HOUSTON
PUBLIC WORKS

2021-2022 Review Cycle

Infrastructure Design Manual

Redlines

July 1, 2022

City of Houston

Design Manual

Chapter 1

GENERAL REQUIREMENTS

Chapter 1
Table of Contents

General Requirements

SECTIONS PAGE

Chapter 1

GENERAL REQUIREMENTS

SECTION 1 - GERNERAL REQUIREMENTS OVERVIEW

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 ~~e~~Extraterritorial ~~j~~Jurisdiction (ETJ).

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 - ~~Chapter 33,~~ City Surveys.

2. Chapter 40 – Streets and Sidewalks, Article V ~~Chapter 40, -~~ - ~~Street and Sidewalk~~Excavation in Public Way

3. Chapter 42 -~~,~~ Subdivisions, Developments and Platting.

4. Chapter 47 – Water and Sewers, Article V ~~,~~ - ~~Chapter 47, Water and Sewers~~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. ~~TCEQ, Water Supply Division, Rules and Regulations for Public Water Systems, latest revision.~~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~~TCEQ, Design Criteria for Sewer Systems, Texas Administrative Code, 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

1.1.02.E.2 continued

Board of Professional Engineers and Land Surveyors.

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

Texas Administrative Code, Title 22, Part 6 Texas Board of Professional Engineers and Land Surveyors.~~State of Texas Engineering Practice Act. State of Texas Professional Land Surveying Practices Act.~~

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

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

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

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 ~~his~~ the City’s designee, having approval authority for Publicly-Funded Projects, ~~p~~Privately-~~f~~Funded ~~p~~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 Design Analysis – Narratives and calculations necessary to support design of a project.~~

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

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

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

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

1.1.04 PLAT AND CONSTRUCTION DRAWING REVIEW PROCESS

1.1.04.A Review of plat and construction ~~d~~Drawings by ~~the Department of~~ 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, ~~Review and Approval Process for Plats and Drawings~~Class III Preliminary Plat.

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

~~1.1.04.C~~ ~~Utility and paving construction in~~For projects requiring a subdivision plat~~s~~, construction of utilities and paving is not permitted until the ~~final~~ plat has been ~~released~~recorded. ~~Plat release by Department of Houston Public Works is authorized by signature of the Director, or his designee, on final design drawings.~~

~~1.1.04.D~~1.1.04.C

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

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

SECTION 2 - GERNERAL DESIGN REQUIREMENTS

1.2.01 DESIGN REQUIREMENTS

1.2.01.A Preliminary Design.

1. Publicly/Privately-~~f~~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 ~~d~~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-~~f~~Funded Projects:

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

   b. Provide ~~review prints~~ electronic ~~d~~Drawings to the City Engineer and ~~r~~Review ~~a~~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 ~~d~~Drawings - "Contractor shall notify the City of Houston, ~~Department of~~ 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 ~~d~~Drawings and ~~s~~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-~~f~~Funded Projects:

   a. To obtain review of final design ~~d~~Drawings for both ~~p~~Publicly-

1.2.02.A.1.a continued

~~f~~Funded and ~~p~~Privately-~~-f~~Funded ~~p~~Projects, first submit ~~d~~Drawings to the Houston Public Works, ~~Plan Review Center~~ Office of the City Engineer for assignment of a ~~log~~ project number before review will commence. The ~~log~~ project number will remain in effect for one year.

~~1.~~b. Once a ~~log~~ project number is assigned, reference the number in all correspondence relating to that project.

~~2.~~c. Obtain and complete ~~plan review application forms for each review phase when the project is logged in~~electronic plan review assigned tasks for each phase of the review process. The same ~~log~~ project number will be used for all review phases of each project unless review of a subsequent phase is delayed by over one year.

~~3.~~d. ~~Plan Review Center personnel~~ Office of the City Engineer personnel will process reviews through appropriate review teams in ~~the Department of~~ Houston Public Works.

~~4.~~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 ~~log~~ project number inactivated.

~~5.~~f. The City has a weekly one-day walk-through procedure for the signature ~~stage of small projects.~~ of revisions and updates of plans approved through the hard copy review. Instruction sheets for this procedure may be obtained ~~in the Plan Review Center~~ from the Office of the City Engineer.

~~6.~~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-~~f~~Funded Projects: Submit ~~one~~ set of the design Drawings and supporting documents through the electronic plan review system. ~~preliminary overall design concept with~~ Provide supporting evidence as described in ~~Paragraph~~Article ~~1.07~~1.2.01~~1.2.01~~ and ~~Paragraph~~Article ~~1.1.08~~1.2.04~~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 ~~C~~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-~~f~~Funded Projects:

a. ~~Submit sets of the final design drawings with prints containing preliminary review comments.~~Plans submitted through the electronic plan review system to the Office of the City Engineer must comply with Article 1.2.02.B.1~~1.2.02.B.1~~.

~~b. For complex projects, it is recommended that a copy of the City review comments on the preliminary drawings be returned with the revised final design drawings.~~

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 ~~d~~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~~1.2.02.B.1~~.

~~B.~~2. Design Contracts with the City:

~~1.~~a. Submit original tracings with prints containing previous review comments.

~~2.~~b. Specification submittals: Submit final design ~~s~~Specifications for review~~ on all City funded projects~~.

~~Provide notes on plans for all privately funded projects stating that all facilities shall be constructed in accordance with City of Houston Standards.~~

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

1.2.02.E.2 continued

~~3.~~d. Submit surveyor's field book and electronic data in accordance with Chapter 2, Survey Requirements.

~~On privately funded projects, submit final computer generated drawing files in acceptable electronic media including plat, right-of-way maps, and construction drawings. Scanned images may be acceptable if project is less than 3 sheets.~~

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.

   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.

1.2.04.A.2 continued

vide 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 ~~Professional Land Surveyor~~RPLS.

1.2.03.B Have recording documents sealed, signed, and dated by a ~~Professional Land Surveyor~~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 ~~d~~Drawings sealed, signed, and dated by the Professional Engineer responsible for development of the ~~d~~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. ~~Department of~~ Houston Public Works
    a. ~~Engineering and Construction Division~~Capital Projects
    b. ~~Planning and Development Services Division File Room~~Customer Account Services
    c. ~~Right-of-Way and Fleet Maintenance Division and Traffic & Transportation Division~~Financial Management Services
    d. ~~Planning and Development Services Division, Utility Planning and Analysis Branch~~Houston Permitting Center
    e. ~~Public Utility Division~~Houston Water
    ~~e.~~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.

~~10.~~1. For capital improvement projects requiring the acquisition of real property, a ~~c~~Conflict ~~v~~Verification is required.

1.2.05 ~~ORIGINAL~~APPROVED DRAWINGS

1.2.05.A Approved ~~d~~Drawings for projects within the city limits and within the ETJ will be assigned a City drawing number and will be filed ~~in~~by the City ~~File Room~~ prior to release back to the Engineer of Record. ~~File Room r~~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.

END OF CHAPTER

City of Houston

Design Manual

Chapter 2

SURVEY REQUIREMENTS

Chapter 2
Table of Contents

Survey Requirements

SECTION PAGE

List of Figures

Chapter 2

SURVEY REQUIREMENTS

SECTION 1 - SURVEY OVERVIEW

2.1.01 CHAPTER INCLUDES

2.1.01.A Suggested guidelines for use by surveyors and engineers in development of construction drawings and ~~r~~Right-of-~~w~~Way maps inside the Houston city limits and outside the Houston city limits within the Extraterritorial Jurisdiction (ETJ). These guidelines are required for c~~C~~apital i~~I~~mprovement p~~P~~rojects designed under professional services contracts with the City of Houston.

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~~, of the City of Houston Code of Ordinances.~~

~~1.~~2. Article I, Chapter 42, Subdivisions, Developments & Platting

~~2.1.02.B Professional Land Surveying Practices Act, Texas Occupations Code Sec. 1071, latest revision.~~

2.1.02.B Texas Board of Professional Engineers and Land Surveyors (TBPELS) ~~Professional and Technical Standards (Texas Administrative Code, Title 22, Part 29, Chapter 663, Subchapter B, Professional And Technical Standards),~~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 ~~City of Houston Department of~~ 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.A~~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 ~~GNSS -~~ Global Navigation Satellite System (GNSS) - A~~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.B~~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.C~~2.1.03.N Site Control Monuments - H~~h~~orizontal and vertical m~~M~~onuments needed to augment existing City monuments, conforming to standards established by the Chief Surveyor.

~~2.1.03.D~~2.1.03.O Street Reference Monuments - H~~h~~istoric monuments used to re-establish existing City street ~~r~~Right~~s-~~-of~~-w~~Ways.

~~2.1.03.E~~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.F~~2.1.03.Q Temporary Benchmark (TBM) - A ~~temporary bench mark is 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 c~~C~~apital ~~I~~improvement ~~P~~projects designed under professional services contracts with the City of Houston.

2.2.01.B When establishing h~~H~~orizontal ~~C~~control, surveyors shall transcribe onto the pages of a standard Survey Field Book, as described in ~~Paragraph~~ Article 2.1.03.P~~A~~, all angles and distances, at the time of measurement, with an accompanying recovery sketch. When establishing ~~V~~vertical ~~C~~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. ~~Temporary Benchmarks (~~TBMs~~)~~ should be set where they are not likely to be destroyed during construction.

2.2.01.C For projects in which the ~~H~~horizontal ~~C~~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 ~~H~~horizontal ~~C~~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 ~~m~~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.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 F~~f~~ield B~~b~~ook 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 ~~H~~horizontal and v~~V~~ertical c~~C~~ontrol monuments must be marked in such a way as to identify the surveyor in responsible charge.)

3. Locate any found monuments and/or property corners and reference them to the design baseline according to the existing City of Houston survey

2.2.01.D.3 continued

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 ~~section~~ 33~~, article 4~~) as a basis for all elevations. Set ~~temporary bench marks (~~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 ~~features~~ information and improvements within the existing public ~~r~~Right-of-~~w~~Way, proposed R~~r~~ight-of-~~w~~Way, any contiguous easements to the R~~r~~ight-of-W~~w~~ay, and any area within the construction ~~right-of-way of the~~ project~~ and~~.

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 ~~20~~100 feet beyond ~~the intersection of the right-of-way lines~~ 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.

~~8.~~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 R~~r~~ight-of-~~w~~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 ~~r~~Right-of-~~w~~Way line, 20 feet beyond the ~~r~~Right-of-~~w~~Way line if possible~~, and on intersecting streets for a distance of 100 feet beyond proposed pavement~~. See Figure 2.1 Perimeter of Standard Topographical Survey.

~~9.~~10. For acquisition of new or additional R~~r~~ight~~s~~-of-~~w~~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 ~~r~~Right-of-W~~w~~ay 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 ~~10~~25 feet of the proposed R~~r~~ight-of-~~w~~Way line.

2.2.01.E Calculations.

1. Calculate coordinates of proposed ~~r~~Right-of-~~w~~Way parcels, ~~c~~Control ~~p~~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 ~~should~~ shall be submitted to the City with Survey F~~f~~ield B~~b~~ooks and ~~database files~~Raw Data Files.

2.2.01.F Construction Drawings.

1. All found monuments (property corners, Street Reference Monuments, bench marks 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 R~~r~~ight-of-W~~w~~ay 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 ~~Paragraph~~Article 2.2.01.D. Coordinates for traverse ~~c~~Control ~~p~~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 ~~c~~Control ~~p~~Points and Street Reference Monuments using the City of Houston recovery sheet format.

3. Show and identify location of the City datum monuments and ~~temporary bench marks~~TBMs used for elevation control. List the TBM located

2.2.01.F.4 continued

closest to that particular sheet in a station/offset, description and elevation format.

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 ~~c~~Control ~~p~~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, ~~the ITRF used~~ and the current published coordinates of the base stations at the time of calculation.

2.2.02.C continued

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.A~~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). ~~Photocopies or carbon copies of field books are not acceptable.~~ Electronic submittals of Survey 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. ~~Computer Aided Drafting files in AutoDesk DWG or DXF format~~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. ~~Data Collection Files~~All Raw Data Files (conventional and GPS/GNSS) as defined in this chapter.

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

1. Drawings:

   a. Overall index map identifying all ~~r~~Right-of-W~~w~~ay parcels for the project.

   b. Individual survey drawings of each parcel,

   c. All maps ~~are~~ and drawings shall be ~~mylar,~~ 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 & ~~B~~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 ~~r~~Right-of-~~w~~Way drawings.

4. ~~Electronic Shape files~~The CAD file generated for parcels ~~to be placed in a GIS environment.~~shall utilize the parcel titleblock template found on the Survey Section website.

~~2.2.02.C~~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 ~~Office~~Section.

~~2.2.02.D~~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 ~~r~~Right-of-~~w~~Way maps, shall be performed by or under the direct supervision of an RPLS.

2.2.03.B Survey Field ~~b~~Books, metes & bounds descriptions and R~~r~~ight-of-~~w~~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 d~~D~~istances shall be shown as "surface" distances and plainly marked as such. All bearings shall be based on the ~~Texas~~ Official Coordinate System~~ of 1983~~.

2.2.04.B Distances on proposed R~~r~~ight-of-~~w~~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 R~~r~~ight-of-~~w~~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 ~~Grid Coordinate values of "x," "y" shall be shown for PCs, PTs, and PIs of curves on the proposed right-of-way lines.~~ Curve data must include the following: delta, radius, arc length, chord length, and chord bearing.

2.2.04.F Grid ~~C~~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 ~~r~~Right-of-~~w~~Way maps:

1. All visible improvements such as buildings, fences, permanent signs, utilities, and other structures located on the property or within ~~10~~ 25 feet outside the proposed R~~r~~ight-of-~~w~~Way line, if accessible.

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

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

4. ~~Real estate numbers obtained from the Chief Surveyor, right-of-way engineer, or Real Estate Division.~~Right-of-Way parcel numbers obtained from Real Estate Services.

~~2.2.05 DOCUMENTS~~

~~Where new construction will damage, destroy, or alter existing Street Reference Monuments, include in specifications a requirement for installation of survey marker boxes by construction contractor at a unit price per box. The Chief Surveyor will determine the number and location of boxes to be furnished and installed by the contractor.~~

~~Survey Control Sheets, plats, metes and bounds descriptions and Survey Field Books shall have the RPLS seal, signature and date affixed to the document.~~

END OF CHAPTER

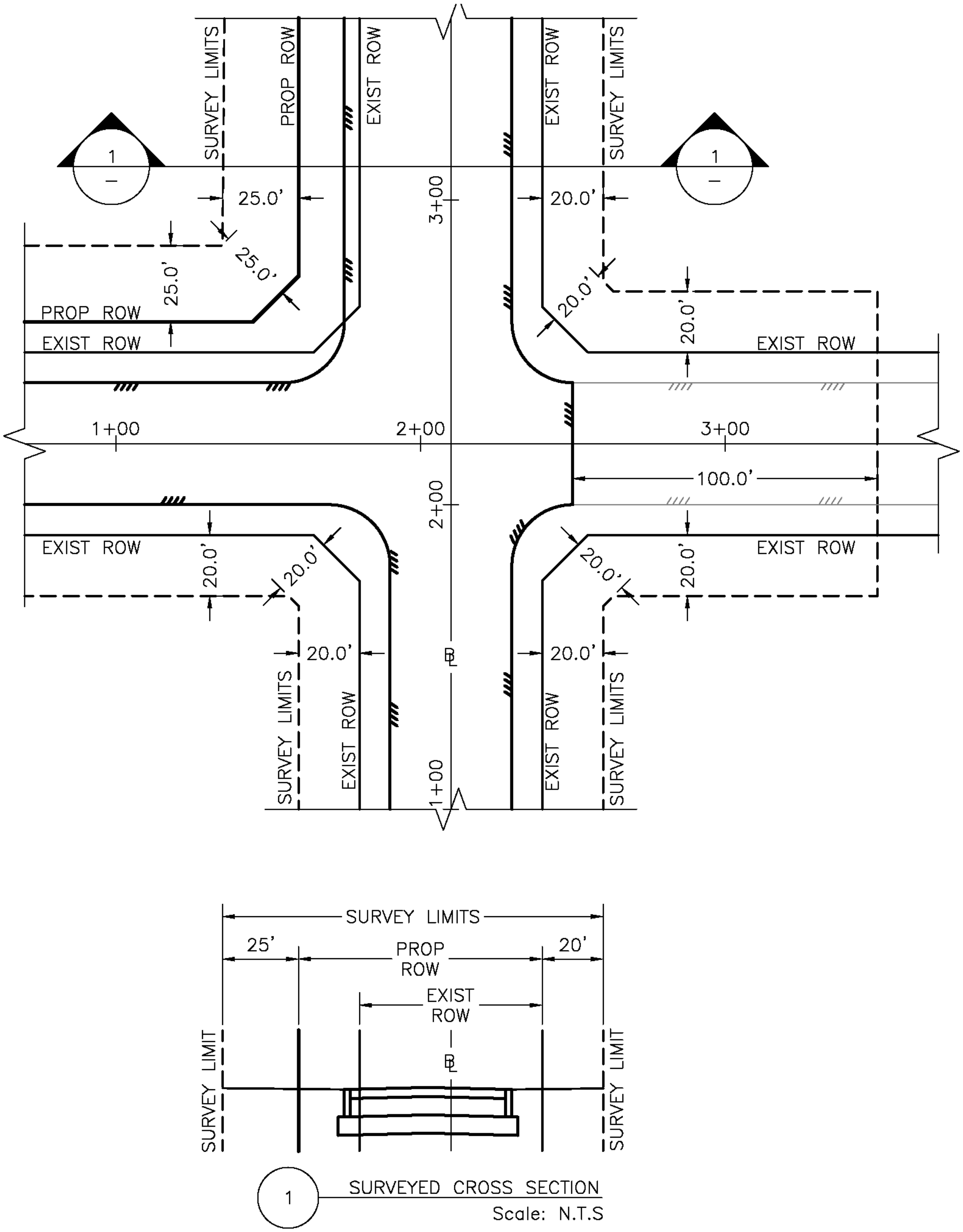


Figure 2.1 – PERIMETER OF STANDARD TOPOGRAPHICAL SURVEY

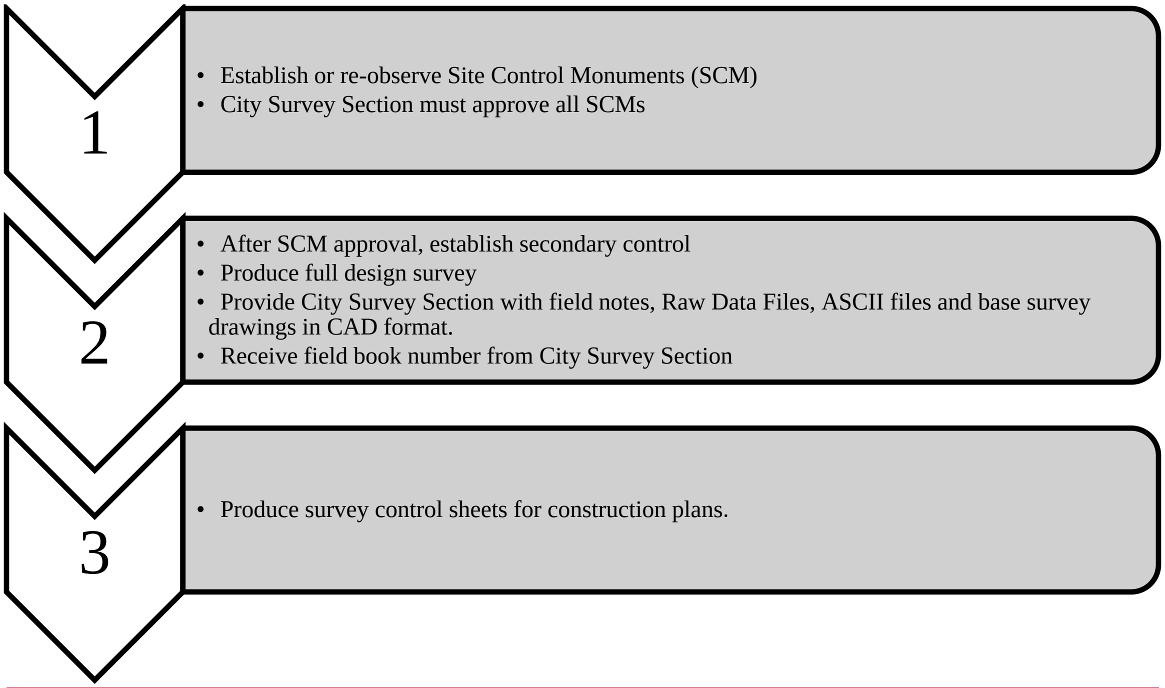


Figure 2.2 – GENERAL PROCESS FOR DESIGN CONTRACTS

City of Houston

Design Manual

Chapter 3

GRAPHIC REQUIREMENTS

Chapter 3
Table of Contents

Graphic Requirements

SECTION PAGE

List of Tables

List of Figures

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, ~~monument ties in compliance with Article IV,~~ Code of Ordinances, Chapter 33, Article IV - City Surveys. ~~, of the Code of Ordinance~~

3.1.02.B City of Houston, Standard Details, ~~C~~current ~~E~~edition.

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

~~3.1.02.D HCFCD – Harris County Flood Control District.~~

3.1.02.D ~~NCS –~~ National Institute of Building Sciences, U.S. National CAD Standard (NCS) ~~is published by the National Institute of Building Sciences~~.

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 - ~~is a~~ 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.B~~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 ~~d~~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.C~~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.D~~3.1.03.P U.S. National CAD Standard (NCS) – ~~was~~ 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 ~~DRAWINGS~~DETAILS

3.1.05.A Standard ~~D~~details shall be imported onto the sheet files when applicable. City standard details shall not be cropped ~~,~~and ~~they~~ 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. ~~four~~ Six 8 ½” x 11” ~~S~~standard ~~D~~details ~~Drawings~~ oriented portrait.

2. Four 8 ½” x 11” standard details oriented landscape.

3. Two 11”x17” standard details oriented landscape.

~~1.~~4. One 22”x34” standard detail oriented landscape.

3.1.05.B The current standard ~~drawings~~ 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

3.1.06.B continued

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.

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 ~~design d~~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 ~~d~~Drawings.

~~1.~~2. Electronic Drawings must be submitted according to SECTION 4 of this chapter.

~~3.2.01.B~~3.2.01.C The seal, date, and original signature of the Professional Engineer responsible for the ~~d~~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) ~~Engineering~~ Practice Act and Rules Concerning Practice and Licensure. Survey ~~C~~control sheets require seal and signature of Registered Professional Land Surveyor (RPLS).

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

~~3.2.01.D~~3.2.01.E Develop ~~d~~Drawings to accurate scale showing proposed pavement, typical cross sections, details, lines and grades, ~~and~~ existing topography within street ~~r~~Right-of-~~w~~Way, and any easement contiguous with the ~~r~~Right-of-~~w~~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 ~~or~~ proposed roadway ~~r~~Right-of-~~w~~Way, of which the wider ~~r~~Right-of-~~w~~Way shall govern) in each direction along cross street for designing adequate street crossings.

~~3.2.01.E~~3.2.01.F If a roadway exists where ~~d~~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 ~~d~~Drawings refer to Chapter 2, Section ~~2.09~~ 2.2.01.F, Construction Drawings.

~~3.2.01.F~~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, ~~m~~Model and ~~l~~Layout -S~~s~~pace.

1. Reference Files.~~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.~~HEET FILES~~

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

3. Model Space. ~~MODEL SPACE~~

   a. ~~A limitless 3D drawing area that is the default in AutoCAD software used for the beginning of a design.~~ Annotation, text, and dimensions that are directly related to the elements in the reference files shall be placed in ~~m~~Model ~~s~~Space. Reference files are to be attached in ~~m~~Model Space.

4. Layout Space.~~LAYOUT SPACE~~

   a. ~~Commonly known as “Paper Space”, is the area designated for producing printed deliverables. Annotation and text typical to the sheet content shall be placed in layout space.~~ 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 ~~d~~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

3.2.03.B.2 continued

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

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

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

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

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

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

5. Details of ~~s~~Special ~~s~~Structures ~~(not covered by approved standard drawings, such as stream or gully crossings, special manholes, or junction boxes)~~ shall be drawn with vertical and horizontal scales equal to each other.

3.2.04 TITLE BLOCK

3.2.04.A ~~Signature Block:~~ Use latest edition of the~~Signature Blocks~~ 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.B~~3.2.05.C The~~is~~ requirement in 3.2.05.B is waived under the following conditions:

1. A storm water sewer, ~~or~~ 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 ~~N~~notes for ~~P~~privately ~~F~~funded ~~P~~projects can be found in the "CAD Tools and Templates" -section located here:

1. https://www.houstonpermittingcenter.org/office-city-engineer/design-and-construction-standards

2. These ~~N~~notes are not intended to be used on City ~~F~~funded ~~P~~projects.

3.2.06.B City Funded Projects.

~~3.~~ General ~~N~~notes for City ~~F~~funded ~~P~~projects can be found in the "Capital Projects" section located here:

~~4.~~1. https://www.houstonpermittingcenter.org/office-city-engineer/design-and-construction-standards

~~5.~~ These notes shall only include third party notes. Any direction given to a contractor shall be handled through the use of ~~C~~construction ~~S~~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.~~,~~ ~~a~~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 ~~r~~Right-of-~~w~~Way.

3.2.09 SURVEY REQUIREMENTS

3.2.09.A Show ~~ties~~times on survey control or swing tie ~~d~~Drawings to City monuments, Control Points and ~~t~~Temporary ~~b~~Benchmarks. All construction ~~d~~Drawings shall be prepared in accordance with Chapter 2, Section ~~2.09~~ 2.2.01.F, Construction Drawings.

~~3.2.09.A~~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:

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, ~~r~~Rights-of-~~w~~Way, and ~~HCFCD~~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.

~~1.~~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

3.2.10.A continued

information is obtainable.

~~2.~~4. Show utility lines 4 inches in diameter or larger within the ~~r~~Right-of-~~w~~Way or construction easement in profile view. Show utility lines, regardless of size, in the plan view, including communication and fiber optic cables.

~~3.~~5. Graphically show flow line elevations and direction of flow for existing ditches.

~~4.~~6. Label proposed top of curb grades except at railroad crossings. Centerline grades are acceptable only for paving without curb and gutters.

~~5.~~7. Show curb return elevations for turnouts in profile view.

~~6.~~8. Gutter elevations are required for vertical curves, where a railroad track is crossed.

~~7.~~9. For street reconstruction projects, show in profile the centerline elevation at the property line of existing driveways.

~~8.~~10. Show both existing and proposed station esplanade noses or the centerline of esplanade openings, including esplanade width.

~~9.~~11. The design of both roadways is required on paving sections with an esplanade.

~~10.~~12. 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.

~~11.~~13. All existing and proposed utilities and pavement shall be on the same plan and profile sheet for a given section.

~~12.~~14. 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).

~~13.~~15. Each ~~sheet of the~~ plan and profile sheet shall have a benchmark elevation and description defined. Refer to Chapter 2~~.09~~ for further specification.

~~14.~~16. 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 ~~r~~Right-of-~~w~~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 ~~r~~Right-of-~~w~~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 BORE HOLE REQUIREMENTS

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

3.2.11.B The ~~B~~bore ~~H~~hole ~~L~~layout ~~S~~sheets shall contain the following information:

1. Project bore holes at the correct location and providing: ~~B~~bore ~~H~~hole ~~N~~number, ~~S~~station, ~~O~~offset, ~~N~~northing and ~~E~~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 ~~S~~survey and ~~S~~surveyed ~~B~~benchmark.

4. Design ~~B~~baseline.

3.2.11.C The ~~B~~bore ~~H~~hole ~~L~~log ~~Drawings~~ 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] ~~can be used as a general guide~~

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 ~~m~~Model ~~s~~Space.

2. Text shall be placed readable from the bottom or right side of the page.

3. Text shall be justified ~~T~~top ~~L~~left, ~~T~~top ~~R~~right, or ~~M~~middle ~~C~~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 ~~S~~sheet ~~T~~title	COH CIP Cover	0.70”	1.0
Cover ~~S~~sheet sub-titles	COH CIP Cover	0.40”	1.0

3.3.03 LINE WEIGHTS

3.3.03.A The “COH.~~CTB~~ 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~~10~~ 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, ~~C~~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

~~3.~~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. ~~The following t~~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~~	~~Extra Fine~~	~~0.10~~	~~0.004~~	~~Hatch patterns, table and section grid lines, and sheet trim lines, existing object lines and text~~
~~2, 8~~1	Fine	0.18	0.007	~~Proposed fine object lines~~Hatch patterns, sheet trim lines
2, 3, 7	Thin	0.25	0.010	~~Proposed thin object lines~~Table and section grid lines, construction details
8	Thin	0.25	0.010	Existing object lines and text
4, 9	Medium	0.35	0.0138	Proposed medium object lines, proposed text, existing ~~ROW~~Right-of-Way
5	Wide	0.50	0.020	Sheet and title block borders, sheet dividers, major title text ~~underlines~~, 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
~~10~~20	XX Wide	1.20	0.048	Drainage ~~A~~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 ~~1. 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.~~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 ~~Custom~~ Standard line type~~s~~ definitions ~~can be~~ 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 | Major Group | Minor Group | Minor Group | Status Field

Designator (1-2 Letters)	(4 Letters)	(4 Letters)	(4 Letters)	(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~~~~National CAD Standards~~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~~iscipline~~ 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 ~~P~~primary ~~S~~structures
BLIN	Baseline
BORE	Test borings
BRDG	Bridge
CABL	Cable
COMM	Communications
CTRL	Control ~~p~~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

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

3.3.05.B continued

SSWR	Sanitary sewer
STRM	Storm ~~S~~sewer
WATR	Water supply
WETL	Wetlands

Table 3.6 – MINOR GROUP

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

SECTION 4 - ELECTRONIC ~~PLANS~~DRAWINGS

3.4.01 ELECTRONIC PLAN REVIEW

~~3.4.01.A~~ The process for registering the ~~E~~engineering firm with the iPermits Customer Portal for the Office of the City Engineer Plan Review, and the electronic plan review system is called Project~~-~~Dox. 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 ~~d~~Drawings, receive comments, and receive approvals. The ~~S~~step-by-step user guide can be found here:

3.4.01.A

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

~~3.4.03~~3.5.01 REVISION PROCEEDURES

~~3.4.03.A~~3.5.01.A Revisions required during the ~~C~~construction ~~P~~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.~~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 ~~S~~sheet ~~I~~index for each plan set shall also reflect revisions with the outlined procedures.

2. Second (and Subsequent) Revisions Procedures.~~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.~~TITLE BLOCK / COVER SHEET ANNOTATION PROCEDURES~~

3.5.01.A.3 continued

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

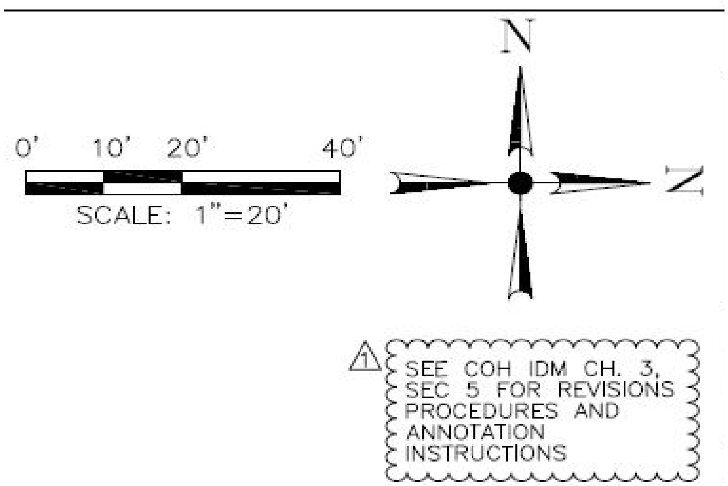
b. All information is to be filled out, to include a brief description of the revision, starting from bottom to top or right to left.

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.

~~REVISION EXAMPLES~~

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~~3.1~~ – REVISON BLOCK EXAMPLES

~~SECTION 5~~SECTION 6 - EXAMPLE PLAN SET SHEETS

~~3.5.01~~3.6.01 CAD STANDARDS APPLICABLE TO CITY AND PRIVATELY FUNDED PROJECTS

~~3.5.01.A~~3.6.01.A Provide a cover sheet for projects involving three or more design ~~d~~Drawings (excluding ~~standard~~ City of Houston standard detail sheets).

~~3.5.01.B~~3.6.01.B The ~~E~~example ~~S~~sheets in the following ~~subsections~~ 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 ~~drawings~~ sheets are listed below and shown ~~here~~in this section:

~~1.~~ Figure 3.3 - ABBREVIATONS~~Abbreviations~~

1.

~~2.~~ Figure 3.4 – LINETYPES, CELLS & STANDARD SYMBOLS~~Symbols~~

2.

~~3.~~ Figure 3.5 – COH SHEET INDEX~~Capital Projects Sheet Index~~

3.

~~4.~~ Figure 3.6 – CAPITAL PROJECTS COVER SHEET~~Capital Projects Cover Sheet~~

4.

~~5.~~ Figure 3.7 – NON- CAPITAL / PRIVATE PROJECTS COVER SHEET~~Non-Capital / Private Projects Cover Sheet~~

5.

~~6.~~ Figure 3.8 – TELECOMMUNICATION COVER SHEET~~General Notes~~

~~7.~~6.

~~8.~~ Figure 3.9 – GENERAL NOTES~~Plan and Profile~~

~~9.~~ Figure 3.10 – PLAN AND PROFILE~~Bore ole ayout~~

7.

8. Figure 3.11 – BORE HOLE LAYOUT

9. Figure 3.12 – BORE HOLE LOGS

~~10. Bore ole ogs~~

3.6.01.B continued

~~3.6.02 ABBREVIATIONS~~

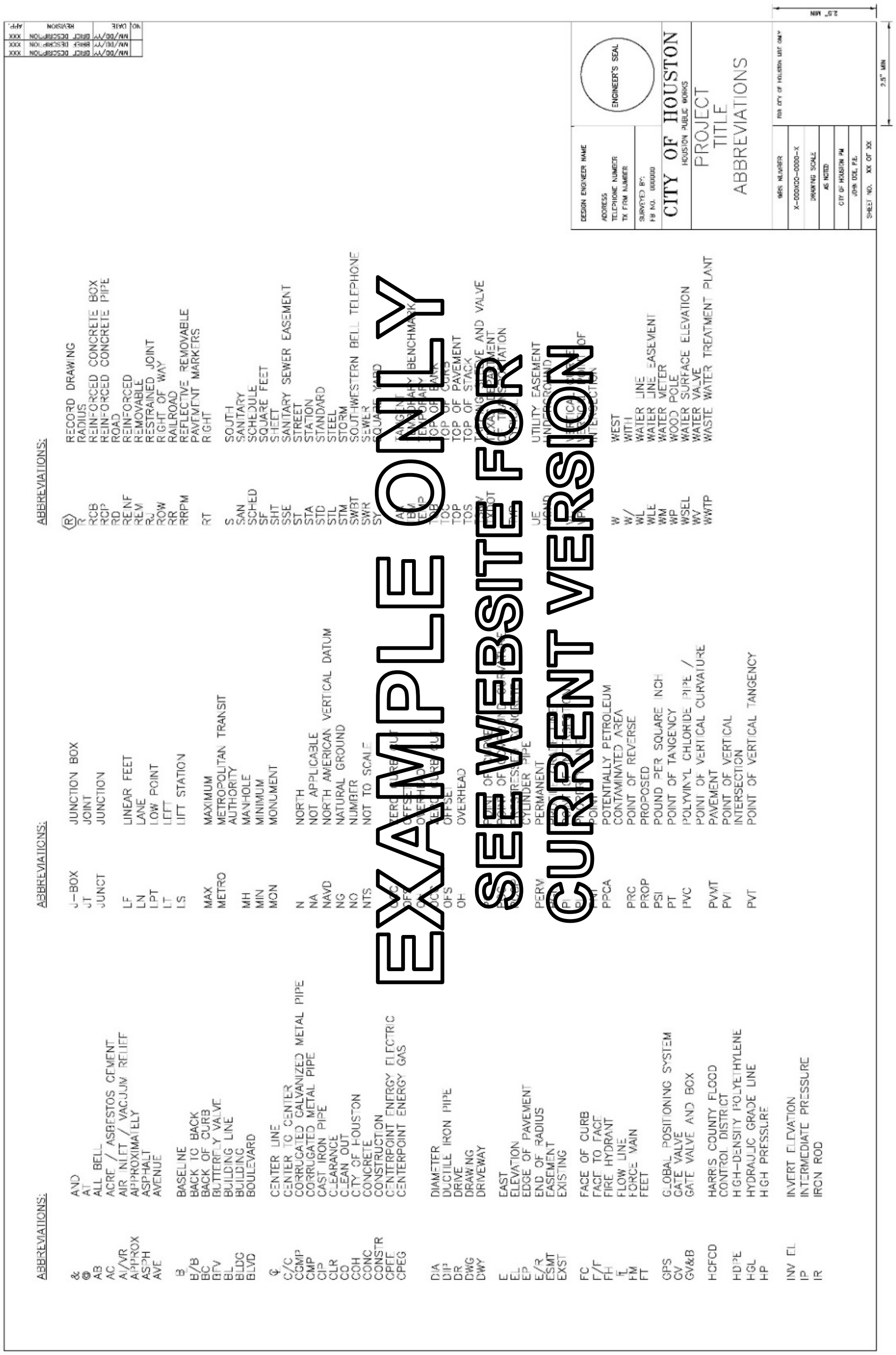


Figure 3.3~~3.2~~ - ABBREVIATONS[2]

[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

~~3.6.03 LINETYPES / CELLS~~

Figure 3.4~~3.3~~ — 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

~~3.6.04 COH SHEET INDEX~~

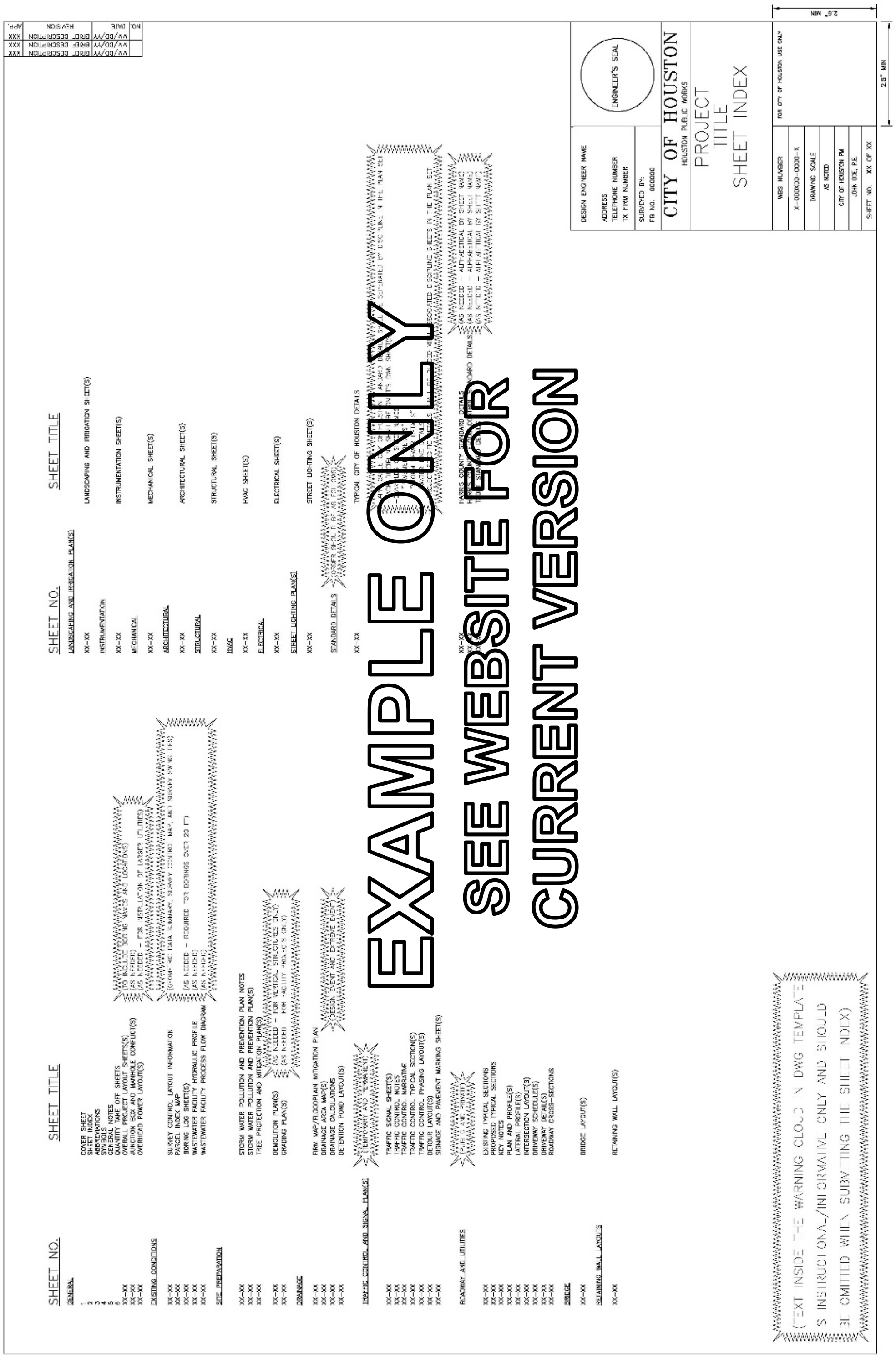


Figure 3.5~~3.4~~ – COH SHEET INDEX[4]

[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

~~3.6.05 CAPITAL PROJECTS COVER SHEET~~

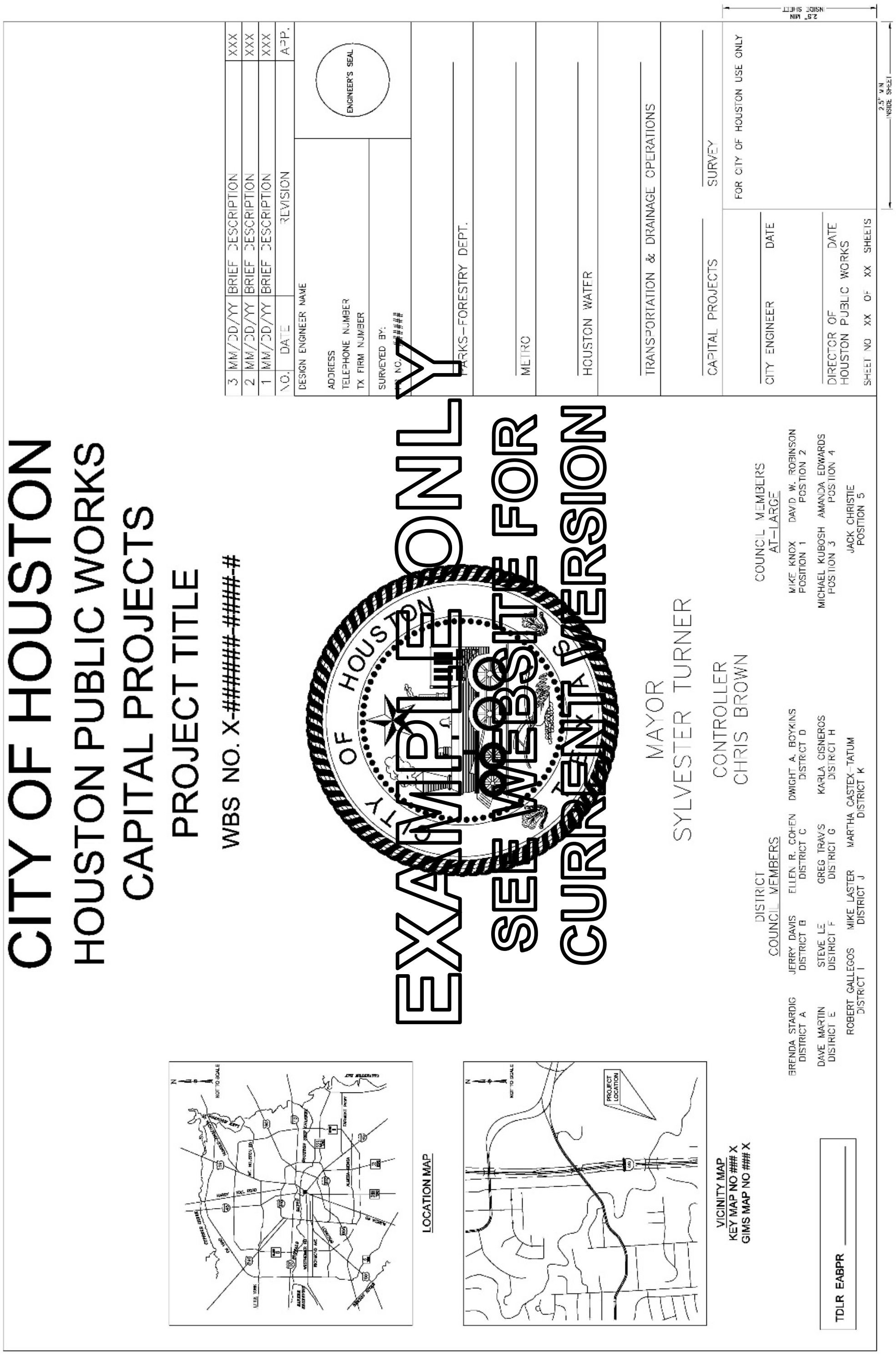


Figure 3.6~~3.5~~ – CAPITAL PROJECTS COVER SHEET[5]

