PUBLIC WORKS
DESIGN GUIDE

SCHERTZ

COMMUNITY★SERVICE★OPPORTUNITY

Public Works Design Specifications

SECTION 1 – SUBDIVISION COMPLIANCE

1.1 PURPOSE AND SCOPE

A.) Every subdivision or development which requires the installation of public infrastructure improvements to serve the proposed subdivision or development is required to submit construction plans to ensure that the required improvements are constructed in accordance with all applicable standards of the UDC or any other codes of the City pertaining to the construction and installation of the improvements. This includes but is not limited to the Illicit Discharge and Connection Storm Water Ordinance, the Ordinance for the Control of Storm Water Run-off, the Construction Storm Water Management Ordinance, and the Flood Damage Prevention Ordinance. All public infrastructure improvement construction plans shall be submitted and approved prior to an application for a final plat. (Unified Development Code Sec. 21.4.15)

B.) The purpose of this design manual and specifications is to establish standard principles, criteria, and practices for the design of infrastructure and to protect and preserve the public welfare. The design factors, coefficients, formulas, and procedures described in this document are intended to serve as guidelines for the solution and design public infrastructure.

Ultimate responsibility for the actual design remains with the design engineer.

1.2 APPEAL

A.) Any deviation from this manual must be approved by the Director of Public Works or City Engineer, provided:

- it is not detrimental to the public welfare
- it meets the requirements of the UDC or has an approved variance
- it is based upon an engineering study performed by a Professional Engineer

SECTION 2 – REQUIRED SUBMISSIONS OF PLANS

2.1 PLAN REQUIREMENTS

A.) Three (3) full sized copies, one (1) half size and one CD or DVD with a PDF copy of plans and profiles for streets, alleys, sidewalks, water, sewage and drainage shall be submitted, and bear the signature and seal of a registered professional engineer, registered in the State of Texas.

Construction plans shall be submitted to the Director of Public Works prior to or concurrently with a development application as indicated in the UDC.

Any set over 4 pages should include an index sheet. The preferred size of construction plans is 22" x 34" or 24" x 36" sheets (half sized plans will be 11" x 17").

Plans should use and reference City of Schertz standard details.

B.) The following are typical plans to be submitted. Each set of plans and what is contained in that set will be dependent upon the project scope.

1.) Front end sheets should contain and cover sheet, and Index and quantity sheets.

2.) Streets and alleys will be shown in plan and profile sheets and cross-section sheets. Provide a plan sheet showing typical existing and proposed street sections detail with the proposed pavement width type thickness and crown; the proposed curb or gutter type, location in relation to centerline and exposure; the proposed sidewalk dimensions and location in relation to curbs and property lines; the proposed parkway grading slopes. This information shall be given for each of the different types of streets and alleys in the subdivision.

3.) Drainage channels, storm drain, and culverts will be shown in plan and profile sheets. Large drainage channel projects will include cross section sheets. Construction details of all drainage structures; including dimension, reinforcing and components, such as grates and manhole covers. HGL will be indicated on profile. Drainage plans shall address interim (i.e. "during construction") and final drainage plan.

If detention ponds or water quality ponds are part of the development or project, then a plan indicating dimensions, grading,

outlet design, downstream protection, and stage-storage-discharge tables should be included.

4.) Plans for erosion and sedimentation controls during construction shall be included as part of the construction plans and be in compliance with the Texas Pollutant Discharge Elimination System (TPDES) permitting requirements and specifications established by the Director of Public Works. All land disturbing or land filling activities or soil storage shall be undertaken in a manner designed to minimize surface runoff, erosion and sedimentation and to safeguard life, limb, property and the public welfare.

5.) Grading plan will include slab elevations, existing and proposed contours, retaining walls, spot elevations, and shall indicate drainage for all lots in the subdivision. Grading plans must include specific paths for the direction of drainage flow away from the building pads or the lots. In addition, whenever drainage flow will impact existing developed land (residential, retail or industrial), grading plans must show how the adjacent land will be impacted, and how the adverse impact will be mitigated.

Retaining walls over 4-ft will require plans signed and sealed by a registered professional engineer.

6.) Utility plans for water mains less than 16-inches in size will require plan sheets with associated details. Utility plans for water mains 16-inches and greater will require plan and profile sheets. Section details only required at critical crossings of infrastructure.

7.) Utility plans for sanitary sewer will require plan and profile sheets, and associated details.

2.2 ENGINEERING REPORTS

A.) In addition to the plans, the following reports are to be submitted for review by the City Engineer. Except for the pavement design, these items should be submitted at the time of development application and updated for and prior to final plat, site plan, and construction plans approval. Pavement design shall be completed prior to final plat, site submittal, or construction plan submittal.

- Engineering Report for pavement design
- TIA as indicated in the current UDC
- Storm Water Management Plan Report
- Storm Water Pollution Prevention Plan
- Engineering Design Report for the water system

- Engineering Design Report for the waste water system

B.) The content and level of detail of the reports shall be as described in this manual, or as determined by the City Engineer. Format of submittal is two (2) hard copies with copies of submittal on a CD or DVD.

2.3 PLAN SHEETS

In general, plan sheets should be oriented with north pointing up, left, or right on the sheet, with proper consideration given to existing and proposed conditions.

A.) *All plans shall require a* scale, north arrow and date. The preferred scale for plan view sheets is 1"= 20' or 1"= 40' or 1"=50'.
Variance to the preferred scale may occur with the approval of the City Engineer or his/her designee.

B.) *Two Bench Marks*, at a minimum, shall be established on and set to NAD 83 and NAVD 88 coordinates and datum.

C) Plans sheets should include all pertinent property and right-of-way information, easements, topographical features, notes and callout necessary for design.

2.4 PLAN AND PROFILE SHEETS

The plan and profile sheets should, at the minimum, include the following:

A.) *All plans shall require a* scale, north arrow and date. The preferred scale for profile view sheets is 1"= 20' or 1"= 40' or 1"=50' horizontal and 1"= 5' or 1" = 10' vertical.
Variance to the preferred scale may occur with the approval of the City Engineer or his/her designee.

B.) *Two Bench Marks*, at a minimum, shall be established on and set to NAD 83 and NAVD 88 coordinates and datum.

Indicate the location, description and elevation of Bench Marks; the top of curb grade at each curb return; the centerline grade at each end and at each fifty (50') foot station of alleys and drainage ditches; the gradient of each tangent grade and the location and length of each vertical curve; the direction of storm drainage flow at each intersection; the flow line elevation of each storm sewer at each point of grade and each end and the intervening gradients.

C) The profiles of streets, alleys and drainage ditches shall show the natural ground at adjacent property lines and the proposed centerline.

D.) *Alignment* of each street, alley, crosswalk way and drainage easement showing a beginning and ending station; each deflection angle of the centerline and the station of the point of intersection; the station of the point of curvature and the point of tangency of each curve; the station and angle of intersection of each intersection with another street, alley or drainage easement; the station and radius of each curb return; the location of adjacent right-of-way lines; the location and limits of sidewalks and curbs of each street; the location of each drainage structure; the location and size of all storm sewers; and the location of monuments.

E.) All pertinent property and right-of-way information, easements, topographical features, notes and callout necessary for design will be shown in the plan view.

2.5 SECTION SHEETS

A.) When required, cross-sections shall be at every fifty foot station (minimum) drawn at a scale of 1" = 10' horizontal and vertical.

B.) Section will include existing ground and existing utilities, and proposed finish ground and proposed utilities, right of way and easement limits.

SECTION 3 – STREET REQUIREMENTS

3.1 GENERAL

A.) Plans for streets, alley, sidewalks and crosswalk ways shall be prepared in accordance with the standards in this document.

B.) Any street design element not specifically addressed in this document shall be designed in accordance with:

- Latest edition of Policy on Geometric Design of Highways and Streets, American Association of State Highway and Transportation Officials (AASHTO);
- Latest edition of Highway Design Division Operations and Procedures Manual and the Standard specifications for Construction of Highways, Streets and Bridges, Texas Department of Transportation (TXDOT)
- Latest edition of Texas Manual on Uniform Traffic Control Devices for Streets and Highways (TMUTCD)

3.2 PAVEMENT DESIGN

A.) The City allows both flexible and rigid structures, as defined by the American Association of State Highway and Transportation Officials (AASHTO). Pavement design shall be based upon a geotechnical analysis of the project conditions, upon AASHTO design methods, and shall be designed by an engineer registered in the State of Texas.

B.) Performance. Service life has been defined as the anticipated number of years that a pavement will be functionally and structurally acceptable with only routine maintenance. Flexible Pavements shall be designed for a 20-year service life; Rigid Pavements shall be design for a 30-year service life.

C.) Design Traffic Levels. Traffic load for the pavement design will be based upon the expected cummulative18-Kip ESAL for the pavement's service life. A table of minimum values is shown below, but a pavement designer may increase the expected ESALS based on the results of a traffic study. Because heavy vehicles cause a majority of pavement structural damage, if the street is to serve as a main source of construction traffic during the phases of subdivision development, then the pavement designer shall use a higher ESAL as determined by the City Engineer or his/her designee.

Table 3.2A Flexible Pavement Design Parameters				
	18-kip ESAL	Reliability Factor, %	Std Dev	Serviceability Po/Pt
Primary and Secondary Arterials	1,500,000	90	0.40-0.50	4.2/2.5
Collector	1,000,000	90	0.40-0.50	4.2/2.5
Local Type street with bus traffic	500,000	70	0.40-0.50	4.2/2.0
Local Type street/Fire Lane	100,000	70	0.40-0.50	4.2/2.0

D.) Resilient modulus (Mr) is to be determined by the geotechnical engineer.

E.) There are areas within the city limits and surrounding region with expansive soils, water lenses, and drainage issues. It is expected that the pavement design will address those issues. Swelling soils, soils with a P.I. of 20 or more, may be treated by removal and replacement, or geogrid, or cement soil treatment, or drains/barriers, or combination as determined by a pavement design. Treatment with lime is discouraged and must be approved by the City. Treated subgrade may be used as a structural layer in the pavement design.

F.) Minimum thickness for hot mix asphalt concrete surface layer is 3-inches compacted depth. Minimum thickness for treated subgrade layer is 6-inches.

G.) Minimum structural numbers will be as follows. These values are minimums, and actual values used in design will account for the design criteria above.

Table 3.2B Minimum Structural Number Level Roadway Conditions	
Street Classification	SN
Secondary Arterial	3.25
Collector Street	2.9
Local/Residential	2.5

3.3 STREETS LAYOUT

A.) *Adequate streets* shall be provided by the Sub-divider and the arrangement, character, extent, width, grade and location of each shall conform to the Comprehensive Plan of the City and shall be considered in their relation to existing and planned streets, to topographical conditions,

to be served by such streets. The street layout shall be devised for the most advantageous development of the entire neighborhood. The location and type of traffic control device to be installed by the subdivision developer shall be indicated on at least one (1) sheet of plans. This shall include the proposal of all Stop, Yield, Speed, Parking and Movement Series devices. The design of location of intersections shall take into account intersection site distance per AASHTO requirements. This specifically shall be utilized for location of intersections in relation to curves and cutbacks to prevent the location of sight barriers including signs, fences, and landscaping. See Tables 3.3G below.

B.) *The following specifications are required minimums*. The analysis of supporting subsurface soils are to be determined and thickness of pavements to be designed by the developer. Substitutes for street geometric or pavement thickness design shall not be less than the minimum design requirements. The minimum horizontal curve radii and vertical curves shall be assigned considering the service of the facility and the conditions of the location of the street in relation to existing and proposed features.

C.) STREET GEOMETRICS

1.) *The following specifications are required minimums*. They are not to be substituted as street geometric or pavement thickness design. The geotechnical borings and analysis of supporting subsurface soils is to be completed by the developer and the design of the pavement structure shall be signed and sealed by a professional engineer licensed in the State of Texas. Flexible and rigid pavements shall be designed for a twenty-year and thirty-year service life respectively. The minimum horizontal curve radii shall be designed considering the conditions of the location of the street in relation to existing and proposed features.

Table 3.3A Primary Arterial Streets (Design Speed – 45 mph)~	
Minimum right-of-way width	120 feet
Minimum pavement width	48 feet
Minimum horizontal curve radius	1200 feet
Minimum tangent between reverse curve	200 feet
Grades	0.5% -5%
Daily Traffic Volume Limit, (vehicles per day)	>34,000

Table 3.3B Secondary Arterial Streets (Design Speed – 45 mph)~	
Minimum right-of-way width	86 feet
Minimum pavement width	48 feet
Minimum horizontal curve radius	750 feet
Minimum tangent between reverse curve	200 feet
Grades	0.5% -5%
Daily Traffic Volume Limit, (vehicles per day)	34,000

Table 3.3C Major Collector Streets (Design Speed – 30 mph)~	
Minimum right-of-way width	60 feet
Minimum pavement width	42 feet
Minimum horizontal curve radius	400 feet
Minimum tangent between reverse curve	100 feet
Grades	0.5% -7%
Daily Traffic Volume Limit, (vehicles per day)	10,000

Table 3.3D Minor Collector Streets (Design Speed – 30 mph)~	
Minimum right-of-way width	60 feet
Minimum pavement width	36 feet
Minimum horizontal curve radius	400 feet
Minimum tangent between reverse curve	100 feet
Grades	0.5% -7%
Daily Traffic Volume Limit, (vehicles per day)	5,000

Table 3.3E Residential Streets (Design Speed – 30 mph)~	
Minimum right-of-way width	50 feet
Minimum pavement width	30 feet
Minimum horizontal curve radius	100 feet
Minimum tangent between reverse curve	50 feet
Minimum Grade	0.5%-10%
Daily Traffic Volume Limits, (vehicles per day)	1,000

2.) Non-residential marginal access streets shall have a right-of-way width of at least fifty (50') feet and a pavement width of at least

thirty (30') feet. Safety lanes shall have a right of way of at least thirty (30') feet and a pavement width of at least twenty-four (24') feet.

3.) Pavement Crown shall have a cross slope of 2% percent.

