4.100 GENERAL

All drainage facilities shall be designed in accordance with accepted engineering principles, and shall conform to these Design Standards.

4.200 SUBMITTAL OF DRAINAGE CALCULATIONS

Drainage calculations are required for any new subdivision of development. Submittal of drainage calculations shall include the following items:

1. Hydrology and hydraulic calculations together with assumptions, charts, tables, references and methods used.

2. A plan, preferably 1" = 100' scale, showing the proposed street system, existing and proposed drainage system, tributary sub-areas (including offsite drainage), and peak flow in all pipes.

3. A plan showing the hydraulic grade line (HGL), the proposed storm drain including slopes and sizes and top of curb in profile. Elevations should be shown at all changes in slope of the HGS, proposed storm drain and top of curb.

4.300 DESIGN FLOW

The Rational Method (Q=CiA) or SCS method shall be used to determine the quantity of runoff (Q) in designing a storm drain system as determined by the City Engineer.

Values for the coefficient of runoff (C) area as follows:

Parks and natural ground	0.1
RE	0.3
R-1 (Residential)	0.5
R-2 (Residential)	0.6
R-3	0.70
Schools & Churches	0.50
Industrial	0.90
Commercial	0.80

Values for rainfall intensity (I) for corresponding time of concentration shall be taken from the following Rainfall Intensity table. Maximum roof to gutter time of 20 minutes shall be used.

The Area (A) shall be the tributary drainage area in acres.

Manning's formula shall be used to determine the relation of design flow, slope, velocity and pipe diameter. The friction factor, "n", shall be 0.013 for concrete pipe.

The underground system shall be designed to handle a 10-year storm.

The streets shall be designed to carry a 100-year storm. The streets should carry this water to a release point where the water can get back into the natural water course of flood control facility. These overland flows should be kept in their original drainage basin if possible.

RAINFALL INTENSITY TABLE							
TC MIN	I_5	I_{10}	I_{100}	TC MIN	I_5	I_{10}	I_{100}
20	0.897	1.244	1.897	**90**	0.495	0.696	1.111
21	0.880	1.221	1.864	**100**	0.475	0.668	1.070
22	0.860	1.195	1.828	**110**	0.458	0.645	1.035
23	0.851	1.183	1.811	**120**	0.442	0.623	1.002
24	0.834	1.159	1.778	**140**	0.416	0.587	0.949
25	0.818	1.138	1.747	**160**	0.394	0.557	0.904
26	0.811	1.127	1.733	**180**	0.376	0.535	0.868
27	0.796	1.108	1.705	**210**	0.354	0.502	0.821
28	0.783	1.089	1.679	**240**	0.336	0.477	0.783
29	0.776	1.081	1.666	**300**	0.308	0.437	0.723
30	0.764	1.064	1.642	**360**	0.286	0.408	0.678
32	0.747	1.040	1.608	**420**	0.269	0.384	0.642
34	0.725	1.011	1.567	**480**	0.256	0.365	0.612
36	0.711	0.991	1.539	**540**	0.244	0.349	0.587
38	0.697	0.973	1.512	**600**	0.234	0.335	0.565
40	0.682	0.952	1.482	**660**	0.225	0.323	0.546
45	0.651	0.910	1.421	**720**	0.218	0.312	0.530
50	0.624	0.873	1.369	**840**	0.205	0.294	0.501
55	0.600	0.841	1.322	**960**	0.194	0.279	0.478
60	0.581	0.814	1.283	**1080**	0.186	0.267	0.459
70	0.546	0.766	1.213	**1200**	0.178	0.256	0.442
80	0.519	0.728	1.158	**1320**	0.171	0.247	0.427

Note: Formulas used for rainfall intensity data on following page.

TC = Time of concentration (Minutes) I_5 – 5 Year Storm Intensity (Inches/Hour)

I = K/TN where: I = Rainfall Intensity (in/hr)
T = Duration (hours)
K = Function of Mean Annual Precipitation and Frequency
N = Function of Mean Annual Precipitation

K and N Values for the City

5 year	K = 0.581	N = 0.395
10 year	K = 0.814	N = 0.386
100 year	K = 1.283	N = 0.356

4.400 STREET DESIGN FOR FLOOD CONTROL

The lowest street within a drainage basin shall be designed with a minimum overall gradient of 0.25 percent toward the nearest existing or proposed 100 year design capacity flood control facility.

4.500 PAD ELEVATION AND LOT GRADING

House pad elevations shall be determined by the following criteria while assuming construction of a slab on grade foundation (first floor 7 inches above pad). The latest Flood Insurance Rate Map shall be used.

1. In a AO zone, the lowest floor shall be at least 1 foot higher than the depth number specified on the FIRM or 1 foot above the nearest high point in the drainage release path, or 2% higher than lowest top of curb, whichever is highest.

2. In an A zone, the lowest floor shall be at least 1 foot higher than the base flood elevation, as determined by this community or 1 foot above the nearest high point in the drainage release path, or 2% higher than lowest top of curb, whichever is highest.

