



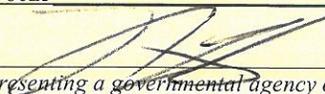
UDC Update Request Application

Part 1. Applicant Information

Name: Mike Frisbie, PE, Director/City Engineer Organization (if applicable): City of San Antonio / TCI

Address: 114 W. Commerce 6th Floor, San Antonio, Texas 78205

Phone: (210) 207-8025 Email: mike.frisbie@sanantonio.gov

Signature:  Date: 4-29-15
(Include title if representing a governmental agency or public/private organization) **AER 4/29/15**

Part 2. Basis for Update (check only one)

- Clarification amendments to provide for ease of interpretation and understanding of the existing provisions of the UDC (Note: Clarification amendments should not change or alter the intent or meaning of existing UDC provisions)
- Editing change that does not alter the impact of the provisions being addressed including changes such as spelling, grammar correction, formatting, text selection, or addition of text in compliance with existing ordinance, statutes or case law
- Completed Rule Interpretation Determination (RID)
- Requested by the Zoning Commission, Planning Commission, Board of Adjustment, HDRC, City Council or other appropriate city board or council (CCR, resolution or signature of the chairperson is required)

Part 3. Reason(s) for Update (check all that apply)

- Modify procedures and standards for workability and administrative efficiency
- Eliminate unnecessary development costs
- Update the procedures and standards to reflect changes in the law or the state of the art in land use planning and urban design
- See Part 4 (if none of the provided choices in this section apply, please discuss the reasons for the proposed update in Part 4)

Part 4. Summary of Proposed Update with Suggested Text (see application instructions)

The proposed amendments to Appendix F are to incorporate new methodologies, and/or updated local (i.e. SARA's LID or NCD manuals) state/federal (i.e. TCEQ, FEMA, etc) references.

2015 UDC UPDATE PROPOSALS

PROPOSAL SUMMARY -

The reason for this proposed UDC amendment is to be consistent with the amendment proposed under Section 35-504 (g) (8). Sections 35-F124 (e) to (f) reflects amendments regarding current environmental design requirements or concerns as well as natural channel design set forth by BRWM, SARA, and FEMA.

FORMATTED PROPOSAL -

APPENDIX F - FLOODPLAINS - AREAS OF SPECIAL FLOOD

Sec. 35-F106. - Special Floodplain Definitions

Unflooded access means that vehicular traffic has a safe access (within the "Proceed with Caution" range per figure 504-2) to a property from a public street in times of a design storm event (reference Section 35-504(b)(2) System Criteria") and to an arterial street that is not adjacent to the development or to a distance of one-quarter mile, whichever is less, during a ~~four~~ ~~twenty (20)~~ percent annual chance ~~(25-year)~~ ~~(20% A.C., or "5-year")~~ future storm event.

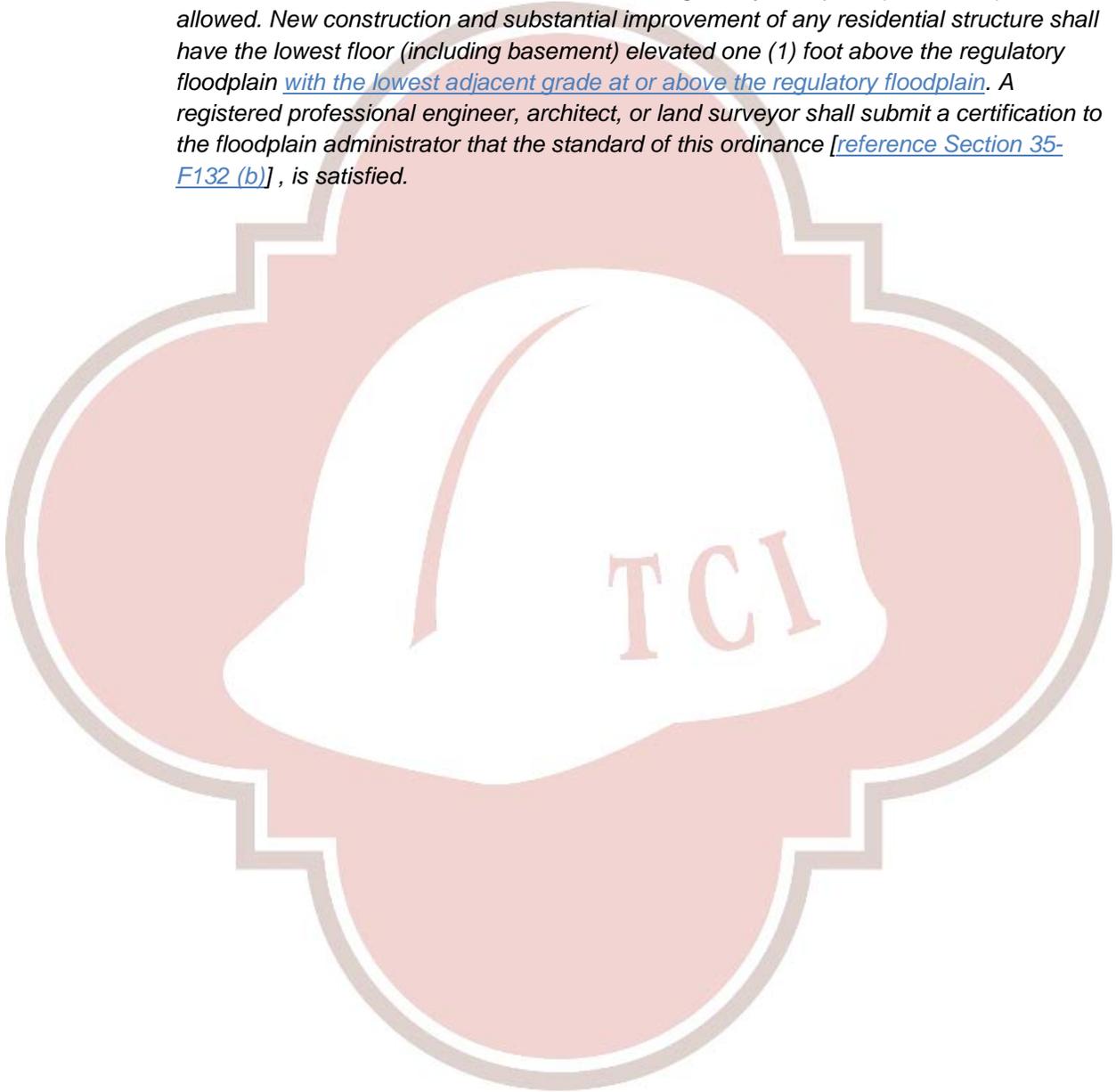
Sec. 35-F124. - Allowable Development Within the Regulatory Floodplain

- (e) *Demonstrate that the development will not increase the regulatory 1% annual chance floodplain velocities above six (6) fps. No increase in velocity will be permitted if predevelopment velocities in the floodplain exceed six (6) fps unless proven that the existing channel/creek is stable (i.e. rocky bottom channel/creek) and no signs of erosion or scour are occurring in predevelopment conditions.*
- (f) (12) *Wetland reestablishment, ~~or~~ mitigation, or environmentally friendly design criteria (i.e. Natural channel design, Low-Impact Development, etc set forth by the San Antonio River Authority and/or U.S. Army Corps of Engineers).*
- (f) (18) *1% annual chance floodplain reclamation where the watershed drainage area is less than three hundred twenty (320) acres when the floodplain storage volume lost due to fill is offset by comparable excavation within the same floodplain (see subsections 35-F124(d) and 35-F124(f)(27). In addition, all federal, state, or local permits shall be obtained, including Section 404 of the Federal Water Pollution Control Act Amendments of 1972, 33 U.S.C. 1334 (see subsections 35-F122 (a)(3)).*
- (f) (21) *1% annual chance floodplain reclamation in overbank areas subject to extensive shallow (0'-3') flooding where velocities in the overbank area are less than three (3) fps and where floodplain storage volume lost to reclamation is offset by comparable excavation*

*within the same creek floodplain (see subsections 35-F124(d) and 35-F124(f)(27).)
Where a maximum amount of fill allowed in the overbank areas is no more than 3 feet
with engineered slope stability calculations.*

Sec. 35-F142. - Specific Standards

- (a) (1) *Construction of habitable structures within the regulatory floodplain (base flood) is not allowed. New construction and substantial improvement of any residential structure shall have the lowest floor (including basement) elevated one (1) foot above the regulatory floodplain with the lowest adjacent grade at or above the regulatory floodplain. A registered professional engineer, architect, or land surveyor shall submit a certification to the floodplain administrator that the standard of this ordinance [reference Section 35-F132 (b)], is satisfied.*





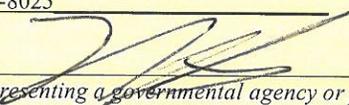
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Part 4. Summary of Proposed Update with Suggested Text (see application instructions)

TCI Storm Water Division has prepared a Storm Water Design Criteria Manual (SWDCM). The management of storm water runoff is necessary to meet state and federal requirements, as well as improve our City's overall quality of life. The SWDCM will assist in providing the engineering community with a design criteria manual that outlines the procedures and calculations needed for the design and construction of drainage systems within the San Antonio area. A draft SWDCM was provided for review to the engineering community in March 2014. The proposed amendments to Section 35-504 include extracting design criteria into the SWDCM and updating and/or re-ordering policy criteria to better match the SWDCM and also incorporate new methodologies, and/or updated local (i.e. SARA's LID or NCD manuals) state/federal (i.e. TCEQ, FEMA, etc) references.

Sec. 35-504. - [Storm Water](#)~~-stormwater~~ Management.

STATEMENT OF PURPOSE

The purpose of this section is to provide adequate measures for the retention, detention and distribution of [storm water](#)~~-stormwater~~ in a manner that minimizes the possibility of adverse impacts on both water quantity and water quality during development. Innovative runoff management practices designed to meet the provisions of this chapter, enhance the recharge of groundwater, and maintain the function of critical environmental features are encouraged. The city recognizes that watercourses and their associated watersheds within the City of San Antonio's jurisdiction represent significant and irreplaceable recreational and aesthetic resources and contribute to the economic and environmental health of the city. In addition, all of the watersheds within the city are vulnerable to concentrated surface water runoff, disturbance of wildlife habitat, non-point source pollution and sedimentation resulting from development activities and should be developed in a sensitive and innovative manner.

This section implements the following policies of the master plan:

- Natural Resources, Policy 1d: Encourage retention of the 100-year floodplains as natural drainageways without permanent construction, unnecessary straightening, bank clearing or channeling.
- Natural Resources, Policy 1d: 2. Adopt strong [storm water](#)~~-stormwater~~ management practices throughout the drainage area which include site specific measures such as:

On-site [storm water](#)~~-stormwater~~ retention and detention;
Reduction in impervious cover;
Natural bank contouring;
Floodplain preservation and buffering;
Preservation of riparian habitat;
[Storm water](#)~~-stormwater~~ harvesting sites for reuse purposes.

- Urban Design, Policy 1g: Prepare design and construction policies and standards for utility and transportation infrastructure, capital improvement projects, public facilities and development projects that reinforce neighborhood centers and provide diverse, pedestrian-friendly neighborhoods.

(a) **Applicability.** The provisions of this section shall apply to any application for subdivision plat, master development plan, [capital improvement project](#), or building permit approval except as otherwise provided by this chapter. A [storm water](#)~~-stormwater~~ management plan shall be provided as set forth in Appendix "B," section 35-B119 of this chapter.

(b) **[Storm water](#) ~~Stormwater~~ Management Program.**

(1) **Regional [Storm water](#)~~-stormwater~~ Management Program (RSWMP).**

A. The City of San Antonio has determined that regional [storm water](#)~~-stormwater~~ management is preferable to site specific [storm water](#) ~~stormwater~~ mitigation. The regional [storm water](#)~~-stormwater~~ management program provides for the administration, planning, design, construction, and operational management of regional [storm water](#)~~-stormwater~~ facilities (RSWF). Regional [storm water](#)~~-stormwater~~ management uses a watershed-wide approach to analyze potential flooding problems, identify appropriate mitigation measures and select site locations and design criteria for RSWF. These RSWF include, but are not limited to, regional detention and retention ponds, watershed protection, land purchase, waterway enlargement, channelization, and improved conveyance structures. The regional [storm water](#) ~~stormwater~~ management program allows developers to participate in the program rather than constructing the on-site detention controls required by this section, where

the resulting use of a RSWF will not produce a significant adverse impact to other properties due to the increased runoff from the proposed development.

