trees ~~in a time of~~ during any construction activity~~, including, without limitation, construction or repair of buildings or other structures, installation or repair of utilities, or installation or repair of streets or sidewalks~~ within the ~~d~~Drip ~~l~~Line circle area of any ~~p~~Protected ~~t~~Tree that is not to be removed~~,~~. Construction includes, but is not limited to, the following: ~~without complying with the applicable provisions.~~

   a. Construction or repair of buildings or other structures;~~,~~

   b. Installation or repair of utilities;~~,~~

   c. Installation or repair of streets or sidewalks.

2. Tree protection must comply with the following requirements as applicable:

   a. City of Houston Code of Ordinances, Chapter 33, Article V "Trees, Shrubs, and Screening Fences." and Article VI "Protection of Certain Trees."

   b. Trees to be preserved must be clearly tagged in the field with ribbon.

   c. Protection barrier shall be composed of wood, wire, snow fence and braces of similar non injurious material.

   d. Tree wells shall be made of a durable material and set a minimum of four feet from any ~~t~~Tree they are designed to protect.

   e. Retaining walls of a durable material, i.e., stone, or treated lumber, are to be constructed around each ~~t~~Tree immediately after the grade is lowered. A retaining wall must be at least four feet from the ~~t~~Tree it is designed to preserve.

   f. Any under story clearing within six feet of existing ~~t~~Tree trunks ~~should~~ shall be done by hand.

   g. No building materials are to be stacked or stockpiled within the ~~d~~Drip ~~l~~Line or within six feet of any ~~t~~Tree to be preserved, whichever is greater.

1.~~2~~3.0~~4~~1.A.2

h. Topsoil shall not be stockpiled within the ~~d~~Drip ~~l~~Line or within six feet of any ~~t~~Tree to be preserved, whichever is greater.

i. Selective thinning of dead or dying vegetation, ~~t~~Tree stumps and other undesired growth is required in buffer areas. Supplemental vegetation shall comply with the landscape buffer requirements.

j. Tree boarding ~~should~~ shall be used if work is required with~~-~~in construction fencing.

~~a.~~k. Where possible, utility lines shall be tunneled beneath ~~t~~Tree roots in order to protect feeder roots, rather than trenched or open cut.

3. Tree Root Barriers

a. Tree root barriers will be used for planting of new ~~t~~Trees, to prevent the uncontrollable spread of ~~t~~Tree roots, following root pruning, to protect land and hardscapes from root damage.

~~b. It can be designed for surround or linear application depends on the hardscape to be protected, distance from surrounding trees, the aggressiveness of the tree, rooting depth of the tree(s).~~

b. Tree root barriers can be designed and configured to surround the ~~t~~Tree or for linear application.

c. Tree root barrier configuration depends on the hardscape to be protected, distance from surrounding Trees, aggressiveness of the Tree, and rooting depth of the Tree(s).

4. Holes for the ~~t~~Tree ~~should~~ shall be excavated two feet greater in width than the diameter of the soil ball.

5. The size of root barriers ~~should~~ shall be three times the diameter of the root ball.

END OF CHAPTER

City of Houston

Design Manual

Chapter 2

SURVEY REQUIREMENTS

Chapter 2
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Chapter 2

SURVEY REQUIREMENTS

SECTION 1 - SURVEY OVERVIEW

2.1.01 CHAPTER INCLUDES

2.1.01.A ~~Suggested g~~Guidelines for use by surveyors and engineers in development of construction drawings and Right-of-Way maps inside the Houston city limits and outside the Houston city limits within the Extraterritorial Jurisdiction (ETJ). These guidelines are required for capital improvement projects designed under professional services contracts with the City of Houston, projects involving underground work greater than or equal to three (3) feet in depth and any other project in which the City requests a survey. Driveway projects do not require a survey.

2.1.02 REFERENCES

2.1.02.A Latest revision of the following City of Houston Code of Ordinances:

1. Article IV, Chapter 33, City Surveys
2. Article I, Chapter 42, Subdivisions, Developments & Platting

2.1.02.B Texas Board of Professional Engineers and Land Surveyors (TBPELS) Practice Acts and Rules Concerning Practice and Licensure

1. Texas Statute, Occupations Code, Title 6, Subtitle A, Chapter 1001 Texas Board of Professional Engineers and Land Surveyor
2. Texas Statute, Occupations Code, Title 6, Subtitle C, Chapter 1071 Land Surveyors
3. Texas Administrative Code, Title 22, Part 6, Texas Board of Professional Engineers and Land Surveyors

2.1.02.C Texas Society of Professional Surveyors (TSPS) Manual of Practice for Land Surveying in Texas, latest edition

2.1.02.D Texas Local Government Code, Title 2, Subtitle C, Chapter 42 Extraterritorial Jurisdiction of Municipalities

2.1.02.E Houston Public Works website

2.1.03 DEFINITIONS

2.1.03.A Central Business District (CBD) – The area of downtown Houston as defined in the City of Houston Code of Ordinances, Chapter 42 - Subdivisions, Developments & Platting, Article I, Sec. 42-1.

2.1.03.B Chief Surveyor - An authorized representative of the City having approval authority for privately-funded projects or having authority for administration of contracts for the City.

2.1.03.C Closure - A mathematical application whereby a determination is made as to the exactness that a geometrical form is generated or attained within its confined elements of connecting lines and points. It is a computation method used by a land surveyor to test the quality of field survey measurements and to apply corrections in balancing or adjusting the survey to meet precision specifications.

2.1.03.D Computer Aided Design (CAD) - Preparation of drawings, plans, prints, and other related documents through the use of computer equipment and software programs.

2.1.03.E Control Point - A point used as a reference for surveying in which horizontal and vertical location/position is known.

2.1.03.F Extraterritorial Jurisdiction (ETJ) - Extraterritorial Jurisdiction shall mean the unincorporated territory extending beyond the corporate boundaries of the City established pursuant to Chapter 42 of the Texas Local Government Code, as may be amended from time to time.

2.1.03.G Engineer of Record - A professional engineer who seals drawings, reports or documents for a project.

2.1.03.H Global Navigation Satellite System (GNSS) - A satellite based positioning system. When it is used with proper observation procedures and equipment, it can provide survey quality locations in terrestrial space.

2.1.03.I GPS - A U.S. owned utility that provides users with positioning, navigation, and timing (PNT) services.

2.1.03.J Official Coordinate System - As defined in Chapter 33, Code of Ordinances for the City of Houston.

2.1.03.K Raw Data File – Computer files generated by all types of field equipment in their original, unprocessed state.

2.1.03.L Registered Professional Land Surveyor (RPLS) - A surveyor currently registered and in good standing with State of Texas Board of Professional Engineers and Land Surveyors (TBPELS).

2.1.03.M Right-of-Way - In this chapter, Right-of-Way refers to any real estate that the City currently has an interest in or will be acquiring an interest in.

2.1.03.N Site Control Monuments - Horizontal and vertical monuments needed to augment existing City monuments, conforming to standards established by the Chief Surveyor.

2.1.03.O Street Reference Monuments - Historic monuments used to re-establish existing City street Right-of-Ways.

2.1.03.P Survey Field Books - Bound standard engineer's field books for transit and level, 7-1/4 inch by 4-3/4 inch.

2.1.03.Q Temporary Benchmark (TBM) - A semi permanent man-made object, bearing a marked point, whose elevation above or below an adopted datum is known.

SECTION 2 - SURVEY DESIGN REQUIREMENTS

2.2.01 DESIGN REQUIREMENTS

2.2.01.A Adhere to these guidelines for capital improvement projects designed under professional services contracts with the City of Houston, projects involving underground work greater than or equal to three (3) feet in depth and any other project in which the City requests a survey. Driveway projects do not require a survey.

~~2.2.01.A~~2.2.01.B When establishing horizontal control, surveyors shall transcribe onto the pages of a standard Survey Field Book, as described in Article 2.1.03.P, all angles and distances, at the time of measurement, with an accompanying recovery sketch. When establishing vertical control, the surveyor shall use differential leveling, and transcribe the vertical data onto the pages of a standard Survey Field Book, with an accompanying recovery sketch. When establishing control using GNSS/GPS methods, record the date, time, and length of each observation. TBMs should be set where they are not likely to be destroyed during construction.

~~2.2.01.B~~2.2.01.C For projects in which the horizontal control exceeds a distance of 2,000 feet from a found City of Houston monument, a Site Control Monument shall be set. Additional Site Control Monuments shall be set should the horizontal control exceed a radial distance of 2,000 feet from an existing City of Houston monument or newly set Site Control Monument. Obtain City monument designation numbers from the City Survey Office. If an existing Site Control Monument is used to reference the project, said Site Control Monument must be re-observed and re-submitted with the resultant horizontal and vertical coordinates. All recovery ties must be re-observed and present on the new recovery sheets.

~~2.2.01.C~~2.2.01.D Field Work.

1. For engineering contracts with the City, field work shall be recorded in field books or electronic field books. Obtain a Survey Field Book number from the Survey Section and record this identification in the title block on drawing sheets.

2. The traverse line and design baseline must be monumented at its beginning, end, street intersections and at angle points with markers of a permanent nature, such as iron rods, spikes, or other lasting identification. Make reference drawings for each control monument showing ties to planimetric features to allow easy recovery. Set markers at a maximum of 1000 feet on long lines. (Wherever practical, all horizontal and vertical control monuments must be marked in such a way as to identify the surveyor in responsible charge.)

2.2.01.D continued

3. Locate any found monuments and/or property corners and reference them to the design baseline according to the existing City of Houston survey system, as required by Article IV, Chapter 33, City Surveys, of the Code of Ordinances.

4. Use the City datum (Code of Ordinances, Article IV, Chapter 33) as a basis for all elevations. Set TBMs within 200 feet of the beginning and end of each project baseline and at intervals not to exceed 1000 feet throughout the project.

5. Show the stations of all side street construction centerlines with angular relationships or bearings of said centerlines of side streets with the main roadway centerline station.

6. Record topographic information and improvements within the existing public Right-of-Way, proposed Right-of-Way, any contiguous easements to the Right-of-Way, and any area within the construction project.

7. Always collect topographic information and improvements a distance of 20 feet beyond the existing Right-of-Way and 25 feet beyond the proposed Right-of-Way, where accessible.

8. Record topographic information and improvements on intersecting streets for a distance of 100 feet beyond proposed pavement. Identify all visible underground structures, such as inlets, manholes, and junction boxes, with size, depth, and type. See Figure 2.1 Perimeter of Standard Topographical Survey.

9. Cross sections shall be taken at intervals of 100 feet for projects outside of the CBD. For projects within the CBD, take cross sections at 25 or 50 foot intervals. For levels recorded in field books, record rod readings or elevations as + or - and distance right or left of the design baseline or roadway centerline. Data collector of a total station can be used to acquire necessary elevations at required intervals. Record elevation of driveways at intersection of driveway centerline with existing or proposed Right-of-Way line. Cross sections shall include a reading at the following points: street centerline and/or crown of the street, flow-line of ditch or gutter, curb or pavement edge, sidewalk, the existing or proposed Right-of-Way line, 20 feet beyond the Right-of-Way line if possible. See Figure 2.1 Perimeter of Standard Topographical Survey.

10. For acquisition of new or additional Right-of-Ways:

    a. Tie all points of beginnings (POB) for each parcel and points of commencing (POC) to the Official Coordinate System as defined in Chapter 33, Code of Ordinances for the City of Houston.

2.2.01.D.10 continued

b. Set iron rods or permanent markers at the intersections of the proposed Right-of-Way and property lines of parcels to be acquired.

c. Identify monuments, corners, angle points, points of curve (PCs), points of intersection (PIs), points of tangency (PTs), and other points as either "found" or "set." Describe each monument in such a way as to clearly define size, type of material and the nature of the monument, i.e., 3/4-inch iron pipe, 5/8-inch iron rod, cotton spindle, mag nail, etc.

d. Locate visible improvements, buildings, fences, permanent signs, utilities and other structures within 25 feet of the proposed Right-of-Way line.

~~2.2.01.D~~2.2.01.E Calculations.

1. Calculate coordinates of proposed Right-of-Way parcels, Control Points, found or set monuments, curve data, lengths, stations and offsets to monuments, and proposed improvement features.

2. Electronic ASCII files of the coordinate calculations shall be submitted to the City with Survey Field Books and Raw Data Files.

~~2.2.01.E~~2.2.01.F Construction Drawings.

1. All found monuments (property corners, Street Reference Monuments, benchmarks etc.) must be plainly shown on the drawings and located by station and distance, right or left from the traverse line, or design baseline. Monuments used to establish the design line or traverse must be identified as Control Points, and their relationship to the design baseline and to the proposed Right-of-Way lines must be shown. If the project is dimensioned from a traverse line, which is different than the design baseline, it must be established and monumented in accordance with the requirements of Article 2.2.01.D. Coordinates for traverse Control Points and all points of curve, points of tangency, and points of intersection along the design baseline shall be shown.

2. Show location and identification of existing Site Control Monuments and found Street Reference Monuments, by station and distance and whether right or left of traverse line or design baseline. Show swing ties for all Control Points and Street Reference Monuments using the City of Houston recovery sheet format.

3. Show and identify location of the City datum monuments and TBMs used for elevation control. List the TBM located closest to that particular sheet in a station/offset, description and elevation format.

2.2.01.F continued

4. Show centerline angles of intersection of side streets with main roadway centerline. Where bearings are used, identify source of bearings and show bearings on both control line and project centerline when they are not the same line.

5. For bridges, overpasses and underpasses show top of pavement elevations at gutter line and centerline for the following locations:

   a. Construction joints

   b. Armor or expansion joints

   c. Intervals between bents that correspond to the increments used for dead load deflection calculations.

6. For bridges and grade separations, drawings must incorporate layout sheets which identify proposed centerline and curve information plus:

   a. Surface coordinates for Control Points so that an inverse between coordinates reflects a surface distance. Identify origin of coordinate system used.

   b. Show coordinates of design baseline at PIs.

   c. Show coordinates of curb lines at their intersection with the centerline of bents and abutments for irregular structures.

7. For all horizontal and vertical control monuments, show coordinates on the Official Coordinate System as defined in Chapter 33, Code of Ordinances for the City of Houston. Proper metadata for GPS - derived points should include the vertical adjustment, the Geoid used, and the current published coordinates of the base stations at the time of calculation.

2.2.02 SUBMITTALS

2.2.02.A Computer Aided Design (CAD) file format shall be submitted in accordance with Chapter 3 requirements.

2.2.02.B Examples, templates and checklists can be found on the survey section website located here, https://www.publicworks.houstontx.gov/survey-section.

2.2.02.C For work performed through a professional service contract with the City, deliver:

1. Original Survey Field Books, signed & sealed by a Registered Professional Land Surveyor (RPLS). Electronic submittals of Survey

2.2.02.C.1 continued

Field Books are acceptable if they are legible, in color, and comply with 22 Tex. Admin. Code §138.35 (2021) and any amendments or recodifications to that statute thereafter.

2. An electronic text file in standard ASCII format (Point Number, Northing, Easting, Elevation, Description) containing all points collected, calculated and set for the project.

3. The CAD file submitted by the project surveyor to the Chief Surveyor shall be the same file that is provided to the Engineer of Record.

4. All Raw Data Files (conventional and GPS/GNSS) as defined in this chapter.

2.2.02.D For projects identifying or describing acquisition of new or additional Right-of-Ways, additional documents to be submitted are:

1. Drawings:

   a. Overall index map identifying all Right-of-Way parcels for the project.

   b. Individual survey drawings of each parcel,

   c. All maps and drawings shall be signed and sealed by an RPLS. Electronic submittals of maps and drawings are acceptable if they are legible, and comply with 22 Tex. Admin. Code §138.35 (2021) and any amendments or recodifications to that statute thereafter.

2. Metes & bounds descriptions (signed and sealed) and Closure report printouts for each parcel.

3. Abstract information, all recorded plats and copies of instruments used (i.e., deeds) in preparation of the Right-of-Way drawings.

4. The CAD file generated for parcels shall utilize the parcel title block template found on the Survey Section website.

2.2.02.E For projects requiring new Site Control Monuments, the surveyor responsible for setting the monuments shall submit sealed City of Houston monument sheets, with necessary supporting data, to the City Survey Section.

2.2.02.F All submittals will be retained in the City's permanent files.

2.2.03 QUALITY ASSURANCE

2.2.03.A Field surveying used in the development of construction drawings, calculations and preparation of metes & bounds descriptions and Right-of-Way maps, shall be performed by or under the direct supervision of an RPLS.

2.2.03.B Survey Field Books, metes & bounds descriptions and Right-of-Way maps shall have the imprinted or embossed seal of the responsible RPLS and shall be dated and signed by the RPLS.

2.2.04 RIGHT-OF-WAY MAPS

2.2.04.A Show "x," "y" values on monuments based on the City survey control and the scale factor used to convert grid coordinates to "surface" coordinates. All distances shall be shown as "surface" distances and plainly marked as such. All bearings shall be based on the Official Coordinate System.

2.2.04.B Distances on proposed Right-of-Way lines shall be continuous from beginning to end of the job. Show either straight line or arc distance across intersecting streets.

2.2.04.C Where a parcel is taken from a larger tract, show dimensions, distances, and area of the remainder of the tract based on recorded information.

2.2.04.D Identify the evidence used to decide the final placement or establishment of the proposed Right-of-Way line, such as angle points, or corner monuments, as either "set" or "found." The description of each point used shall be shown on the drawing as identified in the field survey.

2.2.04.E Curve data must include the following: delta, radius, arc length, chord length, and chord bearing.

2.2.04.F Grid coordinate values of "x," "y" must be given on the POB of each parcel. Show coordinates on map and metes and bounds with the scale factor.

2.2.04.G Other information to be shown on Right-of-Way maps:

1. All visible improvements such as buildings, fences, permanent signs, utilities, and other structures located on the property or within 25 feet outside the proposed Right-of-Way line, if accessible.

2.2.04.G continued

2. Abstract information used in preparation of the Right-of-Way map.

3. Survey Field Book numbers obtained from the Chief Surveyor.

4. Right-of-Way parcel numbers obtained from Real Estate Services.

END OF CHAPTER

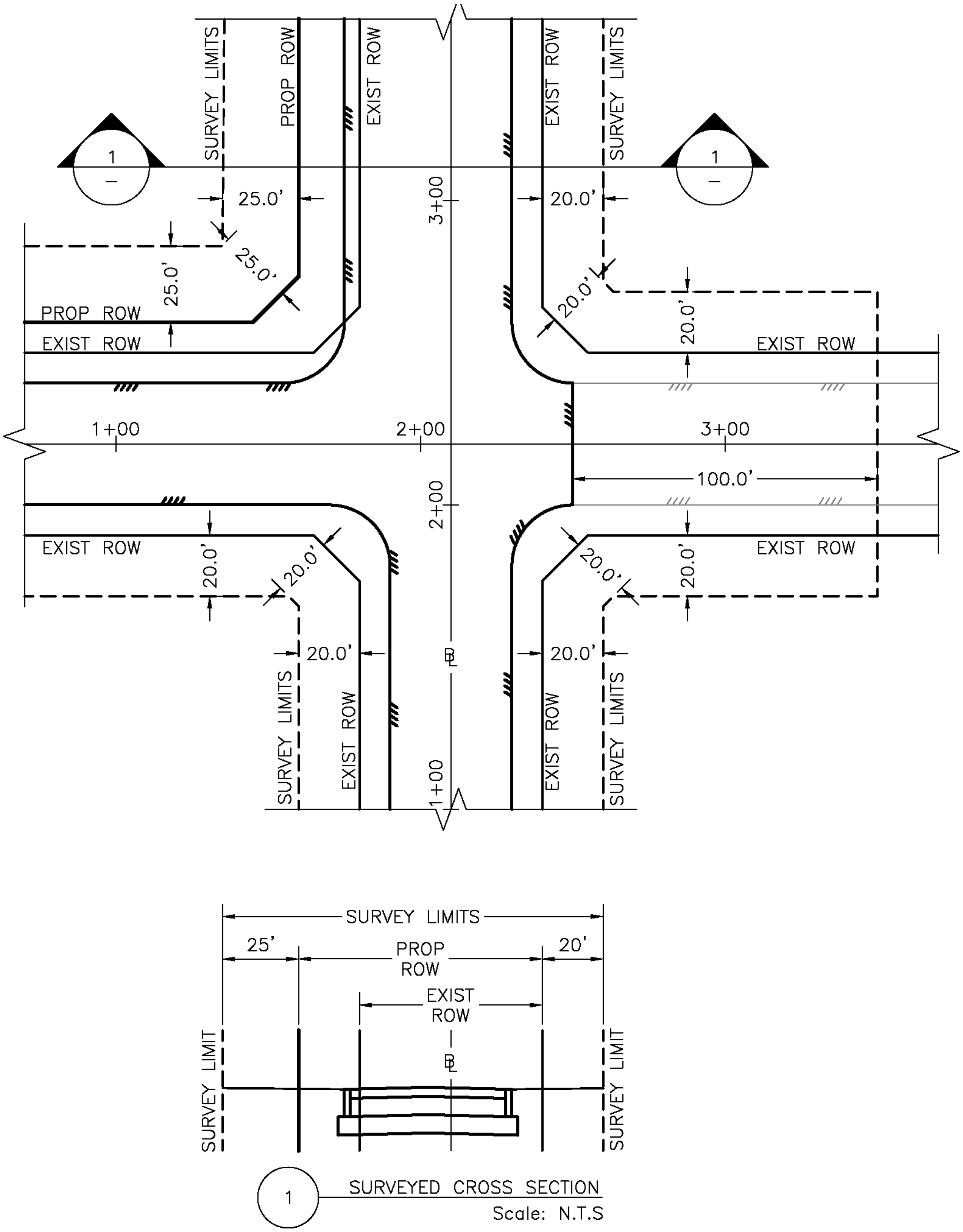


Figure 2.1 – PERIMETER OF STANDARD TOPOGRAPHICAL SURVEY

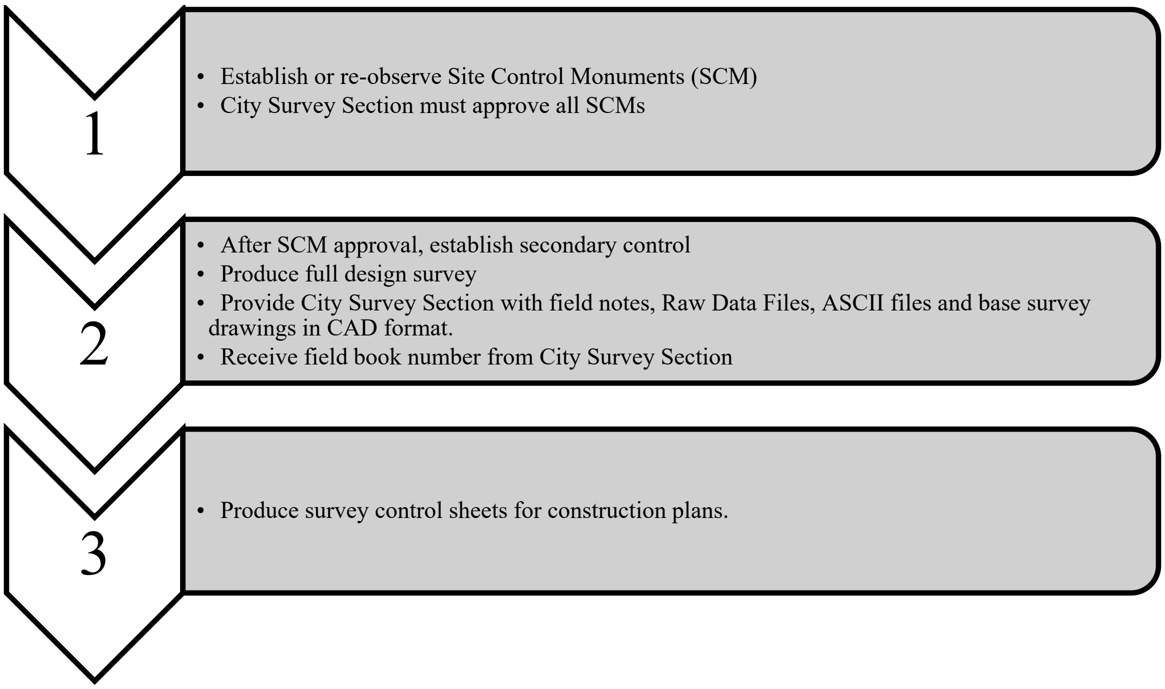


Figure 2.2 – GENERAL PROCESS FOR DESIGN CONTRACTS

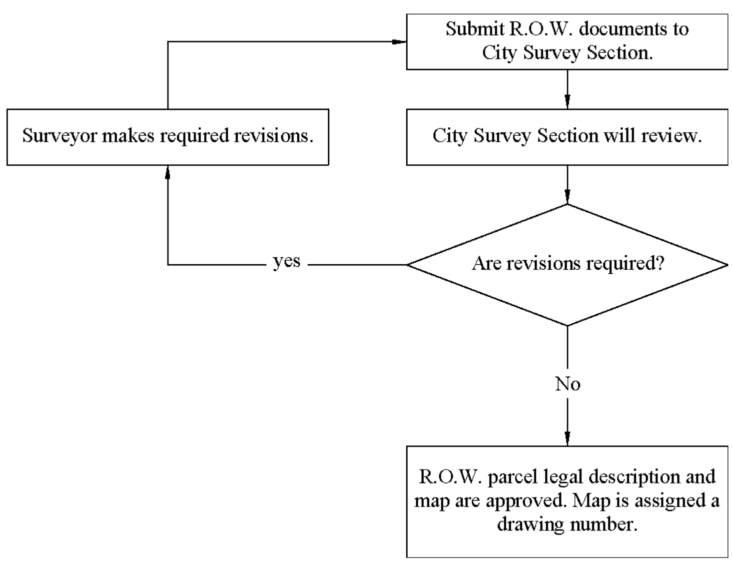


Figure 2.3 – GENERAL PROCESS FOR R.O.W. PARCEL REVIEWS

END OF CHAPTER

APPENDIX A - DESIGN FIGURES

1.01 SITE CONTROL MONUMENT INSTALLATION REQUIREMENTS FOR VARIOUS CONDITIONS (CITY OF HOUSTON)

Site Control Monuments are intended to serve as the primary control for capital improvement projects. They should be established in a location and manner to ensure stability and longevity.

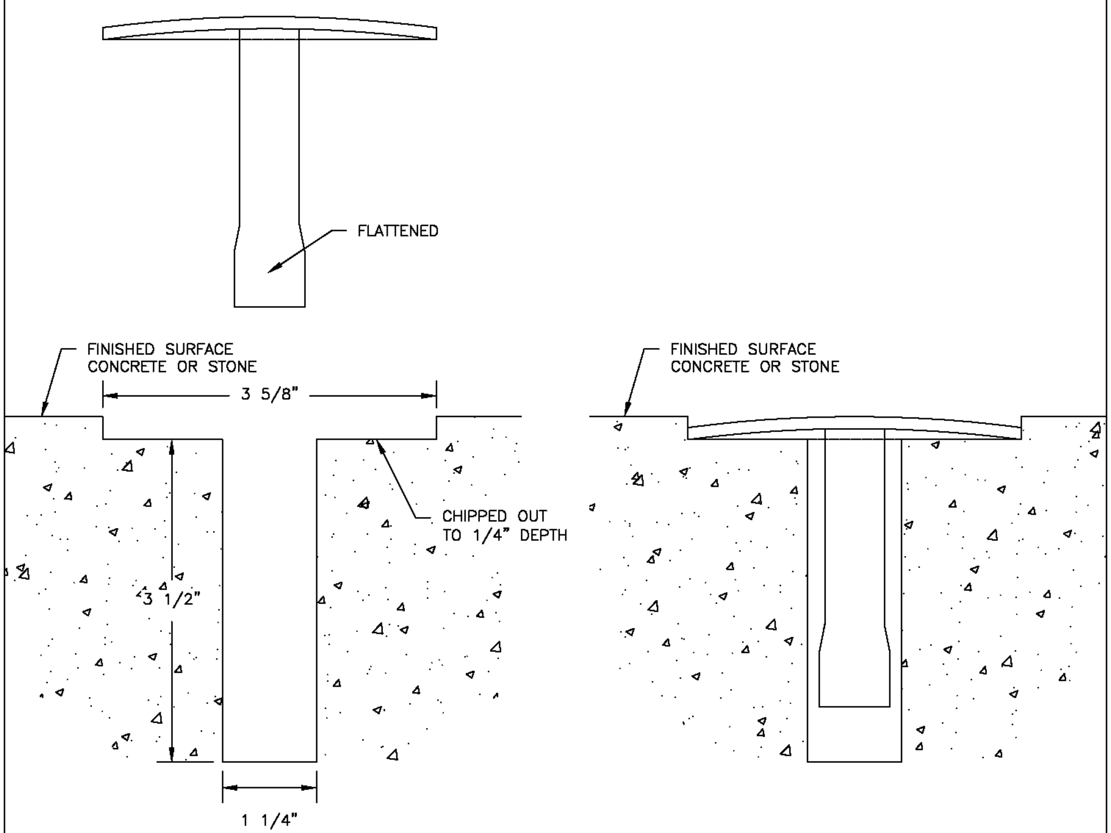
The two options presented in Appendix A are the minimum requirements for installation of Site Control Monuments and will be appropriate for most conditions. Any deviation from these minimum requirements must be approved by the Chief Surveyor.

THE REQUIREMENTS IN THIS APPENDIX ARE HEREBY APPROVED AS MINIMUM REQUIREMENTS FOR SURVEY SITE CONTROL MONUMENTS.

JULY 2022

TYPE I

MARKER IN SURFACE, SET IN DRILL HOLE, CONCRETE OR STONE



A. HOLE PREPARATION

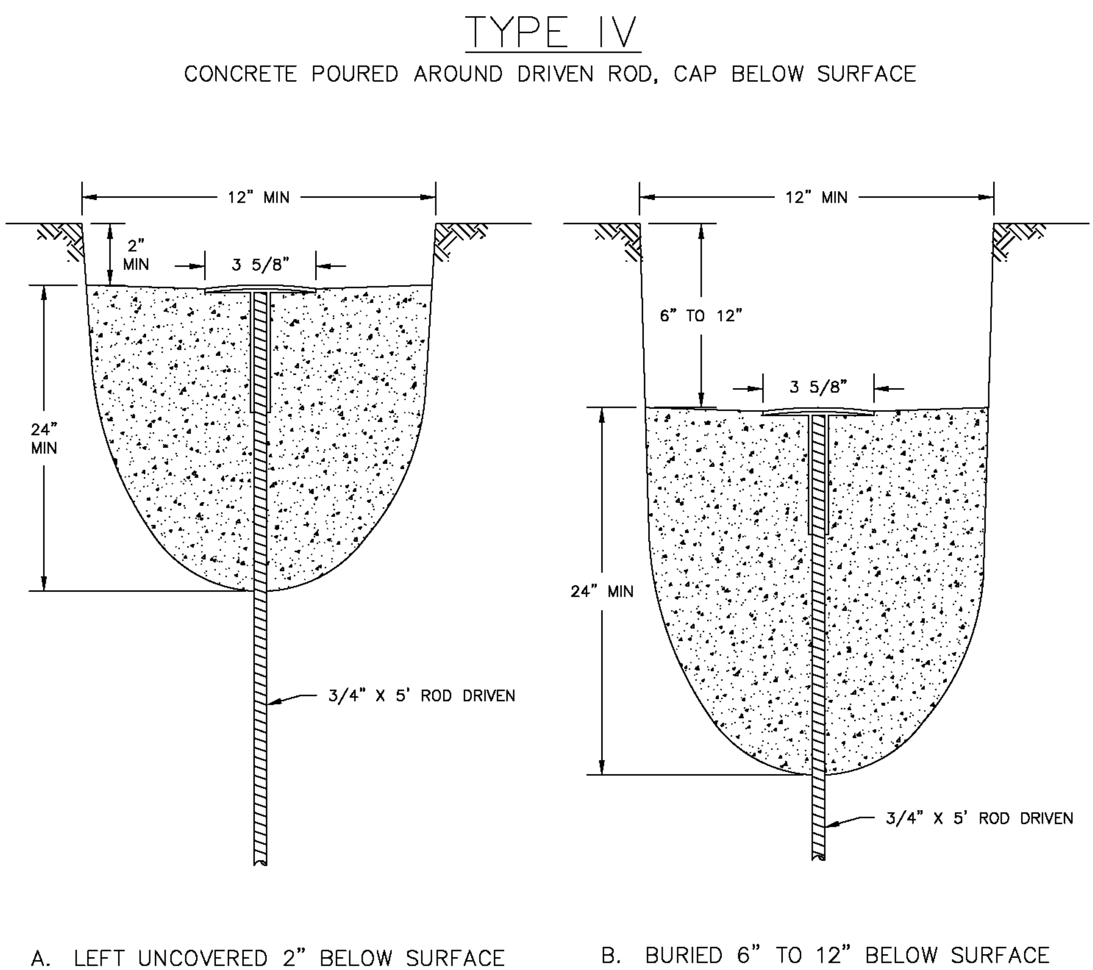
B. FINISHED TYPE 1 MONUMENT

INSTRUCTIONS:

1. DRILL HOLE 3-1/2" TO 4" DEEP BY 1-1/4" DIAMETER.
2. RECESS 3-5/8" BY 1/4" DEEP BY CHIPPING.
3. FILL HOLE WITH EPOXY OR FAST-SET GROUT.
4. PRESS CAP WITH FLATTENED STEM INTO PLACE.
5. CLEAN.

C. SPECIAL CASE
UNDER SOME CONDITIONS, THIS SPECIFICATION MAY BE MODIFIED. WHEN INSTALLATION IS DESIRED IN A SIDEWALK, DRILL THE 1-1/4" HOLE THROUGH THE SIDEWALK AND THEN DRIVE THE ROD IN THE HOLE. CRIMP THE CAP ONTO THE ROD AND COMPLETE THE DRIVE TO FINAL SET IN FAST-SET GROUT.

Figure A. 1 – TYPE I, MARKER IN SURFACE, SET IN DRILL HOLE CONCRETE OR STONE



INSTRUCTIONS:

1. MAKE HOLE A MINIMUM OF 12" AT TOP DUG A MINIMUM OF 24" DEEP, DEPENDING UPON WHETHER MONUMENT IS TO BE EXPOSED OR BURIED.
2. POUR CONCRETE TO LEVEL DESIRED.
3. DRIVE ROD TO 12" ABOVE SURFACE OF GROUND.
4. CRIMP CAP TO ROD.
5. COMPLETE DRIVING UNTIL CAP IMBEDDED IN SURFACE OF CONCRETE. PLACE WOOD OVER CAP TO PROTECT WHILE DRIVING.
6. COMPACT GROUND AROUND CONCRETE.
7. CLEAN.

Figure A. 2 – TYPE IV, CONCRETE POURED AROUND DRIVEN ROD, CAP BELOW SURFACE

END OF APPENDIX A

City of Houston

Design Manual

Chapter 3

GRAPHIC REQUIREMENTS

Chapter 3
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Graphic Requirements

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Chapter 3

GRAPHIC REQUIREMENTS

SECTION 1 - OVERVIEW

3.1.01 CHAPTER INCLUDES

3.1.01.A Graphic requirements are provided for a consistent uniform appearance for engineering drawings. It is not the intent of this manual to be a training guide for AutoCAD, ArcGIS or other software products.

3.1.01.B This chapter is to be used for all new projects. For projects already underway, coordinate with the City Project Manager to assess the appropriateness of implementation. It is not the intent of this update to cause existing projects to incur additional time or cost, and measure should be taken to avoid such.

3.1.02 REFERENCES

3.1.02.A City of Houston, Code of Ordinances, Chapter 33, Article IV - City Surveys.

3.1.02.B City of Houston, Standard Details, current edition.

3.1.02.C City of Houston, Standard Specifications, current edition.

3.1.02.D National Institute of Building Sciences, U.S. National CAD Standard (NCS).

3.1.02.E Texas Board of Professional Engineers and Land Surveyors (TBPELS), Practice Acts and Rules Concerning Practice and Licensure.

3.1.03 DEFINITIONS

3.1.03.A AutoCAD - CAD software platform for two and three-dimensional design and drafting. The file format of AutoCAD is DWG. AutoCAD has included file format support for DXF and DWF.

3.1.03.B ArcGIS – Provides an infrastructure for making maps and geographic information.

3.1.03.C City Project Manager - An authorized representative of the City of Houston who manages the project.

3.1.03.D Computer Aided Design (CAD) - Preparation of Drawings, plans, prints, and other related documents through the use of computer equipment and software programs.

3.1.03.E Control Point – A point used as a reference for surveying in which horizontal and vertical location/position is known.

3.1.03.F Drawings - Plan, profile, detail, and other graphic sheets to be used in a construction contract which define character and scope of the project.

3.1.03.G Engineer of Record - A Professional Engineer who seals Drawings, reports, and documents for a project.

3.1.03.H Geographic Information System (GIS) – A system designed to capture, store, manipulate, analyze, manage, and present geographic data.

3.1.03.I Layout Space - Commonly known as "Paper Space", is the area designated for producing printed deliverables.

3.1.03.J Model Space – A limitless 3-D drawing area that is the default in AutoCAD software used for the beginning of a design.

3.1.03.K Professional Engineer - An engineer currently licensed and in good standing with the Texas Board of Professional Engineers and Land Surveyors (TBPELS).

3.1.03.L Registered Professional Land Surveyor (RPLS) - A surveyor currently registered and in good standing with the Texas Board of Professional Engineers and Land Surveyors (TBPELS).

3.1.03.M Right-of-Way - Any real estate that the City currently has an interest in or will be acquiring an interest in.

3.1.03.N Special Structures – Structures not covered by approved standard details, such as stream or gully crossings, special manholes, and junction boxes.

3.1.03.O Temporary Benchmark - A semi-permanent man-made object, bearing a marked point, whose elevation above or below an adopted datum is known.

3.1.03.P U.S. National CAD Standard (NCS) – Standards created to encourage a more rational construction regulatory environment. The U.S. National CAD Standard is published by the National Institute of Building Sciences. https://www.nationalcadstandard.org/ncs6/

3.1.04 SOFTWARE AND DATA FORMAT

3.1.04.A All CAD files, both references and sheet file deliverables, shall be provided in .DWG file extension format compatible with the most recent version of AutoCAD. However, the use of other software with the ability to convert files into the proper .DWG format, will also be acceptable.

3.1.04.B Electronic .PDF drawings submitted to the City of Houston are to be devoid of AutoCAD SHX comments or .PDF comments automatically generated during the .PDF conversion process, and shall have a minimum of 400 dpi resolution. Annotations and form fields are to be flattened prior to submittal.

3.1.05 IMPORTING STANDARD DETAILS

3.1.05.A Standard details shall be imported onto the sheet files when applicable. City standard details shall not be cropped and must be included in the Drawings as the City provides them. The standard detail's entire border and title block must remain visible. For visibility each sheet shall only have up to:

1. Six 8 ½" x 11" standard details oriented portrait.
2. Four 8 ½" x 11" standard details oriented landscape.
3. Two 11"x17" standard details oriented landscape.
4. One 22"x34" standard detail oriented landscape.

3.1.05.B The current standard details can be found here: https://www.houstonpermittingcenter.org/office-city-engineer/design-and-construction-standards

3.1.06 MODIFICATIONS TO STANDARD DETAILS

3.1.06.A Modifications to standard details are allowed. Any modifications to a City standard detail during the project's design phase, however minor, must follow the requirements in 3.1.06.B.

3.1.06.B Modification Process:

1. CAD files to be used for creating modified standard details are posted online. These CAD files have been modified to remove the City Engineer and Houston Public Works Director's signature. City signatures will not be allowed on modified standard details.
2. All changes in each sheet that are pertinent to each modification shall be enclosed in revision "clouds".
3. The letter of the modification, beginning with "A", shall be placed inside of a triangle, commonly known as a "delta". The letter is meant to indicate the engineer who modified the standard detail. If multiple engineers modify details on the same sheet, they shall use different revision letters. Letters shall only be used for modifications to standard details during the design phase. For modifications during the construction phase follow SECTION 5 of this chapter.
4. Each modification delta shall be placed adjacent to the corresponding modification cloud(s) and next to the corresponding engineer's seal. Modification deltas and clouds shall not be removed from the sheet at any time.

3.1.06.B continued

5. It is acceptable to have multiple clouds with the same modification delta on a sheet if all changes are approved by the same Engineer of Record.

6. The designation "MOD" must be appended to the standard detail title, the sheet title (if different than standard detail title) and must be reflected in the sheet index.

7. Each modification must be documented on the title block area of each sheet.

8. All modification information must be filled out, including the letter of the modification, date, a brief description that explains each item changed, and approver.

SECTION 2 - GENERAL SHEET CONTENT

3.2.01 GENERAL SHEET CONTENT

3.2.01.A Plan sets for typical projects shall be produced to scale on 22” x 34”, ANSI D sheet sizes.

3.2.01.B Final Drawings Submittal.

1. Physical Drawings shall be India ink on mylar or produced by CAD on mylar using non-water based ink. Do not use adhesive-backed material on final Drawings.

2. Electronic Drawings must be submitted according to SECTION 4 of this chapter.

3.2.01.C The seal, date, and original signature of the Professional Engineer responsible for the Drawings is required on each sheet developed by the design engineer. The design engineer may use stamped seal or embossed imprint; however, the embossed imprint must be shaded so that it will reproduce on prints. Use of an electronic seal for plan submittal needs to be in accordance with the Texas Board of Professional Engineers and Land Surveyors (TBPELS) Practice Act and Rules Concerning Practice and Licensure. Survey control sheets require seal and signature of Registered Professional Land Surveyor (RPLS).

3.2.01.D Applicable City standards shall be included in the engineering plan set.

3.2.01.E Develop Drawings to accurate scale showing proposed pavement, typical cross sections, details, lines and grades, existing topography within street Right-of-Way, and any easement contiguous with the Right-of-Way. At the intersection, the cross-street details shall be shown at sufficient distance (20-foot minimum distance outside the existing roadway Right-of-Way or 25-foot minimum distance outside the proposed roadway Right-of-Way, of which the wider Right-of-Way shall govern) in each direction along cross street for designing adequate street crossings.

3.2.01.F If a roadway exists where Drawings are being prepared to improve or construct new pavement or a utility, label the existing roadway width, surfacing type, and thickness.

3.2.01.G Show all street and road alignments on Drawings refer to Chapter 2, Section 2.2.01.F, Construction Drawings.

3.2.01.H Existing utilities shall be plotted in color according to Article 3.3.03 - LINE WEIGHTS.

3.2.02 DRAWING FILE ASSEMBLY

3.2.02.A To ensure consistency, the same drawing file assembly convention must be followed. This section describes the use of reference files, sheet files, Model and Layout Space.

1. Reference Files.

   a. Contain the subset of design elements and geometric components, with all content drawn and placed in Model Space. All reference files are to be drawn full scale 1’ = 1’ with pertinent annotation, text, and dimensions.

2. Sheet Files.

   a. Reference file attachments shall be included in Model Space except for the title block. The title block shall be attached in Layout Space.

3. Model Space.

   a. Annotation, text, and dimensions that are directly related to the elements in the reference files shall be placed in Model Space. Reference files are to be attached in Model Space.

4. Layout Space.

   a. Typical sheet items include north arrow, bar scales, match lines, benchmarks, revision clouds and deltas, sheet and project text, title block information, specific notes, profile street names, profile stationing, and any other annotation unique to each sheet.

3.2.03 DRAWING SCALE

3.2.03.A Draw key overall layouts to a minimum scale of 1" = 200'.

3.2.03.B Standard scales for plan and profile sheets are required on construction Drawings are as follows:

1. Major thoroughfares, streets with esplanades over 400 feet in length, or special intersections/situations.

   a. 1" = 20' Horizontal, 1" = 2' Vertical

2. Minimum standard scales for minor or residential single-family streets.

   a. 1" = 20' Horizontal, 1" = 2' Vertical

   b. 1" = 40' Horizontal, 1" = 4' Vertical

3.2.03.B.2 continued

c. 1" = 50' Horizontal, 1" = 5' Vertical

3. Larger scales may be used to show details of construction.

4. Single-banked plan and profile sheets are acceptable; double-banked plan and profile sheets are allowed such as off-site utility lines in undeveloped areas.

5. Details of Special Structures shall be drawn with vertical and horizontal scales equal to each other.

3.2.04 TITLE BLOCK

3.2.04.A Use latest edition of the title block issued by Capital Projects for private and City projects.

3.2.05 NORTH ARROW

3.2.05.A The approved City north arrow is on the symbols sheet found here: https://www.houstonpermittingcenter.org/office-city-engineer/design-and-construction-standards

3.2.05.B A north arrow is required on all sheets and should be oriented either toward the top or to the right.

3.2.05.C The requirement in 3.2.05.B is waived under the following conditions:

1. A storm water sewer, sanitary sewer, or large diameter water line with flow from east to west or from north to south.

2. A primary outfall drainage ditch with flow from east to west or from north to south.

3. Stationing is intended to start from the cardinal points of the compass and proceed in the direction of construction.

4. The north arrow can be down or to the left on a loop street.

3.2.06 GENERAL NOTES

3.2.06.A Privately Funded Projects.

1. General notes for privately funded projects can be found in the “CAD Tools and Templates” section located here: https://www.houstonpermittingcenter.org/office-city-engineer/design-and-construction-standards

2. These notes are not intended to be used on City funded projects.

3.2.06.B City Funded Projects.

1. General notes for City funded projects can be found in the "Capital Projects" section located here: https://www.houstonpermittingcenter.org/office-city-engineer/design-and-construction-standards

2. These notes shall only include third party notes. Any direction given to a contractor shall be handled through the use of construction specification to be accompanied by a unit price item if appropriate.

3.2.07 STATIONING

3.2.07.A Plan stationing must run from left to right, except for short streets or lines originating from a major intersection, where the full length can be shown on one sheet. Tic symbols shall be used to mark stations.

3.2.07.B Never commence stationing at 0+00. Acceptable start stations are 1+00 or 10+00.

3.2.07.C Every even X+00 station shall be annotated with station text and a tic mark.

3.2.07.D Every X+50 station shall only contain a tic mark.

3.2.08 MATCH LINES

3.2.08.A Match lines shall be located at each end of plan view, perpendicular to the design centerline and shall be labeled as to station, and matching sheet number.

3.2.08.B Match lines between plan and profile sheets shall not be placed or shown within cross street intersections including cross street Right-of-Way.

3.2.09 SURVEY REQUIREMENTS

3.2.09.A Show times on survey control or swing tie Drawings to City monuments, Control Points and Temporary Benchmarks. All construction Drawings shall be prepared in accordance with Chapter 2, Section 2.2.01.F, Construction Drawings.

3.2.09.B Monument ties must comply with the City of Houston Code of Ordinances Chapter 33, Article IV – City Surveys.

3.2.10 PLAN AND PROFILE

3.2.10.A Basic plan and profile sheets shall contain the following information:

3.2.10.A continued

1. Identify and label all existing and proposed lines in plan and profile view regardless of line type, including lot lines, property lines, plat record numbers, easements, Rights-of-Way, and Harris County Flood Control District outfalls.

2. Label each plan sheet as to street/easement widths, pavement widths, pavement thickness where applicable, type of roadway materials, curbs, intersection radii, curve data, stationing, existing utilities (type and location), and any other pertinent feature affecting design.

3. Easement labels must clearly identify the type of easement (i.e., dedicated water, dedicated wastewater, combined storm and wastewater easement, etc.). Label will identify the private utility easement owner if the information is obtainable.

4. Show utility lines 4 inches in diameter or larger within the Right-of-Way or construction easement in profile view. Show utility lines, regardless of size, in the plan view, including communication and fiber optic cables.

~~4.~~5. List on plans the typical aerial utility owners for power, telecommunication and other utility lines. List the name of the owner by location of the line on the pole, with the line closest to the top of the pole as the first listed, followed by the other aerial lines listed from highest to lowest.

~~5.~~6. Graphically show flow line elevations and direction of flow for existing ditches.

~~6.~~7. Label proposed top of curb grades except at railroad crossings. Centerline grades are acceptable only for paving without curb and gutters.

~~7.~~8. Show curb return elevations for turnouts in profile view.

~~8.~~9. Gutter elevations are required for vertical curves, where a railroad track is crossed.

~~9.~~10. For street reconstruction projects, show in profile the centerline elevation at the property line of existing driveways.

~~10.~~11. Show both existing and proposed station esplanade noses or the centerline of esplanade openings, including esplanade width.

~~11.~~12. The design of both roadways is required on paving sections with an esplanade.

3.2.10.A continued

~~12.~~13. Show in plan view station points of curvature (PCs), points of tangency (PTs), and radius returns. Show station radius returns and grade change points of inflection (PIs) with their respective elevations in profile view.

~~13.~~14. All existing and proposed utilities and pavement shall be on the same plan and profile sheet for a given section.

~~14.~~15. Plan view and profile view shall be on the same sheet as long as the entire proposed design within the scope of the project can be shown clearly and legibly (i.e., depth of all utilities can be graphically viewed).

~~15.~~16. Each plan and profile sheet shall have a benchmark elevation and description defined. Refer to Chapter 2 for further specification.

~~16.~~17. Show natural ground profiles as follows:

a. For privately funded projects, centerline profiles are satisfactory except where a difference of 0.50 feet or more exists from one Right-of-Way or easement line to the other, in which case, dual profiles are required.

b. For City funded projects, provide natural ground profiles for each Right-of-Way line. For projects with existing (and/or proposed) roadside ditches, provide ditch flowline in profile view. Also show and label all driveway culverts.

3.2.11 TELECOMMUNICATION REQUIREMENTS

3.2.11.A To ensure identification of utility conflicts, all utilities within the public Right-of-Way shall be shown on the Drawings when any on-ground or underground telecommunication facilities are proposed. For exceptions see article 3.2.11.B.

1. On-ground and underground telecommunication facilities include, but are not limited to, underground telecommunication lines, ground supported utility boxes, telecommunication facility support structures (e.g. utility poles, service poles, and cabinets) and foundations.

2. All utility lines located on both sides of the roadway must be shown regardless of the location of the proposed telecommunication line relative to the roadway.

3.2.11.B For projects where aerial telecommunication facilities are proposed exclusively on existing poles and are supported off-ground (e.g. utility boxes on existing poles, network nodes on existing poles):

1. It is not required to show existing underground utilities and their above grade features (e.g. fire hydrants, cabinets, etc.) on the plan view.

2. Profile view is not required.

3.2.11.C Aerial telecommunication lines, along with other aerial lines must be listed on Drawings according to 3.2.10.A.5.

3.2.11.D Drawings must conform to additional labeling requirements as defined in other chapters of this manual. This includes, but is not limited to, Chapter 6 and Chapter 7 requirements.

~~3.2.11~~3.2.12 BORE HOLE REQUIREMENTS

~~3.2.11.A~~3.2.12.A See Chapter 11 for project types that require geotechnical bore hole information in the Drawings, boring spacing and depth requirements. A bore hole layout along with the corresponding bore hole logs is to be included as part of the Drawings.

~~3.2.11.B~~3.2.12.B The bore hole layout sheets shall contain the following information:

1. Project bore holes at the correct location and providing: bore hole number, station, offset, northing and easting. Station and offset provided should be determined from the project's design base line.

2. Bore hole number or identifier matching the geotechnical report.

3. Topographic survey and surveyed benchmark.

4. Design baseline.

~~3.2.11.C~~3.2.12.C The bore hole log sheets shall contain the following information:

1. Project bore logs, arranged on sheet from left to right, in order of ascending stationing with 6 bore hole logs per sheet. Bore logs should match the project geotechnical report.

SECTION 3 - LEADERS AND DIMENSIONS

3.3.01 LEADERS AND DIMENSIONS

3.3.01.A Leaders shall use straight leader lines and closed, filled arrows.

3.3.01.B The leader style shall attach the leader landing to the top of the multi-line text.

3.3.01.C Leader lines shall be placed as close as possible to the object being identified.

3.3.01.D Leader lines in the same area shall be parallel whenever possible.

3.3.01.E Leader lines shall be avoided that are: horizontal or vertical. At the same angle as cross-hatching, at very small angles to the terminating surface, parallel to extension or dimension lines, curved, or crossed.

Table 3.1 - DIMENSION SETTINGS[1]

Dimension Setting	Value for Proposed	Value for Existing
Associative Dimensions	2”	2”
Extension line beyond dimension line	0.05”	0.05”
Extension line offset from object	0.05”	0.05”
Arrow Size	0.10”	0.08”
Dimension Text Style	RomanS	RomanS
Dimension Text Height	0.10”	0.08”
Dimension Primary Units	2 (Decimal)	2 (Decimal)
Dimension Precision	0.00	0.00

Note:
1. Dimension settings can be used as a general guide.

3.3.02 LETTERING

3.3.02.A Standard text height is 0.10” for most drawing annotations. A minimum height of 0.05” is acceptable when used for special purposes such as for symbols or stacked fractions. The standard text style shall use the upper-case RomanS font. Table 3.2 can be used as a general text property guide.

1. Text shall be in designated Model Space.
2. Text shall be placed readable from the bottom or right side of the page.
3. Text shall be justified top left, top right, or middle center as best applicable for each case.
4. Text strings shall not overlap one another.

3.3.02.A continued

5. Where necessary, place text strings away from the features and use a leader.

Table 3.2 – TEXT PROPERTIES

Existing/Proposed	Text Style	Printed Height	Printed Width
Proposed text and dimensions	RomanS	0.10”	1.0
Existing text and dimensions	RomanS	0.08”	1.0
Major title block text	RomanS	0.30”	1.0
Survey spot elevations	RomanS	0.08”	1.0
Sheet numbers, detail titles, section or detail call outs, match line labels, table and location map sub-titles, and column headings	RomanS	0.20”	1.0
Stacked fractions, symbols, small detail annotation	RomanS	0.05”	1.0
Cover sheet title	COH CIP Cover	0.70”	1.0
Cover sheet sub-titles	COH CIP Cover	0.40”	1.0

3.3.03 LINE WEIGHTS

3.3.03.A The “COH.ctb” plot configuration file included with the City drawings specifies plotted line weights. No modifications are to be made to this file.

1. Colors 1-9 and 20 have been reserved for unscreened elements such as proposed objects, annotations, text and dimensions in the “COH.ctb” file. The basic colors and corresponding weights can be located in Table 3.3.

2. With exception to colors reserved for color plotting for existing utilities, colors 11-248 can be used as needed for the described typical use and each designated weight is represented by various colors within this color rage.

3. Colors 249-254 have been reserved for screening, ranging from 80-30%, in descending value in the “COH.ctb” file

4. Refer to “COH Std Line Weights.pdf” for a visual representation of available colors and corresponding line weights. See SECTION 7 of this chapter for description and weblink to design aids.

5. Table 3.3 is based on the U.S. National CAD Standard (NCS) – V6, 2.0 line width guide and corresponds with colors 1-10 in the “COH.ctb” file.

6. Existing utilities shall be plotted in color according to “COH Std Line Weights.pdf”.

3.3.03.B The line weights shown in Table 3.3 are shown as a general guide. Some objects will need to be shown in a different line weight for clarity.

3.3.03.B continued

Table 3.3 – LINE WEIGHTS

Colors[1]	**Thickness**	**MM**	**IN.**	**Typical Use**
1	Fine	0.18	0.007	Hatch patterns, sheet trim lines
2, 3, ~~7~~4	Thin	0.25	0.010	Table and section grid lines, construction details
8	Thin	0.25	0.010	Existing object lines and text
~~4~~7, 9	Medium	0.35	0.0138	Proposed medium object lines, proposed text, existing Right-of-Way
5	Wide	0.50	0.020	Sheet and title block borders, sheet dividers, major title text, match line text, outlines, location map outlines, section lines, proposed object lines requiring special emphasis, proposed design lines and elements
6	Extra Wide	0.70	0.028	Proposed Right-of-Way
20	XX Wide	1.20	0.048	Drainage areas

Notes:
1. Basic colors are shown. Other pen table colors may be used to satisfy these requirements.

3.3.04 LINE TYPE

3.3.04.A Use Standard line types shown in the "COH Line Type.pdf". See SECTION 7 of this chapter for description and weblink to design aids.

3.3.04.B Standard line type definitions are located in the "COH.lin" file provided by the City and can be downloaded at the following link: https://www.houstonpermittingcenter.org/media/3696/download.

3.3.05 LAYERS

3.3.05.A The layer standard is based on the drawing layer format by the U.S. National CAD Standard (NCS). The NCS format consists of four data fields (Discipline Designator, Major Group, and two Minor Groups), and a status field. Each field is separated by a dash for clarity. The Discipline Designator and Major Group fields are mandatory. The Minor Groups and Status field are optional.

	C	-	A	L	G	N	-	C	N	T	R	-	A	N	N	O	-	1

Discipline Designator (1-2 Letters) | Major Group (4 Letters) | Minor Group (4 Letters) | Minor Group (4 Letters) | Status Field (1 Letter)

Figure 3.1 – LAYER NAMING DIAGRAM

3.3.05.B Table 3.4, Table 3.5, and Table 3.6 are lists of common layer fields. Not all field codes are represented. Refer to the U.S. National CAD Standards (NCS)[1] for layer field codes of disciplines not defined in this section. Layers may be created to provide additional clarity to the data placed in a drawing. The guidelines above shall be observed when creating layers not listed in the NCS. Layer names shall not exceed 18 characters.

Table 3.4 – DISCIPLINE DESIGNATORS

Designator:	Description of Discipline Designator:
G	General
GR	General Record Drawings
V	Survey
VA	Aerial Survey
VF	Construction Field Survey
C	Civil
CD	Civil Demolition
CU	Civil Utilities
CP	Civil Paving
CT	Civil Transportation

Table 3.5 – MAJOR GROUP

Major Field:	Description of Major Layer Field:
ALGN	Alignments
ANNO	Sheet annotation
BLDG	Buildings and primary structures
BLIN	Baseline
BORE	Test borings
BRDG	Bridge
CABL	Cable
COMM	Communications
CTRL	Control Points
DETL	Details
DRIV	Driveways
ESMT	Easements
NGAS	Natural gas
PIPE	Pipes
PROP	Property
PVMT	Pavement
RAIL	Railway
ROAD	Roadways
RWAY	Right-of-Way
SIGL	Traffic signals
SSWR	Sanitary sewer
STRM	Storm sewer
WATR	Water supply
WETL	Wetlands

[1] https://www.nationalcadstandard.org/ncs6/

3.3.05.B
continued

Table 3.6 – MINOR GROUP

Minor Field:	Description of Minor Layer Field:
ANNO	Annotation
ASPH	Pavement: asphalt
CNTR	All: center lines
CONC	Pavement: concrete
DATM	Datum notes
DIMS	Dimensions
EDGE	Channels, major water bodies, ponds, creeks and rivers
FDPL	Flood plain
FIBR	Fiber optic
LABL	Annotation: labels
LEGN	Sheets: legends, symbols keys
NOTE	Sheets: notes
NRTH	Sheets: north arrows
POLE	Utilities: boxes / poles
ROAD	Pavement: roadways
SECT	Sections
TTLB	Sheets: border and title blocks
UTIL	Utilities

Table 3.7 – STATUS GROUP

Status Field:	Description of Status Field:
1	Phase 1
2	Phase 2
3	Phase 3
H	Horizontal (for profile grids)
V	Vertical (for profile grids)
F	Future work

SECTION 4 - ELECTRONIC DRAWINGS

3.4.01 ELECTRONIC PLAN REVIEW

3.4.01.A The process for registering the engineering firm with the iPermits Customer Portal for the Office of the City Engineer Plan Review, and the electronic plan review system is called ProjectDox. The electronic plan review process is broken down into 10 key steps. The process utilizes two systems: iPermits and ProjectDox. The iPermits Customer Portal is used to submit applications and to make payments. ProjectDox is used to upload Drawings, receive comments, and receive approvals. The step-by-step user guide can be found here:

https://www.houstonpermittingcenter.org/media/2296/download

3.4.02 ELECTRONIC PLAN FILE NAMING

3.4.02.A File names are limited to 70 characters. Documents should be submitted in PDF format per the COH I-Permits and ProjectDox system requirements. File names should contain the sheet number, dash, and corresponding sheet title the following format: "### - XXXXXXX" add "00" to single digit page numbers to avoid the page jumping from 1, 11,12, etc. See Table 3.8 below for some examples of common sheet files and corresponding file name to be used.

Table 3.8 – FILE NAMING

Sheet Title	**Sheet Number**	**File Name**
Cover Sheet	01	001 – Cover Sheet
Sheet Index	02	002 – Sheet Index
Abbreviations	03	003 – Abbreviations
Symbols	04	004 – Symbols
General Notes	05	005 – General Notes
Overall Project Layout(s)	06	006 – Overall Project Layout(s)

SECTION 5 - REVISION PROCESS

3.5.01 REVISION PROCEEDURES

3.5.01.A Revisions required during the construction phase shall follow the revision process in this section. Revisions on plans are to be annotated and documented with the following guidelines:

1. First Revision Procedures.

    a. All changes in each sheet that are pertinent to each revision shall be enclosed in revision “clouds”.

    b. The number of the revision shall be placed inside of a triangle, commonly known as a “delta”.

    c. Each revision delta shall be placed adjacent to the corresponding revision cloud(s).

    d. It is acceptable to have multiple clouds with the same revision delta on a sheet if all changes apply to that revision.

    e. It is acceptable to cloud an entire plan view area with a single revision cloud and delta, when a significant portion within the cloud has been revised or when clouding each revised item becomes impractical.

    f. If an entire sheet is added to a plan set as a part of a revision, the sheet title and sheet number shall be clouded along with a delta.

    g. The sheet index for each plan set shall also reflect revisions with the outlined procedures.

2. Second (and Subsequent) Revisions Procedures.

    a. The revision cloud(s) from any previous revision(s) shall be removed from each sheet.

    b. The revision delta(s) from any previous revisions(s) shall remain in their original location on each sheet.

    c. All of the new changes to each sheet shall follow the revision procedures outlines in the above narrative.

3. Title Block / Cover Sheet Annotation Procedures.

    a. Each revision is to be documented on the title block area of each plan sheet or cover sheet, see Figure 3.2 for examples.

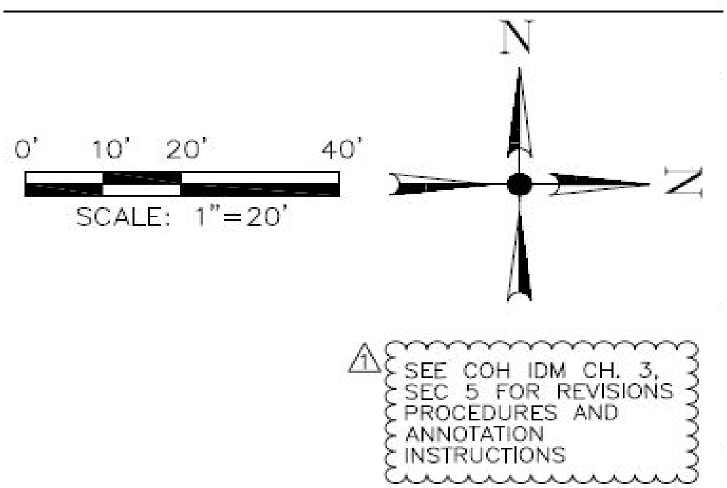
3.5.01.A.3 continued

b. All information is to be filled out, to include a brief description of the revision, starting from bottom to top or right to left.

c. Once the maximum amount of revision lines is completed, the oldest revision annotation will be removed to accommodate the newest current revision information.

d. The oldest revision information will be located at the bottom or right, with the current information located at the top or left.

3	MM/DD/YY	BRIEF DESCRIPTION	XXX
2	MM/DD/YY	BRIEF DESCRIPTION	XXX
1	MM/DD/YY	BRIEF DESCRIPTION	XXX
NO.	DATE	REVISION	APP.



3	MM/DD/YY	BRIEF DESCRIPTION	XXX
2	MM/DD/YY	BRIEF DESCRIPTION	XXX
1	MM/DD/YY	BRIEF DESCRIPTION	XXX
NO.	DATE	REVISION	APP.

Figure 3.2 – REVISION BLOCK EXAMPLES

SECTION 6 - EXAMPLE PLAN SET SHEETS

3.6.01 CAD STANDARDS APPLICABLE TO CITY AND PRIVATELY FUNDED PROJECTS

3.6.01.A Provide a cover sheet for projects involving three or more design Drawings (excluding City of Houston standard detail sheets).

3.6.01.B The example sheets in the following figures are to give the user an overall feel of how specific plans should appear and how they differ from each other. A few basic sample sheets are listed below and shown in this section:

1. Figure 3.3 - ABBREVIATONS
2. Figure 3.4 – LINETYPES, CELLS & STANDARD SYMBOLS
3. Figure 3.5 – COH SHEET INDEX
4. Figure 3.6 – CAPITAL PROJECTS COVER SHEET
5. Figure 3.7 – NON- CAPITAL / PRIVATE PROJECTS COVER SHEET
6. Figure 3.8 – TELECOMMUNICATION COVER SHEET
7. Figure 3.9 – GENERAL NOTES
8. Figure 3.10 – PLAN AND PROFILE
9. Figure 3.11 – BORE HOLE LAYOUT
10. Figure 3.12 – BORE HOLE LOGS

3.6.01.B
continued

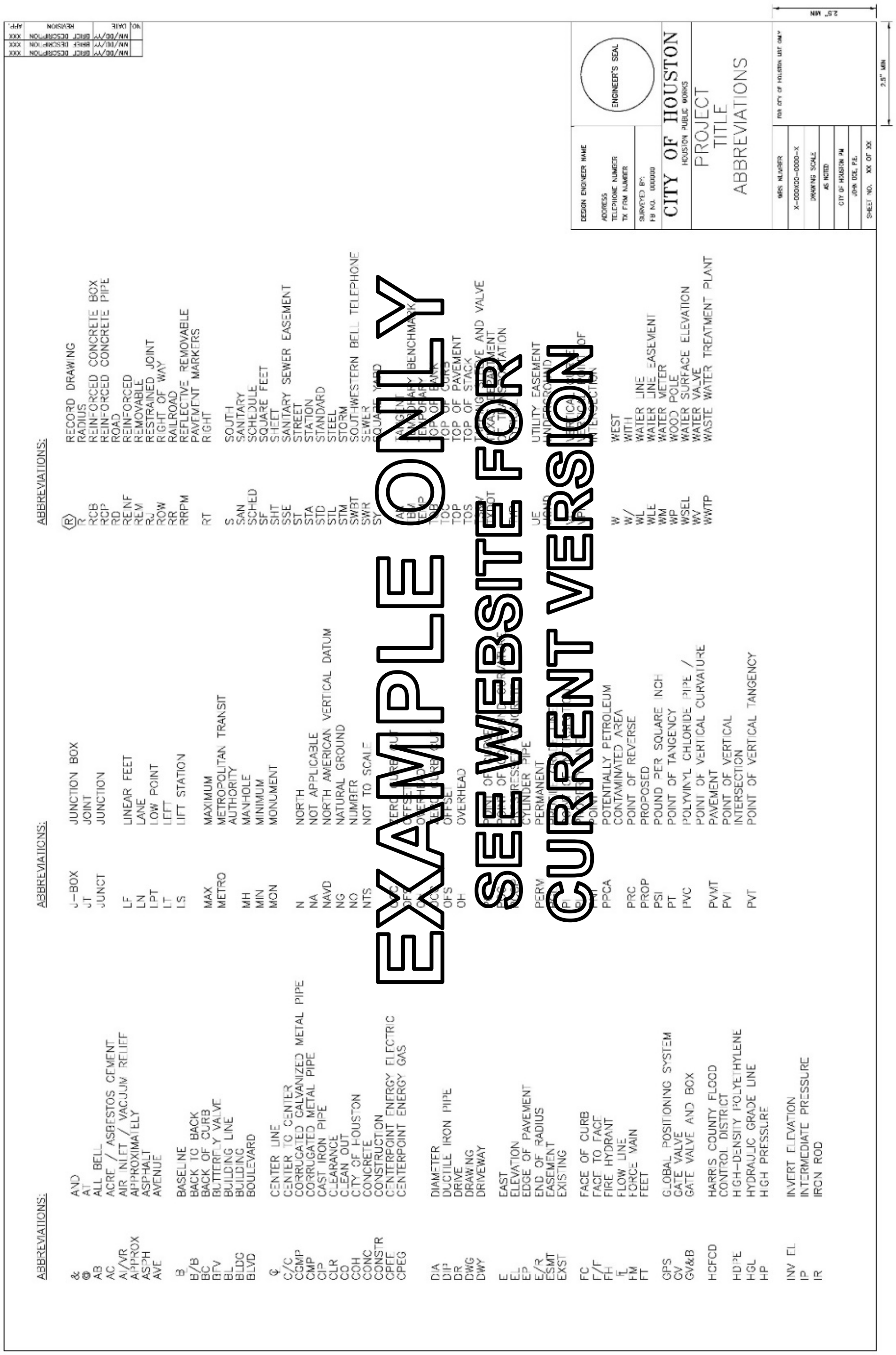


Figure 3.3 - ABBREVIATONS[2]

[2] For the most up to date sheet go to: https://www.houstonpermittingcenter.org/office-city-engineer/design-and-construction-standards

3.6.01.B
continued

Figure 3.4 – LINETYPES, CELLS & STANDARD SYMBOLS[3]

[3] For the most up to date sheet go to:
https://www.houstonpermittingcenter.org/office-city-engineer/design-and-construction-standards

3.6.01.B
continued

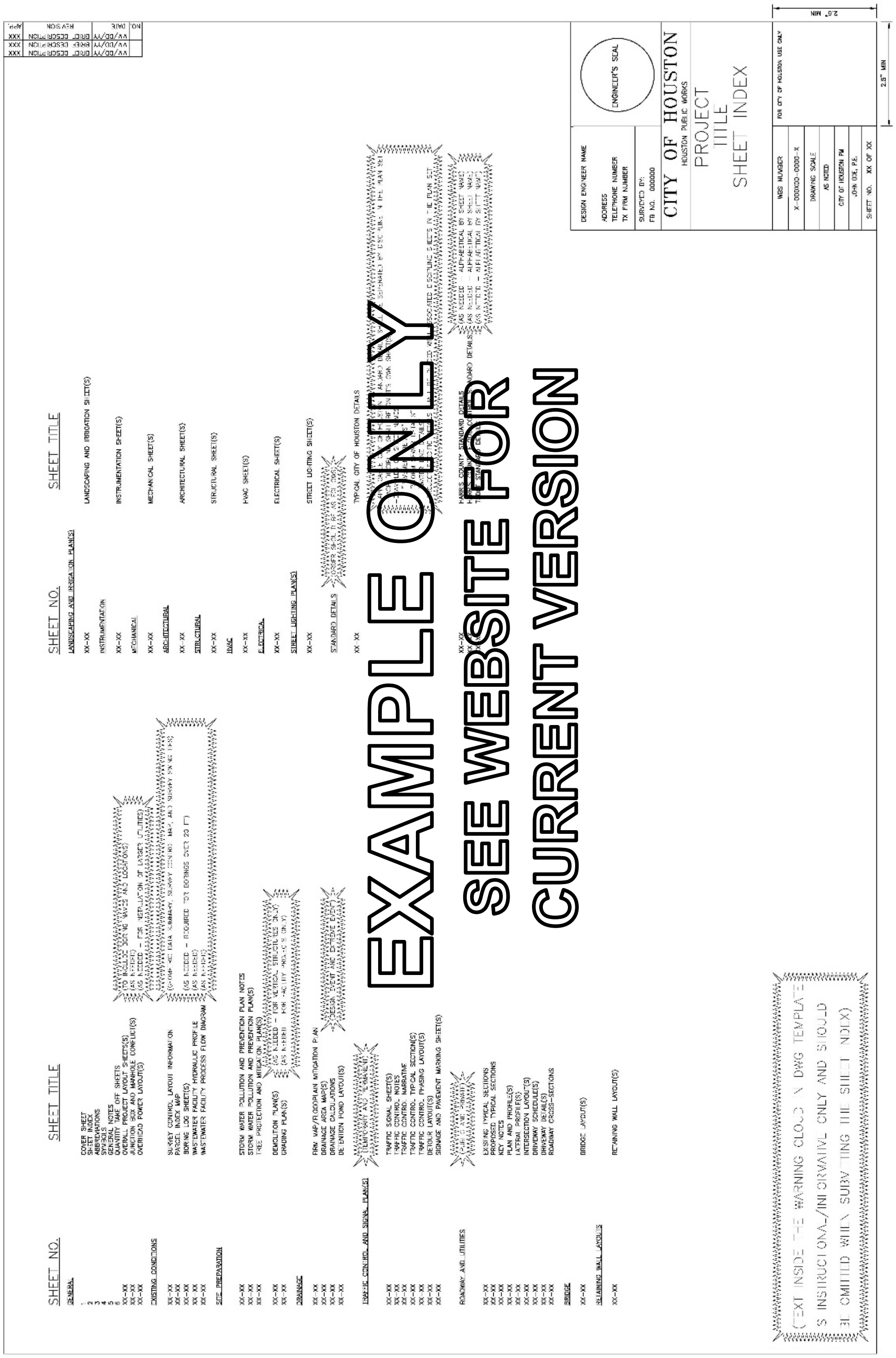


Figure 3.5 – COH SHEET INDEX[4]

[4] For the most up to date sheet go to: https://www.houstonpermittingcenter.org/office-city-engineer/design-and-construction-standards

3.6.01.B
continued

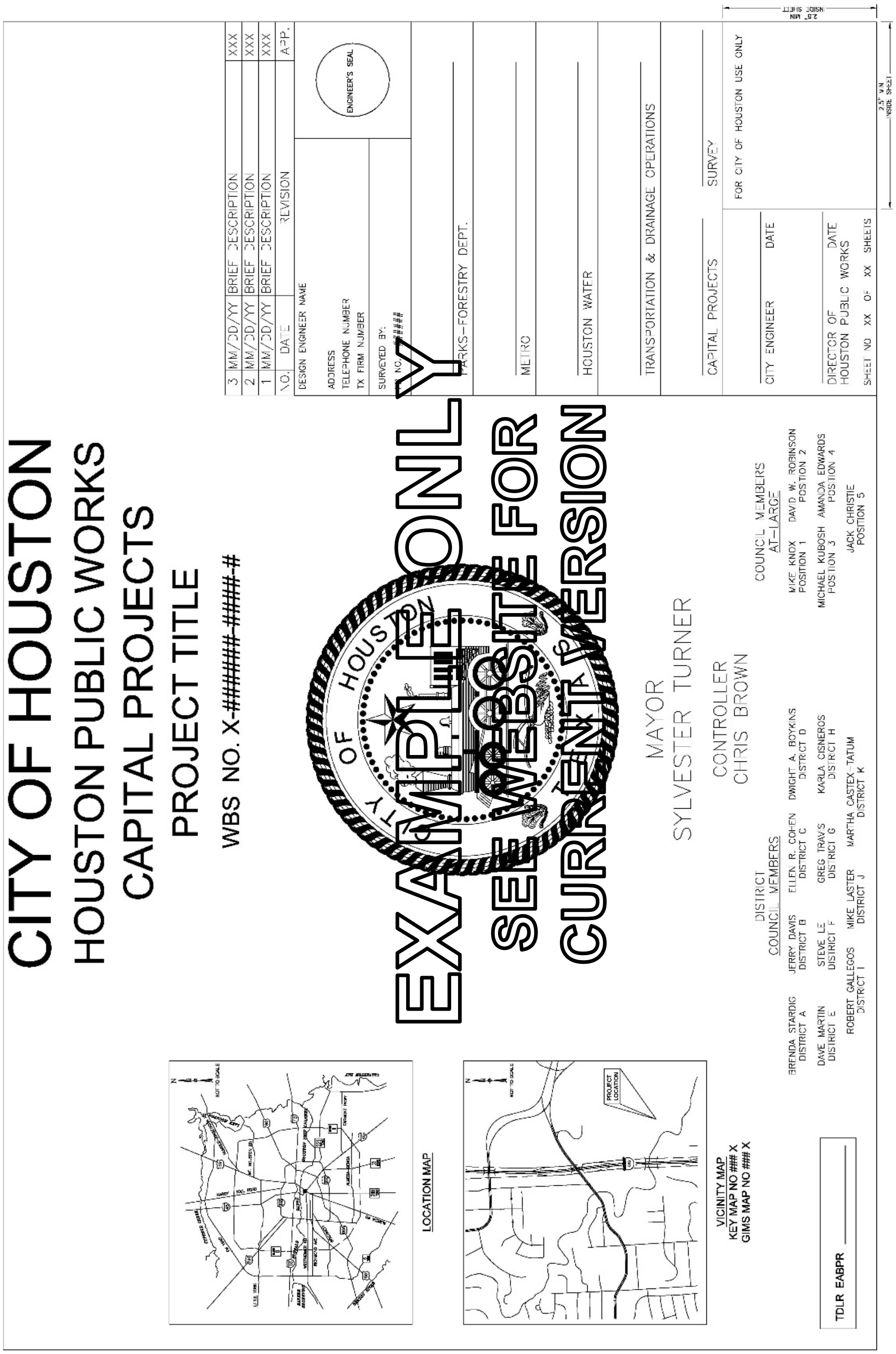


Figure 3.6 – CAPITAL PROJECTS COVER SHEET[5]

5 For the most up to date sheet go to https://www.houstonpermittingcenter.org/office-city-engineer/design-and-construction-standards

3.6.01.B
continued

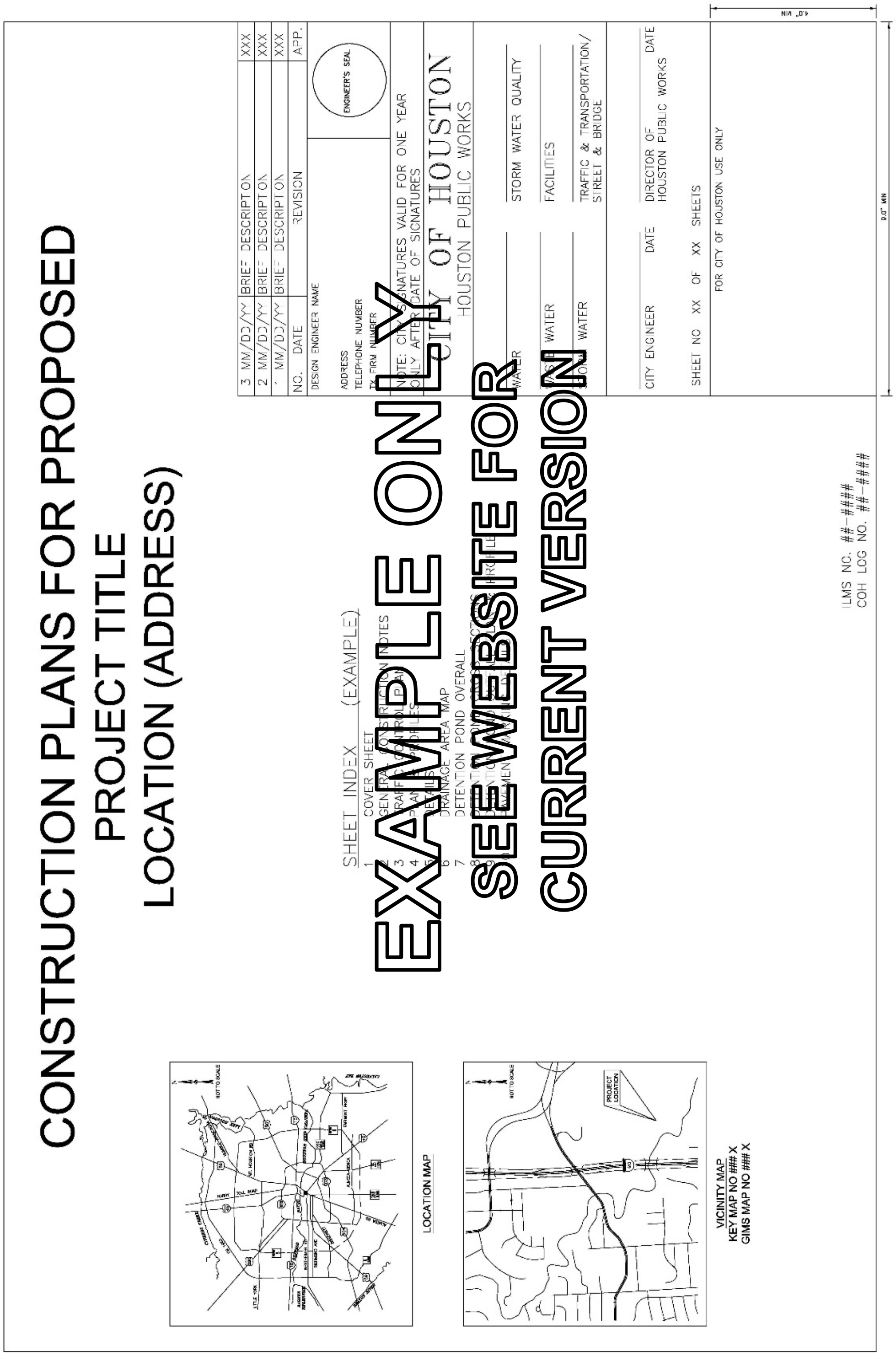


Figure 3.7 – NON- CAPITAL / PRIVATE PROJECTS COVER SHEET[6]

[6] For the most up to date sheet go to: https://www.houstonpermittingcenter.org/office-city-engineer/design-and-construction-standards

3.6.01.B
continued

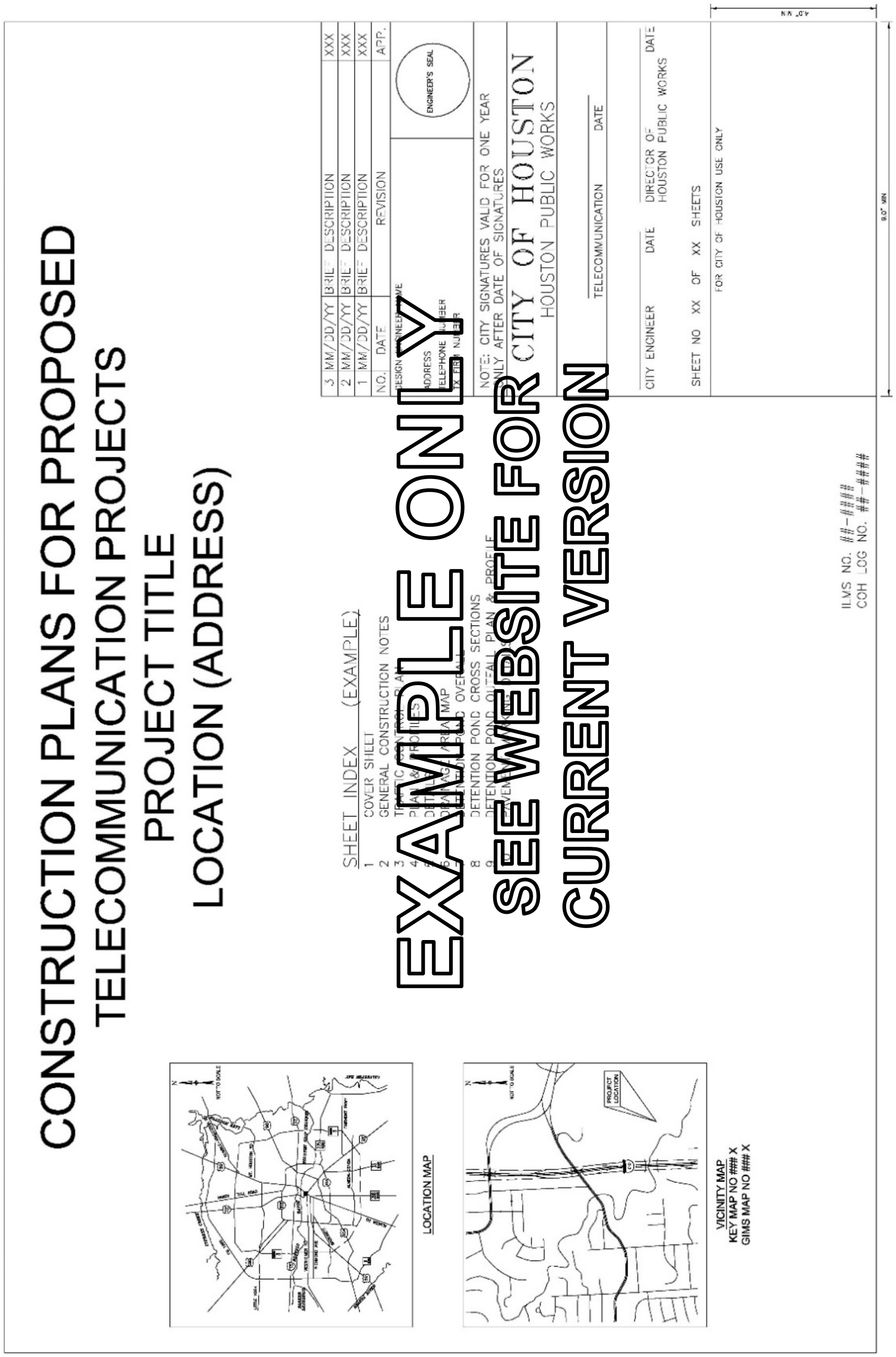


Figure 3.8 – TELECOMMUNICATION COVER SHEET[7]

[7] For the most up to date sheet go to:
https://www.houstonpermittingcenter.org/office-city-engineer/design-and-construction-standards

3.6.01.B
continued

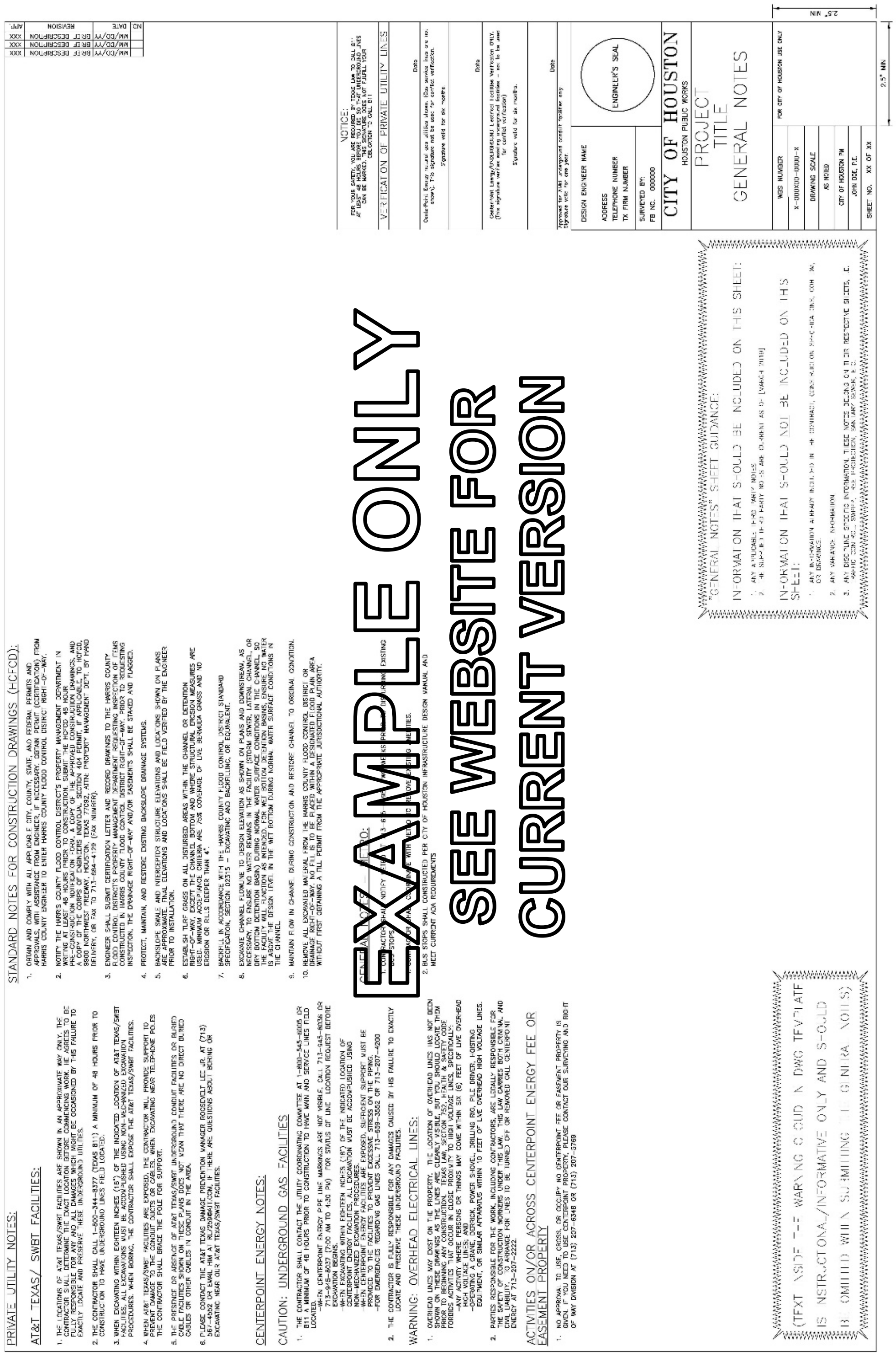


Figure 3.9 – GENERAL NOTES[8]

[8] For the most up to date sheet go to: https://www.houstonpermittingcenter.org/office-city-engineer/design-and-construction-standards

3.6.01.B
continued

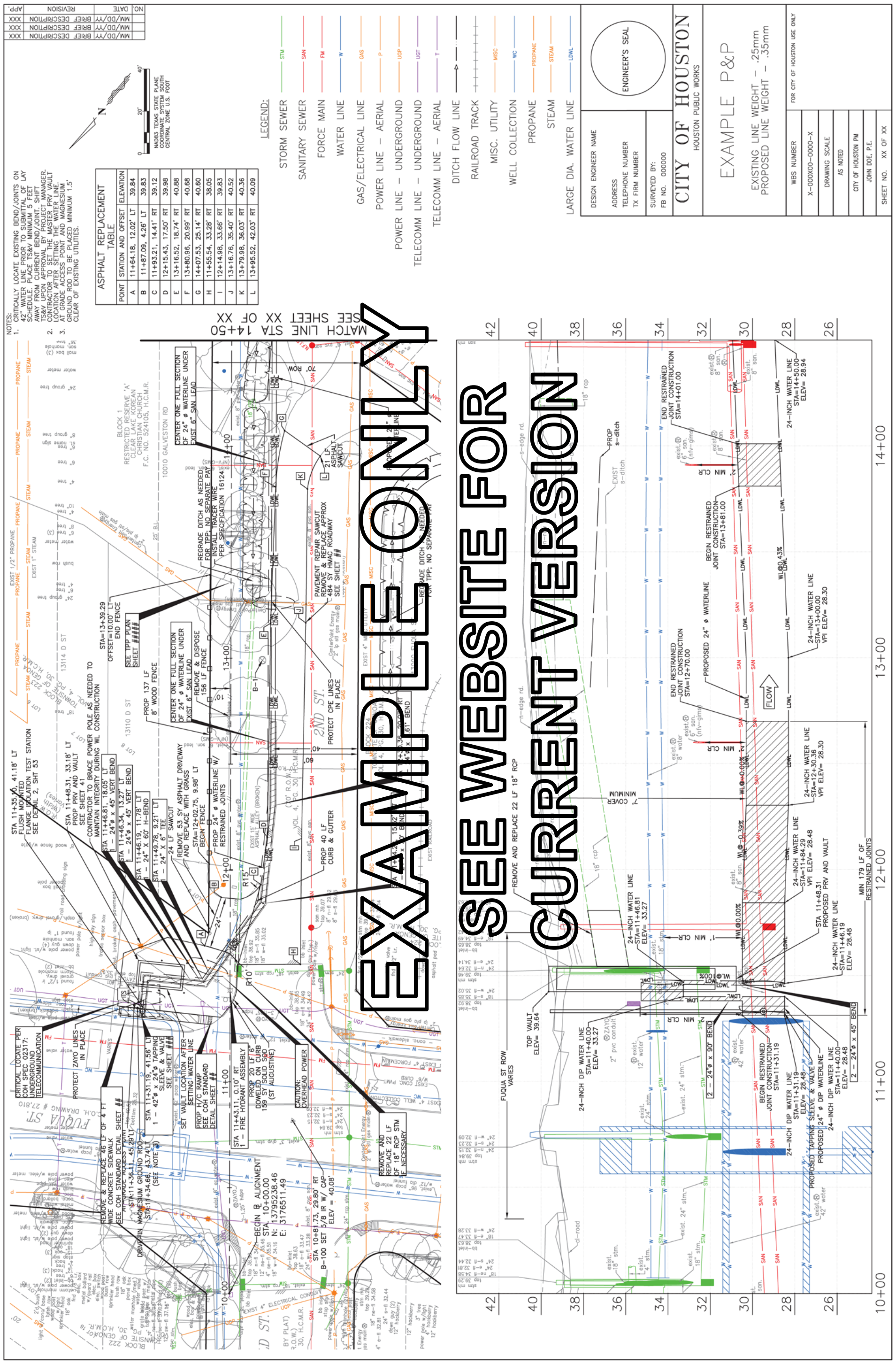


Figure 3.10 – PLAN AND PROFILE[9]

[9] For the most up to date sheet go to:
https://www.houstonpermittingcenter.org/office-city-engineer/design-and-construction-standards

3.6.01.B
continued

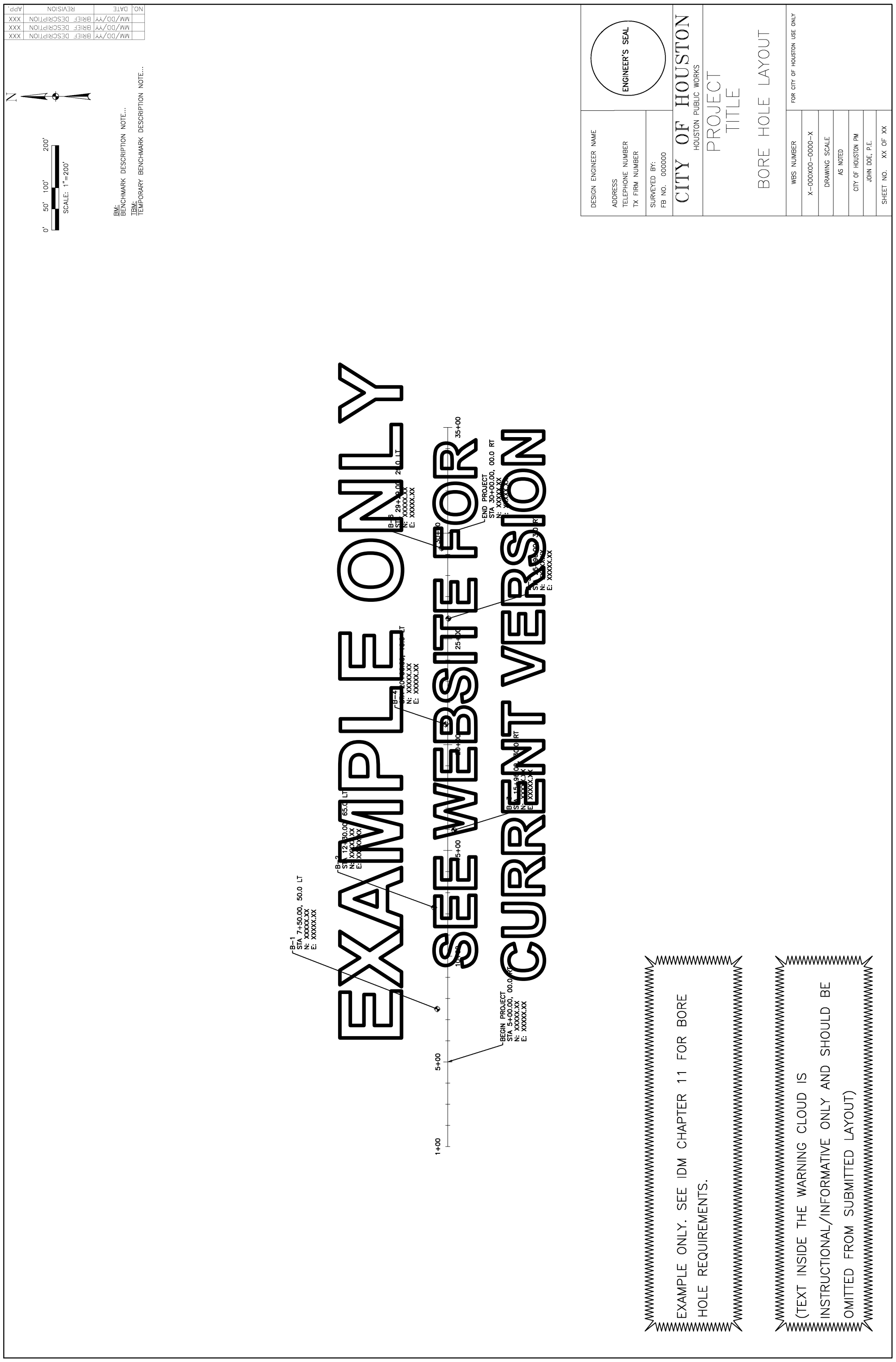


Figure 3.11 – BORE HOLE LAYOUT

3.6.01.B
continued

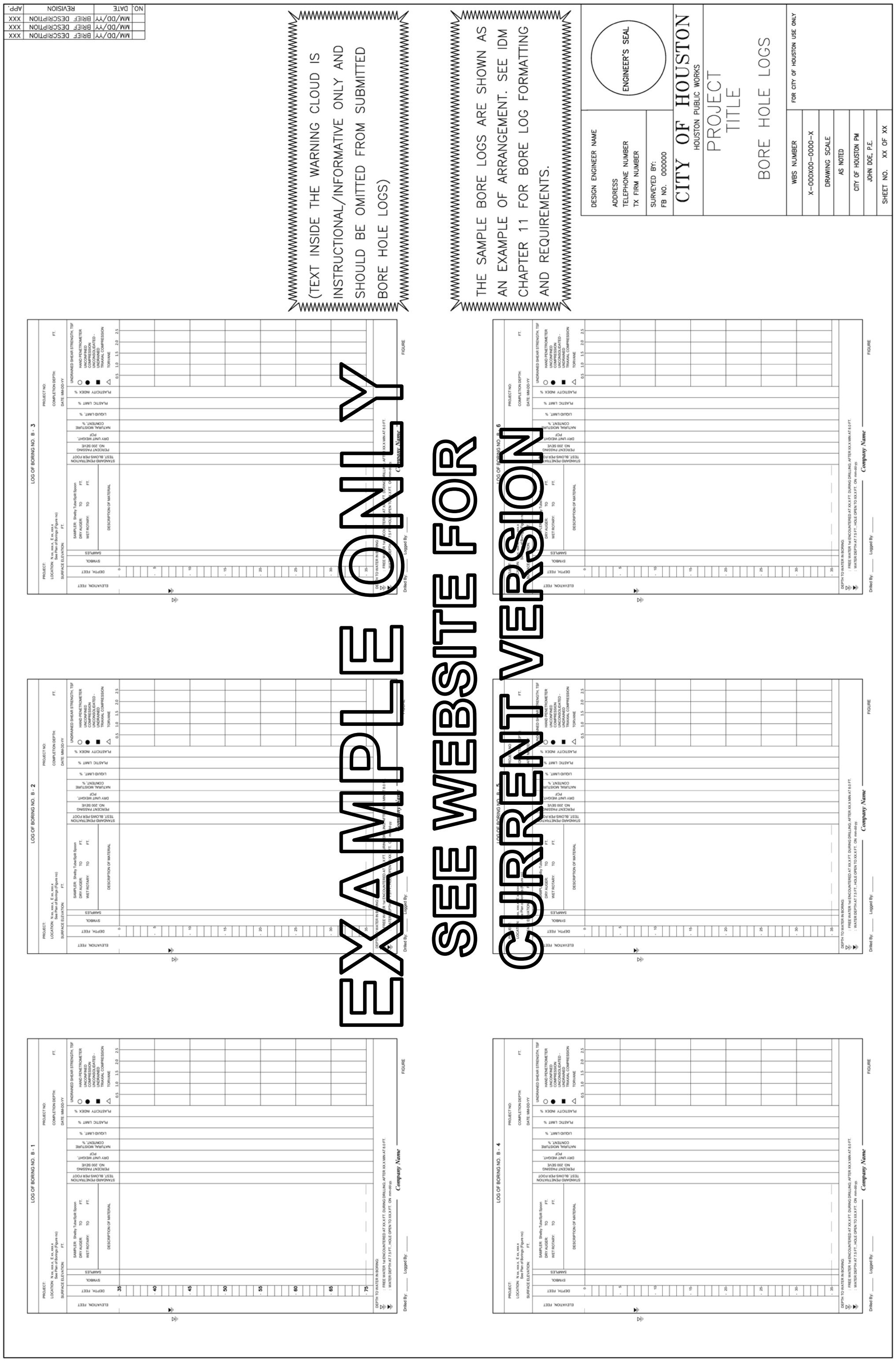


Figure 3.12 – BORE HOLE LOGS

SECTION 7 - RESOURCES

3.7.01 CAD TOOLS

3.7.01.A Listed below are the files that are provided by the City for use along with all the sections of Chapter 3. The files can be found here: https://www.houstonpermittingcenter.org/office-city-engineer/design-and-construction-standards

File Name	Description	File Type
1. COH	COH line types	.LIN
2. COH Line Types	COH line types	.PDF
3. COH	COH plot table	.CTB
4. COH Std Line Weights	COH standard line weights	.PDF
5. COH Drawing Template	COH drawing template	.DWT/PDF
6. COH Symbols	COH standard symbols	.DWG/PDF

3.7.01.B HELPFUL TEMPLATES

File Name	Description	File Type
1. coh_cp_title_block	COH standard title block	.DWG / .PDF
2. coh_cp_cover_sheet	COH standard Capital Projects cover sheet	.DWG / .PDF
3. coh_sheet_index	COH standard sheet index	.DWG / .PDF
4. coh_abbreviations	COH standard abbreviations	.DWG / .PDF
5. coh_symbol	COH standard symbols	.DWG / .PDF
6. coh_cp_general_notes	COH standard general notes	.DWG / .PDF
7. coh_non_cp_cover_sheet	Non-CP/private cover sheet	.DWG / .PDF
8. coh_non_cp_title_block	Non-CP/private title block	.DWG / .PDF
9. coh_telecomm_cover_sheet	Telecommunication cover sheet	.DWG / .PDF

END OF CHAPTER

City of Houston

Design Manual

Chapter 5

EASEMENT REQUIREMENTS

Chapter 5
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Easement Requirements

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Chapter 5

EASEMENT REQUIREMENTS

SECTION 1 – EASEMENT DESIGN OVERVIEW

5.1.01 CHAPTER INCLUDES

5.1.01.A Requirements for allocating and recording Easements for water, wastewater, and storm drainage facilities located outside of Public Rights-of-Way.

5.1.01.B Easements for electrical and gas lines are not covered under this Design Manual.

5.1.02 REFERENCES

5.1.02.A City of Houston Code of Ordinances, Chapter 42 – Subdivisions, Developments and Platting.

5.1.03 DEFINITIONS

5.1.03.A All-Weather Access – Cleared, graded, and stabilized access roadway or driveway that allows vehicles to easily enter and exit the Easement in all weather conditions.

5.1.03.B City Engineer - The authorized representative of the City, or the City's designee, having approval authority for publicly funded projects, privately funded projects, or having authority for administration of design and construction contracts for the City.

5.1.03.C Easement - Area set aside for installation, operation, and maintenance of utilities by public and private utility operators.

5.1.03.D Easement Boundary - Any side of the Easement that defines the boundary of the Easement.

5.1.03.E Extraterritorial Jurisdiction (ETJ) - The unincorporated territory extending beyond the corporate boundaries of the City established pursuant to Chapter 42 of the Texas Local Government Code, as may be amended from time to time.

5.1.03.F Outer-Easement Boundary – The Easement Boundary that is the furthest offset from the adjacent Public Right-of-Way.

5.1.03.G Permanent Access Easement (PAE) – Easement that provides permanent access as defined in the City of Houston Code of Ordinances, Chapter 42 – Subdivisions, Developments & Platting, Article I, §42-1.

5.1.03.H Public Right-of-Way – Property dedicated or deeded for the purpose of public use.

5.1.03.I Public Utility Easement (PUE) – Easement used for public utilities as defined in the City of Houston Code of Ordinances, Chapter 42 – Subdivisions, Developments & Platting, Article III, Division 5, §42-210.

5.1.03.J Registered Professional Land Surveyor (RPLS) - A surveyor currently registered and in good standing with the Texas Board of Professional Engineers and Land Surveyors (TBPELS).

5.1.03.K Semi-Public Right-of-Way - Property partially dedicated or deeded for the purpose of public use, wherein public interest is limited to either the surface or subsurface.

SECTION 2 – EASEMENT DESIGN REQUIREMENTS

5.2.01 GENERAL DESIGN REQUIREMENTS

5.2.01.A Where public utilities are located in, along, across or adjacent to private drives, private streets or Permanent Access Easements in platted single family residential lot subdivisions; such drives, streets or Easements shall have an overlapping Public Utility Easement to provide access and maintenance rights. Public Utility Easement rights shall be superior to Permanent Access Easement rights allowing the City ingress and egress for maintenance of utilities.

5.2.01.B Easements are to be defined and submitted as part of the recorded plat either shown on the plat or by metes and bounds description. The process for recording the plat is described in Chapter 4, Platting Requirements.

5.2.02 QUALITY ASSURANCE

5.2.02.A Recorded plats and metes-and-bounds descriptions of Easements must be prepared under the direction of a Registered Professional Land Surveyor. The surveyor must seal, sign, and date documents prepared under the surveyor's supervision.

5.2.03 PLAT AND EASEMENT REQUIREMENTS

5.2.03.A Requirements for Platted Easements.

1. For construction inside City limits, submit a copy to the Office of the City Engineer of the final plat accompanied by a CPC 101 form together with the original engineering drawings for approval and signatures.

2. For construction outside City limits but within Houston's ETJ.

    a. Where no Easements are required outside the plat boundary, follow the same requirements as for plats inside City limits given in Article 5.2.03.A.1.

    b. Where Easements are to be dedicated outside the plat boundary or through property under different ownership, follow the instructions in Article 5.2.03.A.1 for plats inside City limits and the following additional requirements:

        (1) Submit a copy of the recorded instrument creating the Easement or a metes-and-bounds description and a map of the Easement, along with a letter from the municipal utility district board or property owner stating the intent to obtain or dedicate necessary Easements. The Easement instrument shall be recorded prior or simultaneously to recordation of the plat.

5.2.03.A.2.b continued

(2) All off-site Easements necessary to serve a proposed development must be shown on the face of the plat, or an acceptable reference tie between the plat and Easements must be established between the two documents. Off-site Easements must be recorded prior to recordation of the plat.

5.2.03.B Requirements for Easements dedicated to the public or to the City:

1. Easements required for construction of a proposed project must be approved and accepted prior to approval of final design drawings or issuance of a permit for the proposed construction.

5.2.03.C Additional requirements for Easements dedicated only to the City:

1. Easements shall be either a part of the dedication on the plat of a subdivision, dedicated to the City on standard forms provided by the City for that purpose, or on forms approved by the City Attorney.

2. The person seeking to dedicate an Easement to the City shall furnish the City with a metes & bounds description and map, signed and sealed by a Texas Registered Professional Land Surveyor, showing the Easement and its location.

3. A construction permit will be granted upon acceptance by the City of recorded instruments dedicating the Easements.

5.2.04 EASEMENT DESIGN REQUIREMENTS FOR WATER LINES, SANITARY LINES, STORM LINES AND APPURTENANCES

5.2.04.A Maintain a minimum horizonal clearance between utilities as required in Chapter 9 and other chapters of this manual.

5.2.04.B If an access Easement is needed temporarily for reserves specifically restricted to lift station, wastewater treatment, water production or repressurization, refer to access Easement requirements in Section 42-190 of the City of Houston Code of Ordinances, Chapter 42 – Subdivisions, Developments and Platting.

5.2.04.C Easements for Water Lines and Appurtenances.

1. Water Lines.

a. When outside a street Public Right-of-Way or Permanent Access Easement with overlapping Public Utility Easements, Easements must be dedicated and restricted for water lines only.

b. Easements should be contiguous with Public Rights-of-Way.

5.2.04.C.1 continued

c. Water line Easements that cannot be contiguous with Public Right-of-Way shall meet all of the following criteria:

(1) Minimum Easement width shall be equal to twice the water line diameter plus the depth to the bottom of the water line from natural ground or final ground elevation, whichever is greater;

(2) Easement width shall be rounded up to the nearest 5-foot increment; and

(3) Minimum Easement width shall not be less than 20-feet or as required by Table 5.1 for large diameter water lines.

d. Provide All-Weather Access for water line Easements not contiguous with Public Right-of-Way, unless one already exists.

e. Proposed water lines located within an Easement contiguous with the street Public Right-of-Way or Public Utility Easement that is contiguous with street Public Right of Way:

(1) Small Diameter Water Lines.

(a) For lines 12-inches in diameter and smaller, the minimum Easement width shall be 15-feet. The centerline of the pipe shall be located 5-feet from either Easement Boundary.

(b) For lines 16-inches to 20-inches in diameter, the minimum Easement width shall be 20-feet. The centerline of the pipe shall be located 7-feet from either Easement Boundary.

(2) Large Diameter Water Lines (LDWL).

(a) The minimum Easement width required to install, operate, and maintain water lines are summarized in Table 5.1.

5.2.04.C.1.e.(2).(a) continued

Table 5.1 – MINIMUM EASEMENT WIDTH FOR LDWLs

SIZE OF WATERLINE	EASEMENT WIDTH (2)
24” through 36” (1)(3)	20 ft
42” through 54” (4)	30 ft
60” through 72” (4)	40 ft
84” and Larger (4)	50 ft

Notes:
(1) Water lines shall be centered in 20-foot Easements.
(2) For Easements 30-foot and larger, provide at least 10-foot clearance between water line centerline and Easement Boundary.
(3) For water lines at depths greater than 15-feet, add an additional 10-feet to the permanent Easement. Depth shall be measured to the bottom of the water line from natural ground or final ground elevation, whichever is greater.
(4) For water lines at depths greater than 15-feet, add a 10-foot temporary construction Easement. Depth shall be measured to the bottom of the water line from natural ground or final ground elevation, whichever is greater.

f. Water line Easements are required for proposed water lines located inside of Public Right-of-Way if the exterior of the water line pipe is located within 5-feet of the Public Right-of-Way. The Easement shall be contiguous with the Public Right-of-Way and the Outer-Easement Boundary shall be located the following distance from the Public Right-of-Way:

(1) 12-inch diameter and smaller - minimum 5-feet.

(2) 16-inch to 20-inch in diameter - minimum 10-feet.

(3) 24-inch and larger, use Easement widths defined in Table 5.1.

g. Water lines along state rights-of-way shall be installed outside of the right-of-way in a separate contiguous Easement. Width of Easements shall be as provided in Article 5.2.04.C.1.e.

h. No back-lot Easements will be allowed for the installation of water lines.

i. Side-lot Easements must be accessible for maintenance. They will only be allowed if they result in eliminating dead end water lines.

j. Do not locate water lines 16-inch diameter and larger in side-lot Easements.

k. When using side-lot Easements, such Easements shall be a minimum of 20-feet in width, located on one lot or centered between two lots.

5.2.04.C.1.k continued

If the Easement is centered between two lots, the water line shall be centered within the 10-feet of one lot.

l. Commercial developments inside the City and in the ETJ requiring on-site fire hydrants must provide a minimum 20-foot water line Easement for water lines and fire hydrants.

m. Refer to Chapter 7 "Water Line Design Requirements" Article 7.2.01.E.4 for dedicated water main Easements for commercial developments with public on-site water mains for fire protection.

2. Fire Hydrants.

   a. Use a minimum 10-foot by 10-foot Easement for fire hydrants located outside of Public Right-of-Way.

   b. Do not locate fire hydrants in water line Easements or any water meter Easements.

   c. Refer to Article 7.2.01.D.4.c for additional fire hydrant location requirements.

   d. Use a minimum 5-foot by 5-foot Easement for flushing valves located outside of Public Right-of-Way. Flushing valves must be centered within the Easement.

3. Meters and Valves:

   a. Two-inch and smaller meters and shut-off valves (stop boxes) shall be set within the Public Right-of-Way or water line Easement if possible. Otherwise, they shall be set in a minimum 5-foot by 5-foot sized separate water meter Easements contiguous with Public Right-of-Way.

   b. Three-inch through six-inch meters shall be set in a minimum 10-foot by 20-foot sized separate water meter Easement contiguous with Public Right-of-Way.

   c. Eight-inch and larger meters shall be set in a minimum 15-foot by 25-foot sized separate water meter Easement contiguous with Public Right-of-Way.

   d. Water meter Easements shall be located contiguous with Public Rights-of-Way unless approved by the City. Access Easements a minimum of 15-feet wide will be required when not contiguous with a Public Right-of-Way.

5.2.04.C continued

4. Dedicated water meter Easements shall be placed in unpaved and porous areas.

5.2.04.D Easements for Wastewater Lines and Appurtenances.

1. Gravity sanitary sewer lines and force mains shall be located in either the Public Right-of-Way or Easements. Side-lot Easements may be used only with special approval. Back-lot Easements shall not be utilized except in the case of existing conditions or as approved by the City Engineer.

2. Gravity Sanitary Sewer Lines.

   a. Easements adjacent to Public Rights-of-Way, Easements, or fee strips, including those owned by Harris County Flood Control District, CenterPoint Energy, and pipeline companies.

      (1) Easements for gravity sanitary sewers 10-inches or less in diameter shall have a minimum width of 15-feet or a minimum width equal to the depth of the proposed sewer, whichever is greater.

      (2) Easements for gravity sanitary sewers 12-inches or greater in diameter shall have minimum width of 20-feet or a minimum width equal to the depth of the proposed sewer, whichever is greater.

      (3) Easements for gravity sanitary sewers 24-inches or greater in diameter that are to be installed by trenchless method of construction shall have a minimum width of 20-feet.

   b. Gravity sanitary sewer Easements or other combined Easements for sanitary sewers which meet the conditions below shall have a minimum width equal to twice the sewer's diameter plus the flow line depth of the sewer from natural ground, proposed fill elevation, or 100-year floodplain fill elevation, whichever is greater; but not less than 25-feet. The qualifying conditions are:

      (1) Runs through commercial reserves or across open country (acreage);

      (2) Serves other existing or proposed platted commercial reserves or non-platted acreage tracts; or

      (3) Is not immediately adjacent to Public Rights-of-Way, Easements, or fee strips, including those owned by Harris County Flood Control District, CenterPoint Energy, and pipeline companies.

5.2.04.D.2 continued

c. Gravity sanitary sewers shall be located in the center of the Easement, where feasible.

d. Gravity sanitary sewers less than 20-feet deep, which cannot be located in the center of Easements shall be located a minimum distance of half the depth from the nearest side of the Easement.

e. Gravity sanitary sewers installed in Easements separated from Public or Semi-Public Rights-of-Way by other private or utility company Easements, shall be extended along or across the private utility company Easement to provide access for maintenance of the sewer.

f. Gravity sanitary sewers along state rights-of-way shall be installed outside of the right-of-way in a separate contiguous Easement. Width of Easements shall be as provided in Article 5.2.04.D.2.a.

g. Easements described in Articles 5.2.04.D.2.a through 5.2.04.D.2.f, and Article 5.2.04.D.3 shall be open-ended Easements in conformance with City Code of Ordinances and planning requirements. Such open-ended sanitary sewer Easements shall be extended if necessary and shall be fully connected at both ends to public facilities including existing or proposed:

(1) Street Public Rights-of-Way

(2) Wastewater treatment plant sites

(3) Wastewater pump station sites

(4) Public Utility Easement of adequate size for maintenance access.

3. Force Mains:

a. Force mains of all sizes shall have a minimum Easement width of 20-feet for single lines which are not located adjacent to Public or Semi-Public Right-of-Way.

b. Force mains located in Easements adjacent to Public or Semi-Public Right-of-Way shall have a minimum Easement width of 10-feet subject to location and depth of the force main.

c. Force mains installed in Easements separated from Public or Semi-Public Rights-of-Way by other private or utility company Easements, shall be extended along or across the private utility company Easement to provide access for maintenance of the force main.

5.2.04.D.3 continued

d. Force main Easements shall be open-ended. See Article 5.2.04.D.2.g for open ended Easement requirements.

e. Force mains along state rights-of-way shall be installed outside of the right-of-way in a separate contiguous Easement. Width of Easements shall be as provided in Article 5.2.04.D.3.b.

4. Service Leads.

a. The minimum Easement for building service leads is 6-feet.

5.2.04.E Storm Drainage Lines and Appurtenances

1. Storm Sewer Lines.

a. To the extent practical, storm sewers shall be placed in street Public Rights-of-Way or Permanent Access Easements with overlapping Public Utility Easements in accordance with Chapter 6, Utility Locations.

b. The minimum Easement width required to install, operate, and maintain storm sewers are summarized in Table 5.2.

Table 5.2 – MINIMUM EASEMENT WIDTH FOR STORM SEWERS

SIZE OF STORM SEWER	MINIMUM EASEMENT WIDTH
24" through 36" (1)(3)	20 ft
42" through 72" (2)(3)	25 ft
84" and Larger (2)(3)	30 ft

Notes:

(1) Unless the storm sewer is located within a combined storm and sanitary sewer Easement, storm sewers shall be centered in 20-foot Easements.

(2) Unless the storm sewer is located within a combined storm and sanitary sewer Easement, storm sewers should be centered in the Easement. If the sewer cannot be centered, the horizontal clearance between the exterior of the storm sewer and the Easement Boundary shall be a minimum of 8-feet for sewers that are less than or equal to 15-feet in depth. For storm sewers greater than 15-feet in depth that cannot be centered within the Easement, the horizontal clearance between the exterior of the storm sewer and the Easement Boundary shall be a minimum of 16-feet.

(3) For storm sewers at depths greater than 15-feet, add an additional 15-feet to the permanent Easement. Depths shall be measured to the bottom of the storm sewer from natural ground or final ground elevation, whichever is greater.

5.2.04.E.1
continued

c. Back-lot Easements are discouraged and will require a variance from the City design standards.

d. Center culverts in side-lot storm sewer Easements.

e. Public and private facilities may require a dedicated storm water Easement. Refer to Chapter 9 “Stormwater Design and Water Quality Requirements,” Section 9.2.01.H.5 “Ownership and Easements” for conditions.

f. Storm sewer Easements are required for proposed storm sewers located inside of Public Right-of-Way if the exterior of the storm sewer pipe is located within 5-feet of the Public Right-of-Way. The Easement shall be contiguous with the Public Right-of-Way and the Easement width shall be as follows:

(1) Minimum of 5-foot width when the storm sewer pipe outer wall is located between 3-feet to 5-feet from the Public Right-of-Way.

(2) Minimum of 10-foot width when the storm sewer pipe outer wall is located less than 3-feet from the Public Right-of-Way.

(3) For storm sewers at depths greater than 15-feet, add an additional 10-foot wide permanent Easement to the Easement width required by 5.2.04.E.1.f.(1) or 5.2.04.E.1.f.(2). Depths shall be measured to the bottom of the storm sewer from natural ground or final ground elevation, whichever is greater.

2. Storm Water Detention Basins.

a. Easements for storm water detention basins shall be dedicated by plat or by separate instrument filed in conjunction with plat approval. Such Easements shall be dedicated to the developer, owner, or water district.

b. Such Easements shall have a minimum 20-foot width for private basins surrounding the perimeter of the detention basin as measured from top of bank unless adjacent to a street Public Right-of-Way.

3. Easement Requirement For Sheet Flow Between Lots or Across Reserve Tracks of Land:

a. Provide a minimum 20-foot Easement to accommodate sheet flow that is routed between lots or across reserve tracts.

5.2.04.F Combined Storm and Sanitary Sewer Easements:

1. Total combined Easement width shall be rounded up to the nearest multiple of 5-feet.

2. For combined storm and sanitary sewer Easement not contiguous to the Public Right-of-Way or Semi-Public Right-of-Way:

    a. Combined Easement width shall be as specified in Article 5.2.04.D.2.b and Article 5.2.04.E.1.b, whichever is greater.

    b. The centerline of sanitary sewer lines or force mains shall be located not less than 10-feet from the edge of the Easement Boundary.

    c. Minimum horizontal clearance between the exterior of any storm sewer and either Easement Boundary shall be as required by Table 5.2, Note 2.

3. For combined storm and sanitary sewer Easements contiguous to Public or Semi-Public Right-of-Way:

    a. Combined Easement width shall be as specified in Article 5.2.04.E.1.b or a minimum width equal to the depth of the proposed sanitary sewer line, whichever is greater.

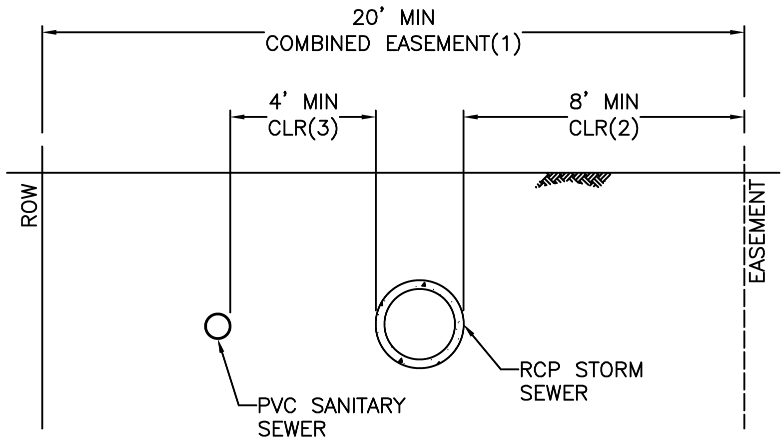
    b. When sanitary sewer lines are placed nearest to the Outer-Easement Boundary of combined Easements, the centerline of sanitary sewer lines or force mains shall be located not less than 10 feet from the edge of the Easement.

    ~~b.~~c. When storm sewers are placed nearest to the Outer-Easement Boundary of combined Easements, the minimum horizontal clearance between the exterior of any storm sewer and the Outer-Easement Boundary shall be as required by Table 5.2, Note 2.

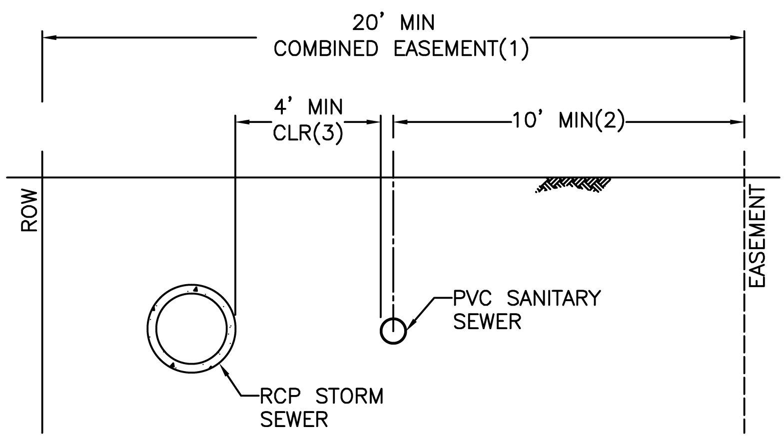
    ~~c.~~d. See Figure 5.1 for an example to be used as a visual aid for these requirements. Figure 5.1 is not a substitute for the requirements in this section.

5.2.04.G No variances will be approved by the City Engineer unless there are extenuating circumstances.

5.2.04.G
continued



CASE (A):
STORM NEAREST TO OUTER EASEMENT BOUNDARY AND UTILITY DEPTH LESS THAN 15 FT



CASE (B):
SANITARY SEWER NEAREST TO OUTER EASEMENT BOUNDARY AND UTILITY DEPTH LESS THAN 15 FT

FIGURE NOTES:

(1) EASEMENT WIDTH SHOWN AS AN EXAMPLE AND IS NOT TYPICAL. SEE ARTICLE 5.2.04.F.3 FOR MINIMUM EASEMENT WIDTH REQUIREMENTS
(2) PIPE LOCATION AND HORIZONTAL CLEARANCE SHOWN AS AN EXAMPLE AND ARE NOT TYPICAL. SEE ARTICLES 5.2.04.F.3.b AND 5.2.04.F.3.c FOR REQUIREMENTS
(3) PIPE HORIZONTAL CLEARANCE SHOWN AS AN EXAMPLE AND IS NOT TYPICAL. SEE ARTICLE 5.2.04.A FOR CLEARANCE REQUIREMENTS

Figure 5.1 – SECTION VIEW EXAMPLES OF COMBINED STORM AND SANITARY SEWER EASEMENTS CONTIGUOUS TO PUBLIC RIGHT-OF-WAY (CASES A & B)

END OF CHAPTER

City of Houston

Design Manual

Chapter 6

UTILITY LOCATIONS

Chapter 6
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Chapter 6

UTILITY LOCATIONS

SECTION 1 - UTLITY LOCATIONS OVERVIEW

6.1.01 CHAPTER INCLUDES

6.1.01.A Location of utilities in rights-of-way and easements.

6.1.02 REFERENCES

6.1.02.A Typical utility location in 10-foot-wide and 14-foot-wide easements in back-to-back lots and perimeter lots as detailed in the most current drawing prepared by the Uniform Color Code (UCC).

6.1.02.B Typical utility locations within City rights-of-way.

6.1.02.C ASCE. (2002, October). Standard guidelines for the collection and depiction of existing subsurface utility data. American Society of Civil Engineers.

6.1.03 DEFINITIONS

6.1.03.A Easements - Areas set aside for installation and maintenance of utilities by public and private utility companies.

6.1.03.B Private Utilities - Utilities belonging to, operated, and maintained by private entities.

6.1.03.C Public Utilities - Utilities belonging to, operated, and maintained by public entities

6.1.03.D Right-of-Way - Public property dedicated or deeded to a municipality for the purpose of public use.

6.1.03.E Storm Sewer Lines - Closed gravity (non-pressure) conduits designed to collect and transport storm water from inlet locations to an open conduit outfall, ditch, creek, stream, bayou, river, holding pond, or bay. Inlets are surface mounted basins designed to collect and funnel storm water to the collection system. Storm sewers from the inlets to the collection system are usually defined as inlet leads.

6.1.03.F Subsurface Utility Engineering (SUE) – A branch of engineering practice that involves managing certain risks associated with utility mapping at appropriate quality levels, utility coordination, utility relocation design and coordination, utility condition assessment, communication of utility data to concerned parties, utility

6.1.03.F continued

relocation cost estimates, implementation of utility accommodation policies, and utility design[1].

6.1.03.G Type 1 Permanent Access Easement - A permanent access easement at least 50 -feet in width that is designed and constructed like a public street in accordance with the design manual and contains one or more public utilities in an unpaved portion of the easement. Refer to Chapter 42 of the Code of Ordinances.

6.1.03.H Water Lines - Closed conduits designed to distribute potable water for human consumption and to provide fire protection. Line size and fire protection accessory locations are dependent on distance from primary source and quantity demand.

6.1.03.I Wastewater Sewer Lines - Closed conduits designed to collect and transport wastewater from residential, commercial, and industrial sites to plants for treatment prior to discharge into open conduits. Wastewater lines may be designed as gravity (non-pressure) flow lines or force (pressure) mains. Gravity flow lines usually fall into three categories in ascending size from service line to lateral line to main line. Service lines (source of wastewater) may discharge into a lateral line or main line.

[1] Refer to paragraph 6.1.02.C (ASCE, 2002)

SECTION 2 - UTLITY LOCATION DESIGN REQUIREMENTS

6.2.01 DESIGN REQUIREMENTS

6.2.01.A Whenever practical, locate public storm sewer, wastewater collection lines, water mains, and appurtenances within public rights-of-way in the manner described by this and corresponding subject-specific chapters in this manual, as well as related details and specifications.

6.2.01.B Research and resolve known conflicts of proposed utilities with existing utilities according to subject-specific criteria developed by the utility owner(s).

6.2.01.C Locate back lot utilities in compliance with UCC recommendations.

6.2.01.D Identify all existing and proposed utilities and related appurtenances in the manner established by the subject-specific chapters in this manual.

6.2.01.E Conduct where appropriate, a subsurface utility exploration (SUE) to definitively locate potential utilities (public and private) that are in conflict with the project. Located utilities shall be shown on the plans as "location verified" with the quality level of SUE listed.

1. Levels of SUE as defined by ASCE 38-02[2]

   a. Utility quality level A:

      1) Precise horizontal and vertical location of utilities obtained by the actual exposure (or verification of previously explored and surveyed utilities) and subsequent measurement of subsurface utilities, usually at a specific point.

      2) Minimally intrusive excavation equipment, such as vacuum excavation, is typically used to minimize the potential for utility damage.

      3) A precise horizontal and vertical location, as well as other utility attributes, are shown on plan documents.

      4) Accuracy is typically set to 15-mm vertical, and to applicable horizontal survey and mapping accuracy as defined or expected by the project owner.

   b. Utility quality level B – Information obtained through the application of appropriate surface geophysical methods, such as pipe and cable locators, terrain conductivity methods, metal detectors, and ground-

[2] Refer to paragraph 6.1.02.C (ASCE,2002)

6.2.01.E.1.b continued

penetrating radar, to determine the existence and approximate horizontal position of subsurface utilities. Quality level B data should be reproducible by surface geophysics at any point of their depiction. This information is surveyed to applicable tolerances defined by the project and reduced onto plan documents.

c. Utility quality level C – Information obtained by surveying and plotting visible above-ground utility features and by using professional judgment in correlation with this information to quality level D information.

d. Utility quality level D – Information derived from existing records or ~~oral recollections~~as-builts.

2. Level of SUE Required

~~d.~~a. For private projects, if a quality level B, C, or D SUE indicates that the proposed utility has a horizontal or vertical clearance that is less than what is required in this manual, a quality level A SUE is required to confirm location of the existing utility. In the case that the proposed utility is parallel to the existing utility, then a quality level A SUE is required at intervals of every 500 feet within the limits where there is less than sufficient horizontal clearance as indicated by the quality level B, C or D SUE. A quality level A SUE must be provided in order to be granted a variance for utility clearance.

b. For private projects in which underground trenchless construction will be performed, if a quality level C or D SUE indicates that the proposed utility will cross (above or below) an existing public utility with less than 10 feet of vertical clearance from exterior of the existing public utility to exterior of the proposed utility, a quality level A or B SUE is required to confirm the location of the existing public utility. If minimum clearances cannot be maintained, see article 6.2.01.E.2.a.

~~e.~~c. At a minimum, a topographical survey equivalent to a quality level C SUE is required for every project in which excavation equal to or deeper than three (3) feet is performed and any other project in which the City requests a quality level C SUE. Driveway projects do not require a quality level C SUE.

6.2.02 SUBMITTALS

6.2.02.A Submittals are to be made according to the criteria established by the utility owner(s).

6.2.03 QUALITY ASSURANCE

6.2.03.A All existing utilities must be shown on project drawings. Sources of data include survey, record drawings, graphical information systems, and field visits. Field visits must be made to verify the project drawings accurately portray the existing conditions.

6.2.04 DESIGN

6.2.04.A Back Lot Utilities: Identify type of electrical service and select the appropriate width of the easement. For mixed overhead and underground service select the 14-foot-wide easement to provide versatility.

6.2.04.B Water Lines

1. Water lines may be located within a public right-of-way, within a Type 1 permanent access easement with overlapping public utility easements, within a dedicated easement adjacent to and contiguous with the right-of-way, or within separate dedicated water line easements, to meet the requirements of this manual. Water lines and related appurtenances shall be as specified in the subject-specific chapter(s) in this manual, as well as related details and specifications.

2. Water lines shall not be located in combination easements without approval of Houston Public Works. Water line easements shall not be combined with wastewater sewer easements.

3. Water lines, with the exception of transmission lines, shall be located within the right-of-way between the property line and back of curb or in a dedicated easement adjacent to and contiguous with the right-of-way.

4. Water lines and fire hydrants shall not be located in State rights-of-way. Water lines and fire hydrants should be located outside of the right-of-way in a separate contiguous easement. Width of easements shall be as provided in Paragraph 5.2.04.C.1.e & 5.2.04.C.2 Existing interagency utility agreements between the City and the State within State rights-of-way may supersede this requirement. Agreements shall be provided upon request for review and applicability.

6.2.04.C Wastewater Lines

1. Wastewater lines shall be located in a public right-of-way, within a Type 1 permanent access easement with overlapping public utility easements or within a dedicated easement adjacent to the public right-of-way. Side lot easements may be used when required. Backlot easements shall not be utilized except in cases of pre-existing conditions and with approval of the City.

6.2.04.C.1 continued

Wastewater, force mains, and related appurtenances shall be as specified in the chapter (7, 8, and 9) in this manual, as well as related details and specifications.

2. Wastewater trunk or collector mains shall not be located inside lot easements without approval of the City.

3. Wastewater gravity sewer trunks, collector mains, and force mains shall be generally located on the opposite side of the right-of-way from the water main.

4. Wastewater force mains are generally located within the right-of-way between the property line and the back of curb, or in a dedicated easement adjacent and contiguous with the right-of-way.

5. When wastewater or force mains are parallel to the storm sewer, they shall not be constructed in the same theoretical trench widths.

6. Wastewater Sewer Lines shall not be located in State rights-of-way. Wastewater Sewer Lines should be located outside of the right-of-way in a separate contiguous easement. Width of easements shall be as provided in Paragraph 5.2.04.D.2 & 5.2.04.D.3 Existing interagency utility agreements between the City and the State within State rights-of-way may supersede this requirement. Agreements shall be provided upon request for review and applicability.

6.2.04.D Storm Water Lines

1. Storm water lines shall be located within public rights-of-way, within a Type 1 permanent access easement with overlapping public utility easements or approved easements. Approval of the location for storm water lines should be obtained from Houston Public Works prior to plan preparation.

2. Coordinate the proposed storm sewer alignment with water line location and future pavement widening.

6.2.04.E Private Utility Lines

1. Proposed work, location, and placement of utilities shall be submitted to the Office of the City Engineer for review and permitting. A minimum separation distance of either three feet (or more as stated in other portions of this design manual and/or related specifications, standards, or details) of horizontal clearance when parallel, and two feet (or more as stated in other portions of this design manual and/or related specifications, standards, or details) vertical clearance when crossing, shall be maintained between the exterior of all private utilities and public utilities.

6.2.04.E continued

2. Structures shall not be imbedded within sidewalks.

3. All proposed work must be coordinated with the City of Houston Capital Improvement Program.

4. Above-ground utility structures and appurtenances shall have a minimum of three feet of horizontal clearance from the right-of-way, unless approved by the City Engineer. Utility poles should be placed within two feet of the ROW line, unless approved by the City Engineer. These clearances do not apply to wireless service facilities: See Chapter 16. In no case shall above ground utility infrastructure from one utility entity be located within a clear distance of other infrastructure (retaining wall, exterior wall, trees, planters, light poles, traffic signals, other utility entity's infrastructure, etc.) that prevents use / travel along the sidewalk's path by persons in wheelchairs.

SECTION 3 - UTILITY LINES ON CITY OF HOUSTON BRIDGES AND OTHER STRUCTURES

Utilities mounted to bridges that go over waterways that fall under the jurisdiction of the Army Corp of Engineers, must meet their requirements and are subject to their approval.

6.3.01 UTILITY LINES ON CITY BRIDGES OVERVIEW

6.3.01.A These criteria are not applicable when removing and replacing a utility in kind on a bridge structure.

6.3.01.B The following information is adapted from the Texas Department of Transportation Bridge Project Development Manual, Chapter 4: Advanced Planning, Section 4: Utility Attachments; March 2018 Edition.

6.3.01.C To every extent possible, do not attach utility lines to bridges and separation structures because the proliferation of such lines and their maintenance constitutes a hazard to traffic and complicates widening or repair. Attaching utility lines to a bridge structure can materially affect the structure, the safe operation of traffic, the efficiency of maintenance, and the overall appearance.

6.3.01.D Where other arrangements for a utility line to span an obstruction are not feasible, Houston Public Works may consider the attachment of such line to a bridge structure. Any exceptions that are permitted will be handled in accordance with the conditions set forth in Title 43 TAC, Section 21.35 and 21.37 (relating to utility structures) and other pertinent requirements contained therein. Each such attachment will be considered on an individual basis and permission to attach will not be considered as establishing a precedent for granting of subsequent requests for attachment.

6.3.01.E Written permission is required from TxDOT’s Bridge Division Office for any utility attachments to on-system bridges. On-system bridges are Federal-Aid highway/roadway bridges. In addition, written permission is also required from the City of Houston (Houston Public Works – Street and Bridge Maintenance) for these any utility attachments to on-system bridges. The reason is that the City of Houston is a stakeholder in terms of taking over maintenance of the bridges, and these bridges, because they cross City of Houston water bodies, watersheds, roads, paths, etc. Permit requests to perform the attachment work to on-system bridges shall be submitted to Office of the City Engineer (see paragraph 6.3.06) as well as any other regulatory agency with jurisdiction.

6.3.01.F Written permission is required from Houston Public Works - Street and Bridge Maintenance for any utility attachments to off-system bridges within the City of Houston’s jurisdiction. Off-system bridges are non-Federal-aid roadway bridges.

6.3.01.G Permit requests to perform the attachment work to off-system bridges shall be submitted to Office of the City Engineer (see paragraph 6.3.06).

6.3.01.H Considerations for allowing or rejecting attachment of utilities to bridges include, but are not limited to the following:

1. Painting of Steel Bridges: Utility attachments may limit the ability of Bridge Maintenance crews to sandblast (prep) and paint steel bridge components. Panting is critical in maintaining steel bridges and extending their useful service life.

2. Hazardous Liquid or Gas Utility Lines: Requests for such lines will be reviewed on a case by case basis. Shut off valves may be required on either side of the bridge.

3. Bridge Maintenance / Repair: Some bridge maintenance / repair work may require vertical displacement of the bridge deck. This work includes replacing bearing pads, repairing bridge columns, or other bridge repair work. Such displacements may damage rigid pipe utilities, used for transporting liquids or gas, or utility conduits, used for carrying cable utilities.

4. Added Cost: There may be added cost for incorporating utility attachment to a bridge. This cost may be comprised of design costs, material costs, construction costs, change orders, schedule delays, etc.

5. Proposed attachment details submitted by the utility owner and the impacts the details may have on the bridge/structure.

6.3.02 DECISION AND NOTIFICATION TO ALLOW ATTACHMENT

6.3.02.A If it is decided to allow utility attachment to a bridge, written permission (Letters of Decision or Issuance of No Objection) will be issued. The following terms and conditions are associated with allowing a utility line to be attached to a bridge or other structure: These terms are not an all-inclusive list, and additional site-specific additions may be required.

1. Maintenance of utility, including all conduit and attachment material for supporting the utility on the bridge (or other structure) shall be the responsibility and at the cost of the utility owner.

2. The City of Houston is not responsible for any damage or out-of-service losses associated with the utility, its conduit (if applicable), coatings, or attachment hardware resulting from any event, including but not limited to bridge repair and maintenance work, such as sand-blasting and painting, raising the deck to replace bearing pads, and any other bridge repair or maintenance activities.

6.3.02.A continued

3. Utility owner shall remove its utility line, conduit, and attachments at the request of the City of Houston at any time. This includes, but is not limited to, shut down, disruption of service, de-inventory / evacuating of a liquid or gas utility pipeline, inerting a flammable liquid or gas utility pipeline, swabbing / cleaning a hazardous liquid pipeline, and traffic control for work areas and potential dropped object zones above roadways. Timing may be immediate if required to protect public safety or the environment. Timing may be urgent for bridge maintenance work. Removal shall be at the expense of the utility owner.

4. The utility owner shall reimburse (pay) the City of Houston Public Works all costs realized by the city to review and facilitate the supported utility on a bridge. The costs may include engineering / design services costs, material costs, and construction costs for new bridges/structures in the design process (not yet existing or being reconstructed) or for a third-party engineering contractor(s) or supplier(s) to review attachment details for existing bridges. The utility owner will still be responsible for reimbursement (payment) of costs realized by the city to review and facilitate the utility attachment if the utility owner ultimately decides not to attach its utility to the bridge for any reason.

5. Utility owner will be responsible for all costs associated with installation and attachment of the utility. This includes, but is not limited to, installation of the utility into pre-existing or pre-installed conduits if available, condition assessment of pre-existing conduits, attachment hardware for supporting the utility, tie-ins, materials not pre-installed by the City of Houston, electrical isolation and grounding of the utility as applicable, removal of existing conduit and attachments that may be inadequate, damaged, or corroded, work to install new conduit and attachment hardware, development and implementation of traffic control plans for the work, and installation execution plans.

6. Permits are required for performing the actual work of attaching the utility. Permit requests for the work shall be submitted to Office of the City Engineer (see paragraph 6.3.06).

6.3.03 OVERALL DESIGN GUIDELINES

6.3.03.A All requests for attachments to an existing City of Houston bridge/structure must be submitted to the City's Bridge Maintenance Office.

6.3.03.B All requests for attachments to a new City of Houston bridge/structure in the design process (not yet existing or being reconstructed) must be submitted to Houston Public Works – Street and Bridge Maintenance, / Interagency Coordinator in consultation with the Bridge Maintenance Office. Requests should be submitted (and addressed) as early as possible in the design process to minimize the cost to the City of Houston in the form of design changes, schedule delay, and change orders.

6.3.03.C All new bridge structures should include conduit for future utilities, per TxDOT's current design standards.

6.3.03.D Attachment Locations

1. Recommended attachment locations are on the overhang, as close as possible to the outside beam, or behind the outside beam. Behind the outside beam is preferred.

2. Hanging lines on the outside of the beams is not aesthetically pleasing and may be subject to vandalism. Attachments to water crossing structures should be placed on the downstream side where exposure to high water is less likely.

3. Bridge attachments shall not be made to any bridge rail or rail hardware, including anchor bolts. Bridge rails are the most susceptible to damage caused by motor vehicles, and hence are not a suitable location for utility placement. This will reduce the risk of damage to the utility, and it will reduce the need to get the utility owner involved when bridge rail repair is performed.

4. Do not hang lines from the bottom of beams. This decreases freeboard (water crossings) and clearance (road crossings), and hence increases the likelihood of damage.

5. It may be beneficial to carry lines across an obstruction using a separate utility structure rather than an attachment to a City of Houston Public Works bridge / structure.

6.3.04 DESIGN GUIDELINES PER TYPE OF UTILITY

6.3.04.A Communication Lines

1. When it is impractical to carry a self-supporting communication line across a stream or other obstruction, Houston Public Works may permit the attachment of the line to its bridges. On existing bridges, Houston Public Works generally requires that the line be enclosed in conduits and located on structures such that it does not interfere with stream flow, traffic, or routine maintenance operations. When a request is made prior to construction of a bridge, suitable conduits will be provided in the structure if the utility company bears the cost of all additional work and materials involved.

6.3.04.B Gas or Fuel Utility Lines

1. No gas or liquid fuel lines may be attached to a bridge or grade separation structure without the specific permission from Houston Public Works. Note that attachment of US Department of Transportation (49 CFR 192 and 49 CFR 195) transmission pipelines and attachment of oil and gas production flowlines/pipelines to City of Houston bridges and other structures are strictly prohibited. Transmission pipelines and production flowlines/pipelines require their separate and dedicated ROW and bridge/crossing. The only exception is that consideration may be given to temporary water or saltwater pipelines (Paragraph 6.3.04.E). See paragraph 6.3.04.D regarding costs.

6.3.04.C Power Lines

1. Power lines are not permitted on bridges under any condition with the exception of low-voltage distribution lines where the cost of independent facilities to carry these lines would be prohibitive. For this requirement, low-voltage lines must carry 600 volts or less.

6.3.04.D Utility Pipelines

1. When a utility company requests permission to attach a pipeline to a proposed bridge prior to construction, and the added load is sufficient to require an increase in the strength of the structure or use of more costly materials or type of construction, the utility owner is required to pay for the increase in cost.

6.3.04.E Temporary Water Lines or Saltwater Pipelines

1. Temporary water lines are sometimes requested to be attached to bridges by companies in the oil and gas industry. If considered, special review and procedures will be required to assure that leaks during operation and an approved de-inventory, swabbing/cleaning/pigging, air-drying, and containment procedure(s) does not cause accelerated corrosion of the bridge/structure when a line is removed. See paragraph 6.3.04.D regarding costs.

