MANUAL FOR THE DESIGN OF
WATER AND SANITARY SEWER LINES

SECTION A – NOTES TO ENGINEERS

This manual is intended to aid and assist private engineers in the layout and design of sanitary sewers and water lines to definite standards and to obtain uniformity in the plans. It is recognized that each addition has its individual problems that no fixed rules will apply to all cases; therefore, final approval of all or any part of any plans rests with the City Engineer.

1. Submittal: On completion of the plan and engineering of a subdivision, it will be to your advantage to bring or send two copies along with a contour map and preliminary water and sewer layout to City Hall, whereby a check can be made as to the general layout and availability of water and sewer. If problems arise as to the availability of water and sewer, it may be necessary to have a meeting with the developer and discuss problems.

2. Preliminary Check: When the engineering plans are complete, send in five sets of good, legible blue line prints. Plans will be reviewed within 10 days of submission to City Hall.

3. Final Check: When the plans are returned to you after preliminary check, and if the corrections were few, the final plans may be brought in with the marked up set. If there were many corrections, then one or more sets of prints should be submitted again.

4. Final Approval of Plans: Before you request approval of the plans, check the following:

    a. The plans must be complete and correct.

    b. The approved plat must have been submitted.

    c. The street grades and storm sewer plans must have been submitted and approved.
    d. The plans must be signed and sealed by the Registered Professional Engineer who is responsible for the design.

e. All fees and other monies due, must be paid in full.

f. Contractor's insurance must be in correct form.

g. Four sets of complete engineering plans are required for city use. There should be additional approved plans available for Contractors and Engineering Consultants use during construction of the improvements. Only those plans with the approved stamp will be recognized by the Construction Inspector.

h. If all of the preceding have been done, the plans are ready for approval by the Engineering Division.

5. Specifications are the Standard Specifications for Public Work Construction, North Central Texas.

6. Special Provisions are City Special Provisions to the Specifications.

7. Standard Details are City Standard Construction Details.

SECTION B – WATER MAINS

In general, water mains are placed on the north and west sides of a street, at a distance of eleven feet from the centerline of the street, or otherwise as directed by the Engineering Division. See City Detail 4005* for locations.

1. The minimum water main size shall be 8" in residential (larger line size may be required by the comprehensive plan, water master plan, or to meet fire protection needs as determined by the city engineer).

2. No water main shall be located nearer than five feet from any tree or structure.

3. Water Main Material:
   a. All water mains 12-inch in diameter and under shall be ductile iron or AWWA C900 PVC, mechanical joint, or a joint of the type which provides a recession in the bell for the employment of a single rubber gasket to be placed before the insertion of the succeeding spigot. Joint material for PVC shall conform to ASTM F477. Tracer wire shall be installed over all PVC mains.

b. All water mains 14-inch in diameter and larger shall be Reinforced Concrete Cylinder Pipe complying with AWWA C301 & C303, AWWA C905 PVC (DR 18, DR 21, DR 25 and DR 32.5) or AWWA C151 Ductile Iron Pipe, thickness class 50. Profile elevations shall be provided for mains 14-inch in diameter and larger.

c. All mains supplying fire sprinkler systems outside of utility easements shall be minimum 200 PSI working pressure and U.L. listed.

4. Valves 12-inch and under shall be placed on or near street property lines not over 800 feet apart in residential, duplex and apartment districts and not over 500 feet apart in all other districts; and in such a manner as to require preferably two, but not more than three valves to shut down each City block, or as may be required to prevent shutting off more than one fire hydrant. On cross-feed mains without services, a maximum of four valves shall be used to shut down each block. Also, can be made for a future main extension without causing loss of service on the existing main. The location of valves larger than 12-inch will be as approved by the Engineering Division. Valves 12-inch and under will be Resilient Seat Gate Valves (RSGV). Valves over 12-inch will be Butterfly valves.

5. Fire Hydrants

Section 1. Number and Locations

A sufficient number of fire hydrants shall be installed to provide hose stream protection for every point on the exterior wall of the building with the lengths of hose normally attached to the hydrants. There shall sufficient hydrants to concentrate the required fire flow, as recommended by the publication "GUIDE FOR DETERMINATION OF REQUIRED FIRE FLOW" published by the Insurance Service Office, around any building with no hose line exceeding the distances hereinafter established and with an adequate flow available from the water system to meet this required flow. In addition, the following guidelines shall be met or exceed:

a. Single Family and Duplex Residential – As the property is developed, fire hydrants shall be located at all intersecting streets and at intermediate locations between intersections at a maximum spacing of 500 feet between fire hydrants as measured along the route that fire hose is laid by the fire vehicle.

