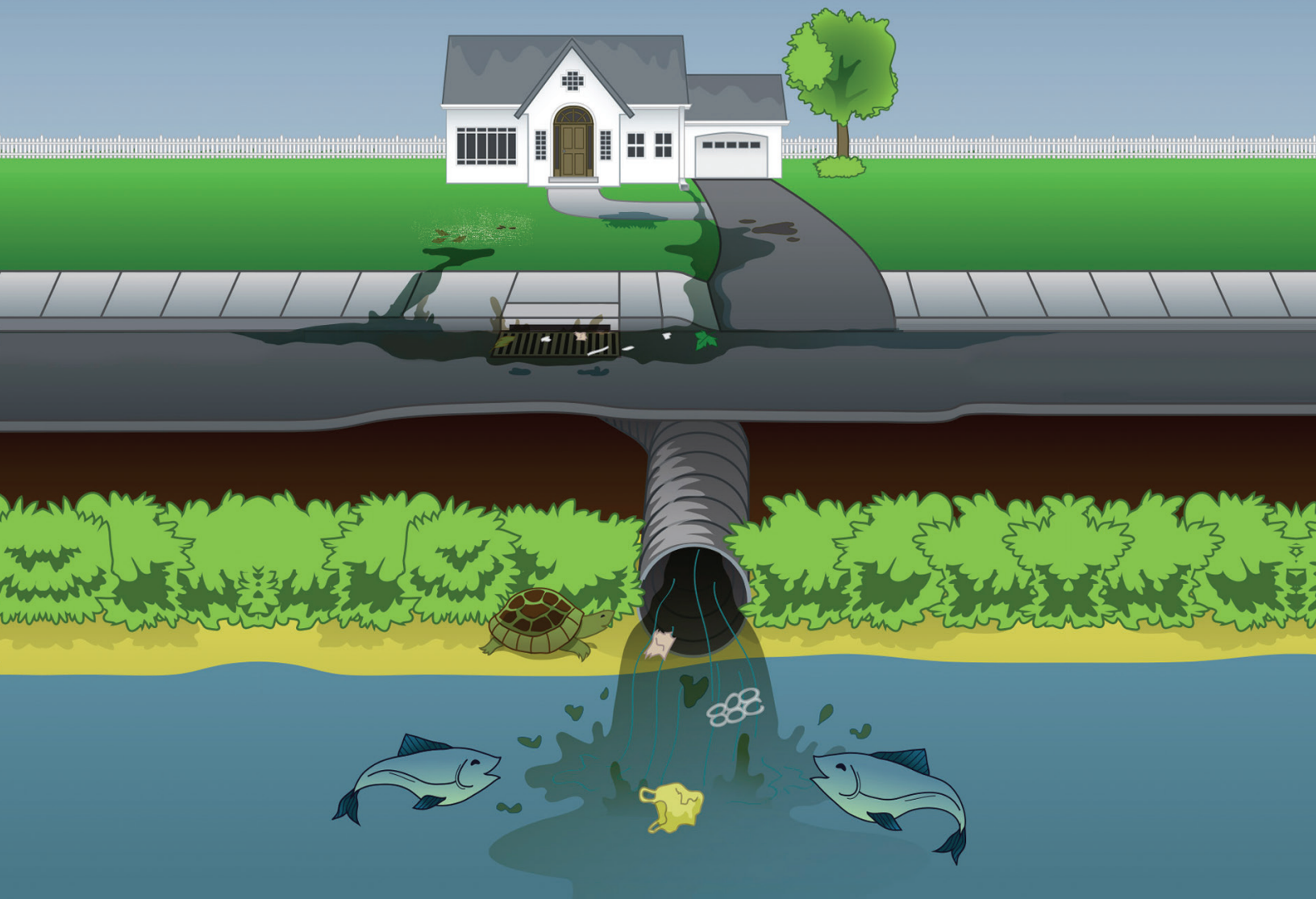
Stormwater Drainage Criteria Manual

City Of Clearwater
Engineering Department
Effective July 1, 2015



Engineering Department

STORMWATER DRAINAGE CRITERIA MANUAL

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1. INTRODUCTION

This manual is a guide to assist Engineers in the design of stormwater systems in the City of Clearwater. In general, these standards are a combination of requirements set by the Southwest Florida Water Management District (SWFWMD), the Federal Emergency Management Agency (FEMA), the Environmental Protection Agency's National Pollutant Discharge Elimination Program (NPDES), Florida Department of Transportation (FDOT), and requirements set by the City of Clearwater Engineering Department. This manual does not propose to itemize the requirements of SWFWMD, FEMA, NPDES or FDOT, but to highlight and detail the requirements of the City of Clearwater. Where design standards of applicable regulatory agencies vary, the more restrictive or higher standard will apply. The Designer is required to be familiar with the current design requirements of SWFWMD. The appropriate SWFWMD stormwater permit and other applicable regulatory agency permits will be required prior to any final construction permit close-out by the City of Clearwater.

The Designer's attention is called to the City of Clearwater requirement that all development and redevelopment will require provisions for stormwater management. In particular, redevelopment will be required to provide stormwater management facilities in accordance with the regulations herein.

For the purpose of administering these stormwater management regulations, redevelopment is defined as the alteration of buildings, parking, or other landform features of a property, which necessitates the Community Development Code review process. Redevelopment of property for which no stormwater management facilities exist will be required to provide such facilities in accordance with the methodology contained herein, despite the fact that the circumstances of the redevelopment may not result in an increase of stormwater runoff.

2. GENERAL

All construction shall comply with the City of Clearwater Contract Specifications and Standards. All stormwater facility designs must be designed and certified by a licensed Florida Professional Engineer.

Record drawings shall be submitted and certified by a licensed Florida Professional Engineer and inspected and accepted by the City before final close out of the project.

DESIGN FREQUENCY	
10-Year	storm systems, culverts
25-Year	channels and detention areas with outfalls
50-Year	detention areas without outfalls
100-Year	detention areas without outfalls which overflow onto private property when capacity is exceeded

3. STORM DRAINAGE CONSTRUCTION PHASING

Detention areas must be constructed before storm sewers are installed. Slopes shall not be steeper than four to one (4:1) and shall be protected from erosion by sod.

4. STORM SEWERS, INLETS, AND STREET DESIGN PERTAINING TO WATER FLOW

Unless specifically approved by the City Engineer or their designee, **reinforced concrete pipe** shall be used in all easements and street rights-of-way. The **minimum pipe size** shall be 15" diameter.

The **design frequency** for pipe on local roads shall be the 10-Year storm.

The **Manning's Roughness Coefficient** for storm pipe shall be consistent with industry standards:

RCP	n
15" - 30" inclusive	.013
36" - 48" inclusive	.012
54" – up	.011

Any alternate materials require approval from the City Engineer or their designee.

The slopes for culverts used as storm sewers shall produce a **velocity** within the following limits:

	Maximum Velocity	Minimum Velocity
RCP	12 fps	2 fps

The **standard hydraulic gradient elevation** shall be a minimum of one foot below the throat of an inlet or a manhole.

Minimum storm pipe/culvert size:

	Minimum Size
Pipe	15 inches
Box Culvert	3 Ft x 3 Ft

Maximum length of pipe without access structure:

	Maximum length
(15" – 18") Pipe	400 ft
(24" – 36") Pipe	400 ft
(42" & over & all box culverts)	400 ft

The minimum cover for pipe shall meet the manufacturer's recommendations.

5. INLETS AND MANHOLES

The following criteria shall be met for the design of inlets and manholes:

- The vertical throat opening for inlets shall be 5 inches.
- Inlets and manholes shall be designed so there is no standing water after a rain event.
- All inlets shall have manhole lids in accordance with the City Index 200 series.
- Inlets shall not be placed in the curb return.
- Pipes shall be cut flush with the inside wall of structures.
- The bottom of the structure shall be grouted to the inverts of pipes so there is no standing water after a rain event.
- Subdrains shall enter the structure a minimum of 30 inches below the top of the structure.
- When the pipe diameter exceeds 30 inches, inlets shall not be used as junction boxes. There is a limit of three pipes per inlet.

For design purposes, **inlet capacity** should be assumed as follows:

Grate Inlet *	4 cfs
5" Throat (No Wing Type) *	4 cfs
5" Throat (Single Wing Type)	6 cfs
5" Throat (Double Wing Type)	8 cfs

* – Subject to City Engineer's approval only.

Standard inlet wings shall be a minimum of four feet in length as per City Standards.

6. STREET DESIGN

Generally gutter water should not be carried for distances exceeding 600 feet.

Channeling water across intersections will not be allowed, except where impractical.

