NOTE: This document is currently being revised and updated. Contact Lyle Jenkins, Town Engineer prior to using any of the information contained herein. In the event of a conflict between this document and more recent Town guidelines and standards, including the Unified Development Ordinance, the more recent document shall control.
### TOWN OF SUNNYVALE
### ENGINEERING DESIGN MANUAL
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PART 1 - GENERAL

1.1 PURPOSE

The purpose of the Engineering Design Manual is to provide a set of standards for designing streets, thoroughfares, drainage facilities, water lines, sanitary sewer lines and preparing construction plans for such facilities that are to be owned, operated and/or maintained by the Town of Sunnyvale, Texas. These standards will be used by the Town staff and consulting engineers employed by the Town for the above described improvement projects, and engineers for private developments in the Town of Sunnyvale. Unusual circumstances or special designs requiring a variance from the standards in this manual may be approved by the Town Administrator.

1.2 STANDARDS OF DESIGN

The Standards of Design, as adopted by the Town of Sunnyvale, are set forth herein. These standards shall be considered as the minimum requirements, and it shall be the responsibility of the developer to determine if more stringent requirements are necessary for a particular development. It is not intended that the Standards of Design cover all aspects of a development. For those elements omitted, the developer will be expected to provide designs and facilities in accordance with good engineering practice and to cause to be constructed facilities utilizing first class workmanship and materials.

1.3 STANDARD SPECIFICATIONS FOR CONSTRUCTION

Standard specifications for construction as adopted by the Town of Sunnyvale shall be in accordance with the "Standard Specifications for Public Works Construction" as published by the North Central Texas Council of Governments (copies obtained from N.C.T.C.O.G. offices) and the Addendum to the N.C.T.C.O.G. specification bound in this document. These specifications shall be considered as minimum requirements, and such additional requirements of the Town or the developer may consider appropriate should be added as supplements.

1.4 UTILITY ASSIGNMENTS

In general, utilities are to be located in public rights-of-way in the location shown in Appendix "B." The Town Engineer shall determine the location of utilities where special circumstances prevent the standard utility assignments from being used.
1.5 GENERAL NOTES

All construction plans for the projects described above shall contain the applicable general notes listed in Appendix "C."

1.6 OWNER'S DEDICATION

All plats shall use all applicable portions of the Standard Owner's Dedication shown in Appendix "D".

1.7 STANDARD DETAILS

Standard construction details are shown in Appendix "F." All construction plans shall either contain the details that apply or make specific reference to these details as being a part of the construction plans. Additional details shall be prepared as required to describe the construction required.

1.8 RECORD DRAWINGS

Record Drawings ("As Built Drawings") are required to be submitted for all public works construction in the Town of Sunnyvale. Record Drawings shall meet the requirements set forth in the Town's addendum to the N.C.T.C.O.G. Specifications. In addition, the final plat of any subdivision shall be submitted to the Town in Autocad® format on electronic media.
PART 2 - PAVING

2.1 STREET AND THOROUGHFARE CLASSIFICATIONS

Town streets and thoroughfares are classified into several types according to their use and locations as indicated in Table 2-1. The basic types include the residential streets including "country lanes" that provide direct access and frontage to adjacent properties, collectors that serve as the distributor-collector arteries and provide direct access to adjacent properties, and parkways and major arterial streets thoroughfares that carry higher volumes of traffic through urban areas. Each traffic artery is made up of elements that are related to the use of that particular facility. These elements include right-of-way, pavement width, median width if required, arrangement of traffic lanes and parking lanes, curb radii at intersections and other characteristics.

2.2 STREET AND THOROUGHFARE GEOMETRICS

A. General

Geometrics of the town streets and thoroughfares may be defined as the geometry of the curbs or pavement areas that governs the movement of traffic within the confines of the right-of-way. Included in the geometrics are the pavement, widths, degree of curvature, width of traffic lanes, parking lanes, or turning lanes, median width separating opposing traffic lanes, median nose radii, curb radii at street intersections, crown height, cross fall, geometric shapes of islands separating traffic movements and other features. Since town streets and thoroughfares are differentiated by their functions and location, there is also a variance in the geometry that describes the path vehicular traffic should follow.

B. Design Vehicles

The geometrics of town street and thoroughfare intersections vary with the different dimensions of the intersection facilities. Criteria for the geometric design of intersections must be based on certain vehicle operating characteristics, and vehicle dimensions. The American Association of State Highway and Transportation Officials (AASHTO) has standardized vehicle criteria into three general designs, and this vehicle data is published in the AASHTO Publication, "A Policy on Geometric Design of Highways and Streets." In the design of street and thoroughfare intersections for Sunnyvale, these vehicle designs are adopted for use. Table 2-2, Design Vehicle Criteria, shall serve as a guide in the selection of the design vehicle to be used in the design of intersections.
### TABLE 2-1
STREET AND THOROUGHFARE GEOMETRIC STANDARDS

<table>
<thead>
<tr>
<th>Street Type</th>
<th>Street Classification</th>
<th>FF/Curb Pнтt Width</th>
<th>Min ROW Width</th>
<th>Lanes</th>
<th>Parking</th>
<th>Parkway</th>
<th>Median</th>
<th>Min. Pнтt Thickness</th>
<th>Min Design Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major Arterial</td>
<td>1</td>
<td>48'</td>
<td>84'</td>
<td>2-12'</td>
<td>0</td>
<td>10.0'</td>
<td>16'</td>
<td>8'</td>
<td>45</td>
</tr>
<tr>
<td>Parkway</td>
<td>1</td>
<td>48'</td>
<td>100'</td>
<td>2-12'</td>
<td>0</td>
<td>18.0'</td>
<td>16'</td>
<td>8'</td>
<td>40</td>
</tr>
<tr>
<td>Collector</td>
<td>2</td>
<td>30'</td>
<td>60'</td>
<td>2-11'</td>
<td>0</td>
<td>15.0'</td>
<td>0</td>
<td>8'</td>
<td>35</td>
</tr>
<tr>
<td>Local Street</td>
<td>2</td>
<td>30'</td>
<td>60'</td>
<td>2-11'</td>
<td>1-8'</td>
<td>15.0'</td>
<td>0</td>
<td>8'</td>
<td>30</td>
</tr>
<tr>
<td>Non-residential</td>
<td>3</td>
<td>26'</td>
<td>50'</td>
<td>2-10'</td>
<td>2-8'</td>
<td>12.0'</td>
<td>0</td>
<td>5'</td>
<td>30</td>
</tr>
<tr>
<td>Country Lane</td>
<td>3</td>
<td>24'</td>
<td>60'</td>
<td>2-12'</td>
<td>0</td>
<td>18.0'</td>
<td>0</td>
<td>5'</td>
<td>30</td>
</tr>
<tr>
<td>Alley</td>
<td>4</td>
<td>10'</td>
<td>15'</td>
<td>1-10'</td>
<td>0</td>
<td>2.5'</td>
<td>0</td>
<td>6'</td>
<td>10</td>
</tr>
<tr>
<td>Alley</td>
<td>4</td>
<td>15'</td>
<td>20'</td>
<td>1-15'</td>
<td>0</td>
<td>2.5'</td>
<td>0</td>
<td>6'</td>
<td>10</td>
</tr>
<tr>
<td>Alley</td>
<td>4</td>
<td>15'</td>
<td>25'</td>
<td>1-15'</td>
<td>0</td>
<td>5.0'</td>
<td>0</td>
<td>6'</td>
<td>10</td>
</tr>
</tbody>
</table>

**NOTE:** All dimensions are to face of curb or edge of pavement.

1 Residential with Front Access. Alley flares to 12 feet wide are required at turns and tees
2 Residential with Rear Access
3 Business & Industrial District

### TABLE 2-2
DESIGN VEHICLES

<table>
<thead>
<tr>
<th>Intersecting Streets Classification</th>
<th>Design Vehicle Used in Intersection Design</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Single Unit Truck (SU)</td>
</tr>
<tr>
<td></td>
<td>Tractor Semi-Trailer Combination (WB-50)</td>
</tr>
<tr>
<td>Class 1 with Class 1</td>
<td>X</td>
</tr>
<tr>
<td>Class 2 with Class 1</td>
<td>X</td>
</tr>
<tr>
<td>Class 2 with Class 2</td>
<td>X</td>
</tr>
<tr>
<td>Class 3 with Class 1</td>
<td>X</td>
</tr>
<tr>
<td>Class 3 with Class 2</td>
<td>X</td>
</tr>
<tr>
<td>Class 3 with Class 3</td>
<td>X</td>
</tr>
</tbody>
</table>

**NOTES:** a. Single Unit Trucks Design shall use a minimum of 20 ft. radius on curbs and turnouts.
b. Tractor Semi (WB-50) design shall use a minimum of 30 ft. radius.
c. Streets that intersect at something different from 90° shall have a radius that will accommodate the specified design.

C. Design Speed

The design speed is a primary factor in the horizontal and vertical alignment on town streets and thoroughfares. Design features such as curvature, superelevation, radii for turning movements and sight distance are directly related to the design speed. The design speed also affects features such as lane widths, pavement width, pavement cross-fall, pavement crown, and clearance.

The design speed is defined as the approximate maximum speed that can be maintained safely by a vehicle over a given section of road when conditions are so favorable that the design features of the roadway govern. The speed limit of posted speed is the maximum legal speed set by local authorities for a certain roadway or area. The design speed should always be greater than the likely legal speed limit for secondary and major thoroughfares.

The various street and thoroughfare classifications, which make up the system within the town, require different design speeds according to their use and location. Presented in Table 2-1 are the minimum design speeds for the various classifications within the Town of Sunnyvale. Lower design speeds may be required for all classifications for unusual conditions of terrain or alignment.

D. Horizontal Geometrics

1. General

The horizontal geometrics of town streets and thoroughfares include the segment of geometric design associated with the alignment, intersections, pavement widths, and related geometric elements. The various classifications, utilizing the design speed as a control, must have certain horizontal and vertical geometrics to provide a safe economical facility for use by the public.

2. Horizontal Curves and Superelevation

The alignment of town streets and thoroughfares is usually determined by the alignment of the existing right-of-way or structures that cannot be relocated. Changes in the direction of a street or thoroughfare are minimized by constructing a simple curve having a radius that is compatible with the speed of vehicular traffic. To increase the safety and reduce
discomfort to drivers traversing a curved portion of a street or thoroughfare, the pavement may be superelevated.

Curvature in the alignment of major thoroughfares and collectors is allowed under certain conditions, but greater traffic volume and higher vehicle speeds that accompany these facilities tend to increase accidents on curving roadways. Curves in the alignment of residential streets usually provide aesthetic values to the residential neighborhoods without affecting the orderly flow of traffic or sacrificing safety.

A recommended minimum radius of curvature for vehicle design speed and pavement cross-slopes is shown in Table 2-3. These are based on traffic consisting of typical present day automobiles operating under optimum weather conditions. There are other important considerations in the design of curves on town streets and thoroughfares including the location of intersecting streets, drives, bridges and topographic features. When superelevation is required on collectors and major thoroughfares, the following basic formula shall be used:

\[ R = \frac{V^2}{15 (e+f)} \]

Where:

- \( e \) = rate of roadway superelevation, foot per foot
- \( f \) = Side friction factor (See Table 2-4)
- \( V \) = vehicle design speed, mph
- \( R \) = radius of curve in feet

For local residential streets minimum centerline radius may be 150 feet when the design speed can be considered to be less than 30 MPH. This decision will be made by the Town Engineer by considering the type of proposed development, location of street and length of street.

3. Turning Lanes

Turning lanes are provided at intersections to accommodate left-turning and right-turning vehicles. The primary purpose of these turning lanes is to provide storage for the turning vehicles. The secondary purpose is to provide space to decelerate from normal speed to a stopped position in
advance of the intersection or to a safe speed for the turn in case a stop is unnecessary. Left turn lanes at intersections are usually 10 feet in width. When turning traffic is too heavy for a single lane and the cross street is wide enough to receive the traffic, two turning lanes may be provided. Availability of right-of-way may limit locations where this is feasible.

**TABLE 2-3**
MINIMUM CENTERLINE RADIUS
FOR THOROUGHFARES

<table>
<thead>
<tr>
<th>Rate of Superelevation (In./Ft.)</th>
<th>DESIGN SPEED (MPH)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30</td>
</tr>
<tr>
<td>-1/2</td>
<td>510</td>
</tr>
<tr>
<td>-3/8</td>
<td>470</td>
</tr>
<tr>
<td>-1/4</td>
<td>435</td>
</tr>
<tr>
<td>-1/8</td>
<td>405</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>+1/8</td>
<td>355</td>
</tr>
<tr>
<td>+1/4</td>
<td>335</td>
</tr>
<tr>
<td>+3/8</td>
<td>315</td>
</tr>
<tr>
<td>+1/2</td>
<td>300</td>
</tr>
</tbody>
</table>

**TABLE 2-4**
SIDE FRICTION FACTORS
FOR THOROUGHFARES

<table>
<thead>
<tr>
<th>Street Classification</th>
<th>Side Friction Factor (f)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1</td>
<td>0.145</td>
</tr>
<tr>
<td>Class 2</td>
<td>0.155</td>
</tr>
<tr>
<td>Class 3</td>
<td>0.160</td>
</tr>
</tbody>
</table>

The location of the median nose at the end of the left turn lane should be so located that left turning traffic will clear the median nose while making a left turn. Other considerations include adequate clearance between the...
median nose and through traffic on the intersecting thoroughfare and locations of the median nose to properly clear the pedestrian crosswalks.

Length of left turn lanes for Class 1 streets shall be as follows:

**TABLE 2-5**
LENGTH OF LEFT TURN LANES FOR THOROUGHFARES

<table>
<thead>
<tr>
<th>Intersecting Street Classification</th>
<th>Range of Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1</td>
<td>150'-250'</td>
</tr>
<tr>
<td>Class 2</td>
<td>100'-150'</td>
</tr>
<tr>
<td>Class 3</td>
<td>60'-100'</td>
</tr>
</tbody>
</table>

The actual length shall be approved by Town Engineer based upon projected left turn volume.

4. Street Intersections

a. Standard

The intersection, at grade, of major thoroughfares, collector streets, and residential streets at or near right angles form the standard intersection. At the intersection of these arterial types the various geometrics including pavement widths, lane widths, curb radii, median widths, turning lane data, crossfall, crown height and other features differ.

b. Special Intersections

Street and thoroughfare types in the town often intersect at angles less than 90 degrees. The radii required to fit the minimum paths of the design vehicles are longer than those for standard or 90 degree intersections. Special intersections shall be designed using data for the design vehicles as specified in Table 2-2.

5. Sidewalks

The purpose of the public sidewalks is to provide a safe area for pedestrians. The Town of Sunnyvale requires that sidewalks be constructed with the paving of streets or when building construction occurs, in residential
areas with lot sizes less than 35,000 ft.sq. All sidewalks must conform to state laws for barrier free construction. Sidewalks are not required in industrial areas, but are required in commercial zoning districts.

The standard concrete sidewalk is 4 feet in width for residential and 5 feet in width for commercial. The edge of the sidewalk located nearest the street right-of-way is normally 2 feet from the right-of-way line for residential districts and against the curb for commercial districts. Special sidewalk designs to include a 6-foot sidewalk located adjacent to the street will be considered for approval where warranted. In areas where screening walls are required, sidewalks shall be constructed against the screening wall and have a minimum width of 5 feet.

Sidewalk alignments may be varied to avoid the removal of trees or the creation of excessive slopes when approved by Town Engineer.

E. Vertical Alignment

1. Street Grades (See Appendix "A")

The vertical alignment of town streets and thoroughfares should be designed to insure the safe operation of vehicles and should allow easy access to adjacent property. A travelway that is safe for vehicles is dependent on criteria that considers operating speeds, maximum grades, vertical curves and sight distance. In addition to these considerations, other factors related to vertical alignment include storm drainage, crown and crossfall and the grade and right-of-way elevation relationship. The grade of street or thoroughfare, particularly at its intersections with another grade, is of prime importance in providing a safe, comfortable riding surface. The intersection design of two class 1 streets shall include grades that will result in a plane surface or at least a surface that approximates a plane surface. A vehicle traveling on either thoroughfare should be able to traverse the intersection at the design speed without discomfort. To accomplish a smooth transition, crossfall toward the median of one lane of each thoroughfare may be required. The use of storm drainage inlets in the median shall be avoided if possible.

In drawing the grades of intersecting thoroughfares in the profile view of plan/profile sheets, profiles of all four curbs shall be shown as a continuous line through the intersection.
a. Minimum Grades

Minimum longitudinal grades for streets and thoroughfares are required to insure proper flow of surface drainage toward inlets. Minimum grades are five tenths percent (0.5%) for all pavement having curbs. Where valley gutters are used for intersecting drainage, the minimum grade for valley gutters is five tenths percent (0.5%) for concrete.

b. Maximum Grades

Maximum longitudinal grades shall be compatible with the type of facility and the accompanying characteristics including the design speed, traffic conditions and sight distance.

Major and secondary thoroughfares and major couplets must move large volumes of traffic at faster speeds and flatter grades will better accommodate these characteristics. Truck and bus traffic on these type facilities often controls traffic movement, particularly if steep grades prevent normal speeds. The normal maximum street grades allowed are shown in Table 2-6. Steeper grades may be permitted for short lengths where dictated by topographical features or restricted alignment.

**TABLE 2-6**

**MAXIMUM STREET GRADES**

<table>
<thead>
<tr>
<th>Street Classification</th>
<th>Normal Maximum Grade in Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1</td>
<td>6%</td>
</tr>
<tr>
<td>Class 2</td>
<td>6%</td>
</tr>
<tr>
<td>Class 3</td>
<td>8%</td>
</tr>
</tbody>
</table>

2. Vertical Curves

When two longitudinal street grades intersect at a point of vertical intersection (PVI) and the algebraic difference in the grades is greater than one percent (1%), a vertical curve is required. Vertical curves are utilized in roadway design to effect a gradual change between tangent grades and should result in a design that is safe, comfortable in operation, pleasing in appearance and adequate for drainage. The vertical curve shall be formed
by a simple parabola and may be a crest vertical curve or a sag vertical curve.

3. Stopping Sight Distance

a. Crest Vertical Curve

When a vertical curve is required, it must not interfere with the ability of the driver to see length of street ahead. This length of street, called the stopping sight distance, should be of sufficient length to enable a person in a vehicle having a height of 3.675 feet above the pavement and traveling at design speed to stop, before reaching an object in his path that is 0.5-foot in height.

The minimum stopping sight distance is the sum of two distances: one, the distance traversed by a vehicle from the instant the driver sights an object for which a stop is necessary, to the instant the brakes are applied; and the other, the distance required to stop the vehicle after the brake application begins.

The minimum safe stopping sight distance and design speeds are shown in Table 2-7. These sight distances are based on each design speed shown and a wet pavement. The length of crest vertical curve required for the safe stopping sight distance of each street type may be calculated using the formula \( L = KA \) and the values of \( K \) for a crest vertical curve shown in Table 2-7.

b. Sag Vertical Curve

When a sag vertical curve is required, the vertical curve shall be of sufficient length to provide a safe stopping sight distance based on headlight sight distance. The minimum length of sag vertical curve required to provide a safe stopping sight distance may be calculated using the formula \( L = KA \) and values of \( K \) for a sag vertical curve are shown on Table 2-7.
**TABLE 2-7**

**MINIMUM LENGTH OF VERTICAL CURVE**

**CREST VERTICAL CURVE**

\[ L = KA \]

- \( L = \text{Minimum Length Vertical Curve required for safe stopping} \)
- \( K = \text{Horizontal Distance in feet required to effect a one percent change in gradient} \)
- \( A = \text{Algebraic Difference in grade} \)

<table>
<thead>
<tr>
<th>Street Type</th>
<th>Design Speed</th>
<th>Safe Stopping Distance</th>
<th>Normal Crest Vertical Curve K</th>
<th>Normal Sag Vertical Curve K</th>
<th>Minimum Length of Curve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1</td>
<td>45</td>
<td>400</td>
<td>100</td>
<td>80</td>
<td>120</td>
</tr>
<tr>
<td>Class 2</td>
<td>40</td>
<td>300</td>
<td>65</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>Class 2</td>
<td>35</td>
<td>250</td>
<td>55</td>
<td>55</td>
<td>100</td>
</tr>
<tr>
<td>Class 3</td>
<td>30</td>
<td>200</td>
<td>30</td>
<td>35</td>
<td>100</td>
</tr>
</tbody>
</table>

**SAG VERTICAL CURVE**

\[ L = KA \]

- \( L = \text{Minimum Length Vertical Curve required for headlight control} \)
- \( K = \text{Horizontal Distance in feet required to effect a one percent change in gradient} \)
- \( A = \text{Algebraic Difference in grade} \)

4. **Intersection Grades**

The grade of an intersecting street with the principal street gutter should not be generally more than four percent (4%) either up or down within the first 20 feet beyond the curb line of the principal street. Grade changes greater than one percent (1%) will require vertical curves.

5. **Street Cross Section**

For curbed streets, the right-of-way shall be graded to drain to the street at a slope of 1/4" per foot. Street back slopes and embankment slopes shall not be steeper than 4:1.