[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

~~3.6.06 NON-CAPITAL / PRIVATE PROJECTS COVER SHEET~~

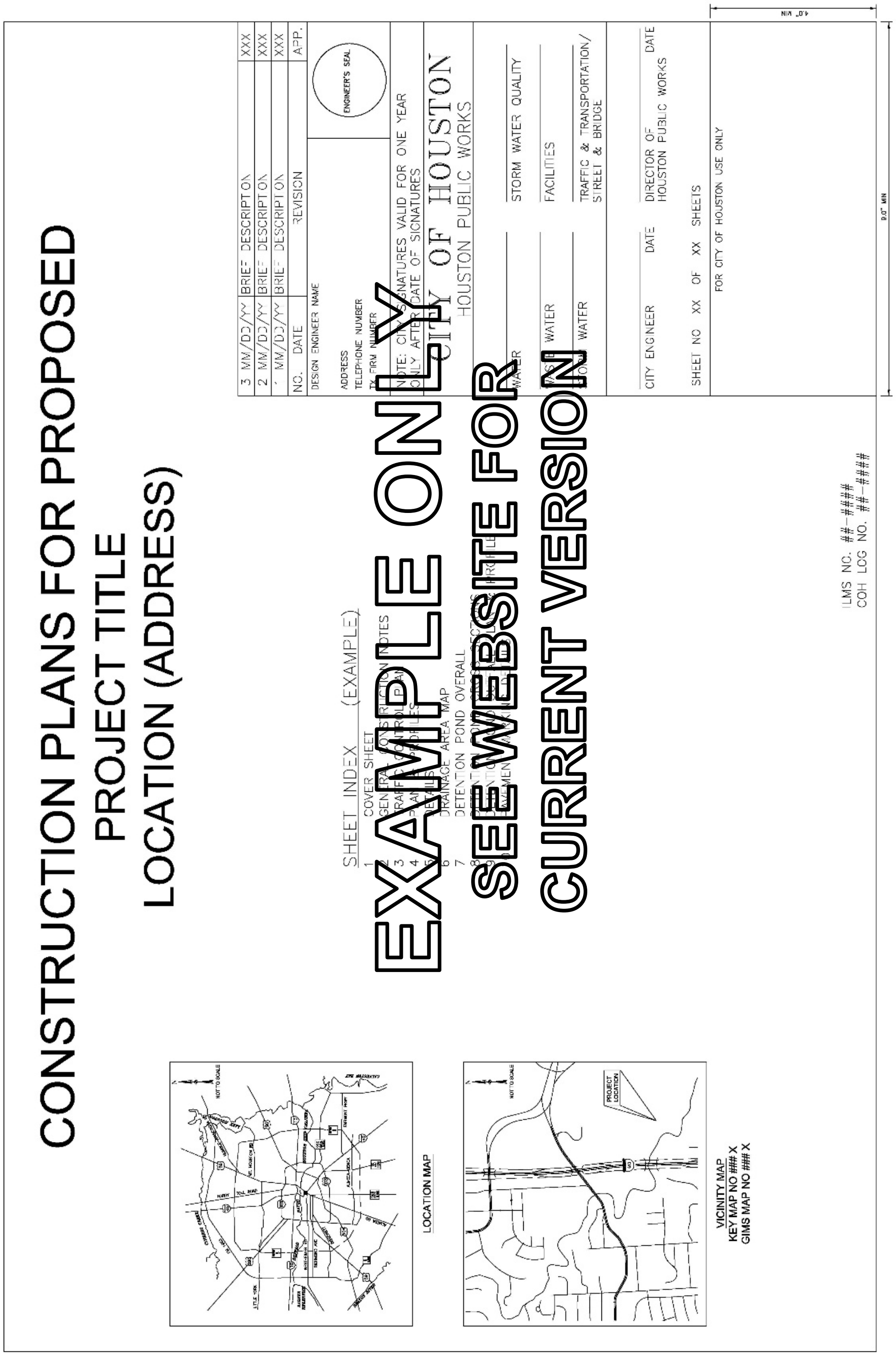


Figure 3.7~~3.6~~ – NON- CAPITAL / PRIVATE PROJECTS COVER SHEET[6]

[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

~~3.6.07 TELECOMMUNICATION COVER SHEET~~

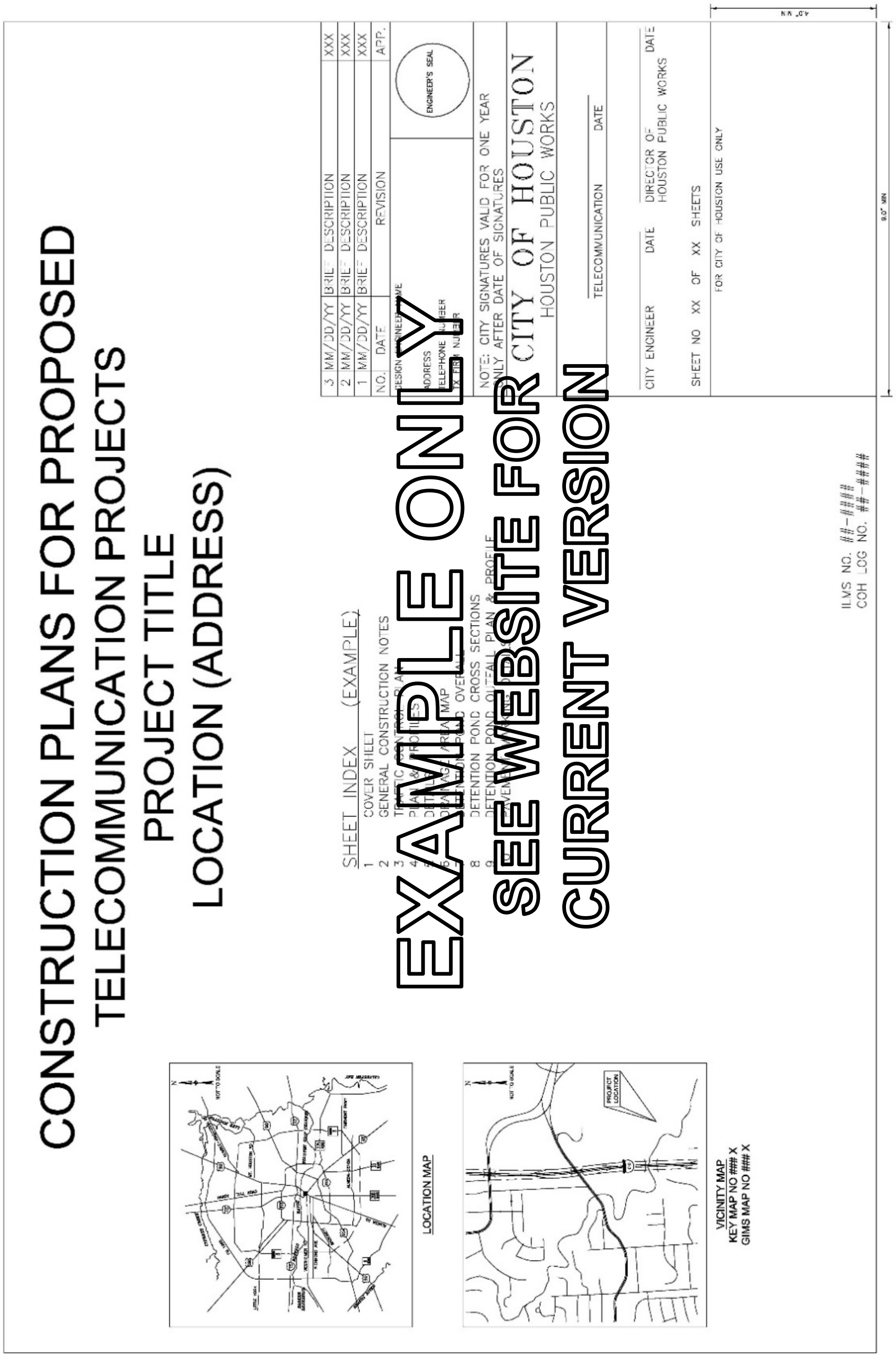


Figure 3.8~~3.7~~ – TELECOMMUNICATION COVER SHEET[7]

[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

~~3.6.08 GENERAL NOTES~~

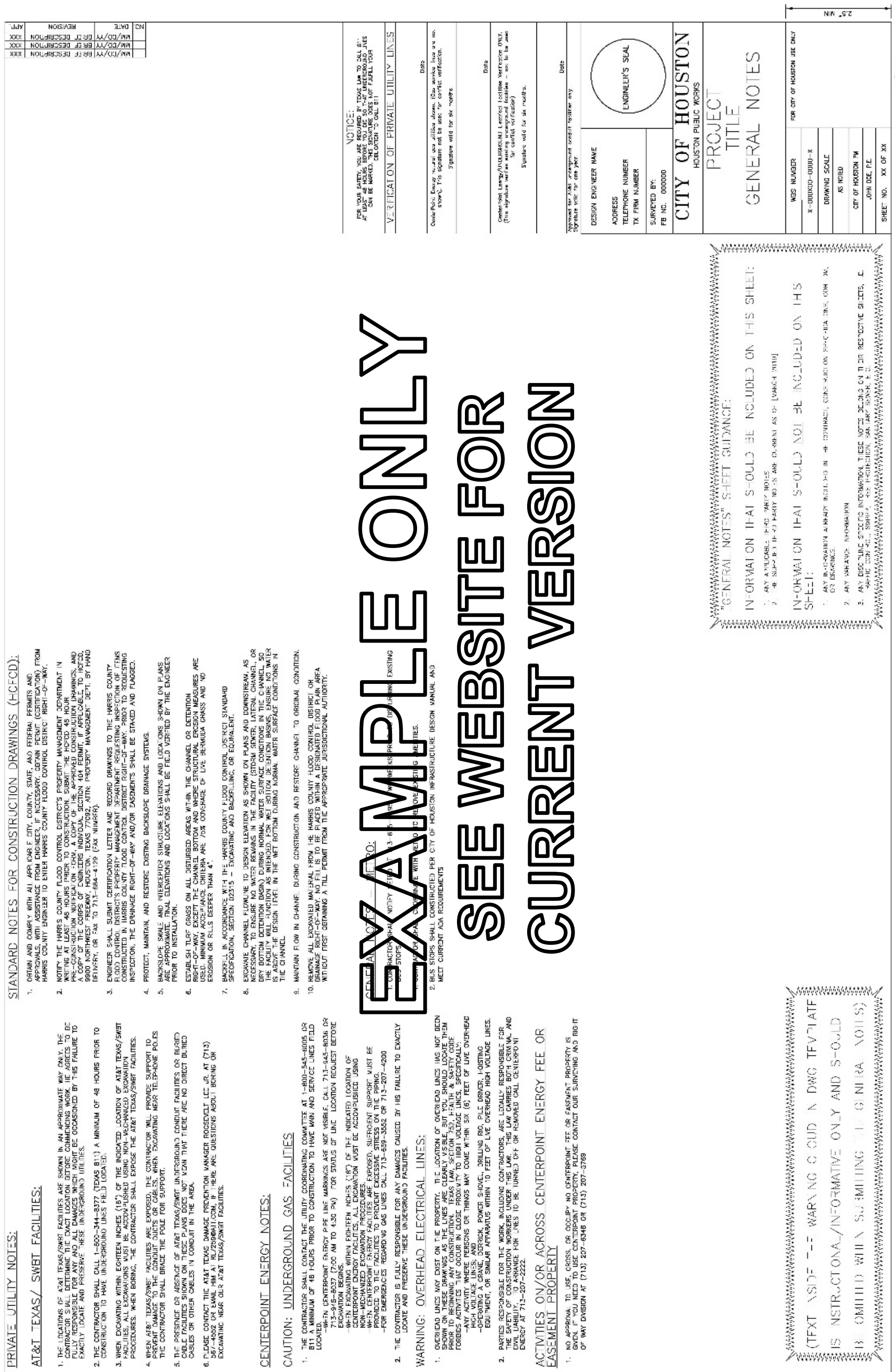


Figure 3.9~~3.8~~ – GENERAL NOTES[8]

[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

~~3.6.09 PLAN AND PROFILE~~

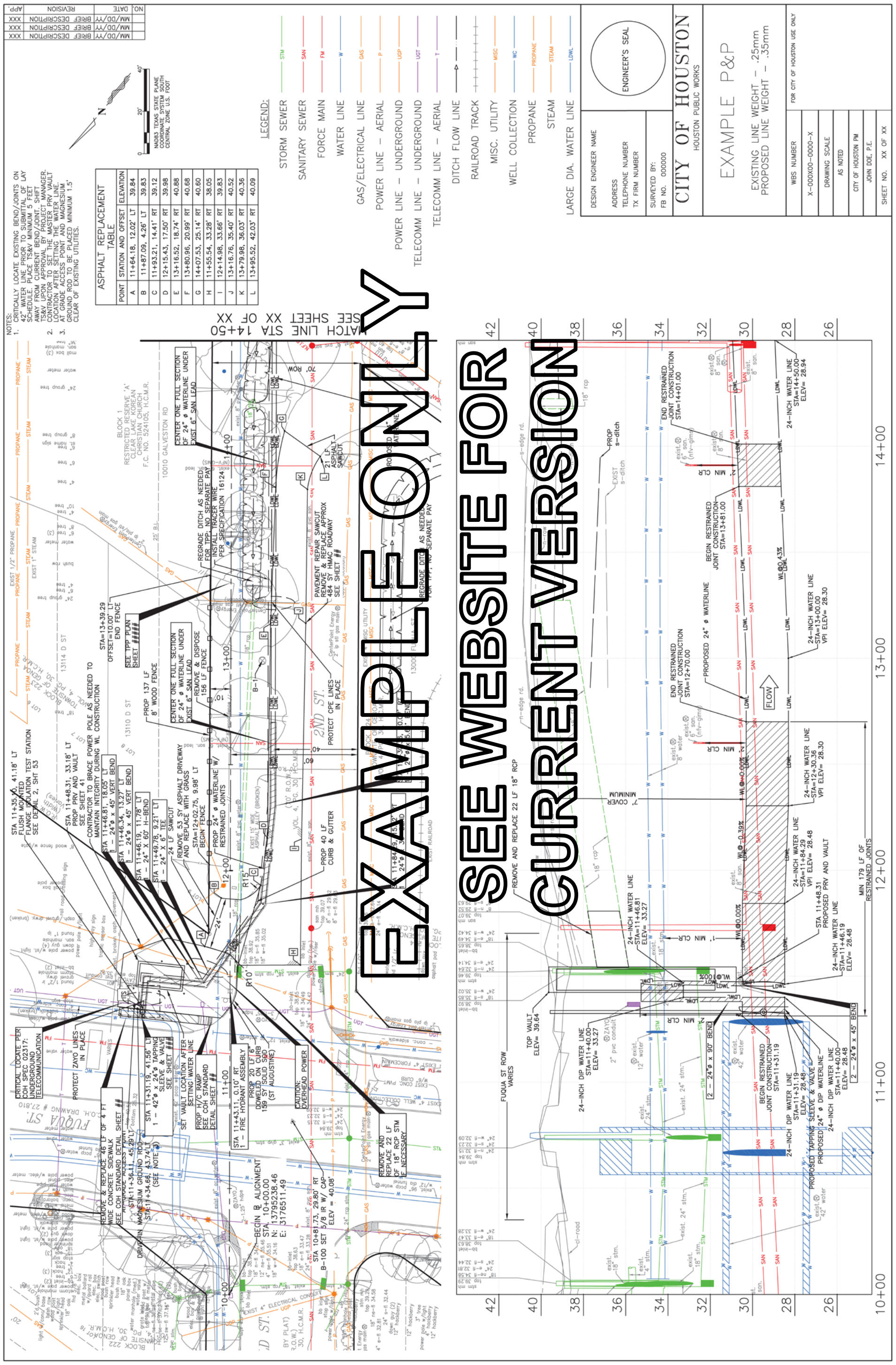


Figure 3.10~~3.9~~ – PLAN AND PROFILE[9]

[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
~~3.6.10 BORE HOLE SHEETS~~

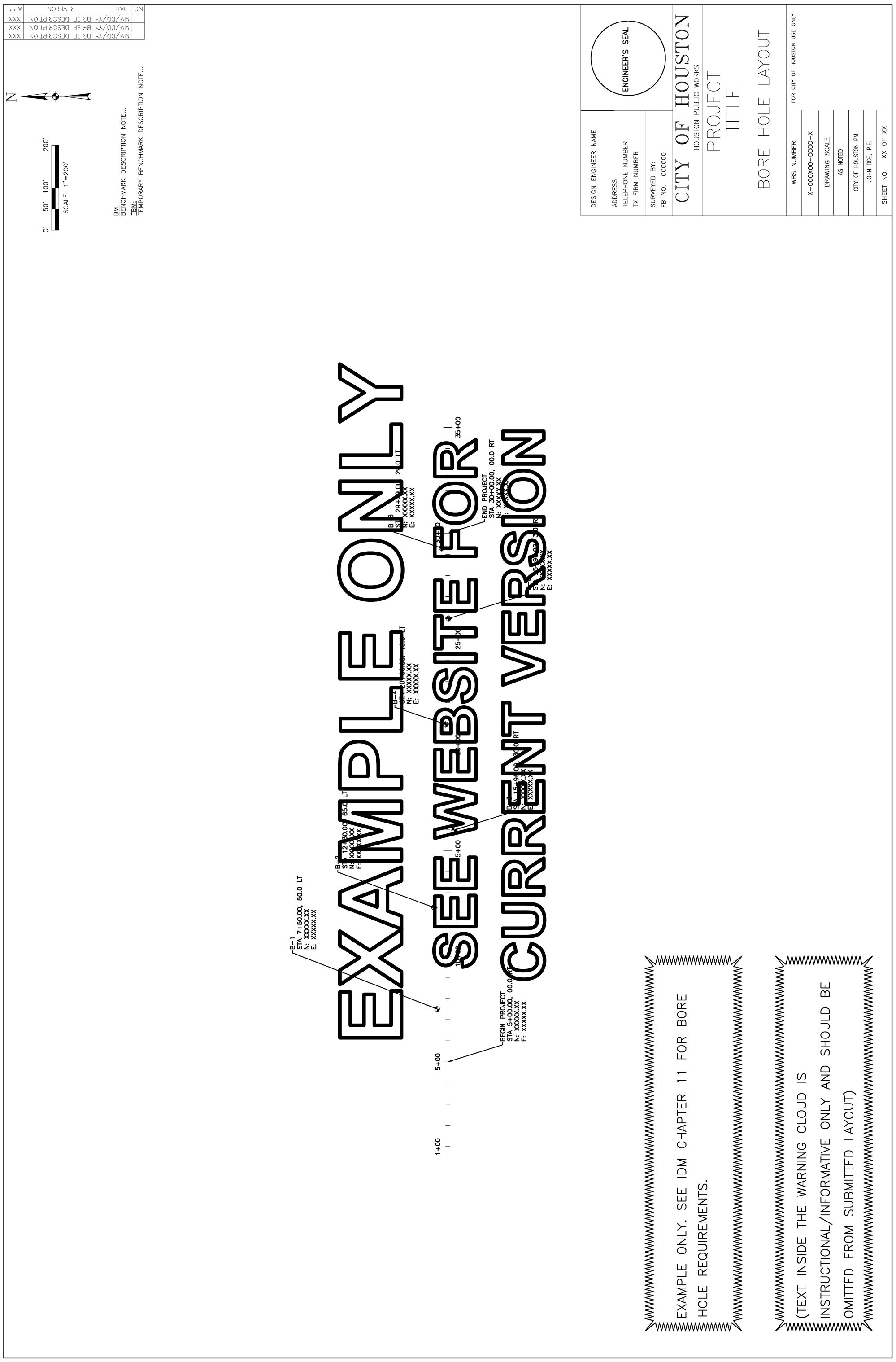


Figure 3.11~~3.10~~ – BORE HOLE LAYOUT

3.6.01.B
continued

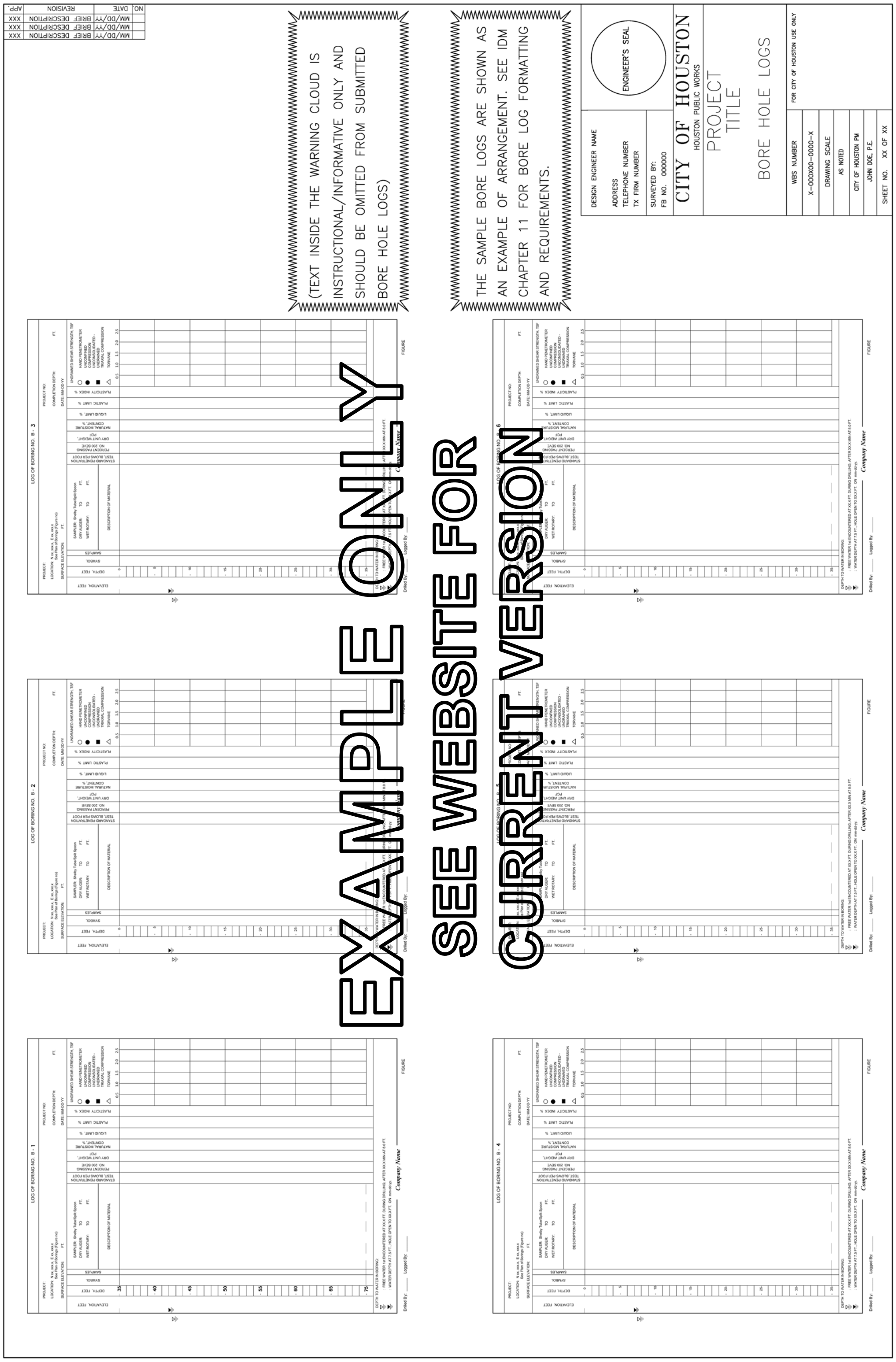


Figure 3.12~~3.11~~ – BORE HOLE LOGS

~~SECTION 6~~SECTION 7 - RESOURCES

~~3.6.01~~3.7.01 CAD TOOLS

~~3.6.01.A~~ Listed below are the files that are provided by the City for use along with all the sections of ~~C~~Chapter 3. The files can be found here: ~~:~~

3.7.01.A https://www.houstonpermittingcenter.org/office-city-engineer/design-and-construction-standards

File Name	Description	File Type
1. COH	COH ~~Custom L~~line ~~T~~types	.LIN
2. COH Line Types	COH ~~L~~line ~~T~~types	.PDF
~~2~~3. COH	COH ~~P~~plot ~~T~~table	.CTB
4. COH Std Line Weights	COH standard line weights	.PDF
~~3~~5. COH ~~Plan and Profile~~Drawing Template	COH ~~Plan and ProfileD~~drawing ~~T~~template	.~~DWG~~DWT/PDF
~~4~~6. COH Symbols	COH ~~S~~standard ~~S~~symbols	.DWG/PDF

~~3.6.01.B~~3.7.01.B HELPFUL TEMPLATES

File Name	Description	File Type
1. coh_cp_title_block	COH ~~S~~standard ~~T~~title ~~B~~block	.DWG / .PDF
2. coh_cp_cover_sheet	COH ~~S~~standard Capital Projects ~~C~~cover ~~S~~sheet	.DWG / .PDF
3. coh_sheet_index	COH ~~S~~standard ~~S~~sheet ~~I~~index	.DWG / .PDF
4. coh_abbreviations	COH ~~S~~standard ~~A~~abbreviations	.DWG / .PDF
5. coh_symbol	COH ~~S~~standard ~~S~~symbols	.DWG / .PDF
6. coh_cp_general_notes	COH ~~S~~standard ~~G~~general ~~N~~notes	.DWG / .PDF
7. coh_non_cp_cover_sheet	Non-CP/p~~P~~rivate ~~C~~cover ~~S~~sheet	.DWG / .PDF
8. coh_non_cp_title_block	Non-CP/~~P~~private ~~T~~title ~~B~~block	.DWG / .PDF
9. coh_telecomm_cover_sheet	Telecommunication ~~C~~cover ~~S~~sheet	.DWG / .PDF

END OF CHAPTER

City of Houston

Design Manual

Chapter 4

PLATTING REQUIREMENTS

Chapter 4
Table of Contents

Platting Requirements

List of Figures

Chapter 4

PLATTING REQUIREMENTS

SECTION 1 – PLATTING OVERVIEW

4.1.01 CHAPTER INCLUDES

4.1.01.A Coordination of platting requirements with the preparation of project drawings and specifications and their review and approval processing.

4.1.02 REFERENCES

4.1.02.A Chapter 42 – Subdivisions, Developments and Platting, Article II – Requirements and Procedures, latest revision.

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

4.1.03 DEFINITIONS

4.1.03.A 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.

~~4.1.01.A~~4.1.03.B Public Right-of-Way - Property dedicated or deeded for the purpose of public use.

~~4.1.02~~4.1.04 GENERAL PLATTING REQUIREMENTS

~~4.1.02.A~~4.1.04.A Platting requirements are found in Chapter 42 of the Code of Ordinances.

~~4.1.02.B~~4.1.04.B Refer to Figure 4.1~~Figure 4.1~~ and Figure 4.2~~Figure 4.2~~ for flow charts of the process by which plats and related documents are submitted, reviewed, and approved by Houston Public Works. There are three classes of subdivision plat: a class I plat, a class II plat and a class III plat. Class I plats and class II plats are optional and may be used in lieu of a class III plat if the subdivision plat meets the qualifications of Sec. 42-23 b and c, Division I, Article II, Chapter 42, of the Code of Ordinances. Class I and class II plats do not propose the creation of any new streets; nor propose the dedication of any easements for public water, wastewater collection or storm sewer lines. A class I plat goes through an administrative review process within the Planning and Development Department. During that review questions may arise regarding the delivery of utilities that may be directed to Houston Public Works staff.

4.1.04.C continued

~~4.1.04.C~~ All class II and class III plats submitted to the Planning and Development Department will be routed to ~~the Department of~~ Houston Public Works for review.

1. All class II & III plats located within the city limits as they existed in 1870 will be routed to the office of the Chief Surveyor for review. Review will be for the following items at a minimum:

   a. Compliance with standards contained in this design manual.

   ~~a.~~b. Compliance with 22 Tex. Admin. Code § 138 (2021) and any amendments or recodifications to that statute thereafter.

4.1.04.D Design drawings (when required) shall be submitted to Houston Public Works with the name of the proposed plat clearly identified on the cover sheet. Design drawings shall be delivered in digital format as computer aided drafting file (.DWG) in accordance with Chapter 3 requirements.

4.1.04.E When the dedication of 20 feet in width or less of street Public Right-of-Way and/or sidewalk is required by separate instrument for plat approval, that dedication can be made through the submission of an easement dedication form (Form 584).

~~4.1.02.C~~4.1.04.F When the dedication of more than 20 feet in width of street Public Right-of-Way and/or sidewalk is required by separate instrument for plat approval, the Real Estate section within Houston Public Works will oversee the dedication pursuant to the process established for such dedications.

SECTION 2 – PLATTING DESIGN REQUIREMENTS

4.2.01 DESIGN REQUIREMENTS

4.2.01.A Class III Preliminary Plat

1. The level of investigation to be performed for a class III preliminary plat is to identify major development impediments to water, wastewater collection and treatment, or storm drainage that are primarily the result of constraints external to the plat itself. Such constraints include, but are not limited to:

   a. Water Lines:

      (1) Long dead-end water lines.

      (2) Single feed water lines.

      (3) Inadequate capacity or pressure to the site.

      (4) Future plans for construction of major City facilities that will impact the site.

   b. Wastewater Collection System:

      (1) Inadequate Public ~~r~~Right-of-~~w~~Way or wastewater easements.

      (2) Limited wastewater service capacity for the area.

      (3) Future plans for construction of major City facilities that will impact the site.

   c. Storm Drainage System:

      (1) Drainage outfall severely under capacity.

      (2) Encroachment into flood-prone areas or floodway.

      (3) Storm water detention or diversions of watershed drainage that impact the property.

      (4) Future plans for construction of major City facilities that will impact the site.

2. Houston Public Works will review class III preliminary plats and take one or more of the following actions:

   a. Pose no objection to the plat.

4.2.01.A.2 continued

b. Request a meeting with the applicant to discuss design and construction requirements.

c. Request specific additional information, easements, or improvements to the plat or the land within the purview of the department.

d. Request one-line drawings be submitted prior to detailed engineering drawings and final plat submittal.

3. Approval of a preliminary plat by Houston ~~Public Works~~Planning Commission does not infer approval of proposed infrastructure. Review of infrastructure will take place upon submittal of one-line drawings, if required, which may occur after preliminary plat approval and must occur prior to final plat approval.

4.2.01.B Class II and Class III Final Plat

1. Houston Public Works will review class II and class III final plats and final design drawings, easement documents, and other data. Review will be for the following items, as a minimum:

a. Compliance with standards contained in this Design Manual.

b. Adequacy of service availability for:

(1) Water

(2) Wastewater

(3) Storm sewer or storm water detention.

c. Other design standards of ~~the Department of~~Houston Public Works ~~and Engineering~~.

4.2.01.C Comments resulting from reviews described in ~~Paragraphs~~ Articles 4.2.01.A and 4.2.01.B will be reported to the Planning and Development Department for inclusion in CPC 101 Form.

4.2.02 DESIGN ANALYSIS

4.2.02.A For plats of land located inside the city limits, review of final design drawings and other documents required by Houston Public Works for final plat approval will address the following:

1. Resolution of conflicts with existing and proposed utilities.

2. Layout of water lines for maximum circulation of water. The pattern shall

4.2.02.A.2 continued

allow at least two sources of water to be constructed within the ~~p~~Public ~~r~~Right-of-~~w~~Way or permanent easement. Side lot easements shall meet the requirements of Chapter 5, Easement Requirements, and Chapter 7, Water Line Design Requirements.

3. Adequate capacity in water and wastewater facilities to be utilized. The City may require a current letter of utility commitment prior to approval of a plat.

4. Adequacy of drainage facilities.

5. Sizing and identification/designation of easements within the plat and required easements outside the plat boundary.

6. Recordation of required off-site easements or lift station sites, their depiction on the site plan, and submittal to the City of record documents.

4.2.02.B For plats of land located outside the city limits, review of final design drawings and other documents required by Houston Public Works for final plat approval will address all items in ~~Paragraph~~ Article 4.2.02.A plus the following:

1. When appropriate, a letter from the municipal utility district's president or board or from the property owner stating that all off-site easements that are not immediately obtainable (for example: those crossing fee strips, rail roads, or other areas under eminent domain) are in progress and that it is the intention of the municipal utility district or property owner to complete the acquisition of such easements. The letter will be accompanied by a certified survey plat and legal description of such easements.

2. That separately platted tracts requiring service are or will be directly served by public utilities located in or abutting ~~p~~Public ~~r~~Rights-of-~~w~~Way~~s~~ or permanent access easements with overlapping public utility easements.

3. That necessary contracts and documents for inside the city limit and outside the city limit are approved and signed.

4. For a plat that includes portions both inside and outside the city limits and where there will be an imminent need for utility services, a current letter of utility commitment may be required prior to approval.

END OF CHAPTER

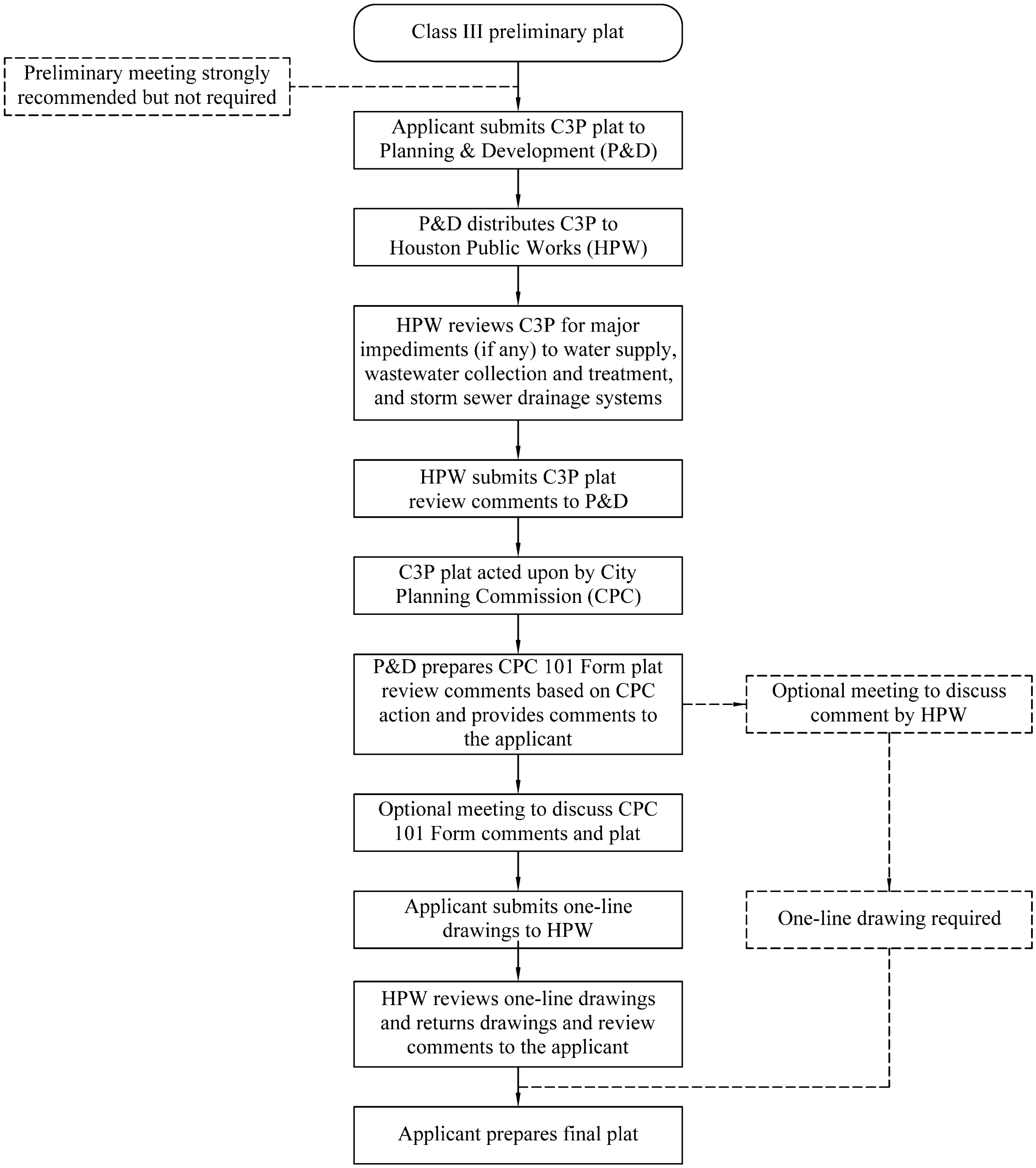


Figure 4.1 - CLASS III PRELIMINARY PLAT

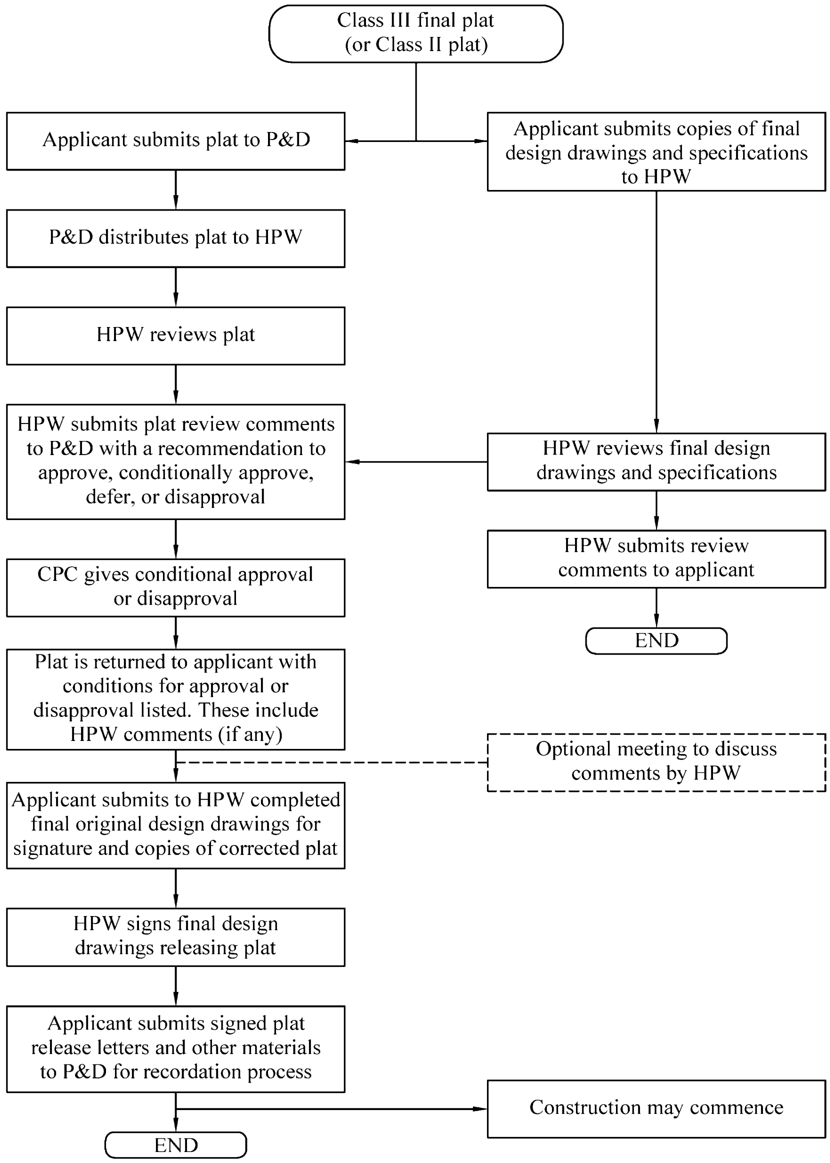


Figure 4.2 - CLASS III FINAL PLAT (OR CLASS II PLAT)

City of Houston

Design Manual

Chapter 5

EASEMENT REQUIREMENTS

Chapter 5
Table of Contents

Easement Requirements

SECTION PAGE

List of Tables

List of Figures

Chapter 5

EASEMENT REQUIREMENTS

SECTION 1 – EASEMENT DESIGN OVERVIEW

5.1.01 CHAPTER INCLUDES

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

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

5.1.02 REFERENCES

~~Utility Coordination Committee (UCC) for the Metropolitan Area-Typical utility location in 10-foot and 14-foot-wide easements, back-to-back lots, and perimeter lots.~~

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~~s~~ - Area~~s~~ 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.A~~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

~~5.1.04~~5.2.01 GENERAL DESIGN REQUIREMENTS

~~5.1.04.A~~5.2.01.A Where public utilities are located in, along, across or adjacent to private drives, private streets or ~~p~~Permanent ~~a~~Access ~~e~~Easements in platted single family residential lot subdivisions; such drives, streets or ~~e~~Easements shall have an overlapping ~~p~~Public ~~u~~Utility ~~e~~Easement to provide access and maintenance rights. Public ~~u~~Utility ~~e~~Easement rights shall be superior to ~~p~~Permanent ~~a~~Access ~~e~~Easement rights allowing the City ingress and egress for maintenance of utilities.

~~5.1.04.B Easements for electrical and gas lines must comply with requirements of the UCC and are not covered under this Design Manual.~~

5.2.01.B Easements are to be defined and submitted as part of the ~~recordable~~ 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.

~~5.1.05~~5.2.02 QUALITY ASSURANCE

~~5.1.05.A~~5.2.02.A ~~Recordable~~ Recorded plats and metes-and-bounds descriptions of ~~e~~Easements must be prepared under the direction of a Registered Professional Land Surveyor. The surveyor must seal, sign, and date documents prepared under ~~his~~ the surveyor's supervision.

~~5.1.06~~5.2.03 PLAT AND EASEMENT REQUIREMENTS

~~5.1.06.A~~5.2.03.A Requirements for Platted Easements.

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

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

   a. Where no ~~e~~Easements are required outside the plat boundary, follow the same requirements as for plats inside ~~c~~City limits given in ~~Paragraph~~Article 5.2.03.A.1~~5.06A.1~~.

   b. Where ~~e~~Easements are to be dedicated outside the plat boundary or through property under different ownership, follow the instructions in ~~Paragraph~~ Article 5.2.03.A.1~~5.06A.1~~ for plats inside ~~c~~City limits and the following additional requirements ~~following~~:

      (1) Submit a copy of the recorded instrument creating the ~~e~~Easement or a metes-and-bounds description and a map of the ~~e~~Easement, along with a letter from the ~~M~~municipal ~~U~~utility

5.2.03.A.2.b continued

~~D~~district ~~B~~board or property owner stating the intent to obtain or dedicate necessary ~~e~~Easements. The Easement instrument shall be recorded prior or simultaneously to recordation of the plat.

(2) All off-site ~~e~~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 ~~e~~Easements must be established between the two documents. Off-site ~~e~~Easements must be recorded prior to recordation of the plat.

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

~~3.~~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.

~~5.1.06.B~~5.2.03.C Additional ~~R~~requirements for Easements ~~D~~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 ~~e~~Easement to the City shall furnish the City with a ~~M~~metes & ~~B~~bounds description and map, signed and sealed by a Texas Registered Professional Land Surveyor, showing the ~~e~~Easement and its location.

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

5.2.04.C.1 continued

~~5.1.04~~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.

~~5.1.04.A~~5.2.04.C Easements for Water Lines and Appurtenances.

1. Water Lines.~~:~~

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

b. ~~When possible, e~~Easements should be contiguous ~~-~~with ~~p~~Public ~~r~~Rights-of-~~w~~Way.~~-~~

c. ~~For w~~Water line Easements that ~~located not~~cannot be ~~adjacent~~ contiguous ~~to~~with ~~p~~Public ~~r~~Right~~s~~-of-~~w~~Way shall meet all of the following criteria:

(1) ~~shall have a m~~Minimum ~~water e~~Easement width shall be equal to twice the water line diameter plus the depth ~~of~~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

~~(1)~~(3) Minimum ~~but~~ Easement width shall not be less than 20~~-~~-feet or as required by Table 5.1 for large diameter water lines ~~on water line across open country (acreage) or commercial reserve~~.

~~b.~~d. Provide ~~a~~All-~~w~~Weather ~~a~~Access for water line ~~e~~Easements not contiguous with ~~p~~Public ~~r~~Right-of-~~w~~Way, unless one already exists.

e. Proposed ~~For~~ water lines located within an Easement contiguous with~~outside of~~ the street ~~p~~Public ~~r~~Right-of-~~w~~Way or Public Utility Easement that is contiguous with street Public Right of Way:

~~The easement shall be contiguous to the street right-of-way, or contiguous to a public utility easement that is contiguous to the street right-of-way.~~

(1) Small Diameter Water Lines.

(a) ~~The minimum width of easement f~~For lines 12-inches in diameter and smaller, the minimum Easement width shall be ~~10~~ 15-feet. The centerline of the pipe shall be located 5-feet from either Easement Boundary.

(b) ~~, and f~~For lines 16-inches to 20-inches in diameter ~~and larger~~, 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.

~~e.~~f. Water line Easements are required ~~F~~for proposed water lines located inside of ~~p~~Public ~~r~~Right-of-~~w~~Way~~,~~ if the exterior of the water line pipe is located ~~less than~~within 5~~-~~-feet ~~from~~of the Public ~~r~~Right-of-~~w~~Way.~~, lines,~~ ~~t~~The Easement shall be contiguous with the Public Right-of-Way~~outside edge of a water line~~and the ~~easement~~Outer-Easement Boundary shall be located the following distance from the Public ~~r~~Right-of-~~w~~Way~~line as follows~~:

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

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

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

g. Water lines along ~~S~~state rights-of-way shall be installed outside of the right-of-~~-~~way in a separate contiguous ~~e~~Easement. Width of ~~e~~Easements shall be as provided in ~~Paragraph~~ Article 5.2.04.C.1.e~~5.07.A.1.d~~.

h. No back-lot ~~e~~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.

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

5.2.04.C.1.k continued

k. When using side-lot ~~e~~Easements, such ~~e~~Easements shall be a minimum of 20-~~-~~feet in width, located on one lot or centered between two lots. If the Easement is centered between two lots, the water line ~~may~~ shall be centered within the 10-~~-~~feet of one lot ~~or centered in the easement~~.

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

~~f. Water Lines shall be located in the center of the easement, where feasible.~~

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 ~~e~~Easement for fire hydrants located outside of ~~p~~Public ~~r~~Right~~s~~-of-~~w~~Way.

b. Do not locate fire hydrants in ~~10-foot-wide~~ water line Easements or any water meter ~~e~~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 ~~p~~Public~~-~~ ~~r~~Right~~s~~-of-~~w~~Way or water line ~~e~~Easement if possible. Otherwise, they shall be set in a minimum 5-foot by 5-foot sized separate water meter ~~e~~Easements contiguous with ~~p~~Public ~~r~~Right-of-~~w~~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. ~~The minimum size of water meter easements contiguous with public right-of- way for three-inch through six-inch meters shall be 10-feet by 20-feet and for eight-inch and larger meters shall be 15-feet by 25-feet.~~

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 ~~e~~Easements shall be located contiguous with ~~p~~Public ~~r~~Rights-of-~~w~~Way unless approved by the City. Access ~~e~~Easements a minimum of 15~~-~~-feet wide will be required when not contiguous with a ~~p~~Public ~~r~~Right-of-~~w~~Way.