- B. All developers shall participate in the RSWMP in one (1) of three (3) ways:
1. Payment of a fee in lieu of on-site detention (except in areas designated by the director of public works as "mandatory detention areas"). The fee schedule is included in Appendix "C," section 35C-109.
 2. Construction of on-site or off-site measures (typically ~~storm water~~~~-stormwater~~ detention facilities) to mitigate increases in runoff resulting from the proposed development.
 3. Construction or participation in the construction of an off-site RSWF to mitigate increased ~~storm water~~~~-stormwater~~ runoff anticipated from ultimate development of the watershed.
- C. To determine a significant adverse impact for the purposes of this section, the following criteria will be used to analyze the receiving ~~storm water~~~~-stormwater~~ facilities within two thousand (2,000) linear feet of the project, to the nearest downstream RSWF, or to the nearest floodplain with an ultimate analysis accepted by the city, whichever is less. For lots less than three (3) acres in size, adverse impact analyses need only extend to where tributary drainage areas equal one hundred (100) or more acres. For properties that are within a mandatory detention area and are less than three acres a peak on peak analysis of the overall site compared to the overall hydrology must extend down to the next junction node based on the effective hydrologic models or best available data.
1. The ~~storm water~~~~-stormwater~~ surface elevation (WSE) in receiving facility [natural or improved] drainage systems within two thousand (2,000) linear feet of the proposed development may not be increased by the proposed development unless the increased WSE is contained within easements or rights-of-way or the receiving systems have sufficient capacity to contain the increased WSE without increasing flooding to habitable structures.
 2. Ultimate development runoff at low water crossings during regulatory (five ~~year~~, 25 ~~twenty-five~~ year and 100 year frequency) storm events must not classify the low water crossing as "Dangerous to Cross" based on Figure 504-2. If the ultimate WSE exceeds this criterion, the crossings may be improved to the standards of this chapter in lieu of providing onsite ~~storm water~~~~-stormwater~~ control measures or paying a fee.
 3. Three ~~(3)~~-development conditions shall be analyzed with each adverse impact analysis.

Existing Conditions. This refers to current development conditions in the watershed and on site. This shall be used as the baseline for determining the impact of the development of the site, or the watershed, to other properties or drainage systems.

Proposed Conditions. This refers to existing conditions with the proposed development added. This shall be used to determine if the increased runoff from the proposed development results in an adverse impact to other properties or drainage systems.

Ultimate Conditions. This refers to ultimate development conditions within the watershed. In addition to being used to design proposed drainage facilities (subsection "(2) System Criteria," below), this condition shall also be used to determine if the increased runoff from the ultimate development of the watershed results in an adverse impact to other properties or drainage systems.

In addition to verifying low water crossing capacity (item 2, above), this analysis shall be used to assist the city in identifying watershed wide [storm water](#)-~~stormwater~~ management issues.

4. Minimum standards for identifying Dangerous Roadway conditions are identified in figure 504-2.

Note: The City of San Antonio contends that any runoff crossing a roadway creates a potentially dangerous condition. Figure 504-2 represents the maximum flow over roadways that the city will accept in adverse impact analyses signed and sealed by the licensed professional engineers.

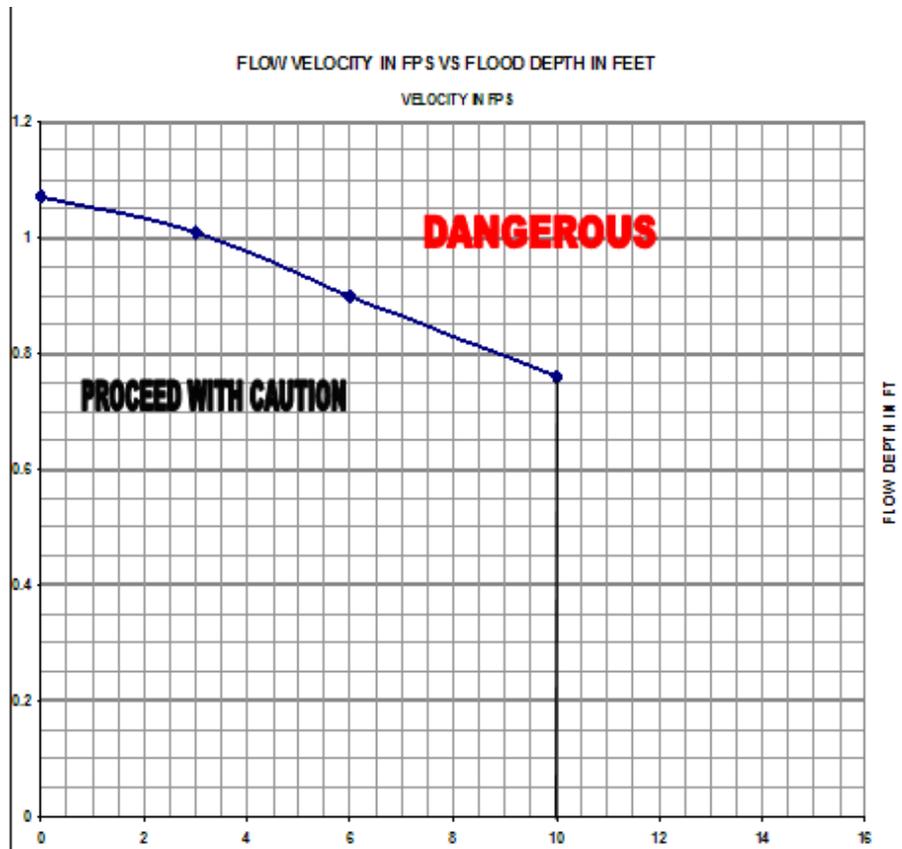


Figure 504-2 Dangerous Roadway Conditions During Flood Events

5. The City of San Antonio may reject a developer's request to participate in the RSWMP by payment or mitigation and require on-site detention. The city's decision will be based on the knowledge of significant adverse impacts that would be created by ultimate development of the watershed regardless of the distance from the development to the area of concern. The city may also reject a request for participation when it is not in the best interests of the RSWMP. The developer is recommended to meet with the [storm water](#) ~~stormwater~~ engineering division of the department of public works to discuss participation options prior to commencing design of a project. This preliminary meeting in no way relieves the developer of his responsibility to prepare the necessary engineering documentation to support his request for participation.

- D. The ~~storm water~~~~stormwater~~ development fee in lieu of on-site detention must be paid prior to a plat being released for recordation by the City of San Antonio or the issuance of a building permit. The fee shall be determined in accordance with the provisions of section 35-C109, [Reference Table 1 for storm water](#)~~stormwater~~ management fees.
- (2) **System Criteria.** All ~~storm water~~~~stormwater~~ management facilities, or combination of facilities, shall be designed for ultimate development. Facilities with drainage areas ~~less than 100~~ ~~under one hundred (100)~~ acres shall be designed for a ~~twenty-five~~ 25 year storm. Facilities with drainage areas over ~~one hundred (100)~~ acres or areas within a FEMA designated floodplain shall be designed for a 100 year storm or a ~~twenty-five~~ 25 year storm plus freeboard ~~(based on Table 504-9)~~ if ~~whichever that~~ elevation is higher. Detention facilities and streets are exceptions to the frequency criteria cited above. Detention facility outflows will be designed for five ~~year~~, ~~twenty-five-year~~ 25 year and 100 year frequency storms. Refer to subsection 35-504(~~g~~ j) for specific drainage design criteria for streets.
- (3) **Responsibility to Accept Storm Water**~~stormwater~~. The owner or developer of property to be developed shall be responsible for the conveyance of all ~~storm water~~~~stormwater~~ flowing through the property. This responsibility includes the ~~storm water~~~~stormwater~~ 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.
- (4) **Positive Overflow Pathways.** ~~Storm water~~~~stormwater~~ management facilities for local drainage systems will be designed to ensure that a positive overflow pathway is provided to the nearest 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.
- (5) **Maintenance.**
- A. 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 both publicly owned and privately owned facilities must be approved by the director of public works prior to the approval of construction drawings.
- B. Authorized personnel from the City of San Antonio shall 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.
- (6) **New Development.** Peak ~~storm water~~~~stormwater~~ 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~~, 25 ~~twenty-five~~ and 100 year design storm events, except as provided in subsection 35-504(b)(1), above.
- (7) **Redevelopment.** Peak ~~storm water~~~~stormwater~~ 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~~, 25 ~~twenty-five~~ and 100 year design storm events, except as provided in subsection 35-504(b)(1), above.
- (8) **Low Impact Development (LID)**. The City of San Antonio ~~(COSA)~~ encourages the installation of ~~low-impact-development (LID)~~ features such as engineered swales, engineered infiltration storm ~~drain sewer~~ systems, bioretention, and engineered wetlands. For all developments proposed within the [City of San Antonio's](#) ~~COSA~~ jurisdictional

boundaries, these features may be considered on-site detention features to the extent that they reduce the ~~storm water~~~~-stormwater~~ runoff expected downstream as a result of such developments. It shall be the developer's responsibility to demonstrate that said LID features provide such benefit. Credit toward RSWMP fees will be considered and approved on a case by case basis by the department of public works.

(c) ~~Method of Computing Runoff~~ **Storm Water Design Criteria Manual (SWDCM)**. The Director of Public Works shall maintain and publish a SWDCM. The SWDCM shall include standard principles and practices for the design and construction of drainage facilities and is hereby adopted by the City Council. The SWDCM may be amended from time to time by the City Council. If any such amendment is in conflict with this chapter, the most restrictive provision shall control. To comply with the RSWMP, all development shall follow the processes and procedures contained in the SWDCM.

(d) **Natural Watercourses or Floodplains**. Diversion of ~~storm water~~~~-stormwater~~ away from the natural watercourse will not be allowed except within the boundaries of the property controlled by the developer, provided that the diverted water is returned to the watercourse within which it would naturally have been flowing prior to leaving the developer's property. ~~A timing~~ **An analysis of the timing** of the diverted hydrograph on watersheds greater than ~~20~~ **twenty (20)** acres, as it reenters the receiving watercourse, must be performed to show that the peak flow rate ~~in the receiving watercourse~~ has not been increased as a result of the diversion.

~~(1) Calculation Methods.~~

~~A. For drainage areas less than six hundred forty (640) acres, the basis for computing runoff shall be the rational formula or some other method provided it is acceptable to the director of public works. Hydraulic calculations shall be performed by using the U.S. Army Corps of Engineers HEC-2 "Water Surface Profiles" or HEC-RAS "River Analysis System" computer models. Normal depth channel calculations are permissible for constructed open channels with a uniform geometric cross section where 1) there is no potential for the water surface elevations to be controlled by backwater and 2) the channel is not in a FEMA floodplain.~~

~~B. For drainage areas six hundred forty (640) acres or greater, the basis for computing runoff shall be a unit hydrograph method, preferably the Soil Conservation Service (SCS) Dimensionless Unitgraph method as contained in the U.S. Army Corps of Engineers Hydrologic Engineering Center HEC-1 "Flood Hydrograph Package," which document shall be maintained on file with the director of public works and is hereby incorporated by this reference. For the SCS method, antecedent moisture condition II shall be used in the runoff model. Design rainfall values listed in Table 504-4 shall be used for hydrograph calculations.~~

~~C. Open channel hydraulic calculations shall be performed by using the U.S. Army Corps of engineers HEC-2 "Water Surface Profiles" or HEC-RAS "River Analysis System" computer models, which documents shall be maintained on file with the director of public works and is hereby incorporated by this reference.~~

~~D. Certain watersheds have hydrologic and hydraulic models that are available through and maintained by the City of San Antonio. 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 consultants' models must use the same computer program that was used in the existing model e.g. HEC-RAS models will not be accepted where the original model used HEC-2. The updated models shall be submitted to the director of public works for incorporation into the master models. The City of San Antonio will periodically update the master models to reflect current watershed development conditions. The updated models will be made available for use and distribution as the latest existing condition models for the watershed.~~

(2) Time of Concentration.

- A. ~~Overland (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.~~
- B. ~~Overland flow – flow over plane surfaces: Maximum allowable time is twenty (20) minutes. Minimum is five (5) minutes. The overland flow time chart from "Design" by Elwyn E. Seelye may be used to calculate overland flow times. Note that the minimum time has been reduced to five (5) minutes.~~
- C. ~~Shallow concentrated flow – overland flow usually becomes shallow concentrated flow after a maximum of three hundred (300) feet: 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.~~
- D. ~~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.~~

(3) Runoff Coefficients. Runoff coefficients (C value) for use in the rational formula shall not be less than the values shown in Tables 504-1A or 504-1B, as appropriate.