4.) The developer shall be responsible for construction of pavement width and rights-of-way dedication of streets forming part of the boundary of the subdivision adjacent as follows:

a) *New adjacent collector or residential access streets* shall conform to the specifications of this section;

b) Where the proposed subdivision abuts upon an existing minor arterial street or half street that does not conform to the specifications of this Section, the Developer shall be required to make the necessary dedication and improvements in conformance with the current UDC or any other applicable code of the City. With regard to paving the adjacent street, the city reserves the right to waive all or a portion of this requirement. In considering such waiver, the following factors shall be considered by the City:

- Current condition of the roadway.
- Current daily traffic on roadway.
- Estimated additional daily traffic resulting from proposed subdivision;
- Total cost for widening roadway;
- Ability of City to finance road widening in the next several years

5.) "Broken-Back" or compound curves shall not be permitted unless approved by the Director of Public Works. Reverse curves may be used provided due consideration for safe sight distance, has been shown.

6.) Transitional Curves may be used where comfort and safety of the motorist will be enhanced.

7.) Combination of Curves: Combination of horizontal and vertical curves shall be permitted provided sufficient sight distance is

available for safe operation. Generally, the horizontal curvature should be introduced on the upgrade of the vertical curve.

8.) No street or alley grade shall be less than half of one (0.5%) percent unless otherwise specified by the Director of Public Works.

9.) Superelevation of road is permissible when minimum horizontal curves are unattainable and when approved by City Engineer. Design of superelevation will follow standard engineering practices and the TXDOT Roadway Design Manual.

10.) Before any pavement is laid to widen existing pavement, the existing pavement shall be cut back two (2') feet on each side to assure an adequate sub-base and pavement joint.

D.) PROPERTY LINE AND CURB RETURNS

At each intersection the curb and the property line at each block corner shall be rounded with a radius, R, varying with the interior angle as specified in the following table:

Table 3.3F

Minimum Radii for Curb Returns (CR) and Property Line Returns (PLR)

Street Intersections

Interior Angles in Degrees	Two Local		Local and Collector		Two Collector		Local/Collector With Arterial		Two Arterial	
	CR	PLR	CR	PLR	CR	PLR	CR	PLR	CR	PLR
150--45	15	5	15	6	20	10	25	15	25	15
145--40	15	5	15	6	20	10	25	15	25	15
140--135	15	5	15	6	20	10	25	15	30	20
135--125	15	5	15	6	20	10	25	15	35	25
125--85	15	5	15	6	20	10	25	15	30	25
85--75	20	10	20	11	25	15	30	20	50	40
75--65	25	15	25	16	30	20	35	25	80	70
65--55	30	20	30	21	35	25	40	30	90	80
55--45	35	25	35	26	40	30	45	35	110	100
45--00	35	25	35	26	40	30	45	35	150	140

E.) INTERSECTIONS

1.) The preferred angle of intersection is 90 degrees. Allowance for non-perpendicular intersecting angles between 80 degrees and 100 degrees will be made on a case by case basis.

2.) The following minimum sight distances shall be provided for a safe stopping and intersection operations. Development design shall be based upon actual conditions and speeds.

Table 3.3G Minimum Stopping Sight Distance Level Roadway Conditions	
Street Classification	Sight Distance
Primary Arterial	300 ft.
Secondary Arterial	300 ft.
Collector Street	250 ft.
Local/Residential	200 ft.

3.) The "sight triangle" at an intersection is that portion of a property over which motorists must see to safely judge and execute a driving maneuver into the intersection and onto the street. The distance to the approaching motorist is the "intersection sight distance", which is one leg of the sight triangle.

The length of the required intersection sight distance shall be based on AASHTO Policy on Geometric Design of Highways and Streets. The driver's eyes are considered to be 3.5 feet above pavement, and the object is considered to be 4.5 feet above pavement. This applies to intersections of two (2) or more streets as well as junctions of driveways and streets.

4.) Landscaping and Signing: No signs, walls or fences shall be placed in the median area other than approved traffic control devices unless approved by the Director of Public Works. No trees, shrubs or other ground cover shall be placed in the median, which will obstruct the driver's sight distance. The area enclosed by the sight triangle must be free of visual obstructions.

5.) At "T-intersections", the minimum intersection offsets is 125 feet between center lines of local streets. In the case of collector-street intersections, this offset shall not be less than 200 feet or the minimum distance required to allow for left-turn storage between intersections, whichever is greater. The distance between intersection offsets is measured from the center line intersection of one intersecting roadway and the centerline intersection of the next intersecting roadway, measured along the centerline of the intersected roadway.

6.) Right turn deceleration lanes shall be required when the daily entering right-turn traffic volume a peak hour volume greater than 50 vehicles per hour (VPH) and the approaching design hourly volume in the adjacent outside lane exceed five hundred (500)

vehicle trips; at street and driveway intersections in TxDOT right-of-way at the option of TxDOT; or where unsafe conditions such as limited sight distance, high travel speed, uneven grade, etc. may exist, as determined in a TIA. Minimum turn lanes width is 11 feet.

7.) Left turn lanes shall be required at all median openings on collector and arterial streets; at all driveways or streets with an average daily entering left-turn traffic volume of five hundred (500) vehicle trips; at street and driveway intersections in TxDOT right-of-way at the option of TxDOT; or where unsafe conditions such as limited sight distance, high speed, uneven grade, etc. may exist, as determined in a TIA. Minimum turn lanes width is 11 feet.

8.) Turn lanes should accommodate the anticipated deceleration length and storage determined for the intersection. Lengths at signalized intersections should be determined in a TIA. Lengths at non-signalized intersections should be determined by the equation

L = (V/30) x 2 x S
where L is storage length (ft), V is turning vehicles per hour, S is queue storage length in feet per vehicle (25).

The following table is a table of minimums values for storage and declaration; taper length may be considered part of the deceleration length. Preferred taper design is symmetrical reverse curve, per AASHTO.

Table 3.3H
Minimum Deceleration and Storage for Left Turn Lanes

Speed (mph)	Deceleration Length (ft)	Taper Length (ft)	Storage Length (ft)	
30	160	50	100	100
35	215	50	100	100
40	275	50	100	100
45	345	100	100	100
50	425	100	100	100
55	510	100	100	100

9) Site design shall take into account appropriate throat length for driveways and intersections for safe and efficient traffic operations for entry to and within the site.

F.) VERTICAL CURVATURE

A gradual transition from one roadway grade to another shall be accomplished by means of a vertical parallel curve connecting two (2) intersecting tangents. The minimum length of vertical curve shall be computed from the following formula and table.

L = KA

Where L = the length of vertical curve in feet
K = a constant related to sight distance and geometry of a parabolic curve (See Table 3.3H).
A = the algebraic difference in grades in percent.

Table 3.3I
Design Value for Constant "K", Vertical Curvature

Street Classification	"K" Crest Curves	"K" Sag Curves
Primary Arterial	70	60
Secondary Arterial	70	60
Collector Street	55	55
Local/Residential	30	40

G.) CURB AND SIDEWALK REQUIREMENTS

1.) CURB

a.) *Curb or curb and gutter shall be installed on all existing or proposed streets* forming the boundary of the subdivision and internally on streets. A *parallel five (5') foot wide sidewalk* meeting all requirements of the American Disability Act shall be required. All corner lots shall have such sidewalks on both the front and sides thereof.

b.) *Curb or curb and gutter* shall be non-reinforced unless otherwise stated. Cold joints shall be steel reinforced.

2.) SIDEWALK

a.) *Sidewalks*: Concrete sidewalks having a width of not less than five (5') feet and thickness of not less than four (4") inches shall be constructed on each side of each street within the subdivision. Said sidewalks shall allow for a three (3') foot greenbelt behind face of curb, shall be one (1') foot inside of the right of way and shall extend along all street frontage including the side of corner lots and block ends; provided however, that where it is impractical for the Sub-divider to provide such sidewalks on the side lot lines

abutting major thoroughfares or drainage ditches, then in those instances, sidewalks may not be required.

b.) *Where a new section of sidewalk is to connect with a walk previously constructed, or abuts on the curbing*, an expansion joint must be made and filled as above provided. Reinforcing bars shall extend ten (10") inches beyond the expansion joint and the ends shall be wrapped with building paper so that the ten (10") inches shall not be bonded to the concrete. Approved types of slip joints may be used in place of wrapping ends of bars. When wire mesh reinforcing is used, three and three eights (3 3/8") inch round smooth dowel bars not less than eighteen (18") inches in length, installed as specified above for bar reinforcing, shall be provided at each expansion joint.

c.) *Concrete shall have a minimum compressive strength* of 3000 pounds per square inch at twenty-eight (28) days. Concrete will conform to material and proportion requirements for the concrete of Section 02751 of the Schertz Construction Specifications. Concrete, which has partially set, shall be disposed. All tests for ingredients and concrete shall be made in accordance with the applicable methods of tests of the American Society for Testing Materials.

d.) *Sidewalks, curb ramps and crosswalks* shall conform to all ADA requirements mandated at the time of construction. They shall have a monolithic finish and shall be floated and troweled to a uniform smooth surface, then finished with a fine-haired brush or wood float so as not to be left with a slick or glossy finish.

e.) *The completed walks and drive approaches* shall be cured in accordance with good engineering practices as approved by the Engineer.

3.) MEDIANS

a.) The minimum width of a raised median is a function of purpose.

Table 3.3J RECOMMENDED MEDIAN WIDTHS (FOC TO FOC)		
Function	Minimum (feet)	Desirable (feet)
Separation of Opposing Traffic	4*	6*
Pedestrian Refuge and Space for Traffic Control	6*	16
Left-Turn, Speed-change and Storage	14	16
Crossing/Entering Vehicle Protection	20	23
"U"-Turns, speed change and storage	20	23
Channelized "T", speed-change and storage	20	23 – 30
* Cannot accommodate left-turn lanes, hence, such turns must be made from the through lanes.		

Source: City of Austin, Department of Public Works and Transportation Based on ITE, Guidelines for Urban Major Street Design

b.) *Raised median openings* shall be at least 20 feet wider than the width of driveway which they are serving, with a minimum width of 60 feet.

c.) Minimum separation distance between raised median openings on local roads should be based on functionality and proximity to street intersections; no closer than 125 feet. Minimum separation distance between raised median openings for collector and arterial streets, measured nose to nose, should provide sufficient storage and deceleration length for the rate of speed on the through traffic road.

H.) ALLEYS

1.) Alley right-of-way minimum shall be twenty-four (24') feet wide and paved, see Section 21.14.4 in the UDC. Eight (8%) percent is the maximum sustained grade for an alley and shall not exceed three hundred (300') feet. Concrete pavement shall be a minimum of six (6") inches in depth – 3000 psi in commercial alleys and a minimum of five (5") inches in depth – 3000 psi in residential alleys. Alleys shall be designed on the basis of a twenty-five (25) year frequency to carry storm water from only the lots within the block abutting the alley.

2.) Intersecting Alleys: Where two alleys intersect or turn at right angle, a cutoff of not less than ten (10') feet shall be provided along each property or easement line.

3.) Dead-end Alleys: Dead-end alleys are not permitted.

4.) Overhang Easements: In all alleys, overhang easements for electric and telephone lines shall be provided if requested by the appropriate electric utility company.

5.) Alleys Which Do Not connect on A Straight Course: If alleys are not themselves straight within each of adjoining blocks, or if the same do not connect on a straight course with the alleys of adjoining blocks, then an easement may be provided for the placing of guy wires on lot division lines in order to support poles set on curving or deviating right-of-way of alleys as determined necessary per the appropriate electric utility company.

I.) DRIVEWAYS AND APPROACHES

1.) Driveways shall be designed as a “lay-down” curb or curb and gutter or a straight driveway section. The driveway width at the property line shall not be greater than the width approved by the City Engineer or his/her designee.

2.) Residential driveways 10 ft to 12 feet in width for single, and not more than 24 feet for double driveway apron. One curb cut per residential property. Two curb cuts may be allowed for circular if frontage is greater than 100 feet if approved by the City Engineer or his/her designee. No new residential driveway curb cut on collector or arterial streets will be allowed, unless lot size is greater then 1 acre, frontage is greater than 100 feet, traffic study indicates no impact, and maneuvering is done off street for turn-around. “Back out” driveway access to collector and arterial streets is not allowed.

3.) Non-residential driveway access width should be between 24 and 40 feet measured at the right of way.

4.) Non-residential lots are permitted to have one (1) point of access per lot or one (1) point of access per 200 feet of frontage of a collector street. Separation of access points to be a minimum of 50 feet of frontage measured along the curb, or as shown in a traffic Impact analysis to maintain safe traffic flow on the collector and site. Total aggregate width of multiple access points not to exceed 50% of frontage.

5.) Non-residential lots are permitted to have one (1) point of access per 400 feet of frontage of an arterial; if 400 feet is not available, then the use of a common access easement would be required. Minimum distance from corner/flare of intersection is the smaller of 90% of frontage, or 125 feet, or as shown in a traffic impact analysis (TIA) to maintain safe traffic flow on the collector and site.

6.) Frontage measured from property line to property line, or from corner/flare of intersection to property line.

7.) Drive approaches shall meet all criteria as minor intersection concerning sight distance and stopping distances to ensure a safe facility.

8.) Driveway aprons within the City Limits to be reinforced concrete per City standard details, unless otherwise approved by Public Works Director

9.) The site design shall take into account appropriate throat length for driveways and intersections for safe and efficient traffic operations for entry to and within the site.

J.) FIRE LANES

1.) Fire lanes will only be allowed within the City, under special circumstances as approved by the Planning and Zoning Commission. A fire lane is interpreted as a hard-surfaced, all-weather material, driving surface constructed specifically for the use of emergency vehicles. Fire lanes shall be designed on the basis of a twenty-five (25) year frequency to carry storm water from only the lots abutting the fire lane.

2.) Fire lanes shall have a minimum pavement width of twenty-four (24') feet and shall connect on a straight course.

3.) Where two (2) fire lanes intersect or turn at right angles, a cut-off of not less than then (10') feet must be provided along each property or easement line.

4.) Dead-end fire lanes are not permitted.

K.) CUL-DE-SAC TURNAROUND

1.) Cul-de-sac turnarounds shall meet the criteria set forth in the UDC Section 21.14.1.E and at minimum shall not exceed five hundred (500') feet in length and have a turnaround of 120 feet in diameter of ROW (100 feet pavement) in single-family residential areas and all other uses not less than 150 feet in diameter of ROW (130 feet pavement).