2.3 **SIGHT DISTANCES AT INTERSECTIONS**

An important consideration in the design of town streets and thoroughfares is the vehicle attempting to cross the street or thoroughfare from the side street or drive. The operator of the vehicle attempting to cross should have an unobstructed view
of the whole intersection and a length of the thoroughfare to be crossed sufficient to permit control of the vehicle to avoid collisions. The minimum sight distance considered safe under various assumptions of physical conditions and driver behavior is related directly to vehicle speeds and to the resultant distance traversed during perception and reaction time and during braking. This sight distance, which is termed intersection sight distance, can be calculated for different street or thoroughfare widths and for various grades upwards and downwards. Intersection sight distance shall be as set forth in AASHTO publication "A Policy on Geometric Design of Highways and Streets."

2.4 MEDIAN OPENINGS

The following standards for median openings are established to facilitate traffic movement and promote traffic safety:

Median openings will normally be permitted at all intersections with dedicated town streets. Exceptions would be at certain class 1 streets where due to unusual conditions a hazardous situation would result.

Midblock median openings or other openings with turns permitted into adjacent property will not normally be permitted unless all the following conditions exist:

A. The property to be served is a significant traffic generator with demonstrated or projected trip generation of not less than two hundred and fifty (250) vehicles in a twelve-hour period.

B. The median opening is not less than 400 feet from an intersection with a major thoroughfare.

C. The median opening is not less than 300 Feet from an intersection with a minor street.

D. The median opening is not less than 300 feet from any other existing or proposed midblock median opening.

E. The median width is sufficient to permit the construction of a left turn storage lane.

2.5 CUL-DE-SAC

The maximum length of any cul-de-sac shall be 600 feet measured from curb line of the intersecting street to the radius point of turn around. Right-of-way and pavement widths shall be as follows:
<table>
<thead>
<tr>
<th>STREET TYPE</th>
<th>RIGHT-OF-WAY RADIUS</th>
<th>PAVEMENT RADIUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country Lane</td>
<td>60</td>
<td>43</td>
</tr>
<tr>
<td>Local Street-Residential</td>
<td>55</td>
<td>43</td>
</tr>
<tr>
<td>Local Street-Non Residential</td>
<td>60</td>
<td>48</td>
</tr>
</tbody>
</table>

All cul-de-sac turnarounds shall be visible from the intersecting street.

2.6 DRIVEWAY STANDARDS

A. Maximum Number of Driveways; Minimum Corner Clearance

The maximum number of driveways per platted lot and the minimum spacing between such driveways shall be as provided for in Table 2-8.

**TABLE 2-8**

MAXIMUM NUMBER OF DRIVEWAYS AND MINIMUM SPACING BETWEEN DRIVEWAYS (PER PLATTED LOT)

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Frontage (Feet)</th>
<th>Maximum Number of Driveways Per Property</th>
<th>Minimum Spacing Between Driveways on Same Property</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-Family</td>
<td>90'or more</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>Single-Family</td>
<td>Less than 90'</td>
<td>1</td>
<td>N/A</td>
</tr>
<tr>
<td>Attached Housing</td>
<td>90'or more</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>Attached Housing</td>
<td>Less than 90'</td>
<td>1</td>
<td>N/A</td>
</tr>
<tr>
<td>Commercial</td>
<td>Less than 250'</td>
<td>1</td>
<td>N/A</td>
</tr>
<tr>
<td>Commercial*</td>
<td>More than 250'</td>
<td>2</td>
<td>100</td>
</tr>
</tbody>
</table>

* One additional driveway may be added for each additional 500 feet of lot width in excess of 250 feet. For driveways on Class 1 thoroughfares, only one driveway is allowed for each 500 feet of lot width instead of 250 feet of width.
NOTE: State standards, if more restrictive, shall apply for properties fronting state or federal roads.

The minimum corner clearance between a driveway and an intersection shall be as provided for in Table 2-9. Corner clearance shall be defined as follows:

1. For Curbed Streets

   The distance between the intersection of the projected curb lines of the two streets and the point of tangency of the driveway curb returns at the street curb.

2. For Country Lanes and Parkways

   The distance between the intersection of the projected edge of pavement lines of the two streets and the intersection of the edge of driveway pavement at edge of pavement of the street shall not be less than the corner clearance shown in Table 2-9.

In no case shall the driveway curb return or the edge of the driveway pavement encroach into the curb return or edge of pavement radius of a street intersection. Encroachment by the curb return or edge of pavement of a driveway onto the frontage of an adjoining property is not permitted.

<table>
<thead>
<tr>
<th>TYPE OF STREET DRIVeway IS ON</th>
<th>TYPE OF STREET INTERSECTED</th>
<th>MINIMUM CORNER CLEARANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1</td>
<td>Class 1</td>
<td>150</td>
</tr>
<tr>
<td>Class 1</td>
<td>Class 2</td>
<td>100</td>
</tr>
<tr>
<td>Class 1</td>
<td>Class 3</td>
<td>50</td>
</tr>
<tr>
<td>Class 2</td>
<td>Class 1</td>
<td>100</td>
</tr>
<tr>
<td>Class 2</td>
<td>Class 2</td>
<td>70</td>
</tr>
<tr>
<td>Class 2</td>
<td>Class 3</td>
<td>40</td>
</tr>
</tbody>
</table>
### MINIMUM CORNER CLEARANCE

<table>
<thead>
<tr>
<th>Type of Street Driveway is On</th>
<th>Type of Street Intersected</th>
<th>Approach Side of Intersection</th>
<th>Departure Side of Intersection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 3</td>
<td>Class 1</td>
<td>50</td>
<td>30</td>
</tr>
<tr>
<td>Class 3</td>
<td>Class 2</td>
<td>40</td>
<td>30</td>
</tr>
<tr>
<td>Class 3</td>
<td>Class 3</td>
<td>30</td>
<td>30</td>
</tr>
</tbody>
</table>

#### NOTES:
1. The above distances notwithstanding, any platted lot may have at least one (1) minimum width driveway onto each street that the lot abuts.
2. Service roads shall be classified as an arterial for driveway purposes.
3. Residential driveways on Class 1 and Class 2 streets are not permitted unless an exception is granted by the Town Council.

### B. Design Standards; Storage Length

Driveway design standards shall be as provided for in Table 2-10.

Driveway storage shall be defined as the distance between the street right-of-way line and the near side of the first intersecting interior aisle. The minimum length of this storage shall be as provided for in Table 2-11.

### C. Driveway Grades

The normal driveway grade within the street right-of-way is set at one-quarter inch (1/4") per foot rise above the top of curb at the property line. The minimum elevation of a driveway at the right-of-way line is two inches (2") above the top of curb. Barrier free sidewalk construction requires a maximum driveway grade as measured from the gutter of eight percent (8%).

Where driveway construction or reconstruction must occur off the street right-of-way, the usual maximum grade is fourteen percent (14%). The maximum change in grade without vertical curve is twelve percent (12%) for any 10 feet in distance. Driveways should be profiled for a distance of at least 25 feet outside the right-of-way to insure adequate replacement design.
Due to state laws requiring barrier free construction of sidewalks, steps or other abrupt changes in sidewalk grades are prohibited at driveways.

D. Driveways Connecting to Country Lanes or Parkways

Driveways connecting to Country Lanes or Parkways and located on public right-of-way shall be constructed according to details adopted by the Town. The size of the drainage pipe or opening shall be established by a Registered Professional Engineer Design calculations shall be submitted to the Town Engineer for review before driveway construction begins.

<table>
<thead>
<tr>
<th>TABLE 2-10 (Revised)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRIVEWAY DESIGN STANDARDS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Driveway Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Approach Width in Feet</td>
</tr>
<tr>
<td></td>
<td>Minimum</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>RESIDENTIAL</td>
<td></td>
</tr>
<tr>
<td>Single Family</td>
<td>10</td>
</tr>
<tr>
<td>Single Family - Rear or Side Entry(^{(3)})</td>
<td>10</td>
</tr>
<tr>
<td>Attached Housing</td>
<td>20</td>
</tr>
<tr>
<td>NON RESIDENTIAL (Undivided Driveways)</td>
<td></td>
</tr>
<tr>
<td>Office</td>
<td>24</td>
</tr>
<tr>
<td>Retail (except Service Station)</td>
<td>24</td>
</tr>
<tr>
<td>Service Station</td>
<td>24</td>
</tr>
<tr>
<td>Industrial</td>
<td>24</td>
</tr>
<tr>
<td>DIVIDED DRIVEWAYS(^{(2)})</td>
<td></td>
</tr>
<tr>
<td>Multi-Family, Office or Retail</td>
<td>18</td>
</tr>
</tbody>
</table>

\(^{(1)}\) Or chamfer distances where driveway attaches to a Country Lane or Parkway.

\(^{(2)}\) Must have raised, landscaped median at least 6 feet wide; approach widths are for each side.

\(^{(3)}\) Residential lots NOT within a platted subdivision may have an approach width up to a maximum of twenty-nine feet (29').

\(^{(4)}\) A rear or side entry driveway connecting to a right of way may have a width up to twenty-nine feet (29') if the garage faces the right of way; all others are limited to seventeen feet (17').
2) Where the width of an aisle change or where the approach width is different from the width of the aisle or driveway farther into the property, the following formula shall be used to determine the minimum taper length:

\[ L = 20 \times W \]

Where: \( L \) = taper length and 
\( W \) = difference in width

TABLE 2-11
MINIMUM DRIVEWAY STORAGE LENGTH

<table>
<thead>
<tr>
<th>Number of Parking Spaces Per Driveway</th>
<th>Minimum Storage Length* (Feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 50</td>
<td>18</td>
</tr>
<tr>
<td>50 to 200</td>
<td>50</td>
</tr>
<tr>
<td>More than 200</td>
<td>78</td>
</tr>
</tbody>
</table>

* Storage length is defined as the distance between the street right-of-way line and the first intersecting aisleway on site.

2.7 PAVEMENT DESIGN

A. Standard Street and Thoroughfare Pavement Design

Table 2-12 shows the required pavement thickness for rigid pavement and the subgrade requirements for various street and thoroughfare types within the Town of Sunnyvale.

B. Alternate Pavement Design

The Town Engineer will consider an alternate pavement design in lieu of selecting a design from Table 2-12, particularly when there are circumstances that warrant an individual design.
TABLE 2-12
STANDARD STREET AND THOROUGHFARE PAVEMENT DESIGN

<table>
<thead>
<tr>
<th>Facility Type</th>
<th>Usual Crown</th>
<th>Subgrade Requirements</th>
<th>Concrete Pavement Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major arterial</td>
<td>1/4&quot; per ft</td>
<td>6&quot; Lime</td>
<td>8&quot;</td>
</tr>
<tr>
<td>Parkway</td>
<td>1/4&quot; per ft</td>
<td>6&quot; Lime</td>
<td>8&quot;</td>
</tr>
<tr>
<td>Collector</td>
<td>5&quot; Parabolic</td>
<td>6&quot; Lime</td>
<td>8&quot;</td>
</tr>
<tr>
<td>Local Street- Non Residential</td>
<td>5&quot; Parabolic</td>
<td>6&quot; Lime</td>
<td>8&quot;</td>
</tr>
<tr>
<td>Local Street Residential</td>
<td>4&quot; Parabolic</td>
<td>6&quot; Lime</td>
<td>5&quot;</td>
</tr>
<tr>
<td>Country Lane</td>
<td>3&quot; Parabolic</td>
<td>6&quot; Lime</td>
<td>5&quot;</td>
</tr>
<tr>
<td>10 ft. Alley</td>
<td>5&quot; Invert</td>
<td>6&quot; Compacted</td>
<td>6&quot;</td>
</tr>
<tr>
<td>15 ft. Alley</td>
<td>6&quot; Invert</td>
<td>6&quot; Compacted</td>
<td>6&quot;</td>
</tr>
</tbody>
</table>

NOTE: 1) Twenty-eight day concrete compressive strength of rigid pavement shall not be less than 3600 P.S.I.

2) No Flexible Pavement will be permitted as permanent pavement.

2.8 PERMANENT LANE MARKINGS

A. Purpose

The purpose of this section is to describe the typical layout of permanent lane markings used by the Town of Sunnyvale. These marking standards are designated by number or letter types. Numerical designation (i.e., TYPE 1, TYPE 2, etc.) is used to denote markings separating lanes of traffic moving in the same direction and are markings separating lanes of traffic moving in the same direction and are white markings. Alphabetical designation (i.e., TYPE A, TYPE B, etc.) is used to denote markings separating lanes of traffic moving in opposing directions. Therefore, any street section with pavement markings can be fully described by a TYPE number and/or letter combination.
B. Types of Markings

Lane lines and center lines will utilize reflectorized thermoplastic hot applied coatings. The width of the marking small be as indicated below., four (4") inch buttons only, unless otherwise stated. Lane and cross walk markings are required on all Class 1 and Class 2 thoroughfares. Stop bars are required for each lane at all traffic lights and stop signs.

C. Types of Layouts

The following describes the types of layouts as designated in these standards. Drawings that include specifications of each type are available from the Town of Sunnyvale.

**TYPE 1:** is a skipped white line normally used on streets having four or more lanes. The normal stripe/skip cycle of 15'/25' is used with a 4-inch wide stripe.

**TYPE 2:** consists of a single solid white line, four inches wide, normally to designate special lane control (RIGHT LANE MUST TURN RIGHT).

**TYPE 3:** consists of a single solid line white line, eight inches wide, to designate a left turn bay.

**TYPE 4:** consists of a 12-inch wide solid white line used to designate each side of a cross walk.

**TYPE 5:** consists of a 24-inch wide solid white line used to designate a stop bar.

**TYPE A:** is a skipped yellow enterline used on roadways of only two lanes of traffic. The normal stripe/skip cycle of 15'/25' is used with a four-inch wide stripe.

**TYPE B:** is a solid yellow centerline used on undivided four lane roadways. These markings consist of two solid four-inch wide yellow stripes with a four-inch space.
2.9 STREET SIGNS AND STREET LIGHTING

A. Street Signs

The developer shall furnish and install all streets signs required for the development. The minimum signage is as follows:

1. One street sign at each street intersection displaying the name of each street.

2. Stop signs and yield right-of-way signs at locations designated by the Town Engineer.

3. Speed limit signs located at the entrance to each alley.

4. For each street terminating in a cul-de-sac, a "Dead End Street - No Outlet" sign.

Other signage shall be installed as required by the Town Engineer to provide for the safety of the public. All street signs shall be purchased from the Town of Sunnyvale and be installed on the specified posts in accordance with the Standard Construction Details.

B. Street Lights

The developer shall erect street lights meeting the Town’s standards. Street lights shall be installed at a spacing of not more than 400 feet and at each street intersection and each cul-de-sac. Street lights shall be installed in accordance with the National Electrical Code and the Town’s Standard Details.

2.10 CONSTRUCTIONS PLAN PREPARATION

A. General

All paving plans for constructing street and thoroughfare improvements in the Town of Sunnyvale shall be prepared in accordance with the Town of Sunnyvale’s procedures.

Plans for subdivision construction should be adequate to allow for review and construction inspection.

If the paving project includes storm drainage improvements, the hydraulic design of the proposed storm shall be accomplished based on procedures and criteria outlined in this manual.
B. Plan Set

Plans shall include a cover sheet, paving plan-profile sheets, typical paving section, paving cross sections, drainage area map, drainage plan-profile sheets and drainage cross sections if required.

C. Paving Plan-Profile Sheets

Usually, paving plan-profile sheets shall be prepared on a horizontal scale of one-inch equals five feet. Plans shall be prepared on 24" x 36" sheets.

1. Plan

   a. In the plan view the centerline of the street shall be drawn and stationed at one hundred foot intervals and each sheet shall begin and end with even or fifty foot stations.

   b. Sufficient data including monuments and other survey controls shall be shown on the plans to permit establishment and staling of the centerline of the project from the construction plans.

   c. If a survey line or transit line is required to locate the street or right-of-way, it shall be properly identified and dimensioned form the centerline. Also shown on the plan view shall be the geo metrics and dimensions of the proposed paving improvements including curbs, curb and gutter, median, pavement edges, driveways, sidewalks, alley approaches, street headers, temporary pavement. Where the cut or fill at the property line exceeds on foot, the top of the cut slope or the toe of the fill slope shall be shown on the plan.

   d. Property line and right-of-way line information shall include dimensions of existing and proposed property lines and right-of-way lines. Right-of-way dimensions shall be shown on the proposed street and on intersecting streets. Each lot fronting on the proposed street shall be dimensioned and the lot and block number, house number, and ownership shown on the plan.

   e. The proposed paving improvements may be shaded as necessary to clarify the intent of the plans. Pavement dimensions, unless otherwise noted, shall be to the face of the curbs.

   f. Proposed storm drains and inlets shall be shown on the plan and the paving station at the centerline of the inlet shall be shown as well as the inlet size, type inlet, top of curb elevation and inlet flow line.
Existing storm drains and utilities shall be shown located by dimension and the name and size of each noted.

g. Other data shown on the plan shall include a benchmark which will remain after construction of the improvements, flow arrows indicating direction of storm water run-off, street names, match lines, scale and north arrow.

2. Profile

a. The profile portion of the plan-profile sheet shall show the existing ground profile at each right-of-way line, the proposed top of curb profile at each side of the street. If the street has a median, the profiles of the median curbs shall also be shown. At street intersections, the top of the curb elevation at the horizontal P.C. and P.I. of the curb radius and the paving station shall be shown in the profile and the name of the intersecting street shall also be shown.

b. Street grades should be set according to the procedure in Appendix "A". Of overriding importance is the safety of all persons and vehicles using the street. The convenience and comfort of thru traffic must be balanced against the necessity to serve the abutting property keeping in mind that the property owners will be assessed for part of the cost of paving.

c. The proposed street grade shall be indicated in percent to the nearest one hundredth percent, vertical curve data shown including length of vertical curve; external distance, station and elevation at point of vertical curvature, PVC, and station and elevation at point of vertical tangency, PVT.

d. Elevations of the proposed top of curb shall be shown at each one hundred-foot station and fifty-foot station including elevations on vertical curves at these stations. Low points on sag vertical curves and high points on crest vertical curves shall also be shown.

3. At some convenient locations (preferably on a separate detail sheet), one or more typical paving sections shall be presented including the required dimensions of pavement width, lane widths, right-of-way width, type and thickness of pavement, subgrade, curb, driveway grades and the location of walks.
4. Special Details and Specifications

a. Special details not shown on Standard Construction Details shall be included in the plans. Structural details for bridges, special retainingwalls, headwalls, junction boxes, culverts, and special inlets shall be provided as well as bridge railings, hard railings, special barricades (permanent and temporary) and warning signs. Material and installation specifications not included in the N.C.T.C.O.G. Specifications for Public Works Construction shall be submitted in writing as a part of the Special Provisions. A sequence of Construction shall be prepared where applicable which will allow traffic movement through projects along existing streets.

b. Structural analysis computations shall be provided in a legible form for any existing structure which will act as a support or supplement to the designed facility. Items on the plans requiring special provisions and special construction techniques shall be clearly delineated on the plans and specifically called to the Town’s attentions by letter prior to final plan submission.
3.1 STORM DRAINAGE SYSTEM

General:

Drainage facilities shall be designed and constructed at such locations and of such size and dimensions to adequately serve the development and the contributing drainage area above the development. The developer shall provide all the necessary easements and right-of-ways required for drainage structures including storm drains and open channels, lined or unlined. Easement widths for storm drain pipelines shall not be less than fifteen (15') feet, and easement widths for open channels shall be at least twenty-five (25') feet wider than the top width of the channel. In all cases, easements shall be of an adequate size to allow proper maintenance.

The design flows for the drainage system shall be calculated by the Rational Method in accordance with standard engineering practice and in accordance with the requirements set forth in this document. Curbs, inlets, manholes, etc., shall be designed and constructed in accordance with the Standard Details. Materials and construction procedures shall conform with the requirements of the Standard Specifications for Construction.

The developer shall comply all requirements of the Environmental Protection Agency, the U.S. Army Corps of Engineers and shall obtain all permits required by these agencies. Further, the developer shall meet all requirements of the City of Dallas regarding the discharge of storm water into Lake Ray Hubbard.

The developer shall provide plans and specifications and design calculations for all drainage structures. The drainage facility requirements will depend on the type of street used within the subdivision as follows:

A. Subdivisions Utilizing Country Lanes and Parkways

1. Storm water may be carried in drainage ditches located adjacent to and parallel to the roadway. Outside the roadway, storm water shall be carried in unclosed pipes.

2. Ditch slopes shall not be steeper than 5:1 on the front slope and 4:1 on the back slope.
3. The velocity of the storm water in the drainage way shall not exceed 6 fps at a ten-year frequency storm event unless erosion control devices meeting the approval of the Town Engineer are used.

4. Ditch flow lines slopes shall not be less than 0.75%.

5. Ditch depth shall not be less than 1.5 feet measured from the edge of pavement.

6. If any of the above criteria cannot be met, the storm water shall be carried in an enclosed pipe system.

7. Slopes steeper than 6:1 shall be solid block sodded with bermuda grass sod.

B. Subdivisions Utilizing Curbed Streets

All storm water shall be carried within the paved street surface or in an enclosed pipe system or both.

Where an enclosed pipe system is required, a rock gabion lined open channel may be substituted for the pipe system when the equivalent pipe size exceeds 66-inches. For flows that exceed the capacity of an equivalent 84-inch pipe, an unlined open channel with a concrete pilot channel constructed in accordance with Figure 3-3 may be used. All open channels that are not rock gabion lined shall be designed to prevent erosion. The methods used to prevent erosion specifically shall be approved by the Town Engineer.

The design, size, type and location of all storm drainage facilities shall be subject to the approval of the Town Engineer. The requirements set forth herein are considered minimum requirements. The developer and his engineer shall bear the total responsibility for the adequacy of design. The approval of the facilities by the Town Engineer in no way relieves the developer of this responsibility.