6.3.05 REQUESTS TO ATTACH A UTILITY TO AN EXISTING BRIDGE

6.3.05.A All requests shall be sent to the Bridge Maintenance Office and each request may include the following as determined applicable by Bridge Maintenance Office:

1. Alternatives Study
2. Hydraulic Impact Analysis (stream analysis and/or scour analysis)
3. Stress analysis showing the effect of the added load on the structure.

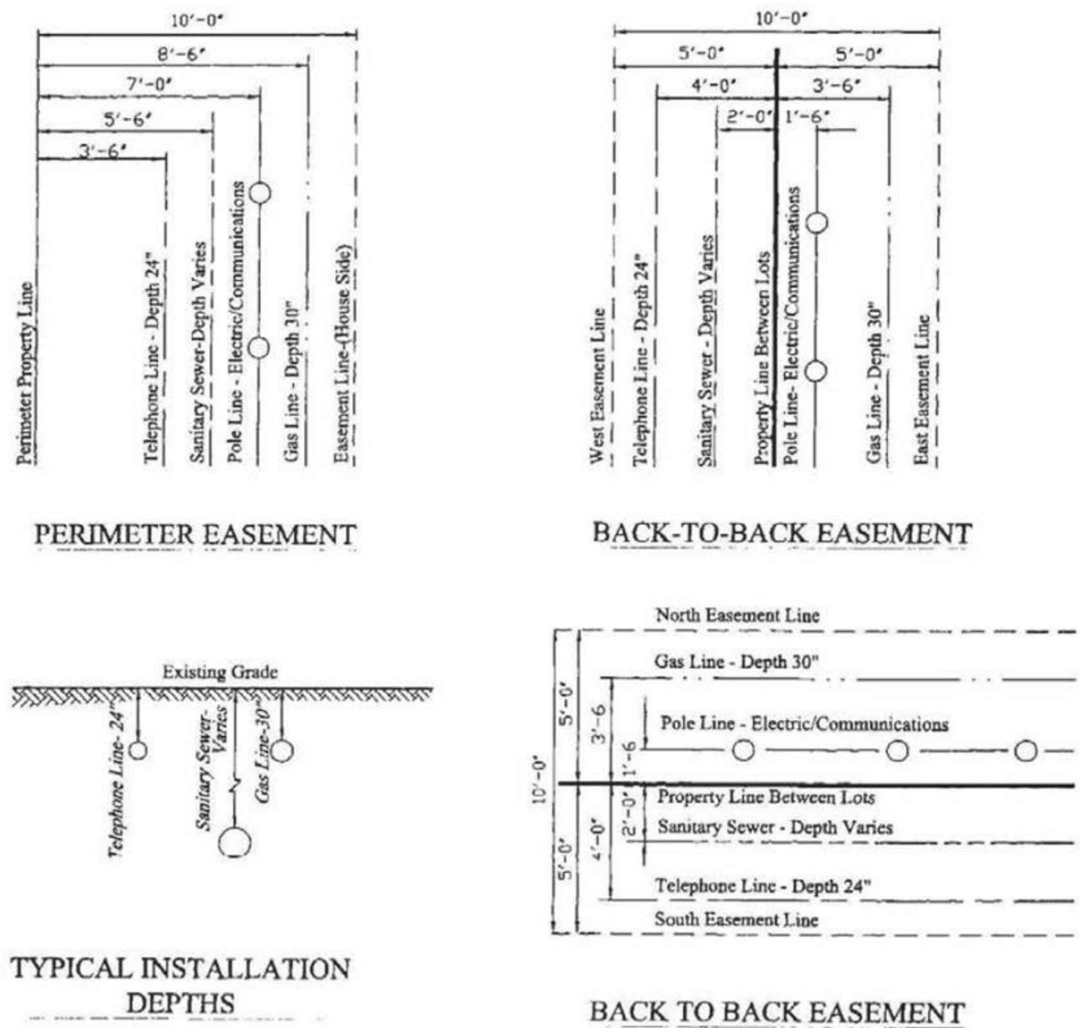
6.3.06 PERMITTING OF UTILITY WORK ON THE CITY OF HOUSTON BRIDGES

6.3.06.A All third-party utility work shall be submitted to the Office of the City Engineer for reviews and permitting.

6.3.06.B Plans shall:

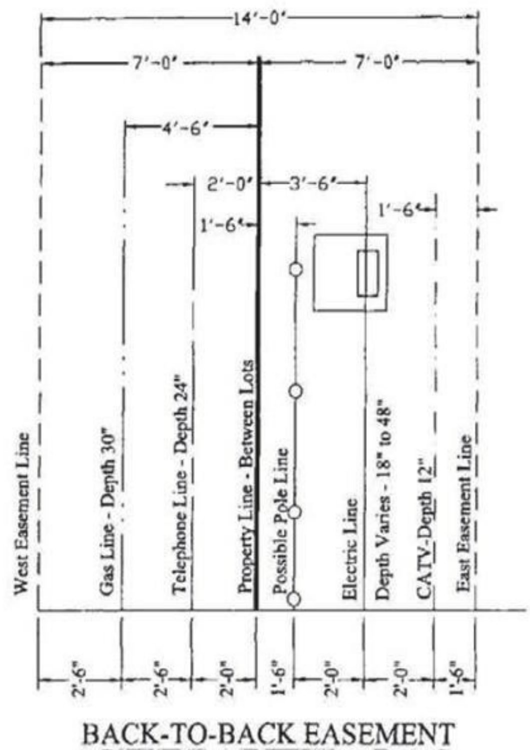
1. Show proposed location of attachment
2. Show specific detail for the attachment
3. Identify materials
4. Traffic Control Plans, including staging, for all work areas
5. Traffic Control Plans, including staging for all dropped object zones for roads being crossed by a bridge on which utility attachment work is being conducted.
6. Installation execution plans
7. Provide Letters of Decision/Issuance of No Objection from the Bridge Maintenance Office for off-system bridges and written permission from TxDOT, with additional written permission from City of Houston Public Works for flammable or hazardous liquid utility pipelines, for on-system bridges.

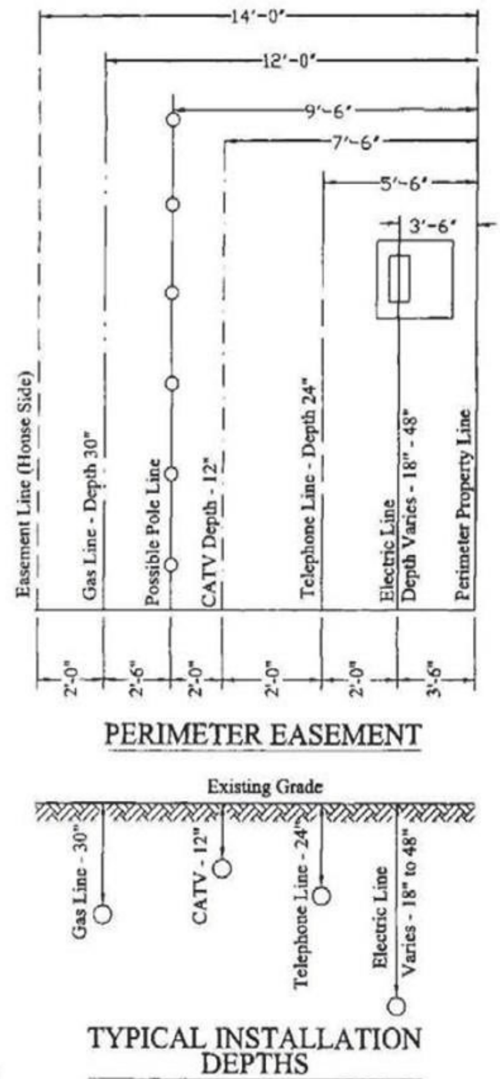
END OF CHAPTER



NOTES:
(1) Utilities are normally installed as shown but depth may vary due to fill or cut by others.
(2) Maintain minimum 4" clearance between utility lines extending from easement to house/building.
(3) Flexible base shall be 8" minimum hot mix asphaltic concrete (hmac).

Figure 6.1 - TYPICAL UTILITY LOCATIONS IN 10-FOOT WIDE RESIDENTIAL EASEMENT





NOTES:

(1) Utilities are normally installed as shown, but depth may vary due to fill or cut by others.

(2) Maintain minimum 4" clearance between all utility lines extending from easement to house/building.

(3) Always exercise extreme caution when digging in utility easements and on or across customer's property, because service lines extend from easement to house.

(4) 10' Utility Easements may be granted if approved by the Utilities and City Council.

Figure 6.2 - TYPICAL UTILITY LOCATIONS IN 14-FOOT WIDE RESIDENTIAL EASEMENT
(NO BACKLOT SEWER)

City of Houston

Design Manual

Chapter 9

STORMWATER DESIGN AND WATER QUALITY REQUIREMENTS

Chapter 9
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Chapter 9

STORMWATER DESIGN REQUIREMENTS

SECTION 1 - STORMWATER DESIGN OVERVIEW

9.1.01 CHAPTER INCLUDES

9.1.01.A Criteria for the design of storm drainage improvements.

9.1.02 POLICY

9.1.02.A Design Requirements.

1. Drainage criteria administered by the City of Houston and complemented by Harris County and the Harris County Flood Control District (HCFCD) for newly designed areas provides protection from Structural Flooding from a 100-year storm event. This is accomplished through application of various drainage enhancements, such as storm sewers, roadside ditches, open channels, detention and overland (sheet) run-off. The combined system is intended to prevent Structural Flooding from extreme events up to a 100-year storm.

2. Recognizing that each site has unique differences that can enhance the opportunity to provide proper drainage, the intent of these criteria is to specify minimum requirements that can be modified provided that the objective for drainage standards is maintained. For projects which require a site-specific approach and where unique engineering solutions will achieve drainage objective, a request for consideration of alternative standards (pipe flow, overland sheet flow, and detention storage) shall be submitted to the City of Houston, Houston Public Works, Office of the City Engineer (1002 Washington), for review and approval.

9.1.02.B Ponding in streets and roadside ditches of short duration is anticipated and designed to contribute to the overall drainage capacity of the system. Storm sewers and roadside ditch conduits should be designed considering a balance of capacity and economics. These conduits should be designed to convey less intense, more frequent rainfalls with the intent of allowing for traffic movement during these events. When rainfall events exceed the capacity of the storm sewer system, the additional runoff is intended to be conveyed or stored overland in a manner that reduces the threat of structural flooding.

9.1.02.C All proposed New Development, Redevelopment, or Site Modifications shall not alter existing or natural overland flow patterns and shall not increase or redirect existing sheet flow to adjacent private or public property[1]. Where the existing sheet flow pattern is

[1] Texas Water Code 11.086 – Overflow Caused by Diversion of Water

9.1.02.C continued

blocked by construction (i.e. raising the site elevation) of the Development, the sheet flow shall be re-routed within the developed property to return flow to original configuration or to the public R.O.W. Except under special circumstances dictated by natural or existing drainage patterns no sheet flow from the developed property will be allowed to drain onto adjacent private property. No impact will be allowed onto adjacent property.

The estimated volume of displaced sheet flow shall be calculated, and the rerouted flow pattern shall have adequate volume to provide that adjacent property is not impacted by the development. No sheet flow from the developed property will be allowed to drain (via sheet flow) onto the adjacent ROW. Any increased quantity discharge should only be discharged to the ROW at the approved point of connection (which have enough capacity to handle the discharged) via a subsurface internal drainage system.

9.1.02.D The City is a participant in the National Flood Insurance Program (NFIP). The flood insurance program makes insurance available at low cost where the municipal entity implements measures that reduce the likelihood of structural flooding. The design criteria in this chapter are provided to support the NFIP. All development located within the City limits shall comply with Chapter 19, FLOODPLAIN, of the Code of Ordinances.

9.1.02.E Approval of storm drainage is a part of the review process for planning and platting of a New Development, site plan review process for Redevelopments, and the permitting process for Site Modifications. Review and approval of plats is conducted by the Department of Planning and Development. Review of storm drainage is conducted by Houston Public Works.

9.1.02.F The City will consider joint project funding with a private entity for construction of drainage systems that improve existing drainage infrastructure. The City's first priority will be to fund those projects included in the Capital Improvement Plan (CIP). Where feasible, City funding will be leveraged with other funding sources including private entities, civic organizations, and other public agencies (Harris County, HCFCD, Corps of Engineers, Housing and Community Development, and other funding sources). For drainage systems that have been identified as deficient and are not scheduled to receive funding in the current CIP, the City will consider authorizing improvements performed by the private entity which comply with the City's objectives, and may be a candidate for a Developer Participation Contract (DPC) contract.

9.1.02.G The criteria in this Chapter apply to all projects located in the City limits and to expanding utility districts and new utility districts located in the City's Extraterritorial Jurisdiction (ETJ). If the criteria conflicts with Harris County, HCFCD, Fort Bend County, Montgomery County or other jurisdictions, the more restrictive criteria shall govern.

(a) No person may divert or impound the natural flow of surface waters in this state, or permit a diversion or impounding by him to continue, in a manner that damages the property of another by the overflow of the water diverted or impounded.

9.1.02.H Property owners and public agencies are responsible for not adversely impacting the community, neighbors, future property owners, or City facilities in terms of flood risks, erosion, infiltration and siltation.

9.1.03 REFERENCES

9.1.03.A Refer to the list of references in Chapter 1, General Requirements.

9.1.03.B City of Houston IDM Chapter 13, Geospatial Data Deliverables

9.1.03.C National Weather Service Documents

1. TP-40 Rainfall Frequency Atlas of the United States.
2. Hydro-35; 5-to-60-Minute Precipitation Duration for the Eastern and Central United States.
3. National Oceanic and Atmospheric Administration (NOAA) - Atlas - Precipitation - Frequency Atlas of the United States (Texas) – Current Edition.

9.1.03.D Hydraulic Engineering Circular No. 22, (HEC-22), Current Edition, "Urban Drainage Design Manual", Federal Highway Administration (FHWA).

9.1.03.E ASCE Manual and Reports of Engineering Practice No. 77, Design and Construction of Urban Stormwater Management Systems, Current Edition.

9.1.03.F HouStorm - The City of Houston's version of The Texas Department of Transportation's (TxDOT) software. The program is available from the City.

9.1.03.G Harris County Flood Control District Policy, Criteria, and Procedure Manual (HCFCD Criteria Manual), Current Edition. https://www.hcfcd.org/

9.1.03.H Texas Department of Transportation. (2011). Hydraulic Design Manual.

9.1.04 DEFINITIONS AND ACRONYMS

9.1.04.A Conduit - Any open or closed device for conveying flowing water examples, culverts, ditches, and storm sewers.

9.1.04.B Continuity Equation:

$$Q = VA$$

Where:
- Q = discharge (cfs or cms)
- V = velocity (ft/sec or m/sec)
- A = cross sectional area of Conduit (square feet or square meters)

9.1.04.C Critical Elevation - The maximum hydraulic grade line elevation a system is allowed to exhibit when conveying the design rainfall. This elevation is related to the level of service of the primary system.

9.1.04.D Design Ponding Depth - The depth of water adjacent to an inlet during the design rainfall event. Depth is measured from the bottom of the inlet opening for curb opening or from the top of the grate openings. This depth is used in inlet capacity calculations.

9.1.04.E Design Rainfall Event - Rainfall intensity upon which the drainage facility will be sized.

9.1.04.F Development - (i) any activity that requires a subdivision plat or development plat pursuant to Code of Ordinances Chapter 42; (ii) the further subdivision of any reserve tract that is part of a subdivision plat approved by the city planning commission or pursuant to Article II of Chapter 42, the Code of Ordinances; or (iii) any activity that requires a construction permit. The term includes New Development and Redevelopment.

1. New Development - Development of an undeveloped parcel of land.
2. Redevelopment - A change in land use that alters the impervious surface from one type of Development to either the same type or another type, or green field, and alters the drainage patterns internally or externally to the Development.
3. Site Modifications - A site improvement that alters the area of impervious surface (e.g., an addition to an existing structure or creating additional parking), or a change in existing storm water collection, conveyance or runoff conditions for the developed site (e.g., replacing existing parking surface with pervious pavement).

9.1.04.G Disturbed Area - means the existing surface has been altered by activity including, but not limited to, clearing, grubbing, demolition, grading, excavating and construction related activity (e.g. equipment staging, stockpiling of fill material and material storage areas), and construction support activity. This does not include altering the surface for

9.1.04.G continued

routine maintenance that is performed to maintain the original line and grade, hydraulic capacity, or original purpose of the site (e.g., the routine grading of existing dirt roads, asphalt overlays of existing roads, the routine clearing of existing right-of- ways, and similar maintenance activities).

9.1.04.H Drainage Area - The surface area determined by topography that contributes rainfall runoff to a point of interception. The drainage area represents the drainage system service area and is not limited by the project boundary or street R.O.W. The possibility of overland flow contributions from adjacent drainage areas during certain extreme events shall be considered for accurate assurance of level of service.

9.1.04.I Drainage Area Map - Service area map of the watershed or drainage system presented as specified in 9.4.01.A.8.

9.1.04.J FEMA - Federal Emergency Management Agency.

9.1.04.K FIS - Flood Insurance Study, the formal document and associated models used to define the floodplain boundaries. An appraisal of the community's flood problems in a narrative that describes: a) the purpose of the study; b) historic floods; c) the area and flooding sources studied; d) the engineering methods employed. FIS serve as the basis for rating flood insurance and for regulating floodplain development and carrying out other floodplain management measures.

9.1.04.L HCFCD - Harris County Flood Control District.

9.1.04.M HouStorm - The City's version of TxDOT's software. The program is available from the City.

9.1.04.N Hydraulic Grade Line (HGL) - A line representing the pressure head available at any given point within the drainage system.

9.1.04.O Impervious Surface - Impervious surface means any area that has been compacted or covered such that it does not readily absorb water or does not allow water to percolate through to undisturbed underlying soil strata. Surface materials considered impervious shall include, but not be limited to, bricks, pavers, concrete, asphalt, compacted oil-dirt, compacted or decomposed shale, oyster shell, gravel, or granite, and other similar materials. Surface features utilizing such materials and considered impervious shall include, but not be limited to, decks (whether on pier and beam or directly over soil), foundations (whether pier and beam or slab), building roofs, parking and driveway areas, sidewalks, compacted or rolled areas, paved recreation areas, swimming pools, dry or wet detention ponds, shade structures and other features or surfaces that are built or laid on the surface of the land and have the effect of increasing, concentrating, or otherwise altering water runoff so that runoff is not readily absorbed. Infiltration report of soil testing, signed and sealed by a Professional Engineer licensed in the State of Texas, must confirm surface can provide infiltration through underlying soil strata at a

9.1.04.O continued

rate of 0.5 inches/hour or greater to be considered permeable.

9.1.04.P Manning's Equation:

$$V = (K/n)\, R^{2/3}\, S_f^{1/2}$$

Where: K = 1.49 for English units,
1.00 for metric units

V = velocity (ft./sec or m/sec)

R = hydraulic radius (ft. or m) (area/wetted perimeter)

S_f = friction slope (head loss/length) (101)

n = 0.012 for corrugated profile-wall polyethylene pipe
0.013 for concrete pipes,
0.015 for concrete boxes,
0.024 for CMP pipes

9.1.04.Q Overland Flow - Flow resulting from a rainfall event that is routed along surface streets or surface channels in a defined manner.

9.1.04.R Rainfall Frequency - Probability of a rainfall event of defined characteristics occurring in any given year at a given location. Information on Rainfall Frequency is published by the National Weather Service. For the purpose of storm drainage design, the following frequencies are applicable:

1. 2-year frequency - a rainfall intensity having a 50 percent probability of occurrence in any given year, that occurs on the average every 2 years over a long period of time.

2. 3-year frequency - a rainfall intensity having a 33 percent probability of occurrence in any given year, that occurs on the average every 3 years over a long period of time.

3. 5-year frequency - a rainfall intensity having a 20 percent probability of occurrence in any given year, that occurs on the average every 5 years over a long period of time.

4. 10-year frequency - a rainfall intensity having a 10 percent probability of occurrence in any given year, that occurs on the average every 10 years over a long period of time.

5. 25-year frequency - a rainfall intensity having a 4 percent probability of occurrence in any given year, that occurs on the average every 25 years over a long period of time.

6. 100-year frequency - a rainfall intensity having a 1 percent probability of occurrence in any given year, that occurs on the average every 100 years over a long period of time.

9.1.04.R continued

7. 500-year frequency - a rainfall intensity having a 0.2 percent probability of occurrence in any given year, that occurs on the average of every 500 years over a long period of time.

9.1.04.S Rational Method - A method for calculating the peak runoff for a drainage system using the following equation for runoff:

	Q	=	I x (CA)
Where:	C	=	watershed coefficient
	A	=	Area (acres)
	I	=	rainfall intensity (inches)

9.1.04.T Sheet Flow - A shallow depth of runoff on a sloping and/or relatively flat surface that does not have a precisely defined bounding condition.

9.1.04.U Spread - Calculated only for design rainfall. The width of flow in the gutter, measured laterally from the roadway curb, approaching an inlet. In HouStorm this value is called the ponding width.

9.1.04.V Storm Sewer Junction Box - Precast or cast-in-place concrete, square or rectangular structure used to merge upstream pipes, accommodate changes in pipe size or direction, or provide service access to the storm sewer system by the addition of a circular manhole structure to the top of the junction box.

9.1.04.W Structural Flooding - The Water Surface Elevation (WSE) from the storm event exceeds the finished slab elevation of the building (for pier and beam construction the top of first floor elevation), resulting in water entering the residential or commercial structure.

9.1.04.X Undeveloped Parcel - a parcel on which there are no structures at the time that a construction permit, subdivision plat or other city approval is applied for or required.

SECTION 2 - DESIGN REQUIREMENTS

SECTION 2A - STORM WATER DESIGN REQUIREMENTS

9.2.01 DESIGN REQUIREMENTS

Projects shall meet the standards of this chapter. The Office of the City Engineer (OCE) may grant exceptions or deviations from these requirements on a project-by-project basis.

9.2.01.A Construction of drainage facilities designed per this chapter shall meet requirements of the City of Houston Standard Specifications and Standard Details. HouStorm shall be used to perform 2-year and inlet design analysis and design of storm drainage systems as follows:

1. City CIP Projects - In conjunction with design analysis using HouStorm, designs shall comply with guidelines provided in Technical Paper No. 100 (TP-100), Storm Sewer Design Applications for the City of Houston, Texas, CIP Projects, February 2005, or the latest published date.

2. Private Projects within City Limits which include City funding participation.

3. 100% Privately-funded Project located in City Limits - HouStorm preferred but alternative equivalent analysis procedures will be accepted.

4. Projects in New or Expanding Utility Districts located in City's ETJ - HouStorm preferred but alternative equivalent analysis procedures will be accepted.

9.2.01.B Determination of Runoff.

1. Design Rainfall Events.

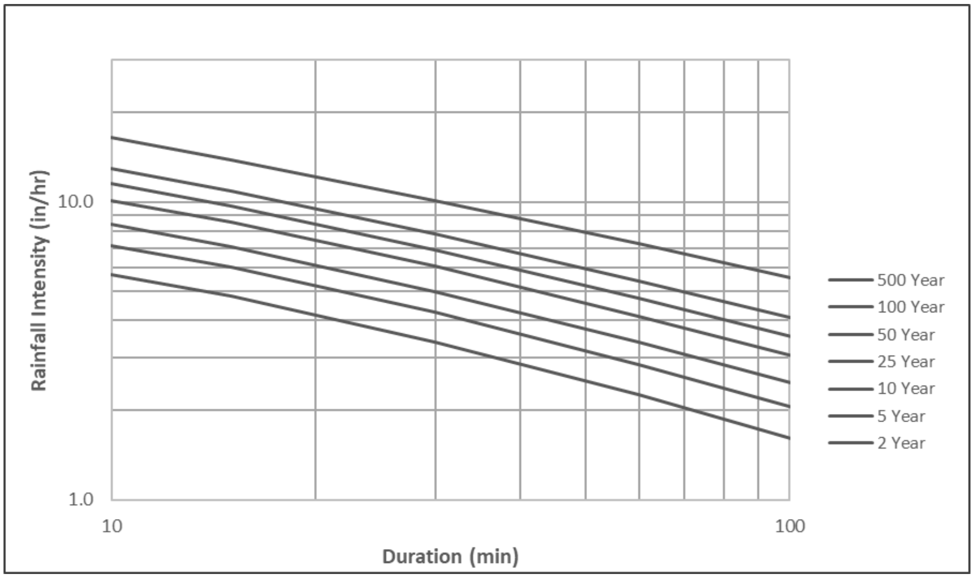
   a. Rainfall Intensity:

      (1) Intensity Duration Frequency (IDF) Curves. Figure 9.1 IDF Curves, depict the intensity-duration curves to be used for storm sewer and roadside ditch design in the City and the ETJ. The source of these curves is data from Atlas 14 IDF Curves, assistance with NOAA Atlas 14 Updates to the Harris County Flood Control District (HCFCD) Policy Criteria & Procedure Manual adopted July 9, 2019. The Atlas 14 IDF Curves report is based upon the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 Precipitation-Frequency Atlas of the United States, Volume 11, Version 2.0 Texas (Atlas 14).

9.2.01.B.1.a.(1) continued

Figure 9.1 - IDF Curves

Intensity vs Time of Concentration vs Rainfall Frequency
Source: Atlas 14



Harris County flood Control District (HCFCD) developed three (3) Hydrologic Regions based on the Atlas 14 rainfall distribution. The city of Houston requires the rainfall intensity for storm sewer design must be determined using the Region 3 data.

(2) Calculate Intensity: The intensity calculation is based on duration equal to the time of concentration. The intensity is calculated as follows:

$$I=b/(d + T_C)^e; \; T_C = 10 A^{0.1761} + 15$$

Where b, d, and e are coefficients dependent on the rainfall event, as provided in Table 9.1, below and are based on City depth- duration-frequency values.

Table 9.1 – Rainfall Intensity Coefficients

Rainfall Frequency	b	d (min.)	e
2-year	48.35	9.07	0.7244
5-year	52.32	7.88	0.6900
10-year	54.68	6.96	0.6623
25-year	57.79	5.89	0.6294
50-year	61.00	5.46	0.6096
100-year	60.66	4.44	0.5797
500-year	62.17	2.95	0.5196

Note: The rainfall data presented above is the latest available as of the date of Ch 9 issuance. The City may adopt revised data not reflected in this table. It is the engineer's responsibility to ensure that current accepted

9.2.01.B.1.a.(2) continued

rainfall intensity calculations are being utilized for the analysis.

(3) The City acknowledges that Harris County and Harris County Flood Control District have adopted new data based on Atlas 14.

2. Application of Runoff Calculation Models.

   a. Rational Method: The Rational Method will be used to estimate peak flows for individual drainage areas up to 200 acres in size, and for project areas up to 640 acres in size. Project areas greater than 200 acres must be broken down into smaller drainage areas for analysis, with each drainage area being less than 200 acres in size. The Rational Method will be used for design on areas served by storm sewers up to 640 acres in size.

   b. Runoff Watershed Modeling: For areas greater than 640 acres, use the methodology specified in the HCFCD H&H Manual.

   c. Hydrograph Development Dynamic Conditions – For development of runoff hydrograph for use in dynamic modeling utilize Clark Unit Hydrograph Method.

   d. Hydrograph Development Static Conditions – For evaluation of detention volume the approved methodology for hydrograph development shall be based upon the NRCS Dimensionless Unit Hydrograph or Malcolm's Small Watershed Method.

3. Coefficients for the Rational Method.

   a. Calculation of Runoff Coefficient.

      (1) The runoff coefficient C values in the rational method formula will vary based on the land use. Land use types and C values which can be used are as follows:

Land Use Type	Runoff Coefficient (C)
Residential Districts	
Lots more than 1/2 acre	0.35
Lots 1/4 - 1/2 acre	0.45
Lots less than 1/4 acre	0.55
Townhomes	0.60
Multi-Family areas	
Less than 20 Service Units/Acre	0.65
20 Service Units/Acre or Greater	0.80
Business Districts	0.80
Industrial Districts	
Light Areas	0.65
Heavy Areas	0.75

9.2.01.B.3.a.(1) continued

Railroad Yard Areas	0.30
Parks/Open Areas	0.18
Pavement/ROW	0.90

(2) Alternatively, the runoff coefficient C in the Rational Method formula can be calculated from the equation:

$$C = 0.6Ia + 0.2$$

Where: C = watershed coefficient
Ia = impervious area/total area

(3) If the alternate form is to be submitted, the calculation of C shall be provided as part of the drainage calculations.

b. Determination of Time of Concentration.
Time of concentration can be calculated from the following formula:

$$TC = 10A^{0.1761}+15$$

Where: TC = time of concentration (minutes)
A = subarea (acres)

c. Sample Calculation Forms.

(1) Figure 9.3, City of Houston Storm Sewer Calculation Form, is a sample calculation form for storm sewer systems.

(2) Figure 9.4, City of Houston Roadside Ditch Worksheet, is a sample calculation form for roadside ditch systems.

4. Hydrograph Development.

Where necessary to calculate runoff hydrographs, the peak flow of the hydrograph should match the Rational Method peak flow as calculated above. The hydrograph should be calculated using the entire drainage area, the FIS rainfall distribution, Green & Ampt loss rates, and the Clark Unit Hydrograph (T_C&R) methodology. These methodologies are described in the HCFCD H&H Manual. For design and impact analyses, Green & Ampt parameters as included in the effective hydrologic model for the watershed, rather than using the values from the FIS models. Selection of the Clark Unit Hydrograph parameters will be done as follows: T_C will be calculated as described above, with a minimum value of 10 minutes, and the storage coefficient (R) will be selected such that the peak flow matches the rational method peak flow. There will be a different R value for each rainfall event.

9.2.01.C Design of Storm Sewers.

1. General Considerations

a. Drainage systems for curb-and-gutter pavement shall consist of underground closed conduits.

9.2.01.C.1 continued

b. City CIP Projects or New Development that is anticipated to become City infrastructure and R.O.W.: The City's Comprehensive Drainage Plan (CDP) may indicate that a larger diameter storm sewer is planned in the area proposed for paving improvements. The Transportation and Drainage Operations of HPW has information on proposed improvements and should be consulted for impact on New Development.

Private Drainage Systems: Storm sewers for private drainage systems should conform to the City Uniform Building Code for development within the City limits. The City recommends the contents of this chapter as a guideline for best practices for all storm sewers within the City or its ETJ.

2. Design Frequency.

a. New Development: The Design Rainfall Event for sizing storm sewers in newly developed areas will be at minimum a 2-year rainfall event.

b. Redevelopment: The existing storm drain (sewer, ditch) shall be evaluated using a 2-year rainfall event, assuming no development takes place. The storm drain shall then be evaluated for the 2-year rainfall event design with the Development in place.

(1) If the proposed Redevelopment has an equal or lesser amount of impervious surface and the existing storm drain (sewer, ditch) meets 2- year level of service, then no modifications to the existing storm drain are required.

(2) If the proposed Redevelopment results in the hydraulic gradient of the existing storm drain below the gutter line, no improvements to the existing storm drain are required.

(3) If the analysis of the existing conditions finds that the existing storm drain is deficient (i.e. the hydraulic grade line is above the gutter line), the applicant should check with the City to see if a CIP or a DPC project is proposed that will require a capital contribution.

3. Velocity Considerations.

a. Storm sewers should be constructed to flow in subcritical hydraulic conditions if possible.

b. Minimum velocities should not be less than 3 feet per second with the pipe flowing full, under the design conditions.

c. Maximum velocities at the storm sewer system outfall should not exceed 8 feet per second without use of energy dissipation at the outfall.

9.2.01.C.3 continued

d. Maximum velocities within storm sewers should not exceed 12 feet per second.

4. Pipe Sizes and Placement.

   a. Use storm sewer and inlet leads with at least 24 inches inside diameter or equivalent cross section. Box culverts shall be at least 3 feet by 2 feet. Closed conduits, circular, elliptical, arch pipe, or box, shall be selected based on hydraulic principles and economy of size and shape.

      (1) Only single-family residential projects, without sharing storm outfall with others, shall be permitted to use the point of connection through a curb via a 4-inch schedule 40 pipe OR to connect to the roadside ditch with 12-inch schedule 40 pipe within the R.O.W. This option is only available if curb or ditch is directly fronting the single-family residential lot.

   b. Larger pipes upstream should not flow directly (via inlet, junction box, manhole) into smaller pipes downstream unless construction constraints prohibit the use of a larger pipe downstream, or the upstream system is intended for use as detention.

   c. Match crowns of pipe at any size change unless severe depth constraints prohibit.

   d. Locate public storm sewers in public street R.O.W. or in approved easements..

   e. Follow the alignment of the R.O.W. or easement when designing cast in place concrete storm sewers.

   f. Conduits shall connect to manholes and inlets preferably on a straight alignment, however angled connections no greater than 10 degrees normal to the wall will be provided.

   g. Refer to Chapter 5, Section 5.2.04.E for storm sewer culvert location relative to easement boundarys.

   h. Minimum horizontal clearance between the exterior of any storm pipe or box culvert shall be at least 48 inches from the exterior of the existing or proposed public or private utility and other appurtenances (i.e., inlet or manhole).

   i. Minimum vertical clearance between the exterior of any storm pipe or box culvert or other appurtenances (i.e., manhole or inlet) shall be at least 24 inches from exterior of the existing or proposed public or private utility and other appurtenances.

   j. Siphon design connection shall not be allowed.

   k. Conflict manhole shall not be allowed.

9.2.01.C.4 continued

l. Conduits with bends over 10 degrees shall have an inlet, junction box, manhole, or cleanout within 100 feet for maintenance.

5. Starting Water Surface and Hydraulic Gradient.

a. Tailwater elevation selections for Hydraulic Gradient Line (HGL) analysis:

(1) If the receiving channel for the storm system being analyzed is less than 2,000-feet from the project limits, then the starting tailwater shall be determined from outfall at the receiving channel according to criteria.

- For the 2-year design rainfall event with non-submerged outfall to the receiving channel, the starting tailwater shall be the top of pipe.

- For the 100-year extreme rainfall event and outfall to the receiving channel, the starting tailwater shall be the 10-year water surface elevation (WSE) or 2-feet below the top of bank.

(2) If the receiving channel for the storm system being analyzed is greater than 2,000-feet from the project limits, then the starting tailwater may be determined from an outfall point, or truncation, downstream of the project interconnect point, as noted below:

- For the 2-yr design rainfall event the starting HGL, shall be the top of pipe 2,000-feet downstream of the project interconnect point assuming pipes are connected at soffit. If pipes are connected at flow line, the top of the larger receiving pipe must be used. If a starting tailwater other than the top of pipe is chosen, the consultant shall analyze the storm system from outfall at the receiving channel upstream to the point of interconnect to demonstrate the alternate starting HGL value.

- For the 100-year extreme rainfall event the starting HGL shall be 2-feet above the top of pipe 2,000-feet downstream of the project interconnect point. If a starting tailwater other than 2-ft above the top of pipe is chosen, the consultant shall analyze the storm system from outfall at the receiving channel upstream to the point of interconnect to demonstrate the alternate starting HGL value.

(3) For the hydraulic impact analysis, a variable tailwater at the downstream end of the model may be used (reference to TP-100). A variable tailwater condition is recommended for use for detention analyses.

b. At drops in pipe invert, where the top of the upstream pipe be higher than the HGL, then the HGL shall be recalculated assuming the starting water surface to be at the top of pipe at that point.

9.2.01.C.5 continued.

c. For the Design Rainfall Event, the hydraulic gradient shall at all times be below the gutter line for all newly developed areas.

6. Manhole Locations.

   a. Use manholes at the following locations:

      (1) Size or cross section changes.

      (2) Inlet lead and conduit intersections.

      (3) Changes in pipe grade.

      (4) A maximum spacing of 700 feet measured along the conduit run.

   b. Use manholes for existing monolithic-concrete storm sewers at the same locations as above except for intersections of inlet leads unless a manhole is needed to provide maintenance access at those intersections.

   c. Do not place manholes in driveways or in the street in front of or immediately adjacent to a driveway.

7. Inlets.

   a. Locate inlets at low points in the gutter.

   b. Valley gutters across intersections are not permitted.

   c. Inlet spacing is a function of gutter slope. The minimum gutter slope shall comply with Chapter 10, Street Paving Design Requirements.

      (1) For minimum gutter slopes, the maximum spacing of inlets shall result from a gutter run of 700-feet from high point in pavement or the adjacent inlet on a continuously graded street section, with a maximum of 1400-feet of pavement draining towards any one inlet location.

      (2) Inlet location should be spaced to ensure that spread does not exceed one lane of the roadway for the design rainfall event.

      (3) Residential Development: Maximum spacing of inlets shall result from a gutter run of 700-feet from high point in pavement to the adjacent inlet on a continuously graded street section, with a maximum of 1400-feet of pavement draining towards any one inlet location.

      (4) Commercial Development: Maximum spacing of inlets shall result from a gutter run of 400-feet from high point in pavement to the adjacent inlet on a continuously graded street section with a maximum of 600-feet of pavement

9.2.01.C.7.c.(4) continued

draining towards any one inlet location.

(5) Spread: Calculate 2-year rainfall flow approaching each inlet from each direction. Additional inlets may be required if the Spread exceeds the maximum allowable value. The Spread in a typical prismatic curb-and-gutter street may be calculated using the following relationships:

$$Q = (K_g/n)(S_x^{1.67})(S_o^{0.5})(T^{2.67}), \text{ and}$$

$$T = y/S_x$$

Where: K_g = 0.56 (US Customary Units) or 0.376 (SI Units)
n = Manning's roughness coefficient
S_x = Transverse slope (or cross slope) (ft/ft),
S_o = Longitudinal pavement slope (gutter slope) (ft/ft)
T = Spread (ft), and
y = Ponded depth (ft)

(6) Allowable Spread:

(a) On a residential street, the Spread shall be no greater than the distance from the curb to the center crown of the roadway.

(b) For a roadway with two or more lanes in each direction, the Spread shall be no greater than the distance from the curb to the inside edge of the outside lane.

(c) The Spread adjacent to an inlet shall be no greater than the point of intersection of the transverse pavement slope with the top of curb elevation (i.e., the maximum Design Ponding Depth).

d. Use only City of Houston standard inlets (See Table 9.2).

9.2.01.C.7.d continued

Table 9.2- *STANDARD STORM SEWER INLETS

INLET	APPLICATION	NOMINAL CAPACITY CFS	DWG. NOS.
Type A	Driveway, parking lots, small areas (curb and gutter system not available area). Please note inlets shall not allowed on travel lanes.	2.50	02632-01
Type B-B (with solid plate or grate)	Curb and gutter system within collector streets (major collector, minor collector), transit corridor street, residential and commercial area.	5.00	02632-04
Modified B-B (with solid plate or grate)	Driveway, parking lots, small areas (with no curb and gutter system). Please note grates shall not allowed on travel lanes.	N/A	
Type C	Curb and gutter system within collector streets (major collector, minor collector), transit corridor street, residential & commercial area.	5.00	02632-06
Type C-1	Curb and gutter system within major thoroughfare, collector streets (major collector, minor collector), transit corridor street & commercial area.	10.00	02632-06
Type C-2	Curb and gutter system within major thoroughfare & commercial area.	15.00	02632-06
Type C-2A	Curb and gutter system within major thoroughfare & commercial area.	20.00	02632-06
Type D	Driveway, parking lots, small areas (curb and gutter system not available area). Please note inlets shall not be allowed on travel lanes.	2.00	02632-07
Type D-1	Driveway, parking lots, small areas (curb and gutter system not available area). Please note inlets shall not be allowed on travel lanes.	2.50	02632.08
Type E	Roadside ditch connect with storm sewer system.	20.00	02632-09, -10
Precast Area Zone Drain (PAZD)	Low profile roadside ditch in residential and commercial area	Varies TBD by Engineer	Styles 'RG' and 'FG' on TxDOT detail prestd08.dgn

* The nominal capacity values provided in Table 9.2 are to be used for initial sizing only. The actual Inlet size all shall be based on hydraulic analysis of the required inlet capacity. Inlet capacities are calculated using either orifice and or weir equations depending upon their location and a type of inlet openings with or without plates.

9.2.01.C.7 continued

e. Do not use beehive grate inlets or other specialty inlets.

f. Do not use grate top inlets in unlined roadside ditch.

g. Do not place inlets in the circular portion of cul-de-sac streets unless justification based on special conditions can be provided.

h. Place inlets at the end of proposed pavement if drainage will enter or leave pavement.

i. Do not locate inlets adjacent to esplanade openings.

j. For new residential development, locate inlets at the center of lots and drainage system with lot site layout such that inlets are not located within the driveway between the radius end points as defined by the driveway radius intersection with the curb or edge of pavement.

k. Place inlets on side streets intersecting major streets, unless justification based on special conditions can be provided.

l. Only the private development directly behind the inlet shall be permitted to make one connection to that inlet and that connection (lead) shall be made to the back of the inlet. All other private developments must connect directly to the storm sewer trunkline even if the trunkline must be extended to the front of such development. The extension is to be designed and constructed in accordance with Section 9.2.01.C.4 Pipe Sizes and Placement. Connection shall not be made to the front face or to the short sides of the inlet. Design the connection not to exceed the pipe capacity minus either the capacity listed in Table 9.2, Standard Storm Sewer Inlets, or calculated inlet inflow.

m. For all new construction, convey public or private alleyway drainage to an inlet prior to entering the public street drainage system.

n. For all new connections, the engineer shall be required to demonstrate that inlets for design storm events have adequate capacity based on ponding and available opening. For New Development, Redevelopment, or Site Modification or connections to curbside inlets, existing B inlets along or immediately downstream of said development shall be enlarged to BB inlets.

o. For inlet calculations reference the TXDOT Hydraulic Design Manual Chapter 10, Section 5, Storm Drain Inlets at http://onlinemanuals.txdot.gov/txdotmanuals/hyd/index.htm

p. Grate inlets shall not be allowed on travel lanes other than the gutter.

q. Do not use inlets without top manhole lip in major streets (i.e. Type BB inlet).

9.2.01.C continued

8. Pipe materials and installation shall conform to latest City of Houston Standard Specification 02631.

9.2.01.D Extreme Event Analysis

1. The design frequency for consideration of overland sheet flow will consider extreme storm events (up to 100-year storms). These events, which exceed the capacity of the underground storm sewer system and result in ponding and overland sheet flow, shall be routed to drain along street ROW or open areas and through the development to a primary outlet.

2. An overland flow analysis of the proposed drainage system shall be prepared by the design engineer. The design engineer shall submit supporting calculations, exhibits, and drawings, which define the conveyance capacity of the roadway, define the flow paths of overland sheet flow and define the ponding depths of overland sheet flow.

   a. Three analysis methods as presented in Technical Paper No. 101, Simplified 100-year Event Analyses of Storm Sewers and Resultant Water Surface Elevations for Improvement Projects in the City of Houston, Harris County, Texas Region will be acceptable to the City.

      (1) Method 1: Hydraulic Grade Line (HGL) Analysis A simplified approach to analyze and control the 100-year water surface elevation (WSEL) can be achieved by designing the storm sewer system for the 2-year frequency rainfall event; imposing a 100-year frequency storm event on the proposed design; calculating the hydraulic grade for the 100-year frequency event for the proposed design; and adjusting the position of the HGL to not exceed the critical elevation by increasing the size of the proposed storm sewer for selective reaches.

      (2) Method 2: Qt = Qo + Qc
      where Qt is the total flow conveyed,
      Qo is the overland flow component, and
      Qc is the calculated flow in the conduit for the 2-year design event. The overland flow component (Qo) is computed by applying Manning's Equation to calculate the flow across the critical street cross-section along the R.O.W. This method accounts for flow in the storm sewer and overland flow across the street crest, but does not account for street ponding or storage.

      (3) Method 3: Qt = Qo + Qc + ΔS/T
      where Qt, Qo, and Qc are as defined above, and
      ΔS/T is the change in storage volume relative to time provided in the streets and adjacent area upstream of the point of interest being analyzed. This method uses a volumetric calculation based on a 100-year frequency storm event with a duration of 3-hours for developments less than 200 acre and 6-

9.2.01.D.2.a.(3) continued

hours duration for developments over 200 acres. The Soil Conservation Service, TR-20 method is used to set a peak triangular hydrograph shape. This method accounts for flow in the storm sewer, overland flow across the street crest, and storage within the street and adjacent area.

b. Analysis using the U.S. Environmental Protection Agency's Stormwater Management Model (SWMM) will be acceptable to the City.

3. Relationship of Structures to Street: All structures shall be above the maximum ponding elevation anticipated resulting from the extreme event analysis.

   a. Barring conditions listed in 9.2.01.D.3.a and b, the maximum ponding elevation for the 100-year event at any point along the street shall not be higher than the natural ground elevation at the R.O.W. line.

   b. For City CIP Projects, the maximum ponding elevations shall be no higher than 12 inches below the finished slab elevations, or, if the finished slab elevations are less than 12 inches above the natural ground elevations at the R.O.W., the ponding elevations shall be no higher than the natural ground elevations at the R.O.W. In instances where the maximum ponding elevation for the 100-year event is not within the natural ground elevation at the R.O.W. line, the engineer will add a note on the drawings indicating the rainfall frequency event is designed to be conveyed within the R.O.W.

   c. For Development or Redevelopment by private entities, the post- project maximum WSE shall be no higher than the pre- project maximum WSE in surrounding areas and proposed finished slab elevation shall be above the post-project maximum WSE. The Maximum Ponding Elevation is determined from the physical characteristics of an area, and may change as a result of the proposed Development. Where existing topographic conditions, project location within a special flood hazard area, and/or other site conditions preclude achieving this objective, the City will consider waiver of this requirement upon submittal of documentation and analysis prepared, signed, and sealed by a professional engineer, registered in the State of Texas. Analysis shall demonstrate that structural flooding will not occur and will identify the rainfall frequency event that will be conveyed within the R.O.W. The limiting parameter will depend on project-specific conditions, and the most restrictive condition (the lowest ponded water elevation) shall govern.

4. Design Considerations:

   Streets shall be designed so that consecutive high points in the street will provide for a gravity flow of drainage to the ultimate outlet. If a detention facility is designed to mitigate peak flows from the extreme event, the overland flow path shall carry the extreme event sheet flow to the detention facility. If the extreme event sheet flow must enter a receiving channel, the overland flow path shall carry the extreme event sheet flow to the channel. In the event that there is no overland flow path, or the overland flow path is insufficient to carry all of the extreme event sheet flow, the

9.2.01.D.4 continued

inlets and storm sewer at the downstream end of the overland flow path shall be sized to carry the extreme event sheet flow from the end of the overland flow path into the detention facility or receiving channel.

a. The maximum depth of ponding at high points shall be 6 inches above top of curb.

b. The maximum depth of ponding at low points shall be 18 inches above top of curb.

c. Refer to Artcile 5.2.04.E.3 for easement requirements for sheet flow. Fence lines and other improvements shall not be constructed on or across dedicated drainage easements.

d. A drawing(s) shall be provided to delineate extreme event flow direction through a Development and how this flow is discharged to the primary drainage outlet.

   The extreme event flow path(s) shall be identified on a plan view drawing(s) such as the drainage area map. There will be multiple extreme event flow paths for most projects. A profile for each path should be shown. Where secondary paths join a primary path, the secondary path profile should extend at least one street high/low point downstream along the major flow path, until the maximum ponding elevation downstream of the confluence is lower than the maximum ponding elevation upstream of the confluence.

e. The drawing for each path shall show a profile of the roadway (or overland flow path) from the upper reach of the drainage area to the primary drainage outlet. The drawing(s) shall be exaggerated vertical scale and shall include roadway profile at the gutter, ground profile at the R.O.W., all the parameters used to determine the maximum ponding elevations, the maximum ponding elevations, and the hydraulic gradient for the extreme event, or an alternative equivalent drawing accepted by the City. The drawing(s) should be separate from the plan and profile sheets, and should include the entire overland flow path on one sheet, if possible. The drawings are not required to include the storm sewer profile.

5. Evacuation Routes and Emergency Service Routes. This standard applies to routes designated by HPW for emergency evacuation and for routes where access by the emergency service vehicles is a public safety need. Ponding of surface runoff is not allowed in the highest travel lane (each direction) for the 100-year event. Exceptions to this standard based on technical infeasibility or cost limitations will require approval of the Director, Houston Public Works, or the Director’s designated representative. This standard may be modified or exempted for locations in the 100-year floodplain.

9.2.01.E. Design of Open Channels.

1. Design Requirements and General Criteria.

   a. Open channels shall be designed according to methods described in the HCFCD Criteria Manual which can be accessed at www.hcfcd.org/dl_manuals.html and shall convey 100 year event.

   b. Design standards for channel construction shall follow the requirements specified in the HCFCD Criteria Manual which can be accessed at www.hcfcd.org/dl_manuals.html.

   c. Design standards for outfalls into channels shall conform to those in the HCFCD Criteria Manual which can be accessed at www.hcfcd.org/dl_manuals.html.

2. Determination of Water Surface Elevation (WSE).

   a. WSE shall be calculated using Manning's Equation and the Continuity Equation.

   b. For the Design Rainfall Event, the water surface shall be calculated to remain 1' below the top of banks.

3. Design of Culverts.

   a. Head losses in culverts shall conform to TxDOT Hydraulics Manual, Chapter 8, and Culverts.

   b. Corrugated metal pipe will be approved only for railroad crossings.

   c. Proposed street parking pads over an existing ditch are not allowed.

9.2.01.F. Design of Roadside Ditches.

1. Design Frequency.

   a. Roadside ditch design is permissible only for single family residential lots or commercial areas equal to or larger than 0.5 acres.

   b. The Design Rainfall Event for the roadside ditches shall be a minimum of 2-year rainfall.

   c. Design capacity for a roadside ditch shall be to a minimum of 0.5 feet below the edge of pavement or 0.5 feet below the natural ground at R.O.W. line, whichever is lower, including head loss across the culvert. Design Capacity calculations shall include head loss calculations for driveway and roadway culverts that are placed along the roadside ditch.

   d. The design must include an extreme event analysis to indicate that structures

9.2.01.F.1.d continued

will not be flooded, and that maximum ponding elevation for the extreme event complies with Paragraph 9.2.01.D.3.

2. Velocity Considerations.

   a. For grass-lined sections, the maximum design velocity shall be 3.0 feet per second during the design event.

   b. A grass-lined or unimproved roadside ditch shall have side slopes no steeper than three horizontal to one vertical (3:1), or as soil conditions will permit.

   c. Minimum grades for roadside ditches shall be 0.1-foot per 100 feet.

   d. Calculation of velocity will use a Manning's roughness coefficient (n) of 0.045 for earthen sections and 0.025 for ditches with paved inverts.

   e. Use erosion control methods acceptable to the City when design velocities are expected to be greater than 3 feet per second.

   f. The top of bank shall not encroach beyond the City R.O.W. or within 2 feet of the edge of pavement.

3. Driveway and Roadway Crossings

   a. Culverts will be placed at all driveway and roadway crossings, and other locations where appropriate.

   b. Culverts shall be evaluated for inlet and outlet control, as well as normal depth. The highest of the three shall be designated as the computed headwater for design of the culvert section.

   c. Roadside culverts are to be sized based on hydraulic analysis. The minimum culvert size shall be 24 inches inside diameter or equivalent 'cross section'. For example, if the ditch is deeper than or equal to 29 inches, the elliptical pipe with inside diameter of 19 inches x 30 inches can be used. Calculations shall be provided for review. In the ETJ, the Regulations for Harris, County, Texas for the Construction of Driveways and/or Culverts on County Easements and R.O.W. shall govern.

   d. Design capacity calculations shall include head loss calculations for driveway and roadway culverts that are placed along the roadside ditch.

   e. Stormwater discharging from a ditch into a storm sewer system must be received by an appropriate structure (i.e., stubs with ring grates or Type E inlets).

   f. Install appropriate structures (i.e., headwall) at both sides of inlet and outlet of a culvert.

9.2.01.F continued

4. Invert Protection.

   a. Ditch invert protection shall be used when velocities exceed 3 feet per second.

   b. Ditch invert protection will be used at the upstream and downstream ends of all culverts.

5. Depth and Size Limitations.

   a. Maximum depth shall not exceed 4 feet from adjacent edge of pavement.

   b. Roadside ditch bottoms shall be at least 2 feet wide, unless design analysis will support a narrower width.

   c. Ditches in adjoining and parallel easements shall have top of bank not less than 2 feet from the outside easement line.

9.2.01.G. Design of Outfalls: Outfalls from storm sewers or detention facilities that discharge directly into a channel or other HCFCD facility shall be designed and constructed in accordance with HCFCD criteria. If the criteria conflicts with City of Houston, the more restrictive criteria shall govern.

9.2.01.H. Stormwater Detention.

1. The intention of Stormwater detention is to mitigate the effect of New Development, Redevelopment, or Site Modifications on an existing drainage system. Stormwater detention volume requirements are based on the acreage of the ~~d~~Disturbed ~~a~~Area that results in ~~i~~Impervious ~~s~~Surface or alters stormwater runoff. Stormwater detention volumes are calculated at the minimum rates set forth in Paragraph 9.2.01.H.3.

2. Application of Detention.

   a. The use of on-site detention is required for all Developments within the City and for new or expanding utility districts within the City's ETJ. Detention may not be required if the City has developed detention capacity for a drainage watershed, and/or infrastructure improvements, to serve the drainage watershed in compliance with the requirements of this Chapter. Under these conditions, the City will consider a funding contribution in lieu of on-site detention volume constructed by the owner.

   b. Stormwater detention requirements are invoked for redevelopments that include disturbed area resulting in ~~i~~Impervious ~~s~~Surface.

   c. If the drainage system outfalls directly into a channel maintained by HCFCD, and the requirements of HCFCD include payment of an impact fee, then no

9.2.01.H.2 continued

further impact fee will be required by the City.

d. Project site ~~larger than 20 acres~~ that discharges directly into the Harris County, HCFCD, Fort Bend County, Montgomery County or other jurisdictions requires ~~HCFCD~~ their review and approval.

e. If the detention criteria conflicts with Harris County, HCFCD, ~~Harris County,~~ Fort Bend County, Montgomery County or other jurisdictions~~or TxDOT~~, the more restrictive criteria shall govern.

f. City no longer allows timing analysis to avoid detention requirements.

g. A master drainage plan for the purpose of grandfathering projects regarding drainage and detention plan is as follows:

A master drainage plan establishes the current and future drainage plan for a developmental site. A master drainage plan generally consists of drainage, grading, detention, and other applicable site plans. These site plans contain detailed calculations for impervious area, detention, restrictors, flow rate, etc. For any master drainage plan with provided detention that is based on the Atlas 14 rainfall data, the City shall allow Development to proceed under the approved master drainage plan for up to five years. If the master drainage plan for provided detention is not based on the Atlas 14 rainfall data, then the delta of the detention requirement must be provided by the property owner.

~~g.~~h. Plat, replat, change the use of, or subdividing any tract to reduce stormwater detention requirements will not be permitted. Original tract size on plat or replat, change the use of, ~~or~~ subdividing, HCAD and survey will be used to determine stormwater detention requirements.

3. Calculation of Detention Volume.

a. Detention volume for redevelopment and new ~~d~~Development areas is calculated on the basis of ~~d~~Disturbed ~~a~~Area that results in ~~i~~Impervious ~~s~~Surface ~~, as~~ (defined in 9.1.04.O) or alters stormwater runoff, associated with the project development.

b. Detention Volume for Criteria 1: For a tract containing only one Single family residential (SFR) home, follow Table 9.3. ~~lots of 15,000 square feet in area or less: SFR Lots are not required to provide detention if the impervious area is less than or equal to 65%. Detention volume of 0.75 acre feet per acre is required for impervious area in excess of 65% of the lot. SFR lot, which is a new development and a part of the subdivision where there is no detention provided, no 65% reduction will be allowed.~~

9.2.01.H.3.b continued

Table 9.3 - Detention Volume For Criteria 1

SFR Tract Size	Percentage/Total Impervious Area[i]	Detention Required (Y/N)	Detention Volume	Notes
One SFR tract ≤ 15000 SF	% Total impervious area ≤ 65% of tract	N	N/A	1-2
One SFR tract ≤ 15000 SF	% Total impervious area > 65% of tract	Y	0.75 ac-ft/ac rate × impervious area in excess of 65% of tract	1-2
One SFR tract >15000 SF	Total impervious area ≤ 9750 SF	N	N/A	1-2
One SFR tract >15000 SF	Total impervious area > 9750 SF	Y	0.75 ac-ft/ac rate × impervious area in excess of 9750 SF	1-2

[i]Total impervious area = (existing + proposed) impervious area.

Notes for Table 9.3:

(1) For a tract with multiple lots, the detention exemption shown in Table 9.3 is not applicable. Refer to Table 9.4 for detention volume requirements.~~Detention Requirement = 0.75 acre-feet per acre of impervious cover (including all disturbed area that results in impervious surface) surface exceeding over 65% of the project area. The impervious area for any shared drive or common drives will be divided equally among all lots within the SFR development.~~

(2) No ~~s~~Sheet ~~f~~Flow shall be permitted to an alleyway, neighboring properties, nor to a ditch. Without sharing storm outfall with others, a point of connection shall be through a curb via a 4-inch schedule 40 pipe or to the roadside ditch with a 12-inch schedule 40 pipe within the ROW.

c. Detention Volume for Criteria 2: For tracts with SFR Developments with direct driveway access, joint access, shared access, courtyard access drive or multi-unit residential (MUR) Development, follow Table 9.4. ~~SFR lots of 15,000 square feet or less utilizing an access road, permanent access easement (28' PAE), private alley or public alley: The individual lots will be required to detain based on the impervious area in excess of 65% at a volume of 0.75 acre-feet per acre. The entire access road, permanent access easement (28' PAE) private alley or public alley will require detention at a volume of 0.75 acre-feet per acre; no 65% reduction will be allowed. The total detention for the development will be a combination of these two volumes. Sharing storm outfall with others, a point of connection shall be at the storm sewer system not through a curb.~~

9.2.01.H.3.c continued

Table 9.4 - Detention Volume For Criteria 2

Tract Size	Percentage/Total Impervious Area[i]	Detention required (Y/N)	Detention Volume	Notes
Tract ≤ 15000 SF	Total % impervious area within tract ≤ 65% of tract	N	N/A	1-5
Tract ≤ 15000 SF	Total % impervious area within tract > 65% of tract	Y	0.75 ac-ft/ac rate × impervious area in excess of 65% of the tract	1-5
15000 SF < Tract < 1 acre	Total impervious area within tract ≤ 9750 SF	N	N/A	1-5
15000 SF < Tract < 1 acre	Total impervious area within tract > 9750 SF	Y	0.75 ac-ft/ac rate × impervious area in excess of 9750 SF	1-5
Tract ≥ 1 acre	All proposed impervious area	Y	Refer to requirements in Table 9.5	1-5

[i]Total impervious area = (existing + proposed) impervious area also including direct driveway access, joint access, shared access, courtyard access drive or MUR Developments.

Notes for Table 9.4:

(1) When a tract of one acre or more is divided into multiple lots; detention is required for all proposed impervious area within the lot. No residential exemption will be granted for the individual lot within this subdivision tract.~~Detention Requirement =~~

~~[0.75 acre feet per acre of impervious cover surface (including all disturbed area that results in impervious surface) in excess of 65%]~~

~~+~~

~~[0.75 acre feet per acre] x [The area of the access easement, a permanent access easement (28'PAE), access road, private alley or public alley, or similar access way by any other name, must be included in the calculation of the project area.]~~

(2) No Sheet Flow shall be permitted to an alleyway, neighboring properties, or a ditch. For projects using Table 9.4, a subsurface drainage system with one shared outfall is required. A point of connection shall be through a minimum 24-inch RCP inside diameter or equivalent cross-section described in 9.2.01.C.4.a. A separate project, plan and profile shall be submitted to OCE for storm outfall approval.

An alternative outfall option to SFR Developments that are 15,000 SF or less with direct driveway access, joint access, shared access, courtyard

9.2.01.H.3.c continued

access drive, and MUR Developments: Storm outfall analysis to be provided by a state of Texas Licensed Professional Engineer to justify using a 4-inch schedule 40 pipe curb cut or 12-inch schedule 40 pipe connection to the roadside ditch. This option is only available if curb or ditch is directly fronting these Developments. The Professional Engineer shall confirm through storm outfall analysis that there is no negative drainage impact on the City system.

(3) The detention exemption for impervious area should be proportionate among all the lots within the tract; this also includes any direct driveway access, shared access, joint access, and courtyard access drive. A state of Texas Licensed Professional Engineer shall breakdown impervious area calculation for each lot to take the detention exemption.

(4) A public alley created with recorded plat prior to January 1st, 2023, is exempt from detention requirements.

~~(2)~~(5) Proposed permanent access easement (28' PAE), private alley, public alley, or similar accessway by any other name requires detention; no detention exemption will be allowed.

d. Detention Volume for Criteria 3: For other projects not subject to 9.2.01.H.3.b or 9.2.01.H.3.c, follow Table 9.5.~~Tract size less than one acre and not subject to 9.2.01.H.3.b or 9.2.01.H.3.c: Detention volume will be required at 0.75 acre-feet per acre of disturbed area that results in impervious surface. Additionally, detention volume will be required to offset redevelopment of existing impervious surfaces.~~

~~If shared driveway is used, detention volume of 0.75 acre-feet per acre is required. In other words, for projects that are platted to contain more than one lot and access to these individual lots is to be provided by a common or shared driveway, such as an access agreement, an access road, a permanent access easement (28' PAE) private alley or public alley, the detention requirements shall be calculated as this section:~~

~~The area of the common or shared driveway, the access easement, a permanent access easement (28'PAE) access road, private alley or public alley, or similar accessway by any other name, must be included in the calculation of the project area.~~

~~Any project when a shared driveway is used, subsurface drainage system is required. A point of connection shall be at the storm sewer system not through a curb.~~

~~Total Detention Volume required is calculated as follows:~~

~~$V_T = [43,560 \times (0.75 \times A_{II})]$~~

~~V_T = Total Detention Volume for the proposed project (Cubic Feet)~~

~~A_{II} = Area of impervious surface (including all disturbed area resulting in impervious surface) (Acres)~~

9.2.01.H.3.d continued

~~Subdividing of larger tracts (greater than 1 acre) into smaller tracts of 1.0 acre or less to reduce stormwater detention requirements will not be permitted.~~

~~(1) Plat, replat, change the use of, or subdividing any tract to reduce stormwater detention requirements will not be permitted. Original tract size on plat or replat, change the use of, or subdividing will be used to determine stormwater detention requirements.~~

~~e. Tract size equal or greater than 1 acre and less than or equal to 20 acres: Detention volume will be required at the acre-feet per acre of disturbed area that results in impervious surface as depicted on the following chart and table.~~

Table 9.5 - Detention Volume For Criteria 3

Tract Size	**Proposed Percent Impervious**[i]	**Detention Required (Y/N)**	**Detention Volume**	**Notes**
Tract < 1 acre	All proposed impervious area	Y	0.75 ac-ft/ac rate × proposed impervious area of the tract	1-2
1 acre ≤ Tract ≤ 20 acre	All proposed impervious area	Y	Follow Figure 9.2/Table 9.6 Minimum Detention Rate chart/table	1-4
Tract > 20 acre	All proposed impervious area	Y	Follow the most current version of the HCFCD PCPM; Minimum rate is 0.75ac-ft/ac	1-4

[i]Proposed percent impervious = proposed impervious area/Disturbed Area.

Notes for Table 9.5:

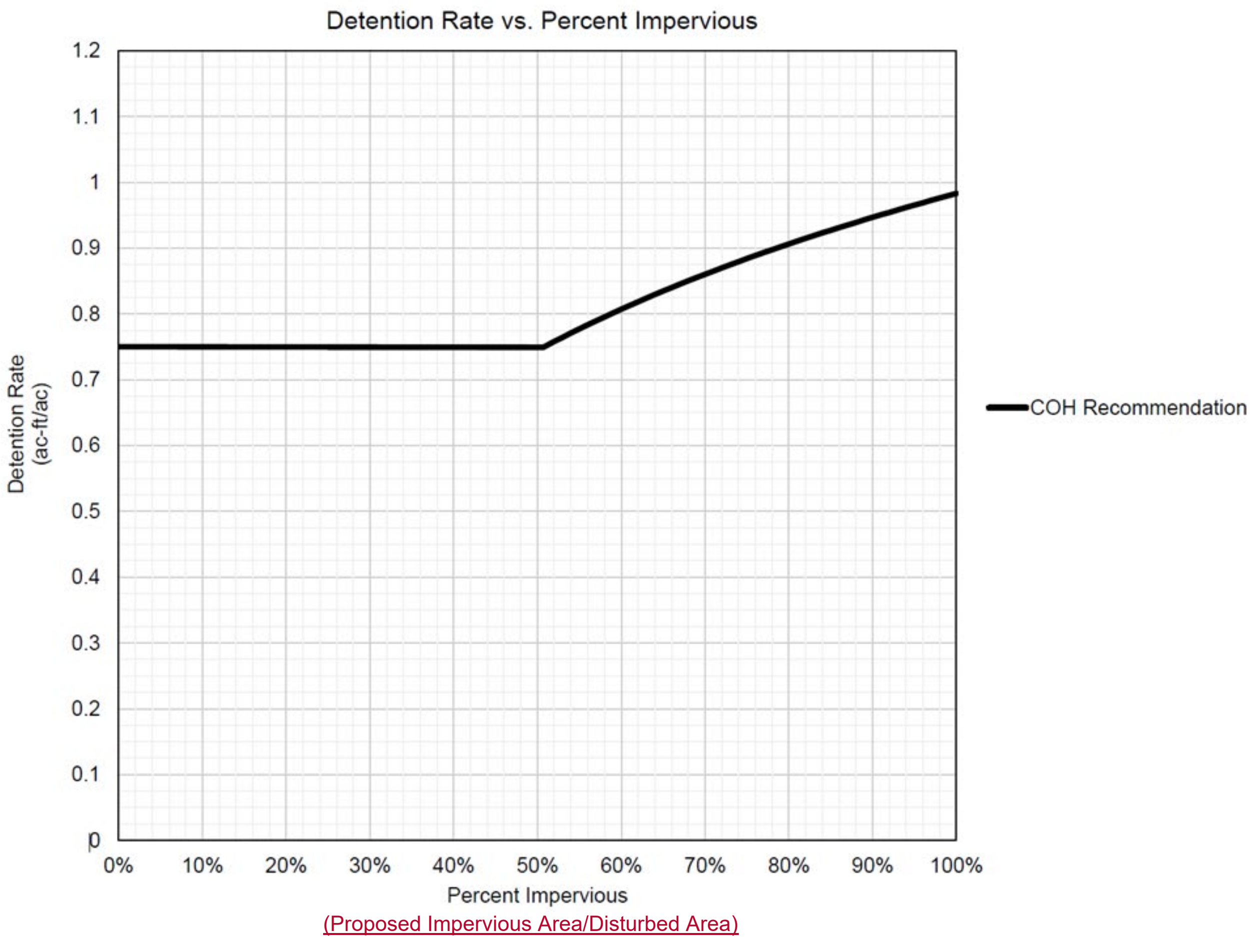
(1) No Sheet Flow shall be permitted to an alleyway, neighboring properties, or a ditch. For projects using Table 9.5, subsurface drainage system is required. A point of connection shall be through a minimum 24-inch RCP inside diameter or equivalent cross-section described in 9.2.01.C.4.a. A separate project, plan and profile shall be submitted to OCE for storm outfall approval.

~~(1)~~(2) ~~However,~~ For projects within City limits, the minimum detention rate is 0.75 acre feet per acre. ~~Project site larger than 20 acres that discharges directly into the HCFCD requires HCFCD review and approval.~~

~~(2)~~(3) Tract size greater than 20 acres: Detention calculation will be per the most current version of the HCFCD PCPM. Refer to https://www.hcfcd.org/About/Technical-Manuals/2019-Atlas-14-Policy-Criteria-and-Procedures-Manual-PCPM

~~(3)~~(4) For those properties equal to 20 acres or more, if property is added to become larger than 20 acres, then the curve/values shown in Figure 9.2 and Table 9.6 must be utilized on the additional property. The percent ~~i~~Impervious ~~s~~Surface will be used to define the detention rate.

Figure 9.2 - Minimum Detention Rate Chart



9.2.01.H.3.d continued

Table 9.6- Minimum Detention Rate

Proposed Percent Impervious (Proposed Impervious Area/ Disturbed Area)	**Minimum Detention Rate** acre-foot/acre
0% - 51%	0.75
55%	0.78
60%	0.81
65%	0.83
70%	0.86
75%	0.88
80%	0.91
85%	0.93
90%	0.95
95%	0.97
100%	0.98

e. In private parking areas, and private streets, provide detention or portion of detention utilizing underground system or detention pond, whenever possible. If the existing conditions do not allow for underground detention or detention pond, detention through ponding in private parking areas, private transport truck only parking areas will be considered. Engineer shall provide calculations and analysis to the Office of the City Engineer for approval of design method prior to plan submittal.

f. If approved for detention through ponding in private parking areas, the maximum depth of ponding cannot exceed 9 inches directly over the inlet and paved parking areas must provide signage stating that the area is subject to flooding during rainfall events.

   If approved for detention through ponding in private transport truck only parking, the maximum depth of flooding cannot exceed 15 inches directly above the inlet and signage must be provided stating that the area is subject to flooding during rainfall events.

g. All mitigation facilities shall be located within or adjacent to the project area except for roadway projects or projects where impacts are mitigated in a regional stormwater detention facility. Engineer shall provide calculations indicating receiving stormwater system was designed to have conveyance capacity to non-adjacent detention facilities.

h. Low Impact Development (LID) techniques that are considered acceptable for achieving detention are Bioretention, Infiltration Trenches, Porous Pavement, Vegetative Swales, Green Roof, Hard Roof, and Rain Barrels. See section 9.10.01 for LID design guidelines.

9.2.01.H.3.h continued

Review and approval of engineering calculations demonstrating the volume of detention achieved for each LID feature will be required.

If LID techniques are considered for achieving detention, review and approval of a maintenance and Life Cycle plan are required per this section and section 9.2.01(H) of this chapter. Review and approval of engineering calculations demonstrating the volume of detention achieved for each LID feature will be required. This plan shall be signed and sealed by a professional registered engineer and included as part of the review and approval process.

i. For any new development or any part of an existing development that is still undeveloped, the most recent detention requirements would apply.

4. Calculation of Outlet Size.

   a. Detention pond discharge pipe into an existing storm sewer line or existing City of Houston ditch:

      (1) If the maximum pool elevation is at or below the design hydraulic grade at the drainage system outfall, the discharge line shall be sized for the Design Rainfall with the discharge pipe flowing full. The pond will float on the drainage system to provide maximum benefit.

      (2) If the maximum pool elevation is at or above the hydraulic grade at the drainage system outfall, provide a reducer or restrictor pipe to be constructed inside the discharge line. The discharge line shall be sized for the Design Rainfall with the discharge pipe flowing full.

   b. Reducer or Restrictor Pipes shall be sized as follows:

      (1) Allowable Discharge Rate - Use the lowest of the discharge rates described below:

9.2.01.H.4.b.(1) continued

(a) Restrictor pipes will provide a combination of low level and high level controlled release from the detention basin. The low level restrictor pipe (primary orifice) shall be sized to provide a release rate of 0.5 CFS/acre when the detention basin water depth is 25% of capacity. The low level restrictor pipe (primary orifice) shall be located at the bottom of the basin to provide complete drainage of the pond. The high level restrictor pipe (secondary orifice) shall be sized to provide a combined release rate (from the primary orifice and secondary orifice) of 2.0 CFS/acre at full basin depth. The high level restrictor secondary orifice) shall begin releasing flow when detention basin water depth reaches 75% of capacity. The combined rate of 2.0 CFS/acre is the approximate discharge from an undeveloped tract for the 100-year storm. The basin is considered 100% full when it reaches its maximum volume during the 100-year storm.

(b) Flow discharged to the storm drain shall not exceed the proportional amount of pipe capacity allocated to the Development. The proportional amount of pipe capacity allocated to the Development shall be determined by the ratio of the area (acres) of the Development (in storm drain watershed) divided by the total drainage area (acres) of the storm drain multiplied by the capacity of the storm drain.

(2) Use the following equations to calculate the required outflow orifice:

$$Q = CA\sqrt{2g}\sqrt{h}$$

$$D = Q^{1/2} / (2.25h^{1/4})$$

Where:

Q	=	outflow discharge (cfs)
C	=	coefficient of discharge
	=	0.8 for short segment of pipe
	=	0.6 for opening in plates, standpipes, or concrete walls
A	=	orifice area (square feet)
g	=	gravitational factor (32.2)
h	=	head, water surface differential (feet)
D	=	orifice diameter (feet)

(3) For rectangular weir flow calculation:

$$Q = CLH^{3/2}$$

Where:

Q	=	weir discharge (cfs)
C	=	weir coefficient
L	=	horizontal length (ft)
H	=	head on weir (ft)

The value of the weir coefficient, C, depends on the weir shape (i.e., broad crested or sharp crested) and if the weir is submerged or not. See Brater and

9.2.01.H.4.b.(3) continued

King's Handbook of Hydraulics or other applicable references.

(4) Restrictor shall be either of the required diameter or of the equivalent cross-sectional area. The orifice diameter D shall be a minimum of 0.5 feet.

c. In addition to a pipe outlet, the detention basin shall be provided with a gravity spillway that will protect structures from flooding should the detention basin be overtopped.

5. Ownership and Easements.

a. Private Facilities:

(1) Pump discharges into a roadside ditch or storm sewer system must comply with the following:
(a) Submittal of pump specifications, including capacity (GPM) of the pump, on the design drawings.
(b) Provide a backup pump in the event of a pump failure.
(c) Provide emergency power from a second source or install a quick connect for a mobile generator.
(d) Provide a stilling basin to dissipate the energy from the pump outlet prior to gravity flow into the ditch or storm sewer.

(2) The City reserves the right to prohibit the use of pump discharges where their use may aggravate flooding in the public R.O.W.

(3) Responsibility for maintenance of the detention facility must be confirmed by letter submitted to the City as part of the design review and shall also be stated on the drawings.

(4) All private properties being served have drainage access to the pond. Dedicated easements may be required.

(5) No public properties may drain into the detention area.

(6) A private maintenance agreement must be provided when multiple tracts are being served.

(7) All detention facilities must completely drain out of property within 48 hours.

(8) A grading set-back of one fifth the vertical height of the cut or 2 feet minimum is required between the top of the cut of pond or swale and the property line or boundary.

9.2.01.H.5.a continued

(9) A grading set-back of one half the height of the slope (H/2) or 2 feet minimum is required between the toe of the slope of pond or swale and the property line or boundary.

b. Public Facilities:

(1) Facilities will only be accepted for maintenance by the City within the City limits in cases if public drainage is being provided.

(2) The City requires a maintenance work area of 20-foot width surrounding the extent of the detention area. Public R.O.W. or permanent access easements may be included as a portion of this 20- foot width. See Table 9.7 below from the HCFCD PCPM for minimum berm widths around a detention basin.

Table 9.7 - Minimum Berm Width around a Detention Basin

Detention Basins That Are	The Minimum Berm Width Is
Grass-lined with a depth > 7 feet	30 feet
Grass-lined with a depth $\leq$ 7 feet	20 feet[1]
Grass-lined where side slopes are 8(horizontal):1(vertical) or flatter	10 feet[2]
Grass-lined with the 20-foot maintenance access on a bench	10 feet
Lined with riprap or articulated concrete blocks or partially concrete-lined	Same as grass-lined channel
Fully concrete-lined	20 feet[1]

[1]Backslope swale system not needed.
[2]Maintenance access is on the side slope.

(3) A dedication of easement shall be provided by plat or by separate instrument.

(4) Proper dedication of public access to the detention pond must be shown on the plat or by separate instrument. This includes permanent access easements with overlapping public utility easements.

(5) Backslope drainage systems are required where the natural ground slopes towards the drainage basin. A basin that is within 30 feet of a parking lot or roadway with berms that drain away from the basin does not require a backslope swale. Comply with criteria provided in HCFCD Criteria Manual.

SECTION 2B - STORM STRUCTURAL DESIGN REQUIREMENTS

9.2.02 STRUCTURAL DESIGN REQUIREMENTS

The engineer of record is responsible for the design of all structural components within the proposed storm water design. This includes but is not limited to pipe, box sewers, manholes and junction boxes.

Cast in place and precast structural elements are both allowed given that each design is signed and sealed by a professional engineer.

SECTION 3 - EASEMENT AND RIGHTS-OF-WAY

9.3.01 EASEMENT AND RIGHTS-OF-WAY

Storm sewer easement and R.O.W. requirements are described in Chapter 5 Easement Requirements.

SECTION 4 - SUBMITTALS

9.4.01 SUBMITTALS

9.4.01.A. Submittal for review and comments:

1. Approximate definition of lots and street patterns.

2. Stormwater Information Form.

3. Any proposed drainage easements.

4. Floodplain information, including floodplain boundary, if any; FEMA map number, effective map date and zone.

5. Copies of any documents which show approval of exceptions to the City design criteria.

6. Design calculations for time of concentration, storm line sizes and grades, and for detention facilities, if any.

7. Design calculations for the Hydraulic Grade Line of each line or ditch, and for detention facilities, if any.

8. Drainage Area Map with the following information:

    a. Existing contour map.

    b. Existing and Proposed drainage area and sub-drainage area boundaries.

    c. Existing and Proposed drainage area (acres) and flow quantity (cfs) draining to each inlet and each pipe segment from storm structure (i.e. manhole, inlet, catch basin, etc.) to storm structure.

    d. Extreme event (100-year) Sheet Flow direction.

    e. Existing condition and proposed condition Sheet Flow direction for the surrounding properties.

9. Plan and profile sheets showing Stormwater design (public facilities only).

    Projects located within a floodplain boundary or within a floodplain management area shall:

    a. Show the floodplain boundary or floodplain area, as appropriate, on the Drainage Area Map.

9.4.01.A.9 continued

b. Comply with all applicable submittal requirements of Chapter 19, Code of Ordinances.

c. Review and approval of this project by the City of Houston Floodplain Management Office (FMO) is required.

10. Profile drawing of roadway (or overland flow path) with exaggerated vertical scale from the upper reach of drainage area to the primary drainage outlet. Show roadway profile at gutter, ground profile at the public R.O.W., and hydraulic gradient lines for the 2-year and 100-year extreme event; or an alternative equivalent drawing accepted by the City.

11. Calculation for proportional amount of pipe capacity allocated to the Development along with the drainage area map used for these calculations.

12. If the detention has been provided by other projects, a Memorandum should be provided to explain how the existing detention facility serves this proposed project.

9.4.01.B. Signature Stage - Submit the following for approval:

1. Review prints with all comments.

2. Original drawings

    a. Provide Stormwater Information Form log number on the cover sheet.

    b. Provide all information requested in section 9.4.01A.

3. Stormwater detention maintenance agreement letters.

4. All required permits from other agencies or departments (i.e., HCFCD approval, Floodplain Management Office (FMO) approval, etc.)

9.4.01.C Geospatial Data Deliverables: Provide GIS datasets in accordance with Chapter 13 – Geospatial Data Deliverables for projects that are proposing or modifying assets identified in Chapter 13 that are or will be operated and/or maintained by the City.

SECTION 5 - QUALITY ASSURANCE

9.5.01 QUALITY ASSURANCE

Prepare calculations and design drawings under the supervision of a Professional Engineer trained and licensed under the disciplines required by the project scope. The final design drawings and all design calculations must be sealed, signed, and dated by the Professional Engineer responsible for the development of the drawings.

SECTION 6 - SURVEY

9.6.01 SURVEY

Projects shall be tied to National Geodetic Survey (NGS) datum adjustment which matches the Federal Emergency Management Agency (FEMA) rate maps or the most current NGS datum which matches the FEMA rate maps. In the event GPS surveying is used to establish bench marks, at least two references to bench marks relating to the rate maps shall be identified. Equations may be used to translate other datum adjustments to the required adjustment.

SECTION 7 - LOW IMPACT DEVELOPMENT

9.7.01 LOW IMPACT DEVELOPMENT

Design requirements for Low Impact Development techniques are included in section 9.10.01. Only three techniques may be considered to have impact on impervious surface: Hard Roof, Green Roof, and Porous Pavement.

STORMWATER QUALITY DESIGN REQUIREMENTS

SECTION 8 - STORMWATER QUALITY OVERVIEW

9.8.01 SECTION INCLUDES

9.8.01.A. Criteria for the design of Stormwater pollution prevention procedures and controls for construction activities.

9.8.01.B. Criteria for the design of permanent Stormwater pollution prevention facilities and controls to minimize impacts for new development and decrease impacts for redevelopment on tracts of land of one acre or more.

9.8.02 REFERENCES

9.8.02.A. Stormwater Management Handbook for Construction Activities, City of Houston, Harris County, Harris County Flood Control District, 2006 or Current Edition.

9.8.02.B. Stormwater Quality Management Guidance Manual, City of Houston, Harris County, Harris County Flood Control District, 2001 or current edition.

9.8.02.C. Minimum Design Criteria (MDC) for Implementation of Certain Best Management Practices for Stormwater Runoff Treatment Options, 2001 edition, City of Houston.

9.8.02.D. Article XII of Chapter 47 Water and Sewers of the City of Houston Code of Ordinances.

9.8.02.E. National Pollutant Discharge Elimination System Permit Number TXS001201.

9.8.02.F. Texas Pollutant Discharge Elimination System (TPDES) Permit No. WQ0004685000 (known as the Municipal Separate Storm Sewer System - MS4 permit)

9.8.02.G. Texas Pollutant Discharge Elimination System (TPDES) General Permit No. TXR150000 (known as the Construction Stormwater General Permit)

9.8.02.H. Texas Pollutant Discharge Elimination System (TPDES) General Permit No. TXR050000 (known as the Industrial Stormwater Multi-Sector General Permit)

9.8.02.I. Texas Pollutant Discharge Elimination System Permit Number WQ0004685000

9.8.02.J. International Stormwater Best Management Practices (BMP) Database, www.bmpdatabase.org

9.8.03 DEFINITIONS

9.8.03.A. Applicant - The owner of the land on which the new development or significant redevelopment will occur, or authorized agent.

9.8.03.B. Best Management Practice (BMP) - Schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the United States. Stormwater management BMP to control or abate the discharge of pollutants when authorized under section 402(p) of the Clear Water Act (CWA) for the control of Stormwater discharges.

9.8.03.C. Best Management Practices (BMP) - A number of Stormwater structural and non-structural control strategies that have become the national focus for the mitigation of Stormwater pollution. BMP types include ponds, bio retention facilities, infiltration trenches, grass swales, and filter strips (Ref EPA.gov- TMDL 2007).

9.8.03.D. Detention - A feature meant to collect a site's stormwater and slowly release it at a control rate to not significantly impact downstream areas.

9.8.03.E. Development - (i) Any activity that requires a subdivision plat or development plat pursuant to Chapter 42 of this Code; (ii) the further subdivision of any reserve tract that is part of a subdivision plat approved by the city planning commission or pursuant to article II of Chapter 42 of this Code; or (iii) any activity that requires a construction permit.

9.8.03.F. Dwelling Unit - A structure, or a portion of a structure, that has independent living including provisions for non-transient sleeping, cooking and sanitation.

9.8.03.G. Engineered Soil - Cement-Based Engineered Soil technology used to stabilize the soil on a work site where it is not solid enough to safely support a building or roadway. Portland cement is blended with soil (sometimes including aggregate) and water and then compacted. The resulting mix, known as soil cement, provides a secure and stable base for construction. It is also used for flood control structures.

9.8.03.H. Engineered Soil Media - Low Impact Design (LID) practice used to reduce storm runoff volume and loading of pollutants in the discharge from its contributing drainage area. Engineered soil incorporate a growing media with the native soil to create a functional soil designed for high infiltration, filtration, and plant sustainability. The layer should be compacted as minimally as possible to allow for surface percolation through the engineered soil layer and into the surrounding native soil or underdrain.

9.8.03.I. Impervious Surface - ~~Any area that does not readily absorb water, including, but not limited to, building roofs, parking and driveway areas, sidewalks, compacted or rolled areas, and paved recreation areas~~See article 9.1.04.O.

9.8.03.J. Low Impact Development (LID) - A land planning and engineering design approach to managing Stormwater runoff. LID emphasizes conservation and use of on-site natural features to protect water quality. This approach implements engineered small-scale hydrologic controls to replicate the pre-development hydrologic regime of watersheds through infiltrating, filtering, storing, evaporating, and detaining runoff close to its source. LID based practices are used to reduce Stormwater runoff volume and pollutant loading from developed sites.

9.8.03.K. Notice of Intent (NOI) - A written submission to the executive director from an applicant requesting coverage under general permit, reference definition 9.8.03.G.

9.8.03.L. NPDES - National Pollutant Discharge Elimination System

9.8.03.M. Regulated Construction Activity - Construction activities, including clearing, grading, and excavation that disturb either one acre or more, or less than one acre if the activities are part of a larger plan of development or sale.

9.8.03.N. Residence Time - The length of time that runoff remains in a pond, which is known as the pond's Hydraulic Residence Time (HRT). Removal efficiency is primarily dependent on the HRT.

9.8.03.O. Significant New Development - Development on a currently undeveloped parcel of land one acre or larger without regard to the amount of land that will actually be disturbed, except for development on an existing undeveloped and undivided parcel of one acre or more of one single-family dwelling unit and/or the types of non-commercial building(s) typically associated with a single-family dwelling unit, including, but not limited to, a garage, carport or barn. If the occupancy for any structure excluded under the foregoing exception at any time changes to a commercial use, the owner of the property will at that time have to comply with all requirements of this program. The term also does not include a Stormwater detention basin that includes a water quality feature. The required Stormwater quality permit must include Detention.

9.8.03.P. Significant Redevelopment - Increase of 0.2 acre or more to the impervious surface on one acre or larger developed parcel, but does not include a Stormwater detention basin that includes a water quality feature. The required Stormwater quality permit must include Detention.

9.8.03.Q. SWQMP - Stormwater Quality Management Plan.

9.8.03.R. Stormwater Pollution Prevention Plan (SWPPP) - A site-specific, written document that: Identifies potential sources of Stormwater pollution at the construction site; describes practices to reduce pollutants in Stormwater discharges from the construction site. Reduction of pollutants is often achieved by controlling the volume of Stormwater runoff (e.g., taking steps to allow Stormwater to infiltrate into the soil). Identifies procedures the operator will implement to comply with the terms and conditions of a construction general permit.

9.8.03.S. Stormwater Quality permit or SWQ permit - shall mean a current, valid permit issued pursuant to Article XII, Chapter 47, Division 2 of the City Code of Ordinances. A SWQ permit shall be obtained for all new development and significant redevelopment sites that will construct or modify their detention features. This requirement applies only to the detention feature if the facility has or will have permit coverage for stormwater discharges from industrial activity issued by the state.

9.8.03.T. TPDES - Texas Pollutant Discharge Elimination System

9.8.03.U. Undeveloped Parcel - A parcel on which there are no structures at the time that a construction permit, subdivision plat or other city approval is applied for or required.

SECTION 9 - DESIGN REQUIREMENTS

9.9.01 DESIGN REQUIREMENTS

9.9.01.A. Obtain approval from the Office of the City Engineer (OCE) for exceptions or deviations from these requirements. Exceptions or deviations may be granted on a project-by-project basis.

9.9.01.B. Construction Activity:

1. SWPPPs and BMPs will be developed in accordance with the Stormwater Management Handbook for Construction Activities (9.8.02 Reference A), for sites that are less than one acre the SWPPP can be as simple as the Stormwater Pollution Prevention Plan Detail (DWG No. 01571-01).

2. Construction plans will include a note requiring contractor to comply with the Construction Stormwater General Permit including preparation of a SWPPP and to provide a copy of the Site Notice, NOI, and maintenance checklist to City Engineer or Building Official five (5) work days prior to commencement of any construction activity.

9.9.01.C. New Development and Significant Redevelopment:

1. All designs must be consistent with the Stormwater Quality Guidance Manual[2] (SWQGM) and the Minimum Design Criteria for Certain Stormwater Runoff Treatment Options[3] (MDC), 2001 edition.

2. Pollutants expected from the site must be identified in the SWQMP. BMPs must be designed and selected to remove the pollutants identified.

3. At a minimum, the system must be designed to treat the first 1/2 inch of runoff, except as noted in the SWQGM or the MDC.

4. BMPs listed in the SWQGM but not in the MDC may be acceptable for implementation pending review of design calculations and site applicability. BMPs not listed in the SWQGM may be considered on a case by case basis. Acceptance of these BMPs will require not only review of design calculations and site applicability, but also review of case studies or other data provided by an uninterested third party indicating the effectiveness of the BMP. All calculations and literature must be provided as part of the plan submittal.

5. In addition to meeting the Stormwater quality requirements of this section, the Stormwater system must also meet the requirements of the rest of this Chapter.

[2] The Stormwater Quality Guidance Manual developed jointly by City of Houston, Harris County, and Harris County Flood Control District can be found at http://www.cleanwaterways.org/downloads/professional/guidance_manual_full.pdf
[3] The Minimum Design Criteria Manual developed jointly by City of Houston, Harris County, and Harris County Flood Control District can be found at http://www.cleanwaterways.org/downloads/criteria_2001_edition.pdf

SECTION 10 - DESIGN STANDARDS

9.10.01 DESIGN STANDARDS

9.10.01.A. When design approaches included in this section are incorporated in designs requiring City Engineer approval, the standards of this section will apply.

9.10.01.B. Low Impact Development (LID):

1. Bioretention

a. Overview

Bioretention is a terrestrial-based (up-land as opposed to wetland), water quality and water quantity control practice using the chemical, biological and physical properties of plants, microbes and soils for removal of pollutants from Stormwater runoff. Some of the processes that may take place in a bioretention facility include: sedimentation, adsorption, filtration, volatilization, ion exchange, decomposition, phytoremediation, bioremediation, and storage capacity. Bioretention may also be designed to mimic predevelopment hydrology.

b. Design Criteria

(1) Determine volume of bioretention area below maximum design water surface. Depth of ponding limited to a maximum of 6 inches.

(2) Demonstrate that sufficient area contributes stormwater runoff to the bioretention area to fill the area to its maximum design water surface for the design storm under consideration.

(3) Using in-situ or new soils, design the bioretention area to empty within 48 hours. This may be accomplished through infiltration, evapotranspiration, and/or the design of a subsurface drainage system.

(4) Mitigating detention volume requirements can be reduced by the volume in the bioretention area below its maximum design water surface.

(5) Runoff from commercial areas and parking lots require pretreatment; grass buffer strip or vegetated swales, prior to draining into bioretention area.

(6) Infiltration rates less than 0.5 inches per hour will require a subsurface drainage system.

(7) Geotechnical testing is required to confirm infiltration rates.

9.10.01.B.1.b continued

(8) The cross section for typical Porous Bioretention Basin is shown on Figure 9.7.

c. Inspection and Maintenance Requirements

(1) Verify presence of vegetation considered in design computations (if any) quarterly.

(2) Verify the bioretention area has adequate volume quarterly by checking whether sedimentation has encroached on design volume. This can be done by comparing actual maximum depth against design maximum depth.

(3) Verify ability of bioretention area to drain within 48 hours twice yearly after rainfall event.

(4) Correct deficiencies related to items 1-3 above as needed.

2. Infiltration Trenches

a. Overview

Trenches or basins that temporarily detain a design water quality volume while allowing infiltration to occur over a prescribed period of time. Trenches are applicable for both water quality and water quantity control practices.

b. Design Criteria

(1) In-situ subsoil shall have a minimum infiltration rate of 0.5 inches per hour. Geotechnical testing including one boring per 5,000 square feet or two per project is required to confirm infiltration rate.

(2) Subsurface drainage systems are required where the in-situ subsoil rate is less than 0.5 inches per hour or where the project is constructed on fill soils.

(3) Avoid placement on slopes greater than 15% in fill areas.

(4) Design of the trench area to empty with 48 hours.

(5) Backfill using clean aggregate larger than 1.5 inches and smaller than 3 inches surrounded by engineered filter fabric.

(6) Provide overflow structure or channel to accommodate larger runoff events.

(7) Provide 4 inches PVC observation well into subgrade.

9.10.01.B.2.b continued

(8) Runoff from commercial areas and parking lots require pretreatment; grass buffer strip or vegetated swales, prior to draining into infiltration trench.

(9) Locate bottom of facility at least 4 feet above seasonal high water table elevation.

(10) Locate at least 100 feet from any water supply well.

(11) Maximum contributing drainage area is 5 acres.

(12) Mitigating detention volume can be reduced by the amount of infiltration into the subsoil and the volume of voids within the trench area.

c. Inspection and Maintenance Requirements

(1) Inspect observation well for water level and drainage times.

(2) Conduct landscaping, mowing, and desilting of facility.

3. Porous Paver Systems and Porous Pavement

a. Overview

Porous Pavement consists of a permeable surface course (typically, but not limited to, pavers, asphalt or concrete) that allows infiltration of stormwater runoff into a permeable layer of uniformly graded stone bed. The underlying permeable layer serves as a storage reservoir for runoff and/or infiltration. Porous Pavement is applicable for both water quality and water quantity control practices.

b. Design Criteria

Minimum requirements for porous paver system

(1) Design details for Porous Paver Systems are shown in Figure 9.8 and for Porous Pavement Systems are shown in Figure 9.9.

(2) Restricted to Single Family Residential Construction or Commercial Construction on private property when the system is covered by a Stormwater Quality Permit.

a. Residential Porous Pavers Systems without a subsurface drainage system may be determined as pervious for up to 10% of the lot area for a Single Family Residential (SFR) lot: (1) qualifying for exemption from detention under 9.2.01.H.3 and (2) for basis of City Drainage Utility charges

9.10.01.B.3.b.(2) continued

b. Commercial Porous Paver Systems without a subsurface drainage system that have a Stormwater Quality Permit may be determined as pervious for commercial areas designed for heavy traffic volume and/or vehicles.

(3) In-situ subsoil shall have a minimum infiltration rate of 0.5 inches per hour. Geotechnical testing including one boring per 5,000 square feet or two per project is required to confirm infiltration rate.

(4) Subsurface drainage systems are required for stormwater detention where the in-situ subsoil rate is less than 0.5 inches per hour or where the project is constructed on fill soils.

(5) Subsurface drainage systems are required to be drained in 48 hours.

(6) If the volume of storage within the voids of the subsurface drainage system's stone bed meets the detention volume rate of 0.5 acre-feet per acre of development or 0.2 acre-feet per acre for tracts less than one acre, the area of the porous pavement is considered undeveloped. Otherwise, the total voids storage volume will be credited toward the required detention volume.

(7) If the time of concentration (Tc) from a project site that includes porous pavement and subsurface drainage system, is equal to the undeveloped time of concentration, the development of the project site is considered undeveloped.

(8) Soft porous pavement area shall be considered undeveloped.

(9) The cross-section typically consists of four layers, as shown in Figure 9.9. The aggregate reservoir can sometimes be avoided or minimized if the sub-grade is sandy and there is adequate time to infiltrate the necessary runoff volume into the sandy soil without by-passing the water quality volume. Descriptions of each of the layers are presented below:

Porous Pavement Layer - The porous pavement layer consists of an open graded pavement mixture, concrete or asphalt, specifically designed to be porous with binding agents that create a cohesive wearing surface. The thickness of this layer is based on the design of the pavement section and the loading requirements associated with the intended use. It is important to note that porous asphalt is not to be confused with Open Graded Friction Course (OGFC) that is used as a driving surface on highways which should not be used in this particular application except as an overlay wearing course over the porous concrete or asphalt. Porous pavement may be considered to contain 18% voids (typical range is 16% to 22%). Technical reference for porous concrete is FHWA-HIF-13-006. Technical reference for porous asphalt is FHWA-HIF-15-009.

9.10.01.B.3.b.(9) continued

Top Filter Layer - Consists of a 0.5 inch diameter crushed stone to a depth of 1 to 2 inches. This layer serves to stabilize the porous concrete layer. Can be combined with reservoir layer using suitable stone.

Reservoir Layer - The reservoir gravel base course consists of washed, bank-run gravel, 1.5 to 2.5 inches in diameter with a void space of about 40 %. The depth of this layer depends on the desired storage volume, which is a function of the soil infiltration rate and void spaces, but typically ranges from two to four feet. The layer must have a minimum depth of nine inches. The layer shall be designed to drain completely in 48 hours. The layer shall be designed to store at a minimum the water quality volume (WQv). Aggregate contaminated with soil shall not be used. A porosity value (void space/total volume) of 0.32 shall be used in calculations unless aggregate specific data exist.

Bottom Filter Layer – The surface of the subgrade shall be a 6 inch layer of sand (ASTM C-33 concrete sand) or a 2 inch thick layer of 0.5 inch crushed stone, and be completely flat to promote infiltration across the entire surface. This layer serves to stabilize the reservoir layer, to protect the underlying soil from compaction, and act as the interface between the reservoir layer and the filter fabric covering the underlying soil.

Filter Fabric - It is very important to line the entire trench area, including the sides, with filter fabric prior to placement of the aggregate. The filter fabric serves a very important function by inhibiting soil from migrating into the reservoir layer and reducing storage capacity. Fabric shall be MIRFI # 14 N or equivalent.

Underlying Soil - The underlying soil shall have an infiltration capacity of at least 0.5 in/hr, but preferably greater than 0.50 in/hr. as initially determined from NRCS soil textural classification, and subsequently confirmed by field geotechnical tests. The minimum geotechnical testing is one test hole per 5,000 square feet, with a minimum of two borings per facility (taken within the proposed limits of the facility). Infiltration trenches cannot be used in fill soils. Soils at the lower end of this range may not be suited for a full infiltration system. Test borings are recommended to determine the soil classification, seasonal high ground water table elevation, and impervious substrata, and an initial estimate of permeability. Often a double-ring infiltrometer test is done at subgrade elevation to determine the impermeable layer, and for safety, one-half the measured value is allowed for infiltration calculations.

c. Inspection and Maintenance Requirements

(1) Initial inspection of porous pavement shall be monthly for the first three months post construction.

(2) Semi-annual inspection to ensure pavement surface is free of sediment.

9.10.01.B.3.c continued

(3) Vacuum sweep hard porous pavement followed by high pressure hosing to keep voids free of sediment quarterly.

(4) Annually inspect pavement surface and subsurface drainage system (if any) for deterioration, spalling or malfunctioning.

d. Additional provisions regarding use as a pervious cover. Approval of plans considering the SFR exemption in cases including porous pavement will include the following condition:

Approval of the proposed development is based in-part on capacity for proposed porous pavement to mitigate increased stormwater runoff.

As condition of approval, applicant is required to provide notice to the owner/buyer of the property of the stormwater quality permit and that maintenance of porous paver system or porous pavement is necessary for continued functionality, that requirements for routine maintenance have been published by Houston Public Works and may be revised in the future, and that failure to fulfill maintenance actions and reporting may result in citations or an increase of drainage utility charges for the property pursuant to City of Houston Ordinance Chapter 47 Water and Sewers, Article XV Drainage Impact Fees.

4. Vegetated Swales

a. Overview

Vegetated Swales (dry or wet) are earthen, planted stormwater conveyances designed to filter a shallow depth of runoff (<4 inches) for water quality improvement and to infiltrate stormwater. There are two types, dry or wet. Dry swales include an underdrain system. Wet swales do not. Swales are typically designed to convey runoff from larger storm events, however, treatment and infiltration is reduced during high flows. Infiltrative soils or an engineered porous subgrade is required for infiltration use. Vegetated Swales are applicable for both water quality and water quantity control practices.

b. Design Criteria for Dry Swale

(1) Soil infiltration rate of 0.27 to 0.50 inches/hour.

(2) Trapezoidal or parabolic cross section.

(3) Bottom width shall be 2 feet wide minimum or 6 feet wide max.

(4) Longitudinal slope shall range from 1% to 6%.

(5) Flow depth shall be less than 4 inches for water quality treatment.

9.10.01.B.4.b continued

(6) Flow velocity shall be less than 1 fps for water quality, less than 5 fps for 2-yr storm (non-erosive velocities for grass and soils).

(7) Length shall yield a 10 minute residence time.

(8) Side slopes shall be flatter than 3:1.

(9) Maximum ponding time shall be 48 hours.

(10) Use proper vegetation (grass or wetland plants) consistent with climate, ecoregion, soils, and hydric conditions.

(11) Provide at least 3 inches of free-board during design storm.

(12) Provide pretreatment of runoff into the swale.

(13) Design details are shown in Figure 9.10.

c. Design Criteria for Wet Swale

(1) Soil infiltration rate of 0.27 to 0.50 inches/hour.

(2) Trapezoidal or parabolic cross section.

(3) Bottom width shall be 2 feet wide minimum or 8 feet wide max. to avoid gullying or channel braiding.

(4) Longitudinal slope shall range from 1% to 6%.

(5) Flow depth shall be less than 4 inches for water quality treatment.

(6) Flow velocity shall be less than 1 fps for water quality, less than 5 fps for 2-yr storm (non-erosive velocities for grass and soils).

(7) Length shall yield a 10 minute residence time.

(8) Slide slopes shall be flatter than 3:1.

(9) Maximum ponding time shall be < 48 hours.

(10) Use proper vegetation (grass or wetland plants) consistent with climate, ecoregion, soils, and hydric conditions.

(11) Provide at least 3 inches of free-board during design storm.

(12) Provide pretreatment of runoff into the swale.

9.10.01.B.4.c continued

(13) Design details are shown in Figure 9.11.

d. Inspection and Maintenance Requirements

(1) Mow dry swales as required during growing season to maintain grass heights in the 4 to 6 inch range. Wet swales, employing wetland vegetation or other low maintenance ground cover do not require frequent mowing. Remove sediment when 25% of the original water quality volume has been exceeded.

5. Green Roof

a. Overview

A green roof, in the simplest terms, is a vegetated roof. The vegetation varies, but must be suitable to the local climate and be drought tolerant unless a method of irrigation is also installed. Installation generally consists of a waterproof membrane installed over a suitably constructed roof deck. For in-situ installations, an under-drain drainage system is installed over the membrane. A lightweight engineered soil is installed on top of the under-drain, as fill dirt or topsoil is typically too heavy to use in rooftop applications. The engineered soil is then planted with select vegetation. If a modular system is selected, the drainage system may already be incorporated into the design, along with the soil and vegetation, depending on the manufacturer. The substrate material and depth are also factors that influence the efficiency of the green roof to store and/or treat stormwater. Roofs consisting of relatively thin soil layers, called extensive roofs, are not as heavy as the intensive roofs, which are covered with thicker soil layers.

b. Design Criteria

(1) Vegetation suitable to the climate and preferably a species that is drought tolerant, unless a method of irrigation is provided, shall be installed. The effect of wind on the vegetation shall also be considered when selecting the roof foliage, as wind velocities are typically higher at rooftop elevations.

(2) The amount of credit given for the rainfall amount stored shall be as prescribed by the manufacturer for a modular system.

(3) The amount of credit given for the rainfall amount stored for non-modular systems shall be calculated for the engineered soil media. The rate shall be derived by in-situ porosity testing. The porosity test shall be performed four times with the first time results being discarded and the three remaining results averaged. The test shall require the first sample remain wet a minimum of 1 hour. The subsequent porosity tests shall be performed the same day. In no case shall the storage volume be credited more than 33% of total volume, as that is the assumed volume of clean

9.10.01B.5.b.(3) continued

graded washed gravel.

(4) The roof membrane must be sufficiently designed and installed to pond a minimum of 1 inch of water at the most shallow point on the roof for 24 hours without leaks. This shall be tested in the same manner as shower pans are tested under the building code. Additionally, special consideration shall be given for the plant root structure and prevention of soil migration during membrane selection. A root barrier may also be required to protect the waterproof membrane integrity.

(5) The under-drain drainage system shall be designed for the selected plant's tolerance for drought and varying soil moisture contents by maintaining the proper balance of moisture and aerobic conditions within the soil media for optimum vegetation sustainability. Design provisions shall address higher volume rainfall events to keep excessive amounts of water from ponding on top of the soil, to prevent erosion, and to prevent soil media saturation for extended periods. Structural calculations shall be submitted that demonstrate the structure's ability to sustain the additional loading of the green roof appurtenances plus the maximum water weight that could be stored.

c. Inspection and Maintenance Requirements

(1) A maintenance plan for the green roof system shall be developed in accordance with the membrane manufacturer's instructions and plant species selected. At a minimum, maintenance inspections shall be performed at least four times per year. The maintenance plan shall include provisions for vegetation maintenance and replacement as needed to maintain a minimum 80% coverage/survival rate in order to sustain Stormwater quality and/or detention credits. Irrigation may be required initially in order to establish the roof vegetation and to supply water under severe drought conditions. Any requirements for initial or intermittent use of fertilizer and pesticides for disease or insect control shall be identified in the plan. Plant species shall be carefully selected to minimize intermittent fertilizer and pesticide applications.

(2) Each green roof installation shall be inspected by the agency responsible for issuing the Stormwater quality or detention credits to check compliance with the approved drawings before final acceptance is issued and the proper credits are approved. At a minimum, the following items shall be checked during the inspection:

(a) Results from porosity testing (for non-modular installations).

(b) Certification from a registered Professional Engineer or registered Architect that the green roof, including membrane, drain system and engineered soil media system, was installed per the approved (permitted) drawings and operates as designed.

9.10.01.B.5.c.(2) continued

(c) Drawings of the green roof installation.

(3) Once the green roof is installed and established, additional inspections will be required in order to properly maintain the vegetation, drainage system and roof membrane. Routine inspections shall be conducted and associated maintenance activities performed on the following:

(a) Joints at adjoining walls, roof penetrations for vents, electrical and air conditioning conduits shall be inspected regularly for leaks. The ceilings located directly below the green roof installation shall also be visually inspected for signs of water staining or leaking.

(b) Designated drainage paths and drainage system components shall be inspected to ensure proper surface drainage is maintained and that the soil layer is drained to prevent excessively saturated soils. Vegetation selected to tolerate drought conditions may rot or die if the soil is allowed to become saturated for extended periods.

(c) Vegetation shall be visually inspected to identify weeds, accumulated trash or debris, dead or dying vegetation, disease or other infestation problems requiring maintenance attention. Weeds and dead vegetation shall be removed on a regular basis, especially right after the roof is planted. If a certain plant or grass species continues to die, that plant or grass shall be removed and replaced with a more tolerant species. Certified professionals shall only be used to apply chemical applications for the control of disease or insects at trouble spot locations.

(d) Trimming and pruning shall be done in accordance with horticulture practices to keep vegetation aesthetically groomed.

6. Hard Roof

a. Overview

Horizontal roof surfaces can be used to attenuate peak runoff associated with rainfall and effectively detain flow resulting from smaller rain events.
The detention volume can be controlled in several ways, but typically a simple drain ring is placed around the roof drains. As stormwater begins to pond on the roof, flow into the roof drains is controlled by orifices or slits in the drain ring. Extreme flows can be designed to overflow the ring and drain directly to the roof drains or be directed to openings in the parapet walls to prevent structural and flood damage to the roof. The roof deck must be designed to withstand the live load and be properly waterproofed.

9.10.01.B.6 continued

b. Design Criteria

(1) The structural capability of the roof system must be considered when designing a temporary rooftop storage system. For example, a 3 inch water depth is equivalent to a load of 15.6 lbs/sq.ft., which is less than most current building code requirements for live loads.

(2) Consideration must be given to the placement of electrical devices on the roof, such as air conditioning or ventilation systems and lights, and proper measures shall be taken to protect the electrical devices from the collected water.

(3) Overflow mechanisms shall be provided so that there is no danger of overloading the roof storage system during major storms. Additionally, roof slopes shall be designed to drain positively toward the roof drains to help minimize localized roof ponding or 'bird bath' formation after the detained water volume is released.

(4) It is recommended that Chapter 16 of the International Building Code, Current Edition be used for additional structural criteria along with ASCE Standard Reference Number 7, Minimum Design Loads for Buildings and Other Structures.

(5) The amount of credit given for detention volume for rooftop storage shall take into account that many flat roofs already pond significant amounts of water, although not by design. Therefore, when measuring credit given for hard roof detention volume, it is recommended that only credit be given for the total rooftop storage volume less the rooftop storage volume associated with the first inch of rain. Typically, rooftop storage volumes are only effective during the smaller, more frequent rainfall events as the larger, less frequent storms typically exceed the rooftop storage capacity.

c. Inspection and Maintenance Requirements

(1) Each hard roof installation shall be inspected by the agency responsible for issuing the detention credits to check compliance with the approved drawings before final acceptance is issued and the proper credits are approved. At a minimum, the following items shall be checked during the inspection:

(a) Roof penetrations for ventilation, electrical or plumbing connections to verify proper sealing against leaks.

(b) The overflow system that drains excessive rainfall off of the hard roof once the maximum storage volume is captured.

9.10.01.B.6.c continued

(c) Certification from a registered Professional Engineer or registered Architect that the hard roof, drain system and appurtenances have been installed and operate as designed.

(d) Drawings of the hard roof installation.

(2) Once the hard roof is installed, additional inspections will be required in order to properly maintain the drainage system and roof membrane. Routine inspections shall be conducted and associated maintenance activities performed on the following:

(a) Designated drainage paths and drainage system components shall be inspected to ensure proper surface drainage is maintained and that the roof is draining properly after the collected stormwater volume is released from a rainfall event.

(b) Routine inspections to collect and remove any trash or debris from the roof shall be conducted to prevent clogging of the roof drains and overflow drainage system.

(c) Visible cracks in the roof surface shall be identified and repaired in accordance with the roof manufacturer's recommendations in order to maintain roof integrity.

7. Rain Barrels / Cisterns

a. Overview

A cistern ("rain barrel"), ranging from 55 gallons to several hundred gallons in capacity, is placed near the down spout of a house and is used to collect rain water runoff from the roof of the house. The captured water is then typically used as a pure water source for plants and lawns.

b. Design Criteria

(1) Gutters and downspouts carry water from the rooftops to rain barrels as shown on Figure 9.12 and/or connect directly to subsurface drainage system.

(2) Screens are required on gutters to prevent clogging.

(3) Rain barrels shall be equipped with a drain spigot.

(4) Overflow outlet must be provided to bypass rain barrel from large rainfall events.

9.10.01.B.7.b continued

(5) Rain barrel must be designed with removable, child resistant covers and mosquito screening.

(6) Minimum rain barrel capacity equal to 1 inch of runoff from roof top surface area.

c. Maintenance and Inspection

(1) As condition of approval, applicant is required to provide notice to the owner/buyer of the property that the stormwater quality permit and the maintenance of rain barrel / cistern is necessary for continued functionality. The requirements for routine maintenance have been published by Houston Public Works and may be revised in the future. Failure to fulfill maintenance actions and reporting may result in citations or an increase of drainage utility charges for the property pursuant to City of Houston Ordinance Chapter 47 Water and Sewers, Article XV Drainage Impact Fees.

(2) Owner/Buyer of Property shall maintain and inspect Rain Barrels and Cisterns according to the following:

(a) Empty rain barrel after each rainfall event.

(b) Rain barrel shall be inspected annually.

SECTION 11 - QUALITY ASSURANCE

9.11.01 QUALITY ASSURANCE

Final design drawings, BMPs, SWPPPs, and SWQMPs will be sealed, signed, and dated by the Professional Engineer registered in the State of Texas responsible for their development.

END OF CHAPTER

Figure 9.3
City of Houston Storm Sewer Calculation Form

Project: ____________
Job No: ____________
System: ____________
By: ____________ Date: ____________
Checked by: ____________ Date: ____________

HGL starting elevation= ____________
Design storm= ____________
b= ____________
d= ____________
e= ____________

MH From	MH To	Area (Acres)	Runoff CoefficientC	Sum of C*A	Intensity I(In/hr)	Sum of Flows(cfs)	Time of Conc (Min)	Reach Length(feet)	Diam or Rise(In)	Span(ft)	Slope(%)	Manning's "n"	Design Capacity(cfs)	Design VelocityV(fps)	Fall(ft)	Manhole Drop (feet)	Flowline Elevation Upstream(ft)	Flowline Elevation Downstream(ft)	Actual VelocityV (fps)	Hydraulic Grad(%)	Change in Head(ft)	Elevation of Hyd. Grad. Upstream(ft)	Elevation of Hyd. Grad. Downstream(ft)	Natural Ground Upstream(ft)	Natural Ground Downstream(ft)

Figure 9.3- STORM SEWER CALCULATION FORM

Figure 9.4
City of Houston Roadside Ditch Worksheet

Project: ____________
Job No: ____________
System: ____________
By: ____________ Date: ____________
Checked by: ____________ Date: ____________

HGL starting elevation= ____________
Design Storm= ____________
b= ____________
d= ____________
e= ____________

STATION TO STATION	SIDE	SLOPE %	DRAINAGE AREA	"C"	Tc (minutes)	I (inches/hr)	Q (CFS)	DITCH SECT			"n"	"d"	VELOCITY (fps)	DITCH LINING	SIDE DRAIN PIPE DIA	REMARKS
								FS	BW	BS						

Figure 9.4 - ROADSIDE DITCH WORKSHEET

Figure 9.5 - DETENTION AND RESTRICTOR CALCULATION SAMPLE

DETENTION:

Tract size =……………..……………………………………………………………………..acres
Disturbed area =…………………………………..........................acres to four decimal places or SF
Proposed (final) Impervious area =……….……………...................acres to four decimal places or SF
Please provide your calculations:
Required Detention Volume =…………………........acre-feet (Show calculations, refer to 9.2.01.H)
Provided Detention Volume =……………………………...…… acre-feet (must show calculations)

RESTRICTORS:

Low Level Restrictor (25% flow):
Total Drainage Area =…………………………………………...acres
Outflow Rate Allowed for Low Flow QL1 =……………………… ……cfs (based on 0.5 cfs/ac)
Head HL1 (water surface differential) for Low Flow =………..ft
Calculated Low Level Restrictor Size DL =…………………….. inches
Provided/Designed Low Level Restrictor Size DL1 =………….............…...inches (min. 6 inches)

High Level Restrictor (75% flow):
Total Drainage Area =…………………………………………...acres
Total Outflow Rate Allowed (100%) Q =…………………………………..cfs (based on 2 cfs/ac)
Re-calculated Head HL2 (water surface differential) for Low Level Restrictor =………………ft
Re-calculated Low Flow Q L2 for Low Level Restrictor =………..cfs (based on DL1 and HL2)

Outflow Rate Allowed for High Flow Qh1 (75%) =………………………cfs (based Q and Q L2)
Head Hh2 (water surface differential) for High Level Restrictor =……………………...............ft
Calculated High Level Restrictor Size Dh =……………………………………………...inches
Provided/Designed High Level Restrictor Size Dh1 (75%) =………………………………inches
Outflow Rate Provided for High Flow Qh2 =……………………cfs (based on Dh1, must < Qh1)

To explain your design above, please provide information below to the plan:

- The location of the restrictor(s) on the plan(s)
- The cross section for the restrictor(s) with the water surface elevations for 25%, 75%, and full detention capacity.
- The location and elevation of the overflow structure.

Figure 9.6 - STORMWATER INFORMATION FORM

HOUSTON PUBLIC WORKS

OFFICE OF THE CITY ENGINEER
STORMWATER INFORMATION FORM

FOR OFFICE USE ONLY							
Log Number:		Private Building ILMS Project #:		Public Plan ILMS Project #:		PW Record Drawing #:	

The Office of the City Engineer reviews and approves development plans to ensure the proper design and construction of storm sewer utilities in addition to enforcing private storm design criteria and parameters as stated in City of Houston Code of Ordinances and the current City of Houston Infrastructure Design Manual. When a property owner proposes new development or redevelopment of property, the applicant must submit this form with their plans. *Completion of this form does not represent an approval or commitment by the City of Houston. This form is informational only to assist in the review and approval of your plans.*

Fee Simple Title Owner Information		Authorized Representative Information	
Name		Name	
Company		Company	
Address		Address	
City, State ZIP		City, State ZIP	
Phone		Phone	
Email		Email	
Signature*		Signature	

** As the fee simple owner of the property referenced in this form, I hereby authorize the referenced representative on this form (if applicable) to submit this form on my behalf. My authorized representative is also approved to make changes or corrections.*

Property Information					
Service Address					
City		State		ZIP Code	
Property Tax Account Number(s)					
Lot(s)		Block		Reserve	
Subdivision		Section			

Development Information *Provide description of development with associated footprint (in square feet).*							
	Single Family Residential Development		Multiple Family Residential Development		Commercial Development		Other
Existing Development:							
Development to be Removed:							
Proposed Development:							

Flood Plain Information											
FIRM Panel Number:											
Property is located within the following FEMA Flood Zone:											
	X (shaded)		X (unshaded)		AE		A		AO	Other:	

STORMWATER INFORMATION FORM

Impervious Cover Information		
Improvements	**Area of Existing Impervious Cover (Sq Ft.)**	**Area of Final Impervious Cover (Sq Ft.)**
Building		
Parking Lot/Driveway		
Sidewalk/Patio		
Detention Pond		
Pool		
Total Area		

Tract Size (Square Feet)		Total Impervious Cover (Square Feet)		Percentage of Impervious Cover (%)	

Storm Sewer Information

Storm Infrastructure Is Maintained By:

NOTE: Any infrastructure maintained by outside agencies will require their respective approval prior to final City plan approval.

	City of Houston		HCFCD		TXDOT
	Clear Lake City Water Authority		Fort Bend County		Montgomery County
	Other:				

Proposed Storm Connection Development Will Be Connected To:

	Existing on-site storm sewer system that outfalls to:	(STREET NAME / PIPE SIZE)		
	Public storm sewer located in:	(STREET NAME)	Pipe Size:	
	Public roadside ditch located in:	(STREET NAME)		
	Off-Road Ditch/Watershed:			

Detention Criteria

Stormwater detention volume was determined utilizing City of Houston Infrastructure Design Manual:

	9.2.01.H.3(b)		9.2.01.H.3(d)		9.2.01.H.3(e)		9.2.01.H.3(f)		9.2.01.H.3(c)

Documentation

This form <u>must</u> be accompanied with:

	A recorded deed or title report in the owner's name		HCAD printout		survey and/or recorded plat

The applicant can also provide the following documentation if applicable to their project:

	Previous Stormwater Letter of Availability		Copy of outside agency approval
	Storm Water Quality Permit: *Per Section 47-631 of the City of Houston Ordinance, SWQ permit is required when the development is meeting the definition of "new development" or "significant redevelopment".*		
	Drainage Study/Hydraulic Analysis: *Please submit Drainage Study when you have more than one (1) section or a larger commercial or subdivision tract. Hard copy must be accompanied with a CD or USB Flash Drive containing the drainage study file.*		

Developer Drainage Impact Fee Rate Information

Service Area Rate is per service unit (1 service unit = 1,000 sf of impervious area) of increased impervious area. Please select one.

☐	*Clear Creek $0.43*	☐	*Greens Bayou $14.62*	☐	*Buffalo Bayou $17.85*	☐	*Addicks Reservoir $0.00*
☐	*Brays Bayou $9.41*	☐	*Hunting Bayou $11.16*	☐	*Sims Bayou $19.31*	☐	*Barker Reservoir $0.00*
☐	*San Jacinto $0.00*	☐	*Ship Channel $0.00*	☐	*Vince Bayou $19.31*	☐	*White Oak Bayou $17.85*

FOR OFFICE USE ONLY			
Employee:		Comments:	

HoustonPermittingCenter.org
832-394-9579

2

revised: May 20, 2020
Form OCE-0004

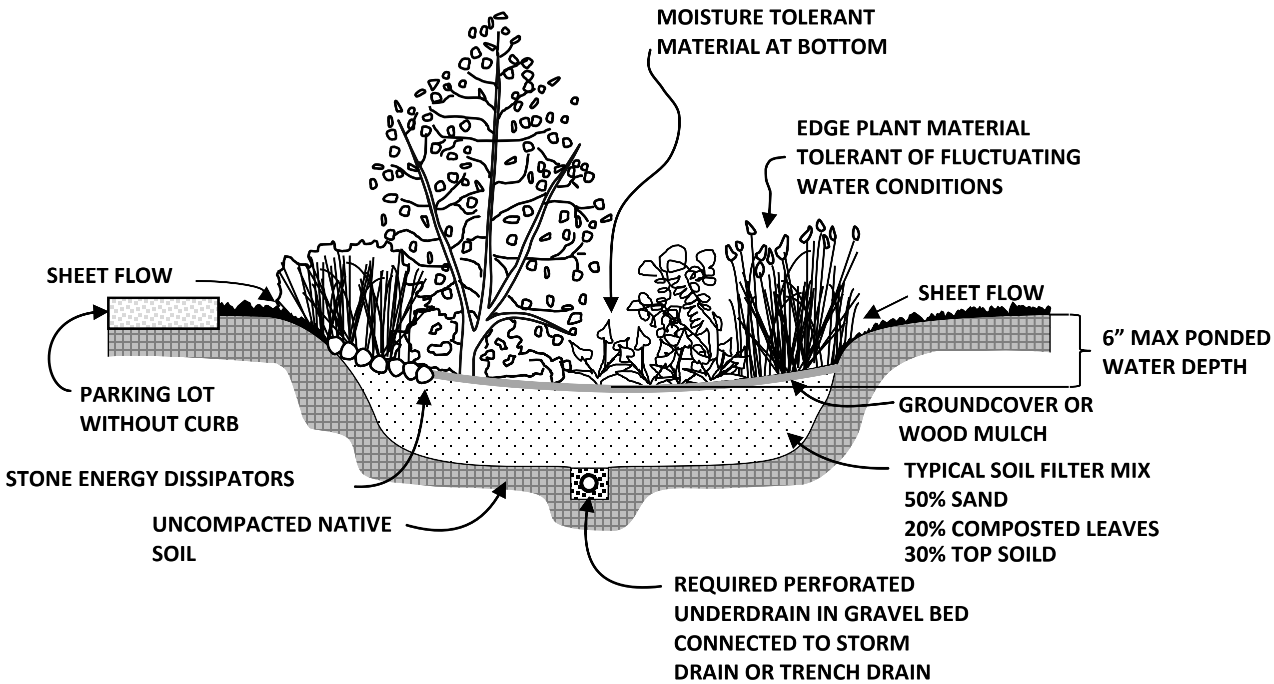


Figure 9.7- POROUS BIORETENTION BASIN

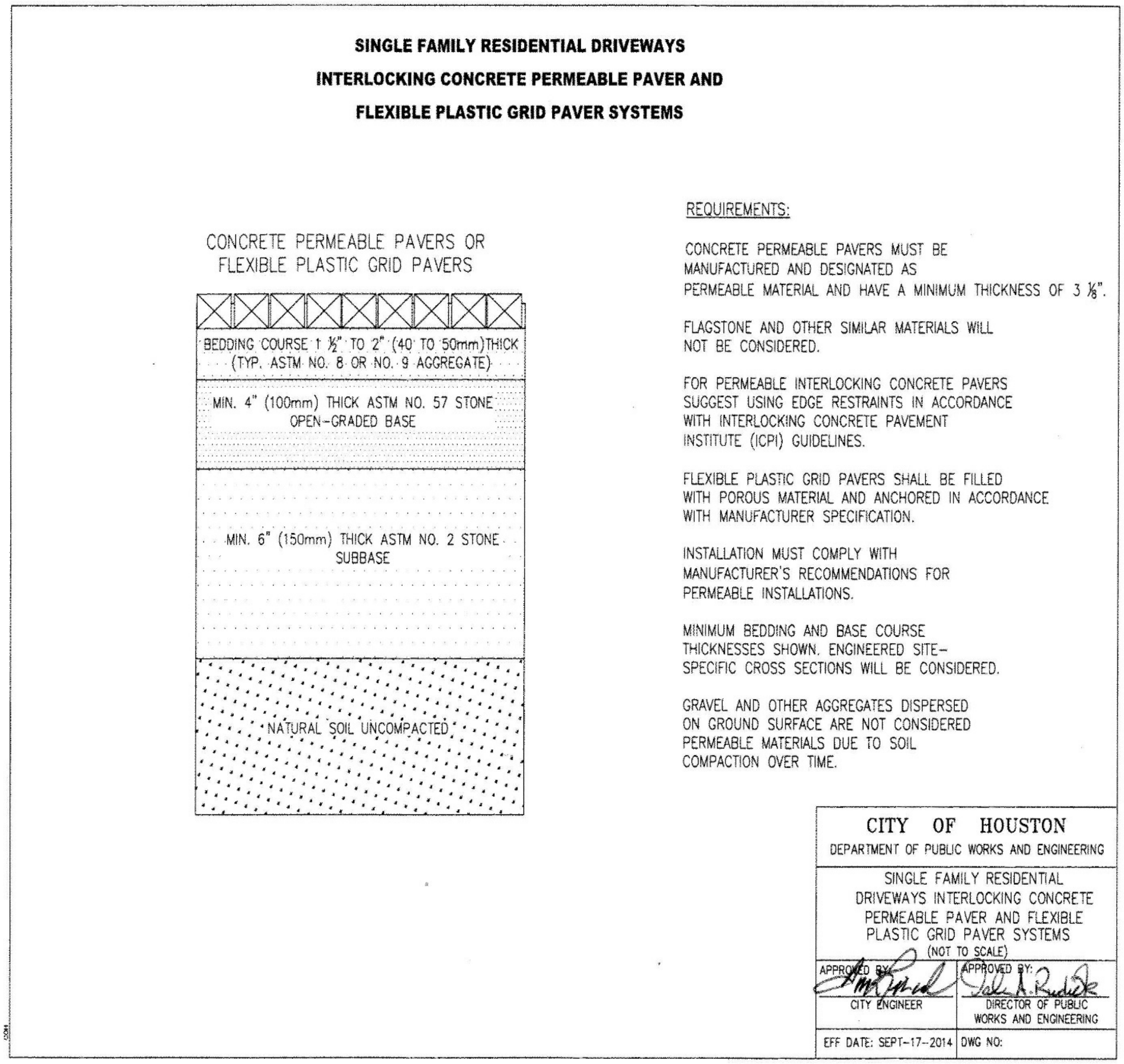


Figure 9.8 - SINGLE FAMILY RESIDENTIAL DRIVEWAYS

INTERLOCKING CONCRETE PERMEABLE PAVER AND FLEXIBLE PLASTIC GRID PAVER SYSTEMS

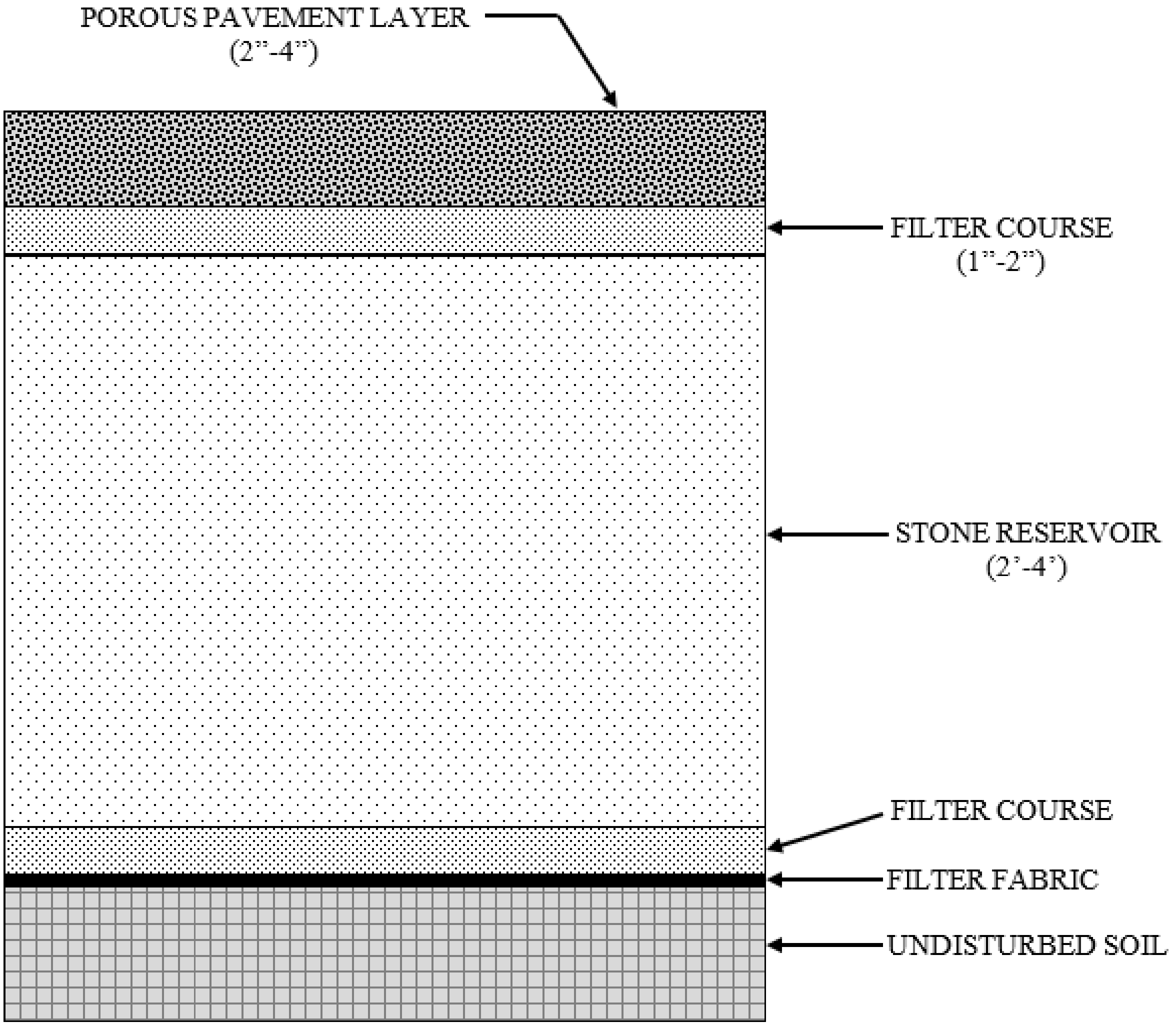


Figure 9.9 – POROUS PAVEMENT TYPICAL SECTION

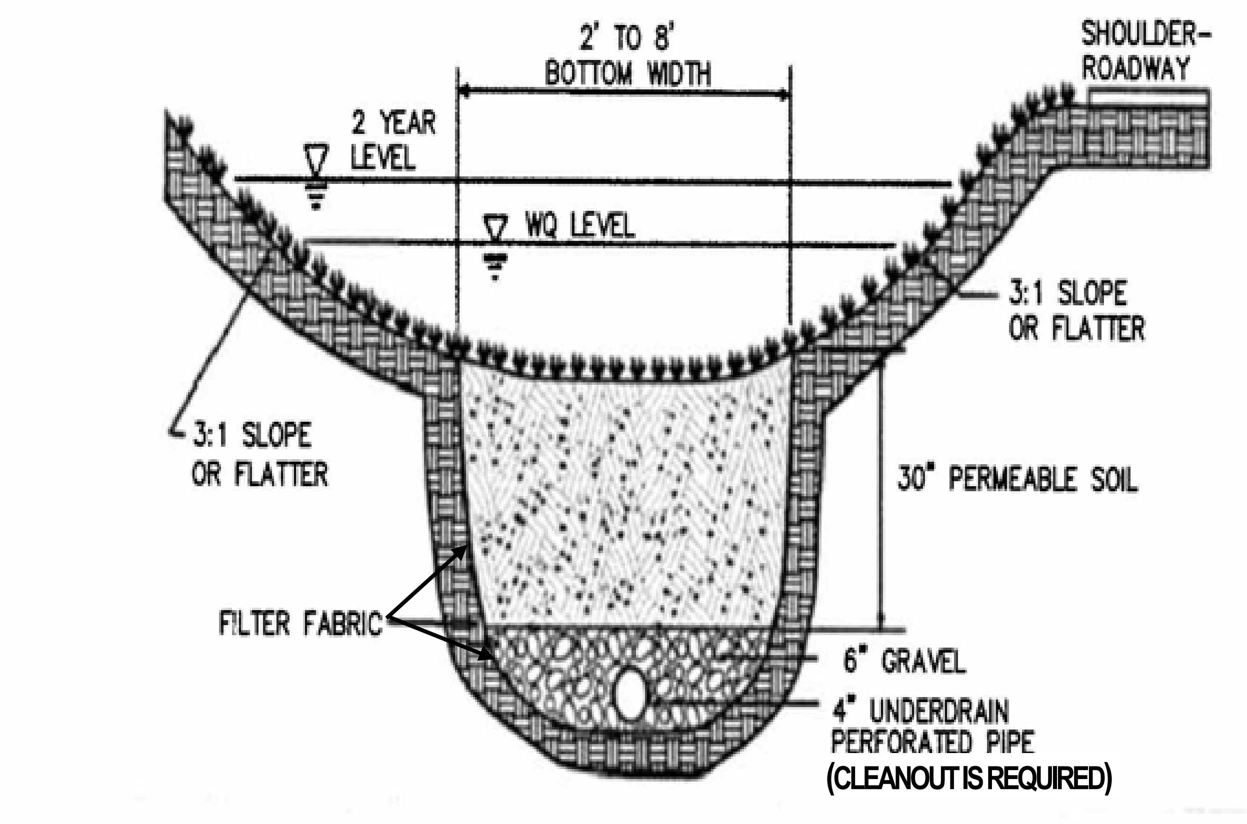


Figure 9.10- DRY SWALE CROSS SECTION

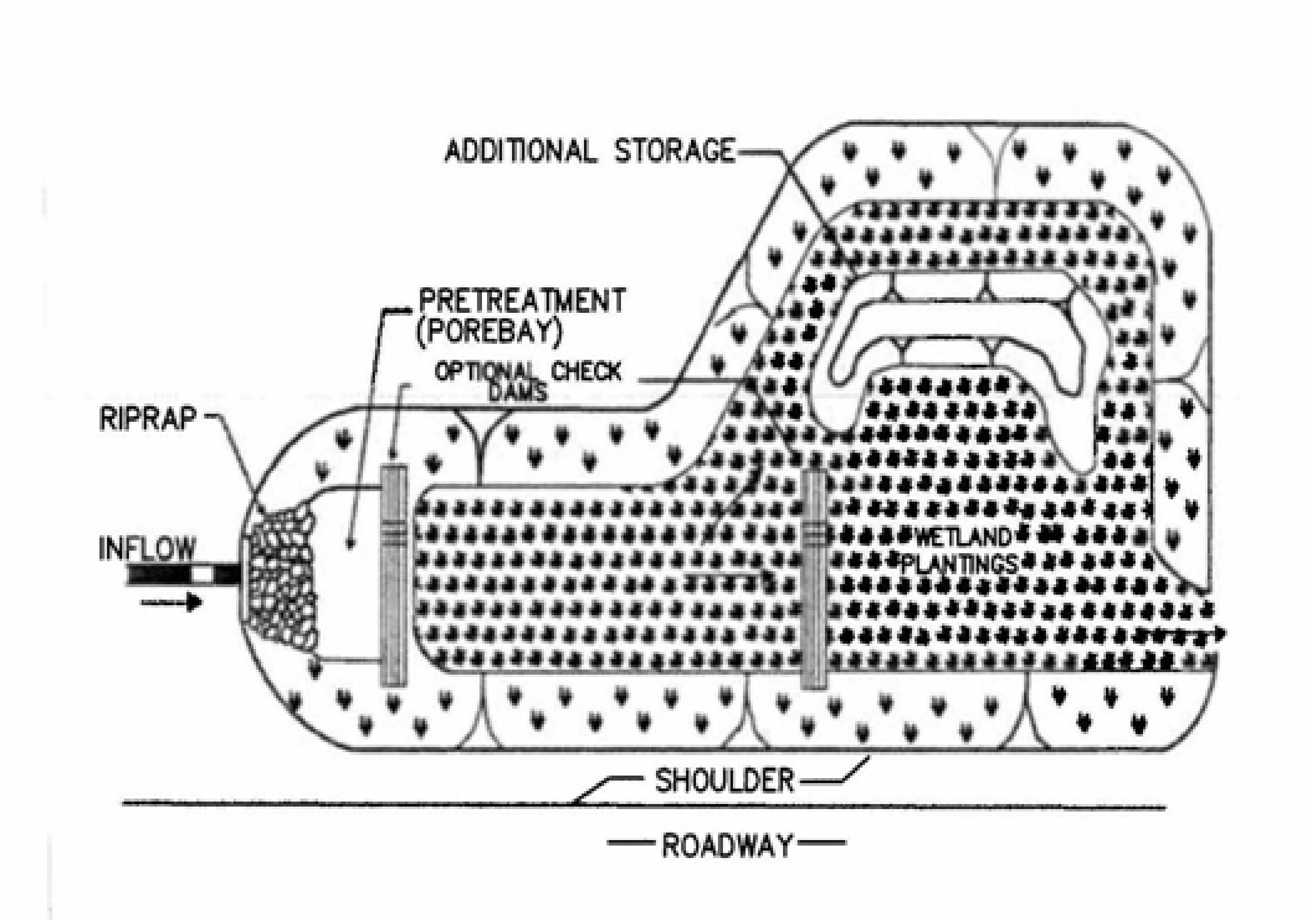


Figure 9.11 – WET SWALE PLAN

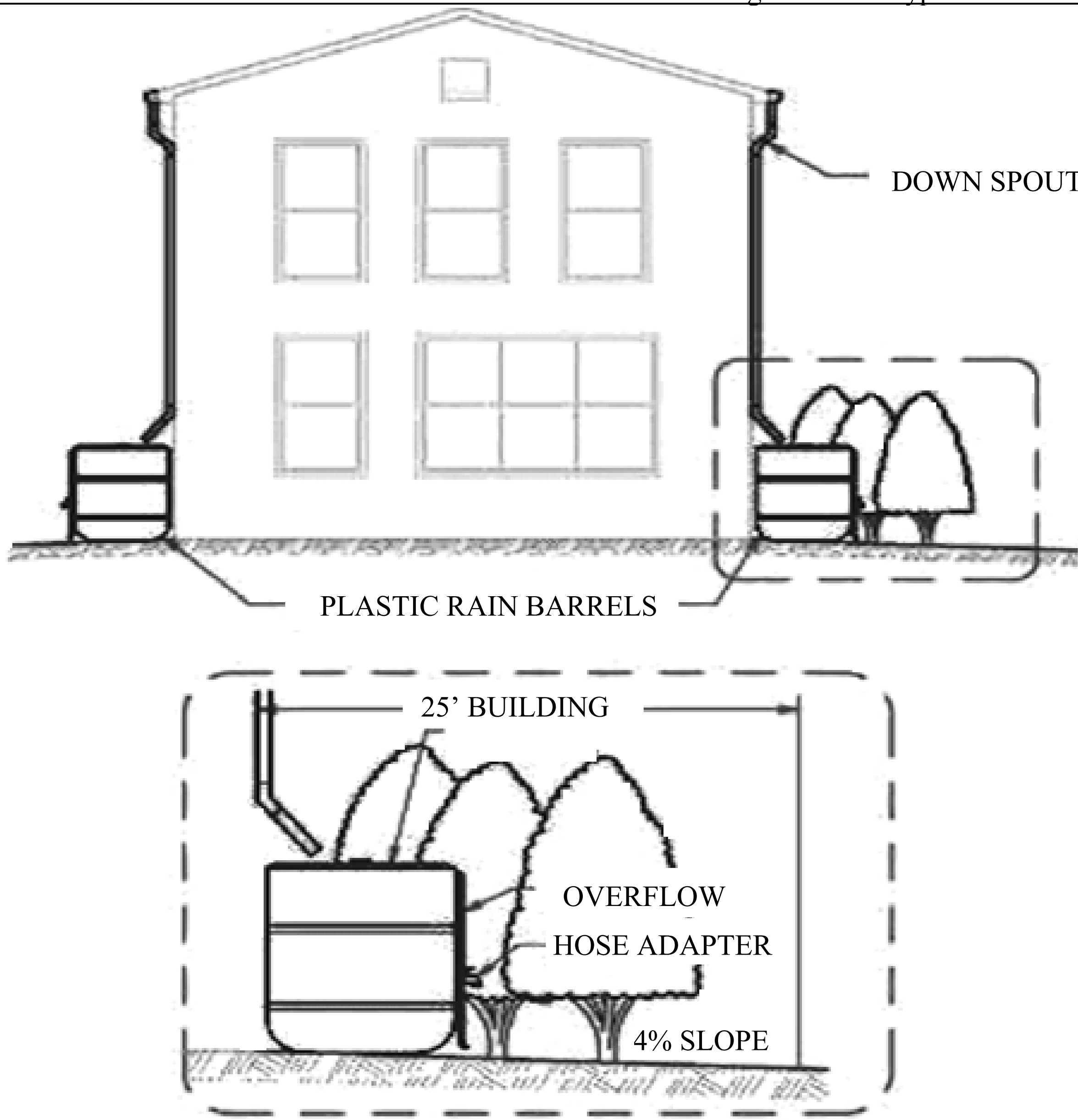


Figure 9.12 – TYPICAL RAIN BARREL

City of Houston

Design Manual

Chapter 10

STREET PAVING DESIGN REQUIREMENTS

Chapter 10
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Chapter 10

STREET PAVING DESIGN REQUIREMENTS

SECTION 1 – STREET PAVING DESIGN OVERVIEW

10.1.01 CHAPTER INCLUDES

10.1.01.A Geometric design guidelines for streets, criteria for street paving, and standard paving notes for drawings.

10.1.02 POLICY

10.1.02.A The design of streets within the City of Houston shall consider all users.

10.1.02.B Roadway designs shall require the use of context sensitive design principles such as those included in the ITE Recommended Practice: Designing Walkable Urban Thoroughfares: A context Sensitive Approach.

10.1.02.C The design requirements set in this chapter are not intended to be the only values used for design. Where applicable, design requirements should be exceeded to enhance safety and comfort for all road users.

10.1.02.D Project designs shall consider roadway context, including adjacent land uses, nearby destinations and infrastructure and existing or potential bicycle, pedestrian or transit use.

10.1.02.E Designers are encouraged to consider the cross sections provided in Appendix 2 of this chapter to support the roadway context of the project. Additionally, information regarding potential enhanced pedestrian environments and bicycle or transit facilities can be found in Chapter 17.

10.1.02.F Designers are encouraged to consider alternate cross sections and design standards to meet the context sensitive needs of their projects. If they find that their proposed design conflicts with portions of this manual, they should meet with the Office of the City Engineer to discuss applicability and what, if any, variances might be needed.

10.1.03 REFERENCES

10.1.03.A Access Management Manual, TRB, current edition

10.1.03.B City of Houston, Code of Ordinances, Chapter 40 – Streets and Sidewalks

10.1.03.C City of Houston, Code of Ordinances, Chapter 42 – Subdivisions, Developments and Platting

~~10.1.03.B~~10.1.03.D Houston Complete Streets and Transportation Plan (HCSTP)

~~10.1.03.C~~10.1.03.E Designing Walkable Urban Thoroughfares: A Context Sensitive Approach, ITE, current edition

~~10.1.03.D~~10.1.03.F A Policy on Geometric Design of Highways and Streets ("The Green Book"), AASHTO, current edition

~~10.1.03.E~~10.1.03.G Guide for the Development of Bicycle Facilities, AASHTO, current edition

~~10.1.03.F~~10.1.03.H Guide for the Design of Pavement Structures, AASHTO, current edition

~~10.1.03.G~~10.1.03.I Highway Capacity Manual (HCM), TRB, current edition

~~10.1.03.H~~10.1.03.J Highway Safety Manual, AASHTO, current edition

~~10.1.03.I~~10.1.03.K International Building Code (IBC), current edition

~~10.1.03.J~~10.1.03.L City of Houston, Houston Public Works Infrastructure Design Manual Chapter 1, General Requirements.

~~10.1.03.K~~10.1.03.M Roadside Design Guide, AASHTO, current edition

~~10.1.03.L~~10.1.03.N Scenic Houston Streetscape Resource Guide

~~10.1.03.M~~10.1.03.O Texas Manual on Uniform Traffic Control Devices (TMUTCD), TXDOT, current edition

~~10.1.03.N~~10.1.03.P Traffic Engineering Handbook, ITE, current edition

~~10.1.03.O~~10.1.03.Q Trip Generation, ITE, current edition

~~10.1.03.P~~10.1.03.R Urban Bikeway Design Guide, NACTO, current edition

~~10.1.03.Q~~10.1.03.S Urban Street Design Guide, NACTO, current edition

~~10.1.03.R~~10.1.03.T Signalized Intersection Information Guide. Report No. FHWA-HRT-04-091, FHWA

~~10.1.03.S~~10.1.03.U Roadway Design Manual, TxDOT, current edition

~~10.1.03.T~~10.1.03.V Roundabouts: An Informational Guide, National Cooperative Highway Research Program (NCHRP) Report 672, current addition

10.1.04 DEFINITIONS

10.1.04.A AASHTO - American Association of State Highway and Transportation Officials

10.1.04.B AC - asphaltic concrete.