Inlet Spacing:

Normal Grades	0.5% up to 2%	400 Ft
Steep Grades	greater than 2%	400 Ft

Where grades exceed 2%, a 6 Ft wing will be required on the inlet. Grades less than 0.5% are subject to City Engineer's approval only. A minimum of 0.5% grade shall be required for asphalt drives and parking lots. Right-of-way shoulders shall be restored with sod to prevent sedimentation and erosion control issues. New residential subdivisions, whether roads will be public or private, shall be constructed to City standards.

7. HEADWALLS

All inlet and outlet pipes shall be provided with a headwall, mitered end section, or flared end section. Headwalls shall be reinforced concrete. All outlets shall have an appropriate apron to prevent erosion.

8. CHANNELS AND SWALES

The Manning's Roughness Coefficient for a channel with vegetation is 0.030 to 0.035 per industry standards. Normal channel depth shall not be within 10% of critical depth. When velocities exceed maximum allowable values, energy dissipators shall be provided. Plans shall include off-site flow, pre-development drainage flows, and pre-development discharge at key design points such as channels, existing ponds, sloughs, etc. Also post-development calculations for storm runoff and proper detention shall be determined.

Type of Soil in Flow Line	Maximum Allowable Velocity (fps)
Fine Sand	1.5
Sandy Loam	1.8
Silt Loam	2.0
Firm Loam	2.5
Fine Gravel	2.5
Stiff Clay	3.8
Coarse Gravel	4.0
Hardpan	6.0

Major channels (flow greater than 30 cfs) shall have a five-foot bottom width. Drainage swales normally will not be permitted along rear lot lines.

Swales shall be vegetated and designed for a 50-Year storm.

9. STORMWATER DETENTION DESIGN METHODS

This policy is to insure that runoff will not be increased beyond its present state by development. It is also intended to protect the quality of receiving waters in the City from additional pollution resulting from new development. The stormwater design calculations can be performed using the Rational method or the NRCS Curve Number Method using the 24-Hour Type II Florida Modified rainfall event.

DESIGN FREQUENCY	
10-Year	storm systems, culverts
25-Year	channels and detention areas with outfalls
50-Year	detention areas without outfalls
100-Year	detention areas without outfalls which overflow onto private property when capacity is exceeded

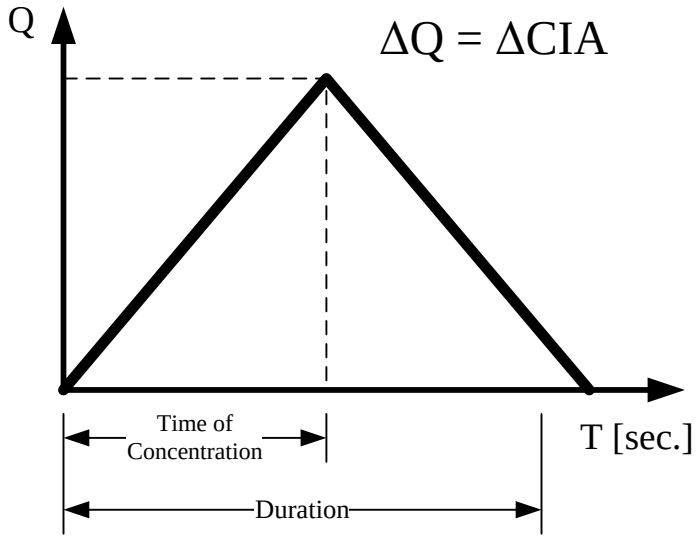
RATIONAL METHOD

1. In the City of Clearwater, one hour is used for the time of concentration for the Rational Method.
2. Calculate the runoff coefficient using the typical c coefficients listed below. Design coefficients shall be obtained by using the coefficients below. For redevelopment, see the redevelopment section.

Ponds, lakes and detention area (wet or dry)	1.00
Buildings, paved areas, and other impervious areas	0.95
Uncompacted Gravel/shell	0.65
Turfblock	0.45
Green or pervious areas	0.20

3. Utilize the IDF curve and a one hour time of concentration to determine the rainfall intensity for the required design frequency.
4. Post development flow shall not exceed the pre-development flow.

The runoff coefficient differential DELTA C is obtained by subtracting the pre-development coefficient from the post-development coefficient.



The volume of detention may be established by multiplying the time of concentration times DELTA Q providing the outlet control structure (weir, pipe, etc.) is designed to restrict flow beyond the pre-development Q. An outfall design allowing less than the pre-developed Q to pass is acceptable if storage is provided and the hydraulic grade line of upstream properties will not be affected.

NRCS CURVE NUMBER METHOD

The U. S. Natural Resources Conservation Service (NRCS) method, previously known as the Soil

Conservation Service (SCS) method, can be used in the City of Clearwater. Developments using stormwater models for design shall demonstrate no adverse impacts to existing conditions with input data that matches the construction plans submitted for approval. Off-site nodes for upstream and downstream properties shall also be required for approval.

When using the NRCS Method, a minimum time of 15 minutes to the first inlet shall be used and the Engineer shall use the Florida Modified ARC II rainfall distribution for the City of Clearwater. The SWFWMD hyetograph shall be used to determine the rainfall from the storm using the 24-Hour storm (see attachments).

REDEVELOPMENT

In the case of redevelopment of land upon which no stormwater attenuation or water quality feature exists, or upon which the existence of such features do not meet the standards applicable at the time of redevelopment, the redeveloper will be required to provide facilities to the extent which the site is affected or disturbed by the redevelopment. In the methodology for stormwater calculations from property undergoing redevelopment, the pre-development volume of runoff will be calculated by the use of a Weighted Runoff Coefficient as described below:

PROPERTY DESCRIPTION*	**WEIGHTED COEFFICIENT OF RUNOFF****
Undergoing redevelopment and not contributing to an existing flooding problem ***	0.5
Undergoing redevelopment and contributing to an existing flooding problem	0.2
Undergoing redevelopment and contributing to an existing flooding problem for which an attenuating stormwater management project is under construction	0.5

* City Engineer shall be the determining authority of the Property Description
** In no case shall the coefficient be less than 0.2 or more then 0.5 for any type of surface
** To be applied only to area of property undergoing alteration
*** Situation where property damage occurs in a 25-Year – 24-Hour storm

The City of Clearwater redevelopment standards in regards to the provision of water quality are proportional to the amount of land and degree of land disturbance required by a redevelopment project. In other words, the City's redevelopment standard requires the provision of treatment of 0.5-inches of rainfall over the affected project area. Deviation from this requirement requires approval from the City Engineer.

Curve Numbers for the NRCS method would be estimated using similar methodology.

WATER QUALITY TREATMENT ONLY

Areas directly outfalling into tidal saltwater basins will be reviewed for water quality impacts only. Water quality treatment shall be available in an above ground treatment process unless a substantial hardship is demonstrated.

FLOODPLAIN COMPENSATION

When development or redevelopment occurs in a designated FEMA floodplain, compensatory volume is required in addition to the designed stormwater improvements.

GEOTECHNICAL INFORMATION

Soils reports, signed and sealed by a licensed Florida Engineer, will be required.

SITE PLANNING

Roof runoff shall be directed toward the site's stormwater infrastructure for treatment. Condensation for air conditioning systems can be directed to stormwater infrastructure as well.

10. STORMWATER TREATMENT SYSTEMS

When designing stormwater systems in the City of Clearwater, the stormwater system can be designed as one main system or multiple stormwater systems used in series (as a treatment train) or in parallel to provide the necessary attenuation and treatment for a private development. Nutrient removal calculations when required for SWFWMD permitting shall be provided to the City for informational purposes only.

DESIGN OF DRY STORMWATER SYSTEMS

Dry stormwater systems are those that have surfaces that are dry after subsidence of a rain event. The system shall draw down within 72 hours of the rain event with a factor of safety of 2. Drawdown calculations and/or mounding calculations shall be required depending on the type of dry system is used for the site. During the design process, the seasonal high water table (SHWT) shall be established with the assistance of a geotechnical report. The bottom of the dry stormwater system shall be a minimum of 6-inches above the SHWT.

DRY DETENTION POND

Dry detention ponds are those that under non-storm conditions are dry, i.e., have a grassed bottom and side slopes that can be mowed. These systems shall be designed with no steeper than 4:1 side slopes, and drain dry within 72 hours or less with a factor of safety of 2. Dry ponds shall have 6 inches of freeboard, i.e., 6 inches are required between the top of bank and the top of control structure. The outfall design flow shall not exceed the pre-development flow for the

design event with appropriate overflow facilities for greater storm events. The side slopes, the pond bottom and top of bank shall be sodded. The pond bottom shall be a minimum of 6 inches above the seasonal high water table (SHWT). Drawdown may be accomplished by the use of an underdrain designed according to City specifications or by percolation if soil conditions permit. At least one soil boring showing the soil profile and the seasonal high water table shall be provided with the site plan. The soil boring shall be located within the footprint of the proposed detention area and multiple borings are encouraged. Stormwater control systems shall be designed as per City Index 215.

