



Public Works Department

Stormwater Management Technical Manual

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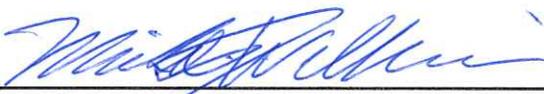


HILLSBOROUGH COUNTY

STORMWATER MANAGEMENT

TECHNICAL MANUAL

APPROVED

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08/31/15
Date

10/01/15
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PREFACE

The following text contains current information for designing and submitting construction plans for all proposed stormwater management facilities to be constructed in unincorporated Hillsborough County. This manual is a readily useable reference document written in specific, concise technical language and is a compilation of existing regulations, policy statements, and engineering requirements. The manual was created to ease coordination of projects, and when applicable, facilitate the planning, design and construction of projects in conformance to the County's standards and requirements.

This technical manual contains criteria and procedures for designing stormwater management systems. The criteria includes both design criteria and material specifications which shall be adhered to when submitting plans for approval by Hillsborough County. The procedures provided in this manual are not mandatory and are not to be construed as criteria. Procedures are included as suggestions for meeting County criteria. Design criteria and standards should be easily distinguishable from recommended or suggested procedures within this manual. In a case of question, the County Engineer, or his or her designee which in this manual, pertains primarily to the Development Services Department, shall make the distinction between criteria and procedure.

As material specifications, technical criteria and County polices change to meet new needs and changing technology, it will become necessary to revise and update this manual. The County's procedure for making revisions which includes issuing technical bulletins, accepting public comments, and requesting design exceptions can be previewed on the County's website at www.hillsboroughcounty.org under Services/Publications. In addition, you can submit comments and suggestions for changes to the manual using the online "Comment on PUD / PW Technical Publications" form located on the County's website.



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SECTION 1.0 INTRODUCTION

This document, the "Hillsborough County Stormwater Management Technical Manual" (Manual), has been adopted by reference in a number of County Ordinances, and in the County's Land Development Code (LDC). Stormwater management design, construction, and maintenance shall comply with the requirements of this Manual, the Land Development Code, and the Transportation Technical Manual provided, however, to the extent of any conflict, the provisions of this Manual shall govern. The Manual contains all current information and standards or criteria for designing and submitting construction plans for all proposed stormwater management facilities to be constructed in unincorporated Hillsborough County. Any proposed designs in conflict with the criteria portion of this Manual must first satisfy the requirements of Section 1.5.13.1 before any related building permits can be issued. In addition, the County Engineer shall be solely responsible for interpreting any criteria in this Manual which may be deemed vague or uncertain. Furthermore, the interpretation shall be in the best interest of the citizens of Hillsborough County.

1.1 PURPOSE

The purpose of this Manual is to guide engineers, architects, planners and developers in the design of stormwater management systems in Hillsborough County. The Manual integrates recommended methodologies and design procedures, as well as the County's required stormwater management design standards and criteria into a single-source document. The Manual is compatible with the requirements of the Hillsborough County Capital Improvement Program and the Stormwater Management Element of the County's Comprehensive Plan. This Manual represents a coordinated effort to bring water resource managers, developers and designers up-to-date with the regulations and criteria applicable to stormwater management design in Hillsborough County. As an integral part of the Hillsborough County Stormwater Management Master Plan, this Manual will be utilized by Hillsborough County for permitting, study, review and design.

1.2 OBJECTIVES

- 1.2.1 Design criteria presented in this Manual have been established to enable architects, engineers, planners and developers to accomplish the following objectives:
 - 1.2.1.1 Protect human life, health and welfare.
 - 1.2.1.2 Minimize private and public property damage resulting from erosion, sedimentation, changes in seepage slopes (i.e. phreatic surfaces) and flooding in and adjacent to proposed developments and other proposed stormwater management systems.
 - 1.2.1.3 Provide a technically efficient stormwater management system design.
 - 1.2.1.4 Provide a cost-effective stormwater management system design.
 - 1.2.1.5 Maintain or enhance the quantity and quality of groundwater supplies.
 - 1.2.1.6 Maintain or enhance the quality of surface waters and receiving water bodies.
 - 1.2.1.7 Provide for the least possible disturbance to community welfare and to the environment during construction.
- 1.2.2 It is also the County's intent for the design criteria specified herein to be compatible with the criteria of other regulatory agencies having jurisdiction within Hillsborough County.
- 1.2.3 Cooperation between the developers and Hillsborough County is necessary since many of the above objectives are attainable only when a balance between profit and social acceptability is



reached. This is especially true since many of the objectives are controlled by the specific design.

1.3 THE STORMWATER PRODUCT REVIEW COMMITTEE

- 1.3.1 The Stormwater Product Review Committee evaluates, on an as needed basis, new and existing products for efficient and economical utilization within the County's stormwater management system. The Committee is charged with the development of a fair and reasonable methodology to systematically evaluate products for use through academic research and field evaluation.
- 1.3.2 The Committee is comprised of representatives from both the Technical Services Division and Transportation Maintenance Division of the Public Works Department, and from the Development Services Department. The representatives have technical and/or management positions, and either supervise design, maintenance or construction personnel, or have a background in design, maintenance, and/or construction.