~~10.1.04.B~~10.1.04.C Applicant - A person who owns real property abutting an alley and seeks to improve such alley for motorized vehicular traffic use either by the public or pursuant to private rights of access.

10.1.04.D ASTM - American Society for Testing and Materials

~~10.1.04.C~~10.1.04.E City Maintained Alley - A right-of-way dedicated to the public for an alley prior to January 1, 2023, that is open and available for vehicular use and travel by the general public and has been formally accepted for maintenance by the City of Houston (City).

~~10.1.04.D~~10.1.04.F CMP - The City Mobility Plan is joint initiative between Planning & Development Department and HPW to examine a range of land development and growth issues by evaluating multi-modal transportation network needs and adjacent land development in the city.

~~10.1.04.E~~10.1.04.G Complete Streets - Complete streets are streets that are designed using context sensitive design principles.

~~10.1.04.F~~10.1.04.H Context Sensitive Design - Context sensitive design takes into account all roadway users, their interactions with one another, and overall effect on the land uses and neighborhoods for which a corridor serves to move people in a safe, effective and predicable manner. Roadway users include people who are driving or riding in cars, using mass transit, riding bicycles, walking, using wheelchairs, driving or riding in trucks, driving or being transported by emergency vehicles, and being served at their residence or property by other users. Context sensitive design principles are flexible and sensitive to community values. Context sensitive design principles take the following variables in account:

1. People being served at their residence or property by other Right-of-Way users.

2. People of all ages and abilities, including children, older adults, and persons with disabilities.

10.1.04.H continued

3. The functional classification of the road (e.g. local, collector, and thoroughfare), the level of comfort for pedestrian and bicycle traffic, as well as vehicle volumes and speeds of the roadway.

4. Multi-Modal Classification Street Type - A public street type classification that takes into account the functional classification (MTFP designation) and land use context, inclusive of right-of-way width, number of lanes and traffic volume. The context of the land use adjacent to the road comprises population and job densities (present and future), projected land use types (residential, commercial community facility or industrial), and modes of operation (pedestrian, bicycle, transit, rail, freight and vehicle lanes) can be used as a determinant in identifying Multi-Modal Classifications.

   a. Complete Streets and Transportation Plan - A plan that, at a minimum, includes the Major Thoroughfare and Freeway Plan, Bikeway/Pedestrian Plan, Rail Plan, Multi-Modal Classification Street Type, Master Parking Plan, Bayou Greenway Initiative, Context Report and METRO's Transit Plan.

   b. Major Thoroughfare - Divided into two classifications; Principal Thoroughfare and Thoroughfare. Major Thoroughfares are those streets designed for fast, heavy truck traffic, high traffic volumes and are intended to serve as traffic arteries of considerable length and continuity throughout the community. For definitions of principal thoroughfare and thoroughfare, see the latest version of the City of Houston Major Thoroughfare and Freeway Plan (MTFP) Policy Statement.

   c. Collector Streets - Public streets that accumulate traffic from local streets for distribution to the Major Thoroughfare streets. A Collector Street may be a Minor Collector or a Major Collector. For definitions of Minor collector and Major collector, see the latest version of the City of Houston Major Thoroughfare and Freeway Plan (MTFP) Policy Statement.

   d. Transit Corridor Streets - Rights-of-way or easements that METRO has proposed as a route for a guided rapid transit or fixed guide way transit system and that is included on the City's MTFP.

~~10.1.04.G~~10.1.04.I Curb-and-gutter Sections - Full width concrete pavement with doweled on six inch curbs or monolithic curb-and-gutter sections for asphaltic concrete pavement. Curb-and-gutter sections require inlets and underground storm sewers.

~~10.1.04.H~~10.1.04.J Geotechnical Engineer - A licensed Professional Engineer in the State of Texas who is practicing in the field of geotechnical engineering.

~~10.1.04.I~~10.1.04.K Houston Complete Street and Transportation Plan- A plan that, at a minimum, includes the Major Thoroughfare and Freeway Plan, Bikeway/Pedestrian Plan, Rail Plan, Multi-Modal Classification Street Type and Master Parking Plan, Bayou Greenway Initiative, Context Report and METRO's Transit Plan.

~~10.1.04.J~~10.1.04.L Intersection Sight Distance - Provides an unobstructed line of sight in each direction at intersections. The unobstructed line of sight allows for vehicles on side streets to observe approaching traffic on the main roadway and to safely enter an intersection from a side street. The unobstructed line of sight allows for vehicles on the main roadway sufficient distance to observe vehicles entering from side streets.

~~10.1.04.K~~10.1.04.M ITE - Institute of Transportation Engineers

~~10.1.04.L~~10.1.04.N Local Streets - Provide access to individual single-family residential lots, multifamily or commercial developments, provide entry and exit to the neighborhood, and provide connectivity to collectors and thoroughfares.

~~10.1.04.M~~10.1.04.O MTFP - Major Thoroughfare and Freeway Plan

10.1.04.P NACTO - National Association of City Transportation Officials.

10.1.04.Q New Alley - A right-of-way dedicated to the public for an alley on January 1, 2023, or after.

10.1.04.R Privately Maintained Alley - A right-of-way dedicated to the public for an alley prior to January 1, 2023, and utilized for right of ingress and egress for property adjacent to and authorized for private access by reference to map or plat showing alleys abutting such real property, and that have not been accepted for maintenance by the City.

~~10.1.04.N~~10.1.04.S Roadside Ditch Sections - Ditch sections adjacent to either full width reinforced concrete pavement or asphaltic concrete pavement. Roadside ditch sections do not require underground storm sewers; however, the ditch sections must be designed to accommodate storm runoff.

~~10.1.04.O~~10.1.04.T Roadway Context - The roadway context includes adjacent land uses, traffic volumes, and multimodal components taken into consideration when determining roadway design features. Although each roadway will have a unique set of characteristics that define its specific context, five major categories of roadway context are defined: commercial, residential, mixed use, industrial and transit. Each category of roadway context has specific design features, standards, and cross sections that must be considered.

1. Commercial Street - The primary land uses adjacent to the street is commercial (with limited amounts of light industrial), and the Planning and Development Department has classified the roadway context as commercial.

2. Mixed-Use Street - The land use is a mix between commercial and residential (either single or multi-family), and the Planning and Development Department has classified the roadway context as mixed-use.

10.1.04.T continued

3. Residential Street - The primary land use is residential (typically single-family, potentially with some multi-family), and the Planning and Development Department has classified the roadway context as residential.

4. Industrial Street - The adjacent land uses are predominantly industrial with some commercial land uses, and the Planning and Development Department has classified the roadway context as industrial.

5. Transit Street - The typical adjacent land uses are those of a Mixed-Use Street with the addition of a fixed guideway or other high-capacity rapid transit system, and the Planning and Development Department has classified the roadway context as transit- related.

~~10.1.04.P~~10.1.04.U Soils

1. Cohesive Soils are those that have 50% or more (by weight) passing the No. 200 Sieve and Plasticity Index greater than seven.

2. Granular Soils are those that have 50% or more (by weight) retain on the No. 200 Sieve.

~~10.1.04.Q~~10.1.04.V TRB - Transportation Research Board

~~10.1.04.R~~10.1.04.W Type 1 Permanent Access Easement - A permanent access easement at least 50 feet in width that is designed and constructed like a public street in accordance with the design manual and contains one or more public utilities in an unpaved portion of the easement. Refer to Chapter 42 of the Code of Ordinances.

~~10.1.04.S~~10.1.04.X Type 2 Permanent Access Easement - A permanent access easement at least 28 feet in width that is designed and constructed like a private street serving a development that has no public utilities other than a public water line, connected to one or more fire hydrants, that provides no domestic water services. All private utilities within a Type 2 permanent access easement must be designed to public utility standards outlined in the Infrastructure Design Manual. Refer to Chapter 42 of the Code of Ordinances.

~~10.1.04.T~~10.1.04.Y Type A Street – A public street that intersects a transit corridor street and that abuts a blockface that is located within 1,320 feet walking distance of the end of an existing or proposed transit station platform.

SECTION 2 – PAVEMENT DESIGN REQUIREMENTS

10.2.01 ASPHALTIC CONCRETE PAVEMENT DESIGN REQUIREMENTS

10.2.01.A AC Surface Minimum Thickness - Pavement design shall be prepared by a Professional Engineer based on current AASHTO design methodology (Guide for the Design of Pavement Structure). Minimum thickness shall be as shown on City of Houston Standard Detail 02741-01.

10.2.01.B Base Course Minimum Thickness - Pavement design shall be prepared by a Professional Engineer based on current AASHTO design methodology (Guide for the Design of Pavement Structure). Minimum thickness shall be as shown on City of Houston Standard Detail 02741-01.

10.2.01.C Subgrade Treatment

1. Type, depth, and percentage of subgrade stabilization, stabilization design, and type of stabilization shall be determined by a geotechnical engineer.
2. For subgrade conditions of cohesive soils, subgrade treatment or stabilization shall be no less than eight inches.

10.2.02 CONCRETE PAVEMENT DESIGN REQUIREMENTS

The following requirements are applicable to pavement within City street rights-of-way.

10.2.02.A Minimum Pavement Thickness, Reinforcing, and Subgrade Stabilization Requirements:

1. Pavement thickness and reinforcement shall be designed by a Professional Engineer based on a current soil analysis, roadway use, traffic loadings, and minimum 50-year life span of proposed pavement. Pavement design shall be prepared by a Professional Engineer based on current AASHTO design methodology (Guide for the Design of Pavement Structure). However, in no event shall the pavement thickness be less than the minimums stated below.
2. For Residential Roadway Concrete Pavement:
   a. Minimum concrete slab thickness shall be six inches.
   b. Minimum concrete strength shall be f'c = 4,000 psi.
   c. Minimum reinforcing steel strength shall be fy = 60,000 psi.
   d. Refer to City of Houston Standard Detail 02751-01 for concrete reinforcement details.

10.2.02.A.2 continued

e. Minimum stabilized subgrade thickness shall be six inches for granular soils and eight inches for cohesive soils.

f. The type and depth of subgrade shall be as determined by a geotechnical engineer.

3. Collector Roadway with Concrete Pavement

a. Minimum concrete slab thickness shall be nine inches.

b. Minimum concrete strength shall be f'c = 4,000 psi.

c. Minimum reinforcing steel strength shall be fy = 60,000 psi.

d. Refer to City of Houston Standard Detail 02751-01 for concrete reinforcement details.

e. Minimum stabilized subgrade thickness shall be six inches for granular soils and eight inches for cohesive soils.

f. The type and depth of subgrade shall be as determined by a geotechnical engineer.

4. For Major Thoroughfares Constructed with Concrete Pavement

a. Minimum concrete slab thickness shall be 11-inches.

b. Minimum concrete strength shall be f'c = 4,000 psi.

c. Minimum reinforcing steel strength shall be fy = 60,000 psi.

d. Refer to City of Houston Standard Detail 02751-01 for concrete reinforcement details.

e. Minimum stabilized subgrade thickness shall be eight inches.

f. The type and depth of subgrade shall be as determined by a geotechnical engineer.

5. Paving headers shall be placed at the end of all concrete pavements.

10.2.02.B Curb Requirements

1. Six inch Vertical Curb:

a. Six inch vertical curb is the standard curb design and shall be in accordance with City Standard Details.

10.2.02.B.1 continued

b. Collector streets and higher volume residential streets where traffic calming measures are in place require construction of six inch vertical curb.

2. Laydown Curb

   a. Is only allowed as an option for street projects on single family residential streets within the City.

   b. Laydown curb shall be in accordance with City Standard Details.

   c. Shall be four inches in height.

   d. Laydown curb shall not be permitted if sidewalk is to be constructed immediately adjacent to the curb.

   e. Laydown curb construction shall provide for necessary transition lengths at curb inlets to go from laydown curb to standard vertical curb section.

   f. Transition from standard six inch to four inch vertical curb shall be extended a minimum of 10feet beyond curb inlets before beginning transitions.

SECTION 3 - GEOMETRIC DESIGN REQUIREMENTS

10.3.01 OVERARCHING CONSIDERATIONS

10.3.01.A Roadway Classifications

1. Major Thoroughfare
2. Collector
3. Transit Corridor
4. Local Street Classifications (not applicable in the ETJ)
   a. Residential Standard Density - Provides access to individual lots equal to or greater than 40-feet in width.
   b. Residential High Density - Provides access to individual lots less than 40-feet in width.
   c. Residential Main - Serves multiple streets and can be described as the "neighborhood feeder / collector."
   d. A summary of the design characteristics for the three local street classifications above is included in Table 10.1. Traffic volumes shown in column "Traffic ADT" are provided as general guidelines. These guidelines are provided to assist in the selection of context-sensitive street cross sections.

Table 10.1 - LOCAL STREET CLASSIFICATION FOR CURB AND GUTTERED STREETS

STREET CLASSIFICATION	GROSS DENSITY DU/AC (4)	TRAFFIC ADT (1)	MIN. PAVEMENT WIDTH (FEET)
Residential Standard Density (2)	0-6	250 - 350	26
Residential High Density (3)	6-27	350 - 1,500	32
Residential Main	0-27	≥ 1,500	36

Notes:
1. ADT - average daily traffic.
2. Lot widths equal to or greater than 40-feet.
3. Lot widths less than 40-feet.
4. DU/AC - dwelling units (DU) per acre.

10.3.01.B Design Considerations

Critical design criteria shall be determined from performing a Traffic ~~Engineering~~ and Design Study (See 15.~~05~~2.02).

1. Context factors that may influence roadway design include, but are not limited to:

   a. Number of dwelling units per acre (density).

   b. Location of services within or near the neighborhood.

   c. Pedestrian and bicycle facilities within the neighborhood.

   d. Connectivity to the collector and thoroughfare network.

   e. Connectivity to pedestrian, bicycle, and transit networks.

   f. Traffic volume guidelines (ADT) are based on full development density.

   g. Level of Comfort for bicyclists and pedestrians, as defined in Chapter 17.

   h. Transit stations and bus stops, destinations, ridership and appropriate facility design for high comfort boarding and alighting, transitions and access to platforms.

2. Design Speed

   a. For purposes of design, design and target speed shall be synonymous.

   b. The design speed shall be set by City Ordinances regulating speed limits.

   c. The minimum design speed for a roadway shall be 30-mph.

3. Vehicles

   The geometric design of a roadway is dependent on the physical characteristics of the various anticipated vehicles using that roadway. To ensure economy and safety, two sub-classifications of vehicles are established.

   a. Design Vehicle

      (1) A vehicle that must be regularly accommodated and is expected to traverse an intersection under normal conditions without encroachment into opposing traffic lanes.

10.3.01.B.3 continued

b. Control Vehicle

(1) A vehicle that infrequently must be accommodated, and is expected to traverse an intersection, but encroachment into opposing traffic lanes, multiple-point turns, or minor encroachment into the street side is acceptable.

c. The vehicles selected for the design of roadway intersections are provided in Table 10.2.

Table 10.2 - VEHICLE REQUIREMENTS

STREET TYPE	DESIGN VEHICLE	CONTROL VEHICLE
Local	P	DL23[1]
Collector	DL23	BUS40
Major Thoroughfare	BUS40	WB40
Major Thoroughfare (Truck) [2]	WB40	WB62

Notes:
1. Local streets along designated transit routes shall use a minimum control vehicle of BUS40 in street design elements that impact the transit route.
2. Major Thoroughfares that have daily truck volumes exceeding 5% of ADT. Truck design/control vehicles shall only apply at intersections where both street truck volumes exceed 5% of ADT.

4. Objects in Right-of-Way

a. Utilities (especially those above ground), trees, and other fixed objects shall not be placed within the sidewalk or otherwise interfere with pedestrian movements or access to transit stops. Sidewalks may be gently shifted to avoid existing fixed objects that cannot be moved or to enable the installation of new fixed objects when the shifting of said object is restricted; however, the designs of the sidewalk and the overall pedestrian realm must still satisfy all design requirements.

b. Utility pole locations within right-of-way: See Chapter 6.

10.3.02 INTERSECTION DESIGN

10.3.02.A Curb Radii

1. Cul-de-Sac Curb Radii

a. For approved cul-de-sac curb radii, refer to Figure 10.10.

b. Curb radii around cul-de-sacs shall be 48-feet for single family areas.

c. Curb radii around cul-de-sacs shall be 50-feet for cul-de-sacs in areas other than single family areas.

2. Street Intersection Curb Radii

10.3.02.A.2 continued

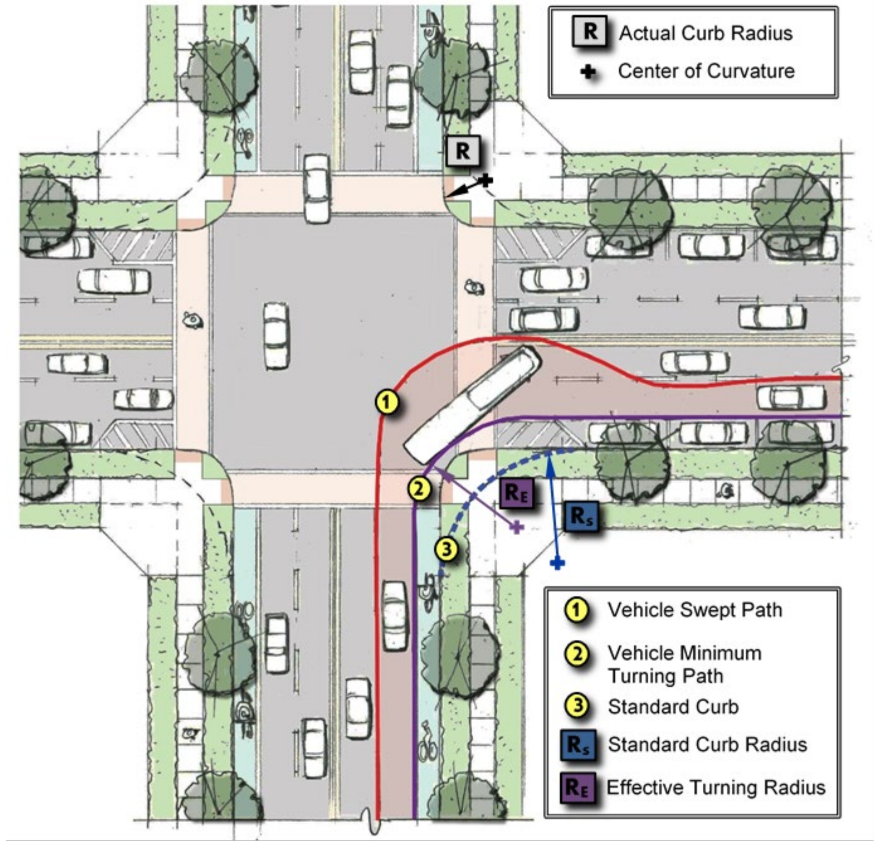


Figure 10.1 - CURB RADII

Smaller curb radii shorten the distance that pedestrians must cross at intersections. The occasional turn made by large trucks can be accommodated with slower speeds and some encroachment into the opposing traffic lanes. The existence of parking and bicycle lanes creates an "effective" turning radius that is greater than the curb-return radius Source: 10.1.03.E. NOTE: BUS40 used as control vehicle for this drawing.

10.3.02.A.2 continued

a. The curb radius is the radius of curvature, measured from the center of curvature, of a physical curb-return at the corner of a street intersection. The selection of appropriate curb radii shall consider the needs of all roadway and pedestrian traffic.

b. For standard curb radii, refer to Table 10.3.

Table 10.3 - INTERSECTION STANDARD CURB RADII

INTERSECTION TYPE	STANDARD CURB RADIUS (R_S) BY INTERSECTION ANGLE	
	90˚	80˚ - 90 ˚
Local / Local	15 ft	15 ft
Local / Collector	20 ft	20 ft
Local / Major Thoroughfare	20 ft	20 ft
Collector / Collector	25 ft	25 ft
Collector / Major Thoroughfare	25 ft	25 ft
Major Thoroughfare / Major Thoroughfare	30 ft	35 ft
Truck / Truck	45 ft	50 ft

Notes:

1. Curb radii have been selected based on the swept paths of design and control vehicles.
2. Truck/Truck radii should only be considered at intersections of streets that each have daily truck volumes exceeding 5% of ADT.
3. Other intersections experiencing heavy truck volumes shall utilize appropriate design vehicles and turning templates for curb radius design.
4. Intersections along designated transit routes shall use a minimum control vehicle of BUS40 for corners along the path of the transit route.
5. Intersecting angles smaller than 80-degrees shall require detailed engineering analysis and approval by HPW.

c. The design of curb radii is a critical component of intersection design. A curb radius that is too small for the design vehicle can be damaged and become a long-term maintenance liability. A curb radius that is too large encourages dangerous speeds, reduces pedestrian refuge areas, and increases pedestrian crossing distances as shown in Figure 10.1. In general, the smallest feasible curb radius should be chosen.

d. Curb radii may vary from Table 10.3 with adequate engineering justification, to be approved by Transportation & Drainage Operations (TDO). Justification shall include consideration of traffic counts or projection, pedestrian activity, vehicle classifications, turning template analysis, and any other documentation requested. Refer to "ITE. Designing Walkable Urban Thoroughfares: A Context Sensitive Approach" (10.1.03.E) for additional guidance on the use of smaller curb radii to encourage safe roadway operations and a pedestrian-friendly environment.

10.3.02.A.2 continued

e. Street intersection curb radii shall be designed to facilitate turning and tracking requirements of the selected design vehicle anticipated to use the facility (i.e. P, DL-23, WB-40, etc.) (10.1.03.T) The curb radii design should allow for frequently turning vehicles to remain in their lane. Larger control vehicles that make the turn less frequently may have the option of encroaching into the adjacent lane to complete their turn (10.1.03.P). A one-foot buffer distance between the face of curb and the swept path of the vehicle should be retained for all turning vehicles. The selected radius of curvature for curb radii is to be rounded up to the nearest five feet.

f. The effective turning radius (R_E), as shown in Figure 10.1 is the radius of curvature of the minimum turning path of a turning vehicle when additional curb offset is provided by a parking lane, bicycle lane, or shoulder. The use of an effective radius is encouraged whenever appropriate. Use of an effective radius will not require a variance, but it will require an engineering analysis to justify adequacy.

10.3.02.B Right-of-Way Corner Cut-Backs

1. For approved right-of-way (ROW) corner cut-back dimensions, refer to Figure 10.2 and Table 10.4.

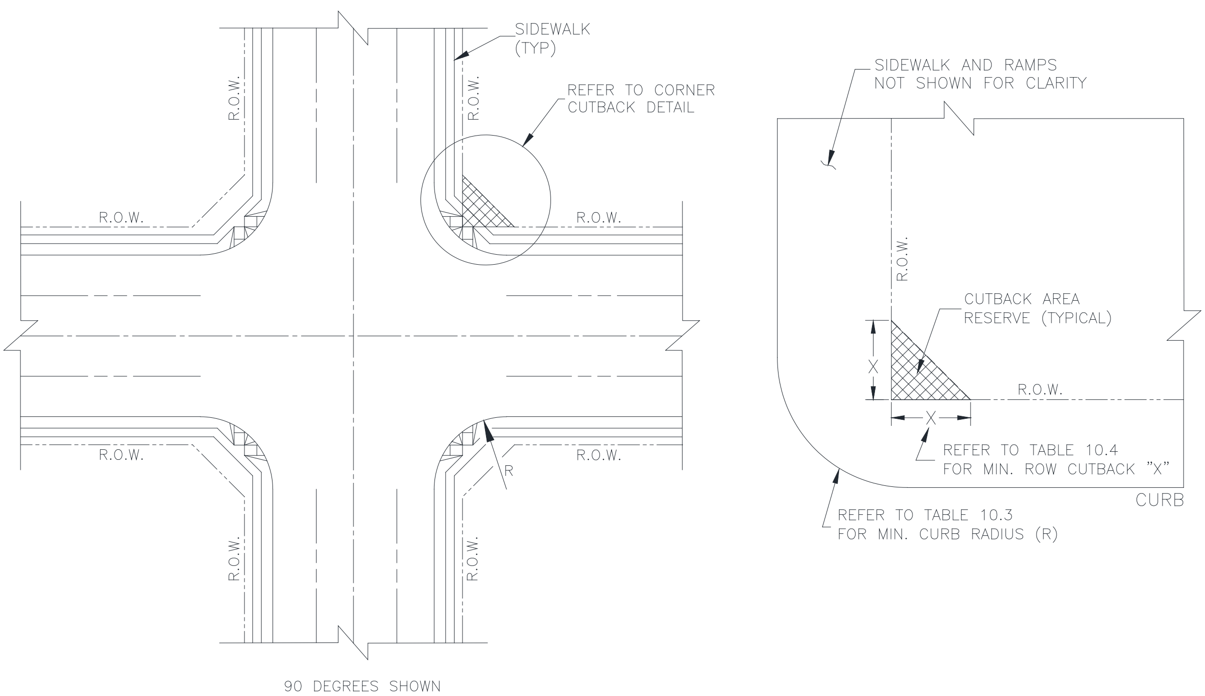


Figure 10.2 - ROW CORNER CUTBACK

10.3.02.B continued

Table 10.4 - ROW CUTBACK REQUIREMENTS

CURB RADIUS (R) (feet)	MINIMUM R.O.W. CUTBACK "X" (feet)
25 or Less	15 x 15
30	20 x 20
35	25 x 25
40	30 x 30
45 or More	35 x 35

2. Right-of-way shall be dedicated for corner cut-backs on major thoroughfares, transit corridor streets, collectors and local streets as a requirement for subdivision platting of adjacent properties under Chapter 42 of the City of Houston Code of Ordinances.
3. Corner cut-backs of right-of-way at street intersections are necessary to provide sufficient public space for intersection visibility, pedestrian sidewalk facilities and ramps, traffic control devices, street signs, street lighting, traffic signal equipment, and all encroachments which could prevent the future installation of such equipment within the cut-back area.
4. When right-of-way corner cut-backs are not feasible, visibility easements will be required. Visibility easements shall conform with Section 10.3.02.C Intersection Sight Distance.
5. In cases where the public ROW behind the curb is sufficient, corner cut-backs may not be needed to provide the required levels of visibility. The Engineer of Record (EOR) shall provide a sight triangle analysis to justify the lack of any corner cut-backs.
6. For intersections with Type 1 Permanent Access Easements, visibility easements shall be provided.

10.3.02.C Intersection Sight Distance

1. Dedicated right-of-way or easements are required to meet the intersection sight distance triangle requirements.
2. Design Basis
   a. Design Vehicle - Passenger Car
   b. Design Standard – AASHTO "A Policy on Geometric Design of Highway and Streets".
   c. Lane Widths - See 10.3.03.C for requirements.

10.3.02.C.2 continued

d. Vertical obstructions and elevations must be considered for all users of the corridor including pedestrians and bicyclists.

e. Sight Distance - Is measured to the center of the outside lane on main roadway approaching from the left and to the center of the inside lane of traffic on the main roadway approaching from the right.

f. The intersection of local streets serving residential properties only, meeting at an angle of 85 degrees or more. Within 250-feet of the intersection, each of the uncontrolled approaches to the intersection of two local residential streets will have:

(1) land uses adjacent to the street that are exclusively single-family residential lots (or unoccupied reserves of limited size, such as landscape reserves, drainage reserves or utility reserves).

(2) Residential lots with driveway access to the uncontrolled approach street.

(3) A posted (or prima facie) speed limit of 30 mph or less.

3. Design Procedures

a. Determine design speed of main roadway based on Section 10.3.01.B.2 of this chapter.

b. Develop a scaled drawing depicting the sight triangle based on the design criteria. For the appropriate design speed, determine the minimum sight distance from Table 1 on Figure 10.6.

4. Exceptions

a. Replats and partial replats at the intersections of a local/local street, local/major collector street, and major collector/major collector street are exempt from providing intersection sight distance rights-of-way or easements where existing site conditions for abutting properties preclude compliance.

b. Variances or deviations to these guidelines will be considered on a site-by-site basis. An engineering analysis should be prepared to support the proposed sight triangle dimensions, based on criteria in the AASHTO "Green Book", latest edition (10.1.03.F). Where the uncontrolled street is existing, design speeds should be based on an analysis of the 85th percentile operating speed.

10.3.02.D Left Turn Lanes

1. Left Turn Lanes are Required:

10.3.02.D.1 continued

a. At all signalized intersection approaches.

b. At all median openings.

c. Overlaps between opposing and adjacent left turn tracking paths should be checked and shown in the intersection review design submittal.

2. Left Turn Lane Design Standards:

   a. Refer to Figure 10.8 for left turn bay geometrics.

   b. The volume of left turn movements shall be based on traffic studies approved by the City Engineer.

   c. At median openings; openings may be directional but whenever possible, left turn lanes should be provided for both directions.

3. Dual Left Turn Lanes

   a. Dual left turn lanes present challenges to people walking across the intersection. Other options for traffic mitigation should be assessed first.
   b. Where other options are not feasible, dual left turn bays may be considered when left turn movement exceeds 300 vehicles for the peak hour, or when traffic analysis of the intersection indicates existing or projected left turn storage space requires dual left turn lanes before the volume threshold is reached.

   c. Where dual left turn lanes are required, right of way for the intersection shall be based on the width required for dual left turns, through lanes, a right turn lane, and minimum landscape/pedestrian zone (dimension S) as shown in Figure 10.4.

4. Special conditions or other constraints may require design criteria other than shown herein.

   a. Exceptions to the requirements must be demonstrated by submittal of a traffic study encompassing AASHTO criteria.

   b. Approval by City Engineer is required for all variances to standard.

10.3.02.E Roadway Offset Through Intersection

1. An intersection shall not be designed such that any through lane is offset more than three feet from the corresponding receiving lane.

2. The addition of auxiliary left- and right- turn lanes shall conform with this requirement.

10.3.02.F Roundabout Intersections

1. Roundabout Planning

   a. Roundabouts shall be considered for all new or reconstructed intersections, especially signalized intersections and all-way stop intersections.

   b. Lane configuration for all approaches shall be based on an approved capacity analysis. The number of lanes may vary by approach.

   c. The analysis shall include considerations for existing traffic and for a 20-year horizon. Lane configurations should result in an overall LOS D or better for existing conditions.

   d. If the 20-year horizon requires a different lane configuration to maintain LOS D or better, the design should include phasing considerations for future modifications to implement those changes when warranted. Constructing a roundabout with more capacity than is currently needed can decrease the safety of the intersection and is discouraged.

   e. The design vehicles shall be consistent with the design vehicle on the approach roadways.

   f. For additional design guidance, refer to reference 10.1.03.V.

2. Roundabout Design

Table 10.5 - ROUNDABOUT DESIGN PARAMETERS

PARAMETERS	SINGLE LANE	MULTI LANE
Typical Capacity (all approaches)	< 20,000	< 40,000
Maximum Number of Entering Lanes	1	2
Maximum Entry Speed	20 mph	25 mph
Typical Inscribed Circle Diameter (feet)	90 to 150	150 to 180
Typical Entry Width (feet)	16 to 20	28 to 32
Typical Entry Radius (feet)	50 to 90	60 to 120
Typical Exit Radius (feet)	50 to 800	200 to 1000
Typical Circulatory Roadway Width (feet)	16 to 20	28 to 32
Minimum Splitter Island Length (feet)	50	50

   a. Design drawings for roundabouts shall include roundabout-specific signage and pavement marking sheets that include the roundabout central island centered on one sheet.

10.3.02.F.2 continued

b. Roundabout geometry shall be based on an analysis of fastest path for all through movements, left-turn movements, and right-turn movements. Fastest path speeds shall be analyzed and approved during preliminary design.

c. No roundabout will be approved for more than two entry lanes (not including right-turn lanes).

d. Physical splitter islands shall be utilized for all approaches.

e. Multilane roundabout shall be designed to minimize path overlap of adjacent entering vehicles.

f. No direct driveway access should be allowed to the roundabout.

g. Appropriate street lighting shall be provided to illuminate all conflict areas, especially entry conflicts and pedestrian conflicts.

h. The central island shall include a concrete curb and, where necessary, a truck apron. The central island shall include a minimum three feet sod mow strip.

i. Conduit for electrical wiring shall be installed to the central island even if no illumination or electrical features are currently planned.

j. All landscaping shall be designed to minimize roadside hazards and maintain required stopping and intersection sight distance throughout the roundabout.

k. The conflicting leg sight triangle decision point is located 50-feet from the yield line. Safe stopping sight distances for the approach shall be evaluated from both the yield line and marked crosswalk.

3. Pedestrian/Bicycle Considerations

a. The crossing of pedestrians/bicycles and location of bus stops at roundabouts shall be carefully considered.

b. Splitter islands shall include a pedestrian cut through with a minimum width of 10-feet and minimum length (between roadways) of six feet. The cut through shall be fully ADA compliant.

c. Raised crosswalks may be used to further improve pedestrian safety and ensure roundabout-compatible vehicular speeds.

d. Roundabout design shall not permit pedestrians to access the central island.

10.3.02.F.3 continued

e. Existing and proposed bicycle facilities shall be fully incorporated into the roundabout design. Bicycles should be brought up to the pedestrian grade, preferably in a dedicated space that is not shared with pedestrians.

f. Sidewalks shall be installed around the roundabout to maximize the buffer between the sidewalk and the edge of pavement, especially at the corners, where run-off-the-road crashes are most likely.

g. Design standards for Roundabouts are shown in Table 10.5.

10.3.03 CORRIDOR DESIGN

Table 10.6 - ROADWAY GEOMETRIC DESIGN CRITERIA

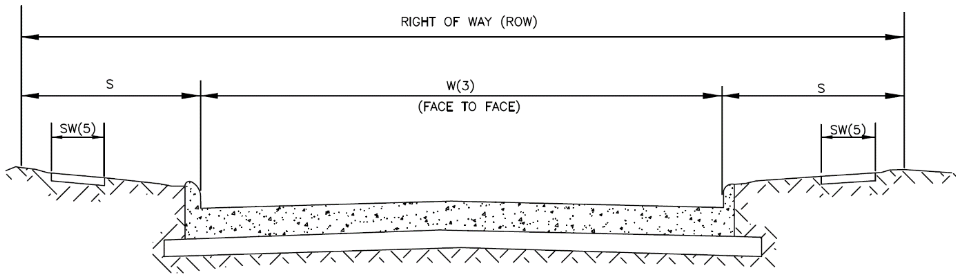
ITEM	DESIRABLE	MINIMUM
Width of Travel Lanes (feet)	10-11[4]	10[4]
Width of Turn Lanes (feet)	10-11[4]	10[4]
Horizontal Curve Radii (feet)	Varies	500
Median Width at turn lanes (feet)	17[1]	15
Median Width face of the curb to the face of curb outside the turn lanes (feet)	6-10[5]	4
Center Turn Lane Width (feet)	10	10
Non-Dedicated Bike Lane (feet)	See Chapter 17 for information	
Standard Bike Lane Width (feet)		
Pedestrian Realm Width (feet)		
Total Buffer to Sidewalk with Tree Well (feet)		
Total Buffer to Sidewalk w/o Tree Well (feet)		
Sidewalk Width (feet)		
Transit Sidewalk Width By Transit Corridor Ordinance (feet)		
Sidewalk adjacent to curb (feet)		
Shared use path/trail (feet)		
Shared use path/trail easement (feet)		

Notes:

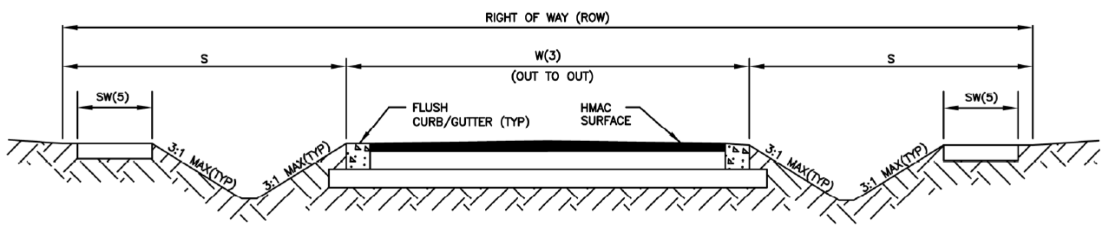
1. Median widths that exceed 17-feet require approval of Transportation and Drainage Operations (TDO). Engineer of Record shall notify TDO of any median widths that exceed 17-feet prior to preliminary design.
2. Curve design radii shall be based on the design speed of the roadway and any super- elevation that may be considered for the design. Where bicycle facility is present, curve radii should provide for highest visibility of a person on a bike by motor vehicle users.
3. For sidewalk design guidance, refer to Chapter 17~~.06~~, Section 3: Pedestrian ~~Design~~ Elements Requirements.
4. See paragraph 10.3.03.C for lane width requirements.
5. See Chapter 17 for more information.

10.3.03.A Roadway Cross Sections

1. The City of Houston utilizes the basic roadway cross sections shown in Figure 10.3, Figure 10.4, and Standard detail 02751-01. With the growing emphasis on Context Sensitive Design, roadway cross section variations are encouraged and will be considered by the Office of the City Engineer.



(a) - Raised Curb and Gutter



(b) - Flush Curb/Gutter with Ditch

Figure 10.3 - UNDIVIDED STREET TYPICAL CROSS SECTION

Table 10.7 - UNDIVIDED STREET DIMENSIONS

	LOCAL STREET SINGLE FAMILY RESIDENTIAL (SFR)					THOROUGHFARE/ COLLECTOR STREET		
	STANDARD DENSITY LOT		HIGH DENSITY LOT		RESIDENTIAL MAIN			
ADT	250 - 350		350 - 1,500		≥1,500	≥5,000		
ROW	50	60	55	60	60	60	70	80
W[3]	26	26	32	36	36	-[1]		
S	12	17	11.5	12	12	≥10	≥13	≥18
# OF LANES	-	-	-	-	-	2-4[2]		

Notes:

1. Roadway width for thoroughfare and collector streets is based on the overall lane configuration and approved lane widths.
2. Number of lanes to be determined through Traffic ~~Engineering~~ and Design Stud~~y~~ies (See 15.~~05~~2.02). Any design or redesign of a major thoroughfare, collector, or any other classified street shall require a Traffic ~~Engineering~~ and Design Study (see 15.~~05~~2.02) or other approved traffic study to be reviewed and approved by TDO prior to design begins.
3. Width (W) does not include width for bicycle lanes. Refer to Appendix 2 for minimum requirements. Requires approval of the City Engineer. Width includes on street parallel parking where approved by City Engineer.
4. Requests for alternative street cross section shall be submitted to City Engineer for review.

10.3.03.A.1 continued

For sidewalk design guidance, refer to ~~Section~~ Chapter 17~~.06~~, Section 3: Pedestrian ~~Design~~ Elements Requirements.

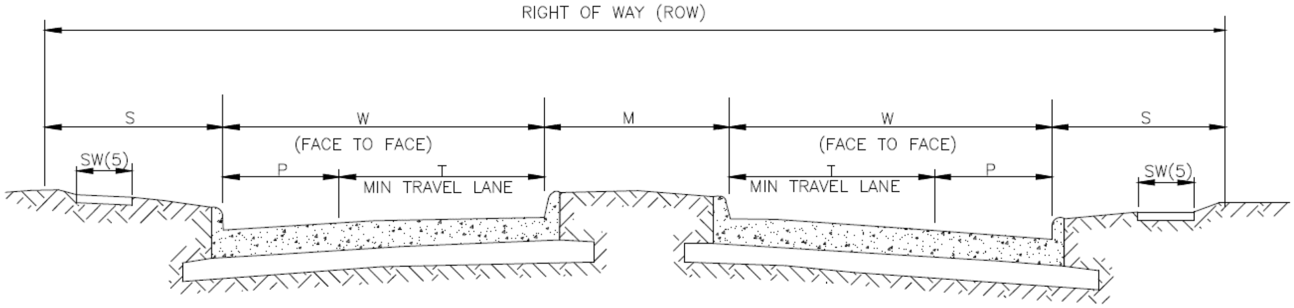


Figure 10.4 - DIVIDED STREET TYPICAL CROSS SECTION

Table 10.8 - DIVIDED STREET DIMENSIONS (FEET)

LOCAL STREET SINGLE FAMILY RESIDENTIAL (SFR)			THOROUGHFARE/COLLECTOR STREET		
	RESIDENTIAL MAIN				
	STD SW	CENTER SW			
ADT	≥1,500	≥1,500	5,000+		
ROW	70	80	80	90	100
W	20	20	-[1]		
M	8	16	17	17	17
S	11	12	≥10	≥12	≥15
T	11	11	-[1]		
P	9	9	-[2]		
# OF LANES	-	-	4	4	4

Notes:

1. Any design or redesign of a major thoroughfare, collector, or any other classified street shall require a Traffic ~~Engineering~~ and Design Study (see 15.~~05~~2.02) or other approved traffic study to be reviewed and approved by TDO prior to design begins. This study shall determine the roadway width and travel way for the road.
2. Parking is generally not permitted along thoroughfares.
3. Any right-of-way dimensions different from those shown shall require special geometric design as determined by City Engineer.
4. Refer to Appendix 2 for optional designs to serve special mobility needs, pedestrian needs, bicycle lanes, or other requirements. Approval by City Engineer required.
5. For sidewalk design guidance, refer to ~~Section~~ Chapter 17~~.06~~, Section 3: Pedestrian ~~Design~~ Elements Requirements.

10.3.03.B Walking, Bicycling, and Transit Considerations

1. Transit Shelters

   a. Engineers shall coordinate with METRO or other Transit groups in regard to placement and design of Bus or other Transit Shelters when designing or rebuilding roadways for the placement of pads and other appurtenances. No bus stops, pads or shelters shall be removed from the ROW without METRO's approval. See this chapter for more information regarding transit and see Chapter 17 for more information regarding pedestrian and bicycle facilities.

2. Pedestrian Realm (Sidewalks, Accessibility Ramps, and Bus Pads)

   a. See Chapter 17 for pedestrian realm design requirements.

   b. Approved sidewalk/ramp details are shown in the City's Standard Details. Use of these details are specific to certain field conditions such as ramp direction, driveway crossings, crosswalk locations and the location of the sidewalk with respect to the curb.

   c. When right-of-way contains a Bus Stop, the engineer will contact METRO at busstops@ridemetro.org to determine the appropriate bus stop type.

      (1) Each bus stop area will be composed of three elements per Figure 10.14:

         i. Bus Pad (one): 17-feet (typical) by eight feet (minimum) (all slopes maximum 2%)
         ii. Bus Landing Area (two): Five feet by eight feet (minimum) (front door landing), and seven feet (recommended) by eight feet (minimum) (back door landing) (all slopes maximum 2%)
         iii. Transitions (two): Five feet (minimum) by eight feet aligning with the landing and tapering to the sidewalk width (maximum longitudinal slope of 5%)

      (2) As additional right-of-way is available beyond the minimum nine feet S-dimension:

         i. Pad will shift back, maintaining a one-foot distance to the edge of right-of-way.
         ii. Landings may extend in width from the curb to one foot from the right-of- way. The width will be extended in order to always maintain an ADA and TAS accessible route between the pad and landing.
         iii. Engineer will use their judgement to specify the proposed surface of the remaining portion between the pad and curb (ex. paving, grass, etc.).

10.3.03.B.2.c continued

(3) Context factors that may influence the design of Standard Bus Pad and Landings.

i. Distance from the curb to the right-of-way (or bus pad easement) is less than nine feet.
ii. Location of bus pad longitudinally along the roadway will need to account for the Critical Shelter Obstruction (as identified in City of Houston Figure 10.14) when verifying safe Intersection Sight Distances (as prescribed by per City of Houston Figure 10.6). If the stop location needs to change due to sight distance requirements, the engineer will contact METRO at busstops@ridemetro.org for coordination and approval.

(4) Where use of standard bus pad and landings details is not possible due to field conditions (ex. driveways, trees, etc.), engineer shall contact METRO at busstops@ridemetro.org for proposed variations and approval.

10.3.03.C Lane Widths

Local street travel way width is dictated by the required cross section width provided in tables 10.7 & 10.8. Lane width standards apply to lanes on major thoroughfares and collectors that are designated by pavement markings, are intended primarily for through movements, and can only accommodate one use at a time (e.g. movement or parking). For more information, refer to paragraph 10.3.03.A Roadway Cross Sections.

1. Inside Interstate 610

   a. The standard lane width on a City street is 10-feet.

   b. On thoroughfares with heavy truck traffic documented (daily truck volumes exceeding 5% of ADT), the use of an 11-foot outside lane may be used based on engineering judgement.

   c. On thoroughfares with transit agency designated bus routes, the outside lane may be 11-feet.

2. Outside Interstate 610

   a. The minimum lane width on a City street is 10-feet. The maximum lane width is 11-feet.

   b. The lane width shall be determined based on engineering judgment. The engineer of record shall make a recommendation for the lane width by considering the following:

      (1) Truck traffic

10.3.03.C.2.b continued

(2) Transit agency designated bus routes

(3) Pedestrian/bicycle activity

(4) Design Speed

(5) Roadway capacity

c. On thoroughfares with heavy truck traffic documented (daily truck volumes exceeding 5% of ADT), the use of an 11-foot outside lane may be used based on engineering judgement.

d. On thoroughfares with transit agency designated bus routes, the outside lane width may be 11-feet.

3. Lane widths other than what is specified above, shall require a variance signed by both the City Engineer and the City Traffic Engineer, unless otherwise specified within this chapter.

10.3.03.D Curve Radii

1. (1) Curve radii design shall be based on the design speed of the roadway and any super-elevation that may be considered for the design.

   (2) Minimum curve radii for collectors/major thoroughfares is 500-feet.

   (3) Minimum curve radii for local streets and minor collectors is 300-feet.

2. Reverse curves for roadways should have a minimum 100-feet tangent between curves excluding turn lane transitions.

3. Maximum super elevation rate will be 4%.

4. Reverse super elevations shall not be allowed on any city roadways.

10.3.03.E Median Design

Median design should accommodate bicycle and pedestrian movements across a street where the need has been established. Midblock crossing standards for bicycle and pedestrian access are defined in Chapter 17.

1. Minimum Median Width

   a. For local streets, refer to Figure 10.4.

   b. Paved medians shall be at least four feet (face to face) in width.

   c. The desired width of reverse median is six feet (face to face).

10.3.03.E continued

2. Minimum Median Length

   a. Median lengths are based on functional street classification of the main roadway and intersecting street. Median Openings should only be installed where the need for an opening exists. Before a median opening is closed, the need to continue pedestrian and bicycle movements across the corridor shall be evaluated per Chapter 17 guidance.

   b. Refer to Figure 10.7 for minimum median length requirements.

3. Median Geometry - Refer to Figure 10.8.

4. Street Taper Geometry - Refer to Figure 10.9 for subdivision street taper geometrics.

10.3.03.F Vertical Geometric Requirements

1. For Pavement Sections:

   a. Minimum grade line shall be 0.30 percent.

   b. Minimum grade line shall be 1.00 percent for radii of 35-feet or less around intersection turnouts. Grades for larger radii shall be determined on an individual basis.

   c. Super elevation - Major thoroughfares shall be super elevated in accordance with AASHTO requirements.

   d. Vertical Curves

      (1) Shall be installed when the algebraic difference in grades exceeds 1.00 percent.

      (2) Elevations shall be shown at 10-foot intervals through vertical curves.

      (3) Maintain a minimum of 0.03 foot elevation change at 10-foot intervals by altering calculated elevations.

      (4) Determine minimum vertical curve lengths based on AASHTO design criteria (minimum shall not be less than 3 times design speed).

   e. Minimum grade line around a cul-de-sac shall be 0.70 percent.

   f. Pavement Cross Slopes:

      (1) Cross slopes for pavement shall be a minimum of 1/4-inch per foot.

10.3.03.F.1.f continued

(2) Cross slopes for left-turn lanes and esplanade openings shall be 1/8-inch per foot minimum.

2. Railroad Crossings

a. Maximum Tangent Grade to Vertical Curves at Railroad Crossings:

(1) 8.0 percent for local streets

(2) 3.5 percent for major thoroughfares

b. Roadway grades at railroad crossings shall be zero percent from centerline of the track to 10-feet either side of the track's centerline, and should not cause a drop of more than six inches from the top-of-rail elevation at a distance of 30-feet either side of the track's centerline.

c. For concrete roadways, the roadway shall terminate at a railroad header, six feet from the centerline of the track and the roadway cross slope shall be zero from the railroad header to four feet before the railroad header.

d. Railroad crossings are shown in Figure 10.13.

e. All roadway crossings of a railroad shall include a minimum six feet pedestrian walkway. See Figure 10.13.

f. At railroad track approaches, decrease curbs from 6-inches to zero inches in two feet, at a distance of ten feet from the nearest track centerline.

g. All roadway crossings of a railroad that involve bicycle facilities shall include appropriate crossing angles and signage for bicyclists as defined in Chapter 17.

10.3.03.G Alleys

1. ~~Definitions~~General

a. Existing Alleys:

(1) ~~Public~~City ~~Use~~ Maintained Alley ~~M~~means a ~~mid-block right use or~~ right-of-way dedicated to the public for an alley prior to January 1, 2023, that is open and available for vehicular use and travel by the general public and has been formally accepted for maintenance by the City of Houston (City). An inventory of these alleys is maintained by the Office of the City ~~e~~Engineer (OCE) of Houston Public Works and can be found on the City's website.

10.3.03.G.1.a continued

(2) Privately ~~Rights of Access~~ Maintained Alley shall mean a ~~mid-block~~ right-of-way dedicated to the public for an alley prior to January 1, 2023 and utilized for right of ingress and egress for property adjacent to and authorized for private access by reference to map or plat showing alleys abutting such real property, and that have not been accepted for maintenance by the City.

~~a.~~b. New Alley means a right-of-way dedicated to the public for an alley on January 1, 2023, or after.

~~b.~~c. Applicant shall mean a person who owns real property abutting an alley and seeks to improve such alley for motorized vehicular traffic use either by the public or pursuant to private rights ~~if~~ of access.

d. Application shall be the ~~plans~~ drawings for the proposed improvements from the Applicant's property to the public street submitted with the Applicants construction drawings~~plans~~ for the improvement to personal property. No separate application is required.

~~c.~~e. Alleys platted, dedicated and/or constructed prior to September 20, 1982, are governed by the City of Houston's Code of Ordinances Chapter 40 Article XV "Alleys".

~~1.~~2. Access

a. ~~Public Use~~ Existing City Maintained Alley

(1) Alley is on the most current list of approved alleys found at https://www.houstonpermittingcenter.org/office-city-engineer/engineering-services-right-way.

(2) Applicant is responsible for providing ~~photos~~ evidence to prove that the existing alley meets the criteria stated in the Private Rights of Access section of this chapter.

(3) Alley access can be approved for residential ~~and commercial~~ properties.

~~(3)~~(4) Alley access can be approved for commercial properties subject to City Engineer review and approval, and compliance with IDM Chapter 15 requirements.

~~(3) A commercial property shall only connect to a Public Use Alley.~~

~~c.~~b. Existing Privately ~~Rights of Access~~ Maintained Alley

(1) Privately Maintained Alleys are not for commercial use. ~~Residential use only.~~

10.3.03.G.2 continued

(2) Applicant has the right to access ~~a Private Rights Access~~ Privately Maintained Alley. The City is not responsible for maintaining these alleys.

~~d.~~c. New Alley

(1) Alley access can be approved for residential and commercial properties.

~~2.~~3. Design Criteria

a. Existing City Maintained Alley

(1) Improvements to alley shall meet City of Houston roadway standards.

(2) Alley drainage must comply with Chapter 9 of the Infrastructure Design Manual.

(3) Proposed alley pavement design must be signed and sealed by a licensed professional engineer in the State of Texas.

(4) A plan and profile signed and sealed by a professional engineer licensed in the State of Texas is required to demonstrate that there are no negative impacts to drainage and traffic flow.

b. Existing Privately Maintained Alley

(1) The City's residential driveway requirements shall apply to the portion of the alley along the Privately Maintained ~~Private Rights Access~~ Alley from the right-of-way (ROW) line to the public street.

(2) The portion of the alley from the City's ROW line (of public street) to the ~~a~~Applicant's property being developed shall be designed and constructed in accordance with the City of Houston, Houston Public Works detail as shown on Figure 10.12.

(3) Sidewalks along alley access point must follow current sidewalk policy for single family homes.

(4) Applicant must prepare and construct the surface of the alley so as to prevent the drainage of storm, surface water, or runoff onto the adjacent property.

(5) Applicant must ensure drainage of stormwater and other runoff along the alley into the intersecting street or drainage facilities.

(6) Maintenance of the alley is the responsibility of the abutting property owner(s).

10.3.03.G.3.b continued

(7) The City does not patrol the alley or enforce parking regulations.

(8) Alley drainage shall comply with Chapter 9 of the Infrastructure Design Manual.

(9) Alley shall not connect to principal thoroughfare or thoroughfare.

(10) For alley improvements, provide Office of the City Engineer a submittal signed and sealed by a professional engineer licensed in the State of Texas showing plan view, surface elevations and proposed cross sections to ensure adequate drainage. Cross sections shall be provided at 20 feet intervals from the property to the nearest City storm facility and any other locations requested by the City Engineer. A profile is required if there are proposed utilities. A profile may be required for drainage design per Chapter 9 of the Infrastructure Design Manual.

c. New Alley

(1) New Alley shall meet City of Houston roadway standards.

(2) Alley drainage must comply with Chapter 9 of the Infrastructure Design Manual.

(3) Proposed alley pavement design must be signed and sealed by a licensed professional engineer in the State of Texas.

(4) A plan and profile signed and sealed by a professional engineer licensed in the State of Texas is required to demonstrate that there are no negative impacts to drainage and traffic flow.

10.3.03.H Street Terminations

1. Where cul-de-sac streets are approved, design geometrics shall comply with Figure 10.10. Bicycle and pedestrian access to nearby existing or proposed bicycle facility or trail shall be provided where feasible.

2. Where termination of a private street or Type 2 Permanent Access Easement is approved, design geometrics shall comply with Figure 10.10. Bicycle and pedestrian access to nearby existing or proposed bicycle facility or trail shall be provided where feasible.

3. Dead-End Streets - Standard City of Houston barricades shall be placed at the end of dead-end streets not terminating in cul-de-sacs. Refer to City of Houston Standard Detail No. ~~01580-01~~01555-14. Bicycle and pedestrian access to nearby existing or proposed bicycle facility or trail shall be provided where feasible.

10.3.03.H continued

4. Street terminations shall consider impacts to bicycle and pedestrian access. Where feasible, bicycle and pedestrian access across street terminations points should be considered, especially when connecting between neighborhoods; to destinations such as commercial districts, parks, and schools; or to existing or proposed bicycle facilities and trails.

5. Temporary Street Termination - Temporary termination of streets (for future extension into adjacent development) shall include construction of street barricades as shown in City of Houston Standard Detail No. ~~01580-01~~01555-14.

10.3.03.I On-Street Parking and Cutback Parking

1. General Requirements

   a. At the discretion of the City Traffic Engineer, parking may be allowed in a traffic lane if current traffic volume do not warrant the need for the additional lane. The City Traffic Engineer may allow this parking to occur all day or may restrict it to certain times of the day as needed for mobility purposes. All parking allowed to occur within a traffic lane shall be considered to be temporary and can be removed at any time.

   b. Designated on-street parking can be approved provided that sufficient right-of-way exists. When a designated parking lane is provided, it shall be at least nine feet in width. Where on-street ADA accessible parking is provided, the minimum required width is 13-feet.

   c. As required by the City of Houston Code of Ordinances, all on-street parking shall be parallel to the curb or edge of pavement unless approved by the City Traffic engineer. Lateral parking shall be treated on a case by case basis.

   d. As required by the City of Houston Code of Ordinances, all parking within the public right-of way behind the curb (curb cutback parking) requires the approval of the Director of Houston Public Works. Parking behind the curb shall be considered on a case by case basis.

   e. Figure 10.5 applies to all on-street parking and curb cutback parking.

10.3.03.I continued

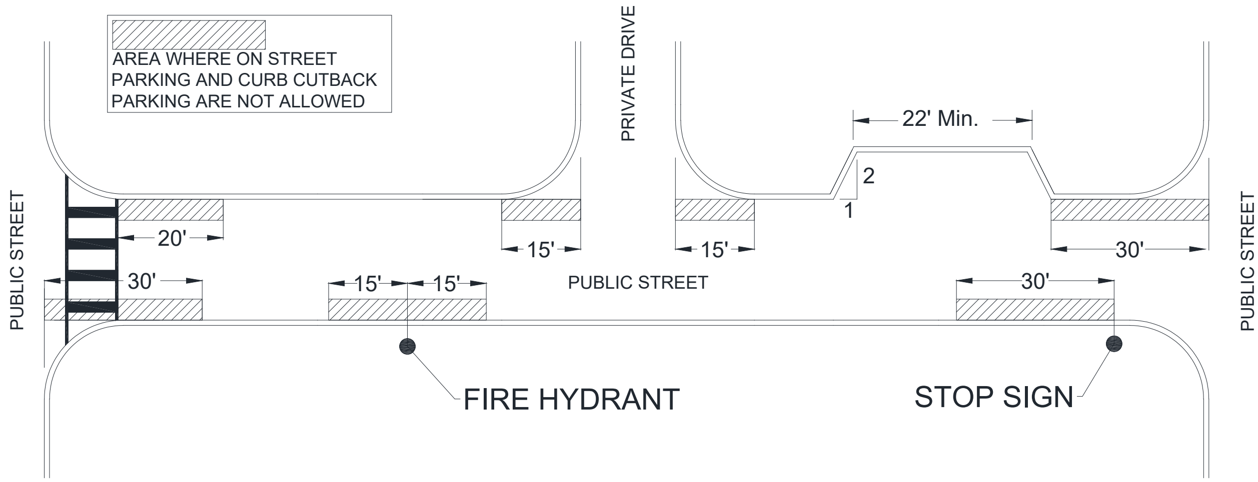


Figure 10.5 - ON-STREET PARKING

2. On-Street Parking for Existing Roadways

   a. Roadway width less than 20-feet

      (1) No parking allowed on the street.

   b. Roadway width equal to or greater than 20-feet but less than 26-feet

      (1) Parking will be allowed on one side, if parking restrictions do not exist.

      (2) If on street parking already exists on one side of the street, parking on the opposite side of the street will not be allowed.

   c. Roadways width equal to or greater than 26-feet

      (1) On-Street Parking will be allowed on both sides of the street, if parking restrictions do not exist.

3. On-Street Parking for Roadways that Require Widening

   a. Widening performed for parking must be per the requirements outlined in this manual.

   b. To allow for parking, the roadway must be widened along the entire property frontage.

   c. The roadway widening must also include transitions outside of the property frontage.

10.3.03.I.3 continued

d. The required transition must follow the requirements outlined in the Manual.

e. Transition requirements apply to both concrete and asphalt roadways.

f. For cases where the required transition starts less than 100-feet from the nearest intersection, the street must be widened along the entire property frontage and extend all the way through the nearest intersection.

4. Curb cutback parking

a. Curb cutback parking is defined as all parking within the public right-of-way:

(1) Behind the curb (Refer to 10.3.03.I.1.d) or

(2) Adjacent to the edge of the pavement for non-curbed streets.

b. Curb cutback parking will not be considered for roadway widths less than 20-feet.

c. Curb cutback parking must be nine feet wide by 22-feet long per parking space.

d. All curb cutback parking must have a curb with appropriate drainage.

(1) Curbed roadways – proposed curb must tie into the existing curb.

(2) Non-curbed roadways – proposed curb is only required along the edge parallel to the roadway.

e. All curb cutback parking shall be confined within the property frontage.

f. Cut back criteria

(1) Transitions into a cutback parking shall taper 2:1.

(2) Cut back area shall conform to all sight distance, distance to intersection and all other existing design criteria.

g. These criteria shall also apply for parking within the public right of way on streets without curb.

10.3.03.J Roadway Widening

10.3.03.J continued

1. For commercial developments, single family residential subdivision developments and multi-unit residential (MUR) subdivision developments, if the existing roadway is less than eighteen (18) feet in width, widen the roadway to at least twenty (20) feet in width to the nearest intersection along the fire access road. Roadway widening must also include transitions outside of the property frontage to comply with 10.3.03.I.3.

2. The requirements to widen a street paving does not apply to a residential development filed in a subdivision plat and recorded after January 1, 2023, if the residential development meets one or more of the following conditions:

    a. The residential development is part of a subdivision plat that is less than or equal to 15,000sf and not out of a tract larger than 15,000 square feet; or

    b. The residential development is less than 25% of the linear feet of the block face as defined in Chapter 42 of the Code of Ordinances (on any street side development is taking access from).

3. For roadways widened to less than twenty-six (26) feet in width, post “No Parking” signs as applicable in 10.3.03.I.2. Signs shall not be installed until after an evaluation by the City is conducted. Applicant must receive permission from the City prior to installation of any “No Parking” signs.

SECTION 4 – STREET CONNECTIONS AND TRANSITIONS

10.4.01 STREET CONNECTIONS

10.4.01.A Where a new street or driveway is proposed to connect to an existing signalized intersection, refer to Chapter 15 Traffic and Signal Design Requirements.

10.4.02 STREET TRANSITION REQUIREMENTS

10.4.02.A Concrete Streets

1. When transitioning from a proposed concrete street to an existing concrete street, the transition shall consist of concrete, and shall equal the existing concrete pavement thickness with a minimum thickness of eight inches.

2. Refer to City of Houston Standard Detail 02751-01.

10.4.02.B Streets Other Than Concrete Pavement

1. When transitioning from a proposed street to an existing street constructed of material other than concrete, the transition shall consist of asphaltic concrete paving.

2. Refer to City of Houston Standard Detail 02741-01.

10.4.02.C Pavement Transition Length

1. The standard transition length for all street types shall be calculated as follows:

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

Where:

L = Transition length (feet)
S = Posted speed (mph)
W = width of offset (feet)
(Source: See 10.1.03.O)

2. Minimum transition length shall be:

   a. 50-feet for street widths less than or equal to 26-feet F-F (face to face of curb).

   b. 75-feet for street widths greater than 26-feet and less than 36-feet F-F (face to face of curb).

10.4.02.C.2 continued

c. 100-feet for street widths greater than 36-feet and less than or equal to 40-feet F-F (face to face of curb).

10.4.03 PROPOSED CURB AND GUTTER STREET CONNECTING TO AN EXISTING CURB AND GUTTER STREET

10.4.03.A When meeting an existing curb-and-gutter street, top-of-curb elevations shall be designed to meet an elevation six inches above the existing gutter.

10.4.03.B At existing inlets, top-of-curb elevations shall be designed to match existing top-of- curb elevations.

10.4.04 CONSTRUCTION REQUIREMENTS FOR CONNECTING A PROPOSED CONCRETE STREET WITH AN EXISTING CONCRETE STREET

10.4.04.A When meeting existing concrete streets at right angles, the existing street should be saw cut in a V-shape extending from the curb returns to a point where the centerline of the proposed pavement intersects the quarter point of the existing concrete street to create a crowned intersection. In the event this construction creates a situation in which traffic on the existing street, at design speed, will bottom out when crossing the proposed street intersection, a special design will be allowed to eliminate this potentially dangerous condition.

10.4.04.B Remove concrete either to an existing joint or a sawed joint. The groove of the sawed joint shall be cut to a minimum depth of two inches along the line designated by the Professional Engineer.

10.4.04.C When meeting existing concrete pavement, horizontal dowels shall be used if no exposed reinforcing steel exists. Horizontal dowels shall be Grade 60 bars, 24 inches long, drilled and embedded 12-inches into the center of the existing slab with PO ROC, or approved equal. Dowels shall be 12-inches center-to-center, unless otherwise specified.

10.4.04.D When concrete is removed for connection with proposed concrete pavement, the pavement shall be saw cut and existing concrete removed to expose a minimum of 15-inches of reinforcing steel. If no reinforcing steel exists, use horizontal dowels per Paragraph 10.4.04.C.

10.4.05 PAVEMENT CONNECTION SPECIAL REQUIREMENTS

10.4.05.A At a T-intersection with a street that has not been improved to its ultimate width, concrete shall be stopped either at the right-of-way line or the end of the curb return. The option that will require the least concrete removal at a future date should be chosen.

10.4.05.B For roadway turnouts placed at an existing cross street intersection, the turnout should be designed to fit the ultimate pavement width of the intersecting cross street and then transitioned to the existing roadway.

10.4.06 L - TYPE STREET

The minimum grade line around the longest radius on an L-type street shall be 0.40 percent.

SECTION 5 – BICYCLE FACILITIES

See Chapter 17 ~~-~~– Pedestrian, Bicycle, and Transit ~~and Pedestrian~~ Design Requirements.

SECTION 6 – SPECIAL REQUIREMENTS

10.6.01.A Pavement Crossing Pipelines - A Letter of agreement between the City and pipeline company is required when paving is placed over a transmission pipeline.

10.6.01.B Bridge design should include a high comfort bicycle facility where a bicycle facility exists or is proposed. See Chapter 17 for details on high comfort bicycle facilities.

10.6.01.C Thoroughfare Construction Considerations

1. When the full section of a thoroughfare is located within the city limits and is dedicated on a final plat, the esplanade and all lanes of the thoroughfare shall be constructed at the time of initial construction of the roadway.

2. If approved by the City Engineer, lanes contained within a plat, left-turn lanes, bicycle facilities, and the esplanade to the centerline of the right-of-way shall be constructed at the time of initial construction of the roadway when only one side of a thoroughfare is located on a final plat. The remaining lanes, left-turn lanes, bicycle facilities and esplanade shall be constructed at the time the final plat containing the opposite side of the thoroughfare is approved.

10.6.01.D Inlets and Manholes

1. The inlet spacing and the maximum allowable curb run to an inlet shall be provided in accordance with Chapter 9.

2. City approved inlets shall be used on all curbs and gutter sections within the city limits and in the ETJ.

3. Keep proposed inlets away from esplanade opening and out of major thoroughfare intersections. For intersections between a major thoroughfare and minor street, locate inlets at the end of return (E/R) of the side street.

4. Inlets shall be placed at the end of pavement in order to eliminate drainage from the pavement gutter into a road ditch.

5. When curb and gutter streets connects to roadside ditches street, place inlets at end of curb and gutter street with reinforced concrete pipe stubs with rings to collect ditch storm water. See standard detail 02632-11- Side Street Ditch Reception.

6. Use only City standard grates for curb inlets.

7. Adjust existing manhole frames and covers within the limits of the proposed pavement to meet the proposed top-of-slab elevation.

10.6.01.D continued

8. Adjust existing manhole frames and covers outside the limits of pavement to conform to the final grading plan.

10.6.01.E When a curb and gutter street intersects a drainage ditch, the gutter elevation shall be above the designed water surface elevation of the ditch.

10.6.01.F Fill/Cut for Proposed Pavement

1. Fill Placement for Curb and Gutter Pavement Sections:

   a. Fill shall be placed to ensure a minimum of 3/8-inches per foot transverse slope toward the curb from the property line. Fill shall be placed between the curb and a point two feet outside of the right-of-way.

   b. Where fill as described above is required, and the pavement is adjacent to a nonparticipating property owner, fill easements shall be obtained, filed, and a copy of the easement shall accompany the final drawings.

   c. Construction of this nature will require back-slope drainage design to prevent trapping storm runoff.

   d. When pavement or curb grades are established below natural ground, slope lines shall be shown on the drawings.

10.6.01.G Drawings

1. Construction drawings shall be prepared in accordance with Chapter 3, Graphic Requirements.

2. Top-of-curb grade for the outside lanes shall be labeled except at railroad crossings where gutter grades shall be labeled. Centerline grades are acceptable for sheets with roadside ditch sections.

3. For proposed driveways, call out centerline stations, widths, and radii.

END OF CHAPTER

APPENDIX 1: DESIGN FIGURES

GEOMETRIC DESIGN GUIDELINES FOR SUBDIVISION STREETS

CITY OF HOUSTON

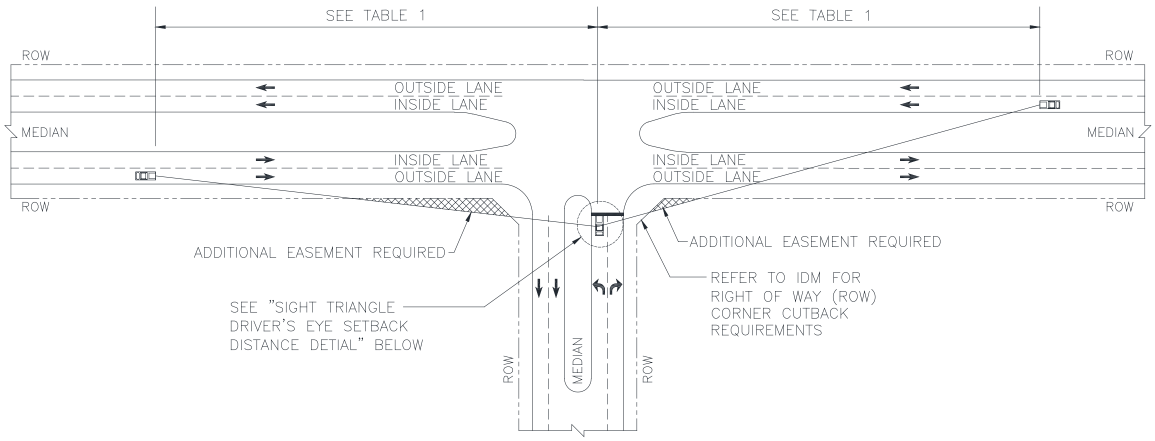
The Guidelines presented in Appendix 1 include the most often requested information regarding geometric design of subdivision streets. All streets within the City of Houston shall be considered for special design features such as presented in Appendix 2 of this Chapter. Design features not shown in Appendix 1 should be considered special design features. Agency Engineer as used throughout this section shall mean City Engineer for the City of Houston. The average daily traffic volumes presented in Table 10.7, Table 10.8, and Appendix 2 Figure 1 are provided as general guidelines to define each street classification. Professional engineering experience and judgment should be used in application of the guidelines to a specific project.

It is advisable to consult with the City and review the most recent edition of the following publications to determine adequate thoroughfare requirements and special design features.

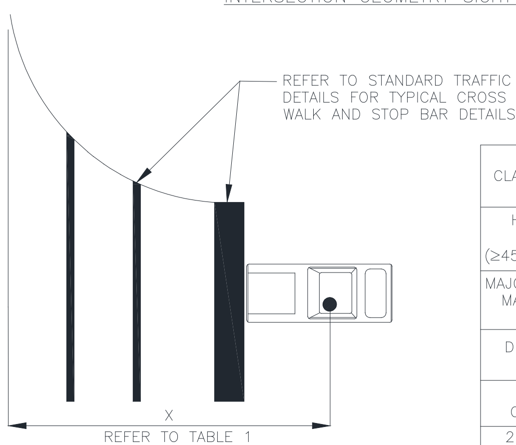
- Recommended Guidelines for Subdivision Streets, Institute of Transportation Engineers
- Guidelines for Urban Major Streets Design, Institute of Transportation Engineers
- A Policy on Geometric Design of Highways and Streets, American Associations of State Highway and Transportation Officials (AASHTO)
- Texas Manual on Uniform Traffic Control Devices (TMUTCD), Texas Department of Transportation
- Urban Street Design Guide, National Association of City Transportation Officials (NACTO)
- Urban Bikeway Design Guide, National Association of City Transportation Officials

THE GUIDELINES IN THIS APPENDIX ARE HEREBY APPROVED AS BASIC REQUIREMENTS FOR FUTURE STREET PLANNING AND DEVELOPMENT

JULY 2020



INTERSECTION GEOMETRY SIGHT DISTANCE TRIANGLE PLAN



SIGHT TRIANGLE DRIVER'S EYE SETBACK DISTANCE DETAIL

TABLE 1: TRIANGLE APPLICABILITY

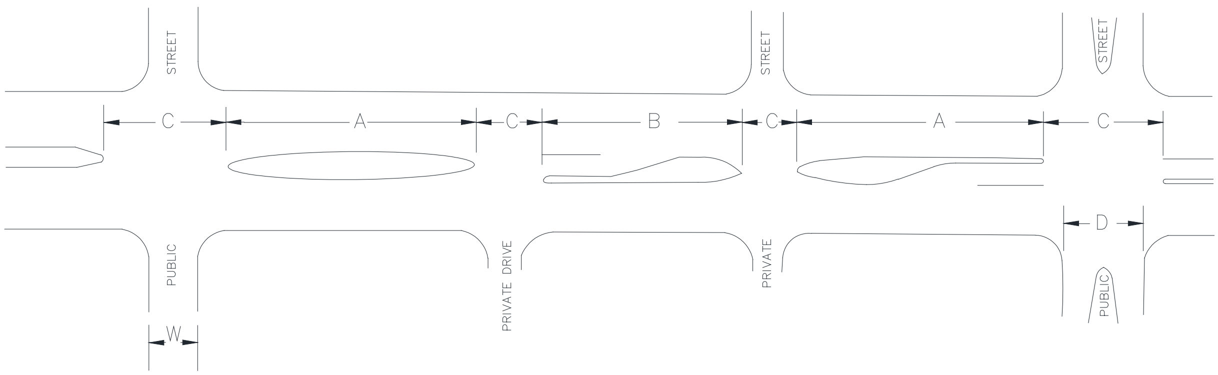
HIGHEST CLASSIFICATION/GREATER WIDTH STREET	SIGHT TRIANGLE DRIVER'S EYE SETBACK DISTANCE "X"	SIGHT TRIANGLE DIMENSION ON UNCONTROLLED STREET (DESIGN SPEED)
HIGH SPEED MAJOR THOROUGHFARE (≥45 MPH POSTED SPEED)	25 FT	SIGHT–SPECIFIC ANALYSIS
MAJOR THOROUGHFARE OR MAJOR COLLECTOR ON MTFP MAP	25 FT	500 FT (45 MPH)*
DIVIDED STREETS AND 41 FT STREETS	15 FT	500 FT (45 MPH)*
26 FT LOCAL AND COLLECTOR STREETS	15 FT	390 FT (35 MPH)*
26 FT SINGLE FAMILY RESIDENTIAL FRONTAGE ON BOTH STREETS (1)	N/A	N/A

*BASED ON A PASSENGER CAR TIME GAP

NOTES:

1. INTERSECTION SIGHT DISTANCES ARE BASED ON AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO) CRITERIA FOR INTERSECTION SIGHT DISTANCE.
2. IF ROADWAY BEING CROSSED OR TURNED INTO HAS A MEDIAN THAT IS 25 FEET OR GREATER, SIGHT DISTANCE TO THE RIGHT MAY BE MEASURED FROM THE POINT AT WHICH A VEHICLE CAN SAFELY STOP WITHIN THE MEDIAN OPENING.

Figure 10.6 - INTERSECTION GEOMETRY SIGHT DISTANCE TRIANGLE



TYPICAL MEDIAN OPENING C

MEDIAN INTERRUPTION FOR	1 LTB (1)	2 LTB (1)
PRIVATE DRIVE OR PRIVATE STREET	52.5'	60'
UNDIVIDED STREET W ≤ 40' W = 44'	52.5' (2) 55' (2)	60' 80'
DIVIDED STREET ALL	D+22' (3)	D+22' (3)

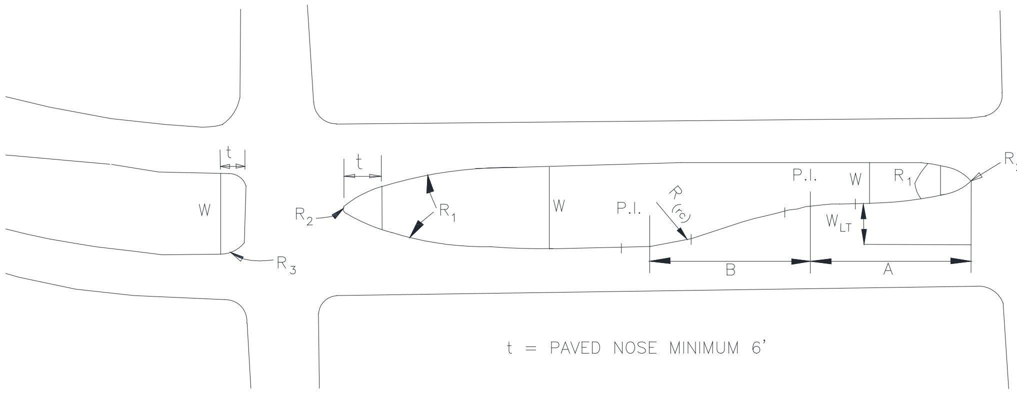
MINIMUM MEDIAN LENGTH A, B

IF DIVIDED STREET IS:	INTERSECTING STREET CLASSIFICATION			
	MAJOR THOROUGHFARE/ MAJOR THOROUGHFARE (A)	COLLECTOR STREET (A)	LOCAL STREET (A)	PRIVATE STREET OR DRIVEWAY (B)
MAJOR THOROUGHFARE/ MAJOR THOROUGHFARE	660'	660'	660'	660'
COLLECTOR STREET	660'	500'	350'	350'
LOCAL STREET	300'	300'	300'	300'

NOTE:

(1) LTB–LEFT TURN BAY.
(2) DISTANCE FROM CENTERLINE OF OPENING TO MEDIAN NOSE WITH LEFT TURN LANE IS 30' FOR RIGHT ANGLE INTERSECTIONS. FOR INTERSECTIONS OTHER THAN 90°, APPLY DESIGN VEHICLE TURNING TEMPLATE TO DETERMINE DIMENSION TO MEDIAN NOSE CUT OFF.
(3) "W" AND "D" DENOTE THE PAVEMENT WIDTH MEASURED FROM FACE OF CURB TO FACE OF CURB

Figure 10.7 - MEDIAN LENGTH AND OPENING



LEFT TURN BAY PLAN

MEDIAN DIMENSIONS

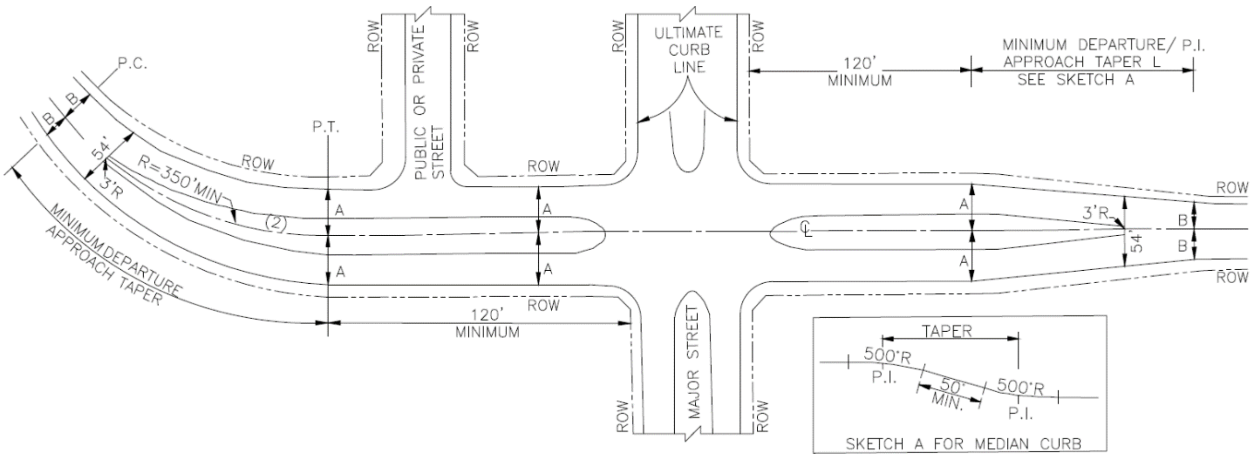
W	R_1	R_2	R_3
≤10'	NONE	$\frac{W}{2}$	NONE
>10'≤40'	90	2'	NONE
>40'	NONE	NONE	15

LEFT TURN BAY DIMENSIONS

INTERSECTION TYPE	DESIGN SPEED	A	B	$R_{(rc)}$	$W_{(LT)}$
MAJOR THOROUGHFARE – MAJOR THOROUGHFARE	≤35 MPH ≥35 MPH	150' 150'	86' 118'	150' 300'	10'/11' 10'/11'
MAJOR THOROUGHFARE – MAJOR COLLECTOR	≤35 MPH ≥35 MPH	150' 150'	86' 118'	150' 300'	10'/11' 10'/11'
ALL OTHER	≤35 MPH ≥35 MPH	100' 100'	86' 118'	150' 300'	10'/11' 10'/11'

TABLE NOTES:
1) $R_{(rc)}$ – REVERSE CURVE RADIUS
2) LEFT TURN BAY LANE WIDTH (W_{LT}) TO CONFORM TO LANE WIDTH REQUIREMENTS SPECIFIED IN SECTION 10.3.03: CORRIDOR DESIGN

Figure 10.8 - MEDIAN NOSE AND LEFT TURN BAY



NOTES:

1) APPROACH AND DEPARTURE TAPER REQUIREMENT:

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

WHERE L = LENGTH IN FEET
S = SPEED IN M.P.H.
W = LATERAL OFFSET IN FEET

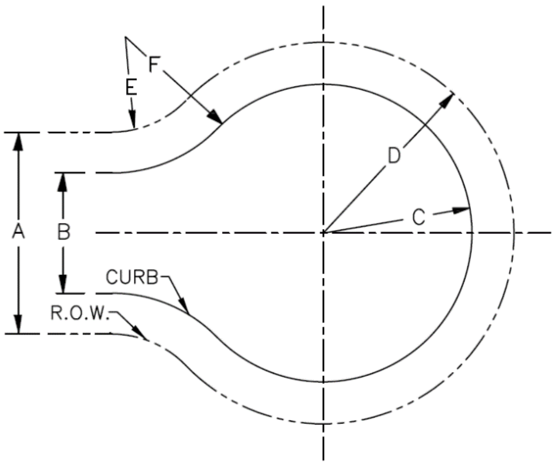
S = 30 M.P.H. MINIMUM DESIGN SPEED FOR SUBDIVISION STREETS

W = A−B

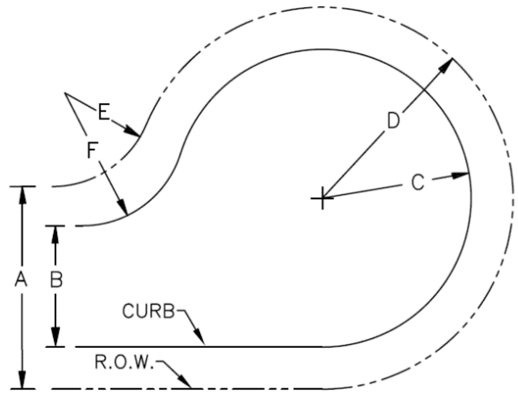
2) 300' MINIMUM CENTERLINE RADIUS FOR HORIZONTAL CURVE WITH APPROACH OR DEPARTURE TAPERS.

3) REFER TO STANDARD DRAWING NO. 10.8 FOR MEDIAN LENGTHS AND MEDIAN OPENING.

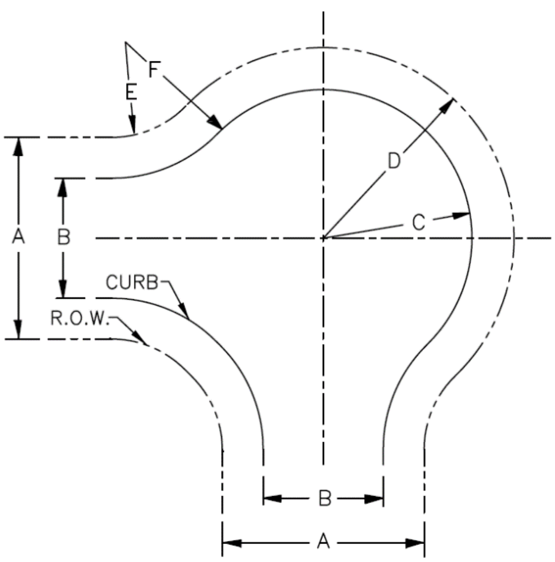
Figure 10.9 - ROADWAY TAPERS FOR MEDIAN DESIGN (LOCAL STREETS)



SYMMETRICAL CUL–DE–SAC



OFFSET CUL–DE–SAC



KNUCKLE CUL–DE–SAC

TABLE 1: CUL–DE–SAC DIMENSIONS

DIMENSION	SINGLE FAMILY	ALL OTHER
A	VARIES (1)	VARIES (1)
B	VARIES (1)	VARIES (1)
C	48 FT	50 FT
D	58 FT	60 FT
E	25 FT	25 FT
F	35 FT	35 FT

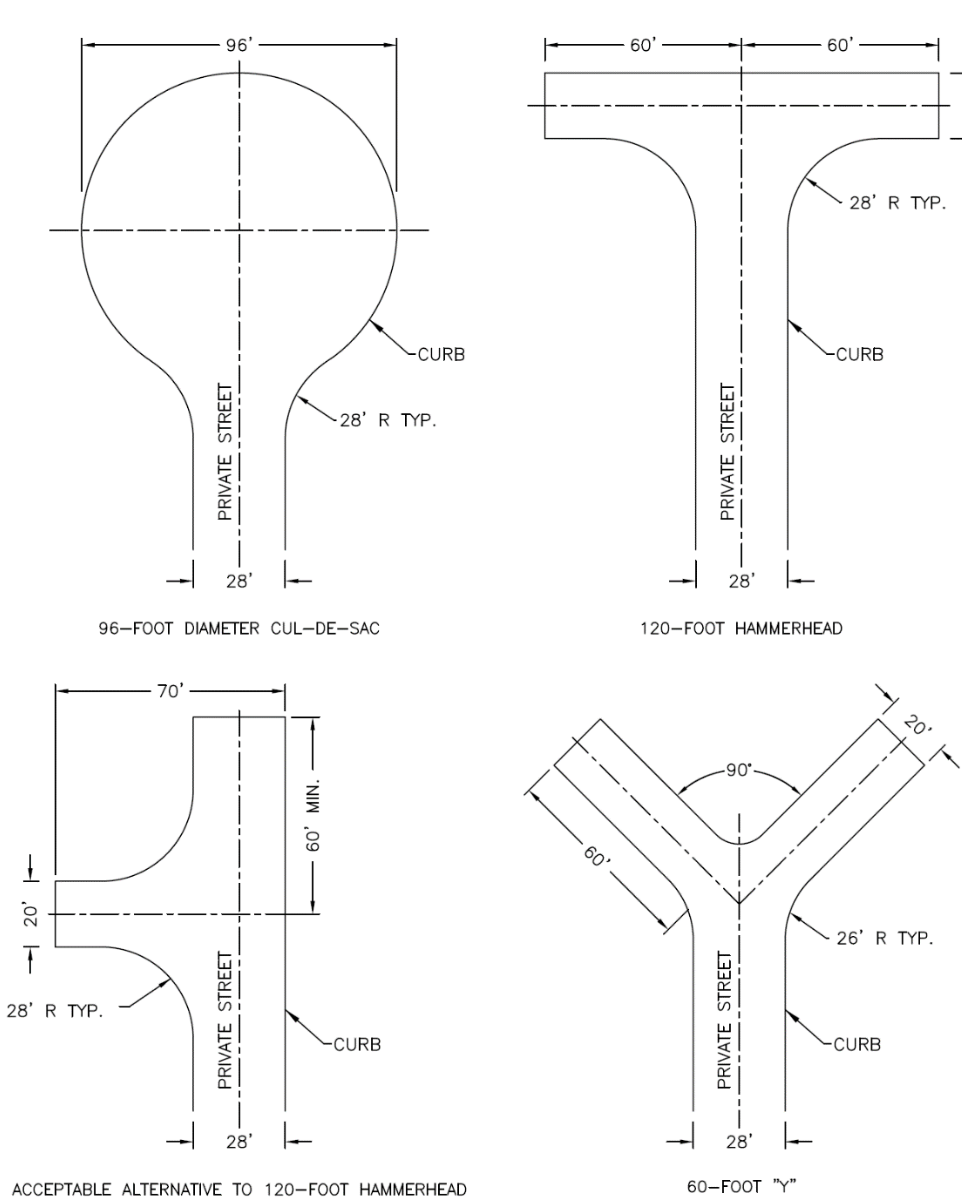
NOTES:

1. FOR STREET AND ROW WIDTHS, REFER TO PARAGRAPH 10.3.03.A OF THE IDM.
2. CURB DENOTES THE FACE OF CURB

Figure 10.10 - STREET TERMINATION CUL-DE-SAC

PUBLIC USE ALLEY REMOVED

ANY PUBLIC USE ALLEY ROW SHOULD MEET CITY ROADWAY STANDARDS



NOTES:

1. PROVIDED ARE SOME DIMENSIONS PER THE CURRENT ADOPTED VERSION OF THE FIRE CODE BY THE CITY OF HOUSTON. THE APPLICABLE TERMINUS DESIGN MUST MEET REQUIREMENTS IN THE CURRENT ADOPTED FIRE CODE BY THE CITY OF HOUSTON. 28–FOOT TYPE 2 PERMANENT ACCESS EASEMENT WIDTH IS PER CITY OF HOUSTON ORDINANCE 42–190.

2. CURB DENOTES THE FACE OF CURB

Figure 10.11 - TYPE 2 PERMANENT ACCESS EASEMENT

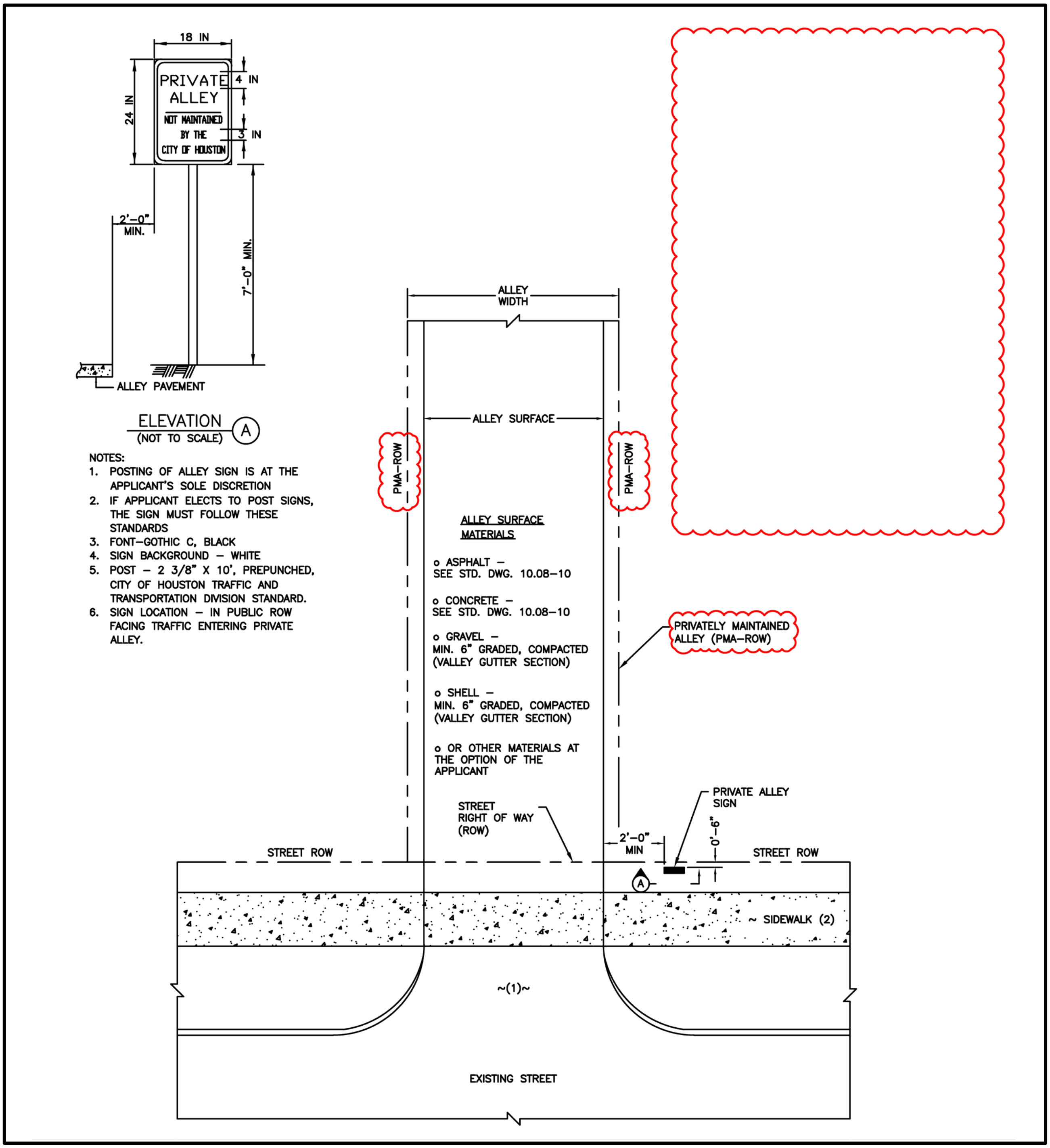


Figure 10.12 - PRIVATELY MAINTAINED ~~USE~~ ALLEY

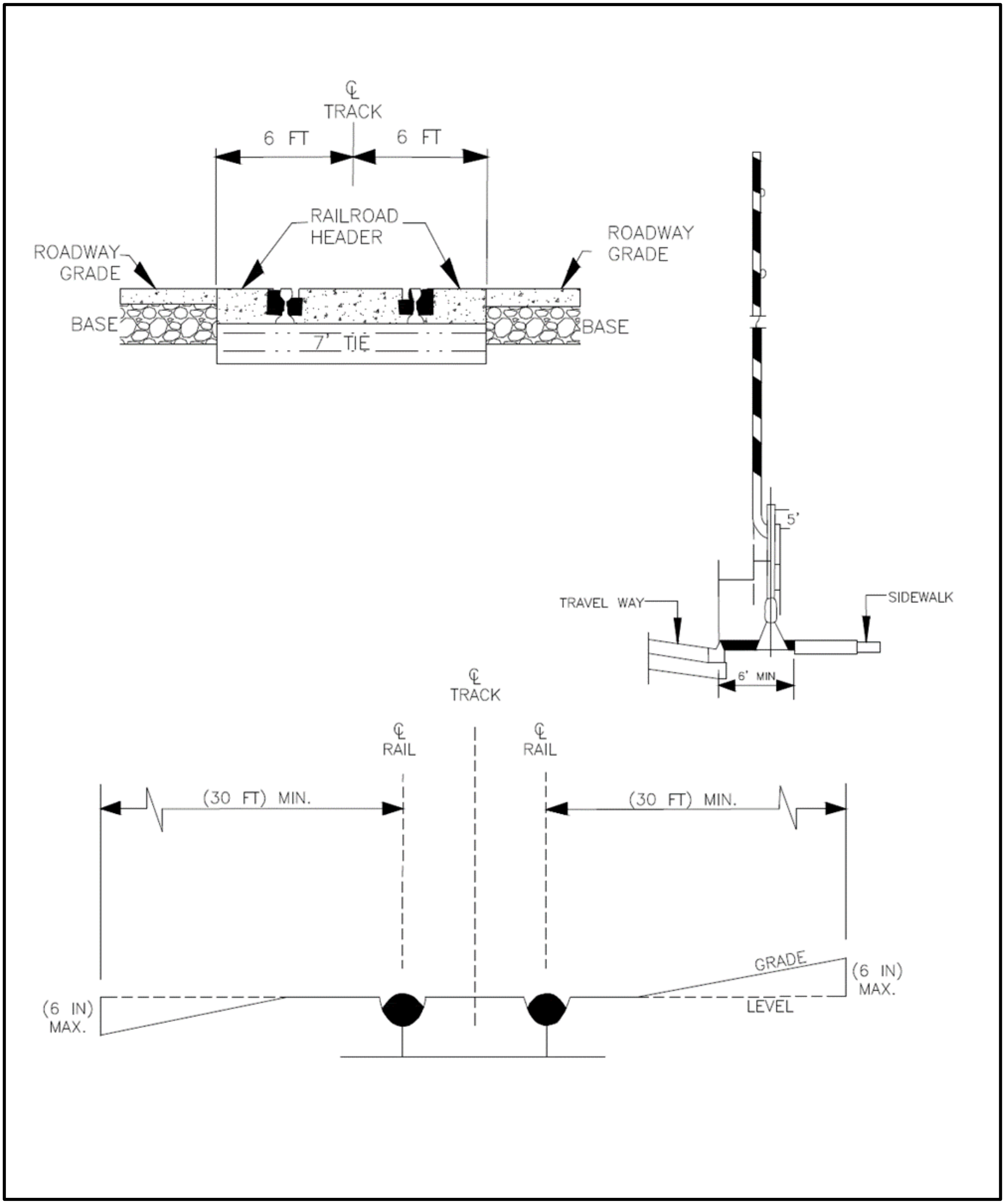


Figure 10.13 - RAILROAD CROSSING

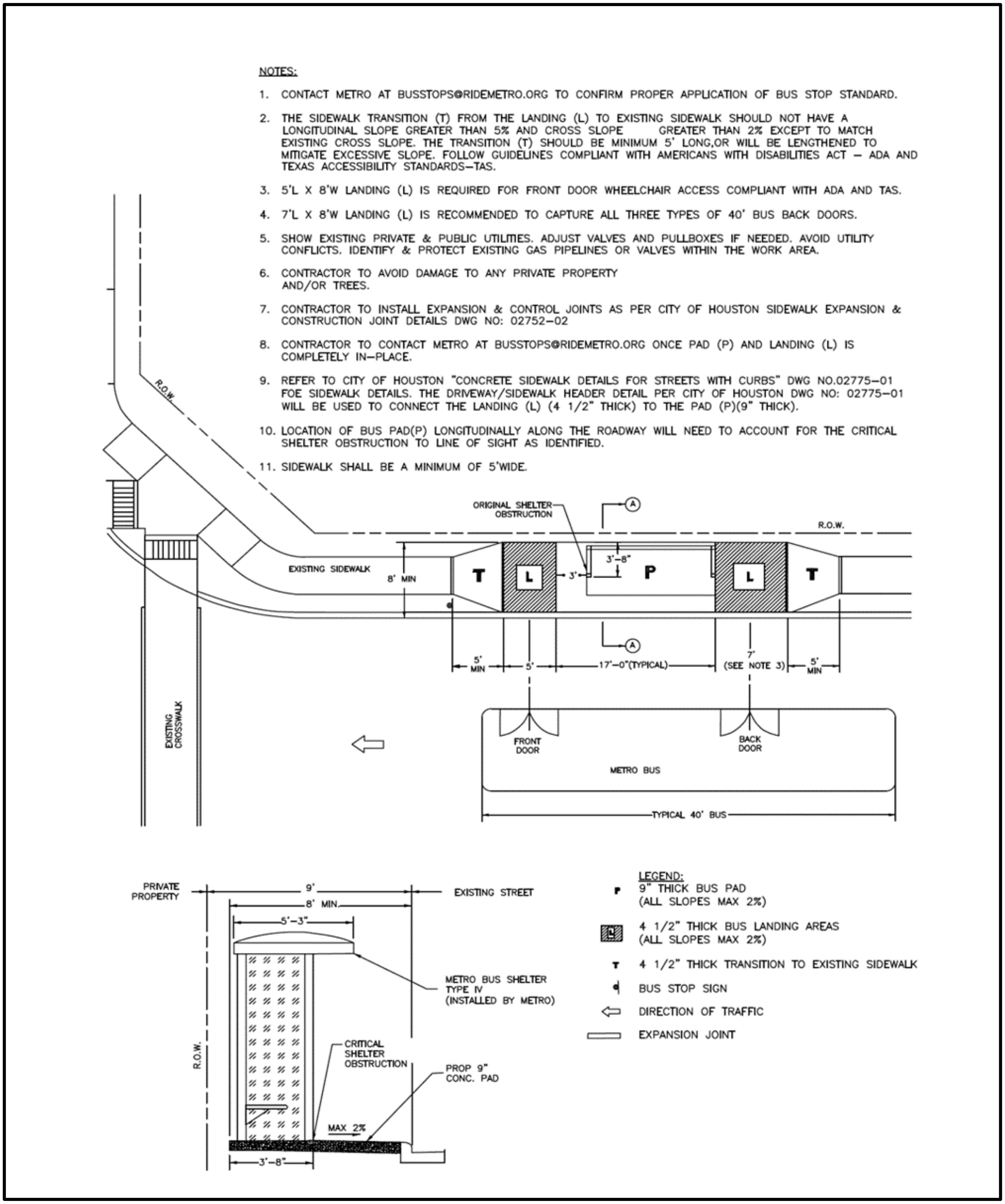


Figure 10.14 - STANDARD BUS PAD AND LANDINGS

APPENDIX 2: STREET DESIGN MENU

Appendix 2 presents a "Street Design Menu" with examples of optional roadway corridor sections that are a result of the 2009 City of Houston Mobility Planning Study. Figure 1 is provided to cross reference the street classifications in the Major Thoroughfare and Freeway Plan to the corridor sections within the City Mobility Plan. These corridor sections can be utilized for development of roadway systems within the City limit of Houston. These roadway sections are not applicable in the ETJ of the City. The tables identify the right-of-way requirements and element dimensions associated with each corridor section.

The design engineer, in consultation with the City, shall determine the appropriate Multimodal Street Classification is applicable for each street using context sensitive design principles. While full right-of-way dedication may not be required under Chapter 42 of the City of Houston Code of Ordinances, it is expected that developer's utilizing these alternative sections will make available the necessary public right-of-way dimensions at no cost to the City of Houston.

NOTES

1. Sidewalk dimensions shown are options. Minimum sidewalk dimension for Transit Street designations and Major Thoroughfare is six feet and five feet for all others.

2. TW - Tree Wells will be considered for use in lieu of a green space dimension where shown in Tables.

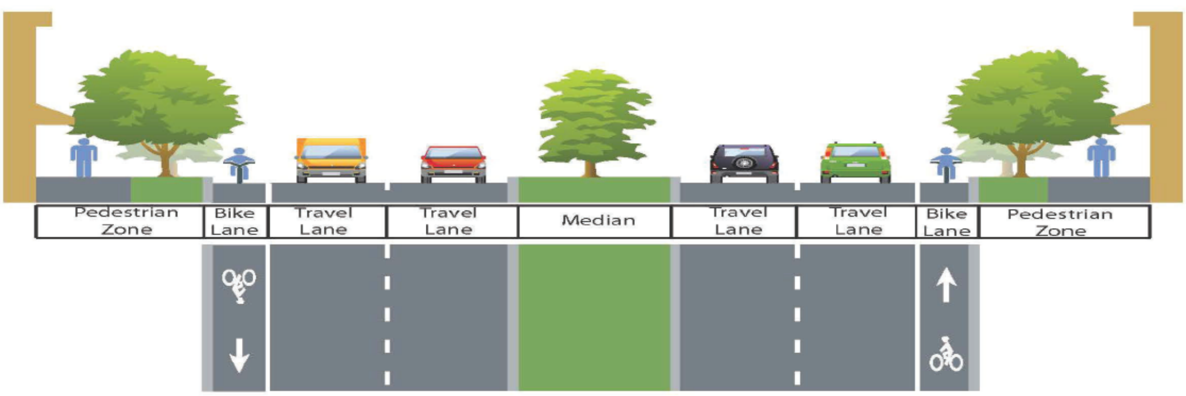
CITY MOBILITY PLAN (CMP)				MAJOR THOROUGHFARE AND FREEWAY PLAN (MTFP)				
MULTIMODAL STREET CLASSIFICATION				EXISTING CLASSIFICATION				
	Proposed Right-of-Way	Number of Lanes	Typical Design Avg Daily Traffic Vol (vpd)	Principal Thoroughfare	Thoroughfare	Major Collector	Minor Collector	Local Street
BOULEVARD								
Commercial	80' - 140'	4 - 8	15,000 - 80,000					
Mixed Use	80' - 140'	4 - 6	15,000 - 50,000					
Residential	80' - 120'	2 - 6	15,000 - 30,000					
Transit	120'	4 - 6	15,000 - 30,000					
Industrial	80' - 140'	4 - 6	15,000 - 50,000					
AVENUE								
Commercial	80' - 100'	2 - 4	1,500 - 30,000					
Mixed Use	80' - 100'	2 - 4	1,500 - 30,000					
Residential	80' - 100'	2 - 4	1,000 - 20,000					
Transit	100'	2	1,500 - 15,000					
Industrial	80' - 100'	3 - 5	5,000 - 35,000					
COUPLET								
Commercial	60' - 100'	2 - 5	1,000 - 45,000					
Mixed Use	60' - 100'	2 -5	1,000 - 45,000					
Residential	60' - 100'	2 -3	1,000 - 25,000					
Transit	60' - 100'	2 - 4	1,000 - 35,000					
Industrial	60' - 100'	2 - 5	1,000 - 45,000					
STREET								
Commercial	60'	2	1,000 -15,000					
Mixed Use	60'	2	1,000 - 15,000					
Residential	60'	2	500 - 5,000					
LOCAL STREET								
Residential Main	60' - 70'	2	≥ 1,500					
Residential High Density	55' - 65'	2	350 - 5,000					
Residential Std. Density	50' - 65'	2	250 - 5,000					

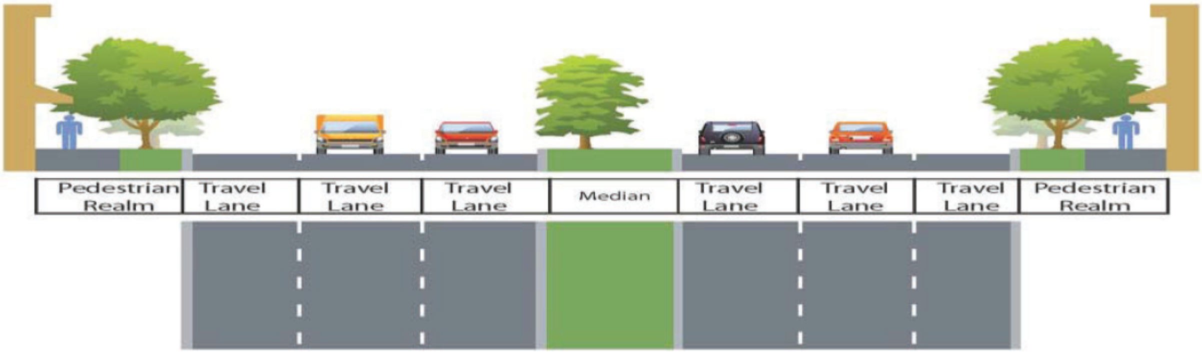
Indicates Shared Classification

Figure 1

Commercial/Mixed Use Boulevard Designation							
Minimum R.O.W (feet)	**Pedestrian Realm* (feet)**	**Tree Well or Swale**	**On-Street Parking (feet)**	**Bike Lane (feet)**	**Median Width (ft)**	**Lane Widths (feet)**	**ADT (vpd)**
80	2 x 10 = 20	TW	N/A	N/A	16	4 x 11 = 44	15,000 - 30,000
100	2 x 18 = 36	TW	N/A	N/A	20	4 x 11 = 44	15,000 - 30,000
	2 x 12 = 24	TW	N/A	2 x 6 = 12	20	4 x 11 = 44	15,000 - 30,000
	2 x 10 = 20	TW	2 x 8 = 16	N/A	20	4 x 11 = 44	15,000 - 30,000
	2 x 13.5 = 27	TW	N/A	2 x 6 = 12	17	4 x 11 = 44	15,000 - 30,000
	2 x 10 = 20	TW	N/A	N/A	14**	6 x 11 = 66	15,000 - 40,000
120	2 x 17 = 34	TW	N/A	N/A	20	6 x 11 = 66	15,000 - 30,000
	2 x 11 = 22	TW	N/A	2 x 6 = 12	20	6 x 11 = 66	15,000 - 30,000
	2 x 12.5 = 25	TW	N/A	2 x 6 = 12	17	6 x 11 = 66	15,000 - 30,000
	2 x 10.5 = 21	TW	2 x 8 = 16	N/A	17	6 x 11 = 66	15,000 - 30,000
140	2 x 16 = 32	TW	N/A	N/A	20	8 x 11 = 88	20,000 - 50,000
	2 x 11.5 = 23	TW	N/A	2 x 6 = 12	17	8 x 11 = 88	20,000 - 50,000

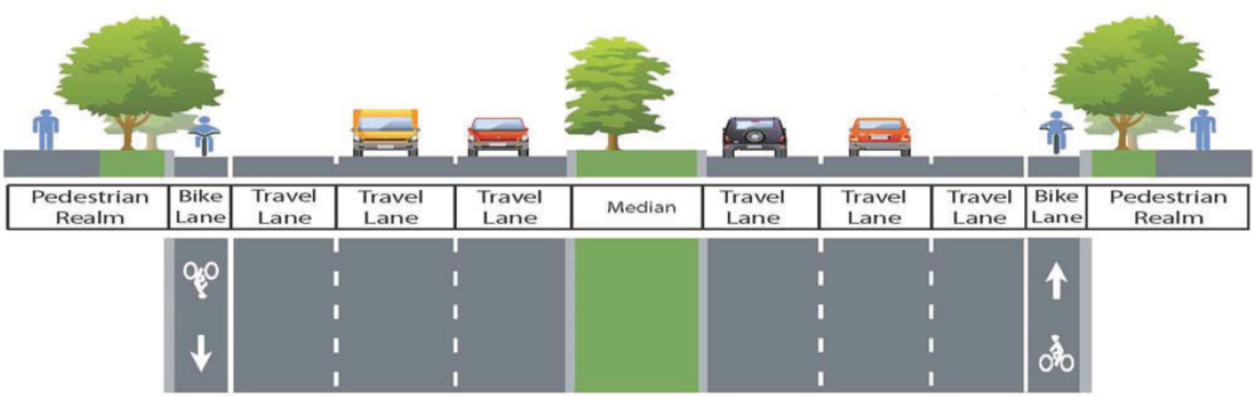
* - Minimum Sidewalk width is a minimum of 5 feet.
** - Not recommended. Requires the concurrence of the City Engineer and the City Traffic Engineer.

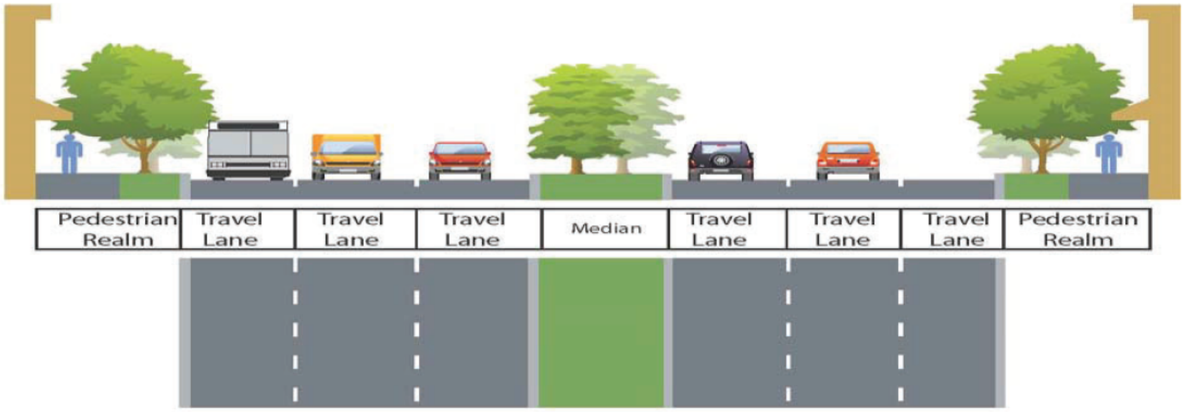




Residential Boulevard Designation							
Minimum R.O.W (feet)	Pedestrian Realm* (feet)	Tree Well or Swale	On-Street Parking (feet)	Bike Lane (feet)	Median Width (ft)	Lane Widths (feet)	ADT (vpd)
80	2 x 11 = 22	TW	2 x 8 = 16	N/A	20	2 x 11 = 22	5,000 - 15,000
	2 x 13 = 26	TW	N/A	2 x 6 = 12	20	2 x 11 = 22	5,000 - 15,000
	2 x 10 = 20	TW	N/A	N/A	16	4 x 11 = 44	15,000 - 30,000
100	2 x 10 = 20	2 x 12.5 = 25	2 x 8 = 16	N/A	17	2 x 11 = 22	5,000 - 15,000
	2 x 10 = 20	2 x 14.5 = 29	N/A	2 x 6 = 12	17	2 x 11 = 22	5,000 - 15,000
	2 x 12 = 24	TW	N/A	2 x 6 = 12	20	4 x 11 = 44	15,000 - 30,000
	2 x 11.5 = 23	TW	2 x 8 = 16	N/A	17	4 x 11 = 44	15,000 - 30,000
120	2 x 10 = 20	2 x 12 = 24	N/A	2 x 6 = 12	20	4 x 11 = 44	15,000 - 30,000
	2 x 12.5 = 25	TW	N/A	2 x 6 = 12	17	6 x 11 = 66	15,000 - 50,000
	2 x 10 = 20	2 x 7 = 14	N/A	N/A	20	6 x 11 = 66	15,000 - 50,000

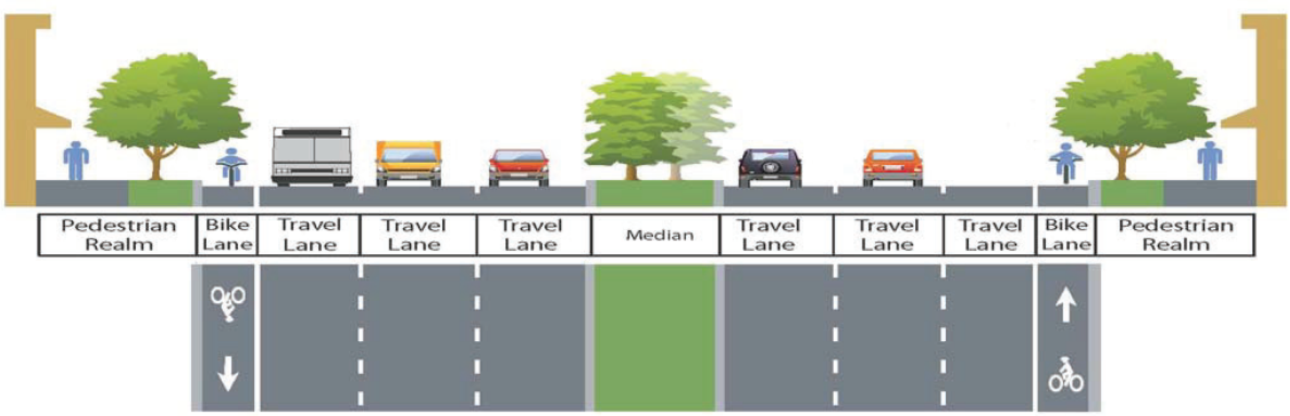
* - Minimum Sidewalk width is a minimum of 5 feet.

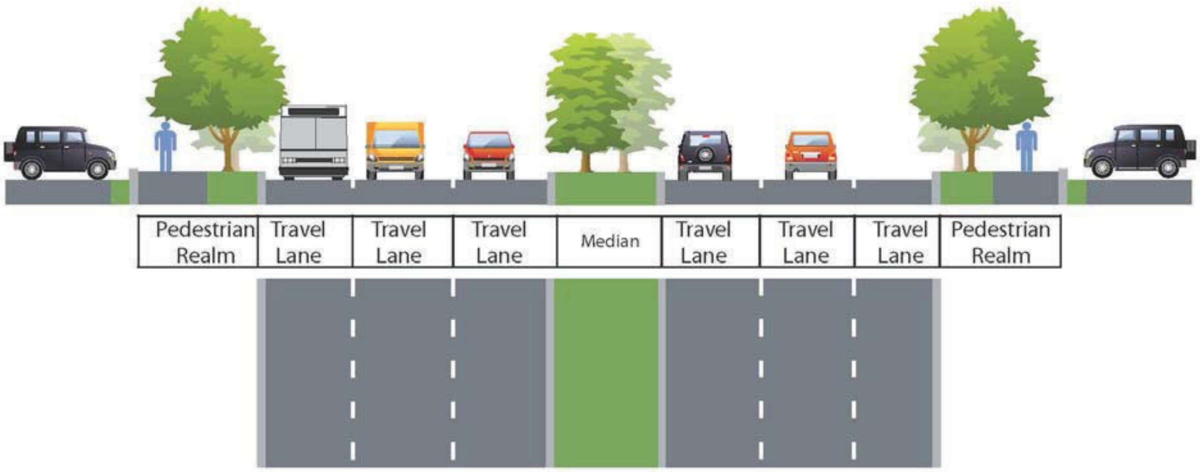




Transit Boulevard Designation							
Minimum R.O.W (feet)	Pedestrian Realm* (feet)	Tree Well or Swale	On-Street Parking (feet)	Bike Lane (feet)	Median Width (ft)	Lane Widths (feet)	ADT (vpd)
100	2 x 13 = 26	TW	N/A	N/A	28	2 x 12 = 24 2 x 11 = 22	15,000 - 30,000
110	2 x 18 = 36	TW	N/A	N/A	28	2 x 12 = 24 2 x 11 = 22	15,000 - 30,000
120	2 x 17 = 34	TW	N/A	2 x 6 = 12	28	2 x 12 = 24 2 x 11 = 22	15,000 - 30,000
	2 x 16 = 32	TW	N/A	N/A	20	2 x 12 = 24 4 x 11 = 44	15,000 - 40,000

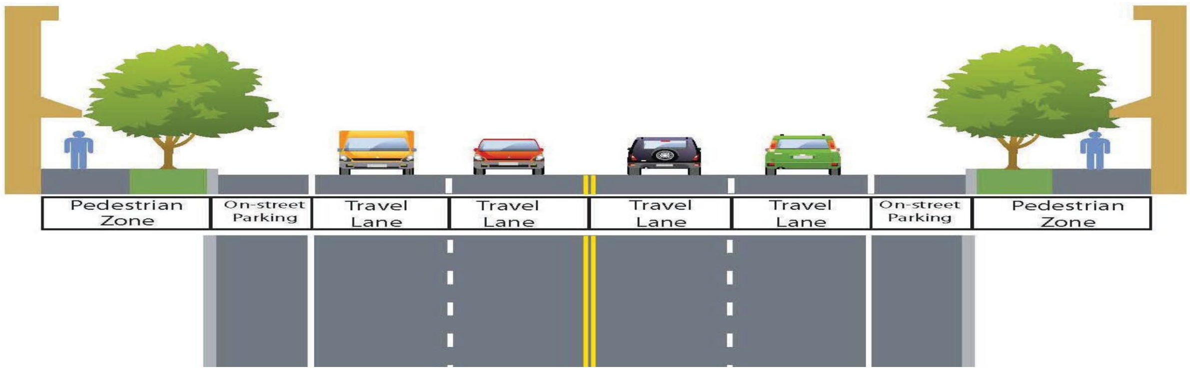
* - Minimum Sidewalk width is a minimum of 6 feet.





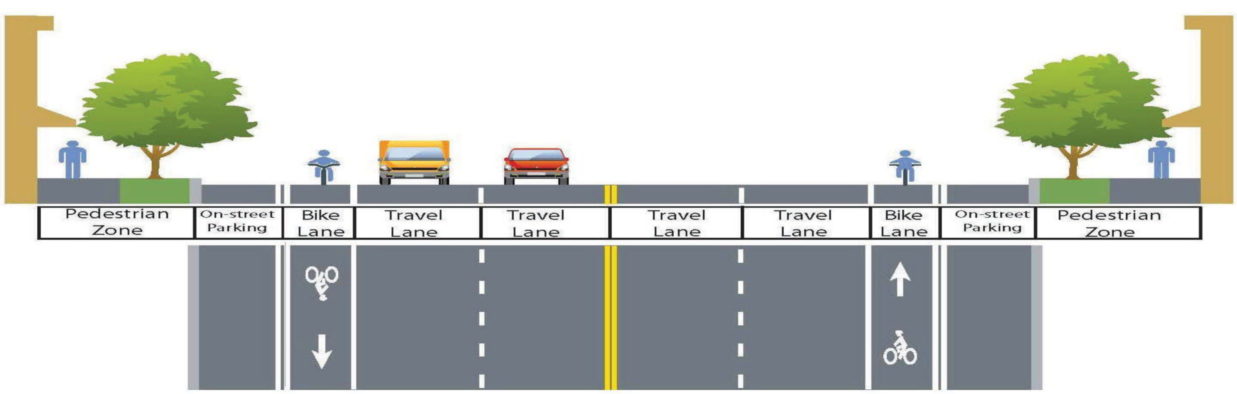
Industrial Boulevard Designation							
Minimum R.O.W (feet)	**Pedestrian Realm* (feet)**	**Tree Well or Swale**	**On-Street Parking (feet)**	**Bike Lane (feet)**	**Median Width (ft)**	**Lane Widths (feet)**	**ADT (vpd)**
100	2 X 17 = 34	TW	N/A	N/A	20	2 X 11 = 22 2 X 12 = 24	15,000 - 30,000
	2 X 11 = 22	TW	N/A	2 X 6 = 12	20	2 X 11 = 22 2 X 12 = 24	15,000 - 30,000
	2 X 10.5 = 21	TW	2 X 8 = 16	N/A	17	2 X 11 = 22 2 X 12 = 24	15,000 - 30,000
120	2 X 16 = 32	TW	N/A	N/A	20	4 X 11 = 44 2 X 12 = 24	15,000 - 50,000
	2 X 10 = 20	TW	N/A	2 X 6 = 12	20	4 X 11 = 44 2 X 12 = 24	15,000 - 50,000

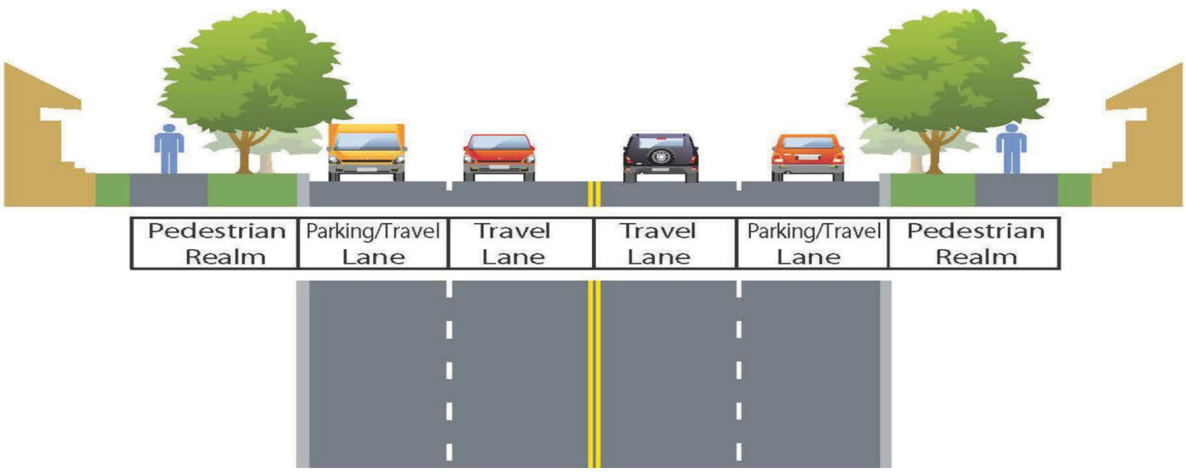
* - Minimum Sidewalk width is a minimum of 5 feet.



Commercial/Mixed Use Avenue Designation							
Minimum R.O.W (feet)	Pedestrian Realm* (feet)	Tree Well or Swale	On-Street Parking (feet)	Bike Lane (feet)	Median Width (ft)	Lane Widths (feet)	ADT (vpd)
80	2 X 21 = 42	TW	2 X 8 = 16	N/A	N/A	2 X 11 = 22	1,500 - 15,000
	2 X 11 = 22	TW	2 X 18 = 36**	N/A	N/A	2 X 11 = 22	1,500 - 15,000
	2 X 15 = 30	TW	2 X 8 = 16	2 X 6 = 12	N/A	2 X 11 = 22	1,500 - 15,000
	2 X 15 = 30	TW	N/A	2 X 6 = 12	N/A	2 X 11 = 22	1,500 - 15,000
	2 X 22 = 44	TW	N/A	N/A	N/A	2 X 11 = 22 + 1 X 14 (CLTL***) = 36	5,000 - 20,000
	2 X 14 = 28	TW	2 X 8 = 16	N/A	N/A	2 X 11 = 22 + 1 X 14 (CLTL***) = 36	5,000 - 20,000
	2 X 16 = 32	TW	N/A	2 X 6 = 12	N/A	2 X 11 = 22 + 1 X 14 (CLTL***) = 36	5,000 - 20,000
	2 X 18 = 36	TW	N/A	N/A	N/A	4 x 11 = 44	10,000 - 30,000
	2 X 10 =20	TW	2 X 8 = 16	N/A	N/A	4 x 11 = 44	10,000 - 30,000
	2 X 12 = 24	TW	N/A	2 X 6 = 12	N/A	4 x 11 = 44	10,000 - 30,000
100	2 x 28 = 56	TW	N/A	N/A	N/A	4 x 11 = 44	10,000 - 30,000
	2 x 22 = 44	TW	N/A	2 x 6 = 12	N/A	4 x 11 = 44	10,000 - 30,000
	2 x 20 = 40	TW	2 x 8 = 16	N/A	N/A	4 x 11 = 44	10,000 - 30,000
	2 x 10 = 20	TW	2 x 18 = 36**	N/A	N/A	4 x 11 = 44	10,000 - 30,000
	2 x 14 = 28	TW	2 x 8 = 16	2 x 6 = 12	N/A	4 x 11 = 44	10,000 - 30,000
	2 x 17 = 34	TW	N/A	N/A	N/A	6 x 11 = 66	10,000 - 30,000
	2 x 11 = 22	TW	N/A	2 x 6 = 12	N/A	6 x 11 = 66	10,000 - 30,000

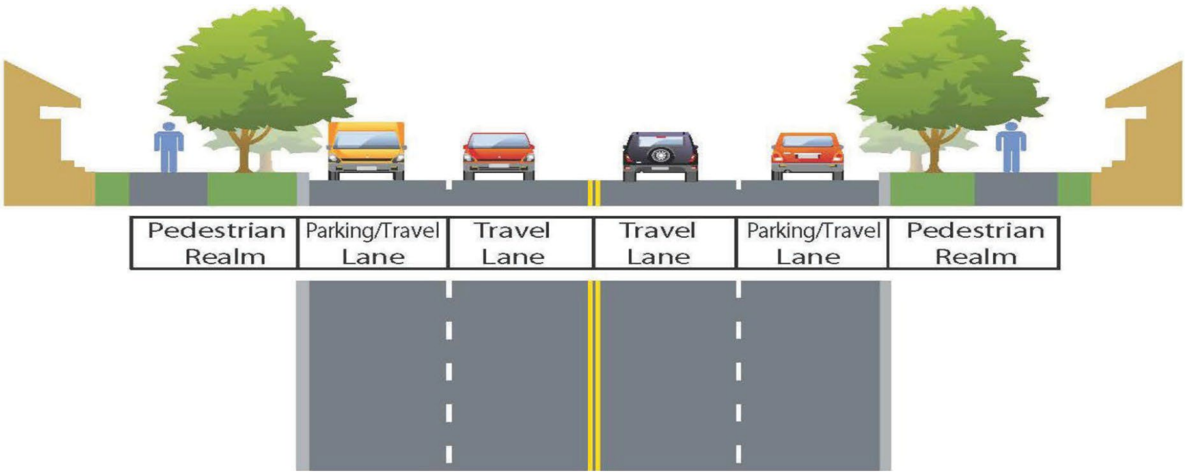
* - Minimum Sidewalk width is a minimum of 5 feet.
** - Angle Parking. Requires permission from the City Traffic Engineer.
*** - CLTL = Continuous Two-Way Left Turn Lane.





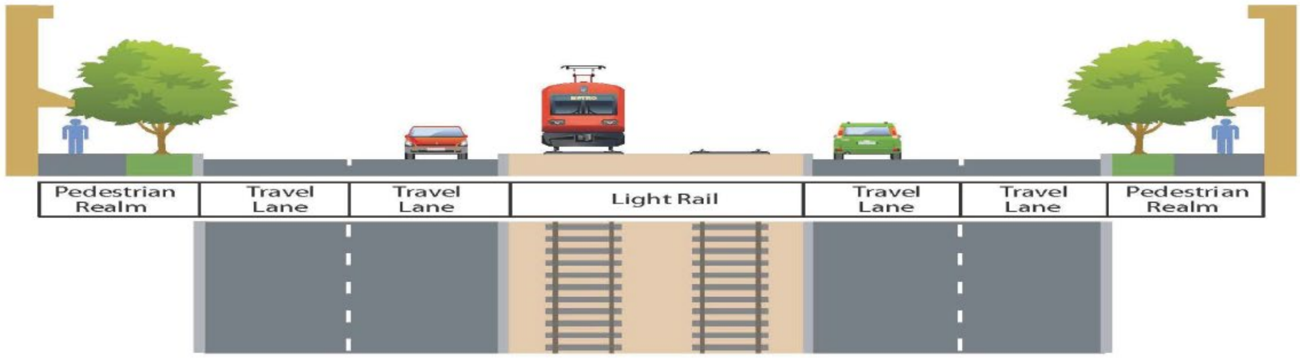
Transit Avenue Designation							
Minimum R.O.W (feet)	Pedestrian Realm* (feet)	Tree Well or Swale	On-Street Parking (feet)	Bike Lane (feet)	Median Width (ft)	Lane Widths (feet)	ADT (vpd)
80	2 x 11 = 22	2 x 10 =20	2 X 8 = 16	N/A	N/A	2 X 11 = 22	1,000 - 10,000
	2 x 8 = 16	2 x 7 = 14	2 X 8 = 16	2 X 6 = 12	N/A	2 X 11 = 22	1,000 - 10,000
	2 x 13 = 26	2 x 10 = 20	N/A	2 X 6 = 12	N/A	2 X 11 = 22	1,000 - 10,000
	2 X 8 = 16	2 x 10 = 20	N/A	N/A	N/A	4 x 11 = 44	5,000 - 20,000
	2 X 10 =20	TW	2 X 8 = 16	N/A	N/A	4 x 11 = 44	5,000 - 20,000
	2 X 12 = 24	TW	N/A	2 X 6 = 12	N/A	4 x 11 = 44	5,000 - 20,000
100	2 x 18 = 36	2 x 10 = 20	N/A	N/A	N/A	4 x 11 = 44	5,000 - 20,000
	2 x 12 = 24	2 x 10 = 20	N/A	2 x 6 = 12	N/A	4 x 11 = 44	5,000 - 20,000
	2 x 10 = 20	2 x 10 = 20	2 x 8 = 16	N/A	N/A	4 x 11 = 44	5,000 - 20,000
	2 x 14 = 28	TW	2 x 8 = 16	2 x 6 = 12	N/A	4 x 11 = 44	5,000 - 20,000

* - Minimum Sidewalk width is a minimum of 5 feet.



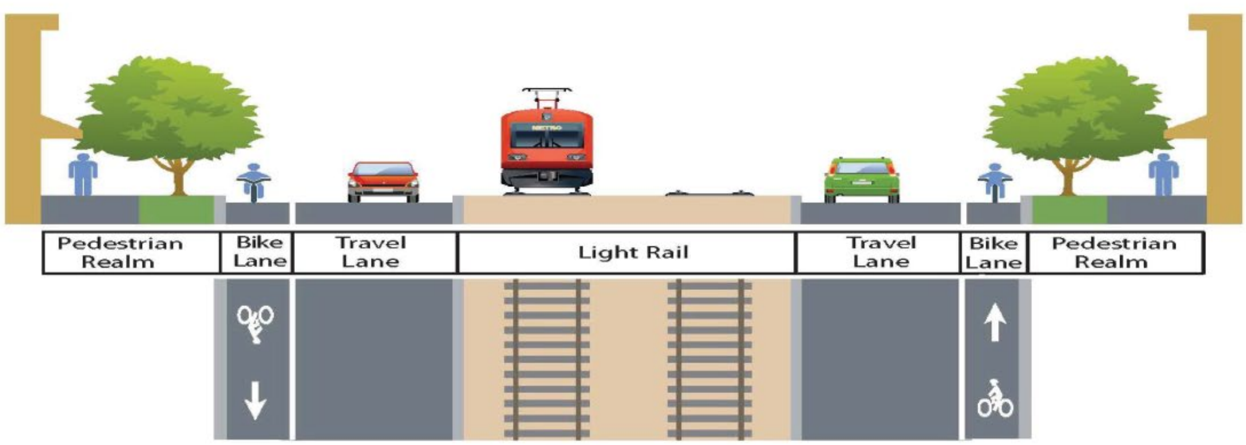
Residential Avenue Designation							
Minimum R.O.W (feet)	Pedestrian Realm* (feet)	Tree Well or Swale	On-Street Parking (feet)	Bike Lane (feet)	Median Width (ft)	Lane Widths (feet)	ADT (vpd)
80	2 x 11 = 22	2 x 10 =20	2 X 8 = 16	N/A	N/A	2 X 11 = 22	1,000 - 10,000
	2 x 8 = 16	2 x 7 = 14	2 X 8 = 16	2 X 6 = 12	N/A	2 X 11 = 22	1,000 - 10,000
	2 x 13 = 26	2 x 10 = 20	N/A	2 X 6 = 12	N/A	2 X 11 = 22	1,000 - 10,000
	2 X 8 = 16	2 x 10 = 20	N/A	N/A	N/A	4 x 11 = 44	5,000 - 20,000
	2 X 10 =20	TW	2 X 8 = 16	N/A	N/A	4 x 11 = 44	5,000 - 20,000
	2 X 12 = 24	TW	N/A	2 X 6 = 12	N/A	4 x 11 = 44	5,000 - 20,000
100	2 x 18 = 36	2 x 10 = 20	N/A	N/A	N/A	4 x 11 = 44	5,000 - 20,000
	2 x 12 = 24	2 x 10 = 20	N/A	2 x 6 = 12	N/A	4 x 11 = 44	5,000 - 20,000
	2 x 10 = 20	2 x 10 = 20	2 x 8 = 16	N/A	N/A	4 x 11 = 44	5,000 - 20,000
	2 x 14 = 28	TW	2 x 8 = 16	2 x 6 = 12	N/A	4 x 11 = 44	5,000 - 20,000

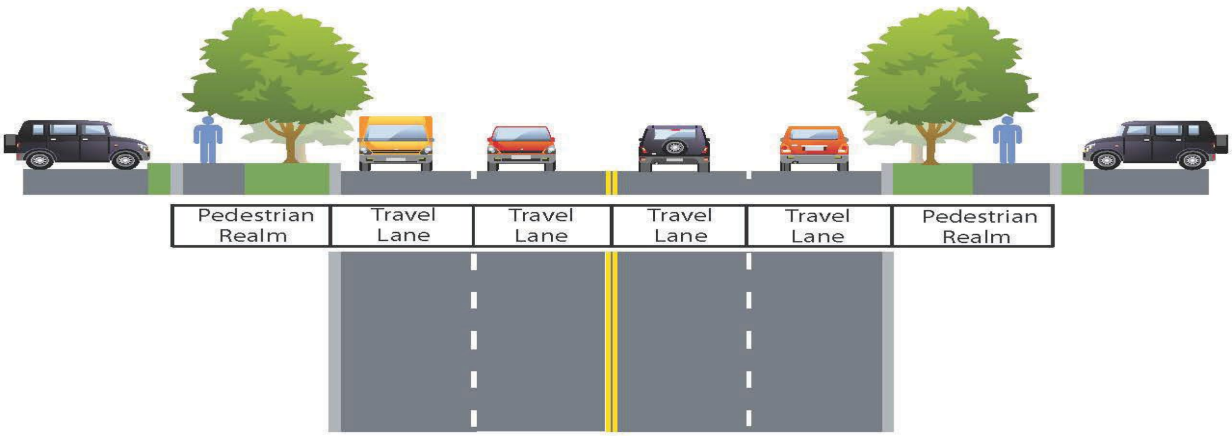
* - Minimum Sidewalk width is a minimum of 5 feet.



Transit Avenue Designation							
Minimum R.O.W (feet)	Pedestrian Realm* (feet)	Tree Well or Swale	On-Street Parking (feet)	Bike Lane (feet)	Transit Lanes** (ft)	Lane Widths (feet)	ADT (vpd)
100	2 x 27 = 54	TW	N/A	N/A	2 x 12 = 24	2 x 11 = 22	1,000 - 15,000
	2 x 21 = 42	TW	N/A	2 x 6 = 12	2 x 12 = 24	2 x 11 = 22	1,000 - 15,000
	2 x 19 = 38	TW	2 x 8 = 16	N/A	2 x 12 = 24	2 x 11 = 22	1,000 - 15,000
	2 x 13 = 26	TW	2 x 8 = 16	2 x 6 = 12	2 x 12 =24	2 x 11 = 22	1,000 - 15,000

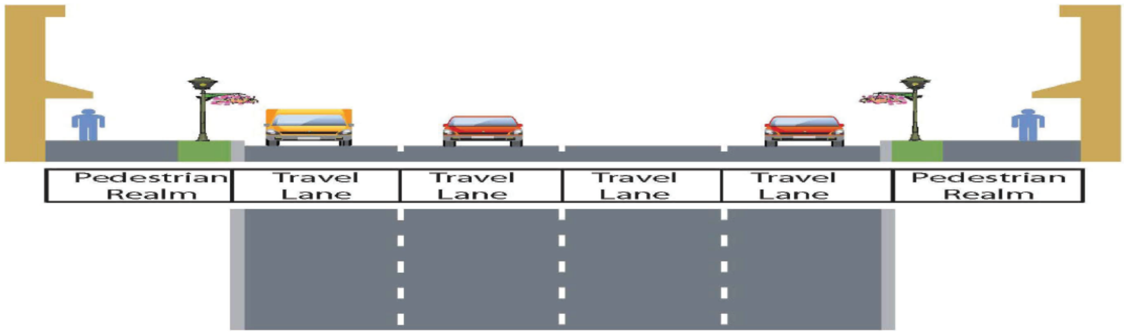
* - Minimum Sidewalk width is a minimum of 6 feet.
** - Transit lanes may be tranist vehicle onl or allow for mixed traffic.





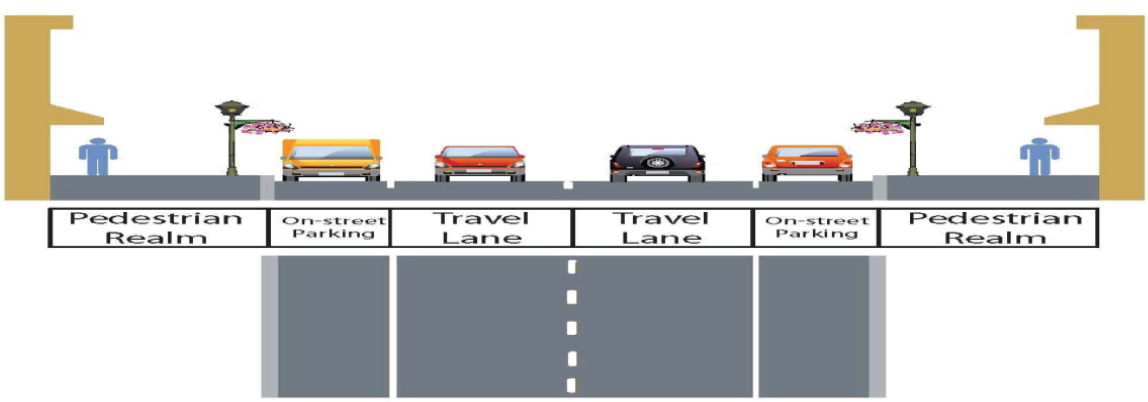
Industrial Avenue Designation							
Minimum R.O.W (feet)	Pedestrian Realm* (feet)	Tree Well or Swale	On-Street Parking (feet)	Bike Lane (feet)	Median Width (ft)	Lane Widths (feet)	ADT (vpd)
80	2 x 10 = 20	2 x 7 = 14	N/A	N/A	N/A	2 x 11 + 2 x 12 = 46	10,000 - 25,000
	2 x 11 = 22	2 x 10 = 20	N/A	N/A	N/A	1 x 14(CLTL**) + 2 x 12 = 38	5,000 - 15,000
90	2 x 18 = 36	TW	2 x 8 = 16	N/A	N/A	1 x 14(CLTL**) + 2 x 12 = 38	5,000 - 15,000
100	2 x 10 = 20	2 x 10 =20	N/A	N/A	N/A	1x14(CLTL**)+ 2x12+2x11= 60	10,000 - 35,000

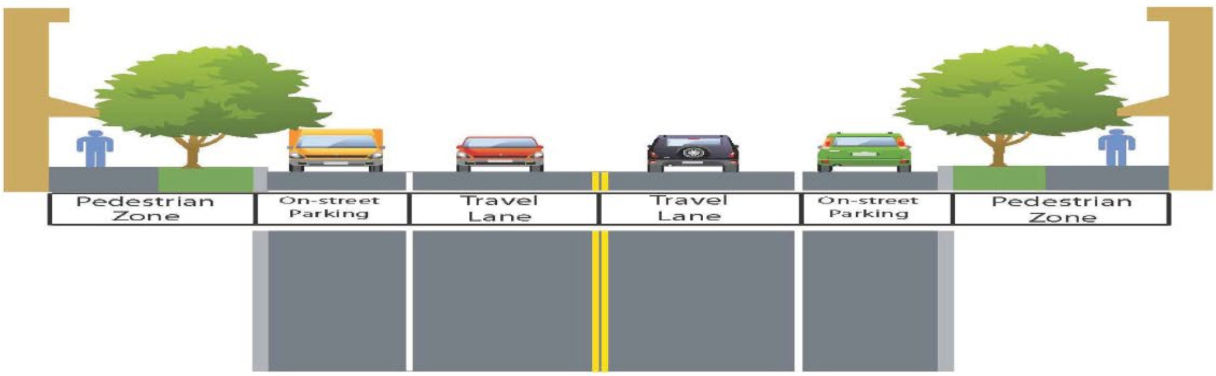
* - Minimum Sidewalk width is a minimum of 5 feet.
** - CLTL = Continuous Two-Way Left Turn Lane.



Commercial/Mixed Use Couplet Designation							
Minimum R.O.W (feet)	Pedestrian Realm* (feet)	Tree Well or Swale	On-Street Parking (feet)	Bike Lane (feet)	Median Width (ft)	Lane Widths (feet)	ADT (vpd)
60	2 x 11 = 22	TW	2 X 8 = 16	N/A	N/A	2 X 11 = 22	1,000 - 10,000
	2 x 13 = 26	TW	N/A	1 x 6 = 6	N/A	2 X 11 = 22	1,000 - 10,000
80	2 x 21 = 42	TW	2 X 8 = 16	N/A	N/A	2 X 11 = 22	1,000 - 10,000
	2 x 23 = 46	TW	N/A	1 X 6 = 6	N/A	2 X 11 = 22	1,000 - 10,000
	2 x 15 = 30	TW	2 x 8 = 16	1 X 6 = 6	N/A	2 X 11 = 22	1,000 - 10,000
	2 x 15.5 = 31	TW	2 X 8 = 16	N/A	N/A	3 x 11 = 33	1,500 - 15,000
	2 x 17.5 = 35	TW	N/A	1 X 6 = 6	N/A	3 x 11 = 33	1,500 - 15,000
	2 x 9.5 = 19	TW	2 X 8 = 16	1 X 6 = 6	N/A	3 x 11 = 33	1,500 - 15,000
	2 x 10 = 20	TW	2 X 8 = 16	N/A	N/A	4 x 11 = 44	5,000 - 20,000
	2 X 12 = 24	TW	N/A	1 X 6 = 6	N/A	4 x 11 = 44	5,000 - 20,000
	2 x 12.5 = 25	TW	N/A	N/A	N/A	5 x 11 = 55	10,000 - 25,000
100	2 x 14 = 28	TW	2 x 8 = 16	1 x 6 = 6	N/A	4 x 11 = 44	5,000 - 20,000
	2 x 14.5 = 29	TW	2 x 8 = 16	N/A	N/A	5 x 11 = 55	10,000 - 25,000
	2 x 15.5 = 31	TW	N/A	1 x 6 = 6	N/A	5 x 11 = 55	10,000 - 25,000
	2 x 9.5 = 19	TW	2 x 8 = 16	1 x 5 = 5	N/A	5 x 11 = 55	10,000 - 25,000

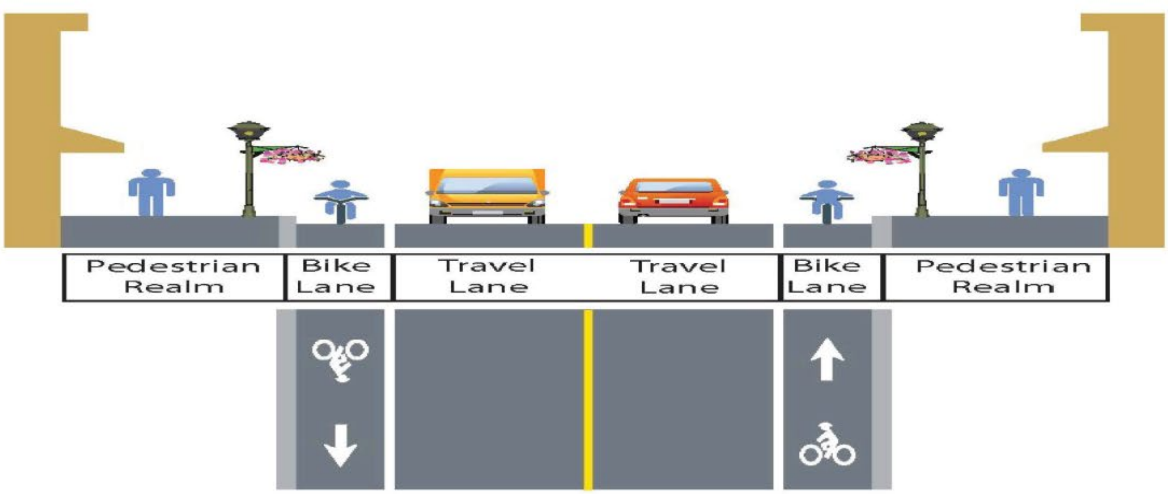
* - Minimum Sidewalk width is a minimum of 5 feet.