DETENTION POND WALLS

The use of vertical walls on the sides of detention ponds or side slopes steeper than 4:1 are discouraged and will not be permitted except as may be specifically approved due to reason of undue hardship to the developer. Vertical walls are not allowed on detention ponds to be permitted adjacent to rights-of-ways, along the boundaries of adjacent parcels of land, on more than two sides or 50% of the perimeter of a detention pond, or any side of a pond serving only as a water quality facility.

EXFILTRATION TRENCH AND/OR UNDERGROUND STORAGE AND RETENTION SYSTEM

An exfiltration trench is an underground retention system consisting of a perforated pipe surrounded by natural or artificial aggregate which stores and infiltrates runoff. The perforated pipe delivers the stormwater into the surrounding aggregate through the pipe perforations. This system is typically a single perforated pipe surrounded by an aggregate reservoir that retains the required treatment volume without a discharge and without considering soil storage. Underground storage and retention systems are retentions systems that capture a required treatment volume in an underground storage system and “drain field”. Underground storage and retention systems consist of lightweight, high strength modular units with open bottoms that allow for soil infiltration. These systems are typically used where the land values are high and the owner desires to minimize the potential loss of usable land with other types of retention. These systems require mechanical means of maintenance, human access is not possible.

The bottom of the aggregate layer will be a minimum of 6-inches above the SHWT. Sustainable void spaces must be used in computing the storage volume in the aggregate reservoir. Only 50% credit will be given for available void space in the aggregate based on the manufacturer’s information. A recovery analysis is required that accounts for the mounding of groundwater beneath the exfiltration system. The system shall recover the required treatment volume within 72 hours with a factor of safety of 2.

TREATMENT SWALE

Treatment swales (also known as bioswales or rain gardens) can be used for online stormwater treatment when properly designed and maintained to provide retention and infiltration of stormwater. They can be designed with or without swale blocks, raised driveway culverts or with control structures. They are essentially linear retention systems which percolate into the ground before discharge. Turf or other acceptable vegetation is established to prevent erosion, promote infiltration and stabilize the bottom and side slopes. Soil permeability and water table conditions must be such that the swale can percolate the required runoff volume. The required design calculations are similar to the ones used for dry detention systems and at least one soil boring shall be required. Side slopes shall be 4:1. Swales shall operate with maintainable vegetation. The vegetation shall not affect the control structure nor reduce the volume of the pond. The use of mulch or shell is not allowed within a treatment swale.

PERVIOUS PAVERS AND PERVIOUS PAVEMENT

Pervious parking areas shall allow stormwater to percolate into the ground as designed as part of an overall stormwater management system. Pervious pavement systems can be used for sidewalks, driveways, and parking lots. Pervious pavers or pavement shall not be allowed in easements granted to the City of Clearwater.

Pervious pavement systems include the subsoil, the sub-base, and the pervious pavement materials which could include pervious concrete, pervious aggregate/binder products, pervious paver systems, and modular paver systems. For design purposes, porous paving materials will be counted as 50 percent impervious surface provided it is installed per the engineer's design calculations. Soil boring(s) shall be required to establish the elevation of the SHWT. The bottom of the pervious pavement system shall be a minimum of 6 inches above the SHWT.

WET DETENTION/RETENTION SYSTEMS

Wet detention/retention systems are those that under non-storm conditions are designed to have a standing pool of water. The design of the pond shall be in accordance with City Index 231 and the design of the control structure shall follow City Index 214 or 216. There shall be 6 inches of freeboard between the **design high water level**, i.e. between the top of the outfall control structure and the top of bank elevation. All wet systems shall incorporate a vegetated littoral shelf over 35% of the areal cover of the pond under normal conditions. Drawdown may include an underdrain system, natural percolation or a slow bleed down system. The wet detention system's treatment volume shall be discharged in no less than 120 hours (5 days) with no more than one-half the total volume being discharged within the first 60 hours (2.5 days). Due to the detention time required for wet detention systems, only that volume which drains below the overflow elevation within 36 hours may be counted as part of the volume

required for water quantity storage.

UNDERGROUND VAULTS

Underground vaults are not generally acceptable in the City of Clearwater. The City Engineer or their designee may permit vaults only when the applicant can prove a substantial hardship due to proximity to the Gulf of Mexico, an unusually high seasonal high water table, and the limited constructability of a site. Watershed specific criteria may also limit the ability to use a vault on a site.

11. PERMITTING

As part of permitting process, the Engineer shall provide the complete set of plans and specifications, as well as coordinate with the City on the inspections and project closeout process. The Engineer shall also submit the following:

A. General site plans and specifications demonstrating existing flow patterns and stormwater infrastructure together with proposed flow patterns and stormwater infrastructure.
B. Drainage calculations or computations including hydrographs for any detention areas, retention ponds, complete with cross sections.
C. A scaled map or plat showing each subdivision drainage basin, as an aid for review of the proposed work. A topographic survey which extends at least 50 feet beyond the perimeter of the proposed site is required.
D. All pertinent information of adjoining properties affected by stormwater from the site such as finished floor elevations of buildings, streets, channels or receiving waters to the final outfall. All adjacent property draining onto the proposed site is to be shown on the site plan.
E. A maintenance and operation plan and schedule for the private stormwater system.
F. A rough inspection can be waived if a signed and sealed letter with appropriate pictures is submitted from the Engineer of Record stating that the system was installed properly. A rough inspection may not be waived if the system ties into the City system. Final inspections are required on all stormwater systems. A Certificate of Occupancy will not be issued without passing inspections.
G. Before the project permit is closed out by the Engineering Department, a licensed Florida Engineer must submit the following language on the as-builts provided to the City: **"The stormwater system was constructed in substantial conformance with the approved drawings. Any work in the right of way was completed per applicable City standards."**
H. The stormwater maintenance and operation plan and schedule shall be provided prior to building permit.
I. All required easements over stormwater systems shall be recorded with the City prior to permit close-out or Certificate of Occupancy.

A submittal table has been provided on the next page for assistance to the designer and project manager.

Phase	Submittal	Date Submitted
Prior to Development Order or Building Permit Issuance	General site plans and specifications demonstrating existing flow patterns and stormwater infrastructure together with proposed flow patterns and stormwater infrastructure.	
Prior to Building Permit Issuance	Drainage calculations or computations including hydrographs for any detention areas, retention ponds, complete with cross sections shall be provided for review.	
Prior to Building Permit Issuance	A scaled map or plat showing each subdivision drainage basin, as an aid for review of the proposed work shall be provided. A minimum of 50 feet of topographical survey shall be required adjacent to the perimeter of the proposed site.	
Prior to Building Permit Issuance	All pertinent information for adjoining properties affected by stormwater from the site such as finished floor elevations of buildings, streets, channels or receiving waters to the final outfall shall be provided. All adjacent property draining onto the proposed site is to be shown on the site plan.	
Prior to Building Permit Issuance	The stormwater maintenance and operation schedule shall identify the responsibilities of the owner, have the owner's signature, and shall be received and accepted by the City.	
During Construction	Schedule the Rough Inspection(s) through the Building Department. Rough Inspections are required when tying into City infrastructure in the right of way. The inspection shall be performed within 48 hours of s scheduling.	
During Construction	If any substantial deviations from the plans occur during construction, these changes shall require a plan amendment prepared by the Engineer of Record and approval from the Engineering Department, Stormwater Division and all other departments that may be affected by the change. Failure to communicate these changes could delay the close out process.	
Prior to Permit Close-out or Certificate of Occupancy (CO)	Record drawings (as-builts) shall have both the design data and construction data and shall be signed and sealed by the Engineer of Record. Record drawings shall be provided at least one day before the Final Inspection Request. For a project that has drainage work within the City's right-of-way or for new residential subdivisions, the Engineer shall have the following note on the drawings: "The stormwater system was constructed in substantial conformance with the approved drawings. Any work in the right of way was completed per applicable City standards."	
Prior to Permit Close-out or CO	Should the as-builts show substantial deviations from the design calculations and permitted plans, a signed and sealed letter from the engineer will be required. Details to be included in the letter may involve comparison of the attenuation volume, comparison of the treatment volume or other pertinent information.	
Prior to Permit Close-out or CO	The Final Inspection request shall be provided 48 hours prior to Final Inspection with passing results.	
Prior to Permit Close-out or CO	Nutrient removal calculations as required for SWFWMD permitting shall be provided to the City for informational purposes only.	
Prior to Permit Close-out or CO	City and private stormwater easements with sketches shall be recorded with Pinellas County, if necessary.	