2.) "Knuckle" or elbow intersections with bulbs will meet the requirements of intersection angles and curb return radii, and meet the UDC requirements for cul-de-sac radius.

L.) STREET LIGHTS

Street lights in new subdivisions within the City Limits and the annexed areas of the City shall be installed from time to time pursuant to agreement between the City of Schertz and the appropriate electric utility company in accordance with the Schertz UDC (Article 14.1.S). Street Lights may be spaced a maximum of five hundred (500') feet apart.

M.) STREET MARKERS

1.) Two street name signs shall be erected at all street intersections in subdivisions for street markers:

a) The material of the street name signs, the method of attaching the sign to the post, the details of lettering, painting and method of installation, as well as the location of the sign at the intersection, shall be in accordance with the specifications on file a Public Works Department of the City of Schertz.

b) All street signs in a new subdivision within the City limits, including street name, speed limit, stop and yield signs, etc. shall be paid for by the developer and shall be provided by and installed by the City's Public Works Department in accordance with the Public Works Specifications Manual. Traffic Control Devices required within the subdivision shall be installed in accordance with the latest revision of the Texas Manual on Uniform Traffic Control Devices for Streets and Highways.

2.) All pavement markings shall be thermo plastic or preformed tape. Follow TMUTCD and TxDOT standards and guidance for marking standards. The following Pavement markings are required

a) Arterials: centerline striping, lane lines, turn bay islands, reflective pavement markers, edge lines for non curbed streets.

b) Collectors: centerline striping, lane lines, edge lines for non curbed streets.

N.) REMOVING AND REPLACING PAVEMENTS, CURBS, AND GUTTERS, DRIVEWAYS, AND SIDEWALKS

1.) Scope: The Specifications shall govern for all work necessary to complete the removing and replacing of all types of pavements,

curbs and gutters, driveways, and sidewalks as required to complete the project.

2.) Method of Cutting: The outline of the trench shall be marked on the surface to be cut. The cut shall be made as nearly vertical as possible. The excavated pavement or concrete shall be removed from the site and disposed of by the contractor.

3.) Concrete Pavement: Replace with eight (8") inch thick 3000 psi concrete slab, reinforced with No. 3 bars at twelve (12") inch center, cut No. 3 dowels into existing concrete at eighteen (18") inch minimum spacing. Repair to be five (5') feet on each side wider than ditch excavation. Concrete slab reinforcement to rest on at least twelve (12") inches of undisturbed soil on each side of ditch.

4.) Asphaltic Black Base Pavement: Replacement with eight (8") inches thick HMAC Type B. Tack coat of RC-2, cut back asphalt shall be applied at a rate of ten one hundredths (0.10) gallons per square yard. Apply hot mix-hot laid asphalt concrete applied at the rate of 220 lb./sy compacted to two (2") inch thickness. Hot mix shall conform to Texas Highway Department Standard Specification Item 340 Type D. Repair to be five (5') feet on each side wider than ditch excavation. Black base shall rest on at least twelve (12") inches of undisturbed soil on each side of the ditch.

5.) Replacing Concrete Driveway: Replace with 3000 psi concrete, six (6") inches thick, reinforced with 6" x 6" W/D4.7xW/D4.7 welded wire mesh when no detail is shown on the drawings. Finish on replaced section same as appearing on old driveway. Use an epoxy-bonding agent, in conformance with the manufacture's recommendations, when bonding new concrete to old concrete.

6.) Replacing Concrete Sidewalks: Replace with 3000 psi concrete four (4") inches thick, reinforced with 6" x 6" W2.9xW2.9 welded wire mesh when no detail is shown on the drawings. Finish on replaced section same as appearing on the old sidewalk. Use an epoxy-bonding agent, in conformance with the manufacture's recommendations, when bonding new concrete to old concrete.

Replacing Curbs and Gutters: Replace with 3000-psi concrete section conforming in all details to original section. All cold joints must be steel reinforced.

All street improvements shall meet the current requirements of the Master Thoroughfare Plan, the City of Schertz Unified Development Code and Section 3 of this document, but in no case shall be less than the following:

Table 3.3K Street Improvement Standards					
Classification	ROW	Pavement	Drainage Width	Sidewalk Width	Hike/Bike Trail
Principal Arterial	120 ft	48 ft (with 16 ft median)	Curb and Gutter	5 ft one side	8 feet other side *
Secondary Arterial	86 ft	48 ft	Curb and Gutter	5 ft one side	8 feet other side
Major Collector	60 ft	42 ft	Curb and Gutter	5 ft both sides	-
Minor Collector	60 ft	36 ft	Curb and Gutter	5 ft one side	8 feet other side
Local Street - Residential	50 ft	30 ft	Curb and Gutter	5 ft both sides	-
Local Street - Commercial/Industrial	60 ft	42 ft	Curb and Gutter	5 ft both side	-
Paved Alley	24 ft	24 ft	Curb or Curb and Gutter	None	-

* For State Highway 8 foot trail on both sides

O.) Any retaining wall with 4 feet measured from foundation, to be designed per accepted geotechnical engineering standards. Refer to TXDOT Geotechnical Manual. Retaining wall plans should be signed and sealed by an engineer registered in the State of Texas and submitted to the City for permitting. Check walls to ensure minimum factors of safety are met for all potential modes of failure including sliding, overturning, bearing pressure, and stability. Retaining walls shall be designed to ensure stability against overturning, sliding, excessive foundation pressure and water uplift. Retaining walls shall be designed for a safety factor of 1.5 against lateral sliding and overturning. Any retaining wall located on private property is the responsibility of the property owner or developer to inspect and maintain.

3.4 MINIMUM TESTING REQUIREMENTS

A.) GENERAL

All materials to be used in subdivision construction shall be subject to testing if warranted. The preponderance of testing to be performed in subdivisions is directly related to street construction and a series of laboratory tests normally associated with road and street construction will be required in subdivisions, said tests being performed by an independent testing laboratory using qualified personnel. The design (or consulting engineer or his designated representative shall be present at all testing.

The sub-divider shall notify the City at least one (1) week prior to the contractor beginning construction. Contractor shall be required to notify

the City a minimum of at least forty-eight (48) hours in advance of all testing being performed. It is assumed that the preponderance of testing required in the subdivision is that testing related directly to street construction. For this reason, the following ration of testing is established:

B.) *Sub-grade materials* shall be compacted by approved mechanical tamping equipment to an apparent dry density as determined by the ASTM 698 or TEX-114-E compaction test made in accordance with the procedure outlined in the Texas Highway Department Testing Manual. *Test for density* will be made within twenty-four (24) hours after compaction operations are completed. If the material fails to meet the density specified, it shall be reworked as necessary to obtain the density required.

C.) *When a fill or embankment is required to achieve the prescribed sub-grade, or structural elevation*, such fill shall be placed in uniform lifts covering the entire width of the cross-section. Prior to compaction, the layers shall not exceed a six (6") inch depth where pneumatic tire rolling is to be used and shall not exceed eight (8") inches in depth for rolling with other types of rollers. Each lift shall be compacted to the required density before succeeding lifts are placed. *Lifts shall be compacted* to not less than ninety (95%) percent of the maximum dry density as determined by the ASTM 698 or TEX-114-E compaction test made in accordance with the procedure outlined in the Texas Highway Department Testing Manual

D.) *Swelling soils (soils with plasticity index of 20 or more)* shall be treated by removal and replacement, or geogrid, or cement soil treatment, or drains/barriers, or combination as determined by a pavement design. Developer must provide the City with lab reports on soil conditions.

E.) *Flexible base materials* shall be compacted by approved mechanical tamping equipment to an apparent dry density of the total material of not less than ninety-five (95%) percent of the maximum dry density as determined by the TEX-113-E compaction test made in accordance with the procedure outlined in the Texas Highway Department Testing manual. *Tests of density* will be made within twenty-four (24) hours after compaction operations are completed. If the material fails to meet the density specified, it shall be reworked as necessary to obtain the density required.

F.) *Each course of six (6") inches or less* shall be compacted to full required density before succeeding layers are placed.

Table 3.4A Ratio of Testing	
Densities	
Sub-grade	Minimum 1 per 300 ft. of street
Under Curb/Gutter	Minimum 1 per 300 ft. of curb
Base	Minimum 1 per 300 ft. of street
Backfill Density Control	
Proctors (Moisture-Density Relationship)	
Sub-grade (raw)	-1 per subdivision unless material changes
Embankment (Street, Berm, Structural)	-1 per lift per 10,000 sq. ft. or
	-1 per lift per 100 ft. berm

Table 3.4B Atterberg Limits & Gradation Hot-Mix Control	
Surface Course Design	1 per subdivision
Base Course Design	1 per subdivision
Extraction	2 per day/run minimum – 1 per 500 ton
Densities (in place)	1 per 1,000 ft. of street

G.) CONCRETE CYLINDER

1.) GENERAL:

Plant Certification Required

The above schedule is a minimum schedule for testing, failures not included. In the event of failures, additional tests will be taken. If excessive rain occurs on a previously tested section, the City shall have the right to order retests as necessary.

2.) *The engineer shall notify the testing lab when tests are to be taken*. If it is necessary to retest, such retesting shall be at the engineer's expense. The scope of testing of materials incorporated in subdivision construction is not necessarily limited to those tests outline above. In the event of unusual conditions or factors which may give the City reason to question the quality of the materials in any portion of the subdivision, the City will have the right to order such additional tests as are necessary at the city's expense.

3.) All testing within these requirements will be performed in accordance with the American Society of Testing Materials (ASTM) latest revision, and/or as elsewhere provided in approved plans and specifications for the subdivision. The City will require all

subdivision test reports to be certified by a Registered Professional Engineer (Texas Registration) and will further require that the City be furnished a minimum of two (2) copies of testing reports.

SECTION 4 – STORM DRAINAGE REQUIREMENTS

4.1 GENERAL

A.) Unless otherwise stated in this document, all storm water management facilities, or combination of facilities, shall be designed for ultimate development. Facilities with drainage areas less than one hundred (100) acres shall be designed for a twenty-five-year storm. Facilities with drainage areas over one hundred (100) acres or areas within a designated floodplain shall be designed for a 100-year storm or a twenty-five-year storm plus freeboard (see Table 4.5G) if that elevation is higher.

B.) Three (3) development conditions shall be analyzed for each development.

1.) Existing Conditions. This refers to current development conditions in the watershed and on-site. Use as the baseline analysis for determining the impact of development.

2.) Proposed Conditions. This refers to existing conditions with the proposed development added. Use to determine if the increased runoff from the proposed development results in an adverse impact to other properties.

3.) Ultimate Conditions. This refers to ultimate development conditions within the watershed used to design the drainage facilities. This condition may be used in-lieu of subsection (2) above, to determine if the increased runoff from the ultimate watershed development results in an adverse impact to other properties.

C.) Responsibility to Accept Storm Water
The owner or developer of property to be developed shall be responsible for the conveyance of all storm water flowing through the property. This responsibility includes the storm water flowing onto the property by any other developed property as well as the drainage naturally flowing through the property by reason of topography. Future upstream development shall be accounted for by assuming ultimate development when sizing drainage systems as specified in this section.

D.) Positive Overflow Pathways
Storm water management facilities for local drainage systems will be designed to ensure that a positive overflow pathway is provided to the nearest one hundred (100) year conveyance facility. The overflow pathway must be delineated on a plan that shows all existing structures in the vicinity impacted by the overflow pathway.

E.) Maintenance

1.) Maintenance of publicly owned facilities will be the responsibility of the City. Maintenance of private facilities is the responsibility of the property owner or the community association and must be specified in the maintenance schedule submitted to the City. A maintenance schedule for privately owned facilities must be approved by the Director of Public Works prior to the approval of construction drawings.

2.) Authorized personnel from the City may conduct periodic inspections of these facilities and structures. Any required repairs will be consistent with current construction standards. Maintenance issues identified by the City or State during inspections shall be the responsibility of the current owner.

F.) New Development
Peak storm water runoff rates from all new development shall be less than or equal to the peak runoff rates from the site's predevelopment conditions for the five-year, twenty-five-year and one-hundred-year (100-yr) design storm events, except as provided in subsection A, above.

G.) Redevelopment
Peak storm water runoff rates from an area of redevelopment due to zoning or replatting shall be less than or equal to the peak runoff rates produced by existing development conditions for the five-year, twenty-five-year and one hundred (100) year design storm events, except as provided in subsection A, above.

4.2 FLOOD HAZARDS

A.) New development within the FEMA designated special flood hazard areas will follow the City's Flood Damage Prevention Ordinance, and the requirements of CFR 44.60.3.

B.) New subdivisions having a portion of that subdivision subject to the special flood hazards shall dedicate on the plat a drainage right-of-way for that area located within the special flood hazard area. If not already determined, the new subdivision shall determine the base flood elevations of the 1% annual chance event for that portion of the special flood hazard area within the subdivision. This must be based on a certified engineering study survey taking into consideration the full development of the watershed.

C.) Proposed subdivisions shall be reviewed to assure that all such proposals are consistent with the need to minimize flood damage. All public utilities and facilities such as sewer, gas, electrical and water systems are located,

elevated and constructed to minimize or eliminate flood damage and, adequate drainage is provided so as to reduce exposure to flood hazards.

D.) New or Replacement water supply systems and/or wastewater systems shall be designed to minimize or eliminate infiltration of flood waters into the system, discharges from the systems into flood water, and to require on-site waste disposal systems to be located above the base flood elevation so as to avoid impairment or contamination from them during flooding.

E) *Preservation of the natural floodplain and native vegetation* contained therein is encouraged. Under story growth which impedes flow may be cleared within the bank of watercourses within the proposed development with Public Works approval however, removal of large trees with diameters greater than eight (8") inches is discouraged and shall follow the requirements for the tree removal in the UDC Article 21.9.H. Lower branches of large trees may be trimmed to provide a vertical clearance of eight (8') feet. The alteration of natural vegetation or unique features within the floodplain of major watercourses shall comply with the City Master Drainage Plan.

F.) *Upon acceptance by the City of Schertz* for construction consisting of Public Utilities, Streets and Drainage, it shall be the responsibility of the homebuilder and/or lot owner to maintain all erosion and sedimentation controls to prevent spoil onto any public right-of-way and/or adjacent owners lots.

