3. STORM DRAINAGE FACILITIES

3.3 Detention:

A. Intent: It is the City's intent to utilize detention (or detention/retention) of storm water runoff as a solution towards control of potential hazards created by storm water runoff including; reduction in the impact on downstream storm water facilities, prevention of erosive conditions in water drainage ways, and preservation of existing floodplains along major creeks. Detention basins may also improve water quality by allowing some sediment to settle out.

B. All non-residential development (not within the Downtown Zoning District or other redevelopment areas that will not impact the storm water flow) shall construct detention facilities. The Modified Rational Method (see H below- example calculations) shall be utilized to determine detention volume. Residential developments shall construct detention facilities if it is determined that the downstream system does not have capacity for the developed flow and the capacity of the downstream storm sewer system cannot be increased to allow the conveyance of the developed flows. *All development within the Squabble Creek drainage basin will construct detention facilities and model Squabble Creek utilizing HEC-2, to ensure no impact on flows or water surface elevation.

C. The following detention facilities are to be utilized for detention:

AREA	TYPE OF FACILITY
½ Acre or Less	**A. Underground**
	B. On Concrete Parking Surface (max. 1-foot water depth)
Greater Than ½ Acre, On-site	**A. Underground**
	B. On Concrete Parking Surface (max. 1-foot water depth)
	C. Detention Basin
	Side Slopes 5 to 1, or Less (no fencing allowed)
	Area to be Landscaped
	Maintained by Developer
	Additional Amenities Preferred
	Ownership Stays With Property Owner
Greater Than ½ Acre, Off-site Shared	**A. Detention Basin Shared with Other Development/s**
	May Expand Existing Pond
	No Increase in 100-year Flood Plain Elevation
	Capacity Expanded Above Existing Water Surface
	Need Engineering Study

AREA	TYPE OF FACILITY
Greater Than ½ Acre, Off-site Shared	**B. Flow to Regional Detention Basin**
	Regional Facility Manager (owner of facility) Must Approve Improvements
	Developer/s Funds Improvements to Regional Basin
	Developer/s Improves Storm Sewer Conveyance System to Basin (based on developed 100-year flow)
	Dams Over 5-foot to be Permitted by State
	Dam Cannot be Over 15-feet
	Basins with Water Retention to have Stored Water Depth of at Least 4-feet
	Need Landscaping and Amenity Features (Approved by Planning Dept.)
	Facility Manager to Assure Good Retained Water Quality
	Trash Collectors Required at Outfall Structures
	Side Slopes to be 5 to 1 or Less
	Developer/Owner Owns and Maintains Basin
	Facility Manager to Develop and Perform Maintenance Program
	Developer/s Improves Storm Sewer Conveyance System to Basin (developed 100-year flow): Underground (preferred); Natural Open Channel (existing creek with 100-year developed capacity); Developer/s to Obtain Additional Drainage Easement for 100-year Developed Flow Area; No Concrete or Gabion Sidewalls
	Possible Pro-rata from Other Developments that Utilize Basin
Greater Than ½ Acre, Off-site Shared	**C. Existing Lake**
	Lake Manager Must Approve
	Developer/s Fund Improvements to Lake

Greater Than ½ Acre, Off-site Shared	**C. Existing Lake (con't)**
	Developer/s Improves Storm Sewer Conveyance System to Lake (developed 100-year flow): Underground (preferred); Natural Open Channel (existing creek with developed 100-year capacity); Developer/s to Obtain Additional Drainage Easement for 100-year Developed Flow Area; No Concrete or Gabion Sidewalls
	Additional Storage Out of 100-year Storage

Existing Ponds	**A. Developer/s Improve Existing Undesirable Detention Facilities**
	Remove Fencing Where Possible
	Provide Concrete Flume in Bottom
	Provide Landscaping
	Improve Maintenance Access
	Reconstruct with Underground System
	Remove Pond by Conveying Storm Water Flow to Shared Detention Facility

D. The proposed development will construct detention facilities to detain the increase in runoff between the existing 100-year flows (C-undeveloped, T_C = 20 minute) and the fully developed flows (C – depends on zoning, T_C = 10 minute). The "C" value is based on zoning, not pervious/impervious areas. Large area of dedicated open space dedicated to City can be considered by City in this value. The detention design calculations and outfall rating curves shall be included in the plans. In addition to the 100-year discharge, the 25-year, 10-year and 5-year peak discharges will not be increased.