12. REFERENCES

1. FDOT Drainage Handbook, Exfiltration Systems, Office of Design, Drainage Section, February 2012.
2. FDOT Drainage Handbook, Hydrology, Office of Design, Drainage Section, January 2015.
3. Lindeburg, M. Civil Engineering Reference Manual for the PE Exam, Eighth Edition, 2001.
4. Pinellas County Stormwater Manual (Draft), Part C, January 15, 2015.
5. SWFWMD Environmental Resource Permit Applicant's Handbook Volume II, October 2013.
6. Urban Hydrology for Small Watersheds, Technical Release TR 55, United States Department of Agriculture, Natural Resources Conservation Service, 1986.
7. Viessman, W. Introduction to Hydrology, Third Edition, 1989.

13. ATTACHMENTS

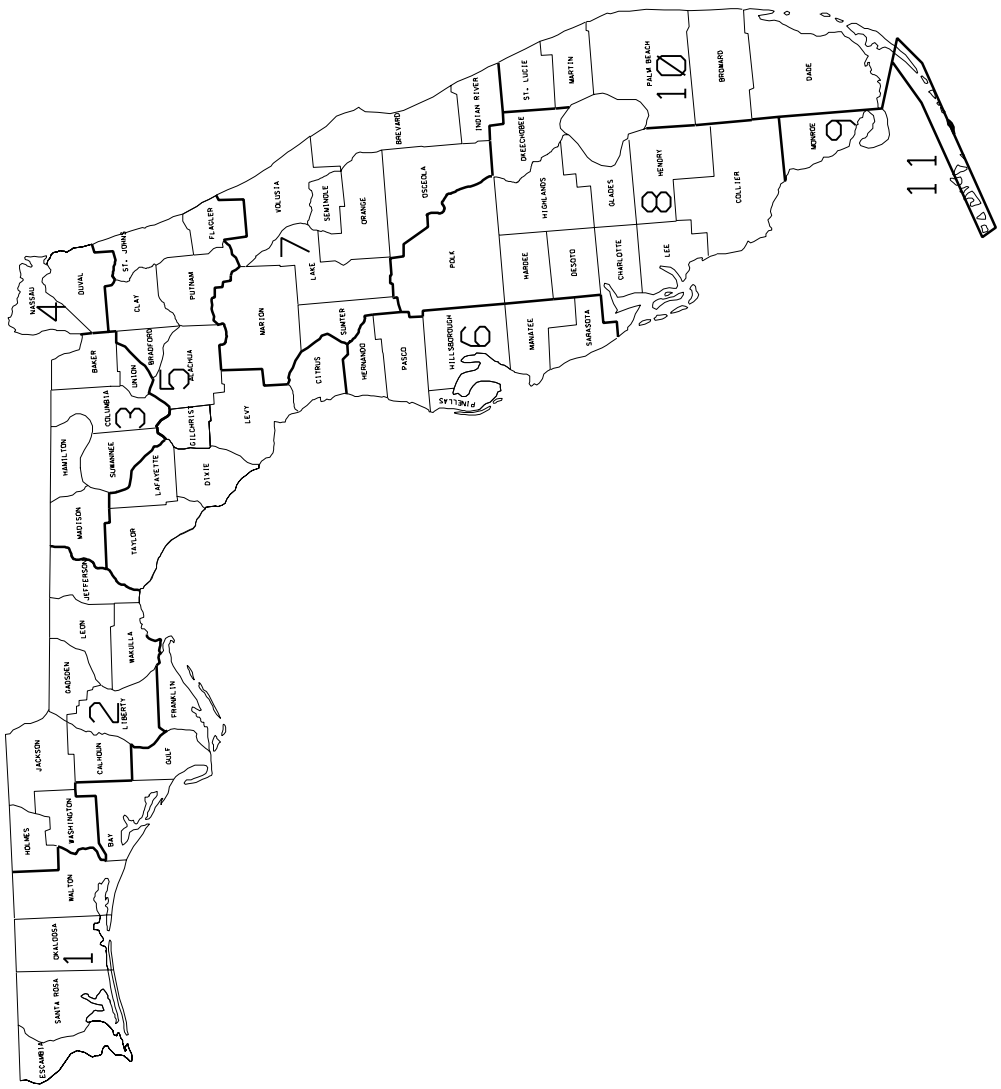
Rainfall – Intensity/Duration – Clearwater – This Rainfall Intensity Graph shall be used for 10, 25, and 50-Year storms.

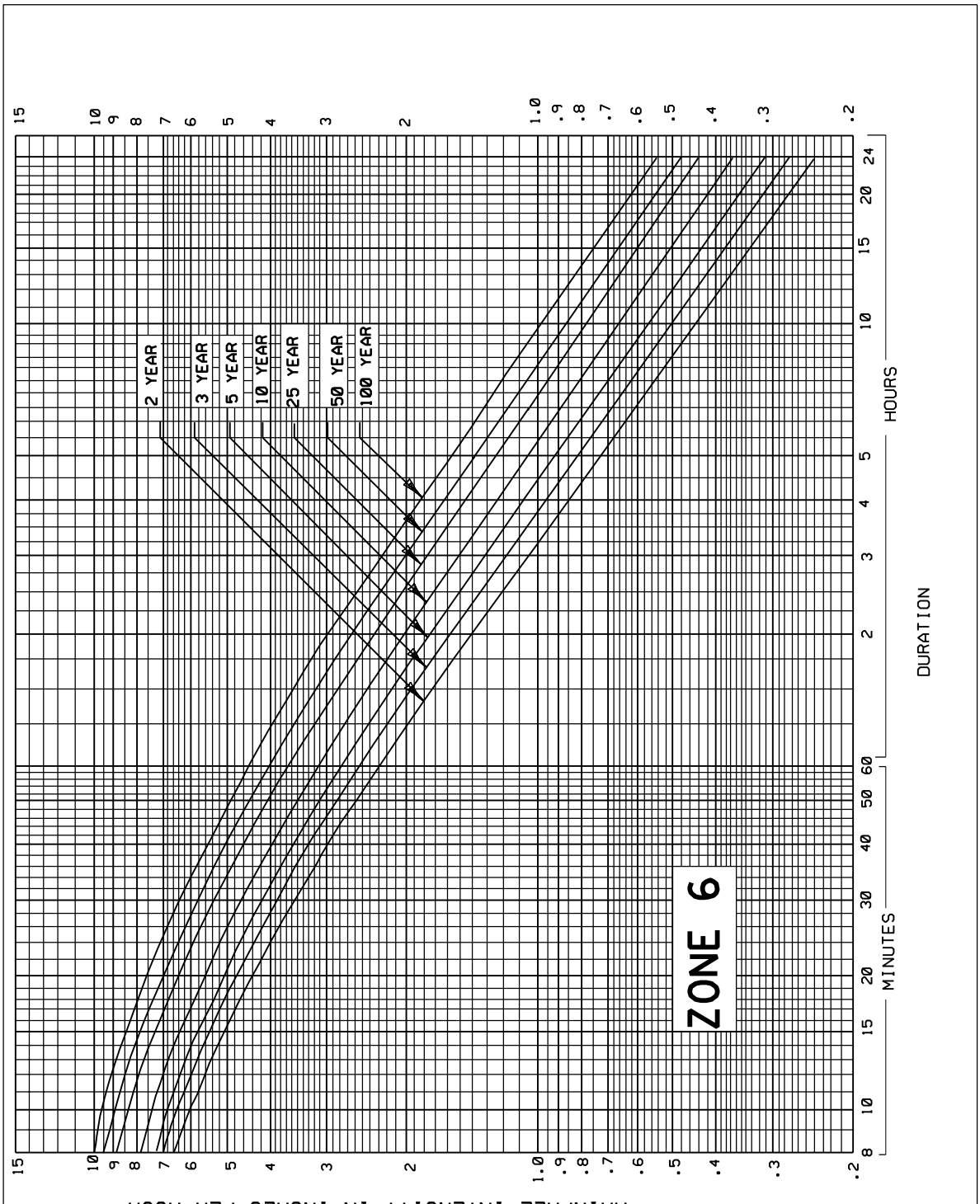
Velocity of Runoff – is for use in determining intensity for above grade runoff.

SWFWMD Hyetograph – is for use in determining total and peak runoff.

CN Values – is for use in the NRCS method.

