MANATEE COUNTY
PUBLIC WORKS STANDARDS

PART 2. STORMWATER MANAGEMENT DESIGN MANUAL

June 2015

Manatee County
Public Works Standards

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PART 2 - STORMWATER MANAGEMENT DESIGN

SECTION 2.1. OVERVIEW

The purpose of this Stormwater Design Procedure Manual is to ensure that an effective management system for an area to be developed or redeveloped is provided. These criteria will provide the basis on which a stormwater management plan will be evaluated by the County prior to approval and ultimate construction. The criteria are a minimum and in certain cases the County may require higher criteria to ensure a properly functioning system to safeguard adjacent or downstream properties, public roadway and drainage systems, and the general public.

In order to aid in understanding the criteria presented in this Manual, a full explanation of the various procedures required for implementation of this criteria is presented.

It is suggested that, prior to the start of the detailed engineering on any project, the proposed preliminary drainage design and procedures be reviewed in detail with the Public Works Department.

The limitation of run-off will require the construction of retention or detention basins. Detention or retention basins will provide the necessary reservoir storage to insure predevelopment flow rates are not exceeded. Manatee County requires that, when possible, large natural conveyance systems in an area to be developed or redeveloped should be preserved (kept in their natural state and without reduction in conveyance capacity), to provide for the passage of stormwater run-off from adjacent and/or upstream areas.

In all cases, attenuated discharge from detentions basins must be to a County approved positive outfall.

The treatment of the appropriate volume of run-off, or in accordance with SWFWMD 40D-4 and 40D-40, 45, or latest revision, from the contributory area of a development will be required. Development within certain watershed boundaries may require additional stormwater treatment. Also, sediment and erosion control measures will be required to control and minimize damage to downstream property, and the conveyance system and to preserve water quality. Stormwater designs including sediment and erosion control measures shall be submitted to and approved by the Public Works Department prior to construction.

For purposes of system evaluation, a stormwater management system will be considered to have two parts, the interior drainage system and the primary drainage system.

The interior drainage system shall consist of swales and/or storm sewers adjacent to or in the streets to carry stormwater run-off from the lots adjacent to these streets to culverts or through lot lines directly to the detention or retention basins or to the interior drainage system and convey it directly to the detention or retention basins (all commercial, residential, industrial sites).

The primary drainage system shall consist of the principal conveyance channels, detention or retention basins and outflow channels leading to the principal receiving water course.

Note: This manual will be updated or modified from time-to-time as the County deems necessary.

SECTION 2.2. PRIMARY DRAINAGE SYSTEM

The selection of detention/retention basin for the purposes of peak flow attenuation will depend on the hydrologic soil group and site specific conditions of the soils in the area to be developed or redeveloped.

The purpose of detention/retention ponds is to serve as a buffer to attenuate peak flows and/or excess runoff volume from urbanized area. In addition to attenuation, it provides treatment of the first flush, which will cover the water quality aspect of stormwater runoff. In general, water quality designs should be based on the minimum performance standard described in Chapter 65-25 FAC, SWFWMD 40D-4, 40D-40 and the Manatee County Comprehensive plan.

In general, retention refers to stormwater storage without access to a positive outlet, while detention facilitates offer temporary storage accompanied by controlled release of the stored water. Wet detention has a pool of water below the outlet elevation; dry detention is typically placed with the basin bottom above the seasonal high water table. Retention and detention can be used separately or together in storage basins as site conditions and management objectives require.

A key element to proper planning of retention/detention facilities is the selection of potential sites that will provide control of both flooding and stormwater quality. Other important considerations include:

A. Stormwater Management Master Plan.

B. Conveyance of drainage to the site.

C. Suitability of site for water storage.

D. Availability of suitable outlet point.

E. Adjacent land use.

F. Roadway control elevation.

G. Soil infiltration capability.

H. Water table fluctuations.

I. Outfall high water elevation.

J. Type of facilities proposed.

K. Safety and maintenance requirements.

L. Other regulatory agencies requirements.

For the design of detention ponds the instantaneous peak discharge expected for the undeveloped site due to 25 year rainfall shall not be exceeded by the instantaneous peak discharge from the developed site due to a 25 year rainfall. Calculation of instantaneous peak discharge from the undeveloped site shall consider the effect of existing storage in attenuating this peak. Off-site runoff must be routed around or through the project without combining with on-site runoff unless the pond and discharge structure are designed to accept this off site runoff.

SECTION 2.3. HYDROLOGY

2.3.1. DESIGN STORM

In most cases, the primary drainage system (detention or retention basins principal conveyance channels of an area to be developed or redeveloped) shall be designed so as to control the runoff from a 25 year - 24 hour Duration Design Rainfall (DDR) as determined from Appendix B-4 without causing flooding of the area. The actual design storm required will be dependent on existing outfall conditions. To provide consistency in the parameters

used by the County staff in their review process, the soil conservation service (SCS) Type II modified rainfall distribution is recommended and will be used. (See appendix A-1)

The 25 year - 24 hour DDR will be applicable where either a more than adequate or an adequate outfall condition exists.

In areas of known drainage problems, a peak sensitive outfall condition shall prevail and require a reduction of up to 50% of the allowable pre-development flow from the 25 year - 24 hour DDR or that adequate off-site improvements be installed to provide for an adequate outfall condition.

Where no positive outfall exists, alternate solutions shall be required. These solutions include:

A. Capacity for retention of the 100 year 24 hour duration design rainfall, with one foot of freeboard, and

B. The upgrading of downstream facilities to provide positive outfall.

In areas of direct discharge to coastal waters or those with proven tidal influence, the attenuation of stormwater runoff as required may be waived by the County, however, the water quality needs to be addressed prior to direct discharge.

2.3.2. HYDRAULIC REQUIREMENTS.

The discharge rate for a given site shall not exceed the predevelopment discharge rate based on not less than a twenty-five (25) year frequency storm. This requirement may be waived when discharge occurs directly into coastal or tidal waters of the State and where State permits have been obtained; provided that it can be demonstrated that there are no adverse effects.

2.3.3. INTERNAL DRAINAGE.

Internal drainage systems within any site shall be designed, at minimum, for the ten (10) year frequency storm, unless the retention areas are provided according to the specifications of Section C, below.

2.3.4. MAJOR DRAINAGE WAYS.

New major drainage ways receiving stormwater runoff from any site shall be designed to maintain positive outfall from the site for the twenty-five (25) year frequency storm, with one (1) foot of free board mandatory. Specific conditions may require more restrictive discharges. This will be determined by the Department Director in accordance with this Manual. New major drainage ways shall not appreciably drawdown the surficial aquifer; or impact wetlands in contravention of Chapter 40D-4, or 62-330 and 62-340, Florida Administrative Code.

2.3.5. RETENTION AREAS.

Retention areas with outlets shall be designed for a twenty-five (25) year frequency storm or as required otherwise in this Manual. Retention areas with no outlets shall be designed for a one hundred (100) year frequency storm. A retention/detention basin shall not be excavated to a depth which causes the direct exposure of the Floridian aquifer to stormwater retained/detained in any such basin. A retention/detention excavation shall not breach an aquiclude; or adversely affect the adjacent wetlands.

2.3.6. STREETS.

New streets shall be designed with traffic lanes a minimum of six (6) inches freeboard above the design storm base flood elevation measured to the crown of the road. New bridges and culverts shall be designed to convey the design storm without any adverse impacts such as increased flooding, flow, velocity or erosion. The design storm for new streets shall have a twenty-four (24) hour duration and return frequencies as follows:

A. For all streets, bridges and culverts within the published FEMA 100 Year Floodplain, the design storm shall be one hundred (100) year return frequency.

B. For streets, bridges and culverts of arterial and collector facilities not in the published 100 Year Floodplain, the design storm shall be fifty (50) year return frequency.

C. For local streets, bridges and culverts not in the published one hundred (100) year floodplain, the design storm shall be twenty-five (25) year frequency.

D. The design storm for internal street drainage systems shall be as required by Section 2.3.3 of this Manual; however, internal roadway lane elevations shall be designed for the twenty-five (25) year return frequency design storm.

2.3.7. HYDROGRAPH COMPUTATION

Design flood hydrographs (pre-development hydrographs or post- development inflow hydrographs to detention or retention basins) resulting from the 25 year - 24 hour DDR may be computed by the TR-20 Model and TR-55 (SCS's unit hydrograph model); the HEC-1 Model (Corps or Engineer's unit hydrograph model); or, for basins 10 acres or less, by the Rational Method, or other equivalent and widely accepted method; however, the flow rates should be compatible with the flow rates computed through software available to the County staff.

2.3.8. TIME OF CONCENTRATION

The time of concentration is the longest travel time it takes a particle of water to reach a discharge point in a watershed. There are three common ways that waters are transported:

A. Overland flow.

B. Pipe flow (storm sewer).

C. Channel flow, including gutter flow.

The velocity method is a segmental approach that can be used to account for each of these types of flow by considering the average velocity for each flow segment being evaluated, and by calculating a travel time using the equation

$$t_i = \frac{L_i}{60(V_i)}$$

Where:

t_i = Travel Time for velocity segment i, (min)

L_i = Length of the flow path for segment i, (Ft)

V_i = Average velocity for segment i, (Ft/sec)

The time of concentration is then calculated expressed as

$$T_C = t_1 + t_2 + t_3 + \ldots t_i$$

Where:

T_C = time of concentration, (Minutes)

t_1 = overland flow travel time (Minutes)

t_2 = channel flow travel time (Gutter Flow) Min.

t_3 = pipe flow time (storm sewer) Min.

t_i = travel time for the ith segment (Min.)

An alternative procedure for evaluating overland flow travel time involves the use of figures in appendices A-2 and A-3 to obtain an estimate of the average velocity for overland flow and consequently calculating the travel time.

Time of concentration[1] can also be obtained from the following methods:

A. Kinematic Wave Equation. The Kinematic Wave Equation (RAGAN, 1971; Flemming 1975) can be used to estimate time of concentration when there exist a Kinematic wave (velocity not changing with distance but changing @ a point). The time of concentration equation for these conditions is.

$$T_C = \frac{0.93[L^{0.6}N^{0.6}]}{I^{0.4}S^{0.3}}$$

Where:

T_C = time of concentration, (Min.)

L = overland flow length (Ft.)

N = mannings roughness co-efficient for overland flow

I = rainflow intensity (In/Hr)

S = average slope of overland flow path Ft/Ft

Following overland flow manning's N values should be used with the above Kinematic wave eq.

Table 1: Overland Flow Manning's N Values

	Recommended Value	Range of Values
Concrete	0.011	0.01-0.013
Asphalt	0.012	0.01-0.015
Bare Sand	0.010	0.010-0.016
Graveled surface	0.012	0.012-0.030
Bare clay-loam (eroded)	0.012	0.012-0.033
Fallow (no residue)	0.05	0.006-0.16
Plow	0.06	0.02-0.10
Range (natural)	0.13	0.01-0.32
Range (clipped)	0.08	0.02-0.24
Grass (bluegrass sod)	0.45	0.39-0.63
Short grass prairie	0.15	0.10-0.20
Dense grass	0.24	0.17-0.30
Bermuda grass	0.41	0.30-0.48
Woods	0.45	-- --

Note: These values were determined specifically for overland flow conditions and are not appropriate for conventional open channel flow calculations.

[1] Other accepted and widely used methods are allowed for computation of the time to concentration.

Values are from Engman (1983), with additions from the Florida Department of Transportation Drainage Manual (1986).

Kinematic wave equation generally involves a cumbersome trial and error process using the following steps:

1. Assume a trial value of rainfall intensity (i).
2. Find the overland travel time (T_C) using the above equation.
3. Find the actual rainfall intensity for a storm duration of T_C from the appropriate intensity duration frequency (IDF) curve for zone 6. Also record the intensity for T_C.
4. Compare rainfall intensities, if they are not the same, select a new trial rainfall intensity and repeat step 1.

An alternative to the above equation is the nomograph presented in Appendix A-4.

B. Soil Conservation Service. The soil conservation service (SCS) (USDA, 1975 or updated version) related the time of concentration to the watershed lag time as follow:

$$T_C = 1.67 t_1$$

Where:

t_1 = watershed lag time in hours (from the center of mass of rainfall excess to the time peak runoff) and:

$$t_1 = \frac{L^{0.8}(S+1)^{0.7}}{1900 y^{0.5}}$$

L = watershed hydraulic length (Ft.)

S = Potential watershed storage (In.)

y = Average watershed slope (Percentage)

To aid in calculating overland flow velocities, the Soil Conservation Service nomograph (SCS 1975) is inserted in Appendix A-3. This alternate SCS method requires an estimate of overland slope and a description of the cover crop or land use. Thus, some engineering judgment must be exercised. Generally, estimates are made for each relatively constant slope and ditches should be divided into smaller homogeneous areas with regard to slope and cover type.

C. Manning's Equation. In storm sewer, gutter and open channels, manning's equation (CHOW, 1959) to calculate average velocities could be used.

$$V = \frac{1.48}{n} R^{2/3} S^{1/2}$$

Where:

V = Velocity (Ft/Sec)

R = Hydraulic Radius, Ft = D/4 for pipe flowing full

S = Slope Ft/Ft

N = Roughness Coefficient

2.3.9. SCS TR-55 METHOD

The SCS has developed an empirical relationship for estimating rainfall excess that accounts for infiltration losses and initial abstraction by using a site-specific runoff parameter called the curve number (CN). The watershed CN is a dimensionless coefficient that reflects watershed cover conditions, Hydrologic Soil group, Land uses and antecedent moisture conditions. In all cases, Manatee County selects only antecedent moisture condition II for design purposes.

A composite curve number (CN) for a watershed having more than one land use, treatment, or soil type can be found by weighting each curve number according to its area. A table showing the runoff curve number is present in appendices A-9 and A-10.

The maximum soil storage and a CN value for a watershed can be related by the following expression

$$S = \frac{1000}{CN} - 10$$

Where:

S = Maximum soil storage, in inches

CN = Watershed curve number, dimensionless

When the maximum soil storage is known, the rainfall excess can be calculated using the following SCS Relationship

$$R = \frac{(P - I_a)^2}{(P - I_a) + S}$$

Where:

R = Accumulated rainfall excess (or runoff) in inches

P = Accumulated rainfall, in inches

S = Maximum soil storage, in inches

I_a = Initial abstraction including surface storage interception, & infiltration prior to runoff (inches)

The relationship between $I_a$and S was developed from experimental watershed data. The empirical relationship used in the SCS runoff equation is:

$$I_a = 0.2\,S$$

Substituting $0.2\,S$ for $I_a$in the runoff equation, above, yields:

$$R = \frac{(P - 0.2\,S)^2}{(P + 0.8\,S)}$$

or directly connected impervious areas, and initial abstraction (I_a) of equal to $0.05\,S$ will be allowed.

Additional information on the SCS relationship can be found in USDA Technical Release No. 55 publication.

2.3.10. RATIONAL METHOD

According to the Rational Method, the peak runoff rate can be estimated as the product of a runoff coefficient, a rainfall intensity, and the drainage area. The Rational Method is expressed mathematically as:

$$Q = CIA$$

Where:

Q = Peak runoff rate in $Ft^3/_{sec}$

C = Rational Method runoff coefficient, dimensionless

I = Average rainfall intensity for the design, inches/hour

A = Watershed drainage area in acres (Basins must be 10 acres or less to use Rational Method for its hydrograph computation)

Assumption:

1. The time of concentration of the drainage basin refers to the travel time required for the runoff to flow along the representative basin flow, which is typically defined to be from the most hydraulically remote point of the design. Overland flow, storm sewer or gutter flow, and channel flow are commonly used in computing travel time.
2. The storm duration equals the time of concentration of the basin.

Rational coefficients should be estimated by using the values in Appendix A-12 for the two to ten (2-10) year design frequency storm. For the 25-100 year frequency storm a correction factor shown in Appendix A-8 is to be applied to the previous areas unless flood routing computations are appropriate for the basin. When using these tables one should consider the following conditions:

1. Land use
2. surface types and percentages
3. soil type
4. slope

For basins with varying cover, a weighted rational coefficient can be determined for the basin by the following equation:

$$Weighted\ C = \frac{C_i A_i}{A_i}$$

Where:

C_i = Rational coefficient for A_i(dimensionless)

A_i = Portion of the basin with a relatively uniform land cover, soil type, and slope, in acres.