Failure to comply shall result in a stop order of all construction on lots owned by the landowner or homebuilder.

4.3 STORM WATER MANAGEMENT PLAN

A.) To standardize the review process and minimize the time for approval by the City during review of the plat and construction drawings for a subdivision, a complete submittal regarding the analysis of existing drainage conditions and the design of modifications or new drainage facilities is necessary. The owner of the property to be developed is required by the Director of Public Works to provide, at the owner's expense and as a condition of construction plan approval, a storm water management plan (SWMP) for the total development area to be ultimately constructed. The SWMP shall be submitted to the City Engineer through the City Manager or his/her designee prior to approval of any construction plans.

B.) Contents of the SWMP

The SWMP shall contain all of the necessary support data, methodologies used in calculations, and conclusions. A checklist is below that will be used by the City reviewer as a guide during the evaluation of all SWMP reports submitted to the City. The purpose of the checklist is to expedite the review process for both the engineer and the City, and to aid the engineer in the preparation of reports for the City's review.

A storm water management concept plan or preliminary drainage plan should be submitted with the preliminary plat or the initial submittal of a minor plat, site plan, or Grading and Clearing permit application. The concept plan should detail in concept how runoff and associated water quality impacts resulting from the development will be controlled or managed. It should address the pre, post and ultimate development conditions of the watershed. The plan should be labeled "Concept" or "Preliminary".

The final SWMP should be submitted at the prior to final plat, minor plat, or building permit. In addition to the information from the preliminary or concept plan, shall include all of the information required in the final Storm Water Management Plan (SWMP) checklist at the end of this section.

In general the Final Storm Water Management Plan should contain the following (for details see the checklist at the end of this section):

- The contact information for the owner of the property or properties affected.
- A vicinity map of the site and affected reach of the outfall channel;
- A topographic base map a detailed map of the area and the outfall channel with all pertinent physiographic information, with 2 foot contours;
- A watershed map showing the existing and proposed drainage area boundary along with all sub area delineations and all areas of existing and proposed development; indicate locations of all rights-of-way and additional easements/rights-of-way required, flow path to nearest downstream 100-year structure;
- All hydrologic and hydraulic calculations: discharge calculations specifying methodology and key assumptions used including a table of discharges at key locations; hydraulic calculations specifying methodology used, assumptions and values of the design parameters;
- Profiles of the affected channels, including water surface elevations for the specified design frequencies, all existing and proposed bridge, culvert and pipeline crossings, the location of all tributary and drainage confluences, and the location of all hydraulic structures;

- Detention basin design calculations, including those used for design of the control structure;
- Additional back-water analysis data as described in the checklist below
- Certification of a professional engineer that the resulting impact of the proposed development will not produce an adverse impact to downstream properties, structures, drainage facilities, and public infrastructure
- Soils map indicating the type of soil and hydrologic group.
- Maintenance and repair plan for permanent BMPs and a maintenance agreement for on-site storm water management measures.
- Erosion and sediment control plans or Storm Water Pollution Prevention Plans (SWPPP) for construction
- Other Environmental Permits

4.4 WATER QUALITY

A.) Post construction storm water quality will eventually be regulated for the quality of the water discharged. Standards for post construction water quality of discharge are not currently being enforced.

B.) In accordance with the City of Schertz Construction Storm Water Management Ordinance and Section 01410 of the Public Works Specifications, no person shall be granted a Grading and Clearing Permit or Construction Permit for land-disturbing activity without the approval of a Storm Water Pollution Prevention Plan (SWPPP) report and plans.

1.) The SWPPP follow the requirements of the Construction Storm Water Management Ordinance and shall include:

a.) Each application shall bear the name(s) and address(es) of the owner or developer of the site and of any consulting firm retained by the applicant together with the name of the applicant's principal contact at such firm, and the designated operator as defined by TPDES General Permit.

b.) A natural resources map identifying soils, forest cover, and resources protected by the City's regulations;

c.) A sequence of construction of the development site, including stripping and clearing; rough grading; construction of utilities, infrastructure, and buildings; and final grading and landscaping. Sequencing shall identify the expected date on which clearing will begin, the estimated duration of exposure of cleared areas, areas of clearing, installation of temporary

erosion and sediment control measures, and establishment of permanent vegetation;

d.) All erosion and sediment control measures necessary to meet the objectives of the City's regulations throughout all phases of construction and after completion of development of the site. Depending upon the complexity of the project, the drafting of intermediate plans may be required at the close of each season;

e.) Seeding mixtures and rates, types of sod, method of seedbed preparation, expected seeding dates, type and rate of lime and fertilizer application, and kind and quantity of mulching for both temporary and permanent vegetative control measure; and

f.) Provisions for maintenance of control facilities, including easements and estimates of the cost of maintenance, dust control and cleaning, stock pile protection, etc.

2.) Major amendments of the SWPPP must be submitted for approval by Public Works and Engineering.

3.) In addition to the report, appropriate details and instructions to be included with the construction plan set.

4.) Provide the Public Works Department copies of all submittals to the Texas commission on Environmental Quality (TCEQ), including the notice of intent (NOI) and notice of termination (NOT).

4.5 STORM DRAINAGE DESIGN CRITERIA

A.) Method of Computing Runoff

1.) The preferred method for computing storm water runoff shall be a unit hydrograph method such as WinTR-20, WinTR-55, HEC HMS models, or some other method provided it is acceptable to the City Engineer or his designee.

2.) For small urban drainage areas less than 200 acres where hydrographs are not required, for storm sewer inlets, for road side ditches, for driveway culverts, or for "peak flow only" calculations, the basis for computing peak flow runoff may be the Rational formula. The Rational method is not allowed for the design or detention ponds nor channels within the FEMA designated special flood hazard area

3.) Normal depth channel calculations are permissible for constructed open channels with a uniform geometric cross section where there is no potential for the water surface elevations to be controlled by backwater and the channel is not in a FEMA special flood hazard area.

4.) Hydraulic calculations for open channels with non-uniform geometric cross sections shall be performed by using the HEC-RAS "River Analysis System" computer models, or other method approved by the City Engineer or his designee.

5.) Watersheds may have hydrologic and hydraulic models that are available contact the City of Schertz Public Works' Department for more information. Developments proposed within the limits of these watersheds must have the models updated by the consultant to reflect changes in flow, channel configuration (including alterations to vegetation) and channel structures. The updated models shall be submitted to the Director of Public Works for incorporation into the master models.

B.) Time of Concentration

Sheet flow, shallow concentrated flow and channel flows are components that need to be considered in the calculation of time of concentration. The following methods are recommended for time of concentration calculation.

1.) Sheet flow - flow over plane surfaces based on TR 55 method and roughness coefficients for sheet flow: Minimum is five (5) minutes. Maximum allowable time is twenty (20) minutes, or a maximum distance of 300 feet.

2.) Shallow concentrated flow – Use Manning's equation to estimate travel time for defined swales, bar ditches and street sections, etc. Figure 3-1 from TR-55 "Urban Hydrology for Small Watersheds", SCS 1986, may be used where a geometric section has not been defined.

3.) Channel flow: Use existing computer models where available or Manning's equation if data is not available. Non-floodplain channel velocities for ultimate watershed development should not be less than six (6) fps when estimating time of concentration. Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on USGS quadrangle sheets.

C.) Runoff coefficients (C value) for use in the Rational formula shall not be less than the values shown in Tables 4.5A as appropriate.

Table 4.5A
Runoff Coefficients (C) - Percentage

Character of Area	Slope			
	Up To 1%	1% To 3%	3% To 5%	Over 5%
Business or Commercial Area (90% or More Impervious), Existing Pavement/Buildings	95	96	97	97
Densely Developed Area (80% To 90% Impervious)	85	88	91	95
Closely Built Residential Area and School Sites	75	77	80	84
Large Lot Residential Area	55	57	62	64
Average Residential Area	65	67	69	72
Undeveloped Areas				
Undeveloped and Ultimate LAnd Use is Unknown	68	70	72	75
Cultivated or Range (Grass Cover <50% of Area)	44	47	49	53
Range (Grass Cover 50-75% of Area)	37	41	49	53
Forest or Range (Grass Cover >75% of Area)	35	39	47	52

1.) In all cases, wet antecedent conditions shall be assumed. Runoff rates shall be computed on the basis of the ultimate development of the entire watershed to the proposed subdivision. For determination of time for concentration, times shall be figured on the basis that there shall be an improved drainage system upstream from the point under consideration.

D.) Rainfall Intensity. Use Table 4.5B to determine rainfall intensity.

Table 4.5B							
Rainfall Intensities (inches/hour)							
Duration	Frequency						
Minutes	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	500-Year
1	6.94	8.00	8.84	9.99	11.09	11.92	13.55
2	6.69	7.72	8.53	9.67	10.69	11.53	13.24
3	6.45	7.46	8.24	9.36	10.31	11.15	12.93
4	6.22	7.21	7.95	9.05	9.95	10.79	12.62
5	6.00	6.96	7.68	8.76	9.60	10.44	12.30
6	5.79	6.73	7.42	8.48	9.27	10.10	11.98
7	5.59	6.50	7.17	8.20	8.95	9.78	11.66
8	5.40	6.28	6.93	7.94	8.65	9.47	11.34
9	5.21	6.08	6.70	7.69	8.37	9.17	11.01
10	5.04	5.88	6.48	7.44	8.10	8.88	10.68
11	4.88	5.69	6.27	7.21	7.85	8.61	10.35
12	4.72	5.52	6.08	6.98	7.61	8.35	10.02
13	4.58	5.35	5.89	6.76	7.39	8.10	9.68
14	4.45	5.19	5.72	6.56	7.19	7.86	9.34
15	4.32	5.04	5.56	6.36	7.00	7.64	9.00
16	4.22	4.94	5.46	6.26	6.89	7.53	8.89
17	4.12	4.84	5.36	6.16	6.79	7.42	8.78
18	4.03	4.75	5.27	6.06	6.68	7.31	8.68
19	3.94	4.66	5.17	5.96	6.58	7.20	8.57
20	3.85	4.56	5.08	5.86	6.48	7.09	8.47
21	3.76	4.48	4.99	5.77	6.38	6.99	8.36
22	3.67	4.39	4.90	5.68	6.28	6.88	8.26
23	3.59	4.30	4.82	5.59	6.18	5.78	8.16
24	3.51	4.22	4.73	5.50	6.09	6.68	8.06
25	3.43	4.14	4.65	5.41	6.00	6.58	7.96
26	3.35	4.06	4.57	5.33	5.91	6.49	7.86
27	3.27	3.98	4.49	5.24	5.82	6.39	7.76
28	3.20	3.91	4.41	5.16	5.73	6.30	7.67
29	3.13	3.83	4.33	5.08	5.64	6.21	7.57
30	3.06	3.76	4.26	5.00	5.56	6.12	7.48
31	2.99	3.69	4.19	4.92	5.48	6.03	7.39
32	2.93	3.62	4.12	4.85	5.40	5.95	7.30
33	2.87	3.56	4.05	4.77	5.32	5.86	7.21
34	2.81	3.49	3.98	4.70	5.24	5.78	7.12
35	2.75	3.43	3.92	4.63	5.17	5.70	7.03

36	2.69	3.37	3.86	4.56	5.09	5.62	6.94
37	2.64	3.31	3.80	4.50	5.02	5.54	6.86
38	2.59	3.26	3.74	4.43	4.95	5.47	6.77
39	2.54	3.21	3.68	4.37	4.88	5.40	6.69
40	2.49	3.15	3.62	4.31	4.82	5.32	6.61
41	2.45	3.10	3.57	4.25	4.75	5.25	6.53
42	2.40	3.06	3.52	4.19	4.69	5.19	6.45
43	2.36	3.01	3.47	4.13	4.63	5.12	6.37
44	2.32	2.97	3.42	4.08	4.57	5.05	6.29
45	2.29	2.92	3.37	4.02	4.51	4.99	6.21
46	2.25	2.88	3.33	3.97	4.45	4.93	6.14
47	2.22	2.85	3.29	3.92	4.40	4.87	6.06
48	2.19	2.81	3.25	3.87	4.34	4.81	5.99
49	2.16	2.78	3.21	3.83	4.29	4.76	5.92
50	2.14	2.74	3.17	3.78	4.24	4.70	5.85
51	2.11	2.71	3.13	3.74	4.19	4.65	5.78
52	2.09	2.69	3.10	3.70	4.15	4.60	5.71
53	2.07	2.66	3.07	3.66	4.10	4.55	5.64
54	2.06	2.63	3.04	3.62	4.06	4.50	5.58
55	2.04	2.61	3.01	3.59	4.02	4.45	5.51
56	2.03	2.59	2.99	3.55	3.98	4.41	5.45
57	2.02	2.57	2.96	3.52	3.94	4.37	5.38
58	2.01	2.56	2.94	3.49	3.91	4.33	5.32
59	2.00	2.54	2.92	3.46	3.87	4.29	5.26
60	2.00	2.53	2.90	3.43	3.84	4.25	5.20
120	1.10	1.54	1.83	2.21	2.50	2.78	3.48
18	0.86	1.19	1.41	1.68	1.88	2.08	2.53
240	0.70	0.97	1.13	1.33	1.50	1.65	1.99
360	0.51	0.71	0.83	0.98	1.09	1.19	1.41
720	0.28	0.39	0.46	0.55	0.61	0.67	0.81
1440	0.165	0.227	0.273	0.32	0.366	0.413	0.513

E.) SCS Curve Numbers.

1.) For the NRCS method, the rainfall distribution type III shall be used in the runoff model and shall be in accordance with the San Antonio River Basin standards for analysis. Design rainfalls values listed in Table 4.5E shall be used for hydrograph calculations. The SCS curve numbers adopted for use by the City of Schertz are shown in Table 4.5C. The hydrologic soil groups are listed in the latest version of the United States Natural Resources Conservation Service, "Urban Hydrology for Small Watersheds", Technical Release No. 55 (TR 55), which document is hereby incorporated by

this reference. Soil types that relate to the hydrologic soil group may be found in the latest version of the United States Natural Resources Conservation Service Soil Surveys for Bexar, Guadalupe and Comal Counties, Texas which documents are hereby incorporated by this reference. Soil types may also be based on a Geotechnical Engineering Report. Alternative curve numbers may be approved by the City Engineer.