1.4 ORGANIZATION OF THE MANUAL

- 1.4.1 The Hillsborough County Stormwater Management Technical Manual integrates into a single source: criteria, recommended methodologies, design procedures, tables, and graphs, to guide Site Designers in a concise and informative manner. Discussions focus upon three major topics, the contents of which are summarized in the following:
 - 1.4.1.1 Relationship Between County Ordinances, Regulations and Policies: Familiarizes the designer/manager/developer with Hillsborough County's applicable ordinances, regulations, and policies. Concise summaries focus upon the purpose and scope of policies pertinent to stormwater management.
 - 1.4.1.2 County Stormwater Criteria and Standards for Design: Incorporates stormwater management design criteria previously presented in various County regulatory documents into a single source. Standards for design are presented in a concise, informative manner.
 - 1.4.1.3 Appendices: Recommended hydrologic methodologies, and hydraulic structure design and lot grading procedures are provided in Appendices A and B, respectively. Related and other pertinent figures, which represent guidelines for commonly encountered situations, are located in "Design Aids" APPENDIX, APPENDIX C. However, a vast array of additional design aids can be found in the referenced literature. The designer is encouraged to refer to the original sources for additional reference materials. Finally, a Glossary is included as APPENDIX D to provide pertinent definitions of terms used within the Manual.

1.5 ROLE OF HILLSBOROUGH COUNTY IN STORMWATER MANAGEMENT

- 1.5.1 In order to effectively deal with development pressures, Hillsborough County developed a state-required (per Chapter 9J-5 F.A.C.) planning document referred to as, "The Future of Hillsborough", Comprehensive Plan (1989). The Hillsborough County Stormwater Management Master Plan (HCSMMP) defines the direction the County is taking to achieve the stormwater goals of the Comprehensive Plan. Additionally, the federally-mandated (per the national "Clean Water Act") National Pollutant Discharge Elimination System (NPDES) permit issued in 1995 to Hillsborough County by the U.S. Environmental Protection Agency partially governs the operation and maintenance activities, in terms of protecting water quality and the environment, for the County's stormwater management system. In order to implement and develop portions of the HCSMMP and some requirements of the County's NPDES permit, County staff is presently



responsible for the following:

- 1.5.1.1 Review of Permits and Rezoning: Staff reviews all permit applications and rezonings to ensure that they meet all County criteria related to stormwater management and to ensure that other properties are not impacted by flooding as a direct result of development. The types of applications reviewed relate to subdivisions, commercial sites, parks and recreation, and any land alterations. The Environmental Protection Commission of Hillsborough County (EPCHC) regulates wetland protection and environmental concerns, on the local level, for the County.
- 1.5.1.2 Overseeing County Flood Damage Control Ordinance
 - a) Staff reviews all proposed developments and rezonings to assure that requirements of the Federal Emergency Management Agency are being met relative to flood zones. The Hillsborough County Flood Damage Control Ordinance (Hillsborough County, 1978 and subsequent revisions - now contained in the County's Land Development Code at Part 3.06.00) is the legislation utilized to evaluate proposed developments and rezonings. Hillsborough County is an Agent of FEMA. The County requires Flood Insurance Rate Map amendments to be filed by the Site Designer as part of the design process when the flood zone designation of portions of the development are proposed to be changed. Staff also assists the public in determining the proper flood zone designation for residential properties.
 - b) County staff will indicate to the developer if a 100-year flood elevation has been determined previously for a particular site. Otherwise, if the property is located in a Flood Zone A, it will be the responsibility of the Site Designer to determine and propose an acceptable 100-year flood elevation.
- 1.5.1.3 Development, Review and Inspection of Plans, Designs and Construction for Public Stormwater Management Systems
 - a) There are numerous stormwater management projects being developed throughout the County; some are included in the County's Capital Improvement Program and others are out-of-cycle projects. The out-of-cycle projects are the result of unforeseen local stormwater management problems.
 - b) Complex projects are evaluated and designed in the following sequence:
 - 1) Preliminary design, including hydrologic and hydraulic evaluations.
 - 2) Final design, including right-of-way and easement requirements, if any.
 - 3) Construction of project. The County is responsible for overall project management, including inspection during construction and contract management.
 - c) Staff also analyzes designs and coordinates permits on smaller projects and assists all roadway projects by either designing or reviewing the stormwater management portions of the projects.
- 1.5.1.4 Citizen Reported Stormwater Management Problems
 - a) Hillsborough County is responsible for evaluation and recommendation of corrective action for citizen reported stormwater management problems. Flooding problems can be caused by overgrown ditches, inadequate outfalls, seepage slope conditions, nonpermitted obstructions that hinder conveyance of runoff, inadequate storm sewer systems and catastrophic rainfall events.
 - b) Reports of stormwater management problems are received via Action Orders, the County Administrator's Office, or by direct mail or telephone calls to staff. Reported problems are handled in the following manner: The County's Transportation Maintenance Division screens the initial reports of problems. If the flooding impacts Hillsborough County right-of-way and if design assistance is needed, the problem description and information are forwarded to the Stormwater



Management staff of the Technical Services Division of the Public Works Department. If the problem may involve development or a violation of the Land Development Code it is forwarded to the Development Services Department.