5.2.04.C continued

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

~~5.1.04.B~~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.

~~1.~~2. ~~Wastewater Collection~~Gravity Sanitary Sewer Lines.~~:~~

a. Easements adjacent to ~~p~~Public ~~r~~Rights-of-~~w~~Way, ~~e~~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.

5.2.04.D.2 continued

b. Gravity ~~S~~sanitary sewer ~~e~~Easements or other combined ~~e~~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 ~~F~~floodplain ~~F~~fill ~~E~~elevation, whichever is greater; but not less than 25~~-~~-feet. The qualifying conditions are:

~~(4)~~(1) Runs through commercial reserves or across open country (acreage);

~~(5)~~(2) Serves other existing or proposed platted commercial reserves or non-platted acreage tracts; ~~and~~or

~~(6)~~(3) Is not immediately adjacent to ~~p~~Public ~~r~~Rights-of-~~w~~Way, ~~e~~Easements, or fee strips, including those owned by Harris County Flood Control District, CenterPoint Energy, and pipeline companies.

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

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

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

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.a2.

~~e.~~g. Easements described in ~~Paragraphs~~ Articles ~~5.07B.2.a~~ 5.2.04.D.2.a through 5.2.04.D.2.f~~5.07B.2.f~~, and Article 5.2.04.D.3 ~~3~~ shall be open-ended ~~e~~Easements in conformance with City Code~~s,~~ of Ordinances and ~~P~~planning ~~R~~requirements. Such open-ended sanitary sewer ~~e~~Easements shall be extended if necessary and shall be fully connected at both ends to public facilities including existing or proposed:

(1) Street Public ~~road r~~Rights-of-~~w~~Way

(2) Wastewater treatment plant sites

(3) Wastewater pump station sites

Public ~~u~~Utility ~~e~~Easement of adequate size for maintenance access.

5.2.04.D.3 continued

Force Mains:

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

b. Force mains located in ~~e~~Easements adjacent to ~~p~~Public or Semi-Public ~~r~~Right~~s~~-of-~~w~~Way shall have a minimum ~~e~~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.

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.~~:~~

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

~~5.1.04.C~~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 ~~p~~Public ~~road r~~Rights-of-~~w~~Way or ~~p~~Permanent ~~a~~Access ~~e~~Easements with overlapping ~~p~~Public ~~u~~Utility ~~e~~Easements in accordance with Chapter 6, Utility Locations.

b. ~~Storm sewers shall have a minimum 20-foot-wide easement. In the event of extreme depth or large sewers, additional width may be required to allow for proper maintenance operations.~~ The minimum Easement width required to install, operate, and maintain storm sewers are summarized in Table 5.2.

~~(1) Maintenance operations require an easement width equal to the storm sewer width plus the depth rounded up to the nearest multiple of 5-feet.~~

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 ft Easements.~~

~~(2) Storm sewer 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 ft for sewers that are less than or equal to 15 ft in depth. For storm sewers greater than 15 ft 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 ft.~~

~~(3) For storm sewers at depths greater than 15 ft, add an additional 15 ft 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.~~

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.

~~(1)~~ 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.

(3)

5.2.04.E.1 continued

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

~~c. Storm Sewers shall be centered within the limits of the easement.~~

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 ~~e~~Easements shall be dedicated to the developer, owner, or water district.

b. Such ~~e~~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 ~~r~~Right-of-~~w~~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.

~~5.1.04.D~~5.2.04.F ~~Easements for~~ Combined Storm and Sanitary Sewer Easements:

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

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

   a. Combined Easement width~~s~~ shall be as specified in Article 5.2.04.D.2.b and Article 5.2.04.E.1.b~~5.07.C.1.b for storm sewer lines~~, whichever is greater.

   b. The centerline~~s~~ of sanitary sewer ~~mains, trunks~~lines~~,~~ or force mains shall be located not less than 10--feet from the edge of the Easement Boundary~~in at least half the width of the easements defined in Paragraph 5.07B.1, but not less than 10 feet from the edge of the easement~~.

   ~~a.~~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.

   ~~b. The centerline of sanitary sewers on the outside of combined storm and sanitary sewer easements adjacent to public or semi-public rights-of-way, shall be located in at least half the width of the easement defined in Paragraph 5.07B.1.d, but not less than 10 feet from the outside edge of the easement.~~

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

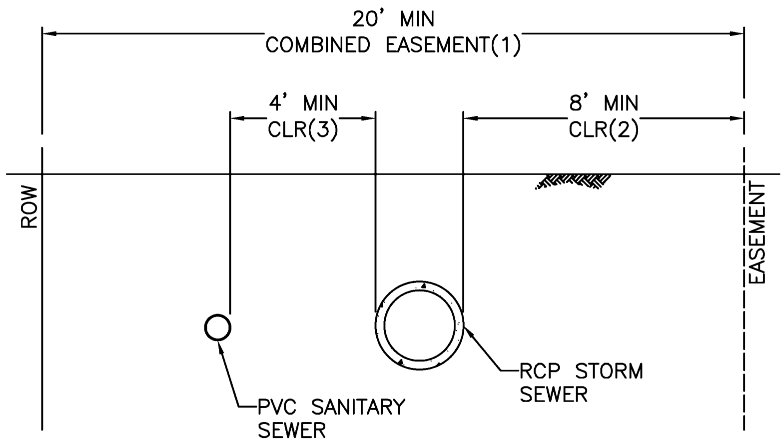
   ~~c.~~a. Combined Easement width shall be as specified in Article 5.2.04.E.1.b -or a minimum width equal to the depth of the proposed sanitary sewer line, whichever is greater.

   b. When 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.

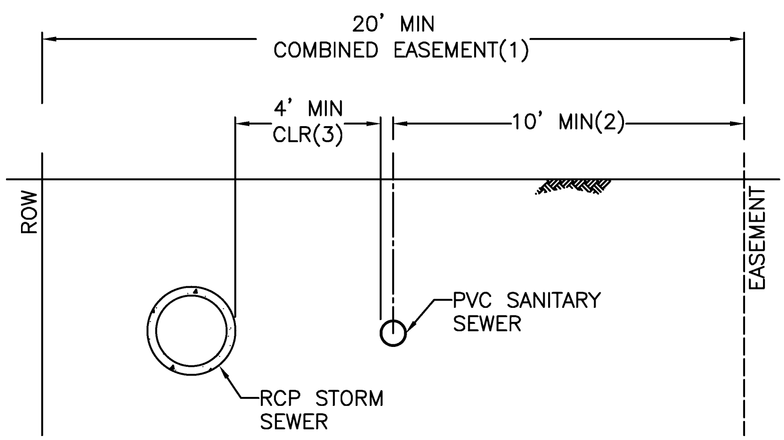
   c. See Figure 5.1 for an example to be used as a visual aid for these requirements. Figure 5.1 is not a substitute for the requirements in this section.

~~5.1.04.E~~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 7

WATER LINE DESIGN REQUIREMENTS

Chapter 7
Table of Contents

Water Line Design Requirements

SECTIONS PAGE

Water Line Design Requirements List of Tables

Chapter 7

WATER LINE DESIGN REQUIREMENTS

SECTION 1 - WATER LINE DESIGN OVERVIEW

7.1.01 CHAPTER INCLUDES

7.1.01.A Criteria for the design of water lines.

7.1.01.B Criteria for 24-inch and larger water lines are in Appendix A of this Chapter.

7.1.02 REFERENCES

7.1.02.A American Water Works Association (AWWA).

7.1.02.B National Sanitation Foundation (NSF).

7.1.02.C Uniform Plumbing Code, latest edition and local amendments that the City has adopted[1].

7.1.02.D AASHTO LRFD Bridge Design Specifications, The American Association of State Highway and Transpiration Officials (AASHTO), latest edition.

7.1.02.E Refer to the list of references in Chapter 1, General Requirements.

7.1.02.F City of Houston IDM Chapter 13, Geospatial Data Deliverables~~GIS Digitization Standards~~.

7.1.02.G Vipulanandan, C., and Qiao, W. (2010). *Small Diameter Water Pipelines: Performance, Maintaining, Monitoring and Repairing* (Report No. CIGMAT/UH 1/9-2010).

7.1.03 DEFINITIONS

7.1.03.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.

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

~~7.1.02.G~~7.1.03.C 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]Refer to weblink for requirements: https://www.houstonpermittingcenter.org/building-code-enforcement/code-development#agency-links-416

SECTION 2 - WATER LINE DESIGN REQUIREMENTS

7.2.01 DESIGN REQUIREMENTS

7.2.01.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.

7.2.01.B Lines.

1. Locate water lines within street rights-of-way, permanent access easements with overlapping public utility easements, easements adjacent to street rights-of-way, or recorded water line easements:

    a. Pipe with 2-inch diameter is allowed only in rehabilitation projects where tie- ins to existing 2-inch lines are necessary.

    b. Pipe with 4-inch diameter may be used within cul-de-sacs less than or equal to 200 feet in length.

    c. Pipe with 6-inch diameter may be used if the line is less than 1000 feet in length and interconnected between 2 lines which are 8-inch diameter or larger, or if the 6-inch line terminates in a cul-de-sac and meets the additional rule of this chapter. Only one fire hydrant or flushing valve is allowed on any length of 6-inch diameter line.

    d. Use minimum 8-inch diameter pipe for lines over 1000 feet long or when 2 or more fire hydrants or flushing valves are required.

    e. Pipe sizes are determined by the Professional Engineer and approved by the City. A minimum of 12-inch diameter pipe shall be used when parallel to a Railway Transit corridor for more than 300 feet.

    f. The terminus of the line shall end with a plug and clamp.

    g. Dead-end water lines are prohibited, and existing dead-end water lines within reasonable reach of the proposed project shall be evaluated for connection and dead-end elimination.

        (1) Water lines within cul-de-sac:

        When adjacent cul-de-sacs are present, extend water line to the adjacent cul-de-sac under the following conditions:

        (a) Obtain an appropriately sized water line easement as per City requirements.

7.2.01.B.g.(1) continued

(b) Install water lines, with restrained joints, and inside a continuous steel pipe casing, from ROW to ROW, where appropriate. Continuous casing cannot contain horizontal or vertical deflections.

(c) Extend water line along both sides of the street and loop.

(d) The diameter of the looped water line shall be of the same size as the diameter of water line perpendicular to the cul-de-sac. The diameter of the water line shall not exceed 8- inch within the cul-de-sac without approval from OCE.

(e) Discontinue water line along perpendicular street between entry and exit locations of the looped water line so that water flow will occur down one side of cul-de-sac street and up the other side without disrupting the continuity of water flow.

(f) Fire hydrants shall be spaced as if only a single line existed.

h. Water lines that cannot be installed in the ROW and are installed in side-lot easements must have restrained joints and be inside a continuous pipe casing from ROW to ROW. Continuous casing shall not contain horizontal or vertical deflections. Diameter of pipe shall not exceed 12 inches. Provide isolation valves within 100 feet of each end.

i. Offsets through intersections shall span the width of the intersection whenever practical.

j. Fittings through intersections shall be placed outside pavement limits whenever possible.

k. The water line alignment shall have the minimum number of bends and appurtenances as is reasonable for the project scope.

l. Restrained joint calculations shall be utilized at all such locations governed by Best Practices and shall be provided to the City upon request.

m. A continuous trace wire, such as high strength copper-clad steel for open trench installations, and extra high strength copper-clad steel for trenchless installation, shall be specified for new non-metallic water lines according to the standard details and specifications.

n. Customers shall not take pump suction directly from City water lines. Design appropriate backflow device or approved air gap downstream of the meter and show in the plans.

7.2.01.C Location, Depth of Cover, and Separation Requirements

Table 7.1 - WATER LINE LOCATION WITHIN A STREET RIGHT-OF-WAY

RIGHT-OF-WAY WIDTH & EXISTING OR ANTICIPATED CURB FACE TO FACE PAVING WIDTH		8" & SMALLER (1) (2) (4)	12"THRU 20"(1) (2) (4)
100-FOOT ROW (ALL STREETS):		8 feet	7 feet
80-FOOT ROW (ALL STREETS):		7 feet	6 feet
60-FOOT ROW:			
MAJOR THOROUGHFARE:	44 feet	5 feet	5 feet
COMMERCIAL, SCHOOL, PARK	40 feet	7 feet	6 feet
RESIDENTIAL:	27 feet	12 feet (3)	12 feet (3)
50-FOOT ROW:			
ALL STREETS:	35 feet	5 feet	5 feet
ALL STREETS:	27 feet	7 feet	7 feet

(1) The number listed below is the maximum allowable distance from the right-of-way to the nearest outside diameter of the proposed water line.
(2) The minimum distance from the right-of-way to the nearest outside diameter of the proposed water line shall be 5 feet without a water line easement adjacent to the rights-of-way (see easement requirements for less than 5 feet).
(3) Design water line for the possibility of a future 35-foot face-to-face curb-and-gutter section to replace existing streets with roadside ditches.
(4) The maximum and minimum distance from the right-of-way shall be applied in such a way as to preserve room in the right-of-way for future expansions and relocations.

1. Boulevard streets: When necessary, water lines may be located within the esplanade. The lines should be located as near the centerline of street right-of-way as possible to avoid conflict with future pavement widening.

2. Locations within an easement:. Refer to Chapter 5, Easement Requirements for minimum easements widths and water line location relative to easements. ~~Do not locate lines 16-inch diameter and larger in side lot easements. For location within side lot easements, see Chapter 5.~~

3. Water lines and their appurtenances shall have minimum horizontal clearance of 4 feet as measured from each outside wall, to adjacent utilities, other than sanitary sewer.

4. When a water line is to be placed parallel to a railway corridor, maintain minimum 30 feet horizontal clearance from centerline of nearest outside track rail.

7.2.01.C continued

5. Do not place water line appurtenances in flow lines of the roadside ditches. The nearest outside diameter of any water line shall be no closer to a building line, building foundation or building slab than 10 feet for water lines 12 inches in diameter and smaller and no closer than 15 feet for water lines 16 inches in diameter and larger.

6. Depth of cover

   a. Provide the following minimum depths of cover from the top of curb for curb- and-gutter streets or from mean elevation of the nearby ditch bottom and the nearby right-of-way for open-ditch section:

Table 7.2 - DEPTH OF COVER FOR WATER LINES

SIZE OF LINE	DEPTH OF COVER		ABSOLUTE MINIMUM(3)
	TOP-OF-CURB	OPEN-DITCH SECTION	
16-INCH & SMALLER	5 feet(2)	6 feet	3 feet(2)
20-INCH	6 feet	8 feet	4 feet(1,2)

(1) Cement stabilized embedment required.
(2) Minimum 6 feet of cover where crossing railway.
(3) Water lines installed within predominantly high plasticity, fat clay (CH) soils shall be installed with an additional 2 feet of cover beyond the absolute minimum requirements (Vipulanandan & Qiao, 2010).

   b. Deflection of joints shall not exceed the maximum deflection recommended by pipe manufacturer.

   c. No vertical or horizontal offsets or bends allowed for water lines that require continuous casings.

   d. Offsets require callouts in the profile view of the drawings that match the required calculated minimum length of the restrained joint.

   e. Use restrained joint pipe for lines 20-inch diameter and smaller with less than 4 feet or more than 8 feet of cover. The following direct bury alternates may be used:

      (1) Ductile iron pipe pressure 250 psi with approved restrained joints.

      (2) PVC pipe with integral restrained joint system, or ductile iron restrained joints fittings, epoxy lined and coated. Use AWWA C900 DR 18 for PVC restrained joints. Use 250 psi AWWA C900 DR 14 for vertical offsets.

      Use only ductile iron and PVC products listed on OCE approved products list and/or in accordance with City Standard Specifications.

7.2.01.C.6.e continued

(3) For depth of cover greater than 16-feet, use ductile iron pipe or PVC inside continuous steel casing.

(4) Water line depth greater than 20-feet shall be minimized by all practical means.

7.2.01.D Appurtenances

1. Appurtenance location shall minimize conflicts with pavement, landscaping, other structures, other utilities, and vehicular traffic.

2. Isolation Valves

   a. Spacing - set at maximum distances along the line as follows, however, use sound engineering judgement to identify placing of valves, and any locations where additional valves may be necessary to enable isolation of any given segment of the water line for maintenance.

      (1) 4-inch through 12-inch diameter - 1000 feet.

      (2) 16-inch and 20-inch diameter - 2000 feet.

   b. Location:

      (1) Normally, locate valves at street intersections along the street right-of- way lines projected across the water line. Tapping sleeves and valves are excluded from this requirement. Maintain a minimum of 30 feet from the centerline of the outside rail. Do not propose valves inside ramps or at curbs.

      (2) Isolate fire hydrants and flushing valves from the water line with a valve located in the fire hydrant or flushing valve branch, closest to the tee. This valve shall not be located in the slope or flow line of roadside ditches.

      (3) Intermediate valves, not located on the projection of the right-of-way line, shall be located on lot lines or 5 feet from fire hydrants but not set in driveways.

      (4) Locate valves a minimum of 9 feet horizontally from sanitary sewer crossings and 4 feet horizontally from other utilities crossings.

      (5) Valves located near reducers shall be located on the smaller diameter pipe.

7.2.01.D.2.b continued

(6) Provide flanged outlet and mount isolation valve directly on the flange on any branches to larger diameter water line.

c. Valve Type (Unless otherwise specified):

(1) 20-inch and smaller - Gate valves.

(2) Gate valves should be used for all meter installation.

d. Number of Valves:

(1) Total number of valves at any water line intersection shall equal total number of lines leading out from the intersection point minus one, three valves for a cross, and two valves for a tee for 20-inch diameter lines and smaller. Fire hydrant branch tees are excluded from this requirement.

3. Air Valves (Air Release, Air/Vacuum, Combination)

a. Air valves are not required on water lines 12-inch and smaller except at aerial crossings.

b. Locate air valves in a manner that provides protection from tampering and vehicular traffic.

c. Vent piping is to be located along property (lot) lines whenever feasible. Avoid locating vent piping in esplanades.

d. Locate air valves such that inlet/outlet vent piping elevation is in accordance with the City of Houston Code of Ordinances Chapter 19 Section 19-33, or four (4) feet above natural ground whichever is greater.

e. Use of air valves shall be in accordance with acceptable engineering practice and sound engineering judgement. Typical applications are:

(1) Combination valve at high points.

(2) Combination valve along long descents at 1250 to 2500 feet intervals.

(3) Combination valves along decrease in downslopes.

(4) Combination or Air Release along long horizontal runs at 1250 to 2500 feet intervals.

(5) Air/Vacuum along long ascents.

(6) Air/Vacuum along decrease in an upslope.

7.2.01.D continued

4. Fire Hydrants and Flushing Valves

   Firefighting capability is required to be at a minimum pressure of 20 psi under combined fire and drinking water flow conditions. The minimum fire flow for the residential area should be 1,500 gpm.

   a. Spacing:

      (1) Single-family residential development - 500-foot maximum spacing.

      (2) All other developments - 350-foot maximum spacing.

   b. Location in or along street right-of-way:

      (1) Locate fire hydrants primarily at street intersections.

      (2) Locate fire hydrants at point of curvature (PC) or point of tangency (PT) of the intersection curb radius, 3 feet behind curb or projected future curb.

      (3) On streets with roadside ditches, set the fire hydrants within 5 feet of rights-of-way lines.

      (4) Set intermediate fire hydrants on lot lines, as extended to pavement, when located between right-of-way intersections. These locations may be adjusted 5 feet either way to avoid driveways or obstructions. In either case, do not locate fire hydrants closer than 3 feet from curbed driveways or 5 feet from non-curbed driveways.

      (5) a. Fire hydrants may be set in the esplanade section of City streets when locations at back of curbs are not feasible. In such cases, the preferred location is 7 feet behind back of curb to provide access for parkway mower. In no instance shall the fire hydrant be closer than 3 feet from back of esplanade curb or closer than 10 feet from esplanade nose.

          b. Fire hydrants shall not be located between parallel adjacent Rail Tracts in Railway Transit Corridor.

      (6) For commercial building with fire service connections, place an additional fire hydrant on the same side of the street as the required connection. This hydrant is not counted in fire hydrant spacing.

      (7) Dedicated fire lines shall be labeled “Fire Line” in the drawings.

      (8) The fire hydrant or blowoff valve shall be located considering adequate drainage to avoid flooding during flushing.

7.2.01.D.4.b continued

(9) Do not cut, plug and abandon or relocate fire hydrants for surface improvements. Explore alternate means to prevent tapping new connections into existing water lines, including curving or local narrowing of proposed sidewalks.

c. Location of fire hydrants or flushing valves outside and adjacent to street rights-of-way:

(1) The City Fire Marshall will establish and approve the location of fire hydrants and flushing valves in apartment complexes, platted private street developments, and other multi-family developments within the City.

(2) Locate fire hydrants and flushing valves in protected, easily-accessible areas behind curb lines.

(3) For fire hydrants ~~or flushing valves~~ which are located adjacent to water lines for fire protection constructed in 10-foot wide water line easements, the fire hydrant ~~or flushing valve~~ shall be centered in a minimum 10-foot by 10-foot separate easement.

d. For commercial developments inside the City and ETJ, provide isolation valves at each end of fire loops requiring on-site fire hydrants.

e. Fire hydrants branches shall be designed to have a 5-foot bury where possible. No bends or offsets in a fire hydrant branch will be allowed. In case of conflict DIP fire hydrant leads may be used for a minimum of 3-foot of bury.

f. Fire hydrant leads shall have restrained joints.

5. Fittings

a. Normally use "all bell" (designated AB) for fittings for diameter 12-inch and smaller, unless a restrained joint (designated as RJ) is required to protect the water line from horizontal or vertical offsets. Provide calculations to determine limits of required restrained joints. Show the length of restrained joints on drawings in the profile view.

b. Provide fittings with approved restraint joints (designated as RJ) for diameters 16-inch and larger. Provide fittings with approved restraint joints for all diameters when crossing a railway. Provide calculations to determine limits of restrained joints. Show length of restrained joints on drawings in the profile view.

7.2.01.E Water Meter Service

1. Water meter service for lines in or along street rights-of-way. Locate in areas with easy access and with protection from traffic and adjacent to rights-of-way whenever possible. Do not locate meters in areas enclosed by fences. Obtain approval from OCE to locate meters within 30 feet from the center line of outside rail.

   a. Obtain water meter count from City Project Manager.

   b. Obtained water meter count shall be confirmed for accuracy in the field at the time of the post survey walk through.

   c. Label all meter line sizes in drawings as per water meter report and any modifications made as a result of the project.

   d. ~~Meters 2 inches and smaller and Shut-off valves (stop boxes): Locate in rights-of-way, water line easements, or in a minimum 5-foot by 5-foot separate water meter easement contiguous with public right-of-way. Provide concrete meter boxes for meters located under sidewalks~~ For meters 2 inches and smaller and Shut-off valves (stop boxes), provide concrete meter boxes for meters located under sidewalks. Refer to Chapter 5, Easement Requirements, for easement ~~.~~requirements.

   e. ~~Meters 3 inches to 6 inches: Locate in minimum 10-foot by 20-foot separate water meter easement contiguous with public right-of-way. Provide Plan and Profile for OCE approval.~~For meters 3 inches and larger, provide plan and profile for OCE approval. Refer to Chapter 5, Easement Requirements, for easement requirements.

   ~~f. Meters 8 inches and larger: Locate in minimum 15-foot by 25-foot separate water meter easement contiguous with public right-of-way. Provide Plan and Profile for OCE approval.~~

   ~~g.~~f. Separate tap and service lead shall be designed for each domestic meter. Meter, line size, and appurtenances shall conform to the latest edition of the Uniform Plumbing Code that the City has adopted.

   ~~h.~~g. All water meters must have the same size as of the service lines except 4-inch and 12-inch diameter service lines shall be installed for 3-inch and 10-inch water meters.

   ~~i.~~h. Irrigation meters are to be branched off the domestic service.

   ~~j.~~i. 3 inches and larger meters set in right-of-way or any placement other than the dedicated easement will require approval from the OCE.

   ~~k.~~j. Meters larger than 10 inches, or applications in potential hazardous chemical environs must be installed in an above ground meter installation assembly.

~~l.~~k. Irrigation meters will require a backflow preventer of PVB type and shall be installed 12” above the highest sprinkler head.

~~m. Dedicated water meter easements shall be placed in unpaved and porous area.~~

~~n.~~l. Water meters must be located outside of building structures.

7.2.01.E.1 continued

~~o.~~m. Both open and closed fire systems connected to the City of Houston water distribution system must be metered with a City of Houston approved fire rated meter.

(1) Open type fire systems, as defined in City of Houston Ordinance Chapter 47, must have a Reduced Pressure Zone Device (RPZ) or tank with air gap for back flow protection.

(2) Chemical injected fire systems are required to install a RPZ before injection point.

(3) Closed type fire systems, as defined in City of Houston Ordinance Chapter 47, must have a minimum double check valve backflow assembly.

~~p.~~n. Fire systems shall not be designed based on pressures obtained from fire flow tests which are indicative only as pressure at a given time; rather, with the understanding that system pressures fluctuate and that the City provides a minimum pressure of 35 psi during normal and 20 psi under combined fire and drinking water flow conditions.

2. Refer to Submittals Paragraph 7.2.02, and Drawings Paragraph 7.2.05 of this Chapter, for approval and drawing requirements for meter service leads 4-inch diameter and larger, and metered sprinkler connections.

3. For proposed apartments or townhomes in private street developments, provide one master meter sized for the entire development. Exceptions may be granted by OCE. If an exception is approved, do not interconnect multiple meters.

4. Provide a dedicated water main easement for commercial developments with public on-site water mains for fire protection or, provide fire service meters adjacent to the public right-of-way with an above ground reduced pressure zone type backflow preventer downstream of the meter for each private fire line.

5. Do not install stub outs for future water services.

6. Services 2-inches and larger shall require connections to be designed and included in plan set to be submitted to the Office of the City Engineer for review and approval.

7. Reusing of an existing water service lead will only be allowed after the inspection by HPW inspectors.

7.2.01.F Water Line Crossings

7.2.01.F continued

1. Public and private utility crossings other than sanitary sewer: Where a water line crosses another utility other than a sanitary or storm sewer, a minimum of 12 inches of vertical clearance must be maintained between the outside wall of the water line and the outside wall of the utility. If there are provisions in this manual for other clearances, the more conservative will govern.

   a. Water line crossings shall be designated with an isolation valve on both sides of the crossing.

   b. Minimum horizontal and vertical clearance from existing PCCP water lines shall be 5 feet.

   c. Minimum horizontal and vertical clearance from existing Asbestos Concrete pipes that are to remain in service shall be 4 feet.

2. Stream or ditch crossings

   a. Elevated crossings, general:

      (1) Elevated crossings shall be designed in accordance with the City of Houston Code of Ordinances Chapter 19 Section 19-33, and shall not have the bottom of the water line pipe placed lower than the low chord of the nearest adjacent bridge. Floodplain Management Office (FMO) approval required.

      (2) Water lines shall be steel pipe and shall extend a minimum of 15 feet beyond the last bend or to the right-of-way line of the crossing, whichever is greater.

   b. Elevated crossings on existing structures:

      (1) 12-inch diameter and smaller water lines supported on existing or proposed bridges, must meet the following criteria. Coordinate location of lines, in advance, with OCE.

         (a) Have adequate structural capacity.

         (b) Have sufficient clearance above bent cap elevation for installation (including air valve(s)) under the bridge.

   c. Elevated crossings on separate structures:

      (1) Use a separate elevated supporting structure for 16-inch diameter and larger water lines unless otherwise approved by OCE. Locate separate structures a minimum of 10 feet clear from other existing or proposed structures.

7.2.01.F.2.c continued

(2) Support the line on columns spaced to accommodate structural capacity of the pipeline considering deflection and loading.

(3) Base column support design on soil capacity, spacing, loading, and structural requirements.

(4) Provide sufficient span length to accommodate the cross section of future widening of the stream or ditch, if available.

(5) Provide appropriately sized air release valves at the highest point of the water line.

(6) Provide pedestrian pipe guards on elevated crossings.

(7) Elevation of the bottom of the water line shall be located in accordance with the City of Houston Code of Ordinances Chapter 19 Section 19-33.

d. Underground Crossings:

(1) Provide a minimum 5-foot clearance above top of pipe to the ultimate flow line of the ditch.

(2) Provide sufficient length to exceed the ultimate future development of the stream or ditch.

(3) Water lines shall be restrained joint pipe in continuous steel casing and shall extend a minimum of 15 feet beyond the last bend or to the right-of-way line of the crossing, whichever is greater.

(4) No water line underneath detention pond or amenity lake is allowed.

(5) Water line shall be installed with an isolation valve on both sides with a 40 foot minimum clearance from the end of casing on at least one side.

3. TxDOT and County Road Crossings

a. Extend carrier pipe from right-of-way to right-of-way.

b. Use restrained joint pipe in continuous steel casing under existing and future roadway from a point 5 feet outside of the service road or outside of pavement toward the right-of-way, to a similar point on the other side of the highway across the right-of-way. For highway or roadway crossings with open-ditch sections, extend restrained joint pipe in continuous steel casing from right-of-way to right-of-way.

7.2.01.F.3 continued

c. Where additional right-of-way has been acquired, or is being acquired, for future widening, the restrained joint pipe in steel casing shall extend to within 10 feet of each right-of-way.

4. Railroad Crossings

a. For mainline and spurline railroad crossings, the water line material shall conform to Railroad requirements and have restrained joint pipe within a continuous steel casing which extends no less than 30 feet from the center line of the outside rails within City of Houston right-of-way, and from right-of-way to right-of- way, on railroad owned property.

b. Install isolation valves on each side of rail crossings.

c. Crossings are to be made perpendicular to rail.

d. Design Engineer shall use a licensed Corrosion Engineer to evaluate pipe and casing materials and the effect to and from rail systems, and to provide any design elements which may be necessary to protect water line from corrosion

5. Oil or Gas Pipeline Crossings: Do not use metallic pipe when crossing oil or gas lines unless using a licensed Corrosion Engineer with a properly designed cathodic corrosion protection system. Maintain a minimum 2-foot vertical separation between the pipeline and water line.

6. On-site Fire Loops within Commercial Developments

a. For commercial developments inside the City and in the ETJ requesting on-site water mains, comply with the following requirements to allow maintenance and future repair operations:

(1) Do not allow placement of structures, paved parking or equipment pads over the easement.

(2) Provide 20-foot-wide longitudinal pavement joints along easement lines where the water line is located under driveway.

(3) Fire loops should be placed under the unpaved and porous area except at driveway crossings .

(4) Fire loops maybe placed in the Type 2 permanent access easement meeting all other requirements.

7.2.01.G Trenchless Construction: Use trenchless construction method by following the general criteria:

7.2.01.G continued

1. Improved streets - Use trenchless construction to cross a street regardless of surface. Trenchless length shall be computed as roadway width at proposed crossing location plus 5 feet to either side of roadway.

2. Driveways - Use trenchless construction to cross active driveways. Compute crossing length as driveways width plus 1 foot to either side. Where proposed lines are in close vicinity and parallel to culvert pipes along roadside ditch streets, the length of crossing shall be the same as the length of existing culvert plus 1 foot either end.

3. Trees - Use trenchless construction to cross within 10 feet of trees 6 inches and larger in diameter. Use an appropriate trenchless length to clear the tree canopy.

4. Transit Railways - Use trenchless construction to cross within 30 feet of center line of outside rails.

7.2.01.H Open Cut Construction:

1. Limits of open-cut trenches shall be taken into account. Engineer shall avoid encroaching into backfill of other utilities.

2. Proper shoring in accordance with acceptable engineering practice shall be considered and specified where appropriate.

7.2.01.I Additional Requirements

1. Use electrically isolated flange joints for transitions between two dissimilar metallic pipes. Electrically isolate water lines from casing pipe and supports.

2. The carrier pipeline shall extend a minimum of 1 foot beyond the end of the casing to allow flanged joints to be constructed.

3. Project schedule shall be determined with the understanding that the City's need to provide water to residents may result in denial to shutdown critical water lines during warmer peak demand months.

4. Project design shall consider the available construction zone. Change of depth of cover over existing PCCP water lines is not allowed. Any loading and vibrations near PCCP water lines shall be minimized.

7.2.01.J Connections to Existing Water Lines

1. Wet connections are normally preferred in any locations where:

   a. Existing water line is to be abandoned and a cut, plug & abandon is required to complete existing water line abandonment.

7.2.01.J.1 continued

b. Size on size connection is necessary and a full size tap is not feasible.

c. Limited work zone is available to perform a tap.

2. Tapping Sleeve and Valve connections are normally preferred when there is adequate work zone and clearances to existing utilities:

   a. To tie into an existing line that will remain in service.

   b. Connecting perpendicularly one standard pipe size smaller than the existing water line.

   c. Needed to supply water for testing. A minimum of one Tapping Sleeve and Valve connection shall be provided per contiguous project, unless another water source is available.

7.2.01.K Circulation and Flushing for Water Quality:

1. The layout of the water distribution system and appurtenances shall provide maximum circulation of water to prevent problems of odor, taste, or color due to stagnant water.

2. Provide a source of fresh water at each end or at multiple points of a subdivision. Provide ways to create circulation and place valves and fire hydrants to allow simple flushing of lines.

7.2.01.L Interconnections

1. For interconnections between utility districts outside the City, written approval must be obtained from the TCEQ and provided to the City in the design submittal.

2. A written agreement between the districts must be approved by the City and recorded in the county records and furnished to the City.

3. Set meter at the point of connection in a separate easement sized to conform to requirements of Chapter 5. Meter to conform to requirements given in the City of Houston Standard Specifications and Standard Details.

4. Customers shall not take pump suction directly from City water lines. Design appropriate backflow device or approved air gap downstream of the meter and show in the plans.

5. Requirements for installation of a meter may be waived by the City, if provisions are made in the agreement between the districts. In this event, a separate easement, sized to conform to requirements of Chapter 5, and valves shall be provided for future meter installation.

7.2.01.L continued

6. Agreement between districts shall provide for annexation of the meter site by one district and shall require the installation of a meter. The installation and full cost shall be provided by the district not annexing the meter site.

7. A connection between any public water systems and City of Houston requires written approval from TCEQ and shall be included in the design submittal to the City. If a customer has his own well or other supply, an appropriate backflow preventer or approved air gap must be installed to prevent water from flowing into City water lines.

7.2.01.M Water Lines Separation from Sanitary Sewers

1. Water Lines Parallel to Gravity Sanitary Sewers and Force Mains:

   Locate water lines a minimum of 9 feet horizontally apart, measured from outside wall to outside wall, when parallel to gravity sanitary sewers and force mains. Use the following procedure when stated separation cannot be achieved:

   a. The existing sanitary sewer shall be replaced with lined ductile iron pipe or PVC pipe meeting ASTM specifications, having a minimum working pressure rating of 150 psi or greater and equipped with pressure-type joints.

   b. The water lines, gravity sanitary sewers, or force mains, shall be separated by a minimum vertical distance of 2 feet, and a minimum horizontal distance of 4 feet, measured between the nearest outside walls of the pipes.

      Following alternate shall be used only, if the above cannot be achieved

   c. Water line or sanitary sewer shall be constructed with approved restrained joints in an approved continuous casing with at least two nominal sizes larger than the carrier pipe. The carrier pipe shall be supported at five-foot intervals with spacers or be filled to the springline with washed sand.

2. Water Lines Crossing Gravity Sanitary Sewers and Force Mains. Conform to requirements of TAC § 290.44 Paragraph (e).

   a. No protection is required if the sanitary sewer is 9 feet below the water line.

   b. For all other cases, use Table 7.3 on the next page.

7.2.01.M.2.b
continued

Table 7.3 - PROTECTION REQUIREMENTS AT WATER LINE (WL) - SANITARY SEWER (SS) CROSSINGS

	PROPOSED WATER LINE				PROPOSED SANITARY SEWER			
	OVER		UNDER		OVER		UNDER	
	EXISTING SS	PROP SS	EXISTING SS	PROP SS	EXIS TING WL	PROP WL	EXISTING WL	PROP WL
Minimum 2 feet vertical clearance	√[1]	√[1]	√	√	√[6]	√	√[1]	√[1]
Place 1 full section (min 18 ft) of WL centered at SS Crossing. Provide restrained joints on WL, spaced at least 9 ft horizontally from centerline of SS	√	√	√	√	√[6]	√		√
Place l full section (min 18 ft) of SS centered at WL Crossing. Provide restrained joints on SS, spaced at least 9 ft horizontally from centerline of WL		√			√[6]		√	√
Replace 1 full section of existing SS with pressure- rated DIP or pressure-rated PVC pipe with adapters and restrained joints centered at WL crossing	√[2,3]		√[3]		√[6]			
Provide DIP for small diameter WL (less than 24 inches), PVC pipe is only allowed if encased as per TAC § 290.44, and use restrained joints for both DIP and PVC pipe			√	√	√[6]	√		
Embed SS with CSS for the total length of 1 pipe segment plus 1 foot beyond the joints on each end	√[2,3]	√[4]	√[3]	√[4]	√[5,6]	√[4]	√[5]	√[4]
Place 1 full section (min 18 ft) of min 150 psi SS centered at WL crossing. Provide restrained joints on SS, spaced at least 9 ft horizontally from centerline of WL or encase in a joint of 150 psi pressure pipe (min 18 ft) two nominal sizes larger with spacers at 5 ft interval.				√	√[6]	√		

1. Minimum clearance is 2 feet for non-pressure rated SS and pressure rated SS (with at least 150 psi pressure rating). If less than 2 feet can not be achieved, then the line is to be encased.
2. Minimum clearance is 2 feet for non-pressure rated SS and 1 foot for pressure rated SS.
3. Required if existing SS is disturbed and/or there is evidence of leakage.
4. Not required for augered WL unless there is evidence of leakage, completely fill augered hole with bentonite/clay mixture.
5. Not required for augered SS, completely fill augered hole with bentonite/clay mixture.
6. Not allowed.
7. Both Waterline and Wastewater main or lateral must pass a pressure and leakage test as specified in AWWA C600 standards.
8. Restraint joint sections including water line protections shall be shown on profile view.

7.2.01.M continued

3. Sanitary Sewer Manholes: Provide a minimum 9-foot clearance from outside wall of existing or proposed manholes unless manholes and connecting sewers can be made watertight and tested for no leakage. If a 9-foot clearance cannot be obtained, the water line may be located closer to the manhole when prior approval has been obtained from OCE by using one of the procedures below; however, in no case shall the clearance be less than 4 feet.

    a. Water line shall be constructed with approved restrained joints in an approved continuous casing with at least two nominal sizes larger than the carrier pipe. The carrier pipe shall be supported at five-foot intervals with spacers or be filled to the springline with washed sand.

4. Fire Hydrants: Do not install fire hydrants within 9 feet of sanitary sewers and force mains regardless of construction.

5. TCEQ Rules and Regulations for Public Water Systems shall apply if they are more conservative than the requirements set forth in this manual.

7.2.01.N Restraint System

1. Concrete thrust blocks may be approved on a case by case basis and may be used in conjunction with restrained joint system as approved or required by OCE. In cases where concrete thrust blocks are utilized, at a minimum the Engineer shall include block dimensions and locations on Drawings. The proximity to other utilities and structures must be taken into account when specifying the use of thrust blocks.

2. Joint restraint shall be calculated for all fittings that require thrust restraint. Joint restraints that require calculations shall be shown on plan.

7.2.02 SUBMITTALS

7.2.02.A Conform to the following submittal requirements in addition to those of Chapter 1 - General Requirements. An electronic copy in Adobe Acrobat (.pdf) format is required with all submittals. All .pdf files shall be flattened prior to submittal to the City and shall have a minimum of 400 dpi resolution. See additional requirements in Chapter 3 for electronic drawings submitted in .pdf format.

7.2.02.B Water Line Sizes: Submit justification, calculations, and locations for proposed water lines, for approval by OCE.

7.2.02.C Water Meter Service

1. For construction inside city limits, submit an application for meter services and metered sprinkler connections, to the Taps and Meters Section, prior to construction.

7.2.02.C continued

2. Submit requests for more than one service meter for townhomes in proposed private street developments to OCE.

7.2.02.D Master Development Plan: For multiple phase developments, submit a master development plan. If within the ETJ, submit an overall district plan prior to the drawings being submitted for first phase construction.

7.2.02.E Interconnections

1. Submit to the TCEQ requests for written approval of:

   a. Connection of City water lines to serve districts or areas outside city limits.

   b. Interconnections of districts.

2. Submit copies of approvals received from TCEQ to OCE.

3. Private interconnections to City water lines 24-inch and larger are not allowed.

7.2.02.F ~~As-Builts~~Record Drawings

1. ~~Engineer shall monitor the up-keep of the As-Builts so that they are a true representation of existing conditions in the field. If Engineer has reason to believe that the As-Builts are not being meticulously and appropriately maintained by the construction team, Engineer shall notify City Project Manager.~~After the completion of construction, Engineer of Record shall prepare and submit Record Drawings in accordance with Chapter 1 – General Requirements. Use revision clouds to document significant changes in work based solely upon the marked-up As-Built Drawings, addenda, revisions, change orders and other data furnished by the contractor. In addition, include the following:

   a. ~~As-Builts must also contain a~~Any materials that were left in place by the Contractor such as shoring, or other elements~~ not expressly shown in the Drawings~~.

   b. ~~Engineer shall add the w~~Water line pipe material(s) including the type of lining and coating.~~,~~ ~~in the As-Builts by any of~~Document ~~the~~using either of the following methods:

      (1) Add the pipe material on the project Layout Sheet, in a tabular format, separated by station number when there is a change in pipe material.

      (2) If there is no project Layout Sheet, add the pipe material on the Notes Sheet, in a tabular format, separated by station number

7.2.02.F.1.b continued

when there is a change in pipe material.

(3) If there is no project Notes Sheet, add the pipe material on the Cover Sheet, in a tabular format, separated by station number when there is a change in pipe material.

(4) Label each plan and profile sheet, at the appropriate location.

c. For every different type of valve used in the project, ~~Engineer shall add~~include the water line valve manufacturer, number of turns, and direction to open~~,~~. ~~in the As-Built Drawings by either of~~Document using either of the following methods:

(1) Add the valve information on the project Layout Sheet, in a tabular format, separated by station number when there is a change in valve type.

(2) If there is no project Layout Sheet, add the valve information on the Notes Sheet, in a tabular format, separated by station number when there is a change in valve type.

(3) If there is no project Notes Sheet, add the valve information on the Cover Sheet, in a tabular format, separated by station number when there is a change in valve type.

(4) Label on each plan and profile sheet, at the appropriate location.

~~2. Engineer shall submit the As-Builts to OCE no later than two weeks following final acceptance of the project.~~

~~Private interconnections to City water lines 24-inch and larger are not allowed.~~

7.2.02.G 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.

7.2.03 QUALITY ASSURANCE

7.2.03.A Prepare calculations and construction drawings under the supervision of a Professional Engineer trained and licensed under the disciplines required by the drawings. The final design drawings must be sealed, signed, and dated by the Professional Engineer responsible for development of the drawings.

7.2.04 DESIGN ANALYSIS

7.2.04.A Water Line Sizes: Analyze system requirements to determine line sizes and obtain concurrence from the City.

7.2.04.B Water Distribution System: The system must be designed to maintain a minimum pressure of 35 psi at all points within the distribution network at flow rates of at least 1.5 gpm per connection. The system must also be designed to provide firefighting capability to maintain a minimum pressure of 20 psi under combined fire and drinking water flow conditions.

7.2.04.C Elevated Stream, Ditch, or Aerial Crossings: Prepare appropriate design calculations for the supporting structure.

7.2.05 DRAWINGS

7.2.05.A Conform to the following drawing requirements in addition to those of Chapter 3, Graphic Requirements and the City's standard water line details and Standard Specifications.

7.2.05.B Provide a cross section drawing (plan and profile showing other utilities and pavement) of branch water lines that extend perpendicularly from main water lines when:

1. Branch line extends 20 feet or more, and/or
2. Branch lines have vertical bends.
3. When proposed lines, including services larger than 2-inches, cross Railway Transit facilities.
4. Any water taps size 4" or larger.

7.2.05.C Appurtenances: Identify, describe, and enclose proposed water line and appurtenances in rectangular box on drawings. The location of all proposed water line, valves, fire hydrants, water meters and backflow preventors shall be identified and shown on drawings.

1. Valves
   a. Designate 2-inch through 16-inch gate valves with box as GV&B.
   b. Provide complete description and size for other valves.
2. Water meters, service leads, and un-metered sprinkler connections
   a. Show the location of service line tees, tapping sleeve and valves, valve boxes, and temporary plugs to be installed to serve future 2-inch diameter or larger meters.
   b. Label water meter types (domestic, irrigation, fire).
   c. Develop plan and profile sheets for 4-inch diameter and larger leads and connections.

7.2.05.D Construction Features

1. Show special construction features required to complete the project in a safe, convenient, and economical manner.

7.2.05.D continued

2. Trenchless Construction

   a. If the construction is predominately open cut, all portions and locations of the street that must be trenchless constructed shall be clearly shown on drawings. Include designation for trenchless sections adjacent to trees with 6 inches or larger diameters located within 10 feet of water line.

   b. If construction is predominately by trenchless construction:

      (1) Clearly show on drawings, areas and locations in which trenchless pits will not be permitted.

      (2) Clearly identify areas where special pipe material or offset sections are required to comply with these guidelines.

3. Do not locate horizontal bends within street intersections between curb returns or within 30 feet of the centerline of the outside rail.

4. Pedestrian Facilities: Include a requirement on drawings to replace any pedestrian facility that is disturbed, such as curb ramp, sidewalk, driveway or crosswalk in conformance with the latest edition of the City of Houston's Standard Details, American with Disabilities Act and Texas Accessibility Standards.

7.2.05.E Future Planned Improvements.

1. When feasible, show and label as "Future, by Others" planned improvements by City, County, TxDOT, Metro, private entities which could impact the proposed water line, or aspects of its design.

7.2.05.F Refer to Chapter 11, Section 4, for geotechnical information required on the drawings.

END OF CHAPTER

APPENDIX A - ADDITIONAL DESIGN REQUIREMENTS FOR LARGE DIAMETER WATER LINES

The following Appendix provides additional requirements to Chapter 7, related to the design of large diameter water lines (LDWL) which are defined as water lines 24-inches and larger. Unaltered portions of Chapter 7 shall remain in effect, but where conflicts exist, this appendix shall supersede requirements in Chapter 7.