Table 4.5C
SCS Curve Numbers

Cover Type and Descritpion	Curve Number for hydrologic soil group			
	A	B	C	D
Open space (lawn, parks, golf courses, cemeteries, etc.):				
Poor condition (grass cover < 50%)	68	79	86	89
Fair condition (grass cover 50% to 75%)	49	69	79	84
Good condition (grass cover > 75%)	39	61	74	80
Impervious areas:				
Paved parking lots, roofs, driveways, etc. (excluding ROW)	98	98	98	98
Streets and roads:				
Paved: curbs and storm sewers (excluding ROW)	98	98	98	98
Paved: open ditches (including ROW)	83	89	92	93
Gravel (including ROW)	76	85	89	91
Dirt (including ROW)	72	82	87	89
Pasture, grassland, or range – continuous forage for grazing, 50 – 75% ground cover and not heavily grazed	49	69	79	84
Meadow–continuous grass, protected from grazing and generally mowed for hay	30	58	71	78
Brush–brush-weeds-grass mixture with brush the major element > 75% ground cover	30	48	65	73
Woods–grass combination (orchard or tree farm). CN's shown were computed for areas with 50% woods and 50% grass(pasture) cover	32	58	72	79
Woods–protected from grazing, and litter and brush adequately cover the soil	30	55	70	77
Farmsteads–buildings, lanes, driveways and surrounding lots	59	74	82	86

2.) Percent Impervious Cover. The percent impervious cover for typical land use types in Schertz are presented in Table 4.5D.

Table 4.5D
SCS Curve Numbers by Impervious Cover and Cover type

Cover Type and Description	Average % Impervious Cover	Curve Number for hydrologic soil group			
		A	B	C	D
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential: 1/8 acre lot or less (town houses) average lot size	65	77	85	90	92
Residential: 1/4 acre average lot size	38	61	75	83	87
Residential: 1/3 acre average lot size	30	57	72	81	86
Residential: 1/2 acre average lot size	25	54	70	80	85
Residential: 1 acre average lot size	20	51	68	79	84
Residential: 2 acre average lot size	12	46	65	77	82

3.) Design Rainfall. A twenty-four-hour rainfall distribution shall be applied for runoff calculations. Design Rainfall Values as adopted for the City of Schertz are given in Table 4.5E and should be used for HEC-HMS input. The lag value for a subarea shall be calculated as 0.6 times the time of concentration. Facilities with watersheds greater than one hundred (100) acres must be designed for the 100-year frequency storm or the 25-year event plus freeboard (see Table 4.5G), unless otherwise stated below.

Table 4.5E
Design Rainfall Values (inches)

Bexar County							
Duration	Frequency						
	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	500-Year
5 minute	0.60	0.70	0.78	0.93	1.04	1.13	1.52
15 minute	1.15	1.37	1.60	1.80	2.10	2.50	3.30
60 minute	2.07	2.46	2.76	3.32	3.85	4.35	5.80
2 hour	2.57	3.11	3.55	4.35	5.10	5.80	8.10
3 hour	2.80	3.42	3.95	4.90	5.70	6.60	9.40
6 hour	3.31	4.01	4.60	5.70	6.50	7.50	10.60
12 hour	3.78	4.60	5.40	6.40	7.50	8.80	12.40
24 hour	4.44	5.36	6.00	7.50	9.00	10.00	13.70
Comal and Guadalupe County							
Duration	Frequency						
	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	500-Year
5 minute	0.51	0.66	0.80	0.96	1.11	1.28	1.77
15 minute	1.05	1.34	1.58	1.89	2.16	2.47	3.37
60 minute	1.86	2.40	2.78	3.34	3.83	4.39	5.39
2 hour	2.24	2.95	3.43	4.16	4.79	5.51	7.55
3 hour	2.45	3.27	3.84	4.67	5.40	6.23	8.58
6 hour	2.80	3.85	4.58	5.64	6.57	7.61	10.58
12 hour	3.15	4.47	5.43	6.76	7.92	9.24	12.98
24 hour	3.52	5.17	6.40	8.07	9.52	11.17	15.88

4.) Routing of Runoff. Routing of the runoff hydrograph through the channel from one subarea calculation point to the next in the HEC-HMS shall be computed using one of the following methods:

a.) Overbank/channel storage not significant: Use normal depth channel routing.

b.) Overbank/channel storage is significant: use the Muskingum method where a hydraulic model is not available. Use Modified Puls Storage method where a hydraulic model is available to develop storage/out flow relationship.

c.) Kinematic wave method for channel reaches where inflow from overbank runoff or multiple point sources (Example: storm sewer outfalls) is significant and where hydrograph attenuation is insignificant. Channel routing methodologies currently being applied in the existing HEC-HMS model of the watershed shall not be replaced with a different methodology without approval or direction from the Director of Public Works.

F.) STREETS

1.) Generally.

a.) Design of streets shall consider public safety and limit potential conflicts between storm water conveyance, traffic, parking, pedestrian access, ADA requirements, and bicycle traffic.

b.) Streets draining a watershed greater than one hundred (100) acres must be designed for the 100-year frequency storm.

c.) Streets may be used for storm water drainage only if the calculated storm water flow does exceed not the flows as outlined below or the velocity does not exceed ten (10) feet per second.

d.) Where streets are not capable of carrying storm water, as outlined above, inlets or curb openings discharging to drainage channels or storm sewers shall be provided. Partial flow past the inlet will be allowed when the capacity of all downstream street systems can accommodate the flow.

e.) Street width shall not be widened beyond the width as determined by the street classification for drainage purposes.

f.) Storm water conveyance on streets shall be designed to account for the cumulative impact of peak flows and runoff volumes on the system as the storm water progresses downgrade.

g.) Curb cuts for driveways on all streets shall be designed for compatibility with the storm water conveyance function of streets.

h.) Potential flooding problems or conflicts at the connection points where new or modified drainage systems (including

streets, storm sewers, etc.) and the existing portions of the downstream street system and storm water conveyance system shall be identified and resolved either in the design of the new or modified drainage system or in modifications to the existing system.

i.) Dwelling units located on the downhill side of a T-intersection with a street or drainage channel discharging onto the intersection shall be sited so as to avoid obstruction of the drainage patterns.

2.) An arterial street is a street so designated on the current major thoroughfare plan. One (1) lane in each direction on arterial streets shall remain passable with a flow depth not to exceed 0.30 feet during a twenty-five-year storm event. The maximum depth of water in the street section must not exceed seven (7) inches (the height of a standard city curb).

3.) A maximum flow depth to the top of curb on a collector street section will be allowed during a twenty-five-year storm event. A collector street is a street with a width of forty-two (42) feet or more and not shown as an arterial street on the current master thoroughfare plan.

4.) Local Streets. Local streets shall be designed on a basis of a five-year frequency. A twenty-five-year frequency storm must be contained within the street right-of-way.

5.) Alleys shall be designed for five-year frequency within the limits of the alley pavement/curbs and twenty-five-year frequency within the right-of-way/easement to carry storm water.

6.) All-Weather Crossings.

a.) Where streets cross existing or proposed watercourses, all weather crossings shall be required. Culverts or bridges shall be adequate to allow passage of 25-year design storm. In the instance the crossing conveys greater than 100 acres of runoff the crossing then must be adequate for a 100-year design storm.

b.) All crossings, culverts and bridges shall be designed for an H-20-44 or HS-20 loading.

G.) CHANNELS

1.) This section addresses proposed improvements or modifications to drainage channels and watercourses required to convey storm water runoff from or through the proposed development.

2.) Except as authorized by a development plan approved by the director of public works or his designee, no person shall place or cause to be placed any obstruction of any kind in any watercourse within the city and its ETJ. The owner of any property within the city, through which any watercourse may pass, shall keep the watercourse free from any obstruction not authorized by a development plan.

3.) Channel Modifications.

a.) Modifications to existing watercourses or newly created open channels may be designed as earth channels, sod channels or as concrete lined channels. Liners other than sod or concrete which enhance the aesthetics or habitat value of the watercourse and which reduce future maintenance requirements are encouraged. Preliminary planning for the applicability of other channel liners shall be reviewed with the director of public works or his representative prior to the submittal of construction plans for approval.

b.) Runoff that results from upstream development and is discharged to an unimproved waterway can cause flood damage to properties adjacent to the waterway. Natural undeveloped waterways do not receive regular maintenance. Design of natural waterways shall take into consideration fluvial geomorphologic principals and practices. Consulting engineers and development review officials shall work to resolve potential downstream impact issues.

4.) Design of new channels or alterations to existing channels shall consider future maintenance requirements. A maintenance schedule for any private channel shall be submitted to and approved by the director of public works prior to approval of construction plans. Maintenance requirements of concrete channels consist of de-silting activities, prevention of vegetation establishment in construction joints, and repair of concrete as necessary. Maintenance of earthen channels includes regular observation and repair, as necessary, of erosion, scouring, and removal of silt deposits, as necessary to maintain design parameters. Developers shall be responsible for maintaining newly planted channels until coverage is established throughout eighty-five (85) percent of the area. This area shall include slopes, floor, and any attendant maintenance easement. New earthen channels

shall be planted with drought resistant, low growth, native species grasses, which will allow unobstructed passage of floodwaters. Johnson grass, giant ragweed and other invasive species shall not be allowed to promulgate in channels. Suggested species shall include, but not be limited to, common bermuda, coastal bermuda, buffalo grass, sideoats grama, seep muhly, little bluestem, and indian grass. Mowing frequencies vary with the vegetation growth rates, but is required when the grass exceeds the design roughness coefficient of the channel.

5.) Planned multiple-use of a watercourse is allowed (e.g. bike paths or greenbelt). If multiple use of the watercourse is to be incorporated, the applicant shall form a property owners' association that shall assume maintenance responsibility for private amenities. The appropriate government agency will be responsible for maintenance of public amenities. The applicant shall provide overlay easements for public or private use.

6.) Table 4.5F shall be used to determine maximum permissible channel velocity.

Table 4.5F
Velocity Control

Velocity	Type Drain Required	Hydraulic Radius	Correction Factor	Max. Permissible Velocity
1 to 6 fps (Maximum Average Velocity = 6 fps)	Grass Lined Channel	0-1 ft	0.8	5 fps
		1-3 ft	0.9	5.5 fps
		3-5 ft	1.05	6.3 fps
		5-8 ft	1.15	6.9 fps
		8-10 ft	1.225	7.35 fps
		Over 10 ft	1.25	7.5 fps
6 to 8 fps	Concrete retards required	NA	NA	NA
8 fps and over	Concrete Lining or Drop Structures Required	NA	NA	NA

a.) Where velocities are in the supercritical range, allowance shall be made in the design for the proper handling of the water by the design of energy dissipaters at the outfall, and the lining of the channel, and the inclusion of freeboard.

b.) Ensure that the channel will contain the hydraulic jump (sequent depth) throughout the extent of the supercritical profile. An exception to this criterion is where concrete lined lateral channels discharge down the side slopes of channels.

These channels may be designed for normal depth plus freeboard provided velocity controls are established at the main channel flow line.

c.) Ensure that the energy grade of the channel will not result in upstream flooding at existing or proposed lateral facility connections.

7.) Retard spacing shall be computed as using the following equations and subject to the Velocity Control standards in Table 4.5F:

$L = 1.0 \div (S1 - S2)$

Where: L = Distance required between retards in feet.
S1 = Actual slope of channel in ft./ft.
S2 = Slope of proposed channel for maximum permissible velocity established from Table 4.5F. For example
$S2 = [V \div (1.486 * n * R^{2/3})]^2$
Where:
V = maximum permissible velocity established from Table 4.5F
n = .035, manning's roughness coefficient for grass lined channel
R = area/wetted perimeter

8.) Concrete Lined Channels. The design of concrete lined channels shall comply with the following general requirements:

a.) Freeboard consistent with Table 4.5G will be applied to the twenty-five-year design.

Table 4.5G
Drainage Freeboard for Concrete Lined and Earth Channels For 25 Year Storm

Design Depth of Flow	Required Freeboard
0-5 ft	0.5 ft
5-10 ft	10% of Design Depth
Over 10 ft	1.0 ft

b.) From the top of the concrete lining to the top of the ditch, a side slope not steeper than three (3) horizontal to one (1) vertical shall be required; nor shall the slope be less than twelve to one (12:1).

c.) For normal conditions, the concrete lining shall be a minimum of five (5) inches thick and reinforced with No. 3 round bars at twelve (12) inches on center each way. Where surcharge, nature of ground, height and steepness of slope, etc., become critical, design shall be in accordance with latest structural standards. All concrete lining shall develop a

minimum compressive strength of not less than three thousand (3,000) pounds per square inch in twenty-eight (28) days. The depth of all toe downs shall be thirty-six (36) inches upstream, twenty-four (24) inches downstream, and eighteen (18) inches for side slopes. The city's construction inspector may permit an eighteen-inch toe down in rock sub grade in lieu of the above toe down requirements. The horizontal dimensions of toe downs shall not be less than six (6) inches.

d.) Maximum concrete riprap side slopes shall be one and one-half (1-1/2) horizontal to one (1) vertical, unless soil tests made by a geotechnical engineer show that a greater slope, or a special design, will be stable. Where vehicular traffic may travel within a horizontal distance equal to one-half (1/2) the vertical rise of the slope, a two-foot surcharge load shall be included in the design.

e.) Fencing will be required adjacent to the channel where channel vertical wall heights exceed two (2) feet. Fencing will also be required adjacent to the channel where channel side slopes exceed two to one (2:1) and the channel depth is greater than two (2) feet. The fencing must not cause sight distance problems for motorists.

f.) Vertical walls will not be permissible for depths greater than two (2) feet unless properly fenced or enclosed. Walls will have a minimum thickness of six (6) inches.

g.) Easements or rights-of-way for concrete lined channels shall extend a minimum of two (2) feet on both sides of the extreme limits of the channel. "Extreme limits" of the channel shall mean the side slope intercept with the natural ground or proposed finished ground elevation. This two (2') foot space shall be constructed of concrete or some other maintenance free material.

h.) A minimum "N" value of roughness coefficient of 0.015 shall be used for a wood float type surface finish. This "n" value is as used in Manning's formula. Recommended "N" are available in Table 4.5H below for approval to alter contact the City Engineer.