b. Multi-Family Residential – As property is developed, fire hydrants shall be located at all intersecting streets and at intermediate locations between intersections at a maximum spacing of 400 feet as measured along the length of the centerline of the roadway, and the front of any structure at grade shall

be no further than 500 feet from a minimum of two fire hydrants as measured along the route that a fire hose is laid by a fire vehicle.

c. Other Districts – As the property is developed, fire hydrants shall be located at all intersecting streets and at intermediate locations between intersections at a maximum spacing of 300 feet as measured along the length of the centerline of the roadway, and in front of any building at grade shall be no further than 300 feet from a minimum of two fire hydrants as measured along the route that the fire hose is laid by a fire vehicle.

d. Protected Properties - Fire hydrants required to provide a supplemental water supply for automatic fire protection systems shall be within 100 feet of the Fire Department connection for such system.

e. Buildings Fire Sprinkled – an 8-inch fir line stub-out with valve shall be provided for all buildings to be sprinkled. A smaller stub-out can only be used with Fire Department approval.

f. Fire hydrants shall be installed along all fire lane areas as follows:
    i. Non-Residential Property or Use
        1. Within 150 feet of the main entrance.
        2. Within 100 feet of any Fire Department connection.
        3. 'At a maximum intermediate spacing of 300 feet as measure along the length of the fire lane.
    ii. Apartment, Townhouse, or Cluster Residential Property or Use
        1. Within 100 feet of any Fire Department connection.
        2. At maximum intermediate spacing of 400 feet as measured along the length of the fire lane.

g. Generally, no fire hydrant shall be located closer than fifty (50) feet to a non-residential building or structure unless approved by the Engineering Division and the Fire Department.

h. In instances where access between the fire hydrant and the building which it is intended to serve may be blocked, extra fire hydrants shall be provided to improve the fire protection. Railroads, divided thoroughfares, expressways, blocks which are subject to buildings restricting movement, and other man-made or natural obstacles are considered as barriers.

Section 2. Restrictions

a. All required fire hydrants placed on private property shall be adequately protected by either curb stops or concrete posts or other methods as approved by the Engineering Division and the Fire Department and shall be in easements. Such stops or posts to be the responsibility of the land owner on which the said fire hydrant is placed.

b. All required fire hydrants shall be installed so that the steamer connection face the fire lane or street, or as directed by the Fire Department.
c. Fire hydrants, when placed at intersections or access drives to parking lots, when practical , shall be placed so that no part of the fire truck will block the intersection or parking lot access when connections to the fire hydrant are made.
d. Fire hydrants, required by this article, and located on private property, shall be accessible to the Fire Department at all times.
e. Fire hydrants shall be located at street or fire lane intersections, when feasible.
f. A Blue Stimsonite, Fire-Lite reflector (or approved equal) shall be placed in the center of the street opposite fire hydrant.
g. In non-residential developments an 8-inch lead will be required on all fire hydrants that are located more than 25 feet from the looped main.

SECTION C – SANITARY SEWERS

INTRODUCTION

The City has been authorized by the Texas Natural Resource Conservation Commission to review all plans for proposed sanitary sewers within the city. To comply with this authorization the city has adopted a policy that all sewers will be designed in accordance with Chapter 30 Texas Administrative Code Chapter 217 – "Design Criteria For Sanitary Sewage Systems." Further, all Engineers submitting designs to the city are required to complete the Administrative and Technical Review Questionnaire found in Appendix A of this manual. The Engineer will be required to keep the questionnaire, and all associated calculations and data, on file for a period of one-year from the date of final acceptance of the completed project. When requested in writing the Engineer will furnish, within five working days of receiving the notice, to the City copies of the questionnaire.

As a minimum, the Engineer shall keep on file copies of submittal documents, correspondence related to the review and approval of the project, construction inspection reports, and testing results.

PROCEDURE FOR VARIANCES

When, in the course of completing the questionnaire, any question is answered "no" a variance from the design criteria set forth in Chapter 217 must be requested. To obtain a variance the Engineer must complete question T-113 of the questionnaire.

SANITARY SEWERS

1. Sizes and grades for sanitary sewer shall be as required by the Engineering Division, and consideration shall be given as to possible extensions for future development. No sanitary sewers, other than laterals and force mains, shall be less than 8-inches in diameter. If feasible, sewers shall be placed in streets. Sewers are usually located on the centerline of the road, seven feet from back of curb to centerline of pipe. Each addition has its individual problems, therefore, no fixed rules will apply to all cases. See City Detail 4005* for locations of sanitary sewer lines.