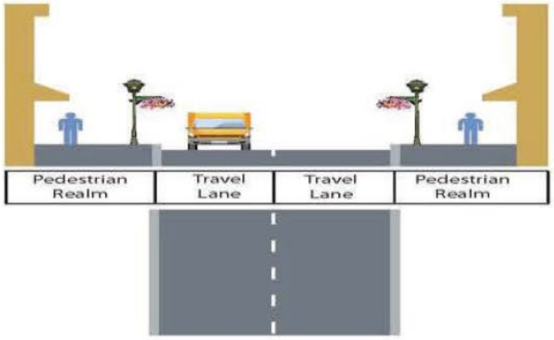


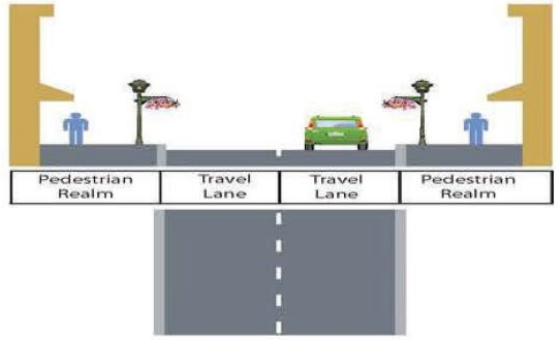


Commercial/Mixed Use Street Designation							
Minimum R.O.W (feet)	Pedestrian Realm* (feet)	Tree Well or Swale	On-Street Parking (feet)	Bike Lane (feet)	Median Width (ft)	Lane Widths (feet)	ADT (vpd)
	2 x 19 = 38	TW	N/A	N/A	N/A	2 X 11 = 22	1,000 - 10,000
60	2 x 11 = 22	TW	2 X 8 = 16	N/A	N/A	2 X 11 = 22	1,000 - 10,000
	2 x 13 = 26	TW	N/A	2 X 6 = 12	N/A	2 X 11 = 22	1,000 - 10,000
	2 X 12 = 24	TW	N/A	N/A	N/A	2 X 11 = 22 + 1 X 14 (CLTL**) = 36	1,000 - 15,000

* - Minimum Sidewalk width is a minimum of 5 feet.
** - CLTL = Continuous Two-Way Left Turn Lane.

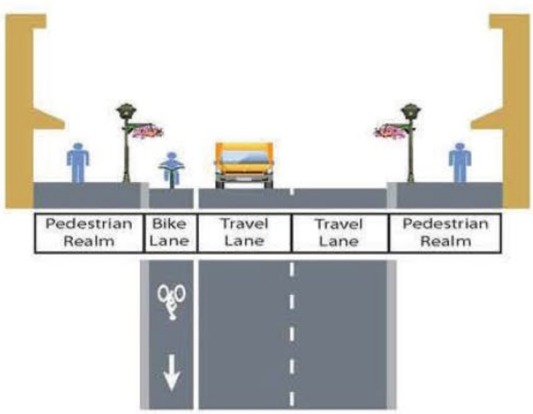


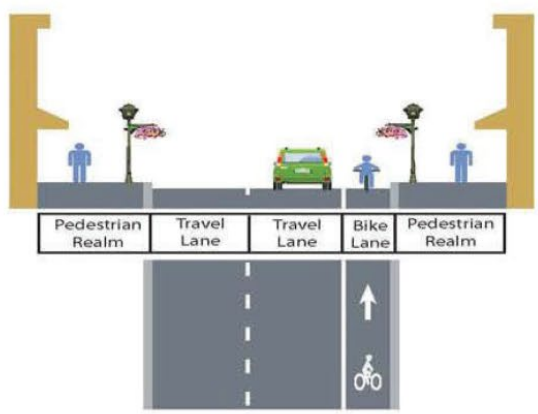


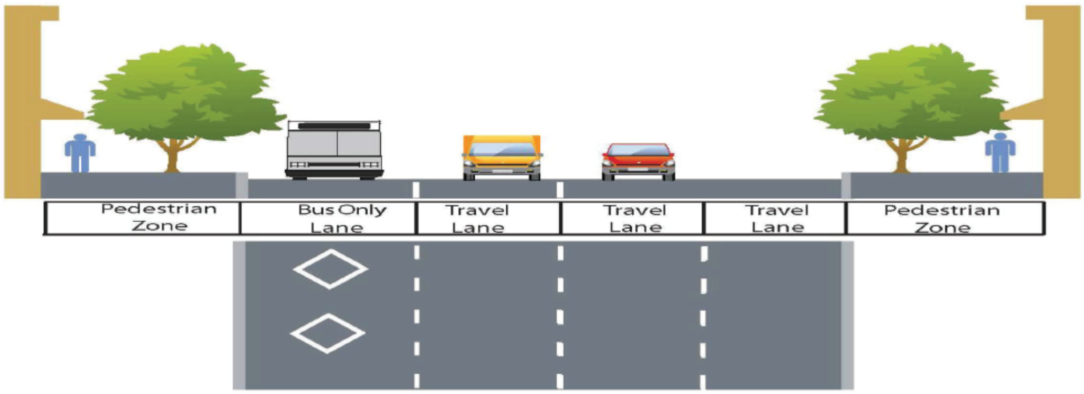


Residential Couplet Designation							
Minimum R.O.W (feet)	Pedestrian Realm* (feet)	Tree Well or Swale	On-Street Parking (feet)	Bike Lane (feet)	Median Width (ft)	Lane Widths (feet)	ADT (vpd)
60	2 x 11 = 22	TW	2 X 8 = 16	N/A	N/A	2 X 11 = 22	1,000 - 10,000
	2 x 13 = 26	TW	N/A	1 x 6 = 6	N/A	2 X 11 = 22	1,000 - 10,000
80	2 x 10 = 20	2 x 10.5 = 21	2 X 8 = 16	N/A	N/A	2 X 11 = 22	1,000 - 10,000
	2 x 10 = 20	2 x 13 = 26	N/A	1 X 6 = 6	N/A	2 X 11 = 22	1,000 - 10,000
	2 x 15 = 30	TW	2 x 8 = 16	1 X 6 = 6	N/A	2 X 11 = 22	1,000 - 10,000
	2 x 15.5 = 31	TW	2 X 8 = 16	N/A	N/A	3 x 11 = 33	1,500 - 15,000
	2 x 17.5 = 35	TW	N/A	1 X 6 = 6	N/A	3 x 11 = 33	1,500 - 15,000
	2 x 9.5 = 19	TW	2 X 8 = 16	1 X 6 = 6	N/A	3 x 11 = 33	1,500 - 15,000
	2 x 9.5 = 19	TW	2 X 8 = 16	1 X 6 = 6	N/A	3 x 11 = 33	1,500 - 15,000

* - Minimum Sidewalk width is a minimum of 5 feet.

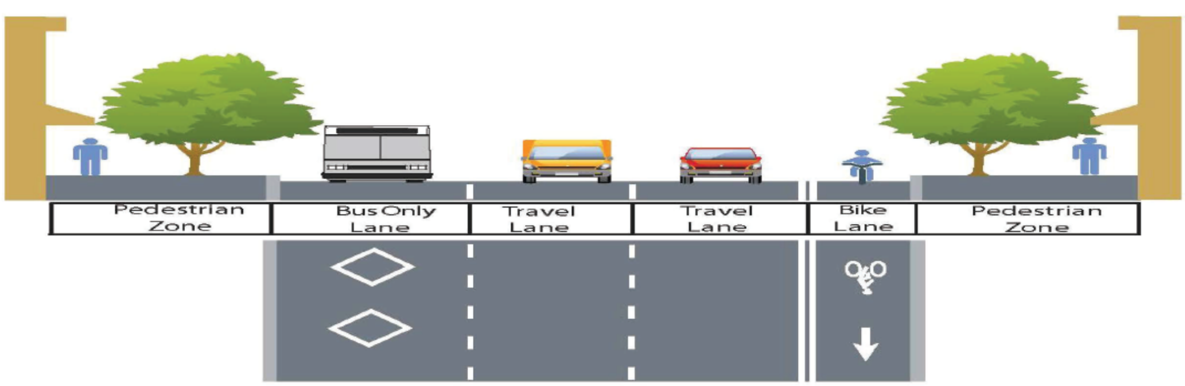


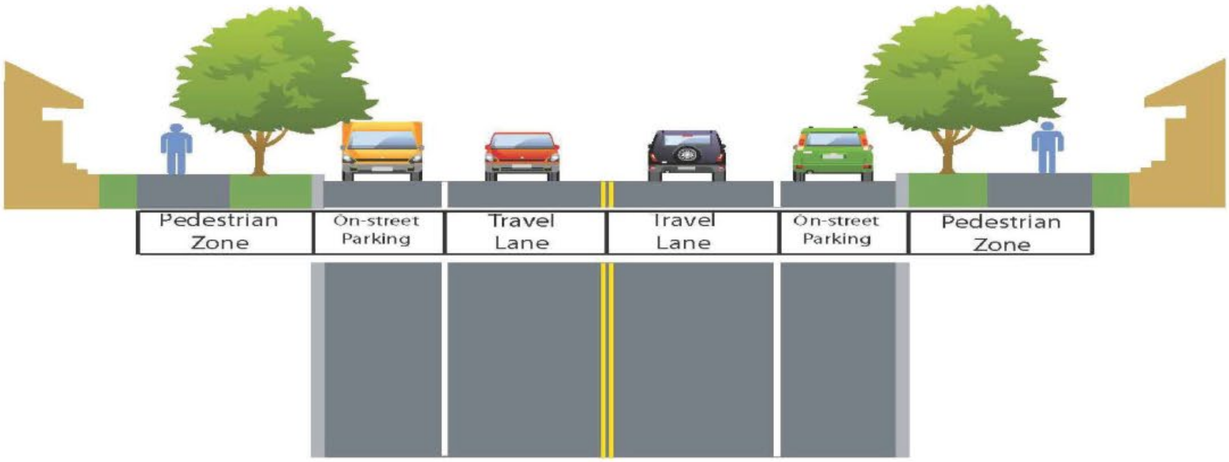




Transit Couplet Designation							
Minimum R.O.W (feet)	Pedestrian Realm* (feet)	Tree Well or Swale	On-Street Parking (feet)	Bike Lane (feet)	Median Width (ft)	Lane Widths (feet)	ADT (vpd)
60	2 x 10.5 = 21	TW	2 X 8 = 16	N/A	N/A	1 x 12 + 1 X 11 = 23	1,000 - 10,000
	2 x 12.5 = 25	TW	N/A	1 x 6 = 6	N/A	1 x 12 + 1 X 11 = 23	1,000 - 10,000
80	2 x 20.5 = 41	TW	2 X 8 = 16	N/A	N/A	1 x 12 + 1 X 11 = 23	1,000 - 10,000
	2 x 22.5 = 45	TW	N/A	1 X 6 = 6	N/A	1 x 12 + 1 X 11 = 23	1,000 - 10,000
	2 x 14.5 = 29	TW	2 x 8 = 16	1 X 6 = 6	N/A	1 x 12 + 1 X 11 = 23	1,000 - 10,000
	2 x 15 = 30	TW	2 X 8 = 16	N/A	N/A	1 x 12 + 2 x 11 = 34	1,500 - 15,000
	2 x 17 = 34	TW	N/A	1 X 6 = 6	N/A	1 x 12 + 2 x 11 = 34	1,500 - 15,000
	2 X 11.5 = 23	TW	N/A	1 X 6 = 6	N/A	1 x 12 + 3 x 11 = 45	5,000 - 20,000
	2 x 12 = 24	TW	N/A	N/A	N/A	5 x 11 = 55	10,000 - 25,000
100	2 x 13.5 = 27	TW	2 x 8 = 16	1 x 6 = 6	N/A	1 x 12 + 3 x 11 = 45	5,000 - 20,000
	2 x 14 = 28	TW	2 x 8 = 16	N/A	N/A	1 x 12 + 4 x 11 = 56	10,000 - 25,000

* - Minimum Sidewalk width is a minimum of 6 feet.

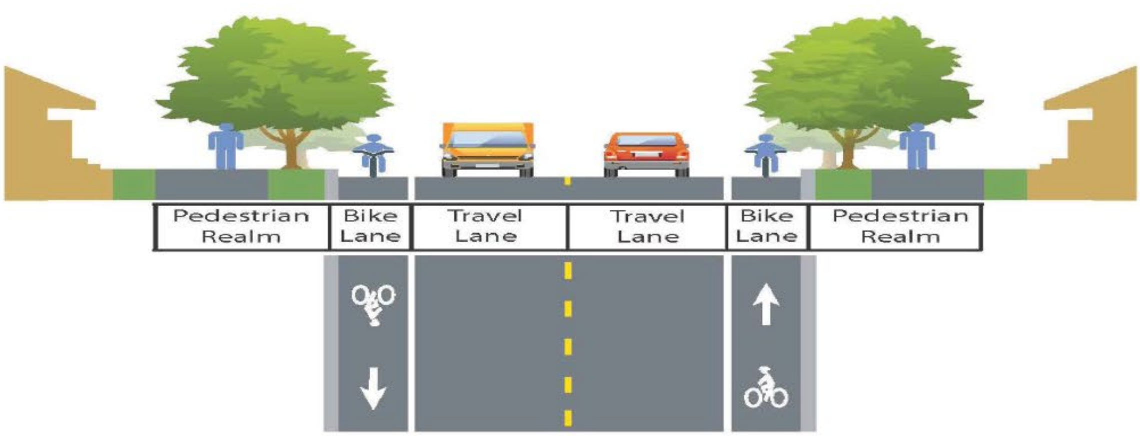




Residential Street Designation							
Minimum R.O.W (feet)	Pedestrian Realm* (feet)	Tree Well or Swale	On-Street Parking (feet)	Bike Lane (feet)	Median Width (ft)	Lane Widths (feet)	ADT (vpd)
50	2 x 12 = 24	TW	N/A **	N/A	N/A	2 x 13 = 26	500 - 5,000
60	2 x 9 = 18	2 x 8 = 16	N/A **	N/A	N/A	2 X 13 = 26	500 - 5,000
	2 x 11 = 22	TW	2 X 8 = 16	N/A	N/A	2 X 11 = 22	500 - 5,000
	2 x 13 = 26	TW	N/A	2 X 6 = 12	N/A	2 X 11 = 22	500 - 5,000

* - Minimum Sidewalk width is a minimum of 5 feet.

** - While space is not specifically set aside for parking, parking may be allowed on a 26' wide residential street.



City of Houston

Design Manual

Chapter 12

STREET CUT REQUIREMENTS

Chapter 12
Table of Contents

Street Cut Requirements

SECTIONS PAGE

Chapter 12

STREET CUT REQUIREMENTS

SECTION 1 – STREET CUT REQUIREMENTS OVERVIEW

12.1.01 CHAPTER INCLUDES

12.1.01.A Criteria for street pavement cuts, excavation, backfill, and pavement restoration in Public Ways.

12.1.01.B This chapter applies to excavation in Public Ways which have been improved for street, sidewalk, surface drainage, or related public transportation infrastructure.

12.1.02 REFERENCES

12.1.02.A Refer to the list of references in Chapter 1, General Requirements.

12.1.02.B Rules and Regulations for Excavation in Public Way

12.1.02.C City of Houston

12.1.02.D City of Houston Street Cut Ordinance

12.1.02.E City of Houston Standard Details

12.1.03 DEFINITIONS

12.1.03.A Excavation - An activity that disturbs, alters, or penetrates any portion of the public way that has been improved for street, driveway, sidewalk, surface drainage, or related public transportation infrastructure purposes. The term includes but is not limited to cutting, tunneling, jacking and boring, backfilling, restoring, and repairing the public way. The term does not include a transportation improvement or maintenance of publicly owned utility systems, such as water and wastewater lines and facilities.

12.1.03.B Backfill - Excavation fill material that meets city specified quality requirements or the placement thereof.

12.1.03.C Facility - Any structure device improvements that may be installed or maintained in, or, within, under, over or above a public way by an excavation.

12.1.03.D Five - Year CIP - Street improvement projects included in a Capital Improvement Program by the City of Houston, Harris County, METRO, TxDOT, or other organization for construction.

12.1.03.E Hole - Excavation in the Public Way with the excavation having a length less than the width of the pavement.

12.1.03.F Patch - Method of pavement replacement that is temporary in nature. A patch consists of: (1) the compaction of the subbase and aggregate base, and (2) the replacement, in kind, of the existing pavement for a minimum of two feet beyond the edges of the excavation in all directions.

12.1.03.G Public Way - Any public street right-of-way located in the city, including the entire area between the boundary lines of every way (including but not limited to roads, streets, alleys, highways, boulevards, bridges, tunnels, or similar thoroughfares), whether acquired by purchase, grant, or dedication and acceptance by the City or by the public that has been opened to use of the public for purpose of vehicular travel.

12.1.03.H Restoration - The process by which an excavated public way and surrounding area, including pavement and foundation, is returned to the same condition or better that existed before excavation.

12.1.03.I Trench - An excavation in the pavement with the excavation having length equal to or greater than the width of the pavement.

SECTION 2 – STREET CUT DESIGN REQUIREMENTS

12.2.01 DESIGN REQUIREMENTS

12.2.01.A Design project so that restoration returns public way to the same or better condition that existed prior to excavation. Minimum limits and methods for pavement restoration shall be in accordance with City Standard Details 02951-01, 02951-02, 02951-03, ~~02902-01~~02951-04, and ~~02902-02~~02951-05.

12.2.01.B Comply with requirements for all open-cut construction including excavation for auger or directional drilling insertion pits.

1. Saw cut existing pavements along lines parallel to and perpendicular to traveled way center lines unless otherwise approved by the City Engineer.

2. For concrete pavements and for Hot Mix Asphaltic Concrete (HMAC), conform to requirements of the City of Houston Infrastructure Design Manual, Chapter 10 – Street Paving Design, paragraph 10.2.02 and Section 3 – Geometric Design Requirements.

3. Construction documents shall require that one lane of traffic be open at all times with a flagman and work zone signage at both ends of the construction unless otherwise provided on an approved traffic control plan.

4. For open-cut construction in street pavement, the drawings shall call for secured steel plate to be placed over open-cut sections whenever the contractor is not working within the open-cut area so that traffic will have full use of the roadway.

12.2.01.C Prepare plan view drawings for all excavations that identify and locate existing underground facilities. If excavation is greater than or equal to three (3) feet in depth, then drawings shall also include profile view. Driveway projects do not require a profile view. The drawings, or verification statements, shall confirm that the underground facilities have been identified, located, and marked by the following organizations:

1. Texas Underground Facility Notification Corporation~~,~~
~~2. City of Houston Public Utilities Division and~~

~~3.~~2. City of Houston Traffic Operations Division~~.~~

12.2.01.D The City may require Plan and Profile drawings for complex projects or when the constructing agency has demonstrated previous non-compliance with underground facility location procedures.

12.2.01.E Plan view drawings shall be in accordance with Chapter 3 – Graphic Requirements in the City of Houston Infrastructure Design Manual.

12.2.01.F Final drawings shall include a list of City of Houston Standard Specifications and related standard details for excavation, bedding, backfilling, and pavement repair and resurfacing.

12.2.02 QUALITY ASSURANCE

12.2.02.A For projects which include conduits, duct banks or pipelines over one-inch, have final design drawings sealed, signed, and dated by the Professional Engineer responsible for development of the drawings.

END OF CHAPTER

City of Houston

Design Manual

Chapter 13

GEOSPATIAL DATA DELIVERABLES

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Geospatial Data Deliverables

SECTION 1 - GEOSPATIAL DATA DELIVERABLES OVERVIEW

13.1.01 CHAPTER INCLUDES

13.1.01.A Guidelines summarizing the geospatial data deliverables as referred to in the other chapters contained within the Infrastructure Design Manual (IDM) and GIS data in support of the Houston Public Works operations geospatial asset management and infrastructure.

13.1.02 BACKGROUND

13.1.02.A The City of Houston has adopted geographic information systems (GIS) technology in order to store, manage, and maintain spatially related geographic data. Houston Public Works (HPW) stores all its spatial assets within an enterprise geodatabase. It is a native data structure for ArcGIS, which is a collection of geographic datasets, including Feature Classes, Geometric Networks, raster data, attribute tables, annotation, Topology, etc. It provides the ability to leverage data relationships and enforce integrity using data-rich features. Its benefits include centralized data storage, efficient data delivery, Database Management Systems (DBMS) security and reliability, Geodatabase Replication, archiving, and multi-user editing.

13.1.02.B This chapter provides guidance for contractors and design consultants in developing and delivering digital geospatial data for public infrastructure projects, includ~~ed~~ing but not limited to capital improvement projects (CIP) and developer participation contracts (DPC). Also included in this chapter is guidance for contractors in developing and delivering digital geospatial data for some privately owned and operated telecommunications projects. These datasets shall be provided in the City of Houston Enterprise GIS geodatabase model format. GIS digital deliverables for projects shall meet or exceed the requirements detailed in this chapter. It is not the intent of this chapter to be a training guide for AutoCAD, ArcGIS or other geospatial software and associated products.

13.1.03 REFERENCES

13.1.03.A City of Houston Code of Ordinances, Chapter 33 – Planning and Development, Article IV – City Surveys.

13.1.03.B City of Houston, Geospatial Data Deliverables Properties Guide, Current Edition.

13.1.04 DEFINITIONS

13.1.04.A Computer Aided Design (CAD) – Preparation of drawings, plans, prints, and other related documents through the use of computer equipment and software programs.

13.1.04.B Database Management System (DBMS) – A set of software applications used to create and maintain databases according to a Schema. They provide tools for adding storing, changing, deleting, and retrieving data.

13.1.04.C Engineer of Record – A professional engineer who seals drawings, reports or documents for a project.

13.1.04.D Feature Class – Homogeneous collections of features with a common spatial representation and set of attributes stored in a database table.

13.1.04.E Geodatabase Replication – A method of distributing data across two or more geodatabases in order to synchronize data changes. An entire geodatabase or a subset of a geodatabase can be replicated. There are three types of Geodatabase Replication: 2-way replication, 1-way replication, and check-out replication.

13.1.04.F Geometric Network – A set of connected edges and junctions, along with connectivity rules, that are used to represent and model the behavior of a common network infrastructure in the real world. Geodatabase Feature Classes are used as the data sources to define the Geometric Network.

13.1.04.G GNSS - Global Navigation Satellite System which includes USA Global Positioning System (GPS), Russian Global Navigation Satellite System (GLONASS), and other regional systems.

13.1.04.H Metadata – A unit of information used to describe a particular characteristic of the data.

13.1.04.I Project Manager – An authorized representative of the City of Houston who manages the project or the Engineer of Record for private development.

13.1.04.J Registered Professional Land Surveyor (RPLS) - A surveyor currently registered and in good standing with State of Texas Board of Professional Engineers and Land Surveyors (TBPELS).

13.1.04.K Schema – The structure or design of a database or database object, such as a table, view, index, stored procedure, or trigger. In a relational database, the Schema defines the tables, the fields in each table, the relationship between fields and tables, and the grouping of objects within the database.

13.1.04.L Topology – The spatial relationships between adjacent or neighboring features.

SECTION 2 - DATA ACCURACY

13.2.01 SPATIAL REFERENCES

13.2.01.A For information regarding the official coordinate system utilized by the City of Houston, refer to the City of Houston Code of Ordinances, Article IV, Chapter 33, Section 33-81, unless project requirements differ.

13.2.02 HORIZONTAL ACCURACY

13.2.02.A The horizontal accuracy of any feature shall meet or exceed submeter accuracies of two (2) feet horizonal root mean square (RMS).

SECTION 3 - GIS DATA COLLECTION METHODS

13.3.01 COLLECTION METHOD REQUIREMENTS

13.3.01.A GIS digital data collection shall be captured using one of two approaches: field data collection with office processes or only office processes. The appropriate method shall be determined by the Engineer of Record and Project Manager. If the accuracy required in this chapter is not possible through office processes alone, field data collection is required.

13.3.01.B Field Data Collection with Office Processes.

1. Field data collection, if required, shall be performed by a Registered Professional Land Surveyor (RPLS).

2. Utilize conventional methods or Global Navigation Satellite System (GNSS) devices/receivers to achieve the accuracy required by this chapter.

3. Use the appropriate software to collect data in the field.

4. Collect the spatial location of assets specified in this chapter for which the accuracy required in this chapter is not possible through office processes alone. The flow lines and elevations can be determined from the post construction as-built or CAD drawings.

5. The line and polygon features can be created in the office provided they connect field verified points.

6. Provide a GIS deliverable signed and sealed by a RPLS that includes the process by which the field data is gathered, GNSS information (e.g. number of satellites), and any associated field notes and sketches.

13.3.01.C Office Processes Only.

1. Data from the post construction as-built and CAD drawings can be converted through various methods to digital features.

2. When digitizing features from maps/ drawings, the source, scale, date, and methods (i.e., process steps) shall be provided to the City and be signed and sealed by the Engineer of Record.

SECTION 4 - ASSET SPECIFICS

13.4.01 STORM WATER ASSET INFORMATION

13.4.01.A Storm Water Asset Descriptions.

1. Abandoned Gravity Main – Any storm water sewer that was installed, used, maintained, and is no longer in use (includes removed infrastructure).

2. Abandoned Open Drain – Any storm water open system (e.g., channel, ditch) that was filled in or replaced with storm water sewer.

3. Abandoned Point – Any storm water node (e.g., manhole, inlet, fitting) that was installed, used, maintained, and is no longer in use (includes removed infrastructure).

4. Detention – Storm water detention facilities (e.g., dry ponds) used to hold storm water for storm events.

5. Discharge Point – Location where storm water leaves a section of the drainage system to enter another section (e.g., outfall from storm sewer system to open system or roadside culvert to open system).

6. Easement – Storm or drainage real property that contains storm infrastructure or is used to convey storm water.

7. Fitting – Storm water feature that is structurally required at the terminus of a line or at the connection point of two or more lines (e.g., plug).

8. Gravity Main – A sewer line which conveys storm water by difference in elevation.

9. Inlet – Structure with a drop that moves storm water into storm sewer or underground drainage system.

10. Manhole – A device which, for pipe length restrictions, change of flow direction, and/or junction with another main, is placed at the end of a gravity main to allow equipment to diagnose and resolve issues while also providing enough clearance for a person to access.

11. Network Structure – A facility which contains infrastructure elements that directly pump and/or hold storm water for large storm events.

12. Open Drain – Any storm water open system (e.g., channel, ditch).

13.4.01.A continued

13. Underpass – Center point location of road crossing under highway or railroad.

14. Virtual Drainline – Virtual linear feature used to maintain connectivity in the storm infrastructure (primarily used to connect storm sewer outfall locations to open drainage system).

13.4.01.B Storm Water Asset Requirements.

1. As applicable, all storm water asset features must contain the required information as depicted in Table 13.1. This information must be delivered to the City following the guidelines outlined in SECTION 6 of this chapter.

2. For more detailed information regarding GIS data that must be provided for each storm water asset, such as field descriptions, subtypes and domain codes, or data processing workflows, refer to the Geospatial Data Deliverables Properties Guide.

Table 13.1– INFORMATION REQUIRED FOR STORMWATER ASSETS

	Asset													
Information	Abandoned Gravity Main	Abandoned Open Drain	Abandoned Point	Detention	Discharge Point	Easement	Fitting	Gravity Main	Inlet	Manhole	Network Structure	Open Drain	Underpass	Virtual Drainline
Abandon Status	X	X	X											
Active Flag			X	X	X		X	X	X	X				
Address		X	X		X				X	X	X	X	X	
Bank Material				X										
Bed Material		X		X								X		
Channel Name		X										X		
Comments				X										
Company	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Construction Material									X					
Council District	X	X	X	X	X	X	X	X	X	X	X	X	X	
Crossing Type													X	
Data Source Type	X		X		X		X	X	X	X	X			
Depth		X	X	X					X	X		X		
Discharge Type					X									
Downstream Depth								X						
Downstream	X							X						

Information	Asset													
	Abandoned Gravity Main	Abandoned Open Drain	Abandoned Point	Detention	Discharge Point	Easement	Fitting	Gravity Main	Inlet	Manhole	Network Structure	Open Drain	Underpass	Virtual Drainline
Elevation														
Downstream Storm Node	X							X						
Drainage Area	X							X						
Facility ID	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Fitting Type							X							
Flood Warning Light													X	
Flow Elevation					X									
Funding Number	X		X	X	X		X	X	X	X	X		X	
Funding Type	X		X	X	X		X	X	X	X	X		X	
Height	X				X			X						
Inlet Type									X					
Install Date	X		X	X	X		X	X	X	X	X		X	
Invert Elevation			X						X	X				
Length	X							X						
Line Type		X										X		X
Location Description				X			X						X	
Main Shape	X							X						
Maintained By	X		X	X	X	X	X	X	X	X	X	X	X	
Manhole Type										X				
Material	X				X			X						
Name				X							X		X	
Number of Crossings													X	
Owned By	X	X	X	X	X	X	X	X	X	X	X	X	X	
Pipe Type	X							X						
Plan Number	X		X	X	X		X	X	X	X	X		X	
Point Type			X											
Pond Area				X										
Pump Station													X	
Rain Gauge													X	
Record Drawing Number	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Rehabilitation Date				X							X	X		
Rim Elevation			X						X	X				
Rotation			X		X		X		X	X	X		X	

Information	**Asset**													
	Abandoned Gravity Main	Abandoned Open Drain	Abandoned Point	Detention	Discharge Point	Easement	Fitting	Gravity Main	Inlet	Manhole	Network Structure	Open Drain	Underpass	Virtual Drainline
Scada													X	
Side Material		X										X		
Slope	X							X						
Structure Type											X			
Utility Type						X								
UF ID	X	X	X		X	X	X	X	X	X	X	X		
Upstream Depth								X						
Upstream Elevation	X							X						
Upstream Storm Node	X							X						
Volume				X										
Wall Material			X							X				
Watershed				X										
Width	X	X			X	X		X				X		

*For publicly/privately funded projects only

13.4.02 WASTEWATER ASSET INFORMATION

13.4.02.A Wastewater Asset Descriptions.

1. Abandoned Wastewater Line/Point – Any wastewater infrastructure that was installed, used, and maintained, and is no longer in use but was not removed.

2. Casing – A pipe, typically made of steel, which is not designed to convey wastewater, but instead surrounds and protects a sewer line.

3. Cleanout – A device designed to allow access to the line for the diagnosing and resolving of structural or other issues with that line. Typically, these are installed on service leads, though they are rarely used on main lines.

4. Fitting – An appurtenance that is structurally required at the terminus of a line or at the connection point of two or more lines. Excepted from this Feature Class are cleanouts, manholes, network structures, and valves.

5. Force Main – A sewer line which conveys wastewater under pressure.

6. Gravity Main – A sewer line which, due to its slope, conveys wastewater using only gravity.

13.4.02.A continued

7. Manhole – A device which, for pipe length restrictions, change of flow direction, and/or junction with another main, is placed at the end of a gravity main to allow equipment to diagnose and resolve issues while also providing enough clearance for a person to access.

8. Network Structure – A facility which contains infrastructure elements that directly pump and/or treat wastewater.

9. Service Lead – Also called service line, a sewer pipe that connects a private property to a public sewer line.

10. Valve – An appurtenance installed on force mains that controls flow.

13.4.02.B Wastewater Asset Requirements.

1. As applicable, all wastewater asset features must contain the required information as depicted in Table 13.2. This information must be delivered to the City following the guidelines outlined in SECTION 6 of this chapter.

2. For more detailed information regarding GIS data that must be provided for each wastewater asset, such as field descriptions, subtypes and domain codes, or data processing workflows, refer to the Geospatial Data Deliverables Properties Guide.

Table 13.2- INFORMATION REQUIRED FOR WASTEWATER ASSETS

Information	**Asset**								
	Casing	Cleanout	Fitting	Force Main	Gravity Main	Manhole	Network Structure	Service Lead	Valve
Buried Depth		x				x			
Creation Source	*	*	*	*	*	*	*	*	*
Data Source Type	X	X	X	X	X	X	X	X	X
Datum	X	X	X	X	X	X	X	X	X
Datum Year	X	X	X	X	X	X	X	X	X
Diameter	X		X	X	X	X		X	X
Distance to Downstream Manhole		X	*			X		X	
Downstream Direction		X	*			X			
Downstream Invert					X				
Fiscal Year	X	X	X	X	X	X	X	X	X
Flow Elevation		X				X			
GFS Or WBS	*	*	*	*	*	*	*	*	*
GFS or WBS	*	*	*	*	*	*	*	*	*

Information	Asset								
	Casing	Cleanout	Fitting	Force Main	Gravity Main	Manhole	Network Structure	Service Lead	Valve
Number									
ILMS Number	*	*	*	*	*	*	*	*	*
Inlet Elevation						*	X		
Inlet Elevation 2						*			
Inlet Elevation 3						*			
In Service Date	X	X	X	X	X	X	X	X	X
Length	X			X	X			X	
Life Cycle Status	X	X	X	X	X	X	X	X	X
Material	X		X	X	X	X		X	
Notes	*	*	*	*	*	*	*	*	*
Owner	X	X	X	X	X	X	X	X	X
Percent Slope					X			X	
Plan Date	X	X	X	X	X	X	X	X	X
Plan Number	X	X	X	X	X	X	X	X	X
Plan Type	X	X	X	X	X	X	X	X	X
Project Number	*	*	*	*	*	*	*	*	*
Project Type	*	*	*	*	*	*	*	*	*
Record Drawing Number	**	**	**	**	**	**	**	**	**
Rim Elevation						X			
Size of Cover		X				X			
Subtype Code	X	X	X	X	X	X	X	X	X
Type						X			
Upstream Invert					X			X	

*If applicable
**For public/private projects only

13.4.03 WATER ASSET INFORMATION

13.4.03.A Water Asset Descriptions.

1. Abandoned Water Line/Point – Any water infrastructure that was installed, used, and maintained, and is no longer in use but was not removed.

2. Casing – A pipe, typically made of steel, which is not designed to carry water, but instead surrounds and protects a water line.

13.4.03.A continued

3. Control Valve – A valve that controls the flow of water and other fluids. By opening and closing the valve this will regulate how much volume is traveling the piping system.

4. Fitting – An appurtenance that is structurally required at the terminus of a line or at the connection point of two or more lines. Excepted from this Feature Class are control valves, hydrants, meters, pressure reducing stations, sampling stations, and system valves.

5. Hydrant – A structurally independent device used primarily for fire or water quality events.

6. Lateral Service – Also called service line, a water pipe that connects a public water line to a fire service and/or private property.

7. Meter – A device that measures water passing through a point. This also serves as a demarcation between a public ownership from private ownership.

8. Pressure Reducing Station – A facility which contains infrastructure elements that drastically and intentionally reduce water pressure to allow a large diameter main to be tapped by a small diameter main.

9. Pump Pressure Main – A water line which collects raw water from a source to a water treatment facility or distributes treated water from a water treatment facility to end users.

10. Sampling Station – A point at which a sample of water for testing and quality control purposes can be taken directly.

11. System Valve – An appurtenance installed on mains that control flow of water.

13.4.03.B Water Asset Requirements.

1. As applicable, all water asset features must contain the required information as depicted in Table 13.3. The information must be delivered to the City following the guidelines outlined in SECTION 6 of this chapter.

2. For more detailed information regarding GIS data that must be provided for each water asset, such as field descriptions, subtypes and domain codes, or data processing workflows, please see the Geospatial Data Deliverables Properties Guide.

Table 13.3- INFORMATION REQUIRED FOR WATER ASSETS

Information	Asset									
	Casing	Control Valve	Fitting	Hydrant	Lateral Service	Meter	Pressure Reducing Station	Pump Pressure Main	Sampling Station	System Valve
Creation Source	*	*	*	*	*	*	*	*	*	
Data Source Type	X	X	X	X	X	X	X	X	X	X
Diameter	X				X	X		X		X
Fiscal Year	X	X	X	X	X	X	X	X	X	X
GFS or WBS Number	*	*	*	*	*	*	*	*	*	*
GFS or WBS Number	*	*	*	*	*	*	*	*	*	*
Ground Cover								X		
Hydrant Lead Diameter				X						
ILMS Number	*	*	*	*	*	*	*	*	*	*
In Service Date	X	X	X	X	X	X	X	X	X	X
Large Main Diameter			*				*			
Length	X				X			X		
Life Cycle Status	X	X	X	X	X	X	X	X	X	X
Material	X				X			X		
Main Diameter				X		X				
Notes	*	*	*	*	*	*	*	*	*	
Owner	X	X	X	X	X	X	X	X	X	X
Plan Date	X	X	X	X	X	X	X	X	X	X
Plan Number	X	X	X	X	X	X	X	X	X	X
Plan Type	X	X	X	X	X	X	X	X	X	X
Project Number	*	*	*	*	*	*	*	*	*	*
Project Type	*	*	*	*	*	*	*	*	*	*
Record Drawing Number	**	**	**	**	**	**	**	**	**	**
Service Address						X				
Small Main Diameter			*				*			
Subtype Code	X	X	X	X	X	X	X	X	X	X

*If applicable
**For public/private projects only

13.4.04 GEOTECHNICAL AND ENVIRONMENTAL INFORMATION

13.4.04.A Geotechnical and Environmental Feature Class Descriptions.

1. geoBoring (Point) – Soil boring location. Soil borings are drilled to evaluate the soil conditions of a site or project location and to obtain soil samples.

13.4.04.A continued

2. geoBoringTestResults (Table) – Boring log test results stored in a tabular format.

13.4.04.B Geotechnical and Environmental Feature Class Requirements.

1. The boring point features are connected to the associated boring test results through the PROJECTID field. The PROJECTID field is a unique identifier generated by the consultant through the concatenation of the report type, report year, the WBS number and BoreID.

2. The relationship between the geoBoring point and the geoBoring Test Results is a one to many (1:M) relationship with one point being related directly back to many test results where the geoBoring point is the parent and the geoBoring Test Results is the child table. This data will be appended into a larger enterprise dataset maintained by the City where bore IDs are recurring between different reports. The City will create a separate unique identifier for the dataset during the City's internal quality control process, and prior to publishing to the production database.

3. To ensure that the data is distinct, the consultant will provide a project ID which will serve as the interim unique identifier delivered with the data. The PROJECT ID field must be formatted as follows:

4. PROJECT ID Format:

   a. ReportTypeReportYear_WBSNumber_BoreID

      (1) Sample Environmental Report: E2020_S-000035-0100-3_EB1 where by:

         (a) E = Environmental

         (b) 2020 = Report Year in a four digit (YYYY) year format

         (c) Underscore = separator character

         (d) S-000035-0100-3 = WBS Number in alphanumeric format

         (e) EB1 = Bore ID in alphanumeric format

      (2) Sample Geotechnical Report: G2021_ S-000035-0100-3_B1 where by:

         (a) G = Geotechnical

         (b) 2021 = Report Year in a four digit (YYYY) year format

13.4.04.B.4.a.(2) continued

(c) Underscore = separator character

(d) S-000035-0100-3 = WBS Number in alphanumeric format

(e) B1 = Bore ID in alphanumeric format

5. As applicable, all geotechnical and environmental features must contain the required information as depicted in Table 13.4. If utilizing a file geodatabase Feature Class format, the applicable information must be delivered to the City following the guidelines outlined in SECTION 6 of this chapter.

6. For more detailed information regarding GIS data that must be provided for each geotechnical or environmental feature, such as field descriptions, subtypes and domain codes, or data processing workflows, refer to the Geospatial Data Deliverables Properties Guide.

Table 13.4- INFORMATION REQUIRED FOR GEOTECHNICAL AND ENVIRONMENTAL FEATURE CLASSES

FIELD	**Feature Class**	
	geoBoring	geoBoringTestResults
PROJECTID	X	X
WBSNUMBER	X	
PROJECTNAME	X	
REPORTTYPE	X	
CONSULTANTPROJECTNO		X
REPORTSIGNEDDATE	X	
CONSULTANTNAME	X	
BOREID	X	
X*	X	
Y*	X	
LATITUDE**	X	
LONGITUDE**	X	
SURFACEELEV	X	
DEPTH	X	
WATERENCOUNTERED	X	
WATERLEVEL	X	
READINGDATE	X	
WATERLEVELREADING	X	
CONTAMINATION	X	
DRILLEDDATE	X	
SAMPLENO		X
SAMPLEDEPTHTOP		X
SAMPLEDEPTHBTM		X
SAMPLETYPE		X
SPT		X
WATERCONTENT		X
DRYDENSITY		X

FIELD	Feature Class	
	geoBoring	geoBoringTestResults
ATTERBERGLIMITSLL		X
ATTERBERGLIMITSPL		X
ATTERBERGLIMITSPI		X
PERPASSSIEVE200		X
TSFUNCONFCOMPTEST		X
TSFUUTEST		X
TSFCONFININGPRESS		X
TSFTORVANE		X
TSFPOCKETPENETROMETER		X
TYPEOFMATERIAL		X
PID**		X

*Only required for geotechnical borings and is not a requirement for environmental borings.
**Only required for environmental borings and/or test results and is not a requirement for geotechnical borings.

13.4.04.C Alternative Tabular Deliverable Requirements for Geotechnical and Environmental Data.

1. The City's preference is to receive boring locations in a file geodatabase Feature Class and Boring Log Test Results in a file geodatabase table, complying with the standards outlined in SECTION 6 of this chapter. However, Boring and Boring Test Result data may be delivered in a comma delimited (.CSV) text file, or Excel spreadsheet alternatively. The corresponding text file or excel spreadsheet must be named: BoringData_WBS_Number. For tabular data, the City will specify the delivery method during project planning.

2. Tabular Data Schema – Table 13.5 and Table 13.6 outline the geoBoring and geoBoring Test Results Schemas that must be utilized in any Excel or .CSV text file deliverable. The associated list values are described in Table 13.7, Table 13.8, and Table 13.9. Figure 13.1 and Figure 13.2 provide examples of said Excel or .CSV text file deliverables.

Table 13.5 - GEOBORING TABULAR ATTRIBUTE FIELDS

Field Name	Type	Description	List Values
PROJECTID	Text	Unique ID for the project populated by the consultant based on report type, year, the project WBS number, and bore ID. Format is: ReportTypeYear_WBSNumber_BoreID	
WBSNUMBER	Text	City of Houston assigned number for the project	
PROJECTNAME	Text	City of Houston assigned project name	
REPORTTYPE	Text	The report classification content either geotechnical or environmental	geoReportType
REPORTSIGNEDDATE	Date	Date the report was signed	
CONSULTANTNAME	Text	Name of the firm who produced the report	

Field Name	Type	Description	List Values
BOREID	Text	Alphanumeric unique identification number assigned to the boring location	
X*	Numeric	Horizontal coordinate	
Y*	Numeric	Vertical coordinate	
LATITUDE**	Numeric	Geographic coordinate in decimal degrees format measured North and South of the equator.	
LONGITUDE**	Numeric	Geographic coordinate in decimal degrees format measured East and West of the prime meridian.	
SURFACEELEV	Numeric	Vertical measurement of the height of the land surface (Feet)	
DEPTH	Numeric	Total distance from the top of the surface elevation to the bottom of the boring (Feet)	
WATERENCOUNTERED	Text	Measurement in Feet at which water was first encountered at the time of drilling	
WATERLEVEL	Text	Measurement in Feet of the water level 15-20 minutes after water was first encountered	
READINGDATE	Date	Date at which the water level measurement in Feet was read 24 hours or more after drilling completed	
WATERLEVELREADING	Text	The water level measurement in Feet read 24 hours or more after drilling completed	
CONTAMINATION	Numeric	Yes/No Field to flag whether or not contamination was detected	dYesNo
DRILLEDDATE	Date	Date the boring was drilled	

*The field is only required for geotechnical borings and is not a requirement for environmental borings.
**The field is only required for environmental borings and/or test results and is not a requirement for geotechnical borings.

Table 13.6 – GEOBORINGTESTRESULTS TABLE ATTRIBUTE FIELDS

Field Name	Type	Description	List Values
PROJECTID	Text	Unique ID for the project populated by the consultant based on report type, year, the project WBS number, and bore ID. Format is: ReportTypeYear_WBSNumber_BoreID	
WBSNUMBER	Text	City of Houston assigned number for the project	
PROJECTNAME	Text	City of Houston assigned project name	
CONSULTANTNAME	Text	Name of firm who produced the report	
REPORTSIGNEDDATE	Date	Date the report was signed	
BOREID	Text	Alphanumeric unique identification number assigned to the boring location	
SAMPLENO	Text	The unique identification number for the sample	
SAMPLEDEPTHTOP	Numeric	Top depth of the boring in Feet	
SAMPLEDEPTHBTM	Numeric	Bottom depth of the boring in Feet	
SAMPLETYPE	Text	Type of sample taken	geoSampleType
SPT	Numeric	Standard penetration test (SPT) measurement in blows/Feet	
WATERCONTENT	Numeric	Percent water content in sample	
DRYDENSITY	Numeric	Dry density of sample measured in pounds per cubic foot (pcf)	

Field Name	Type	Description	List Values
ATTERBERGLIMITSLL	Numeric	Atterberg limits – Liquid Limit (%)	
ATTERBERGLIMITSPL	Numeric	Atterberg limits – Plastic Limit (%)	
ATTERBERGLIMITSPI	Numeric	Atterberg limits – Plasticity Index (%)	
PERPASSSIEVE200	Numeric	Percent passing sieve 200 (%)	
TSFUNCONFCOMPTEST	Numeric	Shear strength (TSF) unconfined compression test	
TSFUUTEST	Numeric	Shear strength (TSF) triaxial compression (UU) test	
TSFCONFININGPRESS	Numeric	Shear strength (TSF) Confining pressure TSF	
TSFTORVANE	Numeric	Shear strength (TSF) torvane	
TSFPOCKETPENETROMETER	Numeric	Shear strength (TSF) pocket penetrometer	
TYPEOFMATERIAL	Text	Type of soil material. For geotechnical borings refer to ASTM D2487. For environmental borings refer to ASTM D2488.	
PID*	Numeric	Photoionization Detector (PID) value (ppm)	

*The field is only required for environmental borings and/or test results and is not a requirement for geotechnical borings.

Table 13.7 - GEOYESNO LIST

Value	Description
0	No
1	Yes

Table 13.8 - GEOSAMPLETYPE LIST

Value	Description
UD	Undisturbed Sample
SS	Split Spoon Sample
AG	Auger Cuttings
SPT	Standard Penetration Test

Table 13.9 - GEOREPORTTYPE LIST

Value	Description
GEO	Geotechnical
ENV	Environmental

WBS Number	
Project Name	
Report Type (Geo or Env)	
Report Signed Date	
Consultant Name	

Bore ID	X	Y	Depth	Water First Encountered at Time of Drilling	Water Level 15-20 minutes after Water was First Encountered	Water Level Measured 24 hours or more After Drilling Completed		Contamination (Y/N)	Drilled Date
						Reading Date	Water Level Reading		

Figure 13.1- SAMPLE HEADING AND FORMAT FOR GEOBORING EXCEL DATA

SUMMARY OF LABORATORY TEST RESULTS *Geotechnical Consultant's Name*								PROJECT NAME: COH WBS NUMBER: CONSULTANT PROJECT NUMBER:								
BORING NO.	SAMPLE				SPT (BLOWS/ FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	ATTERBERG LIMITS			PERCENT PASSING SIEVE 200 (%)	SHEAR STRENGTH (TSF)				TYPE OF MATERIAL
	NO.	DEPTH (FT)		TYPE				LL (%)	PL (%)	PI (%)		UNCONFINED COMPRESSION TEST	UU TEST (CONFINING PRESSURE, TSF)	TORVANE	POCKET PENETR-OMETER	
		Top	Bottom													
B-1	1	0.0	0.5	AG		25										Fat Clay
	2	0.5	2.0	UD		23	100	68	24	44	95	1.5		2.0	2.0	Fat Clay
	3	2.0	4.0	UD		22							1.25 (0.4)	1.5	1.5	Fat Clay
	4	4.0	5.5	SS	22	12					35					Silty Sand
B-2	1															
LEGEND	UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD SS = SPLIT SPOON SAMPLE AG = AUGER CUTTINGS SPT = STANDARD PENETRATION TEST							LL = LIQUID LIMIT PL = PLASTIC LIMIT PI = PLASTICITY INDEX UU = TRIAXIAL COMPRESSION				NOTES:				

FIGURE

Figure 13.2- SAMPLE TEST RESULTS FOR GEOBORINGTESTRESULTS EXCEL DATA

13.4.05 TELECOMMUNICATIONS ASSET INFORMATION

13.4.05.A Telecommunications Asset Descriptions

1. Network Node – An equipment at a fixed location that enables wireless communication between user equipment and a communications network. This includes distributed antenna system nodes.

2. Repeater Pole – A pole on which a repeater antenna (efficient antenna system that receives weak signals and widens transmission coverage) is installed.

3. Fiber Optic Cable – A line containing strands of fiber made of glass or plastic that transmit information quickly over long distances via pulses of light.

13.4.05.B Telecommunications Asset Requirements

1. As applicable, all telecommunications asset features must contain the required information as depicted in Table 13.10. The information must be delivered to the City following the requirements outlined in SECTION 6 of this chapter.

2. For more detailed information regarding GIS data that must be provided for each telecommunications asset, such as field descriptions, subtypes and domain codes, or data processing workflows, refer to the Geospatial Data Deliverables Properties Guide.

Table 13.10 – INFORMATION REQUIRED FOR TELECOMMUNICATIONS ASSETS

Information	**Asset**		
	Network Node	Repeater Pole	Fiber Optic Cable
Cable ID			X
Company Name	X	X	X
Council District	X	X	X
Depth			X
E911 Address	X	X	
From Street			X
ILMS Number	*	*	*
Latitude	X	X	
Length			X
Longitude	X	X	
Material		X	X
Node Name	X		
Node Number	X		
Owner			X
Pole Elevation		X	
Pole ID		X	
Pole Status	X	X	

Information	**Asset**		
	Network Node	Repeater Pole	Fiber Optic Cable
Pole Owner	X	X	
Street Name			X
To Street			X
Zip Code	X	X	

*If applicable

SECTION 5 - DATA QUALITY

13.5.01 TOPOLOGICAL CHECKS

13.5.01.A Appropriate QA/QC standards will be utilized to ensure that the data is topologically correct, accurate, and complete. This shall include:

1. Geometry.

   a. General:

      (1) Point and linear features will be snapped together where appropriate to support networks. Maintain connectivity where all features are connected, and correct flow direction with no duplications, and reversed flow values. Looped systems of uniform size are exempted from this check. Flow direction will be checked for each line using symbology with arrows that point in the direction of digitized flow. Lateral service features must always be drawn towards the meter or hydrant they are serving.

      (2) In instances where two points are constructed on top of each other, digitize one point in the actual location and offset the second point, when applicable per the following tolerances:

         (a) XY Tolerance: 0.0032808333 US Survey Feet

         (b) Z Tolerance: 0.001 US Survey Feet

         (c) M Tolerance: 0.001

      (3) No duplicate features.

      (4) All features must be placed in their correct location, meeting accuracy requirements within this chapter.

   b. Points:

      (1) All point features shall be placed in their correct location, meeting accuracy requirements within this chapter.

   c. Lines:

      (1) No erroneous overshoots, undershoots, dangles, or intersections in the line work.

13.5.01.A.1.c continued

(2) Linear features will not be broken for labeling or aesthetic purposes.

(3) Linear storm water and wastewater features shall be continuous and drawn from upstream to downstream.

2. Attributes.

a. Data Completeness:

(1) Every feature must have each attribute, as applicable, filled with accurate and consistent information as is expected for any submission.

(2) All fields will be checked against the submitted, stamped, and approved plan and profile set for extraneous and erroneous entries.

(3) No null values in required fields.

SECTION 6 - DELIVERABLE SUBMISSION REQUIREMENTS

13.6.01 FORMAT

13.6.01.A All GIS datasets shall be delivered to the City of Houston electronically in an ESRI file geodatabase ArcGIS format with associated Metadata, unless otherwise specified in this chapter. Shapefiles will not be accepted as a submission format.

13.6.01.B For details regarding the digital deliverable submission process please refer to the Geospatial Data Deliverables Properties Guide.

END OF CHAPTER

City of Houston

Design Manual

Chapter 15

TRAFFIC AND SIGNAL DESIGN REQUIREMENTS

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TRAFFIC AND SIGNAL DESIGN REQUIREMENTS

SECTION 1 – TRAFFIC AND SIGNAL DESIGN OVERVIEW

15.1.01 CHAPTER INCLUDES

15.1.01.A Criteria for the design of traffic and signal requirements.

15.1.02 REFERENCES

15.1.02.A References listed are the latest edition, version, amendments, and recodifications unless otherwise noted.

1. Refer to the reference lists in Chapter 1 - General Requirements and Chapter 10 - Street Paving Design Requirements.

2. A Policy on Geometric Design of Highways and Streets ("The Green Book"), AASHTO

3. City of Houston Code of Ordinances

    a. Chapter 40 – Streets and Sidewalks

    b. Chapter 42 – Subdivisions, Developments and Platting

    c. Chapter 45 – Traffic

4. City of Houston Construction Code Amendments, latest adopted amendments[1]

5. City of Houston, Infrastructure Design Manual (IDM)~~.~~

6. City of Houston, Neighborhood Traffic Management Program (NTMP)

7. City of Houston, Standard Details~~, Current Edition~~

8. City of Houston, Standard Operations Procedure (SOP) TMG – 905 Left Turn Warrants[2]

9. City of Houston, Standard Specifications~~, Current Edition~~

Refer to the weblink for reference:
[1] https://www.houstonpermittingcenter.org/help/codes
[2] This reference can be obtained from Transportation and Drainage Operations

15.1.02.A continued

10. City of Houston Vision Zero High Injury Network (HIN)[3]

11. Highway Capacity Manual (HCM), TRB

12. Highway Safety Improvement Program (HSIP)

13. Houston Bike Plan[4]

14. International Building Code (IBC), edition adopted by City of Houston[5]

15. Major Thoroughfare and Freeway Plan (MTFP)[6]

16. Manual for Assessing Safety Hardware (AASHTO MASH)

17. National Cooperative Highway Research Program (NCHRP), Report 350

18. National Cooperative Highway Research Program (NCHRP), Report 812

19. National Electrical Code (NEC)

20. National Electrical Safety Code (NESC)

21. ~~6F~~Roundabout Informational Guide~~, Current Edition~~

~~2.~~22. Standard Highway Sign Designs for Texas (SHSD)

23. Texas Manual on Uniform Traffic Control Devices (TMUTCD)

24. Traffic Signal Timing Manual~~, Current Edition~~

~~3.~~25. Transit-Oriented Development Map[7]

26. Transportation Impact Analyses for Site Development (An ITE Proposed Recommended Practice), ITE

27. Trip Generation~~, Current Edition~~ (An ITE Informational Report, Institute of Transportation Engineers, Washington, D.C.)

28. Trip Generation Handbook, ITE

~~4.~~29. Trip Generation Manual

Refer to the weblink for reference:
[3] https://www.houstontx.gov/visionzero/
Refer to the weblink for reference:
[4] https://www.houstonbikeplan.org/
[5] https://www.houstonpermittingcenter.org/building-code-enforcement/code-development#agency-links-416
[6] https://www.houstontx.gov/planning/transportation/MTFP.html
[7] https://houstontx.gov/planning/tod-standards.html

15.1.02.A continued

30. TxDOT Access Management Manual

31. TxDOT CRIS crash database[8]

32. TxDOT Traffic Signal Manual~~, Current Edition~~

~~5.~~33. Walkable Places Program[9]

~~15.1.03 City of Houston, Standard Details, Current Edition~~

~~15.1.04 City of Houston, Standard Specifications, Current Edition~~

~~15.1.05~~15.1.03 DEFINITIONS

~~15.1.05.A~~15.1.03.A Access Management - ~~is t~~The systematic control of the location, spacing, design and operation of ~~d~~Driveways, ~~m~~Median openings, intersections, bike lanes, and ~~a~~Auxiliary L~~l~~anes.

~~15.1.05.B~~15.1.03.B ADT - ~~is t~~The average daily traffic volume. It represents the total two-way traffic on a street for some period less than a year, divided by the total number of days it represents, and includes both weekday and weekend traffic. Usually, ADT is adjusted for day of the week, seasonal variations, and/or vehicle classifications.

15.1.03.C Auxiliary Lane - ~~is a~~A lane striped for use as an acceleration lane, deceleration lane, right-turn lane, or left-turn lane, but not for through traffic use.

15.1.03.D Background Conditions – Represents the amount of traffic and geometric changes that will be on the area roadway network without any proposed development during build-out, interim, and the horizon year.

15.1.03.E Battery Back Up/Uninterrupted Power Supply – An uninterruptible power supply/battery backup (UPS/BBU) system provides emergency power to the traffic signal cabinet by supplying power from a separate source (batteries) when utility power is not available. The system may also function as a power conditioner and/or voltage regulation device. UPS/BBU systems consist of an enclosure or cabinet, the batteries, the power inverter/conditioner, a battery charger (usually integral to the inverter), and automatic and manual bypass switches.

~~15.1.05.C~~15.1.03.F Blue Tile Street Sign - A street sign made of ¾ inch square blue and white colored ceramic tiles embedded in a concrete curb.

[8] https://cris.dot.state.tx.us/public/Query/app/home
[9] https://houstontx.gov/planning/wp-program.html

~~15.1.05.D~~15.1.03.G Central Business District - ~~District shall mean t~~The area bounded by Interstate Highway 45, United States Highway 59, and Interstate Highway 10.

~~15.1.05.E~~15.1.03.H Connection Spacing - ~~is t~~The distance between connections, which is measured along the edge of the traveled way from the closest edge of pavement of the first access connection to the closest edge of pavement of the second access connection.

15.1.03.I Corner Clearance - ~~is t~~The distance along the edge of the traveled way from the closest edge of pavement of the intersecting public or private street to the closet edge of pavement of the nearest ~~d~~Driveway.

~~15.1.05.F~~15.1.03.J Courtyard Style Development - As defined in the City of Houston Code of Ordinances, Chapter 42 – Subdivisions, Developments and Platting, Section 42-1.

15.1.03.K Design Exception - ~~shall mean a~~Any City Engineer approved variation from the design requirements listed in this chapter.

~~15.1.05.G~~15.1.03.L Development Project - Any public or private project that would modify land use in a way that would require an Access Management Form or Traffic Impact Analysis.

~~15.1.05.H~~15.1.03.M Driveway - ~~is a~~An access connection constructed within the public right-of-way, used to connect a public or private street with adjacent property.

15.1.03.N Driveway Permit ~~–~~ Permit issued by the Building Official based upon the latest version of the ~~Section 3110.4 of the Houston Amendments to the 2006~~ International Building Code adopted by the City and its amendments~~or latest revisions~~. Driveway ~~p~~Permits for access to ~~F~~freeways, ~~H~~highways, ~~F~~frontage ~~R~~roads, ~~T~~tollways and ~~F~~farm to ~~M~~market ~~R~~roads are not under the jurisdiction of the City of Houston. Driveway approvals from the appropriate agency with jurisdiction is required with building permit application.

~~15.1.05.I~~15.1.03.O Driveway Radius – The radius of the curb return from the Driveway edge to the street curb.

~~15.1.05.J~~15.1.03.P Engineer of Record - A Professional Engineer who seals drawings, reports or documents for a project. The engineer or engineering company that will be signing and sealing or otherwise taking responsibility for any study or plan that requires an engineering design.

15.1.03.Q Existing Conditions – Represents the performance of the existing street network and traffic volumes.

15.1.03.R Flashing School Beacon – Speed limit sign beacon used to indicate that the displayed speed limit is in effect. It is used in conjunction with a sign used to indicate the speed limit where a reduced school speed limit has been established.

15.1.03.S Flag Staff Driveway – A Driveway within the flag staff of a flag lot. For flag lot definition refer to City of Houston Code of Ordinances, Chapter 42 – Subdivisions, Developments and Platting, Section 42-1.

15.1.03.T High-Visibility Crosswalk – Crosswalk that is marked with white diagonal lines at 45-degree angle to the line of the crosswalk or with white longitudinal lines parallel to traffic flow, to increase visibility to motorists.

~~15.1.05.K~~15.1.03.U Intersection Limits - ~~shall mean t~~The functional portion of the intersection and shall be defined as the extent or limit of turning bays unless otherwise defined by the City Engineer.

15.1.03.V Joint Access ~~See "Shared Access"~~ Driveway – A single Driveway serving two abutting lots or parcels. ~~It is also referred to as combined Driveway approach and will not require a hared ccess agreement with abutting property owner.~~

15.1.03.W Leading Bicycle Interval – A Leading Bicycle Interval is a signal phase that displays a bicycle phase, if provided, prior to the associated vehicle phase. This treatment allows a bicyclist to establish right-of-way in an intersection and can also increase bicyclist visibility.

~~15.1.05.L~~15.1.03.X Leading Pedestrian Interval – A Leading Pedestrian Interval is a signal phase that displays the pedestrian walk phase prior to the associated vehicle phase. This treatment allows a pedestrian to establish right-of-way in an intersection, and can also aid in pedestrian visibility for drivers, bicyclists, and other system users.

15.1.03.Y Major Activity Center - ~~shall mean t~~Those areas designated as Major Activity Centers pursuant to Section 42-2734 of the Code of Ordinances of the City of Houston, Texas.

15.1.03.Z Major Thoroughfare – A public street designated as a principal thoroughfare or thoroughfare on the latest edition of the City of Houston's Major Thoroughfare and Freeway Plan.

~~15.1.05.M~~15.1.03.AA Management District – A district created by the State of Texas to supplement public services such as in public safety, security, business and economic development as well as beautification inside the district boundaries, which are located within the City of Houston limits. This includes downtown and uptown districts.

15.1.03.BB Median - ~~is t~~The portion of a divided street separating opposing traffic flows. A ~~m~~Median may be traversable or non-traversable.

15.1.03.CC Mitigation Conditions – Represents the performance of the future street network with the proposed project and with proposed mitigations resulting from the proposed project. Modifications to roadway and intersection features that would minimize the negative impacts to roadway safety and operations that are projected to occur as a result of a Development Project.

15.1.03.DD Multimodal Service Standards (MMSS) – Requirements for travel across all modes that capital projects and private Development Projects shall include in their scopes to benefit the safety and mobility of the public.

15.1.03.EE Multi-unit Residential (MUR) Development – As defined in the City of Houston Code of Ordinances, Chapter 42 – Subdivisions, Developments and Platting, Section 42-1.

15.1.03.FF Permanent Access Easement – A privately maintained and owned street easement approved by the commission that provides for vehicular access to three or more single-family residential units and which shall be either a Type 1 Permanent Access Easement or a Type 2 Permanent Access Easement, each of which is defined in section 15.2.07.

15.1.03.GG Permitted Phase – A traffic signal phase that requires vehicles to yield to conflicting vehicles, bicycle, and pedestrian movements.

15.1.03.HH Projected Conditions – Represents the performance of the street network for a future year, “build scenario”, which represents the future street volumes with the proposed project in place. Other than changes in traffic volumes, the Projected Conditions scenario includes the same street network conditions as the Background Conditions scenario.

15.1.03.II Protected Phase – A traffic signal phase that gives vehicles the right-of-way without any conflicting movements.

15.1.03.JJ Protected/Permitted Phase – A combination of traffic signal phases that provides the Protected Phase first, followed by the Permitted Phase, or vice versa.

15.1.03.KK School Advance Warning Assembly – Sign used to warn road users that they are approaching a school area that might include school buildings or grounds, a school crossing, or school related activity.

15.1.03.LL School Crosswalk Warning Assembly – Sign used to warn road users that they are approaching a crossing where schoolchildren cross the roadway if combined with an AHEAD plaque. Sign is used to warn approaching road users of the location of a crossing where schoolchildren cross the roadway if combined with a diagonal downward pointing ARROW.

15.1.03.MM School Speed Limit Assembly – Sign used to indicate the speed limit where a reduced school speed limit has been established.

15.1.03.NN School Zone – School crossing zone, school speed zone, or simply a School Zone means a reduced-speed zone designated on a street by the City to facilitate safe crossing of the street by children going to or leaving a public or private elementary or secondary school during the time the reduced speed limit applies.

~~15.1.05.N~~15.1.03.OO Shared Access/Shared Driveway - ~~is a~~A single ~~connection~~Driveway serving two or more adjoining lots or parcels where the shared portion of access extends into the private property and shared access agreement with adjoining property owners is required. Shared Access/Shared Driveways include Flag Staff Driveways, Courtyard Style Development or Multi-unit Residential (MUR) Development Driveways.

15.1.03.PP Sight Distance - ~~is t~~The distance visible to the driver of a passenger vehicle measured along the normal travel path of a street from a designated vehicle location and to a specified height above the street when the view is unobstructed by traffic. Refer to AASHTO, Geometric Design of Highways and Streets (~~C~~current ~~E~~edition), for application to specific design needs such as stopping ~~s~~Sight ~~d~~Distance~~,~~ and other sight requirements.

15.1.03.QQ Slow Streets – Slow Streets is an advisory measure to discourage through traffic on local streets. Temporary devices are placed at intersections to communicate that the street is a slow and shared environment between all road users. The street remains open to all traffic, including emergency vehicles, and thus does not trigger the processes for Speed or Volume Control as outlined in the Neighborhood Traffic Management Program (NTMP).

15.1.03.RR Speed or Volume Control – Speed Control and Volume Control are two tracks of the NTMP which administers requests for traffic calming devices in residential neighborhoods. A Speed Control project is intended to address speeding problems with speed cushions. A Volume Control project is intended to address cut-through traffic and speeding problems within a neighborhood area with various traffic calming devices.

~~15.1.05.O~~15.1.03.SS Storage ~~Lane~~ Length - ~~is t~~The portion of an A~~a~~uxiliary L~~l~~ane required to store the number of vehicles expected to accumulate in the lane.

15.1.03.TT Tax Increment Reinvestment Zone (TIRZ) – A political subdivision, which is created by City Council, allowing investments in public improvements to be made and the resulting incremental tax is used to pay for the improvements within the district.

15.1.03.UU TIA Impacted Intersection – Any intersection that has been determined to bear public impacts to roadway safety or mobility by a proposed Development Project and that will require specific mitigation as determined by the criteria of ~~15.2.02~~ 15.2.03 - Traffic Studies for Site Development.

15.1.03.VV Traffic Circle – A traffic calming element consisting of a physical, circular structure installed in the center of an intersection to require a circular flow within the intersection. Traffic Circles are different from roundabouts, which tend to be larger, integrate path deflection, and utilize yield-on-entry.

15.1.03.WW Traffic Signal Heads – An assembly of one or more signal faces that is provided for controlling traffic movements on one or more approaches.

15.1.03.XX Transit Corridor Street - ~~is a road along a rail corridor (non-freight) designated on the Major Thoroughfare and Freeway Plan with definition defined in Chapter 42, Code of Ordinances.~~ A Major Thoroughfare designated on the MTFP that METRO has proposed or maintains as a route for a guided rapid transit or fixed guideway transit system.

15.1.03.YY Transit-Oriented Development (TOD) Street – A public street designated as a primary TOD street or secondary TOD street on the transit-oriented development plan.

15.1.03.ZZ Vehicle Level of Service (VLOS) – The City of Houston's specific terminology for all Levels of Service (LOS) computations and thresholds that focus on the LOS of vehicular users. Refer to Highway Capacity Manual for different LOS.

15.1.03.AAA Vulnerable Road Users – Travelers who are most at risk in traffic because they are unprotected by an outside shield, namely pedestrians, bicyclists, and people with disabilities, as they sustain a greater risk of injury in any collision against a vehicle and are therefore highly in need of protection against such collisions.

15.1.03.BBB Walkable Places (WP) Street – A public street designated as a primary WP street or secondary WP street on the WP plan.

~~15.1.05.P~~15.1.03.CCC Wireless Broadband – Wireless Broadband is a type of telecommunication service that provides high-speed internet access without the need for cables or wires. It uses radio waves or satellite signals to transmit data between devices and networks.

SECTION 2 – TRAFFIC AND SIGNAL DESIGN REQUIREMENTS

15.2.01 MULTIMODAL SERVICE STANDARDS

15.2.01.A To ensure that all roadway projects serve all road users, the City of Houston has defined Multimodal Service Standards (MMSS). All projects impacting the public right-of-way shall comply with all applicable MMSS requirements.

15.2.01.B The Multimodal Service Standards (MMSS) are established in Table 15.1 and Table 15.2. Roadway projects must make every attempt to fully satisfy them, and no project will be approved that lowers any element below existing levels unless doing so still satisfies the requirements for those elements.

15.2.01.C Vehicular Level of Service (VLOS) is not considered a Multimodal Service Standard. Where VLOS can be improved while still satisfying all Multimodal Service Standards, doing so can be beneficial to the driver experience and to vehicular emissions goals. However, VLOS goals are secondary to MMSS.

15.2.01.D Existing roadway features may already satisfy MMSS requirements if they are in good repair.

15.2.01.E MMSS and VLOS shall be checked, documented, and reported for existing and proposed conditions for a project that satisfies any of the following criteria:

1. Is proposed to increase or decrease the number of vehicle lanes along a corridor or at an intersection.

2. Is proposed to reduce the width of pedestrian realm along a corridor or at an intersection.

3. Is required to include this analysis as part of another IDM section or report.

15.2.01.F The MMSS requirements apply to all projects impacting the public right-of-way. Specific applications follow:

1. All intersection and roadway reconstruction projects require compliance with both the site adjacent and TIA Impacted Intersections requirements.

2. All Development Projects that require an Access Management form must comply with site adjacent requirements as required by Code of Ordinances, Chapter 40.

3. Development Projects that require a Traffic Impact Analysis (TIA) must comply with both site adjacent requirements as well as all intersections included in the TIA analysis area (“TIA Impacted Intersections”). Certain requirements apply only to certain categories of traffic impact, as defined in Table 15.4.

15.2.01.G For every applicable road and intersection, the MMSS analysis shall identify the current conditions of the facilities defined in Table 15.1 and identify any deficiencies that must be mitigated.

15.2.01.H Specific MMSS standards are defined in other sections of the IDM; Table 15.1 and Table 15.2 reference the appropriate sections.

Table 15.1 - CORRIDOR MMSS REQUIREMENT APPLICABILITY

Corridor MMSS Requirement Applicability				
Design Element (MMSS Requirement)	**Project Type**			
	Development Project[1] (TIA Category 1)	**Development Project[1] (TIA Category 2)**	**Development Project[1] (TIA Category 3+)**	**Capital Project[2]**
Pedestrian Realm (Ch. 17, Section 3)	Sidewalks and safety/frontage buffers on all site-adjacent public streets, side of street immediately adjacent to development only	All sidewalks and safety/frontage buffers along corridor		
Bicycle Facilities (Ch. 17, Section 4)	N/A	For site frontage ≥ 100-ft: All site-adjacent bicycle facilities required by the Houston Bike Plan, side of street immediately adjacent to development only	All bicycle facilities required by the Houston Bike Plan along the corridor and 100-ft along cross streets	
Bus Stops (Ch. 17, Section 5)	N/A	All bus stops, existing or planned along the frontage of the development	All bus stops, existing or planned along the corridor and within 100-ft of any intersection	

Corridor- in- Scope:
1) Development Project: Site-adjacent parts of public street
2) Capital Project: Entire corridor within scope of project.

Table 15.2 – INTERSECTION MMSS REQUIREMENT APPLICABILITY

Intersection MMSS Requirement Applicability

Design Element (MMSS Requirement)	Project Type			
	Development Project[1] (TIA Category 1)	Development Project[1] (TIA Category 2)	Development Project[1] (TIA Category 3+)	Capital Project[2]
Sidewalks (17.3.01.C)	All sidewalks at site-adjacent corners of intersections.	All sidewalks at all intersections.	All sidewalks at all intersections AND a minimum 100-ft from the ROW line on each intersecting street.	
Curb Ramps (17.3.02.A)	Curb ramps on site-adjacent corners of intersections and corresponding receiving ramps.	All curb ramps for all legal crossings at all intersections, including all receiving ramps.		
Intersection Corner Radii (Table 10.3)	N/A	All site-adjacent intersection corners.	All corners of all intersections.	
Curb Extensions (17.3.02.C)	N/A	All adjacent midblock crossings and adjacent intersection legs.	All corners of all intersections.	
Bus Stops (Ch. 17, Section 5)	N/A	All bus stops within 100-ft of a site-adjacent intersection.	All bus stops within 100-ft of all intersections.	
Intersection Bicycle Facilities (17.4.03)	N/A	Fully accommodate all existing/future bicycle facilities defined by the Houston Bike Plan at all intersections.		
Pavement Markings (15.2.06)	N/A	All pavement markings within intersection functional areas.		
Pedestrian Push Buttons (15.2.14)	N/A	All pedestrian push buttons at all legal pedestrian crossings at signalized intersections.		
Pedestrian Signal Heads (15.2.14)	N/A	All pedestrian signal heads at all legal pedestrian crossings at signalized intersections.		
Bicyclist Signal Heads (15.2.14 and 17.4.03.H)	N/A	All bicycle signal heads for all approaches to intersection with an existing dedicated bicycle facility.		
Pedestrian Crossing Signal Timing (15.2.14)	N/A	Ensure signal timing incorporates a walk speed of 3 ft/s and look for opportunities to implement lead pedestrian/bicycle interval and actuation-free pedestrian phases.		

Intersections in Scope:
1) Development Project: Site-adjacent intersections and TIA-impacted intersections
2) Capital Project: All intersections within scope of project

15.2.02 TRAFFIC ~~ENGINEERING STUDY FOR~~ AND DESIGN STUDIES

15.2.02.A GENERAL

~~Whenever a new roadway is constructed, or when changes are proposed to the cross section of an existing roadway, a Traffic Engineering Study should be performed to determine critical design criteria for the project. Example of projects that may modify the cross section of an existing roadway include the dedication of one or multiple lanes to transit vehicles or pavement marking modifications for implementation of bicycle facilities.~~

~~General considerations for a Traffic Engineering Study:~~

1. Traffic and design studies are required to document the approval of changes to public streets, intersections, and traffic control as well as provide justification for the approved changes and alternatives considered. The specific studies required will depend on the scope of the project and must be coordinated with Houston Public Works.

2. Roadway projects associated with private development do not normally need to specifically satisfy the requirements of this section and should instead follow the requirements of Section 15.2.03 - Traffic Studies for Site Development.

~~A. The scope of a proposed Traffic Engineering Study shall be coordinated with Transportation and Drainage Operations.~~

~~B. A Traffic Engineering Study should emphasize roadway safety for all modes of transportation. Access management strategies should be considered for their potential safety benefits. These strategies can include location of driveways; locations of median openings; and turn restrictions.~~

~~1.~~3. ~~A~~ T~~t~~raffic and design studies are required ~~engineering study shall be prepared~~ for:

   a. New or reconstructed thoroughfare or collector streets; ~~roadway construction~~

   b. New or reconstructed local streets that differ from the standard cross sections shown in Tables 10.7 and 10.8; ~~Roadway reconstruction~~

   c. New or reconstructed intersection of two or more thoroughfare/collector streets; ~~Existing roadway cross section modification (e.g. for inclusion of transit, bicycle, or pedestrian infrastructure)~~

d. New, reconstructed, or modified roundabout;

e. New or reconstructed traffic signal;

f. New or modified bicycle facility;

g. Dedicated transit facilities in the road right-of-way;

h. New or enhanced designated pedestrian or trail crossings; and

i. Any other project that has the capacity to modify the cross section and/or traffic control along a roadway.

~~C. The recommendations of the Traffic Engineering Study for design will address such issues including but not limited to:~~

~~1. Number of lanes~~

~~2. Lane assignments~~

~~3. Traffic control including roundabouts and traffic signals~~

~~4. Access management (including driveway locations, median openings, and turn restrictions), and~~

~~5. Accommodations for bicyclists, pedestrians, and transit services~~

4. One project may require several types of studies to document and justify the project. Project types and associated reports are defined in Table 15.3 - Requirements for Study Modules. The scope of needed studies for a project shall be coordinated with Transportation & Drainage Operations.

5. The studies included in this section do not need to be standalone documents if the required scope items are fully included in another approved document, such as a Traffic Impact Analysis (TIA) or Design Concept Report (DCR).

~~D. The Traffic Engineering Study will comply with requirements of the most recent versions of the Texas Manual on Uniform Traffic Control Devices (TMUTCD), Transportation Research Board Highway Capacity Manual (HCM), AASHTO A Policy on Geometric Design of Highways and Streets ("Green Book"), and other standards of traffic engineering practice, as appropriate.~~

~~E. Computer simulation modeling software used in the development of the Traffic Engineering Study must be approved by the City Traffic Engineer for use.~~

~~F. When prepared for City of Houston Capital Projects, study findings will be summarized and documented in the Traffic Engineering Report (TER) for design.~~

Table 15.3 – REQUIREMENTS FOR STUDY MODULES

Scope of Project	**Study Modules**					
	Safety Analysis	Corridor & Access Management Analysis	Intersection Design and Traffic Control Analysis	Intersection VLOS Analysis	Pedestrian Crossing Analysis	Traffic Signal Warrant Analysis
Roadway Construction / Reconstruction	**Y**	**Y**	**Y**	**Y**	**Y**	M
Intersection Construction / Reconstruction	**Y**	N	**Y**	**Y**	N	M
New/Rebuilt Traffic Signal	M	N	**Y**	**Y**	N	**Y**
New/enhanced pedestrian crossings	N	N	M	M	**Y**	M
Road diet / Lane reallocation / Bicycle facilities	**Y**	**Y**	M	**Y**	**Y**	M
Safety studies	**Y**	M	N	N	M	N

Notes:
Y – Study module always required for scope of project
M – Study module may be required by Houston Public Works
N – Study module not usually required unless requested by Houston Public Works

15.2.02.B ~~15.05.02 COMPONENTS OF TRAFFIC ENGINEERING STUDY~~STANDALONE REPORTS

~~1. The following sections summarize general components of a Traffic Engineering Study. Specific scope and level of detail should be coordinated with the City Traffic Engineer to tailor the study to the specific design project.~~

15.2.02.B.1 continued

~~2.~~1. If a project does not require another City-approved study that would cover the scope of studies defined in this section, a standalone report should be prepared to combine all required studies and present combined recommendations. At minimum, the following sections shall be included:

a. ~~Executive Summary – A one- to two-page summary of key features of the report with an emphasis on recommendations. It should be suitable for distribution as an informational handout on the project at public open houses or meetings with citizens.~~Project Description:

(1) Fully describe the project and document:

(a) The funding entity leading the project.

(b) Background and justification for the project.

(c) Any public outreach/engagement performed or planned.

(d) Summary of other projects that are planned, designed, or under construction that would impact the project.

(e) Timeline for the overall project and for implementation of the recommendations included in the report.

b. ~~Introduction – a general project description with location map and a discussion of significant landmarks and destinations in the vicinity.~~Study Modules:

(1) Provide a section for each included study module. Study modules are defined in Section 15.2.02.C - Roadway Study Modules.

~~b. Existing Conditions~~

~~c. Roadway – Inventory of existing conditions for all roadways, intersecting roadways, and intersections to be improved. The inventory shall include but is not limited to:~~

~~d. Roadway geometry and typical roadway cross sections including median treatments and channelization~~

~~e. Major traffic-control devices (roundabouts, signals, school zones, stop signs)~~

~~f. Auxiliary lanes (left- and right-turn lanes)~~

~~g. Sidewalks and designated pedestrian/bicyclist crossing locations~~

~~h. Type and frequency of transit as well as any transit stops or stations~~

i. ~~Bicycle recommendations from the Houston Bike Plan for the corridor and intersecting roadways/trails~~

j. ~~Availability and location of on-street parking~~

k. ~~Posted speed limits~~

l. ~~Ongoing and planned roadway construction projects along or across the project corridor that could impact traffic operations~~

m. ~~Planned major development in the vicinity of the project~~

n. ~~Locations of schools and other major traffic generators, including those in development~~

o. ~~Description of intersection, roadway, and pedestrian lighting~~

p. ~~Description of existing Intelligent Transportation Systems (ITS) based on Transportation and Drainage Operations data~~

q. ~~Traffic signs and pavement markings, when requested~~

r. ~~Traffic data - Traffic data collected for the traffic study shall comply with Section 15.06: Traffic Volumes. The traffic data collection schedule shall be coordinated and approved by the City Traffic Engineer. Data collected should include:~~

s. ~~Turning movement traffic counts for critical intersections (a.m. and p.m. peak hours). Critical intersections will be determined during the project scoping process. If major off-peak activity is identified (including the weekends), traffic counts for additional hours may be required.~~

t. ~~Hourly approach traffic volume counts for one full 24-hour period at critical intersections may be needed to determine feasibility of various traffic control options, or if additional peak hours are identified.~~

u. ~~Average Daily Traffic (ADT) with directional information, hourly volumes, and vehicle speed and classification along the project corridor between existing signalized intersections and other intersecting major streets and critical side streets.~~

~~v. Optional: At least one year of crash data from the Houston Police Department for the roadway and at critical intersections collision data (city data). Crash data is required for safety mitigation projects. Crashes should be categorized by "signal-correctable" or "not-signal-correctable." Signal-correctable crashes include right-angle crashes and crashes involving bicyclists and/or pedestrians. They do not include crashes involving left-turn "failure to yield" crashes from the major street or crashes involving right-turning traffic.~~

~~w. Capacity and level-of-service analyses for existing conditions along the segments and at critical intersections (a.m. and p.m. peak-hour periods).~~

~~x. K (proportion of the ADT occurring in the peak hour) and D (proportion of the peak-hour traffic in the peak direction) factors.~~

~~y. Peak-hour factor by approach and by movement at critical intersections as determined by the project manager in coordination with the traffic engineer.~~

~~z. Heavy vehicle (truck and bus) percentage during the peak a.m. and p.m. peak periods.~~

~~aa. Future Projected Design Conditions~~

~~bb. Future conditions shall be analyzed for opening day with existing geometry and opening day with proposed alternatives. Additionally, analyses may be requested for a future design year (typically 20 years in the future). The future analyses shall include:~~

~~cc. Peak hour volume projections for all roadways, intersecting roadways, intersections, and major driveways within the limits of the project or as determined by the Project Manager in coordination with the City Traffic Engineer. The volumes should be based on existing traffic volumes and on traffic projections prepared by the City of Houston or by the Houston-Galveston Area Council regional transportation demand model.~~

~~dd. Capacity analyses shall be performed at critical intersections impacted by the project for all peak hours. For corridor projects that do not impact critical intersections, Generalized Daily Service Volumes as defined by the HCM may be used to estimate corridor LOS.~~

~~ee. Discussion of potential traffic impacts on adjacent neighborhoods (both during and after construction), including traffic calming and access management issues, as well as potential mitigation strategies.~~

~~ff. Preparation of traffic signal warrant analyses for the project opening year at critical intersections as determined by the Project Manager in coordination with the City Traffic Engineer and identified in the project scoping process. Traffic signal warrant analyses will be conducted in accordance with Section 15.11.~~

~~gg. Preparation of hybrid pedestrian beacon (HAWK) warrants at major midblock crossing locations (e.g. main entrances of schools, trail crossings).~~

c. ~~Conclusions and~~ Recommendations:

(1) Summarize all approved recommendations from all studies. Provide a timeline for implementation for each recommendation. Provide a map of improvements and, if available, schematic drawings.

~~1. Summary of improvements necessary to achieve safety, multimodal, and LOS goals as determined by Project Manager in coordination with the City Traffic Engineer.~~

~~2. Conceptual improvement diagram illustrating recommended improvements.~~

~~3. Recommendations for traffic control including roundabouts, traffic signals, and STOP signs.~~

~~4. Proposed roadway typical cross sections, including general purpose lanes, bike lanes, parking lanes, medians, pedestrian realm, and sidewalk.~~

~~5. Proposed lane assignments at critical intersections to achieve safety, multimodal, and LOS goals.~~

~~6. Auxiliary lanes (left- and right-turn lanes, acceleration and deceleration lanes) including recommended lengths per City approved methodology.~~

~~7. Recommendations for transit, pedestrian, and bicyclist facilities, including:~~

~~i. Bike facility type~~

~~ii. Transit facility stop/station locations and special accommodations~~

~~iii. Sidewalks and curb ramps~~

~~iv. Pedestrian/bicyclist crossing locations, including midblock crosswalks and median openings~~

~~v. Pedestrian amenities, including street trees~~

~~8. For proposed roundabouts: provide a high-level discussion of proposed lane assignments and expected ROW impacts~~

~~9. When the Traffic Engineering Study is prepared to support a City of Houston Capital Project, provide design parameters to be used during final project design including:~~

~~i. Design speeds~~

~~ii. Design vehicle(s)~~

~~iii. Sight distances~~

~~iv. Shoulders~~

~~v. Access control~~

~~vi. Clear zones~~

~~10. Access management features, including:~~

~~i. Proposed driveway locations~~

~~ii. Proposed median opening locations~~

~~iii. Access/turn restrictions~~

~~11. Proposed strategies for mitigating traffic impact to adjacent neighborhoods.~~

~~12. Speed zones if any are proposed that vary from state-defined prima facie speeds, including school speed zones.~~

~~13. Recommended locations for school zone flashing beacons.~~

~~14. ITS recommendations based on Transportation and Drainage Operations program requirements.~~

15.2.02.C ROADWAY STUDY MODULES

The following modules shall be included as applicable.

1. Safety Analysis

15.2.02.C.1.a.(6) continued

a. The Safety analysis module is used to assess crash history and identify safety concerns along a corridor or at one or more intersections.

(1) Use TxDOT CRIS crash database[10] to assess crash trends over a 5-year period.

(2) Determine if the corridor is on the City of Houston Vision Zero High Injury Network (HIN)[11].

(3) Compute corridor crash rates using crash data and traffic counts. Compute intersection crash rates at signalized locations. Collect new traffic counts if none are currently available. See Section 15.2.04 - Traffic Volumes for requirements for traffic volume data.

(4) Determine whether there are any crash trends or hotspots within the project area.

(5) If the corridor or intersection is on the HIN, identify and describe the crashes that contribute to that designation.

(6) Summarize crash reports by at least these factors:

(a) Year

(b) Severity of crash

(c) Involvement of a pedestrian or bicyclist

(d) Illumination level as a contributing factor

(e) Alcohol as a contributing factor

(f) Speed as a contributing factor

(g) Vehicle movements involved

(h) Highway Safety Improvement Program (HSIP) mitigation codes associated with the crash

(7) Identify any projects that have occurred within the study timeframe that may have addressed a preceding crash problem and assess the impacts of the project on the crash problem.

Refer to the weblink for the updated HIN map:
[10] https://cris.dot.state.tx.us/public/Query/app/home
[11] https://www.houstontx.gov/visionzero/

15.2.02.C.2.a continued

(8) Provide recommendations to address any identified crash trends or hotspots and use the crash analyses included in this section to specifically support any recommendation.

(9) Where applicable, identify TxDOT mitigation codes defined for the Highway Safety Improvement Program (HSIP) for all recommendations, and calculate the Safety Improvement Index (SII), as defined by TxDOT.

2. Corridor and Access Management Analysis

This module is intended to define features for roadway segments between intersection of public streets. The cross section of the road shall be determined following the steps below, in order. NOTE: The number of general-purpose lanes shall not be the starting point for determination of cross section.

a. Determine walking, biking and transit needs.

(1) Document Existing Condition in relation to the Multimodal Service Standards (MMSS) defined in 15.2.01.

(2) Determine, document and provide recommendations for pedestrian realm dimensions and features as per the Multimodal Service Standard and Chapter 17, Section 3 - Pedestrian Elements Requirements.

(3) Describe existing bicycle facilities and determine, document, and provide recommendations for proposed bicycle facilities based on the Houston Bike Plan and by the requirements of Chapter 17, Section 4 - Bikeway Facility Requirements.

(4) Describe existing transit service and infrastructure, and determine, document, and provide recommendations for transit infrastructure, including bus stop locations, enhancements and dedicated transit facilities, according to Chapter 17, Section 5 - Transit Facility Requirements and in coordination with METRO.

b. Determine Access Management needs.

(1) Document existing Access Management characteristics including:

(a) Driveway placement

(b) Driveway dimensions

(c) Presence of physical Median of center turn lane

15.2.02.C.2.c continued

(d) Median opening locations

(e) Median opening dimensions

(f) Turn lanes at Median openings

(2) Identify and document any crash problems related to existing Access Management conditions and locations.

(3) Document all existing Access Management characteristics that do not satisfy current IDM requirements.

(4) Identify layouts of Access Management characteristics that would fully comply with all IDM requirements.

(5) Make final recommendations for layouts of Access Management characteristics. Identify and justify any recommendations that do not fully comply with IDM requirements. Recommendations must be coordinated with the determination of vehicle capacity needs in Section 15.2.02.C.2.c.

c. Determine vehicle capacity and other vehicular needs.

(1) Determine the number of general-purpose lanes and/or parking lanes, depending on the needs and context of the project, that can fit within the remaining right-of-way.

(2) Determine the recommended number of general-purpose and/or parking lanes and, if needed, quantify any additional right-of-way that would be required to accommodate these lanes.

(3) Document Vehicle Level of Service (VLOS) for all existing and proposed conditions at all included intersections utilizing an intersection VLOS analysis (see article 15.2.02.C.4).

d. Summarize all requirements for multimodal facilities along the corridor and provide options for achieving as many of them as possible. Identify impacts on VLOS as well as tradeoffs and alternatives. Provide recommendations for the corridor cross section and Access Management characteristics.

3. Intersection Design and Traffic Control Analysis

This module is used to determine intersection design and traffic control.

a. Document existing traffic control at intersection.

15.2.02.C.3.g continued

b. Document Existing Conditions at the intersection in relation to the Multimodal Service Standards (MMSS) defined in 15.2.01.

c. Determine and document required pedestrian realm dimensions and features at the intersection as per Chapter 17, Section 17.3.02 - Intersections and Midblock Crossings.

d. Determine required bicycle infrastructure at the intersection according to the Houston Bike Plan and Chapter 17, Section 17.4.03 - Bikeways at Intersections.

e. Determine required transit infrastructure at the intersection, including bus stop locations and enhancements and dedicated transit facilities, according to Chapter 17, Section 5 - Transit Facility Requirements and in coordination with METRO.

f. All new or reconstructed intersections must satisfy all MMSS.

g. Prepare recommendation of proposed traffic control devices.

(1) All new or reconstructed intersections must assess the feasibility of constructing a roundabout. An analysis should be prepared to justify not constructing a roundabout based on the MMSS, other multimodal standards, or traffic demands.

(2) All new or reconstructed traffic signals must provide a Traffic Signal Warrant Analysis report that follows the Texas Manual on Uniform Traffic Control Devices. See section 15.2.02.C.6 - Traffic Signal Warrant Analysis (TSWA) below.

(3) Recommend the number and designations of travel lanes and Auxiliary Lanes. The number and types of lanes should not be recommended solely on Existing Conditions; they should be evaluated according to the MMSS and measured traffic demand.

(4) Prepare an intersection VLOS analysis for existing and proposed conditions.

4. Intersection VLOS Analysis

This module is used for traditional capacity analysis at intersections to determine primarily Vehicle Level of Service (VLOS).

a. Collect 13-hour turning movement counts at study intersections utilizing the requirements of section 15.2.04 - Traffic Volumes.

15.2.02.C.4.e continued

b. Use Vistro or other approved HCM-compatible software or methodology to build capacity analysis models for each identified study scenario.

c. Time periods for analysis:

(1) AM Peak

(2) PM Peak

(3) 4th Highest Hour

(4) Other period as required (e.g., Off-peak, Noon, Weekend, peak hour of generator)

d. Scenarios for analysis will be project-specific, but should generally include:

(1) Existing Conditions

(2) Background Conditions

(3) Projected Conditions

(4) Mitigation Conditions

e. Provide the following figures at a minimum:

(1) A chart of the total traffic volumes at the intersection for all available hours to visually communicate the spread of the peak hours of demand.

(2) Turning movements at each analysis intersection for each time period/scenario combination.

f. Provide the following tables at a minimum:

(1) Comparison of VLOS and vehicle delays per vehicle across the scenarios and for each analysis time period. For a given time period, it should be easy to compare VLOS for all scenarios.

5. Pedestrian Crossing Analysis

This module is used to determine where crossings should be provided for pedestrians, bicyclists, and other vulnerable roadway users along a corridor and determine the features of the crossings.

a. Use the methodology defined in Chapter 17, Section 17.3.03 - Corridor Crossing Analysis and Treatments.

15.2.02.C.6.d continued

6. Traffic Signal Warrant Analysis (TSWA)

This module is required before any new signal may be permitted. It is also used to determine if existing traffic signals should remain or be removed.

a. The City Traffic Engineer must approve the recommendation for a new traffic signal before the signal may be installed.

b. Before a new signal will be approved, a traffic engineer shall conduct a traffic signal warrant analysis for the intersection that is compatible with the Texas Manual on Uniform Traffic Control Devices (TMUTCD).

~~hh.~~c. Houston Public Works accepts all warrants defined in the TMUTCD. However, satisfaction of one or more warrants shall not in itself require installation of a traffic control signal.

~~ii.~~d. The following warrants are typically reserved for very specific circumstances that are driven by internal Houston Public Works analyses and recommendations:

(1) Warrant 3 – Peak Hour;

(2) Warrant 6 – Coordinated Signal System;

(3) Warrant 8 – Roadway Network; and

(4) Warrant 9 – Intersection Near a Grade Crossing.

e. The use of Warrants 3, 6, 8, and 9 for a specific location shall be coordinated with the City Traffic Engineer before the TSWA is conducted.

f. New signals should be spaced at least ¼ mile away from existing or planned signals.

g. The City requires that a minimum of thirteen (13) hours (includes am and pm peak hours) of turning movement counts be collected for a traffic signal warrant analysis.

h. Warrant 7 – Crash Experience: Requires exhaustion of any other feasible crash mitigation options. A TSWA relying on Warrant 7 must document crash mitigation attempts that were previously made and why other mitigation options are not feasible for the location. If crash mitigation is the primary goal of a traffic signal, the requesting party should meet with the City Traffic Engineer first to determine all possible mitigation options.

15.2.02.C.6 continued

i. The following may be considered signal-correctable crashes for warrant purposes:

(1) any pedestrian/bicyclist-vehicle crash;

(2) through-through crashes; and

(3) through-left turn crashes.

(4) Rear end crashes, single vehicle crashes, and crashes involving right-turning vehicles are not considered correctable because these crashes may occur with equal or greater frequency after installation of a signal.

j. Right Turn Reductions: If a right turn lane is available or is recommended, all right turning traffic shall be deducted from the hourly approach volumes. If a shared through/right turn lane exists, one half of all right turning traffic on the approach shall be deducted, because right-turning vehicles typically do not require a traffic signal to safely enter another street.

k. Left Turn Lane Considerations: Engineering judgment is required to determine whether a left turn lane is counted as an additional lane. As a rule of thumb, the Engineer of Record should consider the ratio of left turning traffic to the other traffic. If the left turning volume exceeds twenty (20) percent of the total traffic, the left turn lane should be counted as an additional lane. Exclusive right turn lanes are not to be counted as an additional lane since their volumes are to be deducted from the totals.

l. Traffic volume reductions for high-speed or rural roadways may be utilized as appropriate.

(1) These reductions may only be applied to:

(a) Warrant 1 - Eight Hour Vehicular Volume;

(b) Warrant 2 - Four Hour Vehicular Volume; and

(c) Warrant 4 - Pedestrian Volume.

(2) Warrant 3 - Peak Hour is excluded.

15.2.03.A continued

(3) Only major street thresholds shall be reduced. Local experience has shown that reducing the thresholds for Warrant 3 - Peak Hour or reducing minor street thresholds would result in a significant number of local intersections satisfying the warrants that otherwise operate safely without a traffic signal. In short, the warrants become very broad, and engineering judgment is effectively removed from the analysis.

m. If a TSWA finds that a proposed signal is not warranted, conduct an Intersection Design and Traffic Control Analysis to determine appropriate traffic control and intersection design parameters.

n. If a TSWA finds that an existing signal is not warranted, coordinate with Houston Public Works to determine whether or not the signal should be removed, and if so, what traffic control should replace it.

15.2.03 TRAFFIC STUDIES FOR SITE DEVELOPMENT

15.2.03.A APPLICABILITY

1. Two levels of traffic studies are identified and are dependent upon specific site location conditions, adjacent street configurations/capacities and traffic generation rates for proposed development. These studies are referred to as "Access~~-~~ Management Data" and "Traffic Impact ~~Studies~~ Analysis (TIA) ". Figure 15.1 ~~Figure 15.04.01~~provides an overview of the submittal and review process.

2. For each proposed development or redevelopment, an Access Management Data ~~Summary~~ Form must be submitted.

   a. The Access Management Data Form provides general property information and an initial estimate of traffic volumes associated with the property.

3. Exceptions to the requirements for the submittal of Access Management Data ~~Summary~~ Form include:

   a. Construction, reconstruction, remodel or additions to a single-family residence.

   b. Remodel of commercial developments with no change in use and/or size.

4. In addition to filing the Access Management Dat~~e~~a Form, a Traffic Impact Analysis may be required.

15.2.03.A.5.c continued

a. If the proposed development or redevelopment generates 100 or more new peak hour trips (PHT), the ~~Analysis Engineer~~Engineer of Record should meet with the City to determine the requirement for a Traffic Impact ~~Study~~ Analysis.

b. If after discussion with the City, a Traffic Impact ~~Study~~ Analysis is required, the extent of the area to be studied will be determined.

c. If an applicant submits a development plat application or building permit application for new development or redevelopment, the applicant may voluntarily submit a TIA to support the trip generation rates and ~~a~~Access ~~m~~Management needs to the adjacent street system for the proposed project.

5. The City may ask for a technical memorandum in lieu of a full Traffic Impact Analysis (TIA). The technical memo shall be submitted when the proposed development generates 80 vph -120 vph during AM or PM peak hours, utilizing the trip generation rates in the latest edition of the ~~Traffic~~ Trip Generation Manual. The technical memo shall address the immediate intersection(s) to the proposed development. The intersection(s) to be included in the technical memorandum shall be decided by the City. The memorandum shall address the studies intersection(s) in terms of:

a. Existing traffic counts (turning movements and 24-hour counts)

b. Existing signal timing

c. The ~~I~~intersection geometric layout including:

(1) Number of lanes for each approach

(2) Lane width

(3) Medians widths and ~~m~~Median openings locations

(4) Existing ~~d~~Driveways location near the proposed development

(5) Signage and lane marking

(6) Type and location of bicycle facilities

~~(5)~~(7) Summary of existing Multimodal Service Standards (MMSS) as defined in section 15.2.01.

d. Existing operation performance using PTV Vistro ~~SYNCHRO~~ or other HCM compatible software packages

e. Number of trips generated by the proposed development

f. The impact of the proposed development on the intersection(s) traffic operation performance under the ~~e~~Existing ~~c~~Conditions (using ~~SYNCHRO~~Vistro or other HCM compatible software packages)

g. The proposed mitigation measures including but not limited to:

(1) Addressing deficiencies in existing Multimodal Service Standards (MMSS)

~~(1)~~(2) Changing lane usage and marking

~~(2)~~(3) Changing geometric and/or layout

~~(3)~~(4) Changing traffic control type

(5) Adding lanes

(a) Note: Any mitigation must fully comply with the requirements of the Multimodal Service Standards (MMSS) defined in 15.2.01.

h. The impact of the proposed mitigation measures on the intersection traffic operation performance (using ~~SYNCHRO~~ Vistro or other HCM compatible software packages).

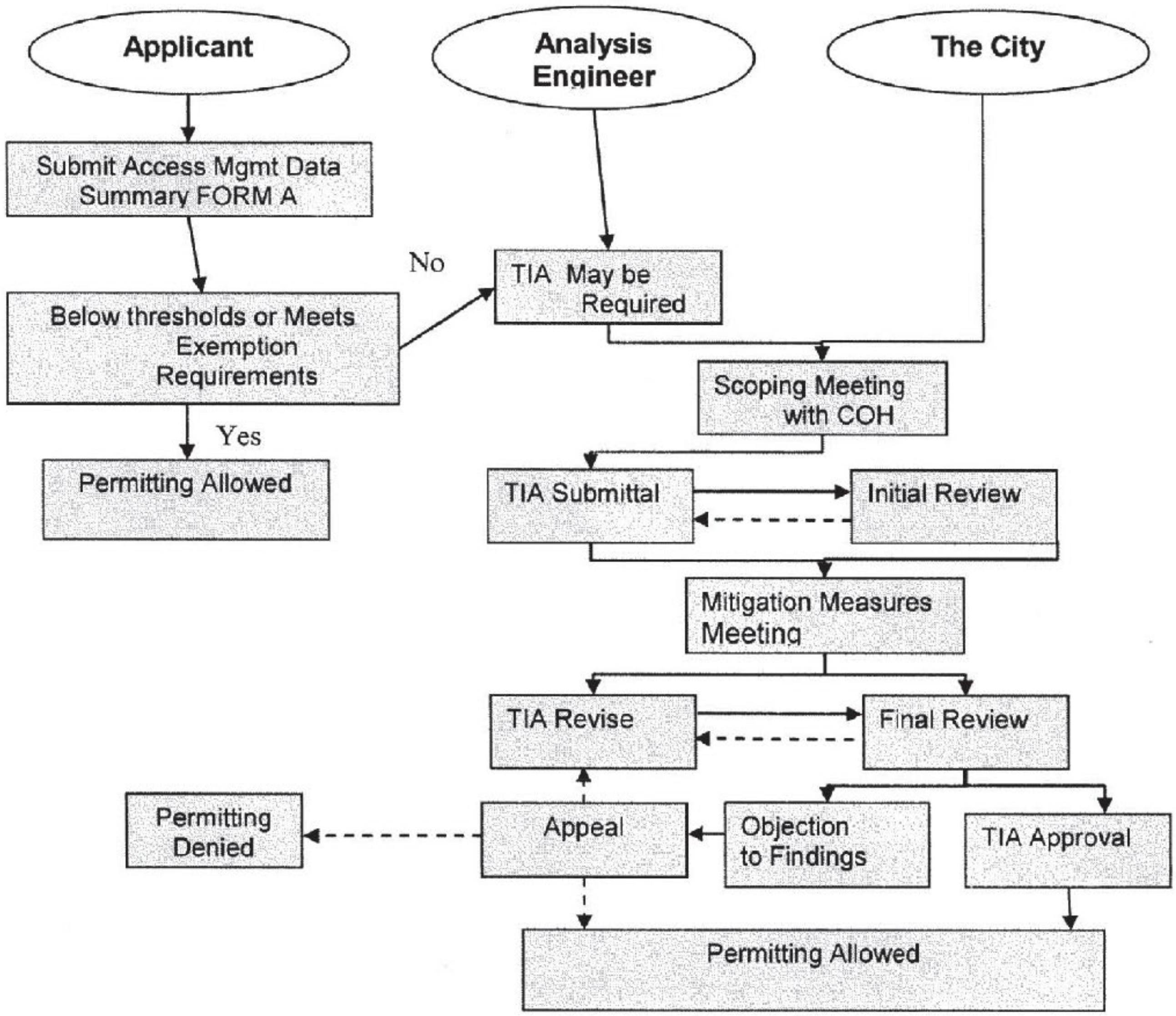


Figure 15.1~~15.1~~ – OVERVIEW OF TRAFFIC IMPACT ANALYSIS PROCESS

ACCESS MANAGEMENT DATA FORM

HOUSTON PUBLIC WORKS

City of Houston
Access Form

Project Name: ______________________________ **Project Number:** _____________

Critical Item:

An Access Form is required for all commercial developments with the exception of developments with no change in use and/or size. Alterations to roadway access points **may result in significant site plan revisions.** For this reason, Access Forms should be submitted prior to or during plat submittal. If platting is not required, this form shall be approved prior to submitting plans for permitting.

Background:

This Access Form provides general property information and initial estimates of traffic volumes associated with the property. Chapter 15 of the City of Houston Infrastructure Design Manual (IDM) requires all commercial properties to submit an Access Form and a Traffic Impact Analysis (TIA) (if applicable). Exceptions to the submittal of an Access Form are:

a) Construction, reconstruction, remodel or additions to a single family residence.
b) Remodel of commercial developments with no change in use and/or size.

Furthermore, existing driveways in the right of way are not grandfathered.

Instructions:

This Access Form must be completely filled and submitted to PWEACCESSFORM@HOUSTONTX.GOV for review. It **must** be accompanied by a dimensioned site plan layout with driveway locations indicating the extent of the access which the commercial property has or (is planned) to access public streets. On-site traffic related features (loading docks, emergency lanes, and driveway entrance/exits) must be depicted on the site plan.

ACCESS MANAGEMENT DATA FORM

Access Form

Project Name: ______________________________ **Project Number:** _______________

Project Address: ____

Applicant: ____

Telephone: ________________________ Email: ________________________________

☐ I have read and understand all items on page 1 of this Access Form (Check mark and initials are required to start review)	Initials: ______________

EXISTING DEVELOPMENT (IF FUNCTIONAL):

Tract Number: _______________ Tract Size: _______________

Building Sq. Ft.	Land Use Description & I.T.E Code	Trip Rate		Peak Hour Trips		Average Daily Traffic Rate	Average Daily Traffic
		AM	PM	AM	PM		
Total							

PROPOSED DEVELOPMENT (NEW ADDED TRIPS):

Tract Number: _______________ Tract Size: _______________

NET NEW ADDED TRIPS:	

Building Sq. Ft.	Land Use Description & I.T.E Code	Trip Rate		Peak Hour Trips		Average Daily Traffic Rate	Average Daily Traffic
		AM	PM	AM	PM		
Total							

ABUTTING ROADWAYS:

Street Name	Number of Driveways	R.O.W Width	Pavement Width

ACCESS MANAGEMENT DATA FORM

Project Name: ________________________________ **Project Number:** ______________

FOR OFFICE USE ONLY:

☐ The Office of City Engineer (OCE) has reviewed the Access Form provided for this project. At this time, the OCE has no objection to permitting for driveway access on the basis of vehicle trips generated by this development. **(Please provide a copy of this form with your permit documents.)**

However, this statement of no objection does not supersede requirements to comply with geometric design standards, codes and ordinances pertaining to median opening/modifications, driveways, auxiliary lane and other roadway improvements. All geometric design modifications must be approved by the Office of the City Engineer.

Reviewed by: ________________________________ Date: __________________

☐ At this time, a Technical Memorandum is required in lieu of a full Traffic Impact Analysis (TIA). The technical memo shall be submitted when the proposed development generates 80 vph -120 vph during AM or PM peak hours, utilizing the trip generation rates in the latest edition of the Traffic Generation Manual.

(If additional concerns arise through the review of a Technical Memorandum, the City of Houston may request a full Traffic Impact Study.)

☐ A Traffic Impact Analysis is required. The Analysis Engineer should meet with the City to determine the scope for a Traffic Impact study and the extent of the study area.

	Traffic Impact Category	Site Traffic Thresholds New Peak Hour Trips (PHT) On Adjacent Street
○	Category I	PHT < 100
○	Category II	100 to 499
○	Category III	500 to 999
○	Category IV	PHT ≥ 1000

15.2.03.B TRAFFIC IMPACT ANALYSIS GUIDELINES (TIA)

1. General

a. Authorization to Perform a TIA:

(1) A TIA shall be prepared by an individual, group, firm, or corporation having demonstrated professional emphasis and experience in traffic engineering, and the preparation of similar analysis, hereinafter referred to as the ~~"Analysis Engineer~~Engineer of Record~~"~~. The TIA document shall bear the seal and signature of a Texas Licensed Professional Engineer specializing in the branch of civil engineering. The responsibility for assessing the traffic impacts associated with a proposed development/redevelopment, hereinafter referred to as the "Development," rests with the ~~A~~applicant and the ~~Analysis Engineer~~Engineer of Record, while the City shall serve as the review and approval authority.

b. Purpose and Intent of TIA Guidelines:

(1) The purpose of the TIA is to identify the adequacy of the existing street right-of-way to accommodate any changes in trips generated from a proposed development/redevelopment (as a stand-alone development or a stage of a master plan). If impacts are identified, potential mitigation measures (on-site or off-site) can be proposed and evaluated. The traffic impact analysis will be used to make a determination as to whether ~~d~~Driveway(s) being considered are necessary to provide reasonable access to the private property consistent with the safety and convenience of the public.

c. Goals of a TIA Completed Within the City of Houston:

(1) To identify any and all potential adverse traffic impacts to the existing area street system, the surrounding community and to additional proposed developments.

(2) To identify transportation improvements with an aim to cost effectively mitigate identified adverse traffic impacts to mobility within the study area/analysis area.

~~(2)~~(3) To assist public and private sector entities to identify methods to facilitate multimodal access to the site, including by walking, bicycling, and transit, by utilizing the Multimodal Service Standards (MMSSs) defined in 15.2.01.

15.2.03.B.1.c continued

~~(3)~~(4) To assist public and private sector entities in identifying and resolving issues related to the location of ~~d~~Driveways, ~~m~~Median openings, turn lanes, traffic signals, and other transportation facilities.

d. Document Limitations:

(1) While this section (15.2.03)~~(15.15.04)~~ contains guidelines and requirements necessary to complete a TIA for the City, the City does not intend this section to be a sole reference for the preparation of a TIA. For more specific information regarding the various aspects of TIA preparation, the City suggests that the reader obtain and refer to the Institute of Transportation Engineer's (ITE) current edition of Transportation Impact Analyses for Site Development (An ITE Proposed Recommended Practice).

2. The Traffic Impact Analysis Process

a. It is a goal of the City that these guidelines will allow for the maximization of efficiency and safety associated with area development/redevelopment. ~~The City emphasizes that the TIA process can begin when the Applicant initiates development planning (i.e. prior to plat preparation).~~

b. The TIA process should begin as early as possible, as early as initial development planning and plat preparation. Early TIA preparation can help align site architectural design and layout with requirements for Driveway Permitting and off-site improvements. Further changes to the development, site plan, and Driveway layout are expected for an early submittal and can be accommodated in the TIA review process.

c. If a TIA is required or the applicant chooses to prepare a TIA, the completed TIA may be submitted at any time prior to or during the plat submittal. If platting is not required, a TIA shall be approved prior to submitting plans for permitting. TIA review may result in significant site plan revisions. The final site plan approval shall not be issued without the TIA approval.

~~a.~~d. The TIA report shall bear the seal and signature of a Texas Licensed Professional Engineer specializing in the branch of civil engineering. The responsibility for assessing the traffic impacts associated with a proposed development or redevelopment rests with the applicant and the ~~Analysis Engineer~~Engineer of Record, while the City shall serve as the review and approval authority.

15.2.03.B.2 continued

~~b.~~e. A TIA determines traffic impacts of a development/redevelopment on the surrounding street system. The City will use this information to assist in establishing immediate transportation infrastructure needs and potential transportation improvements. If the development/redevelopment is a stage of a future larger development (master plan), the TIA should include the impact of the overall development (all stages).

~~c.~~f. Prior to submitting an application for development platting or a building permit the ~~A~~applicant may be required to submit a revised TIA and obtain approval by the City if any changes have been made to the development (site plan) or original TIA assumptions related to:

(1) Land-use (revisions required only for an increase in trips),

(2) Increase in the trip generation variable(s) (revisions required only for an increase in trips),

(3) Intersection and street design, and

(4) Access connections placement and design assumptions.

3. The Proposal of Scope and Initial Trip Generation Estimate

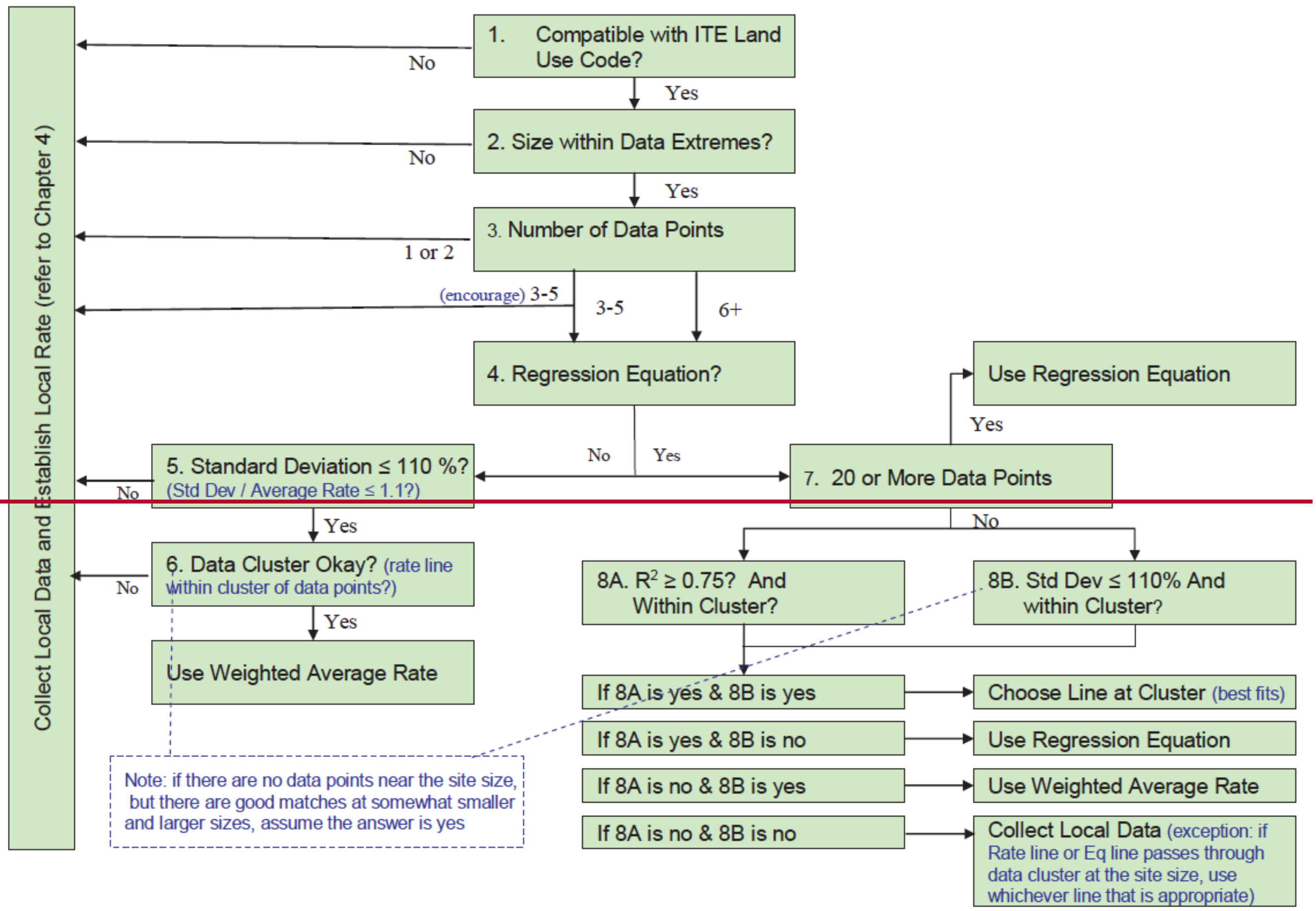
a. Using proposed development redevelopment, or master plan~~-~~ attributes (type, size, etc.), determine a corresponding traffic impact category for the ~~D~~development by calculating the highest number of estimated new peak hour trips generated for an adjacent street (See Table 15.4~~Table 15.~~~~Table 15.04.01~~).

Table 15.4 - ~~Table 15.04.01~~ TRAFFIC IMPACT CATEGORIES

Traffic Impact Category	Site Traffic Thresholds New Peak Hour Trips (PHT) on Adjacent Street
Category I	PHT < 100
Category II	100 to 499
Category III	500 to 999
Category IV	PHT ≥ 1000

b. The City requires that the ~~Analysis Engineer~~Engineer of Record generate site traffic using the methodologies found in the current edition of the ITE publication. ~~This includes following the "Recommended Procedure for Estimating Trip Generation", as shown in Figure 15.04.02.~~

15.2.03.B.3 continued



~~Figure 15.04.02 Recommended Procedure for Estimating Trip Generation~~

~~a.~~c. Using the resulting traffic impact category and the ~~B~~boundaries and ~~H~~horizons ~~G~~guidelines in Table 15.5~~Table 15.04.02~~, the ~~Analysis Engineer~~Engineer of Record shall prepare and submit to the City Engineer a proposed scope for the TIA.

~~b.~~d. It is also a goal of the proposed scope to minimize deliverables. It is mandatory that, regardless of traffic impact category (II, III, or IV), the ~~Analysis Engineer~~Engineer of Record holds a preliminary scoping meeting with the City Traffic Engineer.

~~c.~~e. An approved proposal of scope ensures that the submittal of a TIA will allow the City to evaluate the overall traffic impact of the development on area transportation infrastructure.

4. Preparing the TIA

15.2.03.B.5 continued

a. The TIA shall be prepared according to the requirements detailed in the Traffic Impact Analysis Preparation Overview Figure 15.2~~Figure 15.04.03~~.

Table 15.5 - ~~Table 15.04.02~~ BOUNDARIES AND HORIZONS GUIDELINES

	Requirements	Category I	Category II	Category III	Category IV
General	Access Management Data ~~Summary~~ Form	X	X	X	X
	Scoping Meeting with the City Traffic Engineer		X	X	X
	Proposed Scope		X	X	X
Horizon	Opening Year		X	X	X
	Full Build-Out Year(1)			X	X
Limits(3)	Analysis Area (From boundaries of development)(2)		¼ Mile	½ Mile	½ or 1 Mile
	All Site Access Driveways		X	X	X
	All Site Access Private Street Intersections		X	X	X
	All Adjacent Signalized Intersections		X	X	X
	All Adjacent Major Unsignalized Intersections		X	X	X
	All Analysis Area Signalized Intersections			X	X
	All Analysis Area Major Unsignalized Intersections			X	X

(1) Including the full implementation of master plan.
(2) Category II, III and IV studies should extend to first signalized intersection (minimum) even if outside of ~~B~~boundary and include any critical intersections as defined by the City.
(3) Shall be defined as the limits of the master plan.

5. TIA Submission and Review

a. All TIA submittals ~~should be addressed to the Office of the City Engineer. Paper copies should be submitted through the Office of the City Engineer, 2nd floor of 1002 Washington Avenue, Houston, TX. Electronic copies~~ should be emailed ~~directly~~ to the Office of the City Engineer.

b. The ~~A~~applicant shall submit ~~to the City two (2) paper copies and~~ one electronic copy~~. In addition, one electronic version~~ of the TIA including all appendi~~x~~ces ~~is required~~ (paper copies ~~of the appendix~~ are not necessary unless requested by the City).

~~Figure 15.04.03 Traffic Impact Analysis Preparation Overview~~

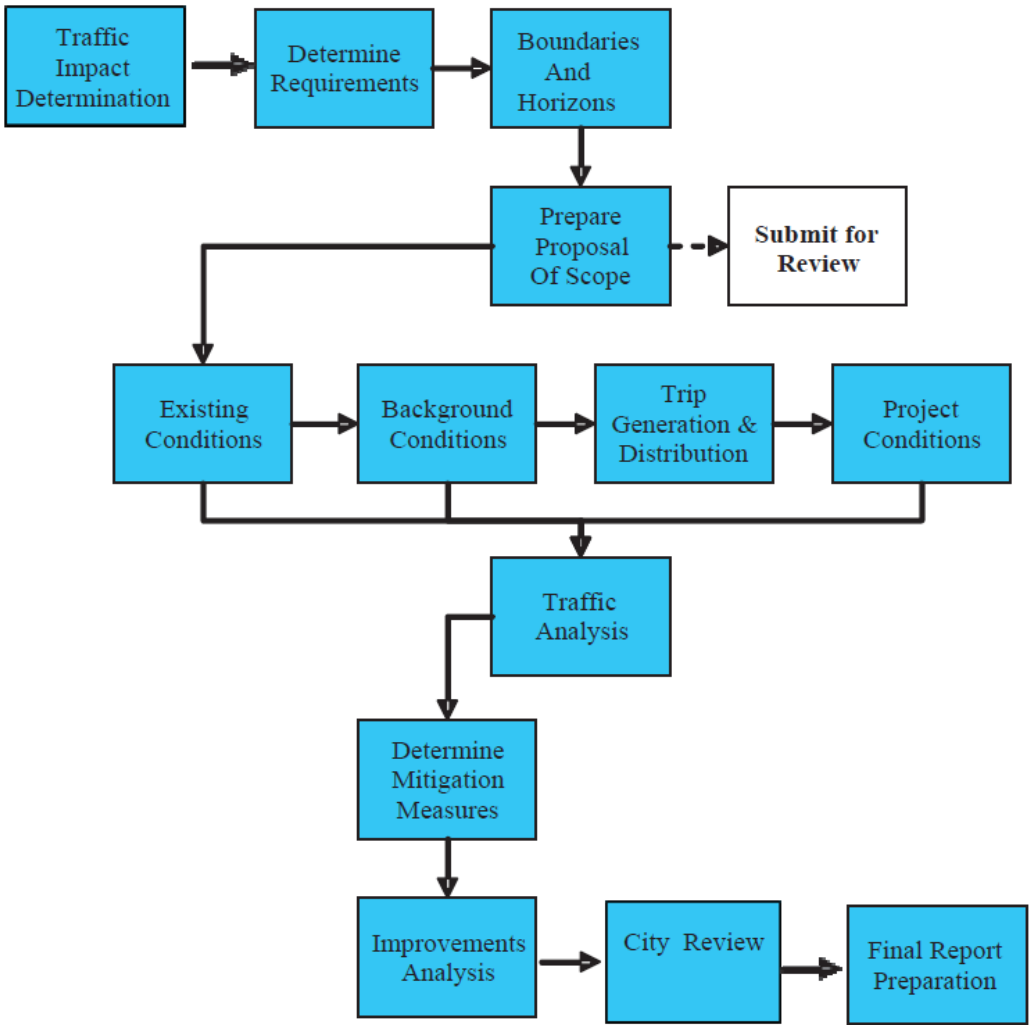


Figure 15.2~~15.2~~ – TRAFFIC IMPACT ANALYSIS PREPARATION OVERVIEW

15.2.03.B.5 continued

c. The City will make an initial review of the TIA to determine if the ~~Analysis Engineer~~Engineer of Record completed the TIA in accordance with the technical requirements and within the submission requirements of the analysis as outlined in this manual or as established at the preliminary scoping meeting or proposal of scope. If the City finds deviations from the technical requirements and/or the submission requirements of the study, the City will terminate the initial review until the ~~Analysis Engineer~~Engineer of Record has addressed said deficiencies. At such a time when the City identifies deficiencies, the City will send a notice of deficiencies to the ~~Analysis Engineer~~Engineer of Record and ~~A~~applicant. Submittal should include, if available, electronics copies of traffic counts (in Excel and pdf formats) and other collected data (i.e., queuing, delay studies, etc.) as well as any traffic analysis models used and referenced in the TIA.

d. All TIA submittals should include either an interim seal or a final seal, which is signed by a Licensed Professional Engineer in the State of Texas.

e. When the ~~A~~applicant submits a final TIA that meets the technical and submission requirements established in this document or at the preliminary scoping meeting or proposal of scope, the City will conduct a final review of the TIA.

f. Following the City's completion of the final review, the City will provide to the ~~Analysis Engineer~~Engineer of Record and ~~A~~applicant written objection to the findings or adequacy of the proposed mitigation measures to address impacts. If no objections are noted, the City will interpose no objection to permitting for the proposed development. If the ~~A~~applicant disagrees with the objections made by the City, the ~~A~~applicant may write an appeal to the Director of Public Works.

g. Approval of a TIA will remain valid for a maximum of three years (from date of final TIA approval). Validity of an approved TIA beyond three years will be allowed by the City Engineer so long as the phased development is proceeding according to the approved plan and the schedule contained within such approved plan. The applicant may be required to update traffic impact data to address changes within the area and will meet with the City Engineer prior to the expiration of the three-year period to determine if an updated TIA is required.

6. Mitigation Measures Requirements

15.2.03.B.6 continued

a. The TIA shall have identified significant adverse vehicular traffic impacts in order to trigger the need for mitigation. The need for mitigation is determined by using the qualitative measure Vehicle Level~~-~~ of~~-~~ Service (VLOS). The threshold of significance for transportation facilities on the area street system is VLOS D.

b. Approval of TIAs will not be withheld if the City agrees that no feasible mitigation options exist.

- ~~Transit Corridor Streets - Chapter 42 of the City of Houston Code of Ordinances (Subdivisions, Developments and Platting) and this Infrastructure Design Manual provide planning rules and design standards to achieve multi- modal transportation corridors along designated Transit Streets.~~

~~7. Where a TIA for proposed development along a Transit Corridor Street is required by this chapter, it shall include trip generation estimates in accordance with guidelines presented in Figure 15.04.02. The TIA shall include a summary of estimated trips by applicable transportation categories. Transportation categories may include automobile, truck, transit, bicycle and pedestrian. Trip allocations shall be supported by documentation including data from local planning agencies, records of actual ridership from local transit agencies, statistical data from similar projects in other locations, standards from professional organizations, and other applicable resources.~~

~~8. Where the existing, background or projected conditions are LOS E or F and existing physical conditions limit available mitigation measures, the Analysis Engineer shall meet with the City Engineer to review probable community impacts and possible mitigation measures, if any. Approval of TIA's along Transit Corridor Streets may not be withheld where all reasonable and feasible access management and offsite mitigation measures in the public street right of way have been exhausted. Access management and offsite mitigation measures may include the addition of pedestrian/bicycle facilities transit amenities, the installation of turn lanes and/or additional lanes of traffic such as deceleration lanes, the installation of traffic signals, the construction of traffic control features or medians, and/or limitations on the number of driveways.~~

- ~~Major Thoroughfares - Chapter 42 of the City of Houston Code of Ordinances establish roadways to be classified as Major Thoroughfares by inclusion on the Major Thoroughfare and Freeway Plan (MTFP). Major Thoroughfares are roadways designed to allow for access from large traffic trip generators and move traffic between adjacent activity centers. Projects in Traffic Impact Categories II, III and IV (see Table 15.04.01) along Major Thoroughfares are expected and fostered because of the traffic carrying capacity. Similar to a Transit Corridor Street, where the existing, background or projected conditions are LOS E or F and existing physical conditions limit available mitigation measures, the Analysis Engineer shall meet with the City Engineer to review probable community impacts and possible mitigation measures if any. Approval of TIA's along Major Thoroughfares may not be withheld where all reasonable and feasible access management and offsite mitigation measures in the public street right of way have been exhausted. Access management and offsite mitigation measures may include the addition of pedestrian/bicycle facilities, the installation of turn lanes and/or additional lanes of traffic such as deceleration lanes, the installation of traffic signals, the construction of traffic control features or medians, and/or limitations on the number of driveways.~~

- ~~Central Business District - Boundaries of the Central Business District (CBD) are defined in Section 15.03. Development and redevelopment of the CBD are anticipated to involve high rise, large traffic generating facilities. Similar to a Transit Corridor Street, where the existing, background or projected conditions are LOS E or F and existing physical conditions limit available mitigation measures, the Analysis Engineer shall meet with the City Engineer to review probable community impacts and possible mitigation measures if any. Approval of TIA's in the CBD may not be withheld where all reasonable and feasible access management and offsite mitigation measures in the public street right of way have been exhausted. Access management and offsite mitigation measures may include the addition of pedestrian/bicycle facilities, the installation of turn lanes and/or additional lanes of traffic such as deceleration lanes, the installation of traffic signals, the construction of traffic control features or medians, and/or limitations on the number of driveways.~~

- ~~Major Activity Centers are defined in Section 15.03. Development and redevelopment in Major Activity Centers is anticipated to involve high rise, large traffic generating facilities. Similar to a Transit Corridor Street or Major Thoroughfare, where the existing background or projected conditions are LOS E or F and existing physical conditions limit available mitigation measures, the Analysis Engineer shall meet with the City Engineer to review probable community impacts and mitigation measures, if any. Approval of TIAs within a Major Activity Center may not be withheld when all reasonable and feasible access management and offsite mitigation measures in the public street right of way have been exhausted. Access management and offsite mitigation measures may include the addition of pedestrian/bicycle facilities transit amenities, the installation of turn lanes and/or additional lanes of traffic such as deceleration lanes, the installation of traffic signals, the construction of traffic control features or medians, and/or limitations on the number of driveways.~~

- ~~The Mitigation Decision Tree for local roadways and collector streets is shown in Figure 15.04.04 below. The chart is color coded. Purple indicates acceptable levels of service A-D; yellow indicates marginal level of service E; and red indicates unacceptable level of service F. The Tree components are defined as follows:~~

    - ~~Existing – represents the performance of the existing street network~~

    - ~~Background – represents the performance of the street network for a future year, "no build" scenario. Includes future volumes without the proposed development; accounts for traffic from projects under construction but not yet in operation; and includes any future improvements to the street network that are already programmed, regardless of whether the proposed development is built.~~

    - ~~Projected – represents the performance of the street network for a future year, "build scenario", which represents the future street volumes with the proposed development in place. Other than changes in traffic volumes, the "Projected" scenario includes the same street network conditions as the "Background" scenario.~~

- ~~Mitigation – represents the performance of the future street network with the proposed development and with proposed mitigations resulting from the proposed development. Mitigation action is required for all conditions indicated in this row of the Decision Tree.~~

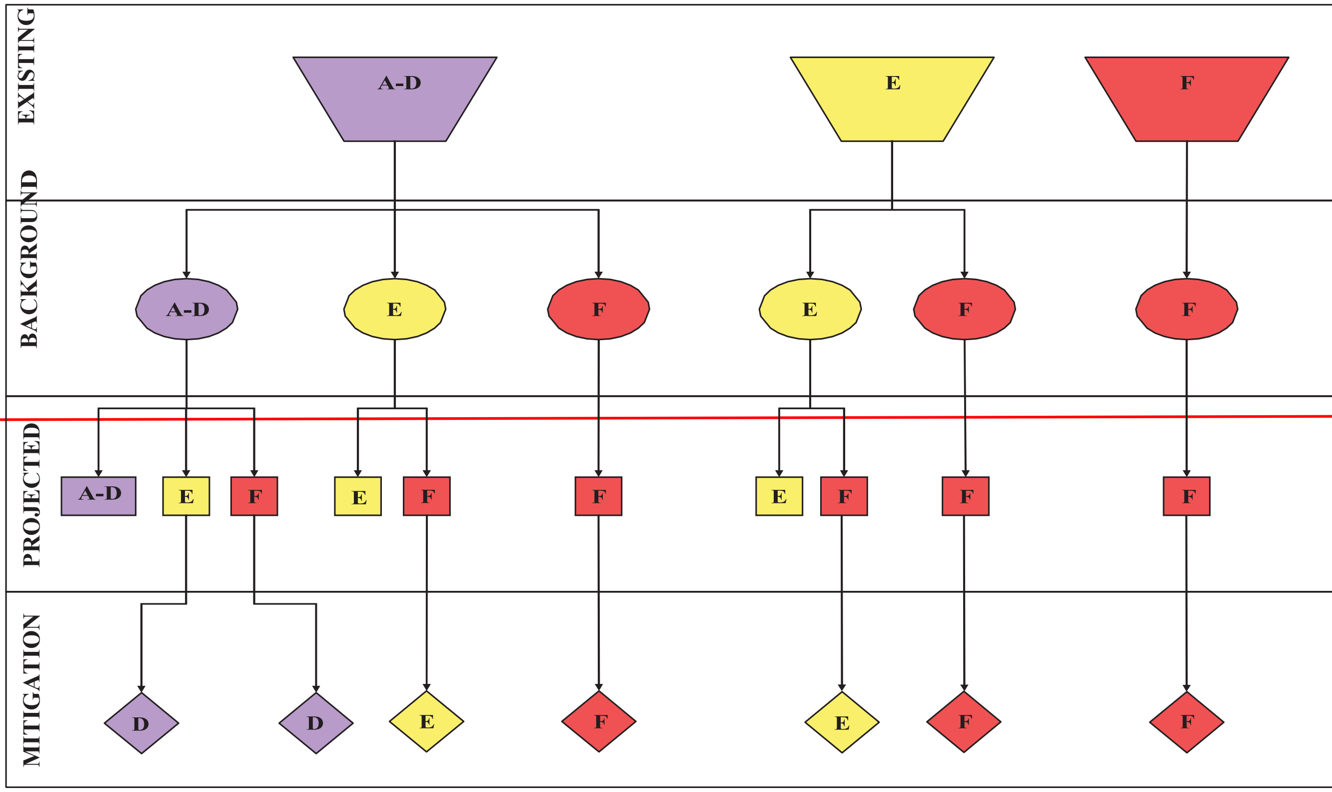
- ~~LOS E and LOS F~~

    - ~~Prior to final approval/disapproval involving LOS E and LOS F, the Applicant will meet with City Engineer to review all aspects of proposed development and adjacent roadway conditions including intersection delays.~~

    - ~~For areas in the street system where the current LOS is E, the existing LOS must be maintained or improved after development. For example, if the LOS prior to the proposed development is E, then once the development is in place, the projected LOS must be at least E.~~

    - ~~For areas in the street system where the current LOS is F, the traffic impacts of the development on the streets and intersection within the analysis area shall be mitigated such that the delay and queuing do not deteriorate beyond Background Conditions.~~

    - ~~Methodology for computing each type of MOE and determining corresponding LOS can be found in the Highway Capacity Manual (HCM).~~



~~Figure 15.04.04 Mitigation Decision Tree (Collector and Local Roadways)~~

~~a.~~c. Traffic signal retiming is not considered an acceptable mitigation measure unless it is first approved by the City of Houston Traffic Signal Operations. Typically, an individual intersection cannot be re-optimized in the future if it is a part of coordinated street network. This may only be possible if the entire street network is re-timed to allow for system wide signal progression. If signal retiming is approved by the City as a mitigation measure, it should be included in the ~~"~~Mitigation Conditions~~" scenario~~.

d. Mitigation Requirements:

(1) The following conditions must be assessed to determine mitigation:

(a) Existing Conditions

(b) Background Conditions

(c) Projected Conditions

(d) Mitigation Conditions

15.2.03.B.6.d.(3) continued

(2) VLOS shall be prepared for all analysis intersections for Existing Conditions, Background Conditions, Projected Conditions, and Mitigation Conditions.

(3) Mitigation Process:

(a) The mitigation process is shown in Figure 15.3.

(b) Each analysis intersection within the TIA scope shall follow this mitigation process.

(c) Mitigation Conditions:

(i) If the VLOS decreases from the Background Conditions, and if the Projected Conditions VLOS is E or F, then mitigation may be required.

(ii) If the Projected Conditions VLOS is higher than or unchanged from the Background Conditions VLOS, or if the Projected Conditions VLOS is D or higher, no mitigation shall be required.

(d) The intersection shall first be brought up to all standards that bring it into compliance with the Multimodal Service Standards (MMSS).

(e) Identify mitigation options that would improve the Projected Conditions VLOS to the Background Conditions VLOS. If the MMSS can be maintained and if the mitigation is feasible, then it should be implemented. No mitigation will be approved that does not comply with MMSS requirements.

(f) Private developers will not be required to acquire right-of-way from a third party to satisfy mitigation requirements. However, right-of-way dedication or easements may be required.

15.2.03.B.7.d.I

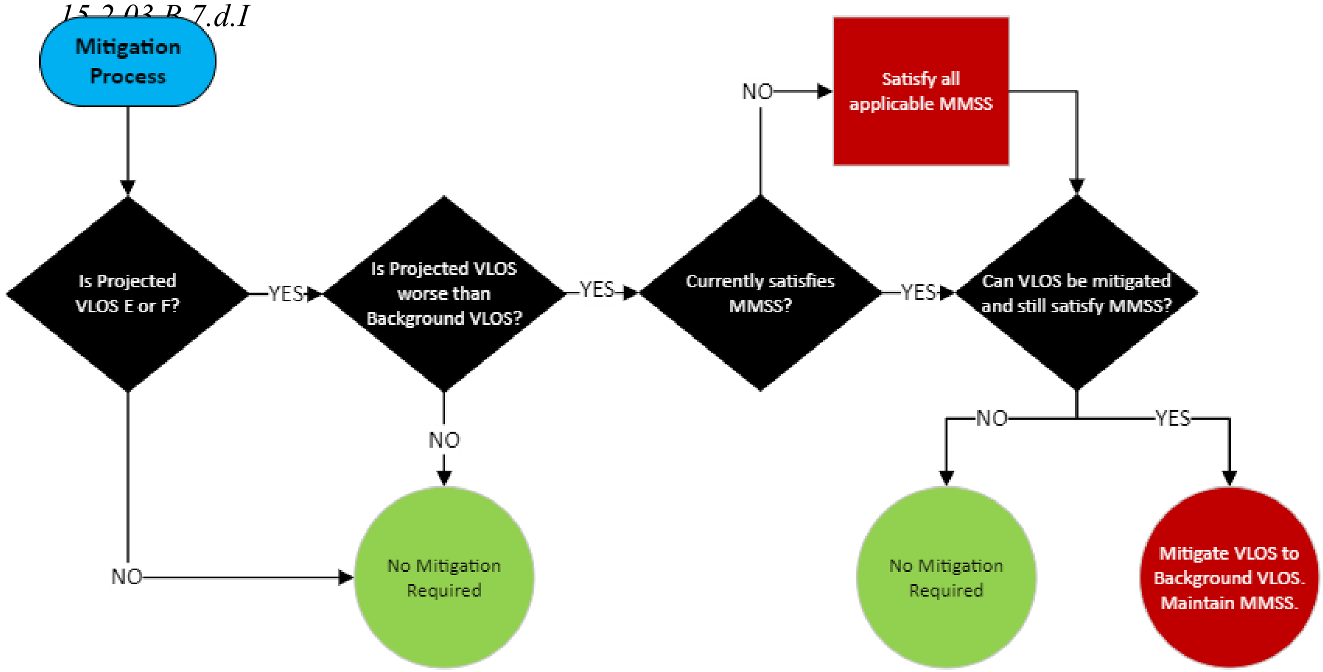


Figure 15.3~~15.3~~ – TIA MITIGATION PROCESS

~~9.~~7. Traffic Impact Analysis Submission Requirements

a. The ~~Analysis Engineer~~Engineer of Record must identify all of the required data and information in the appropriate sections of the report.

b. Text contained in the document shall be comprehensive and complete.

c. The report shall have an electronic copy of final submittals ~~along with the bound copy~~ including all appendices.

d. The report shall contain a table of contents, lists of figures and list of tables.~~-~~ A typical TIA report outline is shown in the following sections.

I. Executive Summary

(a) Site Location & Analysis Area

(b) Development Description

(c) Conclusions

(d) Recommendations

II. Introduction

15.2.03.B.7.d.III.(c) continued

(a) A statement about the purpose and objectives of the analysis.

(b) A description of the existing and expected land use and intensity.

(1) *If residential, number and type of dwelling units.*

(2) *If commercial or industrial, square footage and type.*

(3) *If redevelopment, what is the expected trip generation differential.*

(c) A vicinity map identifying major industrial and site access intersections and other approved projects near the development.

(d) A site plan for the development.

(e) A description of development phasing and estimate year each phase will begin and end.

III. Area Conditions

(a) A description of the analysis area.

(b) A description of existing and future land uses within the analysis area. The description should include current land use, densities and occupancy, anticipated development, undeveloped properties, and current master plans.

(1) If residential, number and type of dwelling units.

(2) If commercial or industrial, square footage and type.

(c) A combination of narratives, tables and figures detailing area street system characteristics within the analysis area including:

(1) Quantify and summarize the existing facility compliance with the Multimodal Service Standards (MMSS) identified in 15.2.01.

~~(1)~~(2) Programmed street improvements in the area (City of Houston 5 year Capital Improvement Plan)

~~(2)~~(3) Additional streets that may be impacted

~~(3)~~(4) Functional Street Classifications (based upon Major Thoroughfare and Freeway Plan)

~~(4)~~(5) Posted Speed Limits

15.2.03.B.7.d.III.(c).(14) continued

~~(5)~~(6) Distance, and alignments from existing streets, ~~d~~Driveways, and/or ~~m~~Median openings to development access (need to assess Access Management Standards)

~~(6)~~(7) Traffic control devices (traffic signals and ~~S~~stop signs)

~~(7)~~(8) Signal locations and timings (offsets need to be shown if in coordination)

~~(8)~~(9) Intersection layout, lane usage, and street configuration

~~(9)~~(10) Street right-of-way widths

~~(10)~~(11) Lane widths

~~(11)~~(12) Current traffic volumes within the past 1 year to have been captured on a typical Tuesday, Wednesday, or Thursday for all streets in the analysis. Any traffic volumes older than 1 year may not be acceptable and will need to be justified. The ~~Analysis Engineer~~Engineer of Record should also make every reasonable effort to count traffic that accurately reflects a true "peak period' for the area, which includes any potential seasonal variations (i.e. schools, churches, etc.). Depending on the type of development, it may also be necessary to capture volumes on a typical weekend.

i. 24-hour counts at major intersection and site access intersections

ii. Turning movement counts (~~P~~peak ~~H~~hours) with pedestrian and bicycle movements

~~(12)~~(13) Pedestrian~~s and Bikes~~ Infrastructure ~~(If Applicable)~~

i. Existing Facilities, with identification of any deficiencies as per Chapter 17, Section 3 - Pedestrian Elements Requirements.

~~ii. Volumes~~

(14) Bicycle Infrastructure

i. Existing facilities, with identification of any deficiencies as per Chapter 17, Section 4 - Bikeway Facility Requirements.

ii. Planned facilities on the Houston Bike Plan

~~(13)~~(15) Transit Service ~~(If Applicable)~~

i. Existing routes and service headways

ii. Planned transit facilities

~~i.~~iii. All bus stops, bus pads, bus shelters

~~ii.~~iv. Ridership (where applicable/when available)

~~iii.Routes and Service Intervals~~

(16) Crash Analysis ~~(if Applicable) over the past 3 years, including number and types of crashes as well as severity of injuries.~~

i. Identify whether any street or intersection in the scope of the TIA is on the City of Houston Vision Zero High Injury Network (HIN).

ii. Use TxDOT CRIS database to identify crash types and locations for three (3) years, and summarize: type of crash, severity of crash, and inclusion of a pedestrian or bicyclist.

iii. Identify any crash hotspots along any roadway or at any intersection included in the scope of the TIA.

iv. Identify any improvements to mitigate any identified crash trends or hotspots.

~~(14)~~(17) Existing ~~s~~Sight ~~d~~Distances – Intersection and stopping ~~s~~Sight ~~d~~Distances, vertical and horizontal clearances. Refer to Chapter 10, Section 10.~~06~~3.02.~~B~~C~~.3~~. - Intersection Sight Distance.