Table 4.5H Manning's Roughness Coefficient "N"	
Channel Description	"N" Value
Concrete Lined Channel	0.015
Grass Lined Channel with Regular Maintenance	0.035
Grass Lined Channel without Recent Maintenance	0.050
Vegetated Channel with Trees, Little or No Underbrush	0.055
Natural Channel with Trees, Moderate Underbrush	0.075
Natural Channel with Trees, Dense Underbrush	0.090
Natural Channel with Dense Trees and Dense Underbrush	0.100
Reinforced Concrete Pipe	0.013
Concrete Box Culverts	0.013
Overbank Description	"N" Value
Pasture	0.035-0.055
Trees, Little or No Underbrush, Scattered Structures	0.060-0.075
Dense Vegetation, Multiple Fences and Structures	0.075-0.090
Corrugated metal pipe	"N" Value
Unpaved ½" corrugated	0.024
Unpaved 1" corrugated	0.027
Asphalt	0.018

9.) Vegetated Earth Channels.

a.) Freeboard consistent with 4.5G will be applied to the twenty-five-year design

b.) The side slope shall not be steeper than three (3) horizontal to one (1) vertical.

c.) Easements or rights-of-way for improved earth channels shall conform to the requirements stated in subsection (d) of this section and shall extend a minimum of two (2') feet on one (1) side and fifteen (15') feet for an access road on the opposite side of the extreme limits of the channels when such channels do not parallel and adjoin an alley or roadway. When such channels do parallel and adjoin an alley or roadway, the easement or right-of-way shall extend a minimum of two (2') feet on both sides of the extreme limits of the channel. Where utilities are installed in the access road of the drainage right-of-way, the right-of-way shall extend two (2') feet on one (1) side and seventeen (17') feet on the opposite side of the design limits of the channel. These seventeen (17') feet are to provide an access way

along the channel with a maximum cross slope of one (1") inch per foot toward the channel. Where designed channel bottoms exceed one hundred (100') feet in width, the fifteen-foot extra width shall be provided on both sides of the channel.

d.) Interceptor drainage easements shall extend a minimum of two (2') feet on both sides of the extreme limits of the channel. Improved earthen channels will be vegetated by seeding or sodding. Eighty-five (85) percent of the channel surface area must have established vegetation before the City of Schertz will accept the channel for maintenance.

10.) Channel Bends. Allowance for extra freeboard shall be made when the centerline radius of the channel is less than three (3) times the bottom width. Where sharp bends or high velocities are involved, the applicant shall use the following formula for computing the extra freeboard:

$$d_2 - d_1 = V^2 * (T + B) \div (2*g*R)$$

Where: d_1 = depth of flow at the inside of the bend in feet.
d_2 = depth of flow at the outside of the bend in feet.
B = bottom width of the channel in feet.
V = the average approach velocity in the channel in feet per second.
T = width of flow at the water surface in feet.
g = 32.2 feet/second squared.
R = the center line radius of the turn or bend in feet.

a.) The quantity $d_2 - d_1$ divided by two (2) shall be added to the normal depth of flow before adding the required freeboard in calculating required right-of-way widths.

b.) Where sharp turns are used without curved sections, the depth required shall be large enough to provide for all head losses. Allowance shall be made for any backwater head that may result.

c.) For normal design conditions no extra freeboard is required. An accepted rule of thumb to follow is this: Centerline radius of channel should be at least three (3) times the bottom width.

11.) Trickle Channel. All channels and detention basins with a bottom width of twelve (12') feet or greater must have a trickle channel, a

minimum of five (5') feet wide, following the centerline to facilitate positive drainage to the outfall or the entire length of the channel.

H.) STORM SEWERS.

1.) For all ordinary conditions, storm sewers shall be designed on the assumption that they will flow full under the design discharge; however, whenever the system is placed under a pressure head, or there are constrictions, turns, submerged or inadequate outfall, etc., the hydraulic and energy grade lines shall be computed and plotted in profile. In all cases adequate outfalls shall be provided and the system adequately designed. Show the HGL in the profile.

2.) No storm sewers shall be less than twenty-four (24) inches in diameter

3.) Minimum easement widths for storm sewers will be the greater of fifteen (15) feet or six (6) feet on both sides of the extreme limits of the storm sewer width (e.g. the easement width for a three (3) barrel ten-foot wide box culvert with six-inch walls would be (3 x 10')+(4 x 0.5')+(2 x 6') = 44').

I.) INLETS AND OPENINGS.

1.) Drop Curb Openings - Sidewalk Does Not Abut Opening. Where drop curb openings are used to take storm water off the streets and into drains or swales, the length of the curb opening can be calculated from the weir formula using the coefficient of 3.087 in the following formula:

$$L = Q \div (C_w * h^{3/2})$$

Where:
L = the length of drop curb opening required in feet
Q = amount of flow in cubic feet per second (cfs) based on twenty-five-year design frequency
C = 3.087
h = head of weir in feet

Gutter line depressions will be permitted where such depressions will not hinder the flow of traffic. For amount of curb exposure, conform to Texas Department of Transportation San Antonio District Inlet Type I or II.

2.) Curb or Drop Inlets. Where drop inlets are used, the city standard inlets with adequate reinforcing steel may be used. All other types or designs shall be subject to the approval of the director of

developments services in consultation with the director of public works. The following formulas for inlet capacity are based on drop inlets in sag points. Inlet capacities on grades will be considered less, the amount of which depends on street grades, deflections, cross slopes, depressions, etc.

3.) Grate Inlets. The flow of water through grate openings may be treated as the flow of water through a rectangular orifice. The following formula may be used for determining grate capacity:

$$Q = C_o * A * (2*g*h)^{1/2}$$

Where:
Q = discharge in cubic feet per second
C_o = orifice coefficient of discharge (taken as 0.70)
g = acceleration due to gravity (32.2 ft./sec^2)
h = head on the grate in feet
A = net area of the openings in the grate in square feet

This formula gives the theoretical capacity of the grate inlet. Since grate inlets are subject to considerable clogging, capacity of the grate inlet will be taken as one-half (1/2) on the value given by this formula.

4.) Curb Opening Inlets. The capacity of curb opening inlets will depend on whether or not the opening is running partially full or submerged. If the depth of flow at the curb opening inlet is such as to cause a partially full opening, a weir effect will develop and the following formula will apply:

$$Q = C_w * L * h^{3/2}$$

Where:
Q = the discharge of capacity in cubic feet per second
C_w= the weir coefficient of discharge (3.087)
L = the length of curb opening in feet
h = the head or depth of water at the opening in feet

If the depth of flow at the curb opening is such as to fully submerge the opening, the orifice effect will develop and the formula used shall be identical to that given under grate inlets with the exception that the head, h, on the curb opening orifice shall be taken as the depth from the top of the water surface to the center of orifice or opening; one hundred (100) percent efficiency will be allowed for curb opening inlets.

J.) DETENTION BASINS

For projects with an increased impervious area of greater than 0.1 acres, for all new developments or redevelopment of individual parcels of

property, detention basins may be used to mitigate peak flow rates to predevelopment or existing development conditions

1. The maximum allowable outflow rate from the detention facility must be restricted to the flow rate from the undeveloped or existing development tract for the five (5)-year, twenty-five (25)-year and one-hundred (100)-year frequency. Best management practices shall be used in the design of detention facilities in accordance with this section. The timing of the hydrograph released from the detention facility must be checked against the timing of the flow rate in the first open watercourse to prevent any increase in the peak flow rate in the receiving watercourse. For detention basins constructed in-line on an existing watercourse, the creation of the basin shall not increase flood elevations in the channel upstream of the new development boundaries.

2. On-site detention facilities must be privately owned and shall be maintained by the community association or property owner. A maintenance schedule shall be submitted to the public works department and approved by the Director of Public Works prior to approval of construction plans. The City will have the right to do periodic inspections of privately owned and maintained detention facilities to ensure that the maintenance schedule is being implemented. When a regional detention facility accepts flow from an area exceeding three hundred (300) acres, the facility shall be considered serving a public purpose and shall be dedicated to the City.

3. Multi-use facilities are encouraged, but not required (multi-use facilities allows for water quality, satisfy TPDES requirements, enhance around water recharge, provide open space, provide recreation or other amenities, and/or provide habitat) and may be utilized so long as the facility meets the standards set forth in subsection (F.1) of this section and does not increase the rate or volume of erosion above that which would result from the use of a facility without multiple uses. The use of multi-use detention facilities to alleviate existing flooding problems, enhance and provide amenities for older neighborhoods, and support the revitalization of economically depressed areas is encouraged in public and private redevelopment initiatives.

4. Maximum water depths over 6 feet will not be allowed without prior approval of the City Engineer.

5. Parking areas may be used as detention facilities provided the depth does not exceed 8 inches, and the impounding of storm water does not impact the adjacent buildings.

6. Storm water retention with permanent wet pool or pumped detention systems will not be acceptable methods of storm water mitigation unless the facility will remain privately owned, operated, and maintained. The City will approve the use of a pumped facility for private use under the following conditions:

    a. A gravity system is not feasible from an engineering and economic standpoint.
    b. At least two (2) pumps are provided each of which is sized to pump the design flow rate.
    c. The selected design outflow rate must not aggravate downstream flooding.
    d. Controls and pumps shall be designed to prevent unauthorized operation and vandalism.
    e. Adequate assurance is provided that the system will be operated and maintained on a continuous basis.

7. Stage- Storage- Discharge tables for basins and associated outlets will be required upon plans and within the SWMP.

K.) OUTFALLS/OUTLETS/TRANSITIONS

If the velocity at an outfall or outlet of a channel, storm drain, or detention pond to an earthen/grass lined channel is greater than 6 feet per second (fps), provide energy dissipaters or other means to reduce velocity and prevent erosion.

Provide retard spacing and concrete transition length calculations to account for the effect of hydraulic jumps.

4.6 STORM WATER CHECKLIST

City of Schertz Storm Water Management Plan (SWMP) Checklist		N/A	Complete	Incomplete
	A. GENERAL			
1.	Signed, sealed & bound SWMP			
	Introduction & Project description			
	Narrative of existing and proposed hydrology			
	Summary of calculations (indicate methodology and key assumptions, time of concentration calculation, Curve Number and Runoff Coefficient determination)			
	Table of runoff values			
2.	Certification by Engineer that the resulting impact of the proposed development will not produce a significant adverse impact to downstream properties, structures, drainage facilities, and public infrastructure.			
3.	Project Location Map			
4.	Flood Insurance Rate Map (FIRM) with site superimposed			
5.	Grading Plan (As required by City Engineer): Lots grading properly according to FHA Lot Grading Type (A, B, C) An upstream watershed no more than the depth of 1 residential lot or 120 feet, whichever is greater, may drain to a platted lot unless an interceptor drain is provided.			
6.	Aerial map: Delineate site boundary, contributing watershed, downstream flow path to 100-year facility, flood plain and floodway location			
	B. HYDROLOGY			
1.	Drainage Area Map (to scale) for Existing and Ultimate Conditions.			
	Show site boundaries, overall drainage areas and sub-areas, acreage of each drainage area, and discharge locations, downstream flow path to 100-year facility			
	Provide Existing & Design time of concentration flow paths with length & slope shown Table of runoff values at key locations.			
	Existing and proposed topographic information with minimum two (2) foot contour elevations			
	Flood plain and floodway location, with BFE indicated			
2.	Detailed Q calculations include:			
	Time of Concentration (provide detailed calculations) (TR 55 method preferred): Overland Sheet - Length, slopes, (5 min < to< 20 max), max 300 feet Shallow Concentrated Flow - Length, slopes Concentrated Flow - Length, slopes, assumed v ≥ 6fps			
	Rational Method Rational Method for watersheds 0 to 200 Acres, peak flow analysis only, no flow routing required, no floodplain analysis Verify Rainfall Intensities (I) & Runoff Coefficient (C)			
	Unit Hydrograph Method (TR 20 or HEC HMS, etc): SCS or other Hydrograph Method for larger watershed or flow routing required (detention pond) SCS curve number, CN value: provide detailed calculations & exhibit Routing Values (if used): Provide detailed calculations			

	Routing Method: Modified Puls or Muskingam Soil Survey Map of area (site delineated, soil type & acreage of each soil group)			
	C. HYDRAULICS			
1.	General: For all storm water facilities with drainage area > 100ac, design for Q100 All storm water facilities shall be designed for Ultimate development			
2.	Street Capacity: Local 'A': Q5 contained within curbs, Q25 contained within ROW. Collector/Local 'B": Q25 contained within curbs Arterial: Q25 within curbs AND one lane in each direction shall remain passable with a flow depth not to exceed 0.3 ft			
	Streets draining a watershed greater than one hundred (100) acres must be designed for the one hundred (100) year frequency storm.			
	Velocity < 10 fps.			
	Street draining to unpaved surface runoff velocity < 6fps.			
	Lateral curb opening sized as weir			
3.	Channels: (provide detailed calculations) If Drainage area < 100ac : Q25 plus freeboard (see Public Works Specifications) If Drainage area > 100ac : Q100 and Q25 plus freeboard (see Public Works Specifications)			
	Slope Conveyance Method (Mannings) – for small channels (BW≤20'), not in floodplain, nor affected by backwater. Provide section of channel indicating normal depth, velocity, Froude number			
	Standard Step Back Water Model (HEC RAS or similar) – for large channels (BW>20'), channels within floodplain, or channels controlled by back water. Provide plan and profile indicating HGL and EGL			
	Concrete channel: Manning's "n" minimum of 0.015 Hydraulic jump calculations			
	Earthen channel: Appropriate Manning's "n". Velocity < 6 fps			
	Channel bend extra freeboard calculations			
	Turf Reinforcement Matting: 6 fps < Vel < 12 fps. If > 12 fps, engineer's report should certify that material is appropriate for velocity. Include manufacturer spec's & installation instructions. Engineer to certify at final inspection that material was installed correctly.			
	Interceptor channel: Easement width calculation			
	Floodplain Submittal is required if property is within or next to a FEMA designated special flood hazard area			
4.	Storm Sewer			
	Inlet designed for 25-yr capacity			
	HGL/EGL: provide detailed calcs (including junction losses). Show in profiles of pipe EGL: below top of junction box or, if approved by City, specify bolted manhole covers. HGL: below gutter			
	Downstream tail water depth calculation			
	Min storm sewer pipe diameter = 24 inches. Pipe velocity between 2 fps and 12 fps			