**Table 504-1A
Runoff Coefficients (C) – Percentage**

Character of Area	SLOPE			
	Up to 1%	Over 1% up to 3%	Over 3% up to 5%	Flow over 5%
Business or commercial areas (90% or more impervious), Existing Pavement / Buildings or Zoning Districts O, C, I-1, I-2	95	96	97	97
Densely developed areas (80% to 90% impervious) or Zoning Districts D, MX, NC, TOD, Use Pattern TND	85	88	91	95
Closely built residential areas and school sites or Zoning Districts MF, R-4	75	77	80	84
Undeveloped areas * – Present land is undeveloped and ultimate land use is unknown. C values for use in ultimate development calculations.	68	70	72	75
Large lot residential area or Zoning Districts R20, RE	55	57	62	64

Undeveloped areas *—Existing conditions. See Table 504-1(b)				
Average residential area or Zoning Districts R-5, R-6	65	67	69	72

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Table 504-1B
Runoff Coefficients (C)—Percentage

Character of Area	SLOPE			
	Up to 1%	Over 1% up to 3%	Over 3% up to 5%	Flow over 5%
Cultivated or Range (Grass Cover < 50% of Area)	44	47	53	55
Range (Grass Cover 50—75% of Area)	37	41	49	53
Forest or Range (Grass Cover > 75% of Area)	35	39	47	52

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~~* Areas included within parks, green belts or regulatory floodplains shall be considered to remain undeveloped per Table 504-1B.~~

~~(4) Rainfall Intensity. Use Figure 504-1 or Table 504-2 to determine rainfall intensity.~~

Table 504-2 Rainfall Intensities (inches/hour)

TIME	FREQUENCY						
MINUTES	2-YEAR	5-YEAR	10-YEAR	25-YEAR	50-YEAR	100-YEAR	500-YEAR
5	7.2	8.4	9.413	11.1	12.432	13.542	18.204
6	6.684	7.836	8.83	10.331	11.648	12.877	17.258
7	6.277	7.381	8.365	9.722	11.025	12.341	16.497

8	5.944	7.009	7.982	9.224	10.512	11.894	15.864
9	5.666	6.696	7.658	8.806	10.079	11.514	15.327
10	5.427	6.427	7.38	8.447	9.707	11.184	14.862
11	5.22	6.194	7.137	8.136	9.382	10.893	14.453
12	5.038	5.988	6.923	7.862	9.095	10.635	14.09
13	4.877	5.805	6.731	7.618	8.839	10.403	13.763
14	4.731	5.641	6.558	7.399	8.608	10.192	13.468
15	4.6	5.48	6.4	7.2	8.4	10	13.2
16	4.458	5.296	6.159	6.959	8.088	9.551	12.765
17	4.328	5.129	5.942	6.741	7.806	9.147	12.368
18	4.209	4.977	5.743	6.541	7.549	8.781	12.005
19	4.099	4.836	5.562	6.357	7.314	8.449	11.672
20	3.998	4.707	5.395	6.188	7.098	8.146	11.364
21	3.904	4.587	5.241	6.031	6.898	7.867	11.079
22	3.816	4.476	5.098	5.886	6.713	7.61	10.814
23	3.734	4.372	4.965	5.749	6.541	7.373	10.566
24	3.658	4.275	4.841	5.622	6.38	7.153	10.335
25	3.586	4.184	4.725	5.503	6.229	6.947	10.117
26	3.518	4.098	4.616	5.39	6.088	6.756	9.913
27	3.453	4.017	4.514	5.284	5.955	6.576	9.72

28	3.393	3.941	4.417	5.184	5.83	6.408	9.538
29	3.335	3.868	4.326	5.089	5.711	6.25	9.365
30	3.28	3.8	4.24	5	5.6	6.1	9.2
31	3.209	3.723	4.155	4.905	5.501	6.003	9.025
32	3.142	3.65	4.074	4.814	5.407	5.911	8.87
33	3.078	3.58	3.997	4.727	5.318	5.823	8.722
34	3.018	3.514	3.924	4.644	5.233	5.739	8.581
35	2.96	3.45	3.854	4.565	5.152	5.658	8.446
36	2.906	3.39	3.787	4.49	5.074	5.581	8.317
37	2.853	3.332	3.723	4.418	4.999	5.507	8.194
38	2.803	3.277	3.662	4.349	4.928	5.435	8.075
39	2.755	3.224	3.604	4.283	4.859	5.367	7.961
40	2.709	3.173	3.548	4.219	4.793	5.301	7.852
41	2.665	3.124	3.494	4.158	4.729	5.238	7.747
42	2.623	3.077	3.442	4.099	4.668	5.176	7.646
43	2.582	3.032	3.392	4.043	4.609	5.117	7.548
44	2.543	2.989	3.345	3.988	4.552	5.06	7.454
45	2.505	2.947	3.298	3.936	4.497	5.005	7.363
46	2.469	2.907	3.254	3.885	4.444	4.952	7.275
47	2.434	2.868	3.211	3.836	4.393	4.9	7.19

48	2.4	2.83	3.169	3.788	4.343	4.85	7.108
49	2.368	2.794	3.129	3.743	4.295	4.802	7.028
50	2.336	2.759	3.09	3.698	4.248	4.754	6.951
51	2.306	2.724	3.052	3.655	4.203	4.709	6.876
52	2.276	2.691	3.016	3.613	4.159	4.664	6.804
53	2.247	2.659	2.98	3.573	4.117	4.621	6.733
54	2.22	2.628	2.946	3.534	4.075	4.579	6.665
55	2.193	2.598	2.913	3.496	4.035	4.538	6.598
56	2.167	2.569	2.88	3.459	3.996	4.499	6.534
57	2.141	2.541	2.849	3.423	3.958	4.46	6.471
58	2.117	2.513	2.819	3.388	3.921	4.422	6.41
59	2.093	2.486	2.789	3.354	3.885	4.386	6.35
60	2.07	2.46	2.76	3.32	3.85	4.35	6.3
120	1.285	1.555	1.775	2.175	2.55	2.9	4.05
180	0.933	1.14	1.317	1.633	1.9	2.2	3.133
360	0.552	0.668	0.767	0.95	1.083	1.25	1.767
720	0.315	0.383	0.45	0.533	0.625	0.733	1.033
1440	0.185	0.223	0.25	0.313	0.375	0.417	0.571

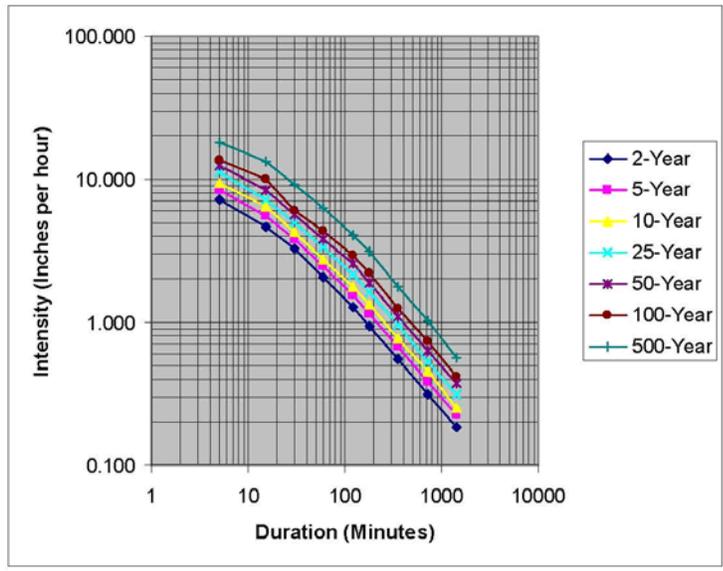


Figure 1. Rainfall Intensities plotted against Duration on Log-Log scale.

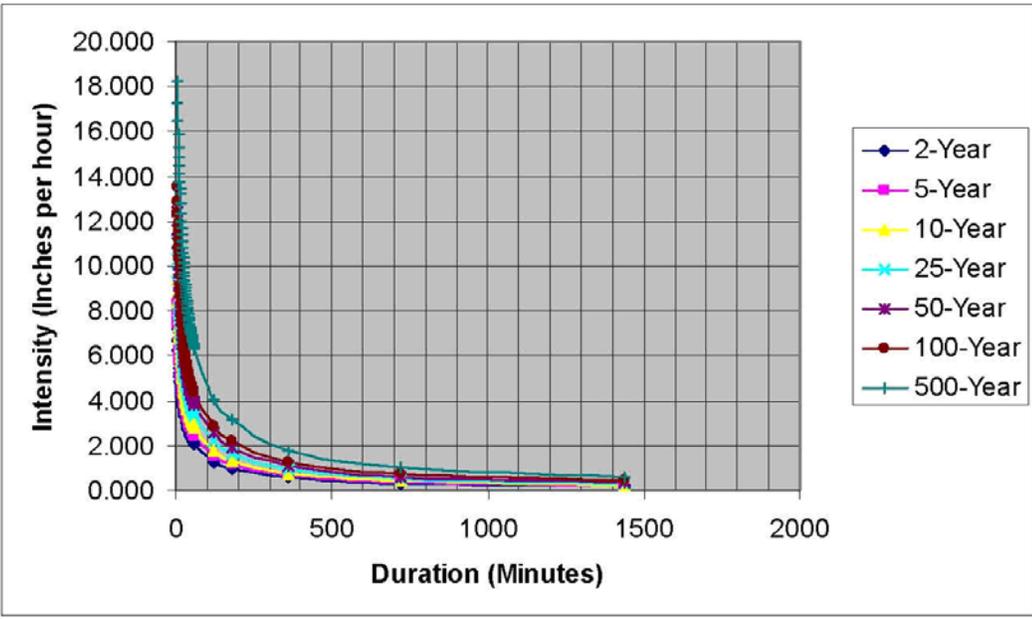


Figure 2. IDF Curves for Bexar County

~~(5) SCS Curve Numbers. The SCS curve numbers adopted for use by the City of San Antonio are shown in Table 504-3. The hydrologic soil groups are listed in the latest version of the United States Natural Resources Conservation Service [formerly the Soil 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 Survey Bexar County, Texas" which document is hereby incorporated by this reference. Soil types may also be based on a Geotechnical Engineering Report.

**Table 504-3
SCS Curve Number by Soil Type**

Hydrologic Soil Group	Description	SCS Curve Number
A	Soils having a low runoff potential due to high infiltration rates. These soils consist primarily of deep, well drained sand and gravels.	25
B	Soils having a moderately low runoff potential due to moderate infiltration rates. These soils consist primarily of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures.	55
C	Soils having moderately high runoff potential due to slow infiltration rates. These soils consist primarily of soils in which a layer exists near the surface that impedes the downward movement of water or soils with moderately fine to fine texture.	70
D	Soils having a high runoff potential due to very slow infiltration rates. These soils consist primarily of clays with high swelling potential, soils with permanently high water tables, soils with a clay pan or clay layer at or near the surface, and shallow soils over nearly impervious parent material.	77

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(6) ~~Percent Impervious Cover.~~ The percent impervious cover for typical land use types in San Antonio are presented in Table 504-4.

**Table 504-4
Percent Impervious Cover by Land Use**

Land Use Category	Average Percent Impervious Cover

Residential	1/8-acre Residential Lots, or Garden or townhouse apartments, or Zoning Districts R-4, R-5, RM-4, RM-5; TND/TOD Use Patterns	65—85%
	¼-acre Residential Lots or Zoning District R-6, RM-6	38%
	1/3-acre Residential Lots or Zoning District R-15	30%
	½-acre Residential Lots or Zoning Districts R-20	25%
	1-acre Residential Lots or Zoning Districts RP, RE	20%
Industrial or Zoning Districts L, I-1, I-2		72—85%
Business or Commercial, or Zoning Districts NC, O, C		85—95%
Densely developed (apartments), or Zoning Districts MF		65—85%
Streets, Roads, and Parking Areas		98%

(7) Design Rainfall and Areal Reduction.

- Design Rainfall.** A twenty-four-hour rainfall distribution shall be applied for runoff calculations. Rainfall intensities as adopted for the City of San Antonio are given in Table 504-5. The lag value for a sub-area shall be calculated as 0.6 times the time of concentration.