Rainfall intensity, (I) is the average rate of rainfall in inches per hour. Critical storm duration equals the time of concentration of the drainage basin for Rational Method. Refer to Appendix B for storm frequency and rainfall intensity curve for this area (Zone 6).

2.3.11. ROUTING CALCULATION

To develop an estimate of the storage volume required to meet allowable discharge requirements, following need to be calculated:

A. Inflow Hydrograph for 25 year storm

B. Stage storage data for proposed retention/detention

C. Allowable peak outflow rate, which should not exceed the existing condition flow rate.

D. Perform filtration, and ex-filtration calculations to comply with appropriate stormwater treatment regulations.

E. Evaluate the downstream effects of detention outflow, as necessary determined by staff, to ensure that the outflow hydrograph does not cause downstream flooding problems.

An acceptable and widely used (state and federal agencies) computer procedure is useful for conducting final routing computations (i.e.: HEC-1, ICPR, . . .). County will also accept analysis based on the following method:

Storage indication method or modified plus

A flood wave passing through a storage reservoir is both delayed and attenuated as it enters and spreads over the pool surface. Water stored in the reservoir is gradually released through outlet control structure.

$$I - O = \frac{ds}{dt}$$

Where:

I	=	Inflow C.F.S.
O	=	Outflow C.F.S.
$\frac{ds}{dt}$	=	Rate of change of storage within the reach

2.3.12. FILTRATION AND UNDERDRAIN CALCULATION

In cases where soil and groundwater flow conditions will not permit recovery of the stormwater treatment volume within the regulated duration, stormwater filtration system may be required. The minimum of 6" underdrain pipe is to be used. A filter fabric envelope shall be used with underdrains and shall be an approved strong, porous nylon, polyester, polypropylene or other fabric approved by the County, which completely covers the underdrain surface in such a way to prevent infiltration of surrounding material. A drawdown worksheet for underdrain calculation is present in Appendix "C" which may be utilized for draw down calculations. Clean outs are to be spaced no greater than every 250 feet and at the ends of the underdrain pipes.

2.3.13. OUTLET CONTROL STRUCTURES

Outlet controls selected for retention/detention facilities should accomplish the necessary functions of the facility. Outlet control can take the form of drop inlets with pipes, weirs, filtration underdrain piping, and orifices. The sizing of a particular outlet control should be based on results of hydrologic routing calculations, and as appropriate subsurface filtration calculations. All control structures shall be designed to prohibit the entrance of floating debris into the structure. The bottom of the skimming device should be at least 2-6” below the weir elevation, and the top no lower than the design high-water elevation. The top of the control structure should be at the elevation of the design high water.

2.3.14. WEIR FLOW CALCULATIONS

A. Free discharge. The equation in computing discharge over a rectangular sharp-crested weir is:

$$Q = CLH^{1.5}$$

Where:

Q = discharge, C.F.S

C = Weir coefficient

L = Weir length, Ft.

H = Head on weir, Ft.

Detailed information for determining specific values of the weir coefficient for various weir configurations is presented by Brater and King (1976).

B. Submerged discharge

When tailwater rises above the weir crest elevation the actual discharge over the weir is inhibited by the backwater conditions. The above calculated "Free" discharge value is multiplied by the following reduction factor to account for the submerged effect:

$$Q_s = Q_f \left(1 - \left[{}^{H_2}/_{H_1}\right]^{1.5}\right)^{0.385}$$

Where:

Q_s = Submerged flow, CFS

Q_f = Free flow, CFS

H_1 = Upstream head above crest (feet)

H_2 = Downstream head above crest (feet)

(1) V Notch Flow. The discharge through a V notch sharp crested weir is given by

$$Q = CH^{5/2}\, tan(O/2)$$

Where:

O = Notch angle, degree

H = Measured head, ft

C = Coefficient of discharge

The head H is measured from the notch elevation to the water surface elevation. The water surface should be measured at least 2.5 H upstream from weir, to be beyond the drop in the water surface near the weir. Values of C, Coefficient of discharge can be taken from nomograph in appendix A-11.

(2) Orifice Flow. When stages exceed the crest elevation of the weir, discharges though the bleeder notch should be calculated using the orifice equation.

$$Q = 4.8AH^{1/2}$$

Where:

Q = Flow, CFS

A = Area of the notch, Sq. Ft.

H = Head above notch centroid, ft.

2.3.15. DETENTION BASINS

Detention basins may be of either the shallow dry type or may be artificial lakes specifically constructed for the purposes of flow attenuation.

Proposed detention basins and their outlet pipe control structures shall be analyzed by the computation of inflow hydrographs to the detention basins resulting from the applicable Design Rainfall on the contributory area to each basin. The determination of the resulting water level in the basins and outflow hydrograph peaks from these basins shall be determined by flood routing.

Hydraulically, outlet structures shall be weir/orifice controlled. Flashboard risers are not acceptable.

The seasonal high groundwater elevation shall be estimated from existing soil conditions and profiles, and existing water level for the location(s) proposed to be utilized as detention ponds. No storage credit will be given below the seasonal high water table elevation (or adjusted S.A.W. elevation). The outlet of detention ponds shall have a water level control structure that enables the pond to function as indicated in the hydraulic calculations. All detentions requirement shall comply with State of Florida regulations. (FAC 65-25; FAC 40D-4; FAC 40D-40; Chapters 120 and 373 F.S.).

2.3.16. RETENTION BASINS

Retention basins constructed for flow attenuation purposes must have sufficient volume to contain the volume of post development runoff from the design storm rainfall, or shall have sufficient volume to contain said runoff volume with a minimum of one (1) foot of freeboard. Exfiltration out of the basin shall not be considered in determining this theoretical basin size.

The storage volume in any retention basin occupied by runoff from the design rainfall shall again be available within a 36-hour period after the design rainfall ceases; stormwater stored in these basins shall be removed in this 36-hour period by infiltration or underdrain drawdown. If infiltration (percolation) rates are used, in excess of the SCS soil book for Manatee County, in the design of retention basins, the rate shall be determined by the performance of double ring infiltrometer test (ASTM standard method D3385-75), which shall be performed at the proposed bottom of the retention basins by a qualified soil engineer or scientist.

It is desirable for the bottom of any retention basin to be a minimum of two (2) feet above the estimated seasonal high water table (SHWT) when percolation is the primary outlet of retention. If the above specified clearance cannot be met the site engineer must demonstrate by calculations that the retention ponds will function according to County criteria and the intended design. These calculations must take into consideration the effects of groundwater mounding on percolation both during the rainfall event and in the recovery of the design storage volume. However, a minimum of one (1) foot of clearance is required from the seasonal high groundwater table to the proposed pond bottom.

The seasonal high groundwater table shall be determined or estimated by a qualified soil engineer or scientist (or use the SCS book for Manatee County).

A suitable emergency overflow outlet and path shall be provided for retention ponds. This flow path shall conduct overflow away from the area without minimizing flooding of adjacent property, either public or private.

2.3.17. DETENTION AND RETENTION SYSTEM DESIGN CRITERIA

A. Dry type systems. Dry, shallow type detention or retention system shall be required to meet the following design standards:

(1) These systems shall maintain dry conditions except for a 36 hour period following the design storm rainfall. There should be a minimum of a one (1) foot clearance between the seasonal high water table (SHWT) to the bottom of the pond;

(2) These areas shall have a food stand of grass or other acceptable coverage;

(3) The maximum allowable side slope is that of 4:1 (4 feet horizontally for every 1 foot vertical);

(4) Inlets to these systems shall be provided, for controlling erosion. This may be done by incorporating miteredends, flumes with riprap, or other accepted methods;

(5) Adequate clearance shall be provided between these systems and the adjacent property; and

(6) A minimum of one (1) foot of freeboard for systems within subdivision and six (6) inches of freeboard for all other systems shall be required unless the 100 Year - 24 Hour Storm Design is required. In those cases, a minimum of one (1) foot of freeboard shall be required on all developments. (100 Year 24 Hour Storm Design).

B. Artificial lake systems. All systems which intend to incorporate wet detention facilities shall be required to meet the following standards:

(1) There shall be a minimum depth of six (6) feet over at least 5% or a minimum of 500 ft., or whichever is larger, of the lake. This will allow for the required littoral zones needed for mitigation or water quality treatment;

(2) The maximum allowable side slope is that of 4:1 (4 feet horizontally for every 1 foot vertical), and is to be maintained for a minimum of three (3) feet vertically below the normal water level;

(3) All side slopes, as well as a two feet band around the entire perimeter of the top of bank shall be sodded;

(4) Provide adequate clearance between the top of bank and adjacent property to provide for a minimum of a 4:1 side slope from the top of bank to the existing ground elevation and a property line swale, when necessary; and

(5) A minimum of one (1) foot of freeboard will be required, regardless of the design storm or the type of development.

2.3.18. WATER QUALITY TREATMENT DESIGN

The design requirements for water quality treatment shall, in general, be reviewed under SWFWMD criteria. However, Manatee County has criteria which exceed those required by SWFWMD, which sets the minimum size of underdrain to be of a six (6) inch diameter.

2.3.19. GENERAL STORMWATER MANAGEMENT DESIGN CRITERIA

For all developments, property line swales shall be required and shall conform to, at a minimum, Manatee County Standards. If the development is occurring within an approved subdivision, the perimeter and property line swales shall conform to that approved per the typical lot grading plan. Should no typical lot grading plan be available, then the grading for the swales shall meet Manatee County Standards for property line swales.

Developments occurring within existing subdivisions where no Master Drainage System exists shall be required to provide their own stormwater management systems.

Detailed information regarding the area of influence shall be provided when drawing down the SHWT or where filling of the site under development may influence the existing groundwater table on adjacent properties.

Easements shall be provided for all property line swales. The site engineer shall field investigate drainage patterns immediately upstream and within at least 1,000 feet downstream of the site. It shall be demonstrated that design tailwater conditions are appropriate and there are no downstream restrictions to conveyance which may necessitate the use of peak sensitive outfall criteria.

2.3.20. OFFSITE DRAINAGE

Offsite surface waters which flow across or to a site proposed for development must be accommodated in the stormwater management plans for the development. The stormwater management system for the development must be capable of transporting existing offsite flows through or around the site development. The estimation of the offsite flows must be calculated separately from the estimation on-site post-development flows (i.e., separate offsite and on-site hydrographs must be computed due to the typically significant differences in land use characteristics).

2.3.21. ENVIRONMENTAL REQUIREMENTS

Water quality standards as established by the State of Florida (FAC 17-25), the Southwest Florida Water Management District, and the Manatee County Comprehensive Plan shall be required by Manatee County. The latest standards or revisions of these agencies shall be adhered to in the design, construction, operation and maintenance of stormwater Management facilities in Manatee County, Florida.

Water quality treatment shall be reviewed jointly between the Manatee County Public Works and Pollution Control Departments.

An additional 50% treatment or volume is required by the Manatee County Comprehensive Plan within the County's watersheds (Evers Reservoir and Lake Manatee Watersheds). Otherwise, the treatment volumes shall be equal to those required by the State of Florida and/or SWFWMD, whichever is more restrictive.

SECTION 2.4. INTERNAL DRAINAGE SYSTEM DESIGN

2.4.1. GENERAL

The type of interior drainage system of an area to be developed or redeveloped will depend on its typical roadway cross section. Where the proposed roadway system is to have curbs and gutters, the interior drainage system shall consist of storm sewers with sufficient drop inlets to insure runoff entry thereto (closed system).

Where no curb and gutter is proposed, the collection system shall consist of shallow grassed swales on both sides of the roadway (open system).

Public roadway drainage conveyed from the roadway between side or near lot lines shall be piped.

2.4.2. MINIMUM GROUNDWATER AND HIGH-WATER CLEARANCES

All roadways shall be designed to provide a minimum of one (1) foot between the bottom of the base course of the roadway and the seasonal high groundwater table. Roadside underdrains may be used in lieu of meeting this standard, provided that the underdrains will result in the seasonal high water table under the roadway being lowered to the above cited level.

In all situations, the crown of proposed roadways shall be no lower than 18 inches below the elevation of the adjacent ground after development.

2.4.3. HYDROLOGY

The interior drainage systems of an area are to be developed or redeveloped shall be designed to carry runoff from a 10 Year Frequency Rainfall. Drainage systems from improvements to or for roadways which are designated part of the Major Thoroughfare Plan shall be designed for the 25 Year Frequency event.

In all cases, the interior drainage system of developments shall be laid out so that if a more intense rainfall (greater than 10 Year Frequency event) overtaxes the system, an unobstructed flow path to lower ground will be provided. The purpose of this path shall be to ensure that no damage to properties located in the lower areas of development will occur and that no extensive ponding of water results.

2.4.4. AREAS DRAINED BY CLOSED SYSTEMS

Storm sewer systems shall be designed to flow full, but not under pressure at the computed peak design discharge.

In all cases, a self-cleaning system will be designed utilizing drop inlets. Longitudinal connecting pipes will run from inlet to inlet. No manholes shall be utilized unless absolutely necessary. Where possible, to insure self-cleansing, pipes will be placed on a minimum grade of 0.2 percent and provide a minimum velocity of 2.5 feet per second when flowing full or half-full. Minimum pipe sizes for closed systems shall be as follows:

1. For longitudinal pipes – 15 inches
2. For runs 75-feet or less – 15 inches
3. For low points on roadways (Bucket) – 18 inches

A. Inlet spacing. Pavement inlets shall be so spaced as to limit the spread of water from a 10 Year Frequency Rainfall to five-feet measured longitudinally on a continuous grade. Spacing shall be based on a maximum of 400 feet gutter flow. If slopes exceed 2% at low points, two pavement inlets on each side of the roadway shall be provided if deemed necessary by hydraulic analysis. Special care shall be taken in the placing of inlets so as to prevent water from flowing across the pavement. For purposes of maintenance, a spacing of 400 feet between junction boxes shall be required.

Headwalls and/or erosion protection devices (i.e., riprap, mitered ends) shall be installed at the ends (outlet pipes) of all closed systems to reduce erosion in the receiving water course.

B. Tailwater Effect. The effect of tailwater level in the receiving water shall be fully considered in the design of all storm sewer systems, such that when the outlet of the storm sewer system is below the tailwater level in the receiving water, the hydraulic grade line for the proposed storm sewer system shall be computed.

In all cases, the computed Hydraulic grade line elevation shall not be higher than 0.25 feet below the gutter line elevation at any drainage structure.

Where the receiving stormwater facility is a detention basin, the design tailwater level can be computed by routing a hydrograph resulting from a 10 Year Frequency storm of a duration equal to that used in designing the pond through the basin.

In the computation of the hydraulic grade line, all energy losses (entrance, exit, friction, structure, etc.) must be considered.

2.4.5. AREAS DRAINED BY OPEN SYSTEMS (INTERIOR SYSTEM)

Swale drainage systems shall be designed as open channels in a manner similar to the closed system.

The minimum slope of swales adjacent to roadways and other swales constituting the interior drainage system shall be to FDOT and Green Book Standards. The maximum velocity of flow in swales shall be as follows (upon project completion):

A. Seeded and mulched – 0 to 2-feet per second

B. Sodded (no staking) – 2 to 4-feet per second

C. Paved – 4-feet per second or greater

D. Existing ground cover:

(1) Good condition – 0 to 4-feet per second

(2) Fair condition – 0 to 2.5-feet per second

(3) Poor condition – 0 to 1.5-feet per second

Flow in roadway swales shall be routed to culverts carrying the primary drainage system through the area to be developed or to flow channels (swales) in dedicated public easements between lots which will convey runoff to the primary drainage system.

The hydraulic engineering circular no. 5, hydraulic charts for the selection of highway culverts, published by the U.S. Department of Transportation, Federal Highway Administration should be used for all culvert design under the roadway.