1.01 DESIGN REQUIREMENTS AND CRITERIA

1.01.A Hydraulic Modeling:

1. Hydraulic modeling effort to be verified with Project Manager, and may be performed by Design Engineer, City, or another consultant. If modelling is to be performed by others, Design Engineer shall provide specific design information to modeler.

2. The following parameters shall be incorporated in the design:

    a. Design Velocity:

Table A.1 - DESIGN VELOCITY

SIZE OF LINE	Desired (ft.sec)	Maximum (ft/sec) *
≥ 24-inch & ≤ 36-INCH	3	5
≥ 42-INCH & ≤ 96-INCH	5	7
> 96-INCH	7	9

* Maximum velocity may be adjusted with approval from Infrastructure Planning Branch (IPB).

    b. Pipe Friction Factors:

Table A.2 - HAZEN WILLIAMS "C" FACTOR

SIZE OF LINE	C (EXISTING LINES)	C (PROPOSED LINES)
≥ 24-inch & ≤ 36-INCH	110	120
≥ 42-INCH & ≤ 96-INCH	120	130
> 96-INCH	130	145

1.01.A.2 continued

c. Maximum pressures anticipated are the greater of:

(1) 150% of operating pressure regardless of pipe size. Operating pressure = 100 psi.

(2) Other special design criteria as determined by modeling results or specified by Project Manager.

3. Modeling effort shall identify location and sizing of other devices, including Pressure Reducing Valves, and Check Valves.

4. Engineer to identify any shut down required of existing lines during construction of proposed project. Location, estimated duration, and timing of shutdown shall be provided to Project Manager and updated with each submittal milestone.

1.01.B Transient (Surge) Analysis

1. Transient modeling effort to be verified with Project Manager, and may be performed by Design Engineer, City, or another consultant. If model is to be provided by others, Design Engineer shall provide specific design information to modeler.

2. In accordance with acceptable engineering practice (e.g. AWWA M51), air release, vacuum relief/air inlet, and/or combination air valves are to be installed at high points and such other intermediate points as determined by transient analysis. The water system is to be modeled under assumed worst case transient scenarios to determine the effects of potential transients on the pipeline and to evaluate air valve type/function, placement and sizing.

3. General Criteria

a. Transient analysis shall, at a minimum, consider the following items to determine the appropriate surge protection methods and devices needed:

(1) Pipe material properties;

(2) Pipe wall thickness;

(3) Fluid properties; and

(4) Existing water line alignments. Existing as-built information and other available information shall be used to develop the computer model of existing conditions.

1.01.B.3.a continued

(5) Proposed waterline alignments. Proposed pipeline design shall be added to the model and modeled based upon assumed "worst-case" scenarios. These scenarios shall be identified in the analysis.

b. Computer modeling of the transient event scenario for each project shall be performed using the Liquid Transient (LIQT©) program or other modeling program acceptable to the City's Houston Water Planning (HWP).

c. Transient analyses shall include a table of recommended surge protection devices to be incorporated into the design drawings. The type of device and approximate station location for each device shall be identified in the table and incorporated into the Drawings.

d. The allowable surge pressure range for each analysis shall be -5 psi to 150 psi. Additional criteria and assumptions used in the analysis shall be identified in a Technical Memorandum signed and sealed by a Professional Engineer licensed in the State of Texas and submit to the Project Manager for review with each submittal milestone.

1.01.C Alignment

1. Horizontal alignments shall be approved during preliminary engineering Phase I services. Evaluation of routes shall include factors including, but not limited to: impact to local public, traffic volumes, land use, width of right-of-way, existing utilities, pavement conditions, landscape features, proposed improvements along the route, constructability and operational cost.

2. Proposed alignment shall minimize fittings and appurtenances, minimize impact with existing utilities and other site conditions. Remain on the same side of road within City Rights-of-Way to the extent possible. Where possible, manhole tops shall not be designed within the tire path along roadways.

3. Minimum depth of cover (depth to top of pipe) shall be 7 feet from top of curb in improved roadway areas or 9 feet measured at the water line centerline in roadways with open ditch drainage. Verify depth of cover will provide adequate space for air valve assembly and other appurtenances within manholes.

4. Normal depth of cover over tunnel shall be a minimum 1.5 x OD (outer diameter of tunnel). For shallower or deeper depths, a geotechnical analysis verifying adequacy of cover is required.

1.01.C continued

5. Public and Private Utility Crossings: The minimum horizontal and vertical separations to a LDWL are summarized in Table A.3 and Table A.4, respectively. Engineer shall consider additional clearance based on material, age, depth of cover, condition of existing utility, and geotechnical conditions. Consideration shall be given to backfill zones of the existing and proposed utilities. Provide a special shoring design when trench width of existing water line with trench width of proposed utility overlap.

Table A.3 - MINIMUM HORIZONTAL SEPARATION REQUIREMENTS

Water Horizontal Separation Requirement (1)(2)		Type of Parallel Utility (5)				
		Water Line	Non-Pressure Rated Sanitary Sewer (3)	Pressure Rated Sanitary Sewer (3)	Storm Sewer	All other Utilities/ Pipelines
LDWL Water Pipe Material	Fiberglass Reinforced Pipe	4 feet	9 feet	9 feet	4 feet	4 feet
	HDPE	4 feet	9 feet	9 feet	4feet	4 feet
	Ductile Iron	4 feet	9 feet	9 feet	4 feet	4 feet
	PCCP	5 feet or 1 WL Pipe Diameter whichever is greater	9 feet	9 feet	5 feet or 1 WL Pipe Diameter whichever is greater	5 feet
	Bar Wrap Concrete Cylinder	4 feet or 1 WL Pipe Diameter whichever is greater	9 feet	9 feet	4 feet or 1 WL Pipe Diameter whichever is greater	4 feet
	Steel	4 feet	9 feet	9 feet	4 feet	4 feet

(1) Minimum clearances are measured from outside of pipe to outside of pipe.

(2) Avoid overlapping trench width of proposed water line with trench width of existing utility, to the extent possible.

(3) Place 1 full section of SS centered at WL crossing and provide restraint joints on SS

(4) For water lines 54-inches in diameter and greater, provide at least 5 feet horizontal clearance from OD to OD from other buried utilities or buried structures.

(5) For possible reduction in separation limits, see Section 7.2.01.M.3.

1.01.C.5 continued

Table A.4 - MINIMUM VERTICAL SEPARATION REQUIREMENTS

Water Vertical Separation Requirement Table [(1)]		Type of Parallel Utility[(3)]				
		Water Line	Non-Pressure Rated Sanitary Sewer [(2)]	Pressure Rated Sanitary Sewer [(2)]	Storm Sewer	All other Utilities/ Pipelines
LDWL Water Pipe Material	Fiberglass Reinforced Pipe Above Utility	2 feet	2 feet	2 feet	2 feet	2 feet
	Fiberglass Reinforced Pipe Below Utility	4 feet	4 feet	4 feet	4 feet	4 feet
	HDPE Above Utility	2 feet	2 feet	2 feet	2 feet	2 feet
	HDPE Below Utility	4 feet	4 feet	4 feet	4 feet	4 feet
	Ductile Iron Above Utility	1 foot	2 feet	1 foot	2 feet	1 foot
	Ductile Iron Below Utility	2 feet	2 feet	2 feet	2 feet	2 feet
	PCCP Above Utility	6 feet	6 feet	6 feet	6 feet	6 feet
	PCCP Below Utility	5 feet	5 feet	5 feet	5 feet	5 feet
	Bar Wrap Concrete Cylinder Above Utility	4 feet	4 feet	4 feet	4 feet	4 feet
	Bar Wrap Concrete Cylinder Below Utility	6 feet	6 feet	6 feet	6 feet	6 feet
	Steel Above Utility	2 feet	2 feet	2 feet	2 feet	2 feet
	Steel Below Utility	3 feet	3 feet	3 feet	3 feet	3 feet

(1) Minimum clearances are measured from outside of pipe to outside of pipe.
(2) Place 1 full section of SS centered at WL crossing and provide restraint joints on SS.
(3) For possible reduction in separation limits, see Section 7.2.01.M.3.

1.01.C continued

6. Offsets/bends within 5 feet of a tunnel section are not allowed.

7. Locate drain line outlets, at areas that will permit draining a majority of the pipe. Place at least one drain line outlet between high points and each set of in-line isolation valves.

   a. Where a local storm sewer system is within close proximity, design storm sewer leads from the drain line service manhole to a nearby drainage facility that is capable of accepting flow when draining the water line. System should be designed to drain by gravity, where possible. Do not connect into storm sewer system that is not owned by City.

   b. Where there is no City-owned storm sewer system within proximity, install drain line outlet and manhole without storm sewer lead.

   c. When flush water is expected to be drained into a storm sewer system owned by another entity such as TxDOT, obtain permit and comply with the owning entity's requirements.

8. To accommodate all approved pipe materials, the alignment plan and profiles (P&Ps) are to be based on the use of Prestressed Concrete Cylinder Pipe (PCCP), unless another material must be specified for sound engineering reasons.

9. In addition to graphical standards in Chapter 3, drawings shall include:

   a. Station and elevation at bends, elevation changes, and beginning and end of each drawing sheet.

   b. Arrow indicating normal direction of flow and slope of water line on the profile sheets.

   c. Valves, manholes and other appurtenances related to the proposed water line.

   d. Water line markers are to be installed where water line is placed in an easement. Markers shall be placed at a maximum spacing of 2000 feet, where there is a change in horizontal alignment, and when crossing property lines. Do not place markers within roadways.

   e. Add callout "CRITICAL LOCATE PER COH SPEC 02317" where:

      (1) Proposed water line crosses existing buried utilities where the horizontal and vertical location cannot be verified with field information.

      (2) Proposed work either crossing or within 10-feet of LDWL.

1.01.C continued

10. Required minimum clearances and separations from adjacent objects to the OD of the water line are required to be called out once per drawing sheet, if they are typical, and as many times as necessary to correctly show changing clearances and separations.

1.01.D Pipe Design Basis

1. Design shall be based upon combined loading conditions including operating, surge, vacuum, and test pressures, as well as depth of backfill earth cover and live loads, and maximum velocity within the pipe.

2. Where different from standard specifications, design shall identify special features, such as: minimum wall thickness, special coatings, linings, shoring or joint requirements. Unusual or unique considerations shall be described in details and/or project specifications as necessary.

3. Acceptable pipe materials for LDWL are listed below, based on currently approved diameters:

Table A.5 - PIPE MATERIALS

TYPE	SIZE (INCHES)
Fiberglass Reinforced Pipe	≤ 30
Ductile Iron	≤ 64
Prestressed Concrete Cylinder (PCCP)	≥ 24
Bar-Wrapped Concrete Cylinder	≤ 60
Steel	≥ 24

4. Engineer must evaluate the requirements for the project and make a recommendation for any specific pipe material in portions of the alignment where applicable. Submit to DWO for consideration. Criteria used to evaluate pipe material for specific installation shall include: system flexibility, hydraulic efficiency, manufacturer and availability, surge protection, corrosion protection, special crossing requirements, operational cost, maintenance, susceptibility to environment and cost.

5. Design drawings must incorporate accurate wall thickness, inside and outside diameter, thrust restraint lengths, bends, fittings, appurtenances.

1.01.D continued

6. Additional Requirements for PCCP and Bar Wrap Cylinder Pipe: The engineer shall also address the following minimum elements; assessment of loads on the adjacent utilities when installing pipe, additional horizontal and vertical clearances required to other utilities including the outside dimension of the pipe, ways to ensure the interior and exterior joints will be successfully grouted including the application and curing of the grout before proceeding with backfill operations, and impacts to power lines due to clearance issues with the equipment required to install the pipe.

1.01.E Corrosion Control

1. All LDWL projects must include corrosion protection recommendations incorporated into the design documents.

2. Corrosion monitoring and/or corrosion control recommendations to be provided by a NACE International certified Cathodic Protection Specialist or certified Corrosion Specialist (referred to herein as Corrosion Engineer) in accordance with the technical standards, test methods and recommended practices of NACE International, AMPP, ASTM, and AWWA as applicable.

3. Provide written Soil Corrosivity Study and include monitoring and/or corrosion control protection in the design.

4. Soil Corrosivity Study shall contain the following minimum elements:

   a. Project name, project number and date of study;

   b. Name, firm and signature of Corrosion Engineer;

   c. Introduction to project and scope of work;

   d. Field soil resistivity testing procedures and results. Resistivities are to be collected at 20 feet, 15 feet, 10 feet, 5 feet and 2.5 feet below ground level – in coordination with the geotechnical borings. Layer resistivities for the above depths are also to be provided;

   e. Laboratory results of chemical analysis. The laboratory work shall include in-situ and saturated soil resistivities, pH, chloride ion, sulphate ion and bicarbonate ion levels;

   f. Interpretation of results/collected data;

   g. Determination of likelihood, sources and locations of stray AC and DC current;

   h. Sources of AC power (when impressed current cathodic protection is recommended), including coordinating power drop location with the utility owner.

1.01.E.4 continued

i. Soil corrosivity conclusions; and

j. Corrosion monitoring and/or corrosion control recommendations.

5. The following items shall be considered for corrosion monitoring and/or corrosion control recommendations. These shall not replace sound professional judgment on the part of Corrosion Engineer. The report shall be finalized upon completion of field work and laboratory testing and evaluation of results and data and appropriate corrosion control incorporated into the design.

   a. Buried metallic and concrete pipe and reinforced structures are subject to corrosion and deterioration. Corrosion Engineer shall consider:

      (1) All pipe material and coatings available to the contractor.

      (2) Options for cathodic protection (sacrificial or impressed current systems). The City's Drinking Water Operations (DWO) to review and approve the cathodic protection method.

      (3) Electrical Isolation from adjacent metallic pipelines, casing and structures. Unless otherwise specified, each project should be designed to be isolated from adjacent projects. Consider monolithic joints where isolation is critical.

      (4) Impact to and from external stray current interference sources (both AC and DC) along the alignment, including adjacent or crossing utilities. Include other buried utilities and pipelines subject to impressed current cathodic protection systems.

      (5) Testing locations. Test stations are to be placed in easily accessible locations and include coordination for connections to any foreign utilities recommended by corrosion engineer.

1.01.F Valves

1. Isolation Valves

   a. Valves shall isolate sections of water lines that may require repairs, maintenance or inspection or provide other operational functions.

   b. Lateral lines shall have a flanged isolation valve placed directly adjacent to tee connection, unless otherwise approved by Project Manager.

1.01.F.1 continued

c. Future accessibility to valves should be considered as part of the design. Actuator/operator manholes shall be located where they are accessible by truck- mounted mechanical valve operator, with minimal impact to traffic.

d. Maximum spacing shall correspond to Table A.6~~Table A.6~~. Additional isolation valves may be required to provide operational flexibility of the overall system:

Table A.6 - ISOLATION VALVE TYPE AND SPACING

TYPICAL TYPES*	SIZES	MAX SPACING (FEET)
Gate	24-inch	2,200
Butterfly*	30-inch to 42-inch	3,000
Butterfly	48-inch and larger	4,000

* Gate valves may be used as determined by the City at critical locations and connections; Design Engineer to confirm that adequate space and depth of cover exists.

e. For butterfly valves, orientation of valve must be shown in Drawings.

f. Foundation support details are required for pipe ends and valves. For butterfly valves, follow guidelines in AWWA C504/C516.

g. Where blind flanges or internal dished head plugs are located close to a butterfly valve, adequate spacing shall be provided to allow valve to be fully opened.

2. Air Valves

a. Locate air valves such that inlet/outlet vent piping elevation is in accordance with the City of Houston Code of Ordinances Chapter 19 Section 19-33, or four (4) feet above natural ground whichever is greater. Vent elevation greater than four feet above natural ground shall require design of support details.

b. Valves that are designed to be exposed shall be located to minimize potential for tampering and/or damage.

c. Drawings shall specify type of air valve at each location based on outcome of transient analysis. At changes in elevations, air valve to be located within 10 feet from the bend.

3. Other Valves

a. Pressure Reducing Valves, Check Valves, or other special purpose valves may be required as determined by modeling or as instructed by the City.

1.01.G Accessibility

1. Manholes

   a. Specialty manhole details are to be provided as required.

   b. Extra depth manholes and details (greater than 20 feet) shall be identified on Drawings.

2. Access Manways

   a. Manways with manholes are required on water lines 30-inches in diameter and larger. Manways with air valves are counted as access locations.

   b. Manways shall be no less than 24-inches in diameter and have a minimum 6- inch opening on top of each manway cover. Manway and flanges larger than 24-inches require the addition of appropriate mechanism to aid in lifting.

   c. Manways shall be located on horizontal sections of the water line between isolation valves, such that access to the water line is provided at least every 1,000 feet, unless otherwise approved by Project Manager. Provide manways for access on both ends of tunnel if tunnel is deeper than 25 feet.

   d. Where space permits, manways shall be designed within 10 feet on each side of the isolation valve in order to eliminate additional buried outlets for flushing and disinfection. Manways shall not impact access to the valves or operator manhole.

   e. Manways shall be placed at each end of the project limits where required to facilitate removal of dished head plugs, installed a maximum of 10-feet from the plug.

1.01.H Thrust Restraints

1. Thrust restraint for new lines shall be provided by means of restrained joints.

2. For connections to existing lines, supplemental restraint or blocking on the existing pipe may be necessary and should be evaluated for inclusion into the design.

   a. Evaluate existing pipe and provide methods as well as limits necessary to properly restrain existing pipe.

   b. Calculate restrained joint lengths or thrust block sizing for existing line when connecting proposed line to existing line.

1.01.H.2 continued

c. Obtain record information for existing line, including pipe lay schedule, if available, to determine location and type of existing joints.

3. Thrust restraint calculations shall be performed to determine the minimum restrained joint lengths and be based on the use of Prestressed Concrete Cylinder Pipe (PCCP), unless a specific pipe material is required, in which case the appropriate AWWA method for thrust restraint calculations should be used. Thrust restraint design calculations shall be signed and sealed by a professional Engineer and provided to the Project Manager prior to (90%) design submittal.

   a. Thrust restraint calculations shall be based upon the following parameters:

      (1) Internal Pressure = maximum pressure to which the pipe is subjected (including working, transient or field test pressures).

         (a) Working Pressure: 150 psi

         (b) Maximum Total Pressure Due to Surge: 225 psi

         (c) Field Test Pressure: 150 psi

      (2) Soil Parameters:

         (a) Buoyant unit weight of soil as identified in project geotechnical report.

         (b) Pipe to soil friction factor based on saturated soil conditions

            i. PCCP, or other cement mortar coated pipe = 0.35

            ii. Tape coated, polyurethane coated or epoxy coated pipe (including epoxy over cement mortar coated pipe) = 0.30

            iii. For ductile iron pipe, reduce friction factor by 0.7 based on use of polyethylene encasement.

   b. Calculations for specific pipe materials shall be based on the following:

      (1) PCCP and Bar-Wrapped: See Table A.7~~Table A.7~~ below:

1.01.H.3.b.(1) continued

Table A.7 - PCCP THRUST RESTRAINT DESIGN METHOD

Horizontal & Vertical Up Bends	Thrust Restraint Design Program (TRDP) (Latest Version)
Vertical Down Bends	AWWA M9, Third Edition, Eq 9-14
Minimum steel cylinder thickness	AWWA M9, Latest Edition

(2) Ductile Iron Pipe: AWWA M41 or DIPRA Thrust Restraint for Ductile Iron Pipe (latest edition).

(3) Steel Pipe: AWWA M11 (latest edition).

(4) Fiberglass Reinforced Pipe: AWWA M45 (latest edition).

c. Passive resistance of soil will not be permitted in calculation of thrust restraint for some pipe materials.

1.01.I Plant Connections and Expansions

1. Direct-bury of couplings or other similar type connections shall be avoided when possible.

2. Water plant connections and expansions shall adhere to the requirements of the City's Groundwater Plant Design Guidelines, latest edition.

1.01.J ~~LWDL~~ LDWL Interconnections: When making connections to existing ~~LWDL~~ LDWLs, specific piping layout design and details must be included with diagrams and support to avoid damage to existing LDWL. Details must be provided with scaled dimensions and showing locations and types of joints for existing LDWL.

1.01.K LDWL Crossings: Comply with Section 7.03 F of this Chapter, with the following additional requirements for LDWL (Note: For the portion of the alignment that is located within Rights- of Way or easements with differing design requirements than are contained herein, the differences shall be identified to the Project Manager, and the more stringent requirements shall govern.):

1. Restrained joints shall be utilized for the entire length for all water lines at crossings, except for dedicated joints for expansion/contraction. Proposed water line shall be perpendicular to the crossing, where practical.

2. Water line markers are required at each end of buried crossings, near ROW lines.

1.01.K continued

3. Design shall comply with requirements of the ROW/easement owner, and requirements incorporated into Contract Documents as necessary. Written approval or acceptance of water line crossing design from owning agencies or companies is required to be provided to the Project Manager prior to the final design submittal.

4. TxDOT and County Road Crossings

   a. Steel tunnel liner is required for proposed LDWL.

   b. Refer to Title 43 of the Texas Administrative Code, Part 1, Chapter 21, Subchapter C, entitled "Utility Accommodation".

5. Railroad Crossings

   a. Refer to the Manual for Railway Engineering, latest edition, prepared by the American Railway Engineering and Maintenance-of-Way Association (AREMA) for the design of railroad crossings.

6. Oil and Gas Pipeline Crossings

   a. Engineer shall coordinate with private utilities to determine the location of their facilities. Where necessary, the utility shall be probed in order to verify accuracy.

7. Harris County Flood Control District (HCFCD)

   a. Design shall identify Ultimate Channel width and depth, and accommodate for future channel improvements.

   b. Actual channel bottom elevation and geotechnical condition should be used to evaluate minimum depth of cover required for tunnels.

   c. Engineer shall determine jurisdiction and if approval is required from USACE and/or Coast Guard, and perform work as required to obtain approvals.

1.01.L Minimum Easement Widths:

1. Refer to Chapter 5 "Easement Requirements" for LDWL easement requirements.

~~2. The minimum easement width required to install, operate and maintain water lines are summarized in Table A.8.~~

~~3. Provide all-weather access to water lines easements parallel to public right-of-way through the use of cleared, graded and stabilized access roadway or driveways.~~

1.01.L continued

~~Table A.8 – MINIMUM EASEMENT WIDTH~~

~~SIZE OF WATERLINE~~	~~MINIMUM EASEMENT WIDTH (1)(2)(3)~~
~~24" through 48" (3)~~	~~30 ft~~
~~54" through 72" (3)~~	~~40 ft~~
~~84" and Larger (3)~~	~~50 ft~~

~~(1) Minimum easement width applicable for easements adjacent to public ROW. Water line easement not parallel to public rights-of-way shall be 10 feet wider than the above.~~

~~(2) Water line shall be centered in the easement for 20 ft and smaller easements~~

~~(3) Do not locate lines 16-inch diameter and larger in side lot easements. For location within side lot easements, see Chapter 5, Easement Requirements.~~

~~(4) Narrower easements will be considered where Engineer provides evidence, to the satisfaction of OCE, that maintenance activities will not be hindered by reduced width.~~

1.01.M Water line Shut-Down Requirements

1.01.M continued

1. Shut down of water line 24” and larger shall only occur during low-demand months (typically between November and February) and when DWO has determined the surrounding system is able to meet the water demands. Coordinate with DWO on the shut-down requirements and determine any additional requirements that need to be incorporated into the design. Drawings shall contain the following minimum notices for contractor to adhere to during construction:

    a. Contractor shall coordinate shut down plan with DWO at least 4 weeks before the scheduled shutdown.

    b. Contractor shall provide 48-hour advance notice to the DWO prior to water line shutdown and participate in a meeting with DWO to discuss detail and sequencing procedure for the proposed work.

    c. No shut down will occur unless all required material and equipment are on site.

1.02 INSTALLATION METHODS

1.02.A Open Cut Installation

1. Limits of special shoring shall be identified on Drawings where the use of a typical trench box is not sufficient.

2. Where utilities extend across LDWL trench, plans shall indicate if utility is to be braced or removed and replaced.

3. Design shall account for groundwater dewatering, where necessary.

4. Identify existing structures or features that may be impacted by zone of influence, and include protection measures, such as special shoring, where applicable.

1.02.B Trenchless Installation

1. Limits of proposed trenchless crossing shall be identified on plan and profile sheets of the Drawings with beginning and end station. Design must denote if a specific trenchless method is required, and appropriate details and specifications shall be provided.

2. Tunnel liner sizing shall be based on the largest part of the pipe, such as the bell or external restraining mechanism.

3. Provide minimum liner plate / casing diameter and thickness for all carrier pipe materials.

1.02.B continued

4. Design shall evaluate ability to dewater, potential for settlement in the zone of influence, and risk to adjacent structures and pavement.

   a. In areas where specific settlement criteria are necessary, a settlement monitoring plan is required and shall and include types of devices, frequency and layout where recommended in geotechnical report.

5. Crossings with tunnel liner plates:

   a. For railroad crossings, liner plate design shall be consistent with Chapter 1, Part 4 of the AREMA Manual for Railway Engineering.

   b. For roadway crossings, live load shall include minimum HL-93 loading conditions as defined by AASHTO LRFD Bridge Design Specifications.

   c. For all other crossings using tunnel liner plates, the liner plate design shall be consistent with AASHTO LRFD Bridge Design Specifications, Section 12.

   d. A minimum factor of safety of 3.0 for seam strength and 2.0 for buckling, with a maximum deflection of 2%, shall be used for liner plate calculations. Larger factors of safety may be required as determined by Design Engineer.

   e. Liner plate shall be specified by material type and shall provide nominal diameter and wall thickness for 2-flange and/or 4-flange.

6. Crossings with smooth-wall, welded steel pipe casing:

   a. For roadway crossings, live loads shall include minimum HL-93 loading conditions as defined by AASHTO.

   b. Live loads at railroad crossings shall include minimum Cooper E-80 loading conditions as defined by AREMA.

   c. A minimum factor of safety of 2.0 shall be used with a maximum deflection of 3% in the casing calculations. Larger factors of safety may be required as determined by the Design Engineer.

   d. Casing pipe shall be specified by material type, inside diameter and wall thickness and meet the requirements of the City's Standard Specifications and AWWA standards.

1.02.C Installation Parallel to Existing LDWL

1. For trenchless parallel to or other excavations adjacent to existing LDWLs, design considerations must consider protection for the existing ~~LWDL~~LDWL.

1.02.C continued

2. Obtain as built and lay schedule information for existing LDWL and perform SUE investigation as needed to verify horizontal and vertical location. Update Drawings based on findings.

3. Confirm that new water line can be installed without construction vehicles, equipment, or material staging over existing LDWL. Identify Limits of Construction which exclude area over existing LDWL. Identify the work zone restrictions on the Drawings so that no spoils or fill material can be placed over existing LDWL.

4. A minimum separation distance of at least 10 feet must be maintained between the outside diameter of existing LDWL and edge of trench or excavation.

    a. Where minimum 10-ft separation cannot be achieved, provide special shoring safety measures. Special shoring may be interlocking steel sheet piling or other approved system designed to prevent ground movements such as structures, pavements or utilities. Refer to Standard Specification 02317, Paragraph 1.08.

    b. Engineer to provide limits of special shoring on the drawings. Where applicable shoring is required, Contract Documents must include a guide specification establishing payment description and minimum requirements for special shoring.

5. For existing LDWLs that are flexible pipes, such as steel pipe, the existing LDWL must remain pressurized and in continuous service during construction operations. This is essential to limit risk of deflection and out-of-roundness of the existing line. Additionally, the pressurized pipe will lessen any effects on the open trench wall and decrease risk of collapse.

6. For propose work that will result in exposing the existing LDWL that is PCCP, coordinate with City of Houston of Houston Drinking Water Operations to review the feasibility and schedule the work.

1.02.D Above Grade Installation

1. Stand-alone bridge structures must be designed by a Structural Engineer registered in the State of Texas.

2. When the above-grade crossing structure is adjacent to an existing roadway bridge, the bridge columns shall be designed so that they are the same size and shape, and line up with the existing roadway bridge. The low and high chords of the water line bridge should fall within the limits of the roadway bridge high and low chords.

1.02.D continued

3. For bayou or channel crossings, the lowest structural member must not be less than 18-inches above the base flood elevation. If this requirement cannot be met, obtain a permit from City of Houston Floodplain Administrator per City of Houston Code of Ordinances, Section 19-43 (c)(1).

4. Pipe material for aerial crossing must be steel pipe with butt-welded joints. Thickness of steel wall to be designed based on span length.

1.02.E Special Construction Requirements for Work in Vicinity of Existing PCCP

1. Call out “Caution PCCP” for all work within 10-feet of PCCP waterlines.

1.03 ADDITIONAL SERVICES

1.03.A For Geotechnical and Environmental requirements, refer to Chapter 11 of the City of Houston Infrastructure Design Manual.

1.03.B Subsurface Utility Engineering (SUE)

1. General Criteria

   a. SUE may be warranted where existing conditions are unknown and likely to significantly impact design and constructability of the proposed alignment.

   b. Perform utility quality levels D, C, B, as defined by Chapter 6 of this manual, on all projects, and level A in locations that is consistent with sound engineering judgement in accordance with Chapter 6 of this manual.

2. SUE Results

   a. SUE results for each location are required to be submitted to the design Engineer and shall be signed and sealed by the SUE Professional Engineer, registered in the State of Texas.

   b. SUE results shall provide sufficient information to ascertain the horizontal and vertical location of the existing utilities but should contain no less than the following items:

      (1) Project name, location, date of field work.

      (2) Owner of the utility.

      (3) Type, size, and material of the utility.

      (4) Survey elevation of the top and at least one side of the utility at the test hole.

1.03.B.2.b continued

(5) Survey elevation of existing grade over the utility at the test hole.

(6) Northing/Easting coordinates of the utility at the test hole.

(7) General plan view of the utility with SUE location shown.

(8) Photographs of the site and the exposed utility; and

(9) General soil type and thickness of pavement within the test hole limits.

(10) If the project is federally/state funded, then federal/state SUE requirements about shall be followed.

END OF APPENDIX A

City of Houston

Design Manual

Chapter 8

WASTEWATER COLLECTION SYSTEM DESIGN REQUIREMENTS

Chapter 8
Table of Contents

Wastewater Collection System Design

SECTIONS PAGE

Wastewater Collection System List of Tables

Chapter 8

WASTEWATER COLLECTION SYSTEM DESIGN REQUIREMENTS

SECTION 1 – WASTEWATER COLLECTION SYSTEM OVERVIEW

8.1.01 CHAPTER INCLUDES

8.1.01.A Criteria for the design of wastewater collection systems.

8.1.01.B This Chapter addresses the design of the wastewater collection systems within the public Right-Of-Way or a dedicated public easement. Sanitary sewers located on private property that are not in such a dedicated easement, are under the jurisdiction of the Plumbing Code, and will be reviewed by the Code Enforcement Branch.

8.1.02 REFERENCES

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

8.1.02.B City of Houston Engineering Design Guidelines Manual for Submersible Lift Stations.

8.1.02.C City of Houston Design Guideline Drawings for Submersible Lift Stations.

8.1.02.D Uniform Plumbing Code, latest edition and local amendments that the City has adopted[1].

8.1.02.E City of Houston IDM Chapter 13, Geospatial Data Deliverables~~GIS Data Digitization Standards~~.

8.1.02.F Refer to City of Houston Building Code Enforcement List of Adopted Codes[1]

8.1.03 DEFINITIONS

8.1.03.A Public Sewer - A closed conduit which conveys wastewater flow and which is located within a public Right-Of-Way, or a dedicated public sanitary sewer easement, or a Type 1 Permanent Access Easement (PAE) that is a minimum width of 50 ft . A public sewer is maintained and operated by the City and is intended to serve more than one residential, commercial, or industrial site. Refer to IDM Chapter 6 for definition of Type 1 Permanent Access Easement.

8.1.03.B Private Sewer - A closed conduit which conveys wastewater flow and is constructed and maintained by a private entity (e.g. homeowner's association). Private sewers may be located in areas such as a private street or common area. Private sewers are

[1]Refer to weblink for City requirements: https://www.houstonpermittingcenter.org/building-code-enforcement/code-development#agency-links-416

8.1.03.B continued

subject to the design and construction requirements of the Infrastructure Design Manual or Plumbing Code, whichever is more stringent, and must discharge to public sewer.

8.1.03.C Service Lead – A portion of sanitary sewer pipe located within the public Right-Of-Way or public easement that connects a building sewer to a sewer main and is owned and maintained by the City. A service lead may not exceed 150 linear feet. No more than the equivalent of two single-family residences may be served by one service lead.

8.1.03.D Building Sewer – A private sewer that connects a building to a service lead that is wholly located within private property. If routed through another tract of land, it shall be located in a private easement, which will include the City as a third party in the easement documents. Building Sewers will be owned and maintained by the owner of the property being served, including portions that may be routed through another tract of land through a private easement. Design shall adhere to the Design Manual or Plumbing Code, whichever is more stringent.

8.1.03.E Community sewer - A private sewer that serves more than two single-family residences. Community sewer will adhere to this manual using an 8-inch pipe terminating in a manhole and will be located within a private easement, which will include the City as a third party in the easement documents. It will be owned and maintained by the owner(s) of the properties being served by the community sewer.

8.1.03.F Project Area - The area in the immediate vicinity of a public sewer to be constructed. This includes the entire road Right-Of-Way and any adjoining easements used for the proposed wastewater line construction.

8.1.03.G Stack - A minimum 6-inch riser pipe, constructed on public sewer or lead, with a maximum of 6-feet of cover on the stack. A stack will be used for connecting service leads to deep public sewers.

8.1.03.H Stub-Outs- A minimum 5-feet of sewer pipe extended from the manhole for future expansion and terminated with a sanitary sewer plug.

8.1.03.I Force Main- A pressure-rated conduit which conveys wastewater from one pump station to one discharge point.

8.1.03.J Single-family residence – A residential establishment serving a single family, or household, which may not include separate living quarters. In those instances where there is no meter on the water supply to the principal household, separate living quarters shall be considered as a separate residence and a separate sewer service charge shall be applied (Refer to City of Houston Code of Ordinances Chapter 47, Article III, Sec.47-121).

SECTION 2 - WASTEWATER COLLECTION SYSTEM DESIGN REQUIREMENTS

8.2.01 DESIGN REQUIREMENTS

8.2.01.A Drawings to be furnished

1. To obtain a permit for the construction of a proposed public sewer or service lead crossing a public Right-Of-Way to an existing public sewer, a plan and profile drawing of the proposed sewer shall be prepared and submitted to the City for approval.

8.2.01.B Drawing/Design Information

1. The detailed drawings will show the exact location of the proposed line in the street, alley, or easement with respect to the edge of the particular Right-Of-Way, the transit base line, any nearby utilities, ”0.2 percent flood elevation” as defined by Chapter 19 Section 19-33 of the City of Houston Code of Ordinances within the project area, major landscaping, and other structures affecting construction.

2. Sewers and manholes shall be identified by number, letter, combination of, or other identification and shown on the sanitary sewer layout sheet.

3. Where sewers are to be placed between existing pavement and the street Right-Of- Way line (or interior easement line) show the existing ground line at both sides (or the closest side for sewers near the edge) of the Right-Of-Way or adjacent sewer easement. Prior approval will be required if proposed sewers are to be placed under existing pavements or toppings.

4. For connection to the City sanitary sewer system include one of the following: a copy of the City's Wastewater Capacity Reservation (WCR) letter or, a copy of the City's Wastewater short form, and a Wastewater Impact Fee Receipt for any proposed wastewater design.

8.2.01.C Drawing Requirements

1. All sewers and connections must be shown in both plan and profile (P&P) views. A record drawing number for all existing public sewers in the P&P shall be provided.

2. The profile shall show other underground and surface utilities and facilities, both in parallel and at crossings; the size, grade of the proposed line, the elevations of the proposed line to hundredths of a foot at manholes, changes of grade and dead ends; and the proposed finished grade over the sewer. It shall show the actual ground line as it exists prior to construction of the sewer. Where proposed fill or cut is contemplated, the proposed new ground line shall be shown as a separate line from the actual ground line (label both lines and use contrasting line types to identify each). Type of pipe and bedding shall comply with City of Houston Standard Specifications and Standard Details.

8.2.01.C continued

3. Commercial sanitary sewer layout sheets for large areas and with a scale of 400 feet or more per inch must have an additional set of layout sheets at not more than 200 feet per inch, with match lines and a small index map showing which portion of the overall layout that the layout of each sheet represents.

4. A scale of not more than 200-feet per inch on the layout sheet will provide the following information:

   a. All easements containing or adjoining sanitary sewers are shown and labeled (including recording information),

   b. Label locations where pipe size or material change,

   c. Identify manhole by letter and/or number,

   d. The sewer alignment shall accurately reflect the relative location of the sewer as shown on the detailed plan view,

   e. Service leads that cross street pavement or serve adjacent property are to be shown on the layout. The detail plans and profiles shall show the flow lines of service leads at the street or easement Right-Of-Way, as well as at manholes where private sewer connections are allowed or required,

   f. The number and size of the lots depicted on both the overall sewer layout sheet and the individual plan-and-profile drawings shall match the number and size of the lots depicted on the final plat after recordation,

   g. The size and direction of flow for existing and proposed sewers shall be shown on the overall sanitary sewer layout sheet,

   h. The location of the proposed sewer within the public Right-Of-Way, easement adjacent to the public Right-Of-Way, or side lot easement (if allowed by the City), and

   i. The overall sanitary sewer layout sheet shall show the area, in acres, which the proposed sewer is designed to serve. Include a location map which references the acreage to nearby major thoroughfares and boulevard streets. The scale used for the project area location map shall be: 1" = 2000' or less and shall be shown on the map.

5. The plan view shall show, at a minimum, the following information for the project area:

   a. Topographical features,

   b. Stationing for the proposed sewers,

8.2.01.C.5 continued

c. Existing buried and overhead utilities (i.e. gas, electric, telecom, etc.),

d. Any significant landscaping or other structures which might impact construction or construction-related activities,

e. The width and type of existing and proposed easements,

f. Proposed service leads,

g. The limits of the proposed bore or tunnel,

h. Locations where pressure pipe is to be installed for water line crossings, and

i. Terrain changes, retaining walls, overhangs, buildings, billboards and any other structure within 25 feet of the proposed line.

6. The profile view shall show, at a minimum, the following information for the project area:

   a. Underground and surface utilities/facilities which are either parallel to the proposed sewer or cross the proposed sewer,

   b. The proposed sewer's diameter, grade and length for each manhole section,

   c. The flow line elevation for sanitary sewers and service leads at each manhole,

   d. The rim elevation of existing and proposed manholes,

   e. The flow line elevation at each sheet match line (i.e., from one sheet to another),

   f. Type of pipe bedding and backfill shall be included in the Standard Details,

   g. The finished grade for proposed and existing pavement. Where cut and fill are proposed, the proposed new ground line should be shown as a separate line from the existing ground line (label both lines and use contrasting line types to identify each),

   h. The existing ground line for the near side of the public Right-Of-Way where a sewer is to be placed between the edge of existing pavement and the edge of the public Right-Of-Way,

   i. The existing ground line at the centerline of the proposed sanitary sewer where a sanitary sewer is to be placed within an easement. Show any proposed cut and fill as described above. Show the finished grade of any proposed and existing pavement,

8.2.01.C.6 continued

j. The flow line elevation of service leads where the service lead crosses the edge of the public Right-Of-Way or the dedicated easement adjacent to the public Right-Of-Way,

k. Locations where pressure pipe and/or casing is to be installed for water line crossings or special conditions (i.e. limited clearance, special protection requirements, etc.),

l. The limits of special backfill and proposed stacks shall be identified by stations indicated on the design plans, and

m. Vertical elevation breaks in profiles shall not be used without clearly identifying breaks on each sheet and dimension the break line elevation difference.

7. Drawings for single-family residential subdivisions shall show the proposed location, by stations, of all service leads, and stacks.

8. Refer to Chapter 11, Section 4, for geotechnical information required on the drawings.

8.2.01.D Service Leads

1. Service leads shall be located either at the side property line between two adjoining lots, or as directed by the City. Service leads shall not be connected to the backlot easement unless both (a) there is no front lot sewer to connect to, and (b) the development consists of no more than one service unit. A single 6-inch service lead located at the property line between two adjoining lots would serve two single-family residences with a wye placed at the end of the service lead. Do not extend the wye beyond the edge of either the public Right-Of-Way or dedicated public easement.

2. Service leads measuring more than 50-feet in length and parallel to the street Right-Of-Way or public sewer easement shall be treated as a public sewer having both a starting and ending manhole, except for cul-de-sac(s)'.

3. Service leads for single-family developments shall not connect to a manhole unless otherwise stated in this manual. Private sewers from developments with more than 5000 gallons-per-day flow shall discharge into a proposed or existing manhole. Where the flow line of the private sewer is 24-inches or greater above the flow line of the manhole, provide a standard City of Houston outside drop to the manhole. Some design exceptions or additional requirements may be made for flow connections to large (36-inch and larger ID sewers) or deep (>20 feet flow line depth) public sewers, depending on the individual circumstances.

8.2.01.D.3 continued

a. Service leads shall be provided to serve every lot within a proposed development, whether inside the city limits or in the ETJ. Provide detail(s) for all typical near-side and far-side sewer connections, including 1-side or 2-sided stacks.

b. Service leads shall be 6-inches in diameter (minimum). If the length of a service lead exceeds 100-feet or the width of the public Right-Of-Way by more than 20-feet, the minimum diameter shall be 8-inches and a manhole shall be utilized for connection to the public sewer. Service leads exceeding 150-feet in length shall be designed as a public sewer.

c. Service leads with a diameter of 6-inches shall utilize full body fittings (extruded or factory-fabricated) for connection to a proposed public sewer or an approved saddle-type connector for connection to an existing public sewer.

d. Saddle-type connectors shall be installed with the stub oriented between the spring line (3 o'clock and 9 o'clock positions) and 45 degrees from the spring line (1:30 and 10:30 positions). Full body fittings used to connect a service lead to a proposed public sewer shall be oriented in the same manner.

e. The service lead shall be designed to minimize the use of bends as conditions permit.

f. Service leads exceeding the limits defined in Paragraph 8.2.01.D.2 shall have a manhole at each end; as well as a plan-and-profile drawing for each Right-Of-Way crossing. All or part of these service leads which are located in a public Right-Of-Way, alley or dedicated sanitary sewer or public utility easement(s) may be treated as a public sewer; depending upon the location of the terminal manhole and any intermediate manholes.

g. For existing lots (which are not served in accordance with these guidelines) that requests a sewer connection and the distance to the nearest existing sewer is less than 50 feet, as measured parallel to the street Right-Of-Way, the sewer connection is under the jurisdiction of the Uniform Plumbing Code, (latest edition that the City has adopted) provided that: a road bore is not required or a major thoroughfare (or collector) road is not being cut, both of which require City approval and an engineering drawing.

h. The location where the service lead crosses the property line shall be shown on the plans and marked in the field. Provide a typical detail of the durable marker to be placed where the service lead crosses the property line.

i. All private sewers, private force mains, and appurtenances, thereto, that are intended to be located inside the public Right-Of-Way must have an encroachment permit with plan and profile sheets.

8.2.01.E General Requirements

1. Connect service leads to stacks, wyes or tees as shown on the City's ~~Geographic Information and Management System (GIMS)~~GeoLink[2]. Where none are shown, a licensed plumber is responsible for placing a City approved saddle for connection to the public sewer and the City Inspector is responsible for determining that the saddle is watertight and properly installed.

2. Materials and construction shall conform to latest City of Houston Standard Specifications, including standard leak test.

3. Unless noted otherwise, all public sewers and service leads shall be embedded in cement-stabilized sand from 6-inches below the pipe to 12-inches above the pipe and for the full trench width. All such bedding shall be compacted to the density required by Standard Specifications. Cement-stabilized sand shall have a 48-hour compressive strength of 100 psi minimum. The cross-section described in this paragraph is defined as the pipe embedment zone.

4. Backfill excavated areas and trenches under or within one foot of existing or proposed pavement with cement-stabilized sand from the top of the pipe embedment zone up to one foot below the paving sub-grade. Cement-stabilized sand must develop 100 psi minimum compression at 48 hours. Backfill shall be compacted to 95 percent standard Proctor density.

5. The actual location of all special backfill and of proposed stacks shall be shown by stations on the drawings.

6. Public sewers 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~~ Refer to Chapter 5, Easement Requirements, for side-lot and back--lot easement requirements.~~.~~

7. Generally, the location of the public sewer within a dedicated easement shall be along the centerline of the easement. However, in those instances where the easement is adjacent to the public Right-Of-Way, the location of the sanitary sewer and its manholes shall be approved on a case-by-case basis by the Director of Houston Public Works, or ~~his~~ the Director's designee. Required easement widths are addressed in Chapter 5, Easement Requirements. Additional information regarding the location of sanitary sewers is contained in Chapter 6, Utility Locations.

8. The final determination as to that portion of a street, alley, or sanitary sewer easement to be occupied by a proposed sewer or force main rests with the City. The Director or designee will take into consideration existing, planned and proposed

[2] https://geohub.houstontx.gov

facilities such as manholes, pavement, pipes/conduits, along with existing trees and shrubs, or other unique surface conditions when arriving at a decision.

8.2.01.E continued

~~9. There shall be no closed-end easements for public sanitary sewers and force mains.~~

~~10.~~9. The drawings for the sewer shall show the location of any pipe, duct, other structure(s), hazardous obstacles and/or protected vegetation known to exist that might interfere with the construction of the sewer and call to the attention of the City any known obstacles that might be encountered in constructing the sewer in any location under consideration. The Professional Engineer of Record shall determine the existence of pipes, ducts, and any above stated obstacles by visually inspecting the site, researching all available public and private records, and conducting subsurface investigations when necessary.

~~11.~~10. Manholes located within Houston Special Flood Hazard Areas, as defined by Chapter 19 of the City of Houston Code of Ordinances, shall have manhole covers that are gasketed and bolted down to prevent inflow. Manhole covers shall be floodproofed to the base flood elevation required by Chapter 19 Section 19-33 of the City of Houston Code of Ordinances. The Engineer of Record (EOR) shall provide a gasketed and bolted manhole detail in Drawings. Manhole vents must be located at least every 1500’ or per the latest TCEQ requirements in Chapter 217 Subchapter C, whichever is more stringent. Vent piping shall be designed in accordance with COH standard detail 02082-06 and City of Houston Code of Ordinances Chapter 19 Section 19-33. Engineering judgement and Aesthetics shall be considered in selecting the location of vent piping. Tunnels must be vented in accordance with TCEQ requirements.