5.	Culverts			
	Culvert design for 25-year event unless upstream water shed is greater than 100 acres, then it shall convey the 100-year runoff.			
	Designed according to FHWA HDS-5			
	Headwater does not overtop road			
	Box culvert, headwalls and wingwalls to conform to TxDOT design standards			
6.	Detention Basin			
	Indicate area to drain to detention basin			
	Provide inflow and outflow hydrographs for 5-yr, 25 yr 100 yr (proposed, ultimate)			
	Provide required storage for the 5 yr, 25 yr and 100 yr (proposed, ultimate)			
	Check tailwater conditions on outlet structure			
	Include a stage/storage/discharge table			
	Provide details on outlet structure (invert, sizes, slopes, details on plan sheet) indicate depth per rainfall event.			
	Verify pond height is 6' high or less from toe on downstream side of embankment (existing grade) to the top of the structure. If not, overflow spillway must have capacity for 100% of the ultimate development probable maximum flood (PMF) and TCEQ approval may be required.			
	Modified rational is not accepted unless approved by City Engineer.			
	Provide maintenance schedule			
	Provide results in tabular format with detailed calculations for allowable/existing, proposed, and ultimate discharges from the structure. Provide electronic files of model.			
7.	Outfalls / Outlets / Transitions			
	If velocity > 6fps at transition to earthen channel, provide energy dissipaters or other means to reduce velocity Provide retard spacing and concrete transition length calculations (hydraulic jump)			
	Receiving facility (street, channel, culvert, etc) capacity to accept runoff.			
8.	Easements			
	Widths include freeboard and access			
9.	Storm Water Pollution Prevention Plan			
10.	Maintenance agreement/plan			

City of Schertz
Floodplain Submittal

		N/A	Comp-lete	Inco-mplete
1.	Narrative (Per section 35-B119(d) of UDC) Table of Contents and abstract or executive summary Introduction that includes project description and history, location, scope and objective of analysis, previous and related studies that may affect this analysis. Summary, conclusions, vicinity map and recommendations. Include the impact on the floodplain's Q, WSEL & velocity.			
2.	Provide detailed Hydrology calculations for changes in hydrology or for unstudied stream reach, see SWMP above (with electronic copy of model)			
3.	Provide analysis of (with hard and electronic copy of) the following using HEC RAS or standard step backwater analysis model: 25 year existing and ultimate development condition hydraulic analyses 100 year existing and ultimate development condition hydraulic analyses			
4.	Provide plans and calculations for channel outfalls perpendicular to the floodplain. Channel outfall must be taken to the invert of the receiving channel or show the velocity to be less than 6 fps going down the side slope.			
5.	Plotted water surface profiles for the 100-year flows (if applicable)			
6.	Provide channel cross sections (existing superimposed on proposed) show the drainage easement, Mannings numbers, property lines, structures, etc.)			
7.	Provide a summary table of the hydraulic model (HECRAS) of the floodplain within the platted area			
8.	Copy of all permits needed under the authority of USACE, TCEQ, or any other applicable regulatory authority			
9.	Current Effective dFIRM of project area			
10.	Grading Plan (existing and finished contours)			
11.	Provide Topographic Work Map: show plan view of project limits, cross sections, existing/proposed contours, proposed development, current and revised flood plain limits, property lines, drainage easement, engineers signature and seal			
12.	Provide U.S.G.S. Quadrangle maps showing overall drainage areas, runoff coefficients, time of concentration, intensity.			
13.	Is this development over the Edwards Aquifer Recharge Zone?			
14.	Flood plain Development Permit Application (1 COPY ONLY).			
15.	Elevation Certificates (if applicable)			
16.	FEMA CLOMR / LOMR/LOMRa/LOMRf			
	Provide the applicable items listed above			
	MT-2 Form 1, Sec D: Provide Owners and Engineer's original signature.			
	MT-2 Form 2, Sec A: Provide an attached explanation if sediment transport is not considered.			
	MT-2 Form 2, Sec B.4: Model names in this section must match the models listed in the CD.			
	For Map Revision Detail study includes 10, 50, 100 and 500 year analysis.			
	If applicable, provide As Built Grading Plan with engineer's seal and signature.			
	Recommend providing Check-RAS output			
	Provide existing and proposed FEMA FIRM Maps with the following: **Existing** - Label Map "Current" and show the site boundaries. **Proposed** – Label Map "Revised", show site boundaries, show only the proposed floodplain limits, floodplain must tie in with the existing floodplain upstream and downstream, show the proposed streets centerline only and label, show the upstream and downstream limits of study.			

SECTION 5 – SANITARY SEWER REQUIREMENTS

5.1 GENERAL

All subdivisions shall be provided with an approved sewage disposal system. An Engineering Design Report for waste water shall be submitted for review by the City Engineer. The report should contain a map of the service area, development LUE count, design flow rates and calculations (Average Dry Weather, Peak Wet Weather flow), design capacity of the sewer, minimum and maximum velocities, and a statement declaring that minimum velocities and pipe capacities have been met. If the project is to require a lift station and force main, the sizing of the wet well, pumps, controls, and force main shall be included in the report.

The sanitary sewer collection system shall be designed in accordance with the standards and specifications set forth hereinafter.

A.) The Sub-divider shall dedicate, at his own cost, such right-of-way and construct such sanitary sewer main and appurtenance of such size as to adequately serve the area being subdivided as determined by the City or the utility company under whose jurisdiction the subdivision falls.

B.) The Sub-divider shall provide, prior to the beginning of such subdivision improvements, a guarantee of performance. Upon completion of the system and acceptance by the City and appropriate utility company, the installation shall become the property of the City and the utility company to operate and maintain.

5.2 MINIMUM STANDARDS

A.) Design Criteria: All gravity sewers shall be PVC gravity sewer pipe and fittings meeting the requirements of ASTM Specifications D 3034 and shall be SDR 26.

B.) Minimum size of sewer mains shall be eight (8”) inches in diameter and all house connections in streets or alleys must be six (6”) inches in diameter belonging to the owner of the lot. The minimum and maximum pipe slopes and velocities shall be in accordance with TCEQ standards (30 TAC Ch 217.53(1)(2)(A) table C.1). All sanitary sewer collection mains shall be of sufficient size to serve the peak dry weather flow from the service area plus infiltration and inflow. Provide flow calculations including the details of the average dry weather flow, the dry weather flow peaking factor, and the infiltration and inflow. The flow calculations must include the flow expected in the facility immediately upon completion of construction and at the end of its 50-year life. The line and must conform to Sanitary Sewer Master Plan recommendations on file in the office of the Director of Public Works.

C.) The following criteria shall be used in formulas in the design of sewer system:

1.) Average Dry Weather Daily Flow is based on 245 gpd/LUE (living unit equivalent).

2.) Peak Dry Weather Daily Flow is based on a peaking factor of 3.0.

3.) Peak Wet Weather Flow is Equal to Peak Dry Weather Flow plus Inflow/Infiltration.

Table 5.2A		
Flow From Contributing Population (245 gpd/LUE)		
Residential	LUE/each	1
Apartments & Extended Living	LUE/unit	3/5
Hotel/Motel	LUE/unit	1/3
Business	LUE/person	20/245
School	LUE/student	15/245
Unknown future development	LUE/acre	4

Rates for other non residential development may be obtained from actual water usage, TCEQ Waste Water Usage Rates (30 TAC §285.91(figure 3), or other method approved by City Engineer.

Table 5.2B	
Infiltration	
Source of Infiltration	Amount of Infiltration In Gallons Per Day Per Acre
Residential Area - Level to 7% Slope	700
Residential Area - 7% To 15% Slope	500
Totally Undeveloped Areas	360
High Water Table (Creek Beds, Lake Areas)	1450
Business and Industrial Areas	1000

D.) The developer shall furnish lift stations with Supervisory Control and Data Acquisition (SCADA) equipment where necessary. These shall be constructed only after approval by the City.

E.) Sewage treatment plants and sewer systems must conform to the requirements of Texas State Department of Health.

F.) Manholes: Five (5') Feet Diameter Precast Manhole Base with watertight manhole ring and cover and 30-inch diameter opening.

1.) Precast concrete manhole sections with steel reinforced concrete base with confined o-ring joints in conformance with ASTM C-443.

2.) Base shall be manufactured in accordance with ASTM C-478. The precast base may have formed smooth invert channels cast at the angles. The invert channel shall have ¼" = 1' fall toward the outlet and inverts shall be designed to prevent reverse flow.

3.) Resilient joint connectors for a watertight seal between the manhole base and specified line pipe shall be provided. This joint shall comply with ASTM C-923.

G.) Construction methods shall be in strict accordance with the manufacturer's installation procedures and recommendations. The items below are listed for emphasis:

1.) The City Public Works Department shall be advised forty-eight (48) hours before any construction is started in order for adequate scheduling inspection to be provided.

2.) Sewers shall be located in the centerline of streets and four (4') feet from the north or east lines where in alleys or as otherwise approved. (See Utility Layout Plat). Mains within earthen channels/drainage ways shall be protected from scour; a scour analysis may be required.

3.) All sewer lines shall be placed on line and grade as directed by the Design Engineer.

4.) Manhole shall be placed at all deflection, intercept and terminating points on the Public system and spaced not more than five hundred (500') feet apart.

5.) Manholes shall be provided at intersecting streets or alleys where there is a possibility of future extensions.

6.) Drop Manholes should be used sparingly and generally, only when it is not economically feasible to steeping the incoming sewer, in no case should a drop be used for a fall less than two (2') feet and all shall be interior drop manholes.

7.) Cleanouts may be used only where not more than one customer is on the line.

8.) Manholes located in the area to be paved shall be left covered below sub-grade until the street contractor has completed the street and then it shall be reset to finish grade.

9.) Compaction of sewer lines shall be according to Section 02317 – Excavation and Backfill for Utilities of the City of Schertz Public Works Standard Specifications.

10.) Construction over the Edwards Aquifer: For subdivisions constructed over Edwards and associated limestone formations, all construction shall meet the latest revision and requirement of the Texas Commission on Environmental Quality.

11.) All manhole section joints shall be wrapped with an external seal wrap meeting Specification 02082 and installed according to manufacturer's recommendations.

12.) Below paved areas, encapsulate manhole with cement stabilized sand or flowable fill; minimum of 1-foot below base, minimum 1-foot around walls, up to within 12-inch of pavement subgrade per specification 02317.

5.3 MINIMUM SANITARY SEWER TESTING REQUIREMENTS

A.) Sanitary Sewer Line Air Testing

1.) Description: This item shall cover the testing of completed sections of installed sewer pipe using low-pressure air tests on all completed sections of sanitary sewer mains.

2.) The air test will be used to evaluate materials and construction methods on the pipeline sections and successful air tests shall be mandatory for the acceptance of the lines.

B.) MATERIALS FOR TESTING

1.) Compressor Air Supply: Any source, which will provide at least three hundred (300) cubic feet per minute at one hundred (100 psi) pounds per square inch.

2.) Plugs, Valves, Pressure Gauges, Air Hoses, Connections and other equipment necessary, to conduct the air test, shall be furnished by the contractor. The test equipment for air testing will consist of valves, plugs and pressure gauges used to control the rate at which air flows to the test section and to monitor the air pressure inside the plugs. Test equipment shall be assembled as follows:

- *Hose connection*
- *Shut-off valve*
- *Throttle valve*
- *Pressure-reduction valve*
- *Gage cock*

- *Monitoring pressure gauge*

3.) Test Procedures:

- *Determine Section of line to be tested*
- *Apply air pressure until the pressure inside the pipe reaches 4 psig.*
- *Allow the pressure inside the pipe to stabilize: then bleed back to 3.5 psig.*
- *At 3.5 psig, the time, temperature and pressure will be observed and recorded. A minimum of five (5) readings will be required for each test.*

If the time in seconds for the air pressure to decrease from 3.5 psig is greater than that shown in the following table, the pipe shall be presumed to be free from defect. When these rates are exceeded, pipe breakage, joint leakage or leaking plugs are indicated and an inspection must be made to determine the cause.

The contractor shall make such repairs as may be required to accomplish a successful air test.

See Section 02533 – Acceptance Testing for Sanitary Sewers. City of Schertz Public Works Standard Specifications for a table of time allowed for pressure loss.

4.) Deflection by testing

Flexible gravity sewer lines shall be tested for deflections by use of a go-no-go testing mandrel calibrated for five (5%) percent maximum deflection of the inside diameter to the pipe.

See Section 02533 – Acceptance Testing for Sanitary Sewers. City of Schertz Public Works Standard Specifications for a table of mandrel sizes, as well as vacuum testing of manhole procedures and requirements for filming of sewer mains.

SECTION 6 – WATER REQUIREMENTS

6.1 GENERAL

All subdivisions within the City and its ETJ shall be provided with water supply and water distribution systems constructed in compliance with an approved water system. An Engineering Design Report for the water system will be submitted for review by the City Engineer. The report should contain a map of the service area, development LUE count, design flow rates and calculations, available local pressures, and a statement declaring that minimum pressures and flow rates will be provided. If additional storage of pressure will be required, the sizing and design of the pumps and storage facilities will be included in the report.

A.) Facilities Required: Every lot in a subdivision shall be provided with an approved supply of water, either by the construction of a distribution system connected to an adequate approved public water system or, if such public source is not available, by construction of a complete water system, including a safe, adequate water source, proper treatment facilities, pumps, storage facilities and distribution system, approved by the TCEQ.

B.) The Sub-divider shall dedicate, at his own cost, such right of way and construct such water main, water lines, fire hydrants and appurtenance as such size as to adequately serve the area being subdivided as determined by the City or the utility company under whose jurisdiction the subdivision falls.

C.) The sub-divider shall provide, prior to the beginning of such subdivision improvements, a guarantee of performance. Upon completion of the system and acceptance by the City and appropriate utility company, the installation shall become the property of the city and the utility company to operate and maintain.