E. Detention ponds with a side slope greater than 5:1 or a depth greater than two feet will have a four-foot (4') fence with an access gate around the perimeter. The fence shall be wrought iron or tubular steel fence.

F. The detention pond bottom grade shall be at a minimum of 1% slope. A 4-inch thick concrete low flow flume with a minimum width of 4-feet shall be installed from the ponds inlet structure/structures to the outfall structure.

G. Sometimes a detention facility will be utilized by several developments, and then a pro-rata agreement may be entered into with the development constructing the facility and the other developments utilizing the facility.

H. Example Calculations:

MODIFIED RATIONAL METHOD DETENTION BASIN DESIGN

Given: A 10-acre site, currently agricultural use, is to be developed for townhouses. The entire area is the drainage area of the proposed detention basin.

Determine: Maximum release rate and required detention storage.

Solution:

1. Determine 100-year peak runoff rate prior to site development. This is the maximum release rate from site after development.

   NOTE: Where a basin is being designed to provide detention for both its drainage area and a by-pass area; the maximum release rate is equal to the peak runoff rate prior to site development for the total of the areas minus the peak runoff rate after development for the bay-pass area. This rate for the by-pass area will vary with the duration being considered.

2. Determine inflow hydrograph for storms of various durations in order to determine maximum volume required with release rate determined in Step 1.

   NOTE: Incrementally increase durations by 10 minutes to determine maximum required volume. The duration with a peak inflow less than maximum release rate or where required storage is less than storage for the prior duration is the last increment.

PROCEDURE

STEP 1. Present Conditions (Agricultural)

$Q = C*I*A$
$C = 0.35$
$T_c = 20$ minutes
$I_{100} = 8.3$ in/hr
$Q_{100} = (0.35)(8.3)(10 \text{ acres}) = 29.05$ cfs (Maximum release rate)

STEP 2. Future Conditions (Townhouses)

$C = 0.80$
$T_c = 10$ minutes
$I_{100} = 9.8$ in/hr
$Q_{100} = (0.80)(9.8)(10 \text{ acres}) = 78.40$ cfs

Check various duration storms:

15 minutes	I = 9.0 Q = (0.80)(9.0)(10 acres) = 72.0 cfs
20 minutes	I = 8.3 Q = (0.80)(8.3)(10 acres) = 66.4 cfs
30 minutes	I = 6.9 Q = (0.80)(6.9)(10 acres) = 55.2 cfs
40 minutes	I = 5.8 Q = (0.80)(5.8)(10 acres) = 46.4 cfs
50 minutes	I = 5.0 Q = (0.80)(5.0)(10 acres) = 40.0 cfs
60 minutes	I = 4.5 Q = (0.80)(4.5)(10 acres) = 36.0 cfs
70 minutes	I = 4.0 Q = (0.80)(4.0)(10 acres) = 32.0 cfs
80 minutes	I = 3.7 Q = (0.80)(3.7)(10 acres) = 29.6 cfs
90 minutes	I = 3.5 Q = (0.80)(3.5)(10 acres) = 28.0 cfs

Maximum Storage Volume is determined by deducting the volume of runoff released during the time of inflow from the total inflow for each storm duration.