**Table 504-5
Design Rainfall Values (inches)**

USGS Adjusted Rainfall Values (pre-areal reduction)						
Frequency of Storm	5-year	10-year	25-year	50-year	100-year	500-year
Exceedance probability	0.2	0.1	0.04	0.02	0.01	0.002
Storm Duration						
Duration	Frequency					

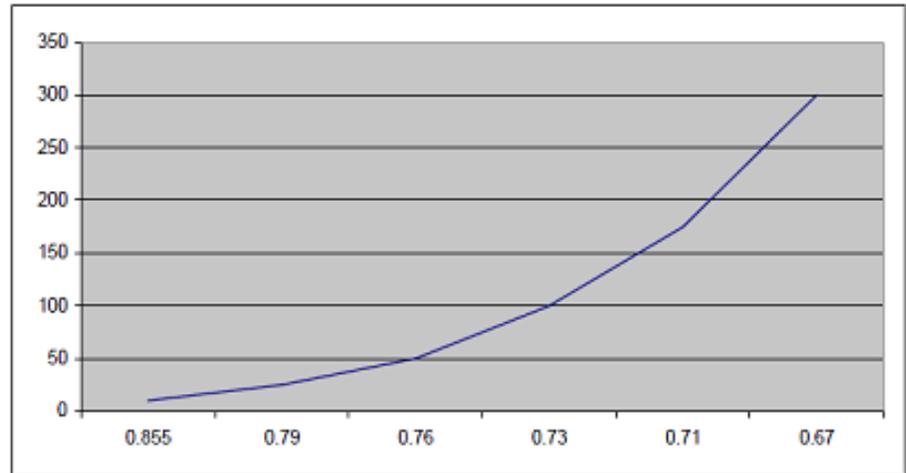
	5-year	10-year	25-year	50-year	100-year	500-year
5-minute	0.68	0.78	0.93	1.04	1.13	1.52
15-minute	1.40	1.60	1.80	2.10	2.50	3.30
1-hour	1.85	2.76	3.32	3.85	4.35	5.80
2-hour	2.37	3.55	4.35	5.10	5.80	8.10
3-hour	3.26	3.95	4.90	5.70	6.60	9.40
6-hour	3.80	4.60	5.70	6.50	7.50	10.60
12-hour	4.40	5.40	6.40	7.50	8.80	12.40
24-hour	5.00	6.00	7.50	9.00	10.00	13.70

2. ~~**Areal Reduction.** Calculated stormwater runoff at a given point may be reduced by the factors shown in Table 504-5.1 based upon the tributary area (in square miles) draining to said point.~~

Areal Reduction Factors **

(for use in calculating Point Rainfall for Bexar County)

Area (sq mi)	Base ARF for Area
10	0.855
25	0.79
50	0.76
100	0.73
175	0.71
300	0.67



** Source: 2007 Watershed "Hydrology Technical Support Data Notebooks" on file with the San Antonio River Authority

~~(8) **Routing of Runoff.** Routing of the runoff hydrograph through the channel from one (1) subarea calculation point to the next in the HEC-1 shall be computed using one (1) 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-1 model of the watershed shall not be replaced with a different methodology without approval or direction from the director of public works.~~

~~(9) **Manning's Roughness Coefficient.** Manning's roughness coefficients ("N" values) for use in routing methods or in hydraulic calculations shall be consistent with the values listed in Table 504-6.~~

Table 504-6 Manning's Roughness Coefficient

Channel Description	Manning's "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

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Overbank Description	Manning's "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

-

The "N" value to be used in Manning's Formula shall conform to the following for design purposes:

- A. Earth channels—0.035
- B. Concrete lined channels—0.015
- C. Reinforced concrete pipe—0.013
- D. Concrete box culverts—0.013
- E. Corrugated metal pipe:
 - i. Unpaved ½" corrugated—0.024
 - ii. Unpaved one (1) inch corrugated—0.027
- F. Asphaltic concrete—0.018

~~Any other "N" value shall be based on generally accepted engineering principles.~~

(de) Drainage Easements/Rights-of-Way.

- (1) **Applicability.** The dedication or acquisition of drainage easements to cover drainage system components is necessary to allow the orderly development and transfer of storm water across properties. Where a subdivision is traversed by a watercourse, drainageway, natural channel or stream, ~~there shall be provided~~ an easement ~~or right-of-way~~ conforming substantially to the limit of such watercourse shall be dedicated, including plus additional width as outlined below.
- (2) **Requirements.** Easement ~~or right-of-way~~ requirements are specified in the following subsections of this section for particular ~~storm water-stormwater~~ management facilities:
 - A. Subsection ~~(ed)(43)(D)~~ Natural ~~Channels Watercourses or Floodplains~~;
 - B. Subsection ~~(ef)(63)~~ Storage Regional Detention Facilities;
 - C. Subsection ~~(eh)(47)(Ae) and (d)~~ Improved Vegetated Earth Channels;
 - D. Subsection ~~(eh)(46)(Be)~~ Concrete Lined Channels;
 - E. Subsection (e)(4)(C) Interceptor Channels
 - F. Subsection ~~(e i)(3e)~~ Storm Drain Systems ~~Sewers~~.
 - G. Subsection (e)(5) Pump Stations

Drainage easements will be required for all storm water-stormwater management facilities accepting runoff from properties other than the lot on which the facility exists or will be constructed.

Drainage easements may be designated as a "Public Drainage Easement" or "Private Drainage Easement". A private drainage easement is required when storm water is to be conveyed across private property from a separate private property up to a contributing drainage area of 100 acres. A Public drainage easement is required when the off-site contributing drainage area exceeds 100 acres or if the contributing area is a FEMA designated floodplain. Drainage easements are also required when storm water is to be conveyed across private property from public property, public rights-of-way and easements, or public infrastructure to an established channel, creek, or other public drainage system.

- (3) **Storm Drain Systems.** Minimum easement widths for storm drains will be the greater of 15 fifteen (15) feet or six (6) feet on both sides of the extreme limits (side slope intercept with the natural ground or proposed finished ground elevation) of the width of storm drain width lines or components.
- (4) **Open Channels.** Constructed channels are created by the movement of earth material by mechanical means and the earth material may be covered by vegetation, or other material to minimize erosion.
 - A. **Improved Earth Channels.** Easements or right-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 15 fifteen (15) feet for an access road on the opposite side of the extreme limits of the channels when the 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 easement right-of-way, the easement right-of-way shall extend two (2) feet on one (1) side and seventeen (17) feet on the opposite side of the extreme limits design limits of the channel. "Extreme Limits" of the

channel shall mean the side slope intercept with the natural ground or proposed finished ground elevation. ~~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~~ 15 foot extra width shall be provided on both sides of the channel.

B. Concrete Channels. Easements ~~or rights-of-way~~ for concrete lined channels shall extend a minimum of two ~~(2)~~ feet on one side and 15 feet for an access road on the opposite side of the extreme limits of the channel when the channel does not parallel and adjoin an alley or roadway. When such channels do parallel and adjoin an alley or roadway, the easement shall extend a minimum of two feet on both sides of the extreme limits of the channel. ~~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.~~

C. Interceptor Channels. Drainage easements for proper conveyance of upstream ~~storm water~~ ~~stormwater~~ runoff shall be required on all subdivision plats where upstream contributing area exceeds the criteria indicated below. Interceptor drains shall be constructed prior to the issuing of building permits on any lot that would intercept natural drainage.

A. (i) Interceptor drainage easements and channels shall be provided for residential subdivisions where the drainage area to the ~~back of~~ platted lots exceeds the depth of two (2) average residential lots with equivalent zoning.

B. (ii) Interceptor drainage easements shall be required on nonresidential subdivision plats where the off-site drainage area contributing to the proposed development exceeds three ~~(3)~~ acres. ~~If necessary, an amending plat may be used to correct drainage easements in conjunction with building permits.~~

(iii) Interceptor easement is required when upstream watershed is discharging storm water to an established development that does not contain a drainage easement and/or drainage infrastructure to properly convey storm water.

(iv) Interceptor drainage easements shall extend a minimum of two ~~(2)~~ feet on both sides of the extreme limits of the channel.

~~(3) D. Natural Channels Watercourses or Floodplains.~~ The limits of easements ~~Easements~~ for natural watercourses shall be the ultimate 100 year floodplain or the ultimate ~~twenty-five~~ 25 year floodplain plus freeboard ~~(see Table 504-9 of this section)~~ whichever is less. In floodplain areas where ongoing maintenance is required or the floodplain will be reserved for use by the public, the drainage easements shall be maintained by a public entity and the property will be dedicated to the city as a multi-use public drainage easement. A drivable access way shall be provided in floodplain easements for the length of the easement when regular maintenance of the floodplain is required. Diversion of storm water ~~stormwater~~ away from the natural watercourse will not be allowed except within the boundaries of the property controlled by the developer, provided that the diverted water is returned to the watercourse within which it would naturally have been flowing prior to leaving the ~~developer's~~ property. An analysis of the timing of the diverted hydrograph on watersheds greater than 20 ~~twenty (20)~~ acres, as it reenters the receiving watercourse, must be performed to show that the peak flowrate in the receiving watercourse has not been increased as a result of the diversion.

~~(4)~~ **E. Maintenance Access in Drainage Easement Right-of-Way.** An unobstructed access drainage easement right-of-way connecting the channel drainage easement with an alley or roadway parallel to or near the easement shall be provided at a minimum spacing of one ~~(4)~~ access easement right-of-way at approximately ~~one thousand~~ 1000 foot intervals. The access easement right-of-way shall be a minimum of ~~fifteen~~ (15) feet in width and shall be maintained clear of obstructions that would limit maintenance vehicle ~~vehicular~~ access. ~~If the flow line of the designed channel incorporates grade control structures or vehicular bridges that would prevent maintenance equipment from accessing that portion of the channel, additional access points may be required.~~ Additional access points may be required if the flow line of the designed channel incorporates grade control structures or vehicular bridges that may block channel access to maintenance equipment. ~~Channel design, earthen or concrete, shall have ramps in the side slopes near the access points that would allow maintenance equipment to descend to the floor level of the channel. The maximum allowable ramp slope for vehicular access is seven to 1 (7:1). Access points adjacent to roadways or alleys shall be provided with a post and cable feature with padlock to prevent unauthorized use.~~

(5) Pump Stations. A drainage easement will be required for all storm water pump stations. An additional 10 foot minimum drainage easement in width shall be required around the pump station for maintenance. All pump stations not included in a street right-of-way or within the storage facilities drainage easement and not adjacent to a public street will require a drainage easement for a 15 ~~fifteen~~ (15) foot width access to the pump station.

(6) Storage Facilities. Drainage easements will be required for all storm water ~~stormwater~~ management facilities accepting runoff from properties other than the lot on which the facility exists or will be constructed. ~~Maintenance of the detention facility shall be the responsibility of the property owner or the property owner's association.~~ For regional detention facilities, the drainage easement will encompass the ~~one hundred~~ (100) year pool elevation plus in addition to all structural improvements (levees, dykes, berms, outfall structures, etc.) necessary to contain the pool. The easement will extend, at a minimum, to the toe of the downstream embankment. The easement shall also extend to a minimum of ~~15~~ fifteen feet outside both the 100 year pool and the structural improvements to facilitate maintenance as well as public safety.

A 100 year ~~frequency flood~~ storm event shall be routed through the proposed dam and all land subject to flooding shall be dedicated as drainage easement ~~or right-of-way~~. An unobstructed ~~15~~ fifteen foot access easement around the periphery of the flooded area shall be dedicated as drainage easement for facilities that require regular mowing or other ongoing maintenance, at the discretion of the director of public works. An unobstructed ~~15~~ fifteen foot access right-of-way shall be established, which connects the drainage easement adjacent to the dam structure to a road or alley and the access shall be dedicated as a drainage easement.

~~All spillway discharges shall be adequately routed to the centerline of the natural low below the dam site. The adequate routing of spillway discharges pertains to the hydraulic routing of the 100 year frequency flood for dedication of drainage easement limits. Probable maximum precipitation (PMP) defined PMP on definition section flood routing or breaches will only be considered for safety considerations (that is, the placement of building and the setting of minimum floor slab elevations below the dams). Any proposed concrete dam structure need not have spillway capable of~~

~~routing a PMP flood, however, it shall be shown to be structurally capable of withstanding any range of flood conditions with regard to possible failure due to sliding, overturning, and structural integrity, up to and including the PMP flood.~~

(5f) Lot and Property Line Crossings. In ~~those~~ cases where drainage easements cross lot and property lines, a statement shall be added to the plat that no fencing or structures that will interfere with adequate drainage flow will be allowed on or across such lines. Fencing may be allowed across drainage easements only in accordance with the following restrictions:

(1)A. Bottom of fence shall be a minimum of the flow depth, plus freeboard (~~see Table 504-9 of this section~~) above design flow line of channel or drain.