IV. Required Table(s)

(a) Twenty-four hour approach volumes at major and site access intersections.

(b) Peak ~~H~~hour approach volumes at major and site access intersections.

V. Required Figure(s)

(a) Major and site access intersection lane configuration diagrams with existing ~~Twenty~~twenty-four hour approach volumes. Preferably overlaid onto aerial photography.

15.2.03.B.7.d.V continued

(b) Major and site access intersection lane configuration diagrams with existing AM and PM peak hour turning movement volumes. Preferably overlaid onto aerial photography.

(c) The ~~Analysis Engineer~~Engineer of Record may also use photographs (identifying location from where it was taken as well as the date and time stamp) to document ~~e~~Existing ~~e~~Conditions.

VI. Projected Vehicular Traffic

(a) Sufficient details of calculations so that all calculations can be verified.

(b) Site generated traffic volumes (24-hour and peak periods) by corresponding development phase or year.

(c) Trip Generation - List of trip generation rates and/or sources of rates used for the study.

(d) Trip Distribution and Assignment - The gravity model or other acceptable trip distribution model used to estimate trip distribution. The ~~Analysis Engineer~~Engineer of Record can complete this task either manually or with applicable computer models.

(1) Background traffic volumes (24-hour and peak periods) by corresponding development phase or year.

(e) Traffic ~~V~~volumes should account for all approved developments in the analysis area as well as area growth beyond the analysis area. Contact the City for information about surrounding developments.

(1) Pass-by and diverted traffic volume reduction rates, if applicable.

(2) Pedestrian, bicycle and transit reduction rates, and supporting evidence, if applicable.

(3) Internal capture reduction rates, if applicable.

(4) Total project traffic volumes (24-hour and peak periods) by corresponding development phase or year. Future traffic as may be required for a development with multiple phases should also be included.

(f) Required Table(s)

(1) Pass-by trip, internal capture, pedestrian, bicycles, and transit reduction rates used, if applicable.

15.2.03.B.7.d.VI.(f) continued

(2) Twenty-~~F~~four hour approach volumes for background, pass-by, site generated, and total project traffic conditions at major and site access intersections and any additional transportation facilities specified by the City.

(3) Peak ~~H~~hour approach volumes for background, pass-by, site generated, and

(4) total project traffic conditions at major and site access intersections and any additional transportation facilities specified by the City.

(g) Required Figure(s)

(1) Twenty-~~F~~four hour, and peak hour approach volumes for background, pass-by, site generated, and total project traffic conditions overlaid onto major and site access intersections lane configuration diagrams. Preferably overlaid onto aerial photography.

(2) Peak hour turning movement volumes for background, pass-by, site~~-~~ generated, and total project traffic conditions overlaid onto major and site access intersections lane configuration diagrams. Preferably overlaid onto aerial photography.

(3) Distribution and assignment rates for pass-by and site generated traffic volumes overlaid onto major and site access intersections lane configuration diagrams. Preferably overlaid onto aerial photography.

VII. Traffic Analysis

Analyze existing, background and project ~~T~~traffic ~~C~~conditions VLOS and ~~D~~delay at all major and site access intersections and determine MOEs of any additional transportation facilities within the analysis area as necessary or as specified by the City.

(a) Analysis must utilize existing traffic volumes.

(b) Analysis must utilize total projected traffic volumes which include site generated traffic and the background traffic to complete analyses for the required study limits and horizons as they correspond to the predetermined TIA category.

(c) Analysis may be prepared manually or by using various software programs such as Highway Capacity Software, ~~Synchro~~ Vistro or as approved by the City.

15.2.03.B.7.d.VII continued

(d) Analysis must utilize the capacity analysis methodology found in the current edition of the Highway Capacity Manual, or control delay calculations from ~~Synchro~~ Vistro or other software as approved by the City, and/or delay calculations from micro-simulation of the complete street network (no individual intersections) to determine VLOS.

(e) Determination of necessary or specified MOEs should be completed using state- of-the-practice engineering methods.

(f) In addition to VLOS and delay, the ~~Analysis Engineer~~Engineer of Record should identify critical movements regarding capacity and potential locations of queue spillback.

(g) The ~~Analysis Engineer~~Engineer of Record should perform a signal warrant analysis for unsignalized intersections (engineering judgment) using the signal warrant guidelines. Additionally, as part of the improvements analysis the ~~Analysis Engineer~~Engineer of Record should analyze any unsignalized intersections warranting a signal as a signalized intersection and discuss within the TIA report.

(h) Tables of existing, background and project traffic conditions VLOS and delay for each major and site access intersection and MOEs for any additional transportation facilities specified by the City, include critical movements and queue spillbacks.

VIII. Additional Information ~~(If Applicable)~~

(a) Site circulation and off-site parking requirements.

(b) Potential parking impact to adjacent neighborhoods and neighborhood parking

(c) Evaluation of potential need for traffic calming including bulb out, chicanes, roundabouts, or those elements found in Section 15.2.11 ~~15.19~~ of this chapter.

(d) Others (If ~~A~~applicable)

(1) Crash ~~A~~analysis

(2) Traffic control needs

(3) Transit (bus and rail)

(4) Pedestrian and bicycle access

(5) Delivery and service vehicles

15.2.03.B.7.d.IX continued

(6) Transportation demand management.

IX. Transportation Improvements Analysis (Mitigation Measures)

(a) A description of enhancements needed to bring all impacted roadways and intersections up to MMSS requirements.

~~(a)~~(b) A description and justification of ~~needed~~ transportation ~~improvements~~ modifications to accommodate projected traffic conditions

~~(b)~~(c) VLOS and ~~D~~delay evaluation and comparison including review of critical movements and queue spillbacks

~~(c)~~(d) MOE comparison for any additional transportation facilities specified by the City

~~(d)~~(e) Table(s)

(1) VLOS and ~~D~~delay comparisons for improvements including critical movements and queue spillback

(2) MOE comparisons for any additional transportation facilities improvements

~~(e)~~(f) Figure(s)

(1) Concept schematics of improvements including corresponding VLOS and ~~D~~delay values.

X. Site Improvement Analysis

(a) A description of site circulation and recommendations for improvement.

(b) A description of on-site parking and recommendations for improvement including shared parking, if applicable

(c) A description of expected delivery and service vehicle operation and facility use and recommendations for improvement.

(d) A description of expected site passenger loading characteristics related to bus stop/transit and recommendations for improvement.

(e) A description of adherence to related ~~a~~Access ~~m~~Management concepts as can be found in the City's set of Access Management Standards including ~~d~~Driveway design, access spacing, and turning movement treatments.

15.2.03.B.7.d.XI.(b) continued

XI. Conclusions and Recommendations

(a) Traffic Impacts

(b) Adjacent transportation improvements for each horizon year addressing, at a minimum, the following:

(1) Recommended MMSS modifications

(2) Bicycle facility implementation/improvements

~~(1)~~(3) Pedestrian and transit facility implementation/improvements

(4) Additional capacity (left, right, or through lanes), if compatible with MMSS requirements

~~(2)~~(5) Traffic control device(s) (modification or installation)

~~(3)~~(6) Need for acceleration or deceleration lanes

~~(4)~~(7) Critical movements

~~(5)~~(8) Length of storage bays

~~(6)~~(9) Implementation schedule

~~(b)~~(c) Off site transportation improvements

(1) Modification to existing traffic control device(s)

(2) Additional traffic control device(s)

(3) Additional capacity at major intersections

(4) Additional street capacity

(5) Other

~~(c)~~(d) Site transportation improvements

(1) Access Management

(2) Site circulation and parking

~~(d)~~(e) Mitigation Measures

15.2.03.B.7.d.XII continued

(1) The TIA report shall identify the mitigation measures needed as a result of any traffic impacts of the proposed development or redevelopment. The TIA report should also identify who or what exactly caused the need for each mitigation measure. This information will be used when the ~~A~~applicant meets with the City Engineer about the implementation and cost appropriations for mitigations measures.

XII. Appendices

Appendices shall be titled appropriately in Adobe PDF file format~~may be included as an attached CD having individual electronic file folders for each appendix and appropriately titled Adobe PDF files~~. General figures and tables required by the TIA process should generally not be included as an appendix and should instead be included near the referencing text in the main document.

(a) Basic ~~T~~trip ~~G~~generation ~~W~~worksheet

(b) Capacity ~~A~~analysis ~~W~~worksheets or ~~M~~modeling ~~S~~software ~~O~~output

(c) Traffic ~~V~~volumes (24-hour and peak hour turning movement counts)

(d) Selected ~~P~~photographs

15.2.03.C TECHNICAL NOTES

1. Background Trip Determination

   a. Background or non-site traffic forecasts are necessary to determine the impact of the development in horizon years such as the projected year of opening, year of full build-out and five years after full build-out. Background traffic consists of all trips that do not begin or end in the analysis area and all attraction and production trips from existing development within the analysis area. Trips generated from existing development within the analysis area are important as the proposed development may influence existing traffic patterns and potentially generate new trips for existing developments. Background traffic volumes should also include trips generated from other proposed developments within the analysis area. The ~~Analysis Engineer~~Engineer of Record should check with the City to ensure that all approved developments have been included in background traffic determination.

2. Methodologies for Background Traffic Determination

15.2.03.C.2 continued

a. There are three basic methodologies used to determine background traffic volumes: build-out, area transportation planning, and trending. Each of these methodologies has strengths and weaknesses. Some methods may be more appropriate depending on the category of the ~~D~~development. The ~~Analysis Engineer~~Engineer of Record may use any of the three aforementioned methods to determine background traffic volumes. The City anticipates that the majority of background traffic calculations will be completed using trending methods. For this reason, the City provides the following information on trending.

b. Trending or the use of growth rates is a common method used to generate background traffic. This method is particularly useful for smaller developments and studies having shorter horizon periods (5 to 10 years). City of Houston traffic volumes have typically grown between one and two percent per year. Although these growth rates are typical for the whole of the City, there are some areas that may have higher and lower rates of growth. The ~~Analysis Engineer~~Engineer of Record may find higher growth rates in outlying areas of the City having lower development density, and lower growth rates in older more mature areas of the City that have little or no year-to-year changes in traffic. In general, the City of Houston experiences a growth rate of one percent for all trending analyses. It is a requirement and the responsibility of the ~~Analysis Engineer~~Engineer of Record to apply appropriate growth rates as they correspond to different areas of the city. The ~~Analysis Engineer~~Engineer of Record should provide and justify an expected area growth rate in the proposal of scope for approval by the City. Where feasible, growth rates should be calculated from historical counts.

3. Site Trip Generation

a. The City requires that the ~~Analysis Engineer~~Engineer of Record generate site traffic and general trip generation rates using the methodologies found in the current edition of the ITE publication, Trip Generation Handbook~~. This includes following the "Recommended Procedure for Estimating Trip Generation", as shown in Figure 15.04.02. General Trip Generation Rates shall be obtained from the Trip Generation Handbook, current edition~~.

15.2.03.C.4 continued

b. The ITE publication suggests using rates from local studies as a preferred method for generating site traffic. If the ~~Analysis Engineer~~Engineer of Record utilizes local studies to determine appropriate rates, it is a requirement and the responsibility of the ~~Analysis Engineer~~Engineer of Record to reference these studies in the TIA report. In addition, the ~~Analysis Engineer~~Engineer of Record must make available copies of the referenced studies if requested by the City. If local rates are not available, the ~~Analysis Engineer~~Engineer of Record shall use equations and rates from the current edition of the ITE Trip Generation report as long as it follows the ITE ~~R~~recommended ~~P~~procedure~~, as shown in Figure 15.04.02~~. Otherwise, ~~Analysis Engineer~~Engineer of Record should consult with the City and local data may need to be collected.

4. Pass-by Trips/Internal Capture

a. The City Traffic Engineer shall approve all pass-by and internal capture reduction for use in the TIA.

b. The added pass-by trip will have little impact on through movement traffic operations or be part of a potential change in travel demand requiring adjacent transportation infrastructure improvements. However, ~~the City recognizes that~~ pass-by trips can affect left- and right- turning movement frequency and may require installation of turn lanes or other forms of mitigation (i.e., exclusive phasing, timing optimization, capacity increase). The ~~Analysis Engineer~~Engineer of Record should redistribute pass-by trips from the through movement to the appropriate left- or right- turning movement for analysis purposes. The ~~Analysis Engineer~~Engineer of Record should provide and justify an expected reduction rate for pass-by trips in the proposal of scope for approval by the City.

~~b.~~c. Development access connections should still carry pass-by trips and the ~~Analysis Engineer~~Engineer of Record should consider those trips in calculating the total number of trips generated by the proposed development and for necessary adjacent street improvements due to these trips. The City also recommends that the ~~Analysis Engineer~~Engineer of Record account for pass-by trips in the trip assignment step to ensure appropriate left and right turning movement volumes as these added turning vehicles may require the need for the installation of new or additional storage at existing left- and right-turn lanes.

~~c.~~d. Internal capture is the application of a percent reduction in generated trips (~~d~~Driveway trips) and is typically applicable to projects such as shopping centers with out-lots and urban mixed-use developments.

5. Generating Trips for Redevelopment

15.2.03.C.6.b continued

a. For proposed redevelopment, the City allows the ~~Analysis Engineer~~Engineer of Record to subtract trips generated by the existing development from those the new development will generate. Existing trips are preferably derived from traffic counts.

b. If an ~~A~~applicant proposes changes to only a portion of an existing development, the City allows the ~~Analysis Engineer~~Engineer of Record to subtract any trips associated with that portion of the existing development from the trip that the proposed redevelopment will generate.

6. Site Trip Distribution and Assignment

a. Site traffic distribution and assignment are very subjective tasks and requires the ~~Analysis Engineer~~Engineer of Record to exercise engineering judgment and to call on past experiences in transportation planning.

b. Trip Distribution

(1) Trip distribution efforts, in general, take into consideration the ~~D~~development as a whole. Determining how generated traffic will access the proposed development can vary greatly and depends on several factors:

(a) Type of development

(b) Size of the development

(c) Where the development will draw or attract traffic from

(d) Competing developments in the area

(e) Surrounding land uses

(f) Condition and capacity of the surrounding street system

c. The City recommends the ~~Analysis Engineer~~Engineer of Record refer to, or utilize previously determined trip distribution models, planning software, or other recognized and substantiated methods to distribute traffic.

d. It is a requirement and the responsibility of the ~~Analysis Engineer~~Engineer of Record to document the methodologies or references utilized in completing the task of trip distribution in the TIA report. The ~~Analysis Engineer~~Engineer of Record will also be responsible to provide copies of referenced studies or models if requested by the City.

15.2.03.C.8 continued

7. Trip Assignment

a. Assigning trips determines the amount of traffic on routes within the street network and analysis area. The ~~Analysis Engineer~~Engineer of Record should assign trips- after- considering several area and street network characteristics such as logical routings, left-turn movements at unsignalized intersections and access connections, available capacity and existing travel times. The ~~Analysis Engineer~~Engineer of Record should consider traffic conditions for each horizon year and adjust trip assignments accordingly. The ~~Analysis Engineer~~Engineer of Record may also find it necessary to prepare different sets of trip assignments for site generated trips. This may especially be useful if there are a significant number of pass-by trips. It is a requirement and the responsibility of the ~~Analysis Engineer~~Engineer of Record to detail and explain assumptions in the narrative portion of the TIA report.

8. Traffic Analysis

a. Capacity analyses shall be performed on the transportation facilities within the determined analysis area. The ~~Analysis Engineer~~Engineer of Record shall use the methodology- of the HCM to complete any capacity analysis. The analyses may be prepared manually or by using various available software programs such as HCS, ~~Synchro~~Vistro, or as approved by the City. In addition to capacity analyses, the ~~Analysis Engineer~~Engineer of Record should consider other factors including safety, circulation, traffic control needs, transit, neighborhood traffic impacts, pedestrian and bicycle access, delivery and service vehicles and transportation demand management.

b. For each analysis horizon, the ~~Analysis Engineer~~Engineer of Record shall utilize the total project traffic volume which includes site generated traffic and the background- traffic. Background traffic shall include traffic from other proposed developments within the analysis area and horizon. The ~~Analysis Engineer~~Engineer of Record shall also complete capacity analyses for ~~e~~Existing and ~~b~~Background ~~c~~Conditions in order to provide VLOS comparisons.

15.2.03.C continued

c. The analysis and site plan of the ~~D~~development are an iterative process required for each horizon year. The purpose is to show the relationship between the site, its circulation, and plan along with the existing area street system. Accomplishing this allows the ~~Analysis Engineer~~Engineer of Record to better determine deficiencies and develop alternatives for consideration. The ~~Analysis Engineer~~Engineer of Record should define and identify impacts, deficiencies, and need for improvement. The analysis of ~~e~~Existing ~~e~~Conditions is essential in order to determine pre-development deficiencies and need for improvements.

d. The ~~Analysis Engineer~~Engineer of Record shall tabulate and report VLOS and ~~D~~delay for the transportation facilities within the determined analysis area. The ~~Analysis Engineer~~Engineer of Record should tabulate overall intersection VLOS and delay for each approach and individual movements. ~~The City recognizes that l~~Left turning movements and, in many cases, the approach VLOS may be ~~less than desirable~~ lower at stop-controlled facilities. Intersection capacity analysis shall include analysis of queue spillbacks and capacity of left and right turn lanes. The~~-~~ VLOS for turning movements at all access connections (~~d~~Driveways and turning lanes) at the project site shall also be analyzed.

e. If the ~~A~~applicant is proposing a traffic signal at an intersection or access connections, the ~~Analysis Engineer~~Engineer of Record shall ~~use the warranting process prescribed by the City's Signal Engineering Section Design Guidelines~~ prepare a Traffic Signal Warrant Analysis (TSWA) to include with the TIA.

f. All capacity analysis worksheets and modeling software outputs for the ~~e~~Existing ~~e~~Conditions and horizon years shall be included in the TIA report as an appendix. The City may also require the actual model to be submitted in electronic form.

9. Site Access and Off-Site Improvements

a. The ~~Analysis Engineer~~Engineer of Record should identify needs and deficiencies using the previously prepared analyses. In addition, the ~~Analysis Engineer~~Engineer of Record should develop alternatives to address these needs and should address both on- and off-site improvements, if applicable.

b. Make recommendations for all site-adjacent streets and intersections to fully comply with the Multimodal Service Standards (MMSS) as defined in section 15.2.01.

15.2.03.C.12 continued

c. Mitigation measures can include, but are not limited to, ~~m~~Median openings, turn lanes, bicycle/pedestrian/transit amenities, traffic calming and traffic signals. The ~~Analysis Engineer~~Engineer of Record shall analyze proposed mitigation measures for capacity and other factors. The ~~Analysis Engineer~~Engineer of Record shall base capacity improvements on the VLOS, however all Multimodal Service Standards (MMSS) must be satisfied before VLOS improvements will be considered.

10. Previously Proposed Transportation Improvements

a. The ~~Analysis Engineer~~Engineer of Record can factor proposed network improvements into the analysis and can use them as mitigation measures. For example, if the ~~A~~applicant schedules a ~~D~~development to open in three years, and the City has a capital project that will widen the street before that time, the ~~Analysis Engineer~~Engineer of Record can consider the proposed capital improvement in the analysis.

11. Phased Developments

a. Phased ~~D~~developments often present a challenge for the ~~A~~applicant. In many cases, ~~P~~phase I of the development is well defined while additional phases are vague and may change with market conditions.

b. It is acceptable to the City for an ~~A~~applicant to submit a TIA for all phases of the ~~D~~development including proposed improvements at the start of a project. However, if future phases of the ~~D~~development change, generating more or less traffic, or if the site and/or Driveway layout changes ~~than what the Applicant had previously submitted to the City~~, it will be necessary for an ~~Analysis Engineer~~Engineer of Record to update the existing TIA or prepare a new one. If the ~~A~~applicant only submits to the City the first phase of the ~~D~~development, the ~~A~~applicant should be aware that conditions may change potentially requiring additional on- and off-site improvements. If a ~~D~~development is to be completed in phases, the TIA can also propose phasing of mitigation. However, the ~~Analysis Engineer~~Engineer of Record must analyze any mitigation measures proposed for the appropriate horizon year.

12. On-Site Planning

a. An integral component of any TIA should include basic site planning. This includes the identification of access connections (e.g., transit connections to existing bicycle and pedestrian facilities), internal circulation, service and delivery access connections and service bays including the use of turning templates as appropriate, and the identification of optimal building locations.

15.2.03.C.12.d continued

b. Access connections operate as intersections and the City treats them as such. They should have an appropriate number of lanes, adequate storage "ready access to existing transit facilities," pedestrian facilities and appropriate signing and pavement markings. Adequate storage for a~~-~~ larger~~-~~ ~~D~~development's access connections is often a concern, and if not designed properly, will operate inefficiently creating the potential for traffic to back up onto the street system. ~~Joint~~ Shared ~~a~~Access between adjoining properties is desirable and should be pursued wherever possible,~~;~~ particularly where street frontages are short or internal volumes will be low. Driveways should be located near the property line if possible, or the ~~A~~applicant should make cross access agreements with adjoining property owners.

c. On-site circulation and street design should be consistent with off-site streets. The area street system has shaped driver behavior and expectations; violating these expectations provides potential for safety problems.

d. Consistency between off-site and on-site signage and pavement markings is desirable for managing drivers' expectations. To the extent practical, use of Texas Manual on Uniform Traffic Control Devices (T~~x~~MUTCD) approved signs and pavement markings is recommended. Site access connections shall conform to City of Houston Access Management Standards and the ~~A~~applicant and the ~~Analysis Engineer~~Engineer of Record should consider the following principles:

(1) Locating proposed traffic signals to provide for progression along the intersecting street.

(2) Providing the minimum number of access connections that can adequately serve all anticipated traffic traveling to the site.

(3) Providing adequate capacity/storage at access connections to ensure that traffic accessing the site does not spill back onto adjacent streets.

(4) Intersecting two-way ~~d~~Driveways with streets as close to perpendicular as possible.

(5) Providing adequate capacity/storage at internal intersections, especially those adjacent to public street access connections, to ensure that traffic within the site does not spill back onto adjacent streets.

(6) Providing adequate ~~s~~Sight ~~d~~Distance and appropriate safety measures at all access connections and internal intersections.

15.2.03.D.1 continued

(7) Locate site ~~d~~Driveways across from existing public streets, ~~d~~Driveways or existing ~~m~~Median break locations, i.e., avoid offset ~~d~~Driveways or access connections.

e. The ~~Analysis Engineer~~Engineer of Record should base ~~s~~Storage ~~l~~Lengths at access connections on the City of Houston Design Manual and Access Management Standards. For smaller developments, the ~~Analysis Engineer~~Engineer of Record should design parking and access connections to allow vehicles to align themselves perpendicularly to the adjacent street system. For larger developments, the ~~Analysis Engineer~~Engineer of Record should provide adequate storage to ensure that exiting traffic does not hinder internal circulation. The ~~Analysis Engineer~~Engineer of Record should estimate potential on-site queuing and provide adequate stacking spaces to prevent impacts on adjacent streets as well as bicycle/pedestrian facilities.

15.2.03.D TRAFFIC ANALISYS IN MAJOR ACTIVITY CENTERS

The City Engineer, together with the Planning and Development Department, may cooperate with ~~m~~Management ~~d~~Districts, development authorities or other public or private organizations to prepare a transportation plan within a Major Activity Center. While the City may provide oversight, the preparation of the plan is not the responsibility of the City.

1. Transportation Plan and Traffic Analysis

a. The horizon year projections can be used to generate trips for the Major Activity Center study area. A Traffic Impact Analysis can be prepared using this transportation plan identifying impacts and mitigation measures. A plan can be included for how mitigation measures are implemented and these can be incorporated into transportation plans and capital improvement programs within a Major Activity Center.

b. It may be necessary for the ~~T~~transportation ~~P~~plan and ~~T~~traffic ~~A~~analysis to be updated once every three years.

c. Any proposed development within the ~~T~~transportation ~~P~~plan and ~~T~~traffic ~~A~~analysis ~~S~~study ~~A~~area that will produce the same or less PHT than a use described in the ~~T~~transportation ~~P~~plan shall be exempt from preparing a TIA.

d. Any proposed development within the ~~T~~transportation ~~P~~plan and ~~T~~traffic ~~A~~analysis ~~S~~study ~~A~~area that will produce more PHT that described in the ~~T~~transportation ~~P~~plan shall be required to amend the ~~P~~plan or submit a separate standalone TIA.

15.2.04.D continued

2. Developments within a Major Activity Center without a ~~T~~transportation ~~P~~plan and associated ~~T~~traffic ~~A~~analysis will follow the traffic study requirements in this chapter.

3. Developments within a Major Activity Center will always have the option of preparing a separate TIA specifically for their development.

15.2.04 TRAFFIC VOLUMES

15.2.04.A The City of Houston, Houston Public Works collects and stores a broad range of traffic data to assist the Engineers of Record ~~design engineers~~ in maintaining and designing safe and cost effective facilities. The traffic data collection efforts include traffic volume and vehicle classification and speed data surveys, utilizing road tubes, permanent loop sensors, or other devices.

15.2.04.B The City of Houston uploads and stores historical traffic counts on the City GeoLink portal. [12]

15.2.04.C Traffic volumes from other sources can be used with authorization of the City Traffic Engineer.

15.2.04.D TRAFFIC STUDIES

1. New traffic volumes must be collected for all traffic studies if existing counts are more than 1 year old if located in an area experiencing high growth or more than 2 years old in all other areas.

2. Counts must be conducted between Tuesday and Thursday when school is in session. They must not be collected on holidays or the day before or after a holiday or when special events may disrupt typical traffic flows.

3. Summer counts may not be used unless authorized by the City Traffic Engineer.

4. General peak hour counts should be conducted between 7-9 am and 4-6 pm. If there is a peak hour generator (such as a bus stop or school) that may affect the designated peak times, this must be identified and approved by the City Traffic Engineer prior to use.

5. ADT and approach counts should include vehicle speeds and a calculated 85th-percentile speed as well as vehicle classifications broken into at least three categories based on size or number of axles.

~~5.~~6. Turning movement counts (TMC) should be 13 hours and should include pedestrians and bicycles.

[12] https://geohub.houstontx.gov

15.2.04.E ADJUSTMENT FACTORS

1. Seasonal Factors. If requested, traffic volumes ~~should~~ shall be adjusted to reflect the seasonal changes in traffic volumes. ~~The monthly seasonal factor for a particular month is computed by dividing the average annual daily traffic (AADT) by the particular month average daily traffic (ADT):~~ $\cancel{SF = \frac{AADT}{MonthlyADT}}$

2. Peak Hour Factor (PHF). The hourly volume during the analysis hour divided by the peak 15-minute flow rate within the analysis hour. Hourly counts used in traffic analyses must use a PHF adjustment, which is computed by dividing the measured hourly volume by the PHF. ~~Intersection~~ PHF for the entire intersection will be applied to all ~~turning~~ vehicle movement volumes unless otherwise directed by the City Traffic Engineer.

$$PHF = \frac{HourlyVolume}{4V_{15}}$$

~~1. K Factors (design hour factor)~~

~~a. The proportion of the AADT occurring in a peak hour. The K-factor is utilized in traffic forecasts to estimate a future peak hour volume to determine roadway capacity needs. The K-factor is used to determine the Design Hour Volume (DHV).~~

~~b. Traffic projections are expressed as AADT and DHV. AADT and DHV are related to each other by use of the K-factor:~~

$$\cancel{DHV = AADT \times K}$$

~~2. D-Factor (Directional Distribution)~~

~~The percentage of the total, two-way design hour traffic traveling in the peak direction.~~

~~a. The directional distribution is an essential traffic parameter used to determine the Directional Design Hour Volume (DDHV) for the design year. The DDHV is the product obtained by multiplying the DHV and the D-Factor.~~

$$\cancel{DDHV = DHV \times D}$$

15.2.04.F GROWTH FACTOR

15.2.05.A continued

1. The City of Houston may require traffic counts to be projected out to future conditions. When Background Conditions and/or future conditions are required for a project assessment, the projection methodology must follow the requirements of this section.

2. The Engineer of Record must recommend a methodology for determining Background and/or future conditions. Linear growth rates are the most common method, but other methods may be acceptable.

3. If a growth rate is used to determine the Background Conditions and/or future conditions, the Engineer of Record shall recommend a growth rate. The City of Houston considers 1-2% to be a typical range of growth rates within most of the City, and the Engineer of Record shall provide justification for using a lower or greater rate.

~~3.~~4. Justification of a growth rate should be based on historical traffic counts in the vicinity of the project and/or knowledge of future land-use changes.

15.2.05 TRAFFIC SIGNS

15.2.05.A GENERAL

1. This section of the Design Manual contains the criteria and formats to be used in designing and preparing plans for the installation and refurbishing of traffic signs in the City of Houston. The intent is to establish standard procedures and requirements that will be used by the ~~engineering designers~~ Engineer of Record ~~and consultants~~ when designing signing for City of Houston projects. All design shall also be in accordance with the Standard Highway Sign Designs (SHSD) for Texas and with the Texas Manual of Uniform Traffic Control Devices (TMUTCD).

2. This document provides the Engineer of Record~~Designers and Consultants~~ with:

   a. the design requirements and guidelines for ensuring uniformity in sign types, mounting, size, and placement; and

   b. the required format of plan sheets to allow ease of review, minimization of construction errors, and facilitation of maintenance.

15.2.05.B DESIGN REQUIREMENTS

1. Description of Design/Review Process

   a. Project Initiation

15.2.05.B.1.b continued

(1) Determine ~~R~~requirements of ~~O~~other ~~A~~agencies. If the project falls under TxDOT's jurisdiction, verify TxDOT's signing requirements and if discrepancies exist between the City's requirements and TxDOT's, the Engineer of Record ~~Consultant~~ shall meet with the City Traffic Engineer to reconcile any differences.

(2) The ~~Consultant~~ Engineer of Record shall meet with the City of Houston prior to beginning the signing design to discuss the project in detail. At this meeting, typical and any specialty signing within the project limits will be discussed. The meeting regarding traffic signing will generally occur as part of other project initiation meetings and will not require a separate meeting.

(3) Any special signs, sign toppers, custom signs and non-standard signs must be identified and approved by the City Traffic Engineer prior to use.

b. Collect Engineering Data

(1) Collect all data required to develop a base map of ~~e~~Existing ~~e~~Conditions which can be used for the design process. Typically, traffic signing design will be included as part of a roadway, intersection, or traffic signal design project, and base maps for traffic signing design can be generated from the topographic survey and/or other design sheets.

(2) The ~~Consultant~~ Engineer of Record shall visit the project site to inventory and identify physical features that may impact traffic signing designs.

(3) The ~~Consultant~~ Engineer of Record shall perform an inventory of existing signing. The inventory shall include but is not limited to the following:

(a) Sign size, sign material, and general condition of the sign

(b) Sign type and legend

(c) Posted speed limit(s)

(d) Any specialty signs

(e) Sign post and foundation type

(f) Identify signs that will need to be relocated or replaced.

15.2.05.B.1.d.(1) continued

(g) Any obstructions or geometric features that may interfere with the installation or visibility of signs.

c. Develop Base Map of Existing Conditions

(1) The ~~Consultant~~ Engineer of Record shall develop a base map showing all the applicable data collected. The base map or drawing will be used to show the traffic signing design.

(2) The base map shall include but is not limited to the following information:

(a) All roadway curb and gutter or edges of pavement

(b) Roadway stations and centerline

(c) Right-of-way, easements and street names

(d) Driveways and intersections

(e) Sidewalks, bus stops, pads, and shelters

(f) Other features deemed pertinent

d. Plans and Drawings

(1) General

(a) All traffic signing design shall be prepared on design sheet size required by the Project Manager~~, using the Sstandard City of Houston, Houston Public Works Ttitle Bblock~~. On the ~~T~~traffic signing plans; proposed pavement markings shall be shown as a background information without callouts. Refer to Section 15.2.06, Traffic Pavement Markings, for details regarding the design of pavement markings.

(b) All full-size designs shall be prepared at a scale of 1-inch equals 40 feet. If other design scales are needed, approval from the City Project Manager is needed before beginning design.

(c) All ~~construction d~~Drawings shall be prepared in accordance with Chapter 3, Graphic Requirements.

15.2.05.B.1.d.(2).(b) continued

(d) On projects where the ~~Consultant~~ Engineer of Record finds it necessary to deviate from the standard format presented herein, due to project scope or design requirements, the City's Project Manager should be consulted to determine an acceptable alternate format. Any changes to the format are at the discretion of the City's ~~p~~Project ~~m~~Manager.

(2) General Notes

(a) General ~~N~~notes shown on City of Houston Standard Detail ~~01509-01~~01554-01 should appear on all traffic sign design sheets. Additional notes may be added by the ~~Consultant~~ Engineer of Record as may be necessary to properly clarify the intent of the design.

(b) The general notes in short include but are not limited to the following items:~~.~~

(i) Prior to start of construction, all existing signs within the area of construction shall be inventoried and documented jointly by the City Inspector and the ~~C~~contractor. This document will be jointly signed by both parties reflecting the sign type, sign size, sign condition, sign location, reflectivity adequacy, etc. The ~~C~~contractor is held accountable for these signs throughout the ~~P~~project and at the ~~P~~project's completion.

(ii) The ~~C~~contractor will be responsible for safeguarding existing signs so that they either continue to remain visible and upright in the field or they are collected and stored in a secure area when temporary signs are used in lieu of the existing signs.

(iii) The ~~C~~contractor will be responsible for re-installing existing signs that have been removed and stored by the ~~C~~contractor if required per construction plans. The ~~C~~contractor will provide and install signs that were documented missing prior to the start of work.

(iv) The ~~C~~contractor shall replace any signs that are lost or damaged during construction. All signs shall meet City standards.

(v) The ~~C~~contractor shall install all permanent signs, posts and hardware as shown on the plans.

15.2.05.B.1.d.(4) continued

(3) Ground Mounted Signs

(a) All ground mounted signs, unless noted otherwise, shall be mounted at a height of seven (7) feet measured from the bottom of the sign to the top of curb or top of roadway at edge of pavement and shall be a minimum of twenty-four (24) inches from the edge of pavement or curb.

(b) All ground mounted signs shall use perforated square metal tubing 1- 3/4" by 1-3/4". Special permission from the City Traffic Engineer will be required to use any other metal sign post.

(c) Refer to City of Houston Standard Details ~~01509-01~~01554-01 and ~~01509-01A~~01554-02 for additional design requirements.

(4) Street Name Signs

(a) New street name shall be approved by the Planning and Development Department.

~~(a)~~(b) Street name signs shall include block numbers per the Standard Details.

~~(b)~~(c) Ground-mounted street name signs shall have a height of nine (9) inches. The length shall be thirty (30) inches minimum and forty-eight (48) inches maximum (in 1- inch increments). Sign plates longer than forty-eight (48) inches must be approved by the City Traffic Engineer.

~~(c)~~(d) Refer to City of Houston Standard Detail ~~01509-02~~01554-03 (Street Name Sign and Sign Mounting) for additional requirements related to ground mounted street name signs. Refer to Chapter 15, Section~~15.11~~ 15.2.14 - Traffic Signals of this ~~M~~manual for overhead mounted street name signs.

~~(d)~~(e) Customized street name signs require separate approval from the City Traffic Engineer. This includes ground mounted signs, overhead street name signs, and sign toppers. Interested parties should contact the Traffic Hotline at 832-395-3000 to apply.

~~(e) All new signs shall have the City bar code stickers.~~

(5) Ground Mounted Sign Sizes

(a) All "STOP" and "YIELD" signs installed in the City of Houston shall be a minimum of thirty-six (36) inches for vehicular traffic and eighteen (18) inches for non-motorized traffic.

(b) Refer to City of Houston Standard Detail ~~01509-03~~01554-06 (Ground ~~M~~mounted ~~S~~sign ~~S~~sizes) for dimensions of typically used sign plates and dimension of attachment holes.

(6) Sign Placement

(a) The placement of all signs shall be in conformance with the latest edition of the Texas Manual of Uniform Traffic Control Devices (TMUTCD).

(b) Refer to City of Houston Standard Detail ~~01509-04~~01554-07 (Typical Sign Placement) for typical sign placement details and street name signs at typical intersections.

(c) Refer to ~~T~~traffic ~~S~~signal ~~D~~details for additional information regarding typical placement and location for signs mounted on mast arms.

(7) City of Houston Approved Signs

(a) City of Houston Standard Detail ~~01509-05~~01554-08 and ~~01509-06~~01554-09 provide lists of ~~R~~regulatory, ~~W~~warning, ~~C~~construction ~~W~~work, ~~B~~bicycle, and ~~S~~school signs with corresponding sign nomenclature, and dimension.

(b) The ~~designer~~Engineer of Record shall use the signs listed on City of Houston Standard Details ~~01509-05~~01554-08 and ~~01509-06~~01554-09. Special permission from the City Traffic Engineer will be required to adjust the sign dimensions and/or use additional signs approved by TMUTCD. Note that this does not apply to special signs and guide signs specifically tailored for a specific location.

(c) Guide signs for the following entities may be permitted within the City right-of-way. These entities may be required to install and maintain their own signs:

15.2.05.B.1.d.(7).(c) continued

(i) Public airports with a minimum of 15 regularly scheduled flights daily.

(ii) College and university campuses with a minimum of 500 off-street parking spaces.

(iii) Recreation and cultural interest facilities with minimum annual attendance of 100,000 visitors.

(iv) Hospitals with designated trauma facilities.

(v) Contact Transportation and Drainage Operations~~TDO~~ for submittal and approval requirements.

(8) Sign Summary Sheet

The ~~Consultant~~ Engineer of Record shall include a sign summary sheet as part of the signing design. The format of the ~~S~~sign ~~S~~summary ~~S~~sheet is shown by City of Houston Standard Detail ~~01509-07~~01554-10 (~~S~~summary of ~~S~~signs). The sign summary table shall include the following information: plan sheet number, sign number, sign nomenclature, sign text, dimensions, post type, number of posts, sign area (square footage only for special signs), and sign post size.

~~Residential Subdivision Markers~~

~~General considerations/ restrictions~~

~~Subdivision markers may display the name of the subdivision or neighborhood but shall not contain any commercial advertising, announcement, or other signage.~~

~~An electronic sign or marker is not allowed.~~

~~Subdivision markers may not be located on, extend on to, nor:~~

~~Intrude upon any portion of a roadway.~~

~~Intrude upon any portion of a sidewalk or pedestrian pathway in the public right of way.~~

~~Create any hazardous condition or obstruction for vehicular or pedestrian travel upon a public street.~~

~~Be located within five (5) feet of underground storm, sanitary sewer, water lines and all appurtenances.~~

~~Be located within 25 feet of a fire hydrant.~~

~~Restrict or block driver's visibility or sight line of traffic, pedestrians, bikeway travelers, or other public user within the right of way.~~

~~Be located within the visibility triangle.~~

~~Locations~~

~~Subdivision markers may be located at the main entrance to a subdivision and at secondary entrances.~~

~~The subdivision marker must be within the boundaries of the subdivision or single family residential development they identify.~~

~~Locations where multiple subdivisions interface will be reviewed on a first come, first serve basis for purposes of establishing allowable subdivision marker locations.~~

~~The City Engineer's approval will be required for installation of more than two markers to identify a single subdivision.~~

~~The following are minimum allowable entrance marker location guidelines:~~

~~50 feet from the Median nose for mid-block Median openings,~~

~~75 feet from the Median nose for intersection openings,~~

~~100 feet from the Median nose of Median for left turn lanes,~~

~~Seven (7) feet from the inside Median curb (this dimension may be reduced if community has entered into maintenance or Adopt-an-Esplanade agreement with Houston Parks and Recreation Department and does not create a hazardous condition),~~

~~Within right-of-way adjacent to property line.~~

~~Size~~

~~Maximum height above the ground surface shall not be greater than six (6) feet.~~

~~Height shall be limited to not obstruct sight lines of vehicular and pedestrian traffic.~~

~~Maximum horizontal width shall not exceed eight (8) feet.~~

~~Maximum display area shall not exceed 36 square feet.~~

~~Width shall be limited to not obstruct sight lines of vehicular and pedestrian traffic.~~

~~Variances to the size requirements for a proposed subdivision marker must be granted by the City Engineer.~~

~~Materials~~

~~Materials for base structure shall be permanent, durable, and weather resistant.~~

~~Marker shall provide pleasing aesthetic elements, clarity, and professional design appearance.~~

~~Marker letters and/or other elements shouldshall be of non-corrosive and non-staining materials, and coated properly to prevent staining and discoloration.~~

~~Material selections shouldshall be capable of clean-up from graffiti mark-ups.~~

~~Utilities~~

~~Marker shall be of size and location to not impede or restrict the City's ability to maintain, repair, or replace the existing utility line(s).~~

~~Existing utilities shall be field located prior to the construction of the entrance marker. It is recommended that existing utilities shall be field located prior to preparation of the measured drawings for the entrance marker and its location.~~

~~Plan review/ permits~~

~~Drawings shall be submitted to the office of City Engineer for review and approval.~~

~~Drawings shall show existing surface and buried facilities within the right of way or easements in plan view.~~

~~If entrance marker design includes landscaping, the growth characteristics of the plants shall be submitted with the drawings.~~

~~Subdivision markers are considered encroachments in the public right-of-way and shall meet the encroachment requirements set out for subdivision markers in Chapter 41 of the City of Houston Code of Ordinances.~~

~~A construction permit will be required prior to construction of a subdivision marker within the public right of way or public easement. The construction permit will be obtained by the applicant from the Houston Permitting Center, Traffic/Paving Permits Section, upon submittal of approved plans and appropriate encroachment permit.~~

15.2.05.C BLUE TILE STREET SIGNS

1. The following are the requirements for the preservation and installation of Blue Tile Street Signs embedded in street curbs:

   a. Coordinate, prepare and submit a preservation action plan to the Planning and Development Department Historic Preservation Division that is in accordance with these requirements:

      (1) Conduct community engagement to understand the local history and community needs for Blue Tile Street Sign preservation.

15.2.05.C.1 continued

(2) Gather input from City of Houston City Council Member's office, neighborhood civic groups, Tax Increment Reinvestment Zones (TIRZ), Management District, and Preservation Houston[13] and any other stakeholders identified by the City.

b. For Capital Improvement Projects, include Blue Tile Street Sign preservation action plan in the Preliminary Engineer Report (PER) submitted to the City.

c. For street maintenance projects, preserve Blue Tile Street Signs - according to these requirements.

d. Existing Curbs Without Blue Tile Street Signs.

(1) City of Houston does not install Blue Tile Street Signs where they did not exist previously.

(2) For public requests to install Blue Tile Street Signs where they did not exist previously:

(a) Coordinate with the Office of the City Engineer (OCE) for any public/third party installation.

e. Existing Curbs with Blue Tile Street Signs.

(1) Proposed curb reconstruction is not City funded

(a) Coordinate with the Office of the City Engineer (OCE) for any public/third party installation or restoration of Blue Tile Street Signs that is not part of a City funded comprehensive street reconstruction.

(2) City funded proposed reconstruction does not include street and curb:

(a) The presence of Blue Tile Street Signs in disrepair does not initiate a City funded reconstruction of existing curb.

(b) Coordinate with the Office of the City Engineer (OCE) for any public/third party installation or restoration of Blue Tile Street Signs that is not part of a City funded comprehensive street reconstruction.

Refer to the weblink for reference:
[13] https://preservationhouston.org/

15.2.05.C.1.e.(3).(a) continued

(3) City funded proposed reconstruction does include street and curb:

(a) Reuse and Salvageability:

(i) Identify existing Blue Tile Street Signs that are salvageable, unsalvageable, and signs that will remain in place.

(ii) Existing curb with embedded sign determined to be in salvageable condition and identified for reinstallation must be approved by the City Engineer.

(iii) Signs considered to be in salvageable condition must meet the following conditions:

- Minor cracks and chips in curbs are acceptable.
- Existing roadway paving does not cover part of the tiles, such that all letters are visible and legible.
- Removal of sign will not significantly damage the sign or irreparably damage the curb the sign is embedded in.

(iv) Existing Blue Tile Street Signs that are damaged beyond repair, determined to be unsalvageable or unacceptable for reinstallation by City Engineer, will be marked for disposal as demolition debris in the contract documents.

(b) Existing Blue Tile Street Signs that are damaged beyond repair, determined to be unsalvageable or unacceptable for reinstallation by the City Engineer will be replaced with a proposed Blue Tile Street Sign.

(c) Design and construct proposed Blue Tile Street Signs to replicate existing Blue Tile Street Signs.

(d) Blue Tile Street Signs must not disrupt the use of City infrastructure and must not block any ADA ramps or storm sewer inlets.

(e) Remove and reinstall existing Blue Tile Street Signs that can remain in the curb at the existing location.

(i) Existing Blue Tile Street Signs that are not affected by construction will remain in place.

15.2.05.C.1.e.(3).(g) continued

(f) Existing Blue Tile Street Signs that cannot remain in place or located in the curb at the existing location, but can be removed and reinstalled in the proposed curb near the existing location:

(i) Relocate the existing Blue Tile Street Sign within thirty (30) feet from the edge of pavement of the cross street.

(g) Existing Blue Tile Street Signs that can be removed and cannot be reinstalled in the proposed curb near the existing location, and are in salvageable condition:

(i) A proposed Blue Tile Street Sign will be installed as a replacement of the existing Blue Tile Street Sign. Locate the proposed sign within thirty (30) feet of the edge of pavement of the cross street.

(ii) In addition to 15.2.05.C.1.e.(3).(g).(i), if the community wants to repurpose the existing signs in a different capacity, such as embedment into the neighborhood sidewalk, direction to the contractor must be communicated in the contract documents.

(iii) If signs cannot be repurposed according to 15.2.05.C.1.e.(3).(g).(ii), remove existing Blue Tile Street Signs and deliver for disposition, as determined through community engagement, to any of the following:

- Local stakeholder;
- Artist who commits to repurposing the tiles;
- City of Houston Building Material Reuse Warehouse.

(h) Label Blue Tile Street Signs on plans with an identification number (ID).

(i) Provide a Blue Tiles Street Sign table on each drawing sheet with the following information:

(i) ID number

(ii) Station

(iii) Offset location

15.2.05.C.1.e.(3) continued

(iv) Sign data (name and block number)

(v) Sign length

(vi) Condition (salvageable or unsalvageable)

(vii) Work direction (remove and reinstall; remove and replace; remove, deliver for disposition and replace; remove, repurpose, and replace; dispose as demolition debris, and replace; existing to remain in place)

(j) Sign length will include an additional 6-inches of curb beyond the extents of each end of the tiled sign.

(k) Provide any details required for construction of signs.

15.2.06 TRAFFIC PAVEMENT MARKINGS

15.2.06.A GENERAL

1. This section of the ~~D~~design ~~M~~manual contains the criteria and formats to be used in designing and preparing plans for the installation of pavement markings in the City of Houston. The intent is to establish standard procedures and requirements that will be used by ~~engineering designer~~ the Engineer of Record ~~and consultants~~ when designing pavement markings for City of Houston projects. All design shall also be in accordance with the Texas Manual of Uniform Traffic Control Devices (TMUTCD).

2. This document provides the Engineer of Record~~Designers and Consultants~~ with:

   a. The design requirements and guidelines for ensuring uniformity in pavement marking materials, arrangement, and details; and

   b. The required format of plan sheets to allow ease of review, minimization of construction errors, and facilitation of maintenance.

15.2.06.B DESIGN REQUIREMENTS

1. Description of Design/Review Process

   a. Project Initiation

      (1) Determine ~~R~~requirements of ~~O~~other ~~A~~agencies. If the project falls under TxDOT's jurisdiction, verify TxDOT's pavement marking requirements and if discrepancies exist between the City's requirements and TxDOT's, the ~~Consultant~~ Engineer of Record shall meet with the City Traffic Engineer to reconcile any differences.

15.2.06.B.1.b continued

(2) The ~~Consultant~~ Engineer of Record shall meet with the City of Houston prior to beginning the pavement marking design to discuss the project in detail. At this meeting, typical and any specialty pavement markings within the project limits will be discussed. The meeting regarding pavement marking generally occurs as part of other project initiation meetings and will not require a separate meeting.

b. Collect Engineering Data

(1) Collect all data required to develop a base map of ~~e~~Existing ~~c~~Conditions which can be used for the design process. Typically, pavement marking design will be included as part of a roadway, intersection, or traffic signal design project and base maps for traffic pavement marking design can be generated from the topographic survey and/or other design sheets.

(2) The ~~Consultant~~ Engineer of Record shall visit the project site to inventory and identify physical features that may impact pavement marking design.

(3) The ~~Consultant~~ Engineer of Record shall perform an inventory of existing pavement markings. The inventory shall include but is not limited to the following:

(a) Lane width, pavement marking material, and general condition of the markings

(b) Posted speed limit(s)

(c) Any special pavement markings such as rail crossings, ~~s~~School ~~z~~Zone, bicycle facilities, etc., and

(d) Existing lane configurations and lane assignments.

c. Develop Base Map of Existing Conditions

(1) The ~~Consultant~~ Engineer of Record shall develop a base map showing all the applicable data collected. The base map or drawing will be used to show the pavement marking design.

(2) The base map shall include but is not limited to the following information:

(a) All roadway curb and gutter or edges of pavement

(b) Roadway stations and centerline

15.2.06.B.1.c continued

(c) Right-of-way

(d) Driveways and intersections

(e) Sidewalks, bus stops, pads, and shelters

(f) Other features deemed pertinent

(3) Before traffic signals are located on the base map, the pavement markings (existing or proposed) should be located to act as a guide in the location of signal heads and detector loops. Pavement markings shall conform to the Standard Specifications and Detail Sheets as well as meet the guidelines in section 15.2.06.B.2.

2. Pavement Marking Materials

a. Preformed plastic pavement markings, as specified in the Standard Specifications, shall be used for all lane lines, island markings, cross hatching, arrows and legends.

b. Preformed plastic pavement markings, as specified in the Standard Specifications, shall be used for all pedestrian crosswalks and stop bars.

3. Lane Lines

a. Lane lines shall be aligned with corresponding lane lines on the opposite side of the intersection.

b. Lane lines shall terminate at the stop or at the curb return (on uncontrolled approaches).

4. Crosswalks

a. Crosswalks shall be installed across all approaches except where pedestrians are prohibited from crossing. They shall provide access to all corners of an intersection. Marked crosswalks shall be installed for all legal pedestrian crossings at signalized intersections. Marked crosswalks may be installed at other legal crossing locations to be evaluated and approved by the City.

~~a.~~b. Crosswalks shall be ten feet wide. See the City of Houston Standard Detail for crosswalk configuration.

~~b.~~c. Crosswalks should match up with ADA accessible ramps where possible.

15.2.06.B.5 continued

~~c.~~d. No transverse marking shall be placed within 18" of the curb or raised Median.

~~d.~~e. High~~- v~~Visibility ~~c~~Crosswalks shall be used only in exceptional scenarios at signalized and non-signalized crossings on collectors and Major ~~t~~Thoroughfares ~~roadways~~ requiring extra emphasis such as immediately adjacent school facilities, rail stations, transit centers, and/or any other consideration evaluated and approved by the City.

5. Stop Lines

a. Stop lines shall be placed at all signalized locations.

b. The stop lines shall be 24” wide and extend from a point 18” from the curb to the solid double yellow line (or a point 18” from the raised Median). It shall be located in accordance with City Standards.

6. Turn Arrows and Legends

a. City of Houston only uses Arrows or Onlys in exclusive turn lanes.

~~a.~~b. Plans and Drawings

(1) General

(a) All pavement markings design shall be prepared on design sheet size required by the Project Manager~~, using the Sstandard City of Houston, Houston Public Works Ttitle Bblock~~. Traffic signing and pavement markings shall be shown on different plan sheets. Refer to Section 15.2.05~~15.09~~, Traffic Signs, for details regarding the design of traffic signs.

(b) All full size designs shall be prepared at a scale of one (1) inch equals forty (40) feet excluding notes and detail sheets. If other design scales are needed, approval from the City Project Manager is needed before beginning design.

(c) All ~~construction d~~Drawings shall be prepared in accordance with Chapter 3, Graphic Requirements.

15.2.06.B.6.b.(1) continued

(d) On projects where the ~~Consultant~~ Engineer of Record finds it necessary to deviate from the standard format presented herein, due to project scope or design requirements, the City's Project Manager should be consulted to determine an acceptable alternate format. Any changes to the format are at the discretion of the City's project manager.

~~(e) Limits of the project (beginning and ending stations) are to be provided including centerlines and stationing at 100-foot intervals.~~

~~(f)~~(e) All changes to pavement marking lines and symbols shall be labeled by station callouts to the nearest whole number (##+##).

~~(g)~~(f) Existing pavement markings to remain and proposed items such as ~~ROW~~ right-of-way lines, edge of pavement, and curbs shall be delineated at lighter weight/shade than proposed pavement markings on pavement marking design sheets.

~~(h)~~(g) At a minimum, lane widths between lane markings and face of curb/edge of pavements shall be provided every 500 feet using the center of the pavement markings as a reference point.

~~(i)~~(h) General notes and quantities of pavement markings and sheet shall be prepared for every design project. In addition, line style designation methodology shown on City of Houston Standard Detail ~~01510-01~~02760-01 shall be used to call out pavement marking line types on all design sheets.

(2) General Notes

General Notes shown in City of Houston Standard Detail ~~01510-01~~02760-01 should appear on all pavement marking design sheets. ~~-~~Additional notes may be added by the ~~Designer~~Engineer of Record as may be necessary to properly clarify the intent of the design.

(a) With the general notes a table showing bid items and quantities shall be provided.

15.2.06.B.6.b continued

(b) Every type of pavement marking line width, pattern, and width combination shall be assigned specific bid item with quantity in linear feet (LF). For example, lane lines (WB4) will have total LF quantity and unique bid item number.

(c) Every symbol and text type shall be assigned a bid item with quantity as Each (EA). For example, white single arrow will have total count quantity and unique bid item number.

(d) Every type of ~~R~~raised ~~P~~pavement ~~M~~marker (RPM) shall be assigned a bid item with quantity as Each (EA). For example, Type I-C "C" RRPM will have total count quantity and unique bid item number.

(3) Left/Right-Turn "Only" and Arrow Spacing (Refer to City of Houston Standard Detail ~~01510-02~~02760-02)

(4) Pavement Marking Words (Refer to City of Houston Standard Detail ~~01510- 03~~02760-03)

(5) Pavement Marking Symbols and Arrows (Refer to City of Houston Standard Detail ~~01510-04~~02760-04)

(6) Standard Pavement Markings with Reflective Raised Pavement Markers for Position Guidance (Refer to City of Houston Standard Detail ~~01510-05~~02760-05)

(7) Use of Reflective Chip Seal Marker for Temporary Markings (Refer to City of Houston Standard Detail ~~01510-06~~02760-06)

(a) On some long-term temporary pavement markings plan, the Engineer of Record~~designer~~ may select use of raised pavement marker buttons instead of chip seal marker. In such cases the ~~designer~~Engineer of Record has to provide special temporary pavement marking RPM button arrangements for each line type and use of reflective raised pavement markers.

(8) Pavement marking for accessible parking (refer to City of Houston Standard Detail ~~01510-07~~02760-07)

(a) ~~Please n~~Note that angled parking on public streets requires City Council approval before implementation per City of Houston Code of Ordinances.

15.2.07.A continued

(9) Railroad Crossing Pavement Markings (Refer to City of Houston Standard Detail ~~01510-08~~02760-08)

(10) Bicycle Facilities Pavement Markings (Refer to City of Houston Standard Detail ~~01510-09~~02760-09)

(11) Crosswalks Pavement Markings (Refer to City of Houston Standard Detail ~~01510-10~~02760-12)

(a) High~~-v~~Visibility ~~c~~Crosswalks should only be used where documented need is identified such as designated school crossings.

(12) Right- and Left-Turn Lanes (Refer to City of Houston Standard Details ~~01510-11~~02760-13 and ~~01510-12~~02760-14)

(13) Two-Way Left-Turn Lanes (Refer to City of Houston Standard Details ~~01510- 13~~02760-15 and ~~01510-14~~02760-16)

15.2.07 ACCESS MANAGEMENT STANDARDS

15.2.07.A GENERAL

1. The overall purpose of implementing the City of Houston Access Management Standards is to ensure safety and enhance the functionality of City streets. This ~~enhancement~~ goal will be accomplished through preservation and improvement of operational efficiency and safety. "Access Management" is the systematic control and proactive management of the location, spacing, design, and operation of ~~d~~Driveways, ~~m~~Medians, ~~a~~Auxiliary ~~l~~Lanes, and intersections ~~in order~~ to improve the balance between access and mobility while preserving street ~~efficiency~~ safety and efficiency ~~and safety~~.

15.2.07.B APPLICABILITY

1. The Access Management Standards contained in this section are applicable to ~~each~~ any new development, addition, or redevelopment, all or a portion, which is located within the defined corporate city limits of the City of Houston, Texas.

2. The requirements contained within this section are design standards and will serve as a basis for development plat approvals and building permits. These standards should be used in conjunction with the Houston City Code of Ordinances and other requirements set forth in the Infrastructure Design Manual.

15.2.07.C.1 continued

3. Requirements for Access Management Design Techniques - Additional references/ resources are available in Chapter 40 - Streets and Sidewalks of the City of Houston Municipal Code of Ordinances[14] and the latest Houston Amendments to the ~~2003~~ International Building Code[15]~~;~~ .~~http://www.municode.com/resources/gateway.asp?pid=10123&sid=43.~~

15.2.07.C ACCESS MANAGEMENT DESIGN

1. Driveways

   a. Proposed and redeveloped Driveways ~~and their associated openings~~ should be located and designed to provide safe and efficient ~~reasonable~~ access between ~~private~~ property lines and the ~~street right of way~~ edge of the roadway. The ~~d~~Driveway should not create ~~an unmanaged~~ a traffic hazard for drivers ~~entering the street~~utilizing the Driveways ~~or for drivers on the through street~~, ~~nor negatively impact normal use of street right of way~~ or other road users including bicyclists and pedestrians.

   b. ~~The proper location and design of a driveway should be consistent with the safety and convenience of the public and must take into account nature and volume of traffic on abutting streets, dimensions and construction of abutting streets, use of developed property, dimensions of the developed property, and type and locations of improvements to the developed property.~~Driveway design considers the effect of vehicles to/from developed property on the movement of traffic and the safety of traveling public on abutting streets.

   c. Driveway~~s~~ design characteristics are based on ~~two property classifications: single family residential and all others~~ proposed development classification (see Table 15.6).

   d. ~~Driveways to/from a property should include no more than the minimum number to provide reasonable access between the property and abutting street~~Driveway placement criteria is shown in Table 15.7 and Table 15.8.

   e. Driveway width is measured at the beginning of the ~~d~~Driveway ~~r~~Radii tangents within the ~~d~~Driveway (see Figure 15.4~~.Figure 15.08.01~~). Driveway Radius is the rounded edge of a ~~d~~Driveway that ~~permits easier~~ accommodates entry and exit by turning vehicles; however, radii should be as small as feasible to ensure a safer crossing for pedestrians and bicyclists. Design standards for minimum ~~d~~Driveway width and radius can be found in Table 15.6.

[14] https://library.municode.com/tx/houston/codes/code_of_ordinances?nodeId=COOR_CH40STSI
[15] https://www.houstonpermittingcenter.org/building-code-enforcement/code-development#agency-links-416

~~Table 15~~

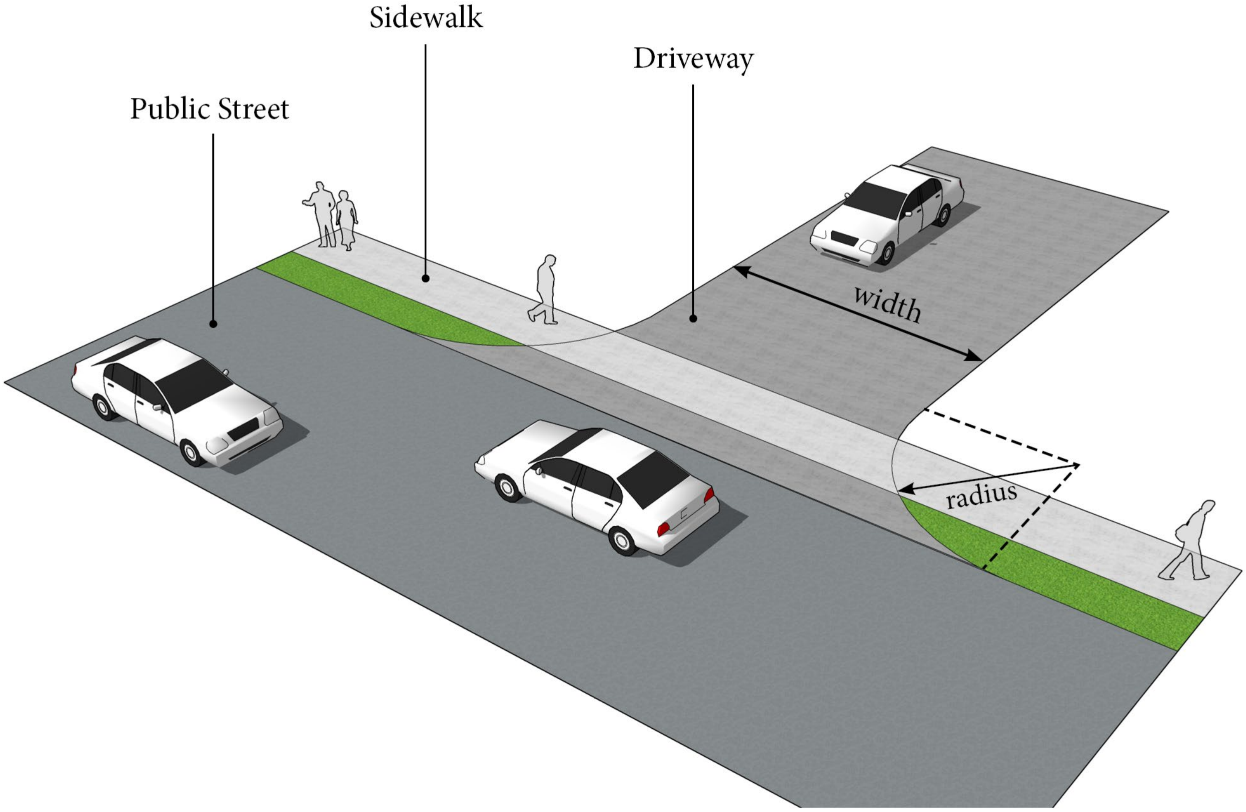


Figure 15.4~~15.4 - Figure 15.08.01~~ DRIVEWAY RADIUS AND WIDTH

~~Table 15.08.01 Driveway Design Criteria~~												
	~~Single Family Residential~~				~~Townhomes / Condos~~				~~Commercial~~			
	~~Radius (ft)~~		~~Width (ft)~~		~~Radius (ft)~~		~~Width (ft)~~		~~Radius (ft)~~		~~Width (ft)~~	
	~~Max~~	~~Min~~	~~Max~~	~~Min~~	~~Max~~	~~Min~~	~~Max~~	~~Min~~	~~Max~~	~~Min~~	~~Max~~	~~Min~~
~~Two-way or Shared Access~~	~~10~~	~~4~~	~~24~~	~~12~~	~~10~~	~~4~~	~~24~~	~~18~~	~~20~~	~~10~~	~~35~~	~~24~~
~~One-Way~~	~~10~~	~~4~~	~~20~~	~~12~~	~~10~~	~~4~~	~~24~~	~~15~~	~~20~~	~~10~~	~~20~~	~~15~~

15.2.07.C.1 continued

Table 15.6 - DRIVEWAY DESIGN CRITERIA

Driveway Design Criteria (1)(2)												
Traffic Type	Type A Driveway (For Single Family Residential Houses or Duplexes)				Type B Driveway (Shared Access/Shared Driveway)				Type C Driveway (Commercial Driveway)			
	Width (ft)		Radius (ft)		Width (ft)		Radius (ft)		Width (ft)		Radius (ft)	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
One-Way	10	12	4	10	12[5]	16[5]	4[5]	10[5]	15	20	10	20
Two-Way	10[3]	24[4]	4	10	16[6]	24	4	10	24	35	10	20

(1) See article 15.2.07.C.1.f for Driveways that require a vehicle swept path analysis.
(2) See 15.2.07.C.1.g.(1) and 15.2.07.C.1.g.(2) for Type 1 PAE and Type 2 PAE requirements.
(3) The minimum width for Joint Access Driveway is 12 ft.
(4) Refer to Chapter 42 of the Code of Ordinances for driveway widths for narrow lots.
(5) Only MURs and Courtyard Style Developments on corner lots can have one-way driveways.
(6) Refer to Chapter 42, Section 42-146 of the Code of Ordinances for exceptions to the minimum driveway width for Shared Driveways.

f. Vehicle Swept Path Analysis Requirements.

(1) Vehicle swept path analysis is required for all commercial Driveways and Driveways connecting to existing alleys or streets that are less than fifteen (15) feet in width.

(2) Minimum Driveway width and radius shall not be less than required in Table 15.6.

(3) Design and Control Vehicles used for analysis are as follows:

(a) Type A and Type B Driveways

(i) Design Vehicle – P

(ii) Control Vehicle – P

(b) Type C Driveways

(i) Design Vehicle – WB40

(ii) Control Vehicle – WB62

15.2.07.C.1.g continued

(4) Driveway width and radius must be rounded up to the nearest whole foot.

g. Permanent Access Easements (PAE) Design Criteria.

(1) Type 1 Permanent Access Easements (Type 1 PAE).

(a) According to Section 42-1 of the Code of Ordinances, Type 1 PAE is a Permanent Access Easement at least fifty (50) feet in width that is designed and constructed like a public street in accordance with this design manual and contains one or more public utilities in an unpaved portion of the easement.

(b) For undivided streets, provide a minimum face to face pavement width of twenty-six (26) feet pursuant to Table 10.7 and Figure 10.3 of this manual.

(c) For divided streets, refer to Table 10.8 and Figure 10.4 of this manual for the minimum face to face pavement width requirements.

(2) Type 2 Permanent Access Easements (Type 2 PAE).

(a) According to Section 42-1 of the Code of Ordinances, Type 2 PAE is a Permanent Access Easement at least twenty-eight (28) feet in width that is designed and constructed like a private street serving a development that has no public utilities other than a public water line, connected to one or more fire hydrants, that provides no domestic water services. All private utilities within a Type 2 Permanent Access Easement must be designed to public utility standards outlined in the Infrastructure Design Manual.

(b) All Type 2 PAEs shall have a minimum face to face pavement width of twenty-eight (28) feet.

(c) Type 2 PAEs shall not connect to an alley.

(d) Curb Radii:

(i) For Type 2 PAEs that connect to a public street or a Type 1 PAE shall meet the standard intersection curb radii requirements for local streets in Chapter 10, Table 10.3.

15.2.07.C.1 continued

(ii) Type 2 PAEs that connect to a Type 2 PAE shall comply with Section 42-129 of the City of Houston Code of Ordinances.

(e) Exception: Type 2 PAEs that are designed as turnarounds must meet fire code requirements. See Figure 10.11 of this manual for requirements.

~~f.~~h. General Driveway Design Criteria.

(1) Driveway Categories.

(a) Type A Driveway is a Driveway for a single-family residential house or a duplex, or a Joint Access Driveway serving two abutting single-family residential lots or parcels taking direct access from a street.

(b) Type B Driveway is either a Shared Access/Shared Driveway (Flag Staff Driveways, Courtyard Style Development, or Multi-unit Residential (MUR) Development Driveways),- or a Driveway constructed on an access easement other than a Permanent Access Easement.

(c) Type C Driveway is a Driveway for commercial developments or for non-single family residential developments (other than Multi-unit Residential Development) taking direct access from a public street.

(2) Outside of the right-of-way, the Shared Access/Shared Driveway and private drive width must meet the corresponding Chapter 42 of the Code of Ordinances and plat requirements.

~~(1)~~(3) ~~A dDriveway shall not connect to a sub-standard street~~ .For Driveways that connect to roadways that are less than 18-feet in width, refer to street widening requirements in Section 10.3.03.J. ~~This~~ Steet widening requirements will not apply to removal and replacement of single-family residential ~~d~~Driveways~~ ~~or duplex homes Driveways.~~A shared dDriveway cannot connect to a street with a width of less than~~ eighteen ~~(18) feet.~~

~~(2)~~(4) One-way ~~d~~Driveways must intersect ~~city~~ streets between 45 and 90 degrees.

~~(3)~~(5) ~~Skewed~~Angled~~,~~ one-way drives are permitted only on one-way streets and divided streets with no ~~m~~Median opening.

15.2.07.C.1.h continued

~~(4)~~(6) Two-way ~~d~~Driveways must intersect city streets at approximately 90 degrees.

~~(5)~~(7) Where situations permit, AASHTO design vehicles may be used to justify ~~d~~Driveway ~~r~~Radii.

~~(6)~~(8) No ~~d~~Driveway ~~r~~Radius shall encroach on abutting property or corner radius.

~~(7)~~(9) Driveways shall not be permitted within limits of any intersection. (Design ~~e~~Exception shall be required for ~~m~~Major ~~t~~Thoroughfare locations with existing esplanades and streets used for residential access.) Intersection Limits are defined by Driveway offsets as defined in Table 15.8.

~~(8)~~(10) For one-way ~~d~~Driveways, the entry ~~d~~Driveway shall precede exit ~~d~~Driveways (in direction of adjacent travel lane).

~~Driveways must remain tangential for a minimum of 20 feet past the property line.~~

(11) All Type A Driveways must remain tangential, uniform in throat width, and unobstructed from the roadway to the property line on private property.

(12) All Type B Driveways must remain tangential, uniform in throat width, and unobstructed for a minimum of eight (8) feet past the property line on private property.

(13) Type C Driveways must remain tangential, uniform in throat width, and unobstructed for a minimum of twenty (20) feet past the property line on private property.

(14) Where present or projected traffic operations indicate needs for alternative ~~d~~Driveway geometrics, additional consideration may be given.

(15) For alley access requirements, refer to Ch. 10, Subsection 10.3.03.G.2.

(16) Where Driveways are installed or altered on roadways with bicycle facilities (refer to Chapter 17, article 17.1.04.B), the bicycle facility shall be incorporated into the proposal and the new configuration of the bicycle facility must be approved by the City of Houston. The proposed bicycle facility design must meet all City of Houston standards (refer to IDM Chapter 17), including but not limited to restoring the bicycle facility to the same or better level of safety and comfort for Vulnerable Road Users (refer to Chapter 17, article 17.1.04.SS). The City of Houston approved design must be implemented before construction can be considered complete.

(17) Refer to Chapter 42 of Code of Ordinances for requirements for alley access or Shared Access for new developments proposing narrow lots as defined in Chapter 42 of the Code of Ordinances.

(18) For narrow lots with an individual Driveway, the maximum Driveway width allowed is twelve (12) feet and must meet Chapter 42 requirements of the Code of Ordinances.

2. ~~Driveways and~~ Loading Docks/Wells/Berths

a. ~~Loading docks/wells/berths are not permitted for back-in loading from an adjacent Major Thoroughfare.~~Back in loading is not permitted on Driveways and accesses to loading docks/ wells/berths from an adjacent Major Thoroughfare.

b. ~~Loading docks/wells/berths must be located on site to provide for approach and maneuvering on-site with appropriate space to accommodate dimensions of vehicles accessing site~~Where Driveways are used to access trash receptacles and loading docks, the Driveways and adjacent areas on the property must be designed to provide appropriate maneuverability and storage for the vehicle and no part of the vehicle shall protrude over the property line or obstruct any public street or sidewalk in whole or in part.

c. Driveways or accesses to loading docks/wells/berths/trash receptacles shall be a minimum of twenty (20) feet from another Driveway on the same property or as defined in Table 15.8.

~~c. Loading docks/wells/berths must be located on site such that sufficient area is available to store commercial motor vehicle, truck tractor, trailer, or semi- trailer or combination of such vehicles within the developed property and no part of vehicle shall protrude over the property line or obstruct any public street or sidewalk in whole or in part.~~

15.2.07.C.2 continued

d. Driveways to utility and infrastructure facilities such as lift stations, cell towers etc. must be designed to prevent obstructions to adjacent public streets or sidewalks, in whole or in part.

3. Driveway and Corner Clearance Spacing

a. General Driveway Spacing Criteria

(1) ~~The distance between connections (driveway-driveway and driveway- street) is measured along the edge of traveled way from the closest edge of pavement of the first connection to the closest edge of pavement of the second connection~~The distance between connections from Driveway to street is measured from the closest edge of the Driveway to the property line. See Figure 15.5.

~~(1)~~(2) The distance from Driveway to Driveway is measured from the closest edge of the first Driveway to the closest edge of the second Driveway. See Figure 15.5.

~~(2)~~(3) A pair of one-way ~~d~~Driveways (entry and exit) should be considered as a two-way ~~d~~Driveway for ~~d~~Driveway spacing purposes.

~~(3)~~(4) Spacing between one-way ~~d~~Driveways requires the entry precedes the exit in the direction off the adjacent travel lane. ~~and the one-way pair meets spacing requirements from adjacent driveways or streets.~~

~~(4)~~(5) For the special situation of multiple entry ~~d~~Driveways placed on one-way street and exit ~~d~~Driveways placed on a different street, two same street ~~d~~Driveways should be considered as a one-way pair.

~~(5)~~(6) Driveways on a street without a ~~m~~Median should align with ~~d~~Driveways on the opposite side of the street, when possible.

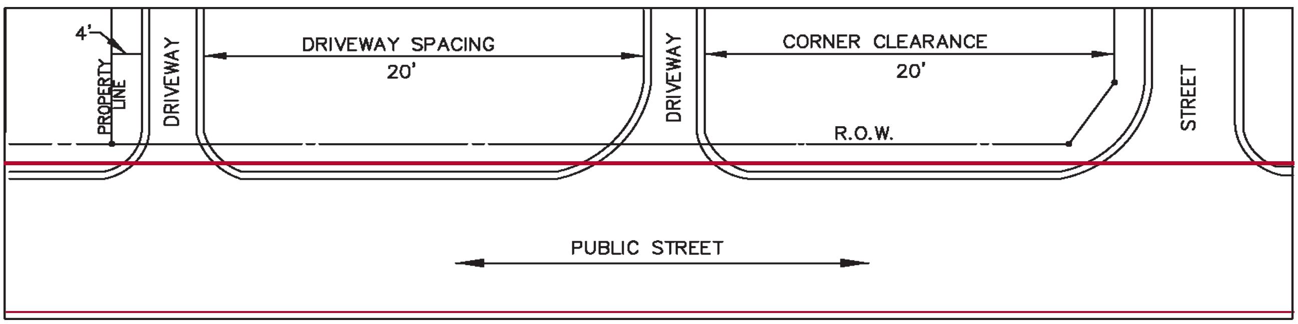
~~(6) Driveways shall not be placed in the intersection limits (see 15.03.I for definition of intersection limits).~~

(7) Driveway should be placed ~~of~~ at a minimum offset distance of seventy-five (75) ft from the ~~m~~Median nose or align the Driveway with the Median opening.

15.2.07.C.3 continued

(8) Bicycle and Pedestrian Pathways at Driveways: With the City of Houston's focus on safety for all modes of travel and an increasing multimodal environment, standards for bicycle lanes/paths and sidewalks where they intersect Driveways have been provided. These can be found in Chapter 17, Sections 17.3.01 and 17.4.02 of the IDM.

b. ~~Residential~~ Type A and Type B Driveway Spacing – ~~s~~See Figure 15.5 ~~Figure 15.0.02~~ for ~~residential~~ Type A and Type B ~~d~~Driveway spacing definitions and Table 15.7~~Table 15.08.02~~ for ~~residential~~ Type A and Type B ~~d~~Driveway spacing criteria.



~~**Figure 15.08.02 Residential Driveway Spacing**~~

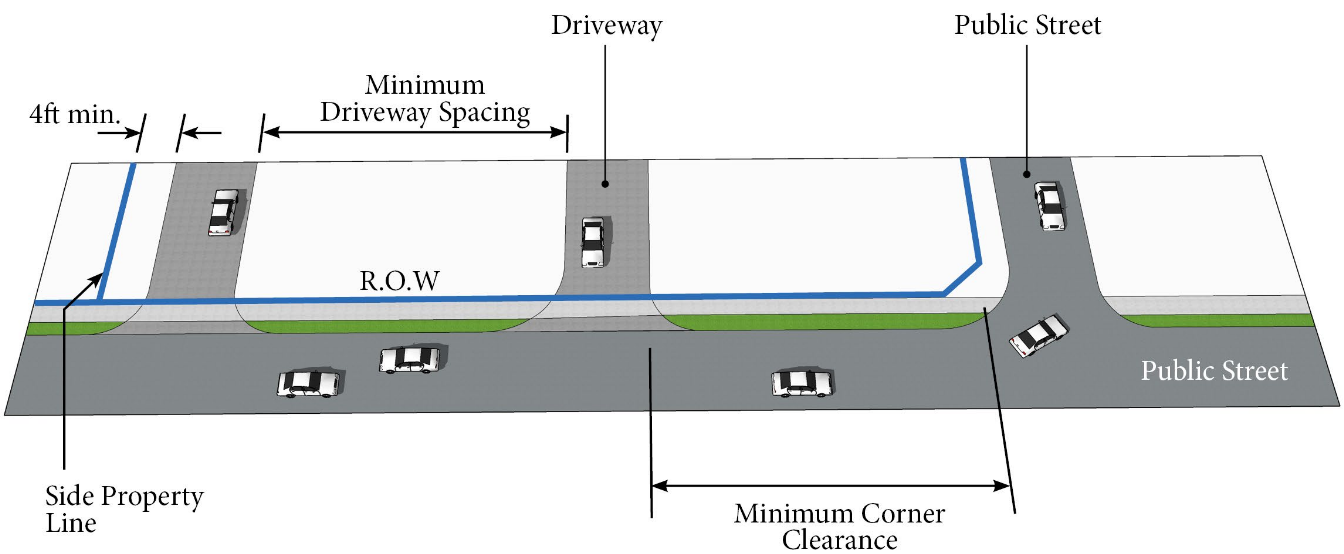


Figure 15.5~~15.5~~ – TYPE A & TYPE B DRIVEWAY SPACING

~~**Table 15.08.02 Residential Driveway Spacing Criteria**~~				
	~~Between Adjacent Driveways~~	~~Between Adjacent Street ROW~~	~~Between Side Property Line~~	~~Maximum Number of Driveways~~
	~~Spacing (Minimum dimension in ft)~~			

~~Single Family Residential~~	~~20(1)~~	~~20~~	~~4(5)~~	~~2~~
~~(1) 10 foot minimum between pair of one-way driveways~~ ~~(2) All proposed access connections must be placed to achieve adequate intersection sight distance for safe and efficient departure from the proposed location (comply with AASHTO standard).~~ ~~(3) Driveway radius cannot extend beyond property line.~~ ~~(4) Driveway radius cannot extend into public street or other driveway curb radius.~~ ~~(5) When spacing of driveways results in a roadside ditch that is less than 8' long (e.g., less than 8' between culverts), options shall be considered to address maintenance challenges and may include replacement of the short roadside ditch with a long run culvert.~~				

15.2.07.C.3 continued

Table 15.7 – TYPE A & TYPE B DRIVEWAY PLACEMENT CRITERIA

Table 15.7 – Type A & Type B Driveway Placement Criteria				
Driveway Type	**Between adjacent Driveways within the same property**	**Between adjacent street ROW**	**Between side property line**	**Maximum number of Driveways**
	Spacing (Minimum dimension in ft)			
Type A	20 (1)	20	4 (5)	2 (6)
Type B *(≤ 20 lots)*	30	30	4 (5)	N/A
Type B *(> 20 lots)*	40	40		

(1) 10-ft minimum between pair of one-way Driveways.

(2) All proposed access connections must be placed to achieve adequate intersection Sight Distance for safe and efficient departure from the proposed location (comply with AASHTO standard)

(3) Driveway Radius cannot extend beyond property line.

(4) Driveway Radius cannot extend into public street or other Driveway curb radius.

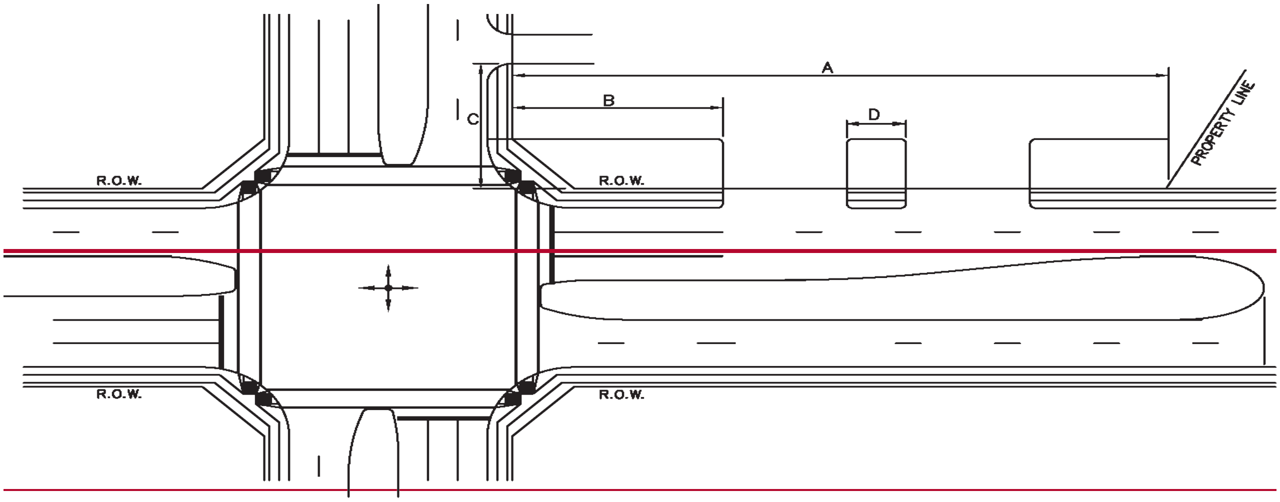
(5) When spacing of Driveways result in a roadside ditch that is less than 8-ft long (e.g., less than 8-ft between culverts), options shall be considered to address maintenance challenges and may include replacement of the short roadside ditch with a long run culvert and a junction box*, which will require a submittal of plans and profiles to the Office of City Engineer.

(6) Unless prohibited by Chapter 42 of the Code of Ordinances.

* No gravel, no sand, no bricks, no alternative material except new sod around the junction box in the open space in right-of-way between the Driveways.

~~4.~~

c. ~~Non-Residential~~Type C Driveway Spacing - ~~s~~See Figure 15.6~~Figure 15.08.03~~ for ~~non-residential~~Type C ~~d~~Driveway spacing definitions and Table 15.8~~Table 15.08.03~~ for ~~non-residential~~ Type C ~~d~~Driveway placement criteria.



~~Figure 15.08.03 Driveway Placement~~

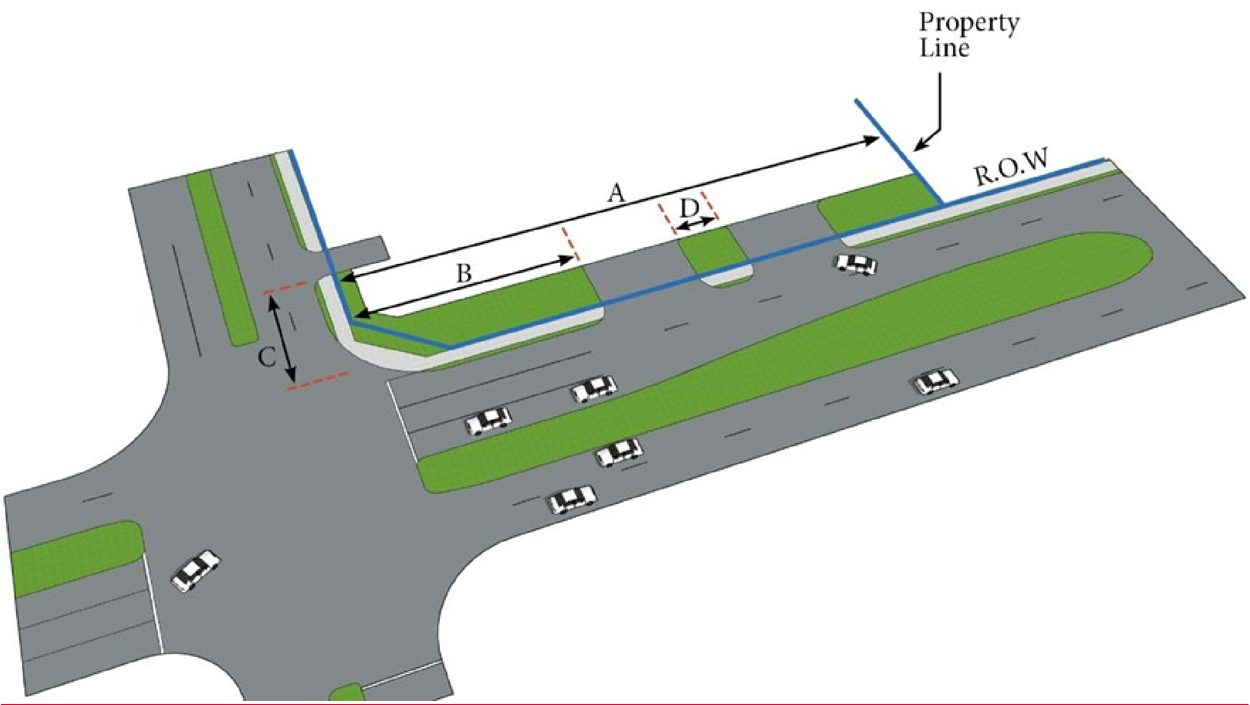


Figure 15.6~~15.6~~ – TYPE C DRIVEWAY PLACEMENT

15.2.07.C continued

Table 15.8 ~~– NON RESIDENTIAL~~TYPE C DRIVEWAY PLACEMENT CRITERIA

Table 15. ~~08~~ ~~.03 Non-Residential~~Type C Driveway Placement Criteria (1)				
A		**B**	**C**	**D**
Frontage(2)	**Maximum Number of Driveways**	**Minimum Driveway Offset (~~Primary Street~~Major Thoroughfares)**	**Minimum Driveway Offset(8) (~~Intersecting~~ Local Streets)**	**Minimum ~~Driveway~~ Spacing Between Adjacent Driveways within the Same Property**
Up to 170 feet	1	100 feet	60 feet	~~20 feet~~N/A
170 to 250 feet	2	100 feet	60 feet	40 feet
250 to 450 feet	3	100 feet	60 feet	40 feet
> 450 feet	1 additional / 250' frontage	100 feet	60 feet	40 feet

(1) Applicable to ~~d~~Driveways designed for commercial traffic (auto, truck, and bus access).
(2) Where the development frontage is equal to or greater than the distance to first ~~m~~Median opening, at least one ~~d~~Driveway will be aligned with the existing and/or future location of the ~~m~~Median opening.
(3) For CBD or ~~L~~locations unable to comply, approval of the City Engineer required.
(4) All proposed access connections must be placed to achieve adequate intersection ~~s~~Sight ~~d~~Distance for safe and efficient departure from the proposed access connection (comply with AASHTO standard).
(5) The minimum ~~d~~Driveway offset for all ~~m~~Major ~~t~~Thoroughfare shall be 100 feet.
(6) Driveway ~~r~~Radius cannot extend beyond property line.
(7) Driveway ~~r~~Radius cannot extend into public street or other ~~d~~Driveway curb radius.
(8) Minimum offset will be 100' along bus routes.

~~5.~~4. Medians

a. Median design involves mainly ~~m~~Median type, opening, and length. Installing ~~m~~Medians provides the potential for safer street operation, increased capacity, and improved aesthetics.

b. Median Openings: Median openings allow vehicles to cross opposing traffic lanes at designated locations. Requirements for ~~m~~Median openings can be found in Chapter 10, section 10.~~08~~ 3.03.E of this manual.

15.2.07.C.4 continued

c. Minimum Median Lengths: The minimum lengths of ~~m~~Medians between openings are determined by the functional classification of the street and the type of interruption (thoroughfare, collector, local street, private ~~d~~Driveway, etc.) of the adjacent openings. Requirements can be found in Chapter 10, section 10.~~08~~ 3.03.E of this Manual.

d. Mid-block Crossings: With the City of Houston's focus on safety for all modes of travel and an increasing multimodal environment, pedestrian safety is being prioritized. Mid-block crossings provide designated areas for pedestrians to cross the street between where vehicular intersections occur. Existing roadway Median may be considered a pedestrian refuge island as long as it is improved to meet the requirements of Chapter 17, section 17.3.02.D.

~~6.~~5. Treatments for Turning Movements

a. Turn lanes provide a refuge area for left and right turning vehicles. Turn lanes may be placed at intersection approaches, ~~d~~Driveway approaches, and ~~m~~Median openings to remove turning vehicles from the through lanes, thus reducing congestion and improving traffic operations, capacity, and safety.

b. Dedicated Left-Turn Lanes

(1) Left-turn lanes shall be considered in the following situations:

(a) To existing and new conditions subject to City of Houston Standard Operating Procedure (SOP) TMG – 905 Left Turn Warrants[16] and approval of the City Traffic Engineer or the City Engineer;

~~(a)~~(b) All signalized intersection approaches along planned or existing streets having a classification of collector or higher;

~~(b)~~(c) All unsignalized intersections and ~~d~~Driveways along divided streets having a classification of collector or higher;

~~(c)~~(d) All unsignalized intersections and ~~d~~Driveways along undivided streets having a classification of thoroughfare or higher;

[16] This reference can be obtained from Transportation and Drainage Operations

15.2.07.C.5.b continued

~~(d)~~(e) All developments in excess of five acres located within 500 feet of the intersection of two or more thoroughfare facilities;

~~(e)~~(f) New public or private school construction;

~~(f)~~(g) Shopping centers and other traffic generators with a lease space in excess of one hundred thousand square feet; and

~~(g)~~(h) Places of worship.

(2) Request not to install dedicated left-turn lanes shall be guided by a traffic study and requires approval from the City Traffic Engineer or the City Engineer.

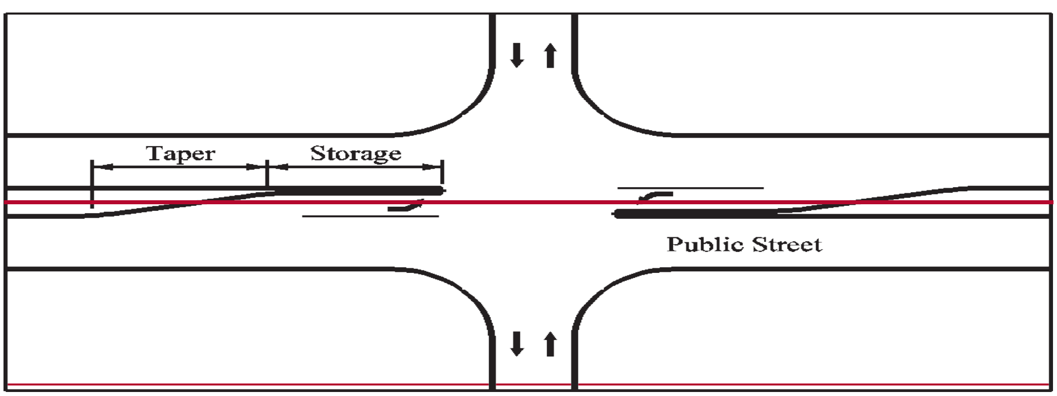
~~(2)~~(3) Dual left-turn and dual right-turn lanes should be designed for the SU-30 in the inside lane and the standard design vehicle in the outside lane.

c. Dedicated Right-Turn Lanes

(1) The use of dedicated right-turn lanes should always be guided by a traffic study. This will be based on TxDOT's Access Management Manual Chapter 2, Section 3, Table 2-3 - Auxiliary Lane Thresholds.

~~7.~~6. Minimum Turning Treatment Storage Length

a. Storage ~~l~~Length, as shown in Figure 15.7~~Figure 15.08.04~~, is an important design element that ensures the provision of sufficient turn lane storage capacity to reduce instances of spillback. Left- and right-turn lane ~~s~~Storage ~~l~~Lengths must not be less than the minimum requirements outlined in Chapter 10~~.06~~, Section 3 – Geometric Design Requirements of this Manual.



~~**Figure 15.08.04 Turn Lane Details**~~

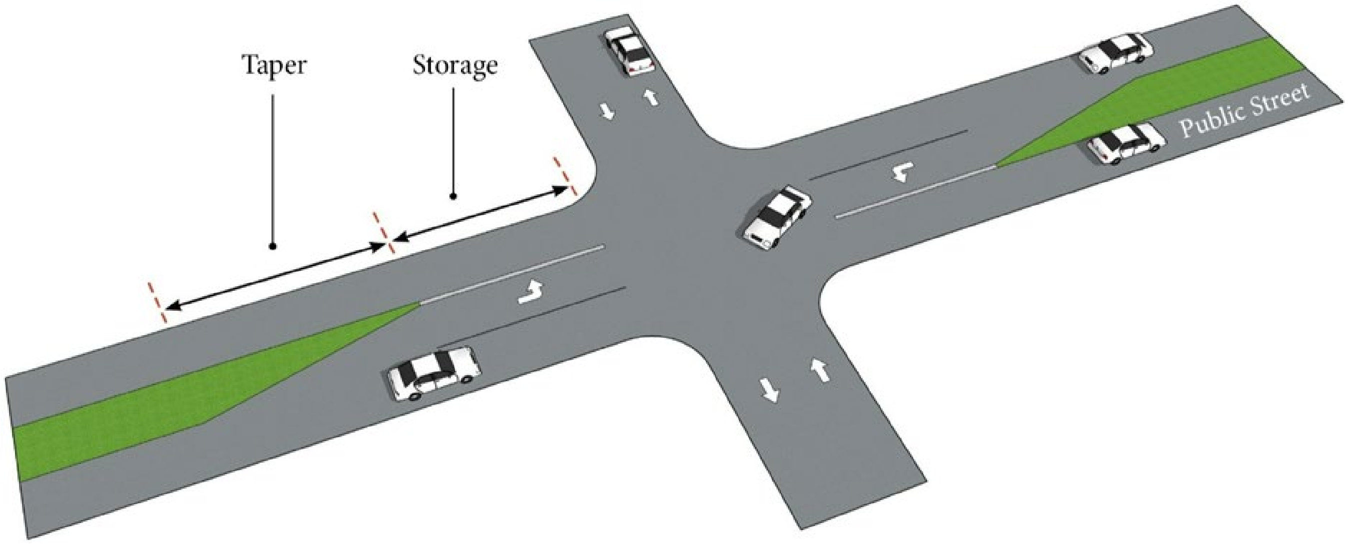


Figure 15.7~~15.7~~ – TURN LANE DETAILS

b. Calculating Required Storage Length (Single Lane)

The required ~~s~~Storage ~~l~~Length for both left- and right-turn lanes can be obtained using traffic modeling software such as the latest version of the HCM Software (HCS) or ~~Synchro/SimTraffic~~ Vistro. The 95th percentile queue length is a widely accepted value for ~~s~~Storage ~~l~~Length. The following methods may be used to determine ~~s~~Storage ~~l~~Length.

(1) Signalized Storage Length: For signalized intersections, the ~~s~~Storage ~~l~~Length should be determined based on results from computer analysis software.

(2) Unsignalized Storage Length: Equation 1 is used to calculate unsignalized ~~s~~Storage ~~l~~Length.

$$L=(V/30)(2)(S) \qquad \text{(Equation 1)}$$

Where:
L = ~~s~~Storage ~~l~~Length in feet
$V/30$ = turning volume in a two-minute interval
2 = a factor that provides for storage of all left-turning vehicles on most cycles
S = queue ~~s~~Storage ~~l~~Length, in feet per vehicle

c. See Left Turn Bay Plan in Chapter 10 of the IDM Figure 10.8 - Median Nose and Left Turn Bay.

15.2.08 TRAFFIC CONTROL PLAN

15.2.08.A GENERAL

1. This section of the Design Manual contains general guidelines and instructions to be used in determining appropriate construction sequencing and preparation of traffic control plans. The intent is to establish standard procedures and requirements that will be used by the ~~e~~Engineer~~ing~~ of Record~~ designers and consultants~~ when preparing traffic control plans for City of Houston projects. In turn consistent application of lane closures and minimal inconvenience to the traveling public will reduce frustration due to negative impacts of construction activities and improve safety because of uniformity of lane/sidewalk closure techniques. All design shall also be in accordance with the latest version of the Texas Manual on Uniform Traffic Control Devices (TMUTCD).

2. This document provides ~~Designers~~ the Engineer of Record ~~and Consultants~~ with:

   a. requirements and guidelines for ensuring uniformity in lane/sidewalk closure techniques; and

   b. the required format of plan sheets to allow ease of review, minimization of construction errors, and facilitation of maintenance of traffic control setup by the ~~C~~contractor.

15.2.08.B DESIGN REQUIREMENTS

1. Description of Design/Review Process

   a. Project Initiation

      (1) Determine ~~R~~requirements of ~~O~~other ~~A~~agencies. If the project falls under TxDOT's jurisdiction, verify TxDOT's traffic control requirements and approval process is needed. The ~~Consultant~~Engineer of Record shall meet with appropriate TxDOT personnel to determine how to prepare the traffic control setup. After the meeting the ~~Consultant~~Engineer of Record shall meet with City of Houston Project Manager/City Traffic Engineer to discuss traffic control plans per TxDOT requirements and come up with an action plan to prepare construction sequencing and traffic control plans. This task could be handled via phone/e- mail correspondence.

15.2.08.B.3 continued

(2) The ~~Consultant~~Engineer of Record shall meet with the City of Houston prior to beginning the construction sequencing and traffic control plans to discuss the project in detail. At this meeting, typical and any conditions that need to be considered in preparation of construction sequencing and traffic control plans will be discussed. The meeting regarding traffic control plans will generally occur as part of other project initiation meetings and design review meetings. Based on the discretion of the City Traffic Engineer and/or City of Houston Project Manager a special meeting may be organized to discuss specifics of the project in regards to construction sequencing and traffic control setup.

2. Data Collection

a. Collect all data required to produce construction sequencing plans and traffic control plans. Typically, at this stage of the design process proposed improvements and goals of the project have been developed. Therefore, existing topographic survey and/or improvement design sheets will be used as the base file to produce construction sequencing plans.

b. The ~~Consultant~~Engineer of Record shall visit the project site to inventory and identify physical features that may impact construction sequencing and traffic control plans such as access ~~d~~Driveways to special adjacent properties that may require special considerations in preparing traffic control plans such as schools, police stations, fire stations, churches, properties with only one access point, and relatively high demand commercial developments.

3. Plans and Drawings

a. General

(1) ~~All construction sequencing and traffic control design plans shall be prepared on 22" x 34" Mylar reproducible sheets, using the Standard City of Houston, Houston Public Works Title Block.~~ Construction sequencing and traffic control plans shall be shown on different plan sheets.

(2) All full-size designs for construction sequencing and traffic control plans shall be prepared at any standard scale as long as the notes and callouts ~~are readable~~ meet Chapter 3 requirements of this manual.

(3) All ~~construction d~~Drawings shall be prepared in accordance with Chapter 3, Graphic Requirements.

15.2.08.B.3.a continued

(4) On projects where the ~~Consultant~~Engineer of Record finds it necessary to deviate from the standard format presented herein, due to project scope or design requirements, the City's Project Manager should be consulted to determine an acceptable alternate format. Any changes to the format are at the discretion of the City's project manager.

(5) Construction sequencing plan should include all aspects of the improvement project such as removal of existing features such as curb, pavement, signs, implementation of temporary pavement to facilitate traffic, implementation of temporary signal locations, and installation of all proposed elements of the project.

(6) Each phase of construction sequencing plan shall have separate traffic control plan including associated detour routes and signal modification plans as necessary. The ~~Consultant~~Engineer of Record should look into using standard lane closures to reduce the number of plan sheets from phase to phase. In addition, if simple signal head adjustments are need for signal modification of different phases, the ~~Consultant~~Engineer of Record is encouraged to only use one signal modification plan for different phases.

(7) Each phase of construction sequencing plan shall make every effort to leave existing sidewalk accessible to pedestrians while project related improvement activities commence forward. Complete sidewalk closure must be minimized as much as possible.

(8) Lane closures on Major Thoroughfares according to the latest classifications by the Planning and Development Department; existing directional vehicular movements shall be maintained throughout the duration of the construction project. There may be special construction activities that may require limitations of movements on ~~m~~Major ~~t~~Thoroughfares. These situations must be approved by the City Traffic Engineer. Typically, such approvals are associated with peak period restrictions and/or special traffic control plan and requirement of extensive advertisement to the traveling public especially to stake holders substantially impacted in the vicinity.

b. Travelway.

15.2.08.B.3.d continued

~~(9)~~(1) ~~The contractor shall p~~Provide 11-foot travel lanes on traffic control plans outside the Central Business District (CBD), and a minimum 10-foot wide travel lanes within the CBD. Any deviation will have to be approved by the City Traffic Engineer.

~~(10)~~(2) The Contractor shall provide at a minimum two traversable lanes within the CBD. Any deviation will have to be approved by the City Traffic Engineer.

c. Pedestrian, Bicycle, and Transit Facilities.

~~(11)~~(1) ~~Where a bicycle facility is present, the Contractor shall provide as high comfort bicycle detour as possible. See Chapter 17 for the design of high comfort bicycle facilities. If the bus stop is present, the contractor shall provide an accessible comfortable pedestrian route to access the bus stop~~Any project that impacts pedestrian, bicycle, and/ or transit facilities must provide approved temporary traffic control measures for the impacted road users. Refer to Chapter 17, Section 17.2.03 - Pedestrian and Bicycle Temporary Traffic Control for requirements for traffic control impacting pedestrian and bicycle facilities. If a transit stop is present, provide an accessible and comfortable pedestrian route to access the transit stop.

(2) For the safety of bike drivers, place steady burn lights on drums at lane closures in the following conditions:

(a) On tangents and tapers in the work zone area shifting bike lane traffic.

(b) At bike lane closures.

(c) Around bike hazards such as potholes and steel plate trench coverings.

~~(a)~~(d) At parking lane closures that are adjacent to a bike lane.

d. Open Trench.

~~(12)~~(1) Trench walls should not be three feet from the edge of the traveled way at any stage of the construction.

~~(13)~~(2) Traffic control devices shall be in place before starting any excavation.

15.2.08.B.3.f continued

~~b.~~e. Barriers.

(1) For vertical drop-off greater than one foot along roadway, low profile concrete barriers with appropriate end protections must be installed.

(2) Water Filled Barriers:

(a) Water filled barriers can be used as instructed by the Engineer of Record and approved by City for projects where space is limited and heavy equipment to place concrete barrier is not feasible.

(b) Place and install water filled barrier units as shown on the plans and per manufacturer's design instructions and specifications on roadways with posted speed limit of 45mph or less.

f. General Notes.

~~c.~~ The following General Notes should be included on the traffic control plan. Additional notes may be added by the ~~Consultant~~ Engineer of Record as may be necessary to properly clarify the intent of the design.

(1) The ~~C~~contractor shall provide and install traffic control devices in conformance with Part VI of Texas Manual on Uniform Traffic Control Devices (TMUTCD) latest edition with revisions during the entire construction period.

(2) All signs and traffic control devices shall conform to the latest version of the TMUTCD.

(3) No lanes shall be closed during the hours of 7:00 AM to 9:00 AM and 4:00 PM to 6:00 PM Monday thru Friday without approval of the City Traffic Engineer.

(4) No work shall be performed in residential areas from 7:00 PM to 7:00 AM.

(5) Contractor shall maintain approved number of through lanes of traffic in each direction during construction working hours. Traffic control plans shall include one-way and/or detour plans. Contractor shall maintain ADA compliant pedestrian access to bus stops and adequate bus access to the bus stops.

(6) Contractor shall maintain traffic lanes and detours according to traffic control plans during working hours.

(7) Contractor shall cover open pavement excavations for minor utility work with anchored steel plates during non-working hours, and open lanes for normal traffic flow when feasible.

(8) If the ~~C~~contractor chooses to use a different method of "Traffic Control Plans" during the construction than what is outlined in the contract drawings, the ~~C~~contractor shall be responsible to prepare and submit an alternate set of traffic control plans to the City of Houston Project Manager for approval ten working days prior to implementation. These plans shall be drawn to scale on reproducible mylars and shall be sealed by a Licensed Engineer in the State of Texas. ~~Transportation & Drainage Operations~~ Office of City Engineer, Mobility Permits Section representative approval is required to accept the proposed changes.

(9) Contractor shall secure lane/sidewalk/bicycle facility closure permits from ~~Transportation & Drainage Operations~~ Office of City Engineer before implementing the traffic control plan.[17] The application must be submitted at least ten business days prior to the implementation of the traffic control plan and/or beginning construction work. The ~~C~~contractor shall provide traffic control plans, construction sequencing, and construction schedule with the application.

(10) Contractor shall have approved traffic control plan and permit at the job site for inspection at all times.

(11) During pavement surface restoration projects; the ~~C~~contractor shall not open closed lanes until the pavement surface has cured enough to allow vehicular traffic according to City of Houston Standard Specifications.

(12) The ~~C~~contractor is responsible for scheduling and coordinating all construction activities with stake holders in the vicinity including emergency response agencies such as Houston Police Department, Houston Fire Department, and Metropolitan Transit Authority.

(13) Contractor shall be responsible for issuing all work directives to all sub-contractors, utility companies, and all other entities performing construction work associated with the project.

[17] Refer to Mobility Permit System weblink at https://geohub.houstontx.gov for permit requirements

15.2.08.B.3.f continued

(14) Nothing in these notes or plans shall relieve the ~~C~~contractor of the responsibility for job site conditions during the course of construction of the project; including safety of all modes of transportation, persons, and property, and that this requirement shall apply continuously and not be limited to working hours.

(15) The ~~Transportation & Drainage Operations~~ Office of City Engineer (Mobility Permits Group) per the direction of the City Traffic Engineer have the right to demand the installation of additional traffic control devices or modifications to these plans and notes, as deemed necessary to promote the safe and orderly flow of traffic, including pedestrians and bicycles, through the construction work zone. The ~~C~~contractor shall comply with these additional requests or modifications with due diligence.

(16) All existing traffic control signs and pavement markings shall be maintained in visible locations during construction unless prior written approval is obtained from City of Houston Project Manager. The ~~C~~contractor shall restore or replace (at the discretion of the City Traffic Engineer) any pavement marking or signing damaged during construction operations, including ~~R~~raised ~~P~~pavement ~~M~~markers (RPMs).

(17) When entering or leaving roadways carrying public traffic, the ~~C~~contractor's equipment, whether empty or loaded shall in all cases yield to public traffic with the assistance of ~~C~~contractor provided certified flagger/peace officer.

(18) Access to ~~d~~Driveways adjacent to the construction work zone shall be maintained at all times as much as possible. Additional cones and/or delineators may be required to delineate the ~~d~~Driveway access route through the construction work zone. A minimum of one travel lane shall be maintained across the ~~d~~Driveways, unless prior written approval is obtained from City of Houston Project Manager.

(19) Spillage resulting from hauling operations along or across any public traveled way shall be removed immediately by the ~~C~~contractor.

(20) The ~~C~~contractor shall submit an application for temporary parking restrictions if there are parking meters located at the proposed lane closures from Parking Management Division (832-393-8690) at least ten business days before implementation of lane closures. In addition, temporary no parking signs shall be posted 24 hours prior to commencement of work.

15.2.08.B.3.f continued

(21) Additional off duty police officers/flaggers may be requested to direct traffic when lanes are blocked at the discretion of the City Project Manager even if they are not specifically identified on the project plans.

(22) The ~~C~~contractor shall replace within 72 hours, all traffic signal loop detectors damaged during construction.

(23) In general, a solar powered flashing arrow board shall be required on all ~~m~~Major ~~t~~Thoroughfare lane closures. Exceptions to flashing arrow boards and/or implementation on residential lane closures shall be approved by the City Traffic Engineer.

(24) Approved traffic control plan shall be in place before starting any excavation.

(25) Water filled barriers can be used as instructed by the Engineer and approved by the City for projects where space is limited and heavy equipment to place concrete barriers is not feasible. Water filled barriers shall not be used on roadways with a posted speed limit more than 45 mph.

(26) Water filled barriers must be installed and maintained per the manufacturer's requirements and routinely inspected for defects.

(27) If water filled barrier is provided, use environmentally safe anti-freezing agent in the water when it is applicable per manufacturer specifications and recover agent when the barrier is drained.

(28) Dispose of water and agent properly. Do not drain water filled barrier into or across existing travel lane.

(29) Provide barrier units that are capable of being lifted and moved when filled if draining is not possible.

(30) Provide water filled barrier that acts as its own free standing, non-redirective end treatment.

(31) When water filled barriers are used to channelize pedestrians, they must have a continuous detectable bottom for users of long canes and the top of the unit shall not be less than 32 inches in height.

15.2.08.B.3 continued

~~(24)~~(32) Any closure of a pedestrian or bicycle facility shall require the shortest detour that maintains the safety of pedestrian and/or bicyclists.

~~d.~~g. General Notes and Channelization Spacing (Refer to City of Houston Standard Detail ~~01512- 01~~01555-01)

~~e.~~h. General Lane Closure Guidance (Refer to City of Houston Standard Detail ~~01512-02~~01555-02)

~~f.~~i. General Detour Guidance (Refer to City of Houston Standard Detail ~~01512- 03~~01555-03)

~~g.~~j. Long Term Major Street Lane Closure (Refer to City of Houston Standard Detail ~~01512-04~~01555-04)

~~h.~~k. Long Term Minor Street Lane Closure (Refer to City of Houston Standard Detail ~~01512-05~~01555-05)

~~i.~~l. Short ~~t~~Term Minor Street Intersection Lane Closures (Refer to City of Houston Standard Details ~~01512-06~~01555-06 through ~~01512-12~~01555-12)

15.2.09 MINIMUM VERTICAL CLEARANCE

~~15.2.08.C~~15.2.09.A GENERAL

1. This section of the design manual contains the requirements for minimum vertical clearances for structures, utilities and traffic control devices.

~~15.2.08.D~~15.2.09.B MINIMUM VERTICAL CLEARANCE GUIDANCE

1. Pedestrian Sky Bridges

   a. Refer to Chapter ~~16, Miscellaneous~~18, Encroachments, for sky bridge clearance requirements.

2. Overhead Traffic Signal Devices

   a. ~~Refer~~ See ~~Chapter 15, S~~Section 15.2.14 – Traffic Signals ~~of this manual~~ and Standard Detail ~~# 02893~~02582-01 for minimum clearance requirements for overhead traffic signal devices.

3. Traffic Signs

   a. ~~Refer to Chapter 15,~~See Section 15.2.14 ~~11 -~~ ~~t~~Traffic ~~s~~Signals ~~section of this manual,~~ and TMUTCD for overhead sign installation requirements.

15.2.09.B continued

4. Vehicular Bridge

   a. The desirable clearance for ~~bottom of~~ the lowest point of the structure in the public right of way is 17.5 feet ~~should be a minimum of 14.5 feet~~ over the entire roadway width. If a clearance is less than 17.5 feet, it must contain appropriate signs, and it requires approval of the City Engineer and the City Traffic Engineer. Absolute minimum clearance is 14.5 feet.

5. Building Structures Over Public Right-of-Way

   a. The bottom of the lowest point of the structure in public right-of-way should be a minimum of 18.5 feet over the entire roadway width.

6. Railroad Overpass Clearances

   a. Highway structures over railroads are referred to as railroad overpasses. Vertical clearance for new structures over railroad tracks must be 23'-6" feet minimum measured from the top of rail to the lowest obstruction under the highway structure. In cases where electric powered trains are involved, additional vertical clearance may be required.

7. Railroad Underpass

   a. Prior to resurfacing under railroads, approval must be obtained from the railroad company.

8. Obtain approval from Office of City Engineer for exception or deviations from these requirements.

~~15.2.09~~15.2.10 SCHOOL ZONES ~~POLICIES~~

~~15.2.09.A~~15.2.10.A GENERAL

1. School Zones are segments of roadway within the vicinity of a school that are designed to identify an area where students cross or are likely to cross that roadway.

~~1.~~2. School speed zones are ~~installed where students cross or are likely to cross roadways by themselves but may not have a level of mental cognizance to do so safely. The school must be clearly defined as an elementary or middle/junior high school~~ used to indicate where a reduced speed zone for a school area has been established in accordance with law based upon an engineering study.

3. Safe and accessible routes for students to walk and bike to school are vital to achieving the City of Houston's commitment to Vision Zero. The City of Houston, ~~HPW~~Houston Public Works, Transportation and Drainage Operations~~, Schools Coordination Program~~ works with school principals or their designated representatives to develop a plan for creating safe ~~and efficient s~~School ~~z~~Zones which ~~balance~~ prioritize pedestrian ~~safety,~~ and bicycle safety~~, and roadway mobility needs~~.

   a. ~~C. As the school's principal is in overall responsible charge for all activities associated with a school, T~~The City of Houston does not respond specifically to community requests related to School Zones. ~~from the community at large but do~~ The City of Houston will present ~~any suggestions~~ requests ~~received~~ to the principal or his/her designated representative for consideration.

   b. ~~D. All proposed changes or new school zone requests shall be referred to the School Coordinator, at 832-395-3000. In addition,~~ The detailed School Zone Policy and application can be obtained at https://www.houstonpublicworks.org/multi-modal-safety-and-design.

~~15.2.09.B~~15.2.10.B DESIGN REQUIREMENTS ~~ON ROADWAYS WITH EXISTING SCHOOL ZONE~~

~~A. Description of Design/Review Process~~

~~1. Project Initiation~~

~~a. The Consultant shall meet with the City of Houston to discuss the project in detail prior to beginning the school zone redesign/replacement. At this meeting, typical and any specialty school zone issues within the project limits will be discussed. The meeting regarding school zone will generally occur as part of other project initiation meetings and will not require a separate meeting.~~

~~2. Collect School Zone Data and Design~~

~~a. Collect all data required to develop existing school zone items including but not limited to school zone beacons, designated school crossings, designated or proposed bikeways and school start time and dismissal time. Typically, school zone information will be included as part of the general existing condition data collection effort as defined by the Policy and Procedures for School Zone Installation and Removal.~~

~~b. The Consultant shall prepare a plan to maintain existing school zones in safe operational manner if school is in session during construction and replace existing school zones as implemented previously before start of construction. Complete replacement or modification may be required by City of Houston to meet the current standards.~~

1. Figure 15.8 displays an example layout of a School Zone, including school speed zone.

2. Newly designated School Zones are installed at elementary, middle/junior, or high school and shall consist of:

   a. Advanced warning notice indicated by School Advance Warning Assemblies consisting of Advance School Warning sign (S1-1) above an AHEAD sign (W16-9p).

   b. Reduced speed limits indicated by School Speed Limit Assemblies. The School Zone begins at first posted School Speed Limit Assembly ("Zone Beginning" in Figure 15.8).

      (1) School Speed Limit Assemblies may be a SCHOOL sign (S4-3) on top of a 20 mph SPEED LIMIT sign (R2-1) above a sign with the effective times of the school speed zone (S4-1).

      (2) School Speed Limit Assemblies may be a 20 mph SCHOOL SPEED LIMIT WHEN FLASHING sign (S5-1) with a Flashing School Beacon.

         (a) Flashing School Beacons shall be installed on designated Major Thoroughfares or collectors and on streets with an average daily traffic count of 5,000 vehicles or greater.

         (b) For the design of Flashing School Beacons, see City of Houston Standard Detail No. 16712-03.

   c. Additional School Speed Limit Assemblies or Flashing School Beacons ("Zone Continuation" in Figure 15.8) that are installed typically every 300 to 500-ft spacing depending on length of zone and intersecting roadway.

   d. School Crosswalk Warning Assemblies consisting of School Crossing sign (S1-1) on top of a Diagonal Arrow plaque (W16-7p) installed only on uncontrolled leg(s) of an intersection and at designated midblock crossings.

15.2.10.B continued

e. High-Visibility Crosswalk markings at intersections and designated midblock crossings. See Chapter 15, Section 15.2.06.B.4 - Crosswalks and Chapter 17, Section 17.3.03 - Corridor Crossing Analysis and Treatments for additional guidance on midblock crossing specifications.

f. End School Zone signs (S5-2) marked with a standard SPEED LIMIT sign (R2-1) showing the speed limit for the section of roadway.

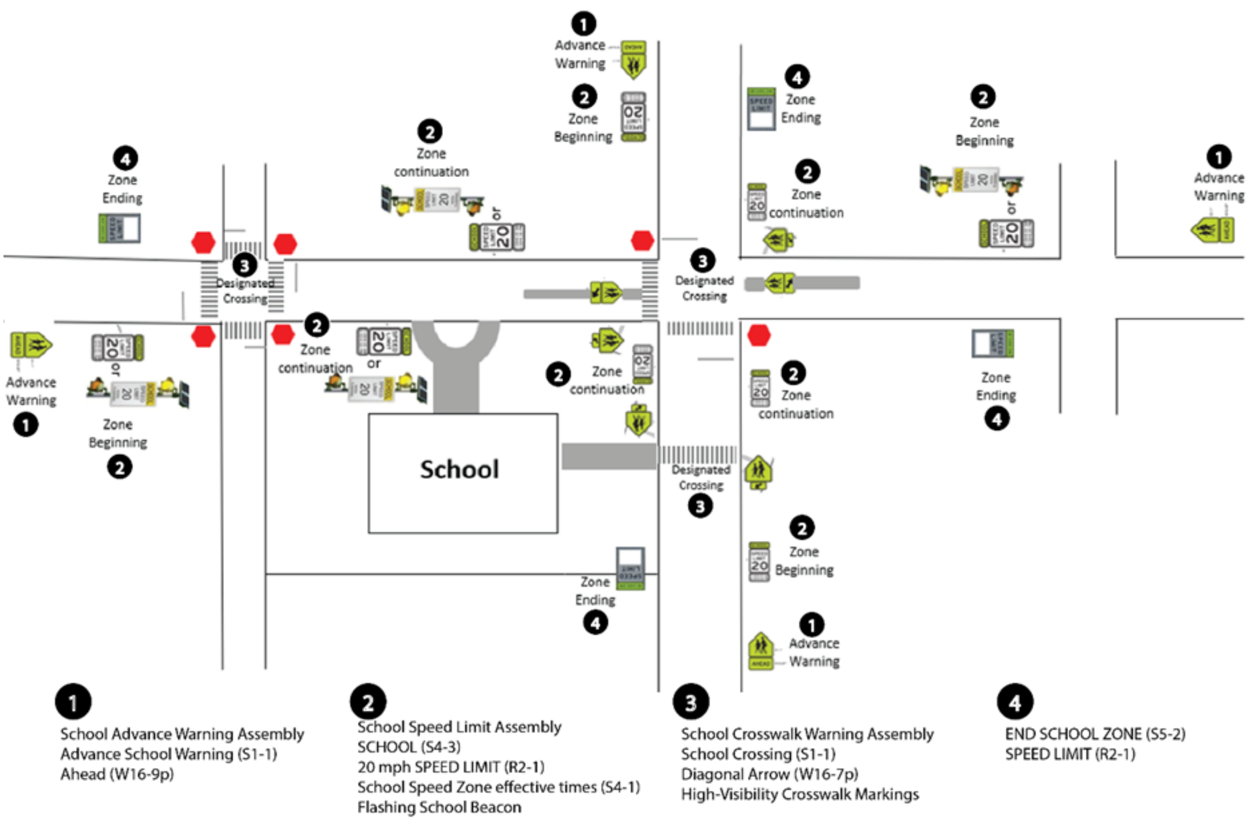


Figure 15.8~~15.8~~ – EXAMPLE SCHOOL ZONE

3. Existing School Zones may be redesigned and, if so, shall consist of:

a. A meeting with the City of Houston, Houston Public Works, Transportation and Drainage Operations to discuss issues with the existing School Zone design. This meeting may occur as part of other project initiation meetings and will not require a separate meeting.

15.2.10.B.3.c continued

b. Data identifying existing School Zone items including School Zone beacons, designated school crossings, designated or proposed bikeways and school start time and dismissal time. Typically, School Zone information will be included as part of the general existing condition data collection effort as defined by School Zone policy.

c. The Engineer of Record shall prepare a plan to maintain existing School Zones in safe operational manner if school is in session during construction and replace existing School Zones as implemented previously before start of construction.

(1) Complete replacement, modification, or additions may be required by City of Houston to meet the current standards.

(2) Any obstructions to pedestrian and bicycle facilities shall follow Chapter 17, section 17.2.03 - Pedestrian and Bicycle Temporary Traffic Control.

~~15.2.09.C~~15.2.10.C EXISTING SCHOOL ZONES DURING CONSTRUCTION

1. It is the responsibility of the ~~C~~contractor performing the work to accommodate safe movement of school related activities during the entire duration of the construction period.

2. The ~~C~~contractor may need to relocate school beacons, ~~s~~School ~~z~~Zone signs temporarily during construction before implementation of ~~s~~School ~~z~~Zone equipment per design plans at the ~~C~~contractor's expense. Coordinate relocation of flashing beacons and signage with City staff and school principal.

~~15.2.10~~15.2.11 ~~NEIGHBORHOOD TRAFFIC MANAGEMENT PROGRAM~~TRAFFIC CALMING

~~15.2.10.A~~15.2.11.A GENERAL

1. All proposed traffic calming must utilize the Neighborhood Traffic Management Program (NTMP).

~~1. Due to House Bill 3082, the City of Houston is obligated to go through the NTMP process as prescribed by City of Houston Code of Ordinances Chapter 45, Article XV in order to implement traffic calming devices within City of Houston jurisdiction.~~

2. NTMP is intended to address traffic safety by combining a robust and defined community outreach approach with a toolbox of street safety elements collectively known as traffic calming. Traffic calming devices are self-enforcing, reduce and manage cut-through traffic and ensure safe and prudent vehicle speeds.

~~2. Traffic calming device is any type of device consisting of the physical structure or other improvement constructed, placed, whether on a temporary or a permanent basis, to mitigate speeding or cut-through traffic on local streets such as but not limited to speed cushions, median islands, traffic circles, chicanes, chokers, and raised pedestrian crossing islands.~~

3. Traffic calming devices can be installed on a temporary or a permanent basis. Traffic calming devices may be implemented as part of newly constructed and reconstructed streets or as part of retrofit and rehabilitation projects.

~~3. The NTMP comprises of the Speed Control Program and Volume Control Program. For neighborhoods that are interested in only speed cushions, the Speed Control Program offers a shorter process with no traffic study and public meeting requirements.~~

4. Reconstruction and rehabilitation projects for minor collectors and residential streets should consider public requests for traffic calming devices, especially where there is a NTMP project on the waiting list.

~~4. If a project receives public requests for traffic calming devices, the design team shall strive to accommodate the requests within the project limits. The NTMP staff can guide the team through the process to obtain the appropriate approvals. Installation cost of the approved devices will be incidental to the project.~~

~~15.2.10.B~~15.2.11.B ~~DESIGN REQUIREMENTS ON ROADWAYS WITH ALREADY APPROVED TRAFFIC CALMING DEVICES~~DEVICES

~~1. Description of Design/Review Process~~

~~2. Project Initiation~~

~~3. The Consultant shall meet with the City of Houston prior to beginning the redesign/replacement of traffic calming devices to discuss the project in detail. At this meeting, typical and any specialty items in regard to the traffic calming measures will be discussed. The meeting regarding traffic calming measures will generally occur as part of other project initiation meetings and will not require a separate meeting.~~

~~4. Collect Traffic Calming Measures Data and Design~~

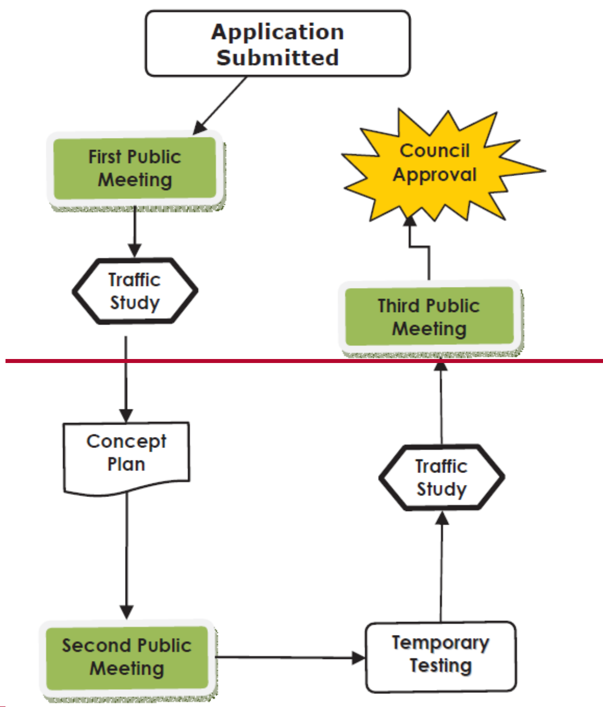
~~5. Collect all data required including but not limited locations of existing speed humps, speed cushions, and any other traffic calming devices.~~

~~6. The City of Houston does not use speed humps anymore. Therefore, all existing speed humps within the affected construction limit of a given project shall be replaced with speed cushions per the requirements of City of Houston Standard Detail 13501-01 as part of the improvement project and using the project funds.~~

~~7. Typically, all existing traffic calming devices shall be returned in place at the same location unless directed by the City Project Manager/City Traffic Engineer to adjust.~~

~~8. NTMP PROCESS~~

~~9. The NTMP process is detailed in the City of Houston Code of Ordinances Chapter 45, Article XV. In summary, Figures 15.15.01 and 15.15.02 outline the process including the requirements of City Council approval for the Speed Control and Volume Control Programs.~~



~~10. Figure 15.15.01 – Summarized NTMP Process – Volume Control Program~~

15.2.11.B.1.a continued

~~11. Figure 15.15.02 - Summarized NTMP Process - Speed Control Program~~

~~12. Typically, the NTMP group directs an applicant through the process. In some cases, a neighborhood group or organization may choose to use a Consultant to go through the process, and construct the traffic calming devices using private funds.~~

~~13. The Consultant tasked by the group shall meet with the City of Houston Transportation & Drainage Operations staff responsible for the NTMP prior to starting the design. At this meeting, there will be discussion of the level of involvement by the Consultant to go through the process.~~

~~14. If the Consultant requests City of Houston resources to assist with some of the tasks, there may be a waiting period to start the process.~~

~~15.~~1. Types of traffic calming include but are not limited to speed cushions, ~~t~~Traffic ~~c~~Circles, partial/full closures, diverters, and chicanes. Below are brief descriptions of the three common traffic calming devices.

a. Speed cushions

(1) Speed cushions are speed humps with wheel cutouts at designated widths to allow for large vehicles to pass unaffected, while reducing passenger car speeds. Speed cushions allow emergency vehicles to pass their wheels on either side of the raised area.

(2) Speed cushions must meet design standards identified in City of Houston standard detail No. 13501-01 and specifications in Section 13501.

b. Traffic Circles

15.2.11.B.2 continued

(1) Traffic Circles are a circular physical structure installed in the center of an intersection to require a circular flow within the intersection.

(2) Traffic Circles can encourage slower speeds by forcing slight path diversions for drivers making a through movement or left turn, and by creating a visual break on a straight path to catch a driver's attention. Traffic Circles are not the same as roundabouts, which are considered a full traffic control device.

(3) Traffic Circles may be installed on a temporary or permanent basis and a variety of materials may be considered to designate a Traffic Circle, such as pavement markings, curbs, flex posts, and mountable concrete islands. Specific materials shall be reviewed and approved by Transportation and Drainage Operations.

c. Chicanes

(1) Chicanes create a horizontal diversion of traffic from a straight travel path.

(2) Chicanes should provide a relatively abrupt taper that shifts travel to have a calming effect on vehicle speeds. They can be created by shifting parking from one side of the street to the other (if there is only space for one side of parking) or by extending the curb.

(3) Chicanes may be demarcated from the existing roadbed using curbs (pre-cast, cast-in-place, or similar), bollards, planters, or other delineation along with pavement markings and striping.

(4) Chicane design and specific materials are subject to review and approval by Transportation and Drainage Operations.

2. All proposed traffic calming measures shall have to go through the NTMP process before implementation. ~~Detailed information on the process, brochure, and application form can be obtained at https://www.publicworks.houstontx.gov/tdo-documents.~~

a. The requestor can also contact the NTMP group at NTMP@Houstontx.gov or 832-395-3000 for additional assistance.

b. The City of Houston, Houston Public Works, Transportation & Drainage Operations administers the Neighborhood Traffic Management Program (NTMP) per the requirements of City of Houston Code of Ordinances Chapter 45, Article XV.

15.2.12.B.3 continued

3. Slow Streets is an advisory measure to discourage through traffic on local streets. Temporary devices are placed at intersections to communicate that the street is a slow and shared environment between all road users. The street remains open to all traffic, including emergency vehicles, and thus does not trigger the processes for Speed or Volume Control as outlined in the NTMP.

~~15.2.11~~15.2.12 STREET EXTENSIONS AND CLOSURES

~~15.2.11.A~~15.2.12.A STREET EXTENSIONS

1. For streets that will be extended, the traffic study will recommend appropriate posted speed limit and parking restrictions that are consistent with the existing street segments at both ends.

2. For street extensions that occur in phases, the design will include installations of appropriate pavement markings and warning signs (e.g., speed reduction signs, no outlet.) to ensure safe traffic operations and street transition until the full extensions are completed.

~~15.2.11.B~~15.2.12.B COMPLETE STREET CLOSURE

1. A street can permanently be closed by a private entity after the City relinquishes the street right-of-way and access easement. The City Joint Referral Committee (JRC) reviews and approves all abandonment and sale of street, alley, or easement. Information about the JRC can be found here:

   https://www.publicworks.houstontx.gov/joint-referral-committee.

2. A local, residential street can be closed for traffic calming purposes. Requests for such closure are administered by the Neighborhood Traffic Calming Program (NTMP).

3. Temporary complete street closure is strongly discouraged. If such closures are required and demonstrated to minimize construction impacts and improve public safety, closure permit can be obtained from the Mobility Permit Section. Temporary closure to serve a special event will require a permit from the Mayor's Office. Below are general requirements for temporary, construction-related street closures.

   a. Planned full street closures require a mobility permit from the Office of City Engineer, Mobility Unit ~~Traffic Management Branch~~.

   b. Purpose and anticipated duration of the proposed full street closure must accompany the mobility permit application.

   c. Traffic Control and Detour Plan must be sealed by a Texas licensed Professional Engineer.

d. Public notification. Change message signs (CMS) must be displayed a minimum of 7 days in advance of the proposed full street closure.

4. Slow Streets is an advisory measure to discourage through traffic on local streets. Temporary devices are placed at intersections to communicate that the street is a slow and shared environment between all road users. The street remains open to all traffic, including emergency vehicles, and thus does not trigger the processes for Speed or Volume Control as outlined in the NTMP.

~~4.~~

~~15.2.12 INTERSECTION TURNING TEMPLATES / DESIGN VEHICLES~~

- ~~Pedestrian and bicycle connections should be maintained whenever possible; otherwise, most direct detours should be provided.~~
- ~~Criteria for selecting design vehicles are provided in Chapter 10~~
- ~~Dimensions and turning templates of design vehicles may be found in the AASHTO Green Book~~
- ~~Turning template diagrams will be submitted to the City upon request~~

15.2.13 STREETLIGHT DESIGN REQUIREMENTS

15.2.13.A DESIGN REQUIREMENTS - CAPITAL IMPROVEMENT PROJECTS

1. The following design requirements are applicable within the City street rights-of-way and are intended for lights owned and installed by CenterPoint Energy. The ~~Consultant~~Engineer of Record is to contact the City~~'s~~ prior to implementing the below criteria to determine ownership and design methodology. This recommended practice is applicable to all capital improvement projects, including but not limited to street, bridge, water, wastewater, and storm sewer projects. The ~~consultant~~Engineer of Record will be responsible for designing the street lighting layout associated with each project by following the guidelines listed below. Note that the below criteria are solely for the use of the standard ~~C~~cobra style light fixtures on cobra poles. Areas requiring or requesting decorative type lighting will need direction from the City's Streetlight Section on developing a streetlight design and cost.

   a. It is the City's practice to upgrade the street lighting along all roadways to current recommended levels as part of capital improvement projects.

15.2.13.A.1 continued

b. Areas without wood power poles are considered candidates for metal pole streetlights. The ~~design consultant~~Engineer of Record will prepare the lighting layout, spacing the streetlights at a distance of approximately 200' +/- 20' for ~~d~~Driveway/utility conflicts. Typically, a streetlight placed 3-4 ft. behind back of curb will illuminate two lanes. Roadway sections that are four or more lanes should be illuminated from both sides. For sections less than four lanes, stagger the streetlights along both sides of the roadway, maintaining the 200' +/- 20' spacing. The design should also include any existing street lighting. Proposed and existing street lights should be called out by station numbers. Generally, begin layouts at intersections and work away.

c. The design must identify which of the existing streetlights will require relocating or temporary removal during the construction phase. Plans shall be submitted to the Transportation & Drainage Operations for review/approval. Upon ~~our~~ approval, the City will submit the approved layout to CenterPoint Energy for a conduit/pullbox layout and cost estimate for the temporary removal/re-installation of the existing streetlights. These costs will then be forwarded to the Project Manager and included as a line item in the bidding documents for cash allowance to pay CenterPoint. Note that CenterPoint will require payment prior to providing service.

d. When overhead power and wood pole street lighting exist in an area, the design should utilize existing wooden utility poles for any additional streetlights while maintaining a 175' +/- 15' spacing. Mixing of wood and metal pole streetlights along local streets in neighborhoods is generally not allowed and shall require prior approval from the City.

e. Along thoroughfares and collectors with four or more lanes, wood poles may exist along only one side of the roadway. In these instances, it is acceptable to have wood pole streetlights along one side while having metal pole streetlights along the other.

f. Upon completion of the project it is the contractor's responsibility to notify the Streetlight Section in writing that the conduit has been installed & inspected and meets CenterPoint's specifications before the authorization for new/re-installed metal pole streetlights can proceed.

g. Locations of existing and proposed streetlights (station numbers) need to be shown. Do not show lighting outside of the public roadway right-of-way.

15.2.13.A.1 continued

h. Pole number for existing streetlights must be shown. This is a 6-digit number that is stenciled approximately 6' above grade on the street side of the light.

i. Depict type of existing and proposed streetlights (metal pole or wood pole) - note: wood poles are never installed for the sole purpose of street lighting).

j. All metal pole streetlights that could potentially be impacted by construction activities shall be removed and reinstalled. The removal and reinstallation will be completed by CenterPoint. The cost for this service will be included in the project as cash allowance to pay CenterPoint.

k. The proposed locations of new streetlights should not necessarily be based on the existing light locations. The layout should be created from scratch, following the spacing criteria described above.

l. When removing/replacing lights in residential areas, it is generally preferable to replace lights in the same location, unless relocation is necessary to meet the lighting and spacing criteria.

m. In residential area, show parcel boundaries (property lines).

n. In residential areas, place lights on property lines and at property corners 2' off the radius of the curve (refer to the CenterPoint Energy streetlight staking detail).

o. No lights should be placed at a 45-degree angle at the intersections

p. Do not place proposed lights under heavy tree canopy (typical mounting height of a streetlight pole is 26'). Field verify to ensure appropriate clearance. Where tree canopy is unavoidable, plans must specify that tree canopy will need to be trimmed a minimum 5' radius around the projected streetlight pole mounting height (all trimming to be part of project cost, CNP will not trim trees nor install lights in heavy tree canopy).

q. Do not place proposed lights in any wheelchair ramps or sidewalks.

r. If decorative lighting is requested by the neighborhood, the ~~Consultant~~Engineer of Record will submit the standard layout to the City. CenterPoint will prepare a separate decorative lighting layout. The City will review both layouts and determine which layout will be implemented.

15.2.13.B continued

s. Based on the City approved layout, CenterPoint will prepare a conduit layout, which the ~~Consultant~~Engineer of Record will incorporate into the design. The ~~C~~contractor is responsible for the conduit installation. CenterPoint will be responsible for installing and energizing the streetlights. Payment to CenterPoint will be included in the project as a cash allowance item.

t. If temporary lighting is required, design and installation will be completed by CNP. Cost for this service will be included in the project as cash allowance from the contractor to CNP.

15.2.13.B DESIGN REQUIREMENTS - CITIZEN REQUEST

1. The primary purpose of street lighting is to illuminate the roadway. Streetlights are not intended for providing security lighting, pedestrian lighting, parking lots lighting or any other private property lighting. A street segment must be within the City limits in order to be eligible for streetlights. All streetlights are installed, owned and maintained by Center Point Energy. However, the City must approve for any street light installation that is within the City right-of-way.~~-~~ Once it is installed, the City pays for the operating and maintenance cost of the street light.

2. Street light types - The City of Houston standard street light type includes Light Emitting Diode (LED) in a cobra style light fixture mounted on wooden pole or metal pole.

   a. Wood Pole Lights: The City will authorize for street light installation on wooden utility poles wherever possible.

   b. Metal Pole Lights: If an area does not have existing wooden pole with overhead power lines, then a metal pole streetlight powered by underground lines will be installed. There may be a cost associated with this type of installation.

   c. Wattage: Various wattages will be installed depending on the road to be illuminated. 45-watt LED fixtures will be installed on local roadways and 95-watt LED fixtures on collector type roadways. 115-watt LED fixtures are typically installed along ~~m~~Major ~~t~~Thoroughfares. LED streetlights technology continues to advance. Increased efficiencies will change the applicable wattages and the ~~designer~~Engineer of Record should refer to the latest City specification for roadway lighting.

15.2.13.B continued

3. Street light spacing requirements. Metal pole streetlights are typically installed approximately 200 feet apart (+/- 20') with 10 feet for property line adjustment. Streetlights are typically installed on public right-of-way avoiding obstructions such as trees, manhole, and inlets. Spacing for streetlights on wooden utility poles may vary depending on the existing location of the wood poles. However, spacing will normally be 150 to 200 feet apart for adequate roadway illumination.

4. Streetlight(s) can be requested by application. A Street Light Survey Request Form is available ~~through the City of Houston website (https://www.publicworks.houstontx.gov/tdo-documents) or~~ by calling ~~(832) 395-3000~~ the City of Houston at 311. This application must be completely filled out and submitted to the City by mail or by fax. Upon receipt of the application, the City will conduct a street light survey and provide a written response in approximately 6 - 8 weeks thereafter. If the City determines that streetlight is feasible as a result of the survey, the City will authorize Center Point Energy for street light installation. Streetlights deemed necessary along Major Thoroughfares will incur an installation cost by CenterPoint Energy. Funding for the installation cost will be processed and paid by the City. CenterPoint Energy will schedule the installation once it receives payment. Timelines for the installation will vary depending on the City's ability to fund the request.

5. Cost for streetlights. Typically, there is no charge to the applicant for any streetlight that can be installed on an existing wooden pole, or any streetlight (wooden or metal) that is installed on a roadway that is classified as a ~~m~~Major ~~t~~Thoroughfare per the City of Houston. However, there is a charge for the installation of a new streetlight on a metal pole on city local roads. There may be an additional charge by CNP for local roads that require a high level of illumination. Per Section 40-3 of the City Code of Ordinances, the applicant is required to pay for the first year's operating cost prior to authorizing the installation of the streetlight. This is a one-time charge to the applicant. The cost may vary but average around $200.00 per streetlight.

6. Enhanced streetlight. The street light program also offers enhanced streetlights upon request. Locations and types of enhanced streetlights must meet the following requirements:

   a. Locations of enhanced streetlights must be within a current Management District, Tax Increment Reinvestment Zone (TIRZ), recognized by City of Houston.

   b. Enhanced streetlight must be approved by the Street Light Program coordinator coordinated with City's other ~~C~~capital ~~I~~improvement ~~P~~project.

15.2.14 TRAFFIC SIGNALS

15.2.14.A continued Requirements for reviewed and approved plans not constructed within a 2-year period.

15.2.14.A GENERAL

1. This document presents the criteria and formats to be used in designing improvements and preparing plans for traffic signal work in the City of Houston. It will also outline general requirements and guidelines to be followed by the Engineer of Record~~designers~~ of traffic signals for the City of Houston. This section is not intended to replace sound engineering judgment or the -standards of engineering practice. The Engineer of Record~~designer~~ shall also follow the guidelines published in the Texas Manual on Uniform Traffic Control Devices and in documents from the Institute of Transportation Engineers.

2. These design guidelines are applicable to both new traffic signal construction and to the modification of existing traffic signals. If any portion of a traffic signal installation is being modified, the City requires the entire signal be upgraded to current standards. Permission to deviate from these standards must be received prior to submission on construction drawings for review and approval.

3. The document provides ~~consultants~~ the Engineer of Record with:

   a. The analysis requirements for determining what improvements should be recommended,

   b. The design requirements and guidelines for ensuring uniformity in type and location of equipment, operational features, and intersection layout; and

   c. The required format of plans and contract documents to allow for ~~ease of review,~~ minimization of construction errors~~,~~ and facilitation of maintenance.

4. New signals must be approved by the City Traffic Engineer before they may be permitted. Any new or reconstructed signal shall follow the requirements of section 15.2.02 - Traffic and Design Studies to satisfy warrants and identify design criteria for all travel modes, including pedestrian, bicyclists, transit users, and motorists.

15.2.14.B DESIGN REQUIREMENTS

1. Description of Design/Review Process

   a. Solicit Information from Other Agencies

15.2.14.B.1.a.(1) continued

(1) Determine Requirements of Other Agencies & Property Owners.

(a) Verify with TxDOT their requirements if the intersection or street approaches fall under their jurisdiction. If discrepancies exist between the City~~'~~’s requirements and TxDOT~~'~~’s, the ~~Consultant~~ Engineer of Record shall meet with the City Traffic Engineer to reconcile any differences. If access to private property (residential, industrial, or commercial, etc.) is involved, the ~~Consultant~~ Engineer of Record shall contact the property owner involved, determine how the access will be affected, and coordinate with the City any differences which may exist.

(2) Contact ~~A~~appropriate ~~E~~electrical ~~U~~utility for ~~P~~power ~~H~~hook-up and ~~I~~illumination ~~R~~requirements.

~~(b)~~(a) The ~~Consultant~~ Engineer of Record shall verify with the electric utility involved in the project the power hook-up requirements. The ~~Consultant~~ Engineer of Record shall work with the ~~U~~utility to determine the service location during design and this location shall be indicated on the plans. The ~~Consultant~~ Engineer of Record shall note who is responsible for each component of a service hook-up, including the conduit and cable run from the load center to the power source, the conduit riser on the power pole and the actual splice into the power system. The responsibilities shall be clearly stated in the project plans.

~~(2)~~(3) Contact the Railroads and ~~V~~verify ~~T~~their ~~R~~requirements ~~R~~regarding ~~T~~traffic ~~S~~signal ~~P~~pre-emption or ~~C~~crossing of ~~T~~tracks with ~~C~~conduit ~~R~~runs.

(a) If railroad pre-emption is required in compliance with MUTCD guidelines, contact should be made with the railroad~~'~~’s manager of telecommunications and signals, and the City of Houston~~'~~’s signal operations representative early in the design process to determine their needs or requirements. If railroad right-of-way must be crossed with conduit runs, the ~~Consultant~~Engineer of Record shall determine the railroad~~'~~’s requirements for conduit type, size, depth, construction methods and restrictions.

b. Collect Engineering Data.

15.2.14.B.1.b continued

(1) Collect all data required to develop a base map of ~~e~~Existing ~~e~~Conditions which can be used for the design process and operational evaluation.

(2) Topographic Features: On each approach where advance detection or street improvements are anticipated, detailed information on topographic features should be collected for the area within 500 feet of the intersection. Otherwise, the topographic information is only required for the distance anticipated for the detection zone setbacks and for poles, traffic signal controllers, and related underground conduits.