The developer shall be responsible for the necessary facilities to provide drainage patterns and drainage controls such that properties within the drainage area, whether upstream or downstream of the development, are not adversely affected by storm drainage from facilities on the development.

Storm drainage released from the site will be discharged to a natural water course of an adequate size to control the peak runoff expected after development.
A. Design Criteria

The Rational Method for computing storm water runoff is to be used for the hydraulic design of facilities serving a drainage area of less than 600 acres. For drainage areas 600 acres to 1200 acres, the runoff is to be calculated by both the Rational Method and the Unit Hydrograph Method with the larger of the two values being used for hydraulic design. For drainage areas of 1200 acres and larger, the Unit Hydrograph or the U.S. Army Corps of Engineers HEC-1 Computer program shall be used. For developments which impact designated Federal Emergency Management Agency (FEMA) flood plains, HEC-1 or other methods designated by FEMA shall be used.

B. Rainfall Intensities

When calculating the quantity of storm runoff, rainfall intensity will be determined from the U.S. Department of Commerce Technical Paper No. 40, "Rainfall Frequency Atlas of the United States." For design hydraulic facilities in the Town of Sunnyvale, the applicable formulas are as follows:

\[
I_{10} = \frac{78}{(t_c + 8.7)^{.77}}
\]

\[
I_{100} = \frac{106}{(t_c + 8.3)^{.62}}
\]

Where: \( t_c \) = Rainfall duration in minutes.

\( I \) = Rainfall intensity for a 10 year and 100 year storm.

The above equations are represented graphically in Figure 3-1.

The storm frequency used for this determination will be according to the facility to be designed as listed in Table 3-1. Emergency overflows where used are to be located at sags and T-intersections of streets and designed to prevent erosion and surface water damage.
Figure 3-1

Rainfall Intensity Curves

- 100 Year Storm Event
- 10 Year Storm Event

Town of Sunnyvale, Texas

Rainfall Intensity Curves

Scale: None
Date: Mar 1994
Sheet:

Town of Sunnyvale

Dallas County, Texas
TABLE 3-1
DESIGN STORM FREQUENCY

<table>
<thead>
<tr>
<th>Drainage Facility</th>
<th>Storm Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drainage ditches located in street right-of-way used in conjunction with Country</td>
<td>100 years</td>
</tr>
<tr>
<td>Lanes and Parkway street construction with no freeboard</td>
<td></td>
</tr>
<tr>
<td>Pipe storm sewers with emergency overflow to give a combined capacity of 100-year</td>
<td>10 years</td>
</tr>
<tr>
<td>frequency</td>
<td></td>
</tr>
<tr>
<td>Pipe storm sewer with no emergency overflow</td>
<td>100 years</td>
</tr>
<tr>
<td>All open channels with a minimum of 2 feet freeboard above to the top of the bank.</td>
<td>100 years</td>
</tr>
<tr>
<td>Culverts (pipe or concrete box)</td>
<td>100 years</td>
</tr>
<tr>
<td>Bridges, low point of bridge beams or similar bridge deck supporting structure to</td>
<td>100 years</td>
</tr>
<tr>
<td>be 2 feet above 100-year storm or highest flood recorded, whichever is greater.</td>
<td></td>
</tr>
</tbody>
</table>

C. Rational Method

The rational method as described in Chapter 2 of the Texas Departments of Transportation "Hydraulic Manual" shall be used to calculate runoff. The storm frequency used for this determination will be according to the facility to be designed as listed in Table 3-1. Emergency overflows, where used, are to be located at sags and T-intersection of streets and designed to prevent erosion and surface water damage.

The time of concentration to any inlet shall be determined from finished grade slopes but in no case may be more than listed in Table 3-3.

D. Unit Hydrograph Method

The Snyder Synthetic Unit Hydrograph method as described in Chapter 2 of the TXDOT "Hydraulic Manual" shall be used. The constants and coefficients shall be used unless documented more specific data is available:
### TABLE 3-2
**COEFFICIENTS \(C_t\) AND \(C_p\)**

<table>
<thead>
<tr>
<th>Drainage Area Characteristics</th>
<th>Approximate Value of (C_t)</th>
<th>Value of (C_p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sparsley Sewered Area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flat Basin Slope (less than 0.50%)</td>
<td>0.65</td>
<td>0.55</td>
</tr>
<tr>
<td>Moderate Basin Slope (0.50% to 0.80%)</td>
<td>0.60</td>
<td>0.58</td>
</tr>
<tr>
<td>Steep Basin Slope (greater than 0.80%)</td>
<td>0.55</td>
<td>0.61</td>
</tr>
<tr>
<td>Moderately Sewered Area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flat Basin Slope (less than 0.50%)</td>
<td>0.55</td>
<td>0.63</td>
</tr>
<tr>
<td>Moderate Basin Slope (0.50% to 0.80%)</td>
<td>0.50</td>
<td>0.66</td>
</tr>
<tr>
<td>Steep Basin Slope (greater than 0.80%)</td>
<td>0.45</td>
<td>0.69</td>
</tr>
<tr>
<td>Highly Sewered Area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flat Basin Slope (less than 0.50%)</td>
<td>0.45</td>
<td>0.70</td>
</tr>
<tr>
<td>Moderate Basin Slope (0.50% to 0.80%)</td>
<td>0.40</td>
<td>0.73</td>
</tr>
<tr>
<td>Steep Basin Slope (greater than 0.80%)</td>
<td>0.35</td>
<td>0.76</td>
</tr>
</tbody>
</table>

The rainfall duration shall be two hours. Initial and subsequent losses shall be 1.11 inches.

**E. Design According to FEMA-FIA Requirements**

All streams have floodway or flood plains designation by FEMA-FIA must be designed to meet the requirements of these agencies.
3.3 RUNOFF COEFFICIENTS AND TIME OF CONCENTRATION

Runoff coefficients, as shown in Table 3-3, shall be the minimum used, based on total development under existing land zoning regulations. Where land uses other than those listed in Table 3-3 are planned, a coefficient shall be developed utilizing values comparable to those shown. Larger coefficients may be used if considered appropriate to the project by the Town Engineer.

Times of concentration shall be computed as shown in Chapter 2, HYDROLOGY, of the Texas Department of Transportation, "Hydraulic Manual," latest edition.

3.4 DESIGN OF DRAINAGE FACILITIES

A. Flow in Gutters and Inlet Locations

Storm drain conduits shall begin at the point where the depth of flow based on the 100-year storm frequency reaches a point not greater than 2 inches over the top of curb. For pavement sections that do not have curbs, including alleys, the 100-year storm shall be contained within the right-of-way. Inlets are then located as necessary to remove the flow based on a 10-year storm frequency. If, in the judgement of the Engineer, the flow in the gutter would be excessive under either of these conditions, then consideration should be given to extending the storm sewer to a point where the gutter flow can be intercepted by more reasonable inlet locations. Multiple inlets at a single location are permitted in extenuating circumstances. Where possible, inlets should be placed upstream from an intersection to prevent large amounts of water from running through intersections. Inlets should also be located on the approach street to an intersection and in alleys where necessary to prevent water from entering these intersections in amounts that would cause the allowed street capacity to be exceeded.
### TABLE 3-3
RUNOFF COEFFICIENTS AND MAXIMUM INLET TIMES

<table>
<thead>
<tr>
<th>Zone</th>
<th>Zoning District Name</th>
<th>Run-off Coefficient &quot;C&quot;</th>
<th>Min. Inlet Time in Minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR</td>
<td>Agricultural Residential</td>
<td>0.40</td>
<td>20</td>
</tr>
<tr>
<td>SF-1</td>
<td>Single Family Residential-1</td>
<td>0.43</td>
<td>15</td>
</tr>
<tr>
<td>SF-2</td>
<td>Single Family Residential-2</td>
<td>0.45</td>
<td>15</td>
</tr>
<tr>
<td>SF-3</td>
<td>Single Family Residential-3</td>
<td>0.48</td>
<td>15</td>
</tr>
<tr>
<td>SF-4</td>
<td>Single Family Residential-4</td>
<td>0.50</td>
<td>15</td>
</tr>
<tr>
<td>AH</td>
<td>Attached Housing</td>
<td>0.70</td>
<td>10</td>
</tr>
<tr>
<td>LR</td>
<td>Local Retail</td>
<td>0.90</td>
<td>10</td>
</tr>
<tr>
<td>GB</td>
<td>General Business</td>
<td>0.90</td>
<td>10</td>
</tr>
<tr>
<td>LC</td>
<td>Lakeside Commercial</td>
<td>0.90</td>
<td>10</td>
</tr>
<tr>
<td>HC</td>
<td>Highway Commercial</td>
<td>0.90</td>
<td>10</td>
</tr>
<tr>
<td>I</td>
<td>Industrial</td>
<td>0.70 to 0.95</td>
<td>10</td>
</tr>
<tr>
<td>FP</td>
<td>Flood Plain</td>
<td>0.40</td>
<td>20</td>
</tr>
</tbody>
</table>
NON-ZONED LAND USES

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Runoff Coefficient &quot;C&quot;</th>
<th>Min. Inlet Time in Minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Church</td>
<td>0.70 to 0.90</td>
<td>10</td>
</tr>
<tr>
<td>School</td>
<td>0.50 to 0.90</td>
<td>10</td>
</tr>
<tr>
<td>Park</td>
<td>0.30 to 0.70</td>
<td>10</td>
</tr>
<tr>
<td>Cemetery</td>
<td>0.30 to 0.50</td>
<td>15</td>
</tr>
<tr>
<td>Street &amp; Highway Right-of-Way</td>
<td>0.95</td>
<td>10</td>
</tr>
</tbody>
</table>

The use of the street for carrying storm water shall be limited to the following:

**SPREAD OF WATER - 10 YEAR STORM FREQUENCY**

Class 1 Streets with curbs and gutters - One traffic lane on each side to remain clear.

Class 2 Street - One traffic lane to remain clear.

Class 3 Streets with curb and gutters - Six inch (6") depth of flow at curb or no lanes completely clear.

Alleys - Contained within the paved surface.

For Country Lanes and Parkway thoroughfares, the spread of water shall be based on a 100-year storm frequency. All storm water must be contained within the right-of-way. The depth of flow shall not exceed the roadway crown elevation.

**SPREAD OF WATER - 100 YEAR STORM FREQUENCY**

Notwithstanding the requirements above, all storm water in the 100-year storm frequency shall be contained within the street or alley right-of-way or with in the drainage easement. The water depth shall not be greater than 1" over any curb.
B. Capacity of Streets and Alleys

Chapter 6 of the Texas Department of Transportation, "Hydraulic Manual," includes a nomograph (Figure 3-2) for flow in triangular channels that may be used for computing the capacity of streets and alleys having a straight cross slope. The capacity of streets with parabolic crowns may be calculated from this nomograph using the composite section that most closely approximates the parabolic section. All street and alley capacities shall be calculated using a roughness coefficient of \( n = 0.0175 \).

C. Capacity of Swales

The capacity of swales shall be calculated according to the Manning Equation as given in Chapter 3 of the Texas Department of Transportation "Hydraulic Manual." All calculations shall be made using a roughness coefficient of \( n = 0.030 \).

D. Valley Gutters

The use of valley gutters to convey storm water across a street intersection is subject to the following criteria:

1. A Class 1 street shall not be crossed with a valley gutter.
2. Wherever feasible, a Class 2 street shall not be crossed with a valley gutter.
3. At any intersection, perpendicular valley gutters will not be permitted and parallel valley gutters should cross only the lower classified street.

E. Alley Capacities

In residential areas where the standard alley section capacity is exceeded, curbs may be used to provide needed capacity. However, all storm drainage shall be contained in the alley right-of-way and may not encroach on to private property especially at connecting driveways.
EQUATION: \( Q = 0.58 \left( \frac{S^2}{n^6} \right) s' y'' \)

- \( z'\) reciprocal of transverse slope
- \( n\) coefficient of roughness in Manning's formula
- \( S\) grade of channel in ft./ft.
- \( y\) depth at curb or deepest point in ft.

EXAMPLE (see dashed lines)

 GIVEN: \( S = 0.03 \)
 \( z = 2.4 \)
 \( n = 0.02 \)
 \( Q = 2.0 \text{ CFS} \)

 FIND: \( y = 0.22 \)

INSTRUCTIONS

1. Connect \( z/n \) ratio with slope (S) and connect discharge (Q) with depth (y). These two lines must intersect at turning line for complete solution.

2. For shallow V-shaped channel as shown use nomograph to determine discharge in sections a and b separately. Then \( Q_a = Q_a + Q_b \).

3. To determine discharge \( Q_a \) in portion of channel having width \( X \), determine depth \( y \) for total discharge in entire section \( a \). Then use nomograph to determine \( Q_b \) in section \( b \) for depth \( y' = y + \frac{z}{2} \).

4. To determine discharge in composite section follow instruction 3. To obtain discharge in section \( a \) at assumed depth \( y' \); obtain \( Q_a \) for slope ratio \( z_b \) and depth \( y' \); then \( Q_a = Q_a + Q_b \).

NOMOGRAPH FOR FLOW IN TRIANGULAR CHANNELS

BRIDGE DIVISION HYDRAULIC MANUAL

6 - 20

-35-
F. Sizing and Location of Inlets

For determining the size and locations of inlets, the following shall be used as a minimum:

**TABLE 3-4**

<table>
<thead>
<tr>
<th>Street Grade</th>
<th>Length of Inlet Opening for Each C.F.S. of Gutter Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sags</td>
<td>0.6 Feet</td>
</tr>
<tr>
<td>Less than 2%</td>
<td>1.0 Feet</td>
</tr>
<tr>
<td>Greater than 3.5%</td>
<td>2.0 Feet</td>
</tr>
</tbody>
</table>

Inlets shall be spaced no closer than 300 feet apart without special permission from the Town. The maximum length of an inlet at one location shall be 20 feet on each side of the street.

No more than 5 cfs can cross intersections in residential areas and no bypass of storm water across major intersections shall be allowed.

G. Hydraulic Gradient of Conduits

After the computation of the quantity of storm runoff entering each inlet, the size and gradient of pipe required to carry off the design storm are to be determined. All hydraulic gradient calculations shall begin at the outfall of the system. The following are the criteria for the starting elevation of the hydraulic gradient:

1. The 100-year water surface elevation in a creek, stream or other open channel is to be calculated for the time of peak pipe discharge in the same storm and that elevation used for beginning the hydraulic gradient.

2. When a proposed storm sewer is to be connected to an existing storm sewer system that has a design flow less than the proposed, the hydraulic gradient for the proposed storm sewer should start at the elevation of the existing storm sewers hydraulics gradient based on the proposed design year of the upstream system.
H. Hydraulic Design of Closed Conduits

All closed conduits shall be hydraulically designed for full flow as shown in Chapter 6, STORM DRAINS, of the Texas Department of Transportation, "Hydraulic Manual."

The crown of the pipe should be near the elevation of the hydraulic gradient, in most cases, to eliminate excessive excavation. The hydraulic gradient shall not be designed above the top of any inlet. The permissible difference between the hydraulic gradient and top of curb is normally 2 feet or $1.5 \sqrt{V^2/g}$ where $V$ is the velocity in feet per second and $g$ is 32.2 feet per second. The hydraulic gradient in the inlet shall not be higher than 1 foot below the top of the inlet.

I. Velocity in Closed Conduits

Pipe grade shall be set to produce a velocity of not less than 3 feet per second (fps) when flowing full. Grades producing velocities of less than 3 fps will not be allowed. All storm sewer pipe and driveway culverts shall be a minimum of 18 inches in diameter. Discharge velocity shall be calculated with a tailwater depth not greater than the lesser of the top of the pipe at the pipe outlet or the actual 100-year water surface elevation in the channel.

Table 3-5 shows the maximum allowable velocities in closed conduits:

<table>
<thead>
<tr>
<th>Type of Conduit</th>
<th>Maximum Velocity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Culverts</td>
<td>15.0 fps</td>
</tr>
<tr>
<td>Inlet Laterals</td>
<td>15.0 fps</td>
</tr>
<tr>
<td>Storm Sewers</td>
<td>12.5 fps</td>
</tr>
</tbody>
</table>

Discharge velocities cannot exceed the permitted velocity of the channel or conduit at the outfall.

J. Roughness Coefficients for Conduits

The recommended value for the roughness coefficient "n" for concrete conduits with smooth joints and good alignment is 0.013. Where engineering judgement
indicates a value other than 0.013 be used, the appropriate adjustments should
be made in the calculations and the variance noted.

K. Head Losses

1. Head losses and gains for wyes and pipe size changes will be calculated
   by the formulas:

   \[ H_i = \frac{V_2^2}{2g} - \frac{V_1^2}{2g} \]  
   \[ H_i = \frac{V_2^2 - V_1^2}{4g} \]

   Where:

   \( H_i \) = the head loss in feet measured at the point of wye or pipe size
   change.
   \( V_1 \) = upstream velocity
   \( V_2 \) = downstream velocity

2. Head losses and gains for manholes and junction boxes will be calculated
   by the formula:

   \[ H_i = \frac{V_2^2}{2g} - \frac{K V_1^2}{2g} \]

   Where:

   \( H_i \) = the head loss in feet measured from the downstream water
   surface elevation.
   \( V_1 \) = upstream velocity or velocity in the lateral
   \( V_2 \) = the downstream velocity
   \( K \) = 0.35 for 90° Lateral
   \( K \) = 0.43 for 60° Lateral
   \( K \) = 0.50 for 45° Lateral
   \( K \) = 0.25 for Thru Line
3. Head losses for pipe bends will be calculated by the formula:

\[ H_f = K \frac{V^2}{2g} \]

Where:

- \( H_i \) = the head loss in feet measured at the upstream end of the bend
- \( V \) = the pipe velocity
- \( K \) = 0.50 for 90° Bend
- \( K \) = 0.43 for 60° Bend
- \( K \) = 0.35 for 45° Bend
- \( K \) = 0.20 for 22.5° Bend

The use of pipe bends is discouraged and will be allowed only in special situations with the permission of the Town Engineer.

In the case where the inlet is at the very beginning of a line, the equation becomes the following without any velocity of approach:

\[ H_f = K_i \frac{V^2}{2g} \]

Where: \( K_i = 0.25 \)

If the head loss calculated under A, B, C & D (above) is less than 0.1 foot, the minimum head loss to be used at wyes, junctions, manholes, and pipe size changes for design of storm drainage system is 0.10 foot.

L. Open Channels

Open channels may be used to convey storm waters where closed conduits are not justified economically. A wide variety of lined, partially lined or unlined channels are permitted except that lined channels may not be constructed in single family, multi-family or townhouse residential developments. All lined channels must be screened by continuous adjacent landscaping of at least 4 feet in height. In general, the use of existing channels in their natural condition is encouraged. Low flow pilot channel lining of earthen channels will be required for any earthen channel carrying more than the capacity of an equivalent 84"
diameter pipe. The design of the low flow pilot channel shall be as shown in Figure 3-3.

For residential developments, no more than two barrel box culverts will be permitted for stream crossings, except in unusual conditions. For unlined channel sections, the maximum side slopes are 4:1 and the maximum permitted mean velocity in the channel is 6 feet per second. Channel side slopes that are steeper than 5:1 shall be hydromulched in accordance with sections 2.15.3 and 3.10.7 of the NCTCOG Specifications and addenda. Temporary erosion control per Section 3.12 of the NCTCOG specifications is required for all channels.

For lined portions of channel sections, the sides may be vertical if the height of vertical wall does not exceed 3 feet. Paved and rip-rapped slopes are to have a side slope of 2:1 maximum. Permitted velocities in totally lined channels are 15 feet per second for finished concrete and 10 feet per second for rock rip-rap. Discharge velocities from lined channels may not exceed 6 feet per second. The minimum velocity in any channel shall be greater the 2 fps, including roadway ditches.

M. Hydraulic Design of Open Channels

The water surface as designed in an open channel is to be a minimum of 1 foot below the top of the channel section for concrete lined channels and 2 feet below the top of the channel section for rock rip-rap and earthen channels to provide a margin of safety for channel obstructions and for flows that exceed the design storm frequency.

Special care must be taken at entrances to closed conduits and culverts to provide for the headwater requirements.

On all channels the water surface elevation, which is coincident with the hydraulic gradient, shall be calculated and shown on the construction plans.

Maximum allowable velocities and roughness coefficients for open channels are shown in Table 3-6. When the normal available grade would cause velocities in excess of the maximums, it may be necessary to design special drops or channel retards.

N. Hydraulic Design of Culverts

In the design of culverts, the Engineer shall keep head losses and velocities within reasonable limits while selecting the most economical structure. This
normally requires selecting a structure that creates a head water condition and has a velocity of flow safely below the allowed maximum.

The vertical distance between the upstream design water surface and the roadway or bridge elevation is termed "freeboard." The dimension is included as a safety factor to protect against unusual clogging of the culvert and to provide a margin for future modifications in surrounding physical conditions. Normally, a minimum of 2 feet shall be considered a reasonable freeboard when the structure is designed to pass a design storm frequency of 100 years. Unusual surrounding physical conditions may be cause for a change in this requirement. Hydraulic design of culverts shall be in accordance with Chapter 4, CULVERTS, of the Texas Department of Transportation, "Hydraulic Manual."

O. Headwalls and Entrance Conditions

Headwalls are to be used to protect the embankment from erosion and the culvert from displacement. Sloped headwalls conforming to the minimum slope specified in this Design Manual shall be constructed at the end of all pipe drainage facilities and vertical headwalls with wingwalls and aprons shall be constructed for all rectangular shaped hydraulic structures.