- c) Hillsborough County also responds to citizen complaints or notification of stormwater pollution problems in the unincorporated County's stormwater management system. Examples of emergency stormwater pollution situations are oil spills, hazardous waste spills, sewage overflows, and excessive soil erosion. All pollution events should be referred for investigation to the Environmental Protection Commission. Hazardous waste response calls are routed to the Hillsborough County Hazardous Response Team or the Hillsborough County Environmental Protection Commission. The Hillsborough County Fire Department is responsible for limiting the spread of a spill to prevent surface water contamination.

1.5.1.5 Impacts of Mining, Land Excavation and Landfill Activities

- a) Mining, land excavations and landfills all have an effect on the natural drainage of the land. Consequently, steps must be taken to provide for adequate stormwater management when the land is altered for these activities.
- b) Staff evaluates the impact of the alterations by reviewing land excavation applications, including on-site inspections. When necessary, recommendations are made to the Development Services Department if there is a stormwater management problem. Under such circumstances Development Services staff meets with the Board of County Commissioners (BOCC) during Land Use Public Hearings. Presently, staff reviews the stormwater management element (other than water quality) of mining activities (e.g. phosphate industry).

1.5.1.6 Implementation of a Ditch Maintenance Program

- a) Ditch maintenance is essential in reducing flooding problems throughout the County. There are two factors that are important in conducting this maintenance -- manpower and permits. The Hillsborough County Transportation Maintenance Division's Maintenance Units are responsible for clearing County-maintained ditches of shoaling, herbaceous growths and debris to the extent necessary to protect the public right-of-way from flooding.
- b) The Department of Environmental Protection (DEP), the Environmental Protection Commission (EPC) and the Southwest Florida Water Management District (SWFWMD) are the agencies that may require permits for the clearing of ditches. The County continually works with the environmental regulatory agencies in obtaining ditch maintenance permits.

1.5.1.7 **Prioritization and Scheduling of Future Projects:** A comprehensive prioritization and scheduling program for future, public stormwater management improvement projects is annually recommended to the BOCC for implementation as a part of the County Five-Year Capital Improvement Program. The program is implemented within budgetary constraints.

1.5.1.8 **Data Collection Program:** Major sources of data are federal agencies (e.g. United States Geological Survey, hereafter referred to as U.S.G.S.), state agencies (e.g. Southwest Florida Water Management District, hereafter referred to as District) and local government agencies (e.g. City of Tampa, hereafter referred to as City). This information is being obtained and cataloged by the County.

1.5.1.9 **Existing Baseline Information:** There is presently a significant volume of information available on water quantity and quality related to stormwater management in the County. This information which is in/on reports, books, journals, maps, plans, microfiche and electronic media is available for viewing at County department offices,



the District and the University of South Florida Library.

1.5.1.10 Interagency Regulation

- a) Both private and public stormwater management activities may be subject to a variety of regulations and/or permitting requirements in addition to those required by Hillsborough County. Stormwater management design criteria, which may differ from Hillsborough County criteria, are specified by various jurisdictional agencies at federal, state and local levels.
- b) Site designers are responsible for assuring that all appropriate permits or approvals are obtained from all necessary agencies prior to construction on a site.
- c) The owner or operator of a site may also be required to submit a Notice of Intent (NOI) to the Florida Department of Environmental Protection (DEP) for Stormwater discharges associated with industrial activity and/or construction activity (involving 1 or more acres of land disturbance) under NPDES Construction Generic Permit (CGP). (Please refer to the DEP CGP for specific information regarding requirements and exemptions.) DEP requirements include Stormwater pollution prevention measures, possible monitoring activities, and inspections. A pollution prevention plan (PPP) must be prepared and implemented for all required sites to include proposed erosion control measures and other best management practices (BMPs).
- d) The Development Services Department will not issue a Natural Resources Permit, required for site development by the Land Development Code, until such time that the department receives a copy of the Southwest Florida Water Management District's "Completeness Letter" for a site. Additionally, for proposed construction sites where one or more acres of land will be disturbed, a copy of the above-referenced DEP NOI must be submitted to the County before the Natural Resources Permit will be issued.

1.5.1.11 **Warning and Disclaimer of Liability:** The degree of protection obtained by use of regulations presented in this Manual is considered to provide a reasonable level of flood protection and is based on sound and accepted engineering practice. Flooding may occur or flood heights may be increased by man-made or natural causes. This Manual does not imply or guarantee that areas or properties designed and constructed according to these regulations will be free from flooding or flood damages. This Manual shall not create liability on the part of Hillsborough County, or any officer or employee thereof, for any flood damages that result from reliance on this Manual or any administrative decision lawfully made thereunder. The Engineer of Record (EOR) remains responsible for any and all adverse impacts that may result from his design.

1.5.1.12 **Violation and Enforcement:** In any instance in which any land is, or is proposed to be, used in violation of this Manual, the County Attorney may, in addition to other remedies provided by law, institute injunction, abatement or any appropriate action or actions to prevent, enjoin, or abate unlawful use. In addition, upon a finding by the County Administrator that any provision of this Manual, the Hillsborough County Land Development Code or related ordinances has been violated, all development and building permits issued to the violator and for the site in violation will be suspended or held in abeyance. Permits may be withheld from the violator or for development on the site in violation, until the violation has been corrected to the satisfaction of the County Administrator. The County Administrator may also present their findings to the State Board of Professional Regulation and/or to the Hillsborough County Code Enforcement Board.