~~12.~~11. A cleanout diameter must be at least equal to the diameter of the pipe to which it is attached.

~~13.~~12. New manholes shall not be located between the top of banks for ditches or swales, unless approved by the City.

~~14.~~13. Manhole covers shall not be placed within driveways and where possible, manhole covers shall not be designed within the tire path along roadways.

~~15.~~14. For Wastewater lines along State Right-of-Way, refer to Chapter 5 for easement requirements. ~~shall be installed outside of the right-of- way in a separate contiguous easement; width of easement shall be as provided in Chapter 5.~~

8.2.01.F Line Size

1. The minimum pipe diameter for a public sanitary sewer shall be 8-inches.

2. Service leads 4-inches in diameter shall be confined to the limits of the lot which they serve and shall serve only the equivalent of one single-family lot. No 4-inch sewer shall be laid in any street, alley, dedicated sewer easement or Right-Of-Way.

3. Service leads 6-inches in diameter shall not serve more than the equivalent of 2 single-family lots or other types of small land tracts.

8.2.01.F continued

4. Service leads of 6-inch and 8-inch diameter for single-family residential lots shall have a minimum grades as shown in Table 8.1.

5. For all service leads that requires a street bore, submit a copy of the wastewater capacity letter to establish the required size of the line.

6. For commercial service leads, the minimum size service lead shall be 8-inches in diameter. Connect all service leads directly to a manhole.

7. Public sewers shall be laid at a size and depth to conform to designs permitting an orderly expansion of the sewer system of the City and so as to avoid a duplication of lines in the future.

8. The City shall be the final judge as to size and depth required and any exception to service leads as previously defined.

8.2.01.G Line Depth

1. Public sewers shall be laid with the top of the pipe a minimum of 3-feet below the surface of the natural ground without side ditches.

2. Sewers laid in the street Right-Of-Way with curb and gutter paved streets shall have a minimum cover of 4-feet from the top of the pipe to top of the curb.

3. Sewers laid in street Right-Of-Way with crowned roads and side ditches shall have a minimum cover of 6-feet from the average ground line at the adjacent street Right- Of-Way to the top of pipe.

4. Where the minimum cover as specified in Paragraphs 8.2.01.G.1, 8.2.01.G.2, and 8.2.01.G.3 is not possible, the sewer shall be laid with Class 150 (150 psi) pressure pipe with cement-stabilized sand backfill as shown in Standard Details. Ductile iron pipe shall be lined with a material listed on the City of Houston Approved Product List and applied by either the pipe manufacturer or an approved applicator. Liners shall meet requirements of TCEQ 217.56(c)

5. Maximum depth for 8-inch, through 12-inch diameter collection lines shall be 20-feet from average ground surface of the trench width to pipe invert. Depths greater than 20-feet are subject to approval by the City Engineer if justified for site-specific reasons during the preliminary engineering phase of the project design.

8.2.01.H Line Grades

1. The following table lists the minimum grades for 6-inch to 27-inch diameter public sewers. (6-in. diameter is for service leads only). The minimum grade is based on a minimum full pipe velocity of 2.3 feet per second (fps). The maximum grade is based on a maximum full pipe velocity of 4.5 fps. In both cases, the Manning Formula has been used with an n coefficient of 0.013. The use of different pipe

8.2.01.H.1 continued

materials will not alter the use of 0.013 for the purposes of the Design Manual.

Table 8.1 - GRADES FOR WASTEWATER LINES

NOMINAL INTERNAL PIPE DIAMETER (INCHES)	MINIMUM GRADE TO DEVELOP V= 2.3 FPS (PERCENT)	MAXIMUM GRADE TO DEVELOP V=4.5 FPS (PERCENT)
6	0.70	2.46
8	0.44	1.73
10	0.33	1.21
12	0.26	0.97
15	0.19	0.72
18	0.15	0.57
21	0.13	0.46
24	0.11	0.38
27	0.09	0.33

2. For sewers larger than 27-inches in diameter, the Professional Engineer of Record shall determine the appropriate grade utilizing the Manning Formula, n = 0.013 and a minimum full pipe velocity of 3.0 fps.

8.2.01.I Line Alignment

1. Gravity sewers shall be laid in straight alignment with uniform grade between manholes. Deviations from straight alignment shall be justified by complying with the TCEQ requirements and approved by the City. Deviations from uniform grade without manholes shall not be allowed.

8.2.01.J Manholes

1. Manholes shall be prefabricated or precast, as per Standard Specifications and Details, unless the Professional Engineer of Record submits a cast-in-place manhole design for review and approval by the City. The Professional Engineer of Record shall determine the need for a liner or coating on concrete manholes. Liner or coatings will be as per Standard Specifications. Fiberglass manholes, per Standard Details are not allowed within the existing or proposed pavement but are allowed outside the street Right-of-Way. Precast manholes shall incorporate a boot-type connector for sewer diameters up to 24-inches. For sewer diameters greater than 24-inches, utilize either the boot-type connector (if available) or an integral gasket. Precast manholes shall conform to the latest ASTM requirements. Manhole covers shall be 32-inches as shown in the Standard Details.

2. Location: For public sewers, manholes shall be placed at changes in alignment, changes in grade, junction points, and either at street, alley, or easement

8.2.01.J.2 continued

intersections as designs may require.

a. Sewers laid in easements shall have a manhole in each street crossed by the sewer.

b. The maximum distance between manholes shall be determined from the following table for 8-inch to 48-inch pipe diameters. Spacing for manholes on mains with diameters larger than 48-inches installed by tunneling methods or open-cut methods shall be determined on an individual project basis.

Table 8.2 - MAXIMUM DISTANCE BETWEEN SANITARY SEWER MANHOLES

PIPE DIAMETER (I.D.) IN INCHES	MANHOLE MAXIMUM SPACING IN FEET
8-15	400
18-48	800
Greater than 48	As approved by the City

c. A design objective is to have sewers with the same, or approximately the same, flow line elevation intersect each other at a 90-degree angle. However, where a true perpendicular intersection cannot be obtained, and where the entering sewer intersects the receiving sewer at, or about, the same flow line elevation, one or more manholes shall be located so that a minimum angle of 80 degrees at the point of intersection can be achieved for the public sewer. When the entering sewer is on the upstream side of the manhole, the minimum angle between the sewers may be reduced to a 45-degree angle provided:

(1) A distinct flow channel can be maintained within the manhole when the flow line elevations of the sewers are at or within one pipe diameter of the smaller pipe; or

(2) The flow line elevation of the entering pipe is above the crown of the primary sewer and clearance can be provided between the sewers.

(3) The design is in compliance with City of Houston Standard Details (02082N-02 & 03)

d. Place manholes at the terminal (most upstream) end of all public sewers. Clean-outs will not be utilized except at the end of each service lead.

8.2.01.J.2 continued

e. Existing manholes located within the city limit shall be identified by the alphanumeric system established by the Department. Refer to Department's "~~GIMS~~Geolink[3]" map's "Wastewater Manholes" data layer for the 8-digit ID #s. If the manhole has no ID #, use the manhole's "Feature ID #" from the "Identify" query-generated pop-up database box.

f. Criteria for Connections to and Utilization of Manholes:

(1) Connections between public sewers at the manhole shall adhere to the following criteria when possible:

(a) The elevation of the crown of the discharging sewer shall either match the elevation of the crown of the receiving sewer or be approved as a special case by the City.

(b) A standard outside drop connection as shown in City of Houston Standard Details is required when the difference in elevation between discharging sewer flow line and receiving sewer flow line is greater than 24-inches.

(2) The routing of a service connection directly to an existing manhole will be allowed only if:

(a) The flow line elevation of the existing sanitary sewer is more than 10 feet below grade and there is no available stack and the lot to be so connected is a single-family, owner-occupied, single lot residence connection to an existing manhole; or

(b) The lot to be so connected is a single-family, single lot connecting to a manhole in a cul-de-sac.

(c) Satisfies discharge requirements of service leads requiring manholes (see Paragraph 8.2.01.D.3).

(3) When routing an approved service lead to a manhole the wall penetration shall not be greater than 10-inches in diameter and shall be sealed using approved water stop and grout, see Paragraph 8.2.01.J.2.f.(2).

(4) When routing an approved service lead to an existing manhole with invert elevation more than 24-inches lower, the connections shall utilize an outside drop and shall adhere to the following criteria, see Paragraph 8.2.01.J.2.f.(3):

[3] https://geohub.houstontx.gov

8.2.01.J.2.f.(4) continued

(a) The manhole wall penetration shall not be greater than 10-inches in diameter,

(b) The outside drop shall be a minimum of 6-inches in diameter and shall be constructed of SDR 26 PVC pipe (ASTM D 3034),

(c) The outside drop shall be located 45-degrees from the upstream side of the public sewer,

(d) Usage of an internal drop will be reviewed on a case-by-case basis. A minimum of 48-inches of clear space shall be maintained inside the manhole between the drop and the opposing manhole wall. The drop pipe shall be firmly and frequently affixed to the manhole wall utilizing stainless steel bands and anchor bolts. All existing coatings shall be repaired per manufacturers recommendations upon completion,

(e) An internal drop shall terminate with a 45-degree bend. The 45-degree bend shall not extend below the top-of-pipe elevation of receiving sanitary sewer, and

(f) The wall penetration shall be sealed using an approved water stop and grout.

(5) When the line is more than 20-feet below grade or the line is greater than 36-inch in diameter a site-specific design is required.

3. Benches and Inverts: The bottom of the manhole shall be provided with a "U" shaped channel that is a smooth continuation of the inlet and outlet pipes. The depth of the "U" shaped channel shall be at least equal to the largest pipe diameter. In manholes with pipes of different sizes, the tops of the pipes shall be placed at the same elevation and flow channels in the invert sloped on an even slope from pipe to pipe. The bench provided above the channel shall be smooth and uniformly sloped at a minimum of 1-inch per foot to a maximum of 1.5 inches per foot, from the wall to the top of the invert channel.

4. Large manholes: All manholes connecting pipes larger than 36-inch and junction boxes shall have the lower corners filleted to prevent solids deposition.

8.2.01.K Lift Stations

8.2.01.K continued

1. Lift station design shall comply with the City of Houston Engineering Design Guidelines Manual for Submersible Lift Stations and Design Guideline Drawings for Submersible Lift Stations, latest revision. The designer shall submit a Final Design Submittal Checklist (available from the City), signed and sealed by the Design Engineer, to ensure that the lift station is designed in compliance with the requirements of applicable codes and regulations. Include a copy of the Engineering Design Report satisfying TCEQ criteria.

8.2.01.L Metro Solutions - Guided Rapid Transit

1. Location of Public Sewers

   a. Public sewers crossing under tracks shall be in steel casing, with minimum pipe size of 10-inches.

   b. Sewer leads (building connections) shall not cross under tracks.

   c. Extend the public sewer stub for a minimum of "depth of sanitary sewer cover + 5 feet" beyond pavement limits.

   d. Relocate existing public sewers for a minimum of 15 feet from centerline of the nearest proposed track.

   e. SDR 35 PVC pipe is not allowed.

   f. Minimum cover of the pipe shall be determined by the Guided Rapid Transit Load Distribution calculations, use the greater of the calculated live or dead loads.

8.2.02 UNSERVED SITES REQUIRING ON-SITE SEWAGE FACILITIES (OSSF) (SEPTIC TANKS)

8.2.02.A Engineer shall conform to applicable County criteria.

8.2.03 SUBMITTALS

8.2.03.A Preliminary Design - Submit the following for review and comment:

1. Copies of any documents, which show approval or exceptions to the City design criteria.

2. Design calculations for line sizes and grades.

3. Contour map for overall area.

4. Plan-and-profile sheets showing proposed improvements (City projects only).

8.2.03.A. continued

5. Geotechnical soils report for the project (City projects only).

8.2.03.B Final Design - Submit the following for approval:

1. Final documents of the above plus plan-and-profile sheets and geotechnical soils reports for non-City projects.
2. Review prints.
3. Original drawings.
4. Complete copy of project specifications.
5. A final engineering design report shall be developed following the latest edition of TCEQ Chapter 217 and submitted to the City for each project. This report shall bear the signed and dated seal of a Professional Engineer registered in the State of Texas who is responsible for the design.

8.2.03.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.

8.2.04 QUALITY ASSURANCE

8.2.04.A Prepare calculations and construction drawings under the supervision of a Professional Engineer trained and licensed under the disciplines required by the drawings. The final construction drawings must be sealed, signed, and dated by the Professional Engineer responsible for the development of the drawings.

8.2.05 RESEARCH REQUIREMENTS

8.2.05.A Discuss project concepts outlining proposed features and usage with City of Houston, ~~Department of~~ Houston Public Works.

8.2.05.B Research existing utility and Right-Of-Way information.

8.2.05.C Verify that no restrictions exist that will deny approval of the project concept.

8.2.06 DESIGN ANALYSIS

8.2.06.A A calculation of design flows for the complete development project.

8.2.06.B Calculations for design of any treatment plant required for the development.

8.2.06.C Calculations for effect of the 25-year storm outfall from any proposed treatment plant.

8.2.07 DRAWINGS

8.2.07.A Drawings shall include layout sheets with contours, plan-and-profile sheets, and detail sheets for special items and treatment plants.

END OF CHAPTER

City of Houston

Design Manual

Chapter 9

STORMWATER DESIGN AND WATER QUALITY REQUIREMENTS

Chapter 9
Table of Contents

Stormwater Design Requirements

SECTIONS PAGE

Stormwater Quality Design Requirements

Stormwater List of Tables

Stormwater List of Figures

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

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

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

9.1.03.~~G~~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.

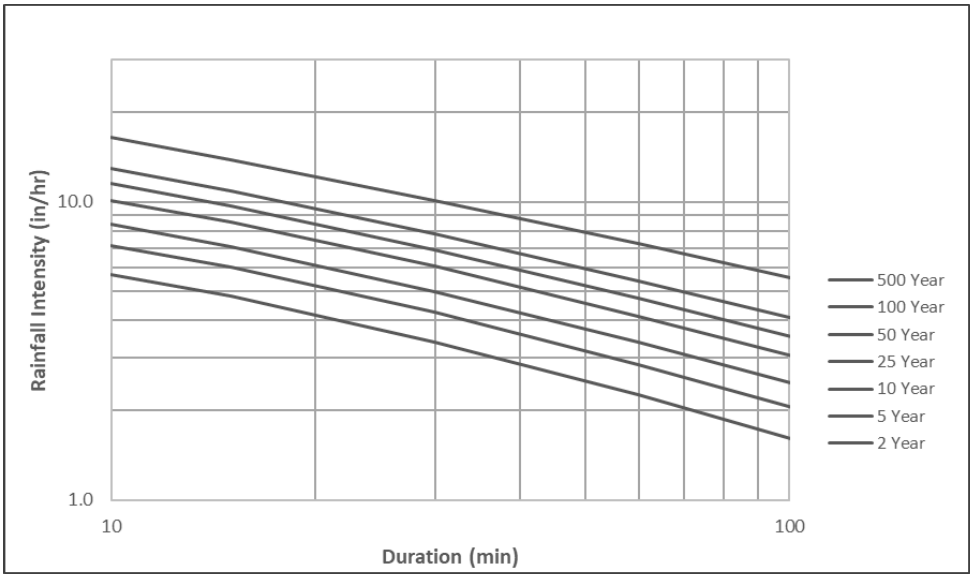
   a. Rainfall Intensity:

      (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. ~~Back lot easements are discouraged and will require a variance from the City design standards~~.

   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. ~~Center culverts inside lot storm sewer easements.~~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.

9.2.01.C.4 continued

k. Conflict manhole shall not be allowed.

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

9.2.01.C.5 continued.

HGL, then the HGL shall be recalculated assuming the starting water surface to be at the top of pipe at that point.

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

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

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 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: $Qt = Qo + Qc + \Delta S/T$
      where Qt, Qo, and Qc are as defined above, and
      $\Delta S/T$ 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. ~~Provide a minimum 20-foot easement to accommodate sheet flow that is routed between lots or across reserve tracts in accordance with~~ Refer to ~~Section 5.07.C.~~ 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 ~~his~~ 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.

9.2.01.F.d continued

d. The design must include an extreme event analysis to indicate that structures 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 disturbed area that results in impervious surface. 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 impervious 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 further impact fee will be required by the City.

9.2.01.H.2 continued

d. If the detention criteria conflicts with HCFCD, Harris County, or TxDOT, the more restrictive criteria shall govern.

e. City no longer allows timing analysis to avoid detention requirements.

3. Calculation of Detention Volume.

a. Detention volume for redevelopment and development areas is calculated on the basis of disturbed area that results in impervious surface, as defined in 9.1.04.O, associated with the project development.

b. Single family residential (SFR) 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.

(1) 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 sheet 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.

(3) 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.

c. SFR lots of 15,000 square feet or less utilizing an ~~shared driveway~~ 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% ~~are required to provide detention~~ at a volume of 0.75 acre-feet per acre. ~~The individual lots will be required to detain based on area in excess of 65% impervious.~~ The entire ~~shared driveway (~~access road, permanent access easement (28' PAE)~~,~~ private alley~~,~~ or public alley~~, or common driveway)~~ will ~~be~~ require~~d~~ 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.(1) continued

(1) 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 common or shared driveway,~~ 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) 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.

d. 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 x (0.75 x 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)

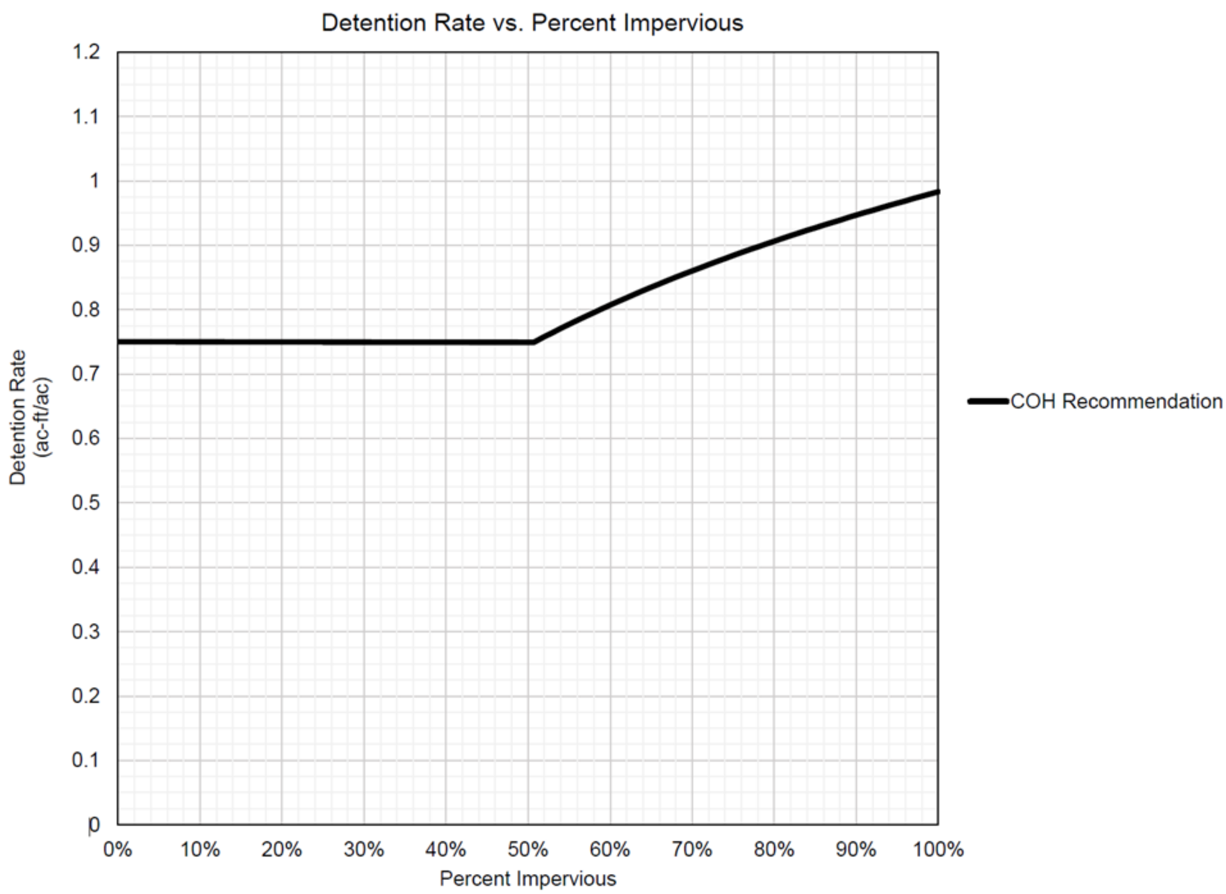
Subdividing of larger tracts (greater than 1 acre) into smaller tracts of 1.0 acre or less to reduce stormwater detention requirements will not be permitted.

9.2.01.H.3.d.(1) continued

(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.

Figure 9.2 - Minimum Detention Rate Chart



9.2.01.H.3.e continued

Table 9.3- Minimum Detention Rate

Proposed Percent Impervious	**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

f. 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

However, 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.

For those properties equal to 20 acres or more, property is added to become larger than 20 acres, then the curve must be utilized on the additional property. The percent impervious surface will be used to define the detention rate.

g. 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.

h. 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.

9.2.01.H.3 continued

i. 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.

j. 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.

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.

k. 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 9.4 below from the HCFCD PCPM for minimum berm widths around a detention basin.

Table 9.4 - 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.

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 9.6~~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 must 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

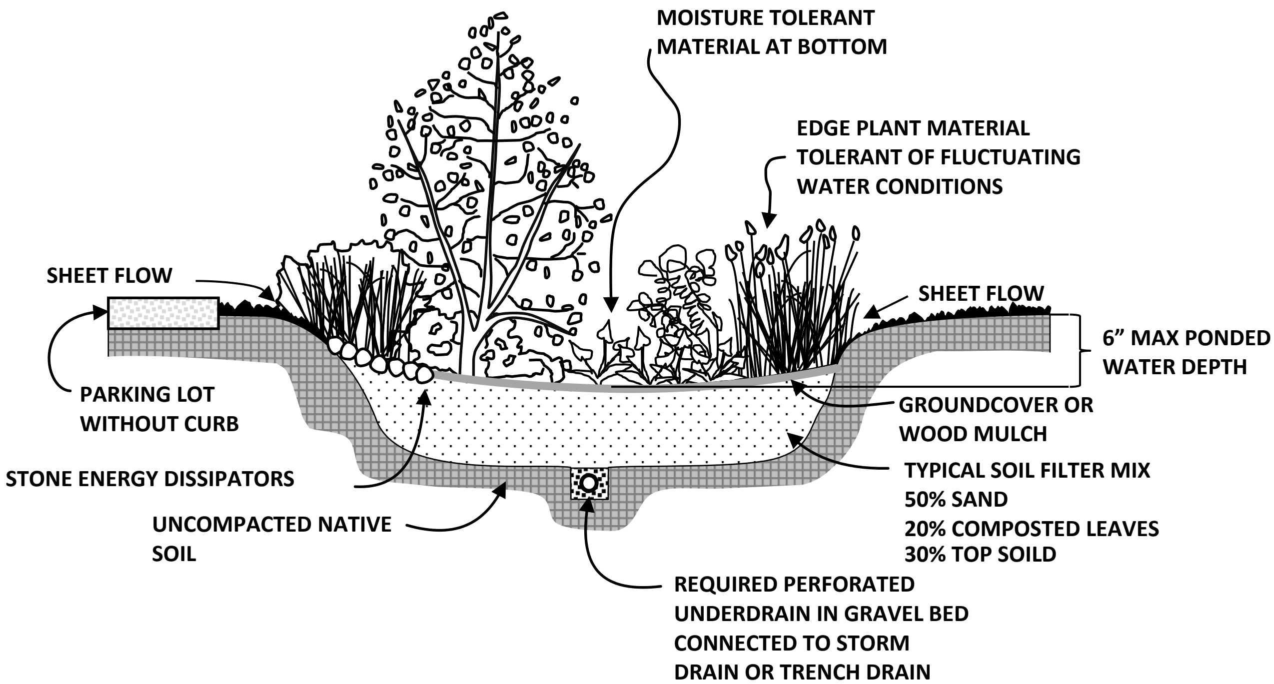
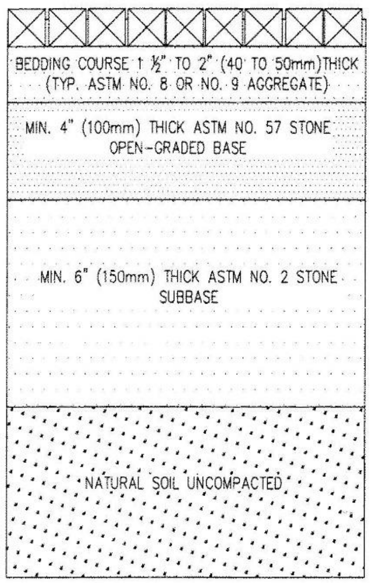


Figure 9.7- POROUS BIORETENTION BASIN

SINGLE FAMILY RESIDENTIAL DRIVEWAYS
INTERLOCKING CONCRETE PERMEABLE PAVER AND
FLEXIBLE PLASTIC GRID PAVER SYSTEMS

CONCRETE PERMEABLE PAVERS OR
FLEXIBLE PLASTIC GRID PAVERS



REQUIREMENTS:

CONCRETE PERMEABLE PAVERS MUST BE MANUFACTURED AND DESIGNATED AS PERMEABLE MATERIAL AND HAVE A MINIMUM THICKNESS OF 3 ⅛".

FLAGSTONE AND OTHER SIMILAR MATERIALS WILL NOT BE CONSIDERED.

FOR PERMEABLE INTERLOCKING CONCRETE PAVERS SUGGEST USING EDGE RESTRAINTS IN ACCORDANCE WITH INTERLOCKING CONCRETE PAVEMENT INSTITUTE (ICPI) GUIDELINES.

FLEXIBLE PLASTIC GRID PAVERS SHALL BE FILLED WITH POROUS MATERIAL AND ANCHORED IN ACCORDANCE WITH MANUFACTURER SPECIFICATION.

INSTALLATION MUST COMPLY WITH MANUFACTURER'S RECOMMENDATIONS FOR PERMEABLE INSTALLATIONS.

MINIMUM BEDDING AND BASE COURSE THICKNESSES SHOWN. ENGINEERED SITE-SPECIFIC CROSS SECTIONS WILL BE CONSIDERED.

GRAVEL AND OTHER AGGREGATES DISPERSED ON GROUND SURFACE ARE NOT CONSIDERED PERMEABLE MATERIALS DUE TO SOIL COMPACTION OVER TIME.

CITY OF HOUSTON DEPARTMENT OF PUBLIC WORKS AND ENGINEERING	
SINGLE FAMILY RESIDENTIAL DRIVEWAYS INTERLOCKING CONCRETE PERMEABLE PAVER AND FLEXIBLE PLASTIC GRID PAVER SYSTEMS (NOT TO SCALE)	
APPROVED BY: CITY ENGINEER	APPROVED BY: DIRECTOR OF PUBLIC WORKS AND ENGINEERING
EFF DATE: SEPT-17-2014	DWG NO:

Figure 9.8 - SINGLE FAMILY RESIDENTIAL DRIVEWAYS

INTERLOCKING CONCRETE PERMEABLE PAVER AND FLEXIBLE PLASTIC GRID PAVER SYSTEMS

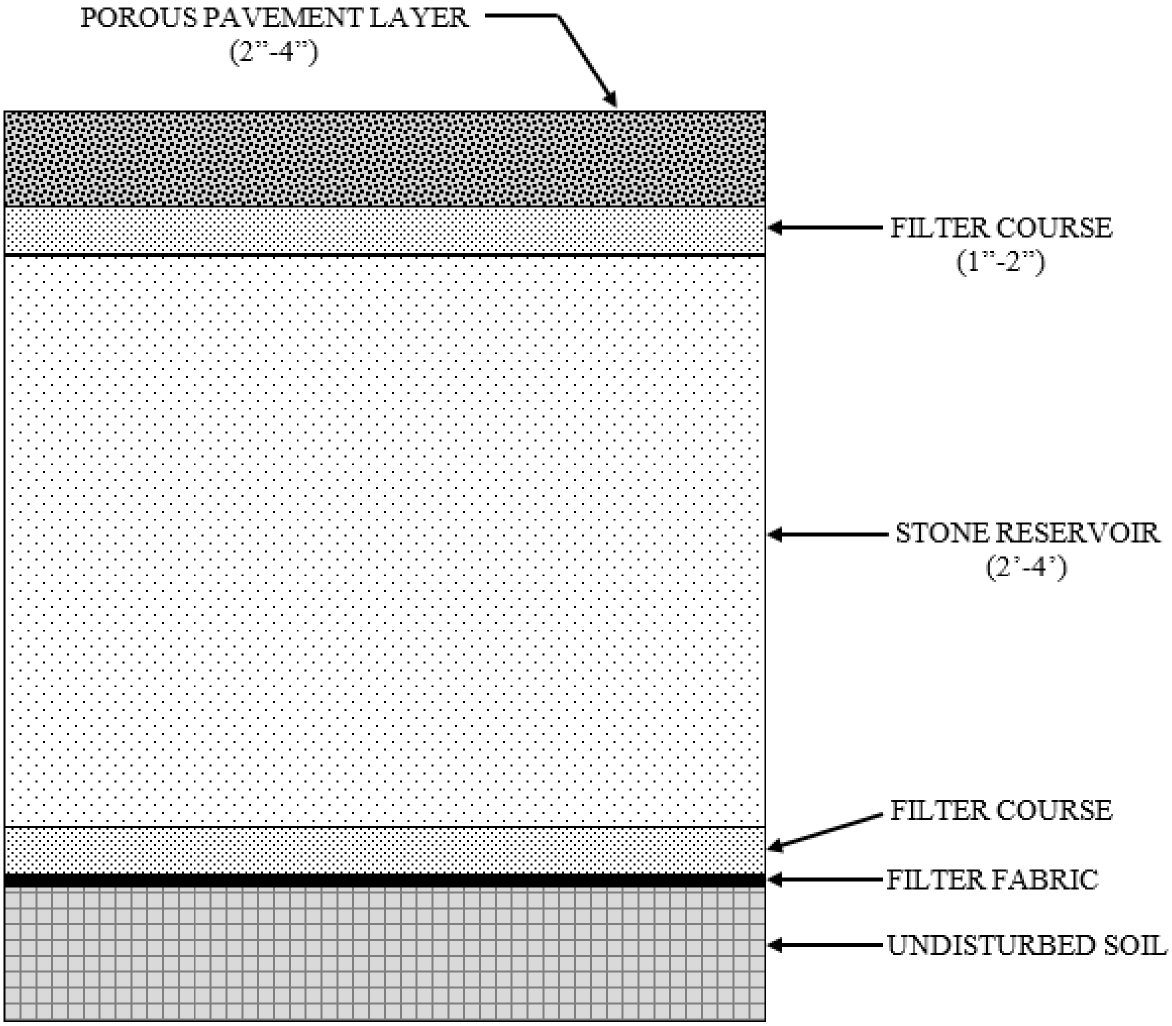


Figure 9.9 – POROUS PAVEMENT TYPICAL SECTION

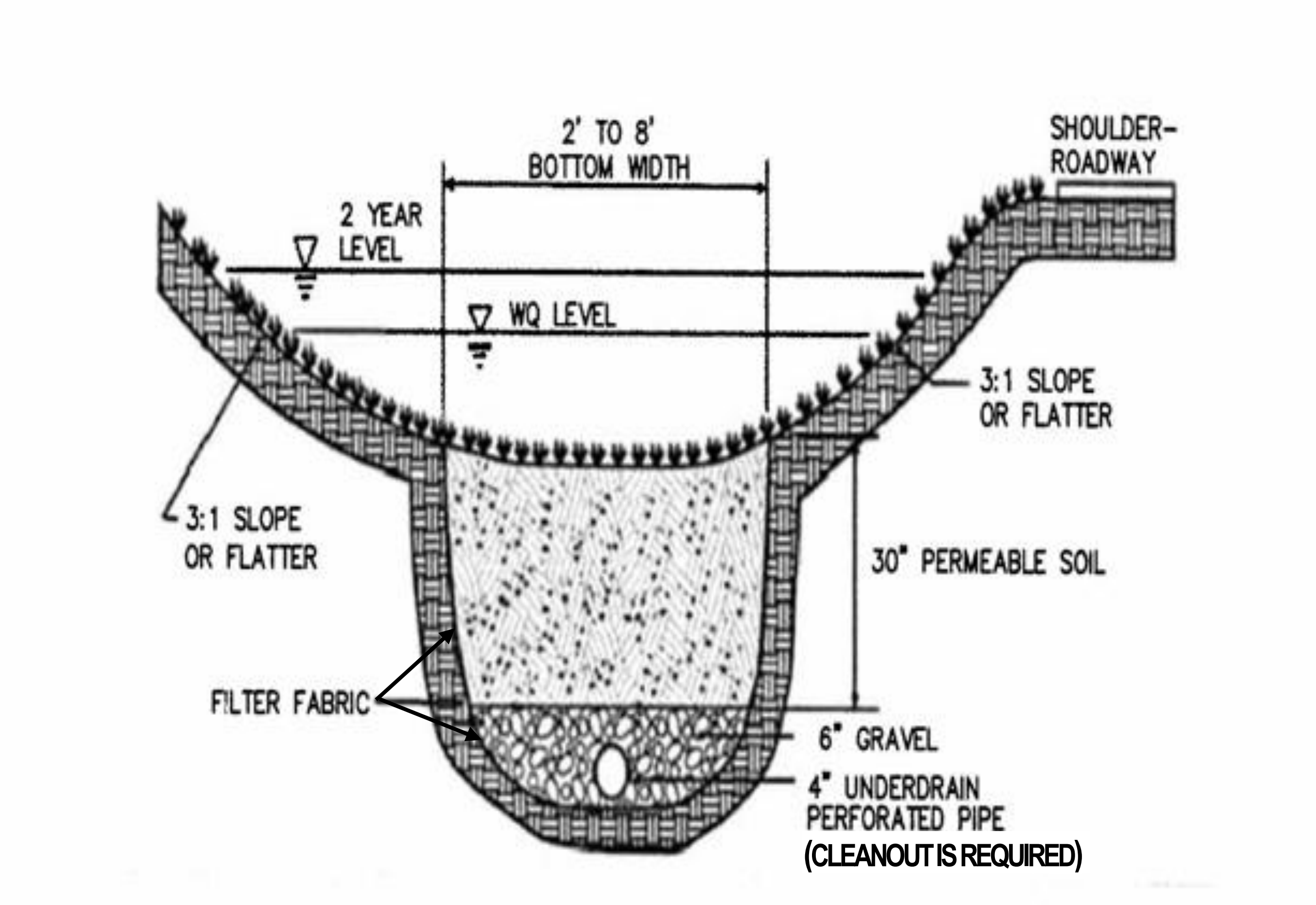


Figure 9.10- DRY SWALE CROSS SECTION

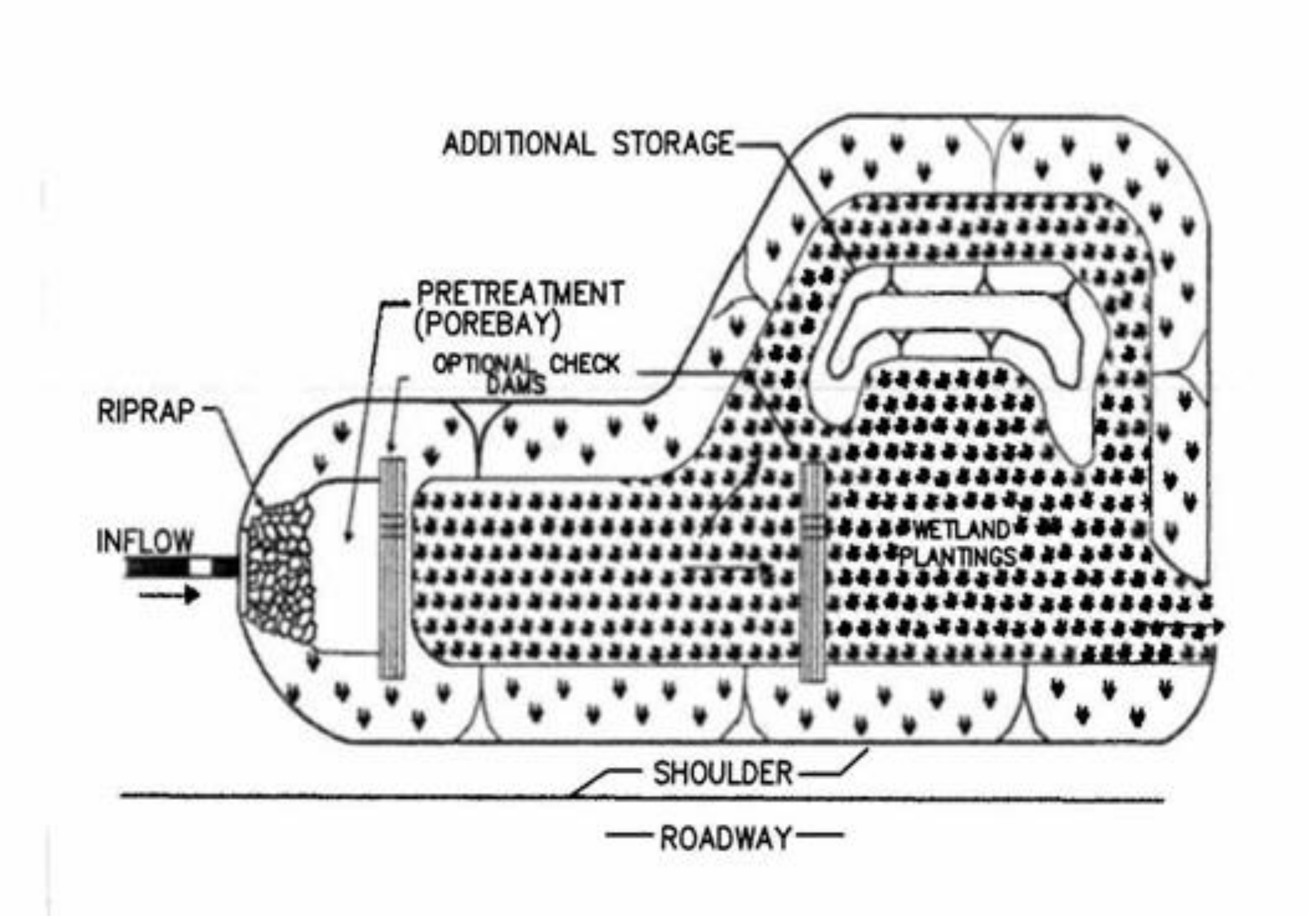


Figure 9.11 – WET SWALE PLAN

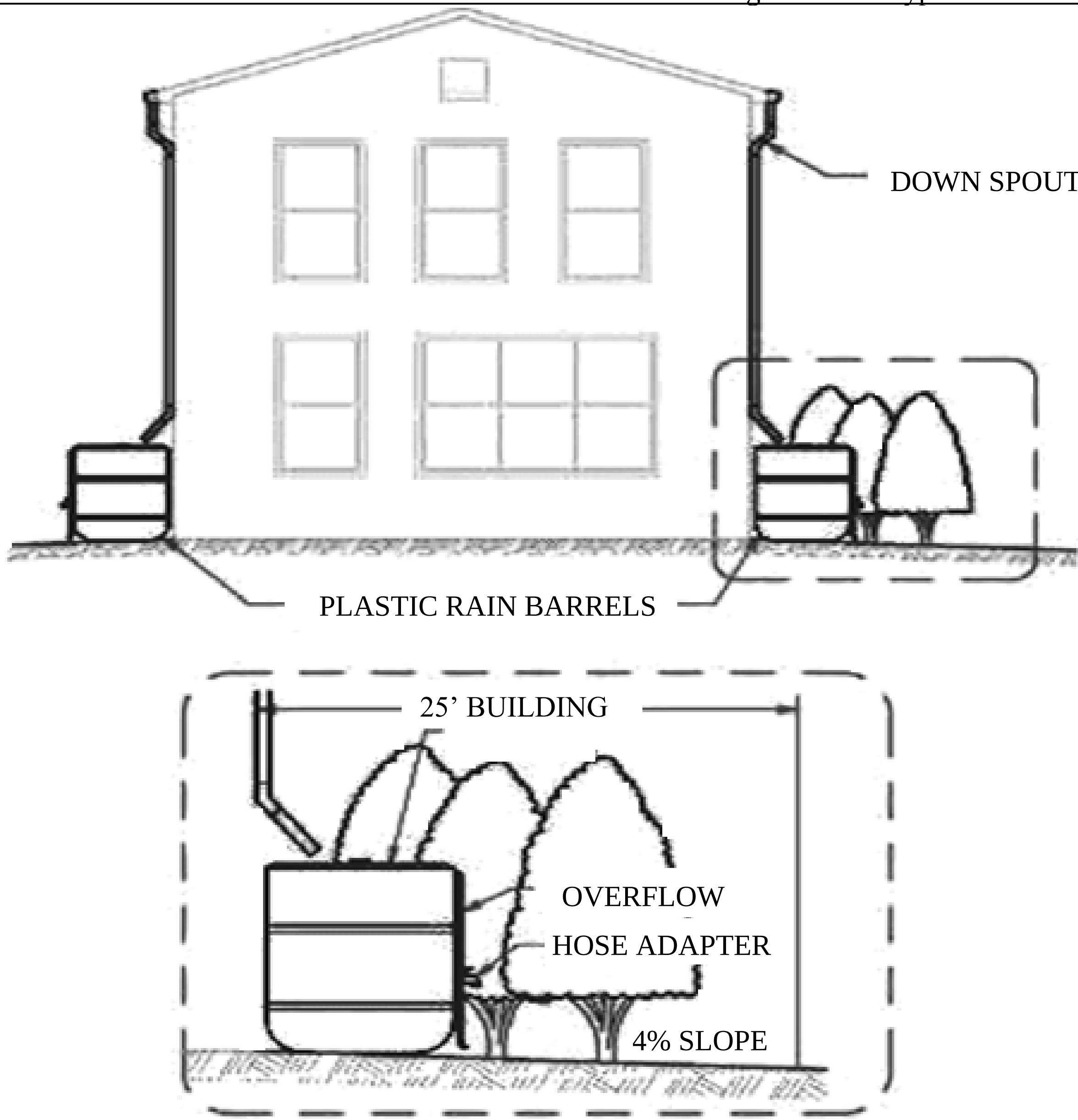


Figure 9.12 – TYPICAL RAIN BARREL

City of Houston

Design Manual

Chapter 13

~~GIS DATA DIGITIZATION STANDARDS~~ GEOSPATIAL DATA DELIVERABLES

Chapter 13
Table of Contents

Geospatial Data Deliverables

List of Tables

List of Figures

CHAPTER 13
GEOSPATIAL DATA DELIVERABLES

SECTION 1 - ~~GIS DATA DIGITAZATION STANDARDS OVERVIEW~~GEOSPATIAL DATA DELIVERABLES OVERVIEW

13.1.01 CHAPTER INCLUDES

13.1.01.A ~~Criteria for the digital submission of GIS data for storm water, wastewater, and water collection systems.~~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.~~13.1.01.B. Feature Class requirements for city-owned storm water, wastewater, and water utility infrastructure assets, which includes lines and points. Required field parameters and associated domain names and valid codes. Quality Assurance processes to determine acceptance of final deliverable.~~

13.1.02 ~~POLICY~~BACKGROUND

13.1.02.A The City of Houston has adopted geographic information systems (GIS) technolog~~ies~~y in order to store, manage, and maintain spatially related geographic data. ~~The database where~~ Houston Public Works (HPW) stores ~~the utilities system is called a geodatabase~~all its spatial assets with-in an enterprise geodatabase. It is a native data structure for ArcGIS, which is a collection of geographic datasets, including F~~f~~eature C~~c~~lasses, G~~g~~eometric N~~n~~etworks, raster data, attribute tables, annotation, T~~t~~opology, etc. It provides the ability to leverage data relationships and~~,~~ enforce ~~data~~integrity~~, and~~ using data-rich features. Its benefits include centralized data storage, efficient data delivery, D~~d~~atabase M~~m~~anagement S~~s~~ystems (DBMS) security and reliability, G~~g~~eodatabase R~~r~~eplication, 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, included but not limited to c~~C~~apital ~~I~~improvement p~~P~~rojects (CIP) and ~~D~~developer ~~P~~participation ~~C~~contracts (DPC) in the City of Houston Enterprise GIS geodatabase model format. ~~Adherence to the guidelines outlined in this chapter is required in order to maintain compatibility between various projects~~ 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.

~~13.1.03~~13.1.04 DEFINITIONS

~~13.1.03.A~~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

~~13.1.03.B~~13.2.02.A The horizontal accuracy of ~~the boring points~~ any feature shall meet or exceed submeter accuracies of two (2) feet horizonal root mean square (RMS).

~~SECTION 2~~SECTION 3 - GIS DATA COLLECTION METHODS

~~13.2.01~~13.3.01 COLLECTION METHOD REQUIREMENTS

~~13.2.01.A~~13.3.01.A GIS digital data collection ~~may~~ shall be captured using one of two approaches:~~;~~ field data collection with office processes or only office processes. The appropriate method ~~should~~shall be determined by the ~~Contractor,~~Engineer of Record and ~~City~~ Project Manager~~, and Service Line GIS Project Manager~~. If the accuracy required in this chapter is not possible through office processes alone, field data collection is required.

~~13.2.01.B~~13.3.01.B Field Data Collection~~ and~~ w~~W~~ith Office Processes.

1. Field data collection, if required, shall be performed by a Registered Professional Land Surveyor (RPLS).

2. Utilize conventional methods or ~~other methods to gain the highest accuracies possible, preferably by utilizing~~ Global Navigation Satellite System (GNSS) devices/receivers to achieve the accuracy required by this chapter.

3. ~~The Contractor shall u~~Use the appropriate software ~~currently provided by vendors such as ESRI, Trimble, CartoPac, and MapText~~ to collect data in the field. ~~No matter the software used, the correct domains shall be used to populate drop down menus to minimize data entry errors.~~

4. ~~For this method the Contractor would c~~Collect the spatial location of ~~all manholes, inlets, and outfalls~~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 ~~would~~ can be determined from the post construction as-built or CAD drawings.

5. The line and polygon features ~~would~~ can be ~~done~~ created in the office provided they connect field verified points.