Special headwalls and wingwalls may be required at the entrance of all hydraulic structures where approach velocities are in excess of 8 feet per second. Culvert exit and headwall shall be designed such as the flow line of the culvert is coincident with the flow line of the stream or channel into which the culvert discharges.

The maximum exit velocity from the culvert is limited to the maximum velocity allowed in the stream or channel. Concrete rip-rap is to be used to protect the stream bed from scour and erosion. The rip-rap shall be reinforced and have toe walls to prevent undermining.
TYPICAL EARTHEN CHANNEL SECTION

FIGURE 3-3

SCALE: NONE
DATE: MAR 1994

TOWN OF SUNNYVALE, TEXAS
TYPICAL SECTION

TOWN OF SUNNYVALE
DALLAS COUNTY, TEXAS
<table>
<thead>
<tr>
<th>Description</th>
<th>Minimum Roughness Coefficient</th>
<th>Maximum Channel Velocity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NATURAL STREAMS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderately Well-defined Channel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grass &amp; Weeds, Little Brush</td>
<td>0.030</td>
<td>6</td>
</tr>
<tr>
<td>Dense Weeds, Little Brush</td>
<td>0.040</td>
<td>6</td>
</tr>
<tr>
<td>Weeds, Light Brush on Banks</td>
<td>0.045</td>
<td>6</td>
</tr>
<tr>
<td>Weeds, Heavy Brush on Banks</td>
<td>0.050</td>
<td>6</td>
</tr>
<tr>
<td>Weeds, Dense Willows on Banks</td>
<td>0.080</td>
<td>6</td>
</tr>
<tr>
<td>Irregular Channel With Pools and Meanders</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grass &amp; Weeds, Little Brush</td>
<td>0.045</td>
<td>6</td>
</tr>
<tr>
<td>Dense Weeds, Little Brush</td>
<td>0.050</td>
<td>6</td>
</tr>
<tr>
<td>Weeds, Light Brush on Banks</td>
<td>0.060</td>
<td>6</td>
</tr>
<tr>
<td>Weeds, Heavy Brush on Banks</td>
<td>0.070</td>
<td>6</td>
</tr>
<tr>
<td>Weeds, Dense Willows on Banks</td>
<td>0.100</td>
<td>6</td>
</tr>
<tr>
<td>Flood Plain, Pasture</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short Grass, No Brush</td>
<td>0.035</td>
<td>6</td>
</tr>
<tr>
<td>Tall Grass, No Brush</td>
<td>0.050</td>
<td>6</td>
</tr>
<tr>
<td>Flood Plain, Cultivated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Grass</td>
<td>0.035</td>
<td>6</td>
</tr>
<tr>
<td>Mature Crops</td>
<td>0.050</td>
<td>6</td>
</tr>
<tr>
<td>Flood Plain, Uncleared</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavy Weeds, Light Brush</td>
<td>0.070</td>
<td>6</td>
</tr>
<tr>
<td>Medium to Dense Brush</td>
<td>0.160</td>
<td>6</td>
</tr>
<tr>
<td>Trees With Flood Stage Below Branches</td>
<td>0.120</td>
<td>6</td>
</tr>
<tr>
<td>UNLINED VEGETATED CHANNELS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mowed Grass, Clay Soil</td>
<td>0.030</td>
<td>6</td>
</tr>
<tr>
<td>LINED CHANNELS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smooth Finished Concrete</td>
<td>0.015</td>
<td>15</td>
</tr>
<tr>
<td>Rip-Rap, Rubble or Gabions</td>
<td>0.040</td>
<td>10</td>
</tr>
</tbody>
</table>
P. Headwalls and Exit Conditions

Headwalls are used to protect the embankment from erosion and the culvert from displacement. The headwalls, with or without wingwalls and aprons, shall be constructed in accordance with the standard drawings as required by the physical conditions of the particular installation.

Culvert exit and headwall shall be designed such that the flow line of the culvert is coincident with the flow line of the stream or channel into which the culvert discharges. The maximum exit velocity from the culvert is limited to the maximum velocity allowed in the stream or channel.

Due to the geometry of the culvert-stream intersection, turbulence or other conditions may tend to produce erosion. Concrete rip-rap will be used to protect the stream bed from scour and erosion. The rip-rap shall be reinforced and have toe walls to prevent undermining.

Q. Bridge Design Hydraulics

Once a design discharge and a downstream depth of flow have been determined, the size of the bridge opening can be determined. Determination of head losses through bridge structures shall be calculated.

The Town of Sunnyvale has the following policy with regard to the hydraulic design of bridge structures:

1. Minor head loss due to the structure is allowed. Normal losses due to channel cross sections are allowable.

2. Excavation of the natural channel is not normally allowed as compensation for loss of cross sectional area.

3. Channelization upstream or downstream of the proposed bridge will normally not be permitted.

4. Hydraulic design for bridges shall conform to the requirements of Chapter 5, BRIDGES, of the Texas Department of Transportation, "Hydraulic Manual."

5. A 2 foot freeboard is required between the designed water surface and the bottom of the lowest beam.
6. Bridge design shall meet all FEMA requirements when a designated floodway is crossed.

3.5 CONSTRUCTION PLANS PREPARATION

A. Drainage Area Map

The drainage area map shall have a minimum scale of 1' = 200', and show the street right-of-way. For large drainage areas, a map having a minimum scale of 1'=2000' is usually sufficient.

The following items/information shall be included:

1. Acres, coefficient, and intensity for each drainage sub-area;

2. Inlets, their size and location, the flow bypass for each, the direction of flow as indicated by flow arrows, the station for the centerline of the line;

3. A chart including data shown shall be submitted with the first review, and included on the map with the final review;

4. Existing and proposed storm sewers;

5. Sub-areas for alleys, streets, and off-site areas;

6. Points of concentration;

7. Runoff to all inlets, dead-end streets, and alleys or to adjacent additions and/or lots;

8. A table for runoff computations;

9. Flow arrows to indicate all crests, sags and street and alley intersections;

10. North arrow;

11. Any off-site drainage shall be included;

12. Street names shall be indicated;

13. 100-year floodplain shall be indicated on the drainage area map.

When calculating runoff, the drainage area map shall show the boundary of the drainage area contributing runoff into the proposed system. This boundary
should be determined from a map having a maximum contour interval of 2 feet. The area shall be further divided into sub-areas to determine flow concentration points or inlet locations. The centerline of all streets (except Residential of Local Streets) will normally be a boundary of a drainage area, to insure that inlets are sized and positioned to fill the need without depending on storm water crossing over the street crown for proper drainage.

In residential areas, the centerline of the street will only be used as a drainage area boundary if the flow in either gutter has not exceeded the street crown elevation.

Direction of flow within streets, alleys, natural and man-made drainage ways, and at all system intersections, shall be clearly shown on the drainage area map and/or paving plans. Existing and proposed drainage inlets, storm sewer pipe systems and drainage channels shall also be clearly shown and identified on the drainage area map. Storm sewers shall show and mark station ticmarks at 100-foot intervals. Plan-profile storm sewer or drainage improvement sheet limits and match lines shall be shown with pipes and channels identified.

The drainage area map should show enough topography to easily determine its location within the Town.

B. Plan-profile Sheets

1. Inlets

Inlets shall be given the same number designation as the area or sub-area contributing runoff to the inlet. The inlet number designation shall be shown opposite the inlet. Inlets shall be located at or immediately downstream of drainage concentration points. At intersections, where possible, the end of the inlet shall be ten feet from the curb return P.T., and the inlet location shall also provide minimum interference with the use of adjacent property. Inlets in residential areas should be located in streets and alleys so the driveway access is not prohibited to the lots. Inlets located directly above storm sewer lines, as well as laterals passing through an inlet, shall be avoided. Drainage from abutting properties shall not be impaired, and shall be designed into the storm drainage system.

Data opposite each inlet shall include paving or storm sewer stationing at centerline of inlet, size and type of inlet number or designation, top of curb elevation and flow line of inlet as shown on construction plans.
2. Laterals

Inlet laterals leading to storm sewers, where possible, shall enter the inlet and the storm drain main at a 60-degree angle from the street side. Laterals shall be four feet from top of curb to flow line of inlet, unless utilities or storm sewer depth requires otherwise. Laterals shall not enter the corners or bottoms of inlets. Lateral profiles shall be drawn showing appropriate information including the hydraulic gradient and utility crossings. Short lateral (30 feet or less) crossings utility lines will be profiled.

3. Storm Sewer

In the plan view, the storm sewer designations, size of pipe, and length of each size pipe shall be shown adjacent to the storm sewer. The sewer plan shall be stationed at one hundred (100) foot intervals, and each sheet shall begin and end with even or fifty (50) foot stationing. All storm sewer components shall be stationed.

The profile portion of the storm sewer plan-profile sheet shall show the existing and proposed ground profile along the centerline of the proposed sewer, the hydraulic gradient of the sewer, the proposed storm sewer, and utilities that intersect the alignment of the proposed storm sewer. Also, shown shall be the diameter of the proposed pipe in inches, and the physical grade in percent. Hydraulic data for each length of storm sewer between interception points shall be shown on the profile. This data shall consist of pipe diameter in inches, the 100-year design storm discharge in cubic feet per second, slope of hydraulic gradient in percent, Manning capacity of the pipe flowing full in cubic feet per second, velocity in feet per second, and $V^2/2g$. Also, the head loss at each interception point shall be shown.

Elevations of the flow line of the proposed storm sewer shall be shown at one hundred (100) foot intervals on the profile. Stationing and flow line elevations shall also be shown at all pipe grade changes, pipe size changes, lateral connections, manholes and wye connections. All soffits shall be connected.

4. Creek Cross-Sections

All plan sheets shall be drawn in ink on 24" x 36" material, to a standard engineering scale, and shall be clearly legible when sheets are reduced to half scale. After each review, all review comments shall be addressed,
additional data incorporated, and drafting of plans completed. Each plan-
profile sheet shall have a benchmark shown.

3.6 CHECK LIST FOR STORM DRAINAGE PLANS

A. Drainage Area Map

1. Normally, use 1" = 200' scale for on-site, and 1" = 400" for off-site. Show
match lines between any two (2) or more maps.

2. Show existing and proposed storm drains and inlets with designations.

3. Indicate sub-areas for alley, street, and off-site areas.

4. Indicate contours on map for on and off-site.

5. Use design criteria as shown in design manual.

6. Indicate zoning on drainage area map.

7. Show points of concentration and their designations.

8. Indicate runoff at all inlets, dead-end streets and alleys, or to and from
adjacent additions or acreage.

9. Provide runoff calculations for all areas showing acreage, runoff coefficient,
and inlet time. (Q = CIA table)

10. For cumulative runoff, show calculations.

11. Indicate all crests, sags, and street and alley intersections with flow arrows.

12. Identify direction of north to top page or to the left.

13. Show limits of 100-year fully developed flood plain on drainage area map.

B. Storm Sewers

1. Diversion of flow from one natural drainage area to another will not be
allowed.

2. Show plan and profile of all storm sewers.

3. Specify Class III pipe unless otherwise noted.
4. Use heavier than Class III pipes where crossing railroads, areas of deep fill and areas subjected to heavy loads.

5. Specify concrete strength for all structures. The minimum allowable is 3600 psi.

6. Provide inlets where street capacity is exceeded. Provide inlets where alley runoff exceeds intersecting street capacity.

7. Do not allow storm water flow from streets into alleys.

8. Do not use high velocities in storm sewer design. A maximum discharge velocity of six (6) fps. at the outfall is required. Velocity dissipation may be necessary to reduce erosion.

9. Flumes may not be allowed unless specifically designated, and will not be allowed on Class 1 & 2 thoroughfares.


11. Discharge flow lines of storm sewers to be two (2) feet above the flow line or creeks and channels, unless channel lining is present. Energy dissipation shall be provided when specified by the Town Engineer.

12. Where fill is proposed for trench cut in creeks or outfall ditches, compaction shall be 95% of the maximum density as determined by ASTM D 698.

13. Investigations shall be made by the engineer to validate the adequacy of the storm sewer outfall to a major stream.

14. Outfall area must have adequate capacity to carry the discharge. Provide erosion control facilities with hydraulic data.

15. Any off-site drainage work or discharge to downstream property will require an easement. Easements shall be sized such that the developed flows can be conveyed within the easement. Submit field notes for off-site easement that may be required (Private development only).

C. Plan and Profile

1. Indicate property lines and lot lines along storm sewers, and show easements with dimensions.
2. If necessary, provide separate plan and profile of storm sewers. The storm drain pipes should also be shown on paving plans with a dashed line, and on sanitary sewer profiles showing the full pipe section.

3. Tie storm sewer system stationing with paving stations.

4. Show pipe sizes in plan and profile.

5. Show hydraulics on each segment of pipe profile to include: \( Q_{10}, Q_{100} \), \( C \) = Manning full flow capacity; \( S, V, V^2/2g \).

6. Show curve data for all storm sewer system.

7. Show all existing utilities in plan and profile. On storm sewer profiles, as a minimum, the sanitary sewer profile will be shown.

8. Indicate existing and proposed ground line and improvements on all street, alley, and storm sewer profiles.

9. Show future streets and grades where applicable.

10. Where connections are made to existing storm sewer show computations on existing system when available. HGL will be calculated from the outfall to the connection point including the designed flows of the added on systems.

11. Indicate flow line elevations of storm sewers on profile, show pipe slope (percent grade). Match top inside of pipe where adjacent to other size pipe.

12. Intersect laterals at sixty (60) degrees with trunk line.

13. Show details of all junction boxes, headwalls, storm sewers, flumes, ad manholes, when more than one pipe intersects the drainage facility or any other item is not a standard detail.

14. Pipe direction changes will be curves using radius pipe unless approved by the Town Engineer.

15. Bends in pipe may be used in unusual circumstances with approval of the Town Engineer. No bend at one location may exceed thirty (30) degrees.

16. Do not use 90-degree (90) turns on storm sewers or outfalls. Provide good alignment with junction structures or manholes (for small systems).
17. Profile outfall with typical flat bottom section.

18. Show all hydraulics, velocity head changes, gradients, and computations.

19. Show water surface at outfall or storm drain.

20. On all dead-end streets and alleys, show grade out to "daylight" for drainage on the profiles and provide erosion control. Show typical section and slope of "daylight" drainage. Side slopes shall not exceed 4:1.

21. At sags in pavement, provide a positive overflow (paved sidewalk in a swale) to act as a safety path for failure of the storm drain system. Minimum finished floor elevations will be shown on the plat to protect building against flooding should the positive overflow be used.

22. Where quantities of runoff are shown on plans or profiles, indicate storm frequency design.

23. Provide sections for road, railroad and other ditches with profiles and hydraulic computations. Show design water surface on profile.

24. For drainage ditches located in street right-of-way running parallel to street paving, show the size of each driveway culvert on the ditch profile. Assume the maximum number and width of driveways allowed for each lot. Show the hydraulic grade lines as required herein.

D. Laterals

1. Show laterals on trunk profile with stations.

2. Provide lateral profiles for laterals exceeding thirty (30) feet in length.

3. Where laterals tie into trunk lines, place at sixty (60) degree angles with centerlines. Connect them so that the longitudinal centers intersect.

4. Calculate hydraulic grade line for laterals and inlets to insure collection of storm water. Check $1.5 \frac{V^2}{2g}$, using trunk line velocity on laterals less than 80-feet long. Final the H.G. at the gutter or inlet lip by adding the $1.5 \frac{V^2}{2g}$ to the hydraulic gradient of the trunk line at the lateral connection. For all inlets, provide HGL and hydraulic data on profile for all profiled laterals. Laterals longer than eighty (80) feet require special analysis.

5. All inlets shall have a minimum eighteen in (18") laterals.
E. Inlets and Intakes

1. Provide inlets where street capacity is exceeded. Provide inlets where runoff from alley causes the capacity of the intersecting street to be exceeded.

2. Indicate runoff concentrating at all inlets and direction of flow. Show runoff for all stub outs, pipes and intakes.

3. On plan view, indicate size of inlet, lateral size, flow line, top-of-curb elevations, paving station, and inlet designation number.

4. Use standard curb inlets in streets. Use recessed inlets in divided streets. Use combination inlets in alleys when on a straight run. Do not use grate or combination inlet unless other solution is not available (special situation).

5. Use type "Y" or special "Y" inlets in ditches or swales. No "Glory Holes" allowed as intake for a storm sewer or at a culvert. A three (3) foot concrete apron shall be constructed around "Y" inlets.

F. Paving

1. Provide six (6) inch curb on alleys parallel to creek or channel on creek side of alley.

2. For a proposed driveway turnout, curb return P.T. must be 10 feet upstream from any existing or proposed inlet, or 5 feet downstream of a standard inlet.

3. Check the need for curbing at all alley turns and "T" intersections. Flatten grades ahead of turns and intersections.

4. Where inlets are placed in an alley, provide curbing for 10 feet on each side of combination inlets.

G. Detention Basins (When required by the Town Engineer)

1. Provide drainage area map and show all computations for runoff affecting the detention basin.

2. Provide a plot plan with existing and proposed contours for the detention basin and plan for structural measures.
3. Where earth embankment is proposed for impoundment, furnish a typical embankment section and specifications for fill include profile for the structural outflow structure and geotechnical report.

4. Provide structural details and calculations for any item not a standard detail.

5. Provide detention basin volume calculations and elevation versus storage curve.

6. Provide hydraulic calculations for outflow structure and elevation versus discharge curve.

7. Provide routings or modified rational determination of storage requirements, demonstrating that critical duration is used (permitted for areas of 600 acres or less).

8. **Fencing may be required around detention area.**

H. Bridges

1. Clear the lowest member of the bridge by 2 feet above the design water surface, unless otherwise directed by the Town Engineer.

2. Show geotechnical soil boring information on plan.

3. Show bridge sections upstream and downstream.

4. Provide structural details and calculations with dead load deflection diagram.

5. Provide vertical and horizontal alignment.

6. Show soil erosion protection measures and concrete rip-rap.
PART 4 - WATER AND SEWER LINES

4.1 WATER MAINS

A. General

Water mains shall be placed on the north and west sides of a street, at a distance of 4 feet behind the curb or otherwise as directed by the Town Engineer. Refer to the Utility Assignments detail sheets that accompany this manual for location of water and sewer lines.

1. Mains over 1200 feet in length or mains supplying more than one fire hydrant, shall be a minimum size of 8-inch diameter pipe in residential districts. For mains in commercial and manufacturing districts, a minimum of 12-inch diameter pipe will be required if the main is over 600 feet in length.

2. In residential districts and in those supplying only one fire hydrant, a 6-inch diameter pipe is required for mains less than 1200 feet in length. Dead end mains shall not exceed 600 feet in length, and at least one fire hydrant or blow-off valve will be required, usually at or near the end of the main.

3. In commercial and industrial districts, minimum 8-inch mains are required. In any event, water mains must be of adequate size to provide for the building total fire flow. Fire flow shall be Needed Fire Flow (NFF) as determined from the "Fire Suppression Rating Schedule" as published by the Insurance Services Office. Fire flow requirements shall be met at peak day demand.

4. Peak day domestic demand shall be as shown in Table 4-1:

<table>
<thead>
<tr>
<th>Density</th>
<th>Peak Day Water Consumption (gallons per acre per day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 D.U./Acre</td>
<td>2600</td>
</tr>
<tr>
<td>2.0 D.U./Acre</td>
<td>3500</td>
</tr>
<tr>
<td>3.0 D.U./Acre</td>
<td>4700</td>
</tr>
<tr>
<td>3.8 D.U./Acre</td>
<td>5000</td>
</tr>
</tbody>
</table>
The density shall be determined by dividing the total number of dwelling units by the total platted area. The domestic water demand shall be calculated by multiplying the water consumption values in the above table by the total acreage in the platted area. For densities other than those listed above, water consumption rates may be interpolated or extrapolated from the values given in the table.

Peak hourly rates may be considered to be two times the peak day consumption. Water lines shall be sized to meet the peak hourly domestic demand as well as the fire flow requirements as described previously.

B. Water Main Material

1. All water mains shall be AWWA C900 or C905 PVC, DR 18, mechanical joint, or a bell and spigot joint. Double bell couplings may not be used for jointing pipe. Ductile iron fittings shall be used.

2. For water mains 24-inches in diameter and larger, Reinforced Concrete, Pretensioned Reinforced (Steel Cylinder Type), complying with AWWA C303, Class 150 may be considered on a case by case basis.

3. Profiles with elevations shall be provided for mains 14-inches in diameter and larger.

4. All water mains outside utility easements that supply fire sprinkler systems shall be minimum 200 PSI working pressure and U.L. listed.

5. All water line easements shall be a minimum of fifteen feet wide.

C. Water Valves

Valves 12-inches and smaller shall be placed on or near street property lines and shall be spaced at a minimum of 800 feet apart in residential, duplex and apartment districts and not over 500 feet apart in all other districts. They shall be placed in such a manner as to require preferably two, but not more than three valves to shut down each town 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, valves shall be placed at or near the ends of mains in such a manner that a shut down can be made for a future main extension without causing loss of service on the existing main. The location of valves larger than 12-inches will be as approved by the Town Engineer. Valves 12-inches and under will be Resilient Seat Gate Valves (RSGV). Sixteen and eighteen inch valves shall be non-rising stem
double disc gate valves placed in the vertical position. Valves larger than 18 inches will be Butterfly Valves.