1.5.1.13 Deviations from Standards and Abandonment of Stormwater Management Facilities

- a) The standards and criteria in this Manual were developed to protect the lives and



property of the citizens of unincorporated Hillsborough County. Deviations from selected criteria may be approved when specifically referenced in the Manual, provided: adequate justification is formally submitted for such approval, the proposed deviations will not appreciably alter a project's impact on offsite properties, the proposed deviations are not in conflict with other applicable ordinances and/or regulations, and the deviations are formally approved by the County Engineer and/or Board of County Commissioners (as may be necessary for waiver of specific ordinance requirements). The approval of a specific deviation for a specific site does not in any way imply that a subsequent approval will be granted for the same deviation for a different site, or for the same deviation for a future phase of the same site.

- b) Stormwater management facilities cannot be abandoned or reduced in capacity, unless a facility is appropriately permitted or formally approved by the County for such a modification. Proper maintenance (including pertinent activities identified in Section 13.0 of this Manual) of any and all stormwater management facilities must be continuously provided by the facility owner. The intentional or unintentional occurrence of a reduction in the attenuation capacity, and/or increase in the discharge capacity, and/or reduction in the treatment capacity of a constructed stormwater management facility or system is a violation of this Manual.
- c) Any proposal to reduce the attenuation capacity, increase the discharge capacity, or reduce the treatment capacity of an existing stormwater management facility must include replacement of the altered capacity at an alternative location to be formally approved by the County Engineer. Any proposed modification to an existing stormwater management facility can improve, but cannot reduce, the net effectiveness and efficiency of the original facility.



SECTION 2.0 COUNTY REGULATIONS AND POLICIES RELATED TO STORMWATER MANAGEMENT

2.1 INTRODUCTION

The purpose of this section is to briefly and generally describe a number of the more prominent County regulations and policies, especially those contained in the Land Development Code (LDC), as they pertain to stormwater management. Detailed descriptions of each regulation and policy will not be included in this Manual as a result of the frequency of revisions. Alterations to the regulations and policies could outdate this Manual frequently and require constant revisions. Therefore, one should refer to the specific regulation or policy to determine up-to-date requirements. However, to the extent of any conflict, the provisions of this Manual shall govern.

2.2 SUBDIVISION REGULATIONS (LDC, SECTIONS 5.01.00 AND 6.02.00)

The purpose of the Hillsborough County Subdivision Regulations (relative to stormwater management requirements) is to establish procedures and standards which (1) insure that subdivision development is sensitive to the environment, and (2) minimize periodic and seasonal flooding through properly designed stormwater management facilities. Standards and design criteria presented in the Manual are supplemental to those limited criteria listed in the Subdivision Regulations. The combined criteria, then, allows for effective stormwater management for subdivisions.

2.3 NATURAL RESOURCES AND LANDSCAPING REGULATIONS (LDC, SECTIONS 4.01.00 AND 6.06.00)

Regulations and standards are specified for land alteration, vegetational protection and the installation and maintenance of landscaping. Regulation of land alteration includes standards and guidelines for: the protection of soil and water resources, the protection of surface water flow patterns, and the protection of environmentally sensitive areas. Landscaping requirements include specific provisions for land use compatibility and stormwater detention and retention ponds, among other factors.

2.4 FLOOD DAMAGE CONTROL REGULATIONS (LDC, SECTION 3.06.00)

The Hillsborough County Flood Damage Control Regulations provide standards for "all areas of special flood hazards" within Hillsborough County. Standards outlined in this ordinance are intended to: (1) restrict or prohibit property uses which could cause excessive water accumulation or erosion due to increased flood heights and velocities, (2) protect construction areas and adjacent properties from flooding, (3) control the alteration of natural floodplains, channels and barriers and (4) regulate developments which could increase erosion or flood damage. Requirements are specified for residential and commercial construction, mobile homes, floodways, and coastal high hazard areas.

2.5 LAND EXCAVATION REGULATIONS (LDC, SECTION 8.01.00)

Land excavation permits are required by the County. In terms of stormwater management standards, the County is primarily concerned with proximity to environmentally sensitive areas, water depth, and the impact that the excavation would cause to the surrounding community. In addition to specifying standards, this regulation specifies permit application requirements, reclamation and reuse plans, public hearing considerations, and permit application procedures.



2.6 SITE DEVELOPMENT REGULATIONS (LDC, SECTIONS 5.02.00 AND 6.03.00)

Review and approval of proposed stormwater management facilities are required for all commercial, industrial, office and residential developments which are not otherwise subject to the requirements of the Hillsborough County Subdivision Regulations. The criteria contained in this Manual are supplemental to the criteria and standards included in the Site Development Regulations, and the combined criteria are applicable to stormwater management system design.

2.7 ZONING CODE (LDC, ARTICLE II)

2.7.1 The Hillsborough County Zoning Code affects all buildings, structures, lands and waters within the unincorporated portions of Hillsborough County. Stormwater management is not dealt with directly in the County's Zoning Code. However, uses, occupancies, and activities of a temporary nature which may potentially cause adverse impacts may require a permit which includes provision for appropriate stormwater management measures.

2.7.2 In addition, stormwater management standards and criteria may become an issue within Planned Development Districts (LDC, Section 5.03.00).