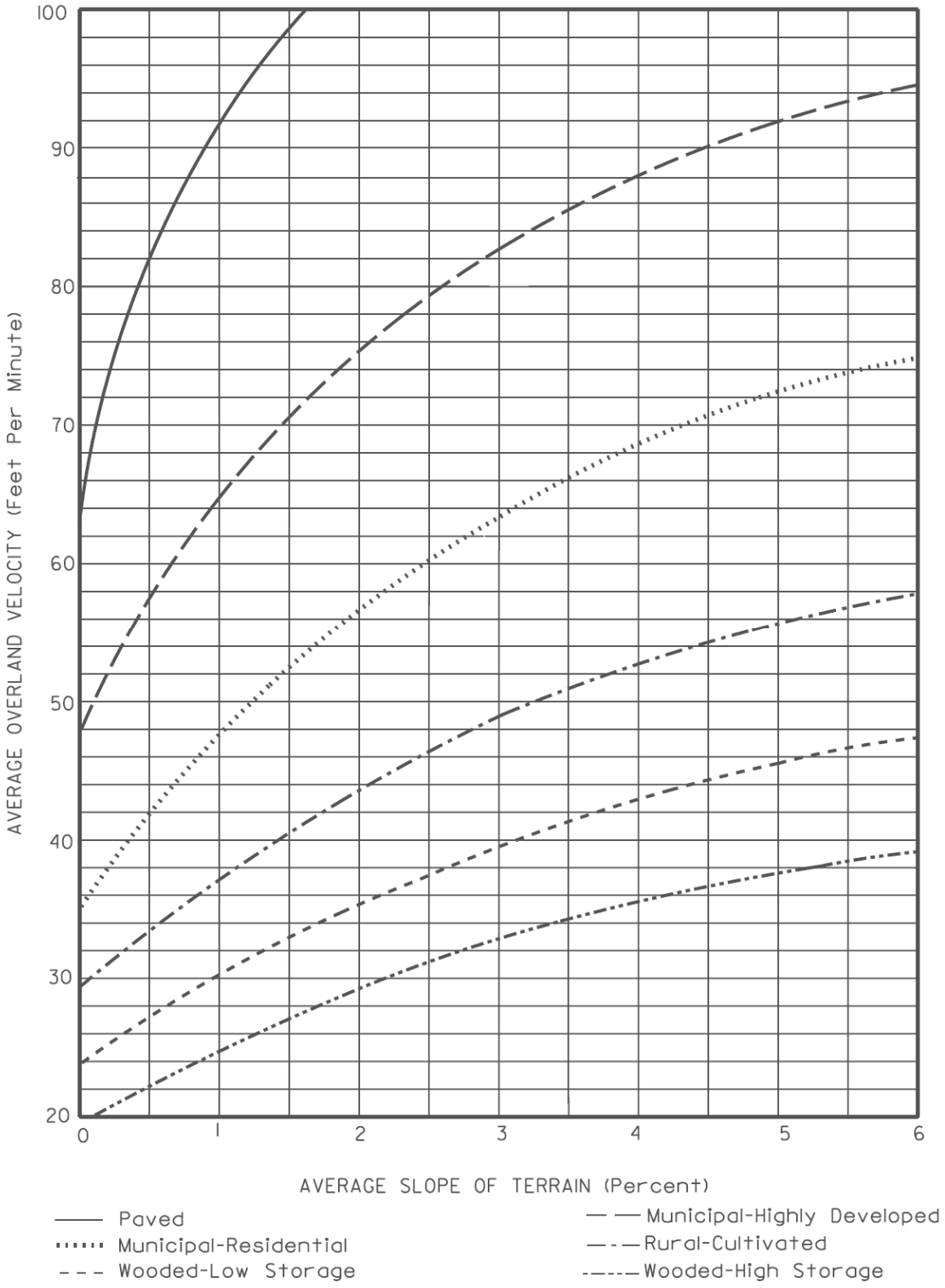
ZONES FOR PRECIPITATION IDF CURVES DEVELOPED BY THE DEPARTMENT





RAINFALL INTENSITY-DURATION-FREQUENCY CURVES
ZONE 6

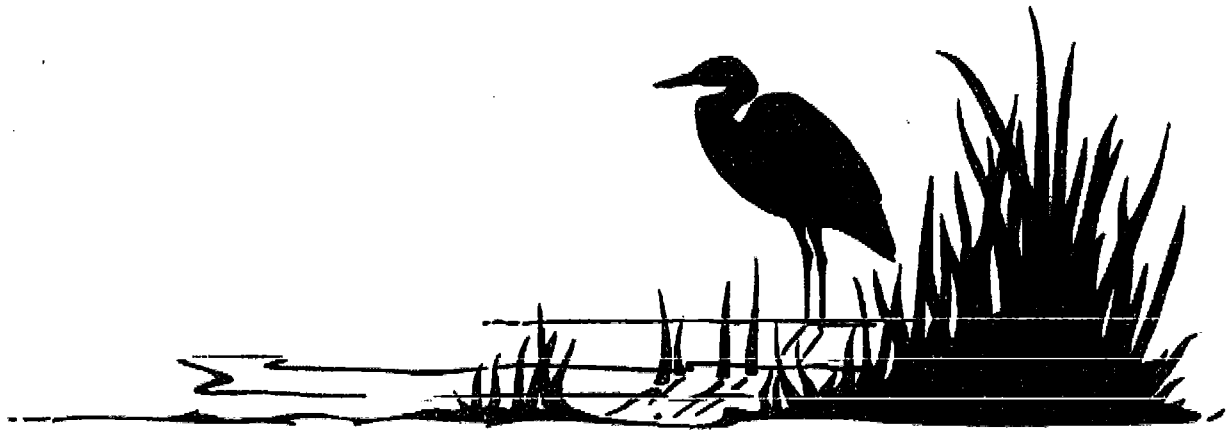
F-2 Overland Flow Velocities for Various Land Use Types



Southwest Florida Water Management District

PART D
PROJECT DESIGN AIDS

ENVIRONMENTAL RESOURCE PERMITTING
INFORMATION MANUAL



MANAGEMENT AND STORAGE OF SURFACE WATERS

JULY 1996

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Twenty-Four-Hour Two-Year Return Period
Rainfall Map