6. Provide a GIS deliverable signed and sealed by a RPLS that includes ~~T~~the process by which the field data is gathered, GNSS information (e.g. number of satellites)~~ recorded as part of the collected feature~~is gathered, and any associated field notes and sketches~~ shall be provided as a table with the GIS deliverable and be signed and sealed by an RPLS~~.~~.~~

~~13.2.01.C~~13.3.01.C Office Processes Only.

1. ~~In the office d~~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 ~~by the Contractor in a Descriptive Document.~~to the City and be signed and sealed by the Engineer of Record.

~~SECTION 3~~SECTION 4 - ~~STORM WATER GIS DIGITAL SUBMISSION REQUIREMENTS~~ASSET SPECIFICS

~~13.3.01~~13.4.01 STORM WATER ASSET INFORMATION~~FEATURE CLASSES~~

~~13.3.01.A Currently there are 14 feature classes or layers in the storm water drainage system dataset.~~

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.

~~1.~~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).

~~13.3.01.B~~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

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
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 Elevation	X							X						
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				

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
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	
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

~~13.3.02~~13.4.02 WASTEWATER ~~FEATURE CLASSES (FEATURE CLASS NAME; FEATURE TYPE; SUBTYPE(S))~~ ASSET INFORMATION

~~13.3.02.A~~13.4.02.A Wastewater Asset Descriptions.

1. Abandoned Wastewater Line/Point ~~(sAbandonedLine; Line / sAbandonedPoint; Point)~~ – Any wastewater infrastructure that was installed, used, and maintained, and is no longer in use but was not removed.

2. Casing ~~(sCasing; Line)~~ – A pipe, typically made of steel, which is not designed to convey wastewater, but instead surrounds and protects a sewer line.

~~Casing (Subtype Value: 1)~~

3. Cleanout ~~(sCleanOut; Point)~~ – 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.

~~1. Cleanout (Subtype Value: 22) – do not digitize cleanouts that are installed on~~

4. Fitting ~~(sFitting; Point)~~ – 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 F~~f~~eature C~~c~~lass are cleanouts, manholes, network structures, and valves.

~~1. Interconnect (Subtype Value: 4)~~
~~2. Plug (3)~~
~~3. Stack (10)~~
~~4. Star Tap (2)~~
~~5. Wye (7)~~

5. Force Main ~~(sForceMain; Line)~~ – A sewer line which conveys wastewater under pressure.

~~1. Force (Subtype Value: 1)~~

6. Gravity Main ~~(sGravityMain; Line)~~ – A sewer line which, due to its slope, conveys wastewater using only gravity.

13.4.02.A continued

~~1. Small Diameter Main (Subtype Value: 3) – Defined as a non-siphon main having a diameter of less than or equal to 24-inch.~~

~~2. Large Diameter Main (8) – Defined as a non-siphon main having a diameter greater than 24-inch.~~

~~3. Siphon (5)~~

7. Manhole ~~(sManhole; Point)~~ – 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.

~~1. Junction Box (Subtype Value: 13)~~

~~2. Manhole (12)~~

8. Network Structure ~~(sNetworkStructure; Point)~~ – A facility which contains infrastructure elements that directly pump and/or treat wastewater.

~~1. Lift Station (Subtype Value: 30)~~

~~2. Private Pump Station (31)~~

~~3. Treatment Plants (33)~~

~~4. Wet Weather Facility (29)~~

9. Service Lead ~~(sServiceLine; Line)~~ – Also called service line, a sewer pipe that connects a private property to a public sewer line.

~~Service Lead (Subtype Value: 0)~~

10. Valve ~~(sControlValve / sSystemValve; Point)~~ – An appurtenance installed on force mains that controls flow.

~~1. Air Valve (Subtype Value: 26)~~

~~13.3.02.B~~13.4.02.B ~~WASTEWATER GIS SUBMISSION REQUIREMENTS~~Wastewater Asset Requirements.

~~13.3.02.A Projected Coordinate System~~

~~NAD_1983_StatePlane_Texas_South_Central_FIPS_4204_Feet~~

~~13.3.02.B Required Feature Classes~~

~~1. For Reference~~

~~a. Right of Way (both current and proposed, if applicable)~~

~~b. Easements~~

~~c. Property Llines (both current and proposed, if applicable)~~

1. ~~2. Include all existing utility infrastructure as required for plan and profile submissi3.~~ As applicable, all ~~new~~wastewater ~~lines and points~~asset features must contain the required information ~~shall be included in theirrespective feature classes, with required fields for each feature class~~ 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, the Geospatial Data Deliverables Properties Guide.

~~Table 13.44~~ Table 13.2- ~~Fields Required per Feature Class (Wastewater)~~INFORMATION REQUIRED FOR WASTEWATER ASSETS

~~FIELD / Feature Class~~Information	**Asset**								
	Casing	Cleanout	Fitting	Force Main	Gravity Main	Manhole	Network Structure	Service Lead	Valve
~~BURIEDDEPTH~~Buried Depth		x				x			
~~CREATIONSOURCE~~Creation Source	*	*	*	*	*	*	*	*	*
~~DATASOURCETYPE~~Data Source Type	X	X	X	X	X	X	X	X	X
~~DATUM~~Datum	X	X	X	X	X	X	X	X	X
~~DATUM_YEAR~~Datum Year	X	X	X	X	X	X	X	X	X
~~DIAMETER~~Diameter	X		X	X	X	X		X	X
~~DISTTODSMH (abbr.)~~Distance to Downstream Manhole		X	*			X		X	
~~DOWNSTREAMDIRECTION~~Downstream Direction		X	*			X			
~~DOWNSTREAMINVERT~~Downstream Invert					X				
~~FISCALYEAR~~Fiscal Year	X	X	X	X	X	X	X	X	X
~~FLOWELEVATION~~Flow Elevation		X				X			
~~GFSORWBS~~GFS Or WBS	*	*	*	*	*	*	*	*	*
~~GFSWBSNUMBER~~GFS or WBS Number	*	*	*	*	*	*	*	*	*
~~ILMSNUMBE~~	*	*	*	*	*	*	*	*	*

~~FIELD /~~ ~~Feature Class~~Information	**Asset**								
	Casing	Cleanout	Fitting	Force Main	Gravity Main	Manhole	Network Structure	Service Lead	Valve
~~R~~ILMS Number									
~~INLETELEVATION~~Inlet Elevation						*	X		
~~INLETELEVATION2~~Inlet Elevation 2						*			
~~INLETELEVATION3~~Inlet Elevation 3						*			
~~INSERVICEDATE~~In Service Date	X	X	X	X	X	X	X	X	X
~~LENGTH~~Length	X			X	X			X	
~~LIFECYCLESTATUS~~Life Cycle Status	X	X	X	X	X	X	X	X	X
~~MATERIAL~~Material	X		X	X	X	X		X	
~~NOTES~~Notes	*	*	*	*	*	*	*	*	*
~~OWNER~~Owner	X	X	X	X	X	X	X	X	X
~~PERCENTSLOPE~~Percent Slope					X			X	
~~PLANDATE~~Plan Date	X	X	X	X	X	X	X	X	X
~~PLANNUMBER~~Plan Number	X	X	X	X	X	X	X	X	X
~~PLANTYPE~~Plan Type	X	X	X	X	X	X	X	X	X
~~PROJECTNUMBER~~Project Number	*	*	*	*	*	*	*	*	*
~~PROJECTTYPE~~Project Type	*	*	*	*	*	*	*	*	*
Record Drawing Number	**	**	**	**	**	**	**	**	**
~~RIMELEVATION~~Rim Elevation						X			
~~SIZEOFCOVER~~Size of Cover		X				X			
~~SUBTYPECD~~	X	X	X	X	X	X	X	X	X

13.4.03.A continued

~~FIELD~~/ ~~Feature~~ ~~Class~~Information	Asset								
	Casing	Cleanout	Fitting	Force Main	Gravity Main	Manhole	Network Structure	Service Lead	Valve
Subtype Code									
~~TYPE~~Type						X			
~~UPSTREAMINVERT~~Upstream Invert					X			X	

*If applicable
**For public/private projects only

~~13.3.03~~13.4.03 ~~WATER FEATURE CLASSES (FEATURE CLASS NAME; FEATURE TYPE; SUBTYPE(S))~~WATER ASSET INFORMATION

13.4.03.A Water Asset Descriptions.

1. Abandoned Water Line/Point ~~(wAbandonedLine; Line / wAbandonedPoint; Point)~~ – Any water infrastructure that was installed, used, and maintained, and is no longer in use but was not removed.

2. Casing ~~(wCasing; Line)~~ – A pipe, typically made of steel, which is not designed to carry water, but instead surrounds and protects a water line.

~~3. Casing (Subtype Value: 7)~~

~~4.~~3. Control Valve ~~(wControlValve; Point)~~ – ~~An appurtenance usually placed at the dead-end of a smaller diameter distribution line or at the high point(s) of a large diameter transmission main typically to allow for the release of trapped air in the system.~~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.

~~5. Air Valve (Subtype Value: 26)~~

~~6. Blow Off (27)~~

~~7. Air Release Valve Inside Manhole (28)~~

~~8. Air Release Valve Inside Vault (29)~~

~~9. Drain Valve in Manhole (30)~~

~~10.~~4. Fitting ~~(wFitting; Point)~~ – 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 F~~f~~eature C~~c~~lass are control valves, hydrants, meters, pressure reducing stations, sampling stations, and system valves.

~~11. Line Interconnect (Subtype Value: 4)~~

~~12. Plug (1)~~

~~13. Reducer (2)~~

~~14. Tap Sleeve (3)~~

~~15. Water Logical Node (5)~~

~~16.~~5. Hydrant ~~(wHydrant; Point)~~ – A structurally independent device used primarily for fire or water quality events.

~~17.~~6. Lateral Service ~~(wLateralService; Line)~~ – Also called service line, a water pipe that connects a public water line to a fire service and/or private property.

~~18. Hydrant Lead (Subtype Value: 5) – Includes all lines that establish a connection from the main line to a fire hydrant.~~

~~19. Fire Line (6) – All publicly owned, typically via easement, lines that serve a property for the purpose of fire protection. Also included are lines that establish a connection from the main line to a meter that serves a private property.~~

~~20.~~7. Meter ~~(wMeter; Point)~~ – A device that measures water passing through a point. This also serves as a demarcation between a public ownership from private ownership.

~~21. Meter (Subtype Value: 10) – Used to indicate the location of any physical meter.~~

~~22. Unmetered Sprinkler (11) – Used to indicate the transition point between public and private ownership on an unmetered fire line, typically at the limits of the applicable right of way or easement.~~

~~23.~~8. Pressure Reducing Station ~~(wPressureReducingStation; Point)~~ – 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.

~~24. Pressure Reducing Station in Vault (Subtype Value: 31)~~

~~25.~~9. Pump Pressure Main ~~(wPumpPressureMain; Line)~~ – 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.

~~26. Distribution Main (Subtype Value: 1) – Defined as a non-well collection main having a diameter of less than 24-inch.~~

~~27. Transmission Main (2) – Defined as a non-well collection main having a diameter greater than or equal to 24-inch.~~

~~28. Well Collection (8)~~

~~29.~~10. Sampling Station ~~(wSamplingStation; Point)~~ – A point at which a sample of water for testing and quality control purposes can be taken directly.

~~30. Test Station (Subtype Value: 9)~~

~~31.~~11. System Valve ~~(wSystemValve; Point)~~ – An appurtenance installed on mains that control flow of water.

~~32. Butterfly (Subtype Value: 19)~~

~~33. Butterfly Valve in Manhole (22)~~

~~34. Gate (21)~~

~~35. Hydrant Gate Valve (33)~~

~~36. Valve from Tapping Sleeve (20)~~

~~13.3.03.B~~13.4.03.B ~~WATER GIS SUBMISSION REQUIREMENTS~~Water Asset Requirements.

~~13.4.02.A Projected Coordinate System: NAD_1983_StatePlane_Texas_South_Central_FIPS_4204_Feet~~
~~13.4.02.B Required Feature Classes~~
~~1. For Reference~~
~~Right of Way (both current and proposed, if applicable)~~
~~Easements~~
~~Property Lines (both current and proposed, if applicable)~~
~~Edges of Pavement and Sidewalk (both current and proposed, if applicable)~~
~~2. Include all existing utility infrastructure as required for plan and profile submission.~~

1. ~~3.~~ As applicable, all ~~new~~ water ~~lines and points~~ asset features must~~shall be included in their respective feature classes, with required fields for each feature class~~ 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.

~~3.~~

~~Table 13.45~~ Table 13.3- ~~Fields Required per Feature Class (Water)~~INFORMATION REQUIRED FOR WATER ASSETS

~~FIELD / Feature Class~~Information	**Asset**									
	Casing	Control Valve	Fitting	Hydrant	Lateral Service	Meter	Pressure Reducing Station	Pump Pressure Main	Sampling Station	System Valve
~~CREATIONSOURCE~~Creation Source	*	*	*	*	*	*	*	*	*	
~~DATASOURCETYPE~~Data Source Type	X	X	X	X	X	X	X	X	X	X
~~DIAMETER~~Diameter	X				X	X		X		X
~~FISCAL_YEAR~~Fiscal Year	X	X	X	X	X	X	X	X	X	X
~~GFSORWBS~~GFS or WBS Number	*	*	*	*	*	*	*	*	*	*
~~GFSWBSNUMBER~~GFS or WBS Number	*	*	*	*	*	*	*	*	*	*
~~GROUNDCOVER~~Ground Cover								X		
~~HYDRANTLEADDIAMETER~~Hydrant Lead Diameter				X						
~~ILMSNUMBER~~ILMS Number	*	*	*	*	*	*	*	*	*	*
~~INSERVICEDATE~~In Service Date	X	X	X	X	X	X	X	X	X	X
~~LARGEMAINDIAMETER~~Large Main Diameter			*				*			
~~LENGTH~~Length	X				X			X		
~~LIFECYCLESTATUS~~Life Cycle Status	X	X	X	X	X	X	X	X	X	X
~~MATERIAL~~Material	X				X			X		
~~MAINDIAMETER~~Main Diameter				X		X				

13.4.04.A continued

~~FIELD / Feature Class~~Information	**Asset**									
	Casing	Control Valve	Fitting	Hydrant	Lateral Service	Meter	Pressure Reducing Station	Pump Pressure Main	Sampling Station	System Valve
~~NOTES~~Notes	*	*	*	*	*	*	*	*	*	
~~OWNER~~Owner	X	X	X	X	X	X	X	X	X	X
~~PLANDATE~~Plan Date	X	X	X	X	X	X	X	X	X	X
~~PLANNUMBER~~Plan Number	X	X	X	X	X	X	X	X	X	X
~~PLANTYPE~~Plan Type	X	X	X	X	X	X	X	X	X	X
~~PROJECTNUMBER~~Project Number	*	*	*	*	*	*	*	*	*	*
~~PROJECTTYPE~~Project Type	*	*	*	*	*	*	*	*	*	*
Record Drawing Number	**	**	**	**	**	**	**	**	**	**
~~SERVICEADDRESS~~Service Address						X				
~~SMALLMAINDIAMETER~~Small Main Diameter			*				*			
~~SUBTYPECD~~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

~~13.3.03.C~~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.

2. geoBoringTestResults (Table) – Boring log test results stored in a tabular format.

~~13.3.03.D~~13.4.04.B Geotechnical and Environmental Feature Class Requirements.

1. ~~The following tables contain all fields found in the boring point features and associated boring test result table with corresponding description, alias name, and domain value names. For purposes of this deliverable t~~The boring point features are connected to the associated boring test results ~~record~~ through the PROJECTID field. The PROJECTID field is a unique

13.4.04.B.4.a.(2) continued

identifier generated by the ~~C~~consultant through the concatenation of the ~~R~~report ~~T~~type, ~~R~~report ~~Y~~year, the WBS ~~N~~number and BoreID.

2. The relationship between the geoBoring point and the geoBoring Test Results ~~are~~is a one to ~~one~~many (1:M~~1~~) relationship with one point being related directly back to ~~one~~many test results where the geoBoring point is the parent and the geoBoring Test Results ~~are~~is the child table. This data will be appended into a larger enterprise dataset maintained by the City where bore ~~ids~~IDs are recurring between different reports. The City will create a separate unique identifier for the dataset during the C~~c~~ity's internal quality control process, and prior to publishing to the production database.

3. To ensure that the data is distinct, the ~~C~~consultant will ~~deliver~~provide a project ~~id~~ID which will serve as the interim unique identifier delivered with the data. The PROJECT ID field ~~needs~~must ~~to~~ 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

         (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 13.56~~ Table 13.4- ~~Fields Required Feature Class and Table~~INFORMATION REQUIRED FOR GEOTECHNICAL AND ENVIRONMENTAL FEATURE CLASSES

FIELD ~~**/ FEATURECLASS**~~	**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
ATTERBERGLIMITSLL		X
ATTERBERGLIMITSPL		X
ATTERBERGLIMITSPI		X
PERPASSSIEVE200		X
TSFUNCONFCOMPTEST		X

FIELD ~~/ FEATURECLASS~~	**Feature Class**	
	geoBoring	geoBoringTestResults
TSFUUTEST		X
TSFCONFININGPRESS		X
TSFTORVANE		X
TSFPOCKETPENETROMETER		X
TYPEOFMATERIAL		X
PID**		X

*~~The field is o~~Only required for geotechnical borings and is not a requirement for environmental borings.
**~~The field is o~~Only required for environmental borings and/or test results and is not a requirement for geotechnical borings.

~~13.3.03.E~~13.4.04.C Alternative Tabular Deliverable Requirements for Geotechnical and Environmental Data.

1. The City's preference is to receive~~deliver this data~~ 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~~ file geodatabase,~~ corresponding text file~~,~~ or excel spreadsheet must~~will~~ be named: BoringData_WBS_Number. For tabular data, the City will specify the delivery method during project planning. ~~The WBS number is a unique identifier for each project as assigned by the City.~~

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 13.51~~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 13.52~~ 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	
~~CONSULTANTPROJECTNO~~ CONSULTANTNAME	Text	~~Consultant assigned number for the project~~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	

Field Name	Type	Description	List Values
DRYDENSITY	Numeric	Dry density of sample measured in pounds per cubic foot (pcf)	
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 13.53~~ Table 13.7 - GEOYESNO LIST

Value	Description
0	No
1	Yes

~~Table 13.54~~Table 13.8 - GEOSAMPLETYPE LIST

Value	Description
UD	Undisturbed Sample
SS	Split Spoon Sample
AG	Auger Cuttings
SPT	Standard Penetration Test

~~Table 13.55~~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 13.35~~ Figure 13.1- SAMPLE HEADING AND FORMAT FOR GEOBORING EXCEL

SUMMARY OF LABORATORY TEST RESULTS								PROJECT NAME:								
								COH WBS NUMBER:								
Geotechnical Consultant's Name								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

DATA

~~Figure 13.36~~ Figure 13.2- SAMPLE TEST RESULTS FOR GEOBORINGTESTRESULTS

EXCEL DATA

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.

~~(2)~~(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.

~~13.3.03.F~~13.6.01.B For details regarding the digital deliverable submission process please refer to the Geospatial Data Deliverables Properties Guide.

~~Table 13.43 Storm Water Feature Classes~~

~~#~~	~~Layer~~	~~Feature Type~~
~~1~~	~~swAbandonedGravityMain~~	~~Line~~
~~2~~	~~swAbandonedOpenDrain~~	~~Line~~
~~3~~	~~swAbandonedPoint~~	~~Point~~
~~4~~	~~swDetention~~	~~Polygon~~
~~5~~	~~swDischargePoint~~	~~Point~~
~~6~~	~~swEasement~~	~~Polygon~~
~~7~~	~~swFitting~~	~~Point~~
~~8~~	~~swGravityMain~~	~~Line~~
~~9~~	~~swInlet~~	~~Point~~
~~10~~	~~swManhole~~	~~Point~~
~~11~~	~~swNetworkStructure~~	~~Point~~
~~12~~	~~swOpenDrain~~	~~Line~~
~~13~~	~~swUnderPass~~	~~Point~~
~~14~~	~~swVirtualDrainline~~	~~Line~~

~~13.2.02 STORM WATER ATTRIBUTES~~
~~13.2.02.A Storm Water Feature Class Fields~~

~~The Storm Water Maintenance Branch (SWMB) i~~In 2018, Storm Water Operations (SWO) ~~completed a GIS data migration from an ArcFM data structure to the ESRI Local Government Information Model (LGIM) data structure. As part of the migration the geometric network was~~

~~created to include both open and closed storm sewer systems. Features classes that do not participate in the geometric network are swAbandonedGravityMain, swAbandonedOpenDrain, swAbandonedPoint, swDetention, swEasement, and swUnderpass. The following table contains all fields found in the storm water features classes with corresponding description, alias name, and domain value names.~~

~~Table 13.2 Feature Class FieldsFieldName~~	~~Length~~	~~Description~~	~~AliasName~~	~~DomainName~~
~~ABANDONSTATUS~~	~~5~~	~~Indicates if abandoned or removed~~	~~Abandon Status~~	~~AbandonStatus~~
~~ACTIVEFLAG~~	~~2~~	~~Indicates if the feature is in use/active~~	~~Active Flag~~	~~BooleanDomain~~
~~ADDRESS~~	~~100~~	~~The street address~~	~~Address~~	
~~BEDMATERIAL~~	~~50~~	~~The material on the bed of the detention area~~	~~Bed Material~~	~~piOpenStructureMaterial~~
~~BEDMATERIAL~~	~~50~~	~~The material on the bed of the open drain~~	~~Bed Material~~	~~piOpenStructureMaterial~~
~~BNKMATERIAL~~	~~50~~	~~The material on the bank of the detention area~~	~~Bank Material~~	~~piOpenStructureMaterial~~
~~CHANNELNAME~~	~~50~~	~~Name of the Channel~~	~~Channel Name~~	
~~COMMENTS~~	~~200~~	~~Additional information or comments~~	~~Comments~~	
~~COMPANY~~	~~150~~	~~Group that project is assigned to~~	~~Company~~	~~AssignedTo~~
~~COUNCILDISTRICT~~	~~1~~	~~Council District the asset belongs to~~	~~Council District~~	~~piCouncilDistrict~~
~~CROSSINGTYPE~~	~~50~~	~~The type of crossing at underpass~~	~~Crossing Type~~	~~piCrossingType~~
~~DATASOURCETYPE~~	~~5~~	~~Type of source data used to capture the information~~	~~Data Source Type~~	~~piDataSourceType~~
~~DEPTH~~	~~8~~	~~The depth of the detention area in feet~~	~~Depth (in Feet)~~	

~~DISCHRGTYP~~	~~50~~	~~The type of storm water discharge point~~	~~Discharge Type~~	~~piDischargePointType~~
~~DOWNDEPTH~~	~~8~~	~~The downstream depth of the gravity main~~	~~Downstream Depth~~	
~~DOWNELEV~~	~~8~~	~~The downstream elevation where the pipe meets the manhole~~	~~Downstream Elevation~~	
~~DOWNSTMNODE~~	~~11~~	~~The downstream storm node Facility ID~~	~~Downstream Storm Node~~	
~~DRAINAGEAREA~~	~~5~~	~~Drainage area the asset belongs to~~	~~Drainage Area~~	
~~FACILITYID~~	~~20~~	~~Locally assigned Facility Identifier~~	~~Facility Identifier~~	
~~FITTINGTYPE~~	~~50~~	~~The type of fitting~~	~~Fitting Type~~	~~piFittingType~~
~~FLOODWARNINGLIGHT~~	~~5~~	~~Indicates whether there are flood warning lights~~	~~Flood Warning Gate?~~	~~YesNo~~
~~FLOWELEV~~	~~8~~	~~Flow Elevation~~	~~Flow Elevation~~	
~~FUNDINGNUMBER~~	~~24~~	~~The Departments Funding Number of the project~~	~~Funding Number~~	
~~FUNDINGTYPE~~	~~5~~	~~The Funding Type~~	~~Funding Type~~	~~piFundingType~~
~~HEIGHT~~	~~8~~	~~The height of the discharge point~~	~~Height (inches)~~	~~piPipeDiameter~~
~~HEIGHT~~	~~8~~	~~The height of the pipe in inches~~	~~Height (inches)~~	~~piPipeDiameter~~
~~INLETMAT~~	~~20~~	~~Construction material of inlet~~	~~Inlet Construction Material~~	~~piPipeMaterial~~
~~INLETTYPE~~	~~10~~	~~Type of inlet~~	~~Inlet Type~~	~~piInletType~~
~~INSTALLDATE~~	~~8~~	~~The date the asset was constructed or date of completion. Note if no Letter of Substantial Completion then use As-Built Date, then Record Drawing~~	~~Completion Date~~	

		~~Date, then most recent signature date on Plan Set. For Field Verifications use Date of Verification.~~		
~~INVERTELEV~~	~~8~~	~~The flow elevation at the bottom of the inlet~~	~~Flow Elevation~~	
~~INVERTELEV~~	~~8~~	~~The flow elevation at the bottom of the manhole~~	~~Flow Elevation~~	
~~LENGTH~~	~~8~~	~~Pipe length from the plan~~	~~Pipe Length~~	
~~LINETYPE~~	~~25~~	~~The type of open drain~~	~~Line Type~~	~~piDrainType~~
~~LINETYPE~~	~~25~~	~~The type of virtual line~~	~~Line Type~~	~~piVirtualLine~~
~~LOCDESC~~	~~200~~	~~Text Description of the geographic location~~	~~Location Description~~	
~~MAINSHAPE~~	~~50~~	~~The shape of the gravity main~~	~~Main Shape~~	~~piPipeShape~~
~~MAINTBY~~	~~2~~	~~Indicates which organization maintains the asset~~	~~Managed By~~	~~AssetManager~~
~~MAINTBY~~	~~25~~	~~Indicates which organization maintains the asset~~	~~Managed By~~	~~piDitchOwner~~
~~MATERIAL~~	~~20~~	~~Material the asset is manufactured with~~	~~Material~~	~~piPipeMaterial~~
~~MHTYPE~~	~~15~~	~~The type of manhole~~	~~Manhole Type~~	~~piManholeType~~
~~NAME~~	~~200~~	~~The name and location description of detention pond~~	~~Name~~	
~~NAME~~	~~20~~	~~The name of the facility or location the network structure~~	~~Name~~	
~~NAME~~	~~100~~	~~Name of the Underpass~~	~~Name~~	
~~NUMBEROFCROSSINGS~~	~~2~~	~~Number of crossings~~	~~Number of Crossings~~	
~~OWNEDBY~~	~~2~~	~~Indicates which~~	~~Owned By~~	~~AssetOwner~~

		~~organization owns the asset~~		
~~OWNEDBY~~	~~25~~	~~Indicates which organization owns the asset~~	~~Owned By~~	~~piDitchOwner~~
~~OWNEDBY~~	~~2~~	~~Indicates which organization owns the asset~~	~~Owned By~~	~~AssetOwner~~
~~PIPETYPE~~	~~50~~	~~The type of storm water pipe~~	~~Pipe Type~~	~~piPipeType~~
~~PLANNUMBER~~	~~10~~	~~The plan number~~	~~Plan Number~~	
~~PONDAREA~~	~~8~~	~~The area of the detention pond in acres~~	~~Area (in Acres)~~	
~~PUMPSTATION~~	~~5~~	~~Indicates whether there is a Pump Station~~	~~Pump Station?~~	~~YesNo~~
~~RAINGAUGE~~	~~5~~	~~Indicates whether there is a rain gauge~~	~~Rain Gauge?~~	~~YesNo~~
~~REHABDATE~~	~~8~~	~~Date of asset rehabilitation for open drains~~	~~Rehabilitation Date~~	
~~RIMELEV~~	~~8~~	~~The elevation at the top of inlet~~	~~Top Elevation~~	
~~RIMELEV~~	~~8~~	~~The elevation at the top of manhole~~	~~Top Elevation~~	
~~ROTATION~~	~~8~~	~~Map Symbol Rotation value~~	~~Rotation~~	
~~SCADA~~	~~5~~	~~Indicates whether there is a SCADA sensor at underpass~~	~~SCADA?~~	~~YesNo~~
~~SIDEMATERIAL~~	~~50~~	~~The material on the side of the open drain~~	~~Side Material~~	~~piOpenStructureMaterial~~
~~SLOPE~~	~~8~~	~~The slope of the main in percent~~	~~Slope (in percent)~~	~~null~~
~~STRUCTTYPE~~	~~30~~	~~Type of Sewer Network structure~~	~~Structure Type~~	~~swNetworkStructureType~~
~~UFID~~	~~8~~	~~The numeric FACILITYID, used by other~~	~~UFID~~	

		~~business systems~~		
~~UPDEPTH~~	~~8~~	~~The upstream depth of the gravity main~~	~~Upstream Depth~~	
~~UPELEV~~	~~8~~	~~The upstream elevation where the pipe meets the manhole~~	~~Upstream Elevation~~	
~~UPSTMNODE~~	~~11~~	~~The upstream storm node Facility ID~~	~~Upstream Storm Node~~	
~~VOLUME~~	~~8~~	~~The volume of detention area in acre feet~~	~~Volume (Acre Feet)~~	
~~WALLMAT~~	~~25~~	~~Wall Material~~	~~Wall Material~~	~~piPipeMaterial~~
~~WATERSHED~~	~~25~~	~~Watershed where the retention basin is located~~	~~Watershed~~	
~~WIDTH~~	~~8~~	~~The width of the discharge point~~	~~Width (inches)~~	~~piPipeDiameter~~
~~WIDTH~~	~~8~~	~~The width of the pipe in inches~~	~~Width (inches)~~	~~piPipeDiameter~~
~~WIDTH~~	~~8~~	~~The width at the top of the open drain in feet~~	~~Width (feet)~~	

~~13.2.02.B Domain Codes and Values~~

~~The tables below contain all the domain values for the storm water feature classes.~~

~~Table 13.3 AdandonStatus Domain~~

~~Code~~	~~Description~~
~~AP~~	~~Abandoned In Place~~
~~REM~~	~~Removed~~
~~ID~~	~~Incorrect Digitization - No Spatial Change~~

~~Table 13.4 AssignedTo Domain~~

~~Code~~	~~Description~~
~~AGS~~	~~Applied Geotech Solutions~~
~~TCI~~	~~Texas Correctional Industries~~
~~WTE~~	~~WatEarth~~
~~COH~~	~~City of Houston~~
~~PAR~~	~~Parsons~~
~~CIP~~	~~CIP Digital Deliverable~~

~~If company name is missing, a code will be assigned as new names are added.~~

~~Table 13.5 piPipeMaterial Domain~~

~~Code~~	~~Description~~
~~BR~~	~~Brick~~
~~CT~~	~~Clay Tile~~
~~CP~~	~~Concrete (Non-Reinforced)~~
~~CMP~~	~~Corrugated Metal~~
~~FRP~~	~~Fiberglass Reinforced~~
~~HDPE~~	~~High Density Polyethylene~~
~~MRC~~	~~Monolithic Reinforced Concrete~~
~~OTH~~	~~Other~~
~~PVC~~	~~Polyvinyl Chloride~~
~~RCP~~	~~Reinforced Concrete~~
~~SP~~	~~Steel~~
~~UNK~~	~~Unknown~~

~~Table 13.6 piOpenStructureMaterial Domain~~

~~Code~~	~~Description~~
~~CP~~	~~Concrete~~
~~EARCP~~	~~Earth & Concrete~~
~~EAR~~	~~Earthen~~
~~OTH~~	~~Other~~
~~UNK~~	~~Unknown~~

~~Table 13.7 piCouncilDistrict Domain~~

~~Table 13.8~~

~~Code~~	~~Description~~
~~A~~	~~A~~
~~B~~	~~B~~
~~C~~	~~C~~
~~D~~	~~D~~
~~E~~	~~E~~
~~F~~	~~F~~
~~G~~	~~G~~
~~H~~	~~H~~
~~I~~	~~I~~
~~J~~	~~J~~
~~K~~	~~K~~

~~piCrossingType Domain~~

~~Code~~	~~Description~~
~~Railroad~~	~~Railroad~~
~~Road~~	~~Road~~

~~Other~~	~~Other~~

~~Table 13.9 piDataSourceType Domain~~

~~Code~~	~~Description~~
~~AB~~	~~As Built~~
~~BM~~	~~Block Map~~
~~CS~~	~~Contracted Survey~~
~~EX~~	~~Existing~~
~~FV~~	~~Field Verified~~
~~Metro~~	~~Metro~~
~~P~~	~~Plan Set~~
~~TM~~	~~Taps and Meters~~
~~THD~~	~~Texas Highway Department~~
~~UN~~	~~Unknown~~
~~WD~~	~~Water Drawing~~

~~Table 13.10 piDischargePointType Domain~~

~~Code~~	~~Description~~
~~Outfall~~	~~Outfall~~
~~Outfall with BFP~~	~~Outfall with BFP~~
~~Roadside Discharge Point~~	~~Roadside Discharge Point~~

~~Table 13.11 piFittingType Domain~~

~~Code~~	~~Description~~
~~Collection Point~~	~~Collection Point~~
~~Drain Node~~	~~Drain Node~~
~~Plug~~	~~Plug~~
~~Reducer~~	~~Reducer~~
~~Safety End Treatment~~	~~Safety End Treatment~~
~~Storm Interconnect~~	~~Storm Interconnect~~
~~Other~~	~~Other~~

~~Table 13.12 YesNo Domain~~

~~Code~~	~~Description~~
~~Yes~~	~~Yes~~
~~No~~	~~No~~
~~Partly~~	~~Partly~~
~~Offset~~	~~Offset~~

~~Table 13.13 piFundingType Domain~~

~~Code~~	~~Description~~
~~ILMS~~	~~ILMS~~

~~WBS~~	~~WBS~~
~~GFS~~	~~GFS~~

~~Table 13.14 piPipeDiameter Domain~~

~~Code~~	~~Description~~
~~Min~~	~~4~~
~~Max~~	~~168~~

~~Table 13.15 piDrainType Domain~~

~~Code~~	~~Description~~
~~Bridge~~	~~Bridge~~
~~Irrigation Canal~~	~~Irrigation Canal~~
~~Low Flow Pilot Channel~~	~~Low Flow Pilot Channel~~
~~Off-road Channel~~	~~Off-road Channel~~
~~Rain Garden~~	~~Rain Garden~~
~~Railroad Open Drain~~	~~Railroad Open Drain~~
~~Roadside Ditch~~	~~Roadside Ditch~~
~~Swale~~	~~Swale~~
~~Unknown~~	~~Unknown~~

~~Table 13.16 piEasementType Domain~~

~~Code~~	~~Description~~
~~DR~~	~~Drainage~~
~~ELC~~	~~Electric Line~~
~~GAS~~	~~Gas Pipeline~~
~~HWY~~	~~Highway Right-of-Way~~
~~RR~~	~~Railroad~~
~~RDST~~	~~Road\Street~~
~~SS~~	~~Sanitary Sewer~~
~~TEL~~	~~Telecommunication~~
~~WL~~	~~Waterline~~
~~URW~~	~~Unimproved Right of Way~~
~~STM~~	~~Storm Sewer~~
~~UTL~~	~~Utility~~
~~UNK~~	~~Unknown~~

~~Table 13.17 piPipeShape Domain~~

~~Code~~	~~Description~~
~~RND~~	~~Round~~
~~ARCH~~	~~Arch~~
~~BOX~~	~~Box~~

~~Other~~	~~Other~~
~~Unknown~~	~~Unknown~~

~~Table 13.18 AssetManager Domain~~

~~Code~~	~~Description~~
~~1~~	~~City~~
~~-1~~	~~Private~~
~~-2~~	~~Other~~

~~Table 13.19 piManholeType Domain~~

~~Table 13.20~~

~~Code~~	~~Description~~
~~Junction Box~~	~~Junction Box~~
~~Stormceptor~~	~~Stormceptor~~
~~Standard~~	~~Standard Manhole~~
~~MH with BFP~~	~~Manhole with Backflow Preventer~~
~~Sample Well Basin~~	~~Sample Well Basin~~

~~piDitchOwner Domain & piEasementOwner Domain~~

~~13.21 piInletType~~

~~Table~~

~~Domain~~

~~Code~~	~~Description~~
~~Army Corps of Engineers~~	~~Army Corps of Engineers~~
~~Bay Area Land Co.~~	~~Bay Area Land Co.~~
~~Bridge~~	~~Bridge~~
~~Center Point~~	~~Center Point~~
~~Chelford City MUD~~	~~Chelford City MUD~~
~~City of Deer Park~~	~~City of Deer Park~~
~~City of Laporte~~	~~City of Laporte~~
~~City of League City~~	~~City of League City~~
~~City of Pasadena~~	~~City of Pasadena~~
~~City of Seabrook~~	~~City of Seabrook~~
~~City of Webster~~	~~City of Webster~~
~~Clear Brook City MUD~~	~~Clear Brook City MUD~~
~~Clear Lake City~~	~~Clear Lake City~~
~~COH~~	~~COH~~
~~COH Bridge~~	~~COH Bridge~~
~~COH Parks~~	~~COH Parks~~
~~COH Roadside~~	~~COH Roadside~~
~~COH Storm Sewer~~	~~COH Storm Sewer~~
~~COH Enclosed~~	~~COH Enclosed~~
~~Ellington Airforce Base~~	~~Ellington Airforce Base~~
~~Fort Bend County~~	~~Fort Bend County~~
~~Harris County~~	~~Harris County~~
~~HCFCD~~	~~HCFCD~~
~~HOU Airport System~~	~~HOU Airport System~~
~~Montgomery County~~	~~Montgomery County~~
~~NASA~~	~~NASA~~
~~Other~~	~~Other~~
~~Private~~	~~Private~~
~~State of Texas~~	~~State of Texas~~
~~To Be Verified~~	~~To Be Verified~~
~~TXDOT~~	~~TXDOT~~
~~Union Pacific~~	~~Union Pacific~~
~~Waller County~~	~~Waller County~~

~~Code~~	~~Description~~
~~A~~	~~A Inlet~~
~~B~~	~~B Inlet~~
~~BB~~	~~BB Inlet~~
~~C~~	~~C Inlet~~
~~C1~~	~~C1 Inlet~~

~~C2~~	~~C2 Inlet~~
~~D~~	~~D Inlet~~
~~E~~	~~E Inlet~~
~~H2~~	~~H2 Inlet~~
~~Other~~	~~Other~~

~~Table 13.22 piPipeType Domain~~

~~Code~~	~~Description~~
~~Collector~~	~~Collector~~
~~Culvert~~	~~Culvert~~
~~Driveway~~	~~Driveway Culvert~~
~~InletLine~~	~~InletLine~~
~~Outfall~~	~~Outfall~~
~~Overflow~~	~~Overflow~~
~~Railroad~~	~~Railroad Culvert~~
~~Siphon~~	~~Siphon~~
~~TrenchDrain~~	~~TrenchDrain~~
~~Walkway~~	~~Walkway Culvert~~

~~Table 13.23 swNetworkStructure Domain~~

~~Code~~	~~Description~~
~~Pump Station~~	~~Pump Station~~
~~Detention Pond~~	~~Detention Pond~~
~~Virtual Junction~~	~~Virtual Junction~~

~~Table 13.24 piVirtualLine Domain~~

~~Code~~	~~Description~~
~~Virtual Line~~	~~Standard Virtual Line~~
~~Detention Pond~~	~~Detention Pond~~
~~Channel~~	~~Virtual Line from Outfall to Channel~~

~~Table 13.25 piDetentionType Domain~~

~~Code~~	~~Description~~
~~Detention Pond~~	~~Detention Pond~~
~~Rain Garden~~	~~Rain Garden~~

~~13.2.02.C Manual and Auto Populated Fields~~

~~The tables below provide the required fields to be populated for the storm water feature classes.~~

~~Legend:~~

~~System Generated~~
~~Editable~~
~~Populated by Attribute Assistant in Staging Environment~~

~~Editor Tracking~~

~~The System Generated fields are:~~

~~Table 13.26 System Generated Fields~~

~~Field Name~~	~~Data Type~~
~~OBJECTID~~	~~Object ID~~
~~SHAPE~~	~~Geometry~~
~~ROTATION~~	~~Double~~
~~GlobalID~~	~~Global ID~~
~~SHAPE.STLength()~~	~~Double~~

~~The following fields are common across all features classes and are populated by Editor Tracking when enabled in the geodatabase. Editor Tracking must be enabled.~~

~~Table 13.27 Editor Tracking Fields~~

~~Field Name~~	~~Data Type~~
~~created_user~~	~~Text~~
~~created_date~~	~~Date~~
~~last_edited_user~~	~~Text~~
~~last_edited_date~~	~~Date~~

~~The following fields are common across all features classes and are populated manually but will have the same value per assigned project:~~

~~Table 13.28 Fields with Same Values per Assigned Project~~

~~Field Name~~	~~Data Type~~
~~FUNDINGNUMBER~~	~~Text~~
~~FUNDINGTYPE~~	~~Text~~
~~PLANNUMBER~~	~~Text~~
~~COMPANY~~	~~Text~~
~~DATASOURCETYPE~~	~~Text~~
~~INSTALLDATE~~	~~Date~~

~~Once the submitted geodatabase passes QA/QC checks, the following fields are populated by the Attribute Assistant utilizing GenerateID and DynamicValue Tables in the Staging Environment:~~

~~Table 13.29 Fields Populated by Attribute Assistant~~

~~Field Name~~	~~Data Type~~	~~Notes~~
~~FACILITYID~~	~~Text~~	
~~UPSTMNODE~~	~~Text~~	
~~DOWNSTMNODE~~	~~Text~~	
~~COUNCILDISTRICT~~	~~Text~~	
~~SLOPE~~	~~Double~~	

~~COUNCILDISTRICT~~	~~Text~~	
~~DRAINAGEAREA~~	~~Text~~	
~~ADDRESS~~	~~Text~~	
~~LENGTH~~	~~Double~~	
~~UFID~~	~~Long Integer~~	
~~ACTIVEFLAG~~	~~Short Integer~~	
~~WIDTH~~	~~Double~~	~~Only for swDischargePoint~~
~~HEIGHT~~	~~Double~~	~~Only for swDischargePoint~~
~~MATERIAL~~	~~Text~~	~~Only for swDischargePoint~~
~~PONDAREA~~	~~Double~~	~~Only for swDetention~~

~~For abandoned and removed assets (swAbandonedGravityMainLine, swAbandonedOpenDrain, and swAbandonedPoint) field information other than Editor Tracking is copied over from original feature class.~~

~~Table 13.30 swAbandonedGravityMainLine~~

~~Field Name~~	~~Data Type~~
~~OBJECTID~~	~~Object ID~~
~~FACILITYID~~	~~Text~~
~~INSTALLDATE~~	~~Date~~
~~MATERIAL~~	~~Text~~
~~WIDTH~~	~~Double~~
~~HEIGHT~~	~~Double~~
~~MAINSHAPE~~	~~Text~~
~~PIPETYPE~~	~~Text~~
~~DOWNELEV~~	~~Double~~
~~UPELEV~~	~~Double~~
~~SLOPE~~	~~Double~~
~~UPSTMNODE~~	~~Text~~
~~DOWNSTMNODE~~	~~Text~~
~~OWNEDBY~~	~~Short Integer~~
~~MAINTBY~~	~~Short Integer~~
~~COUNCILDISTRICT~~	~~Text~~
~~DATASOURCETYPE~~	~~Text~~
~~FUNDINGNUMBER~~	~~Text~~
~~FUNDINGTYPE~~	~~Text~~
~~DRAINAGEAREA~~	~~Text~~
~~LENGTH~~	~~Double~~
~~PLANNUMBER~~	~~Text~~
~~UFID~~	~~Long Integer~~

~~SHAPE~~	~~Geometry~~
~~GlobalID~~	~~Global ID~~
~~created_user~~	~~Text~~
~~created_date~~	~~Date~~
~~last_edited_user~~	~~Text~~
~~last_edited_date~~	~~Date~~
~~ABANDONSTATUS~~	~~Text~~
~~COMPANY~~	~~Text~~
~~SHAPE.STLength()~~	~~Double~~

~~Table 13.31 swAbandonedOpenDrain~~

~~Field Name~~	~~Data Type~~
~~OBJECTID~~	~~Object ID~~
~~FACILITYID~~	~~Text~~
~~LINETYPE~~	~~Text~~
~~WIDTH~~	~~Double~~
~~DEPTH~~	~~Double~~
~~BEDMATERIAL~~	~~Text~~
~~SIDEMATERIAL~~	~~Text~~
~~ABANDONSTATUS~~	~~Text~~
~~OWNEDBY~~	~~Text~~
~~COUNCILDISTRICT~~	~~Text~~
~~ADDRESS~~	~~Text~~
~~NAME~~	~~Text~~
~~SHAPE~~	~~Geometry~~
~~GlobalID~~	~~Global ID~~
~~created_user~~	~~Text~~
~~created_date~~	~~Date~~
~~last_edited_user~~	~~Text~~
~~last_edited_date~~	~~Date~~
~~UFID~~	~~Double~~
~~COMPANY~~	~~Text~~
~~SHAPE.STLength()~~	~~Double~~

~~Table 13.32 swAbandonedPoint~~

~~Field Name~~	~~Data Type~~
~~OBJECTID~~	~~Object ID~~
~~FACILITYID~~	~~Text~~
~~INSTALLDATE~~	~~Date~~
~~INVERTELEV~~	~~Double~~
~~DEPTH~~	~~Double~~
~~RIMELEV~~	~~Double~~
~~WALLMAT~~	~~Text~~
~~POINTTYPE~~	~~Text~~
~~ACTIVEFLAG~~	~~Short Integer~~
~~OWNEDBY~~	~~Short Integer~~
~~MAINTBY~~	~~Short Integer~~
~~ROTATION~~	~~Double~~
~~COUNCILDISTRICT~~	~~Text~~
~~DATASOURCETYPE~~	~~Text~~

~~FUNDINGNUMBER~~	~~Text~~
~~FUNDINGTYPE~~	~~Text~~
~~PLANNUMBER~~	~~Text~~
~~UFID~~	~~Long Integer~~
~~SHAPE~~	~~Geometry~~
~~GlobalID~~	~~Global ID~~
~~created_user~~	~~Text~~
~~created_date~~	~~Date~~
~~last_edited_user~~	~~Text~~
~~last_edited_date~~	~~Date~~
~~ADDRESS~~	~~Text~~
~~ABANDONSTATUS~~	~~Text~~
~~COMPANY~~	~~Text~~