2.4.6. LOT DRAINAGE SPECIFICATIONS.

See Appendix D for graphic lot drainage details.

A. For closed drainage, show curbs, gutters and sidewalks, if applicable.

B. Existing drainage shall be maintained or improved.

C. Minimum driveway rise from curb to garage is 1%.

D. Show all easements.

E. Minimum grade slopes are as follows:

(1) Front Yard - 2.0%;

(2) Rear and Side yards - 1.5%;

(3) Swales - 1.0%.

F. Minor modifications to accommodate special conditions such as trees may be approved by the Public Works Department.

G. Lots with special conditions may have slopes based on an engineer's detailed design approved by the Department Director or designee.

H. Deviations due to existing trees, vegetation or other extenuating circumstances may be approved. Difficulties arising from such deviations are the responsibility of the property owner to satisfactory resolve.

I. Lot slopes apply to a 75' radius from the edge of the house. The intent is to allow flexibility on larger lots.

J. All conflicts shall be remedied to the satisfaction of the Public Works Department Director.

K. Permitee shall submit a copy of the approved subdivision drainage plan. Size requirements are 8-1/2"x11", 8-1/2"x14" or 11"x17" at a scale of 1"=100' or 1"=200' for lots of 5 acres or more.

2.4.7. ACCEPTABLE STORM SEWER PIPES

The following are acceptable materials for the construction of storm sewer systems which must meet County standards:

A. Storm sewer running across a public roadway - RCP or structural plate only

B. Storm sewer running parallel to a public roadway and between lots - RCP, Polyethylene, corrugated metal

Corrugated metal pipe is not permitted under any roadway. Metal pipe will only be allowed if surrounding soils are of proper PH ranges conducive to metal pipe

2.4.8. EROSION AND SEDIMENT CONTROL

Erosion and sediment control must be submitted with the construction or immediately following (same day) of any land disturbing activities. In no case shall silt or debris be allowed to enter a public right of way in such a manner as to create a traffic hazard, a public nuisance or a threat to exiting drainage.

In accordance with best engineering practices, erosion and sediment control measures must be provided on all sites to be developed or redeveloped where existing vegetation or impervious surfaces shall be removed so that bare soil remains. These measures shall be provided not only in areas of the proposed stormwater system (i.e., inlets, ponds, outfalls, etc.), but in all areas disturbed. This includes providing silt screens or hay bales along property lines where the existing ground cover has been removed.

Erosion and sediment controls must be in place prior to construction or immediatelyfollowing (same day) of any land disturbing activities.

Plans for erosion and sediment control must be submitted with the construction plan submittal and be approved prior commencement of any work on site. The following items included in the erosion and sediment control plans:

A. A description of the siltation control program and siltation control practices.

B. Details of erosion and sediment controls.

C. A plan for temporary and permanent vegetative and structural erosion and siltation control measures.

D. A description of the maintenance program for siltation control facilities including inspection programs, re-vegetation of exposed soils, method and frequency of removal and disposal of solid waste material from control facilities and disposition of temporary structural measures.

2.4.9. PROTECTION AND STABILIZATION OF SOIL STOCKPILES

Soil stockpiles shall be protected at all times by on-site drainage controls which prevent erosion of the stockpiled material. Control of dust from such stockpiles shall be required.

In no case shall any unstabilized stockpile remain in place, longer than thirty (30) calendar days.

Stockpiling of material may not occur unless a minimum of thirty (30) feet of clearance between to the toe of slope of the stockpile and the adjacent property is available.

2.4.10. OWNERSHIP AND MAINTENANCE

All erosion control devices shall be checked regularly. Devices shall be cleaned or repaired as required.

Maintenance of all soil erosion and siltation control devices, whether temporary or permanent, shall be at all times the responsibility of the Owner.

A. Lakes and Ponds. When lakes and ponds are incorporated within a subdivision as part of the stormwater management system, the maintenance responsibility shall be provided in either individual or common

ownership; or easement stipulating same. Further, a drainage easement for such lakes or ponds shall be granted to the County along with access easements as required in Section 2.4.9.F, below, and the owner shall be held legally responsible for the continued maintenance and operation of the stormwater management system. Such owner shall have an address of record, and shall represent the interest of all property owners for which the stormwater system has been designed.

B. Streets and Other Common Areas. Stormwater management facilities shall be incorporated into rights-of-way, easements, open space areas, retention/detention areas and similar common facilities.

C. Private Ownership. Swales and other drainage facilities not in common areas shall be maintained in private ownership, with appropriate public drainage easements granted to the County.

D. Common Ownership. Stormwater management systems in private streets and other common areas shall be provided for in common ownership with all lot owners within the development.

E. Major Drainage Facilities. All major drainage facilities servicing any site shall be dedicated to the County together with necessary access easements to said drainage ways.

F. Easement Requirements. All required easements shall be provided as specified in the Land Development Code and the Public Works Standards Manual. All access easements shall be on level ground at the top of the bank and shall be designed and maintained sufficiently free and clear of vegetation or other obstruction for vehicular access to permit inspection and maintenance operations, except that clearing shall not be required for access easements to existing major drainage facilities.

G. Off-Site Stormwater Management Facilities. An off-site stormwater management facility may be considered if a developer can demonstrate that the off-site facility is designed to accommodate the discharge from the development at a twenty-five (25) year frequency storm and that the stormwater management requirements of this Manual and the Land Development Code can be fully achieved for such discharge prior to the discharge entering waters of the State. When an off-site stormwater management facility is proposed, the applicant shall submit for approval a plan indicating the entire contributory area for the off-site facility and written engineering data substantiating the conveyance to the off-site location. Such off-site facilities shall be subject to the approval of the Department Director. Such facilities may only be utilized, however, where adequate ownership and maintenance methods can be shown to provide for their continued functioning. If the developer elects to use an off-site stormwater management facility developed by the County, the developer shall be required to pay a pro-rata cost of the design and construction of said facility based on the quantity of stormwater discharging into the retention/detention facility. All costs associated with upgrading, improving the conveyance system and drainage channels and/or constructing new conveyance systems from the subject development to the off-site retention/detention system shall be borne by the developer.

H. Construction Inspections and Approvals. All work required under this Section, in accordance with the approved construction plans, shall be subject to the approval of the Department Director and shall serve as a prerequisite for any subsequent permit required at the site or for occupancy thereof.

I. Violations. Any development or activity that proceeds in violation of this Section shall be subject to the violations provisions of the Land Development Code. Restoration of land to pre-existing drainage conditions or other corrective actions shall be required where a violation is determined to have occurred.

2.4.11. RIGHTS OF WAY, EASEMENT, AND MAINTENANCE ACCESS REQUIREMENTS

Open drainage channels and piped systems shall have unobstructed maintenance access areas as shown on the drawings in Appendix A. Detention and retention basins shall have an unobstructed access route at least 20-feet

wide from the nearest street and shall have an unobstructed maintenance access area a minimum of 20-feet from the top of bank completely around their perimeter.

All rights of way, easements, and maintenance access areas shall be sodded, or have a good stand of grass or other acceptable coverage per County approval. In all cases there shall be a minimum of 2 foot strip of sod placed at the edge of pavement or back of curbs.

2.4.12. SWALES

Swales shall be constructed along side and rear lot lines sloped toward and discharging into a retention/ detention basin or into an acceptable drainage facility, drainage outfall, or drainage system, approved by the Department Director in accordance with the standards contained in this Manual and the Manatee County Highway and Traffic Standards Manual.

SECTION 2.5. SUBMITTAL REQUIREMENTS FOR STORMWATER MANAGEMENT SYSTEMS

2.5.1. STORMWATER MANAGEMENT PLAN PREPARATION

The criteria below shall be used as minimum design elements of a Stormwater Plan. For projects using the criteria below, a copy of the approved Environmental Resource Permit including the site plans and technical supporting data from applicable State Water Management agencies shall be provided prior to approval by the Manatee County Stormwater Management Division of the Public Works Department. The criteria below shall only be used for approval of a single submittal to Manatee County on a particular piece of land. The criteria below shall not be used on land or lots located within a master drainage system or a subdivision in which each lot is required to provide dedicated stormwater facilities. The criteria below shall not be used for more than one administrative approval on a single piece of property unless otherwise approved by Manatee Stormwater Management or Public Works staff. Regardless of the criteria below, stormwater runoff shall discharge to the historical point(s) of discharge. Drainage runoff which flows from offsite areas shall be conveyed through or bypassed around the development. The criteria below are based upon General Permit for Minor Activities. Section 40D-400.475, 1d. F.A.C., and subject to conformity with any amendments made on this section. The criteria are applicable to all existing platted lots or platted lots of record prior to 1985 with existing improvements and structures that can be claimed as impervious area:

A. For any project, no additional stormwater facilities will be required for • proposed impervious areas less than or equal to 1.000 square feet. However, floodplain and floodway requirements of Sections 717 and 718 continue to apply if the project lies within the FEMA 1 00-year floodplain or floodway or the 25-year floodplain.

B. For projects with less than 4,000 square feet of impervious vehicular use areas (roadways. driveways. drive aisles. loading areas. etc.) and less than 9,000 square feet of total impervious area: i. Attenuation is not required. ii. Water quality treatment is required.

C. For projects with less than 4.000 square feet of impervious vehicular use areas (roadways, driveways, drive aisles. loading areas. etc.) and less than 9.000 square feet of total impervious area located within a Watershed Overlay Protection District or discharge into an Outstanding Florida Waters:

   (1) Attenuation is not required.

   (2) 150% Water quality treatment is required.

D. For projects with less than 4.000 square feet of impervious vehicular use areas (roadways. driveways. drive aisles. loading areas. etc.) and less than 9,000 square feet of total impervious area located within the 1 00-year floodplain or floodway or the 25-year floodplain:

   (1) Attenuation is required and not subject to flow reduction where necessary.

   (2) Water quality treatment is required.

   (3) Floodplain Compensation is required.

   (4) No-rise permit is required where necessary.

E. For projects with over 4.000 square feet of impervious vehicular use areas (roadways. driveways, drive aisles. loading areas. etc.) and/or greater than 9,000 square feet of total impervious area:

   (1) Attenuation is required and subject to flow reduction where necessary.

   (2) Water quality treatment is required and subject to 150 % requirement where necessary.

   (3) Floodplain Compensation is required where necessary.

   (4) No-rise permit is required where necessary.

2.5.2. EXISTING HYDROLOGIC CONDITIONS.

The pre-development rate of discharge from the site shall be identified by field review and computation. The location, elevations, seasonal fluctuation regimes, and nature of all existing watercourses, water bodies, and wetlands on or adjacent to the site of the proposed development shall be shown. Seasonal high water table elevations shall be provided specifically for the site and for all proposed pond locations. The tailwater elevation for the twenty-five year design storm shall be calculated or used directly from existing twenty-five-year floodplain maps, flood profiles or from another best existing source of information available, and shall be used in the design of the stormwater management facilities. Twenty-five-year tailwater information is available from the Public Works Department. The downstream conditions, including culvert, ditch and channels sizes, which may restrict capacity of the outfall must be identified.

2.5.3. STORMWATER MANAGEMENT PLAN REQUIREMENTS

All construction plan submittals are to include the following information for the review of the proposed stormwater management systems:

A. Vicinity sketch and legal description.

B. Basin and sub-basin boundaries, including all on-site and offsite areas contributing to the proposed development site. This is to include both pre- and post-development conditions.

C. Final site topography surveyed by a land surveyor at one (1) foot contours based on NAVD1988, as amended, shall be provided for a minimum distance of fifty (50) feet beyond the lot lines, excluding the rights-of-way. Contours may be mapped by an architect, engineer or land surveyor.

D. Signed and sealed boundary survey (by a Florida registered land surveyor).

E. The location, elevation, slope, cross sections, materials and capacity of all prospective stormwater retention or detention facilities, control structures, culverts, lakes, canals, ditches, swales, vegetative buffers, and any other necessary facilities.

F. Proposed elevations, specifically those for the perimeter and property line swales and for finished grades at the property lines. (Minimum elevations are to be provided at the property lines, lot lines and at the

beginning and end of all swales). Typical profiles at property lines which will indicate that stormwater is not being diverted onto adjacent property.

G. Existing drainage features (ditches, ponds, easements, etc.). Existing features are to be shown downstream of the proposed development. The downstream distance shall be determined from the following, whichever is applicable:

   (1) The Site Designer shall field investigate drainage patterns immediately upstream and a minimum of 1000 feet downstream of the site and provide documentation of field conditions.

   (2) The Site Designer shall demonstrate that design tailwater conditions are appropriate and that there are no downstream restrictions of conveyance which may necessitate the use of Peak Sensitive Outfall conditions.

H. Highwater data upstream and downstream of the proposed development when available.

I. Proposed layout with horizontal and vertical controls.

J. The location, area, permeability, and land cover (existing and proposed) of all proposed drainage basins within the site and the general location, including the area and drainage contribution or surface conditions of all drainage basins related to the project both on and off site, shall be shown. Flow paths, volumes and rates, including those for potential failures or retention/detention facilities shall be indicated throughout the proposed system. In addition, the storage volumes, surface areas, depths, duration, and identification of the final outfall locations and rates shall be indicated.

K. Proposed drainage features, including the location of inlets, swales, ponds, easements, conveyance systems, etc.

L. Notes pertaining to standing water, springs, areas of seepage or sources of highwater data.

M. Specific soils information determined from a geotechnical report or soils analysis. (SHWT data should be included).

N. Soils report indicating infiltration rates, soil type and profile, etc.

O. Flood zone delineation.

P. Existing land uses and ground cover.

Q. Scaled no smaller than 1" = 60'.

R. All necessary computations, hydrographs, and hydraulic analysis prepared by an engineer, which shall include the total project size in acres, acreage by general type of land use, tabulations of the area and percent of impermeable surface by projected type of land use and identification of the frequency and duration of the design storm, including predevelopment and post development runoff rates using an acceptable pond routing procedure or program. Calculations for all of the following must be signed and sealed by the Engineer of Record (Registered in the state of Florida):

   (1) Pre- and Post-development times of concentration.

   (2) Average Runoff Coefficients or Curve Numbers for both pre- and post-development stormwater facilities.

   (3) Volume capacities of existing site storage and post-development stormwater facilities.

   (4) Pre- and Post-development flows.

   (5) Internal pipe calculations (include basin delineation).

(6) Offsite flow contributions.

(7) Cut and fill calculations for mitigation within the 100 year floodplain.

(8) Stage storage discharge.

a. Computer generated reports (Include all input as well as all output.)

b. Water quality treatment and drawdown calculations.

S. Calculations showing compliance with the stormwater management requirements for the WPE and WPM overlay districts as stated in this Manual and the Land Development Code, if appropriate, with identification of the discharge points from the project, the receiving bodies of water, the conveyance routes thereto and presentation of the method of derivation. The design and construction shall be subject to the regulations under Chapters 62-3, 62-4, 62-25, 40D-4, 40D-45, 40D-400, and other applicable chapters of the Florida Administrative Code.

T. Typical Lot Cross Section.

U. Typical Road Cross sections.

V. Plan and Profiles for all roadways.

W. Jurisdictional Survey.

X. Minimum building elevations.

Y. Location, elevation and detail of all stormwater system components (i.e., swales, inlets, ponds, control structures, etc.).

Z. Erosion and sediment control plans.

AA. Design reference material shall be documented and made available upon request.

BB. Drainage and access easements.

CC. Location and elevations of all utilities.

DD. Construction specifications.

EE. The design shall include the description of the construction and maintenance practices to be used during and after construction which will minimize erosion, siltation of wetlands and watercourses, water pollution, and off-site flooding. All swales shall be either sodded or have an equivalent stand of grass prior to approval.

FF. Such other information as may be required to demonstrate compliance with the requirements of the Land Development Code.

SOURCES

SWFWMD "Management and Storage of Surface Waters – Permit Information Manual; Volume I", March 1988

City of Sarasota, "Engineering Design Criteria Manual", 17 January 1989

Hillsborough County, "Stormwater Management Technical Manual", May 1988

Synder, F.F., "Synthetic Flood Frequency", Paper 1908, Journal of the Hydraulics Division, Proceedings ASCE, October 1958

USDA "Urban Hydrology for Small Watersheds", Technical Release 55 (TR-55), 2nd Edition, June 1986

Briley, Wild & Associates, Inc.