(2)B. A hinged gate will be placed across the entire width of the drainage easement. Access must be provided to storm water~~stormwater~~ operations staff at all times to allow access to the easement for the city crews to perform maintenance.

(3)C. Fence posts located within the easement must be structurally designed to resist damage from the storm water~~stormwater~~ flows and impact from debris.

(4)D. A floodplain development permit will be required to construct a fence within an easement within the 100 year floodplain.

(7g) Lower Elevation of Site. All developments shall provide ~~for~~ adequate drainage outfall at the lower end of the site into an existing street, alley, drainage, easements or right-of-way, or to the centerline of an existing natural drain. Where proposed street, storm sewer, or open channel does not discharge into a natural low or into an existing adequate drainage easement then facilities and drainage easements of adequate width to contain the design discharge shall be constructed and dedicated to the centerline of an existing natural low within the same watershed. However, ~~when where~~ the natural low lies within the developer's property, the developer will only be required ~~only~~ to plat an easement to the centerline of the natural low, provided that the easement is able adequate to accommodate the facilities that will be built in conjunction with the future development of that property.

(eh) Site Design and Grading.

(1) 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 in accordance with the NPDES (TPDES) construction site regulation ordinance, Ordinance No. 94002, as amended, and the document entitled "Complying with the Edwards Aquifer Rules; Technical Guidance on Best Management Practices, " by Michael E. Barrett, Ph.D., P.E. Center for Research in Water Resources, Bureau of Engineering Research, University of Texas at Austin, (RG-348, June 1999), which documents are hereby incorporated by this reference.

(2) Erosion and sedimentation controls in accordance with the specifications established by the director of public works in compliance with the National Pollution Discharge Elimination System (NPDES) permitting requirements for the city are required.

(3) Projects shall not be considered complete until restoration has been made in accordance with NPDES requirements.

(4) Where possible, multiple uses of drainage facilities and open space shall be incorporated by the owner or developer of a new subdivision. Alternative uses such as public recreation, horse/bike/hiking trails, walking paths, nature preserves, wildlife habitat areas, etc. are encouraged subject to the approval of the director of public works.

(5) A note must be placed on the plat for residential lots, which states that finished floor elevations must be a minimum of eight (8) inches above final adjacent grade. A grading plan shall be prepared and submitted to the City of San Antonio, which indicates typical lot

grading for all lots in the subdivision using typical FHA lot grading types (A, B and C). A more detailed grading plan is also acceptable. No more than two (2) average residential lots may drain onto another lot unless a drainage easement is dedicated to contain the runoff.

(f) **Storm Water~~stormwater~~ Detention and Other Storm Water~~stormwater~~ Management Facilities.**

(1) For projects with an increased impervious area of greater than ~~0.1 acres~~ 100 square feet that elect not to participate or are not eligible to participate in the regional storm water~~stormwater~~ management program as described in subsection 35-504(b)(1), then storm water~~stormwater~~ detention shall be required for all new developments or redevelopment of individual parcels of property to mitigate peak flow rates to predevelopment or existing development conditions as stated in subsections (b)(6) and (b)(7) of this section. Detention ponds must be placed outside any FEMA 100-year floodplain unless approved by the director of public works or designee.

~~(1) **Maximum Outflow Rate.** 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-year, twenty-five-year and 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 and Water Quality (including Low Impact Development) Features.**~~

(i2) On-site storm water~~stormwater~~ management features 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 of San Antonio will have the right to do periodic inspections of privately owned and maintained detention facilities to ensure that the maintenance schedule is being implemented.

(#3) Where a detention facility accepts flows from public facilities such as city rights-of-way the detention facility will be considered a detention facility serving a public purpose and will be dedicated to the city upon completion and a drainage easement will be dedicated to provide for access to the facility. When a regional detention facility accepts flow from an area exceeding 320 ~~three hundred (300)~~ acres, the facility shall be considered serving a public purpose and shall be dedicated to the city upon completion and a drainage easement will be provided for access to the facility.

~~(3) **Regional Detention Facilities.** General locations and sizes of regional detention facilities have been identified in the master drainage plan for the major watersheds in the city's jurisdiction. The ownership of regional detention facilities may either be public or private. The creation of regional detention facilities designed to service one (1) or several developments is encouraged, but not required. In watersheds where public regional detention facilities exist, mitigation of increased stormwater runoff from new construction may utilize these facilities if the new construction is eligible to participate in the RSWMP. Temporary detention may be required for the development until sufficient capacity in the outfall channel is provided to accommodate increased flows. 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 both publicly~~

~~owned and privately owned facilities must be approved by the director of public works prior to approval of construction drawings.~~

~~Drainage easements will be provided for all regional detention facilities. The easement will encompass the 100-year pool elevation plus all structural improvements (levees, dykes, berms, outfall structures etc.) necessary to contain the pool. The easement will extend, at a minimum, to the toe of the downstream embankment. Maintenance access (fifteen-foot minimum) will be provided around the facility, outside the limits of the 100-year pool elevation. Ramps, as necessary, with a maximum slope of seven to one (7:1) will be provided for access to the flow line of the facility.~~

~~(4) **Easement Requirements.**~~

~~A. Drainage easements will be required for all stormwater management facilities accepting runoff from properties other than the lot on which the facility exists or will be constructed. Maintenance of the detention facility shall be the responsibility of the property owner or the property owner's association.~~

~~B. Full detention basin design may be deferred until the building permit stage IF the property owner submits a "request for detention deferral" demonstrating an understanding of the implications of such design deferral AND the following notes are placed on the subdivision plat AND supporting documentation is provided.~~

~~1. "Stormwater detention is required for this property. The engineer of record for this subdivision plat has estimated that an area of approximately _____ acres and a volume of approximately _____ acre feet will be required for this use. This is an estimate only and detailed analysis may reveal different requirements."~~

~~2. "No building permit shall be issued for this platted property until a stormwater detention system design has been approved by the City of San Antonio or Bexar County for commercial properties within the ETJ."~~

~~C. For regional detention facilities, the easement will encompass the 100-year pool elevation plus all structural improvements (levees, dykes, berms, outfall structures etc.) necessary to contain the pool. The easement will extend, at a minimum, to the toe of the downstream embankment. The easement shall also extend to a minimum of fifteen feet outside both the 100-year pool and the structural improvements to facilitate maintenance as well as public safety.~~

~~(5) **Access Ramps.** Ramps, as necessary, with a maximum slope of seven to one (7:1) will be provided for access to the flow line of all public detention facilities.~~

~~(6) **Multi-Use Facilities.** Multi-use facilities are encouraged, but not required (multi-use facilities allows for water quality, satisfy NPDES 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 (a) 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.~~

~~(7) **Permanent Wet Pool or Pumped Detention Systems.** Stormwater retention with permanent wet pool or pumped detention systems will not be acceptable methods of stormwater 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.~~
- ~~(8) **Location of Detention Facilities and Surrounding Development.** Stormwater detention facilities shall be located in topographically depressed areas where possible. When necessary, dams may be constructed to detain flows. All proposed dams shall conform to the following items:~~
- ~~A. All dams over six (6) feet above existing natural around shall be approved by the Dam Safety Team of the TNRCC for safety. All other new dams shall be designed in accordance with acceptable design criteria as approved by the director of public works, or his authorized representative.~~
 - ~~B. All hydrology and hydraulic properties of a dam will be reviewed by the department of public works with regard to spillway design, freeboard hydraulics, backwater curves and downstream effects due to the dam site.~~
 - ~~C. The spillway section of any earthen dam with a height greater than six (6) feet shall be large enough to pass a PMP (probable maximum precipitation) flood, as defined by the NRCS, without overtopping the crest of the dam in accordance with TNRCC regulations.~~
 - ~~D. A 100-year frequency flood shall be routed through the proposed dam and all land subject to flooding shall be dedicated as drainage easement or right-of-way. An unobstructed fifteen-foot access easement around the periphery of the flooded area shall be dedicated as drainage easement for facilities that require regular mowing or other ongoing maintenance, at the discretion of the director of public works. An unobstructed fifteen-foot access right-of-way shall be established which connects the drainage easement adjacent to the dam structure to a road or alley.~~
 - ~~E. Development below existing dams will take into account the original design conditions of the existing dam. Dam breach analysis checks will be required, dependent upon location of development with respect to dam site.~~
 - ~~F. All spillway discharges shall be adequately routed to the centerline of the natural low below the dam site. The adequate routing of spillway discharges pertains to the hydraulic routing of the 100-year frequency flood for dedication of drainage easement limits. Probable maximum precipitation (PMP) defined PMP on definition section flood routing or breaches will only be considered for safety considerations (that is, the placement of building and the setting of minimum floor slab elevations below the dams). Any proposed concrete dam structure need not have spillway capable of routing a PMP flood, however, it shall be shown to be structurally capable of withstanding any range of flood conditions with regard to possible failure due to sliding, overturning, and structural integrity, up to and including the PMP flood.~~

(g) Streets Drainage.

(1) Generally.

- A. The design of new streets and the improvement Design of existing streets shall consider public safety and limit potential conflicts between storm water ~~stormwater~~ conveyance, vehicular traffic, pedestrian traffic, parking, pedestrian access, ADA requirements, and bicycle traffic.

- B. Streets draining a watershed greater than 100 ~~one hundred (100)~~ acres must be designed for the 100 ~~one hundred (100)~~-year ultimate design frequency storm.
- C. Streets may be used for storm water ~~stormwater~~ drainage only if the calculated storm water ~~stormwater~~ flow does not exceed the maximum flow depth allowable for the street roadway classification, ~~flows outlined in Table 504-7~~ or the velocity does not exceed 10 ~~ten (10)~~ feet per second.
- D. Where streets are not capable of carrying storm water ~~stormwater~~, 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 ~~stormwater~~ 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 ~~stormwater~~ progresses downgrade.
- G. Curb cuts for driveways on all streets shall be designed for compatibility with the storm water ~~stormwater~~ conveyance function of streets. The design criteria maximum frequency storm must be contained within the right-of-way.
- H. Potential flooding problems or conflicts at ~~the~~ connection points where new or modified drainage systems (including streets, storm drains ~~sewers~~, etc.) and ~~the~~ existing portions of the downstream street system and storm water ~~stormwater~~ 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. Where dwelling ~~Dwelling~~ units are located on the downhill side of a T-intersection or Cul-de-sac with a street or drainage channel discharging onto it, ~~the street~~ ~~the~~ intersection shall be graded ~~sited~~ so as to avoid water flowing over the curb and out of the right-of-way ~~obstruction of the drainage patterns~~. Detailed calculations will be required at these locations to show that the discharges are contained within the right-of-way.

~~(2) **Primary and Secondary Arterial Streets.** 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) **Local "B" and Collector Streets.** A maximum flow depth to the top of curb on a standard local "B" and collector street section will be allowed during a twenty-five year storm event. A collector street is a street with a width of forty-four (44) feet or more and not shown as an arterial street on the current major thoroughfare plan.~~

~~(4) **Local "A" Streets.** Local "A" 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.** 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 stormwater.~~

~~(6) **Traditional Street Design.** Traditional street design shall conform to the storm frequency requirements of the standard street designs listed above as follows:~~

~~A. Trails, Alleys and Lanes – Use alley design criteria.~~

~~B. Local Street or Avenue – Use local "A" street design criteria.~~

~~C. Main Street – Use local "A," local "B" or collector street design criteria depending on the pavement widths. Use local "A" criteria where pavement width is less than thirty-four (34) feet.~~

~~D. Boulevard or Parkway – Use arterial street design criteria.~~

~~No flow capacity tables are provided for the traditional street designs due the variety of geometric properties associated with these streets. Drainage calculations specific to a proposed traditional street design must be submitted for approval with every project where a traditional street design is proposed.~~

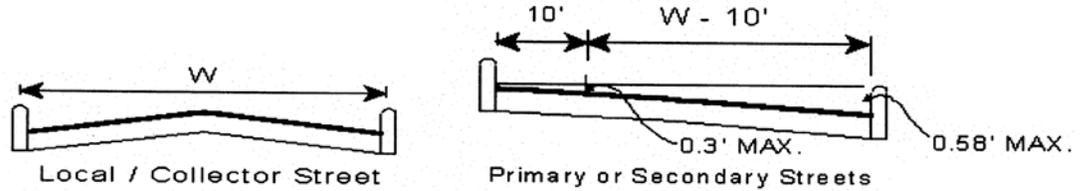
(72) All-Weather Crossings.