~~Table 13.33 swDetention~~

~~Field Name~~	~~Data Type~~
~~OBJECTID~~	~~Object ID~~
~~FACILITYID~~	~~Text~~
~~INSTALLDATE~~	~~Date~~
~~REHABDATE~~	~~Date~~
~~LOCDESC~~	~~Text~~
~~NAME~~	~~Text~~
~~DEPTH~~	~~Double~~
~~PONDAREA~~	~~Double~~
~~VOLUME~~	~~Double~~
~~BEDMATERIAL~~	~~Text~~
~~BNKMATERIAL~~	~~Text~~
~~COMMENTS~~	~~Text~~
~~WATERSHED~~	~~Text~~
~~COUNCILDISTRICT~~	~~Text~~
~~FUNDINGNUMBER~~	~~Text~~
~~FUNDINGTYPE~~	~~Text~~
~~PLANNUMBER~~	~~Text~~
~~ACTIVEFLAG~~	~~Short Integer~~
~~OWNEDBY~~	~~Short Integer~~
~~MAINTBY~~	~~Short Integer~~
~~COMPANY~~	~~Text~~
~~SHAPE~~	~~Geometry~~
~~GlobalID~~	~~Global ID~~
~~created_user~~	~~Text~~
~~created_date~~	~~Date~~
~~last_edited_user~~	~~Text~~
~~last_edited_date~~	~~Date~~
~~SHAPE.STArea()~~	~~Double~~
~~SHAPE.STLength()~~	~~Double~~

~~Table 13.34 swDischargePoint~~

~~Field Name~~	~~Data Type~~
~~OBJECTID~~	~~Object ID~~
~~FACILITYID~~	~~Text~~
~~DISCHRGTYP~~	~~Text~~
~~FLOWELEV~~	~~Double~~
~~INSTALLDATE~~	~~Date~~
~~ROTATION~~	~~Double~~
~~WIDTH~~	~~Double~~
~~HEIGHT~~	~~Double~~
~~ACTIVEFLAG~~	~~Short Integer~~
~~OWNEDBY~~	~~Short Integer~~
~~MAINTBY~~	~~Short Integer~~
~~COUNCILDISTRICT~~	~~Text~~
~~DATASOURCETYPE~~	~~Text~~
~~FUNDINGNUMBER~~	~~Text~~
~~FUNDINGTYPE~~	~~Text~~
~~PLANNUMBER~~	~~Text~~
~~COMPANY~~	~~Text~~
~~SHAPE~~	~~Geometry~~
~~Enabled~~	~~Short Integer~~
~~AncillaryRole~~	~~Short Integer~~
~~GlobalID~~	~~Global ID~~
~~created_user~~	~~Text~~
~~created_date~~	~~Date~~
~~last_edited_user~~	~~Text~~
~~last_edited_date~~	~~Date~~
~~ADDRESS~~	~~Text~~
~~MATERIAL~~	~~Text~~
~~UFID~~	~~Text~~

~~Table 13.35 swEasement~~

~~Field Name~~	~~Data Type~~
~~OBJECTID~~	~~Object ID~~
~~FACILITYID~~	~~Text~~
~~TYPE~~	~~Text~~
~~WIDTH~~	~~Double~~
~~OWNEDBY~~	~~Text~~
~~MAINTBY~~	~~Text~~
~~COUNCILDISTRICT~~	~~Text~~
~~COMPANY~~	~~Text~~
~~UFID~~	~~Text~~
~~SHAPE~~	~~Geometry~~
~~GlobalID~~	~~Global ID~~
~~created_user~~	~~Text~~
~~created_date~~	~~Date~~
~~last_edited_user~~	~~Text~~
~~last_edited_date~~	~~Date~~
~~SHAPE.STArea()~~	~~Double~~
~~SHAPE.STLength()~~	~~Double~~

~~Table 13.36 – swFitting~~

~~Field Name~~	~~Data Type~~
~~OBJECTID~~	~~Object ID~~
~~FACILITYID~~	~~Text~~
~~FITTINGTYPE~~	~~Text~~
~~INSTALLDATE~~	~~Date~~
~~LOCDESC~~	~~Text~~
~~ROTATION~~	~~Double~~
~~ACTIVEFLAG~~	~~Short Integer~~
~~OWNEDBY~~	~~Short Integer~~
~~MAINTBY~~	~~Short Integer~~
~~COUNCILDISTRICT~~	~~Text~~
~~DATASOURCETYPE~~	~~Text~~
~~FUNDINGNUMBER~~	~~Text~~
~~FUNDINGTYPE~~	~~Text~~
~~PLANNUMBER~~	~~Text~~
~~COMPANY~~	~~Text~~
~~UFID~~	~~Long Integer~~
~~SHAPE~~	~~Geometry~~
~~Enabled~~	~~Short Integer~~
~~GlobalID~~	~~Global ID~~
~~created_user~~	~~Text~~
~~created_date~~	~~Date~~
~~last_edited_user~~	~~Text~~
~~last_edited_date~~	~~Date~~

~~Table 13.37 - swGravityMain~~

~~Field Name~~	~~Data Type~~
~~OBJECTID~~	~~Object ID~~
~~FACILITYID~~	~~Text~~
~~INSTALLDATE~~	~~Date~~
~~MATERIAL~~	~~Text~~
~~WIDTH~~	~~Double~~
~~HEIGHT~~	~~Double~~
~~MAINSHAPE~~	~~Text~~
~~PIPETYPE~~	~~Text~~
~~DOWNELEV~~	~~Double~~
~~UPELEV~~	~~Double~~
~~SLOPE~~	~~Double~~
~~ACTIVEFLAG~~	~~Short Integer~~
~~OWNEDBY~~	~~Short Integer~~
~~MAINTBY~~	~~Short Integer~~
~~COUNCILDISTRICT~~	~~Text~~
~~DATASOURCETYPE~~	~~Text~~
~~FUNDINGNUMBER~~	~~Text~~
~~FUNDINGTYPE~~	~~Text~~
~~DRAINAGEAREA~~	~~Text~~
~~LENGTH~~	~~Double~~
~~PLANNUMBER~~	~~Text~~
~~COMPANY~~	~~Text~~
~~UFID~~	~~Long Integer~~
~~SHAPE~~	~~Geometry~~
~~Enabled~~	~~Short Integer~~
~~GlobalID~~	~~Global ID~~
~~created_user~~	~~Text~~
~~created_date~~	~~Date~~
~~last_edited_user~~	~~Text~~
~~last_edited_date~~	~~Date~~
~~UPSTMNODE~~	~~Text~~
~~DOWNSTMNODE~~	~~Text~~
~~UPDEPTH~~	~~Double~~
~~DOWNDEPTH~~	~~Double~~
~~SHAPE.STLength()~~	~~Double~~

~~Table 13.38 – swInlet~~

~~Field Name~~	~~Data Type~~
~~OBJECTID~~	~~Object ID~~
~~FACILITYID~~	~~Text~~
~~INSTALLDATE~~	~~Date~~
~~RIMELEV~~	~~Double~~
~~INVERTELEV~~	~~Double~~
~~ACCESSMAT~~	~~Text~~
~~ACTIVEFLAG~~	~~Short Integer~~
~~OWNEDBY~~	~~Short Integer~~
~~MAINTBY~~	~~Short Integer~~
~~COUNCILDISTRICT~~	~~Text~~
~~DATASOURCETYPE~~	~~Text~~
~~FUNDINGNUMBER~~	~~Text~~
~~FUNDINGTYPE~~	~~Text~~
~~PLANNUMBER~~	~~Text~~
~~COMPANY~~	~~Text~~
~~UFID~~	~~Long Integer~~
~~ROTATION~~	~~Double~~
~~SHAPE~~	~~Geometry~~
~~Enabled~~	~~Short Integer~~
~~AncillaryRole~~	~~Short Integer~~
~~GlobalID~~	~~Global ID~~
~~created_user~~	~~Text~~
~~created_date~~	~~Date~~
~~last_edited_user~~	~~Text~~
~~last_edited_date~~	~~Date~~
~~ADDRESS~~	~~Text~~
~~DEPTH~~	~~Double~~

~~Table 13.39 – swManhole~~

~~Field Name~~	~~Data Type~~
~~OBJECTID~~	~~Object ID~~
~~FACILITYID~~	~~Text~~
~~INSTALLDATE~~	~~Date~~
~~INVERTELEV~~	~~Double~~
~~DEPTH~~	~~Double~~
~~RIMELEV~~	~~Double~~
~~WALLMAT~~	~~Text~~
~~MHTYPE~~	~~Text~~
~~ACTIVEFLAG~~	~~Short Integer~~
~~OWNEDBY~~	~~Short Integer~~
~~MAINTBY~~	~~Short Integer~~
~~ROTATION~~	~~Double~~
~~COUNCILDISTRICT~~	~~Text~~
~~DATASOURCETYPE~~	~~Text~~
~~FUNDINGNUMBER~~	~~Text~~
~~FUNDINGTYPE~~	~~Text~~
~~PLANNUMBER~~	~~Text~~
~~COMPANY~~	~~Text~~
~~UFID~~	~~Long Integer~~
~~SHAPE~~	~~Geometry~~
~~Enabled~~	~~Short Integer~~
~~GlobalID~~	~~Global ID~~
~~created_user~~	~~Text~~
~~created_date~~	~~Date~~
~~last_edited_user~~	~~Text~~
~~last_edited_date~~	~~Date~~
~~ADDRESS~~	~~Text~~

~~Table 13.40 – swNetworkStructure~~

~~Field Name~~	~~Data Type~~
~~OBJECTID~~	~~Object ID~~
~~FACILITYID~~	~~Text~~
~~NAME~~	~~Text~~
~~INSTALLDATE~~	~~Date~~
~~REHABDATE~~	~~Date~~
~~STRUCTTYPE~~	~~Text~~
~~OWNEDBY~~	~~Short Integer~~
~~MAINTBY~~	~~Short Integer~~
~~ROTATION~~	~~Double~~
~~COUNCILDISTRICT~~	~~Text~~
~~DATASOURCETYPE~~	~~Text~~
~~FUNDINGNUMBER~~	~~Text~~
~~FUNDINGTYPE~~	~~Text~~
~~PLANNUMBER~~	~~Text~~
~~COMPANY~~	~~Text~~
~~UFID~~	~~Text~~
~~SHAPE~~	~~Geometry~~
~~Enabled~~	~~Short Integer~~
~~GlobalID~~	~~Global ID~~
~~created_user~~	~~Text~~
~~created_date~~	~~Date~~
~~last_edited_user~~	~~Text~~
~~last_edited_date~~	~~Date~~
~~ADDRESS~~	~~Text~~

~~Table 13.41 – swOpenDrain~~

~~Field Name~~	~~Data Type~~
~~OBJECTID~~	~~Object ID~~
~~FACILITYID~~	~~Text~~
~~INSTALLDATE~~	~~Date~~
~~REHABDATE~~	~~Date~~
~~LINETYPE~~	~~Text~~
~~WIDTH~~	~~Double~~
~~DEPTH~~	~~Double~~
~~BEDMATERIAL~~	~~Text~~
~~SIDEMATERIAL~~	~~Text~~
~~OWNEDBY~~	~~Text~~
~~MAINTBY~~	~~Text~~
~~COUNCILDISTRICT~~	~~Text~~
~~UFID~~	~~Text~~
~~ADDRESS~~	~~Text~~
~~CHANNELNAME~~	~~Text~~
~~COMPANY~~	~~Text~~
~~SHAPE~~	~~Geometry~~
~~Enabled~~	~~Short Integer~~
~~GlobalID~~	~~Global ID~~
~~created_user~~	~~Text~~
~~created_date~~	~~Date~~
~~last_edited_user~~	~~Text~~
~~last_edited_date~~	~~Date~~
~~SHAPE.STLength()~~	~~Double~~

~~Table 13.42 – swUnderPass~~

~~Table 13.43~~

~~Field Name~~	~~Data Type~~
~~OBJECTID~~	~~Object ID~~
~~FACILITYID~~	~~Text~~
~~CROSSINGTYPE~~	~~Text~~
~~INSTALLDATE~~	~~Date~~
~~LOCDESC~~	~~Text~~
~~NAME~~	~~Text~~
~~ROTATION~~	~~Double~~
~~OWNEDBY~~	~~Short Integer~~
~~MAINTBY~~	~~Short Integer~~
~~NUMBEROFCROSSINGS~~	~~Short Integer~~
~~PUMPSTATION~~	~~Text~~
~~SCADA~~	~~Text~~
~~RAINGAUGE~~	~~Text~~
~~FLOODWARNINGLIGHT~~	~~Text~~
~~COUNCILDISTRICT~~	~~Text~~
~~FUNDINGNUMBER~~	~~Text~~
~~FUNDINGTYPE~~	~~Text~~
~~PLANNUMBER~~	~~Text~~
~~COMPANY~~	~~Text~~
~~SHAPE~~	~~Geometry~~
~~GlobalID~~	~~Global ID~~
~~created_user~~	~~Text~~
~~created_date~~	~~Date~~
~~last_edited_user~~	~~Text~~
~~last_edited_date~~	~~Date~~
~~ADDRESS~~	~~Text~~

~~swVirtualDrainline~~

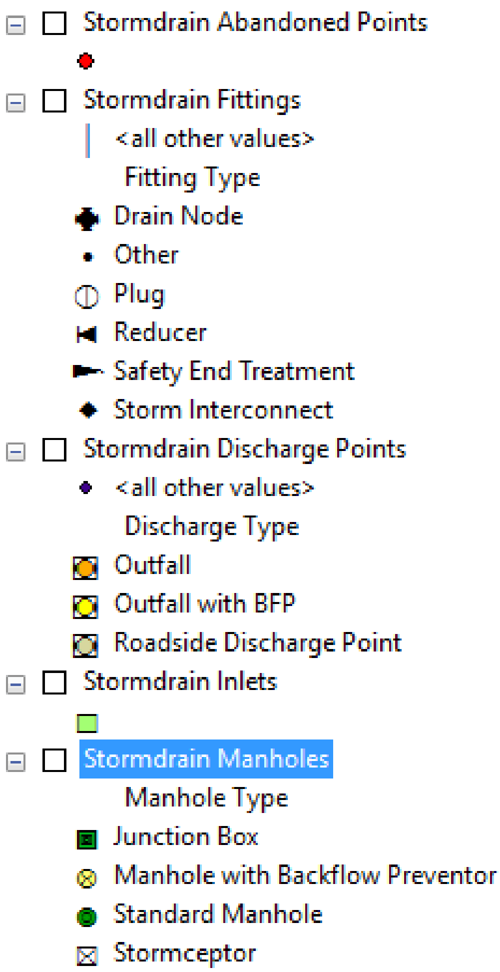
~~Field Name~~	~~Data Type~~
~~OBJECTID~~	~~Object ID~~
~~FACILITYID~~	~~Text~~
~~LINETYPE~~	~~Text~~
~~COMPANY~~	~~Text~~
~~SHAPE~~	~~Geometry~~
~~Enabled~~	~~Short Integer~~
~~GlobalID~~	~~Global ID~~
~~created_user~~	~~Text~~
~~created_date~~	~~Date~~
~~last_edited_user~~	~~Text~~

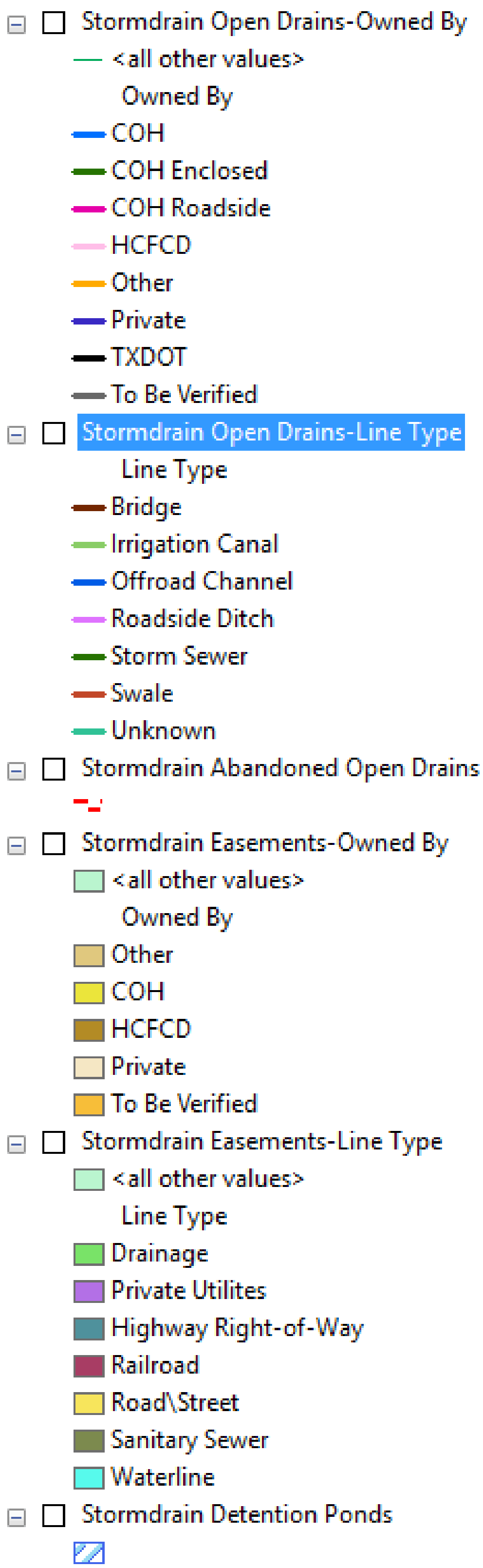
~~last_edited_date~~	~~Date~~
~~SHAPE.STLength()~~	~~Double~~

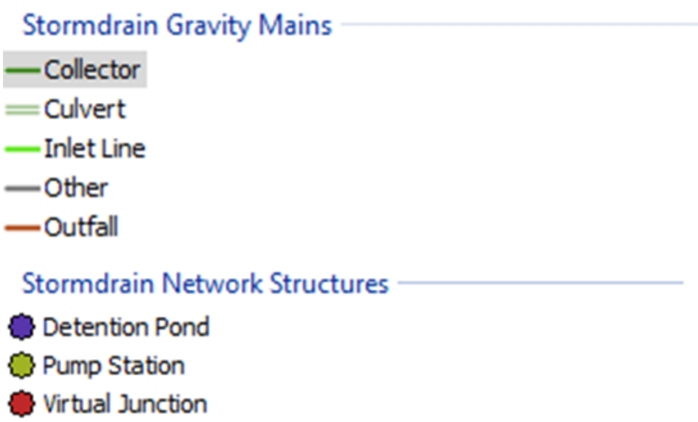
~~13.2.03 STORM WATER FEATURE SYMBOLOGIES~~

~~13.2.03.A Standard Symbologies~~

~~For each storm water feature class, a symbology file has been created respectively, which is called layer file with extension.lyr in ArcGIS. The figure below shows symbols for each storm water feature class.~~




Stormdrain Open Drains-Owned By
<all other values>
Owned By
COH
COH Enclosed
COH Roadside
HCFCD
Other
Private
TXDOT
To Be Verified
Stormdrain Open Drains-Line Type
Line Type
Bridge
Irrigation Canal
Offroad Channel
Roadside Ditch
Storm Sewer
Swale
Unknown
Stormdrain Abandoned Open Drains
Stormdrain Easements-Owned By
<all other values>
Owned By
Other
COH
HCFCD
Private
To Be Verified
Stormdrain Easements-Line Type
<all other values>
Line Type
Drainage
Private Utilites
Highway Right-of-Way
Railroad
Road\Street
Sanitary Sewer
Waterline
Stormdrain Detention Ponds



~~13.2.03.B Feature Class Specifics~~

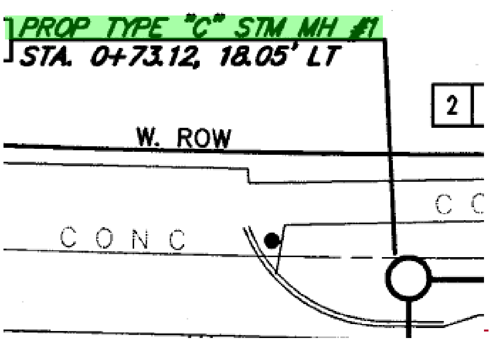
~~Additional information over some storm water feature classes is provided in the section.~~

~~Manhole~~

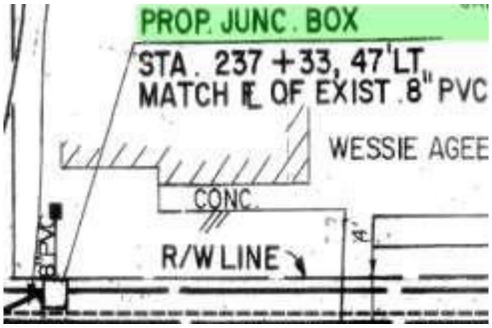
~~The storm manhole feature class has four types: manhole, junction box, stormceptor, and manhole with backflow preventer.~~

~~Standard Manhole and Junction Box~~

~~Figures 1 and 2 show the two common types in a Plan Set. Junction Boxes are made from reinforced concrete.~~



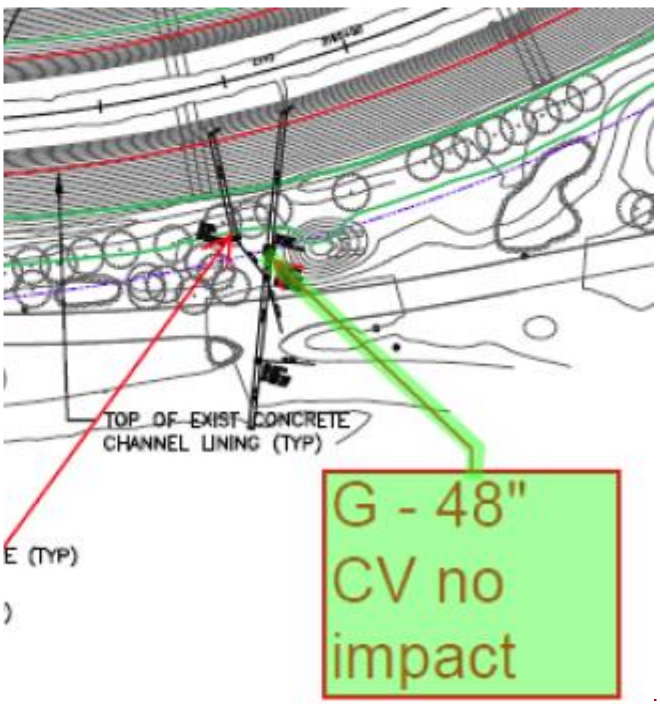
~~Figure 13.1 – Manhole~~



~~Figure 13.2 – Junction Box~~

~~Stormceptor is a special kind of manhole utilized for storm water pollution prevention. It would be identified in the Plan Set.~~

~~Manhole with backflow preventer will have a gate valve, check valve or equivalent device. If the gravity main has a Tideflex valve or similar device this information would still be identified on the upstream manhole as a manhole with backflow preventer.~~



~~Figure 13.3 – Check Valve~~

~~Inlet~~

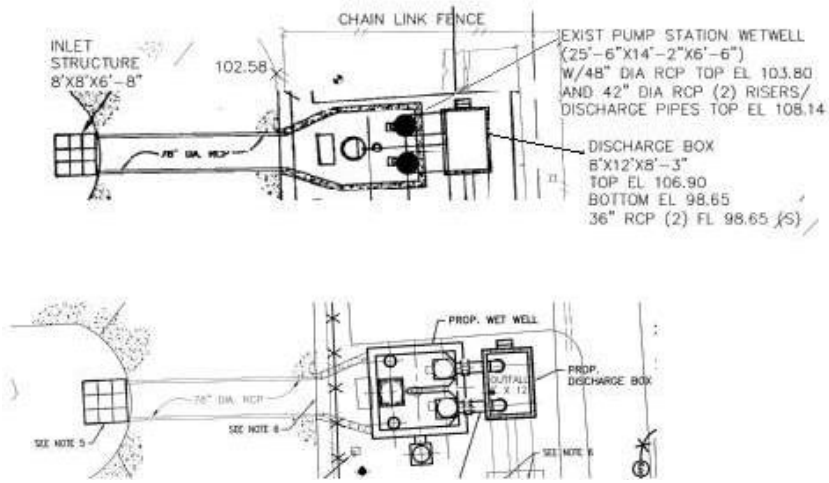
~~The storm inlet feature class has ten types. Nine of the types are considered standard. If any inlet is encountered that is not the standard nine, it will be identified as Other. Also, of note is the C Inlet; C1 is a C with one extension, a C2 is a C with two extensions. Inlets are typically made from concrete.~~

~~Figure 13.4 – C and C1 Inlets~~

~~Figure 13.5 – C2 Inlet~~

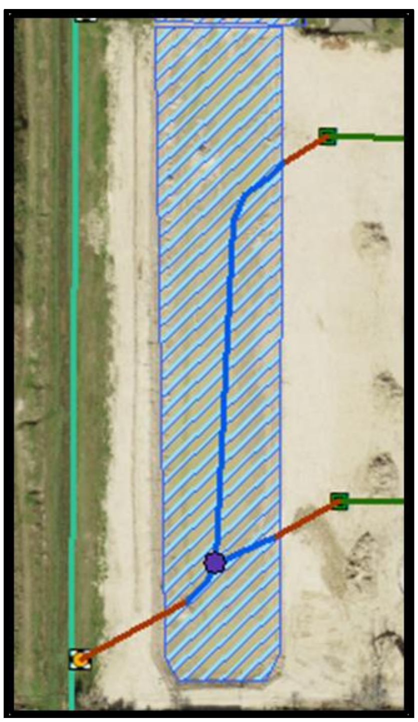
~~Network Structure~~

~~The network structure feature class has only three types: pump station, detention pond, and virtual junction.~~



~~Figure 13.6 – Pump Station~~

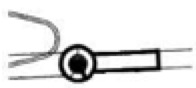
~~In Figure 13.7, two low flow pilot channels are connected to another low flow pilot channel at a Detention Pond Network Structure.~~



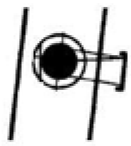
~~Figure 13.7 – Detention Pond~~
~~Virtual Junctions are utilized to connect features where no other physical structure such as detention pond or pump station exits and serves to maintain system connectivity.~~

~~Fitting~~

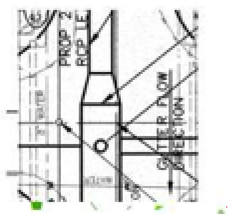
~~The fitting feature class has six types. If any fitting is encountered that is not the standard six it will be identified as Other. Drain nodes are also used when the outfall of the system does not connect to another system.~~



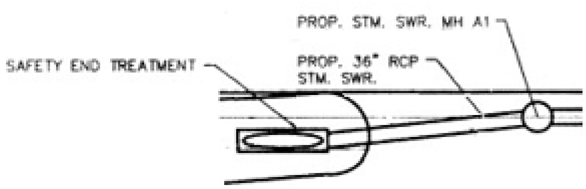
~~Figure 13.8 – Drain Node~~



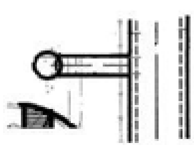
~~Figure 13.9 – Plug~~



~~Figure 13.10 – Plug (Aerial)~~

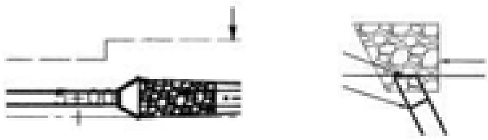


~~Figure 13.11 – Safety End Treatment~~



~~Figure 13.12 – Storm Interconnect Discharge Point~~

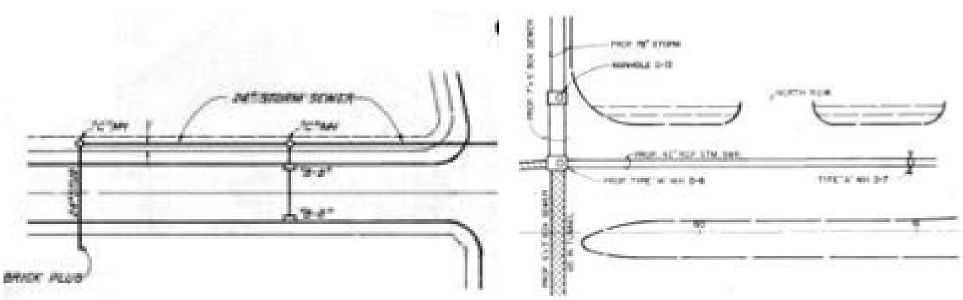
~~The fitting feature class has three types. Headwalls with Structure and Headwalls without Structure are identified as Outfall with BFP (Backflow Preventer) and Outfall, respectively. An Outfall may have riprap. Locations where a roadside ditch drains into off-road channel or other storm water feature are identified as Roadside Discharge Point.~~



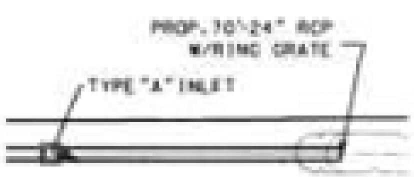
~~Figure 13.13 – Outfall with BFP and Outfall~~

~~Storm Sewer (Gravity Main)~~

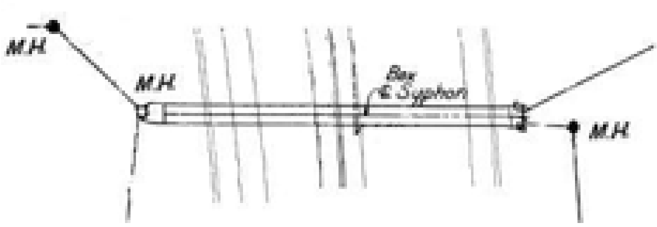
~~The gravity main feature class has seven types. The following figures illustrate each type as found in a Plan Set.~~



~~Figure 13.14 – Collector~~

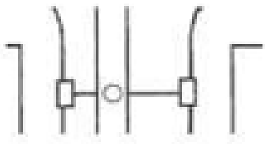


~~Figure 13.15 – Culvert~~

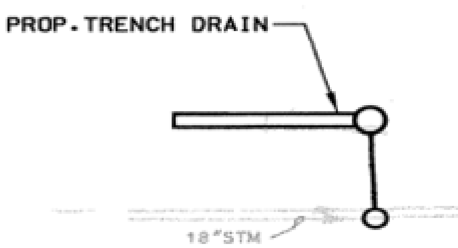


~~Figure 13.16 – Siphon~~

~~Figure 13.17 – Outfall~~



~~Figure 13.18 – Inlet Line~~



~~Figure 13.19 – Trench Drain~~

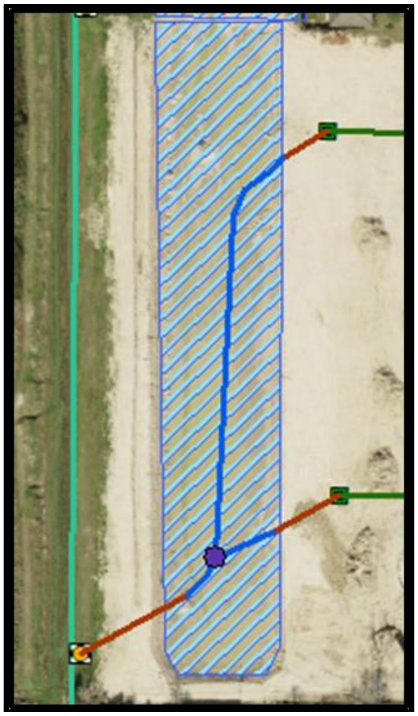
~~Open Drain~~

~~The open drain feature has seven types. The two major types are roadside ditch and off-road channel. The bridge type is used to maintain connectivity in the system when the off-road ditch passes under a bridge. Storm sewer is used when the off-road ditch enters a storm sewer system which has no Plan Set. It serves as a place holder until additional information is collected over storm sewer. Once additional information is collected the storm sewer is removed from the open drain and added to the gravity main feature class. Swale is used when an off-road channel is converted to a storm sewer, but a very shallow ditch is left to collect water into inlets above the storm sewer. Irrigation canals are not maintained by City of Houston but are identified to maintain connectivity in the system. Any off-road channels which need additional field verification and research are identified as Unknown.~~

~~Figure 13.20 - Roadside Ditch~~

~~Figure 13.21 - Earth and Concrete Off-road ChannelsPolygon Storm Sewer Feature Classes~~

~~Detention ponds and storm sewer easements are polygon features which do not participate in the geometric network but are assets tracked by SWMB~~ SWO~~. Easements not maintained by SWMB~~SWO ~~are also digitized for historical information.~~



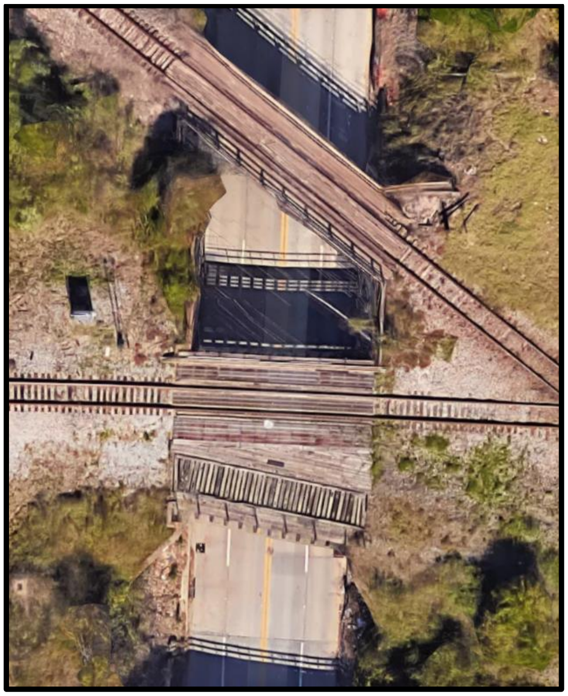
~~Figure 13.22 - Detention Pond~~

~~Abandoned and Removed Features~~

~~When a feature is abandoned or removed (will be stated in Plan Set); the feature is copied and pasted into the appropriate abandoned feature class and given the appropriate status in the ABANDONSTATUS Field. For example, when a manhole is found in gravity line which requires splitting the line, the original line is removed (it is moved to the swAbandonedGravityMain with the status removed), then two new lines are created.~~

~~Underpasses~~

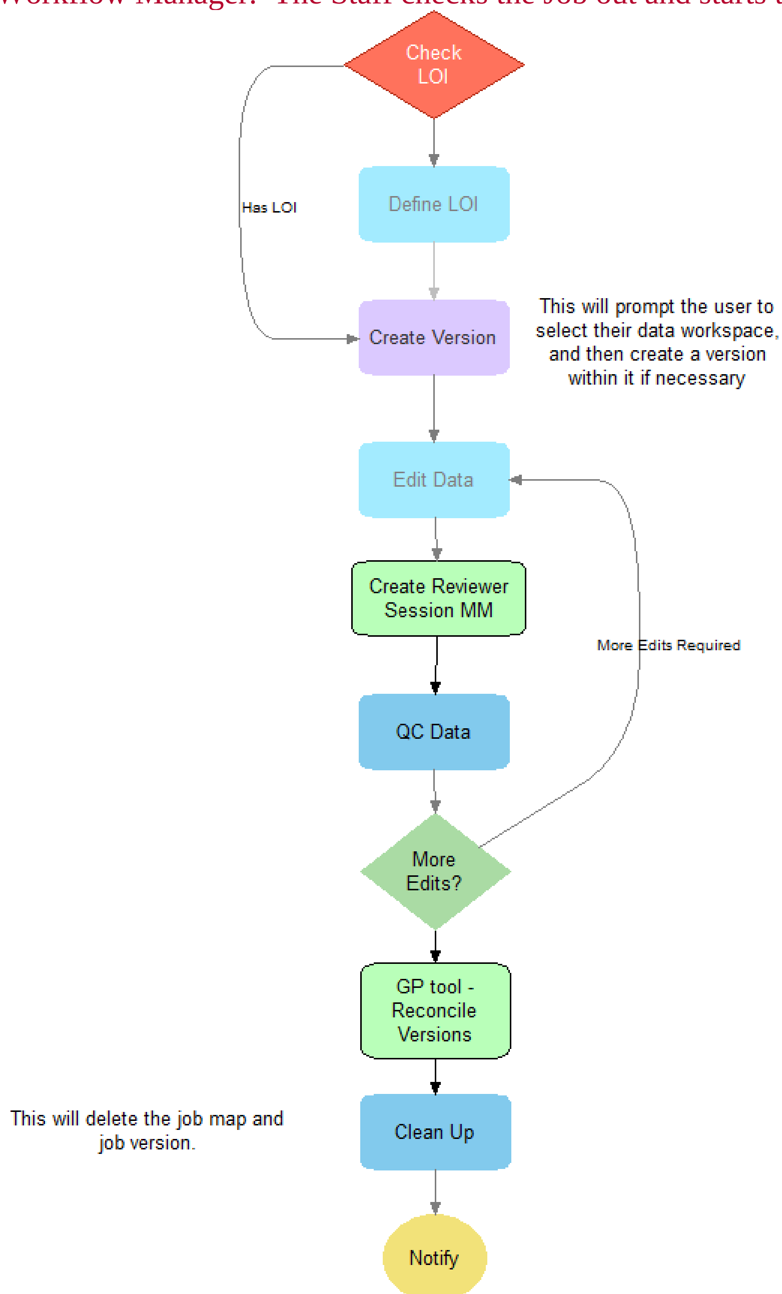
~~Underpasses are point features that do not participate in the geometric network but are critical assets tracked by SWMBSWO. The underpass fields are used to track various flood warning devices. Also, the number and type of crossings at an underpass as tracked.~~



~~Figure 13.23 - Underpass with Three Railroad Crossings~~

~~13.2.04 STORM WATER DATA PROCESSING WORKFLOW~~

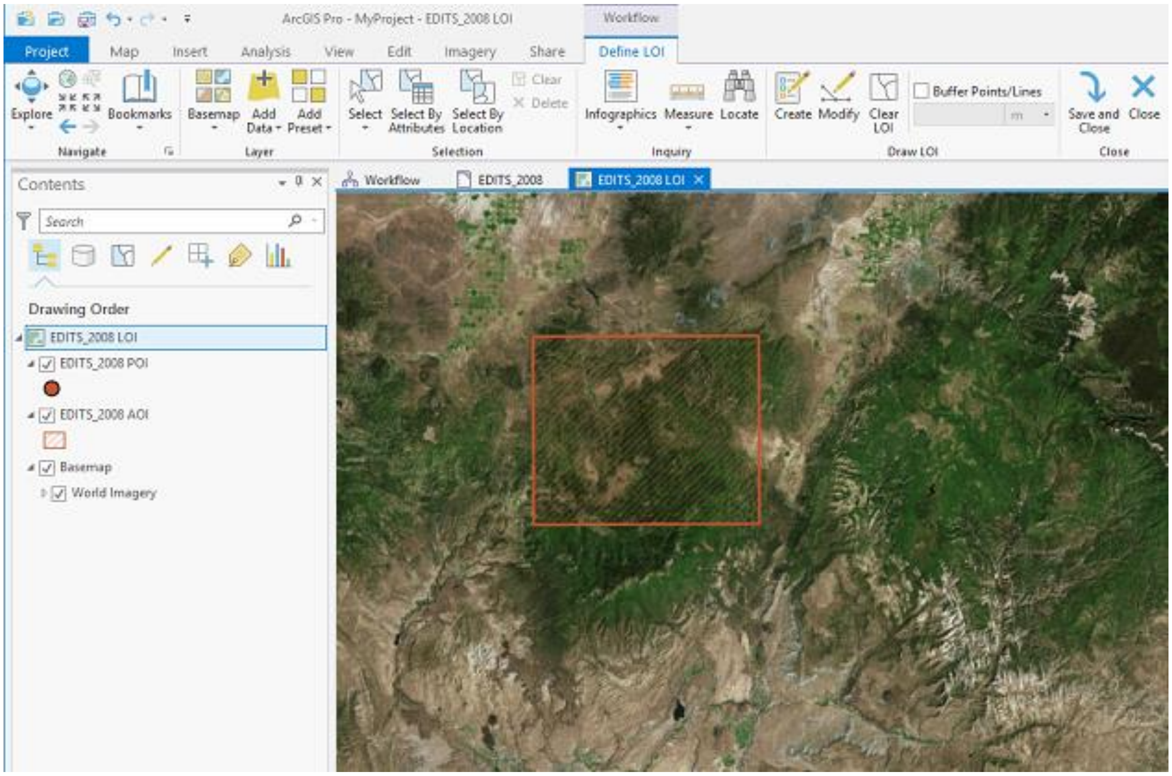
~~The figure below shows the workflow of storm water data processing procedure utilized by SWMB staff within Workflow Manager. While the use of Workflow Manager is not required, the steps utilized to create the GIS deliverable should be similar. Staff are assigned Jobs in Workflow Manager. The Staff checks the Job out and starts the workflow.~~



~~Figure 13.24 - Workflow for Editing, Data Quality Control, and Job Cleanup~~

~~13.2.04.A Check Location of Interest~~

~~Executing a Define Location of Interest (LOI) step in the workflow will open a workflow LOI map based on the map template defined for the job type. The layers marked as selectable in the LOI map template will appear as selectable in the workflow LOI map.~~



~~Figure 13.25 - Location of Interest (LOI)~~

~~13.2.04.B Define Location of Interest~~

~~Define provides common tools to navigate the map and add supplementary base map or feature layers, and it provides the tools required to define an LOI by selecting one or more features in the map.~~

~~13.2.04.C Create Version~~

~~This will prompt the user to select the data workspace and creates the version.~~

~~13.2.04.D Edit Data~~

~~User can start making edits in the Workflow Manager versioned database.~~

~~13.2.04.E Create Data Reviewer Session~~

~~This will initiate the Data Reviewer Session (See paragraph 13.2.05.B for more information).~~

~~13.2.04.F QC Data~~

~~See paragraph 13.2.05.A for QA/QC steps to check for system connectivity and flow direction.~~

~~13.2.04.G Run More Edits (If Required)~~

~~User makes additional edits if error were found using previous steps.~~

~~13.2.04.H Geoprocessing Tool – Reconcile Versions~~

~~In this step the job version is reconciled against the target version.~~

~~13.2.04.I Clean Up~~

~~This will delete the job map and job version.~~

~~13.2.05 STORM WATER QA/QC PROCEDURES~~

~~13.2.05.A Data Quality~~

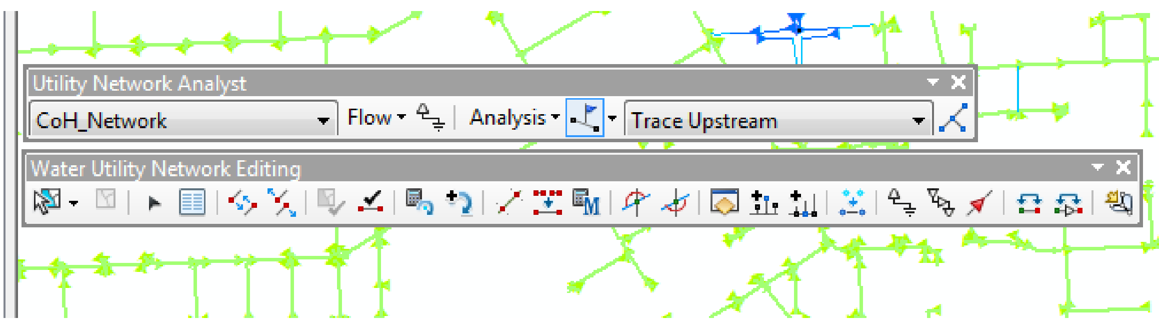
~~Appropriate QA/QC standards will be utilized to ensure that the data is topologically correct, accurate, and complete. This would include:~~

~~No erroneous overshoots, undershoots, dangles or intersection in the line work.~~
~~Point and line features will be snapped together where appropriate to support networks.~~
~~Linear features will not be broken for labeling or aesthetic purposes.~~
~~Line features should be continuous and drawn from upstream to downstream.~~
~~Point features should be digitized as points, using attribute block symbols with insertion points in the center of the block/feature.~~
~~No sliver polygons (noncoincident).~~
~~Digital representation of the common boundaries for all graphic features must be coincident, regardless of feature layer.~~
~~No duplicate features.~~
~~ESRI's Utility Network Analyst and Water Utility Network Analyst are used to check for connectivity and correct flow direction while Data Reviewer is used run batch checks for several issues such as duplications, reversed flow values, and null values in required fields..~~

~~13.2.05.B Utility Network Analyst and Water Utility Network Analyst~~

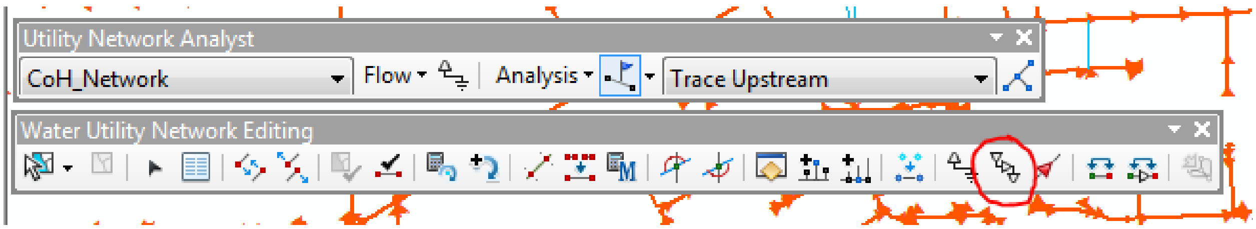
~~Both Utility Network Analyst and Water Utility Network Analyst are used to check flow direction and connectivity of the storm water drainage system.~~

~~The Water Utility Network Tools can be downloaded from the ESRI website. Once installed, right click in ArcMap to activate both Utility Network Analyst and Water Utility Network Analyst.~~



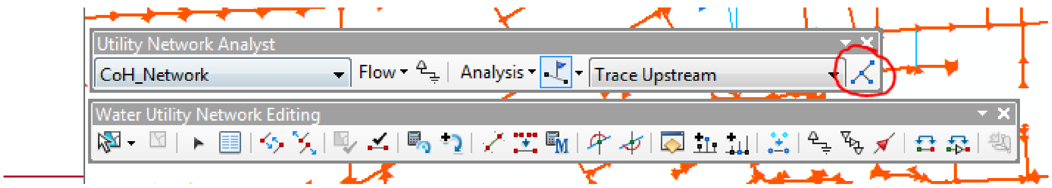
~~Figure 13.24~~

~~Add the entire network from the Geodatabase.~~
~~Right click and start editing any of the shapefiles in the Geodatabase from the table of contents.~~
~~Place a flag to start doing your traces.~~
~~There are two types of flags; Edge Flag and Junction Flag. Junction Flags can only be set at junction points while Edge Flags can bet set anywhere in the network (this is the option often used).~~
~~Once the flag is set, need to run the established digitalized flow direction on the water utility network editing toolbar.~~