Wright-McLaughlin Engineers (1969)

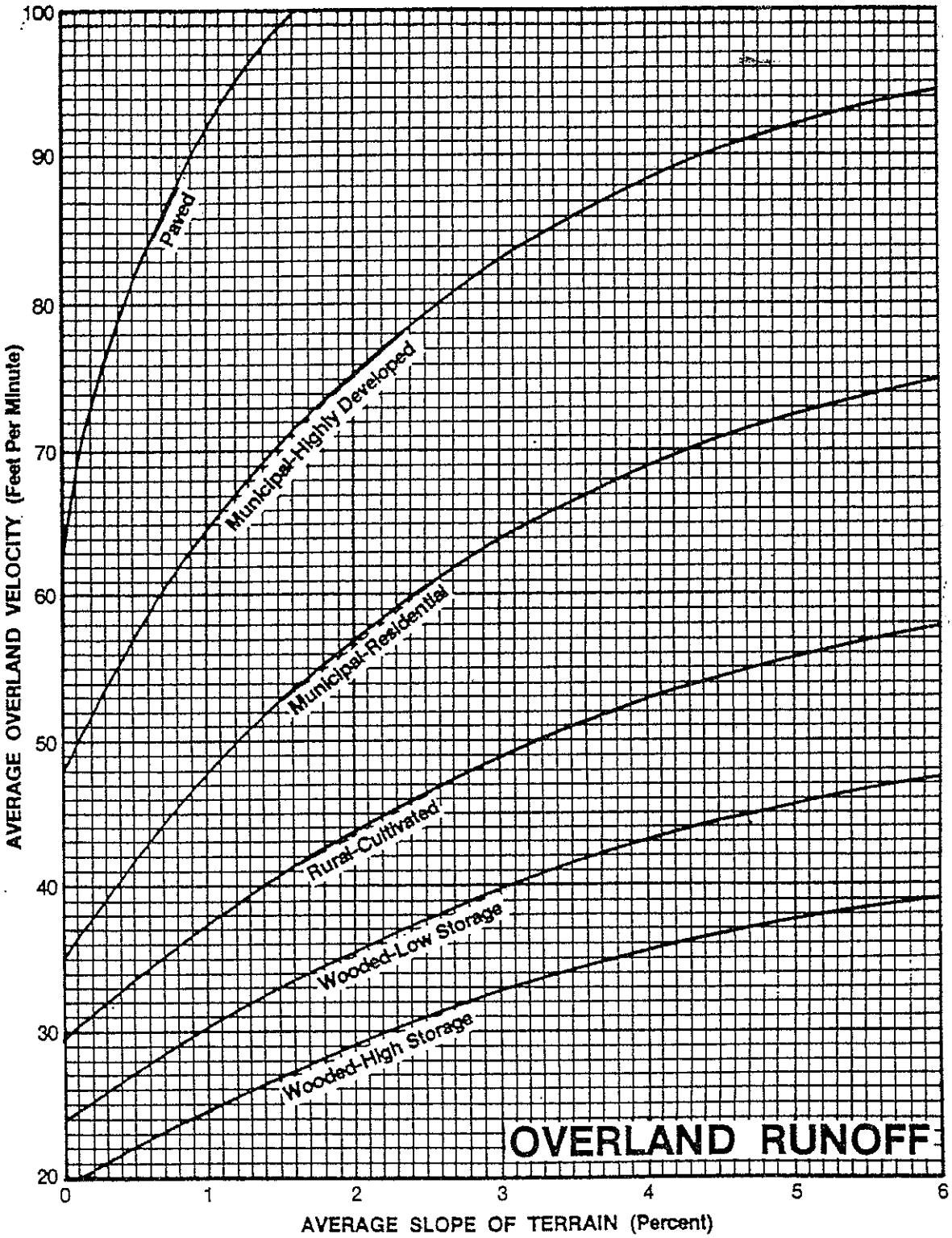
Hydrology and Water Quantity Control
By: M.P. Wanielista, 1990, Wiley Publication

Introduction to Hydrology, 2nd Edition, 1977
By: W. Viessman, Jr., J.W. Knapp, G.L. Lewis, T.E. Harbaugh

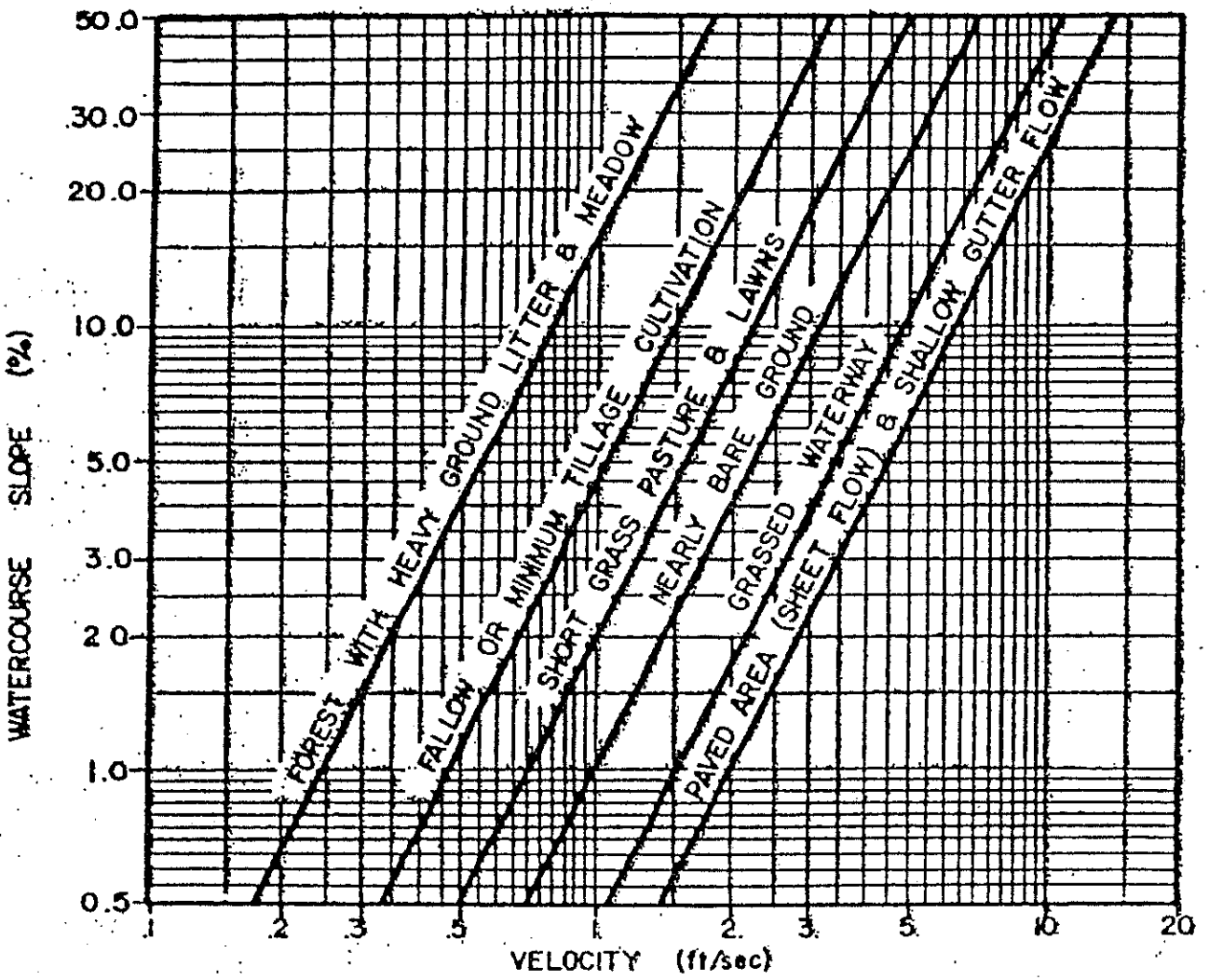
APPENDIX “A”

RAINFALL RATIOS (ACCUMULATED TOTAL 24-HOUR TOTAL)

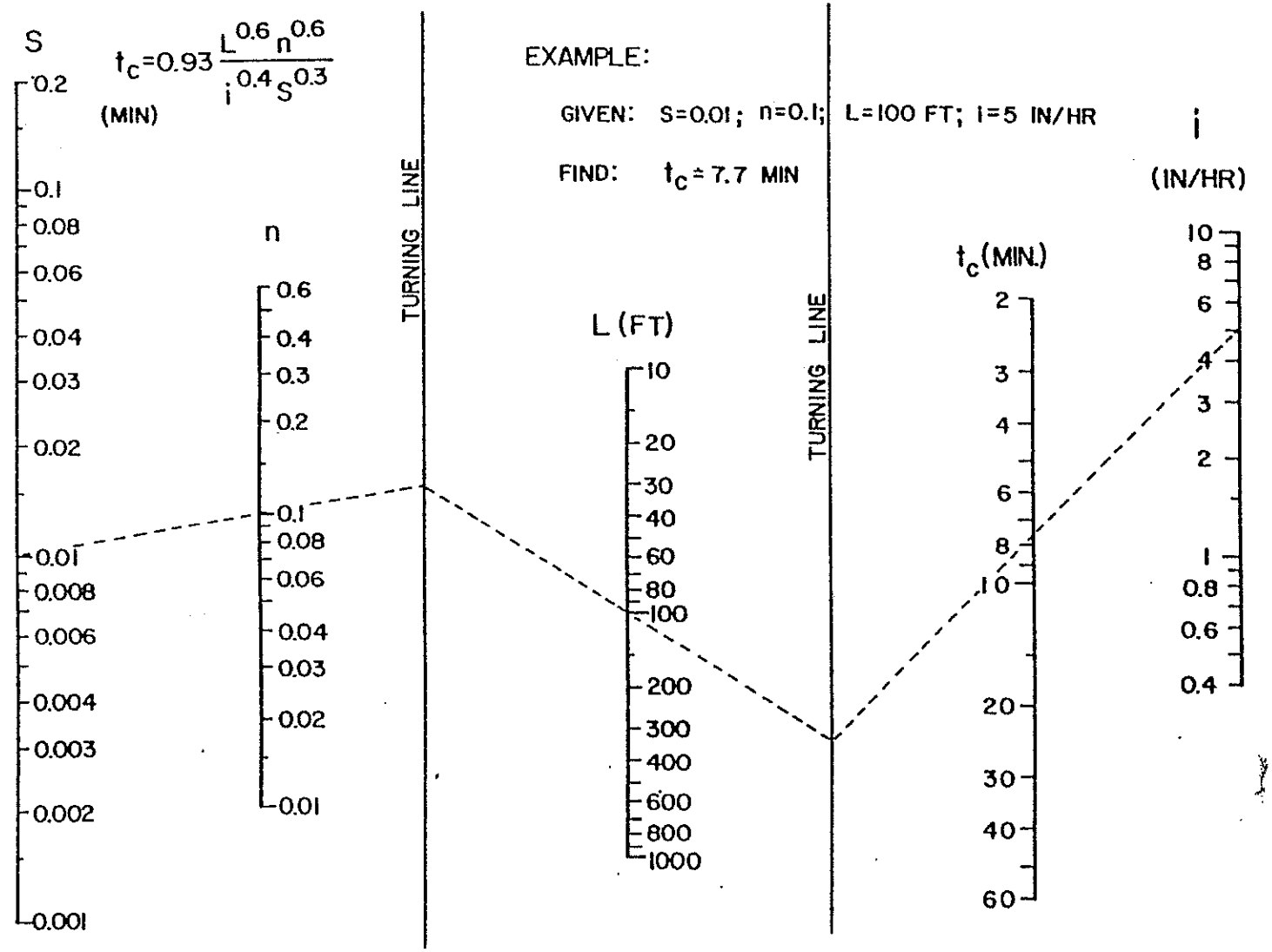
TIME (HR.)	SCS TYPE II FL. MODIFIED
0.0	.000
0.5	.006
1.0	.012
1.5	.019
2.0	.025
2.5	.032
3.0	.039
3.5	.047
4.0	.054
4.5	.062
5.0	.071
5.5	.080
6.0	.089
6.5	.099
7.0	.110
7.5	.122
8.0	.134
8.5	.148
9.0	.164
9.5	.181
10.0	.201
10.5	.226
11.0	.258
11.5	.308
12.0	.607
12.5	.719
13.0	.757
13.5	.785
14.0	.807
14.5	.826
15.0	.842
15.5	.857
16.0	.870
16.5	.882
17.0	.893
17.5	.904
18.0	.913
18.5	.923
19.0	.931
19.5	.940
20.0	.948
20.5	.955
21.0	.962
21.5	.969
22.0	.976
22.5	.983
23.0	.989
23.5	.995
24.0	1.000



Overland Flow Velocities for Various Land Use Types



The average velocities for estimating travel time for overland flow (SCS method). (*Source*: SCS, 1975.)



Reference: USDOT, FHWA, HEC-12 (1984).

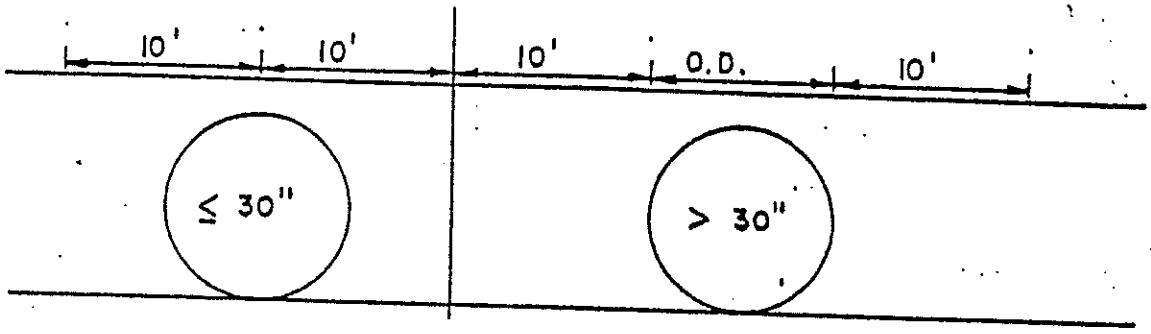
Kinematic Wave Formulation for Determining Overland Flow Travel Time

EASEMENT GUIDELINES FOR PIPE SYSTEMS

I. LESS THAN FIVE FEET OF COVER OVER THE PIPE

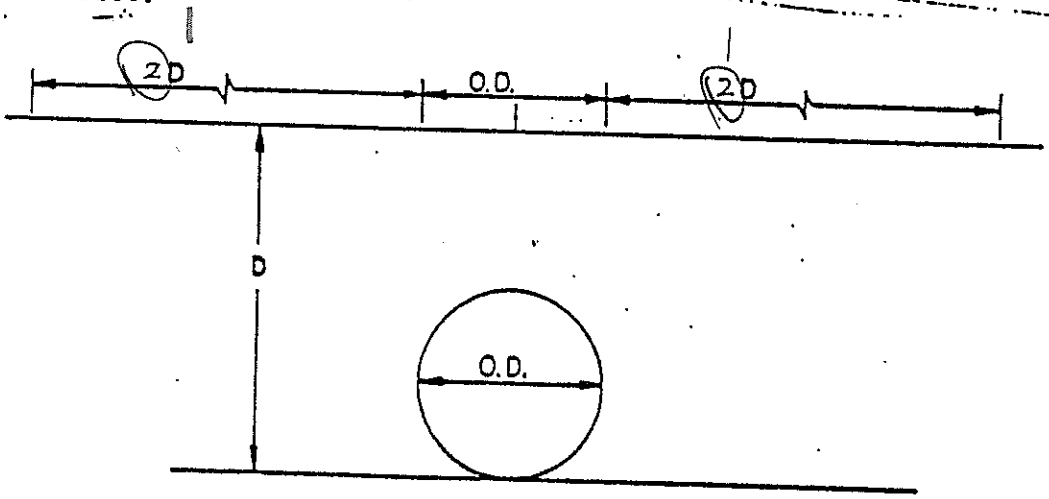
A. Diameter equal to or less than 30" round or equivalent: easement shall be 10 feet either side of the centerline of the pipe.