3. In all other zones, the lowest floor shall be at least 1 foot higher than the base flood elevation, or 1 foot above the nearest high point in the drainage release path, or 2% higher than lowest top of curb, whichever is highest.

Minimum grade of lots shall be 1%. All slopes are no greater than 2:1 or per Soils Report.

4.600 OBSTRUCTIONS

Though local drainage facilities will be designed for a ten year storm, special consideration shall be given to obstructions such as railroads, major freeways, roads and other areas where the natural drainage flow is blocked by manmade features. These obstructions shall be noted in the master plan with all drainage structures through them designed to convey the 100 year storm.

4.700 HYDRAULIC GRADE LINE

All storm drains shall be designed for the maximum storm water entering the drain at the point of concentration and shall have a minimum of 1 foot of freeboard between the top of curb and the Hydraulic Grade Line. However, exceptions to the above standards as they relate to “bubble ups” shall be approved by City Engineer.

4.800 VERTICAL ALIGNMENT

The minimum cover on main line storm drains shall be 2-1/2 feet from finished grade.

Catch basin laterals that have less than 24 inches of cover from finished grade shall be encased in concrete.

A minimum vertical clearance of 3 inches shall be maintained between a sanitary sewer, water main, or other underground utility.

At points of convergence of pipes of various sizes, the tops of the pipe elevations shall match unless specifically approved by the City Engineer. This does not apply to catch basin laterals.

4.900 HORIZONTAL ALIGNMENT

Storm drains shall be placed within street rights-of-way unless placement in an easement is specifically approved by the City Engineer.

Alignment shall be parallel to the street centerline wherever possible.

Curved storm drains are allowed in curved streets when curvature does not exceed the pipe manufacturer’s recommendations.

4.1000 SLOPE

Storm drains shall have minimum slopes equal to that necessary to give a velocity of 2.0 feet per second when flowing half full regardless of the slope of the Hydraulic Grade Line. Pipes with lower velocities shall use available fall and have the specific approval of the City Engineer.

Storm drains shall have a minimum slope of .002.

Catch basin laterals shall have a minimum fall of 0.10 feet between the catch basin and manhole. Desirable fall is 0.30 feet or more.

4.1100 PIPE

The minimum size for storm drains shall be 15-inch diameter.

Al catch basin laterals shall have a minimum diameter of 15 inches.

All pipe shall conform to the following ASTM specifications:

CONCRETE PIPE

Reinforced pipe with rubber gasket joint	C 76
Rubber Gasketed Joints	C 361 Joint & C 443 Gasket

Cast-in-place concrete pipe, 24 inches and larger, may be used when specifically approved by the City Engineer. Cast-in-place pipe will not normally be permitted in existing streets.

4.1200 MANHOLES

Manholes shall be placed at the intersections of all storm drains, at all locations where there is a change in size, change in horizontal or vertical alignment and at the ends of all permanent lines.

Manhole spacing shall conform to the following limits:

Diameter	Maximum Spacing
15” to 30”	400 feet
33” to 54”	600 feet
60” and over	1000 feet

Manholes will not be required where a single catch basin meets the following criteria:

1. Size of catch basin lateral is 15 inches.
2. Storm drain has a diameter of 48 inches or larger.
3. No other existing or future catch basins are within 100 feet along storm drain centerline.

All storm drain manholes shall be constructed in conformance with Standard Detail SD-1 and SD-2 unless otherwise approved by the City Engineer.

4.1300 CATCH BASINS

Side inlet catch basins shall be located at all low points and shall be spaced in such a manner that design flows will not encroach into the travel lanes.

The total gutter run contributing to any catch basin shall not exceed 1,000 feet. It is desirable to locate catch basins on the BCR or ECR which will intercept the most runoff and also keep the main pedestrian crossing as dry as possible.

Drop inlet catch basins shall be constructed only in alleys or as temporary installations on unimproved streets where curb and gutter has not yet been installed.

4.1400 SIPHONS

Inverted siphons are not permitted.

4.1500 ON-SITE DRAINAGE

All developed areas larger than one acre shall tie on-site drainage into the City of Morgan Hill storm drain system.

4.1600 PONDING BASINS

Ponding basin on private or public property shall be designed using the following criteria:

1. A 24-hour, 25-year storm, total rainfall of 4.79 inches shall be used if a reasonable outlet is provided (detention). If no disposal other than evaporation, percolation or irrigation is provided (retention), a 24-hour, 100-year storm, total rainfall of 5.59 inches, shall be used. 25% of the total basin volume shall be considered as freeboard.

2. The maximum water surface of the basin shall be 1 foot below the elevation of the top of curb at the lowest catch basin inlet within the tributary area and a maximum of one foot above the design hydraulic grade line at the basin.

3. Fencing shall be provided around all basins greater than 3 feet in depth.

4. Adequate “all weather” access shall be provided.

5. The tributary drainage system shall be designed to connect to the City’s future storm drainage system.

6. The maximum slope ratio for turfed or landscaped side slopes shall be 4:1.