10 min Storm	Inflow➔ (10)(78.4 cfs)(60 sec/min)	= 47,040 cf
	Outflow➔(0.5)(20 min)(29.05 cfs)(60 sec/min)	= <u>17,430 cf</u>
		= 29,610 cf
15 min Storm	Inflow➔ (15)(72.0 cfs)(60 sec/min)	= 64,800 cf
	Outflow➔(0.5)(25 min)(29.05 cfs)(60 sec/min)	= <u>21,788 cf</u>
		= 43,012 cf
20 min Storm	Inflow➔ (20)(66.4 cfs)(60 sec/min)	= 79,680 cf
	Outflow➔(0.5)(30 min)(29.05 cfs)(60 sec/min)	= <u>26,145 cf</u>
		= 53,535 cf
30 min Storm	Inflow➔ (30)(55.2 cfs)(60 sec/min)	= 99,360 cf
	Outflow➔(0.5)(40 min)(29.05 cfs)(60 sec/min)	= <u>34,860 cf</u>
		= 64,500 cf
40 min Storm	Inflow➔ (40)(46.4 cfs)(60 sec/min)	= 111,360 cf
	Outflow➔(0.5)(50 min)(29.05 cfs)(60 sec/min)	= <u>43,575 cf</u>
		= 67,785 cf
50 min Storm	Inflow➔ (50)(40.0 cfs)(60 sec/min)	= 120,000 cf
	Outflow➔(0.5)(60 min)(29.05 cfs)(60 sec/min)	= <u>52,290 cf</u>
		= 67,710 cf
60 min Storm	Inflow➔ (60)(36.0 cfs)(60 sec/min)	= 129,600 cf
	Outflow➔(0.5)(70 min)(29.05 cfs)(60 sec/min)	= <u>61,005 cf</u>
		= **68,595 cf**
70 min Storm	Inflow➔ (70)(32.0 cfs)(60 sec/min)	= 134,400 cf
	Outflow➔(0.5)(80 min)(29.05 cfs)(60 sec/min)	= <u>69,720 cf</u>
		= 64,680 cf
80 min Storm	Inflow➔ (80)(29.6 cfs)(60 sec/min)	= 142,080 cf
	Outflow➔(0.5)(90 min)(29.05 cfs)(60 sec/min)	= <u>78,435 cf</u>
		= 63,645 cf

90 min Storm	Inflow➔ (90)(28.0 cfs)(60 sec/min)	= 151,200 cf
	Outflow➔(0.5)(100 min)(29.05 cfs)(60 sec/min) =	<u>87,150 cf</u>
		= 64,050 cf

Maximum volume required is **68,595 cf** at the 60 min. storm duration.

3.4 <u>Storm Drainage Management Plan:</u>

A. General: Storm drainage facilities shall include all elements of a drainage system consisting of streets, alleys, storm drains, channels, culverts, bridges, swales and any other facility through which or over which storm water flows, all of which the City must have a right in, either in the form of a dedicated right-of-way, floodway or drainage easements.

Site Drainage: All new subdivisions shall provide as part of the subdivision review process a complete storm drainage management plan. This plan will include, but not be limited to, the following: a complete review of all on-site, upstream and downstream drainage within the impacted watershed; determine all on-site and downstream drainage facility improvements due to the increased runoff from the proposed development and future upstream and downstream developments; and contain calculations necessary to determine compliance with the Standards of Design herein. The plan shall be done, using current zoning conditions or land use prescribed by the City's Land Use Plan (whichever creates the greatest storm water runoff), with maximum development considered throughout the watershed. The storm drainage plan shall show all necessary improvements with flow data provided at each point of interception of water. As part of the storm drainage plan, the developer shall show a lot grading plan to direct all water to proper intersection points avoiding cross flow of water from lot to lot. All upstream discharge shall be intercepted and carried through the proper intersection points avoiding cross flow of water from lot to lot. All upstream discharge shall be intercepted and carried through the proposed development in compliance with the Standards of Design herein. <u>All discharge from the proposed development shall be designed in accordance with the Standards of</u>