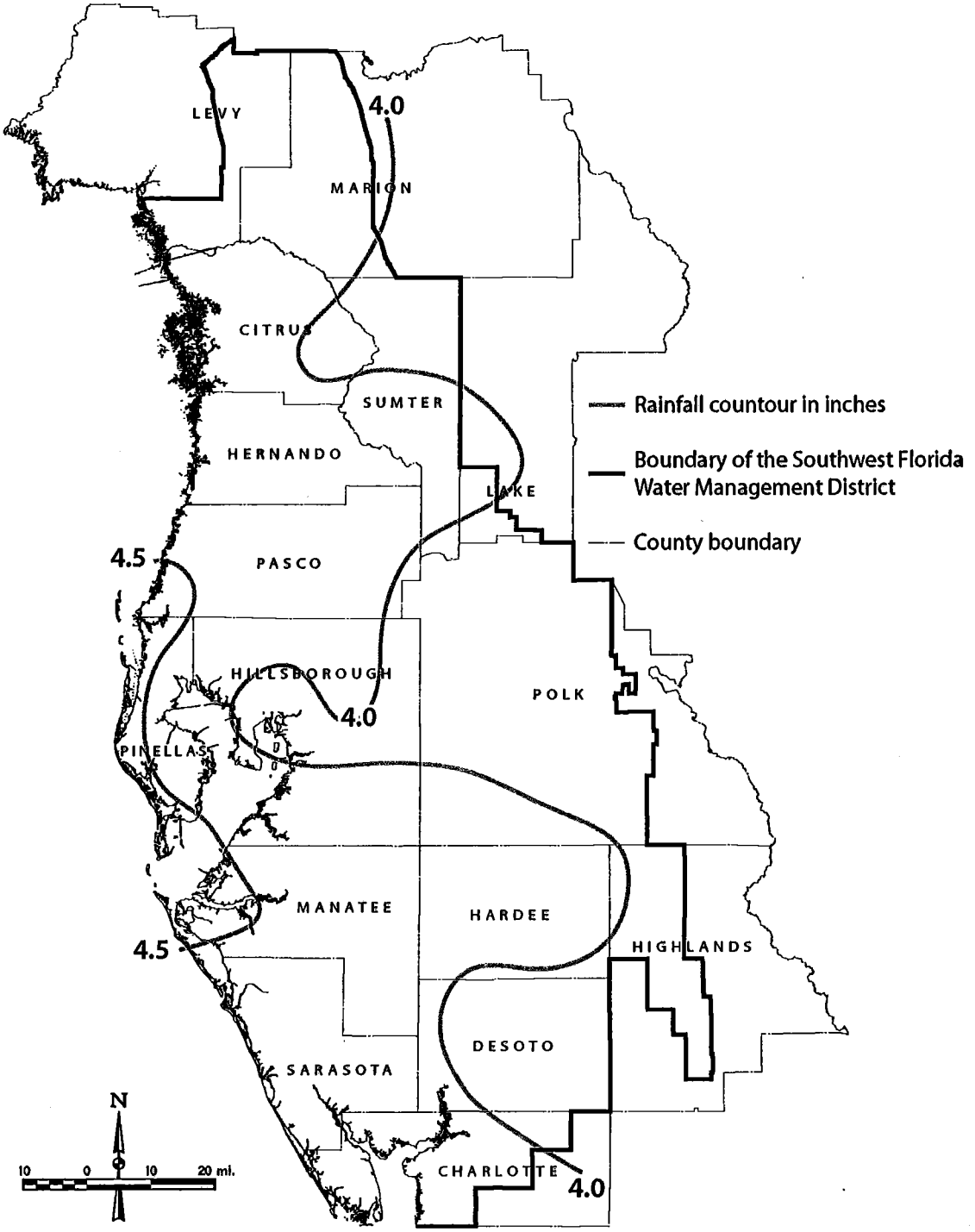

Figure D-2
Twenty-Four-Hour Mean Annual Return Period (2.33 years)
Rainfall Map

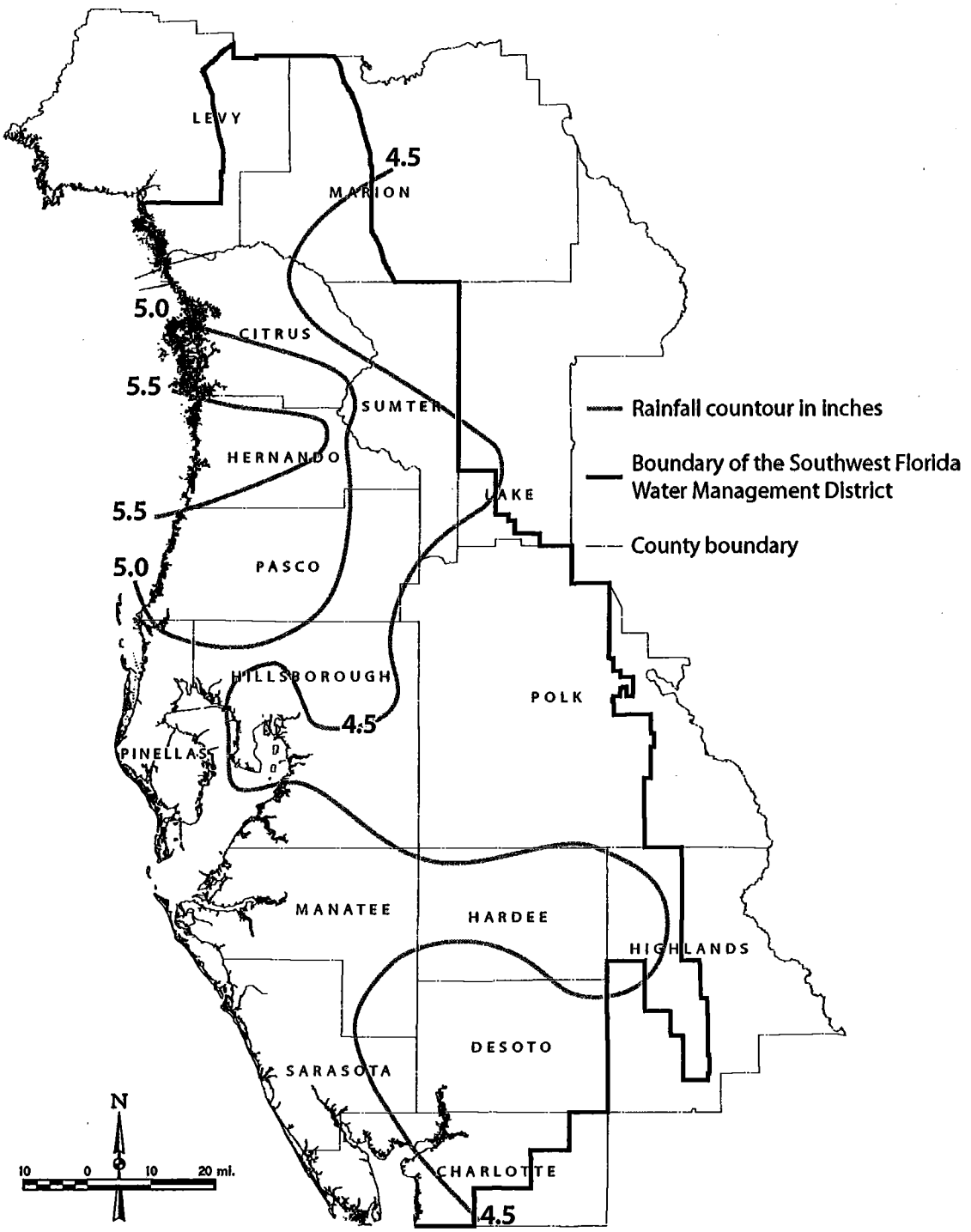

Figure D-3
Twenty-Four-Hour Five-Year Return Period
Rainfall Map

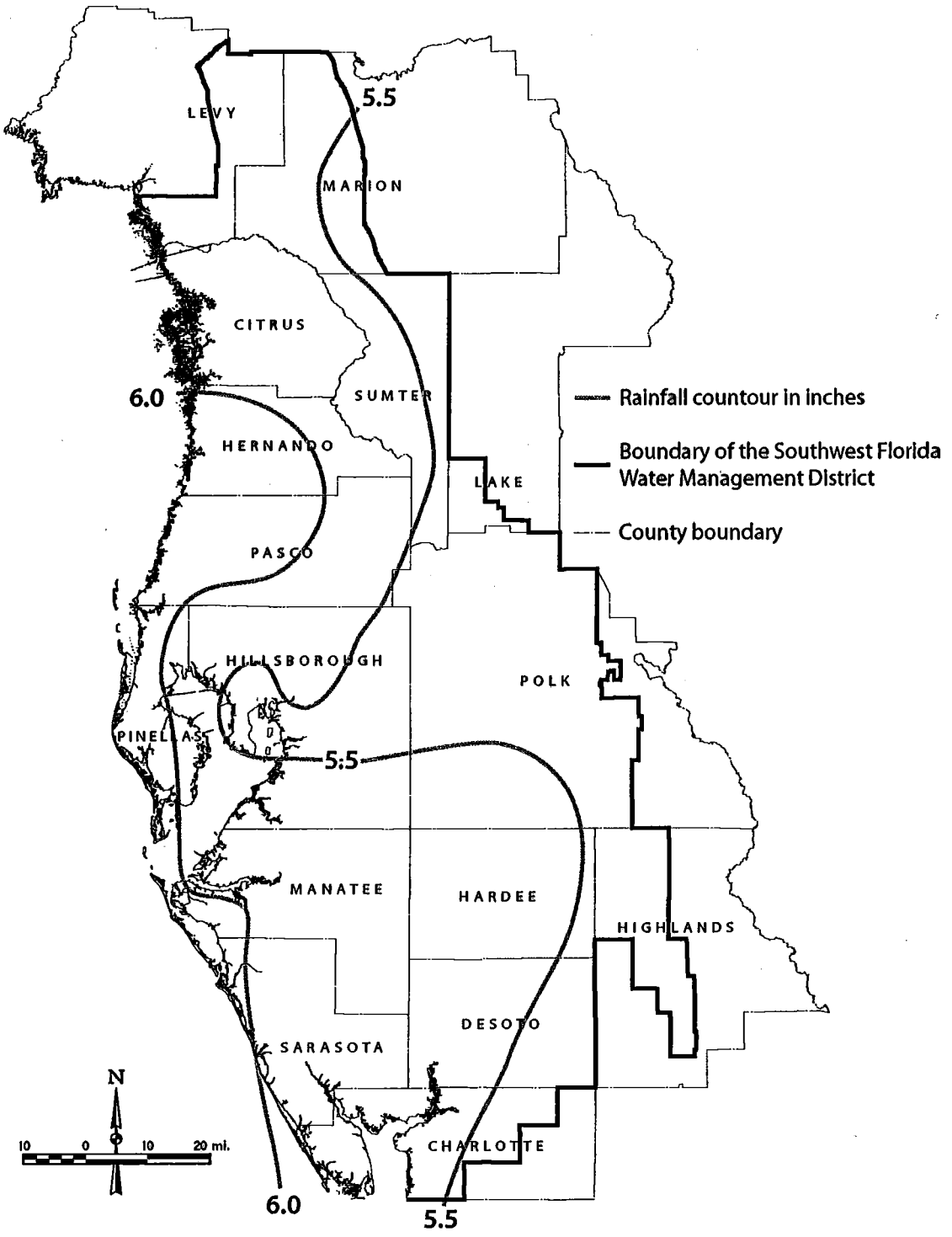

Figure D-4
Twenty-Four-Hour Ten-Year Return Period
Rainfall Map

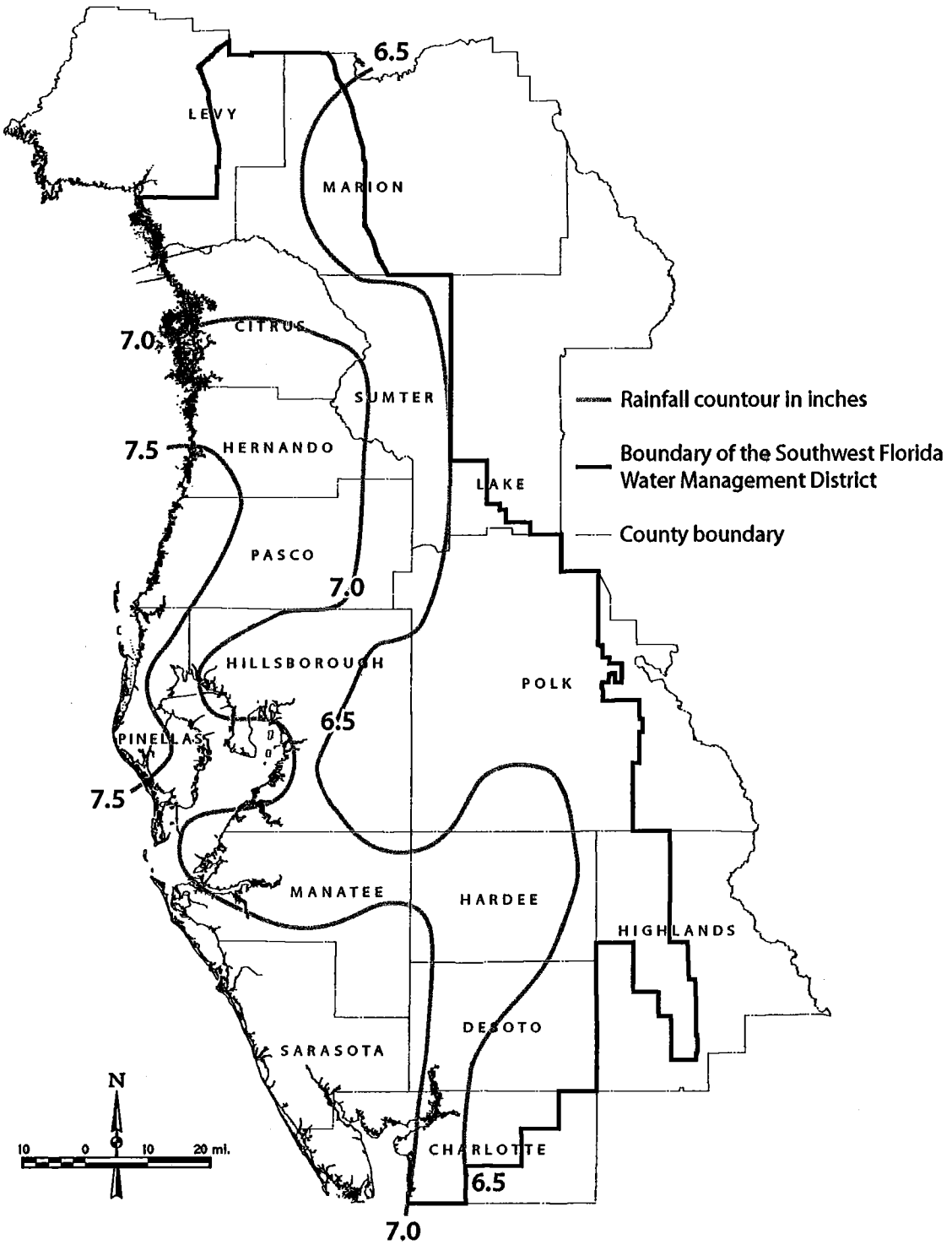

Figure D-5
Twenty-Four-Hour Twenty-Five-Year Return Period
Rainfall Map

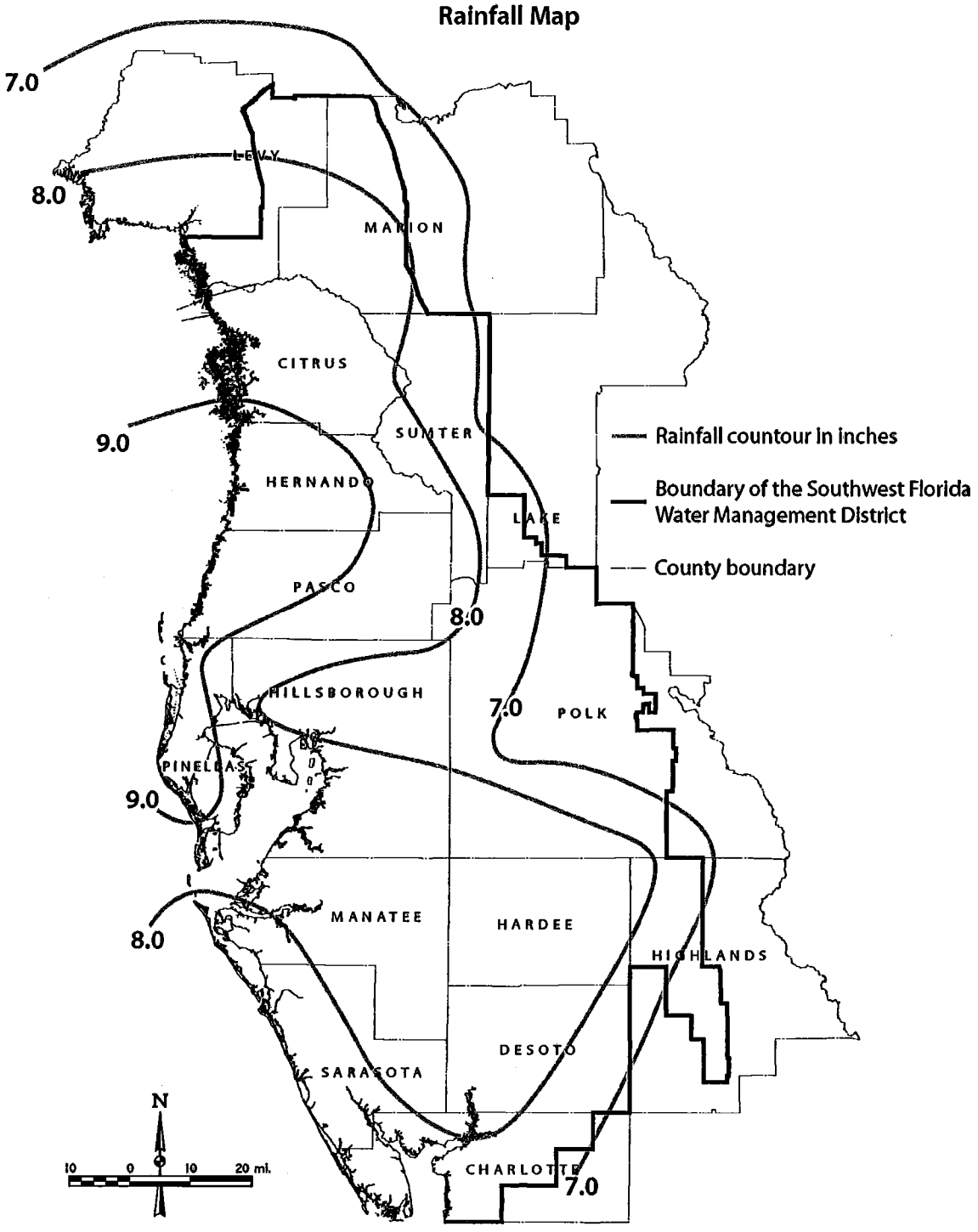

Figure D-6
Twenty-Four-Hour Fifty-Year Return Period
Rainfall Map

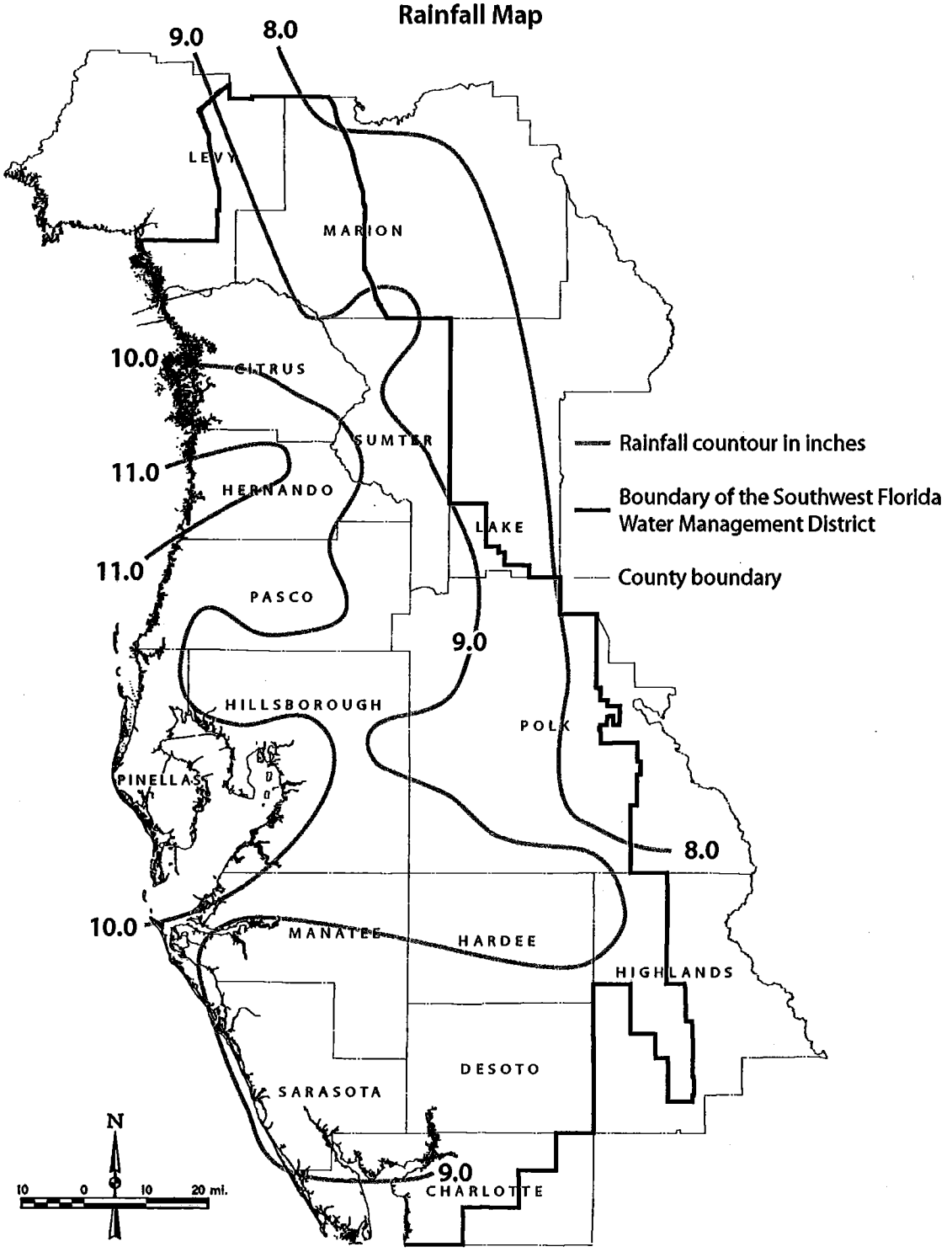

Figure D-7
Twenty-Four-Hour One-Hundred-Year Return Period
Rainfall Map

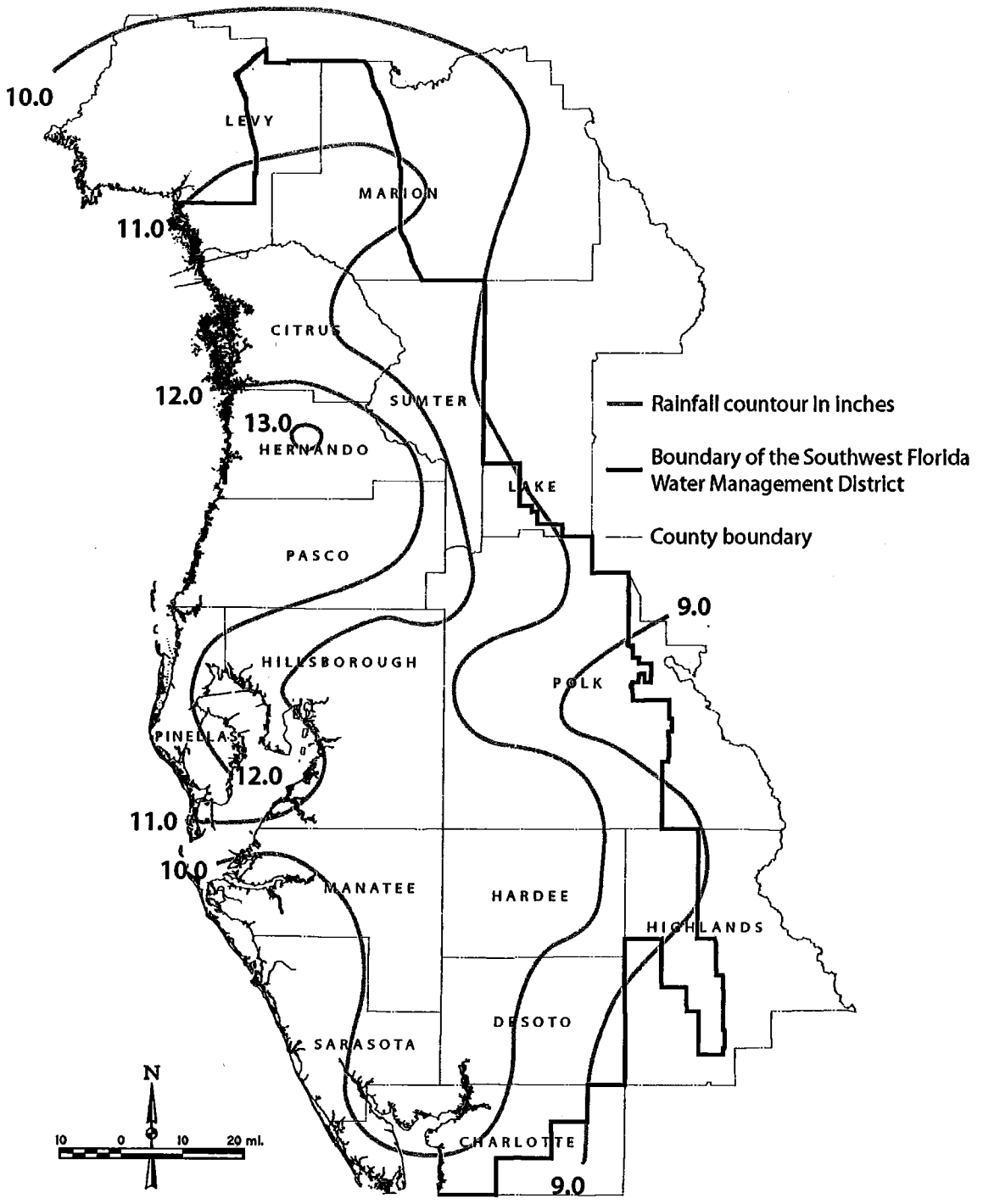

Table 2-2a Runoff curve numbers for urban areas [1/]

Cover description: Cover type and hydrologic condition	Average percent impervious area [2/]	Curve numbers for hydrologic soil group: A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3/]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4/]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	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