(a) Widths and alignments of streets, lanes, and shoulders

(b) Median widths and lengths

(c) Curve radii

(d) Tapers

(e) Turn lanes

(f) Driveways & sidewalks

(g) Pavement type

(h) Existing pavement markings and raised channelization

(i) Grades

(j) Sight ~~d~~Distance obstructions

(k) Parking conditions

(l) Right-of-way lines and easements

(m) Building lines

(n) Angle of intersecting streets

(o) Trees and shrubs

(p) Railings and barriers

(q) ADA accessible curb ramps

(r) Street furniture

(s) Drainage features

15.2.14.B.1.b.(2).(t) continued

(t) Traffic signal equipment:

(i) Pole locations

(ii) Signal head locations and types

(iii) Controller cabinet location

(iv) Pull boxes (location and size), and conduits

(v) Detector locations

(vi) Service location (existing and potential)

(vii) Existing signal communications system and associated infrastructure

(viii) Emergency and/or railroad preemption systems

(u) Existing illumination (location and type)

(v) Existing signs

(w) Existing pavement markings

(x) Overhead utilities (horizontal and vertical clearances)

(y) Underground utilities

(i) Special attention should be given to obtaining a precise location of utilities. The ~~designer~~Engineer of Record shall request utility information from all utilities within the survey area. Field location should be requested for all utilities including traffic signal cables, conduits and detectors. Accurate horizontal and vertical clearance information shall be obtained for overhead utility lines including the sag of the cables between supports.

(3) Operational Data (If the Location has an Existing Traffic Signal):

(a) Phasing and timings

(b) Signal displays

(c) Type of controller and cabinet

(d) Detection methodology

15.2.14.B.1.b.(4) continued

(e) Traffic Signal Communications System Features

(4) Traffic Data (If Required by the City):

(a) Counts and projected volumes (24-hour approach and turning movements in am, pm, and noon peaks)

(b) Speed limit and speed study

(c) Accident history and diagrams (if available)

(d) Pedestrian volume and patterns

(5) Miscellaneous Data:

(a) Bus stops and routes

(b) Adjacent land uses

(c) Proximity of railroad crossings

(d) Proximity of emergency vehicle sources

(e) Other construction in progress in the area

(f) Adjacent street and drainage structures

(6) It may be possible to obtain information on existing topographic features from existing plans or maps. This data may be used for reference, but all plan preparation shall be based on field survey unless pre-approved by the City. Operational data and traffic data may be available from the City but may need to be supplemented by studies conducted by the ~~Consultant~~Engineer of Record.

c. Develop Base Map of Existing Conditions.

(1) The ~~Consultant~~Engineer of Record shall develop a base map showing all the applicable data collected. This map will be used as a base for showing all phases of the traffic signal design work and all geometric design work.

(2) Directional Orientation: All plan sheets shall have the intersection oriented with North to the top of the sheet or to the right of the sheet (if required to provide significantly better utilization of space).

15.2.14.B.1.c continued

(3) Scale: Traffic signal plans should be drawn a 1" = 20' scale at full size. Break lines may be used to show advanced detection of other features away for the intersection. Blown up details at a larger scale shall be used to illustrate areas with numerous conflicts or many items to be shown in a compact area such as intersection corners.

(4) Existing Conditions: The traffic signal base maps shall be printed using CSI Standards resulting in a lighter tone for ~~e~~Existing ~~c~~Conditions. The plan shall include, but not be limited to, the following information:

(a) Right-of-way, easements and street names

(b) Curbs and ~~m~~Medians

(c) Lane lines and channelization

(d) Sidewalks

(e) Utilities (underground and overhead):

(i) Electric

(ii) Gas

(iii) Telephone

(iv) Communications & Cable TV

(v) Traffic and Illumination

(vi) Sanitary Sewer

(vii) Storm Sewer

(viii) Water

(ix) Utility manholes, vaults and valves

(f) Monuments and benchmarks

(g) Driveways

(h) Signs and poles

(i) Angle of intersecting streets

(j) Building lines

15.2.14.B.1.d.(1) continued

(k) Other pertinent features (e.g., trees, shrubs, street furniture, bus stops, etc.)

d. Plans and Drawings

(1) General.

(a) All plans and drawings should be prepared with black ink~~ on ConsultantEngineer of Record furnished 22-inch x 34-inch Mylar reproducible sheets, using the Sstandard City of Houston, Transportation and Drainage Operations Ttitle Bblock on all traffic sheets~~.

(b) Standard Title Sheet, General Notes and Responsibilities Sheet, Traffic Signal Plan Sheet(s), Pole Schedule and Cable Schematic Sheet, and Detail Sheets, should be used for all traffic signal projects. An electronic Title Sheet, General Notes and Responsibilities Sheet and blank Pole Schedule are available from the City for use on traffic signal projects. Plan sets should not include copies of the City~~'~~'s standard traffic signal details.

(c) If necessary, additional sheets for plans and profiles, pavement markings or signing shall be provided as needed or as directed.

(d) A legend will be provided showing any non-standard symbols.

(e) On projects where the ~~Consultant~~Engineer of Record finds it necessary to deviate from the standard format presented herein, due to project scope or design requirements, the City's Project Manager should be consulted to determine an acceptable alternate format. Any changes to the format are at the discretion of the City's project manager.

(f) ~~Graphic requirements for engineering drawings shall comply with Chapter 3, Graphic Requirements. New lane striping shall be shown using CSI/NCS pen format.~~All Drawings shall be prepared in accordance with Chapter 3, Graphic Requirements.

(2) Plan sets should consist of the elements listed below:

(a) Title Sheet (City Standard)

(b) General Notes and Responsibilities Sheet

15.2.14.B.1.d.(2) continued

(c) Traffic Signal Plan Sheet(s)

(d) Pole Schedule and Cable Schematic Sheet(s)

(e) Special (or nonstandard) Detail Sheet(s) (as required)

(f) Plan and Profile Sheets (as required)

(g) Pavement Marking Sheet(s) (as required)

(h) Signing Plan Sheet(s) (as required)

(i) 11-inch by 17-inch plan sheet showing locations of curb lines, sidewalks/ramps, signals and signal cabinets with WB-50 turn movements superimposed over the intersection. This sheet is to be submitted with plan sets for review but is not required as mylar sheet in final plan set.

~~City of Houston Standard Traffic Drawings shall **NOT** be included as a part of the plan set.~~

(3) Provide a table showing stations and offsets for vehicle detection systems and stop lines on the plan sheet. A sample table is shown below.

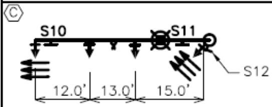
ITEM BY DIRECTION	STREET 1 STATION OF APPROACH EDGE	OFFSET FROM CONST. CL TO CL OF DETECTOR	ITEM BY DIRECTION	STREET 2 STATION OF APPROACH EDGE	OFFSET FROM CONST. CL TO CL OF DETECTOR
EASTBOUND: STOP LINE: PHASE 2 PULSE LOOP PHASE 5 PRESENCE LOOP	STA. XX+XX STA. XX+XX STA. XX+XX	CENTERED IN LANE CENTERED IN LANE	SOUTHBOU: STOP LINE: PHASE 4 PULSE LOOP	STA. XX+XX STA. XX+XX	CENTERED IN LANE
WESTBOUND: STOP LINE: PHASE 6 PULSE LOOP	STA. XX+XX STA. XX+XX	CENTERED IN LANE	NORTHBOUND: STOP LINE: PHASE 8 PULSE LOOP	STA. XX+XX STA. XX+XX	CENTERED IN LANE

Example Stop Line and Detector Locations Schedule

(4) Pole Schedule, Traffic Signal Controller, and Cable Schematic Sheets.

(a) Pole Schedule: A pole schedule shall be provided showing the pole and its identifier, the pole type, information on the mast arm(s), signal heads, luminaire, pedestrian pushbuttons and signs, pole location, communications system, and relative City standards. Each pole will have its own row within the schedule. The pole schedule shall be a table formatted as shown below.

15.2.14.B.1.d.(4)
continued

POLE NUMBER	POLE TYPE	MAST ARM		SIGNAL		LUMINAIRE TYPE	PED PB TYPE/SIGN	REMARKS	LOCATION	STANDARDS
		SIGNAL	LUMINAIRE	MOUNTING	FACE					
C 	TYPE 2	40'	15'	3-ASTROBRAC 1-SIDE OF POLE	1-H3L 2-H3 1-V3L	106-WATT SYSTEM MAX LED COBRA HEAD LUMINAIRE	-	PRE-EMPT SENSOR (DUAL TURRETS) WIMAX ANTENNA SPP RADIO SIGNS: S10 = R10-5L (30"x36") S11 = STREET NAME S12 = R10-5L (30"x36")	AT APPROX: POLE C: STA. 2+89, 51' RT RICHMOND AVE. CONST ℄	02893-02 02893-12 02893-03 02893-04A 02893-04B 02893-05 02893-09

Example Traffic Signal Pole Schedule

(b) Traffic Signal Controller: Meter service and signal controller cabinet assemblies shall be displayed in the Traffic Signal Controller table.

CABINET	TYPE	CONTROLLER	AUX CONTROL	REMARKS	LOCATION	STANDARDS
A	METERED PEDESTAL SERVICE UL TYPE 3R	METERED SERVICE PEDESTAL WITH 30 AMP & 60 AMP SINGLE POLE CIRCUIT BREAKERS	-	PROVIDE METER SOCKET WINDOW 4"H X 6"W	STA. 5+53.18, 53.36' RT (TO CENTER OF CABINET) xxx RD CENTERLINE	02893-14
B	TYPE 340 ITS	2070LX W/1C CPU MODULE W/GPS SERIAL COMMUNICATIONS MODULE	-	STD SPEC 16730 & 16731 UNINTERRUPTIBLE POWER SUPPLY, STD SPEC 16732 FIELD HARDENED ETHERNET SWITCH (MIN. TWO FIBER PORTS AND SIX COPPER PORTS), STD SPEC 16733 WIMAX, STD SPEC 16734 GPS SERIAL COMMUNICATIONS MODULE, STD SPEC 16785	STA. 5+71.84, 52.55' RT (TO CENTER OF CABINET) xxx ROAD CENTERLINE	02893-10C

TRAFFIC SIGNAL CONTROLLER SCHEDULE						
CABINET	TYPE	CONTROLLER	AUX. CONTROL	REMARKS	LOCATION	STANDARDS
A	METERED PEDESTAL SERVICE UL TYPE 3R	METERED PEDESTAL SERVICE WITH ONE 30 AMP AND ONE 60 AMP BREAKER AND PHOTOCELL	-	PROVIDE METER SOCKET WINDOW 4"H X 6"W	AT APPROX: STA. 5+54, 67' RT (CENTER OF CABINET) BELLAIRE BLVD. CONST ℄	02893-14
B	TYPE 340 ITS	2070LX CONTROLLER UINIT W/ 2070-1C CPU MODULE WITH GPS SERIAL COMMUNICATIONS MODULE & UPS BATTARY BACK-UP SYSTEM	-	STANDARD SPECIFICATION 16730 & 16731 UNINTERRUPTIBLE POWER SUPPLY - STANDARD SPECIFICATION 16732 FIELD HARDENED ETHERNET SWITCH (SIX COPPER PORTS ONLY) - STANDARD SPECIFICATION 16733 WIMAX - STANDARD SPECIFICATION 16734 GPS SERIAL COMMUNICATIONS MODULE- STANDARD SPECIFICATION 16785	AT APPROX: STA. 5+56, 78' RT (CENTER OF CABINET) BELLAIRE BLVD. CONST ℄	02893-10C 16735 16740

Example Traffic Signal Controller Schedule

(c) Cable Schematic: Low and high-voltage cable schematics shall be displayed on the pole schedule and cable schematic sheet. The cable schematic shall include:

(i) Conduit Run Identifiers

(ii) Conduit Size

(iii) Type of Conductors in each run

(iv) Legend

(v) ~~Consultant~~Engineer of Record shall conduct interim review of project status and technical issues with city at appropriate project milestones agreed upon by City and ~~consultant~~Engineer of Record.

e. Field Books

(1) Typically, field books will be prepared by the City upon receipt of signed and sealed plans in PDF format and original CAD files. ~~A designer~~The Engineer of Record should not submit a field book unless specifically requested by the City.

~~If requested, field books should contain the following:~~

~~(1) 2070 Programming/Timing Sheets~~

~~(2) CMU Programming Sheets~~

~~(3) ITS Cabinet Drawings~~

~~(4) Input Panel Sheets~~

~~(5) Output Panel Sheets~~

~~(6) Intersection Signal Layout~~

~~(7) Field Terminal Wiring~~

~~(8) Accessible Pedestrian Signal Sheets~~

~~(9) Output Assembly/Controller Interface~~

~~(10) Complete Assembly~~

~~If any timing data is requested by the City, it shall be submitted electronically in a format specified by the City.~~

~~B. Intersection Design Study~~

~~The purpose of this operational analysis is to document the information, assumptions, and~~

~~procedures used to develop the preliminary design and to affirm that the design level of service will be provided through the design year.~~

~~1. Conditions to be analyzed~~

~~The Intersection Design Study shall present an analysis of the intersection traffic operation and level of service for the AM and PM peak hours for each of the following conditions:~~

~~a. Existing traffic and geometric conditions.~~

~~b. Projected traffic and proposed geometric conditions in the design year with the traffic signal(s) in operations.~~

~~c. Projected traffic and proposed geometric conditions at project completion, including projections of any new traffic due to trip diversions and/or known new trip generation with traffic signals in operation.~~

~~d. Projected traffic and proposed geometric conditions in the intermediate year with traffic signals in operation.~~

~~2. Method of Analysis~~

~~The level of service for the signalized conditions shall be determined in accordance with the procedures defined in the current edition of the Highway Capacity Manual (HCM). An approved software (Highway Capacity Software (HCS), Synchro or VisSim) will be used, and the printouts from that software will be part of the study. Other software packages may be acceptable, but their use will require prior approval by the City. When the Consultant proposes a less conservative design than determined by HCM method, Consultant will be required to provide supporting evidence to the satisfaction of the City. If the City requests additional analysis to evaluate new/alternative technology and such work causes additional work, Consultant shall obtain written authorization from the City prior to initiating work.~~

~~3. Required Level of Service:~~

~~The level of service to be provided in the design year shall be level of service D or better (i.e., LOS A, B, or C).~~

~~4. Application Method~~

~~The Operational method shall be used for all analysis.~~

~~5. Procedure~~

~~The Consultant shall determine the geometrics required to provide the design level of service in the design year. After determining the required geometrics, the Consultant shall analyze the intersection for the proposed geometrics and projected traffic upon project completion using the methodology for unsignalized intersections. If these conditions result in a level of service "B" or better for all movements, additional analysis may be required, but will be considered extra work.~~

~~6. Traffic Signal Warrant Analysis~~

~~a. The engineer shall obtain a previously completed traffic signal warrant analysis or perform a new traffic signal warrant analysis for the intersection.~~

~~b. Signal warrant analyses shall employ the traffic signal warrants contained in the Texas Manual in Uniform Traffic Control Devices. New analyses should focus on the "strong" warrants, which the City defines as Warrants 1 - Eight- Hour Vehicular Volume and Warrant 7 - Crash Experience. The other warrants may be considered in special circumstances and with approval by the City Traffic Engineer. Satisfaction of one or more signal warrants does not guarantee approval of a traffic signal. All new traffic signals must be approved by the City Traffic Engineer prior to construction. In the case of satisfaction of Warrant 7 - Crash Experience, all other feasible options for mitigation of the crash problem must be exhausted before a signal is approved.~~

~~c. The engineer should note that not all warrants are applicable to all intersections.~~

~~d. The engineer shall also avoid mid-block locations for new signals. New signals should be spaced at least ¼ mile away from existing or planned signals.~~

~~e. The City requires that a minimum of eight (8) hours (includes am and pm peak hours) of turning movement counts be collected for a traffic signal warrant analysis. If a right turn lane is available or is recommended, all right turning traffic shall be deducted from the hourly approach volumes. If a shared through/right turn lane exists, one half of all right turning traffic on the approach shall be deducted. This is based on the presumption that right turning vehicles typically do not require a traffic signal in order to safely enter another street. In the case of a de-facto right-turn lane, such as when right-turning traffic greatly exceeds through traffic in the rightmost lane, engineering judgment should be used to determine the appropriate reduction of right-turn volumes.~~

~~f. When conducting a traffic signal warrant analysis, engineering judgment is required to determine whether the left turn lane is counted as an additional lane. As a rule of thumb, the engineer should consider the ratio of left turning traffic to the other traffic. If the left turning volume exceeds twenty (20) percent of the total traffic, the left turn lane should be counted as an additional lane. Exclusive right turn lanes are not to be counted as an additional lane since their volumes are be deducted from the totals.~~

g. ~~Crash analysis: One year of crash data shall be used for assessing Warrant 7 - Crash History. Crash records can be obtained through the TxDOT Crash Record Information System (C.R.I.S.) online database or from Houston Police Department. Crashes should be categorized as "signal-correctable" or "not- signal-correctable." Signal-correctable crashes include right-angle crashes and crashes involving bicyclists and/or pedestrians. They do not include crashes involving left-turn "failure to yield" crashes from the major street or crashes involving right-turning traffic. Only "signal-correctable" crashes are to be used in the warrant analysis.~~

7. ~~Hybrid Pedestrian Signals~~

a. ~~Hybrid Pedestrian Signals or High Intensity Activated Crosswalks (HAWK) studies shall follow the same basic procedures as those for a standard traffic signal warrant analysis except they shall use the warranting conditions set forth in Section 4F.01 Application of Pedestrian Hybrid Beacons of the Texas Manual on Uniform Traffic Control Devices.~~

b. ~~HAWK signals are intended for use at mid-block crossings and should not be proposed in conflict with guidelines provided by the Texas Manual on Uniform Traffic Control Devices without discussing with the City Traffic Engineer.~~

8. ~~Bicycle Signals~~

~~An engineering analysis of operational and geometric conditions shall be performed to determine the need and recommendation for bicycle signals. Considerations for application of bicycle signals include but are not limited to the following:~~

a. ~~Where a stand-alone bike path or multi-use path crosses a street, especially where the needed bicycle clearance time differs substantially from the needed pedestrian clearance time.~~

b. ~~To split signal phases at intersections where a predominant bicycle movement conflicts with a main motor vehicle movement during the same green phase.~~

c. ~~At intersections where a bicycle facility transitions from a cycle track to a bicycle lane, if turning movements are significant.~~

d. ~~At intersections with contra-flow bicycle movements that otherwise would have no signal indication and where a normal traffic signal head may encourage wrong-way driving by motorists.~~

15.2.14.B.2 continued

~~e. To give bicyclists an advanced green (leading pedestrian interval), or to indicate an "all-bike" phase where bicyclist turning movements are high.~~

~~f. To make it legal for bicyclists to enter an intersection during an all-pedestrian phase.~~

~~g. At complex intersections that may otherwise be difficult for bicyclists to navigate.~~

~~h. At intersections with high numbers of bicycle and motor vehicle crashes.~~

~~i. At intersections near schools (primary, secondary, and university).~~

~~At intersections near rail stations, transit centers, and where two or more bus routes intersect.~~

2. Left Turn Phasing Guidelines

~~9. Left Turn Phasing Analysis~~

~~f.~~a. Purpose. These guidelines provide a method to uniformly evaluate and install appropriate left turn phasing at traffic signals within the City of Houston. These guidelines attempt to minimize the restrictions placed on motorists' ability to turn safely through gaps in opposing traffic when such turns can be performed safely.

b. The flowchart shown below (Traffic Signal Timing Manual, 2nd edition) can be used to assist in the determination of whether a left-turn phase is needed for a given movement and whether the operational mode should be protected or protected-permissive.

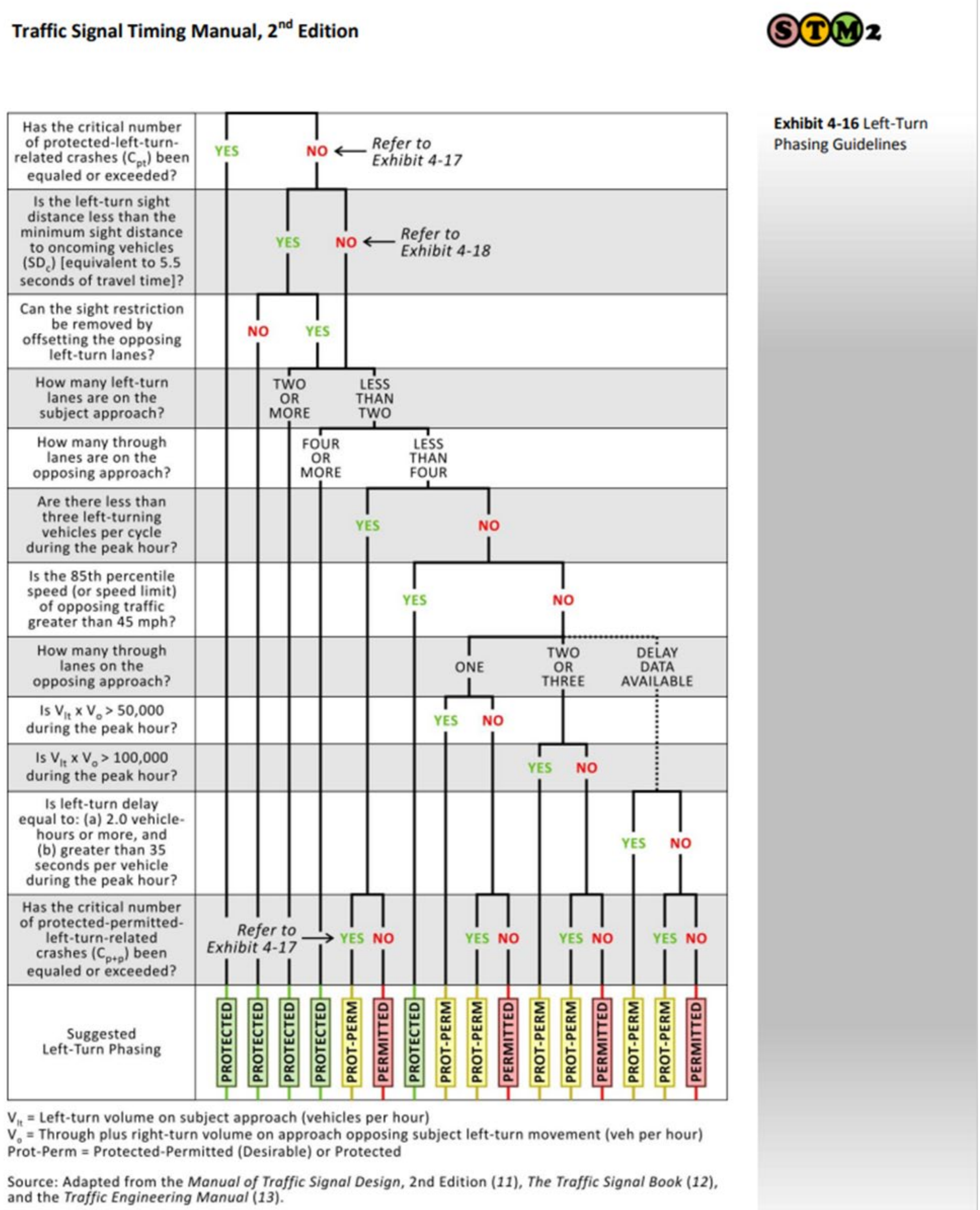


Figure 15.9 – LEFT-TURN PHASING GUIDELINES[18]

[18] Source: National Academies of Sciences, Engineering, and Medicine. 2015. Signal Timing Manual - Second Edition. Washington, DC: The National Academies Press. https://doi.org/10.17226/22097.

STM2 Traffic Signal Timing Manual, 2nd Edition

Exhibit 4-17 Critical Left-Turn-Related Crash Count

Number of Left-Turn Movements on Subject Road	Period During Which Crashes are Considered (Years)	Critical Left-Turn-Related Crash Count (Crashes Per Period)	
		When Considering Protected-Only (C_{pt})	*When Considering Protected-Permitted (C_{p+p})*
One	1	6	4
	2	11	6
	3	14	7
Two	1	11	6
	2	18	9
	3	26	13

Exhibit 4-18 Minimum Sight Distance to Oncoming Vehicles

Oncoming Traffic Speed Limit (Miles Per Hour)	Minimum Sight Distance to Oncoming Vehicles (SD_c) (Feet)
25	200
30	240
35	280
40	320
45	360
50	400
55	440
60	480

In order to account for the inherent variability of crash data, the critical left-turn crash counts identified in Exhibit 4-17 are based on an underlying average critical crash frequency. The underlying averages are 1.3 crashes per year and 3.0 crashes per year for protected-permitted and protected-only left-turn phasing, respectively. If the reported crash count for existing operations exceeds the critical value, then it is likely that the subject intersection has an average left-turn crash frequency that exceeds the aforementioned average (5 percent chance of error), and a more-restrictive operational mode would likely improve the safety of the left-turn maneuver.

Note that the flowchart has two alternative paths following the check of opposing traffic speed. One path requires knowledge of left-turn delay; the other requires knowledge of the left-turn and opposing through volumes. The left-turn delay referred to in the flowchart is the delay incurred when no left-turn phase is provided (i.e. the left-turn movement operates in the permitted mode).

4.3.1.3 Flashing Yellow Arrow Displays

One protected-permitted left-turn display that warrants additional discussion is the recently introduced flashing yellow arrow (FYA) display. (Refer to Chapter 5 for additional guidance on protected-permitted operations.) This indication features a flashing yellow output, which must be accommodated in the signal design with:

- Individual wires to/from the cabinet to each of the four indications in the FYA signal head;
- A signal monitor with the functionality to accommodate the FYA indication; and
- An additional load switch for the flashing yellow indication or an unused load switch channel on a pedestrian load switch (the unused yellow output), as load switches only contain three outputs.

Figure 15.10 – CRITICAL LEFT-TURN RELATED CRASH COUNT AND MINIMUM SIGHT DISTANCE TO ONCOMING VEHICLES[19]

[19] Source: National Academies of Sciences, Engineering, and Medicine. 2015. Signal Timing Manual - Second Edition. Washington, DC: The National Academies Press. https://doi.org/10.17226/22097.

15.2.14.B continued

~~a. Procedure. Information should be obtained by means of engineering studies and compared with these guidelines. Rigid adherence to these guidelines is not a replacement for good engineering judgment.~~

~~b. General Guidelines and Considerations.~~

~~(1) Traffic engineering judgment must be used to determine left turn phasing recommendations. Final engineering recommendations, based on engineering judgment may supersede any or all guidelines.~~

~~(2) The least restrictive form of left turn phasing, that can operate safely, should be considered for implementation. More restrictive control can be made as traffic conditions change.~~

~~(3) Proper "yellow trap" protection phasing is required when protected- permitted phasing is used in a lead-lag configuration.~~

~~(4) Permitted left turn phasing is primarily suited for intersections where opposing and left turn volumes are low and left turns are able to turn through gaps in traffic without great difficulty or excessive delay.~~

~~(5) Protected-permitted phasing is appropriate when the left turn need is based predominately on volume and delay and the signal is at a moderately traveled intersection where frequent gaps for left turns occur.~~

~~(6) Protected-only left turn phasing should be used when left turn phasing is required primarily for safety reasons based on left turn crash experience or site conditions, or when the opposing number of lanes is three or more.~~

~~c. Permitted Left Turn Phasing. Permitted left turn phasing may be installed based on the following guidelines:~~

~~(1) Traffic Volumes. This guideline is based on minimum peak hour left turn volume and the product of the peak hour left turn and opposing volumes (LT x OV) and the number of opposing lanes (NL). Permitted phasing may be appropriate if:~~

~~(a) Peak hour left turn volume is less than 2 vehicles per cycle.~~

~~(b) Peak hour (LT x OV)/NL is below 50,000.~~

~~(2) Site Conditions. This guideline is based on several existing conditions at the intersection location. Permitted phasing may be appropriate if:~~

~~(a) Available sight distance is greater than 350 feet when the opposing traffic is traveling at 35 mph or less, or greater than 400 feet when the opposing traffic is traveling at 40 mph.~~

~~(b) Opposing speed is less than 45 mph.~~

~~(c) Multiple left turns are not in operation.~~

~~(d) Median width and the number of opposing lanes do not preclude safe permitted turn operations.~~

~~(3) Vehicle Delay. This guideline is based on peak hour left turn delay. Permitted phasing may be appropriate if:~~

~~(a) The mean peak hour delay per left turning vehicle is less than 50 seconds.~~

~~(b) The total peak hour left turn delay is less than 3.0 vehicle hours.~~

~~(4) Crash Experience. The installation of a more restrictive form of left turn control may be required if six (6) or more left turn crashes occurred in the past twelve (12) months.~~

~~d. Protected – Permitted Left Turn Phasing. Protected-permitted left turn phasing provides the benefits of permitted left turn phasing while adding left turn capacity and can reduce delay to motorists. Protected-permitted phasing may be appropriate for the following conditions:~~

~~(1) Traffic Volume. Protected-permitted phasing may be appropriate if:~~

~~(a) Peak hour left turn volume is greater than 2 vehicles per cycle.~~

~~(b) Product of the peak hour (LT x OV) is less than 400,000.~~

~~(c) Peak hour (LT x OV)/NL is between 50,000 and 200,000.~~

~~(2) Site Conditions. See guideline for permitted left turn signal phasing.~~

~~(3) Vehicle Delay. Protected-permitted phasing may be appropriate if:~~

~~(a) The mean peak hour delay per left turning vehicle exceeds 50 seconds.~~

~~(b) The total peak hour left turn delay exceeds 3.0 vehicle hours (per leg).~~

~~(4) Crash Experience. See guideline for permitted left turn phasing.~~

~~e. Protected-Only Left Turn Phasing. Protected-only left turn phasing is the most restrictive form of left turn control. Protected-only left turn phasing may be appropriate under the following conditions.~~

~~(1) Traffic Volume. Protected- only phasing may be appropriate if:~~

~~(a) Peak hour left turn volume is greater than 2 vehicles per cycle.~~

~~(b) Product of peak hour (LT x OV) is greater than 400,000.~~

~~(c) Peak hour (LT x OV)\NL is greater than 200,000.~~

~~(2) Site Conditions. Protected-only phasing may be appropriate if:~~

~~(a) Available sight distance is less than 350 feet when the opposing traffic is traveling at 35 mph or less, or less than 400 feet when the opposing traffic is traveling at 40 mph or more.~~

~~(b) Opposing speed is greater than, or equal to 45 mph.~~

~~(c) Multiple left turns are in operation.~~

~~(d) Median width and number of opposing lanes preclude safe permitted turn operations.~~

~~(3) Vehicle Delay. See guideline for protected-permitted left turn signal phasing.~~

~~(4) Crash Experience.~~

~~(a) Six (6) or more left turn crashes occurred in the most recent twelve (12) month period.~~

~~(5) Policy Compliance. All new left turn phasing installed within the City of Houston will be evaluated and installed using these guidelines and engineering judgment.~~

~~(6) Policy Exception. Exceptions shall be allowed, as deemed appropriate, by the Assistant Director managing the Traffic Operations Branch.~~

~~2.~~3. Alternative Lane Configurations

a. An ~~The level of service~~ analysis shall be ~~used~~ conducted to determine the ~~required number of through lanes and auxiliary lanes (left and/or right turn lanes) needed to most economically provide the necessary level of service~~ geometrics of the intersection to satisfy Multimodal Service Standards (MMSS) requirements. Additional lanes may benefit Vehicle Level of Service (VLOS) but should be consistent with MMSS.

b. Left turn lanes greatly benefit the operation of an intersection which has enough traffic to require signals. As a result, all new traffic signal designs shall require the inclusion of a left turn lane unless otherwise specified by the City. In areas such as the Central Business District, where speeds are low and right-of-way is not available or is very expensive, the benefits of left turn lanes may be outweighed by the cost.

c. Right turn lanes and double left turn lanes should be reserved for exceptional circumstances ~~considered as a means of achieving the desired level of service~~ where ~~the specific~~ turning volumes are very high. Ensure that additional lanes are consistent with Multimodal Service Standards (MMSS) requirements.

~~3.~~4. Alternative Phasing

a. Permitted, protected/permitted ~~L~~left ~~T~~turns signal phases should be delayed until the pedestrian WALK phase is terminated and the DON'T WALK phase starts. ~~Permitted only left turns (no separate signal phase displayed) shall be used unless more restrictive left turn phasing is required as described below.~~

~~f. Protected/Permitted Left Turn Phasing. Protected/permitted left turn phases are required when any one of the following criteria is met:~~

~~(1) They are needed to achieve the required level of service.~~

15.2.14.B.4.b continued

~~(2) The left-turn demand meets the guidelines stated in the current "Left Turn Phasing Analysis" section of this document.~~

~~g. Protected Left Turn Phases. Protected only left turn phases are required when the following criterion is met:~~

~~The left-turn demand meets the guidelines stated in the current "Left Turn Phasing Guidelines" section of this document.~~

b. Split Phasing. Split phasing shall be defined as separating two opposing directions of traffic such that the compatible through and protected left turn movement receives the right-of-way simultaneously. Split phasing shall require the approval of the City prior to submitting the preliminary design plans. This phasing should only be used if one of the following conditions exists:

(1) The opposing approaches are offset to the extent that simultaneous left turns in opposing directions would cause a high number of conflicts, resulting in a high collision potential, and the left turn demand is sufficiently high to require as much green time as the adjacent through movement. When left turn volumes are lighter, and physical conflict exists, lead-lag operation should be used.

(2) Double left turn lanes are used in one or both directions and the turning radii are not sufficient to allow simultaneous left turns without conflicts between opposing left turn traffic, and subject to the same volume requirements in item (a) above.

(3) The left turn volume is extremely heavy on an approach that does not allow the construction of a separate left turn lane.

(4) Left turn volumes are extremely heavy on opposing approaches and both are nearly equal to the adjacent through movement critical lane volume (A check should be made to determine that the design hour level of service will be significantly improved and that there will not be substantial decreases in level of service during other hours of the day).

(5) The critical lane volumes are lowest when drivers are permitted to turn left from more than one lane, and are also permitted to use the right- most left turn lane as a through lane.

(6) If the intersection is in an interconnected system and the coordination plan would be improved by splitting the phases.

15.2.14.B.5 continued

c. Right Turn Overlaps. Overlaps are encouraged where needed. Right-turn overlaps should be used only if there is a dedicated right turn lane on the approach and pedestrians are prohibited from crossing parallel and to the right of the concurrent through movement from the same approach. If right turn overlaps are provided, it will be necessary to prohibit u-turns for the opposing left turn approach. Appropriate signing should be detailed in the plans. An example of this operation would be when the left turn arrows on the main street approach are displayed simultaneously with a right turn arrow on one or both side street approaches. This type of operation should only be used where:

(1) there are 250 or more right turns during a peak hour and;

(2) there are 200 or more corresponding left turns during the same hour and;

(3) the per lane through volume for the same approach is approximately equal to, or less than, the right turn volume.

~~4.~~5. Geometric Design Elements: If the construction of geometric changes in the street is required, the work shall be done in accordance with the City of Houston's Uniform Development Code, Chapter 10 of the Infrastructure Design Manual, and in accordance with the following criteria:

a. Design Speed

(1) Motor Vehicles: The ~~design speed for a street shall be based on the~~ anticipated 85th percentile speed plus 5MPH, in accordance with the Major Thoroughfare and Freeway Plan (MTFP), or as directed.

~~(1)~~(2) Pedestrian Walk Speed: 3 ft/s across all crosswalks.

b. Design Vehicle: The design vehicle shall be a WB-50 (AASHTO Green Book) or as directed.

c. Auxiliary Lane Design

(1) Opposing left turn lanes shall be designed for protected/permitted left turn signalization unless protected only left turn phasing is required by ~~S~~section ~~15.11.02.B.7~~15.2.14.B.2. Sight ~~d~~Distance for drivers of left turning vehicles to see beyond opposing left turning vehicles shall be calculated in accordance with Case III A - Crossing Maneuver (AASHTO Green Book).

15.2.14.B.5.f continued

(2) The ~~s~~Storage ~~l~~Length of the left or right turn lanes shall be determined based on the expected queue length as defined in ~~S~~section ~~15.08 C.6~~15.2.07.C.6 of the Infrastructure Design Manual. The minimum left turn lane ~~s~~Storage ~~l~~Length shall be 100 feet unless restricted by other factors. The maximum left-turn lane length should be 400 feet. If the expected queue ~~s~~Storage ~~l~~Length exceeds 400 feet or the left turning volume during the peak hour exceeds 200 vehicles, dual left turn lanes should be considered.

d. Tapers

(1) A taper, in this context, refers to the transition in pavement width between the centerline and the edge of pavement, e.g., the lateral transition of a ~~m~~Median to accommodate a left turn bay. Wherever possible, the transition taper shall be a symmetrical reverse curve. This taper length shall not be subtracted from the total required ~~s~~Storage ~~l~~Length (Total Turn Lane Length = Storage Length + Transition Taper length).

(2) All approach taper ratios for collectors and thoroughfares shall be based on the posted speed limit plus 5 mph or 85th percentile speed (whichever is greater) and shall be calculated using the formulas described in the Texas Manual on Uniform Traffic Control Devices.

e. Islands

Generally, raised (curbed) islands for the use of channelizing traffic, as in the case of a right turn lane, shall not be used. When islands are needed, sizes and dimensions should meet the recommended AASHTO requirements. Mountable curb and gutter shall be used on all islands.

f. Medians

(1) The minimum width of a raised ~~m~~Median shall be four feet from face of curb to face of curb. A six-foot width shall be considered where a left turn lane is opposed by three or more right and through lanes to provide greater pedestrian storage and to reduce pedestrian clearance timings.

(2) Both vehicle and pedestrian characteristics ~~should~~ shall be considered for design of the location of the ~~m~~Median nose.

~~(2)~~(3) Median nose design shall not impede crosswalks or bicycle facilities.

15.2.14.B.5.g.(4) continued

~~(3)~~(4) Bullet nose ~~m~~Medians shall be required adjacent to a left turn bay at an intersection with a street other than a primary arterial. This 3-centered curve shall have radii of 50', 3', and 50'.

~~(4)~~(5) The ~~m~~Median opening must be wide enough to provide for adequate turning movements by left turning vehicles. In no case shall the ~~m~~Median opening be narrower than 40 ft.

~~(5)~~(6) In the development of a left or right turn lane; the pavement shall be widened via a symmetrical reverse curve as described in the Infrastructure Design Manual, Figure 10.~~06~~ ~~07~~8.

g. Pedestrian ~~Access Ramps~~Accommodations at Signals

(1) At intersection corners without sidewalks, where traffic signal poles are to be installed, a pedestrian landing shall be constructed according to the City of Houston Specifications and Standard Drawings. ~~The ramp design should be directional and in most cases, two directional ramps per corner shall be required. Approval of the ramp design as part of intersection layout should not be construed as approval of the ramp designs for traffic signal designs.~~

(2) Pedestrian accommodations, including curb ramp design, are specified in Chapter 17, Section 17.3.02.

(3) For purposes of timing the walk phase, a walk speed of 3 ft/s shall be utilized.

(4) Leading Pedestrian Intervals (LPIs)

(a) LPIs are adjustments to signal timing to increase pedestrian safety at signalized intersections. An LPI gives pedestrians a typical 3-to-7 second head start before motorists in the parallel direction are given the green signal indication.

(b) LPIs improve safety for all road users by reducing conflicts between pedestrians and left- or right-turning motorists. The LPI works to position the pedestrian within the crosswalk thereby improving visibility and decreasing the likelihood of a conflict or crash with a left- or right-turning motorist ahead of the turning traffic.

(c) LPIs shall be implemented in Walkable Places Districts, on designated Transit-Oriented Development Streets, and on streets with bicycle signal heads for bicycle facilities.

15.2.14.B.5.h continued

(d) The LPI length shall be a minimum three (3) seconds in duration. Longer durations may be required when a pedestrian must cross more than one lane of traffic.

(i) Analysis should be performed on corridors with multiple travel lanes to calculate the minimum time required for pedestrians to cross halfway across one direction of travel.

(ii) Longer durations should be considered in the case of a large corner radius, determined by how far pedestrians must travel to establish their position before the turning traffic is released.

(e) LPIs should be included at signalized locations where:

(i) Crash history indicates multiple crashes or severe injury/fatal crashes.

(ii) Pedestrian volumes are heavy for multiple hours of a typical day.

(iii) Vulnerable populations, like school-aged children or older adults, are expected to cross.

(iv) Visibility of pedestrians is limited or restricted by components such as intersection geometry, location of stopped vehicles, vegetation, and streetside features.

h. Bicycle Accommodations at Signals

(1) Bicycle signal heads shall be installed on any approach to a traffic signal that has a high comfort bicycle facility, as defined by Chapter 17.

(2) A Leading Bicycle Interval (LBI) should be installed wherever a conflict exists between bicyclists and turning vehicles.

(3) Wherever LBI is utilized, a Leading Pedestrian Interval (LPI) shall be utilized for the adjacent pedestrian crossing.

~~h.~~i. Curb Return Radius

(1) Where two streets intersect, certain radii are required for the curbs per the Infrastructure Design Manual. Refer to Chapter 10 for curb return radius requirements.

~~C. Pavement Markings~~

~~5.~~6. Traffic Signal Hardware Design

15.2.14.B.6.a.(2) continued

The traffic signal hardware shall be designed in accordance with the following criteria:

a. Traffic Signal Heads and Lane Use Control Signs

(1) Number and Location of Heads:

(a) The minimum number of ~~t~~Traffic ~~s~~Signal ~~h~~Heads for all approaches shall be in conformance with the current edition of the TMUTCD.

(b) Generally, one ~~t~~Traffic ~~s~~Signal ~~h~~Head will be provided for each through lane.

(c) Generally, the ~~t~~Traffic ~~s~~Signal ~~h~~Heads shall be located directly above the center of the travel lane.

(d) Typically, a minimum of two left turn ~~t~~Traffic ~~s~~Signal ~~h~~Heads shall be provided. One left turn ~~t~~Traffic ~~s~~Signal ~~h~~Head will be located centered over the left turn lane. A second left turn head shall be provided on the far-left corner of the intersection adequately aligned with the left turning path. Additional left turn ~~t~~Traffic ~~s~~Signal ~~h~~Heads are required for multiple left turn lanes.

(e) Where there is only one approach lane, two signal heads shall be located at least 8 feet apart between edge of backplates, with the center of the separation between the heads located over the center of the lane.

(f) Bicycle signal heads shall be placed in a location clearly visible to oncoming bicycles. Typically, a single signal head is sufficient; however, consideration of near-sided bicycle signals may be given for improved visibility.

(2) Size and Configuration:

(a) Generally, all ~~t~~Traffic ~~s~~Signal ~~h~~Heads shall be oriented in a horizontal alignment.

(b) All pole mounted ~~t~~Traffic ~~s~~Signal ~~h~~Heads shall be mounted vertically in line with the pole shaft.

(c) All sections of vehicular ~~t~~Traffic ~~s~~Signal ~~h~~Heads shall have 12" LED indications.

15.2.14.B.6.a.(2) continued

(d) For permissive only mode left turns, steady 3-section RYG shall be used (H3 horizontal, V3 vertical). R10-12 "LEFT TURN YIELD ON GREEN BALL" sign shall be installed immediately adjacent to the ~~t~~Traffic ~~s~~Signal ~~h~~Head.

(e) For protected/permissive mode left turns with an exclusive left turn lane, 4-section RYYG flashing yellow arrow signal shall be used (H4LF horizontal, V4LF vertical). R10-17T "LEFT TURN YIELD ON FLASHING YELLOW ARROW" sign shall be installed immediately adjacent to the left turn signal head, and below the second left turn head placed on the far-left corner.

(f) For protected/permissive mode left turns with a left/through share lane, steady 5-section RYYGG signal shall be used (H5L horizontal, V5L vertical). R10-12 "LEFT TURN YIELD ON GREEN BALL" sign shall be installed immediately adjacent to the ~~t~~Traffic ~~s~~Signal ~~h~~Head if horizontal, and below the left turn head if vertical. No supplemental signal head in the far-left corner is required for this case.

(g) For protected only mode left turns, steady 3-section RYG all arrows shall be used (H3L horizontal, V3L vertical). R10-5 "LEFT TURN ON GREEN ARROW ONLY" sign shall be installed immediately adjacent to the left turn signal head, and below the second left turn head placed on the far-left corner.

(h) At split-phase approaches, the left-most head shall be a 4-section RYGG head with a left arrow section (H4TL horizontal, V4TL vertical). No sign is required to accompany this signal head. No supplemental signal head in the far-left corner is required for this case.

(i) Signal heads located in the ~~D~~downtown and ~~U~~uptown ~~D~~district shall be black in color. All other ~~t~~Traffic ~~s~~Signal ~~h~~Heads in the City shall be yellow unless otherwise specified by the City.

(j) Bicycle signal heads shall be mounted vertically.

(k) All sections of bicycle signal heads shall have 12" LED bicycle indications. Steady vertical 3-section RYG bicycle shall be used (B3). "~~b~~Bicycle symbol SIGNAL" sign plaque (R10-10B) shall be added below the bicycle signal head.

15.2.14.B.6.a.(6) continued

(3) Type of Signal Head:

(a) All signal head housings shall be constructed of polycarbonate in accordance with the Standard Specifications.

(b) Optically programmed signal heads shall be used whenever the indications can be viewed by two or more conflicting movements of traffic at skewed intersections, or where two sets of indications for the same direction are not to be viewed simultaneously, such as the second set of indications on the cross street at an offset intersection.

(c) Bi-modal indication signal sections shall not be used.

(4) Type of Mounting:

(a) All mast arm-mounted ~~t~~Traffic ~~s~~Signal ~~h~~Heads will be mounted on a tenon using a fully adjustable "Astro-Brac Atlas Large Capacity" mount assembly, or an approved equal. In exceptional circumstances when a tenon is not available on the mast arm and after obtaining authorization from the City of Houston, a hole should be drilled and a tenon clamp kit used.

(b) Side-mount signal heads shall be mounted using standard mountings and shown on the plans as being on a side of the pole away from vehicular traffic.

(5) Backplates:

(a) All vehicular ~~t~~Traffic ~~s~~Signal ~~h~~Heads on steel poles shall be equipped with black louvered backplates conforming to Standard Specifications.

(b) All bicycle signal heads (B3) shall be equipped with yellow louvered backplates conforming to Standard Specifications.

(6) Installation Procedures:

(a) Mast arms shall be drilled for wire accesses after installation on the pole base to provide concealed wiring and proper signal head location. All signal head installations shall comply with mounting requirements per Standard Specification 16715 - Vehicle Signal Heads.

b. Pedestrian Traffic Signal Heads

(1) Type and Number:

15.2.14.B.6.b.(4) continued

(a) Pedestrian ~~t~~Traffic ~~s~~Signal ~~h~~Heads shall be installed wherever crosswalks are provided, except crossing free right turn lanes.

(b) Two pedestrian ~~t~~Traffic ~~s~~Signal ~~h~~Heads shall be installed, one at each end of the crosswalk being controlled. Pedestrian signals may be placed on ~~m~~Median islands if the signal heads are not visible for the entire length of the crossing and/or operational considerations indicate benefit of two-stage crossings along with adequate pedestrian refuge area available on the ~~m~~Median. In such case, additional pedestrian signal heads shall be placed in the ~~m~~Median facing each direction.

(2) Legend:

(a) Generally, all pedestrian signal heads shall have international symbol messages consisting of a Portland orange upraised hand (symbolizing DON~~'~~’T WALK) and a lunar white walking man (symbolizing WALK).

(3) Size and Configuration:

(a) All pedestrian ~~t~~Traffic ~~s~~Signal ~~h~~Heads shall have 16" LED ~~C~~countdown indications.

(b) Pedestrian ~~t~~Traffic ~~s~~Signal ~~h~~Heads located in the ~~D~~downtown and ~~U~~uptown ~~D~~district shall be black in color. All other pedestrian ~~t~~Traffic ~~s~~Signal ~~h~~Heads in the City shall be yellow unless otherwise specified by the City.

(4) Location:

(a) Pedestrian ~~t~~Traffic ~~s~~Signal ~~h~~Heads shall be located as nearly in line with the crosswalk as possible. If the mast arm pole is located such that the pedestrian signal will be blocked by stopped vehicles or if it is more than twenty (20) feet outside of the crosswalk lines extended, then an alternative means of mounting shall be designed. Pedestrian ~~t~~Traffic ~~s~~Signal ~~h~~Heads shall be mounted 8 feet (to the bottom of the head) above the walking surface on the side of pole away from vehicular traffic. Pedestrian traffic signals shall be shown on the plans as being mounted on the side of the pole away from vehicular traffic by use of the respective symbol.

c. Relocating Traffic Signal Heads

15.2.14.B.6.d.(1) continued

(1) Signal heads shall be relocated only when they are in good condition, are in conformance with this section, and no modifications are necessary. The relocation of any ~~t~~Traffic ~~s~~Signal ~~h~~Heads shall require the prior approval of the City.

d. Mast Arm Assemblies and Poles: Typically, the City requires that mast arm poles be used for all new traffic signal installations. In special cases, the City may allow strain pole installations based on a written recommendation by the ~~e~~Engineer of Record explaining the need for a span wire design. Traffic ~~s~~Signal ~~h~~Heads mounted vertically on a pole shaft shall be allowed as supplemental signal indications~~, but~~; they shall not be used as the exclusive method of mounting traffic signals for any approach without prior approval from the City.

(1) Location (Including Setback):

(a) On streets with curbing, poles shall be located such the center of the pole is a minimum of five (5) feet from the face of curb. On streets without curbing, or with speeds greater than 35 MPH, poles shall be located a minimum of ten (10) feet behind the edge of pavement or three (3) feet behind the edge of the paved shoulder, whichever is greater, and should be located fifteen (15) feet from a line extended from the edge of the through traffic lanes.

(b) Mast arm traffic signal poles should not be located in the ~~m~~Median unless no other option exists. Any mast arm poles located in the ~~m~~Median shall require approval by the City prior to the preliminary plan submittal.

(c) Poles should be located in line with the opposing directions stop line (approximately four feet behind the crosswalk line).

(d) Poles should be located as close to the sidewalk or pedestrian landing as possible for pedestrian pushbutton access, yet still be within the guidelines for distance from the curb or traveled way.

(e) No poles shall be located in wheelchair ramps or such that they are an obstruction to pedestrians or wheelchairs.

(f) On the plans, the ~~Consultant~~Engineer of Record shall tie down the location of all poles referenced to the street centerline by station to the nearest foot and offset to the nearest half foot.

(2) Mast Arm Lengths:

15.2.14.B.6.d continued

(a) Minimum mast arm length that shall be used is 25 feet.

(b) Mast arms longer than 55 feet in length may require an evaluation of the pole and foundation to be used as determined by the City.

(c) Mast arm lengths should allow for probable future modifications to the signal. If a left turn lane exists, the arm should extend to the center of the left turn lane.

(3) Clearances from Utilities:

(a) Poles shall be located such that all portions of the poles and attached equipment have clearances from overhead utilities in accordance with the requirements of the local utility and the National Electrical Safety Code (NESC).

(4) Material and Style:

(a) All poles shall conform to the Standard Specifications and Details. Special poles and features shall be coordinated and approved by the City.

(b) The centerline of the mast arm shall be at 90 degrees to the centerline of the approach it is serving unless otherwise required.

(5) Delivery Time:

(a) Typical delivery time for mast arm poles is 8 - 12 weeks from the approval of submittals. The number of days specified in the contract should account for the long delivery time.

(6) Lumina~~i~~ri<u>i</u>es and Lumina~~i~~r~~e~~<u>y</u> Mast Arms: Lumina~~i~~r<u>i</u>es shall be included in all intersection designs unless otherwise indicated by the City, and shall meet the following requirements:

(a) One luminaire shall be utilized for each leg of the intersection.

(b) Lumina~~i~~r<u>i</u>es to be positioned to illuminate crosswalks.

(c) All installations shall meet the current National Electrical Code requirements.

(d) The street lighting photo cell shall be mounted in the traffic signal service panel unless otherwise designated by the City of Houston.

15.2.14.B.6.e continued

(e) Power for the street lighting should come from the traffic signal service panel.

(f) Fixture attributes shall adhere to the latest City specifications for intersection lighting.

(7) Device Mounting:

(a) No non-traffic related devices may be mounted on the mast arm. Non-traffic related devices may be mounted on the pole shaft with approval. All devices to be installed on the signal pole and mast arm assembly shall be in accordance with the maximum loading information provided by the manufacturer. Reference to City of Houston Standard Detail for Traffic Signal Structures ~~02893-04B~~02582-03. The installation of any device in deviation of the traffic signal items defined on Standard Detail ~~02893-04B~~02582-03 shall be submitted for review to the City with the respective supporting structural analysis. See Chapter 16, Section 2 "Communication Facility Design Requirements" for additional device mounting requirements.

e. Pedestrian Pushbuttons: Pedestrian pushbuttons shall be required at all new or modified traffic signal locations within the City of Houston. The omission of pedestrian pushbuttons at any location shall require the approval of the City.

(1) All pedestrian pushbuttons shall be Polara Navigator or approved equal Accessible Pedestrian Systems (APS).

(2) No more than one pedestrian pushbutton shall be located on a single traffic signal pole.

(3) Pedestrian pushbuttons should be located no more than ten (10) feet from the face of curb or more than five (5) feet from the crosswalk extension.

(4) Pedestrian pushbuttons shall be separated by a minimum distance of ten (10) feet.

(5) All pedestrian pushbutton stations shall be accompanied by a pedestrian pushbutton sign (R10-3e) with instructions.

~~6.~~7. Controller and Cabinet Design

a. Controllers

(1) All new controllers shall be the Type 2070 Advanced Traffic Controllers (ATC) in compliance with the latest Model 2070 Controller Unit Specification unless otherwise directed by the City.

b. Phasing

(1) The sequence of operations shall be shown by the phasing sequence diagram for each intersection on the plan sheet. Permitted movements shall not be indicated unless part of a protected/permitted sequence. All pedestrian movements shall be shown.

(2) Phases shall be designated on the traffic signal plan sheet in accordance with the standard NEMA phase designations. In addition, the phases shall be assigned as follows (unless limited by the controller cabinet). As shown, phases 3 and 8 are to be oriented north on standard 8-phase intersections, and phase 8 is to be assigned to the feeder road approach oriented north or west as shown.

15.2.14.B.7 continued

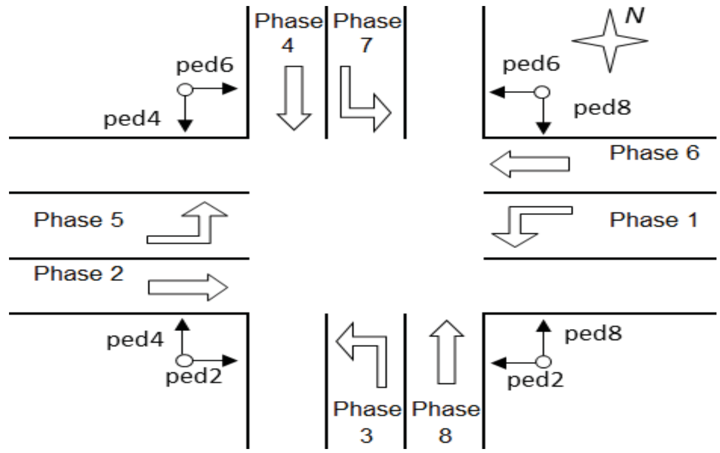


Figure 15.11~~15.9~~ - STANDARD 8-PHASE INTERSECTION

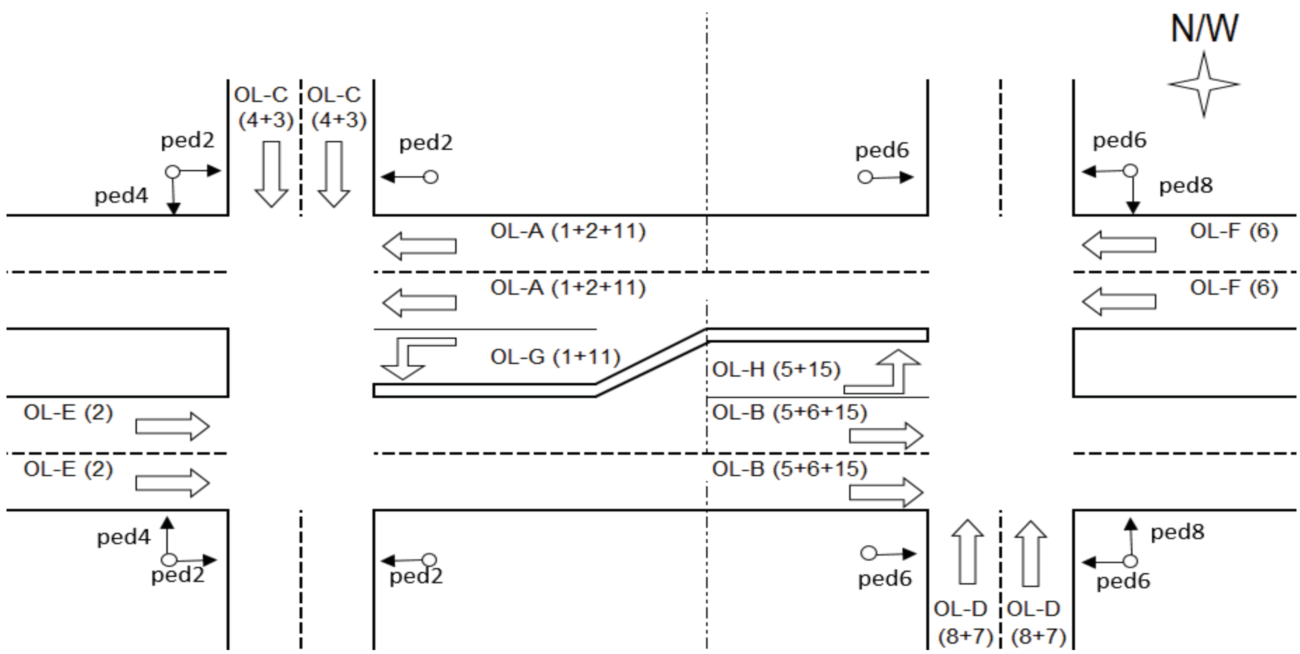


Figure 15.12~~15.10~~ - STANDARD DIAMOND INTERCHANGE INTERSECTION (4-PHASE OPERATION)

c. Controller Cabinet Type

(1) New ~~T~~type 2070 ATC controllers shall be housed in one of a selection of four cabinets from the Standard Specifications:

15.2.14.B.7.c.(1) continued

(a) Type 340 ITS Cabinet (~~H~~housing ~~P~~package ~~T~~type 3): ~~–~~ This is the standard cabinet for installation at City of Houston ~~I~~intersections. This cabinet shall be used at locations where 8 or more phase operation would be employed in the new or future system. This cabinet will fit on a standard NEMA "P" cabinet foundation.

(b) Type 342 ITS Cabinet (~~H~~housing ~~P~~package ~~T~~type 1):~~–~~ The ~~T~~type 342 ITS cabinet is a smaller cabinet that uses the ~~T~~type 332 cabinet profile and will fit a ~~T~~type 332 cabinet foundation. This cabinet should only be used on intersection retrofit projects where the existing foundations and conduit system are to remain. It should not be specified without prior approval by the City.

~~(a)~~(c) Type 346 ITS Cabinet (~~H~~housing ~~P~~package ~~T~~type 2):~~–~~ The ~~T~~type 346 ITS cabinet generally has the same capabilities as the ~~T~~type 342 cabinet in a smaller unit. These cabinets are to be used in the ~~D~~downtown area, pedestrian hybrid beacon locations, and fire stations.

(2) Selection of which cabinet to use shall be based on the cabinet use descriptions above~~,~~ and approved by the City.

d. Controller Cabinet Location

(1) The controller cabinet should be located to minimize the probability of being hit by a vehicle. Locations particularly susceptible to accident damage are:

(a) The far corner (apex) for a dual left turn or right turn movement where the crossing street doesn't have a raised ~~m~~Median.

(b) The far corner (apex) for a heavy left turn movement.

(c) The far-right corner of a high-speed approach where a right-angle collision can knock a car into the controller.

(d) Generally, the controller should be located upstream on the heaviest approach and/or back from the corner on the minor approach if there is a significant difference in approach volumes or speeds. Consideration should be given to locating the controller where it is protected by an existing non-breakaway pole or a mast arm pole.

(2) Where possible, the controller should be located on the same corner as the power supply. Special care should be taken that the load center is not separated from the controller by a wide, high speed or high~~-~~-volume street.

15.2.14.B.7.d continued

(3) Areas subject to flooding shall be avoided. Where not possible, the foundation should be raised 2' above the 100-year flood plain.

(4) Cabinet placement should not obstruct the minimum ~~s~~Sight ~~d~~Distance of any approach of the intersection. The cabinet should not obstruct the sidewalk or the ramp, even when the doors are open. Care shall be taken such that the cabinet doors do not open off the right-of-way.

(5) Cabinets shall be positioned such that when the door opens, the maintenance personnel will have a clear view of the intersection and the inside of the cabinet. If the cabinet is too high to see over, the cabinet shall be positioned and oriented so that the technician has a clear view of the intersection without looking around the open door.

(6) No device serving purposes different that traffic signal operations shall be placed on top or attached in any way to the traffic signal cabinet without the prior review and approval of the City. No device compromising the physical integrity of the signal cabinet will be authorized.

~~7.~~8. Detector Design

a. General

(1) The City's practice is to install inductive loop detectors as primary detection method at all new or upgraded traffic signal installations. The use of ~~wireless magnetometers~~ video detection as an alternative detection method shall be considered if the installation of inductive loops is unfeasible (e.g. bridge deck, paver surface) or impractical (e.g. poor pavement conditions). ~~Video detection should not be proposed as a permanent system as it will only be considered during temporary construction.~~ Any other detection technologies shall require prior approval of the City.

b. Emergency Vehicle Pre-Emption Equipment

(1) All new City traffic signal installations shall require the installation of GTT Opticom emergency pre-emption equipment. Sensors shall be installed for all intersection approaches. The City of Houston uses a coded system which requires proprietary software. For this reason, only GTT (Global Technologies, LLC) Opticom equipment can be used for City installations.

15.2.14.B.8.c.(1) continued

c. Inductive Loop Detectors: Inductive loop detectors are the standard means of vehicle detection to be used in the City of Houston.

(1) Types of loop installations shall be broken into two categories depending on the proposed pavement work:

(a) Pre-formed Loops - Use pre-formed loops any place where the entire loop falls in an area of new, overlaid, milled and replaced, or seal- coated pavement. The excavation and patching required are easily covered up by the pavement work, and the pre-formed loops can last virtually forever, if properly installed.

(b) Saw cut Loops - Use saw cut loops if the loop or any part of the loop would end up in an existing pavement that will not be modified by any of the methods noted above. This is a less desirable method of loop installation but can give acceptable loop life if properly installed.

(2) The detector lead-in cable is a shielded twisted pair cable extending from the loop pull box to the controller cabinet. The detector lead-in cable shall be a continuous run without splices.

(3) Except where noted otherwise, dimensions for detector loop setbacks shall be referenced from stop line. The detector reference line should be curved if needed to follow the alignment of the street.

(4) Each loop shall be connected to its own detector lead-in cable. Multiple detector lead-in cables may run in the same conduit.

~~1. Wireless Magnetometers~~

~~Wireless magnetometers vehicle detection systems (WMVDS) are accepted as a secondary method to provide actuation at an intersection. WMVDS may be proposed only when unfeasible and/or impractical circumstances prevent from installing inductance loops.~~

~~a. Magnetometers are small sensors embedded in holes drilled in the road surface. The installation for this method of detection consists of multiple components including but not limited to access points, contact closure cards, radios, and repeaters. Care shall be taken to assure proper location and placement of each to achieve the envisioned performance.~~

~~b. A single magnetometer sensor provides a 6-foot by 6-foot detection zone. Multiple wireless magnetometer sensors shall be used to provide the equivalent detection zones defined for high and low-speed approaches.~~

~~c. All wireless magnetometers shall be called out on the signal plan sheet with specific labels, stations and offsets for accurate placement.~~

d. Identification Scheme

(1) Detectors shall be identified on the plan sheets by their phase, lane and purpose. Each lane will be numbered from left to right starting with the lane closest to the centerline. Advance detection loops shall be identified as pulse loops. Detectors in through lanes at the stop line will be designated as call detectors. Finally, detectors in the turn lanes or on low-speed minor approaches shall be presence detectors. For example, when speaking about the advance loop for eastbound in the lane closest to the ~~m~~Median would be referred to as the Phase 2 pulse loop 1.

e. ~~Advance~~ Detectors on Higher Speed Approaches (~~P~~posted ~~S~~speed ≥ 30 MPH)

(1) Location

(a) For higher speed approaches, advance inductance loop detectors for the through lanes of traffic are required and shall be located five (5) seconds from the stop line using the following table:

15.2.14.B.8.e.(1)(a) continued

Table 15.9 - ADVANCE DETECTOR LOCATION TABLE

Posted Speed/ Design Speed (mph)	Advance Detector Distance (ft.)*
30	220
35	260
40	300
45	330
50	370
55	410
*As measured from the leading detector edge to the stop line.	

(b) In addition to the advance detectors, call detectors in each lane shall be placed near the crosswalk. The front edge of a 6’ x 6’ detection zone (either pre-formed or saw cut loops, or video ~~magnetometers~~) shall be located four (4) feet back from the stop line. At locations involving skewed intersections, or other extenuating circumstances, the detector positions and sizes may need to be adjusted to account for vehicles stopping in front of or in the crosswalk. In all cases, detection must be provided ten (10) feet upstream from the back of the crosswalk. The intent of the detector’s placement is to prevent the smallest passenger cars, motorcycles and bicycles from being caught in an undetected area. If adjusted, the size and spacing of the detectors shall remain constant.

(2) Detector Lead-in Cable

(a) The upstream pulse loops for the dilemma zone protection shall be on separate detector amplifier channels.

(b) If there is more than one through lane, adjacent upstream loops shall be placed on separate channels without connection to any other loop.

(c) The two stop line loops shall be spliced in series at the cabinet and connected to the same detector amplifier. This amplifier shall be the "call" input amplifier, with the loops of each lane split between the two channels.

15.2.14.B.8.e.(2) continued

(d) The upstream loop detector lead-in cables shall be routed to the nearest junction box along a patch perpendicular to the direction of travel. Homeruns for adjacent loops, less than sixteen (16) feet apart, should be routed to the nearest junction box in the same cut to the extent possible to minimize excavation of the pavement. When loops are adjacent to ~~m~~Medians, the homerun can be routed directly to the ~~m~~Median and then to the nearest junction box.

(e) The stop line loop lead-in cable will generally be routed to the same junction box. All the detector lead-in cables for conduit-encased loops should be routed parallel and adjacent to each other along a path perpendicular to the direction of travel. A path parallel to the direction of travel may be needed from the individual loop to the common perpendicular routing.

f. Detectors on Low~~-~~-Speed Approaches

(1) Location

(a) Large area presence detection shall be used on approaches with less than 35 MPH posted or anticipated 85th percentile speed. It shall also be used on side street approaches, with a posted or anticipated 85th percentile speed of 35 MPH, if the higher through phase critical lane volume is less than one-half the critical lane volume of the highest volume main street through phase.

(i) Pre-formed ~~L~~loops. A 6' x 21' presence detection zone shall consist of one (1) 6' x 6' detector loop placed in each lane beginning at the stop line, and a second 6' x 6' detector loop placed an additional nine (9) feet upstream of the trailing edge of the first detector. An additional 6' x 6' detector loop shall be placed in front of the stop line if the curb return allows for a full vehicle length to the stop line.

(ii) Saw cut ~~L~~loops.~~-~~ A 6' x 20' presence detection zone shall consist of one (1) 6' x 6' detector loop placed in each lane beginning at the stop line, and one (1) 6' x 10' detector loop placed four (4) feet upstream of the trailing edge of the first detector. An additional 6' x 6' detector loop shall be placed in front of the stop line if the extension of the curb line allows for a full vehicle length to the stop line.

15.2.14.B.8.f.(1) continued

~~(iii)If using magnetometer vehicle detectors, an equivalent detection zone shall be provided considering a single sensor offers a 6-foot by 6-foot coverage. An additional sensor shall be placed in front of the stop line if the curb return allows for a full vehicle length to the stop line.~~

(b) At locations involving skewed intersections, or other extenuating circumstances, the detector positions, number or sizes may need to be adjusted to account for vehicles stopping in front of or in the crosswalk. Care should be taken to not leave too much undetected space immediately upstream of the crosswalk. The intent of the detector placement is to prevent the smallest passenger cars, motorcycles and bicycles from being caught in an undetected area. If adjusted, the distances between the detectors shall remain constant.

(2) Detector Lead-in Cable

(a) In the case of the pre-formed detector loops, the loops in a lane may be combined on one channel. In all cases, each loop shall be spliced to its own detector lead-in cable running back to the cabinet.

(b) Detector lead-in cables for the loops closest to the intersection should be routed to the same junction box. Detector lead-in cables for adjacent loops should be routed to the nearest junction box in the same cut to the extent possible to minimize excavation of the pavement. A path parallel to the direction of travel may be needed from the individual loop to the common perpendicular routing.

g. Downstream Detection

(1) Downstream detector loops shall be placed on the receiving lanes of all through approaches, low and high speed, one hundred (100) feet measured from the crosswalk line furthest from the intersection. In case of no crosswalk line present or not clearly marked, downstream detector loops to be placed one hundred (100) feet measured from the curb return furthest from the intersection.

h. Left Turn Lane Detection

(1) Location

15.2.14.B.8.h.(1) continued

(a) Large area presence detection shall be used for left turn lane detections.

(b) Pre-formed Loops. A 6'x 51' presence detection zone shall consist of one (1) 6'x 6' detector loop with trailing edge four (4) feet in front of the stop line extending into the crosswalk, and additional three (3) 6'x 6' detector loops placed at nine (9) feet intervals upstream starting at the trailing edge of each loop.

(c) Saw cut Loops. A 6'x 50' presence detection zone shall generally consist of one (1) 6'x 6' detector loop with trailing edge four (4) feet in front of the stop line extending into the crosswalk, one (1) 6'x 6' detector loop placed with leading edge at the stop line, and one (1) 6'x 30' detector loop placed four (4) feet behind the trailing edge of the stop line detector loop.

~~(d) If using magnetometer vehicle detectors, an equivalent detection zone shall be provided considering a single sensor offers a 6-foot by 6-foot coverage.~~

~~(e)~~(d) At locations involving skewed intersections, or other extenuating circumstances, the detector positions, number or sizes may need to be adjusted to account for vehicles stopping in front of or in the crosswalk. Care should be taken to not leave too much undetected space immediately upstream of the crosswalk. The intent of the detector placement is to prevent the smallest passenger cars, motorcycles and bicycles from being caught in an undetected area. If adjusted, the distances between the detectors shall remain constant.

(2) Detector Lead-in Cable

(a) Where ~~m~~Medians are constructed adjacent to left turn lanes, the detector lead-in cable(s) should be routed to a junction box in the ~~m~~Median.

(b) In the case of the pre-formed loops, the upstream loop shall be connected to its own channel on an amplifier. The other loops may be combined on one channel. For multiple saw cut loops, the rear loop and front loops shall be on separate channels. In all cases, each loop shall be spliced to its own lead-in cable running back to the cabinet.

15.2.14.B.8.i continued

(c) If there are two or more left turn lanes, all the loops in one lane shall be connected in a like manner as described in ~~paragraph b~~ article 15.2.14.B.8.h.(2) above.

i. Right Turn Lane Detection

(1) Location: Detection for a right turn lane shall be installed in the same manner as a presence detection zone for a through lane on a low-~~-~~speed approach.

(2) Detector Lead-in Cable: The right turn presence detection loop shall be connected into its own detector lead-in cable, and separate channel on an extension amplifier for the through phase.

j. Installation of Vehicle Detection Systems: See the Standard Specifications and Details for construction requirements for primary (inductance loops) and secondary ~~(wireless magnetometers)~~ (video) vehicle detection methods.

k. Video ~~Imaging Vehicle~~ Detection Systems ~~(VIVDS)~~

(1) The City's practice is to install inductive loop detectors as a standard means of detection. ~~Wireless magnetometers are considered acceptable when installation of loops is unfeasible and/or impractical. Video detection is only to be used to provide vehicle detection on a temporary basis (e.g. construction) and in special cases where the City has approved its use prior to the preparation of final plans.~~ The use of video detection system as an alternative detection method shall be considered if the installation of inductive loops is unfeasible (e.g. bridge deck, paver surface) or impractical (e.g. poor pavement conditions).

(2) When using video detection systems, at least one camera shall be installed for each intersection approach.

l. Bicycle Detection

~~(3)~~(1) Bicycle detection systems shall be consistent with the method used for vehicle detection at the intersection.

(2) Applications for bicycle detection:

(a) ~~Bicycle detection shall be considered at new and modified signalized intersections when the existing or proposed bicycle lane meets any of the conditions to warrant a bicycle signal~~On any approach that warrants installation of a bicycle signal head.

15.2.14.B.8.l.(3) continued

(b) ~~Bicycle detection shall be installed at~~ On new and modified signalized intersections when the existing or proposed bicycle ~~lane~~ facility is on an approach that typically operate~~d~~s in actuated mode.~~,~~ In these situations, specific bicycle detection is ~~and that therefore,~~ require~~s~~d ~~a method~~ to recognize the presence of a bicycl~~e~~ist ~~to receive~~ and provide a green indication for the bicyclist to ~~and~~ proceed ~~parallel to the adjacent vehicular movement~~.

(c) Bicycle detection shall not be installed at signalized intersections when none of the applications to warrant bicycle signals are met, or the bicycle lane is located on a major approach typically operated in fixed-time mode, and that therefore, does not require~~s~~ a method to recognize the presence of a bicycle to receive a green indication and proceed parallel to the adjacent vehicular movement served every signal cycle.

~~(4)~~(3) Design requirements for bicycle detection:

(a) If loop detectors are used, diagonal slashed and quadrupole loop detectors are recommended for bicycle lanes. Refer to ~~L~~loop ~~D~~detector ~~S~~standard ~~D~~details.

(b) ~~If wireless sensors are used, the system selected shall supplement and be compatible with the existing or selected wireless vehicle detection system used at the intersection.~~ If camera detection is used, a detection zone shall be defined that captures any place where a bicyclist may be expected to legally stop and wait.

~~(b)~~(c) A bicycle detection symbol shall be adequately placed in reference to the bicycle detector to assist bicyclists in knowing where to stop. Refer to standard pavement marking drawings.

~~l.~~m. ~~When bicycle detection is used, a Bicycle Signal Actuation sign (R10-22) shall be used, and a symbol shall be placed on the pavement indicating the optimal position for a bicyclist to actuate the signal. Refer to Standard Signs and Pavement Markings Drawings.~~ Other Detection Devices: The ~~e~~Engineer of Record may recommend other detection technologies and submit a written recommendation outlining the benefits of the technology. However, the City reserves the final authority to approve or disapprove the use of these technologies.

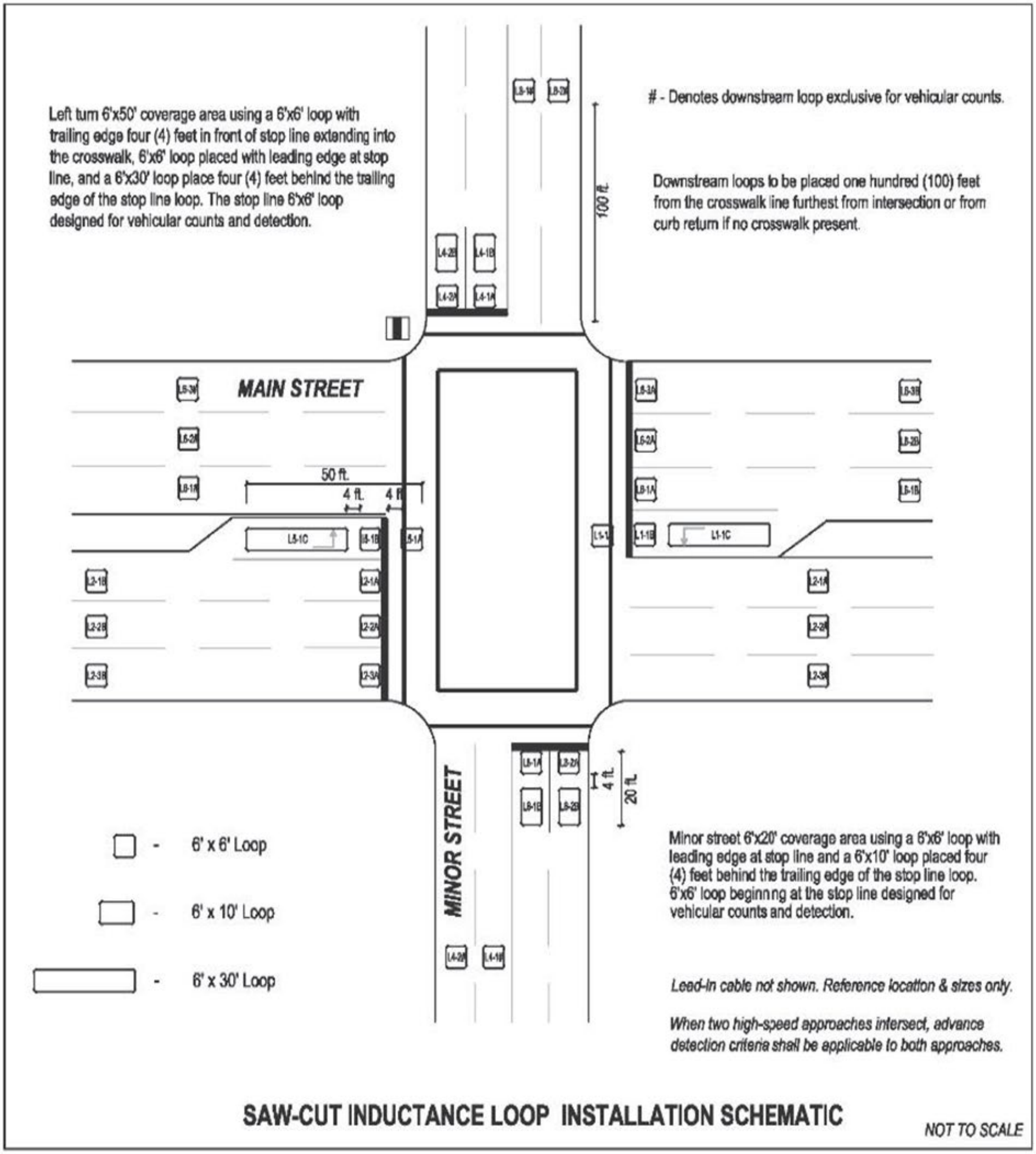


Figure 15.13~~15.11 -Figure 15.11.01a~~ SAW-CUT INDUCTANCE LOOP INSTALLATION SCHEMATIC

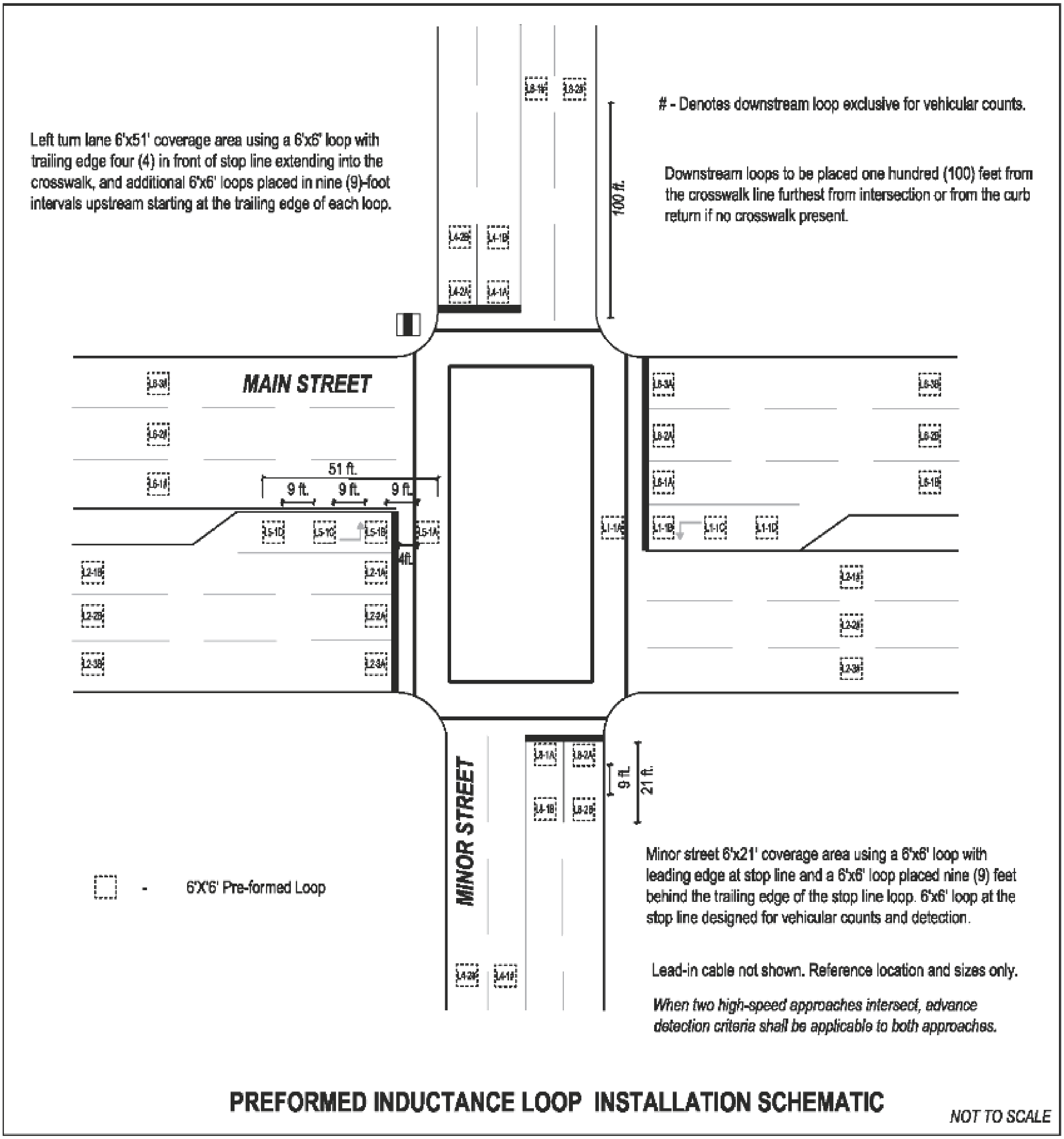
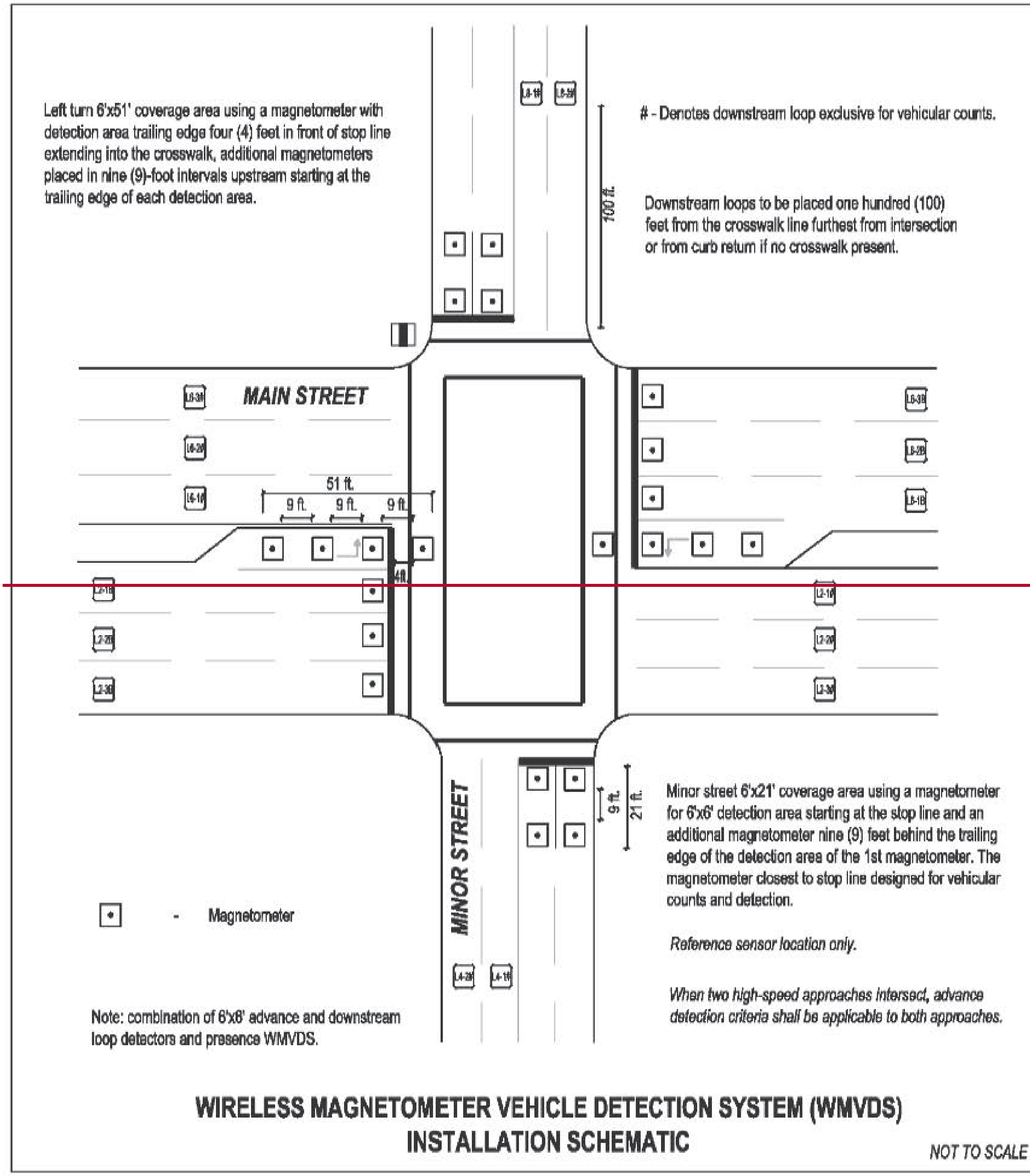


Figure 15.14~~15.12 -Figure 15.11.01b~~ PRE-FORMED INDUCTANCE LOOP INSTALLATION SCHEMATIC



~~Figure 15.11.01c Wireless Magnetometer Vehicle Detection System (WMVDS) Installation Schematic~~

~~8.~~9. Underground Systems

a. Conduit

(1) Type of Conduit

(a) All conduits shall be as specified in the ~~S~~standard ~~S~~specifications. The Engineer of Record~~designer~~ must pay careful attention to where the ~~S~~standard ~~S~~specifications call for certain types of conduits for certain uses as well as when boring and encasing is to be used so the estimates can accurately reflect the field quantities.

(2) Installation

(a) Conduit shall be installed according to the ~~S~~standard ~~S~~specifications. Requirements for depth below finish grade shall be strictly adhered to.

(b) The ~~Consultant~~Engineer of Record, in conjunction with the City, shall determine if conduit crossing certain paved streets should be shown as open cut or bored due to extensive utility problems. The specifications should require an alternate bid option of both methods to allow for unforeseen factors.

(c) In general, conduit runs crossing paved alleys, drives, and streets shall be bored.

(3) Conduit Sizing

(a) Conduits shall be sized according to minimum allowed sizes and allowed conduit fill.

(b) Conduit placed under roadway shall not be less than 3-inches in diameter.

(c) Conduit shall be in ½" incremental sizes, with the exception of the rigid galvanized conduits on span-wire installations as shown in the ~~S~~standard ~~D~~details.

(d) Conduit fill shall not exceed 40% on any one conduit or 26% average for all conduits on any one run.

(e) When crossing the street with interconnects cable, the spare conduit required for a street crossing may be used if adequate capacity is available.

(f) One (1) inch conduit shall only be used to protect the ~~S~~street ~~L~~loop ~~W~~wire from the loop to the adjacent pull box.

15.2.14.B.9 continued

Table 15.10 ~~Table 15.11.01~~ DIMENSIONS AND MAXIMUM PERCENTAGE OF FILLED AREA OF CONDUIT

Trade Size	Internal Diameter (In)	Cross Sectional Area (Sq In)	26% Fill (Sq In)	40% Fill (Sq In)
1"	1.029	0.83	0.22	0.33
2"	2.047	3.29	0.86	1.32
2-1/2"	2.445	4.70	1.22	1.88
3"	3.042	7.27	1.89	2.91
4"	3.998	12.55	3.26	5.02

Source: National Electrical Code; Chapter 9, Table 4.

(4) Length of Conduit Run

(a) Conduit runs should be limited to 190 feet between pull boxes or structures where the cable is reasonably accessible for pulling. If the conduit run is very straight, with no more than 180 degrees of bend, and contains only a single cable, the run may be extended to ~~about~~ 350 feet.

(5) Spare Conduits

(a) Spare conduits shall be installed as shown in the ~~S~~standard ~~D~~details.

(6) Location of Conduit Runs

(a) If new sidewalk is part of the construction, conduit runs may be located under the new sidewalk with the junction boxes being constructed flush with the sidewalk.

(b) If the sidewalk is existing, and a planting strip exists between the curb and the sidewalk, the conduit and junction boxes should be located either in the planting strip or on the other side of the sidewalk (right- of-way permitting), whichever has fewer utility conflicts.

(c) If there is no curb and gutter, the conduit and junction boxes should be located as far as possible back near the right-of-way, but not in drainage areas.

(d) Conduit runs shall be located away from drainage collection points whenever possible.

b. Pull Boxes

(1) Size~~:~~ Three sizes are available for use from the ~~S~~standard ~~S~~specifications and ~~D~~details. The ~~designer~~Engineer of Record shall select the applicable box based on number and size of conduits to be contained in the box. If the ~~designer~~Engineer of Record is concerned that the standard pull box will be too small, they should select the next larger size pull box. The three sizes of standard pull boxes used by the City and their applications are:

(a) Type A - To be used for detector loop pull boxes and hardwire interconnect boxes.

(b) Type B - This is the standard traffic signal pull box but may also be used as a detector loop pull box where multiple loops enter a single pull box.

(c) Type C - This is the standard pull box to be used for most communications applications. It can also be used for traffic signals where a large pull box is required due to multiple large conduits entering the pull box. The most frequent use of this pull box in traffic signal construction is for the pull box adjacent to the controller cabinet.

(2) Location

(a) A pull box is generally required adjacent to each loop, set behind the curb or located on the shoulder to minimize being run over by vehicles.

(b) For low-~~-~~speed approach and turn lane detectors, a junction box should be located to minimize the length of the detector lead-in cable.

(c) Each quadrant of the intersection shall have a pull box that is within 30 feet of the traffic signal pole. This pull box should service the traffic signal pole, detector lead-in conduit, and the conduit crossing the street. If the intersection is actuated, this pull box can usually be the same box servicing the detectors at the crosswalk, and possibly the left turn detectors if no ~~m~~Median island exists. It should be located to allow the most direct path for the detector lead-in cables as well as the conduit crossing the street.

(d) Pull boxes located on corners should be positioned so that turning vehicles do not track across the pull box.

15.2.14.B.9.b.(2) continued

(e) At span-wire signal installations, item (c) holds true for the pull box location with the exception that you do not have a street-crossing conduit running to this pull box in most cases.

(f) On the quadrant where the controller cabinet is located, there should generally be only the one pull box which services the conduit crossing the street, some detector loops, traffic signal pole, and the controller cabinet. An additional pull box is required in the Type 332 foundation, per the ~~S~~standard ~~D~~detail, and is also required in many cases where the controller cabinet is post-mounted.

(g) For interconnect runs between intersections, pull boxes shall be provided at appropriate intervals.

c. Traffic Signal Communications

(1) See requirements in Section 15.2.15.C~~15.19~~.

~~9.~~10. Electrical Cable

a. Detector Lead-In Cable

(1) Detector lead-in cable shall be 14 AWG IMSA 50-2-1984 shielded cable meeting the requirements of the Standard Specifications.

(2) All detector lead-ins cables shall be continuous runs from the splice with the loop to the controller cabinet terminal strip.

(3) Each loop shall be individually brought back to the cabinet on a separate shielded cable.

b. Street Loop Wire

(1) Street ~~L~~loop ~~W~~wire shall be 14 AWG IMSA 51-5-1985 cable.

c. Power Cable

(1) Power shall be 120 volt, single-cycle, 60 Hz AC.

15.2.14.B.10.c continued

(2) All services shall comply with ~~E~~electric ~~C~~company requirements and consist of six (6) #4 AWG XHHW stranded wires and an 8 AWG Solid Bare Ground. The six (6) #4 AWG XHHW wires shall consist of two (2) white, one (1) black, one (1) red and two (2) green wires. A black #4 AWG XHHW stranded wire will be used for the "hot" signal leg and a white #4 AWG XHHW stranded wire will be used for the "common" signal leg. The two green, one red and one spare white #4 AWG XHHW stranded wires shall be reserved as spares or for future luminaire usage.

d. Signal Cable

(1) Traffic Signal Heads

(a) All ~~t~~Traffic ~~s~~Signal ~~h~~Heads shall be serviced with a 7 conductor, 14 AWG IMSA 19-1-1984 cable meeting the requirements of the ~~S~~standard ~~S~~specifications.

(b) IMSA cables are to run un-spliced from the controller cabinet to the terminal strip in the pole or to the signal heads where termination in the pole is unavailable.

(c) Each approach will require that at least two heads be on separate IMSA cables. For additional heads, cables may be run from the first through head with a second cable from the first head to the additional heads.

(d) Each protected/permissive and protected only left turn signal heads shall be serviced by its own cable with no splices to other heads.

(2) Pedestrian Signal Heads and Pushbuttons

(a) Each pedestrian signal head shall be serviced by its own five (5) conductors, 14 AWG IMSA 19-1-1984 cables with no splices to other heads.

(b) Each pedestrian pushbutton shall be serviced by a three (3) conductor, 14 AWG IMSA 19-1-1984 cables.

(3) Installation, Continuity of Cables, and Splices

(a) All cable shall meet the requirements of the ~~S~~standard ~~S~~specifications for installation, continuity, and splices.

(b) No conduit or isolated cable for purposes different than traffic signal service should be attached or placed inside any signal pole.

15.2.14.B.10 continued

e. Spare Cables

(1) Where future pedestrian movements or left turn signal heads are anticipated, spare electric cables shall be routed from the controller cabinet to the pole on which they would be installed. In all cases, sufficient spare cable should be provided to connect to the future location of the equipment.

f. Voltage Drop Calculations

(1) The ~~designer~~Engineer of Record shall take into account voltage drop calculations where applicable due to loss over long distances and consider special exceptions to the wire sizes normally used to accommodate losses.

~~10.~~11. Electrical Services

a. Type

(1) The City~~'~~'s standard installation for electrical service will be a service pedestal. All service pedestals and poles shall be as shown in the ~~S~~standard ~~S~~specifications and ~~D~~details and in compliance with the electric company standards.

b. Procedures for Hook-Up to Utility Company

(1) The utility company shall be contacted for the location of the power source and to verify their procedures for hook-up of power during the design process.

(2) Appropriate notes shall be placed on the plan sheet detailing the ~~C~~contractor's responsibilities for hook-up, including sufficient advance notice to allow hook-up when the signal system is ready for testing.

(3) The service center shall be a ground-mounted service pedestal when there is to be a steel pole installation. On wood pole span-wire type installations, a wood pole-mounted service assembly is appropriate. Under no circumstances will the electric company or the City allow a meter assembly to be attached to an electric company pole. The assembly has to be located either on a corner signal support pole or a separately installed service pole, put in by the contractor.

~~11.~~12. Signs

a. General

15.2.14.B.12.a continued

(1) All traffic sign codes in this section are from the current editions of the Standard Highway Sign Designs for Texas and the TMUTCD.

b. Overhead Mounted Street Name Signs

(1) A street name sign (D3, Texas Manual on Uniform Traffic Control Devices) for each approach shall be installed on the mast arm between the pole and the first signal head as shown on the ~~S~~standard ~~D~~detail.

(2) If the two legs of the cross street have different names, two signs with arrows shall be installed in lieu of a single street name sign. The sign on the left shall have an arrow pointing left followed by the street name. To the right of this sign is a sign with the name of the street to the right followed by an arrow pointing right.

(3) Street name signs shall include block numbers per the ~~S~~standard ~~D~~details.

(4) Customized street name signs require separate approval from the City Traffic Engineer. Interested parties should contact the Traffic Hotline at 832-395- 3000 to apply.

c. Overhead Lane Use Control Signs

(1) Refer to Traffic Signal Heads and Lane Use Control Signs in Section ~~E~~15.2.14.B.6.

d. Median and Island Approaches

(1) Median approaches should have an R4-7 Keep Right sign (symbol only) mounted at the nose of the ~~m~~Median.

(2) Island approaches, with same directional traffic on both sides shall have a W12-1 Double Arrow sign mounted at the nose of the island.

e. Pedestrian Pushbutton Signs: Pedestrian ~~P~~pushbutton signs shall be as shown in the ~~S~~standard ~~D~~details.

(1) An R10-3e shall be used at most locations.

(2) An R10-3b may be used at installations where standard pedestrian indications without the countdown feature are used.

f. No Pedestrian Crossing Signs

15.2.14.B.12.f continued

(1) An R9-3A sign with plaque shall be installed on the mast arm pole at each side of an approach where no pedestrian signals or crosswalks are used.

g. Sheeting on Intersection Control Signs

(1) All traffic control signs that are mounted overhead shall have diamond grade reflective sheeting. This applies to street name signs, one-way signs, turn restriction signs, etc. Any other supplemental intersection control signs that are ground mounted shall use at a minimum high intensity prismatic reflective sheeting.

h. Other Traffic Signs

(1) Other traffic control signs, e.g., one-way, left lane must turn left, no right turn on red, no parking, etc., shall be installed as needed. These signs shall meet the requirements of the TMUTCD.

i. Battery Backup/ Uninterrupted Power Supply (UPS) Systems

(1) General: The City of Houston shall require the installation of Battery Back Up/Uninterrupted Power Supply (UPS) systems on all new or reconstructed traffic signals. The Battery Backup/UPS System will meet the requirements of the Standard Specifications.

15.2.15 INTELLIGENT TRANSPORTATION SYSTEMS (ITS)

15.2.15.A ITS Devices: All existing ITS infrastructure must be shown on design plans and kept operational during construction. All new and redesigned traffic signals shall have new ITS infrastructure included in the design. All ITS devices shall be designed with the following criteria:

1. Ethernet Switch - A new ~~F~~field ~~H~~hardened ~~M~~managed ~~E~~ethernet ~~S~~switch~~es~~ shall be installed at all traffic signals. If fiber cable is the communication method then the switch shall have City of Houston standard fiber cable ports.

2. Bluetooth - A new Bluetooth card and antenna shall be installed at all traffic signals with existing Bluetooth infrastructure. All new Bluetooth equipment shall be compatible with existing Bluetooth travel time monitoring system.

3. Gateway - A new ~~G~~gateway shall be installed at all traffic signals. The ~~G~~gateway shall be ~~Meraki Z1 Teleworker or an approved equal and shall include a 5 year enterprise license~~ the City of Houston current approved equipment.

15.2.15.A continued

4. Dynamic Message Sign (DMS) - A new DMS shall be installed on all projects that require the removal or relocation of existing DMS.

5. Closed Circuit TV (CCTV) - A new CCTV camera shall be installed at all traffic signals with existing cameras.

6. Midblock Count Station - A new midblock count station shall be installed on all projects that require the removal or relocation of existing midblock count stations.

15.2.15.B General Requirements

1. It is the responsibility of the ~~design e~~Engineer of Record to field verify all ITS devices and communications infrastructure within the project limits. Also, it is the responsibility of the ~~design e~~Engineer of Record to perform all necessary research, coordination and analysis for ITS device and communications deployment.

2. All ITS devices and communications infrastructure shall be:

   a. Compatible with existing infrastructure;

   b. Securely installed and mounted on din rail~~-/-~~shelf if applicable;

   c. Integrated into the relevant central system for control and monitoring;

   d. Kept operational during construction;

   e. Properly configured to current City of Houston Specifications and Standards.

3. Refer to the City of Houston's website for ITS device specifications and standard drawings. Contact Transportation & Drainage Operations / ITS section for compatibility questions with City of Houston ITS and/or communications infrastructure. Contact the Transportation & Drainage Operations / ITS section for questions and/or request at 713.881.3172.

15.2.15.C Traffic Signal Communications

1. Fiber ~~O~~optic ~~C~~cable (FOC) shall be the standard form of traffic signal communications. All City of Houston projects shall include provisions for new FOC. Also, provisions for tying the new FOC into Houston TranStar via existing FOC (or Wireless Broadband (WB) if no FOC path exists to Houston TranStar) shall be included.

2. Fiber Optic Cable (FOC)

   a. All drop cable shall be terminated in ~~an~~a secondary fiber distribution unit (SFDU);

15.2.15.C.2 continued

b. Pre-connectorized pigtails shall be used - all cables to be spliced;

c. For traffic signals being reconstructed:

(1) Ensure new conduit is deployed between traffic signal cabinet and splice enclosure;

(2) Deploy new drop cable at all locations;

(3) Deploy new communications service box next to cabinet;

(4) Deploy new splice enclosure at all locations.

d. All FOC deployed shall be tied into existing FOC for backhaul to Houston TranStar (if the existing FOC is within close proximity**);

e. All design plans need to have splice details.

~~2. WB Subscribers - In special cases where there is no FOC backhaul to Houston TranStar, within close proximity**, WB subscribers shall be deployed as the communications backhaul method. The subscriber shall be installed on a 10 foot extension pole mounted on top of traffic signal pole.~~

3. Cellular - USB air cards are in use at many traffic signals. These shall be maintained during construction. Also, the air card shall be reinstalled with newly deployed ITS infrastructure. In special cases where there is no FOC backhaul to Houston TranStar, air cards shall be deployed as the communications backhaul method.

**Close proximity is ~~considered less than ½ mile. If existing FOC is further, contact the Transportation & Drainage Operations / ITS section for guidance and clarification at 713.881.3172. A FOC master plan is maintained by the ITS section. This will be referenced to determine if FOC shall be routed to the existing FOC even if further than ½ mile.~~if the FOC is within one intersection from any approach of the project intersection (new or rebuild) regardless of distances. Fiber optic cable shall be extended to the newly built or reconstructed intersection.

15.2.15.D ITS Notes to be added to all plans:

1. Any interruption of ITS operations requires City of Houston Transportation & Drainage Operations / ITS section approval at a minimum of one (1) week in advance at 713-881-3172 or 713-881-3000 (Houston TranStar).

2. All existing ITS infrastructure and traffic signal communications shall be kept operational during construction.

3. Any questions or concerns related to deployment of any ITS device call City of Houston Transportation & Drainage Operations / ITS section at 713-881-3172 or 713-881-3000 (Houston TranStar).

4. All ITS devices that are being removed due to construction shall be ~~given~~ delivered to Transportation & Drainage Operations. Notify ITS section staff immediately upon removal at 713-859-3362.

~~4.~~5. If a fiber optic cable (FOC) exists within 1500 feet of the intersection being upgraded, the existing FOC should be extended to serve the new or upgraded traffic signal.

END OF CHAPTER

APPENDIX ~~1~~A - -TYPICAL SIGNALIZED INTERSECTION DESIGNS ~~CHAPTER 15~~

Appendix ~~1~~ A presents a typical City of Houston signalized intersection design illustrating the requirements for proposed new traffic signal installation or reconstruction of existing ones. Existing field conditions vary from one location to another; therefore, the ~~design~~ ~~e~~Engineer of Record with consultation with the City of Houston's project manager shall determine the appropriate type, size, and location of any applicable traffic component.

Typical positions and arrangements of ~~t~~Traffic ~~s~~Signal ~~h~~Heads and signs related to various configurations are also shown in Appendix ~~1~~A.

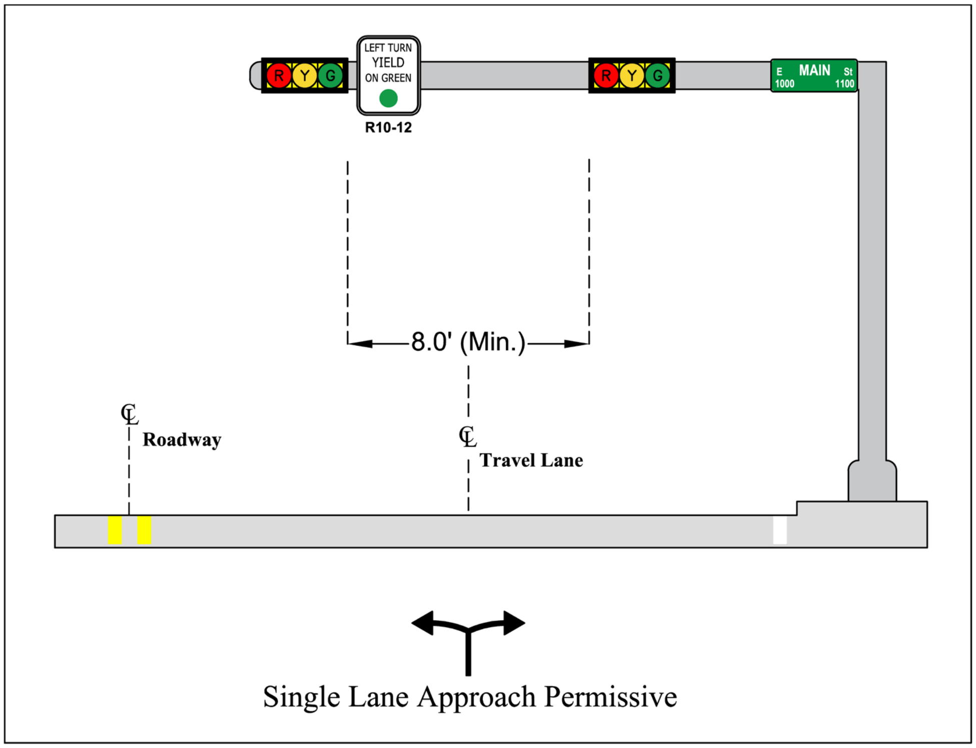


Figure 1

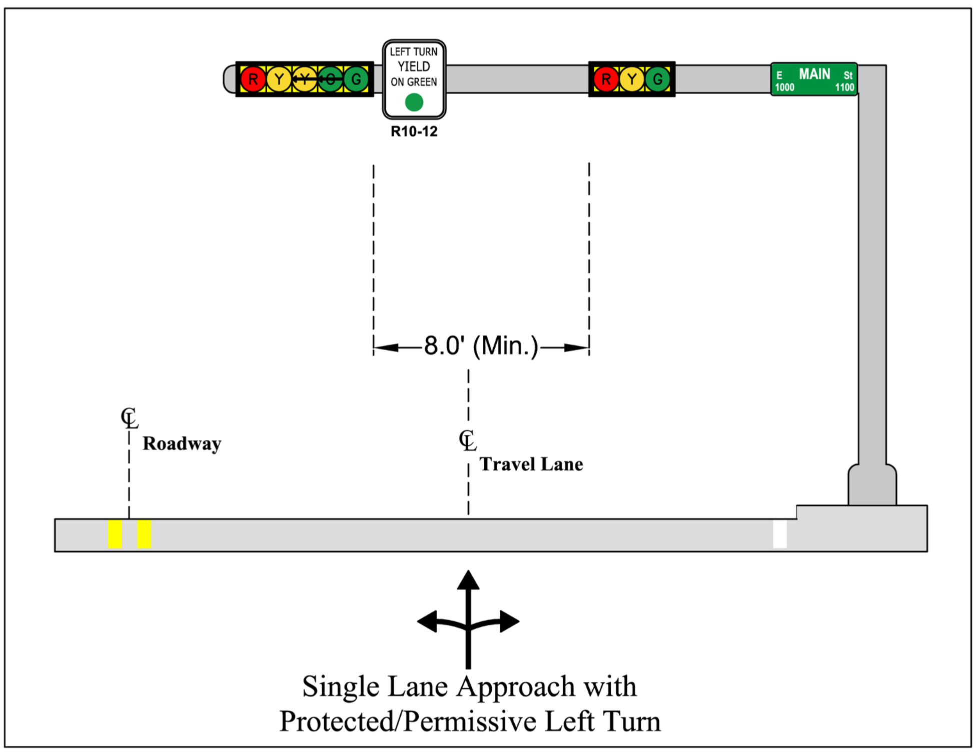
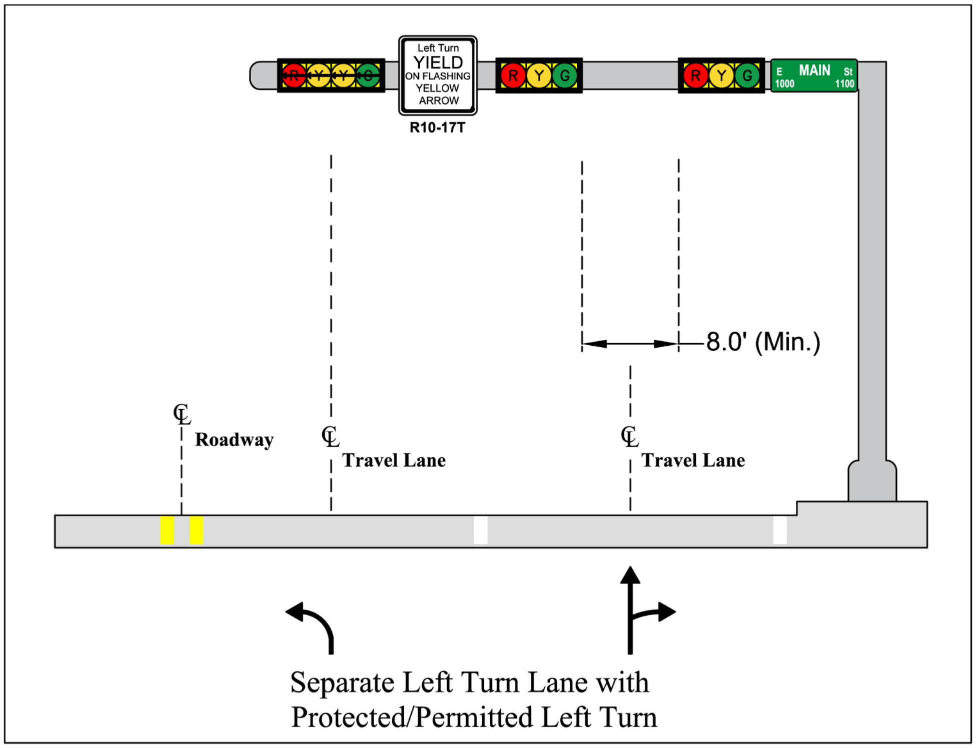


Figure 2



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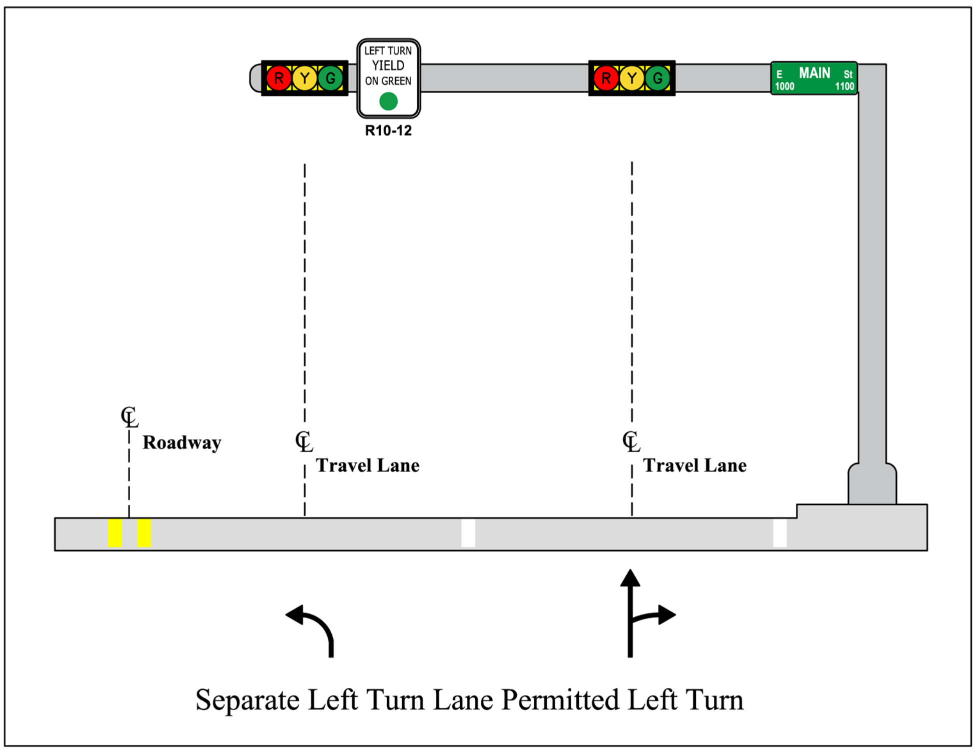

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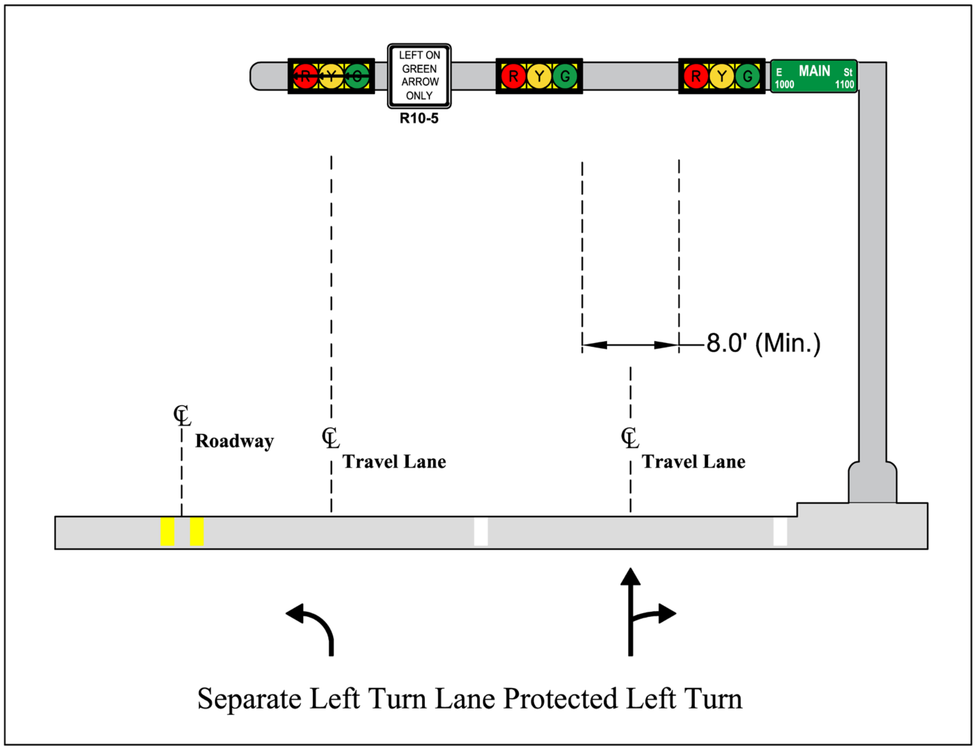
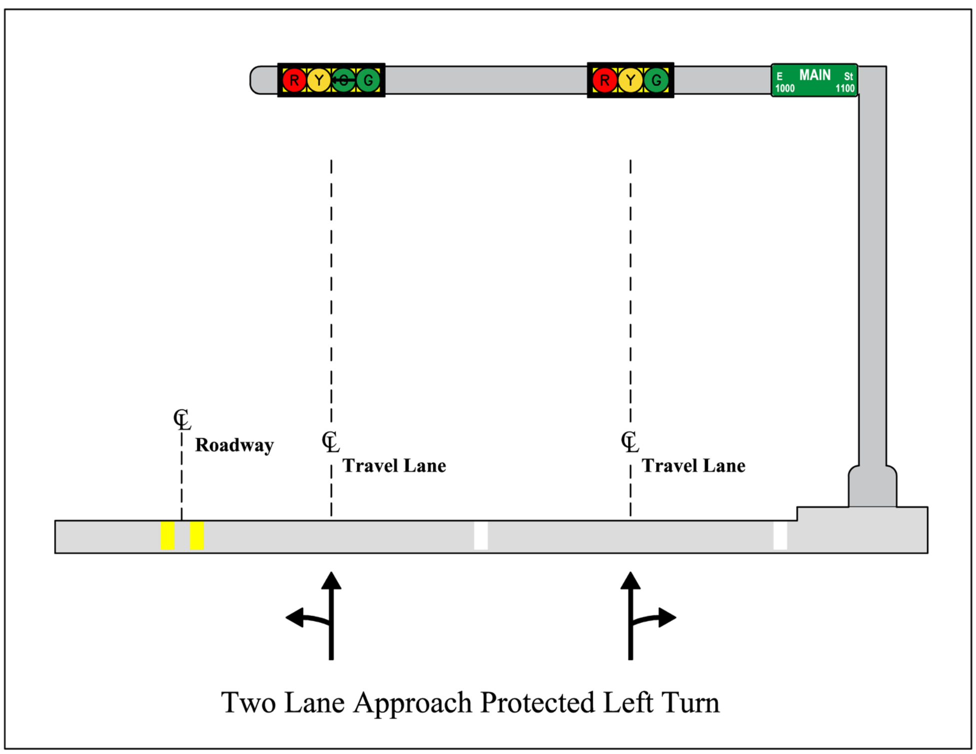


Figure 5



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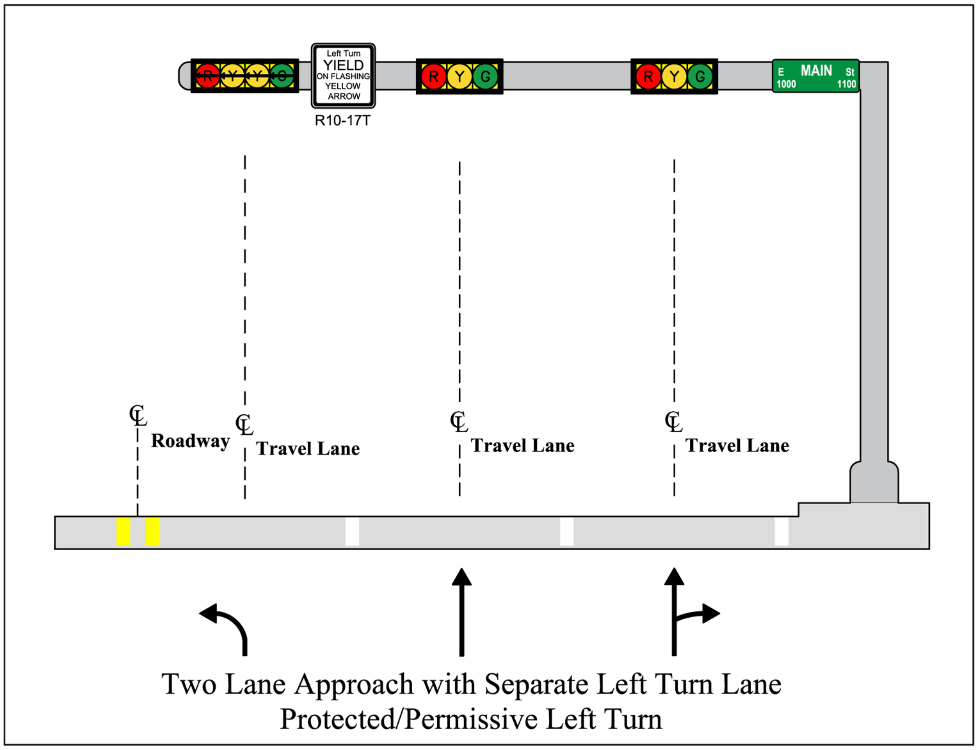

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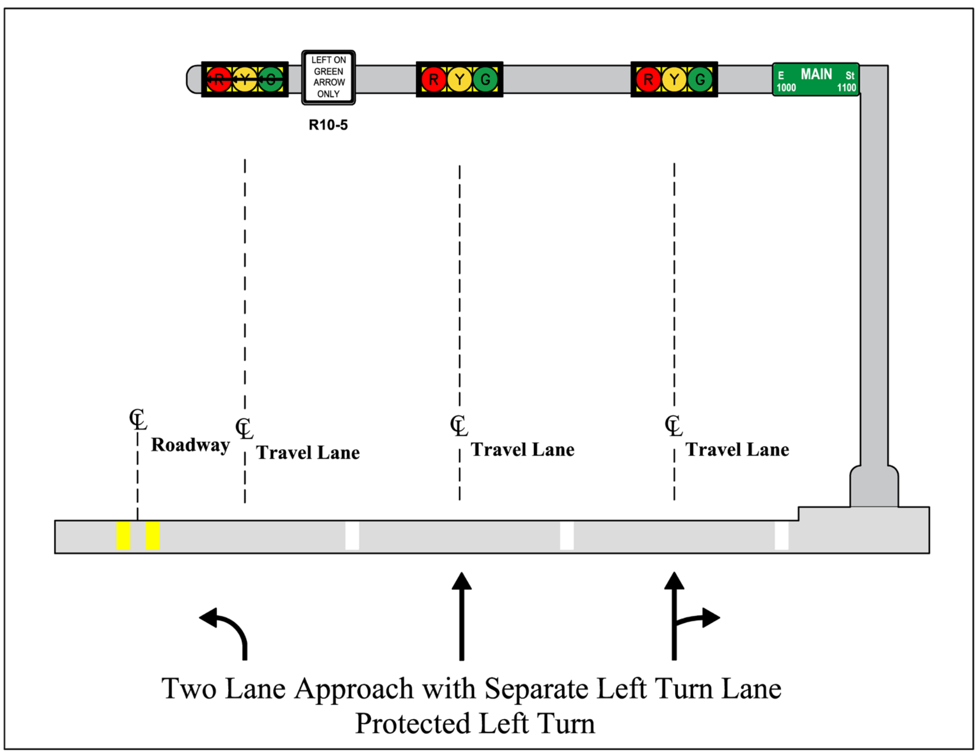
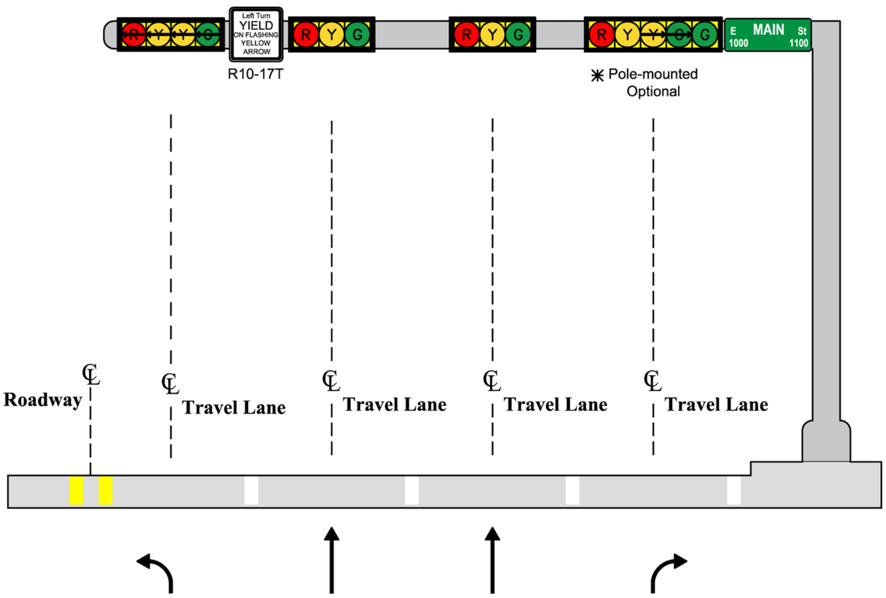
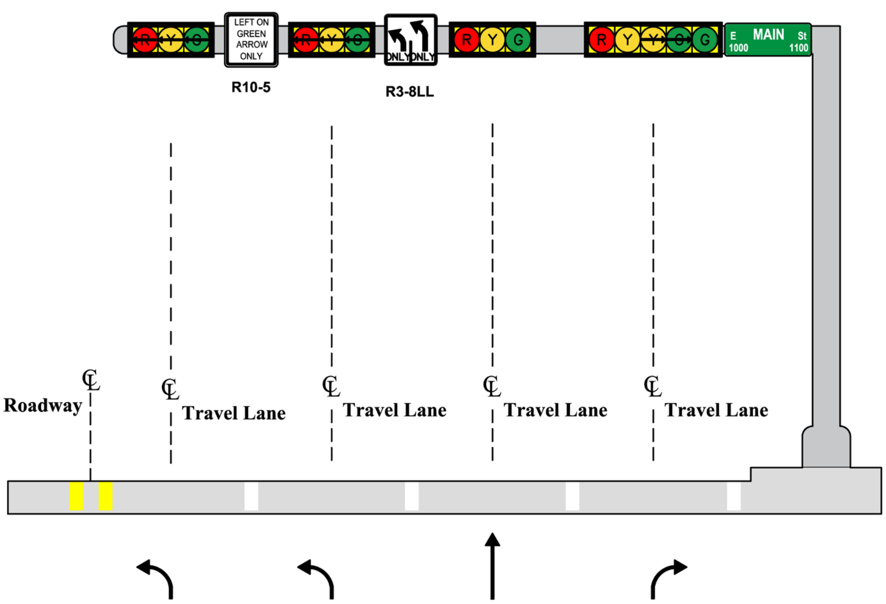


Figure 8



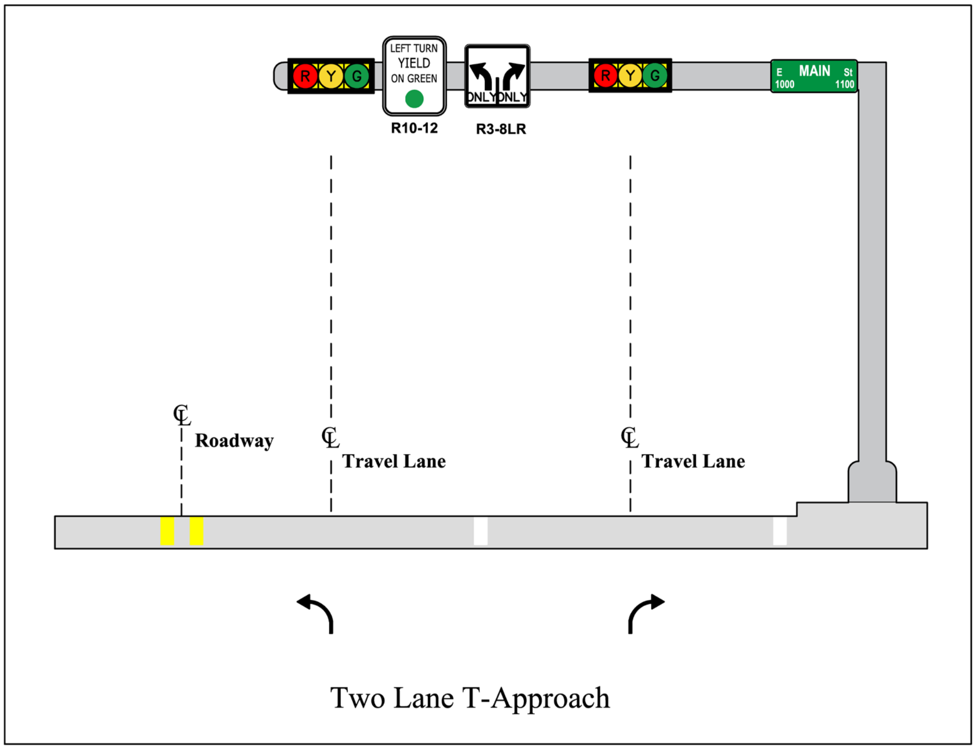
Two Lane Approach with Separate Left and Right Turn Lane
Protected/Permitted Left Turn (Right Turn Overlap)

Figure 9



Two Lane Approach with Separate Dual Left Turn Lanes
Protected Dual Left Turn

Figure 10


R
Y
G
LEFT TURN
YIELD
ON GREEN
R10-12
ONLY
ONLY
R3-8LR
E
MAIN
St
1000
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Roadway
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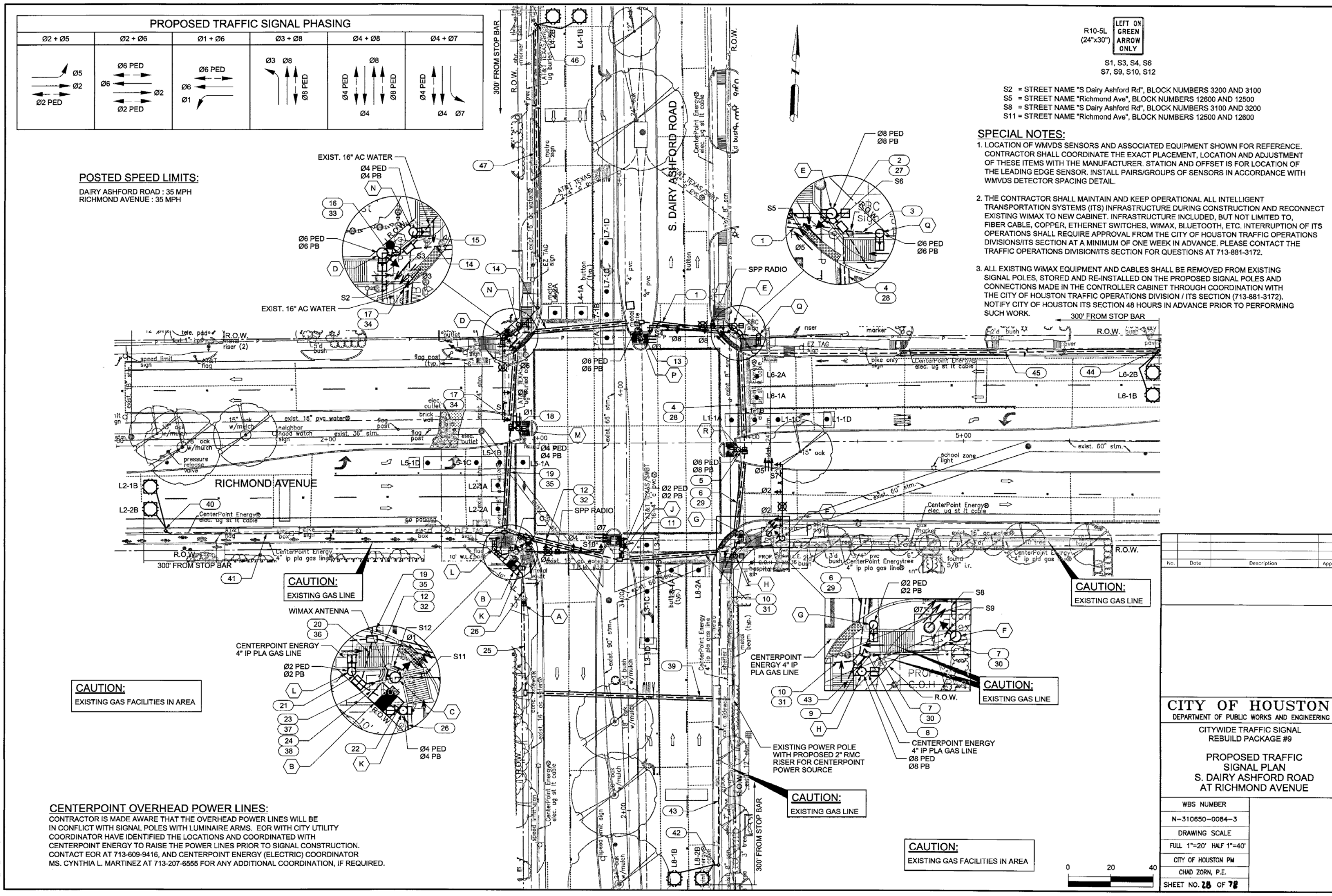
Travel Lane
℄
Travel Lane
Two Lane T-Approach

Figure 11

APPENDIX B - TRAFFIC SIGNAL DESIGN EXHIBITS


PROPOSED TRAFFIC SIGNAL PHASING
Ø2 + Ø5
Ø2 + Ø6
Ø1 + Ø6
Ø3 + Ø8
Ø4 + Ø8
Ø4 + Ø7
POSTED SPEED LIMITS:
DAIRY ASHFORD ROAD : 35 MPH
RICHMOND AVENUE : 35 MPH
RICHMOND AVENUE
S. DAIRY ASHFORD ROAD
300' FROM STOP BAR
SPECIAL NOTES:
1. LOCATION OF WMVDS SENSORS AND ASSOCIATED EQUIPMENT SHOWN FOR REFERENCE. CONTRACTOR SHALL COORDINATE THE EXACT PLACEMENT, LOCATION AND ADJUSTMENT OF THESE ITEMS WITH THE MANUFACTURER. STATION AND OFFSET IS FOR LOCATION OF THE LEADING EDGE SENSOR. INSTALL PAIRS/GROUPS OF SENSORS IN ACCORDANCE WITH WMVDS DETECTOR SPACING DETAIL.
2. THE CONTRACTOR SHALL MAINTAIN AND KEEP OPERATIONAL ALL INTELLIGENT TRANSPORTATION SYSTEMS (ITS) INFRASTRUCTURE DURING CONSTRUCTION AND RECONNECT EXISTING WIMAX TO NEW CABINET. INFRASTRUCTURE INCLUDED, BUT NOT LIMITED TO, FIBER CABLE, COPPER, ETHERNET SWITCHES, WIMAX, BLUETOOTH, ETC. INTERRUPTION OF ITS OPERATIONS SHALL REQUIRE APPROVAL FROM THE CITY OF HOUSTON TRAFFIC OPERATIONS DIVISIONS/ITS SECTION AT A MINIMUM OF ONE WEEK IN ADVANCE. PLEASE CONTACT THE TRAFFIC OPERATIONS DIVISION/ITS SECTION FOR QUESTIONS AT 713-881-3172.
3. ALL EXISTING WIMAX EQUIPMENT AND CABLES SHALL BE REMOVED FROM EXISTING SIGNAL POLES, STORED AND RE-INSTALLED ON THE PROPOSED SIGNAL POLES AND CONNECTIONS MADE IN THE CONTROLLER CABINET THROUGH COORDINATION WITH THE CITY OF HOUSTON TRAFFIC OPERATIONS DIVISION / ITS SECTION (713-881-3172). NOTIFY CITY OF HOUSTON ITS SECTION 48 HOURS IN ADVANCE PRIOR TO PERFORMING SUCH WORK.
R10-5L (24"x30") LEFT ON GREEN ARROW ONLY
S1, S3, S4, S6 S7, S9, S10, S12
S2 = STREET NAME "S Dairy Ashford Rd", BLOCK NUMBERS 3200 AND 3100
S5 = STREET NAME "Richmond Ave", BLOCK NUMBERS 12600 AND 12500
S8 = STREET NAME "S Dairy Ashford Rd", BLOCK NUMBERS 3100 AND 3200
S11 = STREET NAME "Richmond Ave", BLOCK NUMBERS 12500 AND 12600
CAUTION: EXISTING GAS LINE
CAUTION: EXISTING GAS FACILITIES IN AREA
WIMAX ANTENNA
CENTERPOINT ENERGY 4" IP PLA GAS LINE
EXISTING POWER POLE WITH PROPOSED 2" RMC RISER FOR CENTERPOINT POWER SOURCE
SPP RADIO
EXIST. 16" AC WATER
CENTERPOINT OVERHEAD POWER LINES:
CONTRACTOR IS MADE AWARE THAT THE OVERHEAD POWER LINES WILL BE IN CONFLICT WITH SIGNAL POLES WITH LUMINAIRE ARMS. EOR WITH CITY UTILITY COORDINATOR HAVE IDENTIFIED THE LOCATIONS AND COORDINATED WITH CENTERPOINT ENERGY TO RAISE THE POWER LINES PRIOR TO SIGNAL CONSTRUCTION. CONTACT EOR AT 713-609-9416, AND CENTERPOINT ENERGY (ELECTRIC) COORDINATOR MS. CYNTHIA L. MARTINEZ AT 713-207-6555 FOR ANY ADDITIONAL COORDINATION, IF REQUIRED.
CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING
CITYWIDE TRAFFIC SIGNAL REBUILD PACKAGE #9
PROPOSED TRAFFIC SIGNAL PLAN
S. DAIRY ASHFORD ROAD AT RICHMOND AVENUE
WBS NUMBER N-310650-0084-3
DRAWING SCALE FULL 1"=20' HALF 1"=40'
CITY OF HOUSTON PM
CHAD ZORN, P.E.
SHEET NO. 28 OF 78

PROPOSED TRAFFIC SIGNAL POLE SCHEDULE

POLE NUMBER	POLE TYPE	MAST ARM		SIGNALS		LUMINAIRE TYPE	PED PB TYPE/SIGN	REMARKS	LOCATION	STANDARDS
		SIGNAL	LUMINAIRE	MOUNTING	FACE					
C S10 S11 S12 13' 13' 14'	TYPE 2	40'	15'	3 - ASTROBRAC 1 - SIDE OF POLE	1 - H3L 2 - H3 1 - V3L	115 WATT LED COBRA HEAD LUMINAIRE W/PHOTOCELL	-	PRE-EMPT SENSOR (DUAL TURRETS) WIMAX ANTENNA SPP RADIO SIGNS: S10 = R10-5L (24"x30") S11 = STREET NAME S12 = R10-5L (24"x30")	BY ENGINEER IN FIELD AT APPROX: POLE C: STA. 2+89, 51' RT RICHMOND AVE. CONST ℄	02893-02 02893-03 02893-04A 02893-04B 02893-05 02893-09 02893-12
D S1 S2 S3 13' 13' 14'	TYPE 2	40'	15'	3 - ASTROBRAC 2 - SIDE OF POLE	1 - H3L 2 - H3 1 - V3L 1 - CDP	115 WATT LED COBRA HEAD LUMINAIRE	POLARA NAVIGATOR R10-3E (R)	PRE-EMPT SENSOR (DUAL TURRETS) SIGNS: S1 = R10-5L (24"x30") S2 = STREET NAME S3 = R10-5L (24"x30")	BY ENGINEER IN FIELD AT APPROX: POLE D: STA. 2+83, 52' LT RICHMOND AVE. CONST ℄	02893-02 02893-03 02893-04A 02893-04B 02893-05 02893-09 02893-12
E S4 S5 S6 13' 13' 14'	TYPE 2	40'	15'	3 - ASTROBRAC 2 - SIDE OF POLE	1 - H3L 2 - H3 1 - V3L 1 - CDP	115 WATT LED COBRA HEAD LUMINAIRE	POLARA NAVIGATOR R10-3E (R)	PRE-EMPT SENSOR SPP RADIO (DUAL TURRETS) SIGNS: S4 = R10-5L (24"x30") S5 = STREET NAME S6 = R10-5L (24"x30")	BY ENGINEER IN FIELD AT APPROX: POLE E: STA. 3+92, 56' LT RICHMOND AVE. CONST ℄	02893-02 02893-03 02893-04A 02893-04B 02893-05 02893-09 02893-12
F S7 S8 S9 13' 13' 9'	TYPE 1	35'	15'	3 - ASTROBRAC 1 - SIDE OF POLE	1 - H3L 2 - H3 1 - V3L	115 WATT LED COBRA HEAD LUMINAIRE	-	PRE-EMPT SENSOR (DUAL TURRETS) SIGNS: S7 = R10-5L (24"x30") S8 = STREET NAME S9 = R10-5L (24"x30")	BY ENGINEER IN FIELD AT APPROX: POLE F: STA. 4+14, 46' RT RICHMOND AVE. CONST ℄	02893-02 02893-03 02893-04A 02893-04B 02893-05 02893-09 02893-12
H	PED POLE 15'	-	-	1 - SIDE OF POLE	1 - CDP	-	POLARA NAVIGATOR R10-3E (L)	-	BY ENGINEER IN FIELD AT APPROX: POLE H: STA. 3+92, 54' RT RICHMOND AVE. CONST ℄	02893-02 02893-03 02893-06 02893-07
G L N Q	PED POLE 15'	-	-	1 - SIDE OF POLE	1 - CDP	-	POLARA NAVIGATOR R10-3E (L)	-	BY ENGINEER IN FIELD AT APPROX: POLE G: STA. 3+95, 43' RT POLE L: STA. 2+78, 49' RT POLE N: STA. 2+90, 57' LT POLE Q: STA. 4+03, 51' LT RICHMOND AVE. CONST ℄	02893-02 02893-03 02893-06 02893-07
J M P R	PED POLE 15'	-	-	2 - SIDE OF POLE	2 - CDP	-	POLARA NAVIGATOR R10-3E L (R)	-	BY ENGINEER IN FIELD AT APPROX: POLE J: STA. 3+38, 50' RT POLE M: STA. 2+89, 07' LT POLE P: STA. 3+46, 54' LT POLE R: STA. 4+94, 03' RT RICHMOND AVE. CONST ℄	02893-02 02893-03 02893-06 02893-07
K	PED POLE 15'	-	-	1 - SIDE OF POLE	1 - CDP	-	POLARA NAVIGATOR R10-3E (R)	-	BY ENGINEER IN FIELD AT APPROX: POLE K: STA. 2+90, 59' RT RICHMOND AVE. CONST ℄	02893-02 02893-03 02893-06 02893-07

TRAFFIC SIGNAL CONTROLLER

CABINET	TYPE	CONTROLLER	AUX. CONTROL	REMARKS	LOCATION	STANDARDS
A	METERED PEDESTAL SERVICE UL TYPE 3R	METERED PEDESTAL SERVICE WITH ONE 30 AMP AND ONE 60 AMP BREAKER	-	PROVIDE METER SOCKET WINDOW 4" H X 6" W	BY ENGINEER IN FIELD AT APPROX: STA. 2+92, 75' LT (CENTER OF CABINET) RICHMOND AVE. CONST ℄	02893-14
B	TYPE 340 ITS	2070L WITH GPS SERIAL COMMUNICATIONS MODULE	-	STANDARD SPECIFICATION 16730 & 16731 UNINTERRUPTIBLE POWER SUPPLY - STANDARD SPECIFICATION 16732 FIELD HARDENED ETHERNET SWITCH (SIX COPPER PORTS ONLY) - STANDARD SPECIFICATION 16733 WIMAX - STANDARD SPECIFICATION 16734 WIRELESS MAGNETOMETER VEHICLE DETECTION SYSTEM - STANDARD SPECIFICATION 16751 GPS SERIAL COMMUNICATIONS MODULE- STANDARD SPECIFICATION 16785	BY ENGINEER IN FIELD AT APPROX: STA. 2+86, 57' RT (CENTER OF CABINET) RICHMOND AVE. CONST ℄	02893-10C

NOTES:

1. ALL SIGNAL HEADS WILL BE 12" WITH LOUVERED BACK PLATES AND YELLOW HOUSING
2. POLES G, K, L, M AND Q WILL HAVE CONCRETE FOUNDATION
3. POLES H, J, N, P AND R WILL HAVE SCREW-IN ANCHOR FOUNDATION

STOP LINE AND WMVDS SENSOR LOCATIONS

ITEM BY DIRECTION	STATION S. DAIRY ASHFORD RD.	OFFSET
SOUTHBOUND		
STOP LINE @ GUTTER	4+32	39' LT
STOP LINE @ CENTERLINE	4+32	01' LT
SOUTHBOUND (THRU LANES)		
PHASE 4 CALL SENSOR		
L4-1A SENSOR	4+36	CENTERED IN LANE
L4-2A SENSOR	4+36	CENTERED IN LANE
PHASE 4 PULSE LOOPS		
L4-1B LEADING EDGE (6'X6')	300' FROM STOP BAR	CENTERED IN LANE
L4-2B LEADING EDGE (6'X6')	300' FROM STOP BAR	CENTERED IN LANE
SOUTHBOUND (LEFT TURN LANE)		
PHASE 7 PRESENCE SENSOR		
L7-1A SENSOR	4+24	CENTERED IN LANE
L7-1B SENSOR	4+35	CENTERED IN LANE
L7-1C SENSOR	4+46	CENTERED IN LANE
L7-1D SENSOR	4+69	CENTERED IN LANE
NORTHBOUND		
STOP LINE @ GUTTER	3+18	39' RT
STOP LINE @ CENTERLINE	3+18	03' RT
NORTHBOUND (THRU LANES)		
PHASE 8 CALL SENSOR		
L8-1A SENSOR	3+14	CENTERED IN LANE
L8-2A SENSOR	3+14	CENTERED IN LANE
PHASE 8 PULSE LOOPS		
L8-1B LEADING EDGE (6'X6')	300' FROM STOP BAR	CENTERED IN LANE
L8-2B LEADING EDGE (6'X6')	300' FROM STOP BAR	CENTERED IN LANE
NORTHBOUND (LEFT TURN LANE)		
PHASE 3 PRESENCE SENSOR		
L3-1A SENSOR	3+26	CENTERED IN LANE
L3-1B SENSOR	3+15	CENTERED IN LANE
L3-1C SENSOR	3+08	CENTERED IN LANE
L3-1D SENSOR	2+81	CENTERED IN LANE
ITEM BY DIRECTION	**STATION RICHMOND AVE.**	**OFFSET**
EASTBOUND		
STOP LINE @ GUTTER	2+84	39' RT
STOP LINE @ CENTERLINE	2+84	01' RT
EASTBOUND (THRU LANES)		
PHASE 2 CALL SENSOR		
L2-1A SENSOR	2+80	CENTERED IN LANE
L2-2A SENSOR	2+80	CENTERED IN LANE
PHASE 2 PULSE LOOPS		
L2-1B LEADING EDGE (6'X6')	300' FROM STOP BAR	CENTERED IN LANE
L2-2B LEADING EDGE (6'X6')	300' FROM STOP BAR	CENTERED IN LANE
EASTBOUND (LEFT TURN LANE)		
PHASE 5 PRESENCE SENSOR		
L5-1A SENSOR	2+92	CENTERED IN LANE
L5-1B SENSOR	2+81	CENTERED IN LANE
L5-1C SENSOR	2+76	CENTERED IN LANE
L5-1D SENSOR	2+47	CENTERED IN LANE
WESTBOUND		
STOP LINE @ GUTTER	3+98	40' LT
STOP LINE @ CENTERLINE	3+98	05' LT
WESTBOUND (THRU LANES)		
PHASE 6 CALL SENSOR		
L6-1A SENSOR	4+02	CENTERED IN LANE
L6-2A SENSOR	4+02	CENTERED IN LANE
PHASE 6 PULSE LOOPS		
L6-1B LEADING EDGE (6'X6')	300' FROM STOP BAR	CENTERED IN LANE
L6-2B LEADING EDGE (6'X6')	300' FROM STOP BAR	CENTERED IN LANE
WESTBOUND (LEFT TURN LANE)		
PHASE 1 PRESENCE SENSOR		
L1-1A SENSOR	3+90	CENTERED IN LANE
L1-1B SENSOR	4+02	CENTERED IN LANE
L1-1C SENSOR	4+12	CENTERED IN LANE
L1-1D SENSOR	4+35	CENTERED IN LANE

No.	Date	Description	App.