B. Diameter greater than 30" round or equivalent: easement shall be 20 feet plus the outside diameter of the pipe in width (rounded up to the nearest 5 foot increment) and centered on the centerline of the pipe.

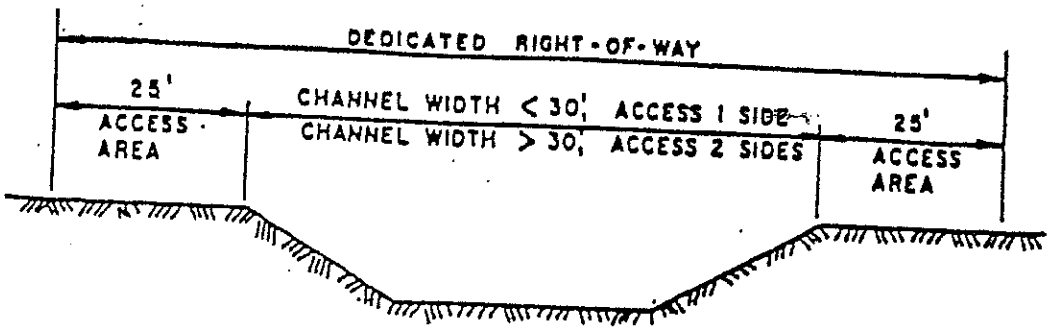


II. EQUAL TO OR GREATER THAN FIVE FEET OF COVER OVER THE PIPE

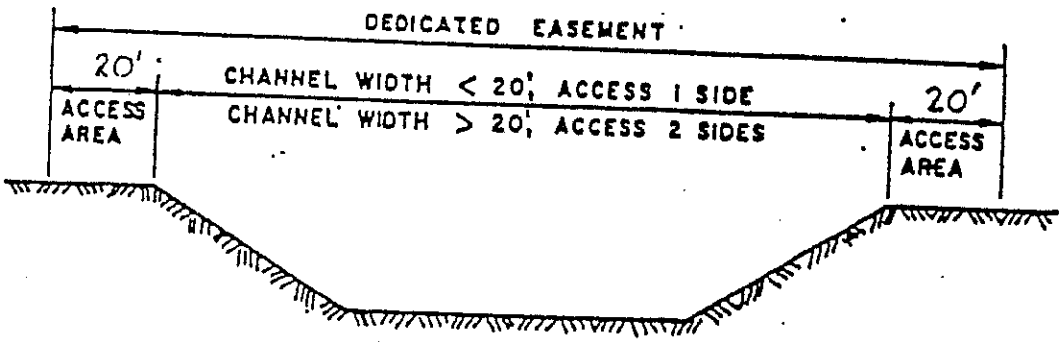
Easement will be equal to the outside diameter of the pipe plus twice the distance from the ground surface to the trench bottom measured at the deepest point along the path of the proposed easement (rounded up to the nearest five foot increment), and centered on the centerline of the pipe. Minimum easement width is 20 feet.



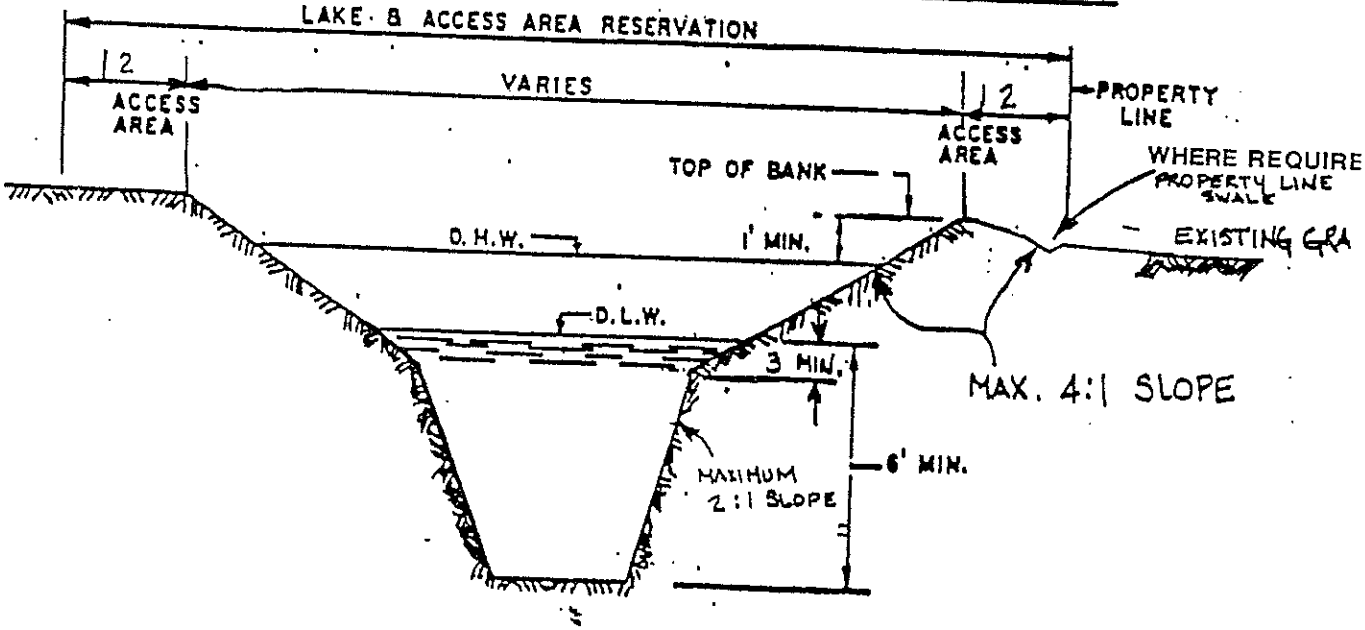
DRAINAGE R/W GUIDELINES FOR MAJOR OPEN DRAINAGE CHANNELS



DRAINAGE EASEMENT GUIDELINES FOR MINOR OPEN DRAINAGE CHANNELS

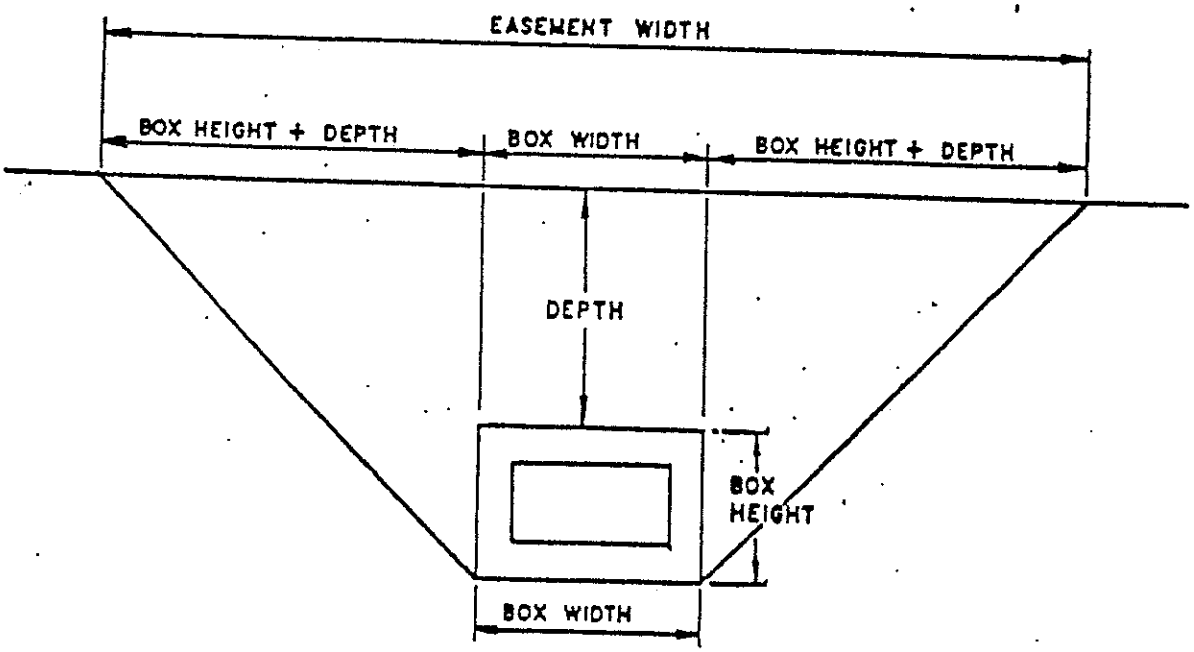


LAKE RESERVATION GUIDELINES FOR DETENTION AND RETENTION BASINS



EASEMENT GUIDELINES FOR BOX SYSTEMS

1. All dimensions shown are external dimensions.
2. Depth of cover is measured from the ground surface to the top of the box.
3. Easement Width = [(2) x (Depth of Cover + Box Height)] + Box Width. All calculations are to be rounded up to the nearest five foot increment for easement purposes.
4. Minimum easement width is 20 feet.



DESIGN STORM FREQUENCY FACTORS
FOR PERVIOUS AREA RUNOFF COEFFICIENTS

Design Storm Return Period (years)	Frequency Factor, X_T
2 to 10	1.0
25	1.1
50	1.2
100	1.25

Reference: Wright-McLaughlin Engineers (1969).

SCS RUNOFF CURVE NUMBERS FOR SELECTED AGRICULTURAL, SUBURBAN, AND URBAN LAND USE

Land Use Description	Hydrologic Soil Group A	B	C	D
Cultivated Land[a]:				
Without conservation treatment	72	81	88	91
With conservation treatment	62	71	78	81
Pasture or range land:				
Poor condition	68	79	86	89
Good condition	39	61	74	80
Meadow: good condition	30	58	71	78
Wood or Forest Land:				
Thin stand, poor cover, no mulch	45	66	77	83
Good cover[b]	25	55	70	77
Open Spaces, Lawns, Parks, Golf Courses, Cemeteries:				
Good condition: grass cover on 75% or more of the area	39	61	74	80
Fair condition: grass cover on 50% to 75% of the area	49	69	79	84
Poor condition: grass cover on 50% or less of the area	68	79	86	89
Commercial and Business Areas (85% impervious)	89	92	94	95
Industrial Districts (72% impervious)	81	88	91	93
Residential[c]:				
Average lot size — Average % Impervious[d]				
1/8 acre or less — 65	77	85	90	92
1/4 acre — 38	61	75	83	87
1/3 acre — 30	57	72	81	86
1/2 acre — 25	54	70	80	85
1 acre — 20	51	68	79	84
Paved Parking Lots, Roofs, Driveways[e]:	98	98	98	98
Streets and Roads:				
Paved with curbs and storm sewers[e]	98	98	98	98
Gravel	76	85	89	91
Dirt	72	82	87	89
Paved with open ditches	83	89	92	93
Newly graded area (no vegetation established)[f]	77	86	91	94

[a]For a more detailed description of agricultural land use curve numbers, refer to Table 5-9.

[b]Good cover is protected from grazing and litter and brush cover soil.

[c]Curve numbers are computed assuming the runoff from the house and driveway is directed toward the street with a minimum of roof water directed to lawns where additional infiltration could occur.

[d]The remaining pervious areas (lawn) are considered to be in good pasture condition for these curve numbers.

[e]In some warmer climates of the country, a curve number of 96 may be used.

[f]Use for temporary conditions during grading and construction.

Note: These values are for Antecedent Moisture Condition II, and $I_a = 0.2S$.

Reference: USDA, SCS, TR-55 (1984).

SCS RUNOFF CURVE NUMBERS FOR AGRICULTURAL LAND USES

Land Use	Cover Treatment or Practice	Hydrologic Condition	Hydrologic Soil Group A	B	C	D
Fallow	Straight row	----	77	86	91	94
Row crops	Straight row	Poor	72	81	88	91
	Straight row	Good	67	78	85	89
	Contoured	Poor	70	79	84	88
	Contoured	Good	65	75	82	86
	Contoured and terraced	Poor	66	74	80	82
	Contoured and terraced	Good	62	71	78	81
Small grain	Straight row	Poor	65	76	84	88
	Straight row	Good	63	75	83	87
	Contoured	Poor	63	74	82	85
	Contoured	Good	61	73	81	84
	Contoured	Good	55	69	78	83
	Contoured and terraced	Poor	61	72	79	82
	Contoured and terraced	Good	59	70	78	81
Close seeded legumes[a] or rotation meadow	Straight row	Poor	66	77	85	89
	Straight row	Good	58	72	81	85
	Contoured	Poor	64	75	83	85
	Contoured and terraced	Good	55	69	78	83
	Contoured	Poor	63	73	80	83
	Contoured and terraced	Good	51	67	76	80
Pasture or range		Poor	68	79	86	89
		Fair	49	69	79	84
		Good	39	61	74	80
	Contoured	Poor	47	67	81	88
	Contoured	Fair	25	59	75	83
	Contoured	Good	6	35	70	79
Meadow		Good	30	58	71	78
Woods		Poor	45	66	77	83
		Fair	36	60	73	79
		Good	25	55	70	77
Farmsteads		----	59	74	82	86
Roads (dirt)[b]		----	72	82	87	89
(hard surface)[b]		----	74	84	90	92

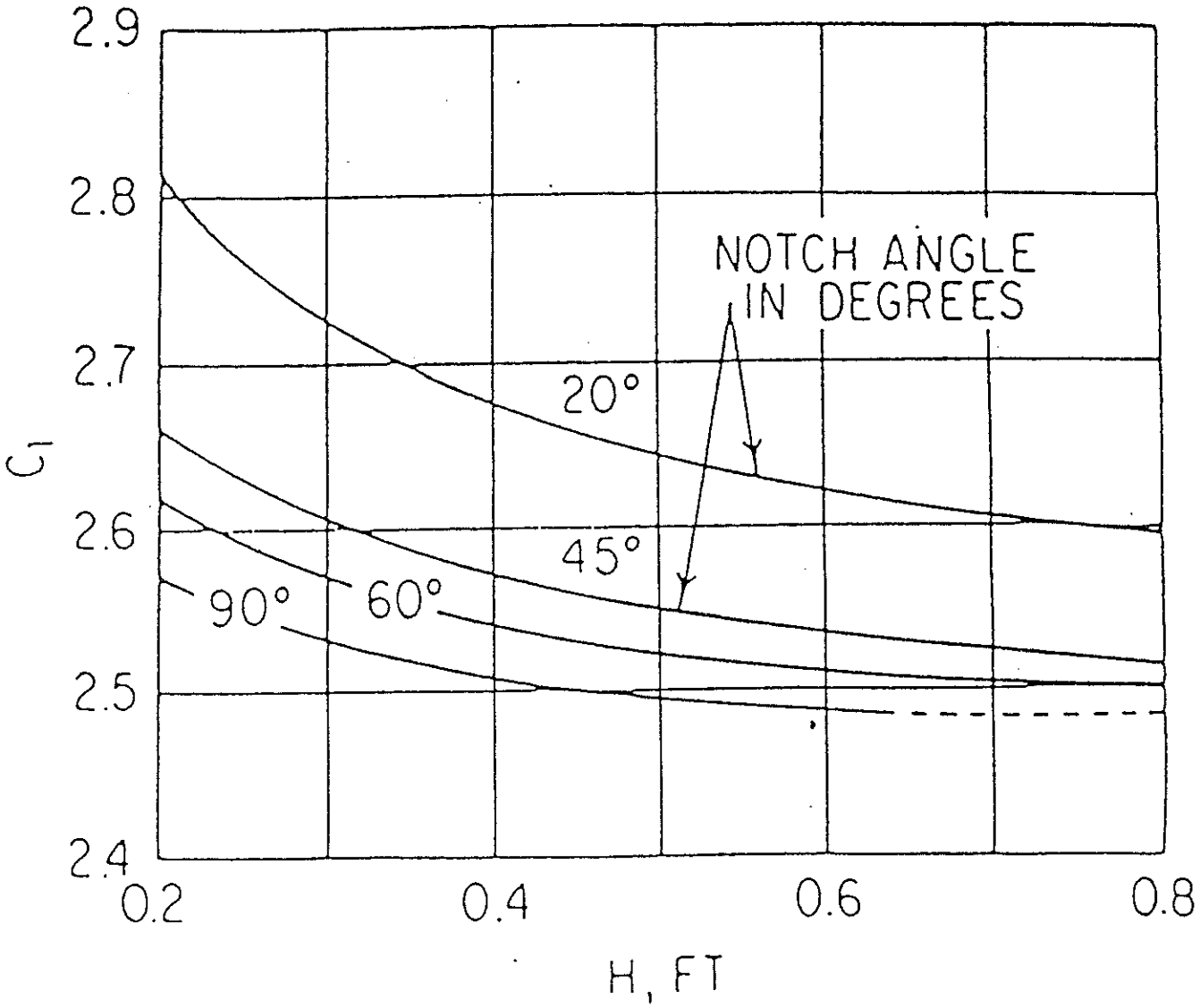
[a] Close-drilled or broadcast.