2. Railroad, State Highway and creek crossings, etc. shall be as approved by the Engineering Division.

3. The Engineer shall include on the design plans a summary of pipe sizes, pipe materials, and joint materials.

4. If possible, sewer lines shall be located in the alleys, streets, or easements and shall be a minimum of five feet (5') deep to invert; exceptions authorized by the Engineering Division shall have concrete protection. In general, the minimum depth for sewer to serve given property with a 4-inch lateral shall be 3-feet plus 2% times the length of the house lateral (the distance from the sewer to the center of the

house). Thus, for a house 135 feet from the sewer, the depth would 3-feet plus 2% x 135 feet= 3.0 plus 2.7 feet = 5.7 feet. The depth of the flow line of the sewer should then be at least 5.7 feet below the elevation of the ground at the point where the service enters the house. Profiles of the ground line 20-feet past the building line will be required to verify that this criteria is met. On lines deeper than 12 feet, a parallel sewer line will be required when laterals are to be attached. This requirement should be discussed with the Engineer.

5. No sewer line shall be located nearer than five feet from any tree or structure.

6. No sanitary sewer in alleys unless approved by the Engineering Division.

7. Curved Sewers

   No vertical curves will be allowed.

   Horizontal curvature may be by joint deflection or pipe flexure but not both. The Engineer must specify on the plans the method of deflection allowed and the allowable radius or joint deflection for each pipe size. Type B-1 Tongue and Groove pulled radius pipe will be accepted or approved other.

   When pipe flexure is used, the minimum radius of curvature shall be equal to that recommended by the pipe manufacturer or $300 * D_0$, where $D_0$is the average outside diameter of the pipe in inches, which is greater. The Engineer shall note on the plans that, when using pipe flexure, all joints are to remain fully seated.

   If joint deflection will be used to provide horizontal curvature, the allowable deflection shall be 5^o or 80% of the Manufacturer's recommended maximum joint deflection, or 80% of the Natural Reference Standard maximum recommended joint deflection, whichever is less. When joint deflection is used the Engineer must specify the size of mandrel used for deflection testing. The mandrel shall be sized to verify that the maximum joint deflection has not been exceeded.

   Horizontal curves shall match change in street direction as near as possible, but will not be allowed across residential single family and duplex lots.

   Slopes on curved sewers shall be a minimum of 3% greater than the corresponding minimum slope of sewers on a straight line.

   Manholes on curved sewers shall be located at the P.C. and P.T. of the curve and a maximum spacing of 300 feet along the curve. Sewage flow shall be computed in

accordance with Sanitary Sewer Daily Flow Calculations (see pages 13 & 14), with the exceptions, as required by the Engineering Division. The minimum acceptable "n" factor for use in design of sanitary sewers shall be 0.013. Pipes should be placed on such a grade that the velocity when flowing full is not less than two feet per or more than ten feet per second. Minimum grades based on n=0.013 shall be as follows:

Size of Pipe in IN. I.D.	Minimum Slope in Percent	Maximum Slope in Percent
6	0.50	12.35
8	0.33	8.40
10	0.25	6.23
12	0.20	4.88
15	0.15	3.62
18	0.11	2.83
21	0.09	2.30
24	0.08	1.93
27	0.06	1.65
30	0.055	1.43
33	0.05	1.26
36	0.045	1.12
39	0.04	1.01
>39	*	*

*For lines larger than 39-inches in diameter, the slope shall be determined using Manning's equation to maintain a minimum velocity of 2 feet per second when flowing full and a maximum velocity of 10 feet per second when flowing full.

$$V = \frac{1.486}{n} * R^{2/3} * \sqrt{S}$$

Where V= velocity (ft/sec)

N= Manning's Roughness Coefficient (0.013)

R= Hydraulic Radius (ft)

S= Slope (ft/ft)

8. All grades shall be shown to the nearest 0.01 foot.

9. The sizes and locations of manholes, wyes, bends, tap connections, cleanouts, etc., shall be designated by the Engineering Division. In general, manholes shall be placed at all four-way connections and three-way connections, changes in grade and direction, and the maximum spacing 400 feet in subdivisions. See City Detail 5001* for General Construction Wastewater Notes.

10. The diameter of a manhole constructed over the center of a sewer should vary with the size of the sewer. For 6” to 12” sewers, the manhole shall be 48” minimum diameter; for 15” to 27” lines, the manhole shall be 60” minimum diameter; 30” to 36” lines – 72” minimum diameter; for 42” to 48” lines – 96” minimum diameter. Any manholes 10 feet deep shall be a minimum 60-inch diameter, at the flow line and eccentric with one vertical wall.