D. Fire Hydrants

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. There shall be sufficient hydrants to concentrate the required fire flow, as recommended by the publication "Fire Suppression Rating Schedule" published by the Insurance Services Office, around any building with an adequate flow available from the water system to meet this required flow. In addition, the following guidelines shall be met or exceeded:

a. Single Family and General 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 a fire vehicle.

b. Attached Housing

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 400 feet as measured along the length of the center line of the roadway, and the front of any structure at grade and shall be no further than 400 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 center line of the roadway, and the front of any structure at grade and shall be no further than 400 feet from a minimum of two fire hydrants as measured along the route that a 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 fire 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:

(1) Attached Housing

(a) Within 150 feet of the main entrance.

(b) At maximum intermediate spacing of 400 feet as measured along the length of the fire lane.

(2) Non-Residential Property or Use

(a) Within 150 feet of the main entrance.

(b) Within 100 feet of any fire department connection.

(c) At a maximum intermediate spacing of 300 feet as measured along the length of the fire lane.

(3) Fire lanes shall be a minimum of 24-feet wide. All radiuses shall be set to accommodate a standard SU vehicle.

(4) Generally, no fire hydrant shall be located closer than fifty (50') feet to a non-residential building or structure unless approved by the Town Engineer.

(5) In instances where access between the fire hydrant and the building that it is intended to serve may be blocked, extra fire hydrants shall be provided to improve the fire protection. Railroads, expressways, major thoroughfares and other man-made or natural obstacles are considered as barriers.
2. Restrictions

a. All required fire hydrants shall be as required by the North Central Texas Council of Governments Specifications and Addenda and shall be placed on water mains of no less that six (6") inches in size. Fire hydrants shall be as specified in the North Central Texas Council of Government Specifications and associated addenda.

b. Valves shall be placed on all fire hydrant leads.

c. Required fire hydrants shall be installed so the break away point will be no less than three (3") inches, and no greater than five (5") inches above the grade surface.

d. Fire hydrants shall be located as shown in Appendix "B." The fire hydrant shall not be in the sidewalk.

e. In non-residential developments an 8-inch lead will be required on all fire hydrants that are located more than 50 feet from the looped main.

f. All required fire hydrants placed on private property shall be adequately protected by either curb stops or concrete filled steel posts or other methods as approved by the Engineer and shall be in easements. Such stops or posts to be the responsibility of the landowner on which the said fire hydrant is placed.

g. All required fire hydrants shall be installed so that the pumper nozzle connection will face the fire lane or street, or as directed by the Engineer.

h. 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.

i. Fire hydrants, required by this article, and located on private property, shall be accessible to the Fire Department at all times.

j. Fire hydrants shall be located at street or fire lane intersections, when feasible.

k. Fire hydrant bonnet shall be painted according to North Central Texas Council of Governments and Addenda.
3. Main Size for Hydrant Supply

Four inch mains used for hydrant supply shall be replaced and dead ends eliminated where practical. Six-inch lines shall be connected so that not more than one hydrant will be between intersecting lines and not more than two hydrants on an 8-inch main between intersecting lines. The maximum length of a six-inch fire hydrant lead is 150'.

4. Fire Line Metering

Generally, the Town of Sunnyvale will own, operate and maintain all fire lines serving fire hydrants. Such fire lines shall be designed and constructed in accordance with the Town's standards and shall be placed in an easement dedicated to the Town for this purpose. Sprinkler service lines, fire line connections and other fire lines that are not maintained by the Town shall be equipped with either a water meter or a detector check valve having a capacity equal to the required fire flow. Water meters and detector check valves shall be constructed in accordance with Town standards.

E. Minimum Cover

The minimum cover to the top of the pipe must vary with the valve stem. In general, the minimum cover below the street grade or furnished grade (whenever is lower) should be as follows: 8-inch and smaller, 4.0 feet; 12-inch, 4.5 feet to 5 feet; 16-inch, 5.0 feet to 5.5 feet. Lines larger than 16-inch shall have a minimum of 6 feet of cover that is sufficient to allow water and sewer and other utilities to go over the large main. For water lines to be constructed along county type roads, which are commonly built with a high crown about the surrounding property, increase the cover as required to allow for future paving grade changes.

F. Meter Box and Service

A service with a meter box is constructed from the main to a point just behind the curb line, usually in advance of paving. The location of the meter box is as shown on the Utility Assignments detail sheets and as shown on the Construction Details. On multiple apartments and business properties, the desired size and location are usually specified by the owners. Minimum requirements for water service sizes are:

1. Three quarter-inch water services are required to serve all residential lots including townhouse lots, patio homes and duplexes. Separate meter connections shall be provided for each of the family units.
2. The size of apartment, condominium, multi-family services or commercial will depend on the number of units served with a minimum of one meter per building.

G. Service Connections - Hydrants

A service connection shall not be allowed on fire hydrant leads except as authorized by the Town Engineer.

4.2 SANITARY SEWERS

A. General

All platted lots must be served by an approved means of wastewater collection and treatment. In most cases, lots will be served by a municipal sewer system. Where, in the opinion of the Town Engineer, connection to the municipal system is not economically feasible, on site treatment of wastewater may be allowed.

B. Location of Sewer Lines

Sizes and grades for sanitary sewers shall be as required by the Town Engineer. Sewers shall be constructed with extensions to the development boundary to allow for direct connection by future developments. If feasible, sewers shall be placed in streets. Sewers are usually located in the center of the street. Each addition has its individual problems, therefore, no fixed rules will apply to all cases. Where easements are used, they shall be not less than fifteen feet wide.

C. Minimum Cover

Minimum cover shall be 3.5 feet; exceptions authorized by the Town Engineer shall have concrete protection. For sanitary sewers in streets, the minimum cover shall be 5.0 feet. In general, the minimum depth required for the sewer to serve given property with a 4-inch lateral shall be 3 feet (4.5 feet if the water line is on the same side of the street as the lateral in question) 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 be 3 feet plus 2% x 135 feet = 2.7 plus 3.0 = 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 these criteria are met. A minimum of 3 feet of cover on sewer services is required at all points in Street R.O.W. where swales are constructed. 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 Town Engineer.

D. Sewage Flows, Size and Grades

Sewage flow shall be computed in accordance with the following formula:

\[
Q = \frac{C^{0.85}}{295}
\]

Where:

\[
Q = \text{Peak wastewater flow (million gallons per day)}
\]
\[
C = \text{Equivalent single family connections}
\]

This equation is graphically displayed in Figure 4-1. Equivalent single family connections are based on a density of 2.7 persons per dwelling unit. Densities for other residential uses shall be determined by the Town Engineer. Sewage flow for non-residential uses shall be determined by the Town Engineer.

Pipes should be placed on such a grade that the velocity when flowing full is not less than two feet or more than ten feet per second. Minimum grades shall be as follows:

- 6" - 0.60%; 8" - 0.40%; 10" - 0.26%; 12 - 0.20%;
- 15" - 0.14%; 18" - 0.12%; 21" - 0.10%; 24" - 0.08%.

All grades shall be shown to the nearest 0.01 foot. Grades shall be evenly divisible by 4, and if practical, they should be even, such as: 0.20%, 0.40%, 0.60% and 1.00%, etc., in order to facilitate field computations. When the slope of a sewer changes, a manhole will be required. Vertical curves may be used only at manholes to eliminate drop manholes. The length of vertical curves in this instance shall not exceed 100 feet. No other vertical curves will be allowed. Horizontal curves to match change in street direction will be allowed as approved by the Town Engineer.

E. Manholes, Wyes, Bends, Taps, and Cleanouts

The sizes and locations of manholes, wyes, bends, tap connections, cleanouts, etc., shall be as designated by the Town Engineer. In general, manholes shall be placed at all four-way connections and three-way connections. The diameter
of a manhole constructed over the center of a sewer should vary with the size of the sewer. For 6", 8", and 10" sewers, the manhole shall be 4.0 foot minimum diameter; for 12", 15", and 18" sewers - 4.5 foot minimum diameter; for 21", 24" and 27" - 5.0 foot minimum diameter; 30" - 5.5 foot minimum diameter; and 36" - 6 foot minimum diameter. In Flood Plains, sealed manholes "Type S" are used. Clean-outs shall be placed on the ends of all lines. Drop manholes shall be required when the inflow elevation exceeds the outflow elevation by more than 18 inches.

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 manhole spacing shall be a maximum of 500 feet; 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.

F. Laterals

The sizes and locations of laterals shall be as designated by the Town Engineer. 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 10 feet downstream from the center of the lot, and shall have a 10-foot lateral separation from the water service. Manholes will be required on 8-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 lateral per residential lot shall be required.

G. Railroad, Highway and Creek Crossings

Railroad, State Highway and creek crossings, etc., shall be as approved by the Town Engineer.

H. Sewer Line Materials

1. All sewer pipe shall be PVC or Reinforced Concrete sewer pipe. Reinforced Concrete Pipe is allowed only on lines larger than 24 inches in diameter.

2. Sewer pipe shall conform to the North Central Texas Council of Governments (NCTCOG) Specifications and associated addenda.

3. Sewer pipe joint materials shall have resilient properties, conforming to the NCTCOG Specifications and associated addenda.
4.3 PREPARATION OF WATER AND SEWER PLANS

A. Form of Plans

1. Plans shall be clear, legible, and neatly drawn on bordered sheets, size 24' x 36". Each sheet shall clearly display the Texas Professional Engineer's seal of the Engineer under whose direction the plans were designed. A title block in the lower right-hand corner shall be filled in to include: (1) project name; (2) Engineer's name, address, and telephone number.

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 sheet. The lines on the profile sheet shall be drawn in the same direction as on the plan. Lettering shall be oriented to be read upward or to the left.

3. On large additions or layouts requiring the use of more than six sheets (total of plan & profile), key sheets may be required on a scale of 1' = 400' or 1" = 1000", as designated by the Town Engineer. They shall show the overall layout with the specific project clearly indicated with reference to individual sheets.

4. The use of "off-standard" scales will not be permitted. A plan shall be drawn to scales of 1" = 100', or 1" = 40'. Plans for water and sewer that do not involve great detail should be drawn on a scale of 1" = 100'. These may be on plan-profile sheets or the "plan" may be drawn with the profiles on full ruled profile cloth. (If required for clarity, a separate sheet on 1" = 40' scale may be used to show details.) Plans in and along creeks, heavily wooded sections, streets with numerous utilities, or as may be required to produce a clean and legible drawing, shall be drawn on plan-profile sheets or separate plan and profile sheets on a scale 1" = 40'. If the plan is in an extremely congested area, a scale of 1" = 20' may be necessary and will be permitted. All profiles shall be drawn on a vertical scale as required for clarity, and the horizontal scale shall be the same as for the plan unless otherwise directed by the Town Engineer.
B. 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 0.1 foot and each new line shall begin at 0+00 at the outlet and increase up the sewer. Station pluses at all junctions or sewers, horizontal P.C.'s and P.T.'s bends, angle points, wyes, cleanouts, manholes, the centerlines of all cross streets 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 200 feet. Sewer laterals shall be shown at a location most convenient to serve the property. Sewer laterals will usually be 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 street or alley grade. Profiles shall also show the sewer pipe, manholes, cleanouts, etc. The size of the sewer, the direction of the flow, and the grade to the nearest 0.01 foot should 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 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 Town Engineer. 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 crossing the proposed sewer or water line shall be adequately
designated as to 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 need to be included. Indicate the location of any existing valves required for shut-down purposes and of any tees, 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, creeks, railroad or highway crossings, tunnels, meter boxes, valve vaults, and other appurtenances at each intersection or as required. Where the pipe is a curve, the curve data in 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 of 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 outlined for sewers, except that the grades and elevations of the proposed water line usually need not be shown closer than the nearest 0.01 foot.

4.4 ON-SITE TREATMENT OF WASTEWATER

A. Design Criteria

All applicable design criteria shall be used in the design and construction of on-site wastewater treatment systems including the Texas Natural Resources Conservation Commission, North Texas Municipal Utility District and Dallas County. All on site treatment systems shall be approved by the Town of Sunnyvale. The minimum lot size for on site treatment systems is 43,560 square feet.

B. Platting Requirements

Where on site wastewater treatment systems are allowed, the location of the proposed drain field shall be shown on the preliminary plat. The final plat shall indicate the minimum finished floor elevation if a gravity system is used. The minimum finished floor elevation shall not be less than 3.5 feet above the highest elevation of ground at the proposed drain field unless documentation is submitted and approved that demonstrates that a lower finished floor elevation will allow the on site treatment system to function properly.
TYPICAL STREET SECTIONS
APPENDIX A

RECOMMENDED PROCEDURE FOR SETTING STREET GRADES
TOWN OF SUNNYVALE
ENGINEERING DESIGN MANUAL

APPENDIX "A"

RECOMMENDED PROCEDURE FOR SETTING STREET GRADES

1. Plot profiles on plan sheets for each right-of-way line.
   Check for the following:
   a. Have drives, intersections, ditches, etc., been shown? Profile must give realistic picture of conditions grades must meet.
   b. If additional right-of-way is to be acquired, have profiles been plotted along proposed property line, not existing?
   c. If property line falls in a ditch, has second profile been shown to normal ground elevation?
   d. Check any sharp breaks in the profile which might identify plotting errors.

2. Spot critical points in profile which will control top of curb elevation. Calculate maximum curb elevation permissible at these points.

3. Lay tentative grade for low side of street. Minimum grade = 0.5%.

4. Lay matching grade on high side of street. Watch the following:
   a. On divided streets slope of traffic lanes must not be less than 0.5 foot between curbs nor more than 1/2 inch per foot anywhere in the roadway.
   b. Avoid fill if at all possible. If absolutely necessary to fill, try to limit height so access to abutting property will not be restricted.
   c. In extreme cases the street may slope the same direction for the full width of the street. Special permission is required for this.
   d. Occasionally the centerline of the proposed pavement can be offset to aid in matching improvements on the high side.
e. In flat areas of town try to keep top of curb 0.5' below ground at property line. This will assure good drainage from the abutting property.

f. If street is in flood plain, the minimum curb elevation must be determined after consultation between paving and drainage engineers and approved by competent authority.

5. Use standard design criteria for vertical curves. Safe sight distances must not be compromised.

6. Check safe speed of all curves. Superelevation may be necessary on short radius curves to maintain safe design speed.

7. Avoid changing shape of crown since this requires hand work by the contractor and increases cost.

8. Plot proposed tops of curbs on cross sections. Check for proper slope in parkway at every location. Look for places grade can be improved to serve property better. Numerous breaks in grade to enhance value of street to abutting property are preferable to long straight grades which may be detrimental to property.

9. Check every intersection carefully. Give special attention to:
   a. Drainage. Make sure ditches and gutters drain.
   b. Riding quality. This is very important at the intersection of two thoroughfares. Severe grade breaks must be avoided in both directions.
   c. Approach grades should not be over 4%. Steeper grades require special consideration. Vehicles should be able to see both directions clearly.

10. Check both ends of project as to drainage and riding quality. Avoid such solutions as "Grade to Drain". If necessary to drain into existing ditches show ditch profiles and proposed grades in profile. Show spot ditch elevations in plan view.

11. Sags in grades should fall at locations where inlets will cause least inconvenience to abutting property owners.

12. Median grades on divided thoroughfares follow the curb line of the through traffic lane, usually 7 to 10 feet from centerline. Therefore it is necessary to show top of curb elevations at critical points on left turn lanes. Show these in the plan view. Slope of left turn lane should match slope of adjacent through lanes is possible.
13. In general, street grades need to meet the needs and safety requirements of the traveling public, but must also serve the abutting property.
APPENDIX B

UTILITY ASSIGNMENTS
LOCAL STREET - NONRESIDENTIAL
SECTION LOOKING NORTH OR WEST
SCALE: N.T.S.

SEWER SERVICE
ELECTRIC CABLE
(DEPTH = 36"-48")
TELEPHONE & T.V. CABLE
IN SAME DITCH - 12" ABOVE
ELECTRIC CABLE.

STORM SEWER

WATER SERVICE

GAS MAIN
(DEPTH = 24"-48")

WATER MAIN
(4' MIN. COVER)

FIRE HYDRANT

SIDEWALK

LOCAL STREET - NONRESIDENTIAL
SECTION LOOKING NORTH OR WEST
SCALE: N.T.S.

SCALE: NONE
DATE: MAR 1994
SHEET: 3

DESIGN STANDARDS
UTILITY ASSIGNMENTS

TOWN OF SUNNYVALE
DALLAS COUNTY, TEXAS
RESIDENTIAL LOT

NOTE:
TELEPHONE AND T.V. CABLE PEDESTALS,
WHEN LOCATED IN THE STREET, SHALL BE
PLACED AT THE SAME LOT LINE.

TYPICAL UTILITY PLAN

SCALE: NONE
DATE: MAR 1994

DESIGN STANDARDS

UTILITY ASSIGNMENTS

TOWN OF SUNNYVALE
DALLAS COUNTY, TEXAS
APPENDIX C

GENERAL NOTES FOR CONSTRUCTION PLANS
GENERAL NOTES

1. All construction shall be in accordance with the North Central Texas Council of Governments "Standard Specifications for Public Works Construction" and the Town of Sunnyvale's addendum thereto.

2. Before beginning construction, the contractor shall prepare a construction sequence schedule. The construction schedule shall be such that there is the minimum interference with traffic along or adjacent to the project.

3. Construction may not be begun earlier than 7:00 A.M. on weekdays nor continued after dark without permission from the Town of Sunnyvale. Construction on Saturday may not be begun before 8:00 A.M. and work on Sunday is prohibited without special permission.

4. Utilities shown on the plans were taken from field surveys and information provided by the utility companies. The completeness and the accuracy of this data is not guaranteed.

The contractor is responsible for verifying the location of all underground utilities and structures and protecting them from damage during construction.

5. Work may not be backfilled or covered until it has been inspected by the Town.

6. Material testing shall be performed by an independent testing laboratory and paid for by the Contractor.

7. All excavation on the project is unclassified.

8. Temporary erosion control shall be used to minimize the spread of silt and mud from the project on to existing streets, alleys, drainageways and public and private property. Temporary erosion controls may include
straw bales, berms, dikes, swales, strips of undisturbed vegetation, check
dams and other methods as required by the Town Administrator or his representative.

9. Finished slopes on public rights-of-way and easements shall not be
steeper than 4:1. All slopes steeper than 6:1 shall be hydromulched and
maintained by the contractor until grass covers all parts of the slope.

10. The contractor shall maintain two-way traffic at all times along the
project.

11. Remove, salvage and replace all street and traffic control signs which
may be damaged by the construction of the project.

12. All trenching and excavation shall be performed in accordance with
OSHA standards.

PAVING

1. All embankment shall be compacted to 95% Standard Proctor density.

2. All streets and alleys shall be placed on lime stabilized subgrade with a
lime content of not less than 6%.

3. The minimum 28 day compressive strength of concrete street paving shall
not be less than 3600 psi and shall be air entrained. Water may not be
applied to the surface of concrete paving to improve workability.

4. All curb and gutter shall be integral with the pavement.

5. Parabolic crowns are required on all street pavement except on major
thoroughfares where straight sections are required.

6. Streets and alleys shall be constructed with provisions for sidewalk ramps
at all intersections.

DRAINAGE

1. Storm sewer pipe shall be reinforced concrete, Class III unless otherwise
noted.

2. All structural concrete shall be Class "C" (3600 psi compressive strength
at 28 days), air entrained.
3. The contractor shall install plugs in storm sewer lines or otherwise prevent mud from entering the storm sewer system during construction.

WATER AND SANITARY SEWER

1. Water mains shall be AWWA C-900 PVC Class 150 unless otherwise noted. Minimum cover for waterlines is 48" or as required to clear existing utilities, whichever is greater.

2. Marking tape shall be installed over PVC water lines.

3. Fittings for PVC water lines shall be ductile iron and be encased in a polyethylene sheath.

4. Valves shall be resilient seat gate valves.

5. All direct burial valves shall be provided with cast iron valve boxes with PVC stacks. Valve stacks shall be vertical and concentric with the valve stem. Stainless steel valve extensions are required on all valves where the operating nut is greater than 4 feet below finished grade.

6. Fire hydrants shall be field painted per Town of Sunnyvale specifications.

7. All exposed bolting on any buried equipment or material shall be stainless steel. Included are:
   a. Bonnet and stuffing box bolts on valves.
   b. Shoe bolts on fire hydrants.
   c. Flange bolts.

"Cor-ten" mechanical joint "T" bolts are acceptable for direct burial service.

8. Meter boxes shall be as approved by the Town of Sunnyvale. Contact the Town Engineer for specifications.

9. Sanitary sewer mains shall be DR 35 PVC.

10. The contractor shall install and maintain water tight plugs in all connections to the Town’s sanitary sewer system until the project is accepted by the Town.

11. All sanitary sewer lines and manholes shall be leak tested before the project is accepted. Deflection testing of PVC sewer lines is required.
APPENDIX D

STANDARD OWNER'S DEDICATION
All applicable portions of the following certificate shall be placed on all final plats:

NOW, THEREFORE, KNOW ALL MEN BY THESE PRESENTS:

THAT ________________________________, acting herein and through its duly authorized officers, does hereby adopt this plat designating the hereinabove described property as ________________________________, an addition to the Town of Sunnyvale, Texas, and does hereby dedicate to the public use forever the streets and alleys thereon; and does hereby dedicate the easement strips shown on the plat for mutual use and accommodation of all public utilities desiring to use, or using same. No buildings, fences, trees, shrubs, or other improvements shall be constructed or place upon, over, or across the easement strips on said plat. Any public utility shall have the right to remove and keep removed all or part of any buildings, fences, trees, shrubs, or other improvements, or growths, which in any way endanger or interfere with the construction, maintenance, or efficiency of its respective system on any of these easement strips, and any public utility shall at all times have the right of ingress or egress to and from and upon any of said easements for the purpose of constructing, reconstructing, inspecting, patrolling, maintaining, and adding to or removing all or part of its respective system without the necessity at any time of procuring the permission of anyone.