2.8 PHOSPHATE MINING REGULATIONS (LDC, 8.02.00)

This regulates activities associated with phosphate mining and processing to insure that resource development is compatible with the overall needs and development of Hillsborough County. This Ordinance applies to all phosphate mining activities conducted within the boundaries of Hillsborough County. Stormwater management requirements related to phosphate mining are set forth in the specification for permit submittal application and are to be included within the applicant's Mining and Reclamation Plan.

2.9 BUILDING AND CONSTRUCTION CODE

Building code provisions do not directly address stormwater management issues except that "finished floor" elevations for habitable buildings may be required to be at or above a specific height above adjacent roadways. Such issues become more important for building locations in a flood zone and/or tidal area. Under such circumstances, the Hillsborough County Subdivision or Site Development Regulations, and the Flood Damage Control Regulations, would apply.

2.10 FUTURE OF HILLSBOROUGH, COMPREHENSIVE PLAN – FUTURE LAND USE ELEMENT

Hillsborough County's Comprehensive Plan offers a guide for future land development to the year 2025. Goals, objectives and policies are classified into five categories: General Development, Residential, Commercial, Industrial and Agricultural. Policies included in the plan address future growth issues and are used for planning and development in unincorporated Hillsborough County. The Future Land Use Element defines and discusses water bodies and environmentally sensitive areas in the context of determining land use densities. Discussion of stormwater management in the Comprehensive Plan is generally concentrated in the Stormwater Management Element.

2.11 FUTURE OF HILLSBOROUGH, COMPREHENSIVE PLAN – STORMWATER MANAGEMENT ELEMENT

The stormwater management element examines hydrologic modification caused by stormwater management activities, quantity and quality control strategies, flooding problems, and the cost of



stormwater management facilities to both the public and private sectors. Attention is focused primarily upon retaining runoff on-site, through the incorporation of retention and/or maintained percolation, minimizing public expenditures on future drainage activities, ensuring wise floodplain management techniques, and ensuring that a proper hydrologic balance is maintained.

2.12 RULES OF THE ENVIRONMENTAL PROTECTION COMMISSION OF HILLSBOROUGH COUNTY – WATER POLLUTION (CHAPTER 1-5)

The Environmental Protection Commission of Hillsborough County (EPCHC) specifies water quality criteria for Public Water Supplies, Shellfish Harvesting, Recreation - Propagation and Management of Fish and Wildlife, Agricultural and Industrial Water Supplies and Navigation, Utility and Industrial Uses (Classes 1 to 5 Waters, respectively). In addition, the EPCHC specifies minimum standards for earthen dams. According to these standards, "drainage facilities shall be provided to maintain the water level on the outside of the dam within design limitations" (Hillsborough County Environmental Protection Agency, 1987).

2.13 RULES OF THE ENVIRONMENTAL PROTECTION COMMISSION OF HILLSBOROUGH COUNTY – WETLANDS (CHAPTER 1-11)

County policy for wetland identification, delineation and mitigation is regulated by the Environmental Protection Commission of Hillsborough County (EPCHC) in this rule. Discussion of surface water is limited to the EPCHC's review of proposed development within the wetlands. Stormwater design criteria is not included in this chapter.

2.14 HILLSBOROUGH COUNTY STORMWATER QUALITY MANAGEMENT ORDINANCE

This Ordinance gives Hillsborough County the authority to prohibit illegal discharge of pollutants to the County stormwater management system. The Environmental Protection Agency (EPA) requires National Pollutant Discharge Elimination System (NPDES) permitted municipalities to provide the legal authority to regulate discharges to the Municipal Separate Storm Sewer Systems (MS4s). Please refer to Hillsborough County Ordinance 94-15 (and any subsequent revisions) for further information.

SECTION 3.0 BASIS OF REVIEW

For projects to be developed in phases, each phase must be associated with a concurrent stormwater management system, which has adequate attenuation, discharge and treatment capacity. A master plan may be submitted for future phases. Criteria shown in an approved master plan sets the criteria for the future phases. The design requirements identified in the following, and the design requirements and criteria found in any other part of this Manual, are the requirements which must be met to receive approval of a proposed stormwater management system by Hillsborough County. Other regulatory agencies may have additional permitting requirements and design standards which must also be appropriately incorporated into any stormwater management system design in Hillsborough County.

3.1 NEW DEVELOPMENT

- 3.1.1 All new development shall be designed such that post-development stormwater runoff from the site shall be substantially similar to or better than predevelopment runoff in terms of rate and shall meet applicable state and water management district (Southwest Florida Water Management District, SWFWMD or District) water quality standards. In addition to the pertinent requirements contained in Sections 7 and 13, the specific stormwater management system design requirements for “new development” sites are as follows:
- 3.1.1.1 Individual single family dwelling or individual duplex – Section 4.0, Development Requirements (4.1 only) and lot grading requirements in Section 7.0.
 - 3.1.1.2 Small sites (less than or equal to 10 acres) – Section 4.0, Development Requirements. Small Site Design Criteria (Section 5.0): All criteria.
 - 3.1.1.3 Large sites (greater than 10 acres) – Section 4.0, Development Requirements. Large Site Design Criteria (Section 6.0): All criteria.