[b] Including right-of-way.

Note: These values are for Antecedent Moisture Condition II, and $I_a = 0.2S$.

Reference: USDA, SCS, NEH-4 (1972).

DISCHARGE COEFFICIENTS FOR SHARP-CRESTED
V-NOTCH WEIRS



RUNOFF COEFFICIENTS [a] FOR A DESIGN STORM RETURN PERIOD OF 10 YEARS OR LESS

Slope	Land Use	Sandy Soils Min.	Sandy Soils Max.	Clay Soils Min.	Clay Soils Max.
Flat (0-2%)	Woodlands	0.10	0.15	0.15	0.20
	Pasture, grass, and farmland[b]	0.15	0.20	0.20	0.25
	Rooftops and pavement	0.95	0.95	0.95	0.95
	Pervious pavements [c]	0.75	0.95	0.90	0.95
	SFR: 1/2-acre lots and larger	0.30	0.35	0.35	0.45
	Smaller lots	0.35	0.45	0.40	0.50
	Duplexes	0.35	0.45	0.40	0.50
	MFR: Apartments, townhouses, and condominiums	0.45	0.60	0.50	0.70
	Commercial and Industrial	0.50	0.95	0.50	0.95
Rolling (2-7%)	Woodlands 0.15	0.20	0.20	0.25	
	Pasture, grass, and farmland [b]	0.20	0.25	0.25	0.30
	Rooftops and pavement	0.95	0.95	0.95	0.95
	Pervious pavements [c]	0.80	0.95	0.90	0.95
	SFR: 1/2-acre lots and larger	0.35	0.50	0.40	0.55
	Smaller lots	0.40	0.55	0.45	0.60
	Duplexes	0.40	0.55	0.45	0.60
	MFR: Apartments, townhouses, and condominiums	0.50	0.70	0.60	0.80
	Commercial and Industrial	0.50	0.95	0.60	0.95
Steep (7%+)	Woodlands 0.20	0.25	0.25	0.30	
	Pasture, grass and farmland [b]	0.25	0.35	0.30	0.40
	Rooftops and pavement	0.95	0.95	0.95	0.95
	Pervious pavements [c]	0.85	0.95	0.90	0.95
	SFR: 1/2-acre lots and larger	0.40	0.55	0.50	0.65
	Smaller lots	0.45	0.60	0.55	0.70
	Duplexes	0.45	0.60	0.55	0.70
	MFR: Apartments, townhouses, and condominiums	0.60	0.75	0.65	0.85
	Commercial and Industrial	0.60	0.95	0.65	0.95

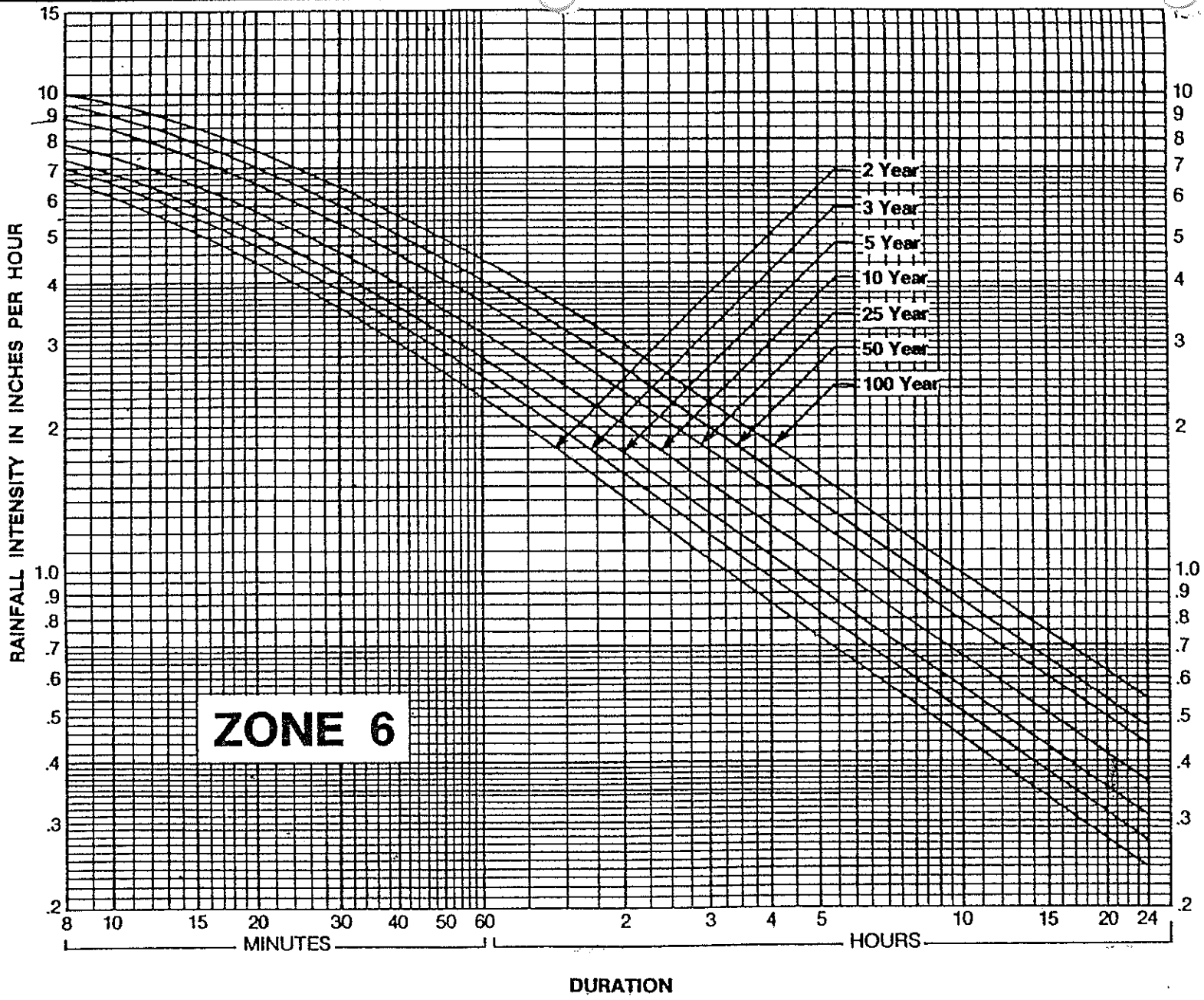
[a] Weighted coefficient based on percentage of impervious surfaces and green areas must be selected for each site.

[b] Coefficients assume good ground cover and conservation treatment.

[c] Depends on depth and degree of permeability of underlying strata.

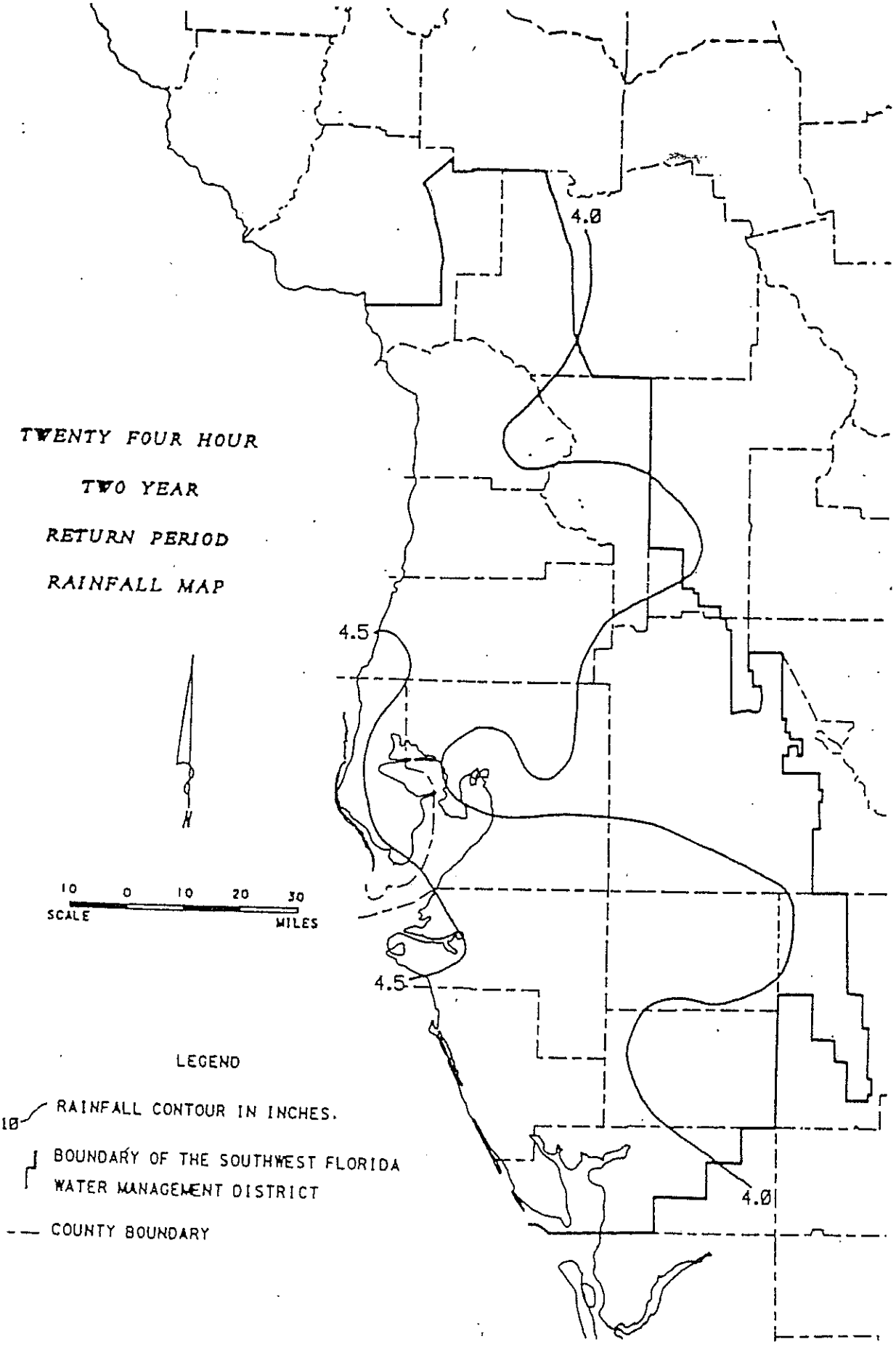
Note: SFR = Single Family Residential
MFR = Multi-Family Residential

APPENDIX "B"