Witness my hand this ________day of ________________, 19__.  

______________________________  
Owner’s signature

All signatures shall be notorized.
APPENDIX E
ADDENDUM TO NCTCOG STANDARD SPECIFICATIONS
This addendum to the North Central Texas Council of Governments Standard Specifications for Public Works Construction, as amended, sets forth (by reference number) exceptions or requirements of the Town of Sunnyvale and thereby takes precedence over any conditions or requirements of the Standard Specifications with which it is in conflict.

1.0 The term "OWNER" shall refer to the Town of Sunnyvale. The term "OWNER'S Representative" shall refer to the Town's Engineer or other duly authorized assistant, agent, engineer, inspector, or superintendent acting within the scope of the particular duties instructed to him.

1.21.1(e) MAINTENANCE BONDS

The Contractor shall furnish the Town of Sunnyvale with a Maintenance Bond from an approved surety company which protects the Town against defective workmanship and materials for a period of two (2) years from the date of the final acceptance by the Town. Where defective workmanship and/or materials are discovered requiring repairs to be made under this guarantee, all such repair work shall be done by the Contractor at his own expense within five (5) days after written notice of such defect has been given to him by the Town. Should the Contractor fail to repair leaks or correct such defective workmanship and/or materials within five (5) days after being notified, the Town may make the necessary repairs and charge the Contractor with the actual cost of all labor and materials required.

The Maintenance Bond shall be in the amount of one hundred percent (100%) of the amount of the Contract. The Contractor shall execute the Maintenance Bond on the forms furnished by the Town.

1.35 Insert the following between the third and fourth paragraphs:

Neither such usage, as performed under this section nor the written statement of work still to be done shall be held in any way as an acceptance of said work or structure or any part thereof or as a waiver of any of the provisions of the specifications or the contract pending
final completion and acceptance of the work. All necessary repairs and removal of any section of the work so put into use, due to the defective materials or workmanship or due to operations of the Contractor, shall be performed by the Contractor at his own expense.

1.42.3 Add the following:

    Testing of all materials shall be performed by an independent testing laboratory acceptable to the Town. The Contractor shall pay the cost of all material testing including the retesting of all materials which fail the required tests. Test reports of all materials tested shall be sent to the Town.

1.64 MEASUREMENT AND PAYMENT

Only those items in the Proposal will be measured and paid for. All other items of work required to complete the project shall be considered subsidiary to the pay items in the proposal and no claims whatsoever for extra work for such subsidiary items will be considered.

1.65 RECORD DRAWINGS

The Contractor shall furnish two (2) sets of prints and one milar reproducible drawings marked with the location of all water and sewer services, electrical cables and any changes in the plans to the Town of Sunnyvale.

2.1.1(c)(4) Add the following after the first paragraph:

    No more than 40% difference shall be retained between any two consecutive sieves.

2.10.1(b) Add the following:

    All supplied extra material to make systems operational must be shown on "As-built" drawings with copies provided to the Town.

2.12.2 The following materials may be used only with special permission by the Town:

<table>
<thead>
<tr>
<th>Section</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.12.7</td>
<td>Gray Cast Iron Pipe and Fittings</td>
</tr>
<tr>
<td>2.12.12</td>
<td>ABS Truss Pipe for Sanitary Sewers</td>
</tr>
</tbody>
</table>

E-2
2.12.5(c)(1) Bolts for flanges shall be Type 316 stainless steel.

2.12.5(c)(2) Mortar for Joints

a. Inside of joint - one part portland cement and two parts washed sand. Add only enough water to form a zero slump mixture. Mix in a mechanical mixer to a uniform consistency.

b. Outside of joint - one part portland cement and two parts washed sand. Add enough water to make the mixture flowable. Mix in a mechanical mixer to a uniform consistency.

2.12.5(c)(3) Dielectric Bushings, Sleeves and Washers

a. The dielectric bushings and sleeves shall be made from a nylon molding compound or a nylon-base, Grade N-1, laminated thermosetting material. Washers shall be made from linen or fiber reinforced thermosetting plastics.

b. The insulation for each bolt in the bolt circle shall be 1/32" thick and shall be in length equal to the thickness of the two steel flanges and the 1/8" thick insulating gasket. They shall fit the bolts snugly.

c. The insulating fiber reinforced plastic washer shall be of the same diameter as the steel washers furnished with the bolt set and shall be 3/32" thick.

2.12.5(c)(4) Apply mortar support rings on at least ten (10') foot centers on all pipe to be placed in encasement pipe to prevent the pipe from resting on the bells.

2.12.5(g)(2) Design Criteria - Prestressed Concrete Cylinder Pressure Pipe

The pipe manufacturer shall design the pipe to withstand the design pressure and support the trench loads with the embedment type (including the bedding angle) shown on the plans. All design shall be performed according to the Applicable Standards and according to generally accepted engineering procedures. Submit design calculations.
to the Engineer for review before manufacturing pipe. The following values shall be used in designing the pipe:

a. Unit weight of soil \( w \) = 125 lb. per cu. ft.

b. Coefficient of friction between backfill and trench wall \( (K\mu' = 0.110) \)

c. Bedding angle - \( \alpha = 30^\circ \)

Unless otherwise noted, pipe shall be designed for a pressure of 150 p.s.i.

2.12.5(h)(2) Design Criteria - Pretensioned Concrete Pressure Pipe

a. The pipe manufacturer shall design the pipe to withstand the design pressure and support the trench loads with the embedment type (including the \( E' \)) shown on the plans. All design shall be performed according to the Applicable Standards and according to generally accepted engineering procedures. Submit design calculations to the Engineer for review before manufacturing pipe. The following values shall be used in designing the pipe:

(1) Unit weight of soil \( w \) = 125 lb. per cu. ft.

(2) Coefficient of friction between backfill and trench wall \( (K\mu' = 0.110) \)

(3) Modulus of soil reaction - \( E' = 100 \)

Unless otherwise noted, pipe shall be designed for a pressure of 150 p.s.i.

b. The manufacturer may use only 25% of the calculated composite moment of inertia of the pipe wall for P-303 pipe. The pipe shall be capable of supporting the trench loads with superimposed H-20 wheel load.

2.12.5(j) Add: Repair or replace pipe or fittings with the following imperfections as directed by Engineer:

a. A piece broken out of the pipe.
b. Any crack extending entirely through the barrel of the pipe or to the steel cylinder or rods.

c. Any shattering or flaking of concrete at a crack.

d. Any excessive surface cracking due to temperature conditions. The pipe supplier shall control these cracks by adequate concrete mix, curing or preservation of moisture in pipe interior during yard storage and shipment to jobsite.

2.12.7(d) Add the following:

All gray iron pipe fittings shall be sheathed in polyethylene film and tape per section 2.9.5.

2.12.7(e) Add the following:

Bolts for buried flanged ends shall be Type 316 stainless steel unless encased in mortar. Fittings sheathed in polyethylene film.

2.12.8(c) Change "Type 3" to "Type B".

2.12.8(d) All ductile iron pipe and fittings shall be sheathed with polyethylene film and tape per section 2.9.5.

2.12.8(e) Add the following:

Bolts and nuts for mechanical joint ends shall conform to ASTM Designations A 325 (A 325M) (Type B). Bolts for buried flanged ends shall be Type 316 stainless steel unless encased in mortar. Fittings shall be cement mortar coated with a seal coat in accordance with AWWA C-104 and sheathed in polyethylene film and tape per section 2.9.5.

Delete:

All references to AWWA C 153 or compact fittings. Compact ductile iron fittings may not be used.

2.12.8(i) The embedment to be used for ductile iron pipe shall be Class D+ unless otherwise specified.

2.12.19(d) Change "one-half" to "one-third of the total number".
2.12.20(b) Polyvinyl Chloride (PVC) Water Pipe. PVC pipe shall have a pressure class of 150 psi, be minimum thickness DR 18, and have cast iron outside dimensions.

2.12.20(d) Fittings shall be sheathed in polyethylene film and tape per section 2.9.5.

Change "Type 3" to "Type B".

2.12.20(g) The embedment to be used for PVC water pipe shall be Class C+ unless otherwise noted. The bolts and nuts for direct buried flanges shall be Type 316 stainless steel. Mechanical joint bolts and nuts shall conform to ASTM A325 (Type B).

2.12.25 Copper Water Service Tubing.

(1) Copper water service tubing shall be type K copper per Section 2.18.

(2) Embedment for copper water service tubing shall be Class D+ except as otherwise noted.

(3) Service fittings for copper water service tubing shall be as follows:

(a) Corporation Stops - Mueller H15000 or approved equal.

(b) Angle Stops for Single Water Services - Mueller H-14255, or approved equal.

2.12.27 Special Requirements for Water Service Taps on PVC Water Pipe

(1) Direct tapping of PVC pipe will not be permitted.

(2) Taps may be made on PVC pipe using the following devices at the Contractor’s option.

(a) Service Saddles - Clow Twin Seal brass saddle or Mueller Series 16100 double strap bronze. Any other service saddle must be submitted to the Engineer for approval before installing.

(b) Main Line Fitting - Taps may be made in a mechanical joint plug installed in the branch of a tee.
(3) All Water Services shall be marked on the end of services with a blue plastic tape with the word "Water" stamped thereon.

(4) After the completion of paving, all water deadheads shall have a meter box installed by the Contractor. The type of meter box shall be approved by the Town.

2.13 The following valves types shall be used unless special permission is given to do otherwise:

- 2.13.1 Gate Valves (AWWA C 500) 14" through 48"
- 2.13.2 Air Valves
- 2.13.3 Brass Wheel Valves 3" and smaller
- 2.13.4 Butterfly Valves 16" and larger
- 2.13.5 Resilient Seat Gate Valves (AWWA C 509) 4" through 12"

2.13.1(b) Bonnet bolts shall be Type 316 Stainless Steel.

2.13.1(i)(3) Stuffing box bolts and nuts shall be Type 316 Stainless Steel.

2.13.1(o) Add: "Valves shall be sheathed in polyethylene film and tape per section 2.9.5."

2.13.1(r)(2) Change third paragraph to read "Steel sleeves shall be restricted to use on pipe sizes 20" and larger and subject to the following additional specifications:"

2.13.4(a)(7) Delete split-V packing.

2.13.4(a)(8) Discs shall be epoxy coated.

2.13.4(a)(10) The interior of the valve shall be epoxy coated.

2.13.4(a)(11) Valves shall be Class 150-B unless otherwise noted.

2.13.4(c) Unless otherwise noted, valves for direct burial service shall have mechanical joint ends and exposed valves shall have flanged ends.

2.13.4(c)(4) Change "Type 3" to "Type B".

2.13.4(d)(1)(A) Add:
(3) Operator shall be located on the side of the valve, suitable for buried service.

(4) Manufacturing Experience - Five (5) years minimum manufacturing experience is required.

2.13.4(d)(1)(D) Add: Operator shaft extensions are required and shall be stainless steel. Shafts shall be of sufficient length to bring operating nut to within 2" of the bottom of the valve cover.

2.13.4(h) Valves and operators shall be sheathed in polyethylene film and tape per section 2.9.5.

2.13.5 Resilient Seat Gate Valves

(1) General Description - All gates valves 4" through 12" NPS shall conform to the AWWA standard for Resilient Seated Gate Valves, 3 through 12 NPS, of Water and Sewage Systems, AWWA Standard C509, except for changes or specified alternatives as detailed in this section of these specifications or as shown on the plans or in the contract specifications.

All valves 4" through 12" shall be iron body, non-rising stem, resilient-seated gate valves.

(2) Stuffing Box Bolting and Nuts shall conform to AWWA Standard C509 with the following exceptions: Stuffing box bolts and nuts shall be Type 316 Stainless Steel.

(3) Drawings - The manufacturer shall have on file with the Town for approval a detail drawing of each type and size of valve to be furnished under these specifications. Offerings having exceptions or modifications to these specifications must be accompanied by new detailed drawings and statement of changes effected. Failure to meet these requirements shall be sufficient cause for rejection.

(4) Ends - Valves shall have flanged, push-on, or mechanical-joint ends, or any combination of these as may be specified. Bolts for mechanical joint ends shall meet ASTM A-325M (Type B). Bolts for direct buried flanges shall be Type 316 Stainless Steel.
(5) Bonnet Bolts and Nuts shall conform to AWWA Standard C509 with the following exception. All Bonnet bolts and nuts shall be Type 316 Stainless Steel.

(6) Stuffing Boxes - Stuffing Boxes shall conform to AWWA Standard C509 with the following exceptions. A minimum of two (2) O-rings shall be used in stuffing box. Packing shall not be used.

(7) Hand Wheels and Operating Nuts - All valves 2" (5.1 cm) in diameter and above shall be nut operated unless otherwise shown or specified. All operating nuts shall be ductile iron or cast iron. Handwheels shall be furnished only when called for on plans or in the contract specifications. All valves shall open by turning counterclockwise.

(8) Tests - All valves shall be tested by the manufacturer in accordance with AWWA Standard C500. Any leaking at the test pressure through any casting or between the bronze ring and the cast iron body shall cause the said casting to be rejected. No plugging or patching to stop any leakage shall be allowed.

(9) Inspection and Rejection - When requested by the Town, the Contractor shall furnish test coupons on each heat of ferrous or nonferrous metal going into the valves. Such specimen shall be furnished upon sworn affidavit by the manufacture. When requested at any time, notarized reports of physical tests performed on material used in the manufacture of valves furnished hereunder shall be provided. Such reports or coupons furnished shall be identified by purchase order or contract. The material shall also be identified as to location within the valve and specification or composition. Valves may be rejected for failure to comply with all of the requirements of this specifications.

(10) Valve Seats - Resilient seats shall be applied to the gate. The seating surface in the body of the valve shall be machined and shall be metallic. Resilient seats shall be secured to the gate mechanically by stainless steel screws.
(11) Valves shall be sheathed in polyethylene film and tape per section 2.9.5.

(12) Valves shall be Mueller.

2.14.1 Fire hydrants shall be Mueller Centurion.

2.14.2(a) Scissor type main valves are not acceptable.

2.14.2(b) All accessories for mechanical joint hub shall be attached to foot when shipped. All mechanical joint gland bolts and all bolts located below finished grade, shall be high strength, low alloy, corrosion resistant steel, and shall conform to ASTM Designation A 325, Type B. or type 316 stainless steel

2.14.2(c) All hydrants shall be equipped with:


2.14.2(h) Two or more non corrosive outlets for drainage shall be provided in the base or barrel or between the base and barrel of the hydrant. The outlet shall be an integral part of the drain valve. Drain rods independent of the main stem shall not be accepted.

2.14.2(i) Direction to open shall be counter-clockwise.

2.14.2(k) The operation nozzle cap nuts shall be 1-1/2 in. point to face at base and 1-1/4 in. point to face at top. A weathercap or shield shall be furnished to protect the opening between the operating nut and the top of the bonnet.

2.14.4 Replace paragraph 2.14.4 with the following:

Breakable type hydrants shall be furnished.

(a) Definition

A breakable type hydrant is one that will break at the design point and is repaired by replacing the stem coupling and bolting the head back on to the standpipe. The whole repair shall not require any excavation or any work on the seat valve.
(b) Standpipe

Breakable parts of standpipe shall be located at the base of the head assembly. These parts shall be of the breakable flange type, or integral flange with sawed bolts or breakable nuts. Breakable flanges screwed to the standpipe will not be accepted. Flanges shall be designed so that an end wrench can be used on the nuts and bolts. Two piece standpipes are not permitted.

(c) Stem

Provision shall be made in the design of the stem to disconnect the stem from the hydrant parts above the standpipe break point.

Provision shall be made for an automatic travel stop to prevent the hydrant from being opened. Travel stop may be in the form of a stop-nut or a positive stop against the base of the hydrant shoe.

(d) Breakable or Sleeve Type Couplings

If breakable or sleeve type couplings are used they shall have sufficient torsional strength such that the torsional failure of the stem will occur at some point other than at the coupling. Design of the coupling shall be such that when the coupling is broken no parts will come loose and fall into the hydrant barrel, and the break will not occur through the pins or bolts holding the coupling to the stem.

(e) Blocking Requirements

The foot of the hydrant shall be designed with surfaces for placement of temporary thrust blocking and weight support. The area provided for temporary thrust blocking shall be opposite the center line of the inlet waterway.

2.14.5 Main valve seats shall be of such design that incorrect positioning is impossible and that the threads will be adequately guided into position. Arrangements shall also be made to hold the main valve gasket in place during assembly. The main valve shall be made of
bronze and threaded into a bronze retainer ring or it may be threaded into a heavy bronze bushing in the hydrant base.

2.14.8

Any flanges shall have a minimum thickness of 7/8 in. (2.2 cm). Bolt hole edge distance shall be sufficient to provide full support for the bolt head and nut.

2.14.9

Operating stems whose threads are located in the barrel or waterway shall be of Manganese bronze, Everdur, or other high quality non-corrodible metal, and all working parts in water way shall be bronze to bronze. Operating stems whose threads are not located in the barrel or water way may be made of high grade bronze or steel, and stem nuts shall be bronze. Steel stems shall have bronze, stainless steel, or other non-corrodible metal sleeve where passing through O-rings. Operating threads must be sealed against contact with the water at all times regardless of open or closed position of the main valve.

2.14.11

All hydrants shall be capable of being extended to accommodate future grade changes without excavation. Hydrants shall have breakable type stem couplings installed at the ground line flange. Extension of this type hydrant shall be made by adding at the ground line flange, a new coupling and stem section equal to the length of the extension. Stem extensions made by adding new section of stem to the threaded section of the stem at the top of the hydrant will not be accepted.

2.14.17

A copy of an independent certified testing laboratory test results shall be submitted regarding the flow data from hydraulic tests for head loss through the hydrant.

2.14.20

Hydrants closing against the flow or with the flow must have any stem threads protected against contact with the water. This protection can be in the form of cap nuts or lower valve washers. Cap nuts shall be locked in place to prevent loosening by normal operation of the fire hydrant.

If cap nuts are provided, they can be made of either bronze or ductile iron. If ductile iron cap nuts are used, a gasket must be provided to prevent seepage of water from contacting stem threads.

2.14.21

Nozzle outlets shall not be of the lead-in type. Nozzles shall be screw-in or breach lock type and safeguarded against blowing out. A pin or
other approved method shall be employed to prevent the outlet nozzle from turning or backing out.

2.16.3 Add the following at the end of the second paragraph: "Valve must have a positive stop to prevent damage to brass ball over opening."

In the sixth paragraph change "streamline" to "solder."
In the seventh paragraph change "streamline" to "solder."

2.19.2 Joints shall have trapped O-ring rubber gaskets in accordance with Item 2.12.4(c).

2.19.6 Exfiltration and Infiltration

Each manhole shall be tested either individually or with an associated sewer line. If manholes are tested individually, they may be tested by either infiltration or exfiltration. The maximum allowable leakage is 0.1 gallons per hour per foot of height.

2.20 Fiberglass manholes may be used only with special permission of the Town.

3.7.3 Add the following:

Density tests shall be performed by an independent testing laboratory and paid for by the Contractor. One density test shall be performed for each 1000 C.Y. of embankment at a location selected by the Town. The Town may perform additional density tests at his expense. Density tests which fail shall be retested at the Contractor's expense. The minimum density for embankments subjected to vehicular traffic is 95% at 0 to 2% above optimum moisture in accordance with method Tex 113 E.

4.6.1 Unless otherwise noted, lime treatment applied to pavement subgrade shall be at a rate of not less than 6% of the subgrade dry weight.

4.6.4(b)(1) Dry placing of lime is allowed only with special permission of the Town.

4.6.4(c)(1) Add the following:

One gradation test shall be performed for each 300 linear feet of pavement which receives lime treatment. The gradation test
shall be performed by an independent testing laboratory. The Town shall select the location of each test. The cost of testing shall be borne by the Contractor.

4.6.4(d) Add the following:

One density test shall be performed for each 300 linear feet of pavement. The density test shall be performed by an independent testing laboratory. The Town shall select the location of each test. The cost of testing shall be borne by the Contractor.

4.7 Portland cement treatment of base and subgrade may be used only with special permission of the Town.

4.8 Asphalt treatment of subbase may be used only with special permission of the Town.

5.8.2(e)(1) Expansion joints shall be spaced at not greater than 600 foot centers. Expansion joints are required across the entire pavement width on all sides of an intersection.

5.8.2(e)(2) Construction joints (sawed dummy joints) shall be spaced both transversely and longitudinally on 20 foot centers. Longitudinal joints are not required on 20 foot wide pavement.

5.8.2(g)(2) Add the following:

When the temperature of the air is above 85° F., an approved retarding admixture shall be used in the concrete mix.