- A. Where proposed streets cross existing or proposed watercourses, all-weather crossings shall be required. Culverts or bridges shall be adequate to allow passage of the design storm identified in subsection 35-504(b)(24).
- B. All crossings, culverts and bridges shall be designed for an H-20-44 or HS-20 loading.

(83) Unflooded Public Road Access.

- A. During a design storm event (see "subsection 35-504(b)(2) System Criteria") unflooded access (within the "Proceed with Caution" range per figure 504-2) shall be available from each proposed new development to an adjacent public street during a regulatory flood event.
- B. Additionally, unflooded access shall be accessible to an arterial street that is not adjacent to the development or to a distance of one-quarter ~~(1/4)~~ mile, whichever is less, during a future conditions four ~~twenty (20)~~ percent annual chance (25 year) ~~(twenty-five year)~~ ultimate flood event.
- C. The director of public works may waive criterion ~~Bb~~ of this requirement for developments under three ~~(3)~~ acres in size.

Figure 504-2 Table 504 - 7 Storm Drainage, street Velocities & Capacities, Manning's N=0.018



**STORM DRAINAGE
STREET VELOCITIES AND CAPACITIES
Manning's n=0.018**

Slope %	LOCAL TYPE "A" W=30'		LOCAL TYPE "B" W=40'		COLLECTOR W=44'		SECONDARY (W/MEDIAN) Maximum Water Depth = 7" W=24' Min. and 29' Max.		PRIMARY & Secondary (W/O MEDIAN) Maximum Water Depth = 7" W=24' Min. and 29' Max.	
	Q cfs	V f/s	Q cfs	V f/s	Q cfs	V f/s	Q cfs	V f/s	Q cfs	V f/s
0.40	35.4	2.8	47.8	2.9	44.1	2.7	20.6	2.5	19.2	2.3
0.45	37.5	3.0	50.7	3.0	46.8	2.8	21.9	2.7	20.4	2.4
0.50	39.6	3.2	53.4	3.2	49.3	3.0	23.1	2.8	21.5	2.5
0.55	41.5	3.3	56.0	3.4	51.7	3.1	24.2	2.9	22.5	2.7
0.60	43.3	3.5	58.5	3.5	54.0	3.3	25.3	3.1	23.6	2.8
0.65	45.1	3.6	60.9	3.7	56.2	3.4	26.3	3.2	24.5	2.9
0.70	46.8	3.8	63.2	3.8	58.4	3.5	27.3	3.3	25.4	3.0
0.75	48.5	3.9	65.4	3.9	60.4	3.7	28.3	3.4	26.3	3.1
0.80	50.0	4.0	67.6	4.1	62.4	3.8	29.2	3.5	27.2	3.2
0.85	51.6	4.1	69.6	4.2	64.3	3.9	30.1	3.7	28.0	3.3
0.90	53.1	4.3	71.7	4.3	66.2	4.0	30.9	3.8	28.8	3.4
0.95	54.5	4.4	73.6	4.4	68.0	4.1	31.8	3.9	29.6	3.5
1.00	55.9	4.5	75.5	4.5	69.8	4.2	32.6	4.0	30.4	3.6
1.50	68.5	5.5	92.5	5.5	85.4	5.2	40.0	4.9	37.2	4.4
2.00	79.1	6.4	106.8	6.4	98.6	6.0	46.1	5.6	43.0	5.1
2.50	88.5	7.1	119.4	7.2	110.3	6.7	51.6	6.3	48.1	5.7
3.00	96.9	7.8	130.8	7.8	120.8	7.3	56.5	6.9	52.7	6.2
3.50	104.7	8.4	141.3	8.5	130.5	7.9	61.0	7.4	56.9	6.7
4.00	111.9	9.0	151.1	9.1	139.5	8.5	65.2	7.9	60.8	7.2
4.50	118.7	9.5	160.2	9.6	148.0	9.0	69.2	8.4	64.5	7.6
5.00	125.1	10.0	168.9	10.0	156.0	9.5	72.9	8.9	68.0	8.0
5.50	116.0	10.0	153.0	10.0	163.6	9.9	76.5	9.3	71.3	8.4
6.00	108.0	10.0	143.0	10.0	157.0	10.0	79.9	9.7	74.5	8.8
6.50	102.0	10.0	134.0	10.0	148.0	10.0	81.0	10.0	77.5	9.1
7.00	96.0	10.0	127.0	10.0	140.0	10.0	76.0	10.0	80.4	9.5
7.50	91.0	10.0	120.0	10.0	132.0	10.0				
8.00	87.0	10.0	115.0	10.0	126.0	10.0				
8.50	83.0	10.0	110.0	10.0	120.0	10.0				
9.00	79.0	10.0	105.0	10.0	115.0	10.0				
9.5	76.0	10.0	101.0	10.0	111.0	10.0				
10	73.0	10.0	97.0	10.0	106.0	10.0				

(Hk) **Drainage Channels and Watercourses.** This section addresses proposed improvements or modifications to drainage channels and watercourses required to convey [storm water](#) runoff from or through the proposed development. Refer to subsection 35-504(b)(2+) for storm frequency design criteria.

(1) **Watercourses to Remain Unobstructed.** 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.

~~(2) **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. **Natural Unimproved Waterways.** 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 and other erosion control measures. Consulting engineers and development review officials shall work to resolve potential downstream impact issues.~~

~~(3) **Maintenance.** 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 tagweed 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.~~

(4) **Multiple Uses.** 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.~~

~~(5) **Velocity Criteria.** Table 504-8 shall be used to determine maximum permissible channel velocity.~~

Table 504-8 Velocity Control

Velocity (fps)	Type of Facility Required	Hydraulic Radius (ft.)	Correction Factor	Maximum Permissible Velocity

				(fps)
1 to 6 (Maximum Average Velocity = 6 fps)	Vegetated Earthen Channel	0—1	0.8	5
		1—3	0.9	5.5
		3—5	1.05	6.3
		5—8	1.15	6.9
		8—10	1.225	7.35
		Over 10	1.25	7.5
*6 to 12	Turf Reinforcement Mat (TRM)	NA	NA	12
6 to 8	Concrete Retards	NA	NA	NA
>8	Concrete Lining or Drop Structures	NA	NA	NA

~~* If Turf Reinforcement Mat (TRM) is proposed, please see City of San Antonio Standard Specifications for Construction Item 554 for submittal requirements. The improvement plan sheets should include the location of placement, details, and manufacturer's installation instructions.~~

~~A. Where velocities are in the supercritical range, allowance shall be made in the design for the proper handling of the water.~~

~~B. Ensure that the channel will contain the hydraulic jump (sequent depth) throughout the extent of the supercritical profile. An exception to this criteria 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.~~

~~(6) **Retard Spacing.** Retard spacing shall be computed as follows when using the city standard retard section Figure 504-3 and the following equations:~~

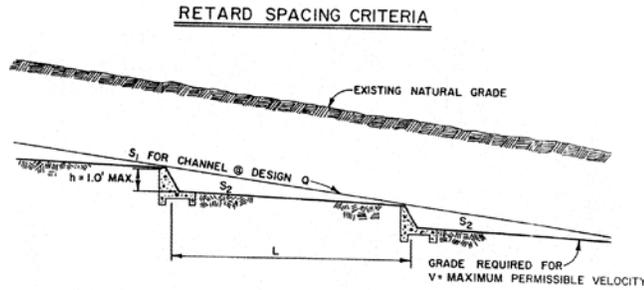


Figure 504-3

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

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 504-8, i.e.:

and

$$S2 = \left[(NV)^2 \div (1.486R^{2/3}) \right]^2$$

Where: V = maximum permissible velocity established from Table 504-8

N = .035

R = area/wetted perimeter

~~(7) **Concrete Lined Channels.** The design of concrete lined channels shall comply with the following general requirements:~~

~~A. Freeboard consistent with Table 504-9 will be applied to the twenty-five-year design.~~

~~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). The minimum slope of concrete lined channels shall be 0.4 percent, or 0.1 percent with a minimum "cleaning" velocity of two (2) feet per second (2 fps) during an existing conditions two-year storm event.~~

~~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 subgrade 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 (1½) 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 (½) 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.~~
- ~~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.~~

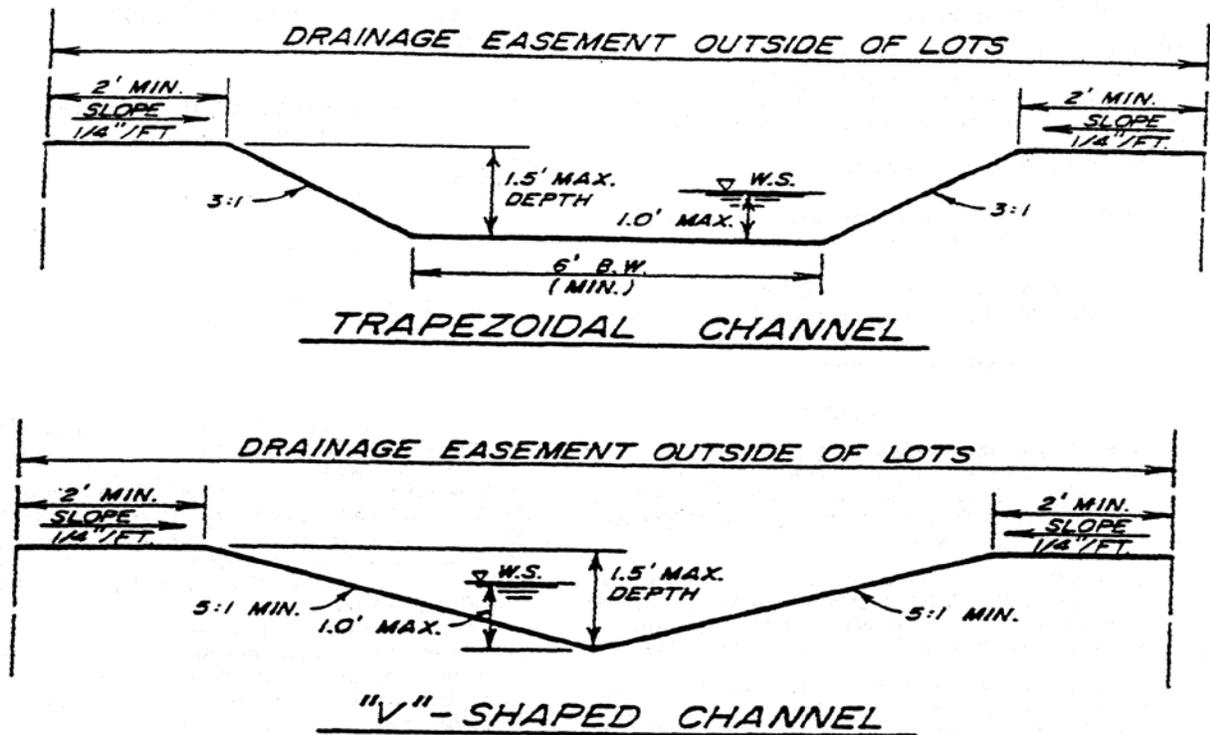
**Table 504-9
 Drainage Freeboard for Concrete
 Lined and Earth Channels for Twenty-Five-Year Storm**

Design Depth of Flow	Required Freeboard
0 to feet 5 feet	0.5 foot
5 to 10 feet	10% of design depth
10 feet and over	1.0 foot

(8) ~~Vegetated Earth Channels.~~

- ~~A. Freeboard consistent with Table 504-9 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. Refer to Figure 504-4.~~
- ~~E. 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 San Antonio will accept the channel for maintenance.~~
- ~~F. For vegetated earthen channels with slopes less than 0.5 percent or bottom widths greater than thirty (30) feet, concrete pilot channels shall be provided. The minimum~~

bottom width of the pilot channel shall be four (4) feet. The minimum [earthen] slope draining toward the pilot channel shall be one (1) percent.