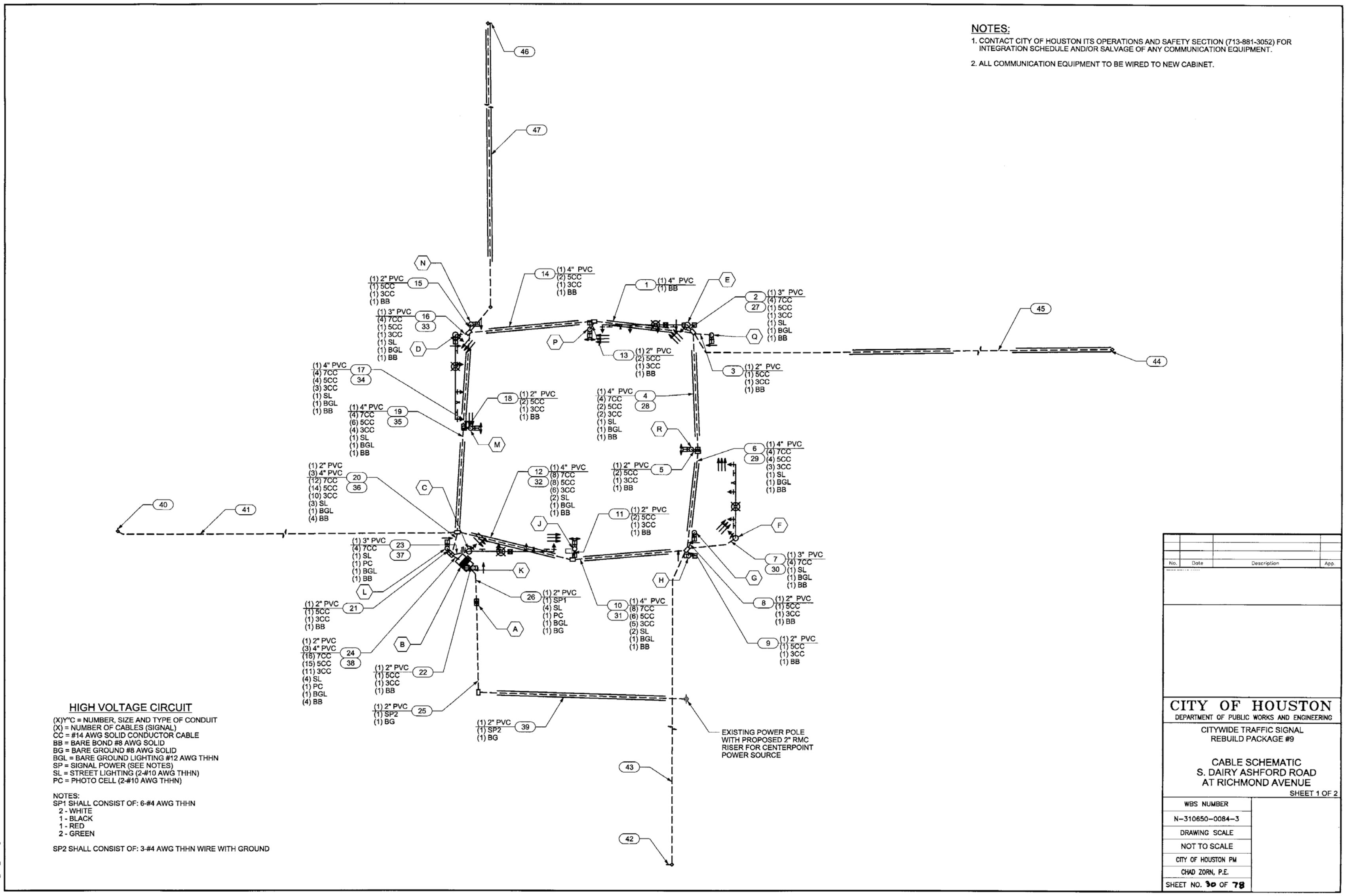
CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING

CITYWIDE TRAFFIC SIGNAL
REBUILD PACKAGE #9

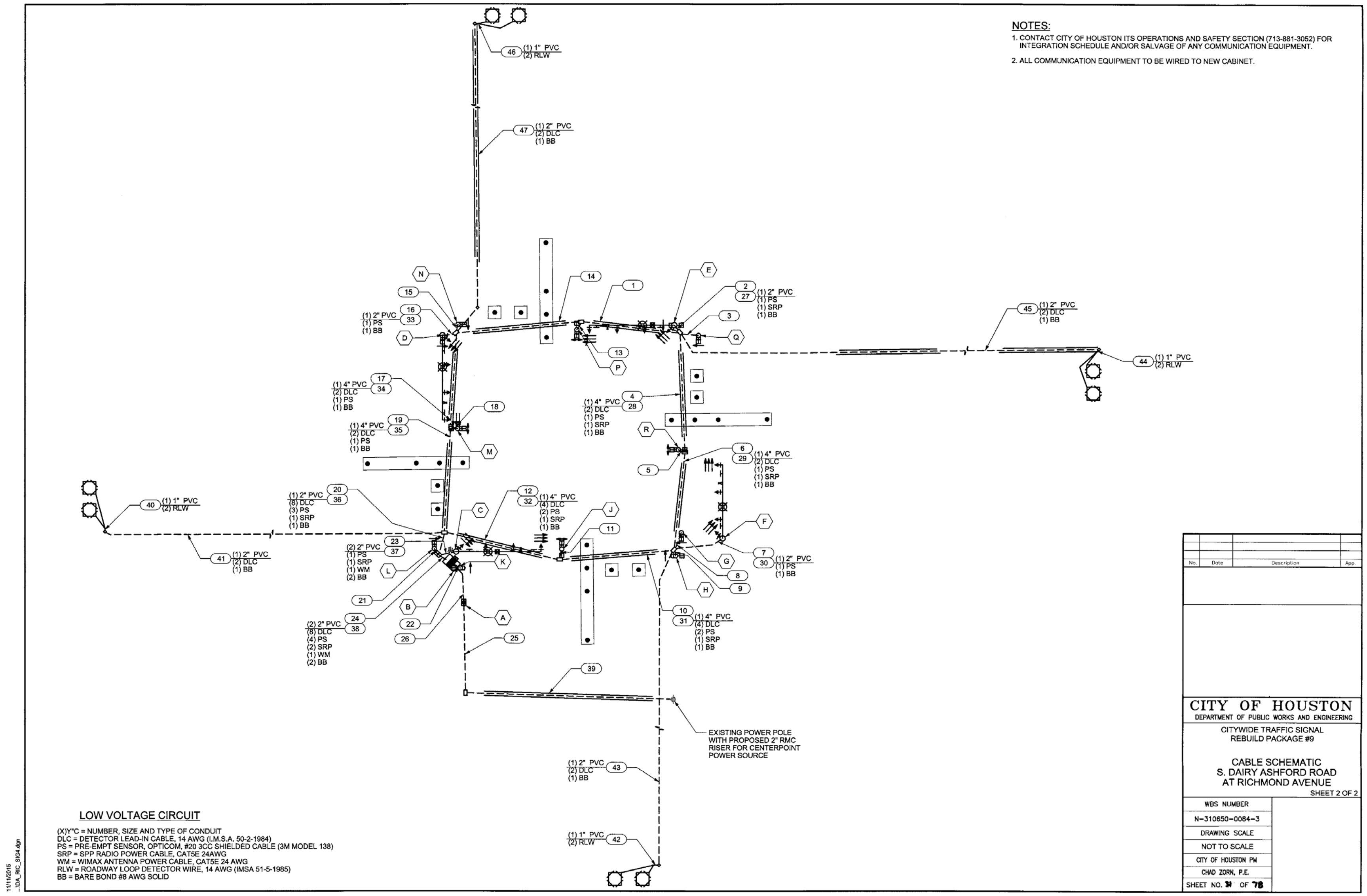
TRAFFIC SIGNAL
POLE SCHEDULE
S. DAIRY ASHFORD ROAD
AT RICHMOND AVENUE

WBS NUMBER
N-310650-0084-3
DRAWING SCALE
NOT TO SCALE
CITY OF HOUSTON PM
CHAD ZORN, P.E.
SHEET NO. 29 OF 78

11/11/2015
...\DA_RIC_SIG2.dgn



NOTES:
1. CONTACT CITY OF HOUSTON ITS OPERATIONS AND SAFETY SECTION (713-881-3052) FOR INTEGRATION SCHEDULE AND/OR SALVAGE OF ANY COMMUNICATION EQUIPMENT.
2. ALL COMMUNICATION EQUIPMENT TO BE WIRED TO NEW CABINET.
EXISTING POWER POLE WITH PROPOSED 2" RMC RISER FOR CENTERPOINT POWER SOURCE
HIGH VOLTAGE CIRCUIT
(X)Y"C = NUMBER, SIZE AND TYPE OF CONDUIT
(X) = NUMBER OF CABLES (SIGNAL)
CC = #14 AWG SOLID CONDUCTOR CABLE
BB = BARE BOND #8 AWG SOLID
BG = BARE GROUND #8 AWG SOLID
BGL = BARE GROUND LIGHTING #12 AWG THHN
SP = SIGNAL POWER (SEE NOTES)
SL = STREET LIGHTING (2-#10 AWG THHN)
PC = PHOTO CELL (2-#10 AWG THHN)
NOTES:
SP1 SHALL CONSIST OF: 6-#4 AWG THHN
2 - WHITE
1 - BLACK
1 - RED
2 - GREEN
SP2 SHALL CONSIST OF: 3-#4 AWG THHN WIRE WITH GROUND
CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING
CITYWIDE TRAFFIC SIGNAL
REBUILD PACKAGE #9
CABLE SCHEMATIC
S. DAIRY ASHFORD ROAD
AT RICHMOND AVENUE
SHEET 1 OF 2
WBS NUMBER
N-310650-0084-3
DRAWING SCALE
NOT TO SCALE
CITY OF HOUSTON PM
CHAD ZORN, P.E.
SHEET NO. 30 OF 78


NOTES:
1. CONTACT CITY OF HOUSTON ITS OPERATIONS AND SAFETY SECTION (713-881-3052) FOR INTEGRATION SCHEDULE AND/OR SALVAGE OF ANY COMMUNICATION EQUIPMENT.
2. ALL COMMUNICATION EQUIPMENT TO BE WIRED TO NEW CABINET.
EXISTING POWER POLE WITH PROPOSED 2" RMC RISER FOR CENTERPOINT POWER SOURCE
LOW VOLTAGE CIRCUIT
(X)Y"C = NUMBER, SIZE AND TYPE OF CONDUIT
DLC = DETECTOR LEAD-IN CABLE, 14 AWG (I.M.S.A. 50-2-1984)
PS = PRE-EMPT SENSOR, OPTICOM, #20 3CC SHIELDED CABLE (3M MODEL 138)
SRP = SPP RADIO POWER CABLE, CAT5E 24AWG
WM = WIMAX ANTENNA POWER CABLE, CAT5E 24 AWG
RLW = ROADWAY LOOP DETECTOR WIRE, 14 AWG (IMSA 51-5-1985)
BB = BARE BOND #8 AWG SOLID
11/11/2015
...\DA_RIC_SIG4.dgn
No.
Date
Description
App.
CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING
CITYWIDE TRAFFIC SIGNAL
REBUILD PACKAGE #9
CABLE SCHEMATIC
S. DAIRY ASHFORD ROAD
AT RICHMOND AVENUE
SHEET 2 OF 2
WBS NUMBER
N-310650-0084-3
DRAWING SCALE
NOT TO SCALE
CITY OF HOUSTON PM
CHAD ZORN, P.E.
SHEET NO. 31 OF 78

City of Houston

Design Manual

Chapter 16

COMMUNICATION FACILITY REQUIREMENTS

~~MISCELLANEOUS~~

Chapter 16
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Communication Facility Requirements

SECTION PAGE

Chapter 16

COMMUNICATION FACILITY REQUIREMENTS

~~**SECTION 1 MISCELLANEOUS**~~
~~**SECTION 2**~~

SECTION 1 - COMMUNICATION FACILITY REQUIREMENTS OVERVIEW

~~16.2.01~~16.1.01 CHAPTER INCLUDES

~~16.2.01.A~~16.1.01.A Criteria for Communication~~miscellaneous~~ ~~f~~Facilities within the P~~p~~ublic R~~r~~ight~~-~~-of~~-~~-W~~w~~ay including:

~~1. Tree protection~~

~~2. Residential subdivision markers~~

~~3. Sky bridges~~

1. Wireless or radio, cable and wireline ~~F~~facilit~~y~~ies, G~~g~~round ~~E~~equipment, and~~/or~~ ~~L~~~~licensee P~~~~p~~ole.

~~16.2.02~~16.1.02 REFERENCES

16.1.02.A ~~Refer to list of references in Chapter 1, General Requirements~~AASHTO, Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, latest edition.

1. LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals

2. Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals

16.1.02.B AASHTO, A Policy on Geometric Design of Highways and Streets ("The Green Book"), latest edition.

16.1.02.C AASHTO, Roadside Design Guide, latest edition.

16.1.02.D City of Houston Code of Ordinances, Chapter 40, Article XXI - Facilities in the Public Right-of-Way.

16.1.02.E City of Houston Construction Code Amendments, latest adopted amendments.

~~16.2.02.A~~16.1.02.F International Building Code (IBC), edition adopted by the City of

Houston.

~~16.2.02.B~~16.1.02.G Structural Standard for Antenna Supporting Structures, Antennas and Small Wind Turbine Support Structures (TIA-222), editions identified in the International Building Code (IBC).

16.1.02.H Texas Local Government Code 283 – Management of Public Right-of-Way Used by Telecommunications Provider in Municipality.

~~16.2.02.C~~16.1.02.I Texas Local Government Code 284 – Deployment of Network Nodes in Public Right-of-Way.

~~16.2.02.D~~16.1.02.J Texas Utilities Code, Chapter 251 - Underground Facility Damage Prevention and Safety.

~~16.2.02.E~~16.1.02.K Refer to list of references in Chapter 1, General Requirements.

~~16.2.03~~16.1.03 DEFINITIONS

16.1.03.A The following terms are as defined in Chapter 284 of the Texas Local Government Code:

~~16.2.03.A~~1. Antenna

~~1.~~ Collocate and Collocation

2. ~~“~~Design District~~” means an area that is zoned, or otherwise designated by municipal code, and for which the City maintains and enforces unique design and aesthetic standards on a uniform and nondiscriminatory basis.~~

3. ~~“~~Historic District~~” means an area that is zoned or otherwise designated as a historic district under municipal, state, or federal law.~~

4. Micro Network Node

5. Municipal Park

6. Network Node

7. ~~“~~Network Provider~~” means a) a wireless provider; or b) a person that does not provide wireless services and that is not an electric utility but builds or installs on behalf of a wireless service provider.~~

8. Node Support Pole

9. Permit

~~2.~~10. Public Right-of-Way

~~3.~~11. Service Pole

12. Utility Pole

16.1.03.B Communication Facility – Devices and equipment for wired and radio communications, including transport fiber or other transmission lines, above ground cabinets, radios, Antennas, Network Nodes, backup batteries, transmitters, wires, and support ports.

~~16.2.03.B~~16.1.03.C Drawings – Plans, profiles, details, and other graphic sheets to be used in a construction contract which define character and scope of the project.

16.1.03.D Professional Engineer - An engineer currently licensed and in good standing with the Texas Board of Professional Engineers and Land Surveyors (TBPELS).

16.1.03.E Repeater Device – An efficient Antenna system, that receives weak signals and widens transmission coverage.

16.1.03.F Repeater Poles – Poles on which Repeater Devices are installed.

16.1.03.G Residential Areas – Single-family, multifamily, town home, duplex, apartment, any other residential configurations, and undeveloped land that is platted for residential use.

16.1.03.H Street Right-of-Way ~~-~~ – The ~~E~~entire width between the boundary lines of every way which is held by the ~~c~~City, county, state or otherwise by the public in fee or dedication when any part thereof is open to the use of the public for purposes of vehicular travel.

~~Plan Reviews/Permits~~

~~SECTION 3~~SECTION 2 - COMMUNICATION FACILITY DESIGN REQUIREMENTS

16.2.01 ~~WIRELESS SERVICE FACILITIES~~DESIGN REQUIREMENTS

~~16.3.01.A~~16.2.01.A General Requirements

~~Definitions as follows are a partial list of those defined in Local Government Code 284 – Deployment of Network Nodes in Public Right-of-Way and are repeated here for clarity:~~

1. ~~Wireless Service~~ Communication Facilities shall comply with Texas Local Government Code 283 – Management of Public Right-of-Way Used by Telecommunications Provider in Municipality, Texas Local Government Code 284 – Deployment of Network Nodes in Public Right-of-Way, ~~and City Ordinance Chapter 40,~~ Article XXI, Chapter 40, – Facilities in the Public Right-of-Way of the City of Houston Code of Ordinances and this Infrastructure Design Manual. The most stringent requirements shall govern.

2. Facilities must comply with all applicable state and federal requirements, including the Americans with Disabilities Act and must not create a visibility or accessibility issue as finally configured.

3. Communication Facility Markings:

   a. All Communication Facilities must have a permanent identification marking that provides the following owner information:

      (1) Name (Pole owner or ground facility owner)

      (2) Address

      (3) Phone Number

   b. Permanent identification marking text must be legible at eye level for all poles.~~A Network Provider shall comply with the design and aesthetic standards of a Historic or Design District and explore the feasibility of using certain camouflage measures to improve the aesthetics of the new network nodes, new node support poles,, or related ground equipment, or any portion of the nodes, poles, or equipment, to minimize the impact to the aesthetics in a historic district or on a design district's decorative poles.~~

4. Prior to submitting ~~d~~Drawings to the City of Houston, the Network Provider shall coordinate with the Historic or Design District~~.~~ and ~~S~~submit the evidence of coordination with the ~~design drawings~~Drawings to the Houston Permitting Center located ~~at~~on the 2nd floor of 1002 Washington Ave, Houston TX 77002.

~~2.~~5. The maximum dimensions measured for the Antenna components of the installation shall meet the Texas Local Government Code, Chapter 284.

16.2.01.A~~A.10~~

6. Proposed equipment (i.e., power supply and cabinets) associated with the ~~Wireless Service~~ Communication Facilities can be placed in line with existing poles if the proposed node is ~~c~~Co-~~l~~located on the existing pole. The edge of the equipment shall not be any closer to the curb than the associated pole.

7. If the proposed pole(s) or equipment installation cannot meet required clearances from sidewalk, public utilities, and other public infrastructure, then the proposed pole or equipment must be relocated to a location where the clearances are met. Special circumstances need to be reviewed and approved by the Office of the City Engineer.

~~16.3.02 Sidewalk, public utilities and other public infrastructure can be relocated if the proposed pole(s) or equipment installation cannot meet required clearances.~~

8. The use of City infrastructure is prohibited without the approval of the City Engineer and the City Bridge Engineer/Traffic Engineer or the Director of the operations unit responsible for its maintenance. The standard approval is dependent on the type of City infrastructure.

   a. Upon request from the City, approved non-traffic related devices mounted to City infrastructure that interfere with any existing traffic signal communications or ITS equipment shall be immediately removed at the cost of the provider.

9. ~~Wireless Service~~ At or above ground Communication Facilities and related equipment shall be placed in accordance with the following requirements:

   ~~b.~~a. Within two (2) feet inside of the ~~s~~Street ~~r~~Right-of-~~w~~Way line. ~~If unable to place within 2 feet of right-of-way line, then Wireless Service Facilities shall be placed no closer than 2 feet of the back of curb of any roadway.~~

      (1) Curb and Gutter Roadway Section

         (a) Provide a minimum clearance of two (2) feet between the back of curb and outer surface of Communication Facilities and poles.

      (2) Roadways with Ditch

         ~~c.~~(a) No at or above ground Communication Facilities and poles are allowed within the ditch or between the ditch and the edge of pavement.

   ~~d.~~b. Poles and cabinets shall ~~N~~not be within ten (10) feet of a driveway.

   ~~e.~~c. Poles and cabinets shall ~~N~~not be within fifty (50) feet (measured from the Street ~~r~~Right-of-~~w~~Way line) of a local street intersection and one hundred (100) feet (measured from the Street ~~r~~Right-of-~~w~~Way line) of a major street intersection.

16.201.A.9 continued

~~f.~~d. Network Provider shall not install Network Nodes or Repeater Devices within two hundred and fifty (250) foot radius from a traffic signal pole or ITS equipment. Any Network Node or Repeater Device within two hundred and fifty (250) feet will require a zero (0) interference study and must be approved by the City Engineer through a variance request.

e. ~~Not within any~~A clearance of one (1) foot from the edge of the sidewalk is required for Communication Facilities above ground.~~area or within 3 feet of the centerline of a sidewalk which is less than 5 feet in width.~~

f. Installing above ground Communication Facilities on Main Street in the downtown urban Design Districts is prohibited.

g. Preferred locations for poles are industrial areas, highway areas and retail/commercial areas that are not adjacent to Municipal Parks, Residential Areas, and Historic or Design Districts.

h. In Residential Areas, poles and cabinets shall be located where the shared property line between two residential parcels intersects the Public Right-of-Way.

i. In non-Residential Areas, poles and cabinets shall be located between tenant spaces, storefront bays, or adjoining properties where their shared property lines intersect the Public Right-of-Way.

j. In no instance shall any pole or cabinet be located in front of a building entrance or exit.

k. No components may obstruct any existing signage, signals or ITS devices.

l. All components must be positioned as to assure that all intersection and driveway visibility requirements are maintained.

~~2.~~10. Requirements for Communication Device Installation on Poles:

a. No penetration of the pole is allowed.

~~16.3.02.B~~16.2.01.B Network Nodes:

1. Network Node attachments to all poles shall be installed at least twelve (12) feet above the ground. If a Network Node attachment is projecting toward the street, the attachment shall be installed no less than eighteen and half (18.5) feet above the ground to the bottom of the node, for the safety and protection of the public and vehicular traffic.

2. The City encourages Collocation of more than one Network Node on any one pole.

16.2.01.C.1 continued

16.2.01.C Network Poles:

1. Node Support Poles and Repeater Poles:

a. Wooden poles are prohibited in the clear zone as defined in AASHTO Green Book.

b. All new poles and substitution poles located in the clear zone are required to be breakaway poles. All breakaway poles shall weigh less than 992 lbs. as described in Section 12 "Breakaway Supports" of AASHTO's Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signal.

c. The style and color of proposed Node Support Poles and Repeater Poles shall match existing Node Support Poles and Repeater Poles in order to blend into the surrounding environment and be visually unobtrusive. The proximity of the existing pole from the proposed pole will be established by the following criteria:

(1) Within Design Districts and Historic Districts:

(a) Node Support Poles and Repeater Poles must meet Design District or Historic District requirements.

(2) Outside Design Districts and Historic Districts:

(a) Proposed Node Support Poles and Repeater Poles shall be generally consistent with color and height of existing Node Support Poles and Repeater Poles within a 1,000 feet radius and shall be subject to City approval.

(b) When different types of existing poles are in the 1,000 ft radius area, type of new proposed poles within that area will be subject to City approval.

~~a.~~d. All attachments for the Network Node shall also match the color of the Node Support Pole or Repeater Pole.

e. It is preferred that Node Support Poles and Repeater Poles shall be installed along arterials or residential collectors.

f. For any ~~p~~Public ~~r~~Right-of-~~w~~Way that is ~~not more than~~ fifty (50) feet wide or less:

(1) ~~No new node support pole shall be installed on either side of the right-of-way that border a street that is next to a municipal park.~~No new ~~n~~Node ~~s~~Support Poles and Repeater ~~p~~Poles shall be installed on either side of the Public ~~r~~Right-of-~~w~~Way that includes a street ~~border a street~~ that is next to or in ~~r~~Residential ~~a~~Areas ~~(single-family, multifamily, town~~

16.2.01.C.1 continued

~~home, duplex, apartment, or any other residential configuration)~~ or undeveloped land that is platted for residential use. ~~Pole(s) can be installed at the side of commercial areas across the street from residential areas (single-family, multi-family, town home, duplex, apartment, or any other residential configuration), when the public street right-of-way is more than 50 feet wide.~~

~~(2)~~

g. For any Public Right-Of-Way that is more than fifty (50) feet wide:

(1) Node Support Poles and Repeater Pole~~(s)~~ can be installed in ~~r~~Residential ~~a~~Areas ~~(single-family, multi-family, town home, duplex, apartment, or any other residential configuration)~~ but must be installed at the lot line ~~when the public street right-of-way is more than 50 feet and~~ if both sides of the street are residential.

(2) If one side of the street is commercial, then the Node Support Poles or Repeater Poles shall be located on the commercial side of the street.

h. Node Support Poles and Repeater Poles shall be set back a minimum of fifteen (15) feet from any pedestrian ramp.

i. Node Support Poles, Repeater Poles and accessory equipment shall be located at least ten (10) feet from a driveway.

j. No Node Support Poles or Repeater ~~p~~Pole(s) are to be installed in front of the front door or entry way of any single-family, multi-family, town home, duplex, apartment, or any other residential configuration, either on the same side of the street or directly across from the structure's door or entry way.

~~b.~~k. Existing poles that are determined to be structurally inadequate, will be replaced with a new pole or reinforced by the provider at the cost of the provider.

(1) If pole reinforcement is necessary, Network Provider shall provide Drawings for the proposed alteration to the existing pole.

16.2.01.C.1 continued

2. Utility Poles: Existing Utility Poles (electric and telephone poles) are the most preferred support pole for Network Nodes and related equipment.

3. City-Owned Service Poles:

   a. City Service Poles can be used for installation of Network Nodes and related equipment, if approved by the City.

   b. Any reinforcement or replacement of a pole shall match the color of the existing pole.

   c. Any pole reinforcement or replacement shall be at Network Provider's sole cost.

16.2.01.D Network Pole Load Analysis and Design Criteria:

1. Analysis and design of pole and device attachments must be according to the latest edition of any of the following applicable codes:

   a. International Building Code (IBC) and, City of Houston Construction Code Amendments;

   b. AASHTO Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals;

   c. Structural Standard for Antenna Supporting Structures, Antennas and Small Wind Turbine Support Structures (TIA-222); and

   d. Any other relevant codes required.

2. Basic wind speed used for design must be according to the adopted City of Houston Construction Code Amendments to the International Building Code (IBC).

~~2.~~3. The analysis and design must include all structural elements, including but not limited to, the concrete foundation, base plate, anchor bolts, pole, mast arm and device connection.

16.2.01.D.3 continued

a. Include a summary of critical unity checks for all components of the structure and device connections. The reported values shall correlate with the pole analysis report and documented device specifications. Analysis must clearly show that all members have adequate size and reinforcement to withstand all imposed:

(1) Gravity and lateral loads;

(2) Bending stresses;

(3) Shear stresses;

(4) Deflection; and

(5) Fatigue due to stress fluctuations. (A dynamic analysis of structures may be performed), where applicable.

4. Summary of criteria used in pole analysis and analysis results including, at a minimum, material properties, loadings, load combinations, reactions, deflections and dimensions assumed.

16.2.01.E Ground Equipment:

1. Ground equipment near street corners and intersections:

a. Ground equipment shall be minimal and the least intrusive.

b. Ground equipment shall be installed outside of visibility/sight triangles for safe travel of vehicular and pedestrian traffic.

2. Ground equipment shall be neutral color, and of material compatible with the surrounding structures as determined by the City.

3. Ground equipment near public parks: The Network Provider shall not install ground equipment in a Public Right-of-Way that is within a park or within two hundred and fifty (250) feet of the boundary line of a park, unless approved by the City.

4. Minimize ground equipment density: The City may deny a request for a proposed location if the Network Provider installs Network Node ground equipment where existing ground equipment within three hundred (300) feet already occupies a footprint of twenty-five (25) square feet or more.

16.2.01.F Underground Facilities:

1. Perform field surveys for all underground facility projects to verify depths and horizontal locations of all utilities in the vicinity of the proposed scope of work. Refer to Chapter 2 for surveying requirements.

16.2.01.F continued

2. Underground installations for communications equipment, cables and conduits shall be per Texas Utilities Code, Chapter 251 - Underground Facility Damage Prevention and Safety.

3. Underground facilities must have a minimum three (3) feet of vertical clearance and four (4) feet of horizontal clearance from outside diameter of any utility lines (not centerline). Where minimum clearances in other chapters of this manual conflict, the strictest requirement shall govern. In addition, the underground facilities must be located vertically so that service connections to the public storm sewer line and public sanitary sewer line on either side of the right of way are not occluded or blocked vertically.

~~16.3.02.C~~16.2.01.G Subsurface Utility Exploration (SUE): SUE is required for all underground installations of communication equipment, cables, and conduits. Refer to Chapter 6 for SUE requirements.

16.2.02 SUBMITTALS

16.2.02.A Installations on all City Service Poles shall be in accordance with a written agreement with the City.

16.2.02.B Drawings:

1. Network Provider shall submit Drawings prior to:

    a. Installation of proposed Network Node, Node Support Pole and Repeater Pole;

    b. Installation, modification, or relocation of Network Node on an existing pole or structure;

    c. Modification or relocation of an existing Node Support Pole or Repeater Pole; or

    d. Installation of any other Communication Facility in the City's right-of-way.

2. All existing utilities must be shown on Drawings. Sources of data include survey, record drawings, graphical information systems, and field visits. Field visits must be made to verify the Drawings accurately portray the existing conditions, and the field visit date shall be listed on the Drawings. Refer to Chapter 3 for exceptions.

3. For existing poles, submit applicable design detail drawings, site plan and pictures of the specific pole and surrounding area.

    a. Pictures shall show any existing pole damage or oxidation if it exists.

    ~~a.~~b. Pictures shall show an unobstructed view of the entire pole and mast arm.

4. Drawings must show type, height, size and location of all existing and proposed

devices and signs on the pole.

5. Identify proposed location and method of proposed installation (trench, bore, existing conduit pull) of proposed and existing Communication Facilities necessary to connect the Network Node to the public switched telephone network.

6. Provide specific location with X, Y coordinates (northing and easting) and Pole ID.

7. Identify on Drawings existing and proposed placement of Network Node, devices and equipment on pole, and any ground equipment, cabinets, and appurtenances.

8. Show vertical and horizontal distances of all existing and proposed signs and devices that are attached to the pole as measured from the bottom of the pole's baseplate.

9. Show each proposed device attachment and physical specifications. Drawings must include the device quantity, description, manufacturer, model number, azimuth, cable length, weight and dimensions.

10. Show proposed device attachment details.

16.2.02.C Specifications:

1. Provide pole manufacturer drawings and specifications (height, class, material properties);

2. Provide electrical and any other device specifications upon request by the City.

16.2.02.D Pole Load Analysis:

1. Pole load analysis reports must be submitted with each Permit application for proposed or replaced Network Nodes to be placed on proposed or existing poles.

2. Pole load analysis must be for the actual pole, device configuration and device attachment.

3. Engineer's cover letter, pole load analysis, design calculations and Drawings must be signed, and sealed by a Texas Registered Civil/Structural Professional Engineer.

   a. Engineer cover letter for pole design must indicate that it is in full accordance with the analysis and design criteria as established in 16.2.01.D.

~~2.~~4. All codes and design criteria used for design and analysis must be indicated on Drawings, engineer's cover letter and within the pole load analysis report.

16.2.02.~~EB.3~~ continued

16.2.02.E SUE Deliverable:

1. SUE reports are required for quality level A SUE. Reports shall include general locations, photographs of test holes, test hole data sheets (x, y and z coordinates, utility type, size, and material). Refer to Chapter 6 for additional SUE requirements.

16.2.02.F Geospatial Data Deliverables:

Provide GIS datasets in accordance with Chapter 13 – Geospatial Data Deliverables.

1.

16.2.03 QUALITY ASSURANCE

16.2.03.A Calculations, reports and Drawings must be prepared, signed, and sealed by a Texas licensed Professional Engineer.

16.2.03.B The City may perform visual inspections of any Micro Network Node, Network Node, Node Support Pole, Repeater Pole, or related ground equipment located in the Public Right-of-Way as the City deems appropriate without notice. If the inspection requires physical contact with the Micro Network Node, Network Node, Node Support Poles, Repeater Poles, or related ground equipment, the City will provide written notice to the Network Provider. Network Provider may have a representative present during such inspection. In the event of an emergency, the City may, but is not required to, notify Network Provider of an inspection. The City may take action necessary to remediate the emergency and the City will notify Network Provider as soon as practically possible after remediation is complete.

END OF CHAPTER

City of Houston

Design Manual

Chapter 17

~~BICYCLE, TRANSIT AND~~ PEDESTRIAN, BICYCLE, AND TRANSIT DESIGN REQUIREMENTS

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Pedestrian, Bicycle, and Transit Design Requirements

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~~BICYCLE, TRANSIT AND~~ PEDESTRIAN, BICYCLE, AND TRANSIT DESIGN REQUIREMENTS

SECTION 1 - PEDESTRIAN, BICYCLE, AND TRANSIT OVERVIEW

17.1.01 CHAPTER INCLUDES

17.1.01.A ~~A. Geometric design guidelines for bicycle, pedestrian, and transit facilities.~~ Standards and guidelines for the design of complete streets that are safe, accessible and enjoyable for Vulnerable Road Users who walk, use a mobility aid, bike, and take transit. By improving the street for its most Vulnerable Road Users, we improve safety for everyone.

~~17.1.01.A~~17.1.01.B Standards and guidelines for pedestrian, bicycle and transit infrastructure including but not limited to new streets/ full street reconstruction, Retrofit projects, and street rehabilitation.

17.1.02 POLICY

17.1.02.A Designing complete streets with space for pedestrians, bicyclists, transit users, and other Vulnerable Road Users is necessary to meet the goals and commitments established by the City of Houston in the Houston Vision Zero Action Plan, Houston Bike Plan, Houston Climate Action Plan, and Resilient Houston strategy. Combined, these plans aim to fulfill a need for Houston to be a safe, resilient city for everyone.

17.1.02.B Roadway projects are an opportunity to increase the overall resilience of our streets to serve multimodal needs, adapt to climate change, and improve safety, accessibility, and equity.

1. New streets or fully reconstructed streets provide the opportunity to reimagine the right-of-way and implement infrastructure that provides space for multiple uses and functions, such as pedestrian, bicycle, and transit facilities for people of all ages and abilities; Green Infrastructure to manage stormwater, shade structures to decrease urban heat island effects; and Placemaking that incorporates universal design principles.

~~1.~~2. Retrofit projects provide the opportunity to reconfigure existing roadways using a range of temporary or permanent solutions to meet multimodal transportation needs of the most Vulnerable Road Users and mitigate the impact and rate of future climate change.

17.1.02.C The City of Houston will approve pedestrian, bicycle, and transit facilities that are safe and accessible for people of all ages and abilities. This means that street design must meet the needs of children, who have less ability to detect risks or negotiate conflicts; older adults who have lower visual acuity and slower riding and walking speeds; and people who may use mobility aids or adaptive bicycles which are wider, lower to the ground, and operate at lower speeds. The standards in the following sections aim to establish all ages and abilities design criteria.

~~17.1.02~~17.1.03 REFERENCES

17.1.03.A References listed are the latest edition, version, amendments, and recodifications unless otherwise noted.

1. AASHTO Guide for the Development of Bicycle Facilities~~, AASHTO, current edition~~

2. Americans with Disabilities Act (ADA, Standards for Transportation Facilities)

3. City of Houston Code of Ordinances [1]:

   a. Chapter 40 – Streets and Sidewalks

   b. Chapter 42 – Subdivisions, Developments and Platting

4. FHWA Separated Bike Lane Planning and Design Guide~~, Federal Highway Administration Bicycle and Pedestrian Program, current edition~~

5. Highway Capacity Manual

~~2.~~6. ~~Bicycle Master Plan (~~Houston Bike Plan and Houston Bike Plan Network [2] ~~current edition~~

~~3. Bicycle Parking Guidelines, Association of Pedestrian and Bicycle Professionals (APBP), current edition~~

~~4. Designing for All Ages and Abilities - Contextual Guidance for High-Comfort Bicycle Facilities, NACTO, current edition~~

~~5. Designing Walkable Urban Thoroughfares: A Context Sensitive Approach, ITE, current edition~~

Refer to the weblink for reference:
[1] https://www.houstontx.gov/codes/
[2] https://houstonbikeplan.org/

17.1.03.A continued

~~6. Houston Complete Streets and Transportation Plan~~

~~7. Implementing Context Sensitive Design on Multimodal Thoroughfares, ITE, current edition~~

~~8. A Policy on Geometric Design of Highways and Streets ("The Green Book"), AASHTO, current edition~~

~~9. Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations, FHWA, current edition~~

7. Houston Climate Action Plan [3]

8. Houston Vision Zero Action Plan [4]

9. Major Thoroughfare Freeway Plan (MTFP) [5]

10. NACTO, Urban Street Design, Urban Bikeway Design, and Transit Street Design Guide~~, NACTO, current edition~~

~~10. Parks Master Plan, current edition~~

11. Resilient Houston [6]

~~12. Roadside Design Guide, AASHTO, current edition~~

~~13. Scenic Houston Streetscape Resource Guide~~

~~14. Separated Bike Lane Planning and Design Guide, Federal Highway Administration Bicycle and Pedestrian Program, current edition~~

~~15.~~12. Texas Accessibility Standards (TAS)

~~16.~~13. Texas Manual on Uniform Traffic Control Devices (TMUTCD), TXDOT~~, current edition~~

~~17.~~14. Texas Transportation Code, Chapter 552 - Pedestrians

~~17.1.03. Trail Sponsor Guidance Document, Harris County Flood Control District (HCFCD), current edition~~

~~ACCESSIBILITY GUIDELINES FOR PEDESTRIAN FACILITIES IN THE~~

[3] http://greenhoustontx.gov/
[4] https://www.houstontx.gov/visionzero/
[5] https://www.houstontx.gov/planning/transportation/MTFP.html
[6] https://www.houstontx.gov/policies/executive_orders.html

~~PUBLIC RIGHT OF WAY (PROWAG)~~

~~17.1.05~~17.1.04 DEFINITIONS

~~17.1.05.A~~17.1.04.A ~~Bicycle Master Plan - Also called the Houston Bike Plan, this is a planning document that outlines the City's vision for bicycling in the City and associated goals for achieving the stated vision.Bike Routes - A bicycle route can be designated along any bikeway type with signing and can provide guidance along a series of different styles of bicycle facilities.~~Bicycle Corral – A group of bike racks installed adjacent to the curb in the parking lane of the roadway or in the area of Curb Extensions. They are often sited near the intersection in areas where space behind the curb is limited. See Figure 17.17 for a conceptual design of Bicycle Corrals.

17.1.04.B Bicycle Facility - A portion of the right-of-way for bicyclists that is either off-street and adjacent to the Sidewalk (Dedicated Bike Path), shared with pedestrians (Shared Use Path), on-street and separated from vehicle traffic with striping, physical delineation (Protected Bike Lane), above-grade features (Raised Bike Lane) or shared with motorists (Neighborhood Bikeway). ~~parts of a bikeway which may be dedicated, non-dedicated or off-street.~~

~~17.1.05 Dedicated On-Street Bicycle Facilities provide dedicated space for bicyclists separate from vehicle lanes within the roadway. These facilities can be located on the right side or left side of the road as appropriate based on engineering judgment to accommodate roadway conflicts such as transit vehicles, driveways, and turn movements. Examples include Standard Bike Lane, Buffered Bike Lane, Separated Bike Lane, and Side Path.~~

~~17.1.05 Non-Dedicated On-Street Bicycle Facilities are on-street are on-street bikeways where bicyclists share the street with motor vehicle traffic. They can be high-comfort facilities on roadway with certain characteristics such as low traffic volumes and speeds.~~

17.1.04.C Bike Boxes - A designated area at the head of a traffic lane at a signalized intersection that provides bicyclists with a safe and visible way to be ahead of queuing traffic during the red signal phase.

~~17.1.05 Bicycle Parking:~~

~~17.1.05.E Bicycle Parking Station: An area on or projecting on any public right-of-way upon which one or more bicycle racks may be affixed. Amenities may include bicycle fixit stations, bicycle lockers, etc.~~

~~17.1.05.F Bike Rack: A fixture upon which one or more bicycles may be parked.~~

~~17.1.05.G Specifications and guidelines for bike racks and their installation are provided in the Houston Bike Racks Application.~~

~~17.1.05.H Cycle Track - see Separated Bike Lane~~

~~17.1.05.I Conflict Zone - Space where one mode's primary path crosses another, and can occur at points of transition such as at intersections, bus stop, primary commercial driveways, etc. Pavement markings and signage should be used to define the space and communicate proper use by facility user whether a pedestrian, bicycle, car, or bus.~~

~~Contraflow Bike Lanes Aare typically separated bike lanes that flow against vehicle traffic on a one-way street. They can be used where the contraflow path closes an important gap in the network and other alternatives are not feasible. They can be installed in conjunction with a separated bicycle facility or non-dedicated bicycle facility on the opposite side of the road that flows in the same direction as vehicle traffic. Contraflow Bike Lanes may be located on the left side of a corridor.~~

17.1.04.D Corridor Crossing Analysis – Identifies safe and convenient locations for Vulnerable Road Users to cross streets. Any crossing that provides a type of treatment as recommended by this analysis will be known as an Enhanced Crossing.

17.1.04.E Crossing Treatments – Traffic control proposed at unsignalized crossings for Vulnerable Road Users. Crossing Treatments are based on traffic data and context and may include a variety of design elements to facilitate safe crossings, either as standalone treatments or grouped together.

~~17.1.05.J~~17.1.04.F Curb Extensions – Also known as bulb-outs. Tools that add space for pedestrians along a roadway by extending the Pedestrian Realm from the Sidewalk into the street. This narrows the roadway width, which can improve pedestrian safety by increasing visibility, shortening the crossing distance, and reducing exposure time to traffic.

17.1.04.G Curb Management – Proactively determining the function of curbside street space for a variety of specified uses such as transit, municipal services, commercial loading zones, parklets, non-vehicular transportation, or parking based on the priorities for the corridor. These uses may change over time to improve safety, accessibility, or other needs defined for the location.

17.1.04.H Daylighting – A design strategy to increase visibility and sight distance at intersections, typically achieved by removing parking near the intersection.

17.1.04.I Dedicated Bicycle Facility - A portion of the right-of-way dedicated exclusively for bicyclists (e.g. Dedicated Bike Path, Raised Bike Lane, and Protected Bike Lane).

17.1.04.J Dedicated Bike Paths – Bicycle Facilities that run alongside a roadway behind the curb within the right-of-way. Dedicated Bike Paths are at the same grade as the Sidewalk and increase safety by grade-separating bicyclists and people driving and provide a physical buffer or detectable warning surface to separate pedestrian traffic in the Sidewalk.

~~Delineator - treatment or object used to physically separate a bike facility from vehicular traffic or bike traffic from pedestrian traffic. They provide the comfort and safety that make separated bike lanes attractive facilities. The selection of separation type(s) should be based on the presence of on-street parking, overall street and buffer width, cost, durability, aesthetics, traffic speeds, emergency vehicle and service access, and maintenance. Example of delineators include but are not limited to:~~

~~Armadillo: Oblong low delineator that creates the physical separation for separated bike lanes.~~

~~Raised curb buffer: Precast or concrete unit raised and spaced appropriately for continued maintenance and drainage that creates the physical separation for separated bike lanes.~~

17.1.04.K ~~Desired Bicycle Width - Desirable width of a bicycle facility, based the facility's bicycle level of comfort as it relates to roadway traffic volumes, posted speeds and number of vehicular lanes.~~Desire Lines - Also known as a desire path or goat path. An unplanned route, typically in a grassy area, created by human or animal traffic in preference to or in the absence of a designated alternative, such as a paved Walkway. The desire line usually represents the shortest or most easily navigated route between an origin and destination.

17.1.04.L Enhanced Crossing – Any crossing that provides a type of treatment as recommended by the Corridor Crossing Analysis.

17.1.04.M Floating Bus Stop ~~— A~~ Floating B~~b~~us S~~s~~tops ~~whose specific~~ have a layout that allows pedestrian and B~~b~~icycle F~~f~~acilities ~~right-of-way~~ to locate behind the bus boarding pad, safely separating different modes of transportation while reducing bus delays by remaining in-lane. ~~Generally used when a dedicated/ protected bike lane travels through a bus stop.~~

17.1.04.N Frontage Buffer – The area between the outermost edge of the Sidewalk and the edge of the right-of-way or easement that is designed to improve visibility and reduce potential conflicts between Vulnerable Road Users and motorists.

17.1.04.O Green Infrastructure – The range of measures that use plant or soil systems; permeable pavement or other permeable surfaces or substrates; and stormwater harvest and reuse, or landscaping to store, infiltrate, or evaportranspirate stormwater and reduce flows to sewer systems or to surface waters.

~~17.1.05.K~~17.1.04.P High-Comfort (HC) Bicycle Facility – A Bicycle Facility that provides comfortable, low stress bicycling conditions for people of all ages and abilities based on contextual factors like vehicle speeds and volumes, operational uses, and observed sources of bicycling stress.

~~17.1.05.L Houston Bike Plan Map – Map of all existing and planned City of Houston maintained bicycle facilities. The primary purpose of the map is to define a connected network of bicycle facilities that is updated on a regular basis. Additional facilities may be proposed based on individual project, neighborhood, and connectivity needs.~~

~~17.1.05.M High-Comfort (HC) Bicycle Facility – A Bicycle Facility that provides comfortable, low stress bicycling conditions for people of all ages and abilities based on contextual factors like vehicle speeds and volumes, operational uses, and observed sources of bicycling stress.~~

17.1.04.Q High-Visibility Crosswalk – Use patterns (bar pairs, continental, ladder) that are visible to both the driver and pedestrian from farther away compared to traditional transverse line crosswalks.

17.1.04.R Houston Bike Plan – Establishes the vision and goals for the City of Houston to be a safer, more accessible, bike-friendly city. The Houston Bike Plan will change over time.

~~17.1.05.N~~

~~17.1.05.O Level of Comfort – A qualitative measure of the ability of a bicycle facility to provide an experience that the target user considers safe and comfortable. Elements that impact the level of comfort include volume and speed of adjacent automobile traffic, width of bicycle facility, number of driveway and intersection crossings, quality of pavement, and type and width of buffer provided between the bicycle facility and adjacent vehicle travel and parking lanes.~~

~~17.1.05.P Minimum Width – Alternative width to be considered where ROW is constrained. Values lower than the provided minimum result in a Low-Comfort facility and require review and approval of Houston Public Works staff.~~

17.1.04.S Houston Bike Plan Network – A map developed as part of the Houston Bike Plan and establishes where neighborhood, on-street, and off-street bicycle facilities are existing, programmed, and planned. Streets indicated as planned are intended to be a guide for future Bicycle Facilities. The Houston Bike Plan Network will change over time.

17.1.04.T Median Refuge Islands – Protected spaces located in the center of the roadway to allow for safe crossings at midblock locations. They enable bicyclists and pedestrians to cross a single direction of traffic at a time, thereby limiting pedestrian and bicyclist exposure to traffic. May also be called pedestrian refuge islands. A crosswalk across a full median on a median-divided roadway is not considered a Median Refuge Island.

17.1.04.U Micromobility – Transportation that includes small, lightweight vehicles operating at slow speeds. It may include bicycles, e-bikes, electric scooters, and skateboards.

17.1.04.V Neighborhood Bikeways – Also known as bicycle boulevards. Low speed, typically residential streets shared by motorists and bicyclists.

17.1.04.W Off-Street Bicycle ~~Facilities~~ Facility - ~~provide d~~Dedicated space for bicyclists that is separate from vehicle ~~lanes~~ traffic outside of the roadway. Off-Street Bicycle Facilities ~~a. Trail: A facility for bicyclists and pedestrians~~ may be outside of street right-of-way~~. For~~ like trails in Harris County Flood Control District; within the street right-of-way but outside the roadway and shared with pedestrians (Shared Use Path); or adjacent to the sidewalk (Dedicated Bike Path). ~~rights-of-way, refer to the HCFCD "Trail Sponsor Guidance Document." B. Side Path: A facility for bicyclists and pedestrians within the street right-of-way but outside the roadway. May consist of a sidewalk widened sufficiently to also support bicycle travel~~

17.1.04.X Off-Street Bicycle Facility Bus Stop – Allows for a bus stop at the standard location on the curb of the vehicular travel lane while the Bicycle Facility travels at Sidewalk grade adjacent to, and behind, the bus pad.

17.1.04.Y On-Street Bicycle Facility – Dedicated space for bicyclists that is separate from vehicle traffic within the roadway. Separation may be created with striping, physical delineation (Protected Bike Lane), or above-grade features (Raised Bike Lane).

~~17.1.05.Q~~17.1.04.Z On-Street Shared Bus Stop – A shared space between buses and road-grade Dedicated Bicycle Facilities.

17.1.04.AA Pedestrian Hybrid Beacons (PHBs or HAWKS) – Special type of traffic control device used to warn and control traffic at an unsignalized location to assist pedestrians in crossing a street or highway at a marked crosswalk. PHBs are made up of a signal head in three sections, consisting of two horizontally arranged circular red sections over a single circular yellow section that is centered between the red lights.

~~17.1.05.R~~17.1.04.BB Pedestrian Realm - ~~The Pedestrian Realm is the a~~Area within a public right-of-way or easement between the back of curb (or Curb Extension) or ~~the~~ edge of the roadway~~, as applicable,~~ and outermost edge of the public right-of-way or easement. ~~This area~~ The Pedestrian Realm provides the necessary space for safe, comfortable, and accessible pedestrian activity, and may accommodate other approved public amenities, infrastructure, or uses. ~~This section details the requirements and design standards for the Pedestrian Realm.There are three main components of the Pedestrian Realm:~~ It consists of a Frontage Buffer,~~the Safety Buffer, the~~ Sidewalk~~,~~ and Safety Buffer.~~the Frontage Buffer. Figure 17.4 illustrates the relative location of each component within the Pedestrian Realm.~~

~~17.1.05.S Pedestrian Clear Zone - The primary, accessible area along a roadway where pedestrian travel is prioritized. Additional pedestrian clear zone widths are required within transit areas.~~

17.1.04.CC Placemaking – Participatory process for shaping public space that harnesses the ideas and assets of the people who use it. An effective Placemaking process capitalizes on a local community's assets, inspiration, and potential and it results in the creation of quality public spaces that contribute to people's health, happiness and well-being.

17.1.04.DD Protected Bike Lanes – On-Street Bicycle Facilities between curb faces with physical delineation between the vehicle lane and bike lane. In Retrofit projects where a Dedicated Bike Path is not feasible, Protected Bike Lanes provide enhanced safety for bicyclists.

17.1.04.EE Protected Intersections – Reduce conflicts at intersections by providing safe, separated bikeways that set the bikeway back from parallel motor vehicle traffic so that bicyclists are not forced to merge into mixed traffic. Bicyclists can safely move straight and make two-stage turns through a Protected Intersection.

17.1.04.FF Raised Bike Lanes – Grade-separated Bicycle Facilities that are at a level between the Sidewalk and the roadway.

17.1.04.GG Raised Crosswalks – Provide a crossing that brings the level of the roadway up to the level of the Sidewalk. Raised Crosswalks increase visibility of Vulnerable Road Users, which can improve safety for all road users.

17.1.04.HH Retrofit – In the context of streets, any reconfiguration of the street and/or components in the right-of-way that is not part of a full street reconstruction. Typically, Retrofits use low-cost measures to improve existing infrastructure.

17.1.04.II ~~Retrofit Bicycle Facility - A bicycle facility provided through the reallocation of existing roadway pavement by reducing the width or number of existing vehicle or parking lanes or by using excess, unused pavement. Retrofits typically do not require the roadway widening or median reduction.~~ "S" Dimensions — Defines the total space in the public right-of-way behind the face of ~~ad~~curb on a roadway.

~~17.1.05.T~~17.1.04.JJ Safety Buffer – Area between the back-of-curb or the edge of roadway and the edge of the Sidewalk nearest the back-of-curb or the edge of roadway.

17.1.04.KK ~~It creates a safe and comfortable distance between a person using the Sidewalk and vehicles on the adjacent roadway.~~Seamless Curb Extensions – Also known as seamless curb. A continuation of the Pedestrian Realm or median such that the grade, concrete, sodding and other components are consistent.

17.1.04.LL Shared Raised Bus Stop – Allows for a bus stop to be in line with a Dedicated Bicycle Facility without altering the Pedestrian Realm and allows for bus boarding at the Sidewalk level by ramping up the Dedicated Bicycle Facility to the curb.

17.1.04.MM Shared Use Paths – Combined bicycle and pedestrian facilities that run alongside a roadway behind the curb within the right-of-way.

17.1.04.NN Sidewalk – Publicly accessible firm-and-stable path as defined in the City of Houston Code of Ordinances, Chapter 40 – Streets and Sidewalks, Article XXII, Section 40-551.

17.1.04.OO Sidewalk Easement – Grants to the public a perpetual, non-exclusive right to cross or otherwise use someone else's land for a specified purpose as defined in the City of Houston Code of Ordinances, Chapter 40 – Streets and Sidewalks, Article XXII, Section 40-551.

17.1.04.PP Traffic Calming – Range of visual and physical elements used to slow vehicle speeds. Traffic Calming methods may include devices, roadway geometry adjustments, and/or other physical elements. Methods may be implemented temporarily or permanently to mitigate speeding.

17.1.04.QQ Transit-Oriented Development (TOD) Street – Public street designated as a primary TOD street or secondary TOD street on the transit-oriented development plan.

17.1.04.RR Two-Stage Turn Queue Boxes – Offer bicyclists a designated way to make left turns at multi-lane signalized intersections from a right-side Dedicated Bicycle Facility, or right turns from a left-side Designated Bicycle Facility. Two-Stage Turn Queue Boxes may also be used at unsignalized intersections to simplify turns from a Dedicated Bicycle Facility onto a Neighborhood Bikeway.

17.1.04.SS Vulnerable Road Users – Those most at risk in traffic. Vulnerable Road Users are mainly those unprotected by an outside shield, namely pedestrians, bicyclists, and people with disabilities, as they sustain a greater risk of injury in any collision against a vehicle and are therefore highly in need of protection against such collisions.-

17.1.04.TT Walkable Places (WP) Street – Public street designated as a primary WP street or secondary WP street on the Walkable Places plan.

~~17.1.05.U~~ Walkway – Also known as “walkable surface”. Portion of the right-of-way or easement that is for pedestrian traffic. A Walkway may not include a clearly defined Sidewalk. ~~Transit Lane Configurations - Special roadway configurations that dedicate lanes/space to specific modes of transportation.~~

~~17.1.05.V Transit Only Lane – Roadway lanes dedicated to transit vehicles, typically using signs and pavement markings. Vehicles and bicycles may use said lanes if necessary to make a turn or reach a business front or curbside parking (aka Business Access/Transit (BAT) lanes).~~

~~17.1.05.W Transit and Bicycle Shared Lane – Roadway lanes dedicated to bicycles and transit, ideal for low speed, low traffic roadways.~~

~~17.1.05.X Bus Turn Radii – Buses require more space on roadway infrastructure due to larger turning radii (20-40 ft). This factor must be considered when designing intersections and station/stop areas as well as the route alignment.~~

~~17.1.05.Y Transit Stations/Stops – A designated location for boarding/alighting of a transit vehicle. Stations/stops may also provide transit users shelter to wait for vehicles.~~

~~17.1.05.Z Bus Stop - Any location designated as a boarding/alighting zone within a bus transit route.~~

~~17.1.05.AA Far Side Stop – A bus stop located beyond an intersection. It requires that buses cross the intersection before stopping to serve passengers.~~

~~17.1.05.BB Near Side Stop – A bus stop located on the approach side of an intersection. The buses stop to serve passengers before crossing the intersection.~~

~~17.1.05.CC Mid-Block Stop – A bus stop located between two intersections. Traditionally, these stops are located next to a mid-block pedestrian crossing for safe crossing.~~

~~17.1.05.DD Bypass Lane - Transit only lane or right turn lane at the near side of an intersection that allows transit vehicles to pass queued automobiles without a specific transit only signal.~~

~~17.1.05.EE Transit Shelter - Infrastructure installed at transit stop locations to provide protection from the weather.~~

~~17.1.05.FF Bus Boarding Pad - A rectangular slip resistant concrete pad connected to adjacent sidewalks and sidewalk ramps and provide access to transit vehicles.~~

~~17.1.05.GG Bus Pullout - A dedicated space adjacent to roadway infrastructure that brings transit vehicles completely out of traffic into a dedicated space. Provides increased safety during the boarding/alighting process.~~

~~17.1.05.HH BRT Station - A transit station for bus rapid transit and its passengers.~~

~~17.1.05.II Rail Station - A transit station for trains. It is typically an off-street facility where passengers wait for, board, alight, or transfer between transit units (vehicles or trains). A station usually provides information and a waiting area and may have boarding and alighting platforms, ticket or farecard sales, fare collection, and other related facilities Rail stations can be both at-grade or grade separated (for elevated guideways).~~

~~17.1.05.JJ Pedestrian Clear Zone - The primary, accessible area along a roadway where pedestrian travel is prioritized. Additional pedestrian clear zone widths are required within transit areas.~~

~~17.1.05.KK Public Transit - Any form of publicly provided passenger transportation containing fixed/non-fixed routes and an established fare system.~~

~~17.1.05.LL Bus Transit - A form of public transit that uses bus fleets to provide fixed route and non-fixed route service.~~

~~17.1.05.MM Bus Rapid Transit (BRT) - High capacity bus service with dedicated lanes and upgraded stations. BRT systems are characterized by several of the following components: exclusive transitways, enhanced stations, easily identified vehicles, high frequency, all-day service, simple route structures, simplified fare collection, and ITS technologies.~~

~~17.1.05.NN Light Rail Transit (LRT) - A metropolitan electric railway system characterized by its ability to operate single cars or short trains along exclusive rights-of-way at ground level, on aerial structures, in subways, or occasionally, in streets, and to board and discharge passengers at track or car floor level.~~

~~17.1.05.OO Separated Bike Lane - Dedicated on-street space for bikes separated from vehicle traffic with a buffer and a physical delineation device. Facilities can be one or two-way where a one-way facility is similar in nature to buffered bike lanes. Sometimes called a "Cycle Track."~~

17.1.04.UU ~~Wayfinding - Directional signage to certain destinations such as libraries, parks, schools, trail entry points, and other attractions.~~

SECTION 2 - GENERAL REQUIREMENTS FOR PEDESTRIAN, BICYCLE, AND TRANSIT DESIGN

17.2.01 APPLICABILITY OF CHAPTER 17 DESIGN REQUIREMENTS

17.2.01.A Design requirements of Chapter 17 apply to any project that builds or impacts pedestrian, bicyclist, and transit infrastructure in the public right-of-way. All pedestrian, bicyclist, and transit infrastructure shall satisfy the requirements of this chapter.

17.2.01.B All street projects shall submit all required reports as defined in Chapter 15, Section 15.2.02 – Traffic and Design Studies and comply with all applicable Multimodal Service Standards (MMSSs) as defined in Chapter 15, Section 15.2.01 - Multimodal Service Standards.

17.2.01.C Design of pedestrian, bicycle, and transit facilities must consider the users perceived safety, also known as subjective safety. Using minimum values without consideration of facility context may result in ineffective facility use. The dimensional values in this chapter fall under two categories and should be used as follows:

1. In general, preferred values should be used to maximize the safety and comfort benefits for pedestrians, bicyclists and other users. Alternative values should only be used in locations where it is not possible to use preferred values due to social, economic, and environmental impacts. Where the Pedestrian Realm is wide enough to accommodate preferred values, preferred values shall be used.

2. Minimum values should not automatically be considered a default for pedestrian, bicycle, and transit elements due to the inherent vulnerability of its users.

3. Where ranges are presented within the chapter, the most conservative value is considered the preferred value, while the least conservative value in the range is considered the minimum value.

17.2.01.D All street projects shall ensure that all new or modified pedestrian, bicyclist, and transit elements are designed to minimize conflict with motorists, maximize safety for all road users, and meet the all ages and abilities design criteria established in the following sections.

17.2.02 SHADE AND GREEN INFRASTRUCTURE

17.2.02.A Shade, either from trees and vegetation or from structures, is important for pedestrian, bicyclists, and transit users and should be included wherever possible in infrastructure built for those users. Although street trees are desirable, this section does not specifically require their planting.

17.2.02.B Trees shall be selected and planted so that they:

1. Maximize shade for pedestrian Walkways and bicycle infrastructure;

2. Maximize the health of the tree;

3. Minimize damage to infrastructure including Sidewalks, curbs, pavement, foundations, and underground utilities. Tree selections and plans shall be reviewed and approved by the Houston Parks and Recreation Department and City Engineer;

4. Maintain all required clear zones from overhead utilities when trees achieve mature tree height; and

5. Will not cause damage to buses or other vehicles at any stage of the tree lifecycle.

17.2.02.C Trees and plants shall be selected and planted such that they ensure proper clearance for vehicular and infrastructure safety and ensure they do not interfere with visibility and sight line requirements at any stage of their lifecycles. Visibility obstructions from both the foliage of individual plants as well as clumping of multiple plants, including trees, can create safety concerns and shall be avoided.

17.2.02.D Root barriers shall be used whenever the health of the tree and impact to adjacent infrastructure cannot otherwise be mitigated. Refer to City Standard Details 02912-01 and 02912-02.

17.2.02.E For additional information regarding allowed installations and planting in the Safety Buffer between the Sidewalk and the roadway, see section 17.3.01.D.6.

17.2.02.F Pedestrian, bicycle, and transit infrastructure provides an opportunity for Green Infrastructure for stormwater management. This may include permeable surfaces, which are encouraged to be used on pedestrian and bicycle paths to promote water infiltration and reduce ponding and general street runoff.

17.2.03 PEDESTRIAN AND BICYCLE TEMPORARY TRAFFIC CONTROL

17.2.03.A Temporary traffic control must be provided for all pedestrian and bicyclists that are impacted or obstructed.

17.2.03.B Justification for type of temporary traffic control for pedestrian and bicyclists shall be provided to the City for review and approval. Temporary traffic control must follow the requirements listed in the order provided in this section.

17.2.03.C Options for Pedestrian and Bicycle Traffic Control (Ordered from Most to Least Preferred)

17.2.03.C continued

1. Option 1: Provide protection for pedestrians and bicyclists from debris in their present-day path using scaffolding, fencing or other barriers.

2. -Option 2: Temporary Pedestrian and Bicyclist Traffic Diversions.

   a. Diversion may be provided on-street depending on local conditions to be determined by Houston Public Works. If on-street space is used for a diversion, barriers shall delineate vehicle travel lanes from pedestrians and/or bicyclists. See Chapter 15 requirements for type of barriers allowed.

   b. ADA compliant temporary curb transition ramps shall be provided for pedestrian or bicycle diversions that include a movement over a curb or other vertical barrier.

   c. Clear pedestrian and bicycle diversion signage shall indicate a diversion ahead, and along diversion route at all changes in direction and at regular intervals as necessary to highlight the diversion.

   d. Pedestrians and bicyclists may share the same diversion if approved by Houston Public Works.

3. Option 3: Pedestrian and Bicycle Detours ~~BIKE DETOURSBicycle detours shall be provided wherever a bicycle facility is obstructed.~~

   a. Pedestrian and bicycle detours shall satisfy all design requirements for pedestrian and bicycle infrastructure as defined in this chapter.

   b. Pedestrian and Bicycle Facility detours shall provide the most direct route possible.

   c. Any closure of a pedestrian or Bicycle Facility shall require the shortest detour that maintains the safety of pedestrians and/or bicyclists.

   d. If detour users must cross the street, an existing safe crossing shall be used or a temporary safe crossing shall be provided.

   e. ADA compliant temporary curb transition ramps shall be provided for pedestrian or bicycle detours that include a movement over a curb or other vertical barrier.

   f. Clear pedestrian and bicycle detour signage shall indicate a detour ahead, and along detour route at all changes in direction and at regular intervals as necessary to highlight the detour.

~~a.~~g. Pedestrians and bicyclists may share the same detour if approved by Houston Public Works.

~~17.1.06. Bicycle detours shall provide a level of user comfort that is equivalent to or superior to that of the obstructed facility.Bicycle detours shall be provided for trail obstructions that reroute trail users to a public street.~~

~~17.1.07~~17.2.04 BRIDGE CROSSINGS AND TUNNELS~~:~~

~~17.1.07.A~~17.2.04.A All new ~~B~~bridges and tunnels shall accommodate multimodal transportation usage by implementing the following requirements.

1. When the approach roadway to the bridge/tunnel has an existing or planned ~~b~~Bicycle ~~f~~Facility, the ~~quality and comfort of bBicycle fFacility on the~~ bridge/tunnel shall provide a Bicycle Facility that satisfies all current IDM requirements. ~~equal or exceed that of the facility on the approach roadways.~~

2. When the approach roadway to the bridge/tunnel does not have either an existing or planned ~~b~~Bicycle ~~f~~Facility, a 10-ft or greater~~,~~ ~~s~~Sidewalk~~s~~ that is accessible to bicyclists ~~should~~ shall be provided. ~~considered for multimodal consideration on the bridge/tunnel. The absence of an existing bBicycle fFacility on the approach roadway does not justify failure to accommodate bicyclists on the bridge or tunnel.~~ This ensures that, at a minimum, a Shared Use Path will be available if a Bicycle Facility is ever planned for the corridor.

3. Bridge ~~s~~Sidewalks and ~~s~~Shared~~-~~ ~~u~~Use ~~p~~Paths shall be physically separated from the vehicle pavement, either by a grade difference or physical delineation. ~~raised above the vehicular pavement level.~~

~~17.1.07.B Railing/Delineator:~~

17.2.04.B Exterior bridge railings adjacent to a pedestrian/~~b~~Bicycle ~~f~~Facility shall meet the following standards:

1. Maintain a ~~M~~minimum height of~~:~~ 42-inches. A ~~H~~height of 48--inches ~~should~~ shall be ~~considered~~ used in the following cases:

    a. Speed of adjacent traffic exceeds 35 mph.

    b. Width of pedestrian/~~b~~Bicycle ~~f~~Facility is less than 10-ft.

2. The railing design ~~should~~shall minimize opportunities for bicycle handlebars to get caught in the railing.

3. A railing or delineator may be used to separate bicycle traffic from pedestrian traffic to improve bicycle/pedestrian safety and comfort where appropriate.

~~SECTION 2~~SECTION 3 - PEDESTRIAN ~~REALM DESIGN~~ ELEMENTS REQUIREMENTS

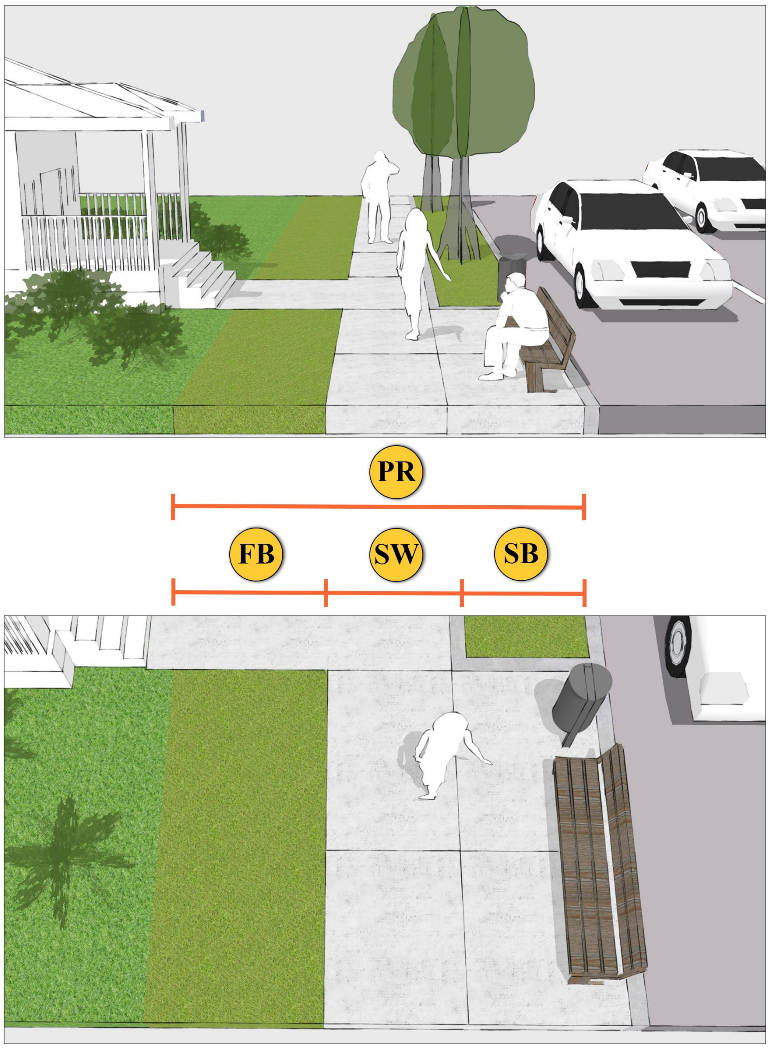
~~PEDESTRIAN REALM OVERVIEW~~

17.3.01 PEDESTRIAN REALM

17.3.01.A For Pedestrian Realm components see Figure 17.1.

~~Figure 17.4 Pedestrian Realm Components~~

Elevation View



PR Pedestrian Realm

FB Frontage Buffer

SW Sidewalk

SB Safety Buffer

Plan View

Figure 17.1~~17.117.1~~ – PEDESTRIAN REALM COMPONENTS

17.3.01.B Frontage Buffer

1. The Frontage Buffer is the area ~~immediately adjacent to~~ between the outermost edge of the Sidewalk and the edge of the right-of-way or easement~~. It~~ that is designed to improve visibility and reduce potential conflicts between Vulnerable Road Users and motorists.~~that may decrease pedestrian visibility or limit the practical use of the Sidewalk.~~

2. The Frontage Buffer preferred width is three (3) feet. The Frontage Buffer shall maintain a minimum width of one (1) foot. See Table 17.2.

~~1. .2Frontage Buffer and Safety Buffer Width~~

~~2. Table 17.2 illustrates both the optimal and minimum width standards for the Safety Buffer and the Frontage Buffer.~~

~~3. Frontage Buffer~~

~~4.~~3. The Frontage Buffer ~~must~~ shall be kept free from visual obstructions in the space above twenty four (24) inches and below eight (8) feet in height as measured vertically from the surface of the adjacent Sidewalk.~~Vertical elements that do not significantly restrict visibility are permitted (e.g. individual trees, streetlights, utility poles, signposts, and certain street furniture). The City Engineer may modify the standards of this subsection when, upon review of written documentation provided by the individual or entity requesting the modification, the City Engineer concludes that the standards are technically or otherwise infeasible due to the presence of existing permitted physical conditions.~~

4. The Frontage Buffer may be paved or unpaved~~and is an essential component for pedestrian safety and comfort~~. If paved, it will be indistinguishable from the Sidewalk. Alternative materials of Frontage Buffer construction, such as permeable materials, may be used to support resiliency goals. All alternatives shall meet minimum Frontage Buffer requirements and shall be coordinated and approved by the City Engineer.

~~5. D. PEDESTRIAN SAFETY AND VISIBILITY BUFFER~~

5. The intersection of ~~a Sidewalk~~ the Pedestrian Realm with a driveway is subject to a ~~P~~pedestrian ~~S~~safety and ~~V~~visibility ~~B~~buffer in accordance with Chapter 40, Article I of the Code of Ordinances and illustrated in Figure 17.2~~Figures 17.7~~ and Figure 17.3~~17.38 below~~. The Frontage Buffer of the Pedestrian Realm as defined in this chapter may be used to satisfy the pedestrian safety and visibility buffer requirements.~~The Pedestrian Realm may overlap part of the Pedestrian Safety and Visibility Buffer requirement, where applicable.~~

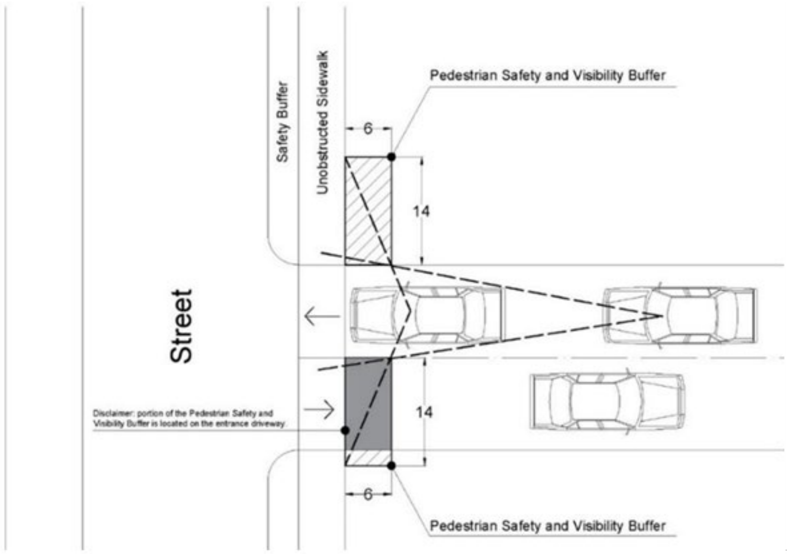


Figure 17.2~~17.2 Figure 17.7~~ – PEDESTRIAN SAFETY AND VISIBILITY BUFFER ~~–~~(TWO-WAY DRIVEWAY) [7]

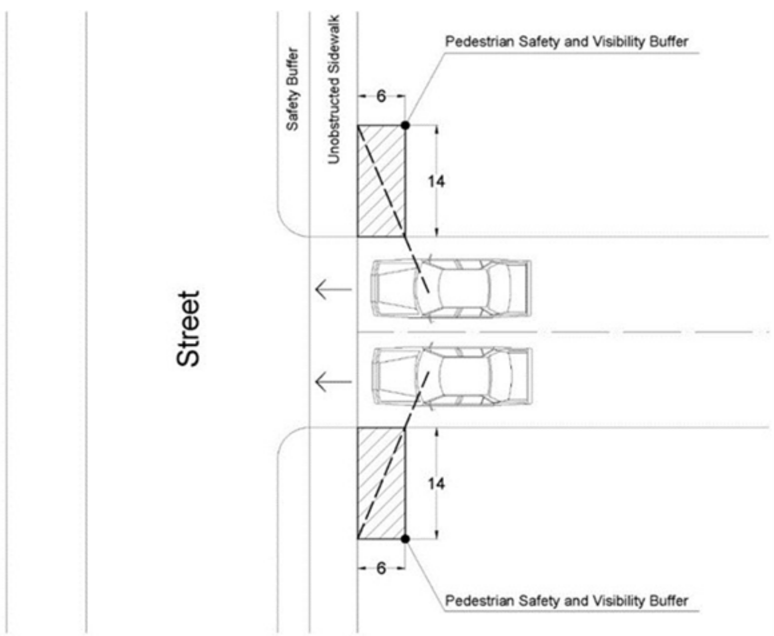


Figure 17.3~~17.3 Figure 17. 8~~ – PEDESTRIAN SAFETY AND VISIBILITY BUFFER ~~–~~(ONE-WAY DRIVEWAY) [8]

[7] City of Houston Code of Ordinances Section 40-32
[8] City of Houston Code of Ordinances Section 40-32

17.3.01.C ~~continued~~ 17.3.01.C Sidewalk

The Sidewalk is a ~~A~~ publicly accessible ~~firm and stable surfaced~~ path ~~that is improved and~~ designed ~~for or is ordinarily used by pedestrians.~~ [9] ~~This is the primary accessible pathway in the Pedestrian Realm and serves as a continuous obstacle-free space for people to safely and comfortably walk or use a wheelchair.~~

~~6. General Sidewalk Design~~

~~7. The Sidewalk must be designed~~ to ensure that a person has a safe and comfortable place to walk or use a ~~wheelchair~~mobility aid. ~~It~~ The Sidewalk must be ~~a level and continuous surface~~ free of obstructions and encroachments and shall be designed as a continuous, obstacle-free space that maintains adequate drainage. ~~, including but not limited to above-grade features such as utility poles and equipment, signposts, kiosks, traffic signal equipment, parking meters, guywires, fire hydrants, bollards, bus or transit shelters, bicycle racks, planters or plantings, street furniture, valet parking service stands , artwork, mailboxes, fences or barriers, door or gate swing, and structural support columns or other building elements.~~

~~8. Sidewalk Width~~

1. Sidewalks shall adhere to standards in Table 17.1. ~~illustrates the minimum Sidewalk width standards based on the classification of the street which the Sidewalk runs along. Modifications to the minimum Sidewalk width may be granted under the Modification of Standards process detailed in Chapter 40, Article XXII of the Code of Ordinances.~~

2. The Sidewalk cross slope shall be 2% to maintain ADA access and ensure that water flows across the Sidewalk without pooling in the Walkway.

~~*Additional Sidewalk Design Considerations*:~~

~~11.~~3. The Sidewalk must be constructed in accordance with ~~Agency~~ Houston Public Works standard~~s~~~~details~~, Texas Accessibility Standards (TAS), and Americans with Disabilities Act (ADA) requirements. If there is a conflict in the requirements, the strictest requirement(s) shall govern.

~~12.~~

~~0. Vertical Clearance Standards~~

~~[9] City of Houston Code of Ordinances: Section 40-551~~

~~14. Sidewalk~~

~~15.~~4. The minimum unobstructed vertical clearance of a Sidewalk is eight (8) feet as measured vertically from the surface of the Sidewalk. Additional vertical clearance requirements apply for certain improvements constructed over a Sidewalk along a designated ~~Walkable Place~~WP Street or TOD Street in accordance with the Enhanced Pedestrian Realm Standards of Chapter 42, Article IV of the Code of Ordinances.

5. The design of a Sidewalk near an approved bus or transit stop must meet the requirements ~~of Section 17.05~~in this section, Chapter 10 subsection 10.3.03.B.2 and~~, when applicable,~~ be coordinated with METRO or other transit operators.

6. Sidewalks should be continuous and follow Desire Lines. When a Sidewalk must deviate to circumnavigate obstructions, transition curves should avoid sharp turns and be as long as necessary to ensure the highest comfort pathway.

7. ~~The Sidewalk must be designed to avoid conflicts with approved above-grade features or topography and to form a continuous path of travel along the street that connects to other existing Sidewalks, where applicable. Sidewalks should keep as much as possible to the natural path of travel parallel to the roadway and should align with the crosswalk at intersections. While Sidewalks do not need to be perfectly straight, curves or turns that direct the pedestrian away from the natural path should not be introduced solely for aesthetic reasons. When a Sidewalk must deviate from a straight path to accommodate trees, connect to other existing Sidewalks (including adjoining property), or to avoid surface utilities or other above-grade features, legible and smooth transitions are required to ensure the minimum unobstructed width required by this section is maintained.~~The placement of a new above-grade feature within the minimum required Sidewalk width or within an existing substandard Sidewalk is prohibited unless a modification is granted under the Modification of Standards process detailed in Chapter 40, Article XXII of the Code of Ordinances or otherwise expressly authorized by law.

8. Sidewalks Traversing Driveways:

   a. Sidewalks should maintain Sidewalk grade across driveways.

   b. Sidewalks should be differentiated from driveways through pavement materials or Sidewalk edge delineation.

17.3.01.C.10 continued

~~16.~~9. Sidewalks traversing a railroad track must be at 0% slope for a distance of five (5) feet from the centerline of the track in each direction. The S~~s~~idewalk should cross the railroad track as close to 90-degrees as possible ~~to 90-degrees~~.

10. Sidewalk Materials

a. Sidewalks should typically be concrete.

b. Alternative methods of Sidewalk construction may be used in places where tree preservation is of concern.

~~a.~~c. Alternative materials for Sidewalk construction, such as permeable materials, ~~must comply with 17.06.B.1.a of this subsection. They~~ may be used to support resiliency goals.

d. ~~, but are not limited to, decomposed granite and checkered plates.~~ If alternative material is selected by the Engineer, the Engineer shall create and submit an alternative material ~~s~~Sidewalk construction specification as a part of the design submittal. The specification shall include measurement and payment, material requirements, and instructions on execution.

~~b.~~e. All alternatives shall meet minimum Sidewalk requirements and shall be coordinated ~~with the City's Urban Forester, as applicable,~~ and approved by ~~the City Engineer~~Houston Public Works.

~~. If a Sidewalk is designed to also be used by people on bicycles or other approved micro-mobility devices, it must meet the design requirements for an off-street bicycle facility or trail under Section 17.04 (Bicycle Geometric Design Requirements).~~

11. Sidewalks may be paired or combined with off-street bike paths. These Sidewalks shall comply with all requirements of this section and Section 17.4.02, High-Comfort Facility Type Standards.

Table 17.1 – MINIMUM SIDEWALK WIDTH STANDARDS

Street Type	Type	Minimum Width
Within Central Business District [10]	All	8 feet

[10] "Central Business District" is defined in Chapter 42, Article I of the Code of Ordinances.

17.3.01.D.1 continued

Major Thoroughfare	~~Walkable Places~~ WP Street	As designated by the Walkable Places Plan
	TOD Street	8 feet
	All Others	6 feet
All Other Public Streets	~~Walkable Places~~ WP Street	As designated by the Walkable Places Plan
	TOD Street	6 feet
	All Others	6 feet preferred / 5 feet minimum

~~17.2.01.B Table 17.3.01.B Minimum Sidewalk Width Standards~~

17.3.01.D Safety Buffer—

1. The Safety Buffer is the area between the back-of-curb or the edge of roadway, and the edge of the Sidewalk nearest the back-of-curb or the edge of roadway. [11]

   a. ~~It~~ The Safety Buffer creates a safe and comfortable distance between a person using the Sidewalk and vehicles on the adjacent roadway.

   b. The Safety Buffer also provides the opportunity to use Green Infrastructure to manage stormwater and reduce the urban heat island effect through the use of shade trees.

   ~~b.~~c. The Safety Buffer may be utilized to accommodate different utilities; pedestrian, bicycle or transit amenities; or other approved uses.

   d. The Safety Buffer shall not be used for vehicle purposes including but not limited to parking, loading/unloading, valet zones, and ride share zones.

2. Safety Buffers shall adhere to the width standards in Table 17.2.

~~2. General Safety Buffer Design~~

3. ~~The~~ Safety Buffers greater than 2-feet wide may be paved or unpaved.-

[11] City of Houston Code of Ordinances: Section 40-551

a. If paved, it may be indistinguishable from the Sidewalk. ~~Approved above-grade features such as utility poles and equipment, signposts, kiosks, traffic signal equipment, parking meters, guywires, fire hydrants, bollards, bus or transit stops, bicycle racks, planters or plantings, street furniture, valet parking service stands, artwork, mailboxes, and other permitted uses may be placed within the Safety Buffer. Except for approved driveways that perpendicularly cross the Safety Buffer, vehicular uses are prohibited.~~

4. Safety Buffers less than or equal to 2-feet wide shall be paved.

   a. Pavement may be indistinguishable from the Sidewalk.

5. Alternative methods of Safety Buffer construction, such as permeable materials, may be used to support resiliency goals. All alternatives shall meet minimum Safety Buffer requirements and shall be coordinated and approved by the City Engineer.

6. Where the Safety Buffer width is at least four (4)-ft or greater, trees should be planted to provide Sidewalk shade. Trees shall not be planted in a Safety Buffer that is narrower than four (4)-ft. The selected tree variety shall be chosen to maximize shade coverage for pedestrians while also maximizing tree health and minimizing impact to infrastructure. For more information on providing shade and trees, see Section 17.2.02 - Shade and Green Infrastructure.

7. ~~If a~~ A combination Sidewalk and paved Safety Buffer is ~~immediately adjacent to an approved on-street cutback for either a pedestrian drop-off/loading area or parking, then the minimum width of the Safety Buffer may be reduced~~acceptable adjacent to dedicated on-street parking or valet zones. The entire Pedestrian Realm must still satisfy all requirements of this chapter.

   a. ~~-~~The resulting combined width of the Sidewalk and paved Safety Buffer in this scenario must be at least ten (10) feet.

   ~~a.~~b. Subject to approval ~~and the design must be approved~~ by both the Traffic Engineer and City Engineer~~. The minimum Sidewalk required by this Section must remain free of obstructions and encroachments.~~, ~~T~~the minimum width of the Safety Buffer may be reduced or eliminated~~, as appropriate,~~ adjacent to the section of the Sidewalk designed to create a continuous path of travel to connect to an existing Sidewalk.

~~3.~~8. Approved above-grade features may be placed within the Safety Buffer.

Table 17.2 – FRONTAGE BUFFER AND SAFETY BUFFER WIDTH STANDARDS

Classification	~~Optimal~~Preferred	Minimum
Safety Buffer	6 feet or more	4 feet
Frontage Buffer	3 feet or more	1 foot

~~ENHANCED PEDESTRIAN REALM STANDARDS ON TRANSIT-ORIENTED DEVELOMPENT STREETS AND WALKABLE PLACES STREETS~~

17.3.01.E Other Pedestrian Realm Requirements

1. The Pedestrian Realm at an intersection corner is formed by the intersection of Pedestrian Realms on the cross streets plus the additional right-of-way for corner cut-back as required by Chapter 10, Section 10.3.02.B. The entire space should be made available for a combination of Safety Buffer, curb ramps, Walkway, and other approved Pedestrian Realm features.

2. New development and certain redevelopment along a designated ~~Transit-Oriented Development Street (~~TOD Street~~)~~ or ~~Walkable Places~~WP Street must meet additional requirements for the Pedestrian Realm and private property adjacent to the public street. These requirements are detailed in Chapter 42, Article IV of the Code of Ordinances.

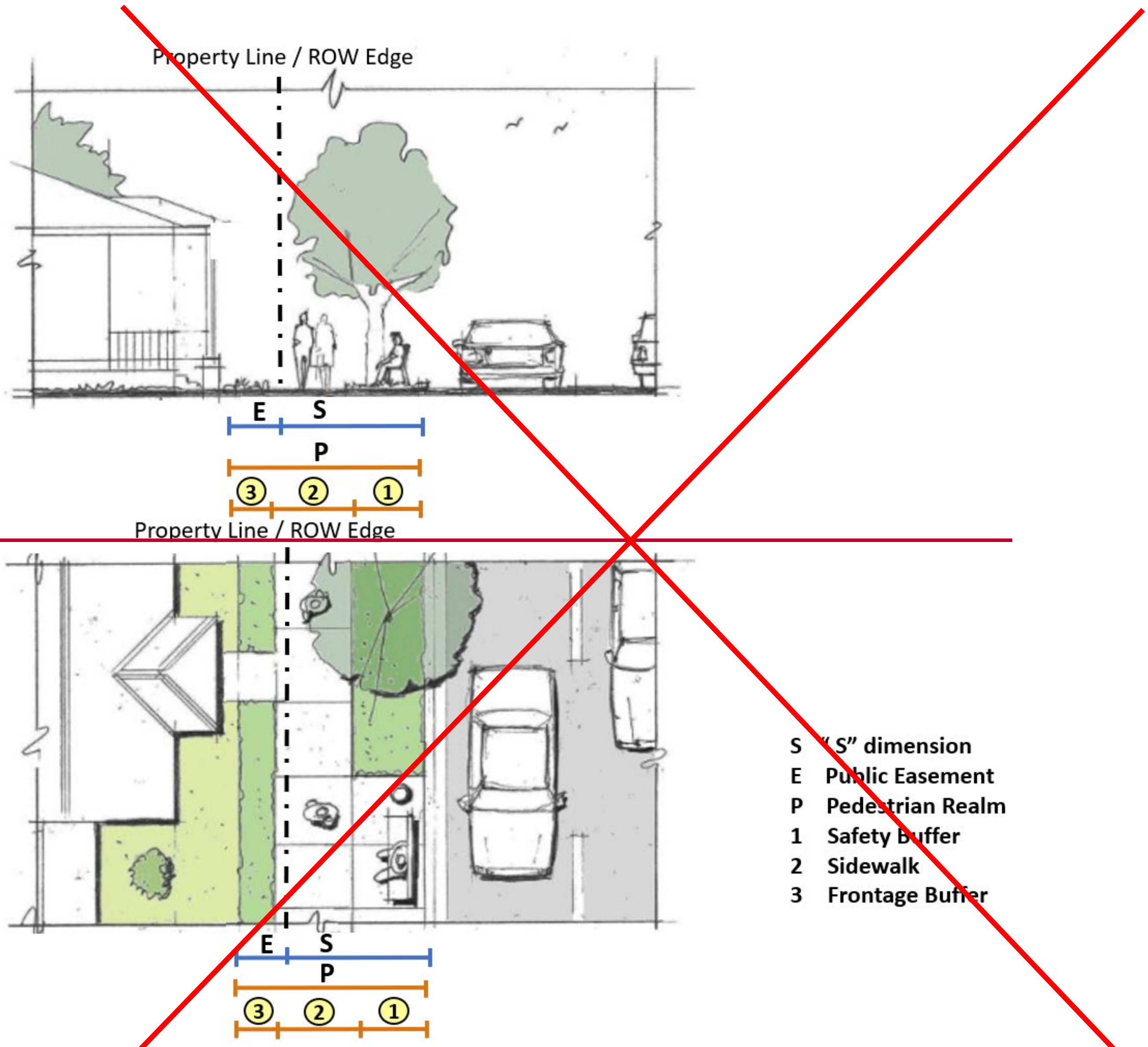
3. ~~In most scenarios, the entire Pedestrian Realm is located within the public right-of-way. In some scenarios, however, a portion of the Pedestrian Realm may be within a public easement on private property. Whether part of Pedestrian Realm is within private property or not depends on the~~ "S" ~~d~~Dimension, Easements and Pedestrian Realm: ~~under subsection 10.3.03.A (Roadway Cross Sections):~~

   a. The "S" Dimension may be smaller than or sufficient for the required Pedestrian Realm.

      (1). When the "S" ~~d~~Dimension is wide enough to accommodate the required Pedestrian Realm ~~components detailed in 17.06.B~~, the ~~entire~~ Pedestrian Realm will be located within the public right-of-way. See Figure 17.4~~Figure 17.5~~. ~~illustrates this scenario.~~

~~Figure 17.5 Entire Pedestrian Realm Located within Public Right-of-Way~~

~~(3).~~(2). When the "S" ~~d~~Dimension is not wide enough to accommodate the required Pedestrian Realm components ~~detailed in 17.06.B~~, part of the Pedestrian Realm will need to be within a public Sidewalk ~~e~~Easement on the private property. See Figure 17.5.

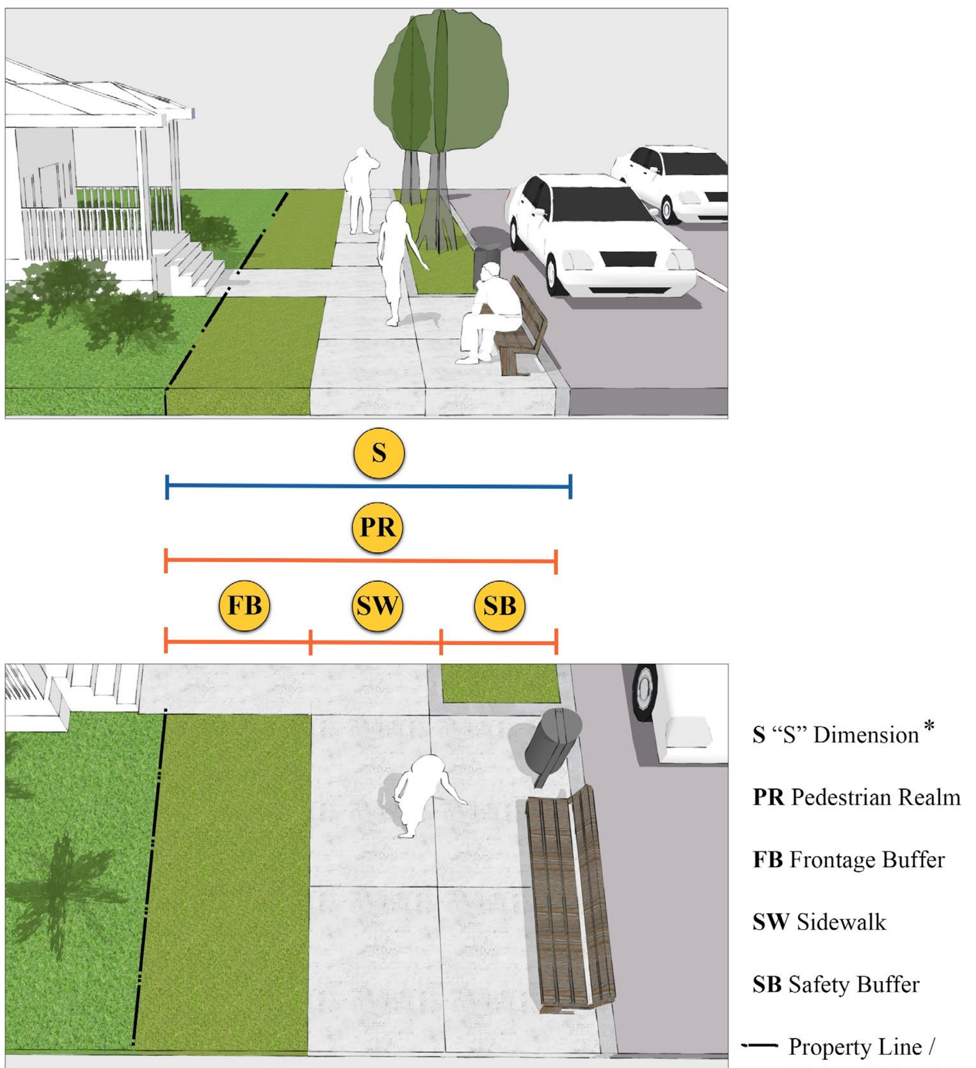


~~Figure 17.6 Portion of Pedestrian Realm Located within Private Property~~

~~c.~~b. The duly recorded easement must grant the public a perpetual, non-exclusive easement on, over, and across the private land for the construction, maintenance, and use of a ~~s~~Sidewalk. ~~Figure 17.6 illustrates this scenario.~~

~~d.~~c. See Figure 17.4 and Figure 17.5 for conceptual designs of the Pedestrian Realm and "S" Dimensions. All IDM conceptual designs are for reference only and do not constitute design standards.

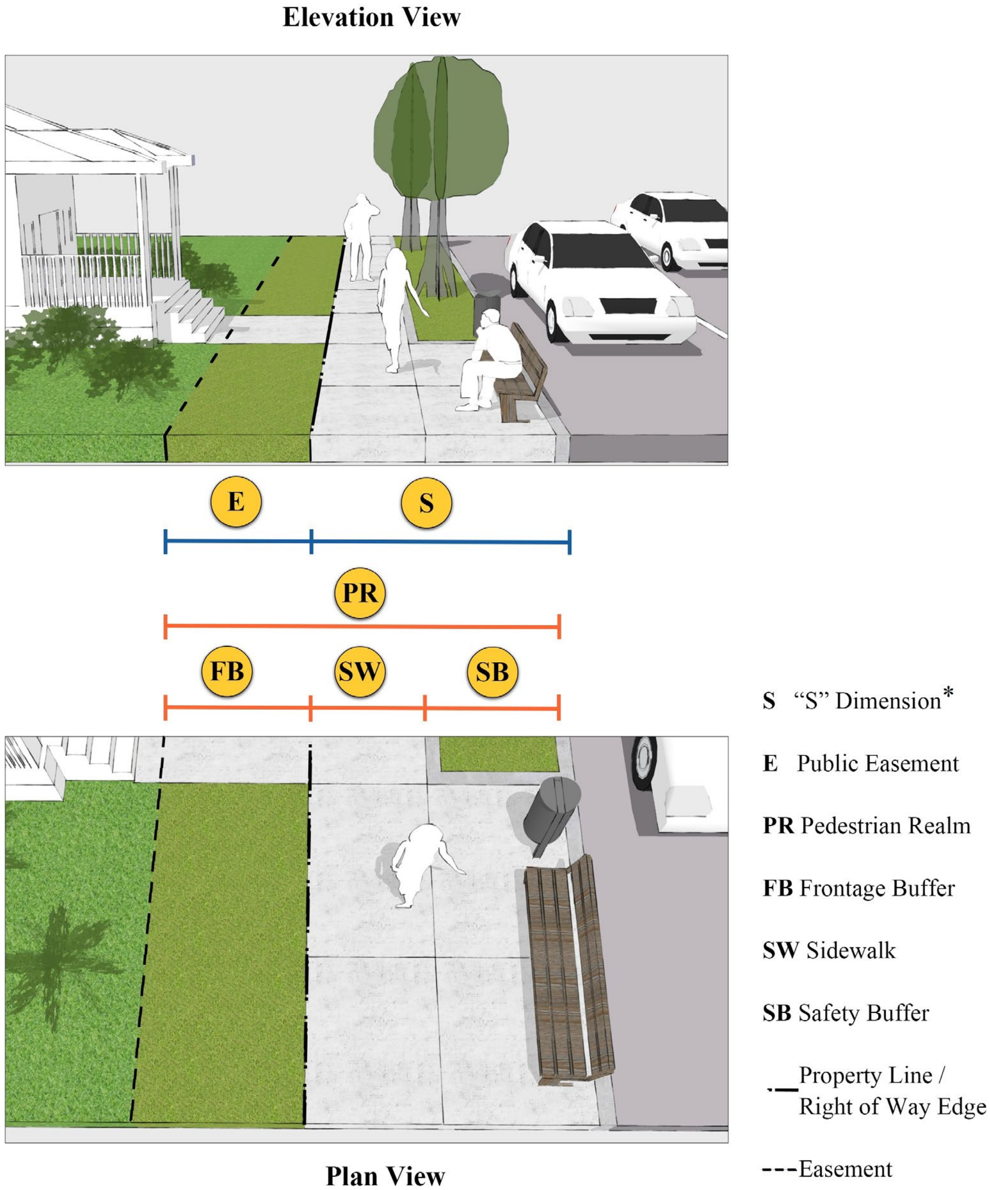
Elevation View



Plan View

Note: "S" Dimension is measured from the face of curb as defined in Chapter 10 of this manual.

Figure 17.4~~17.4Figure 17. 5~~ – ENTIRE PEDESTRIAN REALM LOCATED WITHIN PUBLIC RIGHT-OF-WAY



Note: "S" Dimension is measured from the face of curb as defined in Chapter 10 of this manual.

Figure 17.5~~17.5 Figure 17.6~~ – PORTION OF PEDESTRIAN REALM LOCATED WITHIN PRIVATE PROPERTY

~~Pedestrian Realm Width Standards~~

~~0. This subsection establishes minimum width standards for each of the main Pedestrian Realm components for all new Sidewalk construction and certain reconstruction of a Sidewalk. Chapter 40, Article XXII of the Code of Ordinances details scenarios that are exempt from one or more of these standards.~~

17.3.02 INTERSECTIONS AND MIDBLOCK CROSSINGS

~~17.2.03.A a. General: Midblock crossings are legal pedestrian and bicycle street crossing locations that are not located at roadway intersections. Intersection crossings are generally preferred, but occasionally midblock crossing locations are acceptable. Examples of potentially acceptable midblock crossing locations include a trail in a utility easement that crosses a street at a distance that is farther from the nearest signalized intersection than a trail user would be expected to traverse.~~

~~17.2.03.B b. Midblock crossings shall require Houston Public Works approval.~~

~~17.2.03.C c. Midblock crossings shall be designed at minimum with the following considerations: i. Midblock crossings shall be located at least 100-ft from adjacent intersections.~~

~~17.2.03.D ii. Street name signs should be placed at Major Thoroughfare crossings and should be considered on Collector and Local Street crossings.~~

~~17.2.03.E Midblock Crossings~~

~~17.2.03.F Requires prior approval by the Traffic Engineer and City Engineer.~~

~~17.2.03.G Must be designed with legible and smooth transitions to ensure the minimum unobstructed Sidewalk width required by section 17.06.B is maintained.~~

~~17.2.03.H May be appropriate based on area context including, but not limited to, trail intersections and at major trip generators.~~

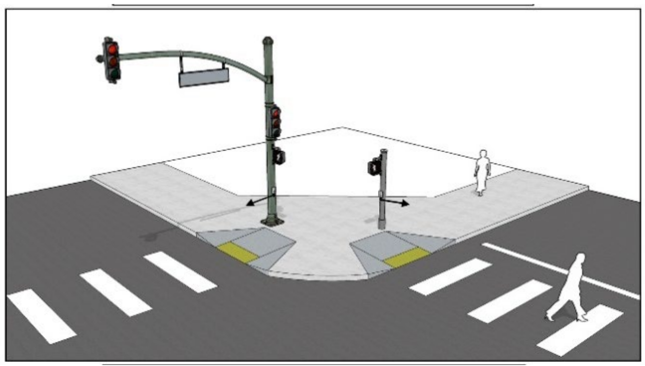
~~17.2.03.I All Midblock Crossings must meet or exceed applicable accessibility standards.~~

~~17.2.03.J For further design considerations, see subsection 17.04.E.7 (Midblock Crossings).~~

~~17.2.03.K Midblock Enhancements: Additional treatments should be considered for increased visibility and refuge at midblock crossings. Enhancements shall require justification per engineering judgment and approval by Houston Public Works. Potential enhancements may include:~~

~~17.2.03.L~~17.3.02.A Curb Ramps and Corner Treatments

1. Curb ramps provide accessible connections across roadways by creating a slope from the Pedestrian Realm to the street. Properly designed curb ramps ensure a high level of comfort and safety for Vulnerable Road Users. Figure 17.6 shows conceptual designs of intersection curb ramps that satisfy the pedestrian elements standards and guidelines defined in this section. This figure is for reference only and does not constitute design standards.



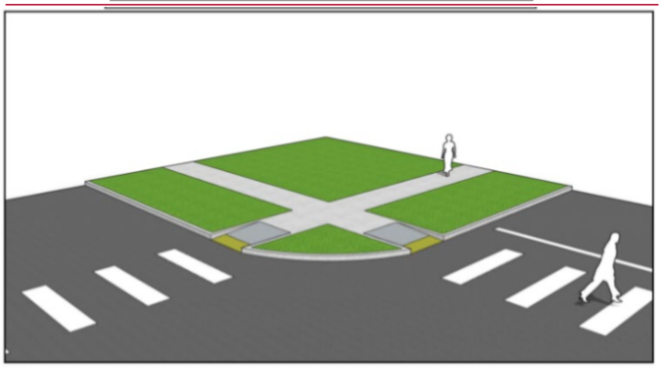


Figure 17.6~~17.6~~ – EXAMPLES OF PREFERRED CURB RAMPS TREATMENTS

~~1.~~2. Curb ramps shall be constructed at all intersection corners and midblock crossing locations for any approach that includes a ~~defined~~ Sidewalk and/or that serves a legal crosswalk. Typically, this means that each corner should have curb ramps serving two crossings, regardless of traffic control.

~~Curb ramps constructed on an intersection corner shall be interconnected to create a walking route around the corner that does not require a Sidewalk user to enter the street.~~
~~The design of curb ramps shall consider ramp direction, driveway crossings, crosswalk locations and the location of the Sidewalk with respect to the curb. Standard curb ramp details are shown in the City's Standard Details.~~
~~Where use of standard curb ramp details is not possible due to field conditions, engineer shall submit proposed design drawings to City Engineer for approval. Design drawings shall include site field survey conditions.~~

17.3.02.A continued

~~6.~~3. All Curb ~~r~~Ramps ~~and sidewalks/walkways~~ shall be constructed in accordance with ~~Agency~~ Houston Public Works standard details, Texas Accessibility Standards (TAS), and Americans with Disabilities Act (ADA) requirements. If there is a conflict in the requirements, the strictest requirements shall govern. At absolute minimum, all curb ramps must comply with all applicable ADA and TAS requirements.

~~7.~~4. All curb ramps constructed as part of an adjacent development or as part of a capital project with the capacity for right-of-way acquisition must comply with the curb ramp standards and guidelines.

~~8.~~5. -Curb Ramp and Corner Treatment Design Standards

a. ~~Curb ramps must cross the street as close as possible~~ For openings that are perpendicular~~to~~ (90 degrees) to the centerline of street~~.~~, ~~C~~curb ramps shall not point into the center of the intersection.

b. Minimum width shall be 5-ft, not including curb (see Figure 17.7).

c. Maximum slope shall be 1:12. Small/flatter slopes are strongly preferred. See Figure 17.7. ~~Curb ramps that are steeper than a 1:15 max slope will not be accepted by the City of Houston.~~

d. Provide a minimum 5-ft by 5-ft clear and level landing space at the top of every curb ramp (see Figure 17.7).

~~d.~~e. Provide detectable warning strip of 2-ft at the interface with the roadway (see Figure 17.7). Every pedestrian-accessible trail, Walkway, or ramp shall meet this requirement.

~~e.~~f. Ramps and the 5-ft x 5-ft level landing shall be free of obstructions, utilities, and hardware. Any obstructions, utilities, or hardware installed in an approved area shall maintain a minimum 5-ft clearance zone (see Figure 17.8).

~~f.~~g. Curb ramp flares shall be provided for any side of a curb ramp that is adjacent to the walkable surface.

~~g.~~h. The walkable surface shall be maximized at every corner of a signalized location and other pedestrian-dense areas to safely and comfortably accommodate pedestrians waiting to cross the street.

~~h.~~i. See Figure 17.7 and Figure 17.8 for curb ramp dimensions and clearance zones, respectively.

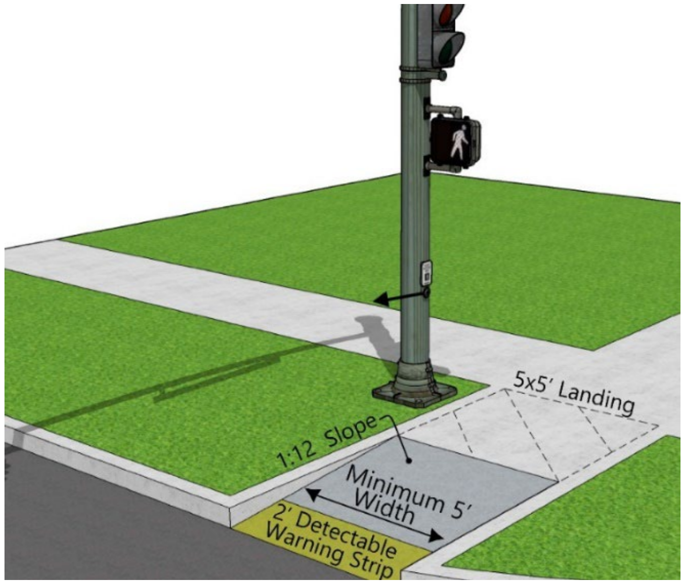


Figure 17.7~~17.7~~ – CURB RAMP DIMENSIONS

17.3.02.A continued

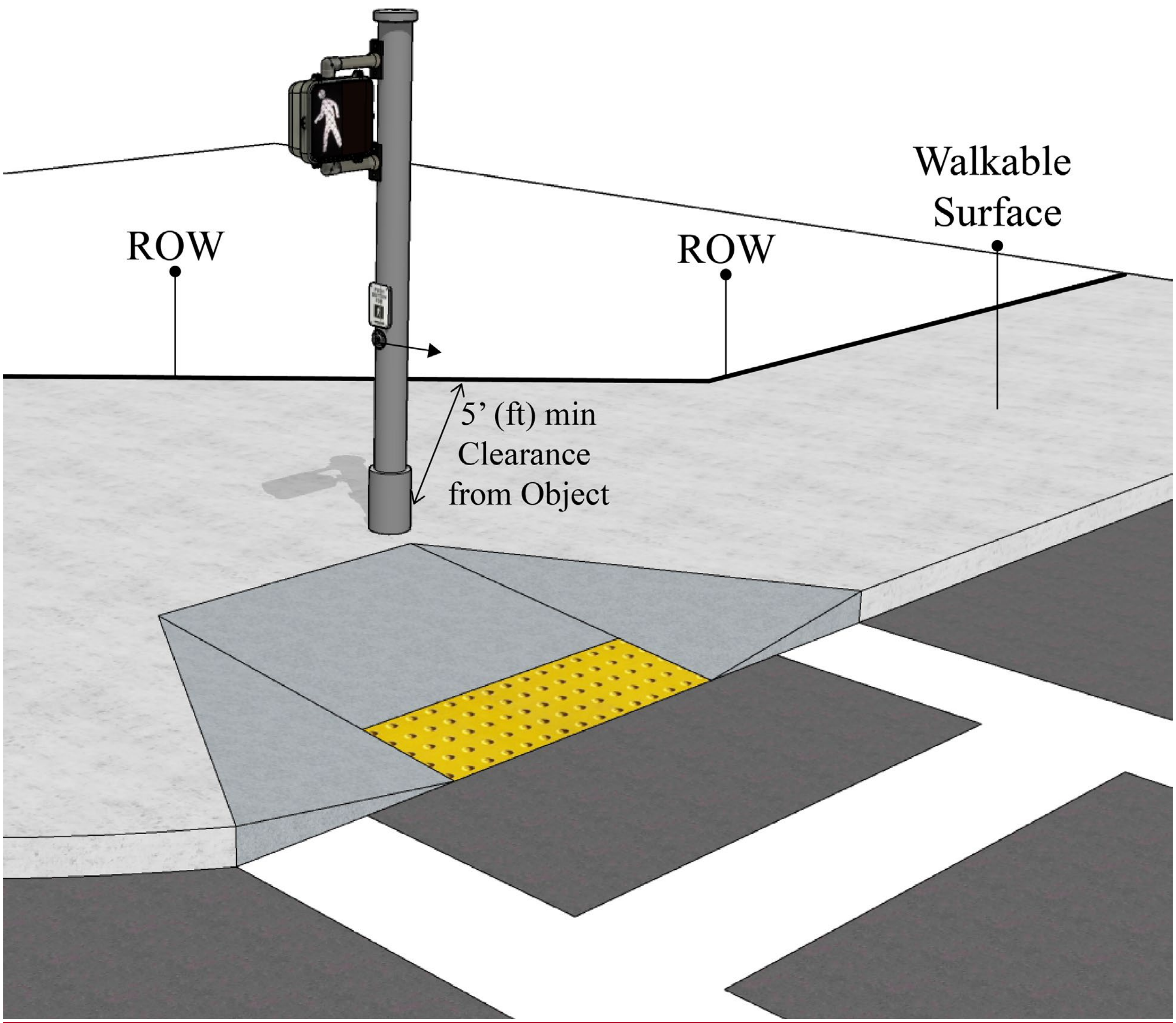


Figure 17.8~~17.8~~ – CURB RAMP CLEARANCE ZONE

~~9.~~6. Curb Ramp Design Guidelines

a. Curb ramps should be directional so that a person traveling down the ramp is directed towards a legal crosswalk and towards a receiving ramp.

~~a.~~b. Curb ramp construction on an intersection corner should be interconnected to facilitate a walking route around the corner that does not require a pedestrian to utilize a ramp or enter the street.

17.3.02.A.6 continued

~~b.~~c. Where a ~~The width of~~ curb ramp~~s~~ serv~~ing~~es a ~~midblock crossing~~ Walkway, Bicycle Facility or trail that is directed toward the ramp, the width of the ramp should generally match ~~shall be equal to~~ the width of the ~~approaching pedestrian or~~ Walkway, ~~b~~Bicycle ~~f~~Facility and/or trail.~~Detectable warning surfaces shall extend the full wid~~

~~c.~~d. ~~th of the ramp.~~ Curb ramps should be designed so that water does not pool on or at the bottom of the ramp. This may require minor pavement work around the ramp to ensure adequate gutter flow.

~~d.~~e. Presence of a curb ramp does not in and of itself require crosswalk markings. Legal crosswalks exist at most intersections regardless of installation of crosswalk markings.

f. Pedestrian pushbuttons should be placed adjacent to a level Walkway that directs a pedestrian crossing in the direction served by the pushbutton. See Figure 17.9 for a conceptual design of pedestrian pushbuttons. This figure is for reference only and does not constitute design standards.

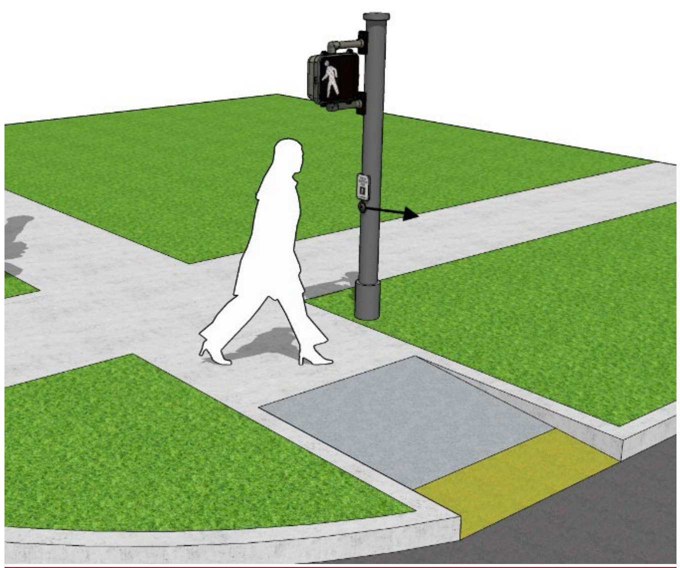


Figure 17.9~~17.9~~ – EXAMPLE OF A PEDESTRIAN PUSHBUTTON LOCATED IN THE DIRECTION SERVED BY THE PUSHBUTTON

~~e.~~g. Pedestrian pushbuttons should be located so that they are equally accessible for pedestrians traveling via any Sidewalk and/or crosswalk served by the corner.

~~f.~~h. Signal poles without pedestrian pushbuttons should be installed in a fashion that maximizes the surrounding walkable surface.

~~g.~~i. Signal equipment may be installed in the walkable surface if doing so provides a net gain in space for pedestrians.

17.3.02.B Crosswalk Markings (see Chapter 15.2.06.B.4)

17.3.02.C Curb Extensions

~~10.~~1. Curb extensions~~.~~ (also known as bulb-outs) ~~Curb extension reduce crossing distance and increase visibility of people in the crossing. This treatment can be used when on-street parking exists or where excess pavement exists such that a curb extension can be constructed without decreasingroadway capacity.~~ are tools that add space for pedestrians along a roadway by extending the Pedestrian Realm from the Sidewalk into the street. This narrows the roadway width, which can improve pedestrian safety by increasing visibility, shortening the crossing distance, and reducing exposure time to traffic.

a. Curb Extensions can achieve Daylighting, which is a safety measure that improves visibility and comfort for all road users at intersections by eliminating visual barriers between motorists and Vulnerable Road Users on the cross street.

~~11.~~2. Curb Extensions can be added at intersections, midblock crossings, and where travel lanes are reduced or reconfigured.

a. Streets with 24-hour on-street parking shall have Curb Extensions at intersections and midblock crossings. Curb Extensions can be implemented at midblock crossings and intersections where construction would not require obstructing a travel lane.

b. See Section 17.3.03 - Corridor Crossing Analysis and Treatments for additional guidelines on Curb Extension placement.

~~12.~~3. Curb Extensions should be added at all intersections with excess width where roadway geometry allows. Excess width is present when a roadway cross section meets the following condition:

$$If, x > (y \times 11) + m$$

$$Then, e = x - \big((y \times 11) + m\big)$$

Where: x = face of curb to face of curb width (ft)
y = number of through and turn lanes
m = median width (ft)

17.3.02.C continued

e = excess width (ft)

~~13.~~4. Curb Extensions should be a minimum twenty (20)-ft in length from a point beginning at the crosswalk, marked or unmarked. The length may be altered if driveways, bus stops or other uses of the curb-adjacent area are present.

~~14.~~5. Curb Extensions shall maintain or improve existing crosswalk and curb ramp widths. Curb Extensions shall not impede pedestrian travel paths.

6. Curb Extensions can be made from corner reconstruction and extend the Sidewalk into the roadway, or they may be defined with the use of pavement markings, curbs, bollards, planters, or a combination of the aforementioned.

~~15.~~7. Materials for Curb Extensions:

a. Seamless Curb Extensions shall be used in new or full street reconstruction projects and may be used in Retrofit projects. Seamless Curb Extensions should be a continuation of the Pedestrian Realm such that the grade, concrete, sodding, and other components are consistent. See Figure 17.10 for a conceptual design of an intersection with Seamless Curb Extensions. This figure is for reference only and does not constitute design standards.

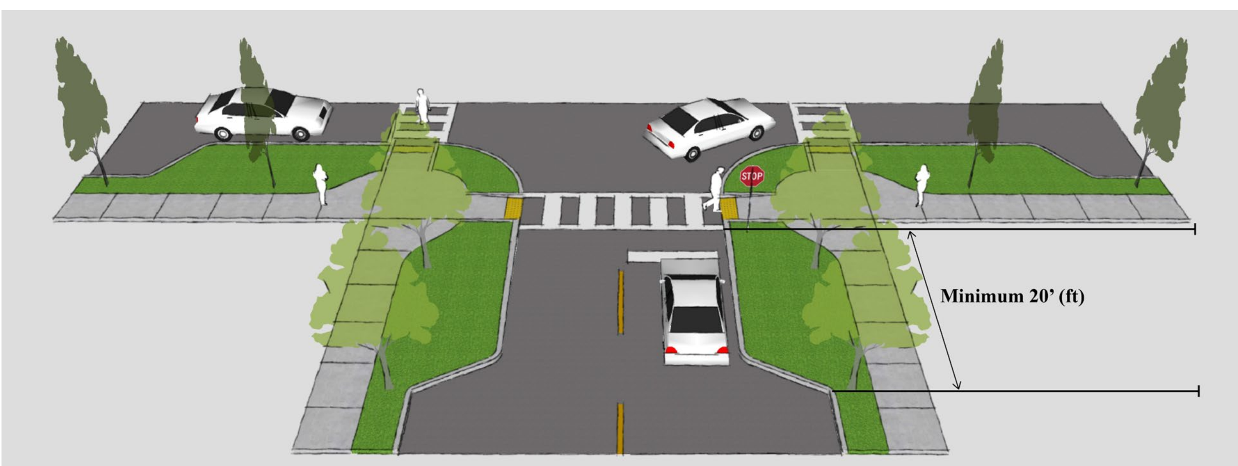


Figure 17.10~~17.10~~ – SEAMLESS CURB EXTENSION WITH ON-STREET PARKING

b. Median concrete (also known as floating curb) can only be used in Retrofit projects.

(1). On curb and gutter streets, median concrete shall maintain an eighteen (18)-in wide gutter flow area.

17.3.02.C.7 continued

(2). Median concrete may be installed on open ditch streets subject to Houston Public Works review and approval.

~~a.~~c. Precast or cast-in-place curb can only be used in Retrofit projects. The length and openings of precast and cast-in-place curb will vary depending on context but generally should be placed such that vehicles cannot encroach.

~~b.~~d. Bollards or flexible posts with pavement markings can only be used in Retrofit projects. Hatched pavement markings (see 17.3.02.C.7.e) shall create a buffer and the bollards or flexible posts shall be placed on the inside edge of the buffer. Spacing between individual bollards or flex-posts will vary depending on context but generally should be placed such that vehicles cannot encroach.

~~c.~~e. Hatched pavement markings alone may only be used where all other Curb Extension treatments are not feasible. Curb Extensions that consist only of hatched pavement markings are subject to approval by City Traffic Engineer.

(1). Hatched pavement markings shall consist of twenty-four (24)-in diagonal white stripes spaced at eight (8)-ft bounded by a six (6)-in solid white line.

~~d.~~f. Other materials may be considered to delineate Curb Extensions, such as planters. Alternative materials are subject to approval by the City Traffic Engineer.

~~16.~~8. Curb Extensions may include street furniture, bike racks/corrals (see section 17.4.01.C), or other amenities to enhance the public realm. The City of Houston will maintain standard Curb Extension delineation (see subsections 17.3.02.C.7.a-d) and bike racks ('U' Racks, refer to Standard Detail 02871-01) within Curb Extensions. Other amenities require a maintenance agreement.

~~17.~~9. Where Curb Extensions intersect with Dedicated Bicycle Facilities, see Protected Intersections, Section 17.4.03.A11.

~~18.~~10. Drainage

a. On curb and gutter streets, Curb Extensions should include a new stormwater inlet on the upstream side of the Curb Extensions. If a new inlet is not feasible, the Curb Extensions shall at a minimum maintain the existing gutter flow line. This may be achieved through cuts in median concrete or curb spacing.

17.3.02.D continued

b. Curb Extensions on open ditch streets are subject to Houston Public Works review and approval.

~~17.2.03.M~~17.3.02.D Median Refuge Islands

1. Median ~~r~~Refuge ~~i~~Islands are protected spaces located in the center of the roadway to ~~permit~~ allow ~~a two-stage~~ for safe crossings in stages ~~of the roadway~~. Median ~~r~~Refuge~~s~~ Islands ~~should be considered where center turn lanes are present and are encouraged on corridor with 4 or more lanes, or where roadway configuration is reconfigured from a 4-lane corridor to a 3-lane corridor.~~ enable bicyclists and pedestrians to cross a single direction of traffic at a time, thereby limiting pedestrian and bicyclist exposure to traffic.

2. Median Refuge Islands at unsignalized locations must be recommended as part of a Corridor Crossing Analysis report, as defined in Section 17.3.03.

3. Crossings through an existing median or at an unsignalized intersection with an existing median are not considered Median Refuge Islands for the purpose of these standards; however, many of the standards and guidelines presented here may be utilized as applicable for those crossings.

4. Materials

   a. Median Refuge Islands shall be constructed with a suitable material to discourage driver encroachment.

   b. The preferred treatment is standard concrete curb with a fill of sod or other Green Infrastructure. Concrete fill may be used.

5. Geometry

   ~~b.~~a. Median Refuge Island dimensions shall meet the minimums established in Table 17.3.

   ~~c.~~b. The front edge of the Median Refuge Island shall be rounded to discourage the accumulation of roadway debris.

   c. The Walkway through the Median Refuge Island may be either cut-through or ramped:

      (1). For Median Refuge Islands less than 20-ft width, a cut-through design is required.

(2). For Median Refuge Islands greater than 20-ft width, a Walkway with ramps shall be used to keep debris from accumulating and to increase the height of pedestrians to make them more visible to drivers.

d. Detectable warning surfaces shall be provided at the entrance and exit of the Median Refuge Island and at both roadway edges as part of accessible curb ramps.

~~5.~~6. See Figure 17.11 for a conceptual design of a Median Refuge Island. This figure is for reference only and does not constitute design standards.

17.3.02.D continued

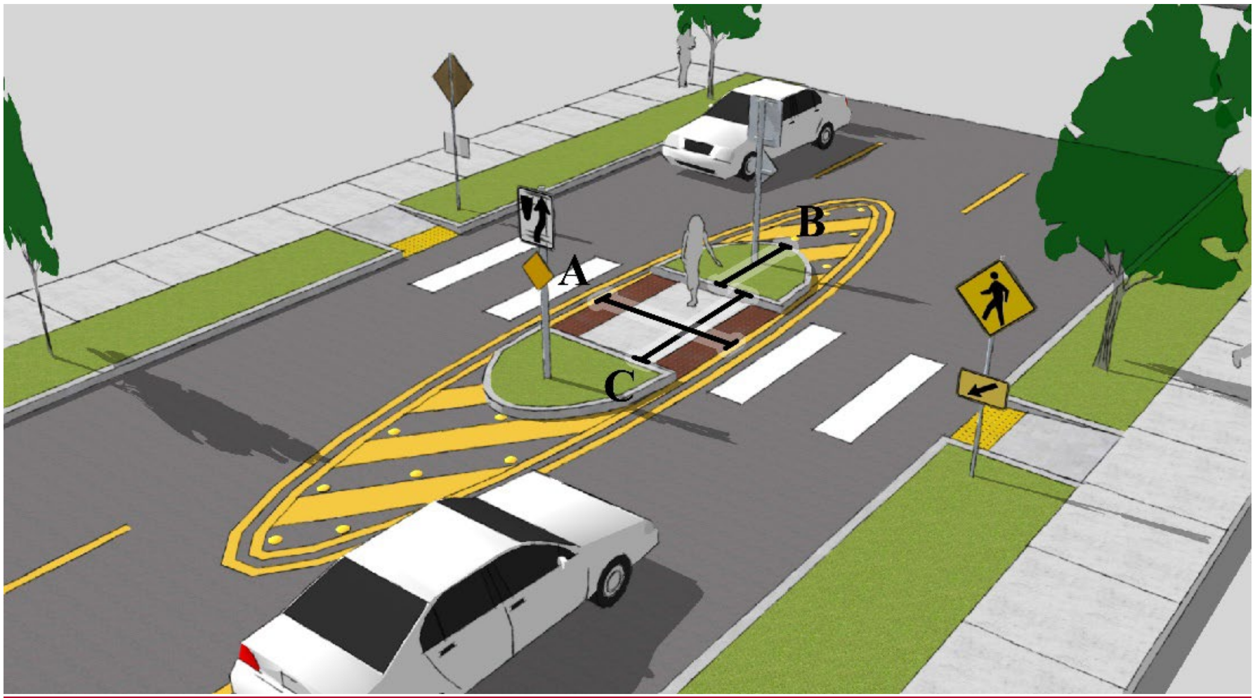


Figure 17.11~~17.11~~ – MEDIAN REFUGE ISLAND WITH WIDTH (A), LENGTH (B) AND WALKWAY WIDTH (C)

Table 17.3 – MINIMUM DIMENSIONS FOR MEDIAN REFUGE ISLANDS

Design Element(2)	Label	Minimum (ft) (1)
Median Refuge Width	A	8
Median Refuge Length	B	6
Walkway Width	C	6

Notes:

(1) Dimensions measured from face of curb to face of curb.

(2) See Figure 17.11 for an example of design elements

~~6.~~7. Signage and Pavement Markings

17.3.02.D.7 continued

a. Median Refuge Islands installed on undivided roadways will be treated as a roadway obstruction and shall follow all TMUTCD requirements for markings and signage.

b. The approach edge of the Median Refuge Island shall utilize retroreflective treatments. If it is a curb, the curb shall be painted with retroreflective paint. Yellow paint shall be used when the Median Refuge Island is located between opposing directions of traffic. White paint shall be used when the Median Refuge Island is located between lanes in the same direction.

c. A Keep Right sign (R4-7) shall be installed in the center of the Median Refuge Island near the approach edge.

d. Signing and striping for the crosswalks shall comply with Section 17.3.03.C - Crossing Treatments.

~~7.~~8. Street lighting shall be installed in the vicinity of the Median Refuge Island. See Chapter 15, Section 15.2.13 - Streetlight Design Requirements. ~~Street lighting at midblock trail crossings where feasible and approved by Houston Public Works.~~

~~8.~~9. The height of any Median Refuge Island features, such as landscaping, that could restrict visibility of road users shall be no greater than four (4)-ft from the roadway surface.

10. All Median Refuge Islands must comply with all requirements defined in 17.3.02 - Intersections and Midblock Crossings and with Standard Details 02760-10, 02760-11 and 02760-12.

11. Guidelines

a. Median Refuge Islands can be located at intersections or midblock.

b. Z-style Walkways within the Median Refuge Islands are preferred to increase the chance that a pedestrian can see a conflicting vehicle before entering the road and to slow movements by bicyclists and other higher-speed users.

c. When extra visibility is required, such as when site conditions make street lighting challenging, reflective bollards should be installed along the approach edge of the Median Refuge Island.

d. A Median Refuge Island should not be placed in front of or near a driveway unless access control into or out of the driveway is specifically desired. Coordination with Houston Public Works will be required whenever access to a driveway is impacted.

17.3.02.D continued

~~9.~~12. Sod or other LID features may be preferable in the median if adequate drainage is provided and with Houston Parks and Recreation Department approval. Additional landscaping shall require an approved maintenance agreement.

17.3.02.E Raised Crosswalks

~~10. i.Raised crossing (a.k.a. raised crosswalk). Raised crossings elevate people in the crossing above the road level, thereby increasing their visibility. Raised crossings are not permitted on corridors with design speeds greater than 35 miles per hour.~~

~~11.~~1. Raised Crosswalks provide a crossing that brings the level of the roadway up to the level of the Sidewalk. Raised Crosswalks increase visibility of Vulnerable Road Users, which can improve safety for all road users. Figure 17.12 and Figure 17.13 show conceptual designs of Raised Crosswalks. These figures are for reference only and do not constitute design standards.

Figure 17.12~~17.12~~ - RAISED CROSSWALK ON A TWO-WAY, UNDIVIDED ROADWAY

17.3.02.E continued

Figure 17.13~~17.13~~ - RAISED CROSSWALK ON A ONE-WAY ROADWAY WITH A Z-STYLE CROSSING

~~12.~~2. Raised Crosswalks may be installed at intersections, midblock, as part of trail crossings, pedestrian and bicyclist crossings at roundabouts, or other locations where approved by City Traffic Engineer or designated approver.

3. Raised Crosswalks at unsignalized locations, shall only be installed where determined by Corridor Crossing Analysis report and approved by City Traffic Engineer, as defined in 17.3.03.B.

4. Geometry

   a. Raised Crosswalks shall follow the design standards established in Table 17.4.

   b. Figure 17.14 demonstrates the platform width (W), approach slope (S_a) and departure slope (S_d) and Figure 17.15 demonstrates the height (H).

c. Raised Crosswalks on undivided roadways shall have an identical approach and departure slope. On divided and one-way roadways, the approach and departure slopes shall vary according to Table 17.4.

Table 17.4 – RAISED CROSSWALK DIMENSIONS AND SLOPE

Classification & Speed (85th % or posted)	Platform Width W (ft)	Height H (in)	Undivided	Divided/ 1-Way	
			Approach & Departure Slope S_a & S_d	Approach Slope S_a	Departure Slope S_d
Unclassified 30 MPH or less	10	6	1:15	1:15	1:35
Classified 30 MPH	20	4	1:20	1:15	1:35
Classified 35 MPH	20	4	1:25	1:20	1:35
Classified 40 MPH	20	4	1:25	1:25	1:35

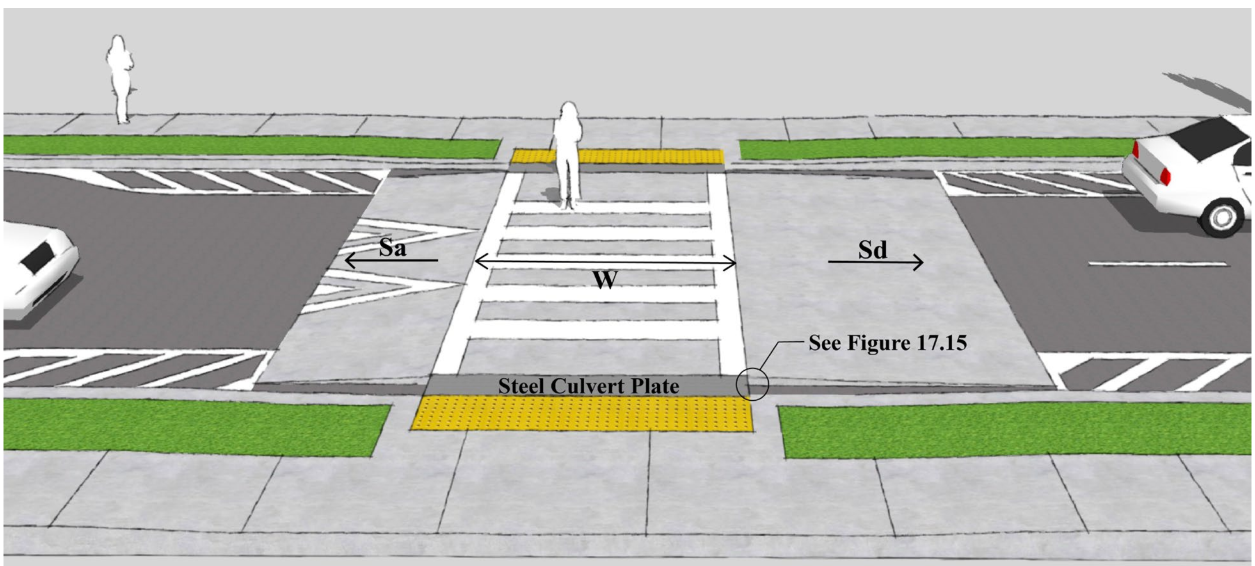


Figure 17.14~~17.14~~ – RAISED CROSSWALK ON A ONE-WAY ROADWAY WITH THE APPROACH SLOPE (S_a), DEPARTURE SLOPE (S_d) AND PLATFORM WIDTH (W)

17.3.02.E continued

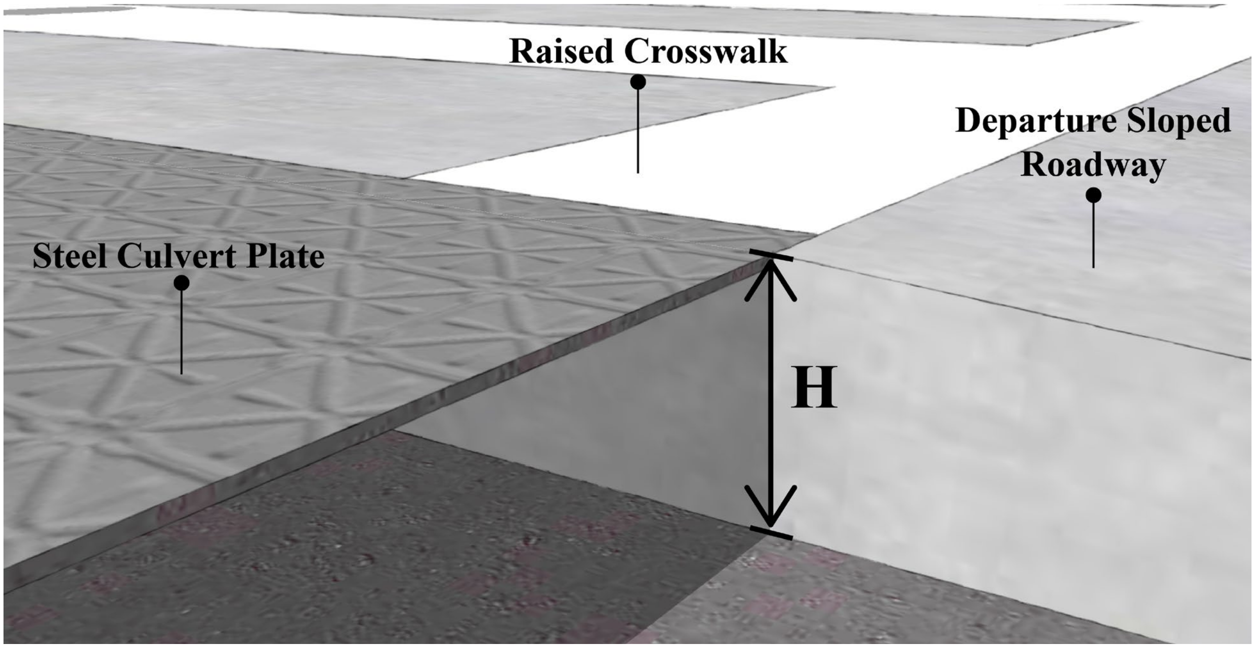


Figure 17.15~~17.15~~ – DEMONSTRATION OF RAISED CROSSWALK HEIGHT (H)

5. Signage and Pavement Markings

   a. All Raised Crosswalks shall provide High-Visibility Crosswalk or dual-use crossing markings.

   b. White retroreflective chevron markings, consistent with those shown on Standard Detail 13501-01, shall be installed on the sloped part of the Raised Crosswalk on the approach section.

   c. Whenever a drainage gap is approved, drivers shall be guided away from the gap. At a minimum, pavement markings shall be provided consisting of retroreflective edge lines and white hatched tapers compliant with lane narrowing requirements in the Texas Manual on Uniform Traffic Control Devices.

   d. Signing and striping for the crosswalks shall comply with Chapter 15, Section 15.2.06.B.4 - Crosswalks and Section 17.3.03.C - Crossing Treatments.

6. Drainage

   a. Raised Crosswalk design shall fully accommodate drainage. A Raised Crosswalk shall not create new ponding of stormwater.

17.3.02.E.6 continued

b. For classified collector and major thoroughfare streets and any street with a posted speed of 35 mph or higher:

(1). Raised Crosswalks shall be installed on a high point of the gutter flow line or a new storm inlet with appropriate connections installed on the upstream side of the Raised Crosswalk.

~~a.~~

c. For Local Streets:

(1). Raised Crosswalks should be installed on a high point of the gutter flow line or a new storm inlet with appropriate connections installed on the upstream side of the Raised Crosswalk.

~~b.~~d. Roundabouts with Raised Crosswalks shall include inlets upstream on the legs of the roundabout to avoid ponding in the inscribed circle.

~~c.~~e. A minimum eighteen (18)-in gap shall be provided to preserve the gutter flow. An easily removable steel plate shall be provided over the drainage gap at the level of the Raised Crosswalk. Retroreflective edge lines and hatch markings shall be provided to guide drivers away from the gap.

7. Street lighting shall be installed in the vicinity of the Raised Crossing. See Chapter 15, Section 15.2.13 – Streetlight Design Requirements.

8. Guidelines

a. Raised Crosswalks can be located at intersections or midblock.

b. Raised Crosswalks may be placed on median-divided roadways such that a Z-style Walkway is created within the median (see Figure 17.13). Z-style crossings are preferred to increase the chance that a pedestrian can see a conflicting vehicle before entering the road and to slow movements by bicyclists and other higher-speed users.

c. A Raised Crosswalk shall not be placed in front of a driveway unless access control into or out of the driveway is specifically desired. Coordination with Houston Public Works will be required whenever access to a driveway is impacted.

17.3.02.F For safe crossings at Roundabouts see Chapter 10, Section 10.3.02.F - Roundabout Intersections.

17.3.03 CORRIDOR CROSSING ANALYSIS AND TREATMENTS

~~17.2.03.N~~17.3.03.A General

1. Legal crosswalks exist at most intersections, regardless of presence of signage or striping (Texas Transportation Code Chapter 552.003). Most crosswalks across minor streets do not require any special treatment.

2. New crossings or modifications to existing crossings for Vulnerable Road Users at unsignalized locations must be recommended as part of a Corridor Crossing Analysis as defined in 17.3.03.B and require approval by Houston Public Works.

3. Trail crossings at classified roadways (MTFP) shall follow the general crossing analysis methodology described below. Trail crossings at local streets should follow the criteria in Section 17.3.03.D - Special Case: Midblock Trail Crossing at Local Streets.

17.3.03.B Corridor Crossing Analysis

1. Applicability and Scope

   a. All new marked crosswalks at unsignalized locations must be recommended as part of a Corridor Crossing Analysis. All enhancements to an existing marked crosswalk shall also require a Corridor Crossing Analysis to justify the enhancements.

   b. The requirements of this section apply to improvements to a single location and to a corridor with multiple crossing locations. Both situations require an assessment of corridor conditions between existing crossing locations that meet the requirements of this section. A full corridor assessment assures that new crossing locations do not preclude other high-demand crossing locations.

   c. Special cases may be appropriate for the assessment of a single crossing location instead of a corridor assessment. Such cases may include a trail crossing location that is dictated by the geometric constraints of the trail corridor. Any Crossing Analysis of a single site instead of a full corridor requires Transportation and Drainage Operations approval.

   d. Note: This section does not provide requirements for the installation timeline of any crossing improvement. It only provides the requirements for acceptable locations for crossings and infrastructure treatments.

2. Corridor Crossing Analysis Report

17.3.03.B.2 continued

a. A Corridor Crossing Analysis report shall summarize all data, analysis, and recommendations required by this section. The report must be signed/sealed by a registered Professional Engineer and submitted to Houston Public Works for approval by the City Traffic Engineer or designated approver.

b. Corridor Crossing Analysis Reports shall recommend locations for crossings using the methodology in this section and shall recommend treatments for each crossing using the methodology in Section 17.3.03.C - Crossing Treatments.

3. Siting of Enhanced Crossings

a. Crossing enhancements may be provided midblock or at an unsignalized intersection. New ~~M~~midblock crossings shall be ~~located~~ at least 100-ft from ~~adjacent~~ an intersection~~s~~.

b. A Corridor Crossing Analysis shall result in safe, convenient crossings for Vulnerable Road Users spaced approximately every 500-720 feet. This distance ensures that no Vulnerable Road User must travel more than 360 feet (approximately two (2) minutes at three (3) ft/s walking speed) out of their way to reach an established crossing location. Closer spacing may be appropriate depending on land use and context.

(1). Note: Traffic signals, all-way stops, and modern roundabouts may be considered roadway treatments with acceptable crossings.

c. The locations of Enhanced Crossings recommended by a Corridor Crossing Analysis shall:

(1). Maintain spacing standards for the next adjacent designated crossing on either side of the proposed crossing location.

(2). Ensure that future, potentially desirable crossing locations can be installed according to the spacing standards.

(3). Use the following criteria to identify and prioritize crossing locations:

(a). Trail crossings

(b). Bus/transit stops

~~(a).~~(c). Houston Bike Plan

17.3.03.B.3.c.(3) continued

(d). Schools, especially where students are expected to cross at the location

(e). Adjacent parks

(f). Adjacent churches

(g). Other significant pedestrian generators

(h). High-crash location along the corridor

(i). Desire Lines or other indications of existing pedestrian activity.

17.3.03.C Crossing Treatments

1. General Considerations for Crossing Treatments

a. Crossing Treatments define the details of traffic control associated with various types of unsignalized crossings for Vulnerable Road Users. Specific Crossing Treatment requirements are included in Section 17.3.03.C.3.

b. All new or enhanced marked crossings at unsignalized locations shall comply with these standards. The type of crossing and specific location of an Enhanced Crossing shall be defined by a Corridor Crossing Analysis (see Section 17.3.03.B).

c. All Enhanced Crossings must be recommended by a Corridor Crossing Analysis or required by another section of this manual. All other Enhanced Crossings require approval by Transportation and Drainage Operations.

d. Street lighting shall be provided at Enhanced Crossings to illuminate the crosswalk where approved by Houston Public Works.

~~b.~~e. Pavement markings shall be used to define all midblock crossing locations.

~~c.~~f. All Enhanced Crossings shall be fully ADA-compliant and provide curb ramps that meet design requirements of Section 17.3.02.A.

2. Selection of Appropriate Crossing Treatments:

~~d.~~a. An existing or proposed treatment shall satisfy all applicable City standards for that treatment before it may be considered an Enhanced Crossing.