11. Manholes within the 100-year floodplain will be constructed in accordance with City Details 5060 and 5085*.

12. Cleanouts shall be installed on the ends of all lines. A drop pipe shall be provided for a sewer entering a manhole more than 18-inches above the invert. If the drop pipe is inside the manhole, a minimum of 48-inches of clear space shall be maintained and the drop shall be permanently affixed to the wall of the manhole. Where sewer lines enter the manhole higher than 24-inches, above the manhole invert, the invert shall be filled to prevent solids deposition. Construct manholes at each end of lines that are installed by other than open cut and at each end of aerial crossing lines.

13. Where unequal size pipes enter a manhole, the crown of the pipes should be set at the same elevation.

14. In order to provide access for sewer lines for cleaning, manholes and/or cleanouts shall be so located that 250 feet of sewer rod can reach any point in the line. This means that spacing between a manhole and an upstream cleanout shall be limited to 400 feet. Cleanouts may be located at the end of the line only.

LATERALS:

1. The sizes and locations of laterals shall be designated by the Engineering Division. In general, for single family dwellings, the lateral size shall be 4” minimum; for multiple units, apartments, local retail and commercial – 6” minimum; for manufacturing and industrial, the size should be 8” or larger as required. House laterals usually come out at the centerline of the lot and shall have an eight foot lateral separation from the water service. Manholes will be required on 6-inch and larger laterals where they connect to the main line. Laterals will not be attached to sewer mains that are deeper than 12 feet. A minimum of one lateral per building

shall be required. Also a minimum of one later per residential lot shall be required. Duplexes shall have two laterals.

2. Construction staking – Line and grade stakes for construction shall be furnished by the developer's Engineer. All property lines and corners must be properly staked to insure correct alignment. The city will not be liable for improper alignment or delay of any kind caused by improper or inadequate surveys by the developer or by interference of other utilities.

3. Materials for Sewer Lines:

Rigid Pipe – For this manual, rigid pipe shall include reinforced concrete pipe and ductile iron pipe. If the proposed project contains the option for used of rigid pipe, the Engineer shall perform an engineering analysis which shows that pipe is adequate to withstand the designed loads. The Engineer shall, as a minimum consider trench, depth of cover, effect of water table, etc. when analyzing the pipe. Copies of the analysis must be provided to the City within five days of written request from the city.

Flexible Pipe – The Engineer shall include in his analysis the following:

Method of defining the modulus of subgrade reaction, E';

For the bedding material, E'_b and;

For the natural soil, E'_n or other specific information that is necessary to quantify of the in situ material on the effective modulus, E'_e ;

Included within the analysis are calculations for the effective modulus, prism loads, live loads, long-term deflection, strain, buckling, and wall crushing. Copies of the analysis must be provided to the City within five days of written request from the city.

a. All sewer shall be PVC complying with ASTM 3034 of F794 with a cell classification of 12454b or c.

   Reinforced Concrete pipe is allowed only on a case by case basis and then only, on lines larger than 30 inches in diameter. The City will issue written approval for use of RCP on those projects where it must be used.

   Vitrified pipe will not be allowed in the City.

b. Sewer pipe shall conform to the Specifications and/or Special Provisions.
c. Sewer pipe joint materials shall have resilient properties, conforming to the Specifications and/or Special Provisions.

SECTION D – FORM OF PLANS

1. IN IN DOUBT, CHECK WITH THE ENGINEERING DIVISION BEFORE PROCEEDING.

2. The plan sheet should be drawn so that the north arrow points to the top or to the left side of the sheet. It is important that the plan show sufficient surrounding streets, lots, and property lines so the existing water and sewer may be adequately shown and so that proper consideration may be given to future extensions. Proposed water and sewer lines shall be stubbed out to the addition extremities in order that future extensions may be made with a minimum of expense and inconvenience. Unless it would make the plan very difficult to read, both water and sewer lines should be shown on the same street. The lines on the profile sheet shall be drawn in the same direction as on the plan. Lettering shall be oriented to read upward or to the left.