NO RETARDS
VEL. CONTROL
**STANDARDS FOR
INTERCEPTOR DRAINS
FOR INTERCEPTING SHEET FLOW
(WITHOUT ACCESS EASEMENT REQ'D)**

Figure 504-4

35-504(h)(8) continued

~~(9) Channel Bends and Turns - Freeboard. 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 and the flow regime is sub-critical, the applicant shall use the following formula for computing the extra freeboard:~~

~~$$d_2 - d_1 = V^2(T + B) \div 2gR$$~~

~~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.~~

~~$g = \frac{32.2}{R^2}$ 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 where centerline radius of channel should be at least three (3) times the bottom width. For critical and super-critical flow regimes, the extra freeboard calculated with the above formula shall be doubled.~~

(i) **Storm Sewers Drains.**

- (1) For all ordinary conditions, storm ~~drains sewers~~ shall be designed on the assumption that they will flow full under the design discharge; however, ~~when whenever~~ there are constrictions, turns, submerged or inadequate outfall, etc., the ~~Hydraulic and Energy Grade Lines hydraulic and energy grade lines~~ shall be computed and plotted in profile. The ~~Energy Grade Line energy grade line~~ (EGL) shall be below the top of curb and the ~~Hydraulic Grade Line hydraulic grade line~~ (HGL) shall be below the gutter elevation of the drainage structure. In all cases adequate outfalls shall be provided, including review of point source discharges.
- (2) No storm ~~sewers drains~~ shall be less than ~~24 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 $(3 \times 10') + (4 \times 0.5') + (2 \times 6') = 44'$).~~

~~(j) Inlets and Openings.~~

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

~~$L = Q \div Ch^{3/2}$~~

~~Where: L = the length of drop curb opening required in feet.
Q = amount of flow in 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 hamper the flow of traffic. For amount of curb exposure, conform to City of San Antonio inlet standards.~~

- ~~(2) Curb or Drop Inlets. Where drop inlets are use, 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 public works in consultation with the director of planning and development services. 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:~~

$$Q = CA(2gh)^{1/2}$$

Where: Q = discharge in cubic feet per second.
 C = 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.

Sec. 35-504. - Storm Water Management.

STATEMENT OF PURPOSE

The purpose of this section is to provide adequate measures for the retention, detention and distribution of storm water in a manner that minimizes the possibility of adverse impacts on both water quantity and water quality during development. Innovative runoff management practices designed to meet the provisions of this chapter, enhance the recharge of groundwater, and maintain the function of critical environmental features are encouraged. The city recognizes that watercourses and their associated watersheds within the City of San Antonio's jurisdiction represent significant and irreplaceable recreational and aesthetic resources and contribute to the economic and environmental health of the city. In addition, all of the watersheds within the city are vulnerable to concentrated surface water runoff, disturbance of wildlife habitat, non-point source pollution and sedimentation resulting from development activities and should be developed in a sensitive and innovative manner.

This section implements the following policies of the master plan:

- Natural Resources, Policy 1d: Encourage retention of the 100-year floodplains as natural drainageways without permanent construction, unnecessary straightening, bank clearing or channeling.*
- Natural Resources, Policy 1d: 2. Adopt strong storm water management practices throughout the drainage area which include site specific measures such as:*

*On-site storm water retention and detention;
Reduction in impervious cover;
Natural bank contouring;
Floodplain preservation and buffering;
Preservation of riparian habitat;
Storm water harvesting sites for reuse purposes.*

- Urban Design, Policy 1g: Prepare design and construction policies and standards for utility and transportation infrastructure, capital improvement projects, public facilities and development projects that reinforce neighborhood centers and provide diverse, pedestrian-friendly neighborhoods.*

(a) **Applicability.** The provisions of this section shall apply to any application for subdivision plat, master development plan, capital improvement project, or building permit approval except as otherwise provided by this chapter. A storm water management plan shall be provided as set forth in Appendix "B," section 35-B119 of this chapter.

(b) **Storm water Management Program.**

(1) **Regional Storm Water Management Program (RSWMP).**

A. The City of San Antonio has determined that regional storm water management is preferable to site specific storm water mitigation. The regional storm water management program provides for the administration, planning, design, construction, and operational management of regional storm water facilities (RSWF). Regional storm water management uses a watershed-wide approach to analyze potential flooding problems, identify appropriate mitigation measures and select site locations and design criteria for RSWF. These RSWF include, but are not limited to, regional detention and retention ponds, watershed protection, land purchase, waterway enlargement, channelization, and improved conveyance structures. The regional storm water management program allows developers to participate in the program rather than constructing the on-site detention controls required by this section, where the resulting use of a RSWF will not produce a significant adverse impact to other properties due to the increased runoff from the proposed development.

- B. All developers shall participate in the RSWMP in one (1) of three (3) ways:
1. Payment of a fee in lieu of on-site detention (except in areas designated by the director of public works as "mandatory detention areas"). The fee schedule is included in Appendix "C," section 35C-109.
 2. Construction of on-site or off-site measures (typically storm water detention facilities) to mitigate increases in runoff resulting from the proposed development.
 3. Construction or participation in the construction of an off-site RSWF to mitigate increased storm water runoff anticipated from ultimate development of the watershed.
- C. To determine a significant adverse impact for the purposes of this section, the following criteria will be used to analyze the receiving storm water facilities within two thousand (2,000) linear feet of the project, to the nearest downstream RSWF, or to the nearest floodplain with an ultimate analysis accepted by the city, whichever is less. For lots less than three (3) acres in size, adverse impact analyses need only extend to where tributary drainage areas equal one hundred (100) or more acres. For properties that are within a mandatory detention area and are less than three acres a peak on peak analysis of the overall site compared to the overall hydrology must extend down to the next junction node based on the effective hydrologic models or best available data.
1. The storm water surface elevation (WSE) in receiving facility [natural or improved] drainage systems within two thousand (2,000) linear feet of the proposed development may not be increased by the proposed development unless the increased WSE is contained within easements or rights-of-way or the receiving systems have sufficient capacity to contain the increased WSE without increasing flooding to habitable structures.
 2. Ultimate development runoff at low water crossings during regulatory (five year, 25 year and 100 year frequency) storm events must not classify the low water crossing as "Dangerous to Cross" based on Figure 504-2. If the ultimate WSE exceeds this criterion, the crossings may be improved to the standards of this chapter in lieu of providing onsite storm water control measures or paying a fee.
 3. Three development conditions shall be analyzed with each adverse impact analysis.

Existing Conditions. This refers to current development conditions in the watershed and on site. This shall be used as the baseline for determining the impact of the development of the site, or the watershed, to other properties or drainage systems.

Proposed Conditions. This refers to existing conditions with the proposed development added. This shall be used to determine if the increased runoff from the proposed development results in an adverse impact to other properties or drainage systems.

Ultimate Conditions. This refers to ultimate development conditions within the watershed. In addition to being used to design proposed drainage facilities (subsection "(2) System Criteria," below), this condition shall also be used to determine if the increased runoff from the ultimate development of the watershed results in an adverse impact to other properties or drainage systems.

In addition to verifying low water crossing capacity (item 2, above), this analysis shall be used to assist the city in identifying watershed wide storm water management issues.

4. Minimum standards for identifying Dangerous Roadway conditions are identified in figure 504-2.

Note: The City of San Antonio contends that any runoff crossing a roadway creates a potentially dangerous condition. Figure 504-2 represents the maximum flow over roadways that the city will accept in adverse impact analyses signed and sealed by the licensed professional engineers.

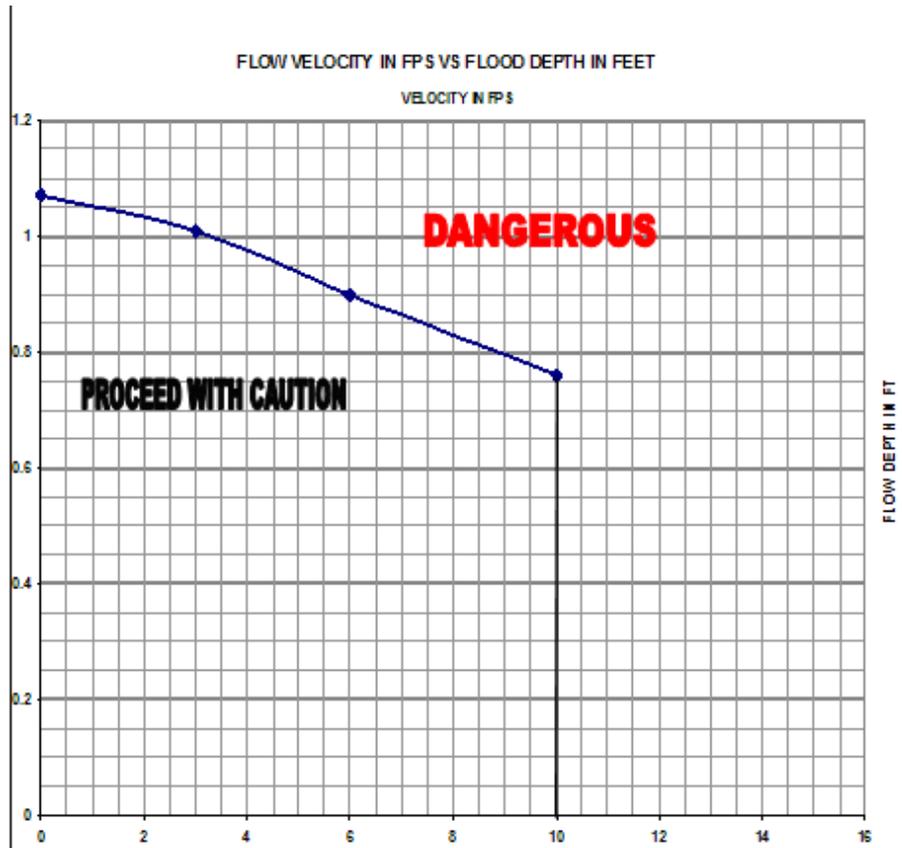


Figure 504-2 Dangerous Roadway Conditions During Flood Events

5. The City of San Antonio may reject a developer's request to participate in the RSWMP by payment or mitigation and require on-site detention. The city's decision will be based on the knowledge of significant adverse impacts that would be created by ultimate development of the watershed regardless of the distance from the development to the area of concern. The city may also reject a request for participation when it is not in the best interests of the RSWMP. The developer is recommended to meet with the storm water engineering division of the department of public works to discuss participation options prior to commencing design of a project. This preliminary meeting in no way relieves the developer of his responsibility to prepare the necessary engineering documentation to support his request for participation.
- D. The storm water development fee in lieu of on-site detention must be paid prior to a plat being released for recordation by the City of San Antonio or the issuance of a building permit. The fee shall be determined in accordance with the provisions of section 35-C109, Reference Table 1 for storm water management fees.

- (2) **System Criteria.** All storm water management facilities, or combination of facilities, shall be designed for ultimate development. Facilities with drainage areas less than 100 acres shall be designed for a 25 year storm. Facilities with drainage areas over 100 acres or areas within a FEMA designated floodplain shall be designed for a 100 year storm or a 25 year storm plus freeboard whichever elevation is higher. Detention facilities and streets are exceptions to the frequency criteria cited above. Detention facility outflows will be designed for five year, 25 year and 100 year frequency storms. Refer to subsection 35-504(j) for specific drainage design criteria for streets.
 - (3) **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.
 - (4) **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 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.
 - (5) **Maintenance.**
 - A. 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 both publicly owned and privately owned facilities must be approved by the director of public works prior to the approval of construction drawings.
 - B. Authorized personnel from the City of San Antonio shall 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.
 - (6) **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, 25 and 100 year design storm events, except as provided in subsection 35-504(b)(1), above.
 - (7) **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, 25 and 100 year design storm events, except as provided in subsection 35-504(b)(1), above.
 - (8) **Low Impact Development (LID).** The City of San Antonio encourages the installation of LID features such as engineered swales, engineered infiltration storm drain systems, bioretention, and engineered wetlands. For all developments proposed within the City of San Antonio's jurisdictional boundaries, these features may be considered on-site detention features to the extent that they reduce the storm water runoff expected downstream as a result of such developments. It shall be the developer's responsibility to demonstrate that said LID features provide such benefit. Credit toward RSWMP fees will be considered and approved on a case by case basis by the department of public works.
- (c) **Storm Water Design Criteria Manual (SWDCM).** The Director of Public Works shall maintain and publish a SWDCM. The SWDCM shall include standard principles and practices for the design and construction of drainage facilities and is hereby adopted by the City Council. The SWDCM may be amended from time to time by the City Council. If any such amendment is in conflict with this chapter, the most restrictive provision shall control. To comply with the RSWMP, all development shall follow the processes and procedures contained in the SWDCM.

(d) **Natural Watercourses or Floodplains.** Diversion of storm water away from the natural watercourse will not be allowed except within the boundaries of the property controlled by the developer, provided that the diverted water is returned to the watercourse within which it would naturally have been flowing prior to leaving the developer's property. A timing analysis of the diverted hydrograph on watersheds greater than 20 acres, as it reenters the receiving watercourse, must be performed to show that the peak flow rate has not been increased as a result of the diversion.

(e) **Drainage Easements.**

(1) **Applicability.** The dedication or acquisition of drainage easements to cover drainage system components is necessary to allow the orderly development and transfer of storm water across properties. Where a subdivision is traversed by a watercourse, drainageway, natural channel or stream, an easement conforming substantially to the limit of such watercourse shall be dedicated, including additional width as outlined below.