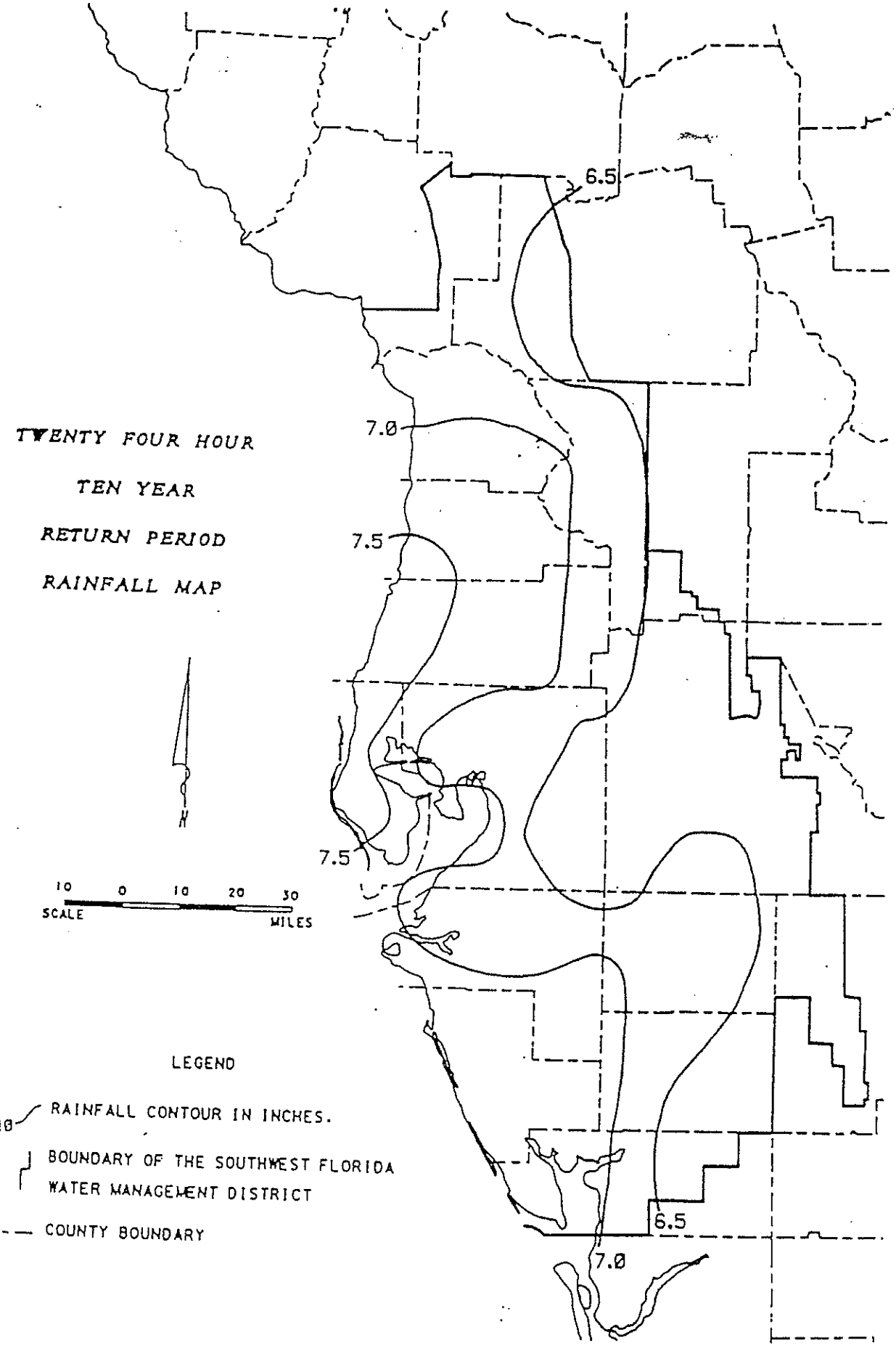


Rainfall Intensity-Duration-Frequency Curves for Zone 6

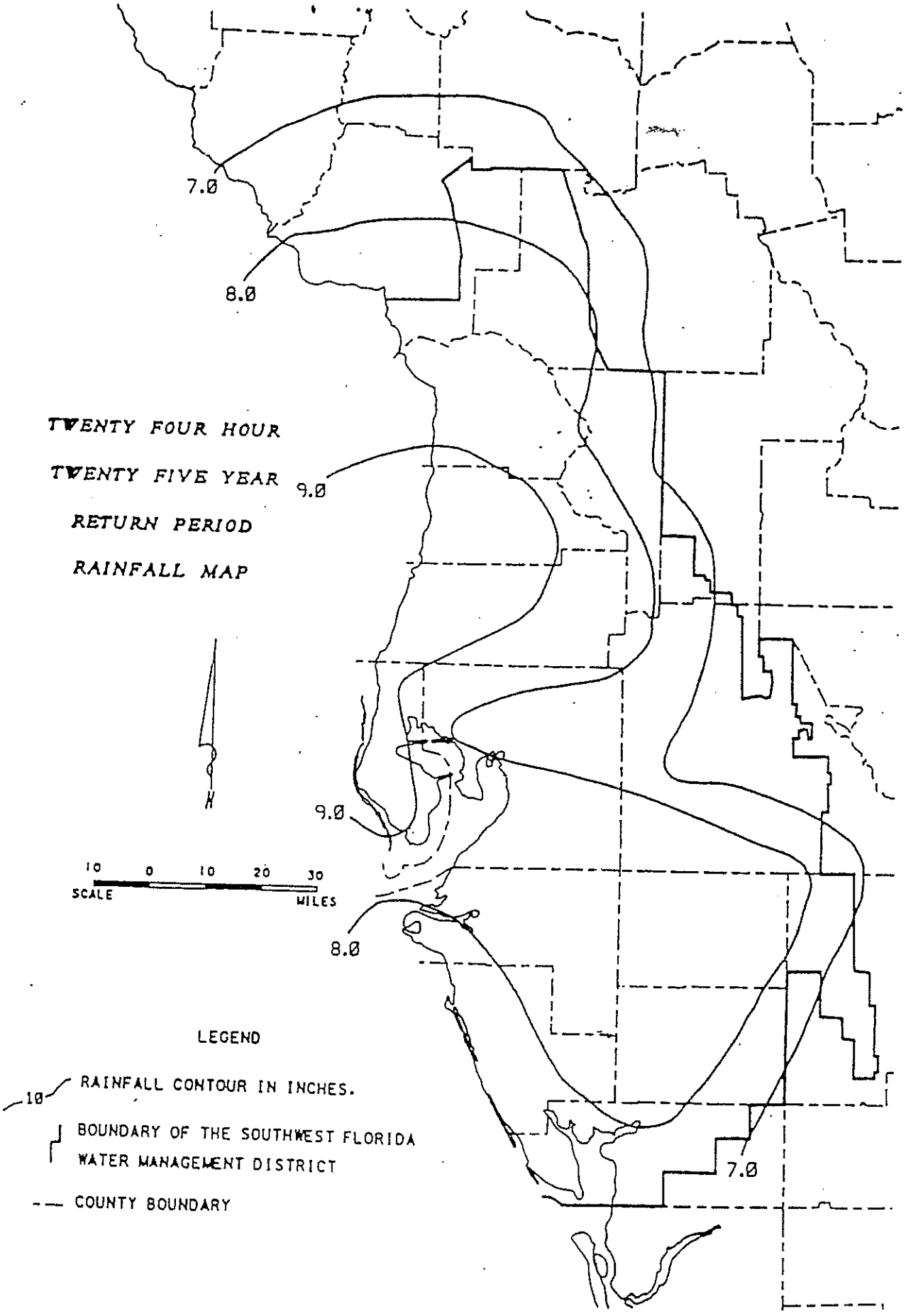
SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT



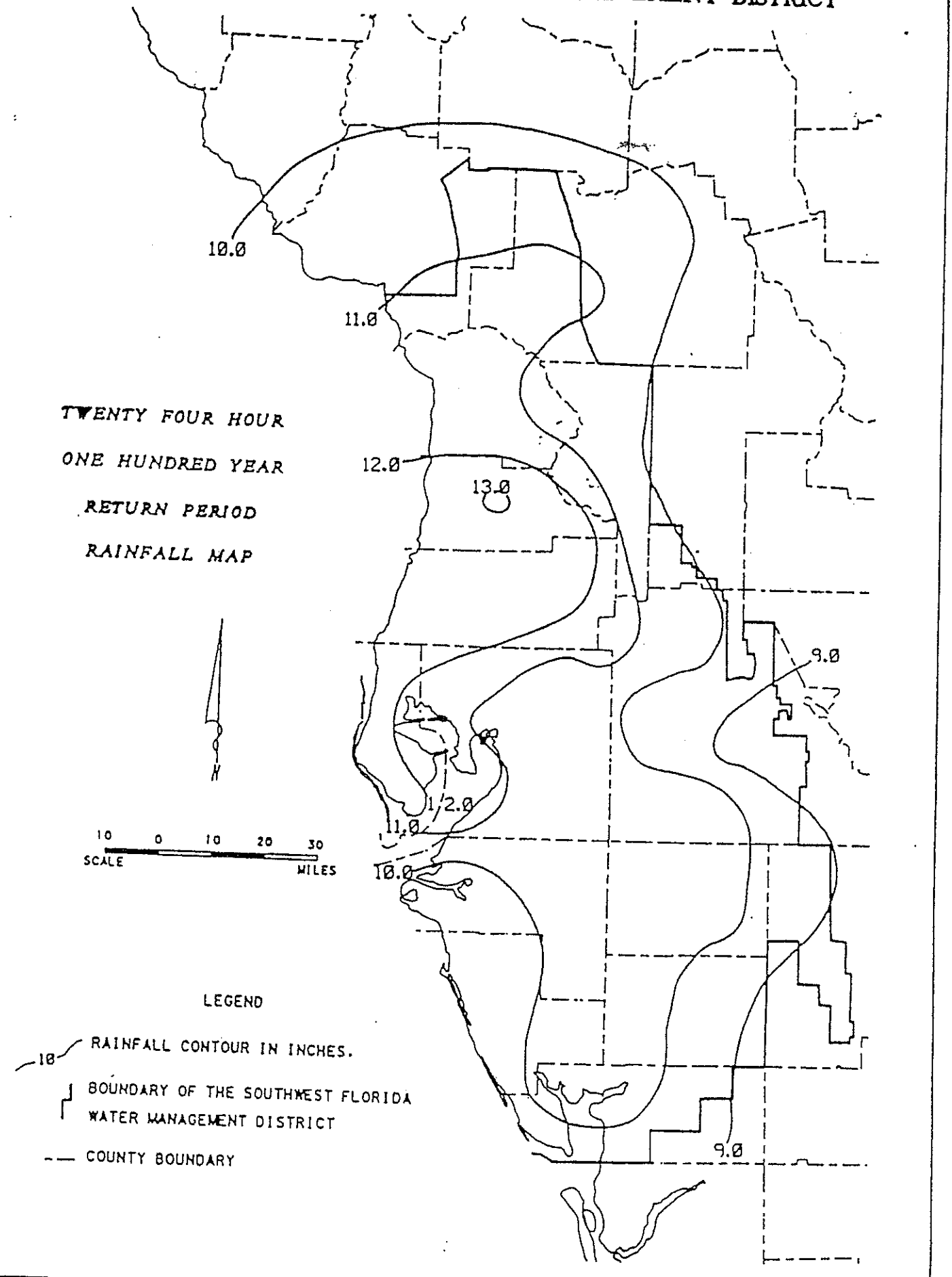
SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT



SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT



SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT



APPENDIX "C"

DRAWDOWN WORKSHEET FOR TYPE V (a) UNDERDRAIN

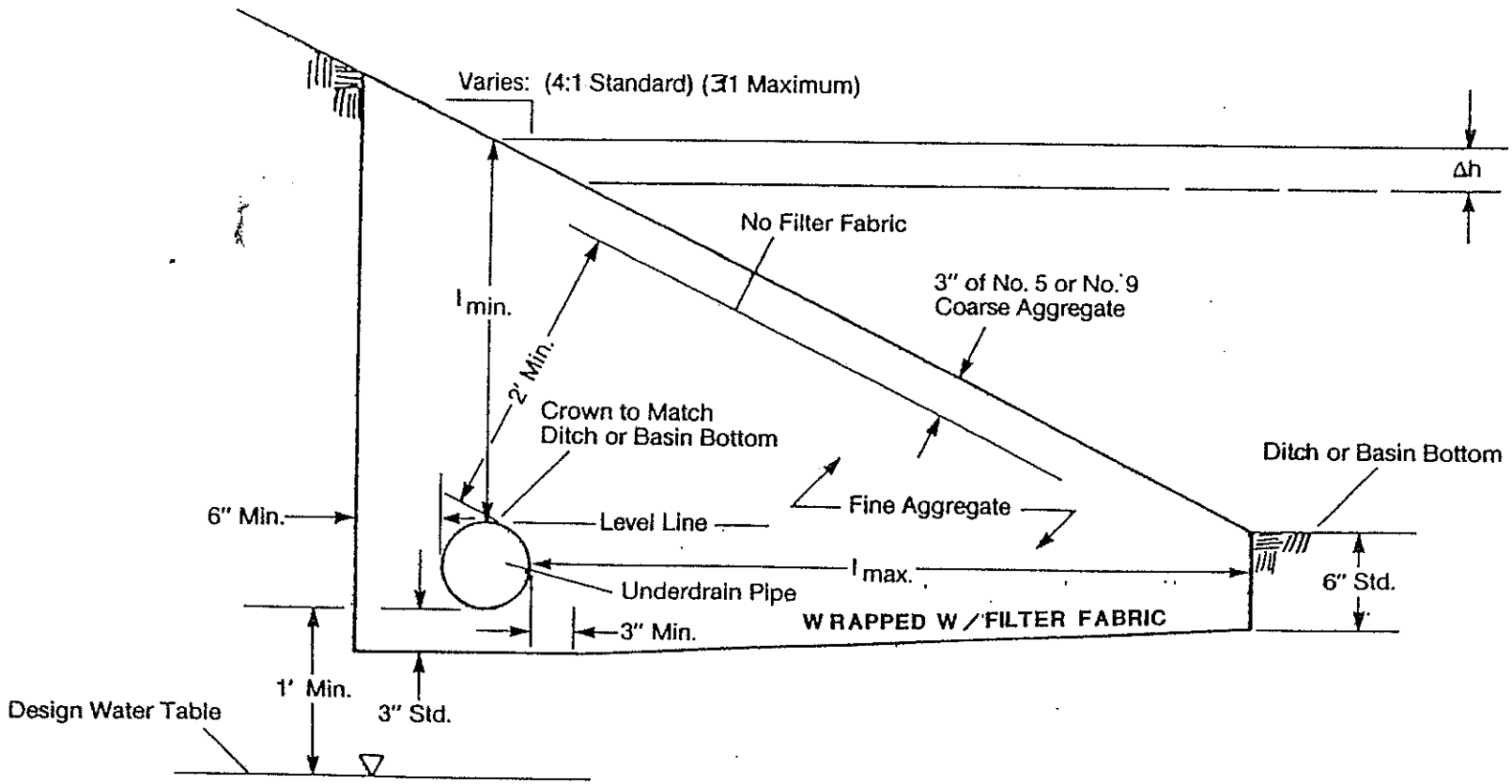
(Using Darcy's Law for Flow-Through Porous Material)

1	2	3	4	5	6	7	8	9	10	11	12	13	14
E Elevation (NGVD)	h Total Head (ft)	Δh Incr. Head (ft)	V Total Volume (ft^3)	ΔV Incr. Volume (ft^3)	I max Maximum Flow Length Through Filter (ft)	I min Minimum Flow Length Through Filter (ft)	I avg Avg. Flow Length Through Filter (ft)	Hydraulic Gradient $i = h/la$	Area of Filter $A = Lxh$ (ft^2)	Darcy Flow $Q = KIA$ (ft^3/hr)	Avg. Flow $\frac{Q_1 + Q_2}{2}$ (ft^3/hr)	ΔT Incr. Time (hr)	ΣT Total Time (hr)

Assumed Length L = _____ Hydraulic Conductivity K = _____ ft/hr

See Figure 13-4 for Typical Section Details

Drawdown Worksheet for Type V (a) Underdrain



Typical Section for the Type V (a) Underdrain

APPENDIX “D”

LOT DRAINAGE INDEX

MANATEE COUNTY
TRANSPORTATION DEPARTMENT

REV.BY	DATE

6/12/07
DATE OF B.O.C.C. APPROVAL

LOT DRAINAGE INDEX

700.0

GENERAL NOTES:

1.) FOR CLOSED DRAINAGE, SHOW CURBS, GUTTERS AND SIDEWALKS, IF APPLICABLE.

2.) EXISTING DRAINAGE SHALL BE MAINTAINED OR IMPROVED.

3.) MINIMUM DRIVEWAY RISE FROM CURB TO GARAGE IS 1%.

4.) SHOW ALL EASEMENTS.

5.) MINIMUM GRADE SLOPES ARE AS FOLLOWS: FRONT YARD – 2.0%; REAR AND SIDE YARDS – 1.5%; SWALES – 1.0%.

6.) MINOR MODIFICATIONS TO ACCOMMODATE SPECIAL CONDITIONS SUCH AS TREES MAY BE APPROVED BY THE ACCESS/DRAINAGE INSPECTOR.

7.) LOTS WITH SPECIAL CONDITIONS MAY HAVE SLOPES BASED ON AN ENGINEER'S DETAILED DESIGN APPROVED BY THE TRANSPORTATION DIRECTOR OR A DESIGNEE.

8.) DEVIATIONS DUE TO EXISTING TREES, VEGETATION OR OTHER EXTENUATING CIRCUMSTANCES MAY BE APPROVED. DIFFICULTIES ARISING FROM SUCH DEVIATIONS ARE THE RESPONSIBILITY OF THE PROPERTY OWNER TO SATISFACTORILY RESOLVE.

9.) LOT SLOPES APPLY TO A 75' RADIUS FROM THE EDGE OF HOUSE. THE INTENT IS TO ALLOW FLEXABILITY ON LARGER LOTS.

10.) ALL CONFLICTS SHALL BE REMEDIED TO THE SATISFACTION OF THE TRANSPORTATION DIRECTOR.

11.) PERMITTEE SHALL SUBMIT A COPY OF THE APPROVED SUBDIVISION DRAINAGE PLAN. SIZE REQUIREMENTS ARE 8–1/2"x11", 8–1/2"x14" OR 11"x17" AT A SCALE OF 1"=100' OR 1"=200' FOR LOTS OF 5 ACRES OR MORE.