5.8.2(n) A stamp or die shall be used to mark on the face of the curb or edge of pavement, the location of all of the following facilities:

<table>
<thead>
<tr>
<th>Facility</th>
<th>Marking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Valve</td>
<td>V</td>
</tr>
<tr>
<td>Water Service</td>
<td>W</td>
</tr>
<tr>
<td>San. Sewer Service</td>
<td>S</td>
</tr>
</tbody>
</table>

For water valves, the bottom of the "V" shall point in the direction of the valve. The stamp or die shall be approved by the Town.
5.8.6(a) Testing of concrete pavement strengths shall be performed by an independent testing laboratory acceptable to the Town and paid for by the Contractor. The Contractor shall furnish all materials, equipment and labor required to perform all concrete tests including but not limited to slump, air content and concrete test beams.

5.8.6(c) Minimum pavement compressive strength shall be 3600 psi at 28 days for all streets, curbs, gutters and alleys unless otherwise noted. Air content shall be 3-5%.

6.1.11 Add: The Owner will pay for ninety (90%) per cent of the actual quantity of pipe which has been installed and backfilled until such time that the right-of-way is finish graded, and cleaned up. Such payment for pipe installed is additionally subject to the project retainage.

6.1.12 Add the following:

    All construction water shall be furnished at standard commercial rates by the Town from the nearest convenient Town main. A water meter shall be used to determine the amount of water used. The Contractor may rent water meters from the Town or furnish his own meters at the choice of the Town. If Town water is unavailable, Contractor shall be responsible for purchasing water from a local supplier or another city. The Town reserves the right to designate the time of day in which water can be withdrawn from Town mains.

6.2.6 Where pipelines and conduits are placed in existing lawns or landscaped areas, remove and replace topsoil sod and other plants and guarantee the survival of all plants so replaced.

6.2.8(d) Removal and separation of topsoil is required unless otherwise noted. Finished grade shall be ± 0.1 feet of original grade unless otherwise noted. The Contractor is responsible for removing and disposing of all excess excavated materials. Such materials may not be left on public right-of-way or adjacent property without written permission to do so.

6.2.8(f) EXCAVATIONS, TRENCHING AND SHORING

    All trenches excavated within the Town Limits of Sunnyvale, Texas shall be excavated in accordance with OSHA standards.
TRENCH SAFETY

(1) After award, the Contractor shall submit to the Owner five (5) sets of a trench excavation plan. This excavation plan must be designed and sealed by a professional engineer registered in the State of Texas with professional experience in Soil Mechanics.

(2) The Contractor is responsible for obtaining borings and soil analysis as required for plan design. The trench excavation plan shall be designed in conformance with OSHA standards and regulations.

(3) No trenching in excess of 5 feet below existing grade will be allowed until this plan is reviewed. Any changes in the trench excavation plan after initiation of construction will not be cause for extension of time or change order and will require the same review process. The Contractor accepts sole responsibility for compliance with all applicable safety requirements.

(4) The review is only for general conformance with OSHA safety standards and review of the trench excavation plan does not relieve the Contractor of any or all construction means, methods, techniques and procedures. Any property damage or bodily injury (including death) that arises from use of the trench excavation plan, from Contractor's negligence in performance of contract work, or from Town's failure to note exceptions to the excavation plan shall remain the sole responsibility and liability of the Contractor.

Add: The Contractor shall guarantee the backfilling of excavation and trenches against excessive (as determined by the Engineer) settlement for a period of one year after the final completion of the contract under which the work is performed. Make all repairs or replacements necessary by settlement including refilling and compacting the upper portion of the ditch and repairing broken or settled pavements within thirty (30) days after notice from the Engineer or Town.

Add: Excavations within five (5') of pavement shall be considered to be influenced by vehicular traffic.

The moisture content shall be 2-4% above optimum moisture.

Density tests shall be performed by an independent testing laboratory and paid for by the Contractor. One density test shall be performed
for each 250 L.F. of backfill placed at a location selected by the Town. The Town may perform additional density tests at their expense. Density tests which fail shall be retested at the Contractor's expense.

6.2.9(c)(15) Change "select material" to "granular material".

6.4.3(b) The maximum vertical deviation from the plan grade for sanitary sewer lines shall be 1/2 inch per 10 feet. Reverse grades will not be permitted.

6.4.3(d) In the first sentence of the seventh paragraph - after "tunnel lining shall be" add "backfilled with Class B concrete or grouted per ASTM C476. No concrete or grout shall be".

6.5.1(b)(1)&(2) Delete both paragraphs.

6.5.2(c) Add: "(c)(1) Measurement of Reinforced Concrete Pavement."

Replacement of the reinforced concrete pavement shall be measured at the specified trench width plus 2 feet, thickness in inches and length in linear feet. Additional reinforced concrete pavement ordered by the Town to be placed will be measured as the thickness in inches; and length and width in linear feet.

6.5.3 Add: "If the limiting ditch width occurs within 3 feet of an expansion joint, construction joint, or dummy joint, the Town may order the pavement removed and replace to the existing joint."

Replacement of the reinforced concrete pavement shall be the thickness measured in inches, specified ditch width plus two feet, and the length measured in linear feet.

Additional reinforced concrete pavement ordered by the Town to be placed will be measured as the thickness in inches, and the length and width in linear feet.

6.7.1(c) Pipe must be swabbed clean prior to placing in the ditch.

6.7.2(c) Visual inspection of sanitary sewers is required. The contractor shall furnish one copy of the video tape of the sewer inspection in VHS format to the Town.
Add the following:

The rate of infiltration or exfiltration for manhole testing shall not exceed one tenth of a gallon per hour per foot of height.

Deflection testing shall be performed not sooner than 30 days from date the backfill is completed.

Fiberglass manholes may be used only with special permission of the Town. Brick manholes shall not be used.

Throughout this section, change "Type 'F'" to read "Class 'F' with limestone course aggregate and silica sand."

Add the following:

Wall thickness will be as follows:

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Wall Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>48&quot;</td>
<td>5&quot;</td>
</tr>
<tr>
<td>60&quot;</td>
<td>6&quot;</td>
</tr>
<tr>
<td>72&quot;</td>
<td>7&quot;</td>
</tr>
</tbody>
</table>

Tongue and groove with premolded joint sealing compound will not be permitted.

Polyethylene wrap meeting 2.9.5 is required for all cast iron and ductile iron pipe, fittings and valves.

Add: Installation of Concrete Pressure Pipe

(1) Pipe Laying

a) Install pipe and fittings at the locations shown on the plans. Lay pipe to the grade shown on the shop drawings which have been reviewed by the Engineer and released for construction. The Contractor shall establish the grade in the trench from grade stakes set by the Engineer. Use a string line or laser set on the centerline of the ditch to establish trench and pipe grades.

b) Minor deflections in the line may be made by unsymmetrical closure of pipe joints; however, the maximum
pull shall be 3/4" for sizes twelve (12") inch through twenty-one (21") inch and one (1") inch for sizes twenty-four (24") inch through forty-eight (48") inch. Beyond these limits use short pipe sections, beveled joints or angle adaptor to make necessary line and grade changes.

c) Lay pipe and fittings on specified bedding so as to be uniformly supported along its entire length. No "blocking up" of pipe or joints will be permitted. Provide bell holes to allow making the exterior joint.

d) Keep the pipe clean during the laying operation and free of all sticks, dirt and trash, and at the close of each working day, seal the open end of the pipe against the entrance of all objects, especially water.

(2) Pipe Jointing

a) After the subgrade and embedment materials have been placed and the length of pipe has been placed in the trench, true to line and grade, thoroughly clean the bell and spigot by brushing and wiping.

b) Lubricate the rubber gasket and the inside surface of the bell with a lubricant approved by the pipe manufacturer. Snap the rubber gasket into the spigot ring groove to equalize circumferential distribution of the gasket. For pipe 18" and smaller, butter the end bell with mortar such that when the joint is made up, the mortar will completely fill the recess in the inside surface of the pipe at the joint. After the joint is engaged, clean the inside of the joint with a swab. Mortar the inside of joints of pipe eighteen (18") inches and larger by applying mortar to the annular space by hand after the joint is made up and hand troweling the mortar smooth.

c) Force the spigot into the bell by use of a choke chain or chain and ratcheting hoist. Do not use a backhoe or other excavating machinery to force the spigot into the bell. After the spigot is forced into the bell of the adjacent pipe, the inside recess between the ends of the pipe shall have a maximum opening of 1" and a minimum opening of 1/4".
d) Mortar the exterior surface of the joint by placing a joint wrapper around the pipe, using a band crimping tool. The joint wrapper shall be seven (7") inches minimum width and be hemmed on each side with steel bands. It shall encircle the pipe, leaving an opening at the top to allow placing mortar. Joint wrappers shall be the type and quality recommended by the pipe manufacturer.

e) Pour liquid grout in the top of the joint wrapper in a continuous operation until the grout is completely around the pipe. During the filling of the wrapper, rod the mortar to eliminate voids.

f) Apply a one (1") inch coating of portland cement mortar on all exposed steel on fittings or specials. Allow the coating to take an initial set. Wrap the mortar coating in steel wire mesh and apply a second one (1") coating of mortar. Immediately after the mortar has set, cover the mortar with damp earth or burlap to prevent rapid moisture loss.

(3) Cutting of Pipe

Field cutting of pipe will not be permitted except with special permission of the Engineer.

(4) Reaction Blocking and Anchorage

a) Block, anchor or harness all piping subject to internal pressure to preclude separation of joints. Provide suitable reaction blocking, anchors, harnesses or other acceptable means for preventing movement of pipe caused by internal pressure for all unlugged bell and spigot or all-bell tees, Y-branches, bends deflecting 11-1/4 degrees or more, and plugs.

b) Extend 2000 psi concrete blocking from the fitting to solid undisturbed earth and install so that all joints are accessible for repair. The bearing area shall be as shown on the plans.

c) If adequate support against undisturbed ground cannot be obtained, install metal harness, anchorages consisting of stainless steel rods, bolts and washers across the joint
and securely anchor to pipe and fitting or install other adequate anchorage facilities to provide necessary support. Should the lack of a solid vertical excavation face be due to improper trench excavation, the entire cost of furnishing and installing metal harness anchorages shall be borne by the Contractor. Welding of joints will not be permitted without special permission of the Engineer.

d) Protect from corrosion all steel clamps, rods, bolts and other metal accessories used in reaction anchorages or joint harnesses subject to submergence or in direct contact with earth and not encased in concrete with two inches of wire reinforced field applied mortar cured with wet burlap bags.

(5) Insulation of Dissimilar Metals

Furnish and install dielectric bushings, sleeves and washers between concrete steel cylinder pipe and cast iron pipe, ductile iron pipe or any dissimilar metal. Also furnish dielectric bushings, sleeves and washers on all blind flanges.

6.7.3(g) Underground marking tape shall be installed 6"-12" above the top of all PVC water pipe. Marking tape shall consist of a 0.5 inch thick layer of aluminum foil bonded between two pieces of polyethylene film. The total thickness of the marking tape shall be not less than 5.5 mils thick nor less than 2 inches wide. Marking tape shall be blue in color and have the wording "Caution Water Line Buried Below" displayed prominently and continuously along the tape. The ends of the marking tape shall be brought up inside each main line valve box.

6.7.3(i)(2) Add the following:

Taps and blow-offs for testing and disinfection purposes on all contracts will be installed by the Contractor, at locations specified by the Town, and shall not be paid for separately but shall be included in the appropriate bid item.

Upon completion of the testing and purification the Contractor shall return to the job site and remove the blow-off down to the corporation stop. He shall leave the corporation stop and backfill, replacing all pavement. Removal of blow-off shall
include all labor, materials, tools, equipment and incidentals necessary to complete the work, including excavation, disposal of surplus materials and backfill and shall not be paid for separately but shall be included in the appropriate bid item.

6.7.3(j)(1)(A)(2) Add the following:

The two sections or halves type saddle may only be used on PVC pipe. Single strap clamps will not be permitted on any type pipe.

6.7.3(j)(1)(B) Only soft copper (Type K) tubing will be allowed and a curb stop will be required in lieu of a brass gate valve.

6.7.3(j)(2) Direct tapping of cast iron and ductile iron pipe will be 3/4" and 1" only.

6.7.3(k)(2) Add: All valve stacks shall be of cast iron pipe or PVC pressure pipe and of one continuous piece to the finished grade. Furnish and install stainless steel valve operator extensions when operating nut is more than four (4') feet below finished grade.

6.7.3(m)(2) Fire hydrants shall be braced and blocked on concrete slab or stone slab not less than 4" thick unless in sound rock trench.

Above grade, fire hydrants shall be painted as follows:

a) Clean all surfaces to receive paint to remove all dirt, oil and other contaminants.

b) Apply one 5 mil dry film thickness coating of epoxy mastic equal to Carboline 801 or Sherwin Williams B58.

c) Apply two 1.5 mil dry film thickness coats of aliphatic urethane equal to Carboline 134 or Sherwin Williams B65.

d) Color of the urethane coatings for the barrel of the hydrant shall be white.

e) Color of the urethane coatings for the bonnet of the hydrant shall be based on the largest size line within 75 feet horizontally from the hydrant according to the following table:
f) All colors except grey shall be safety colors per ANSI Z53.1. Grey color shall be per ANSI Z55.1

A Blue Stimsonite, Fire-Lite reflector (or approved equal) shall be placed in the center of the street opposite fire hydrants.

6.7.3(m)(3) Blocking shall be included in payment for fire hydrants and shall not be paid separately.

6.7.3(o)(1) Bullheads and services 1" and smaller in diameter up to fifty (50') feet (15 meters) in length shall be installed with one continuous piece of water service tubing with no splices, couplings, etc.

6.7.3(r)(2) Blocking will not be measured and paid for as a separate pay item but is subsidiary to water conduit installation.

6.7.3(s) The Contractor shall furnish all labor, materials and equipment to purge, disinfect and test the completed waterline. Bacteriological test samples shall be collected and tested by an independent testing laboratory approved by the Town. The cost of testing shall be borne by the Contractor.

6.7.3(t)(2) Tongue and groove pipe with pre-molded joint sealing compound will not be allowed for manholes.

7.1.3(b) Add the following:

2000 psi concrete will be used in inaccessible locations when a mechanical device cannot compact to required densities and as directed by the Town, i.e.: under pipes, road washouts, under paving, etc.

Backfill shall be placed and compacted in not greater than 6" layers. The minimum backfill density shall be 95% at 2 to 4% above optimum moisture for all backfill subject to vehicular traffic. All other backfill shall be placed at a density equal to adjacent, undisturbed soil. Backfill density tests shall be
determined in accordance with ASTM D698 by an independent testing laboratory selected by the Contractor and acceptable to the Town. The Contractor shall pay for all costs of testing backfill densities. One density test shall be performed at each location for each 500 C.Y. of backfill placed. The location of the backfill test shall be selected by the Town. The Town may perform additional backfill density tests at its expense. The Density tests which fail shall be retested at the Contractor's expense.

7.4.5 All structural concrete shall be Class C.

7.4.5(b) Add the following:

Testing of structural concrete strength shall be performed by an independent testing laboratory acceptable to the Town and paid for by the Contractor. The Contractor shall furnish all materials, equipment and labor required to perform all concrete tests including but not limited to slump, air content and concrete test beams or cylinders.

7.6.10(a) Add the following to the first paragraph:

No water or dry cement shall be added to surface of concrete for finishing.

7.9.1 Pneumatically Placed Concrete may be used only where specifically called for on the plans or where special permission has been obtained from the Town.

8.3.1 All concrete for sidewalks and driveways approaches shall be Class A with an air content of 3-5%.

8.3.2(b) Reinforcement is required in all driveways and walks.

8.4.1 All concrete for medians shall be Class A with an air content of 3-5%.

8.5.1 All concrete for headers shall be Class A with an air content of 3-5%.

8.6.1 All concrete for concrete steps shall be Class A with an air content of 3-5%.

8.7.1 All concrete for retaining walls shall be Class C.
8.10.3 Delete the entire fifth paragraph beginning with "Unless otherwise specified.....".

8.13.3(a) Delete the last sentence in the paragraph and replace with:

The Contractor shall locate the position of work according to plans.

8.15.4 Measurement of rip-rap will be based on specified trench width plus 2 feet. In the event of excessive excavation, the Contractor will be required to rip-rap the entire excavation plus 1 foot on both sides at his expense.

OTHER PROVISIONS:

1. Measurement and Payment

Only those items in the Proposal will be measured and paid for. All other items of work required to complete the project shall be considered subsidiary to the pay items in the proposal and no claims whatsoever for extra work for such subsidiary items will be considered.

2. Record Drawings

The Contractor shall furnish two (2) sets of prints of the drawings marked with the location of all water and sewer services, electrical cables and any changes in the plans to the Engineer.

3. Concrete Class

Unless otherwise noted or specified, concrete shall be Class C.

4. Street Lights

Street light poles shall be Type RTAZB as manufactured by Trimble House, Pinckneyville, Georgia. Pole height shall be 20 feet nominal. Poles shall be furnished with ¾" x 30" hot dipped galvanized steel anchor bolts.

Light fixture shall be Trimble House No. 415 with CR-1 arm. Light fixture shall be 150 watt high pressure sodium.
5. Street Signs

All street signs and hardware shall be purchased from the Town of Sunnyvale. Signs shall be mounted on 2" nominal diameter Schedule 40 hot dipped galvanized steel pipe posts. Post lengths shall be 12'-0" for street identification signs and be 10'-0" long for traffic control signs.

6. Pavement Striping

Pavement markings and striping shall be hot applied thermoplastic road striping compound equal to Cata-Therm as manufactured by Cataphote, Inc., Jackson, Mississippi. Striping compound shall be placed on a clean substrate in strict accordance with the manufacturer’s recommendations. Reflective glass beads shall be applied to the fluid compound. Glass beads shall meet TxDOT specifications regarding material and application.
APPENDIX F

CONSTRUCTION DETAILS
PAVING SECTIONS
LOCAL STREET - RESIDENTIAL

SCALE: NONE
DATE: MAR 1994
SHEET: 1

DESIGN STANDARDS

TOWN OF SUNNYVALE
DALLAS COUNTY, TEXAS

TYPICAL PAVEMENT SECTIONS
NOTE:
WHERE THIS SECTION IS USED AS A COLLECTOR STREET, PAVEMENT THICKNESS SHALL BE 8" AND REINFORCING STEEL SHALL BE #4@24 EW.

COUNTRY LANE

DATE: MAR 1994

TOWN OF SUNNYVALE
DALLAS COUNTY, TEXAS
LOCAL STREET - NONRESIDENTIAL

6" CURB (SEE DETAIL)
6" PARABOLIC CROWN
6" LIME STABILIZED BASE
6"-3600 P.S.I. CONC. PAVEMENT
3:1 MAX. SLOPE

TOWN OF SUNNYVALE
DALLAS COUNTY, TEXAS
COLLECTOR

SCALE: NONE
DATE: MAR 1994
SHEET: 4

DESIGN STANDARDS
TOWN OF SUNNYVALE
DALLAS COUNTY, TEXAS

6" CURB (SEE DETAIL)
6" PARABOLIC CROWN
#4 @ 24" c/c E.W.
6" LIME STABILIZED BASE
8"-3600 P.S.I. CONC. PAVEMENT
MAJOR ARTERIAL

SCALE: NONE
DATE: MAR 1994
SHEET: 5

DESIGN STANDARDS

TOWN OF SUNNYVALE
DALLAS COUNTY, TEXAS

TYPICAL PAVEMENT SECTIONS
PARKWAY

SCALE: NONE
DATE: MAR 1994
SHEET: 6

DESIGN STANDARDS

TOWN OF SUNNYVALE
DALLAS COUNTY, TEXAS

TYPICAL PAVEMENT SECTIONS

100'-0" R.O.W.
18'-0"
24'-6"
15'-0"
24'-6"
18'-0"
14'-0"
24'-0"
7'-6"
7'-6"
24'-0"
4'-0"
SHOULDER
SWALE

5" CURB (SEE DETAIL).
SLOPE 2%
6" TYP
1'-0" TYP
#3 ø 24" c/c E.W.
8"-3600 P.S.I. CONC. PAVEMENT
6" LIME STABILIZED BASE

TYPICAL PAVEMENT SECTIONS
STANDARD 10' ALLEY SECTION

STANDARD 12' ALLEY SECTION

STANDARD 15' ALLEY SECTION
PAVING DETAILS
TYPICAL INTERSECTION JOINTING

SCALE: NONE
DATE: MAR 1994

DESIGN STANDARDS

TOWN OF SUNNYVALE
DALLAS COUNTY, TEXAS

TYPICAL PAVEMENT DETAILS
#3 BARS ON 24" CTRS. BOTH WAYS

NOTE: DOWELS AND REINFORCING BARS SHALL BE SUPPORTED BY AN APPROVED DEVICE

REDWOOD EXPANSION JOINT FILLER

DOWEL SLEEVE (CLOSED END) TO FIT DOWEL AND BE SECURED TO BE INSTALLED 2' C.-C.

TRANSVERSE EXPANSION JOINT DETAIL

NOTE: SPACE 600' O.C., LOCATE AT INTERSECTIONS

CONTRACTION JOINT DETAIL

NOTE: DOWELS AND REINFORCING BARS SHALL BE SUPPORTED BY AN APPROVED DEVICE

DOWEL SLEEVE (CLOSED END) TO FIT DOWEL AND BE SECURED TO BE INSTALLED 2' C.-C.