(2) **Requirements.** Easement requirements are specified in the following subsections of this section for particular storm water management facilities:

- A. Subsection (e)(4)(D) Natural Channels;
- B. Subsection (e)(6) Storage Facilities;
- C. Subsection (e)(4)(A) Improved Earth Channels;
- D. Subsection (e)(4)(B) Concrete Channels;
- E. Subsection (e)(4)(C) Interceptor Channels
- F. Subsection (e)(3) Storm Drain Systems.
- G. Subsection (e)(5) Pump Stations

Drainage easements will be required for all storm water management facilities accepting runoff from properties other than the lot on which the facility exists or will be constructed.

Drainage easements may be designated as a "Public Drainage Easement" or "Private Drainage Easement". A private drainage easement is required when storm water is to be conveyed across private property from a separate private property up to a contributing drainage area of 100 acres. A Public drainage easement is required when the off-site contributing drainage area exceeds 100 acres or if the contributing area is a FEMA designated floodplain. Drainage easements are also required when storm water is to be conveyed across private property from public property, public rights-of-way and easements, or public infrastructure to an established channel, creek, or other public drainage system.

(3) **Storm Drain Systems.** Minimum easement widths for storm drains will be the greater of 15 feet or six feet on both sides of the extreme limits of the width of storm drain lines or components.

(4) **Open Channels.** Constructed channels are created by the movement of earth material by mechanical means and the earth material may be covered by vegetation, or other material to minimize erosion.

A. Improved Earth Channels. Easements for improved earth channels shall extend a minimum of two feet on one side and 15 feet for an access road on the opposite side of the extreme limits of the channels when the channels do not parallel and adjoin an alley or roadway. When such channels do parallel and adjoin an alley or roadway, the easement 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 easement, the easement shall extend two feet on one side and 17 feet on the opposite side 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. Where designed channel bottoms exceed one 100 feet in width, the 15 foot extra width shall be provided on both sides of the channel.

- B. Concrete Channels.** Easements for concrete lined channels shall extend a minimum of two feet on one side and 15 feet for an access road on the opposite side of the extreme limits of the channel when the channel does not parallel and adjoin an alley or roadway. When such channels do parallel and adjoin an alley or roadway, the easement shall extend a minimum of two feet on both sides of the extreme limits of the channel.
- C. Interceptor Channels.** Drainage easements for proper conveyance of upstream storm water runoff shall be required on all subdivision plats where upstream contributing area exceeds the criteria indicated below. Interceptor drains shall be constructed prior to the issuing of building permits on any lot that would intercept natural drainage.
- (i) Interceptor drainage easements and channels shall be provided for residential subdivisions where the drainage area to the platted lots exceeds the depth of two (2) average residential lots with equivalent zoning.
 - (ii) Interceptor drainage easements shall be required on nonresidential subdivision plats where the off-site drainage area contributing to the proposed development exceeds three acres.
 - (iii) Interceptor easement is required when upstream watershed is discharging storm water to an established development that does not contain a drainage easement and/or drainage infrastructure to properly convey storm water.
 - (iv) Interceptor drainage easements shall extend a minimum of two feet on both sides of the extreme limits of the channel.
- D. Natural Channels.** The limits of easements for natural watercourses shall be the ultimate 100 year floodplain or the ultimate 25 year floodplain plus freeboard whichever is less. In floodplain areas where ongoing maintenance is required or the floodplain will be reserved for use by the public, the drainage easements shall be maintained by a public entity and the property will be dedicated to the city as a public drainage easement. A drivable access way shall be provided in floodplain easements for the length of the easement when regular maintenance of the floodplain is required. Diversion of storm water away from the natural watercourse will not be allowed except within the boundaries of the property controlled by the developer, provided that the diverted water is returned to the watercourse within which it would naturally have been flowing prior to leaving the property. An analysis of the timing of the diverted hydrograph on watersheds greater than 20 acres, as it reenters the receiving watercourse, must be performed to show that the peak flowrate in the receiving watercourse has not been increased as a result of the diversion.
- E. Maintenance Access in Drainage Easement.** An unobstructed access drainage easement connecting the channel drainage easement with an alley or roadway parallel to or near the easement shall be provided at a minimum spacing of one (1) access easement at approximately one thousand 1000 foot intervals. The access easement shall be a minimum of 15 feet in width and shall be maintained clear of obstructions that would limit maintenance vehicle access. Additional access points may be required if the flow line of the designed channel incorporates grade control

structures or vehicular bridges that may block channel access to maintenance equipment.

- (5) **Pump Stations.** A drainage easement will be required for all storm water pump stations. An additional 10 foot minimum drainage easement in width shall be required around the pump station for maintenance. All pump stations not included in a street right-of-way or within the storage facilities drainage easement and not adjacent to a public street will require a drainage easement for a 15 fifteen (15) foot width access to the pump station.
- (6) **Storage Facilities.** Drainage easements will be required for all storm water management facilities accepting runoff from properties other than the lot on which the facility exists or will be constructed. For regional detention facilities, the drainage easement will encompass the 100 year pool elevation in addition to all structural improvements (levees, dykes, berms, outfall structures, etc.) necessary to contain the pool. The easement will extend, at a minimum, to the toe of the downstream embankment. The easement shall also extend to a minimum of 15 feet outside both the 100 year pool and the structural improvements to facilitate maintenance as well as public safety.

A 100 year storm event shall be routed through the proposed dam and all land subject to flooding shall be dedicated as drainage easement. An unobstructed 15 foot access easement around the periphery of the flooded area shall be dedicated as drainage easement for facilities that require regular mowing or other ongoing maintenance, at the discretion of the director of public works. An unobstructed 15 foot access shall be established, which connects the drainage easement adjacent to the dam structure to a road or alley and the access shall be dedicated as a drainage easement.

The adequate routing of spillway discharges pertains to the hydraulic routing of the 100 year frequency flood for dedication of drainage easement limits.

- (f) **Lot and Property Line Crossings.** In cases where drainage easements cross lot and property lines, a statement shall be added to the plat that no fencing or structures that will interfere with adequate drainage flow will be allowed on or across such lines. Fencing may be allowed across drainage easements only in accordance with the following restrictions:
 - (1) Bottom of fence shall be a minimum of the flow depth, plus freeboard above design flow line of channel or drain.
 - (2) A hinged gate will be placed across the entire width of the drainage easement. Access must be provided to storm water operations staff at all times to allow access to the easement for the city crews to perform maintenance.
 - (3) Fence posts located within the easement must be structurally designed to resist damage from the storm water flows and impact from debris.
 - (4) A floodplain development permit will be required to construct a fence within an easement within the 100 year floodplain.
- (g) **Lower Elevation of Site.** All developments shall provide adequate drainage outfall at the lower end of the site into an existing street, alley, drainage, easements or right-of-way, or to the centerline of an existing natural drain. Where proposed street, storm sewer, or open channel does not discharge into a natural low or into an existing adequate drainage easement then facilities and drainage easements of adequate width to contain the design discharge shall be constructed and dedicated to the centerline of an existing natural low within the same watershed. However, when the natural low lies within the developer's property, the developer will only be required to plat an easement to the centerline of the natural low, provided that the easement is able to accommodate the facilities that will be built in conjunction with the future development of that property.

(h) **Site Design and Grading.**

- (1) 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 in accordance with the NPDES (TPDES) construction site regulation ordinance, Ordinance No. 94002, as amended, and the document entitled "Complying with the Edwards Aquifer Rules; Technical Guidance on Best Management Practices, " by Michael E. Barrett, Ph.D., P.E. Center for Research in Water Resources, Bureau of Engineering Research, University of Texas at Austin, (RG-348, June 1999), which documents are hereby incorporated by this reference.
- (2) Erosion and sedimentation controls in accordance with the specifications established by the director of public works in compliance with the National Pollution Discharge Elimination System (NPDES) permitting requirements for the city are required.
- (3) Projects shall not be considered complete until restoration has been made in accordance with NPDES requirements.
- (4) Where possible, multiple uses of drainage facilities and open space shall be incorporated by the owner or developer of a new subdivision. Alternative uses such as public recreation, horse/bike/hiking trails, walking paths, nature preserves, wildlife habitat areas, etc. are encouraged subject to the approval of the director of public works.
- (5) A note must be placed on the plat for residential lots, which states that finished floor elevations must be a minimum of eight (8) inches above final adjacent grade. A grading plan shall be prepared and submitted to the City of San Antonio, which indicates typical lot grading for all lots in the subdivision using typical FHA lot grading types (A, B and C). A more detailed grading plan is also acceptable. No more than two (2) average residential lots may drain onto another lot unless a drainage easement is dedicated to contain the runoff.

(i) **Storm Water Detention and Other Storm Water Management Facilities.**

- (1) For projects with an increased impervious area of greater than 100 square feet that elect not to participate or are not eligible to participate in the regional storm water management program as described in subsection 35-504(b)(1), then storm water detention shall be required for all new developments or redevelopment of individual parcels of property to mitigate peak flow rates to predevelopment or existing development conditions as stated in subsections (b)(6) and (b)(7) of this section. Detention ponds must be placed outside any FEMA 100-year floodplain unless approved by the director of public works or designee.
- (2) On-site storm water management features 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 of San Antonio will have the right to do periodic inspections of privately owned and maintained detention facilities to ensure that the maintenance schedule is being implemented.
- (3) Where a detention facility accepts flows from public facilities such as city rights-of-way the detention facility will be considered a detention facility serving a public purpose and will be dedicated to the city upon completion and a drainage easement will be dedicated to provide for access to the facility. When a regional detention facility accepts flow from an area exceeding 320 acres, the facility shall be considered serving a public purpose and shall be dedicated to the city upon completion and a drainage easement will be provided for access to the facility.

(j) **Street Drainage.**

- (1) **Generally.**

- A. The design of new streets and the improvement of existing streets shall consider public safety and limit potential conflicts between storm water conveyance, vehicular traffic, pedestrian traffic, parking, pedestrian access, ADA requirements, and bicycle traffic.
- B. Streets draining a watershed greater than 100 acres must be designed for the 100 year ultimate design frequency storm.
- C. Streets may be used for storm water drainage only if the calculated storm water flow does not exceed the maximum flow depth allowable for the street roadway classification, or the velocity does not exceed 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. The design criteria maximum frequency storm must be contained within the right-of-way.
- H. Potential flooding problems or conflicts at connection points where new or modified drainage systems (including streets, storm drains, etc.) and 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. Where dwelling units are located on the downhill side of a T-intersection or Cul-de-sac with a street or drainage channel discharging onto it, the street intersection shall be graded so as to avoid water flowing over the curb and out of the right-of-way. Detailed calculations will be required at these locations to show that the discharges are contained within the right-of-way.

(2) All-Weather Crossings.

- A. Where proposed streets cross existing or proposed watercourses, all-weather crossings shall be required. Culverts or bridges shall be adequate to allow passage of the design storm identified in subsection 35-504(b)(21).
- B. All crossings, culverts and bridges shall be designed for an H-20-44 or HS-20 loading.

(3) Unflooded Public Road Access.

- A. During a design storm event (see "subsection 35-504(b)(2) System Criteria") unflooded access (within the "Proceed with Caution" range per figure 504-2) shall be available from each proposed new development to an adjacent public street during a regulatory flood event.
- B. Additionally, unflooded access shall be accessible to an arterial street that is not adjacent to the development or to a distance of one-quarter (1/4) mile, whichever is less, during a future conditions four percent annual chance (25 year) ultimate flood event.
- C. The director of public works may waive criterion B of this requirement for developments under three acres in size.

- (k) **Drainage Channels and Watercourses.** This section addresses proposed improvements or modifications to drainage channels and watercourses required to convey storm water runoff from or through the proposed development. Refer to subsection 35-504(b)(2) for storm frequency design criteria.
- (1) **Watercourses to Remain Unobstructed.** 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.
 - (2) **Multiple Uses.** 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.
- (l) **Storm Drains.**
- (1) For all ordinary conditions, storm drains shall be designed on the assumption that they will flow full under the design discharge; however, when there are constrictions, turns, submerged or inadequate outfall, etc., the Hydraulic and Energy Grade Lines shall be computed and plotted in profile. The Energy Grade Line (EGL) shall be below the top of curb and the Hydraulic Grade Line (HGL) shall be below the gutter elevation of the drainage structure. In all cases adequate outfalls shall be provided, including review of point source discharges.
 - (2) No storm drains shall be less than 24 inches in diameter.