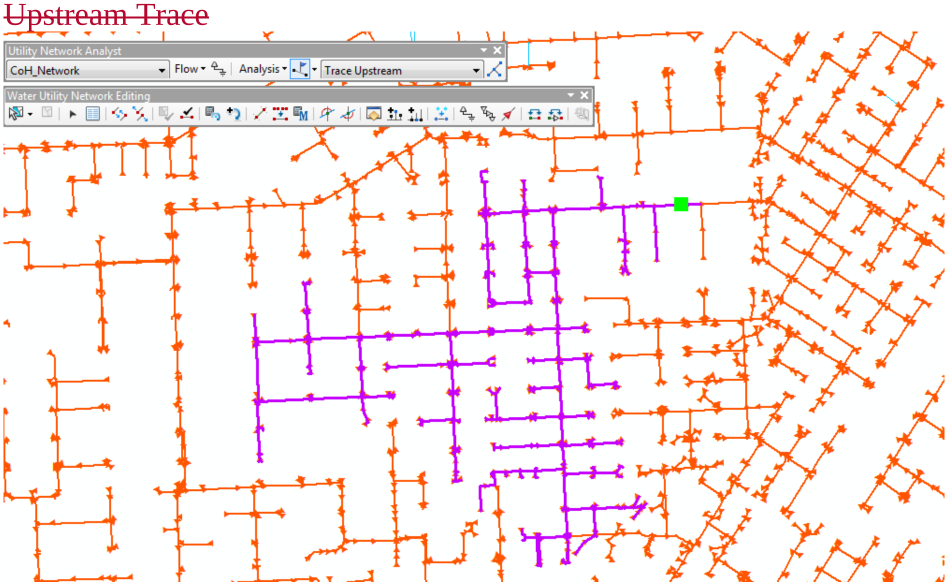
~~Figure 13.25~~

~~Simply hit the solve button on Utility network analyst~~



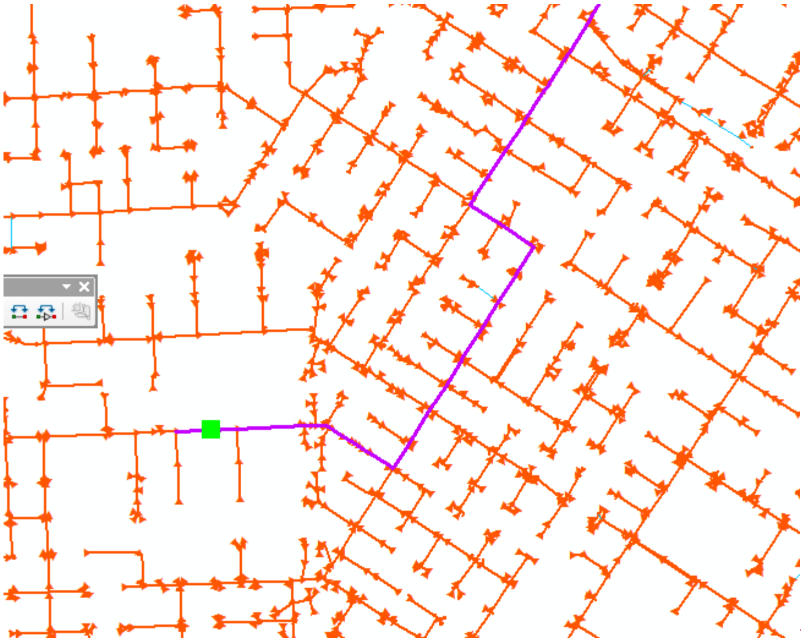
~~Figure 13.26~~

~~Upstream Trace~~



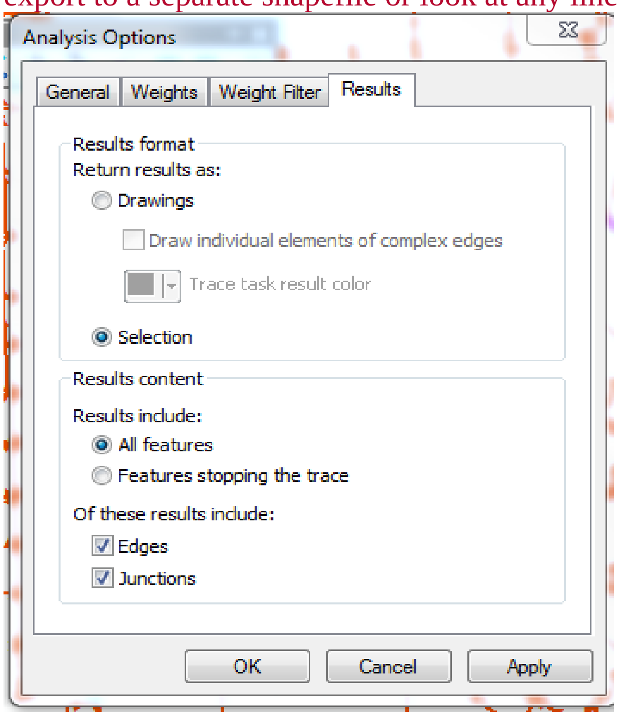
~~Figure 13.27~~

~~Downstream Trace~~



~~Figure 13.28~~

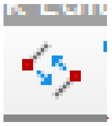
~~The trace is performed by choosing Selection under Options within the Analysis tab in Utility Network Analyst. Run the formal Trace again after changing this output. That way you can export to a separate shapefile or look at any line data you want.~~



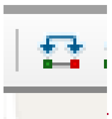
~~Figure 13.29~~

~~After any trace to clear the results/flags so the line is no longer highlighted. You do this by selecting clear results/flags under analysis on the Utility Network Analyst.~~

~~Features are connected to the geometric network by using the Connect Geometric Network Feature Icon.~~



~~If flows are found to be incorrect, the Flip Selected Line Icon is used.~~



~~These procedures are rerun until all feature classes are connected and the flow direction is correct.~~
~~13.2.05.C Data Reviewer~~
~~Data Reviewer uses a Reviewer Btach Job file (.rbj) to check the data for errors. This file will be provided. The Data Reviewer session organizes the records in the Reviewer table.~~

~~On the main menu, click Customize > Toolbars > Data Reviewer.~~

~~Click the Reviewer Session Manager Button~~  ~~on the Data Reviewer toolbar. The Reviewer Session Manager Dialog Box appears.~~

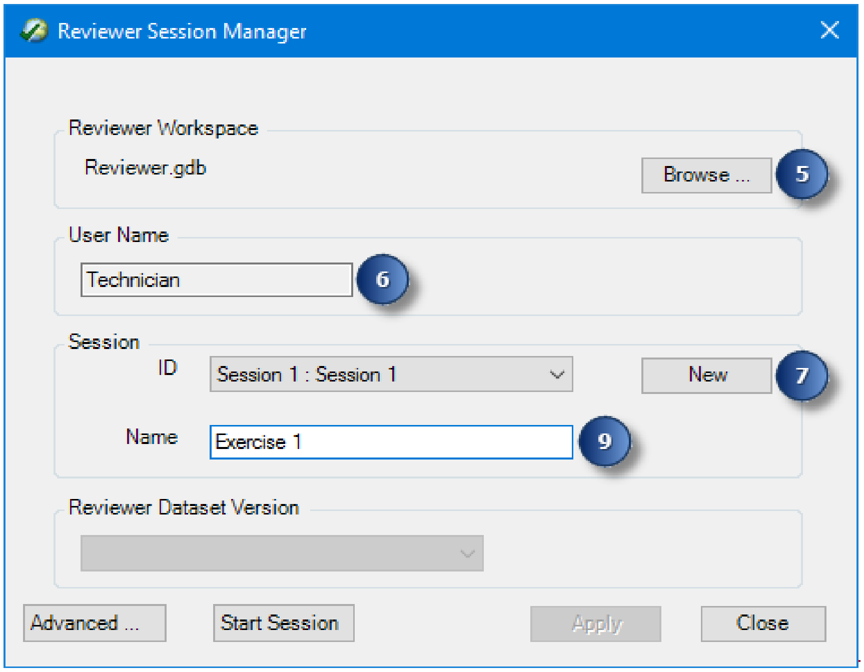
~~Click Browse in the Reviewer Workspace area. The Reviewer Workspace dialog box appears.~~

~~Navigate to the Reviewer workspace and click Add.~~

~~The Reviewer workspace is in the Data Reviewer directory where the sample data was copied. Reviewer.gdb appears in the Reviewer Workspace area in the Reviewer Session Manager Dialog box.~~

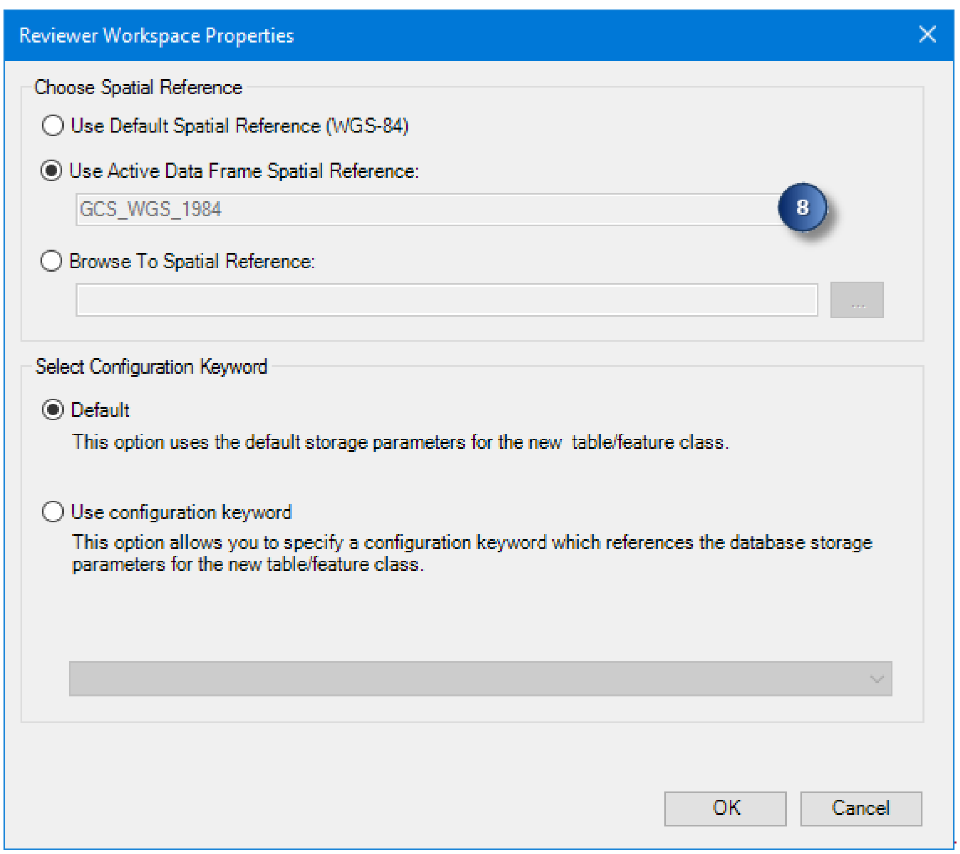
~~The User Name value is automatically populated with the Windows login name.~~

~~Click New. The Reviewer Workspace Properties dialog box appears.~~

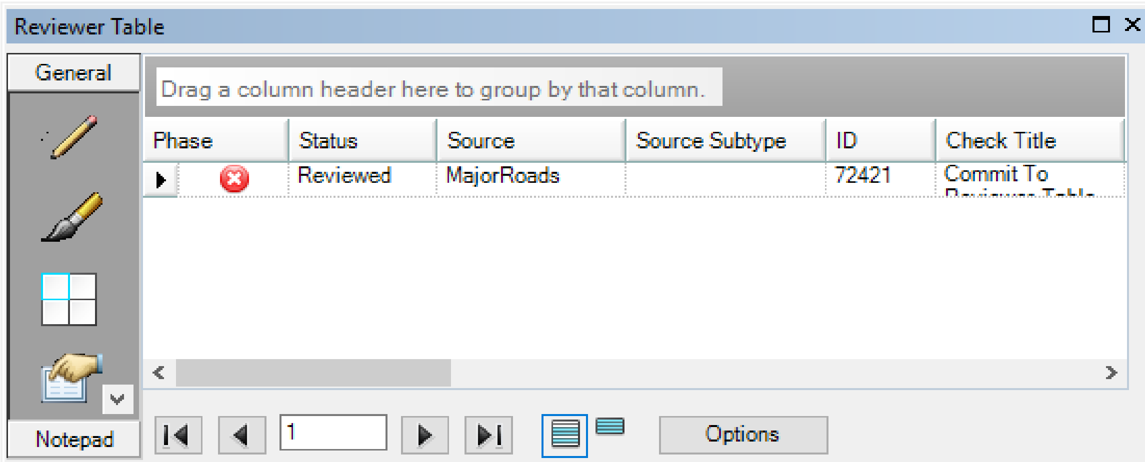


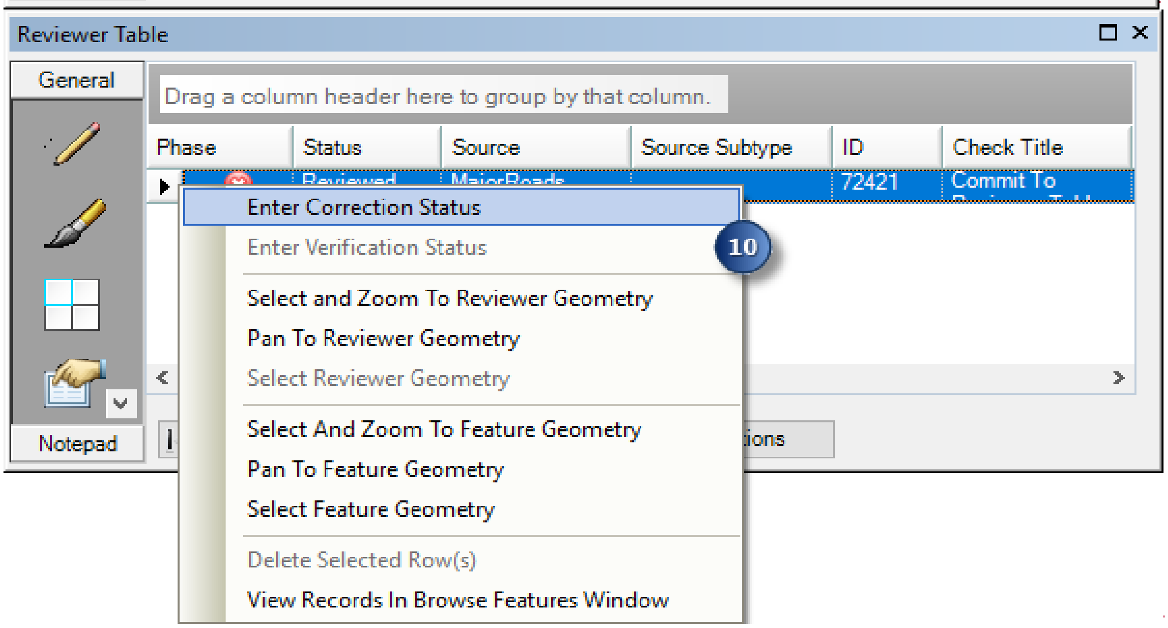
~~Figure 13.30 – Review Session Manager~~

~~Ensure that the Use Active Data Frame Spatial Reference option is selected and click OK. The Reviewer Session Manager Dialog Box appears with the session information populated.~~



~~Figure 13.31 – Reviewer Workspace Properties~~
~~Commit Records to Reviewer Table~~





~~Figure 13.32 – Reviewer Table and Correction~~

~~End Review Session~~

~~Click the Reviewer Session Manager Button on the Data Reviewer toolbar. Click End Session.~~

~~The Reviewer session ends, and the button name changes to Start Session. Click Close and the Reviewer Session Manager Dialog Box closesSECTION – WASTEWATER GIS DIGITAL SUBMISSION REQUIREMENTS~~

~~13.3.01~~ 13.3.02 ~~WASTEWATER FEATURE CLASSES (FEATURE CLASS NAME; FEATURE TYPE; SUBTYPE(S))WASTEWATER ASSET INFORMATIONS~~

~~13.3.02.C Field Requirements~~
~~1. BURIEDDEPTH: Depth, in feet, of cleanout or manhole, as measured from flow elevation to rim elevation.~~

~~2. CREATIONSOURCE: Indicator of assets that were built as part of a Capital Projects contract or DPC agreement.~~

~~3. DATASOURCETYPE: If submission includes revisions that are or will be included on final as built deliverable to the file room, all features~~ must~~should be tagged with As Built; otherwise, select Plan and Profile.~~

~~4. DATUM, DATUM_YEAR: Horizontal benchmark information, including datum source for survey control points in the DATUM field and year of the datum reference (adjusted year, if applicable) in the DATUM_YEAR field.~~

~~5. DIAMETER: In inches, the nominal diameter.~~

~~6. DISTANCETODOWNSTREAMMANHOLE: Distance, in feet, from where the feature connects to the gravity main to the nearest downstream manhole.~~
~~7. DOWNSTREAMDIRECTION: Relative to the point where the feature connects to a sewer main, the closest cardinal direction of downstream flow.~~

~~8. DOWNSTREAMINVERT: In feet and rounded to the nearest hundredth, the elevation of the downstream terminus of the line.~~

~~9. FISCALYEAR: Based on the In-Service Date, the fiscal year is defined as July 1st of the previous year to June 30th of the current year. For example, FY21 is delimited by July 1, 2020 and June 30, 2021. Format is "FY" followed by the 2-digit year.~~

~~10. FLOWELEVATION: In feet and rounded to the nearest hundredth, the elevation of the flow line for the pipe that is conveying wastewater away from that manhole.~~

~~11. GFSORWBS, GFSWBSNUMBER: As assigned by the Capital Projects Service Line, this number is defined as a 1-character utility code, a 6-character project type code, a 4-character project number code, and a 1-digit phase code. Only required for Capital Improvement Projects.~~

~~12. ILMSNUMBER: Sometimes called project number, the integrated land management number is always 8 digits, starting with a 2-digit year followed by an assigned 6-digit number.~~

~~13. INLETELEVATION, INLETELEVATION2, INLETELEVATION3: In feet and rounded to the nearest hundredth, the elevation of the flow line for each pipe that is conveying wastewater into that manhole (or network structure). Only flow lines for gravity mains or force mains shall be included. In the event of more than one line entering the manhole, the lowest elevation shall be in INLETELEVATION, the next lowest elevation shall be in INLETELEVATION2, and, if necessary, the next lowest elevation shall be in INLETELEVATION3. In the event that there are~~

~~more than 3 pipes flowing into a manhole, additional elevations should~~must ~~be identified in the NOTES field.~~

~~14. INSERVICEDATE: As applicable, the date of final acceptance by the city or the effective date of a substantial completion inspection. Only one date shall be used for the entirety of a project.~~

~~15. LENGTH: In feet, the length of a line feature defined as follows:~~
~~Casing: Total distance from start point to end point~~

~~Force Main: Distance from network structure (or fitting or valve, as applicable) to the next manhole (or fitting or valve, as applicable)~~
~~Gravity Main: The whole stretch of pipe from upstream manhole to downstream manhole.~~

~~Service Lead: Measured from property line (typically also a Right-of-Way or easement line) to connection with gravity main.~~
~~16. LIFECYCLESTATUS: Each feature shall be tagged with its post-construction use status; Abandoned (still in the ground, but no longer in use), Existing (being used and maintained), or Rehabilitated.~~

~~17. MATERIAL: Manholes are required to have one of the materials listed from the sJunction Material domain, while all line features shall have one of the materials listed on the sWater Line Material domain. If a gravity main has more than one material in between the two manholes it connects, the material with the longer total length should~~shall ~~be listed in this field. The material with the shorter overall length should~~must ~~be noted, with its length, in the NOTES field.~~

~~18. NOTES: Including, but not limited to, the specific use of this field as listed in this section, this field is to be used to communicate any discrepancies between the standards outlined in this section and the final digital deliverable. The~~
~~explanations will receive consideration but will not guarantee acceptance of the feature(s) involved.~~

~~19. OWNER: Tag each feature as publicly owned or privately owned. If responsibility for maintenance is not with the owner, that detail should~~must ~~be indicated by selecting the appropriate option in the domain.~~

~~20. PERCENTSLOPE: In percentage form, the slope of the line. If there is a~~
~~significant deviation from the minimum required slope or the slope as it will be depicted on the plan and profile drawings, indicate as such in the NOTES field.~~

~~21. PLANDATE: The date the city granted approval to the most recent revision of the plans used for construction. This is typically the date the director, or the director's designee, signed off on the plan set.~~

~~22. PLANNUMBER: The drawing number assigned to the plan set by the file room.~~

~~23. PLANTYPE: If the city assigned a plan set a THD number (at present, a 3-digit number), then PLANTYPE shall be Texas Highway Department (THD).~~
~~Otherwise, Plan and Profile (P) shall be selected.~~

~~24. PROJECTNUMBER: Sometimes called receipt number or permit number, this is a 7-digit number assigned by the city engineer's office. In the case of a TxDOT job, the number follows the format ####-##-###.~~

~~25. PROJECTTYPE: If a project number is assigned by the city engineer's office, the project type is Permit Number (PN). If the project number is assigned by TxDOT, the project type is Control Section Job (CSJ).~~

~~26. RIMELEVATION: The elevation, in feet, of the top of the cover of the manhole. It can also be calculated as Flow Elevation plus Depth.~~

~~27. SIZEOFCOVER: In inches, the diameter of the cover of the manhole.~~

~~28. SUBTYPECD: The specific type of feature within each feature class. The integer value for each subtype is listed in section 13.3.01.~~

~~29. TYPE: If a specific kind of manhole was installed, it shouldmust be indicated here.~~
~~Otherwise, standard manhole shouldshall be selected.~~

~~30. UPSTREAMIVERT: In feet and rounded to the nearest hundredth, the elevation of the upstream terminus of the line.13.3.03WASTEWATER FIELDS (FIELD NAME; FIELD TYPE; LENGTH; DOMAIN NAME, IF APPLICABLE)~~
~~13.3.03.A BURIEDDEPTH; Double; 38~~
~~13.3.03.B CREATIONSOURCE; String; 20; sCreation Source~~
~~13.3.03.C DATASOURCETYPE; String; 20; sData Source Type LINE~~
~~13.3.03.D DATUM; String; 10; sDatum~~
~~13.3.03.E DATUM_YEAR; String; 4~~
~~13.3.03.F DIAMETER; Double; 10~~
~~13.3.03.G DISTANCETODOWNSTREAMMANHOLE; Double; 38~~
~~13.3.03.H DOWNSTREAMDIRECTION; String; 5; sDownstream Direction~~
~~13.3.03.I DOWNSTREAMINVERT; Double; 38~~
~~13.3.03.J FISCALYEAR; String; 10~~
~~13.3.03.K FLOWELEVATION; Double; 38~~
~~13.3.03.L GFSORWBS; String; 5; sProject Type2~~
~~13.3.03.M GFSWBSNUMBER; String; 24~~
~~13.3.03.N ILMSNUMBER; String; 15~~
~~13.3.03.O INLETELEVATION; Double; 38~~
~~13.3.03.P INLETELEVATION2; Double; 38~~
~~13.3.03.Q INLETELEVATION3; Double; 38~~
~~13.3.03.R INSERVICEDATE; Date; 8~~

~~13.3.03.S LENGTH; Double; 10~~
~~13.3.03.T LIFECYCLESTATUS; String; 5; sLifecycle Status~~
~~13.3.03.U MATERIAL; String; 5; sWater Line Material / sJunction Material~~
~~13.3.03.V NOTES; String; 255~~
~~13.3.03.W OWNER; String; 10; sOwner~~
~~13.3.03.X PERCENTSLOPE; Double; 38~~
~~13.3.03.Y PLANDATE; Date; 8~~
~~13.3.03.Z PLANNUMBER; String; 10~~
~~13.3.03.AA PLANTYPE; String; 20; sPlan Type~~
~~13.3.03.BB PROJECTNUMBER; String; 24~~
~~13.3.03.CC PROJECTTYPE; String; 30; sProject Type_2~~
~~13.3.03.DD RIMELEVATION; String; 38~~
~~13.3.03.EE SIZEOFCOVER; String; 5~~
~~13.3.03.FF SUBTYPECD; Integer; 10; Various~~
~~13.3.03.GG TYPE; String; 25; sType of Manhole~~
~~13.3.03.HH UPSTREAMINVERT; Double; 38~~
~~13.3.04 WASTEWATER DOMAINS (DOMAIN NAME; VALID CODES; CODE DESCRIPTIONS)~~
~~13.3.04.A sCreation Source~~
~~1. CIP; Capital Improvement Project~~
~~2. DPC; Developer Participation Contract~~

~~13.3.04.B sData Source Type LINE~~
~~1. AB; As Built~~
~~2. P; Plan and Profile~~

~~13.3.04.C. sDatum~~
~~1. HCFnnnn; Harris County Flood Control~~
~~2. COHnnnn; City of Houston~~
~~3. THDnnnn; Texas Highway Dept~~
~~4. USGSnnnn; U.S. Geological Survey~~
~~5. CORPnnnn; U.S. Army Corps of Engrs~~
~~6. UCGSnnnn; U.S. Coastal and Geodetic Survey~~
~~7. NGSnnnn; National Geodetic Survey~~
~~13.3.04.D. sDownstream Direction~~
~~1. S; South~~
~~2. E; East~~
~~3. W; West~~
~~4. N; North~~
~~13.3.04.E sJunction Material~~
~~1. FBGL; Fiberglass~~
~~2. CONC; Concrete~~
~~13.3.04.F sLifecycle Status~~
~~1. A; Abandoned~~
~~2. E; Features Being Used and Maintained~~

~~3. R; Rehabilitated~~
~~13.3.04.G sOwner~~
~~1. C; City Owned & Maintained~~
~~2. CP; City Owned & Privately Maintained~~
~~3. P; Privately Owned & Maintained~~
~~4. PC; Privately Owned & City Maintained~~
~~13.3.04.H sPlan Type~~
~~1. P; Plan and Profile~~
~~2. THD; Texas Highway Department~~
~~13.3.04.I sProject Type_2~~
~~1. CSJ; Control Section Job~~
~~2. PN; Permit Number~~
~~13.3.04.J sProject Type2~~
~~1. WBS; Work Business Structure~~

~~13.3.04.K SType of Manhole~~
~~1. CR; Corrosion Resistant~~
~~2. FMD; Force Main Discharge~~
~~3. SMRT; Smart~~
~~4. STAN; Standard~~
~~13.3.04.L sWater Line Material~~
~~1. DIP; Ductile Iron~~
~~2. ESC; Extra Strength Clay~~
~~3. FRP; Fiberglass Reinforced Pipe~~
~~4. PEP; Polyethylene Pipe (includes High Density)~~
~~5. PLP; Plastic-Lined Concrete Pipe~~
~~6. PVC; Polyvinyl Chloride~~
~~7. RCP; Reinforced Concrete Pipe~~
~~13.3.05 WASTEWATER QA/QC PROCEDURES~~
~~13.3.05.A Field Checks~~
~~1. Every feature should have each attribute, as applicable per Table 13.44, 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.~~
~~13.3.05.B Visual Checks~~
~~1. All features must be placed in their correct location relative to all other features and with respect to the parcel and right-of-way layers.~~
~~2. All line features shall be digitized in the direction of flow (i.e. from source to sink). Flow direction will be checked for each line using symbology with arrows that point in the direction of digitized flow.~~

~~13.3.05.C Logic Checks~~
~~1. Each feature must have proper connection to the features around it. The following circumstances are prohibited and will be verified using a valence tool:~~

~~Hanging fFeatures~~
~~Overshoots~~
~~Points snapped to points~~
~~2. In the instances where two points are constructed on top of each other (i.e. a double wye), digitize one point in the actual location and offset the second point a small enough difference so it looks correct visually, but the points are technically adjacent.~~
~~13.4.02.C Field Requirements~~
~~CREATIONSOURCE: Indicator of assets that were built as part of a Capital Projects contract or DPC agreement.~~

~~DATASOURCETYPE: If submission includes revisions that are or will be included on final as built deliverable to the file room, all features shouldmust be tagged with As Built; otherwise, select Plan and Profile.~~
~~DIAMETER: In inches, the nominal diameter.~~

~~FISCAL_YEAR: Based on the In-Service Date, the fiscal year is defined as July 1st of the previous year to June 30th of the current year. For example, FY21 is delimited by July 1, 2020 and June 30, 2021. Format is "FY" followed by the 2-digit year.~~

~~GFSORWBS, GFSWBSNUMBER: As assigned by the Capital Projects Service Line, this number is defined as a 1-character utility code, a 6-character project type code, a 4-character project number code, and a 1-digit phase code. Only required for Capital Improvement Projects.~~

~~GROUNDCOVER: In feet, the minimum cover for the water main.~~

~~HYDRANTLEADDIAMETER: In inches, the diameter of the lead line that connects a fire hydrant to the main~~

~~(could change) ILMSNUMBER: Sometimes called project number, the integrated land management number is always 8 digits, starting with a 2-digit year followed by an assigned 6-digit number.~~

~~INSERVICEDATE: As applicable, the date of final acceptance by the city or the effective date of a substantial completion inspection. Only one date shall be used for the entirety of a project.~~

~~LARGEMAINDIAMETER: In inches, the diameter of the main as follows:~~

~~Fitting (Reducer): The larger end of the fitting~~
~~Fitting (Tap Sleeve): The line being tapped~~
~~Pressure Reducing Station: The line from which the water pressure needs to be reduced.~~
~~LENGTH: In linear feet, the length of a line feature defined as follows:~~

~~Casing: Total distance from start point to end point~~
~~Pump Pressure Main: Distance from one digitized appurtenance to the next.~~
~~Lateral Service: Total distance from fitting to hydrant (or meter)~~

~~LIFECYCLESTATUS: Each feature shall be tagged with its post-construction use status; Abandoned (still in the ground, but no longer in use) or Existing (being used and maintained).~~

~~MATERIAL: All line features shall have one of the materials listed on the wWater Line Material domain. If a water main has more than one material in between the fitting(s) and/or valve(s) it connects, water logical nodes shall be used to delineate material changes, and each pipe shall be attributed appropriately.~~

~~MAINDIAMETER: In inches, the diameter of the main line to which a meter or hydrant is tied.~~

~~NOTES: Including, but not limited to, the specific use of this field as listed in this section, this field is to be used to communicate any discrepancies between the standards outlined in this section and the final digital deliverable. The explanations will receive consideration but will not guarantee acceptance of the feature(s) involved.~~

~~OWNER: Tag each feature as publicly owned or privately owned. If responsibility for maintenance is not with the owner, that detail should~~must ~~be indicated by selecting the appropriate option in the domain.~~

~~PLANDATE: The date the city granted approval to the most recent revision of the plans used for construction. This is typically the date the director, or the director's designee, signed off on the plan set.~~

~~PLANNUMBER: The drawing number assigned to the plan set by the file room.~~

~~PLANTYPE: If the city assigned a plan set a THD number (at present, a 3-digit number), then PLANTYPE shall be Texas Highway Department (THD). Otherwise, Plan and Profile (P) shall be selected.~~

~~PROJECTNUMBER: Sometimes called job number, this is currently a 5-digit number assigned by city engineer's office. In the case of a TxDOT job, the number follows the format ####-##-###.~~

~~PROJECTTYPE: If a project number is assigned by the city engineer's office, the project type is City Job (J). If the project number is assigned by TxDOT, the project type is Control Section Job (CSJ).~~

~~SERVICEADDRESS: On meters, the address of the property being served. This includes the address number and, in all caps, street name.~~

~~SMALLMAINDIAMETER: In inches, the diameter of the main as follows:~~

~~Fitting (Reducer): The smaller end of the fitting.~~
~~Fitting (Tap Sleeve): The line coming from the tap sleeve.~~
~~Pressure Reducing Station: The line leaving the pressure reducing station.~~

~~SUBTYPECD: The specific type of feature within each feature class. The integer value for each subtype is listed in 13.4.01.~~

~~13.4.03 WATER FIELDS (FIELD NAME; FIELD TYPE; LENGTH; DOMAIN NAME, IF APPLICABLE)~~
~~13.4.03.A CREATIONSOURCE; String; 20; wCreation Source~~
~~13.4.03.B DATASOURCETYPE; String; 20; wData Source Type~~
~~13.4.03.C DIAMETER; Double; 10~~
~~13.4.03.D FISCAL_YEAR; String; 10~~
~~13.4.03.E GFSORWBS; String; 5; wProject Type2~~
~~13.4.03.F GFSWBSNUMBER; String; 24~~
~~13.4.03.G GROUNDCOVER; Double; 7~~
~~13.4.03.H HYDRANTLEADDIAMETER; Double; 38~~
~~13.4.03.I ILMSNUMBER; String; 15~~
~~13.4.03.J INSERVICEDATE; Date; 8~~
~~13.4.03.K LARGEMAINDIAMETER; Double; 7~~
~~13.4.03.L LENGTH; Double; 10~~
~~13.4.03.M LIFECYCLESTATUS; String; 5; wLifecycle Status~~
~~13.4.03.N MATERIAL; String; 5; wWater Line Material~~
~~13.4.03.O MAINDIAMETER; Double; 10~~
~~13.4.03.P NOTES; String; 255~~
~~13.4.03.Q OWNER; String; 10; wOwner~~
~~13.4.03.R PLANDATE; Date; 8~~
~~13.4.03.S PLANNUMBER; String; 10~~
~~13.4.03.T PLANTYPE; String; 30; wPlan Type~~
~~13.4.03.U PROJECTNUMBER; String; 24~~
~~13.4.03.V PROJECTTYPE; String; 30; wProject Type~~
~~13.4.03.W SERVICEADDRESS; String; 50~~
~~13.4.03.X SMALLMAINDIAMETER; Double; 7~~
~~13.4.03.Y SUBTYPECD; Integer; 10; Various~~
~~13.4.04 WATER DOMAINS (DOMAIN NAME; VALID CODES; CODE DESCRIPTIONS)~~
~~13.4.04.A wCreation Source~~
~~1. CIP; Capital Improvement Project~~
~~2. DPC; Developer Participation Contract~~
~~13.4.04.B wData Source Type~~
~~1. AB; As Built~~
~~2. P; Plan and Profile~~
~~13.4.04.C wLifecycle Status~~
~~1. A; Abandoned~~
~~2. E; Features Being Used and Maintained~~
~~13.4.04.D wOwner~~
~~1. C; City Owned & Maintained~~
~~2. CP; City Owned & Privately Maintained~~
~~3. P; Privately Owned & Maintained~~

~~4. PC; Privately Owned & City Maintained~~
~~13.4.04.E wPlan Type~~
~~1. P; Plan and Profile~~
~~2. THD; Texas Highway Department~~
~~13.4.04.F wProject Type~~
~~1. CSJ; Control Section Job~~
~~2. JOB; City Job~~
~~13.4.04.G wProject Type2~~
~~1. WBS; Work Business Structure~~
~~13.4.04.H wWater Line Material~~
~~1. DI; Ductile Iron~~
~~2. FRP; Fiberglass Reinforced Pipe~~
~~3. PVC; Polyvinyl Chloride~~
~~4. STL; Steel~~
~~13.4.05 WATER QA/QC PROCEDURES~~
~~13.4.05.A Field Checks~~
~~1. Every feature should have each attribute, as applicable per Table 13.45, 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.~~
~~13.4.05.B Visual Checks~~
~~1. All features must be placed in their correct location relative to all other features and with respect to the parcel and right-of-way layers.~~
~~2. All line features shall be digitized in the direction of flow (ie from larger line to smaller line). 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 should always be drawn towards the meter or hydrant they are serving.~~
~~13.4.05.C Logic Checks~~
~~1. Each feature must have proper connection to the features around it. The following circumstances are prohibited and will be verified using a valence tool:~~
~~Hanging Features~~
~~Overshoots~~
~~Points snapped to points~~
~~2. In the instances where two points are constructed on top of each other (ie a Tap Sleeve and Valve), digitize one point in the actual location and offset the second point a small enough difference so it looks correct visually, but the points are technically adjacent.~~

~~SECTION 5 GEOTECHNICAL AND ENVIRONMENTAL GIS DIGITAL SUBMISSION REQUIREMENTS~~

~~The following state the minimum technical specifications required for geotechnical and environmental digital data. All data delivered will conform to the below stated requirements.~~

~~13.5.01 SPATIAL REFERENCES~~
~~13.5.01.A Coordinate System: State Plane Texas South Central Zone (4204) Feet~~

~~13.5.01.B Horizontal Datum: North American Datum of 1983 (NAD83)~~

~~13.5.01.C Vertical Datum: North American Vertical Datum of 1988 (NAVD88)~~

~~13.5.01.D Units: Feet~~
~~13.5.03~~13.3.04 ~~BORING POINT LOCATIONS AND BORING LOG TEST RESULTS TABLE~~
~~There are two required data submissions for geotechnical and environmental reports: soil boring location points and the associated boring log test results.~~
~~13.5.03.A~~13.3.04.A
~~13.5.03.C~~13.3.04.B ~~Geodatabase Feature Class and Table~~

1. ~~The following tables contain all fields found in the boring point features and associated boring test result table with corresponding description, alias name, and domain value names. For purposes of this deliverable~~

~~Table 13.46 - geoBoring Feature Class Attribute Fields for Geotechnical~~ or /~~Environmental Borings~~

~~FieldName~~	~~Type~~	~~Length~~	~~Description~~	~~AliasName~~	~~DomainName~~
~~PROJECTID~~	~~Text~~	~~50~~	~~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~~	~~Project ID~~	
~~WBSNUMBER~~	~~Text~~	~~25~~	~~City of Houston assigned number for the project~~	~~WBS Number~~	
~~PROJECTNAME~~	~~Text~~	~~250~~	~~City of Houston assigned project name~~	~~Project Name~~	
~~REPORTTYPE~~	~~Text~~	~~5~~	~~The report classification content either geotechnical or environmental~~	~~Report Type~~	~~geoReportType~~
~~REPORTSIGNEDDATE~~	~~Date~~		~~Date the report was signed~~	~~Report Signed Date~~	
~~CONSULTANTNAME~~	~~Text~~	~~250~~	~~Name of the firm who produced the report~~	~~Consultant Name~~	
~~BOREID~~	~~Text~~	~~25~~	~~Alphanumeric unique identification number assigned to the boring~~	~~Bore ID~~	

~~FieldName~~	~~Type~~	~~Length~~	~~Description~~	~~AliasName~~	~~DomainName~~
			~~location~~		
~~X*~~	~~Double~~		~~Horizontal coordinate~~	~~X~~	
~~Y*~~	~~Double~~		~~Vertical coordinate~~	~~Y~~	
~~LATITUDE**~~	~~Double~~		~~Geographic coordinate in decimal degrees format measured North and South of the equator.~~	~~Latitude~~	
~~LONGITUDE**~~	~~Double~~		~~Geographic coordinate in decimal degrees format measured East and West of the prime meridian.~~	~~Longitude~~	
~~SURFACEELEV~~	~~Double~~		~~Vertical measurement of the height of the land surface (Feet)~~	~~Surface Elevation~~	
~~DEPTH~~	~~Double~~		~~Total distance from the top of the surface elevation to the bottom of the boring (Feet)~~	~~Depth~~	
~~WATERENCOUNTERED~~	~~Text~~	~~50~~	~~Measurement in Feet at which water was first encountered at the time of drilling~~	~~Water Encountered~~	
~~WATERLEVEL~~	~~Text~~	~~50~~	~~Measurement in Feet of the water level 15-20 minutes after water was first encountered~~	~~Water Level~~	
~~READINGDATE~~	~~Date~~		~~Date at which the water level measurement in Feet was read 24 hours or more after drilling completed~~	~~Reading Date~~	
~~WATERLEVELREADING~~	~~Text~~	~~50~~	~~The water level measurement in Feet read 24 hours or more after drilling completed~~	~~Water Level Reading~~	
~~CONTAMINATION~~	~~Short~~		~~Yes/No Field to flag whether or not contamination was detected~~	~~Contamination~~	~~dYesNo~~
~~DRILLEDDATE~~	~~Date~~		~~Date the boring was drilled~~	~~Drilled Date~~	

~~*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 13.47 - geoBoringTestResults Table Attribute Fields for Geotechnical Borings~~

~~FieldName~~	~~Type~~	~~Length~~	~~Description~~	~~AliasName~~	~~DomainName~~
~~PROJECTID~~	~~Text~~	~~50~~	~~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~~	~~Project ID~~	
~~WBSNUMBER~~	~~Text~~	~~25~~	~~City of Houston assigned number for the project~~	~~WBS Number~~	
~~PROJECTNAME~~	~~Text~~	~~250~~	~~City of Houston assigned project name~~	~~Project Name~~	
~~CONSULTANTPROJECTNO~~ ~~CONSULTANTNAME~~	~~Text~~	~~50~~~~250~~	~~Consultant assigned number for the project~~ ~~Name of firm who produced the report~~	~~Consultant Project Number~~ ~~Consultant Name~~	
~~REPORTSIGNEDDATE~~	~~Date~~		~~Date the report was signed~~	~~Report Signed Date~~	
~~BOREID~~	~~Text~~	~~25~~	~~Alphanumeric unique identification number assigned to the boring location~~	~~Bore ID~~	
~~SAMPLENO~~	~~Text~~	~~25~~	~~The unique identification number for the sample~~	~~Sample Number~~	
~~SAMPLEDEPTHTOP~~	~~Double~~		~~Top depth of the boring in Feet~~	~~Sample Depth Top~~	
~~SAMPLEDEPTHBTM~~	~~Double~~		~~Bottom depth of the boring in Feet~~	~~Sample Depth Bottom~~	
~~SAMPLETYPE~~	~~Text~~	~~5~~	~~Type of sample taken~~	~~Sample Type~~	~~geoSampleType~~
~~SPT~~	~~Double~~		~~Standard penetration test (SPT) measurement in blows/Feet~~	~~SPT~~	

~~FieldName~~	~~Type~~	~~Length~~	~~Description~~	~~AliasName~~	~~DomainName~~
~~WATERCONTENT~~	~~Double~~		~~Percent water content in sample~~	~~Water Content~~	
~~DRYDENSITY~~	~~Double~~		~~Dry density of sample measured in pounds per cubic foot (pcf)~~	~~Dry Density~~	
~~ATTERBERGLIMITSLL~~	~~Double~~		~~Atterberg limits – Liquid Limit (%)~~	~~Atterberg Limits LL~~	
~~ATTERBERGLIMITSPL~~	~~Double~~		~~Atterberg limits – Plastic Limit (%)~~	~~Atterberg Limits PL~~	
~~ATTERBERGLIMITSPI~~	~~Double~~		~~Atterberg limits – Plasticity Index (%)~~	~~Atterberg Limits PI~~	
~~PERPASSSIEVE200~~	~~Double~~		~~Percent passing sieve 200 (%)~~	~~Percent Passing Sieve 200~~	
~~TSFUNCONFCOMPTEST~~	~~Double~~		~~Shear strength (TSF) unconfined compression test~~	~~TSF UC Test~~	
~~TSFUUTEST~~	~~Double~~		~~Shear strength (TSF) triaxial compression (UU) test~~	~~TSF UU Test~~	
~~TSFCONFININGPRESS~~	~~Double~~		~~Shear strength (TSF) Confining pressure TSF~~	~~TSF Confining Pressure~~	
~~TSFTORVANE~~	~~Double~~		~~Shear strength (TSF) torvane~~	~~TSF Torvane~~	
~~TSFPOCKETPENETROMETER~~	~~Double~~		~~Shear strength (TSF) pocket penetrometer~~	~~TSF Pocket Penetrometer~~	
~~TYPEOFMATERIAL~~	~~Text~~	~~250~~	~~Type of soil material. For geotechnical borings refer to ASTM D2487. For environmental borings refer to ASTM D2488.~~	~~Type of Material~~	
~~PID*~~	~~Double~~		~~Photoionization Detector (PID) value (ppm)~~	~~PID~~	

~~*The field is only required for environmental borings and/or test results and is not a requirement for geotechnical borings.~~

~~13.5.03.C.1 Domain Codes and Values~~

~~The tables below contain all the domain values for the geotechnical and environmental boring~~

~~point feature class and the associated boring log test results table.~~

~~Table 13.48 - geoYesNo Domain~~

~~Code~~	~~Description~~
~~0~~	~~No~~
~~1~~	~~Yes~~

~~Table 13.49 - geoSampleType Domain~~

~~Code~~	~~Description~~
~~UD~~	~~Undisturbed Sample~~
~~SS~~	~~Split Spoon Sample~~
~~AG~~	~~Auger Cuttings~~
~~SPT~~	~~Standard Penetration Test~~

~~Table 13.50 - geoReportType Domain~~

~~Code~~	~~Description~~
~~GEO~~	~~Geotechnical~~
~~ENV~~	~~Environmental~~

~~13.5.03.D~~13.3.04.C ~~Tabular Data~~

~~If a file geodatabase cannot be delivered, the following tables contain all fields found in the boring point and test result tabular data which may be delivered in comma delimited or Excel spreadsheet format.~~

~~13.5.03.D.1 List Values~~

~~The tables below contain all the list values for the geotechnical and environmental boring point and boring log test results tables.~~

~~13.5.03.E Required Attributes~~

~~The following table summarizes the required attribute fields that are to be populated, if relevant, for the boring point feature class or tabular data and the associated boring log test results table.~~

~~13.5.04 DELIVERABLE FORMATS~~

~~13.5.04.A The geotechnical and environmental data products may be delivered in one of the following formats:~~

~~1. Boring Locations (geoBoring) - file geodatabase feature class, comma delimited text file (.CSV), or Excel Spreadsheet; and~~

~~2. Boring Log Test Results (geoBoringTestResults) - file geodatabase table, comma delimited text file (.CSV), or Excel Spreadsheet.~~

~~13.5.04.B The preferred delivery format is to submit both the boring locations and the test results within one file geodatabase. Shapefiles will not be accepted as a submission format.~~

~~13.5.04.C The City will specify the delivery method during project planning.~~

END OF CHAPTER