TOWN OF SUNNYVALE
DALLAS COUNTY, TEXAS
CONSTRUCTION JOINT DETAIL

SAWED DUMMY JOINT DETAIL

DATE: MAR 1994

DESIGN STANDARDS
TOWN OF SUNNYVALE
DALLAS COUNTY, TEXAS
INTEGRAL CURB DETAIL
CONCRETE HEADER DETAIL

#3 @ 24" O.C. - LONGITUDINAL BENT DOWN - POUR HEADER MONOLITHICALLY

ASPHALT PAVEMENT DETAIL
TO BE USED FOR TRANSITIONS TO EXISTING ASPHALT ONLY
BARRIER FREE CURB RETURN DETAIL

SCALE: NONE  DATE: MAR 1994  SHEET:

DESIGN STANDARDS

TOWN OF SUNNYVALE
DALLAS COUNTY, TEXAS

TYPICAL PAVEMENT DETAILS
NOTE:

AT MARKINGS THE CONCRETE SHALL BE CUT 1" DEEP, FOLLOWED BY GROOVING TOOL. STRENGTH SHALL BE 2500 p.s.i. WITH #3 BARS @ 24" O.C.

PLAN

TYPICAL SECTION

EXPANSION JOINT DETAIL
If slip form paver is used, an alternate joint location may be used as approved by the engineer.

If existing drive is concrete, sawcut & remove drive to here. Pour new driveway approach against exist drive. Install Exp. joint w/ no dowels.

If existing drive is asphalt, sawcut & remove drive to here. Install 24" wide asphalt pavement behind concrete approach.

If existing drive is gravel, remove drive to here. Install 6" flex base. Compact until settlement ceases.

If existing drive is dirt, backfill behind approach and compact to 95% std. proctor density.
MILSAP ROCK

STREET PAVEMENT

ELEVATION

FINISHED
GRADE

1" MIN.

3'-0"

8'-0"

3'-0"

4'-6"

6" CURB

6X6X10 GA WWF

MILSAP ROCK

COMPOSITE STEEL FLOOR

#4@12 EW

12'-0"

SECTION A-A

MILSAP ROCK

COMPOSITE STEEL FLOOR

12'-0"

SECTION B-B

DRIVEWAY DETAILS

SCALE: 1/4" = 1'0"

DATE: MAR 1994

PAVEMENT DETAILS

TOWN OF SUNNYVALE
DALLAS COUNTY, TEXAS

DESIGN STANDARDS
DRAINAGE DETAILS
FINE GRADATION CRUSHED STONE - TOP LAYER IS TO BE PLACED TO GRADE TO PROVIDE UNIFORM SUPPORT OF PIPE BARREL. EXCAVATE BELL HOLES.

SELECT MATERIAL FREE OF ROCKS, CLUMPS OR DEBRIS LARGER THAN 6" IN GREATEST DIMENSION. COMPACT TO 90% STANDARD PROCTOR DENSITY. UNDER STRUCTURES, ROADWAYS AND PAVEMENT, USE GRANULAR MATERIAL (SAND) COMPACTED TO 95% STANDARD PROCTOR DENSITY.

R.C.P. EMBEDMENT

DESIGN STANDARDS

TOWN OF SUNNYVALE
DALLAS COUNTY, TEXAS

TYPICAL DRAINAGE DETAILS
PLAN - STANDARD INLET

NOTE: PIPES SHALL CONNECT TO THE ENDS OR SIDES OF INLETS. CONNECTION SHALL NOT BE MADE AT CORNER OR BOTTOM.

TOWN OF SUNNYVALE
DALLAS COUNTY, TEXAS
SECTION A–A

RECESSED AND STANDARD DETAILS

SCALE: NONE
DATE: MAR 1994

DESIGN STANDARDS

TOWN OF SUNNYVALE
DALLAS COUNTY, TEXAS

TYPICAL STORM DRAINAGE DETAILS
# Reinforcing Steel Schedule

**Dimensions shown are for max. size inlets**

<table>
<thead>
<tr>
<th>Inlet Length</th>
<th>Bar Type</th>
<th>Bar Dia. (1/8&quot;)</th>
<th>No. Req'd</th>
<th>Bar Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>3</td>
<td>9</td>
<td>3'-2&quot; 0'-3&quot;</td>
</tr>
<tr>
<td>6 FT.</td>
<td>B</td>
<td>3</td>
<td>1</td>
<td>4'-10&quot;</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>4</td>
<td>15</td>
<td>6'-8&quot; 0'-6&quot;</td>
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* See Diagram for dimensions

---

**Typical Drainage Details**

**Scale:** None

**Design Standards**

_Town of Sunnyvale_

_Dallas County, Texas_

**Typical Drainage Details**
## REINFORCING STEEL SCHEDULE
### DOUBLE INLETS

Dimensions shown are for max. size inlets.

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</table>

* See diagram for dimensions

Bend to allow a min. 1 1/2" clr. of drain pipe.

## REINFORCING DETAILS

Scale: None
Date: Mar 1994
Sheet:

Design Standards

Typical Drainage Details

Town of Sunnyvale
Dallas County, Texas
WATERSTOP SHALL BE A PREFORMED PLASTIC SEALING COMPOUND EQUAL TO SYNCO-FLEX PRODUCTS CO.

SECTION "B-B"

SECTION "C-C"
NOTE:
DETAIL SHOWN IS FOR INLETS LARGER THAN 10' IN WIDTH. FOR INLETS 10' IN WIDTH AND LESS, DELETE CENTER ROOF BEAM AND ONE MANHOLE COVER.
PLAN OF COVER

SECTION OF FRAME AND COVER

INLET FRAME AND COVER

DESIGN STANDARDS

TYPICAL DRAINAGE DETAILS
NOTES:

1. WIDTH OF HEADWALL IS EQUAL TO PIPE O.D. + 24".
2. SAWCUT 4:1 BEVEL ON PIPE.
WATER SYSTEM DETAILS
STANDARD GRADATION CRUSHED STONE – TOP LAYER IS TO BE PLACED TO GRADE TO PROVIDE UNIFORM SUPPORT OF PIPE BARREL. EXCAVATE BELL HOLES.

GRANULAR MATERIAL (SAND) COMPACTED TO 95% STANDARD PROCTOR DENSITY.

SELECT MATERIAL FREE OF ROCKS, CLUMPS OR DEBRIS LARGER THAN 6" IN GREATEST DIMENSION. COMPACT TO 90% STANDARD PROCTOR DENSITY. UNDER STRUCTURES, ROADWAYS AND PAVEMENT, COMPACT TO 95% STANDARD PROCTOR DENSITY.

<table>
<thead>
<tr>
<th>SIZE OF PIPE IN INCHES DIA.</th>
<th>KIND OF PIPE</th>
<th>EXTERNAL DIA. (Bc) IN INCHES</th>
<th>TRENCH WIDTH (Bd) IN INCHES</th>
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<tr>
<td>6&quot;</td>
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CLASS "C" EMBEDMENT

TOWN OF SUNNYVALE
DALLAS COUNTY, TEXAS
CLASS "G" EMBEDMENT

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<th>TRENCH WIDTH (Bd) IN INCHES</th>
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<td>10&quot;</td>
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NOTE:
The 4" MIN. SHALL APPLY TO THICKNESS AROUND PIPE AND OVER TOPS OF BELLS.

TOWN OF SUNNYVALE
DALLAS COUNTY, TEXAS
CONSTRUCT 18"x18"x4" CONC. SLAB AROUND VALVE BOX EXCEPT WHEN VALVE IS IN PAVEMENT.

TOP OF VALVE BOX TO BE FLUSH WITH FINISHED GRADE

C.I. COVER

C.I. VALVE BOX TOP PIECE

6" DR 35 PVC PIPE

FURNISH C.I. OR S.S. SHAFT EXTENSION IF OPERATING NUT IS DEEPER THAN 4 FEET

BACK FILL TO VALVE FLANGE

2000 PSI CONCRETE BLOCKING UNDER VALVE & AGAINST TRENCH WALLS
DO NOT COVER VALVE BOLTS

VALVE INSTALLATION DETAIL

TOWN OF SUNNYVALE
DALLAS COUNTY, TEXAS
FIRE HYDRANT SHALL BE MEULLER CENTURION OR APPROVED EQUAL.

TAPERED PENTAGON 1-1/4" POINT TO FACE AT BASE, 1-1/8" POINT TO FACE AT TOP OF NUT. VALVE SHALL OPEN BY TURNING TO THE LEFT.

(2) 2 1/2" NOZZLES

4 1/2" OPENING TO FACE STREET

GROUND LINE

MIN 7 CUBIC FEET OF WASHED GRAVEL FILL

CLASS "B" CONC. THRUST BLOCK MUST NOT BLOCK WEEP HOLE. BLOCK DIMENSIONS SHALL BE THE SAME AS FOR A 6" PLUG.

INSTALL 6" MJ GATE VALVE BETWEEN FIRE HYDRANT AND WATER MAIN.

FIRE HYDRANT ASSEMBLY DETAIL
BLOCKED INSTALLATION

NOTE: ALL MATERIALS SHOWN ON THIS DETAIL SHALL BE INCLUDED IN THE UNIT PRICE FOR A FIRE HYDRANT ASSEMBLY. NO SEPARATE PAYMENT WILL BE MADE FOR VALVES, PIPE, FITTINGS ETC.

SCALE: NONE
DATE: MAR 1994
SHEET:

DESIGN STANDARDS

WATER SYSTEM DETAILS

TOWN OF SUNNYVALE
DALLAS COUNTY, TEXAS
1. Blow-off to be constructed using a tangential outlet off of main line. If main line is D.I.P., use a D.I. tee in lieu of tangential outlet.

2. Blow-off gate valve shall be furnished with a stainless steel or cast iron extension stem. Operating nut shall be 12" below valve box cover. Extension shall be connected to valve operator with a stainless steel pin.

BLOW-OFF VALVE INSTALLATION DETAIL
SANITARY SEWER DETAILS
SLOPE TRENCH WHEN TRENCH DEPTH EXCEEDS 5' OR USE TRENCH BOX OR SHORING SYSTEM

1. FINE GRADATION CRUSHED STONE – TOP LAYER IS TO BE PLACED TO GRADE TO PROVIDE UNIFORM SUPPORT OF PIPE BARREL. EXCAVATE BELL HOLES.

2. GRANULAR MATERIAL (SAND) COMPACTED TO 95% STANDARD PROCTOR DENSITY.

3. SELECT MATERIAL FREE OF ROCKS, CLUMPS OR DEBRIS LARGER THAN 6" IN GREATEST DIMENSION. COMPACT TO 90% STANDARD PROCTOR DENSITY. UNDER STRUCTURES, ROADWAYS AND PAVEMENT, COMPACT TO 95% STANDARD PROCTOR DENSITY.

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<th>SIZE OF PIPE IN INCHES DIA.</th>
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CLASS "B-2" EMBEDMENT
**CLASS "B" CONCRETE**

**SIZE OF PIPE IN INCHES DIA.**

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**NOTE:**

The 4" MIN. SHALL APPLY TO THICKNESS AROUND PIPE AND OVER TOPS OF BELLS.

**CLASS "G" EMBEDMENT**
PLAN

SECTION

SANITARY SEWER SERVICE

SCALE: NONE
DATE: MAR 1994

DESIGN STANDARDS

SANITARY SEWER DETAILS

TOWN OF SUNNYVALE
DALLAS COUNTY, TEXAS
DEEP CUT CONNECTION USING P.V.C. PIPE

LATERAL CONNECTION FOR DITCHES WITH SLOPING SIDES USING PVC PIPE

SCALE: NONE  DATE: MAR 1994  SHEET:

DESIGN STANDARDS
SANITARY SEWER DETAILS

TOWN OF SUNNYVALE
DALLAS COUNTY, TEXAS
STANDARD 5' DROP MANHOLE CONNECTION

- Standard or adjustable MH frame & cover
- PVC pipe drop connection - 2" larger than upper incoming pipe
- Bell and spigot tee
- U-bolt anchors

Design Standards

Sanitary Sewer Details

Town of Sunnyvale
Dallas County, Texas
STANDARD M.H. FRAME & COVER

2" MORTAR COATING

USE PRECAST CONCRETE GRADE RINGS & MORTAR OR BRICK & MORTAR AS REQUIRED TO RAISE TO GRADE.
(MIN. 12" OF GRADE RINGS)

REQ'D. IN STREETS

STANDARD M.H. FRAME & COVER

SEE TRANSITION DETAIL FOR 5' & 6' M.H.'S

TRANSITION DETAIL
FOR 5' & 6' M.H.'S

3000 PSI CONCRETE MONOLITHIC POUR

STD. PLASTIC COATED MANHOLE STEPS

STUBOUTS TO BE A MIN. OF 5' LONG WITH CONC. CRADLE (FROM SAME POUR) UNDER ENTIRE LENGTH

A-LOK MANHOLE PIPE CONNECTOR

FIRM, WELL DRAINED MATERIAL OR ROCK FOUNDATION

STANDARD CAST-IN-PLACE MANHOLE

SCALE: NONE
DATE: MAR 1994
SHEET:

DESIGN STANDARDS
SANITARY SEWER DETAILS

TOWN OF SUNNYVALE
DALLAS COUNTY, TEXAS
PLAN OF COVER

1" LETTERS, RAISED 1/4"

2 - 2" x 3 3/4" PICK SLOTS
WITH 2 - 1" DIA. STEEL RODS

SANITARY

PLAN OF COVER

A-A

MANHOLE FRAME
& COVER DETAIL

1" DIA. STEEL RODS MATERIAL PER ITEM 2.11.5 (b) (2)
RING & COVER MATERIAL PER ITEM 2.11.5 (c)

7/8"

24 3/8"

4 5/16"

22 3/8"

DESIGN STANDARDS

SANITARY SEWER DETAILS

TOWN OF SUNNYVALE
DALLAS COUNTY, TEXAS
MANHOLE PIPE CONNECTOR
(FOR ALL CAST-IN-PLACE MANHOLES)

DIMENSIONS FOR MANHOLE PIPE CONNECTOR A.S.T.M. D-923

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<td>10&quot;</td>
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TYPICAL SEPTIC TANK INSTALLATION
MISCELLANEOUS DETAILS
SIGN AND HARDWARE PURCHASED BY CITY

2" GALV STEEL STREET SIGN POST, 35#/FT, 12'-0" LONG

1" TYP.
MIN. 1/2"
WASH

3xO.D.
PIPE

3'-0"\n3'-6"
10"\n10"

TYPICAL SIGN POST

TOWN OF SUNNYVALE
DALLAS COUNTY, TEXAS

DESIGN STANDARDS

TYPICAL DETAILS
STREET LIGHT POLE INSTALLATION

3 C SO CABLE
POLE GROUND LUG
FILL VOID W/ NON-SHRINK GROUT AFTER LEVELING
3/8" DIA. PVC FOR WEEP
5/8" DIA. x 8' Cu-CLAD STEEL GND ROD
3000 PSI 28 DAY CONC. PIER 18" DIA. x 6' DEEP

PLASTIC COATED RIGID STEEL FOR FIRST 8', THEN CONVERT TO SCH. 40 P.V.C.
4 #6 VERTICALS
#4 SPIRAL 10" O.C. TOP TO BOTTOM

HANDHOLE
GND BUSHING-BOND EGC THERETO
ANCHOR BOLTS W/ DOUBLE NUTS HDG TOP 12"

FINISHED GRADE

DESIGN STANDARDS
TYPICAL DETAILS
TOWN OF SUNNYVALE
DALLAS COUNTY, TEXAS
1. Add to the notes on the top of page 5, the following:

d. All alleys shall be designed to accommodate an SU vehicle.

2. Change paragraph 2.5 to read:

STREET AND CUL-DE-SAC DIMENSIONS

The maximum length between intersecting streets shall not exceed 1200 feet. The maximum length of any cul-de-sac shall be 450 feet measured from curb line of the intersecting street to the radius point of turn around. All cul-de-sac turnarounds shall be visible from the intersecting street. Right-of-way and pavement widths shall be as follows:

<table>
<thead>
<tr>
<th>STREET TYPE</th>
<th>RIGHT-OF-WAY RADIUS</th>
<th>PAVEMENT RADIUS</th>
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<tbody>
<tr>
<td>Country Lane</td>
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<tr>
<td>Local Street-Residential</td>
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<tr>
<td>Local Street-Non Residential</td>
<td>60</td>
<td>48</td>
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3. Change the first sentence of paragraph 4.2, D to read:

Sewage flow shall be computed according to the following formula:

\[ Q = \frac{C^{0.89}}{295} \]

Where:

- \( Q \) = Peak wastewater flow (million gallons per day)
- \( C \) = Equivalent single family connections

4. Refer to Appendix B. Replace all four drawings entitled "Utility Assignments" with the four drawings that accompany this addendum.

5. Refer to Appendix F. In the Paving Details, delete the drawing entitled "Driveway Details." Add the two Pavement Details, one Water System Detail and two Sanitary Sewer System Details that accompany this addendum.
LOCAL STREET - RESIDENTIAL
SECTION LOOKING NORTH OR WEST
SCALE: N.T.S.

SEWER MAIN
ELECTRIC CABLE
(DEPTH = 36"-48")
TELEPHONE & T.V. CABLE
IN SAME DITCH - 12" ABOVE
ELECTRIC CABLE.

STORM SEWER
WATER SERVICE
FIRE HYDRANT
STORM SEWER
WATER SERVICE
GAS MAIN
(DEPTH = 24"-48")
WATER MAIN
(4" MIN. COVER)

15 FT. ALLEY
SECTION LOOKING NORTH OR WEST
SCALE: N.T.S.

GAS MAIN
(DEPTH = 24"-48")
ELECTRIC CABLE
(DEPTH = 36"-48")
TELEPHONE & T.V. CABLE
IN SAME DITCH - 12" ABOVE
ELECTRIC CABLE.

NOTE: GAS, ELECTRIC AND T.V. CABLE UTILITIES ARE TO BE LOCATED IN ALLEYS WHERE POSSIBLE.

SCALE: NONE
DATE: MAR 1995
SHEET: 1

DESIGN STANDARDS

UTILITY ASSIGNMENTS

TOWN OF SUNNYVALE
DALLAS COUNTY, TEXAS
COUNTRY LANE
SECTION LOOKING NORTH OR WEST
SCALE: N.T.S.

10 FT. ALLEY
SECTION LOOKING NORTH OR WEST
SCALE: N.T.S.

NOTE: GAS, ELECTRIC AND T.V. CABLE
UTILITIES ARE TO BE LOCATED IN
ALLEYS WHERE POSSIBLE.
TYPICAL UTILITY PLAN

NOTE:
TELEPHONE AND T.V. CABLE PEDESTALS, WHEN LOCATED IN THE STREET, SHALL BE PLACED AT THE SAME LOT LINE.

DESIGN STANDARDS

UTILITY ASSIGNMENTS

TOWN OF SUNNYVALE
DALLAS COUNTY, TEXAS
NOTE:
1. MILSAP ROCK MAY BE DELETED IF DRIVEWAY CONNECTS TO A STREET THAT WAS CONSTRUCTED BEFORE MARCH 1995.
2. 18" PIPE MAY BE USED WHERE DRAINAGE AREA IS LESS THAN 2 ACRES. FOR LARGER DRAINAGE AREAS, LARGER PIPE(S) MAY BE REQUIRED OR BRIDGE TYPE DRIVEWAY MUST BE INSTALLED. IF PIPE TYPE DRIVEWAY IS TO BE USED WHERE DRAINAGE AREA IS GREATER THAN 2 ACRES, THE PIPE(S) MUST BE SIZED BY A REGISTERED PROFESSIONAL ENGINEER AND DESIGN CALCULATIONS SUBMITTED TO THE TOWN FOR REVIEW.

ELEVATION

SECTION A-A

SECTION B-B

DRIVEWAY DETAILS
(PIPE TYPE)

DATE: MAR 1995

DESIGN STANDARDS

PAVEMENT DETAILS

TOWN OF SUNNYVALE
DALLAS COUNTY, TEXAS
NOTE:
MILSAP ROCK MAY BE DELETED IF DRIVEWAY CONNECTS TO A STREET THAT WAS CONSTRUCTED BEFORE MARCH 1995.

DRIVEWAY DETAILS (BRIDGE TYPE)

DATE: MAR 1995
SHEET:

DESIGN STANDARDS
PAVEMENT DETAILS

TOWN OF SUNNYVALE
DALLAS COUNTY, TEXAS
GENERAL NOTES:
1. CONTRACTOR WILL SET METER BOX IN ALL CASES
2. METER BOX SHALL BE SET WITHIN THE RIGHT OF WAY, A UTILITY OR A DEDICATED EASEMENT
3. THE METER BOX SHALL BE LOCATED WITHIN AN AREA PROTECTED FROM VEHICULAR TRAFFIC

SERVICE CONNECTION WITH METER BOX

SCALE: NONE
DATE: MAR 1995

DESIGN STANDARDS
WATER SYSTEM DETAILS

TOWN OF SUNNYVALE
DALLAS COUNTY, TEXAS
NOTE:
FOR SEAL BETWEEN FRAME AND COVER
USE EITHER A 1/16" COPPER GASKET
OR A 1/4" NEOPRENE O-RING GASKET
(LOCATION OF O-RING GASKET IS LEFT
TO MFR., BUT IS SUBJECT TO
CONSTRUCTION ENGINEER).

INDEX MARKS ON FRAME & COVER
ENGRAVED INTO CASTING 1/8" DEEP

SECTION A-A
24 1/4" PRESSURE TYPE
CAST-IRON M.H. FRAME & COVER

SCALE: NONE
DATE: MAR 1995
SHEET:

DESIGN STANDARDS
SANITARY SEWER DETAILS

TOWN OF SUNNYVALE
DALLAS COUNTY, TEXAS
DETAIL
SANITARY SEWER CLEANOUT

USE REDUCER IF DIAMETER IS MORE THAN 6"