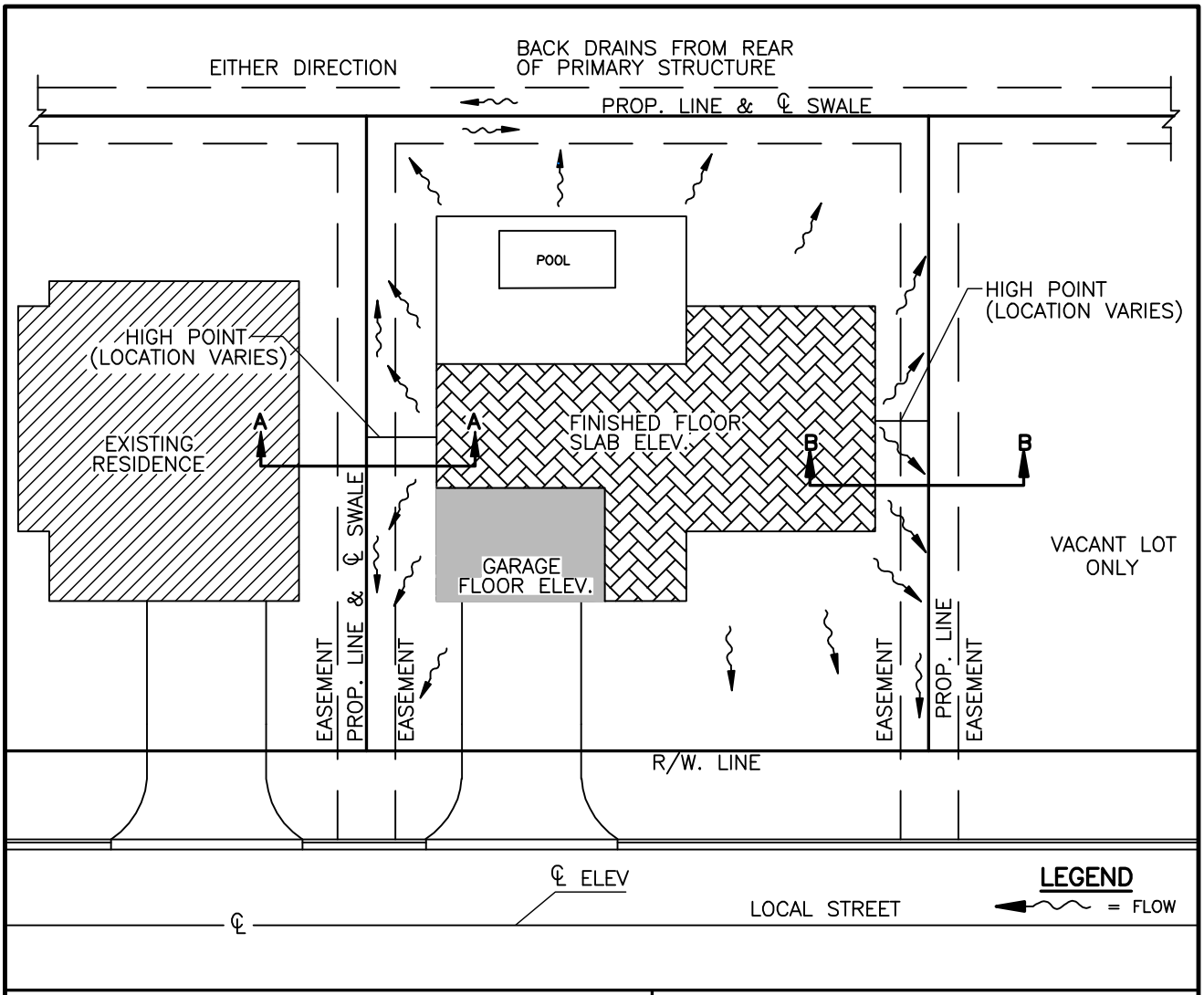
MANATEE COUNTY
TRANSPORTATION DEPARTMENT

REV.BY	DATE

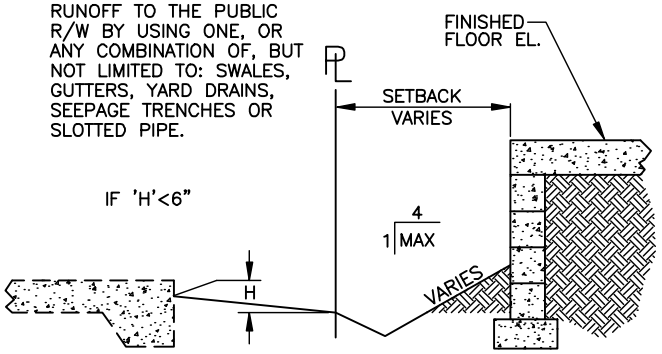
6/12/07
DATE OF B.O.C.C. APPROVAL

LOT DRAINAGE GENERAL NOTES

700.1

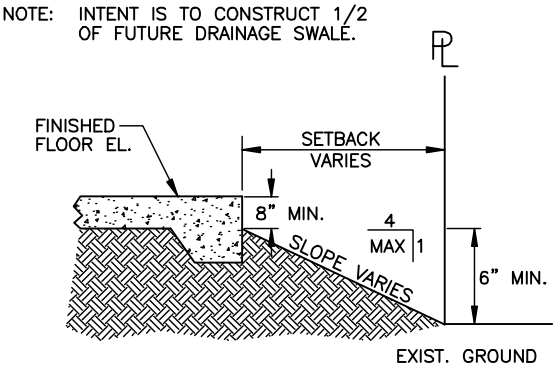


NOTE: THE INTENT IS TO CONVEY RUNOFF TO THE PUBLIC R/W BY USING ONE, OR ANY COMBINATION OF, BUT NOT LIMITED TO: SWALES, GUTTERS, YARD DRAINS, SEEPAGE TRENCHES OR SLOTTED PIPE.



SECTION A–A
NTS

NOTE: INTENT IS TO CONSTRUCT 1/2 OF FUTURE DRAINAGE SWALE.



SECTION B–B
NTS

NOTES:

1.) STEM WALL FOUNDATION REQUIRED IF 4:1 MAX. GRADE SLOPES CANNOT BE ACHIEVED WITH MONOLITHIC SLAB DESIGN.

2.) ALL MEASUREMENTS ARE EQUIVALENT TO TOP OF SOD MULCH.

3.) THIS STANDARD IS INTENDED TO APPLY FOR INFILL LOTS.

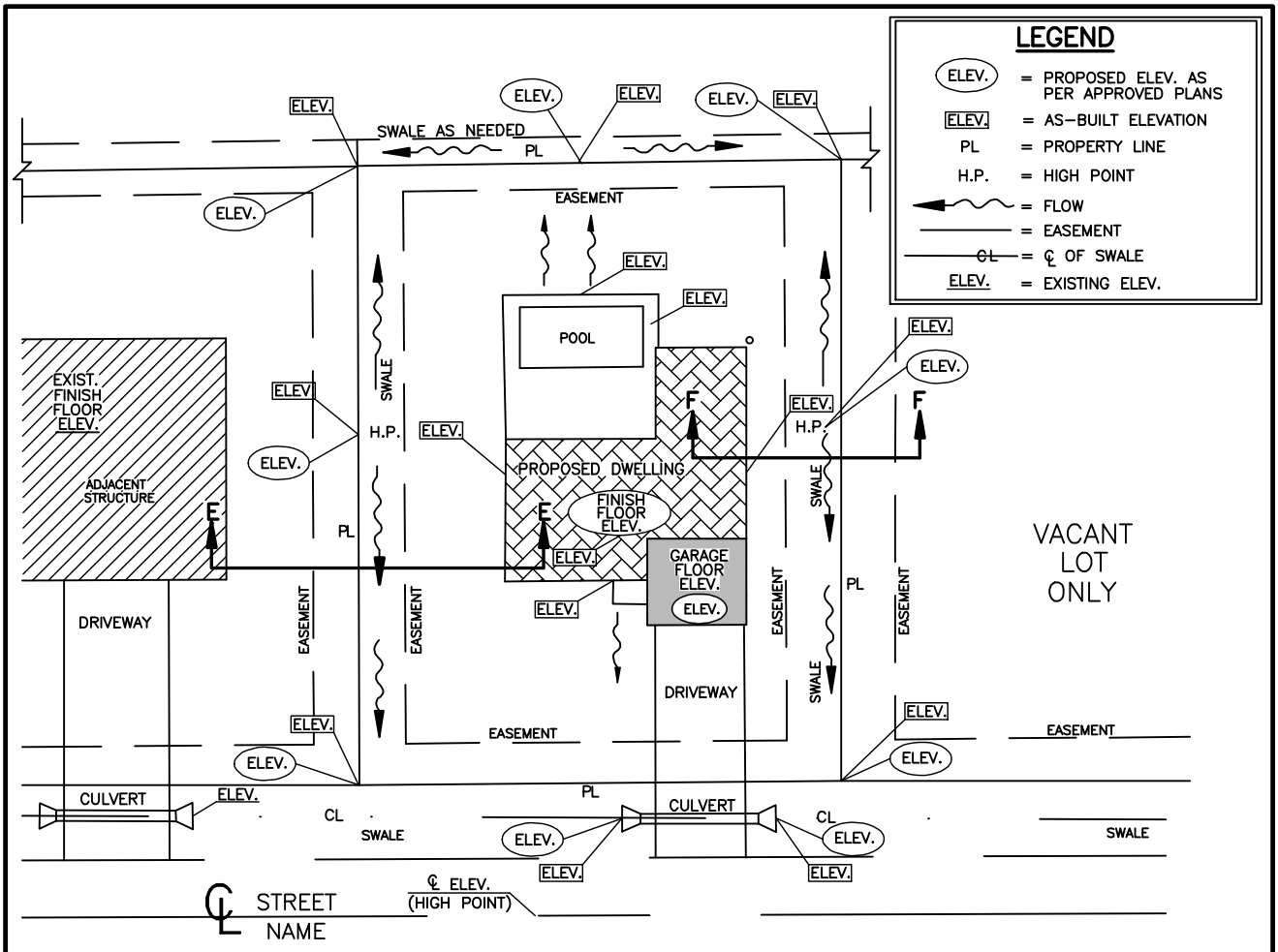
MANATEE COUNTY
TRANSPORTATION DEPARTMENT

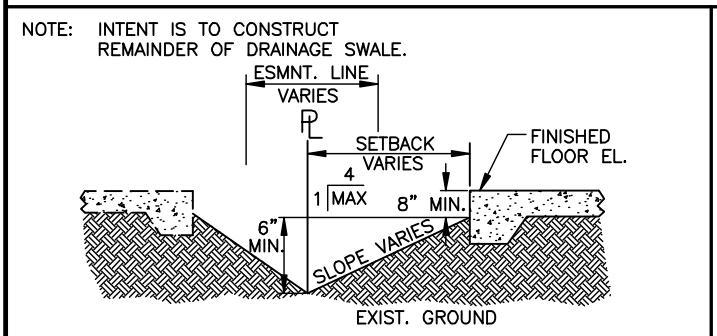
REV.BY	DATE

6/12/07
DATE OF B.O.C.C. APPROVAL

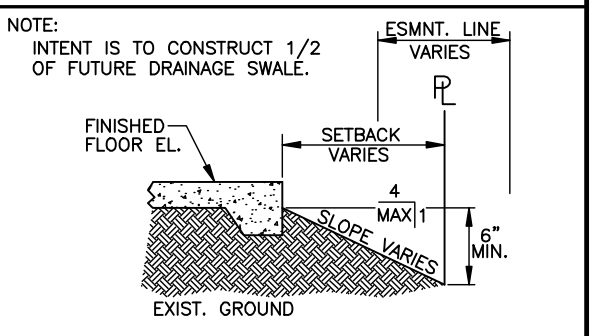
LOT DRAINAGE PATTERN EXAMPLE FOR SITE

700.2





SECTION E–E
NTS



SECTION F–F
NTS

NOTES:

1.) USE SECTION F–F IF NO SIDE OR REAR LOT LINE DRAINAGE SWALES ARE PRESENT. THE PROPOSED TOE OF SLOPE ELEVATION MUST MATCH THE EXISTING GRADE AT THE PROPERTY LINE.

2.) FOR MID LOT TO BACK/FRONT, FINISH FLOOR ELEVATION = 21" MINIMUM ABOVE ℄ OF ROADWAY.

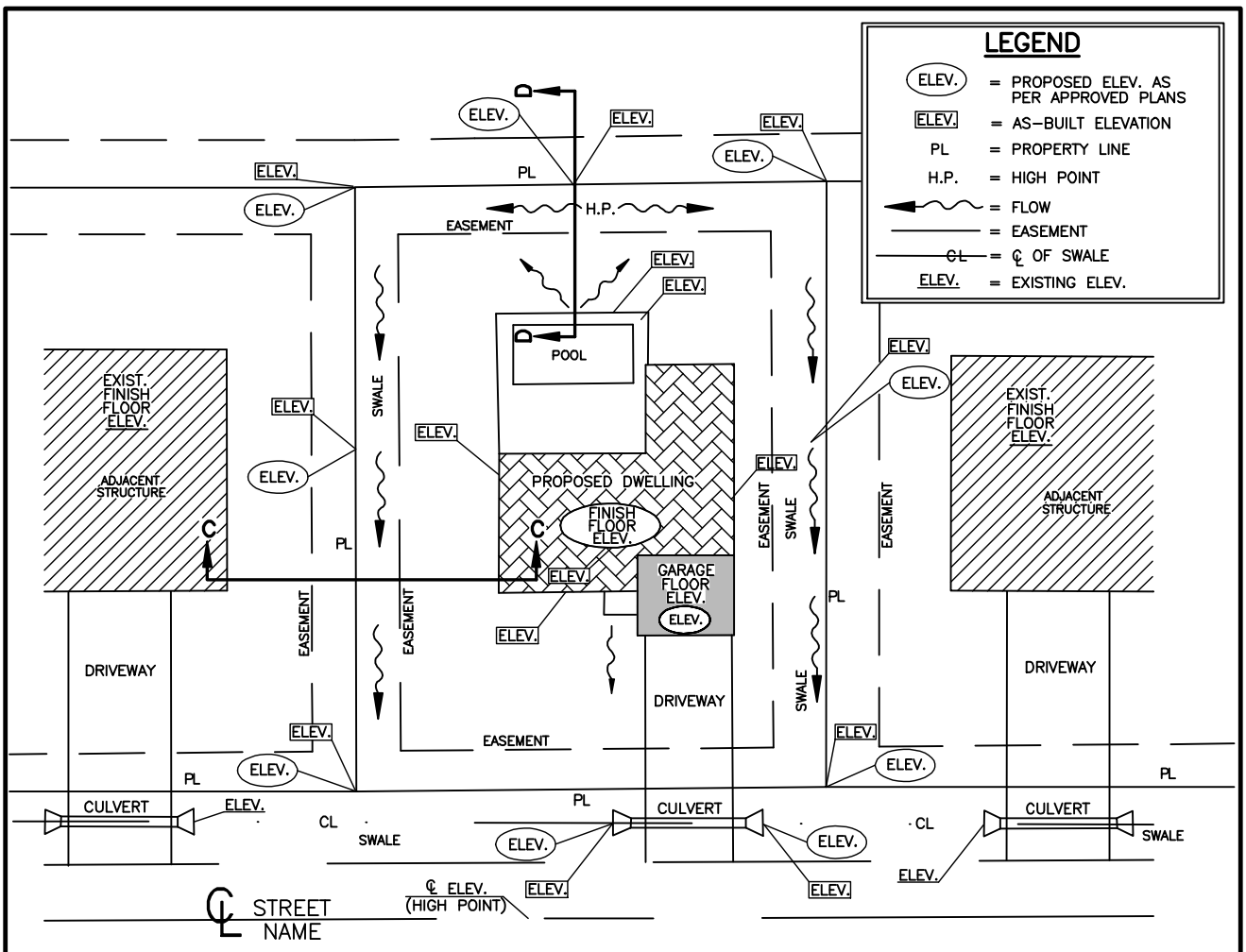
MANATEE COUNTY
TRANSPORTATION DEPARTMENT

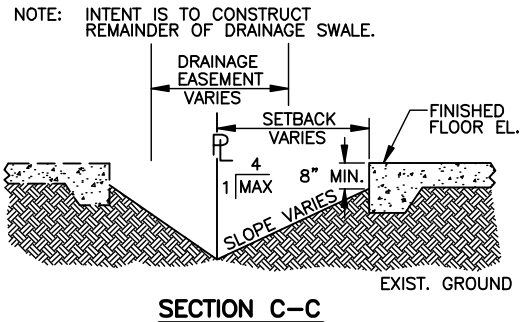
REV.BY	DATE

6/12/07
DATE OF B.O.C.C. APPROVAL

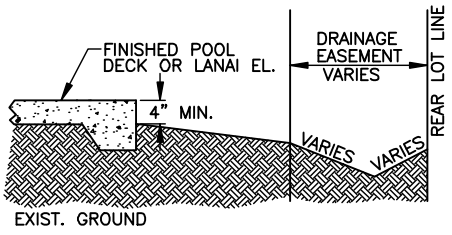
MID LOT TO BACK/ MID LOT TO FRONT DRAINAGE PLAN

700.3





SECTION C–C
NTS



SECTION D–D
NTS

NOTES:

1.) USE SECTION D–D IF NO SIDE OR REAR LOT LINE DRAINAGE SWALES ARE PRESENT. THE PROPOSED TOE OF SLOPE ELEVATION MUST MATCH THE EXISTING GRADE AT THE PROPERTY LINE.

2.) FOR REAR TO FRONT LOT DRAINAGE, FINISH FLOOR ELEVATION = 24" MINIMUM ABOVE ℄ OF ROADWAY.

MANATEE COUNTY
TRANSPORTATION DEPARTMENT

REV.BY	DATE

6/12/07
DATE OF B.O.C.C. APPROVAL

REAR TO FRONT LOT DRAINAGE PLAN

700.4