3.2 REDEVELOPMENT

- 3.2.1 All nonresidential and nonagricultural redevelopment and expansions of existing nonresidential and nonagricultural development shall construct or contribute to a stormwater management system for the entire site which: treats stormwater runoff to state and water management district water quality standards, and has a runoff rate which is substantially similar to that for predevelopment conditions. In addition to the pertinent requirements contained in Section 13.0, the specific stormwater management system design requirements for “redevelopment and expansion” sites are as follows:
- 3.2.1.1 A redevelopment or expansion site with a cumulative alteration area of less than or equal to 1,000 square feet (exempt redevelopment site) - Section 4.0: Development Requirements (Section 4.1 only).
 - 3.2.1.2 A redevelopment or expansion site with: a cumulative alteration area of less than or equal to 5,000 square feet (or for original sites greater than 50,000 square feet, a cumulative alteration area of less than or equal to 10 percent of the site, and less than or equal to 10 acres), or a cumulative alteration of less than or equal to 50 percent of the original site’s remaining pervious area, if such cumulative pervious area alteration is greater than 1,000 square feet, but less than or equal to 10 acres (minor redevelopment site) - Section 4.1: General Requirements and minor redevelopment site standards in Small Site Criteria (Section 5). A redevelopment or expansion site with: a cumulative alteration area of more than 5,000 square feet (or for original sites greater than 50,000 square feet, a cumulative alteration area of more than 10 percent of the site, but less than or equal to 10 acres), or a cumulative alteration of more than 50 percent of the



original site's remaining pervious area, if such cumulative pervious area alteration is greater than 1,000 square feet, but less than or equal to 10 acres (major redevelopment site) - Development Requirements Section and Small Site Design Criteria (Section 5.0) and major redevelopment site standards (contained in Section 5.1.3.1.b) only.

- 3.2.1.3 A redevelopment or expansion site with: a cumulative alteration area of more than 5,000 square feet (or for original sites greater than 50,000 square feet, a cumulative alteration area of more than 10 percent of the site, but less than or equal to 10 acres), or a cumulative alteration of more than 50 percent of the original site's remaining pervious area, if such cumulative pervious area alteration is greater than 1,000 square feet, but less than or equal to 10 acres (major redevelopment site) - Development Requirements Section and Small Site Design Criteria (Section 5.0) and major redevelopment site standards (contained in Section 5.1.3.1.b) only.
- 3.2.1.4 A redevelopment or expansion site with a cumulative alteration area of more than 10 acres total - Development Requirements (Section 4.0) and Large Site Design Criteria (Section 6.0): and redevelopment site standards (contained in Section 6.1.1.2) only.



SECTION 4.0 DEVELOPMENT REQUIREMENTS

All small (Section 5.0) and large sites (Section 6.0) are subject to the requirements of this section.

4.1 GENERAL REQUIREMENTS

4.1.1 General Provisions

- 4.1.1.1 A stormwater management system review will be required for all of the following types of developments:
 - a) Residential/Subdivision
 - b) Commercial
 - c) Industrial
 - d) Multi-family/Non-subdivision
- 4.1.1.2 All stormwater management systems designs shall include water quality treatment in accordance with the rules and regulations of the Southwest Florida Water Management District (SWFWMD), and any other federal/state/local agency having jurisdiction. Refer to Section 13.0.
- 4.1.1.3 Provisions shall be included in the site development construction plans to control soil erosion and sedimentation both during and after the construction phase of the development. Refer to Section 13.0.
- 4.1.1.4 Impervious areas shall include, but not be limited to:
 - a) Buildings
 - b) Asphalt surfaces
 - c) Concrete
 - d) Shell
 - e) Limerock
 - f) Any other material either temporary or permanent which will shed over 70 percent of the water falling upon it.
- 4.1.1.5 If a proposed site's outfall is through an adjacent site where an outfall did not previously exist, or if an outfall is proposed from an existing landlocked site, proof of an appropriate drainage easement(s) from the downstream affected property owner(s) will be required. If Hillsborough County is to maintain the proposed site's stormwater management system, the appropriate drainage easement(s) within the affected adjacent sites shall be for a point discharge and shall be dedicated to the County. If the adjacent site is a jurisdictional wetland, determination of potential wetland water surface elevation impacts due to the proposed discharges will be required to qualify for consideration of exemption from this requirement.
- 4.1.1.6 The Site Designer shall verify that the proposed design is compatible with the completed design of any Hillsborough County capital improvement projects that may impact the site or that the site may impact. If design conflicts are encountered, the design constraints imposed by the capital improvement project shall take precedence. The proposed site design must not rely upon the improvements included in any Hillsborough County capital improvement project unless the County project is to be constructed before or concurrently with the proposed site.
- 4.1.1.7 Design criteria for culverts, bridges, storm sewers, roadway underdrains, non-roadway ditches, and roadway pavement (drainage) design are specified in Sections 7.0 through 11.0. These hydraulic structure/conveyance way design criteria are applicable to all public or public works projects and to all private development projects in unincorporated Hillsborough County.