17.3.03.C.2 continued

b. New crossings shall provide a pedestrian Level of Service (LOS) E or better and have a calculated pedestrian delay less than 30 seconds based on the Pedestrian Mode methodology in the Two-Way STOP-Controlled Intersections chapter of the Highway Capacity Manual (latest edition). This methodology applies to Two-Way STOP-Controlled intersections and midblock crossings.

c. The simplest option that would achieve the required pedestrian LOS shall be used.

~~c.~~d. Prior to choosing a Crossing Treatment, alternatives shall be considered for reducing the crossing distance for the Vulnerable Road User, which impacts the pedestrian LOS. This reduction can be achieved with lane narrowing, lane repurposing, and curb extensions.

e. Crossings at existing medians shall be considered a two-stage crossing for the analysis if the crossing satisfies or will be retrofitted to satisfy all applicable requirements for a Median Refuge Island.

f. A combination of Crossing Treatments may be utilized; the highest yield rate of the combination should be used for the analysis unless a justifiable combined yield rate is available.

g. Other treatments may be acceptable; however, it will be the responsibility of the requestor to present justifiable yield rates.

~~f.~~h. Satisfaction of these requirements shall constitute an acceptable Corridor Crossing Analysis for the approved toolset defined above. The Corridor Crossing Analysis must be approved by Houston Public Works before the treatment may be installed.

3. Enhanced Crossing Treatments

a. High-Visibility Signs and Markings. See Section 17.3.03.C.4 - High-Visibility Signs and Markings.

b. Raised Crossing. See Section 17.3.02.E - Raised Crosswalks.

c. Curb Extensions. See Section 17.3.02.C - Curb Extensions.

d. Median Refuge Islands. See Section 17.3.02.D - Median Refuge Islands.

~~g.~~e. Rectangular Rapid Flashing Beacons (RRFBs)

17.3.03.C.3.e continued

(1). RRFBs are pedestrian-actuated enhancements used in combination with a pedestrian, school, or trail crossing warning sign to improve safety at uncontrolled, marked crosswalks. The device includes two rectangular-shaped yellow indications, each with an LED-array-based light source, that flash with high frequency when activated.

(2). RRFBs shall include Level B or C high-visibility signs and markings, as defined in Section 17.3.03.C.4 - High-Visibility Signs and Markings.

~~(1).~~(3). RRFB indicators shall be provided on both sides of the road for each approach, to ensure that drivers are aware that pedestrians may begin crossing from either side. This applies to both divided roads and undivided roads.

f. Pedestrian Hybrid Beacons (PHBs or HAWKS) are a special type of traffic control device used to warn and control traffic at an unsignalized location to assist pedestrians in crossing a street or highway at a marked crosswalk. PHBs are made up of a signal head in three sections, consisting of two horizontally arranged circular red sections over a single circular yellow section that is centered between the red lights.

4. High-Visibility Signs and Markings

a. Where a Corridor Crossing Analysis recommends high-visibility signs and markings, or where another kind of Crossing Treatment requires high-visibility signs and markings, the signs and markings shall follow the requirements of this section.

b. General Signage and Pavement Marking Requirements:

(1). For pedestrian-only crossings, white High-Visibility Crosswalk markings shall be used.

(2). For shared use midblock crossings, dual use markings shall be used, consisting of a series of white strips flanked by square bicycle-green pavement markings (refer to Standard Detail 02760-10).

~~(2).~~(3). For median-divided roadways, all signs required by this standard shall be mirrored on either side of a direction of travel.

17.3.03.C.4.b continued

~~(3).~~(4). ~~On four-lane r~~Roadways with more than one lane in each direction, ~~install~~ require R1-5b ~~"~~"~~Yield~~Stop Here to Pedestrians~~"~~" (pedestrian-only crossing) or R1-5PBb ~~"~~"~~Yield~~Stop Here to Pedestrians and Bicyclists~~"~~" (shared-use crossing) signage and ~~yield lines consisting of isosceles triangles pointing toward oncoming vehicles~~ stop bars (~~see~~ refer to Standard Detail ~~01510-09A~~02760-10).

~~Table 1-B Criteria for Midblock Crosswalk~~Table 17.5 — LEVEL OF TREATMENT CRITERIA SUMMARY
~~(Levels A, B, C, D are defined below)~~

ADT	Speed Limit	4 Lanes with Median	2 Lanes without Median	4 Lanes without Median
≤5,000	≤ 30 mph	A	A	A
	> 30 mph	A	B	C
5,000 – 15,000	≤ 30 mph	B	B	B
	> 30 mph	C	C	~~D~~C*
>15,000	≤ 30 mph	C	~~D~~C*	~~D~~C*
	> 30 mph	~~D~~C*	~~D~~C*	~~D~~C*

* Indicates that high-visibility signs and markings may not be sufficient for these crossings and should be combined with higher level treatments.

c. The following levels of treatment are specified for pavement markings and signage at locations with characteristics specified by Table 17.5.

~~Selection of Midblock Treatments:~~
~~Midblock treatments shall be selected to maximize safety of people crossing the street at the midblock location. Selection of treatments should consider the corridor speed, number of lanes and average daily traffic in addition to area context. Several levels of treatment based on these factors are presented below. Standard treatments are required for each level. Optional treatments may be used based on engineering judgment and with Houston Public Works approval. Table 1-B provides guidance for the selection of treatment level~~
~~Level of Treatment~~

~~(6).~~(1). Level A~~:~~ = ~~Midblock C~~Ccrossing pavement markings only

(a). ~~Standard:~~ Install, as appropriate, white ~~h~~High-~~v~~Visibility ~~c~~Crosswalk markings (pedestrian-only crossing) or ~~D~~dual ~~U~~use ~~Markings~~crossings (shared-use crossing).

~~(7). OPTIONAL:~~

~~. Install W11-2 pedestrian warning sign (pedestrian-only~~

17.3.03.C.4.c.(2) continued

~~crossing) or W11-15 pedestrian/bicycle warning sign (shared-use crossing) with W16-9P AHEAD (plaque) mounted on the side of the roadway in advance of the crossing.~~

~~b. Install W11-2 pedestrian warning sign (pedestrian-only crossing) or W11-15 pedestrian/bicycle warning sign (shared-use crossing) with W16-7PL diagonal downward arrow plaque mounted on the side of the roadway at the crossing.~~

~~(10).~~(2). Level B~~:~~ = ~~Level A +~~ ~~a~~Advance warning signage + Level A

~~(10). Standard:~~

(a). Install, as appropriate, white ~~h~~High-~~v~~Visibility ~~c~~Crosswalk markings (pedestrian-only crossing) or ~~D~~dual ~~U~~use ~~Markings~~crossings (shared-use crossing).

(b). Install W11-2 pedestrian warning sign (pedestrian-only crossing) or W11-15 pedestrian/bicycle warning sign (shared-use crossing) with W16-9P AHEAD (plaque) mounted on the side of the roadway in advance of the crossing.

(c). Install W11-2 pedestrian warning sign (pedestrian-only crossing) or W11-15 pedestrian/bicycle warning sign (shared-use crossing) with W16-7PL diagonal downward arrow plaque mounted on the side of the roadway at the crossing.

~~(11). Optional:~~

~~(12). Install "PED XING" (pedestrian-only crossing) or "BIKE XING" (shared-use crossing) advanced pavement marking.~~

~~(13).~~(3). Level C~~:~~ = ~~Level B +~~ ~~a~~Additional pavement markings + Level B

(a). Install, as appropriate, white ~~h~~High-~~v~~Visibility ~~c~~Crosswalk markings (pedestrian-only crossing) or ~~D~~dual ~~U~~use ~~Markings~~crossings (shared-use crossing).

(b). Install W11-2 pedestrian warning sign (pedestrian-only crossing) or W11-15 pedestrian/bicycle warning sign (shared-use crossing) with W16-9P AHEAD (plaque) mounted on the side of the roadway in advance of the crossing.

~~(a).~~(c). Install W11-2 pedestrian warning sign (pedestrian-only crossing) or W11-15 pedestrian/bicycle warning sign (shared-use crossing) with W16-7PL diagonal downward arrow (plaque) mounted on the side of the roadway at the crossing.

(d). Install ~~"~~"PED XING~~"~~" (pedestrian-only crossing) or ~~"~~"BIKE XING~~"~~" (shared-use crossing) advanced pavement marking.

~~17.2.03.O Optional:~~

~~17.2.03.P Raised crossing~~

~~17.2.03.Q Curb extension~~

~~17.2.03.R Median refuge island~~

~~**17.2.03.S** Level D: Level C + crossing enhancements~~

~~17.2.03.T Standard:~~

~~17.2.03.U Install, as appropriate, white high-visibility crosswalk markings (pedestrian-only crossing) or Dual Use Markings (shared-use crossing).~~

~~17.2.03.V Install W11-2 pedestrian warning sign (pedestrian-only crossing) or W11-15 pedestrian/bicycle warning sign (shared-use crossing) with W16-9P AHEAD (plaque) mounted on the side of the roadway in advance of the crossing.~~

~~17.2.03.W Install W11-2 pedestrian warning sign (pedestrian-only crossing) or W11-15 pedestrian/bicycle warning sign (shared-use crossing) with W16-7PL diagonal downward arrow plaque mounted on the side of the roadway at the crossing.~~

~~17.2.03.X Install ""PED XING"" (pedestrian-only crossing) or ""BIKE XING"" (shared-use crossing) advanced pavement marking.~~

~~17.2.03.Y On four-lane roadways, install R1-5 ""Yield Here to Pedestrians"" (pedestrian-only crossing) or R1-5PB ""Yield Here to Pedestrians and Bicyclists"" (shared-use crossing) signage and yield lines consisting of isosceles triangles pointing toward oncoming vehicles (see Standard Detail 01510-09A).~~

~~17.2.03.Z Consider a traffic signal or hybrid pedestrian beacon if the appropriate warrants in the TMUTCD are satisfied. Requires approval of City Traffic Engineer.~~

~~17.2.03.AA Enhancements are strongly encouraged where appropriate, including:~~

~~17.2.03.BB Raised crossing~~

17.3.03.D.2 continued

~~17.2.03.CC Curb extension~~

~~17.2.03.DD Median refuge island~~

17.3.03.D Special Case: Midblock Trail Crossings at Local Streets

1. Trails that cross classified roadways (MTFP) shall follow the Corridor Crossing Analysis methodology described above. Trails that cross midblock on local streets (i.e. not on the MTFP) shall follow the below criteria.

2. Trails that cross local streets should first determine whether the trail, street, or both are stop-controlled.

   a. If the street ADT is greater than 1,000, then the general crossing analysis methodology should be used to determine appropriate Crossing Treatments.

   b. If the street ADT is less than or equal to 1,000, then the road shall be stop-controlled and the trail shall be free-flow, unless there is an identified visibility concern, in which case the trail should also be stop-controlled.

   c. If the street is proposed to be stop-controlled, stop bars, stop ahead signage, and pedestrian/bicycle warning signage shall be provided on the street approaches.

   d. Install dual use crossings (shared-use crossing) for the trail crossing.

~~SECTION 3~~SECTION 4 - ~~BICYCLE GEOMETRIC DESIGN~~BIKEWAY FACILITY REQUIREMENTS

17.4.01 GENERAL BIKEWAY FACILITY REQUIREMENTS

17.4.01.A Guides and Standards

1. The City of Houston uses the Houston Bike Plan as a guide to determine type and location of Bicycle Facilities. Street design should incorporate the Houston Bike Plan Network. Any street can include safe Bicycle Facilities even if not on the Houston Bike Plan Network.

2. The City of Houston encourages Bicycle Facility design standards that exceed the requirements in this section. The following standards should be utilized when designing Bicycle Facilities: AASHTO Guide for the Development of Bicycle Facilities, FHWA Separated Bike Lane Planning and Design Guide, and NACTO Urban Bikeway Design Guide.

~~1. General Design Guidance~~

~~2. The design of streets within the City of Houston shall consider options for high- comfort bicycle design solutions to improve bikeway connectivity and expansion of the planned bicycle network.~~

~~3. Low-comfort bicycle facilities should be avoided wherever possible. Proposed design of any facilities that would be considered low-comfort shall require prior approval from the Transportation and Drainage Operations.~~

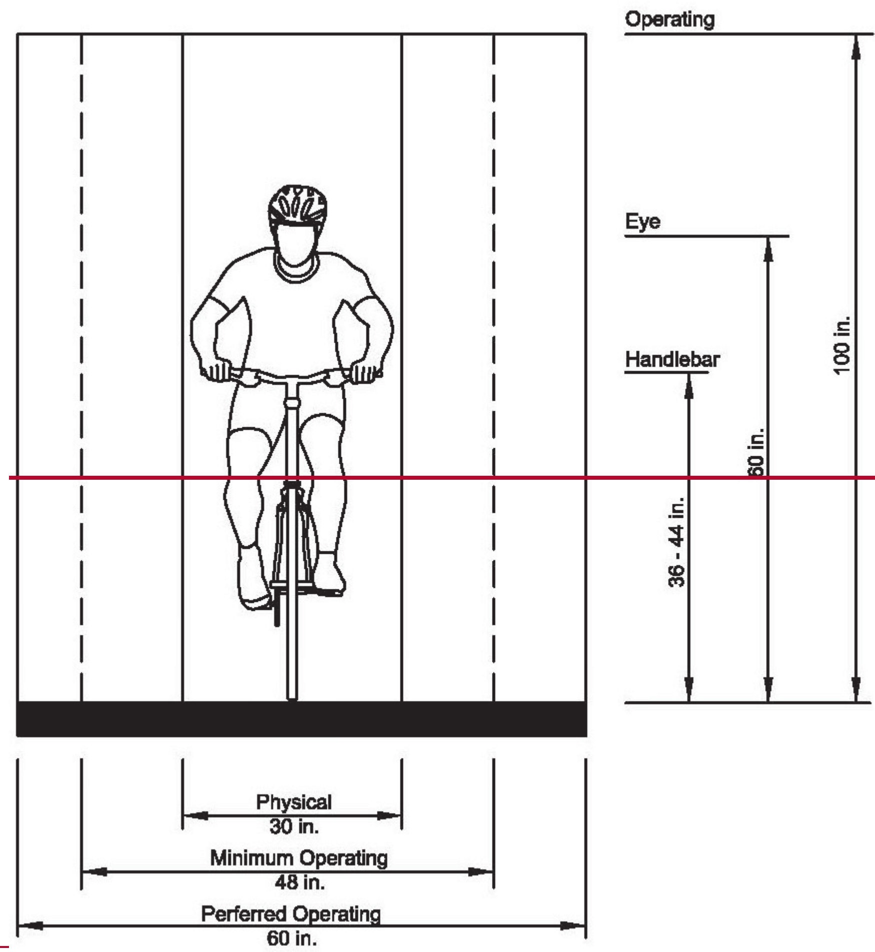
~~4. The design of bicycle facilities shall accommodate the design bicyclist. The dimensions of a bicycle and associated operating space are summarized in Figure~~

~~5. 17.1 and interpreted from the Guide for the Development of Bicycle Facilities, AASHTO.~~

~~6. Bicycling is an increasing component of multimodal thoroughfares. Bicycle facilities may be placed at sidewalk level, between sidewalk and pavement level, against the curb, between the curb and the parking lane, or between the parking lane and the vehicle travel lane. Bicycling facilities can benefit pedestrians by providing a buffer between the walking area and the vehicle traveled way.~~

~~7. Bicycle design speed for bicycle facilities is 12 mph.~~

~~8. Visibility of bicycle crossings may be emphasized by the use of bicycle-green pavement markings.~~



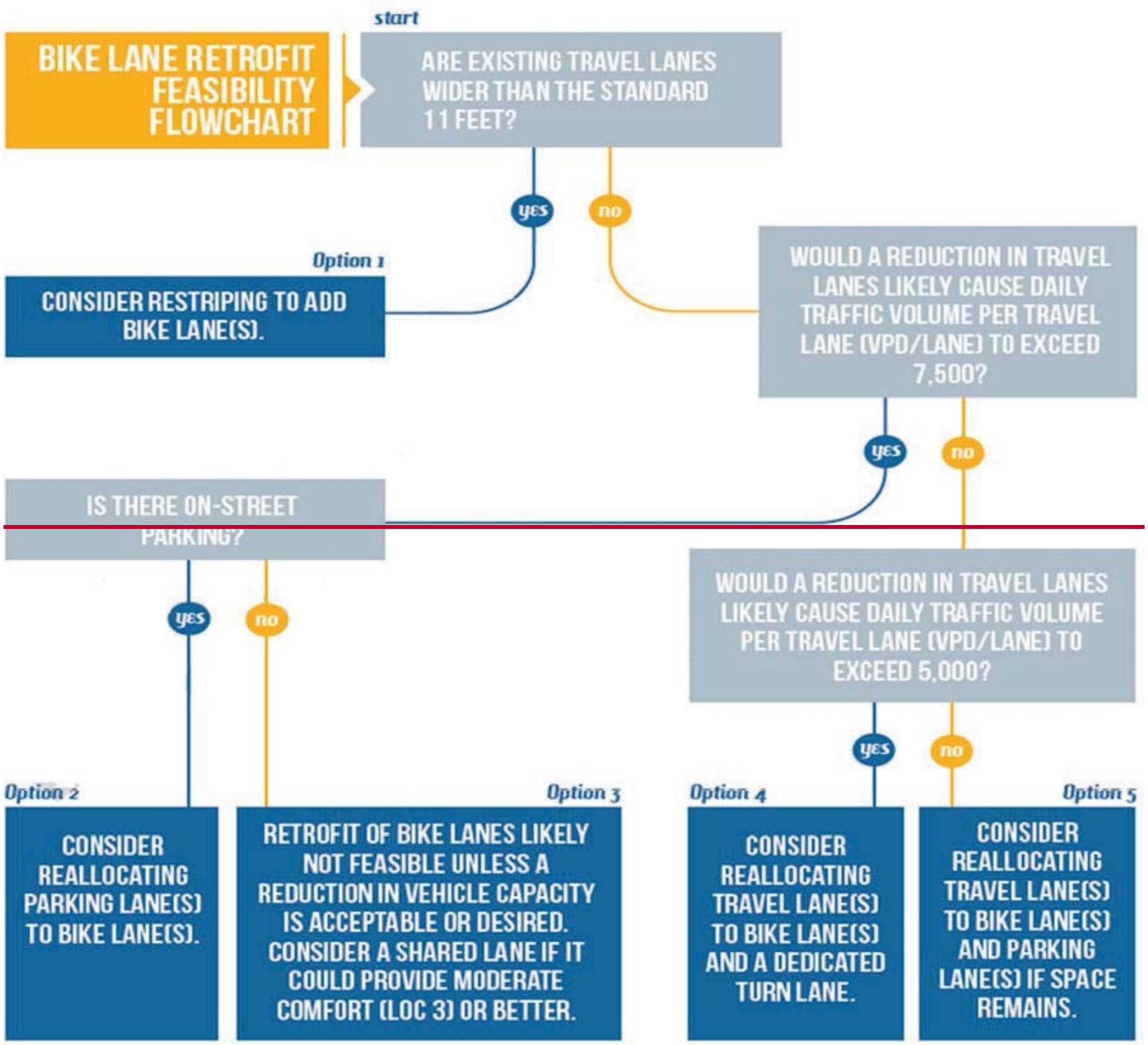
~~Figure 17.1 Design Bicyclist~~

~~9. Design Considerations~~

~~10. Bikeway facilities can be implemented as part of roadway reconstruction projects, through retrofit projects, or in the case of facilities outside of the roadway pavement, through special capital projects or other.~~

~~11. Bicycle Retrofit Projects: In some cases, retrofit bicycle facilities can be provided by reallocating existing pavement or by utilizing unused, excess pavement. A traffic study shall be required to determine the impact to other modes of travel on the roadway where an existing vehicular lane of traffic is removed. The traffic study shall be reviewed and approved by Houston Public Works staff before the retrofit can proceed. Houston Public Works may require a public meeting to gauge the public input on a proposed retrofit project. The flowchart below outlines the questions to be addressed by the traffic study.~~

~~12. Where delineator is being considered, the designer should evaluate its impacts on accessibility for other road users such as a bus accessing a bus stop, driveway ingress and egress, street sweeper, garbage collection truck, etc.~~



~~13.~~

~~Figure 17.2 Bike Lane Retrofit~~

~~14. Selection of Bicycle Facility Type~~

~~15.~~3. ~~New bicycle facilities shall provide as high a level of comfort for bicycle traffic as possible within the constraints of a given project. The flowchart below can be used to determine what type of bicycle facility may be appropriate for achieving a desired level of comfort with the specific roadway and traffic characteristics of a given project.~~The type of Bicycle Facility shall be determined using the Bicycle Facility Type Decision Matrix (see Figure 17.16).

~~16.~~4. Bicycle Facilities that change the number/type/width of existing lanes shall require a Traffic and Design Study as defined in Chapter 15, Section 15.2.02.

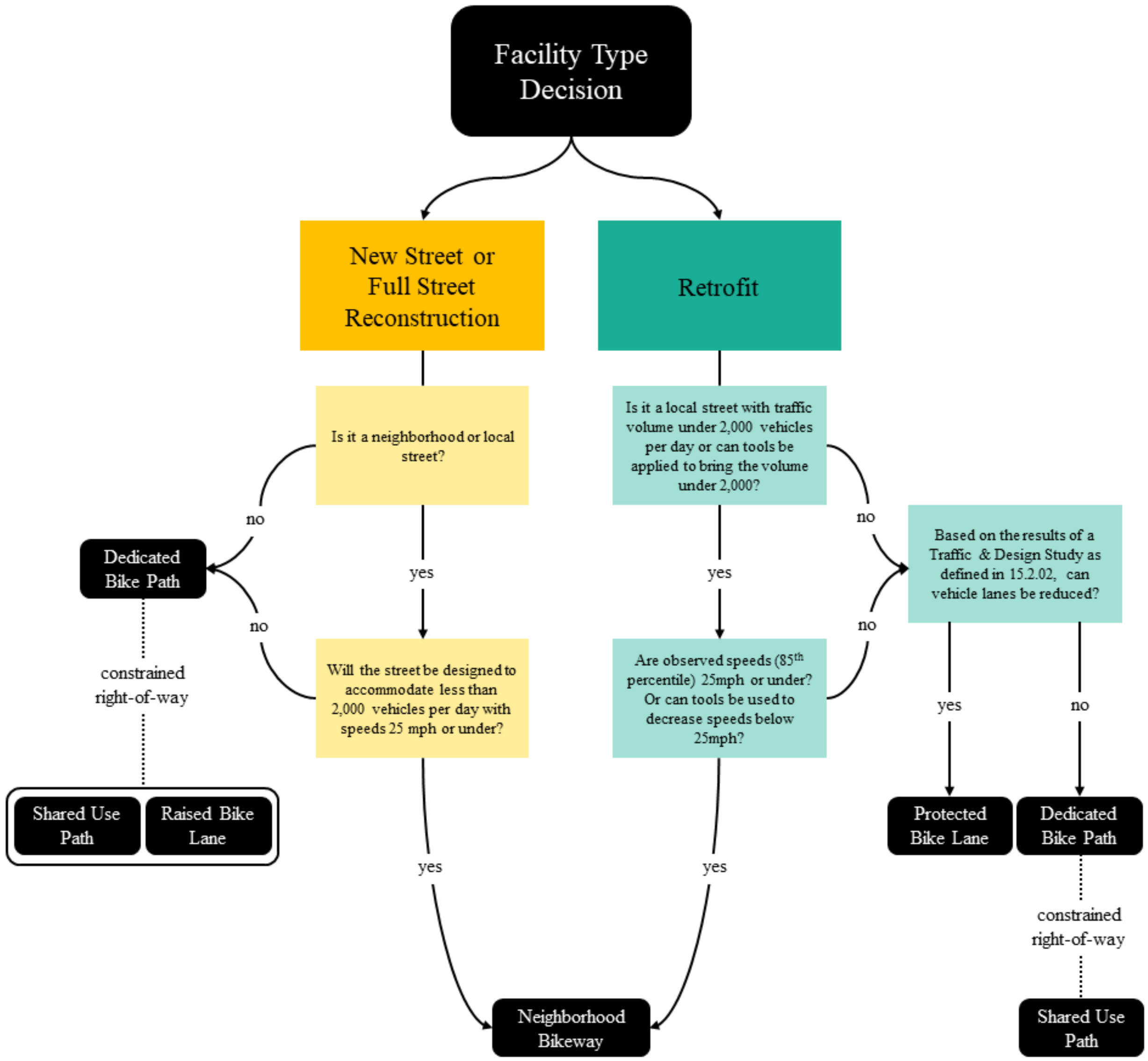


Figure 17.16 - BICYCLE FACILITY TYPE DECISION MATRIX

~~17.3.01.B~~

~~17.3.01.C~~17.4.01.B Curb Management

1. Curb Management shall be incorporated in all Bicycle Facility designs.

2. Curb Management may consist of solid waste, recycling, and heavy trash services, school queues, parcel and mail delivery, and loading zones.

~~17.3.01.D~~17.4.01.C ~~BIKEWAY AMENITIES~~ Bicycle Parking

17.4.01.C.1 continued

1. ~~Bike Parking:~~ Bicycle parking ~~and associated~~includes ~~bicycle rack~~bike racks, Bicycle Corrals and any other designated space to store bicycles. ~~placed within the public right of way should not impede the flow of traffic (vehicular, pedestrian, or other) or cause any unnecessary obstruction within the right of way. Bike rack spacing and placement shall be approved by Houston Public Works staff. General Spacing standards include:~~

   a. Bike Rack: A fixture upon which one or more bicycles may be parked.

   b. Bicycle Corral – A group of bike racks installed adjacent to the curb in the parking lane of the roadway or in the area of Curb Extensions (see Section 17.3.02.C). Bicycle Corrals are often sited near the intersection in areas where space behind the curb is limited.

2. Bicycle parking shall be included in the design of all Bicycle Facilities where feasible. Bicycle parking may be added to existing Bicycle Facilities.

3. Bicycle parking may be provided in many configurations subject to City of Houston approval. The City of Houston preference is a ‘U’ rack (refer to Standard Detail 02871-01). The guidelines for spacing of multiple ‘U’ racks is available in Table 17.6 – ‘U’ Rack Spacing Standards and Standard Detail 02871-01.

~~Table 17.1~~ Table 17.6– ‘U’ RACK SPACING STANDARDS

Location	Orientation	Minimum ~~(in)~~	~~Standard~~ Preferred ~~(in)~~
Between Racks	Side-by-Side	3’-~~36~~0”	~~48~~4’-0”
	End-to-end	~~72~~6’-0”	~~96~~8’-0”
From Back of Curb	Perpendicular	~~36~~2’-0”	-3’-0”
	Parallel	~~24~~2’-0”	-3’-0”
From Wall	Perpendicular	4’-~~48~~0”	-
	Parallel	~~36~~3’-0”	-
From ~~Tree~~Obstruction*	~~Parallel~~All	~~36~~3’-0”	~~48~~4-0”

17.4.01.C.4 continued

From Crosswalk	Perpendicular	5'-0"	-

* Streetlights, trees, sidewalk furniture, traffic signs or posts, parking meters, utility facilities/covers, etc.

4. Bicycle Parking Siting Guidelines

   a. Land Use: Sites along a Bicycle Facility should be prioritized based on nearby land uses. These land uses include commercial, retail, libraries, parks, community centers, other public institutions, medical centers and sports facilities.

   b. Transportation: Locations that allow for connections to additional transportation opportunities should be prioritized, such as METRO bus; Bus Rapid Transit (BRT) or Light Rail Transit (LRT) stations; Houston Bicycle stations; a high density of Micromobility options; or car sharing locations.

   c. Existing Conditions: Avoid locating bike racks in areas where public utilities or emergency services are present or in locations that are prone to flooding.

   d. Bicycle Facility Type: Bike racks may be installed off-street (see 17.4.01.C.5) or on-street (see 17.4.01.C.6).

   e. Lighting is an important component of safe and secure bicycle parking. If good nighttime lighting does not already exist, then nighttime lighting shall be provided wherever bike parking is installed.

5. Off-Street Bicycle Parking

   a. Bike racks shall not impede the minimum Sidewalk width and shall have a clearance zone of 4-ft x 6-ft (refer to Standard Detail 02871-01).

   b. Racks must be oriented so that users can safely enter and exit without conflicting with motorists or pedestrians.

   c. Bicycle parking should have a minimum of two (2) 'U' racks installed per bicycle parking location.

   d. Bicycle parking installed by any entity besides the City of Houston or an entity with an established maintenance agreement shall apply for a bike rack encroachment permit with the Office of the City Engineer.

e. Custom elements, such as non-standard racks or bicycle parking shelters, are subject to approval by the City of Houston and require a maintenance agreement.

6. On-Street Bicycle Parking (aka “Bicycle Corrals”)

~~e.~~a. Bicycle Corrals will consist of bike racks located within the public right-of-way at street grade. See Figure 17.17 for a conceptual design of Bicycle Corrals. This Figure is for reference only and does not constitute design standards.

17.4.01.C.6 continued

Figure 17.17 – ON-STREET BICYCLE PARKING

b. All proposed Bicycle Corrals require approval by the City Traffic Engineer.

c. Bicycle Corrals should be installed near intersections or driveways to create necessary sight distance clearances for motorists (see subsection 17.3.02.C - Curb Extensions). Bicycle Corrals may be installed in place of on-street parking, including midblock locations.

d. Bicycle Corrals must be oriented so that bicyclists can safely enter and exit without conflicting with motor vehicles or pedestrians.

e. Bicycle Corrals should provide six (6) or more ‘U’ racks for bicycle parking. The minimum number of ‘U’ racks installed at a Bicycle Corral shall be three (3).

f. Bicycle Corrals must include delineation that complies with the delineation requirements of Curb Extensions. See Section 17.3.02.C - Curb Extensions.

g. Custom elements, such as non-standard racks or bicycle parking shelters, are subject to approval by the City of Houston. Custom elements require a maintenance agreement.

17.4.01.D Wayfinding

17.4.01.D continued

Wayfinding is made up of directional signage, confirmational signage, decision signage and pavement markings that guide bicyclists along High-Comfort Bicycle Facilities and to certain destinations such as neighborhoods, parks, and trail entry points. ~~Wayfinding provide direction, destination, and distance information as needed for bicycle travel. If several destinations are to be shown at a single location, they may be placed on a single sign with an arrow (and the distance, if desired) for each name. If more than one destination lies in the same direction, a single arrow may be used for the destinations.~~

~~2. A Bike Route sign (D11-1) may be used along any type of bicycle facility as a wayfinding sign.~~

1. ~~The D1 series of wayfinding signage may be used in conjunction with a Bike Route sign (D11-1).~~

   ~~a. Wayfinding signage, if used, should be placed at logical intervals, especially prior to and at bicycle network decision points.~~

   ~~b. Alternative wayfinding signage design may be provided on off-street trails.~~

   ~~c. Listed Destinations: Requires coordination with and approval by Houston Public Works. Wayfinding should indicate directions to neighborhood amenities and destinations. Wayfinding within the public right-of-way shall not promote the use of any one private or for-profit business (except for grocery stores). Examples of acceptable destinations include:~~

   ~~d. Management District (i.e. Downtown, Montrose, EaDO, etc.),~~

   ~~e. Transit station (i.e. Park-n-Ride, light rail platform)~~

   ~~f. Government service centers~~

   ~~g. Trail access points~~

   ~~h. School/University~~

   ~~i. Library,~~

   ~~j. Grocery Store~~

   ~~k. Bikeway amenities (bike parking, bike shop, bike service center.~~

   ~~l. Bicycle Parking Area - D4-3~~

17.4.01.D.5 continued

a. Directional signs indicate to bicyclists the direction in which a Bicycle Facility continues.

b. Confirmational signs indicate to bicyclists that they are on a Bicycle Facility and make motorists aware of the Bicycle Facility.

c. Decision signs mark the junction of two or more bikeways and inform bicyclists of the designated bike route to access key destinations.

2. Wayfinding signage and pavement markings shall be provided for all Bicycle Facilities in addition to regulatory signage and standard bike facility pavement markings.

3. This section applies generally to all Bicycle Facility types. Individual Bicycle Facilities may have additional wayfinding requirements. See Bicycle Facility design standards for more details.

4. General requirements for usage of Houston Bikeways signage:

a. The Houston Bikeways Bike Route, Bike Route Ahead and Bike Route Ends signs shall only be used along High-Comfort Bicycle Facilities.

b. The Houston Bikeways Bike Route sign (D11-1 MOD HB) shall be used along all High-Comfort Bicycle Facilities as a confirmational, directional, and decision sign and shall be placed at regular intervals no more than ½ mile apart and directly preceding all intersections with other High-Comfort Bicycle Facilities.

c. A Houston Bikeways Bike Route Ahead (D11-1 MOD HB-A) confirmational and directional sign shall be included at the beginning of all High-Comfort Bicycle Facilities. This shall be substituted with a Bike Lane Ahead sign on Raised or Protected Bike Lanes.

d. A Houston Bikeways Bike Route Ends (D11-1 MOD HB-E) sign shall be included at the end of all High-Comfort Bicycle Facilities. This shall be substituted with a Bike Lane Ends sign on Raised or Protected Bike Lanes.

5. At all intersections of multiple High-Comfort Bicycle Facilities:

~~m.~~a. Include Houston Bikeways Bike Route sign on all bicycle approaches to the intersection.

~~n.~~b. A modified Houston Bikeways Bike Route directional sign shall indicate with arrows the direction of all High-Comfort Bicycle Facilities (e.g. left, right and forward arrows).

c. Destination placards (D1-1c, 2c, 3c) shall be added underneath the Houston Bikeways Bike Route sign as decision signs to indicate the direction and distance of destinations.

(1). Destinations should generally be neighborhoods; public parks; nearby streets; trail entrances; Bus Rapid Transit (BRT) or Light Rail Transit (LRT) stations; or other locations of community importance; and be accessible via High-Comfort Bicycle Facilities from the sign location.

(2). Other destination types shall require approval by Houston Public Works.

~~17.3.01.E~~17.4.01.E Railroad Crossings~~:~~

1. ~~General: Bicycle tires can become stuck in rail flanges when they cross tracks at a small angle.~~ Where ~~b~~Bicycle F~~f~~acilities cross a street-surface rail track, bicyclists should be directed to cross tracks at a safe angle (90 degrees preferred, 60 degrees minimum~~, 90 degrees desirable~~)~~.~~ so that bicycle tires do not become stuck in rail flanges.

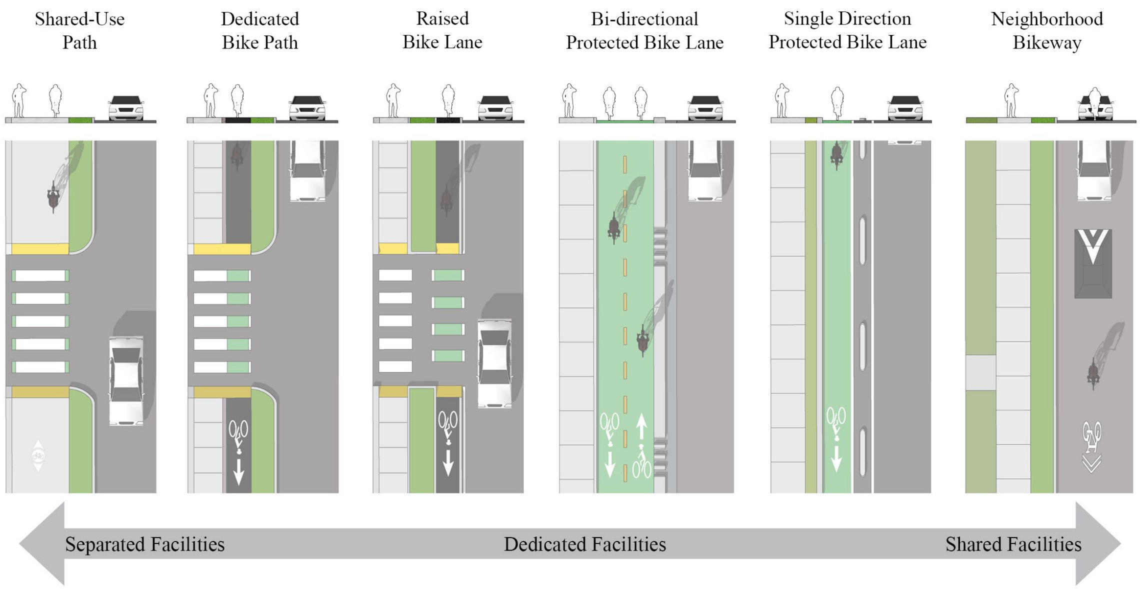
2. If ~~desired~~preferred crossing angle is not possible, a warning sign (W10-1 or W10-12) shall be placed in advance of the rail crossing alerting the bicyclist of skewed railroad crossing.

3. In the presence of uneven railroad tracks, a warning sign (W10-6) should be installed.

~~3.~~4. Where Bicycle Facilities cross Light Rail Transit (LRT) tracks, a warning sign (W10-1) shall be placed in advance of the rail crossing alerting the bicyclist of the railroad crossing.

~~17.3.02~~17.4.02 HIGH-COMFORT FACILITY TYPE STANDARDS ~~AND GUIDELINES~~

~~17.3.02.A~~17.4.02.A Figure 17.18 shows a summary of the types of bicycle facilities as defined by the City and their level of roadway separation. See the following section for a detailed description of each type of facility.



~~Figure 17.3 Bicycle Facility Type~~
Figure 17.18 – BICYCLE FACILITY TYPES BY LEVEL OF SEPARATION

~~17.3.02.B~~

~~17.3.02.C~~17.4.02.B Dedicated ~~Bicycle~~Bike ~~Facilities~~ Path

1. Dedicated Bike Paths are Bicycle Facilities that run alongside a roadway behind the curb within the right-of-way. See Figure 17.19 for a conceptual design of a Dedicated Bike Path. This figure is for reference only and does not constitute design standards.

17.4.02.B continued

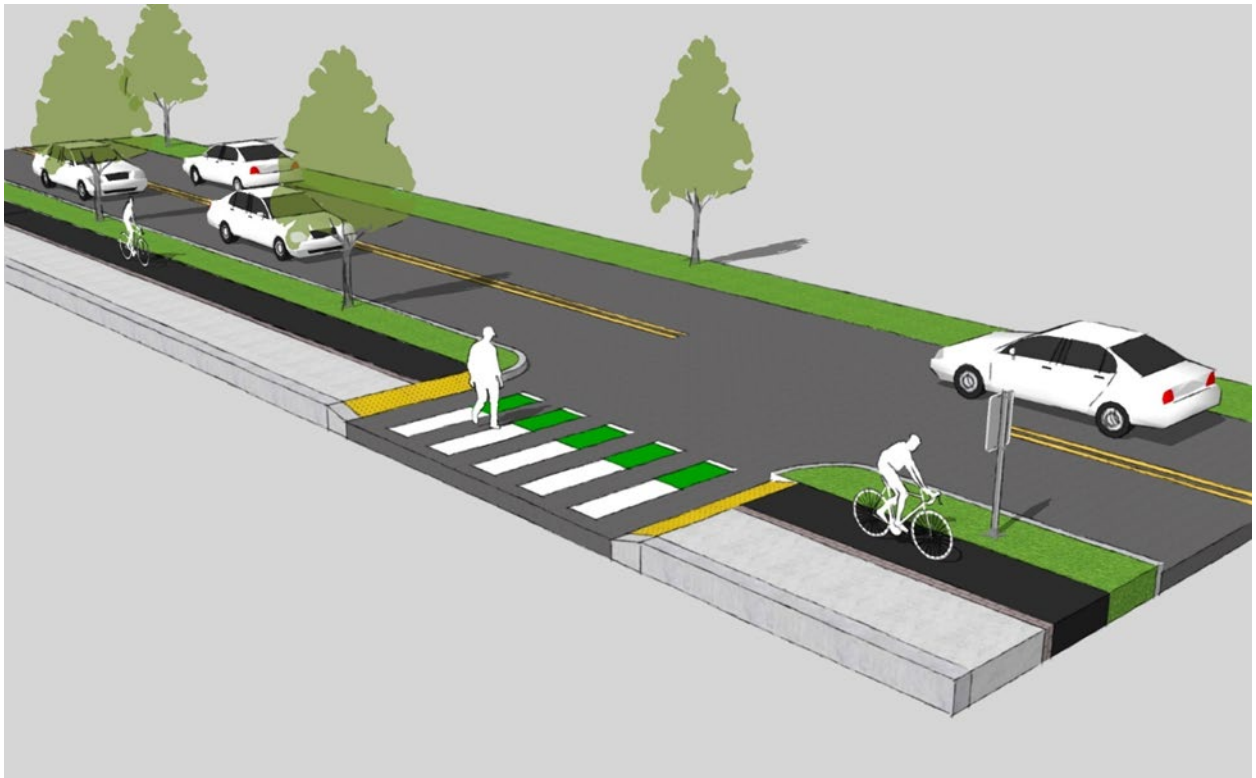


Figure 17.19 – DEDICATED BIKE PATH

2. Dedicated Bike Paths must be at the same grade as the Sidewalk and increase safety by grade-separating bicyclists and people driving.

3. Dedicated Bike Paths must be separated from pedestrian traffic with a physical buffer or with a detectable warning surface.

4. Dedicated Bike Paths may provide single or bidirectional bicycle traffic flow.

~~2. Standard Bike Lanes are delineated from vehicular traffic with pavement markings and do not provide a buffer.~~

5. ~~Dimensions:~~ A Dedicated Bike Path shall maintain a minimum ~~Standard~~ width ~~is~~ of six (6)-ft ~~(minimum five (5) ft)~~ for a single directional bicycle traffic flow and a twelve (12)-ft preferred, ten (10) ft minimum width for bidirectional traffic flow.~~.~~ This is in addition to the width of the pedestrian travel area.

17.4.02.B continued

6. A Safety Buffer of at least four (4)-ft shall be provided between the side path and the adjacent motor vehicle lane.

7. Driveways: Dedicated Bike Paths shall maintain bikeway facility grade at driveways. Dedicated Bike Path pavement materials and striping shall continue across driveways. Warning signage may be placed facing driveways depending on width, traffic volume, and visibility. Refer to Figure 17.2 and Figure 17.3 for pedestrian safety and visibility buffer requirements.

8. Signage:

   a. A Dedicated Bike Path may include signage to indicate separation between the bicyclist and pedestrian facility.

   b. A Bicycle Warning sign (W11-1) shall be implemented at all intersecting streets along the corridor preceding the intersection with the Dedicated Bike Path.

~~Signage: Bike lane signs (R3-17) and plaques (R3-17aP and R3-17bP) are required and should be placed at the beginning of a bike lane facility and at the start of every block or at regular intervals as necessary to reinforce the intended use.~~

9. General Pavement Markings

   a. Pavement Marking (Symbols): ~~In accordance with the Texas MUTCD Section 9c.04, a~~A bicycle symbol and arrow markings shall be used to define ~~bicycle lanes~~Dedicated Bike Paths. ~~and~~ Alternative pavement marking symbols are subject to the approval of Houston Public Works. Symbols ~~should~~shall be placed at the beginning of a ~~bike lane~~ Bicycle ~~f~~Facility and the start of every block or at regular intervals as necessary to reinforce the intended use. ~~See~~ Refer to Standard Detail ~~01510-04~~02760-04. ~~for pavement marking details.~~

   b. Longitudinal Pavement Markings ~~(Longitudinal)~~: ~~A six (6) inch solid white stripe shall be used to separate the bicycle lane from the adjacent vehicle lane.~~ A dashed yellow line may be used to separate two-way bicycle traffic.

10. Ramps: See Section 17.3.02.A - Curb Ramps and Corner Treatments.

11. Wayfinding:

    a. Signage: See Section 17.4.01.D.

~~c.~~b. The Pavement Markings required in Section 17.4.02.B.9 are sufficient for Wayfinding.

~~3.~~12. For ~~standard~~ Dedicated B~~b~~ike ~~lanes~~ Path design criteria, refer to City of Houston Standard Detail ~~01510-09~~02760-09.

13. See Section 17.4.01 - General Bikeway Facility Requirements and Section 17.4.03 - Bikeways at Intersections for General Facility Requirements that apply to all bikeway facility types.

~~. Buffered Bike Lanes can be provided on local streets, collectors and major thoroughfares. They are standard bike lanes with additional striped, delineated space separating the bicycle lane from the adjacent vehicle travel lane and/or parking lane. Buffered bike lanes can provide a higher level of comfort in given traffic conditions than standard bike lanes. Buffered bike lanes are generally preferred over of standard bike lanes for increased bicyclist comfort where ROW is sufficient.~~

~~Dimensions: The lane and buffer together shall be at least eight (8) ft wide. Buffer may be reduced if a raised delineator is provided as approved by Houston Public Works. The minimum bicycle lane width is five (5) ft.~~

~~Pavement Markings (Buffer): The buffer shall consist of two six (6)- inch solid white lines, with six (6)-inch diagonal white hatching if three (3) -ft in width or wider. Spacing of hatching should be between 10 and 40 -ft as determined by the engineer to increase motorist compliance.~~

~~Delineator: A raised, physical delineator shall be provided where buffer space is less than 2-ft between vehicles and bicycles and should be used for increased comfort based on engineering judgment. Examples include armadillos and raised curb buffer. Delineator selection should consider impacts on drainage, bus stops, street sweeping and where not specified here shall require approval from Houston Public Works.~~

~~Pavement Marking (Symbols): In accordance with the Texas MUTCD Section 9c.04, a bicycle symbol and arrow markings shall be used to define bicycle lanes and should be placed at the beginning of a bike lane facility and at the start of every block or at regular intervals as necessary to reinforce the intended use. See Standard Detail 01510-04 for pavement marking details.~~

~~Signage: Bike lane signs (R3-17) and plaques (R3-17aP and R3-17bP) are required and should be placed at the beginning of a bike lane facility and at the start of every block or at regular intervals as necessary to reinforce the intended use.~~

~~For buffered bike lanes design criteria, refer to City of Houston Standard Detail 01510-09.~~
~~Separated One-way Bike Lanes can be provided on collectors and major thoroughfares. It is a dedicated on-street space for bikes, wide enough to allow for one-way bicycle traffic, separated from vehicle traffic with a buffer and, where applicable, a physical delineation device.~~

~~Dimensions: The buffer shall be designed to accommodate and complement the selected delineator device but should typically be at least three (3) -ft. Buffer may be reduced if raised delineators are provided as approved by Houston Public Works staff. The minimum bicycle lane width is five (5) -ft.~~

~~Delineator: A raised, physical delineator shall be provided where the bike lane runs against the vehicular traffic (contra flow) or buffer space is less than 2-ft between vehicles and bicycles and should be used for increased comfort based on engineering judgment. Examples include armadillos and raised curb buffer. Delineator selection should consider impacts on drainage and street sweeping and where not specified here shall require approval from Houston Public Works staff.~~

~~Pavement Markings (Buffer): Should complement the delineator type selected. For delineators utilizing a series of discrete elements (e.g. armadillos), a striped buffer shall be utilized and shall consist of two six (6)-in solid white lines, with six (6)-inch diagonal white hatching if three (3)-ft in width or wider. Spacing of hatching should be between 10 and 40-ft as determined by the engineer to increase motorist compliance.~~

~~Pavement Marking (Symbols): In accordance with the Texas MUTCD Section 9c.04, a bicycle symbol and arrow markings shall be used to define bicycle lanes and should be placed at the beginning of a bike lane facility and at the start of every block or at regular intervals as necessary to reinforce the intended use. See Standard Detail 01510-04 for pavement marking details.~~

~~Signage: Bike lane signs (R3-17) and plaques (R3-17aP and R3-17bP) are required and should be spaced at the beginning of a bike lane facility and at the start of every block or at regular intervals as necessary to reinforce the intended use.~~

~~For one-way separated bike lanes design criteria, refer to City of Houston Standard Detail 01510-09.~~
~~Separated Two-way Bike Lanes: can be provided on collectors and major thoroughfares. It is a dedicated on-street space for bikes separated from vehicle traffic with a buffer and a physical delineation device wide enough to allow for two-way bicycle traffic.~~

~~Dimensions: The buffer shall be designed to accommodate and complement the selected delineator device but should typically be at least three (3) ft. The minimum bidirectional bicycle lane width is ten (10) ft.~~

~~Delineator: A raised physical delineator shall be provided as additional buffer. Examples include armadillo and raised curb buffer. Delineator selection should consider impacts on drainage and street sweeping and shall require approval from Houston Public Works staff.~~

~~Pavement Markings (Buffer): Should complement the delineator type selected. A striped buffer shall be utilized and shall consist of two six (6) inch solid white (or yellow if contra flow) lines, with six (6) inch diagonal white (or yellow) cross-hatching if three (3) ft in width or wider. Spacing of hatching should be between 10 and 40 ft as determined by the engineer to increase motorist compliance. Delineators are generally placed in the center of the striped buffer.~~

~~Pavement Markings (Longitudinal): A dashed yellow line should be used to separate two-way bicycle traffic.~~

~~Pavement Marking (Symbols): In accordance with the Texas MUTCD Section 9c.04, a bicycle symbol and arrow markings shall be used to define bicycle lanes and should be placed at the beginning of a bike lane facility and at the start of every block or at regular intervals as necessary to reinforce the intended use. See Standard Detail 01510-04 for pavement marking details.~~

~~Signage: Bike lane signs (R3-17) and plaques (R3-17aP and R3-17bP) are required and should be placed at the beginning of a bike lane facility and at the start of every block or at regular intervals as necessary to reinforce the intended use.~~

~~If physical delineators are used, access should be considered for driveways, solid waste collection, bus stops, and mail delivery.~~

~~. For two-way separated bike lanes design criteria, refer to City of Houston Standard Detail 01510-09.~~

~~. Side Paths are bike facilities that run alongside a roadway within the ROW. Side paths may be slightly raised from the street level or at the same grade as the sidewalk. Side paths may provide single or bidirectional bicycle traffic flow. Side paths may be designed as shared use space for bicycles and pedestrians or as dedicated single or double lane bicycle facilities separate from both pedestrian and vehicular traffic. Bicycle-dedicated side paths can be separated from pedestrian traffic physically with a buffer or simply with contrasting pavement materials or colors. Maintenance responsibilities for side paths should be determined before implementation. Side paths can be provided along any roadway regardless of the speed of adjacent traffic. However, they can present challenges when there are an abundance of driveways, intersections, and other conflict points.~~

~~. Dimensions.~~

~~0. A two-way, bidirectional side path should maintain a standard width of ten (10) ft (minimum eight (8) ft), and can be more if separated pedestrian traffic is desired.~~

~~0. A buffer of at least three (3) ft should be provided between the side path and the adjacent motor vehicle lane, and tree plantings incorporated for increased shading.~~

~~0. Where pedestrian traffic and bicycle traffic are both heavy, a portion of the side path cross section should be designated for exclusive bicycle use. Designation may include unique pavement texture and/or colors, bike lane pavement markings, and/or signage. For two-way bicycle travel the width of this area is ten (10) ft; minimum eight (8) ft. For one-way bicycle travel the width of this area is six (6) ft; minimum five (5) ft. This is in addition to the width of the pedestrian travel area.~~

~~. Pavement Markings (Longitudinal): A dashed yellow line may be used to separate two-way bicycle traffic on bidirectional side paths.~~

~~. Pavement Marking (Symbols): For bicycle-exclusive side paths, a bicycle symbol and arrow markings may be used to define bicycle lanes and, if used, should be placed at the beginning of a bike lane facility and every block or at regular intervals as necessary to reinforce the intended use. See Standard Detail 01510-04.~~

~~. Signage: Signage should be provided to designate intended use of the side path. At a minimum, "Bike Route" signs should be provided at the start of the facility and at regular intervals.~~

~~. Access Drives: Shall incorporate design considerations for enhanced visibility of the bicycle facility to motorized vehicle users. Prioritized mode at crossing should be clearly defined by signage and/or pavement markings. See E. CORRIDOR DESIGN CONSIDERATIONS of this section.~~

~~. Ramps: Width of curb ramps that incorporate pedestrian and bicycle movements shall be equal to the width of the shared use path. Detectable warning surfaces shall extend the full width of the ramp run (excluding any flared sides).~~

~~For side path design criteria, refer to City of Houston Standard Detail 01510-09.~~

17.4.02.C Shared Use Path

1. Shared Use Paths are combined bicycle and pedestrian facilities that run alongside a roadway behind the curb within the right-of-way. See Figure 17.20 for a conceptual design of a Shared Use Path. This figure is for reference only and does not constitute design standards.

Figure 17.20 – SHARED USE PATH

2. Shared Use Paths may provide single or bidirectional bicycle traffic flow.

3. A Shared Use Path shall maintain a minimum width of ten (10)-ft. A width of fourteen (14)-ft in contexts with high pedestrian or bicyclist traffic is preferred.

4. A Safety Buffer of at least four (4)-ft shall be provided between the Shared Use Path and the adjacent motor vehicle lane.

5. Driveways: Shared Use Paths shall maintain bikeway facility grade at driveways. Shared Use Path pavement materials and striping shall continue across driveways. Warning signage may be placed facing driveways depending on width, traffic volume, and visibility.

6. Signage: A Bicycle Warning sign (W11-1) shall be implemented at all intersecting streets along the corridor preceding the intersection with the Shared Use Path.

~~1.~~7. General Pavement Markings

a. Pavement Marking (Symbols): A bicycle dot shall be used to define Shared Use Paths. The arrows on the bicycle dot shall be used to guide bicyclists in the direction of the facility. Symbols shall be placed at the beginning of a bike facility and the start of every block or at regular intervals as necessary to reinforce the intended use. Refer to Standard Detail 02760-04.

b. In a bidirectional Shared Use Path, a bike dot with arrows in both directions of travel is required.

c. In a single direction Shared Use Path, a bike dot with one or more arrows pointing in the direction of bicycle traffic shall be used.

d. Alternative pavement marking symbols for single direction Shared Use Paths and/or where there may be opportunities for Placemaking are subject to approval by Houston Public Works.

8. Wayfinding:

a. Signage: See Section 17.4.01.D.

b. The Pavement Markings required in Section 17.4.02.C.7 are sufficient for Wayfinding.

9. Ramps: See Section 17.3.02.A - Curb Ramps and Corner Treatments.

10. See Section 17.4.01 - General Bikeway Facility Requirements and Section 17.4.03 - Bikeways at Intersections for General Facility Requirements that apply to all bikeway facility types.

17.4.02.D Raised Bike Lane

1. Raised Bike Lanes are grade-separated Bicycle Facilities that shall be at a level between the Sidewalk and the roadway with a minimum three (3)-in and maximum six (6)-in grade separation from the roadway surface. See Figure 17.21 for a conceptual design of a Raised Bike Lane. This figure is for reference only and does not constitute design standards.

17.4.02.D continued

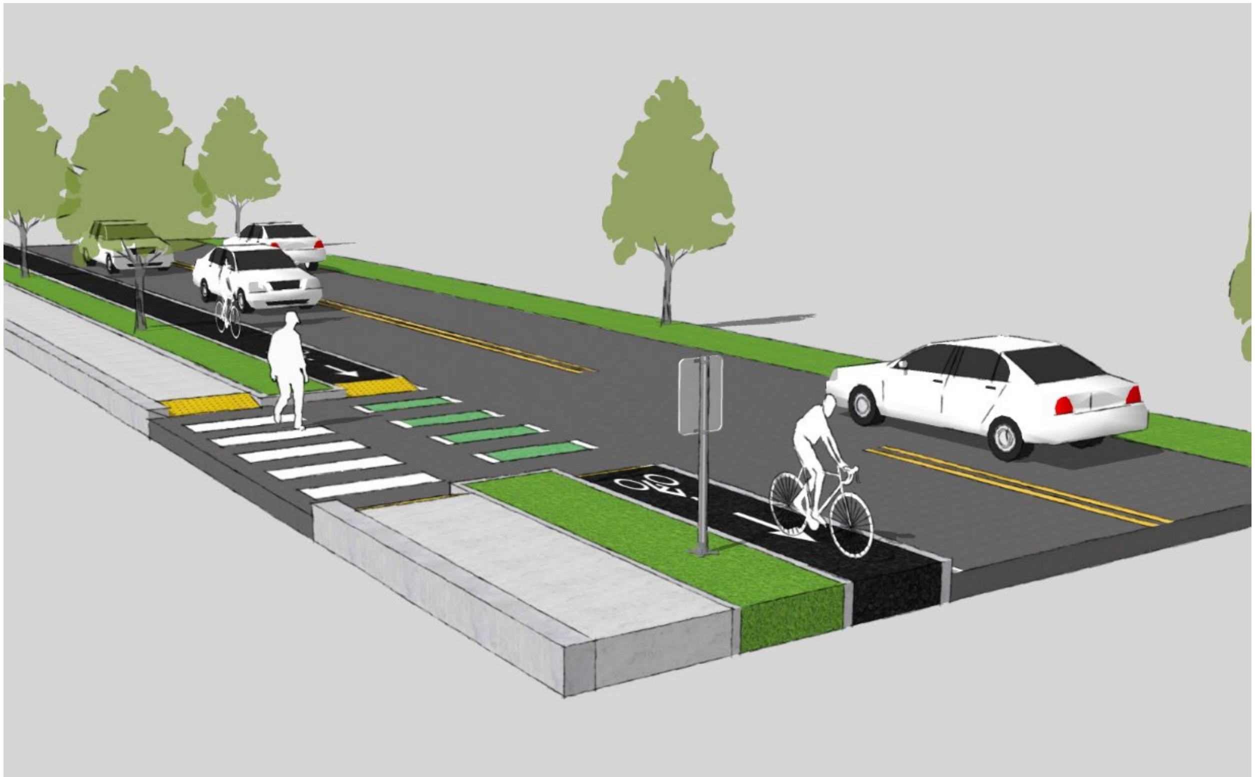


Figure 17.21 – RAISED BIKE LANE

2. Raised Bike Lanes shall be placed immediately adjacent to the vehicle lane.

3. Parking shall be prohibited along Raised Bike Lanes.

4. Raised Bike Lanes shall provide single direction bicycle traffic flow (one-way) only.

5. Raised Bike Lanes should maintain a standard width of six (6)-ft. Raised Bike Lanes cannot be narrower than five (5)-ft. The effective width of the bike lane shall not include the mountable curb.

6. General Pavement Markings

   a. Pavement Markings (Buffer): A six (6)-in solid white line is required between the Raised Bike Lane and the vehicle lane.

17.4.02.D.6 continued

b. Pavement Marking (Symbols): A bicycle symbol and arrow markings shall be used to define bicycle lanes and shall be placed at the beginning of a Bicycle Facility and at the start of every block and at regular intervals as necessary to reinforce the intended use. Refer to Standard Detail 02760-04 for pavement marking details.

c. Pavement Markings (Driveways): Conflict markings shall be used at driveways with high traffic uses, with a width greater than thirty-five (35)-ft, or where consecutive adjacent driveway openings are greater than fifty (50)-ft.

7. Signage:

a. A Bicycle Warning sign (W11-1) shall be implemented at all intersecting streets along the corridor preceding the intersection with the raised bikeway.

b. No Parking in Bike Lane signs (R7-9) should be placed on every block and at regular intervals no more than ½ mile apart.

8. Wayfinding

a. Signage: See Section 17.4.01.D.

b. Pavement Markings: The Pavement Markings required in Section 17.4.02.D.6 are sufficient for Wayfinding.

9. See Section 17.4.01 - General Bikeway Facility Requirements and Section 17.4.03 - Bikeways at Intersections for General Facility Requirements that apply to all Bicycle Facility types.

~~17.3.02.O~~17.4.02.E Protected Bike Lane (Retrofit)

~~1. Separated on-street bicycle facilities:~~

~~2. i. For two-way separated on-street bicycle facilities (i.e., cycle tracks), bidirectional bicycle traffic shall be designated through the intersection with a center yellow dash and corresponding white dash on the vehicle side lateral extension of the bicycle facility.~~

~~3. ii. Bicycle-green pavement markings may be considered when additional guidance is needed to direct bicyclists through the intersection or when increased visibility is desired.~~

~~4.~~1. Protected Bike Lanes are On-Street Bicycle Facilities between curb faces with physical delineation between the vehicle lane and bike lane. In Retrofit projects where a Dedicated Bike Path is not feasible, Protected Bike Lanes provide enhanced safety for bicyclists. See Figure 17.22 and Figure 17.23 for conceptual designs of Protected Bike Lanes. These figures are for reference only and do not constitute design standards.

17.4.02.E continued

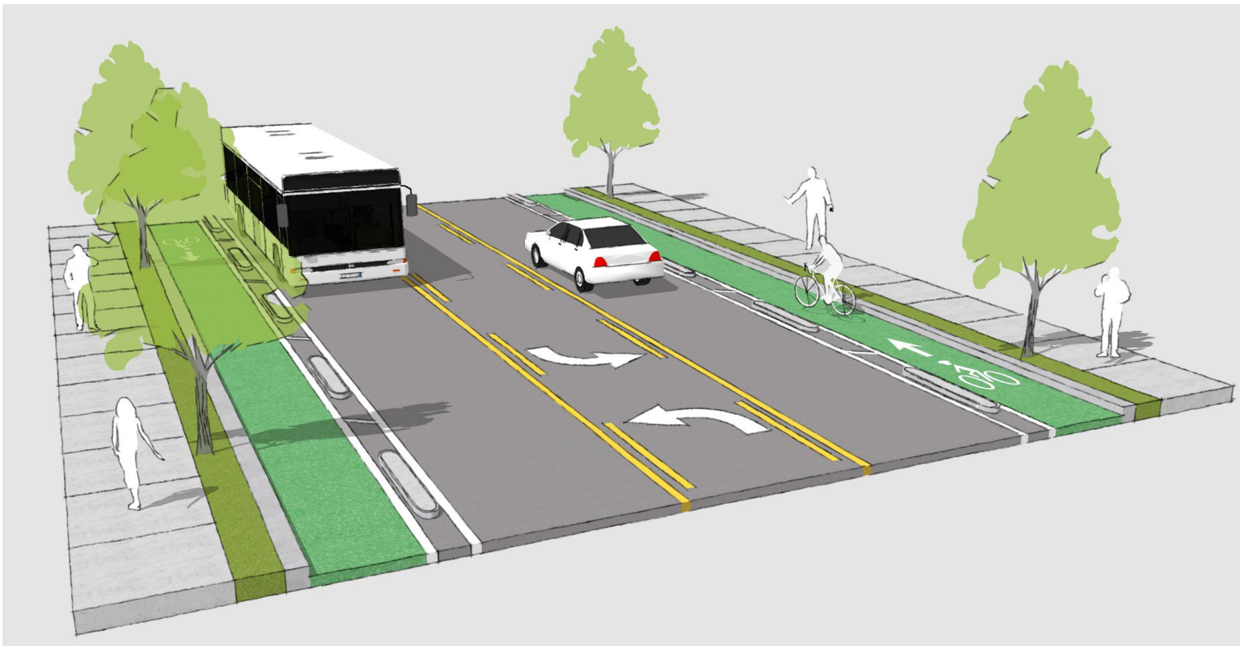


Figure 17.22 – SINGLE DIRECTION PROTECTED BIKE LANE WITH PRE-CAST CURB

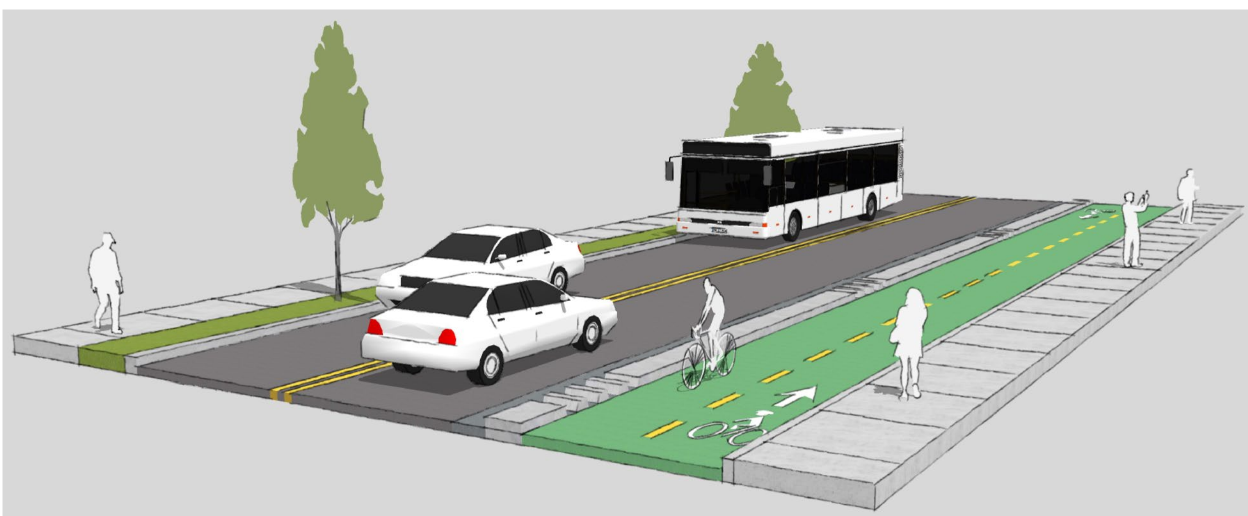


Figure 17.23 – BIDIRECTIONAL PROTECTED BIKE LANE WITH CAST-IN-PLACE CURB

2. Protected Bike Lanes may provide single or bidirectional (two-way) bicycle traffic flow.

3. A bidirectional Protected Bike Lane shall maintain a standard width of ten (10)-ft. A one-way Protected Bike Lane shall maintain a standard width of six (6)-ft.

17.4.02.E continued

4. Delineator: A vertical barrier shall be provided to physically separate the bike lane and vehicle lane. Delineators are generally placed in the center of the striped buffer.

   a. The vertical barrier may be discrete elements, such as curb stops or bollards, or a continuous element, such as a concrete median. Delineator selection shall require approval from Houston Public Works.

   b. Delineators shall maintain existing stormwater flow or include improvements to the stormwater drainage system where necessary per Chapter 9. Delineators shall accommodate stormwater runoff at all drainage inlets.

   c. A continuous delineator shall have ten (10)-ft wide openings at least every two hundred fifty (250)-ft to enable bicyclists to exit the bike lane.

      (1). Openings at driveways, intersections and inlets can be used to satisfy this requirement.

   d. Breaks in delineation shall be provided at all driveways. Refer to detail 02760-11 for requirements on placement.

   e. Delineator placement should consider Curb Management such as driveways, solid waste and recycle collection, bus stops, and mail delivery. Use of mountable curb may be desirable to accommodate heavy trash pick-up.

5. General Pavement Markings

   a. Pavement Markings (Buffer): The buffer shall be designed to accommodate and complement the selected delineator device and shall typically be at least three (3)-ft.

      (1). For delineators that are discrete elements, a striped buffer shall be utilized and shall consist of two six (6)-in solid white lines, with six (6)-in diagonal white hatching of three (3)-ft in width or wider. Spacing of hatching should be between ten (10) and forty (40)-ft.

      (2). For delineators that are continuous elements, a six (6)-in solid white line shall be striped on either side.

17.4.02.E.5 continued

b. Pavement Marking (Symbols): A bicycle symbol and arrow markings shall be used to define bicycle lanes and shall be placed at the beginning of a Bicycle Facility and at the start of every block and at regular intervals as necessary to reinforce the intended use. Refer to Standard Detail 02760-04 for pavement marking details.

c. Pavement Markings (Driveways): Conflict markings shall be used at driveways with high traffic uses, with a width greater than thirty-five (35)-ft, or where consecutive adjacent driveways cause a gap in protection greater than fifty (50)-ft.

d. Pavement Markings (Longitudinal): For bidirectional Protected Bike Lanes, a dashed yellow line shall be used to separate two-way bicycle traffic.

6. Signage: Bike Lane signs (R3-17 series) are required at the start, end, and throughout a Bicycle Facility in the direction of travel.

a. Bike Lane signs (R3-17) are required and should be spaced at the start of every block and at regular intervals as necessary to reinforce the intended use.

b. Bike Lane signs (R3-17) and plaques (R3-17aP) are required preceding the Bicycle Facility.

c. Bike Lane signs (R3-17) and plaques (R3- 17bP) are required at the end of a Bicycle Facility.

d. A Bicycle Warning sign (W11-1) shall be implemented at all intersecting streets along the corridor preceding the intersection with the protected/separated bikeway.

7. Wayfinding:

a. Signage: See Section 17.4.01.D.

b. Pavement Markings: The Pavement Markings required in Section 17.4.02.E.5 are sufficient for Wayfinding.

8. For Protected Bike Lane design criteria, refer to City of Houston Standard Detail 02760-09.

9. See Section 17.4.01 - General Bikeway Facility Requirements and Section 17.4.03 - Bikeways at Intersections for General Facility Requirements that apply to all Bicycle Facility types.

~~17.3.02.P Non-Dedicated Bikeway Facilities~~

17.4.02.F continued

~~17.3.02.Q Neighborhood Shared Streets are low speed, low volume, and typically residential streets shared by motor vehicles and bikes and marked with "Bike Route" signs and potentially wayfinding signage. This designation does not include additional treatments to manage vehicle speed or volume.~~

~~17.3.02.R Pavement Markings: No special pavement markings are required. Shared Lane Markings may be used if the shared nature of the roadway should be emphasized to encourage driver compliance.~~

~~17.3.02.S Signage: Bike Route signs (D11-1) should be placed at regular intervals based on engineering judgment to inform bicyclists of bicycle route direction changes and to confirm route direction. Bikes May Use Full Lane signs (R4-11) may be used. Wayfinding can be used to provide direction to other high comfort bicycle facilities, trails, or neighborhood destinations and amenities such as schools.~~

17.4.02.F Neighborhood Bikeway (Local Streets Only)~~:~~

1. Neighborhood Bikeways, also known as ~~"B~~bicycle ~~B~~boulevards,~~"~~ are low speed, typically residential streets shared by motorists and bicyclists.~~similar to Neighborhood Shared Streets but provide a more regional connector and may be provided on local streets or collectors where the speed limit does not exceed 30 mph. They have three essential elements:~~ See Figure 17.24 for a conceptual design of a Neighborhood Bikeway. This figure is for reference only and does not constitute design standards.

Figure 17.24 – NEIGHBORHOOD BIKEWAY

17.4.02.F.4 continued

~~2. Street design elements that enhance bicycle and pedestrian safety and comfort while maintaining vehicle traffic speeds at levels appropriate to the neighborhood context.~~

~~3. Intersection treatments to assist bicyclists crossing roadways with high traffic volumes and/or speeds.~~

~~4. Bicycle signage and wayfinding~~

2. Neighborhood Bikeways should only be installed on local/unclassified streets without marked lanes.

3. Neighborhood Bikeways should include measures to improve bicycle safety along streets and intersections as recommended in a traffic engineering report. Such measures include:

    a. Curb Extensions (see section 17.3.02.C)

    b. Median Refuge Islands (see section 17.3.02.D)

    c. Raised Crosswalks (see section 17.3.02.E)

    d. Median Closures (see section 17.4.03.F)

    e. Mini Roundabouts

    f. Traffic Calming (see Chapter 15, Section 15.2.11 for suggested tools). Traffic Calming elements require specific approval by Houston Public Works.

4. General Pavement Markings

    a. Pavement Markings: Shared ~~L~~lane ~~M~~markings ~~should~~shall be ~~used~~placed at the beginning of a Neighborhood Bikeway and at the start and end of every block and at regular intervals as necessary to reinforce the intended use.~~to emphasize the shared nature of the roadway.~~ Refer to ~~See~~ Standard Detail ~~01510-04~~02760-04. ~~for shared lane marking placement and design consideration. On-street parking may but is not required to be delineated. Parking delineation may be appropriate in dense urban or commercial contexts.~~

5. Signage:

a. ~~Bike Route signs (D11-1) should be placed at regular intervals based on engineering judgment to inform bicyclists of bicycle route direction changes and to confirm route direction. Bikes~~ May Use Full L~~l~~ane signs (R4-11) shall be ~~used~~placed on every other block and at regular intervals to reinforce the intended use.~~emphasize the shared nature of the roadway. Wayfinding should be used to provide direction to other high comfort bicycle facilities, trails, or neighborhood destinations and amenities such as schools. Stop sign placement and direction should provide priority to the bikeway over intersecting local streets to minimize bicycle stops.~~

b. A majority of stop signs on the Neighborhood Bikeway shall provide priority to the bikeway over intersecting local streets to minimize bicycle stops.

c. A Bicycle Warning sign (W11-1) shall be implemented at all intersecting streets along the corridor preceding the intersection with the Neighborhood Bikeway.

6. Wayfinding:

a. Signage: See Section 17.4.01.D.

b. Shared lane markings (refer to Standard Detail 02760-04) shall be included on every block and no more than ½ mile apart in the direction of the Bicycle Facility.

c. Additional shared lane markings may be necessary where there are many driveways or large traffic generators present.

d. The arrows in the shared lane marking shall generally indicate the forward direction of bicycle movement. At turning locations, the arrow shall indicate the forward direction of all bicycle routes.

7. See Section 17.4.01 - General Bikeway Facility Requirements and Section 17.4.03 - Bikeways at Intersections for General Facility Requirements that apply to all bikeway facility types.

~~Optional Treatments: Bicycle safety enhancements, such as speed cushions, neighborhood traffic circles, chicanes, and bike-only through movements at intersections can be considered based on engineering judgment and shall require Houston Public Works approval.~~

~~d. Shared Lanes can be located on minor collector, major collector and certain major thoroughfares where there is insufficient ROW for dedicated facilities. They represent roadway travel lanes shared by vehicles and bicyclists on thoroughfares. They do not provide the highest level of comfort for bikes and are appropriate only where ROW is insufficient to provide a dedicated bikeway. They may be used in combination with higher-quality bike facilities to accommodate ROW pinch points. Shared lanes are restricted to roadways with posted speed limits 35 mph or less. Shared Lanes should not exceed 12-ft where no on-street parking is present. Signage and pavement markings are used to provide a visual indicator to vehicle traffic of the dual use and nature of the roadway~~

~~. Pavement Markings: Shared Lane Markings shall be used to encourage bicycle travel in the middle or most visible portion of the travel lane.~~

~~If on-street vehicular parking is not present, pavement markings should be placed far enough from the curb to direct bicyclists away from gutters, seams, and other obstacles. Minimum Placement:~~

~~0. Shared Use Vehicular Lane Defined: 6-ft from the lane line of the shared use lane~~

~~0. Shared Use Lane Not Defined: 6-ft from the center of the roadway where roadway lines do not exist.~~

~~. Signage: Bike Route signs (D11-1) should be placed at regular intervals based on engineering judgment to inform bicyclists of bicycle route direction changes and to confirm route direction. Bikes May Use Full lane signs (R4-11) shall be used to emphasize the shared nature of the roadway.~~

~~Q. CORRIDOR DESIGN CONSIDERATIONS:~~

~~3. Overview: Bicycle facilities should provide a safe, high-comfort experience for the user as it traverses a corridor from intersection to intersection. Elements along a corridor may present unintended obstacles for bicyclists if not properly designed.~~

~~Design considerations presented in this section are not exhaustive. Additional considerations for review should be raised based on engineering judgment and approved by Houston Public Works.~~

~~3. General:~~

~~n. Gutter seams, drainage inlets, and utility covers should be flush with the pavement and oriented to prevent conflicts with bikes. Bicycle facility width should not include the gutter pan because people on bikes are typically unable to use this space.~~

~~o. Bicycle facilities are intended to be flexible to maximize comfort and can transition between facility types to accommodate corridor elements. Bicycle facility transitions (e.g., a bike lane to an off-street side path) should be logical and smooth. Abrupt facility transitions can be confusing, decrease bicycle predictability and increase vehicle conflicts.~~

~~p. Where possible, bicycle facilities should connect to other bicycle facilities, and facility termination should be minimized. Where bicycle facilities terminate, clear signing and striping shall be provided to communicate the termination to bikeway users and other roadway users. Where appropriate, on-street bicycle facilities may transition to a shared space with pedestrians (i.e. side path/trail) or to a non-dedicated bicycle facility type. Bicycle facilities should not terminate in areas that abruptly force bicyclists to merge with high-speed or high-volume vehicular traffic or heavy pedestrian activity.~~

~~q. Ramps may be used to transition bicycles on and off the street and shall not compromise pedestrian realm minimum standard widths.~~

~~r. All signs, signals, and markings related to bicycle facilities shall have maintenance responsibilities established and, if relevant, approved by Houston Public Works.~~

~~s. The design of bicycle facilities and associated physical delineation shall not restrict curbside access for solid waste trucks on streets with curbside trash and/or recycling pickup.~~

~~t. The design of bicycle facilities and associated physical delineation shall not restrict curbside access for transit vehicles at designated transit stops. Physical delineators should be stopped prior to transit stops. On streets where frequent breaks in physical delineation would be required, alternative bicycle facility designs that do not require physical delineation should be considered.~~

~~3. On-Street Parking:~~

~~. Bike lanes may be provided between the parking lane and the curb or between the parking lane and travel lane.~~

~~. Where on-street parallel parking would otherwise be allowed, No Parking in Bike Lane signs (R7-9) may be considered.~~

~~x. A 3-ft buffer should be provided between a bike lane and an adjacent parking lane to accommodate the door zone when high parking turnover is expected.~~

~~3. Loading/Commercial Zones:~~

~~z. Dedicated loading/commercial zones shall not impede bicycle traffic or encroach on a bicycle facility. Where possible, dedicated bicycle facilities should be placed behind loading zones and adjacent to the pedestrian zone whether on or off-street.~~

~~aa. To avoid conflicts with loading/commercial zones bicycle facility may be transitioned to the adjacent sidewalk where a minimum 10-ft separate pedestrian realm is maintained.~~

~~bb. A painted crosswalk may be provided across the bikeway facility to accommodate loading and unloading of commercial vehicles.~~

~~cc. Midblock crossings shall require Houston Public Works approval.~~

~~dd. Midblock crossings shall be designed at minimum with the following considerations:~~

~~. Midblock crossings shall be located at least 100-ft from adjacent intersections.~~

~~. Street name signs should be placed at Major Thoroughfare crossings and should be considered on Collector and Local Street crossings.~~

~~. The width of curb ramps serving a midblock crossing shall be equal to the width of the approaching pedestrian or bicycle facility. Detectable warning surfaces shall extend the full width of the ramp.~~

~~3. Driveways:~~

~~ii. Driveways shall be designed to safely accommodate bicyclists, pedestrians and motorized vehicle users. Where a driveway crosses a dedicated on-street or off-street bikeway, the driveway should be designed to enhance the visibility of the bikeway user.~~

~~jj. Signage:~~

- ~~Stops signs (R1-1) should be placed on primary commercial driveways to indicate a full stop by motor vehicles before entering and crossing a bicycle facility. Where the bicycle facility is in or immediately adjacent to the roadway, the stop sign should be placed before the bicycle facility.~~

- ~~Where a stop sign is not provided on the driveway approach, Bicycle Crossing Warning Sign (W11-1) or dual Combination Bike and Ped Crossing Warning Sign (W11-15) should be considered.~~

- ~~Pavement Markings: Where bicycle facilities cross driveways, the design should clearly communicate that bicyclists have the right-of-way by defining the bicycle facility width and associated placement across the driveway. Green bicycle pavement markings should be used across primary commercial driveways.~~

- ~~Curb Radius: Driveway curb radius should be selected to encourage slower vehicular movements across the bicycle facility. Based on engineering judgment, the smallest feasible curb radius should be selected based on AASHTO design vehicles. Additional curb radius design considerations are discussed in Chapter 15.08.~~

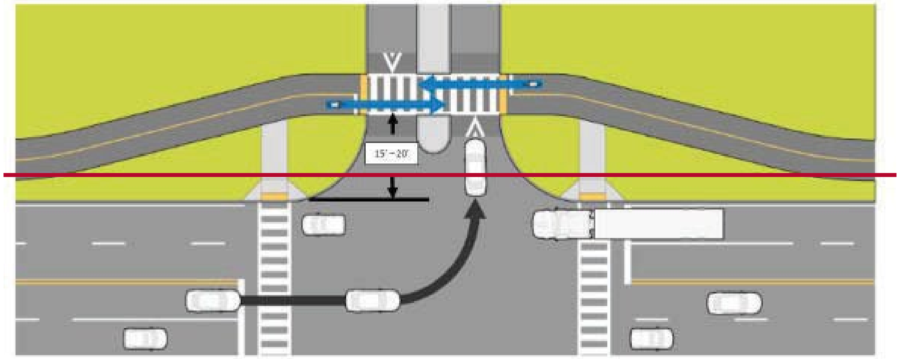
- ~~Driveway Spacing: Driveway consolidation should be considered where bike facilities are present. Each driveway presents an additional vehicle-bicycle conflict point. Refer to Chapter 15.08 for driveway spacing standards.~~

- ~~Vehicle Parking should be prohibited at least 20-ft from the edge of a driveway along the roadway.~~

- ~~Landscaping and other street-side elements shall not reduce sight distance across the bicycle facility below AASHTO minimums.~~

- ~~Optional Treatments: Bicycle safety enhancements such as raised crossings and recessed driveway crossings can be considered based on engineering judgment and shall require Houston Public Works approval prior to implementation. Recessed driveway crossings should be between 15-ft to 20- ft from the edge of the roadway pavement to enable one vehicle to queue between the roadway and the bicycle facility. See figure below:~~

17.4.03.A continued



~~17.3.46~~17.4.03 ~~INTERSECTION TREATMENTS~~BIKEWAYS AT INTERSECTIONS

17.4.03.A General

1. ~~Overview:~~ Intersections present significant challenges to bicyclists, and specific design features~~accommodations~~ should be provided to ensure bicyclist safety and comfort through an intersection. These design features~~accommodations may include additional signing and striping, signal modifications, and deliberate transitions from one type of bicycle facility to another.~~ shall also increase pedestrian safety.

~~2. Standard Intersection Treatments for Bicycles Facilities~~

~~3. General:~~

~~4. Bicyclists are required by law to obey traffic control devices at intersections; therefore, traffic control devices shall be designed to account for identified bicycle needs.~~

~~5. Intersections shall be designed to logically position bicyclists through an intersection from an approaching bicycle facility to the receiving bicycle facility.~~

~~6.~~2. ~~Wayfinding signage should be included wherever two designated bicycle facilities intersect or where a bicycle facility changes direction.~~Design features shall include roadway geometry alterations, signing, striping, signal modifications, and deliberate transitions from one type of Bicycle Facility to another.

3. At all approaches to a signalized intersection with a cross street with a Dedicated or Off-Street Bicycle Facility, a No Turn on Red sign (R10-11A) shall be mounted on the signal assembly directed towards the motorists on the cross street.

17.4.03.A continued

4. Signalized intersections where Bicycle Facilities intersect one another shall be designed to facilitate bicyclist left turns.

   a. Protected Intersections shall be implemented to facilitate safe two-stage left turns.

   b. At intersections with Bicycle Facilities where Protected Intersections cannot be included in the design due to roadway geometry, right-of-way width or other factors, Bike Boxes should be included.

   c. Two-Stage Turn Queue Boxes may be added in certain contexts where additional guidance and space for bicyclists turning movements are needed. Two-Stage Turn Queue Boxes must be approved by Transportation and Drainage Operations.

5. For Protected Bike Lanes, barriers and/or delineators shall extend as close to the intersection without impeding vehicle turning movements or pedestrian crossings. Refer to City of Houston Standard Detail 02760-11 for typical delineator layout.

6. For Raised Bike Lanes, the bike lane shall return to road grade prior to the intersection. Barriers and/or delineators shall extend as close to the intersection without impeding vehicle turning movements or pedestrian crossings. Refer to City of Houston Standard Detail 02760-11 for typical delineator layout.

7. Green bicycle pavement markings ~~may~~shall be used at intersections to increase B~~b~~icycle ~~f~~Facility visibility and identify potential conflict areas between motorists and bicyclists.~~and increased cyclist/vehicular awareness.~~ Green bicycle pavement markings should not be used in lieu of but in addition to white pavement markings. Refer to City of Houston Standard Detail No. 02760-10 and 02760-11.

8. Bicycle Facility crossings where the cross street is free flow shall follow the Enhanced Crossing requirements in Section 17.3.03.C - Crossing Treatments.

9. Where a Bicycle Facility includes physical delineation, delineation shall continue to the approach edge of the intersecting pedestrian crosswalk or bicycle box, whichever comes first.

~~7. On-street bicycle facilities:~~

~~8. On-street bicycle facilities generally do not include crossing markings through intersections. However, crossing markings should be considered when additional guidance is needed to direct bicyclists through the intersection or when increased awareness of bicyclists activity is desired.~~

~~9. Intersection crossing markings are shown on Standard Detail 01510- 09A and may consist of:~~

~~10. Dashed white pavement markings aligned with the lateral extensions of the approach bicycle facility.~~

~~11. A combination of dashed white pavement markings and green bicycle pavement markings may be considered when additional guidance is needed to direct bicyclists through the intersection or when increased visibility is desired.~~

~~12. If used, intersection crossing markings shall define a space through the intersection with a width that is the greater of 1) the width of the approaching bicycle facility or 2) the standard width for a corresponding high-comfort bicycle facility.~~

~~13. On approaches to intersections without dedicated right-turn lanes, on-street bicycle facilities should be extended to the STOP bar with the typical characteristics of the facility.~~

~~14. On approaches to major intersections without dedicated right-turn lanes and with high right-turn volumes or with a transit stop, on-street bicycle facilities should be extended to the STOP bar. Any buffer should be dropped approximately 50-200-ft from the STOP bar, and from that point the bicycle facility should be defined by dot striping to emphasize the movements of right-turn vehicles across the bicycle facility.~~

~~15.~~10. Bicycle F~~f~~acilities should not ~~generally~~ terminate at intersections.~~ Where on-street bicycle facilities end at an intersection, signage should be sufficient to provide bicyclists an opportunity to safely make necessary accommodations. At a minimum, "Bike Lane Ends" signage (R3-17, R3-17b) signage shall be used.~~

a. At intersections where ~~o~~On-~~s~~Street~~, high-comfort~~ B~~b~~icycle F~~f~~acilities cannot be extended to the intersection because of geometric or ~~ROW~~ right-of-way constraints, ~~o~~Off-~~s~~Street ~~b~~Bicycle ~~f~~Facility transitions should be explored.

~~b. When transitioning between off-street bicycle facilities and on-street bicycle facilities, the grade should be smooth and comfortable, without significant longitudinal pavement joints or sharp changes in direction. Maximum slope should be 1:7.~~

~~c.~~b. Where On-Street Bicycle Facilities end at an intersection, and Off-Street Bicycle Facility transitions are not feasible, at a minimum, Bike Lane Ends signage (R3-17, R3-17b) shall be placed preceding the intersection.

~~16.~~11. Wayfinding signage is required at intersections. See Section 17.4.01.D.

17.4.03.B Protected Intersections

1. Protected Intersections reduce conflicts between motorists, bicyclists, and pedestrians by providing safe, separated waiting areas for each mode. See Figure 17.25 and Figure 17.26 for conceptual designs of Protected Intersections. These figures are for reference only and do not constitute design standards.

Figure 17.25 - PROTECTED INTERSECTION

17.4.03.B continued

Figure 17.26 - PROTECTED INTERSECTION (RETROFIT)

2. Protected Intersections are an intersection improvement that sets the bikeway back from parallel motor vehicle traffic so that bicyclists are not forced to merge into mixed traffic.

3. Protected Intersections allow bicyclists to safely move straight and make two-stage turns through an intersection. They are given a dedicated path through the intersection and have the right-of-way over motorists making turns.

4. For siting requirements, see Section 17.4.03.A - General Bikeways at Intersections.

~~17.~~5. Design

a. Protected Intersections shall consist of pavement markings and concrete median or other physical delineation.

17.4.03.B.5 continued

b. Protected Intersections shall include green bicycle pavement markings with an approved material that provides adequate surface traction.

c. Protected Intersections shall include Curb Extensions. See Section 17.3.02.C - Curb Extensions.

(1). Protected Intersections shall have barrier-protected bicycle queue areas on all corners of the intersection where there will be a designated two-stage turn onto a Bicycle Facility.

(2). Protected Intersections shall include barrier-protected pedestrian islands on all corners of the intersection where a barrier-protected bicycle queue area is present.

(3). Barriers at Protected Intersections may be made up of concrete curb, vertical flex posts, bollards, or other delineation.

(4). Barriers at Protected Intersections may contain mountable elements so that smaller curb radii can accommodate large vehicles.

d. Protected Intersections shall include crosswalk markings adjacent to the bikeway crossing markings. See Section 17.3.03.C - Crossing Treatments.

e. Protected Intersections may include bicycle symbols and turn arrow pavement markings to assist in bicyclist navigation through the intersection.

6. Protected Intersection materials and design are subject to approval by Houston Public Works.

~~17.3.46.B Off-street bicycle facilities:~~

~~17.3.46.C People riding bicycles on off-street facilities may not utilize standard pedestrian crosswalks, whether the crosswalks are marked or unmarked. Bicycle crossings must provide bicycle-specific crossing markings.~~

~~17.3.46.D Where off-street bicycle-only facilities cross a road, bicycle-green continental pavement markings should designate the bicycle crossing area. These markings should be placed adjacent to the white pedestrian continental pavement markings if present. These roadway crossings may be midblock, at unsignalized intersections, or at signalized intersections.~~

~~17.3.46.E Where off-street shared bicycle/pedestrian facilities cross a road, Dual Use Markings shall be used. These roadway crossings may be midblock, at unsignalized intersections, or at signalized intersections.~~

~~17.3.46.F Dual Use Markings shall consist of white 24-inch continental pavement markings flanked by 24-inch by 24-inch square green bicycle pavement markings. The width of the white markings shall be greater of 8-ft or the width of the approach facility. See Standard Detail 01510-09A.~~

~~17.3.46.G Special Case Intersection Accommodations for Bicycle Facilities~~

~~17.3.46.H Dedicated Right-Turn Lanes~~

~~17.3.46.I General:~~

~~17.3.46.J Dedicated right-turn lanes present crossing challenges for bicycle facilities and should be designed to highlight the crossing maneuver and prioritize bicyclists.~~

~~17.3.46.K The need for dedicated vehicular turn lanes at intersections should be based on vehicular capacity requirements. Where capacity requirements are satisfied by multiple lane assignment combinations, a dedicated right-turn lane should be considered when bicycle/right-turn conflicts are projected to be high (more than approximately 5 bike/turning-vehicle conflicts/peak hour).~~

~~17.3.46.L Design:~~

~~17.3.46.M See Standard Detail 01510-09A for design details.~~

~~17.3.46.N Where a dedicated right-turn lane is used, an adjacent on-street bike lane should continue through to the intersection on the left side of the right-turn lane.~~

~~17.3.46.O An on-street bike lane shall not be located on the right side of a dedicated right-turn lane.~~

~~17.3.46.P Where a dedicated right-turn lane crosses a bike lane, the bike lane shall not be required to shift more than 3-ft. This is intended to clarify the requirement for vehicles crossing into the dedicated right-turn lane to yield to bicyclists in the bicycle lane.~~

~~17.3.46.Q Markings:~~

~~17.3.46.R The width of an on-street bike lane adjacent to the left side of a dedicated right-turn lane shall be a minimum of 5-ft (desirable 6- ft).~~

~~17.3.46.S The bike lane through the bike/right-turn conflict zone shall be delineated with combination white/bicycle-green dashed pavement markings.~~

~~17.3.46.T The defined conflict zone should end a minimum of 20-ft from the intersection. Within the section of the bike lane past the conflict zone, the lane shall be fully demarcated with green bicycle pavement markings between two 6-in solid white lines and shall include bike lane symbol and arrow pavement markings.~~

~~17.3.46.U Signage:~~

~~17.3.46.V A "Right Lane Must Turn Right" sign shall be used at the intersection, and a "Begin Right Turn Lane / Yield to Bikes" sign shall be used at the beginning of the bike lane/right-turn conflict zone.~~

~~17.3.46.W~~17.4.03.C Two-Stage Turn Queue Boxes

1. ~~General:~~Two-Stage Turn Queue Boxes are an intersection improvement consisting of pavement markings and signage that ~~simplify~~accommodate a safe left turn ~~movements~~ for bicyclists ~~across adjacent lanes of traffic or to accommodate two stage crossings.~~ by providing space for crossing in two stages. ~~They are most frequently used to facilitate left-turn movements for bicyclists in a bike lane without requiring bicyclists to first merge with adjacent traffic into the appropriate turn lane.~~

~~1.~~2. ~~Instead,~~Two-Stage Turn Queue Boxes allow bicyclists to make the turn in two movements: first, proceeding through the intersection in the bike lane, then turning ninety degrees within the ~~Q~~queue ~~B~~box to face in the desired direction in front of motorists on the cross street. ~~Two- Stage Turn Queue Boxes should be considered at intersections for roadways with heavy traffic volumes and when designated on- street bicycle facilities are provided on both intersecting streets.~~

~~2. Shall require approval by Houston Public Works.~~

~~3. Should only be installed along roadways with designated on-street bicycle facilities.~~

3. For siting recommendations, see Section 17.4.03.A - General Bikeways at Intersections.

4. Design

   a. Two-Stage Turn Queue Boxes ~~S~~shall be placed in a protected zone that will not be encroached upon by ~~vehicles~~motorists or bicyclists along the origin street.

17.4.03.C.4.a continued

(1). Depending on the intersection geometry, this zone ~~can~~may be located between the lateral extension of the ~~b~~Bicycle ~~f~~Facility and the adjacent travel lane on the origin street when a buffer exists or between the pedestrian crosswalk and the lateral extension of the bicycle ~~lane~~facility.

b. Two-Stage Turn Queue Boxes ~~S~~shall be green bicycle pavement markings with an approved material that provides adequate surface traction.

c. Two-Stage Turn Queue Boxes ~~S~~shall include a bicycle symbol and turn arrow pavement markings to designate the space for turning bicycle use only. Refer to City of Houston Standard Detail No. 02760-04.

~~4.~~5. Two-Stage Turn Queue Boxes ~~S~~shall include a ~~"~~No Turn on Red~~"~~ (R10-11A) sign mounted on the signal assembly directed towards the ~~vehicles~~motorists on the cross street that would stop behind the ~~turn~~queue box.

~~5.~~6. Two-Stage Turn Queue Boxes ~~S~~should be positioned to orient the bicyclist towards the receiving ~~b~~Bicycle ~~f~~Facility on the cross street.

~~17.3.46.X May utilize Intersection Crossing Markings to indicate desired path of bicyclists across the intersection in relation to the Two-Stage Turn Queue Box.~~

~~17.3.46.Y~~17.4.03.D Bi~~cycle~~ke Box~~:~~es

1. ~~Purpose:~~ Bike ~~b~~Boxes are an intersection ~~design~~improvement ~~component~~ consisting of pavement markings and signage that ~~enables bicyclists to queue at a red light in front of stopped vehicles in adjacent lanes. Bike boxes promote bicyclist~~ safe~~t~~ly ~~by~~ position~~s~~ing bi~~ke riders~~cyclists in front of vehicular traffic ~~improving bicyclist visibility and reducing potential conflicts between bicyclists and turning vehicles~~. ~~They should be considered at locations where the volume of turning traffic in conflict with an adjacent bicycle facility is high.~~

2. Bike Boxes consist of pavement markings that enable bicyclists to queue at a red light in front of stopped vehicles in adjacent lanes. Bicycle Boxes facilitate bicyclists moving forward or turning left.

~~1.~~3. For siting recommendations, see Section 17.4.03.A - General Bikeways at Intersections.

~~a. Suitability and approvals~~

~~b. Shall require approval by the City Traffic Engineer.~~

17.4.03.D.4 continued

~~c.~~a. Bike Boxes ~~S~~shall be allowed only at signalized intersections.

~~d.~~b. Bike Boxes ~~S~~shall only be used in conjunction with ~~o~~On-~~s~~Street B~~b~~icycle ~~f~~Facilities.~~, including standard bike lanes, buffered bike lanes, and separated bicycle lanes.~~

~~2. Shall only be approved across a single direction of general purpose lanes. A single bike box will not be approved across bidirectional travel lanes.~~

~~3. A bike box may extend across multiple adjacent lanes to accommodate bicycle left-turn movements.~~

4. Design

~~a. See Standard Detail 01510-09A for design details.~~

~~b. Shall be filled with bicycle-green pavement markings that provides adequate surface traction.~~

~~c.~~a. Bike Boxes ~~S~~shall be located between the pedestrian crosswalk and the vehicular ~~STOP~~stop bar.

~~d.~~b. Bike Boxes ~~S~~shall be filled with bicycle-green pavement markings that provide~~s~~ adequate surface traction.

~~e.~~c. Bike Boxes ~~S~~shall include a bicycle symbol pavement marker to designate the space for bicycle use only and WAIT HERE pavement marking beneath the stop bar. Refer to Standard Detail 02760-10 for design details.

d. Bike Boxes ~~S~~shall include a No Turn on Red sign (R10-11A) ~~"No Turn on Red" sign~~ mounted on the signal assembly when those movements would be otherwise allowed across the ~~b~~Bike ~~b~~Box.

e. Bike Boxes shall only be approved across a single direction of general-purpose lanes. A single Bike Box will not be approved across bidirectional travel lanes.

f. A Bike Box may extend across multiple adjacent lanes to facilitate bicyclist left-turn movements.

~~f.~~g. A Bicycle Facility should implement physical delineation devices along the approach to the Bike Box. For physical delineation devices see Section 17.4.02.E.4 - Protected Bike Lane Delineator.

17.4.03.E Bicycle Crossing Pavement Markings

17.4.03.E continued

1. Crossing pavement markings for dedicated bicycle lanes and paths shall continue in line with the Bicycle Facility through the intersection with the combination hatched bicycle green and white pavement markings (refer to City of Houston Standard Detail No. 02760-10 Detail "A").

    a. Bidirectional dedicated bicycle lanes and paths shall include a dashed yellow line to separate the lanes.

    b. Bidirectional dedicated bicycle lanes and paths shall be the greater of ten (10)-ft or the width of the approach facility.

    c. Single direction dedicated bicycle lanes and paths shall be the greater of six (6)-ft or the width of the approaching facility.

2. Crossing pavement markings for Shared Use Paths shall continue in line with the Bicycle Facility through the intersection with the combination enhanced crosswalk and bicycle green pavement markings (refer to City of Houston Standard Detail No. 02760-10 Detail "B").

    a. Crossing pavement markings for Shared Use Paths shall be the greater of ten (10)-ft or the width of the approach facility.

3. Bicycle crossing pavement markings shall be included in conflict zones between bicyclists and motorists and shall not be included through crosswalks or in bicycle or pedestrian waiting areas. Bicycle crossing pavement markings may be set back from or adjacent to parallel crosswalk markings.

17.4.03.F Median Closures

1. Median closures prevent motorists from through and left turn movements and maintain pedestrian and bicyclist crossings. Median closures may be included in any Bicycle Facility design to improve safety of pedestrians and bicyclists.

2. Median closures shall only be included on roadways with a median width of eight (8)-ft or greater. Median closures shall match the width of the existing median.

3. Median closures shall be made up of Seamless Curb median extensions that are a continuation of the existing median such that the grade, concrete, sodding, and other components are consistent.

    a. The Seamless Curb median should include permeable treatments where feasible.

17.4.03.F continued

b. For Retrofit roadway construction projects, alternative treatments may be considered. Alternative materials are subject to approval by the City of Houston.

4. Median closures shall include median openings for pedestrians and bicyclists where a pedestrian or bicyclist crossing is located.

a. The median openings shall be the same width as the approaching pedestrian or Bicycle Facility.

b. Median opening widths greater than or equal to eight (8)-ft should install a bollard or flex post in the center at both approaches to discourage driver encroachment.

5. Pavement Markings

a. Pedestrian crosswalk pavement markings shall be included in median closures. See Chapter 15, Section 15.2.06.B.4.

b. Bicyclist crossing pavement markings shall be included in median closures. See Section 17.4.03.E for bicycle crossing pavement markings.

6. Signage: A Right Turn Only (R3-5) sign with an Except Bicycle plaque shall be implemented.

~~17.3.46.Z~~17.4.03.G Bicycle Facilities at Roundabouts

1. Bicycle ~~lanes~~Facilities shall not be provided within the circulatory roadway.

2. Where ~~b~~Bicycle ~~lanes~~Facilities or shoulders are used on approach roadways, they should be terminated at least one hundred (100)-ft from the edge of the circulatory roadway.

~~3. Bicyclists may choose to merge with traffic and travel like other vehicles, or a ramp may be provided to allow them to exit the roadway onto the sidewalk (or shared use path) and travel as pedestrians.~~

3. A ramp should be provided to allow bicyclists to exit the roadway onto an Off-Street Bicycle Facility and to re-enter the roadway after the roundabout.

4. If a ramp is provided for bicyclists to access the ~~s~~Sidewalk, the slope shall not exceed 1~~7~~:7~~1~~.

5. Street ~~L~~lighting should be considered for increased facility safety at transition points.

~~4.~~6. See Section 17.4.03.E for bicycle crossing pavement markings.

~~5.~~7. ~~Purpose:~~ See Chapter 10~~5~~ regarding general ~~R~~roundabout ~~C~~considerations for all roadway users. ~~Bicycle considerations are discussed here.~~

~~17.3.46.AA Side-of-street Transitions~~

~~17.3.46.BB General: Side-of-street transitions provide options for transitioning a bicycle facility from one side of the street to the other. For example, a bidirectional cycle track that transitions to a pair of standard one-way bicycle lanes at a traffic signal.~~

~~17.3.46.CC Two Stage Crossings~~

~~17.3.46.DD General~~

~~17.3.46.EE Accommodate bicyclist transitions from one side of the roadway to the other at a signalized intersection by requiring bicyclists to cross each road on a separate signal phase.~~

~~17.3.46.FF Shall require approval by Houston Public Works.~~

~~17.3.46.GG Shall require bicycle-specific signals and/or signal timing consideration for each stage of the crossing.~~

~~17.3.46.HH A designated staging zone shall be provided in which bicyclists can safely wait for the second crossing phase. Staging locations may be located on or off-street based roadway geometrics, available pavement width, presence of on-street parking, lane assignments, and turning movements.~~

~~17.3.46.II This staging zone shall not place the bicyclist in conflict with vehicular traffic.~~

~~17.3.46.JJ Appropriate pavement markings should be provided to define each crossing.~~

~~17.3.46.KK Design~~

~~17.3.46.LL Shall use bicycle-green pavement markings with an approved material that provides adequate surface traction.~~

~~17.3.46.MM Shall include a bicycle symbol and turn arrow pavement markings to designate the space for turning bicycle use only.~~

~~17.3.46.NN Shall be placed in a protected zone that will not be encroached upon by vehicles along the origin or cross street.~~

~~17.3.46.OO May utilize Intersection Crossing Markings to indicate desired path of bicyclists across the intersection.~~

~~17.3.46.PP Diagonal Crossing Phase~~

~~17.3.46.QQ General: Bicyclists transition from one side of the road to the other in a single, independent signal phase at a signalized intersection.~~

~~17.3.46.RR Shall require approval by Houston Public Works.~~

~~17.3.46.SS Is, when feasible, the preferred method of transitioning bicycle travel from one side of the roadway to the opposite side.~~

~~17.3.46.TT Shall require a traffic study to determine feasibility of a diagonal crossing phase. The study shall utilize existing traffic counts and bicycle counts or, if bicycle counts are unavailable, a projection of bicycle usage to determine existing and projected intersection level-of-service (LOS) under NO-BUILD and BUILD scenarios. The LOS shall be computed using Highway Capacity Manual methodology, as detailed in Chapter 15: Traffic Studies.~~

~~17.3.46.UU Shall utilize a bicycle-specific signal head, pointing diagonally across the intersection from the receiving bicycle facility towards the originating bicycle facility.~~

~~17.3.46.VV Shall utilize a specific bicycle crossing signal phase that allows bicycles to travel diagonally across the intersection without vehicular conflicts.~~

~~17.3.46.WW Shall require bicycle detection of a type approved by Houston Public Works to call the diagonal signal phase. The diagonal signal phase shall not be called without a detected bicyclist.~~

~~17.3.46.XX May utilize individual signal phases for the different directions of bicycle travel (when applicable) so that the diagonal signal phase is only called when a bicycle is traveling in that direction.~~

~~17.3.46.YY Shall utilize Intersection Crossing Markings to delineate diagonal path of travel across intersection.~~

~~17.3.46.ZZ Should utilize a Bicycle Pavement Marking Symbol and an Arrow Pavement Marker to indicate the diagonal direction of bicycle travel.~~

~~17.3.46.AAA Shall utilize signage to indicate the diagonal crossing for the bicycle approach.~~

~~17.3.46.BBB~~

17.4.03.H Bicycle Facilities Traffic ~~s~~Signals ~~considerations:~~

17.4.03.H.5 continued

1. General standards for signalized intersections are defined in Chapter 15 and include signal phasing for ~~b~~Bicycle ~~accommodations~~Facilities. Bicycle-related signal options are summarized below.

~~2. Signal timing and actuation shall consider the needs of bicyclists.~~

2. Bicycle signal heads ~~may~~shall be installed at signalized intersections with On-Street or Off-Street Bicycle Facilities.~~to provide guidance for bicyclists at intersections where movements may not be apparent or where~~

3. ~~b~~Bicycle-specific signal strategies (e.g. bicycle-~~-only phases~~pedestrian leading interval) ~~are~~shall be employed where there are bicycle signal heads at intersections.

~~3.~~4. Bicycle detection shall~~should~~ be used ~~along high-comfort~~at all ~~b~~Bicycle ~~f~~Facilit~~y~~ies intersections with ~~at~~ actuated traffic signals to alert the signal controller of bicyclist demand.

5. ~~When~~Where bicycle detection is ~~used~~present, a Bicycle Signal Actuation Sign (R10-22) ~~should~~shall be used, and a ~~B~~bicycle ~~D~~detection ~~M~~marking (Standard Detail ~~01510-09A~~02760-10) shall be placed on the pavement indicating the optimal position for a bicyclist to actuate the signal.

   a. Where Bike Boxes are present, utilize bicycle detection that will detect within the entire Bike Box. If bicycle detection is not feasible for the entire Bike Box, indicate bicycle detection location with the bicycle signal actuation sign and bicycle detection marking.

6. Visibility-limited signal faces shall be adjusted to ensure bicyclists can see the signal indications. If the visibility-limited signal faces cannot be aimed to serve the bicyclist, then separate signal faces shall be provided for bicyclists.

~~SECTION 4~~SECTION 5 - ~~RESERVED FOR~~ TRANSIT FACILITY~~DESIGN~~ REQUIREMENTS

17.5.01 TRANSIT OVERVIEW~~: RESERVED~~

17.5.01.A In coordination with Metropolitan Transit Authority of Harris County (METRO), the City of Houston works to design safe streets that prioritize transit, improve transit service quality, and support other goals related to transit so that everyone may have safe and accessible multimodal transportation options.

17.5.01.B The City of Houston requires designs for city streets and multimodal transportation facilities that meet IDM standards and improve safety for all road users. The City uses other design standards and guidelines to achieve safe streets, including but not limited to, METRO transit design guidelines.

17.5.01.C The METRO transit design guidelines are referenced in the sections below and serve to work in tandem with the City of Houston's design standards, guidelines, and references.

1. The Street-Side Guidelines and Curb-Side Guidelines should be referenced when impacting the City right-of-way.

2. The whole of METRO transit design guidelines should be referenced for any project impacting an existing or future transit facility.

17.5.01.D All projects impacting an existing or future transit facility shall coordinate with METRO and meet design criteria and guidelines that improve safety for all road users.

~~17.4.01~~17.5.02 ~~TRANSIT SECTION INTRODUCTION: RESERVED~~TRANSIT STOP TYPOLOGIES, CONFIGURATIONS, AND STANDARD DIMENSIONS~~: RESERVED~~

17.5.02.A Refer to METRO transit design guidelines for all transit stop typologies, configurations, and standard dimensions.

17.5.02.B Bus Stops on High-Comfort Bicycle Facilities

1. All bus stop locations shall prioritize the safety of pedestrians and bicyclists in the design of High-Comfort Bicycle Facilities.

2. Floating Bus Stops

17.5.02.B.2 continued

a. Floating Bus Stops have a layout that allows pedestrian and Bicycle Facilities to locate behind the bus boarding pad, safely separating different modes of transportation while reducing bus delays by remaining in-lane.

b. Floating Bus Stops shall be included along Raised Bike Lanes and Protected Bike Lanes (Retrofit). Refer to Figure 17.27 below.

(1). Floating Bus Stop A (see Figure 17.28) is the default, unless conditions in article 17.5.02.B.2.b.(2) or article 17.5.02.B.2.b.(3) apply.

(2). Floating Bus Stop B shall be used where on-street parking or excess pavement width is present. Refer to Figure 17.29 below.

(3). A Shared Raised Bus Stop may be used in right-of-way-constrained settings, subject to approval by Transportation and Drainage Operations.

3. Dedicated Bike Path bus stops shall be included along all Off-Street Bicycle Facilities.

a. A Seamless Curb version of Floating Bus Stop A may be included on Off-Street Bicycle Facilities.

4. Typically, corridors with proposed Neighborhood Bikeways will not have bus stops along them. Houston Public Works will work with METRO for the design of bus stops on these corridors.

5. All METRO bus stop design and location requirements must be met.

a. METRO will review and approve all bus stop locations and design.

b. Planned METRO bus stop improvements and/or optimization shall be incorporated into the Bicycle Facility design.

c. With METRO's approval, new or reconstructed bus stops should be located near safe pedestrian and bicycle crossings, typically intersections.

17.5.02.C Off-Street Bicycle Facility Bus Stop

~~2.~~1. An Off-Street Bicycle Facility Bus Stop allows for a bus stop at the standard location on the curb of the vehicular travel lane. See Figure 17.27 for a conceptual design of Off-Street Bicycle Facility Bus Stop concept. This figure is for reference only and does not constitute design standards.

17.5.02.C continued

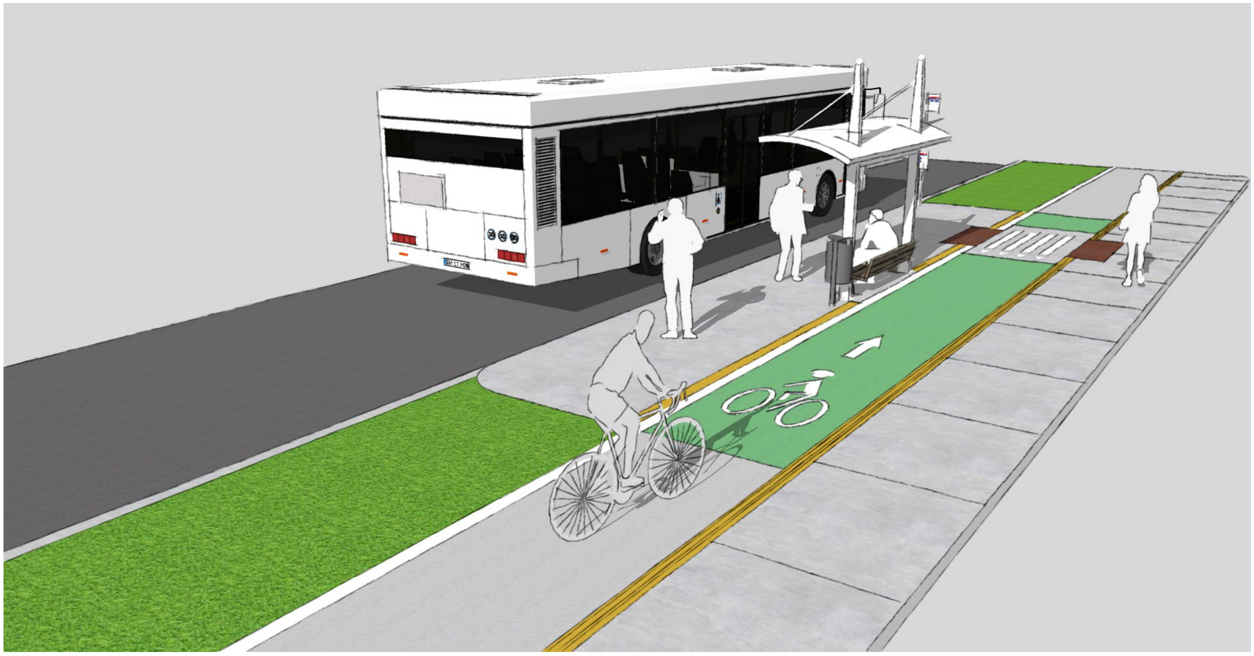


Figure 17.27 – OFF-STREET BICYCLE FACILITY BUS STOP

2. Where an Off-Street Bicycle Facility Bus Stop is present, the Off-Street Bicycle Facility will travel at Sidewalk grade adjacent to the bus pad.

3. Pedestrian Crossings

   a. Off-Street Bicycle Facility Bus Stops adjacent to Shared Use Paths do not require pedestrian crossings.

   b. Off-Street Bicycle Facility Bus Stops adjacent to Dedicated Bike Paths shall have at least one marked pedestrian crossing from the Sidewalk to the bus boarding pad.

      (1). Pedestrian crossings shall be level between the bus boarding pad and the Sidewalk.

      (2). Pedestrian crossings shall be clearly indicated with crosswalks made up of four (4) six (6)-in wide, minimum five (5)-ft long white stripes perpendicular to the Bicycle Facility. Additional stripes may be necessary for wider bicycle paths.

      (3). Yield lines made up of white yield triangles shall be placed in advance of the pedestrian crossing. YIELD TO PEDS pavement markings may be included.

17.5.02.C.3.b continued

(4). Two (2)-ft wide detectable warning surfaces shall be placed on either side of the pedestrian crossing.

4. Pavement Markings

a. Dedicated Bike Paths

(1). Solid bicycle green pavement markings shall be placed over the entire width of the bicycle lane adjacent to the bus boarding pad with breaks provided for pedestrian crossings.

(2). A bicycle symbol and arrow marking shall be included in the segment of the bicycle path adjacent to the bus boarding pad, not conflicting with pedestrian crosswalk pavement markings.

b. In constrained right-of-way settings where an Off-Street Bicycle Facility travels through a bus boarding pad, crosswalk and yield pavement markings shall be included that indicate the conflict zones between pedestrians and bicyclists.

5. Drainage: Off-Street Bicycle Facility Bus Stops shall maintain the existing gutter flow line.

17.5.02.D Floating Bus Stop A

~~3.~~1. Floating Bus Stop A is constructed in line with the Bicycle Facility so that the bicycle lane, and the Sidewalk if necessary, are shifted away from the roadway to accommodate the bus boarding pad. See Figure 17.28 for a conceptual design of Floating Bus Stop A. This figure is for reference only and does not constitute design standards.

17.5.02.D continued

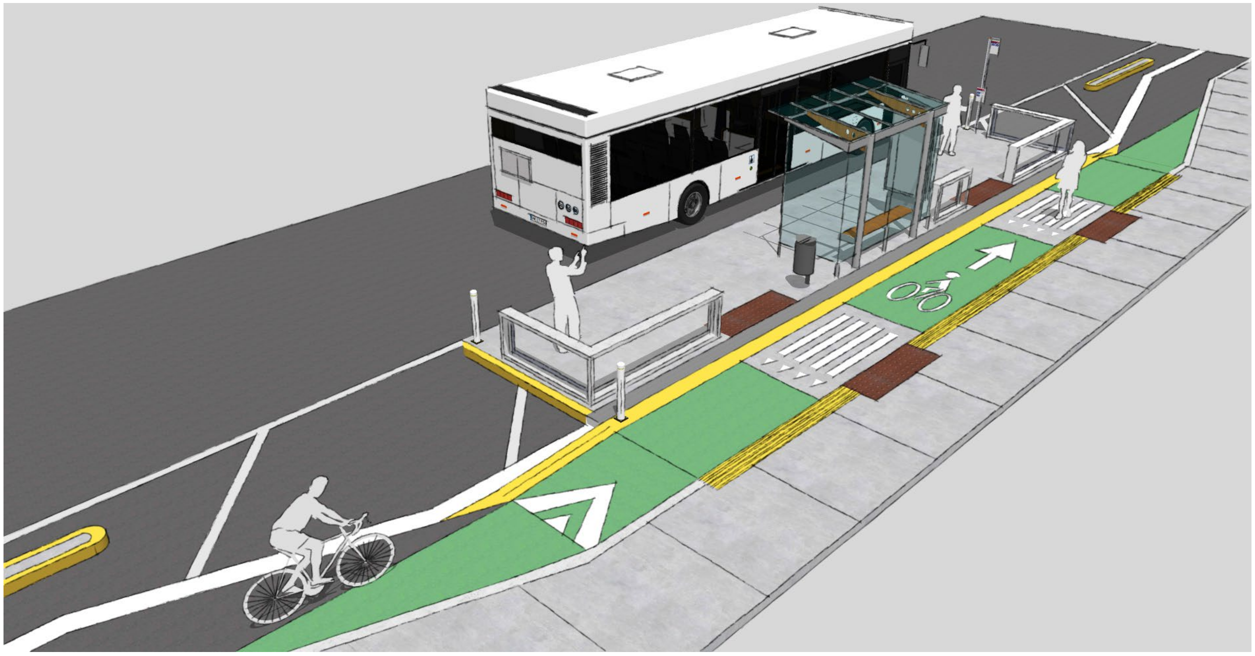


Figure 17.28 – FLOATING BUS STOP A

2. The bicycle lane shall shift away from the roadway to travel between the Pedestrian Realm and the bus boarding pad with transition curves as long as necessary to ensure the highest comfort bicycle movement.

3. For level pedestrian access to the bus pad, the Bicycle Facility shall transition before and after the pedestrian crossings at a maximum slope of 1:7 and a preferred slope of 1:15. The minimum length of the Sidewalk level Bicycle Facility should be twenty-five (25)-ft.

4. Any curb that could be struck by bicyclists because of a deviation of normal path of travel shall be painted yellow.

5. Vertical delineation should be implemented where there may be limited visibility of the curb.

6. Pedestrian Crossings

    a. There shall be at least one marked pedestrian crossing from the Pedestrian Realm to the bus boarding pad.

    b. Pedestrian crossings shall maintain the height of the Sidewalk and curb and have a cross slope of 2%.

17.5.02.D.6 continued

c. Pedestrian crossings shall be clearly indicated with crosswalks made up of four (4) six (6)-in wide, minimum five (5)-ft long white stripes perpendicular to the Bicycle Facility. Additional stripes may be necessary for wider bicycle lanes.

d. Yield lines made up of white yield triangles shall be placed in advance of the pedestrian crossing. YIELD TO PEDS pavement markings may be included.

e. Two (2)-ft wide detectable warning surfaces shall be placed on either side of the pedestrian crossing.

f. A longitudinal detectable warning strip should be placed adjacent to the Sidewalk-grade segment of the bicycle lane.

7. Pavement Markings

a. Solid bicycle green pavement markings shall be placed over the entire width of the bicycle lane behind the bus boarding pad with breaks provided for pedestrian crossings. Bicycle green pavement markings shall extend to include all bicycle lane area behind the gutter line.

b. A bicycle symbol and arrow marking shall be included in the Sidewalk-grade segment of the bicycle lane, not conflicting with pedestrian crosswalk pavement markings.

c. A six (6)-in solid white striped buffer shall delineate the area between the Bicycle Facility and the vehicular lane and shall provide bicycle lane alignment behind the bus boarding pad.

8. Drainage

a. Drainage shall be fully accommodated by the design of Floating Bus Stop A. Implementation of Floating Bus Stop A shall not create new ponding of stormwater.

b. Floating Bus Stop A should be installed on a high point of the gutter flow line.

(1). If it is not feasible to install Floating Bus Stop A on a high point of the gutter flow line, a new storm inlet with appropriate connections should be installed on the upstream side of the bus platform.

17.5.02.D.8.b continued

(2). If article 17.5.02.D.8.b.(1) is not feasible, an eighteen (18)-in gap between the curb and the bus boarding pad shall be provided to preserve the gutter flow. An easily removable steel plate shall be provided over the drainage gap along any walkable surface.

17.5.02.E Floating Bus Stop B

1. Floating Bus Stop B is constructed on-street in line with on-street parking or where a road segment has excess width that allows the bus boarding pad to be constructed on-street. See Figure 17.29 for a conceptual design of Floating Bus Stop B. This figure is for reference only and does not constitute design standards.

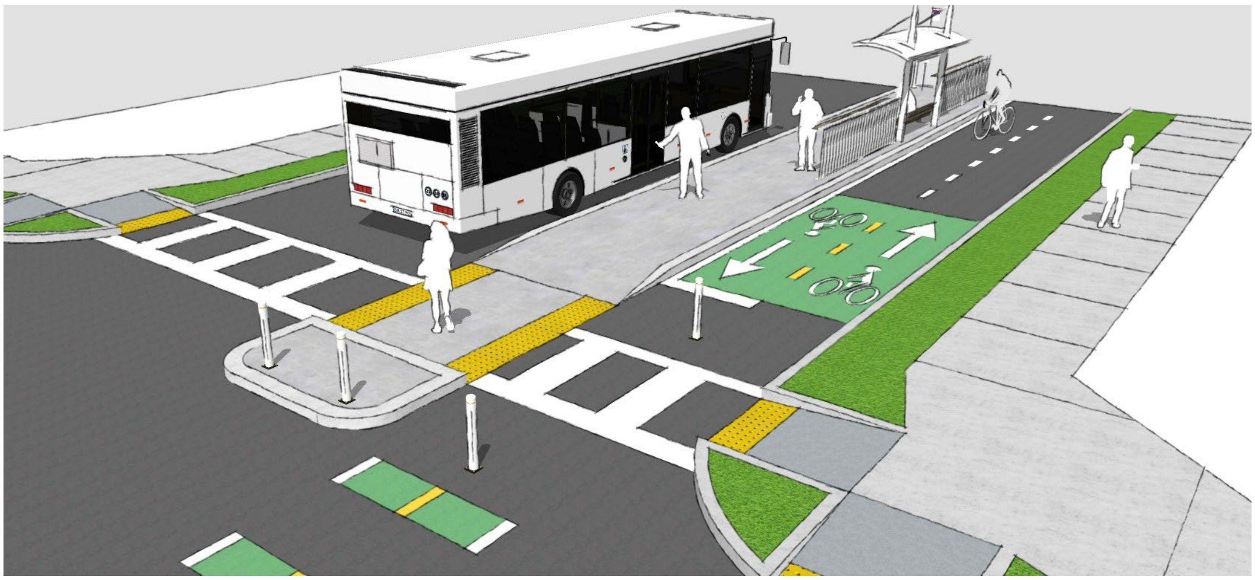


Figure 17.29 – FLOATING BUS STOP B

2. Floating Bus Stop B allows the bicycle lane to continue at roadway grade without shifting significantly around the bus boarding pad.

3. Any curb that could be struck by bicyclists because of a deviation of normal path of travel shall be painted yellow.

4. Vertical delineation should be implemented where there may be limited visibility of the curb.

5. When a Floating Bus Stop B is placed at a marked crosswalk, the existing pedestrian crosswalk and pedestrian ramps should be used as access to the bus boarding pad.

17.5.02.E.5 continued

a. All pedestrian ramps shall meet the requirements in Section 17.3.02.A – Curb Ramps and Corner Treatments.

b. A Median Refuge Island shall be included where the bus boarding pad intersects with the crosswalk. The Median Refuge Island shall meet the requirements in Section 17.3.02.D – Median Refuge Islands.

6. When a Floating Bus Stop B is not placed at a marked crosswalk, accessible pedestrian ramps and pedestrian crosswalk markings shall be provided at Sidewalk grade or at road grade.

a. If a Sidewalk grade pedestrian crossing is provided, use Floating Bus Stop A pedestrian crossing and drainage requirements.

b. If a Sidewalk grade pedestrian crossing is provided, the Bicycle Facility shall transition before and after the pedestrian crossings at a maximum slope of 1:7 and a preferred slope of 1:15. The minimum length of the Sidewalk level Bicycle Facility should be twenty-five (25)-ft.

7. Drainage

a. Drainage shall be fully accommodated by the design of Floating Bus Stop B. Implementation of Floating Bus Stop B shall not create new ponding of stormwater.

17.5.02.F Floating Bus Stop B shall maintain the existing gutter flow line. Shared Raised Bus Stop

1. A Shared Raised Bus Stop allows for a bus stop to be in line with the Bicycle Facility without altering the Pedestrian Realm and allows for bus boarding at the Sidewalk level by ramping up the bicycle lane to the curb. See Figure 17.30 for a conceptual design of a Shared Raised Bus Stop. This figure is for reference only and does not constitute design standards.

17.5.02.F continued

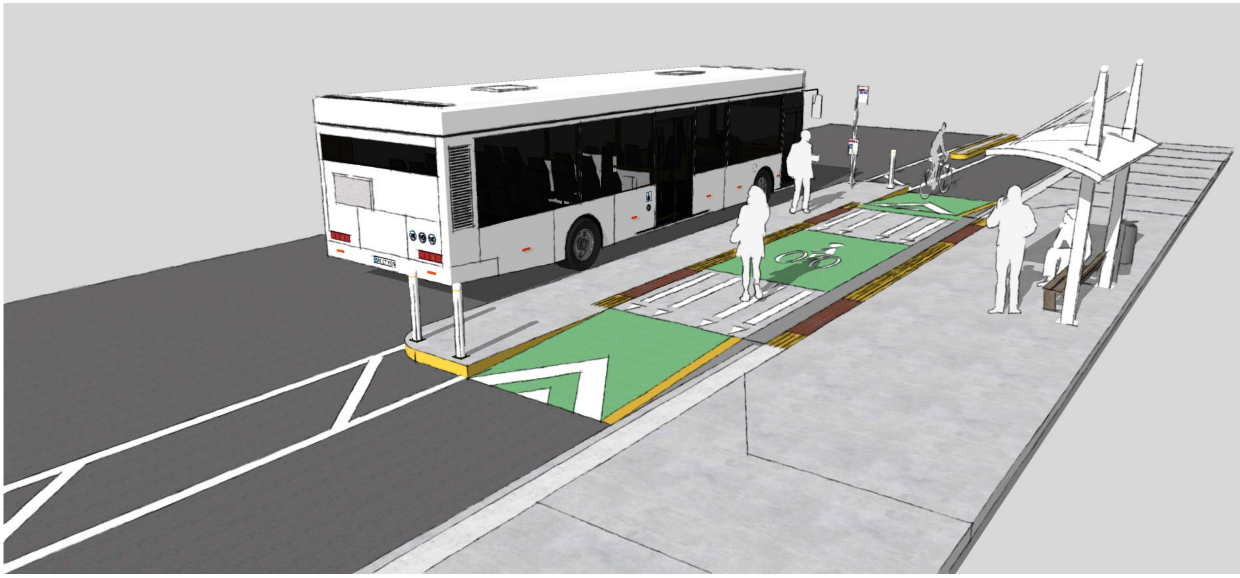


Figure 17.30 - SHARED RAISED BUS STOP

2. Shared Raised Bus Stops should only be used on right-of-way-constrained roadways where the Off-Street Bicycle Facility Bus Stop, Floating Bus Stop A or Floating Bus Stop B is not feasible.

3. Any curb that could be struck by bicyclists because of a deviation of normal path of travel shall be painted yellow.

4. Vertical delineation should be implemented where there may be limited visibility of the curb.

5. Bicycle Facilities shall transition before and after the pedestrian crossings at a maximum slope of 1:7 and a preferred slope of 1:15.

6. Pedestrian Crossings

    a. There shall be at least one marked pedestrian crossing across the Bicycle Facility.

    b. Pedestrian crossings shall maintain the height of the Sidewalk and curb and have a cross slope of 2%.

    c. Pedestrian crossings shall be clearly indicated with crosswalks made up of four (4) six (6)-in wide, minimum five (5)-ft long white stripes perpendicular to the Bicycle Facility. Additional stripes may be necessary for wider bicycle lanes.

17.5.02.F.6 continued

d. Yield lines made up of white yield triangles shall be placed in advance of the pedestrian crossing. YIELD TO PEDS pavement markings may be included.

e. Two (2)-ft-wide detectable warning surfaces shall be placed on either side of the pedestrian crossing.

f. A longitudinal detectable warning strip should be placed on both sides of the Sidewalk-grade segment of the Bicycle Facility.

7. Pavement Markings

a. Solid bicycle green pavement markings shall be placed over the entire width of the Bicycle Facility adjacent to the bus stop. Breaks shall be provided for pedestrian crossings.

b. A bicycle symbol and arrow marking shall be included in the Bicycle Facility adjacent to the bus stop, not conflicting with pedestrian crosswalk pavement markings.

c. A six (6)-in solid white striped buffer shall delineate the area between the Bicycle Facility and the vehicular lane and shall provide bicycle lane alignment behind the bus boarding pad.

d. A six (6)-in solid yellow stripe shall be included on the gutter side of Bicycle Facility ramps.

8. Drainage

a. Drainage shall be fully accommodated by the design of the Shared Raised Bus Stop. Implementation of the Shared Raised Bus Stop shall not create new ponding of stormwater.

b. Shared Raised Bus Stops should be installed on a high point of the gutter flow line.

(1). If it is not feasible to install the Shared Raised Bus Stops on a high point of the gutter flow line, a new storm inlet with appropriate connections should be installed on the upstream side of the bus platform.

(2). If article 17.5.02.F.8.b.(1) is not feasible, an eighteen (18)-in gap between the curb and the Bicycle Facility shall be provided to preserve the gutter flow. An easily removable steel plate shall be provided over the drainage gap along any walkable surface.

~~17.5.02.G continued~~

17.5.02.G On-Street Shared Bus Stop

~~4.~~1. On-Street Shared Bus Stops are bus stops where buses share space with road-grade Bicycle Facilities. See Figure 17.31 for a conceptual design of an On-Street Shared Bus Stop. This figure is for reference only and does not constitute design standards.

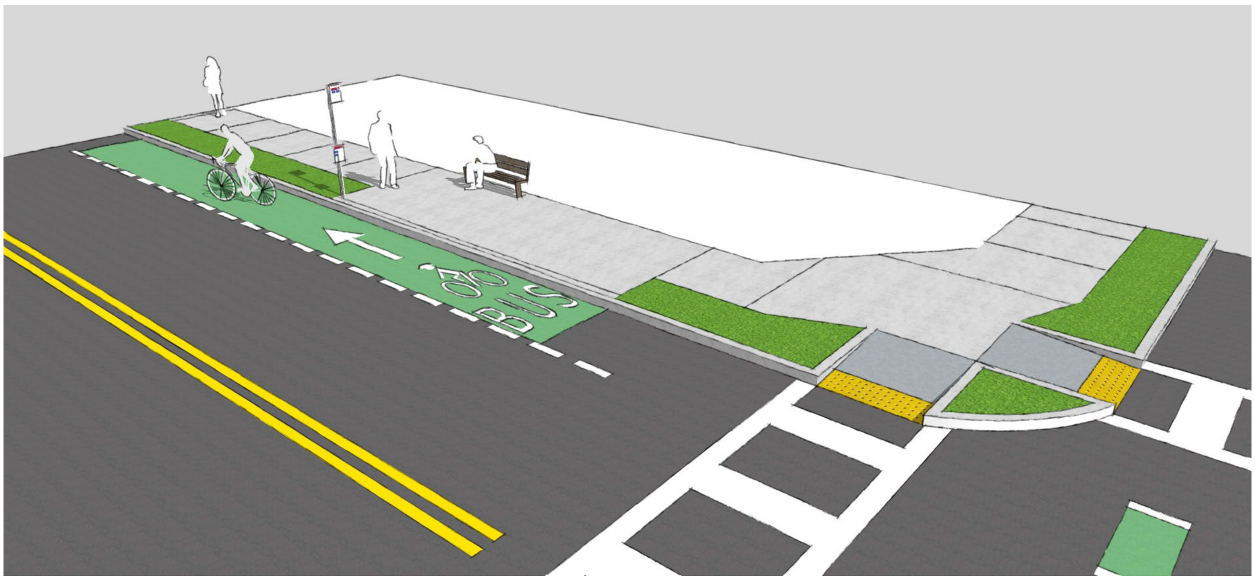


Figure 17.31 – ON-STREET SHARED BUS STOP

2. Where right-of-way is constrained, bus frequency is greater than or equal to 60 minutes, and the scope of the project does not allow for Shared Raised Bus Stops, On-Street Shared Bus Stops may be used.

3. On-Street Shared Bus stops should be placed on the far side of intersections. Where they are placed at the near side of intersections, they should be placed such that motorists cannot use the bicycle lane to make a right turn.

4. Pavement Markings

   a. On-Street Shared Bus Stops are made up of bicycle green pavement markings adjacent to the bus stop.

   b. There shall be bicycle green pavement markings combined with a bicycle symbol, an arrow and BUS pavement markings preceding the bus stop (refer to Standard Detail 02760-04).

   c. Dashed, white six (6)-in guideline pavement markings shall be placed adjacent to the bus stop area and in advance of the bus stop to allow for bus access to the curb.

17.5.02.G.5 continued

5. Delineation

a. On-street bike lane delineation shall end in advance of the bus stop area. The area without delineation can include driveways.

(1). For near side bus stops, delineation should be placed such that motorists cannot use the bicycle lane to make a right turn.

(2). For far side bus stops, delineation should only be placed following the stop.

~~17.4.02~~17.5.03 TRANSIT STOP PLACEMENT~~: RESERVED~~ (REFER TO METRO TRANSIT DESIGN GUIDELINES)

~~TRANSIT STOP CONFIGURATIONS: Reserved~~
~~TRANSITWAYS: Reserved~~

~~17.4.05~~17.5.04 PAVEMENT MARKINGS/SIGNAGE~~: RESERVED~~ (REFER TO METRO TRANSIT DESIGN GUIDELINES)

END OF CHAPTER

City of Houston

Design Manual

Chapter 18

ENCROACHMENT REQUIREMENTS

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ENCROACHMENT REQUIREMENTS

SECTION 1 - ENCROACHMENT REQUIREMENTS OVERVIEW

18.1.01 CHAPTER INCLUDES

18.1.01.A General Encroachment requirements and special Encroachment requirements for residential subdivision markers, Skybridges, monitoring wells and environmental test boring Facilities in the Public Right-of-Way.

~~18.1.01.A~~18.1.01.B This chapter does not cover encroachments into City of Houston easements.

18.1.02 REFERENCES

18.1.02.A Latest revision of the following City of Houston Code of Ordinances:

1. Chapter 40 – Streets and Sidewalks, Article I – In General

2. Chapter 40 – Streets and Sidewalks, Article XII - Monitoring Wells and Environmental Test Boring Facilities

18.1.03 DEFINITIONS

18.1.03.A Encroachments - Private uses into, upon, over, or under the City's right-of-way. The City's Office of the City Engineer (OCE) issues an Encroachment permit including, but not limited to, tunnels, vaults, pedestrian walkways, basements, tiebacks, railroad spurs, utilities, high and low voltage circuits, cables, conduits, signs, tanks, balconies, canopies, planters, columns, sculptures, and pavers.

18.1.03.B Entrance Marker – Ornamental gate(s), column(s), or other ornamental works of wood, iron, masonry, earth, or other materials denoting the entrance to a platted and recorded single family residential subdivision.

18.1.03.C Esplanade - Unpaved area between two paved roadway sections.

18.1.03.D Facility - Any mechanical device or monitoring well and its associated apparatus, placed within a Public Right-of-Way, and designed and constructed to measure or monitor the quality or movement of foreign substances, elements, chemicals, fluids, or pollutants below the surface of the ground; or any mechanical device, method, or apparatus, placed in a Public Right-of-Way and designed and constructed to obtain a sample soil core boring from a depth of greater than one foot below the surface of the ground, for the purpose of removing soil for environmental quality testing.

18.1.03.E ~~Street~~ Public Right-of-Way - Entire width between the boundary lines of every way which is held by the ~~c~~City~~, county, state or otherwise by the public in fee~~ or dedication when any part thereof is open to the use of the public~~ for purposes of vehicular travel~~.

18.1.03.F ~~A s~~Skybridge~~,~~ - ~~as defined in this Chapter,~~ A bridge or elevated structure that permits pedestrian and other access between two adjacent structures (not necessarily under the same property ownership) ~~via an elevated structure or bridge~~ within the ~~p~~Public ~~r~~Right-of-~~w~~Way.

SECTION 2 – ENCROACHMENT PERMIT REQUIREMENTS

18.2.01 GENERAL ENCROACHMENT PERMIT REQUIREMENTS

18.2.01.A Encroachment permit requirements can be found at the Houston Permitting Center website: https://www.houstonpermittingcenter.org/hpwoce1006

18.2.02 SPECIAL ENCROACHMENT PERMIT REQUIREMENTS

18.2.02.A Residential Subdivision Marker~~s~~ Design Requirements

1. General Considerations/Restrictions

   a. Subdivision markers are considered Encroachments in the ~~p~~Public ~~r~~Right-of-~~w~~Way and shall meet the Encroachment requirements set out for subdivision markers in Chapter 4~~1~~0 of the City of Houston Code of Ordinances.

   b. Subdivision markers may display the name of the subdivision or neighborhood but shall not contain any commercial advertising, announcement, or other signage.

   c. An electronic sign or marker is not allowed.

   d. Subdivision markers may not be located on, extend on to, nor:

      (1) Intrude upon any portion of a roadway.

      (2) Intrude upon any portion of a sidewalk or pedestrian pathway in the ~~p~~Public ~~r~~Right-of-~~w~~Way.

      (3) Create any hazardous condition or obstruction for vehicular or pedestrian travel upon a public street.

      (4) Be located within five (5) feet of underground storm, sanitary sewer, water lines and all appurtenances.

      (5) Be located within twenty-five (25) feet of a fire hydrant.

      (6) Restrict or block driver's visibility or sight line of traffic, pedestrians, bikeway travelers, or other public user within the Public ~~r~~Right-of-~~w~~Way.

      (7) Be located within the visibility triangle.

2. Locations

18.2.02.A.2 continued

a. Subdivision markers may be located at the main entrance to a subdivision and at secondary entrances.

b. The subdivision marker must be within the boundaries of the subdivision or single-family residential development they identify.

c. Locations where multiple subdivisions interface will be reviewed on a first come, first serve basis for purposes of establishing allowable subdivision marker locations.

d. The City Engineer's approval will be required for installation of more than two markers to identify a single subdivision.

e. The following are minimum allowable Entrance Marker location guidelines:

(1) Fifty (50) feet from the median nose for mid-block median openings,

(2) Seventy-five (75) feet from the median nose for intersection openings,

(3) One hundred (100) feet from the median nose of median for left turn lanes,

(4) Seven (7) feet from the inside median curb (this dimension may be reduced if community has entered into maintenance or Adopt-an-Esplanade agreement with Houston Parks and Recreation Department and does not create a hazardous condition),

(5) Within Public ~~r~~Right-of-~~w~~Way adjacent to property line.

3. Size

a. Maximum height above the ground surface shall not be greater than six (6) feet.

b. Height shall be limited to not obstruct sight lines of vehicular and pedestrian traffic.

c. Maximum horizontal width shall not exceed eight (8) feet.

d. Maximum display area shall not exceed thirty-six (36) square feet.

18.2.02.A.3 continued

e. Width shall be limited to not obstruct sight lines of vehicular and pedestrian traffic.

f. Variances to the size requirements for a proposed subdivision marker must be granted by the City Engineer.

4. Materials

a. Materials for base structure shall be permanent, durable, and weather resistant.

b. Marker shall provide pleasing aesthetic elements, clarity, and professional design appearance.

c. Marker letters and/or other elements ~~should~~shall be of non-corrosive and non-staining materials and coated properly to prevent staining and discoloration.

d. Material ~~selections should~~shall be capable of clean-up from graffiti ~~mark ups~~.

5. Utilities

a. Marker shall be of size and location to not impede or restrict the City's ability to maintain, repair, or replace the existing utility line(s).

b. Existing utilities shall be field located prior to the construction of the ~~e~~Entrance ~~m~~Marker. It is recommended that existing utilities shall be field located prior to preparation of the measured drawings for the ~~e~~Entrance ~~m~~Marker and its location.

18.2.02.B Skybridge~~s~~ Design Requirements

1. General Requirements

a. Skybridges are considered ~~e~~Encroachments in the ~~p~~Public ~~r~~Right-of-~~w~~Way and shall meet the Encroachment requirements set out in Chapter 4~~1~~0 of the City of Houston Code of Ordinances including all administrative, permitting and fees.

b. Skybridges may be open air or conditioned space depending upon the specific location and application.

18.2.02.B.1 continued

c. Skybridges shall not interfere with the operation of the ~~p~~Public ~~r~~Right-of-~~w~~Way across which it traverses and is subject to following height restrictions:

(1) The bottom of the lowest portion of the ~~s~~Skybridge over the ~~p~~Public ~~r~~Right-of-~~w~~Way must be a minimum of eighteen and half (18.5) feet above the roadway surface.

~~(2) Clearances less than 18.5 feet require review a variance and approval of the City Engineer.~~

d. Skybridges proposed to traverse an intersection of two public street rights-of way requires approval of the City Engineer.

18.2.02.C Monitoring Wells and Environmental Test Boring Facilities Design Requirements

1. General Requirements

a. Facilities are considered Encroachments in the Public Right-of-Way and shall meet the Encroachment requirements set out for Facilities in Chapter 40, Section 40-281 of the City of Houston Code of Ordinances.

2. Location on Public Streets

a. A Facility must not be located on, extend on to, nor intrude upon any portion of a roadway or a sidewalk unless the City Engineer determines that no reasonable alternative site exists. In any instance in which a Facility must be situated on a sidewalk or roadway, it shall be installed entirely below the surface and covered in such a manner as to allow normal use of the roadway or sidewalk.

b. A Facility must not create any hazardous condition or obstruction of any mode of travel upon a public street, alley, sidewalk, or bikeway.

c. The design and location of a Facility shall include all reasonable planning to minimize potential harm, injury, or interference to the public in the use of the public streets.

d. Upon its removal, a Facility shall be properly closed by cementing or other sound engineering practice to prevent injuries to persons at the surface and underground contamination.

18.2.03 SUBMITTALS FOR ENCROACHMENT PERMIT

18.2.03.A continued

18.2.03.A General Permits Submittal Procedures

1. Complete and submit the Encroachment permit application including additional documents required for approval. The application can be submitted online and can be found at https://www.houstonpermittingcenter.org/hpwoce1006.

2. Drawings shall be submitted to the ~~office~~ Office of City Engineer for review and approval.

3. Drawings shall show existing surface and buried ~~f~~Facilities within the Public ~~r~~Right-of-~~w~~Way or easements in plan view.

4. If ~~entrance marker design~~ Encroachment area includes landscaping, the growth characteristics of the plants shall be submitted with the drawings and an approval ~~ID~~ letter is required from Houston Parks and Recreation Department.

18.2.03.B Subdivision Marker Submittal Procedures

~~6.~~1. Complete and submit the Subdivision Marker application including additional documents required for approval. The permit application form and related documents can be found at https://www.houstonpermittingcenter.org/hpwoce1005.

2. A ~~construction~~ street cut/excavation permit and traffic control permit will be required prior to construction of a subdivision marker within the ~~p~~Public ~~r~~Right-of-~~w~~Way ~~or public easement~~. The ~~construction~~ permits will be obtained by the applicant from the Houston Permitting Center, ~~Traffic/Paving Permits Section~~ Street Cut Permits Section and Mobility Section, upon ~~submittal of~~ obtaining ~~approved plans and appropriate encroachment permit~~ the approved subdivision marker permit. The permit application form and related documents can be found at https://www.houstonpermittingcenter.org/hpwoce1006 and https://www.houstonpermittingcenter.org/hpwmp1001.

3. For subdivision markers within a City of Houston esplanade, provide approved Adopt-an-Esplanade letter from City of Houston Parks and Recreation Department. For more information, e-mail askparks@houstontx.gov.

18.2.03.C Monitoring Wells and Environmental Test Boring Facilities Submittal Procedures

1. Each applicant shall submit detailed plans prepared under the seal of a professional engineer registered as such in Texas with the application. Each set of plans shall show the design, dimension, and depth of the Facility, and the process that will be used for its removal and closure.

~~7.~~2. An approved street cut/excavation permit is required prior to submitting the monitoring wells permit application. The monitoring wells permit application form and related documents can be found at https:///www.houstonpermittingcenter.org/hpwoce1003.

3. A traffic control permit is required prior to construction of a Facility within the Public Right-of-Way or public easement. The traffic control permit can be obtained by the applicant from the Houston Permitting Center, Mobility Section.

18.2.04 QUALITY ASSURANCE

18.2.04.A Have drawings sealed, signed, and dated by the professional engineer responsible for development of the drawings.

END OF CHAPTER