6.2 MINIMUM WATER STANDARDS

A.) FIRE HYDRANTS:

1.) Hydrant location must follow both of two rules:

- *No structure should be further away, in a direct fire hose line, than five hundred (500') feet from a fire hydrant*

- *Hydrant spacing along a water main should not exceed five hundred (500') feet in single-family residential areas or three hundred (300') feet in mercantile, industrial and heavily congested residential area.*

2.) Fire Hydrants branch lines shall connect to an 8-inch water main.

3.) Any new fire hydrant is required to have a hydrant locator reflector (blue bump) installed in the roadway perpendicular to the hydrant.

B.) WATER MAINS:

1.) Design Specifications: The water distribution system design shall include the minimum requirements of the Texas State Fire Insurance commission for residential, mercantile and industrial areas in addition to the requirements for a peak hour customer demand a determined by the Public Works Director.

2.) Supply Mains: Supply mains in the distribution system shall be looped and have a minimum size of twelve (12”) inches diameter and shall not exceed six thousand (6,000’) feet in length between cross connecting mains.

3.) Mercantile and Industrial Mains: Mains in all mercantile areas shall be looped between supply mains and shall have a minimum size of eight (8“) inches inside diameter and shall be the shortest of the two following lengths: three thousand (3000’) feet of a length that would by fluid friction render the line incapable of producing flows and pressures set out herein for the type of area to be served and with pressure and flows that exist at the supply mains connections as determined by the Public Works Director. Mains in mercantile areas shall be located in streets or fire lanes and shall be sized to provide minimum fire flow from any single hydrant of not be less than one thousand five hundred (1,500 gpm) gallons per minute with twenty (20 psi) pounds per square inch residual pressure.

4.) Residential Mains: Mains in residential areas shall be looped, shall have a minimum size of eight (8”) inches inside diameter, and shall be the shortest of the two following length: three thousand (3,000’) feet, or a length where fluid friction would render the line incapable of producing the flows that exist at the supply mains connections and as determined by the Public Works Director. Domestic mains shall be installed in dedicated street right-of-way and sized so that the minimum fire flow at any single fire hydrant shall not be less than seven hundred fifty (750 gpm) gallons per minute with thirty (30 psi) pounds per square inch residual pressure and a domestic use of two (2 gpm) gallons per minute for every lot in the subdivision.

5.) One LUE (Living Unit Equivalent) produces a water demand of:

- 2 gpm peak hour flow demand

- 1 gpm peak day flow demand
- 300 gpd (0.208 gpm) average daily flow
- Peak Flow Factor formula:
  PFF = $(18+ (0.0144*F)^{0.5}) / (18+ (0.0144*F)^{0.5})$
  Where, F = avg flow (gpm) = 70*gpcd*population/1440

6.3 DESIGN CRITERIA

A.) Water Mains within the City's Jurisdiction shall be ANSI/AWWA C900 or C905 PVC DR 14 or as allowed in Sections 02511, 02501, 02502, 02506 of the Public Works Construction Specifications; other material as approved by Public Works.

1.) Minimum Working Pressure in any part of the system shall be twenty (20psi) pounds per square inch during fire flow conditions and two thirds (2/3) of the normal water use domestic or commercial. This pressure pertains to the point of delivery of water to the consumer at the house service line, and for residences not exceeding two stories. A minimum working pressure of thirty-five (35) psi should be provided wherever possible.

2.) Normal Working Pressure under average conditions of flow should range between thirty-five (35) psi and seventy (70) psi.

3.) Maximum Pressures in excesses of one hundred (100) psi should be avoided. Anything over 80 psi shall be protected with pressure release valve to be owned and maintained by the homeowner.

4) See section 6.4 for testing pressure

5.) No Private Water Supply shall be installed in any subdivision in the Schertz ETJ or City limits without City Council approval and a water franchise agreement.

B.) The depth of cover of the main shall be not less than the forty-eight (48") inches from the top of pipe, and shall be sufficient to safely sustain all anticipated live and dead loads in conjunction with the pipe material design. Mains within earthen channels shall be protected from scour; a scour analysis may be required.

1.) The initial material in backfilling utility trenches to be in accordance with Section 02317 – Excavation and Backfill for Utilities of the City of Schertz Public Works Standard Specifications and applicable

manufacturer's instructions: The City requires water and sewer utilities to be encased in six (6") inches of sand.

2.) After the initial material has been properly compacted, the remaining upper portion of the trench can be backfilled. Backfill shall be of selected materials according to Section 02317 – Excavation and Backfill for Utilities of the City of Schertz Public Works Standard Specifications. Certified laboratory shall provide City proctor density testing results. The use of flowable backfill in streets and driveways may be required in areas subject to traffic. The mix shall utilize cement, fly ash, fine aggregate (100 % passing ¾" sieve), and water with a shrinkage compensator as per City's specification.

3.) The practices of water jetting or ponding backfill in roadways, drainage right-of-way, driveways, concrete or paved easements are NOT ACCEPTABLE

C.) Water Service Lines shall be constructed using an approved double strapped saddle copper service line with suitable brass CC threaded compression gasket and compression stops. Developers will also be required to install the angle stop and meter box before acceptance by the City. Meter boxes are to be as shown in standard details and shall be installed at the finish grade of the property to be served. A 2" blue painted dot on the curb shall mark location of new meters.

D.) Air Relief And Blow-Off Valves:

Air relief valves and blow-off valves should not be used except in locations where fire hydrants are not practical or at true dead end mains. Air relief valves shall be located at high points on the line and blow-off valves shall be placed at low points. Air release valves shall be screened with Stainless Steel No. 16 Mesh. Blow-off valves shall be AWWA approved cast iron with two (2") inch operating nut.

E.) Gate Valves:

1.) Location of the valves shall be uniformly located in some standard area such as street or curb line to facilitate their location. A valve box, with its cover at the finish grade, shall always be placed over a buried valve. A sufficient number of valves should be placed in the distribution system so that a short section of main may be repaired or serviced without interruption of service of more than one block. Valves should be located on all branches from feeder mains and between distributors and fire hydrants. Three (3) vales shall be used as crosses and two (2) valves at tees; the valves should be places on the smaller lines at each cross or tee. On arterial mains

and minor distributors, valves should be placed at least every six hundred (600') feet. Valves shall also be installed on each side of major streets, railroad crossings and drainage channels.

2.) Material for gate valve construction shall comply with the current AWWA Standard C-509-80 Resilient Seat Gate Valves from list of approved manufactured parts located at the Public Works Department for Ordinary Water Lines. All valves shall be left-handed open valves.

3.) Valves will be accompanied by a "v" etched into curb face, painted blue.

4.) Operation of Valves: No existing valves, in the City's water distribution system, shall be operated by the contractor; without prior permission from the Public Works Department. The contractor shall notify the Public Works Director when a valve is to be operated and shall only operate the valve in the presence of the City's representative.

F.) Fire Hydrants: Five and one fourth (5 ¼") inch steamer outlet, NST and two and a half (2 ½) outlets, NST fire hydrants shall be installed as part of the water distribution system per the City design standards. Fire hydrants shall be installed with a separate gate valve and valve box shall be from the list of approved manufactured parts located at the Public Works Department. Bonnets and caps to be painted white.

G.) Private fire lines shall meet the City's specifications for pipe material and trench backfill.

1.) A Double Check Assembly (DCA) or a Double Check Detector Assembly (DCDA) backflow device will be provided on private fire lines within 100 feet of the City's water main; DCA for fire line for sprinklers (no chemicals), DCDA for fire line with fire hydrants.

2.) The DCA or DCDA may be installed in a vault if proper consideration is given for drainage and clearance to vault walls for access and repair.

H.) PROTECTION OF WATER SUPPLIES

1.) Horizontal Separation: Whenever possible, water mains shall be laid at least nine (9') feet, radially, from any existing or proposed sewer. Should local conditions prevent a lateral separation of nine (9') feet, a water main may be laid closer than nine (9') feet to a sewer if it complies with 30 Texas Administrative Code (TAC) (or TCEQ rules) Chapter 217: Rule 217.53.d.

2.) Vertical Separation: Whenever sewers cross under water mains, the water main shall be laid at such an elevation that at the bottom of the water main is a least nine (9') feet above the top of the sewer. The vertical separation shall be maintained for that portion of the water located within ten (10') feet horizontally of any sewer it crosses.

3.) Special: When it is impossible to obtain proper horizontal and vertical separation, both the water main and sewer shall be constructed with in accordance to 30 TAC Chapter 217: Rule 217.53.d.

4.) Relation to Sewer Manholes: No water main shall pass through, or come in contact with, any part of a sewer manhole. All sewer design shall meet 30 TAC Chapter 217: Rule 217.53.d.

5.) Cross Connections: There shall be no physical connection between the distribution system and any pipe, pumps, hydrant or tanks, which are supplied, or may be supplied, with water that is, or may be, lesser standards or contaminated.

6.) Water Mains Near or Crossing Obstructions: Water mains within ten (10') feet of railroad tracks or crossing under railroad tracks shall be Ductile Iron Pipe equipped with restrained clamps or other acceptable provisions to minimize the affect of vibration. Mains crossing under waterways, a valve shall be placed at both ends of such crossing to permit isolation for repair and testing of the section.

7.) Sampling taps shall be provided to facilitate sanitary control. These taps shall not be subject to flooding.

l.) Disinfection of Water Mains: For disinfecting newly laid mains or after repairs to the system, the mains shall be disinfected in accordance with AWWA Standard for Disinfecting Water Mains – C651, the requirements of the TCEQ, and the City of Schertz Public Works Standard Specifications Section 02514 – Disinfection of Water Lines.

6.4 MINIMUM WATER TESTING REQUIREMENTS

Flushing, hydrostatic testing and chlorination of the City water main shall be in accordance with the City of Schertz Public Works Standard Specifications Section 02515 – Hydrostatic Testing of Pipelines, current AWWA standards as well as TCEQ rules and regulations.

For all water lines, expel air and apply minimum test pressure of 200 psi. During the test, pressures shall not vary more than ±5 psi.

SECTION 7 – INSPECTIONS, TESTING, AND CHARGES

7.1 LABORATORY TESTING:

A.) The sub-divider shall notify the City at least one week prior to the contractor beginning construction. Contractor shall be required to notify the City a minimum of at least forty-eight (48) hours in advance of all testing being performed.

B.) All materials to be used in subdivision construction shall be subject to testing if warranted. The preponderance of testing to be performed in subdivisions is directly related to ensure quality of construction. Street construction and a series of laboratory tests normally associated with road and street construction will be required in subdivisions, said tests being performed by an independent testing laboratory using qualified personnel. The design (or consulting) engineer or his designated representative shall be present at all testing.

Whenever a developer, contractor or engineer needs an inspection of any street or utility improvement, the Public Works Director shall be contacted first, a minimum of at least forty-eight (48) hours in advance of the inspection. When the Public Works Director or his Department should be contacted, messages should not be left on a proposed date and time for inspection with anyone other than the Public Works Director or his designated representative. The design engineer or his designated representative shall be present at all inspections. With regard to testing of water and sewer lines, all testing will be done according to American Water Works Association (AWWA), ASTM and ASCE Standards.

In addition, the following procedures for testing of these lines will be as follows:

- No new water lines will be connected directly to an existing City line. A backflow preventer with a hand valve (jumper) shall be used between old and new lines for loading.

- No new sewer lines will be installed in a manner that would prevent testing of any part of the new line. All new sewer lines will be tested.

- Pre-testing of water and sewer lines will be conducted by contractor prior to calling for an inspection to assure all lines will hold required pressure. If City representatives arrive and find the lines have not been pre-tested, they have been instructed to leave the inspection site immediately and the re-inspection will have to be rescheduled.

C.) With regard to street inspection: Streets shall be checked by contractor, to ensure readiness; prior to calling for an inspection. No streets covered with debris, vehicles or equipment will be inspected.

D.) Inspections of water and sewer lines and streets will be made at the same time on all such lines and streets within that particular subdivision. Minimum test spacing set out shall be not less than five hundred (500') feet. No piecemeal inspection of parts of lines or small sections of streets will be made. However, with regard to sub-grade inspections, sections of the street can be inspected when needed to protect the sub-grade from bad weather or other conditions that may deteriorate the sub-grade. No more than three (3) sub-grade inspections will be made in any one (1) subdivision.

E.) The City staff, or an authorized inspector, may at the direction of the City, inspect all subdivision site work at any time and any stage. The City shall bear the cost of all inspections and the sub-divider shall bear the cost of all re-inspections. The judgment of the City and/or the City Engineer as to the need for any re-inspections of any part thereof, at any stage shall be final. The sub-divider shall immediately reimburse the city for the full actual cost and expense of all such re-inspections after the initial inspection requested by the developer, except street sub-grade inspections as noted above, upon being billed therefore.

F.) Testing will be performed by, an approved, independent testing laboratory. The following test schedule will be adhered to:

- Streets: sub-grade moisture, density test at the rate of one per each block not to exceed five hundred (500') fee spacing.

- Flexible Base: P.L., L.L., P.I. and gradation of material used; moisture, density test on same spacing as sub-grade.

- Concrete Structures: Concrete cylinders, one/50 cy. Or for each pour is less than 50 cy. Shall be taken for curbs, drainage structures and sidewalks.

- All testing is the responsibility of the developer. Copies of all test results shall be furnished to the City before final approval of the subdivision is given.

G.) Before initial final acceptance of a subdivision is given by the City for street or utility work, the consulting engineer responsible for the design of said work shall issue a letter to the City stating that he/she has made an inspection of such improvements and that said improvements were constructed in accordance with the approved construction plans. Attached

to the letter shall be one (1) set of reproducible “As Built” drawings showing the work to be accepted for use by the City as well as one (1) PDF and one (1) CAD drawing on CD. These should include location of valves, fire hydrants, manholes, storm drain inlets and outlets (with elevations), and blow-off valves.

H.) Guarantee of Material and Workmanship: The sub-divider or developer shall require of his construction contractors with whom he contracts, and shall himself be responsible for guaranteeing that all materials required under this Code and workmanship in connection with such improvements are free of defects for a period of one (1) year after such acceptance of the improvements by the City. The responsibility for all cost of the in-place improvements shall be borne by the sub-divider, and all criteria of Section 4.15 of the Schertz UDC shall be met before acceptance