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5/]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

[1] Average runoff condition, and $I_a = 0.2S$.

[2] The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

[3] CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

[4] Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

[5] Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Table 2-2b Runoff curve numbers for cultivated agricultural lands [1/]

Cover description			Curve numbers for hydrologic soil group			
Cover type	Treatment [2/]	Hydrologic condition [3/]	A	B	C	D
Fallow	Bare soil	—	77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured & terraced (C&T)	Poor	66	74	80	82
		Good	62	71	78	81
	C&T+ CR	Poor	65	73	79	81
		Good	61	70	77	80
Small grain	SR	Poor	65	76	84	88
		Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C + CR	Poor	62	73	81	84
		Good	60	72	80	83
	C&T	Poor	61	72	79	82
		Good	59	70	78	81
	C&T+ CR	Poor	60	71	78	81
		Good	58	69	77	80
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C&T	Poor	63	73	80	83
		Good	51	67	76	80

[1] Average runoff condition, and I_a=0.2S

[2] Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.

[3] Hydraulic condition is based on combination factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness.

Poor: Factors impair infiltration and tend to increase runoff.

Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

Table 2-2c Runoff curve numbers for other agricultural lands [1/]

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing. [2/]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element. [3/]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30 [4/]	48	65	73
Woods—grass combination (orchard or tree farm). [5/]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods. [6/]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30 [4/]	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

1 Average runoff condition, and $I_a = 0.2S$.

2 *Poor:* <50%) ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: > 75% ground cover and lightly or only occasionally grazed.

3 *Poor*: <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

4 Actual curve number is less than 30; use CN = 30 for runoff computations.

5 CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

6 *Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.