SECTION E – DATA TO BE INCLUDED

1. Sewer Data to be included on Plan Sheet: The plan shall show the existing and proposed water and sewer lines and all appurtenances thereto. The plan should also have the storm sewer system dashed in. All lines shall be numbered, lettered or otherwise designated on both plan and profile sheets. All lines shall show sizes and direction of flow on both plan and profile sheets. Stationing shall be shown to the nearest 0.01 foot and each new line shall begin at 0+00 at the outlet and increase up the sewer. Station pluses at all junctions of sewers, horizontal P.C.'s, and P.T.'s, and railroads, and all crossing utilities, etc., shall be shown on both plan and profile. The degree of angles and horizontal curve data shall be shown on the plan only. Minimum Radius for sanitary sewer mains is 300 feet. Sewer laterals shall be shown at a location most convenient to serve the property. Sewer laterals will usually be located near the center of the lot, either at the street or alley. If the lateral is to be adjacent to the water service, then show the lateral 10 feet downstream. The location shall be designated on the plans.

2. Sewer Data to be included on the Profile Sheet: The data for the profile sheet shall be obtained by running a line of levels along the actual route and by taking any other necessary observations. Profiles shall show the elevations to the nearest 0.1 foot of the ground at the centerline of the sewer, and to the right and left of the centerline of the sewer at the location of the approximate center of the proposed houses or buildings to be served, and the approved or alley grade. Profiles shall also show the sewer pipe, manholes, cleanouts, etc. The size of the sewer, the directions of the flow, and the grade to the nearest 0.01 foot shall be indicated just over the "pipe" and the total linear footage of line, size, kind of pipe, and type of embedment or encasement shown below the "pipe". All of the information pertaining to the horizontal data, station pluses, appurtenances to be

built, etc., is usually shown just above the ground line, whereas, the flow line (invert) elevations are shown below the pipe. Elevations of crossing and parallel utilities shall be shown. All invert elevations shall be shown to the nearest 0.01 foot. Invert elevations shall be recorded at all junctions (all lines-in and out), at grade breaks, the ends of lines, or other points as requested by the Engineering Division. Bench marks used shall also be clearly shown, giving the descriptive locations and elevations. Elevations must be from sea level datum, not assumed. Bench level circuits should begin at a USGS monument and bench mark of second order accuracy established at least every one-half mile through the project. All existing water, sewer, gas, storm sewer, telephone, power, and other utilities parallel to or crossing the proposed sewer or water line shall be adequately designated as the size, type, and location. Drainage area maps and capacity calculations for mains 10" and larger will be required.

3. Data to be Included for Water Plan and Profile: For water lines in new subdivisions, very little data needed to be included. Indicate the location of any existing valves required for shut-down purposes and of any trees, ends, etc., to be tied into. Indicate clearly the sizes of the lines to be installed, and all proposed valves, fire hydrants, tees, crosses, bends, reducers, plugs, sleeves, wet connections, tap connections, creek, railroad or highway crossings, tunnels, meter boxes, valves vaults, and other appurtenances at each intersection or as required. Where the pipe is to be laid around a curve, the curve data on the plat is usually sufficient unless otherwise requested. The size and type of services and the material, type of joint, and class of pipe may be indicated by adequate notation in the lower left or right hand corners on the plan sheet. Water services and meter boxes shall be indicated and shall be located at or near the center of the front of each lot. If a water line requires a profile, then follow the general procedures as outlines for sewers, except that the grades and elevations of the proposed water line usually need not be shown closer than the nearest 0.1 foot.

SECTION F – SYMBOLS

All plans drawn for the city by engineers shall be as nearly alike as possible; therefore, standard symbols and lines will be on all plans.

SANITARY SEWER DAILY FLOW CALCULATIONS

*Note the following are example calculations.

Apartment Sanitary Sewer Flow

95 gal. x .75 = 71.25 gal. per day per person

22 units per acre with 3 persons per unit

Calculations (71.25) (22) (3) = 4,702 or 4,700 gallons per day per acre

Office Sanitary Sewer Flow

3100 parking spaces for 34.7 acres

One person per parking space

20 gallons per person per day

$\frac{3100}{34.7\ acres}$ = 89.33 persons per acre (20 gal) = 1,786.7 or 1,790 gal. per day per acre

Residential Sanitary Sewer Flow

95 gallons per person per day

4 units per acre

3.5 persons per unit

(95) (4) (3.5) = 1330 gallons per acre per day

Hospital Sanitary Sewer Flow

200 beds – General Hospital

200 gallons per day per bed

200 x200 = 40,000 gallons per day

Nursing Home Sanitary Sewer Flow

150 beds – Heritage Manor

90 gallons per day per bed

90 x 150 = 13,500 gallons per day

Residential Sanitary Sewer Flow

95 gallons per person per day

10 units per acre

3.5 persons per unit

(95) (10) (3.5) = 3,325 gallons per day/acre

APPENDIX A