- 4.1.2 Documentation Requirements: The developer is required to provide sufficient documentation to the County Administrator to ensure the standards of this Manual and Section are being met. Although general data requirements are located in Section 4.2, additional or special documentation requirements for projects may be required due to differences in their complexity, potential offsite impacts and other factors.
- 4.1.3 Finished Floor Elevation Requirements: Finished floor elevations shall be at or above the appropriate Federal Emergency Management Agency (FEMA) or County-adopted (by the Board of County Commissioners (BOCC) or County Administrator) 100-year flood elevation. Criteria for the minimum finish floor elevation can be found in the most current copy of the Hillsborough County Construction Code.
- 4.1.4 General Grading and Excavation Requirements
- 4.1.4.1 General Grading
- a) Indiscriminate development can change established drainage patterns and create problems which then defy practical solution. Therefore, the Hillsborough County Land Development Code stipulates (exclusive of exemptions) an appropriate permit (Natural Resources permit) for any action which changes the existing and/or natural contours of a site.
 - b) Sites must be graded such that all stormwater runoff drains in a manner no worse than that which occurred during the predevelopment condition along private property boundaries, with any excess runoff directed to the nearest public right-of-way or drainage facility having capacity, without crossing or causing detrimental impact to adjacent property. Minor exceptions to this grading policy may be granted when the site topography is such that there is no practical way to divert all excess runoff to the street or drainage facility with adequate capacity. However, portions which may be allowed to continue to drain according to natural patterns will be restricted to pervious areas left in a natural configuration and the runoff patterns are clearly indicated by preconstruction elevations. This exception is not applicable for side slopes of filled areas.
 - c) The proposed work must comply with the following requirements:
 - 4) Side Slope: Unless restrained by an adequate retaining wall terracing or other accepted stabilizing method, the maximum side slope for any fill shall be one foot vertical and two feet horizontal.
 - 5) Erosion Control: All sites must have an erosion control plan addressing waterborne erosion, windblown erosion, and sediment deposited by vehicles entering or leaving the site. The erosion control plan may consist of, but is not limited to, either a temporary system installed by the applicant or a 20-foot wide buffer of undisturbed vegetation. In all instances, the plan must remain in effect until the site is permanently vegetated.
- 4.1.4.2 General Excavation and Pond Requirements: Proposed excavation must comply with the following requirements. Standards for mines and borrow pits are not addressed in this Manual.
- a) Setback: The minimum horizontal setback from any property line to any part of a pond that is higher than the adjacent ground (toe of slope or maintenance berm) is five feet. The maintenance berm shall not be considered as a part of the setback. No part of the maintenance berm shall encroach into the setback. The minimum horizontal separation from any sidewalk, normal pedestrian area, slab or grade type patio, vehicle driving or parking area or leisure activity area to the top of bank for



any excavation is five feet unless separated from the excavation by a fence (as specified in the following). The maximum constructed slope within a setback area is one foot vertical to eight feet horizontal.

- b) Depth: Depressions less than or equal to two feet shall be considered a function of grading.
- c) Side Slope - Side slopes shall not promote erosion, shall be easily maintainable, grassed and shall be appropriate for the soil conditions. The maximum allowable side slope for an excavation without a fence is one foot vertical to four feet horizontal. The maximum allowable sideslope for an excavation with a fence is one foot vertical to two feet horizontal. Hillsborough County Public Works Department retrofit projects, which may include roadside ditches, are exempted from this requirement to the extent that adequate public safety is not compromised by such an exemption, on a project by project basis. See Sections 6.1.4.10 through 6.1.4.19 for additional requirements and alternatives regarding pond sideslopes
- d) Fencing: All proposed excavations with sideslopes steeper than one foot vertical to four feet horizontal (1:4) shall be fenced, whether the excavation is ongoing or complete. The fence shall be a FDOT Type B Fence, green or black vinyl coated or an equivalent safety fence and be constructed along the outer perimeter and on top of the maintenance berm. Ingress and egress for pond maintenance shall be provided, but restricted by lockable gates of adequate size to allow for the easy passage of necessary maintenance equipment. See Sections 6.1.4.10 through 6.1.4.19 for additional alternatives and requirements regarding fencing.
- e) Maintenance: A written maintenance plan is required for all excavations, said plan providing for access to all areas within the excavation and providing for the maintenance thereof. See Sections 6.1.4.10 through 6.1.4.19 for additional alternatives and requirements regarding pond maintenance berms or corridors.
- f) Erosion Control and Stabilization: All sites must have an erosion control plan addressing waterborne erosion, windblown erosion, and sediment deposited by vehicles entering or leaving the site. The plan must remain in effect until the site is permanently grassed. See Sections 6.1.4.20 to 6.1.4.24 for additional grass requirements.

4.1.5 Development within Floodprone and Restricted Areas

4.1.5.1 Development on Red Lined Properties

- a) Hillsborough County maintains a listing titled "Stormwater Management Program Red Line Properties." This list is periodically updated and is available from the County Administrator. This property may be restricted because of the need to acquire an easement for an existing or proposed drainage facility, illegal fill, and/or any area subject to periodic flooding. In addition, lands subject to periodic flooding may be determined using Federal Flood Insurance Rate Maps (FIRM), US Geological Survey (USGS) studies, County records, County Stormwater Management Master Plans, County or other approved stormwater models, or other reliable sources. Special considerations may be imposed upon the planned development of this property during the permitting procedure.
- b) In order to protect and advise the current and any future owners of the property, the County may require the owner to execute a Hold Harmless Agreement. This agreement, when deemed appropriate by the County Administrator, will be required for properties red lined because of flooding potential. The Hold Harmless Agreement will be on a form prepared by County staff and signed, notarized, and executed by the owner in accordance with established procedure, and recorded in



the Public Records of Hillsborough County prior to the issuance of the Building Permit. Under a Hold Harmless Agreement, a development is not excluded from any County requirements normally imposed upon development. Applicability of using the Hold Harmless Agreement will be determined on a case-by-case basis.

- 4.1.5.2 Special Requirements for Designated Drainage Basins: Throughout unincorporated Hillsborough County are drainage basins which are subject to special stormwater management requirements based on County Stormwater Management Master Plans and improvement projects or special studies. Information as to whether or not a site is within such an area may be obtained from the County Administrator. If a site is within such an area, the County Administrator will issue any special stormwater management considerations upon request.
- 4.1.5.3 Development in Existing Low Lots
- a) A request or an application for a building permit for construction in a lot which is lower than the street will require the following:
 - b) If the lot is lower than the street and receiving runoff from the road due to a low point in the road located along the front area of the lot in question, a building permit may be issued. However, no fill will be permitted, except as follows: Within the foundation limits, sufficient fill may be allowed to raise the building floor elevation to meet the minimum floor elevation requirements. The yard will not be permitted fill except in the event that a raised drain field is required by the Health Department or if there will be no adverse offsite impacts. In these cases, detailed evaluation of off-site impacts will be required. If the project proposes fill and has no positive discharge for drainage, equivalent storage will be required.
 - c) If the lot is lower than the street but located at the top of a hill or between two street intersections where the grade in the road continues (no low point between intersections exist), then the yard may be filled (in accordance with provisions in the Land Development Code) provided neighboring property will not be adversely affected.
- 4.1.5.4 Equivalent Storage within Flood Prone Areas
- a) Hillsborough County maintains records of some properties that have experienced severe stormwater flooding. The limits of the flooding are shown in the FEMA FIRM and/or the current floodplain maps of the Hillsborough County Stormwater Management Master Plan. The storage capacity of the floodplain must be preserved or the result may be to relocate the flooding problem and usually to make it more severe.
 - b) In order to ensure that any proposed development will not decrease the floodplain storage capacity of stormwater conveyance systems, all development will be evaluated for compliance with the following:
 - 1) No earth fill may be placed within a flood hazard area unless an equal amount of flood storage volume is created by excavation below the base flood elevation and above the seasonal high groundwater table elevation. In those cases where the provided flood storage compensation volume is to be located contiguous with an existing surface water body, the seasonal high surface water elevation, rather than groundwater table, elevation shall be used as the lower limit reference. An exception to this criteria may be provided for large sites (greater than 10 acres) if it is demonstrated by computer modeling that the timing is such that all of the required attenuation and compensation



volumes can be provided by the same storage area. If timing is utilized, the computer model must also demonstrate that full recovery of the required attenuation volume can be achieved, by gravity flow, within 72 hours after the storm event.

- 2) No portion of any structure which reduces the storage capacity of the flood hazard area may be constructed within the limits of the flood hazard area unless equal replacement storage volume is provided.
- 3) A flood hazard area is defined as an area that has experienced flooding in 1979 or later, or is recorded in either the FEMA Flood Insurance Rate Maps or the current floodplain maps of the Hillsborough County Stormwater Management Master Plan.

4.1.6 Drainage Patterns Not to be Changed to the Detriment of Neighboring Properties

4.1.6.1 Notwithstanding the issuance of a Natural Resources permit by the County the act(s) of stockpiling material, grading, excavating, and other act(s) affecting drainage shall not change the surface drainage patterns to the detriment of neighboring properties or public rights-of-way.

4.1.6.2 By common law, an upstream property owner has an easement over lands of a lower owner for surface waters to flow or escape from his land by natural ways and routes. An upper property owner may not, without liability, change the point of discharge of surface waters, nor concentrate them in ditches, nor divert in one direction waters which would have escaped in another direction, nor discharge them at a higher velocity, nor add to their pollution and cause a downstream property adverse impact. Likewise, the lower owner may not, without liability, obstruct natural flow of surface waters onto his land, either by excluding it or causing backwater on his neighbor. These criteria also apply to changes in seepage slope and/or phreatic surface conditions. In disputes between private property owners, it is the right of the injured private party to seek an injunction because of a private nuisance created when the drainage was altered.

4.1.7 Erosion and Sedimentation Control

4.1.7.1 Proposed temporary and permanent erosion and sediment control plans shall be submitted with each application for development approval. These plans shall specify in detail the erosion and sedimentation control measures to be used during all phases of clearing, grading, filling, construction and permanent development, and accurately describe their proposed operation. In addition, these plans shall be in accordance with the latest applicable specifications and recommendations as contained in the Florida Department of Environmental Protection's (FDEP's) publication, "The Florida Stormwater, Erosion and Sedimentation Control Inspector's Manual", latest edition. Copies of this publication can be obtained from FDEP.

4.1.7.2 No clearing, grading, excavating, filling, or other disturbing of the natural terrain will be permitted until County-approved erosion and sediment control measures have been installed, except those operations needed to implement these measures. All erosion and sediment control measures shall be continuously maintained during the construction phase of the development.

4.1.7.3 These erosion and sediment control measures shall apply to all features of the construction site, including street and utility installations as well as to the protection of individual lots.

4.1.8 Functional Stormwater System During Construction: During all phases of construction, all



stormwater entering, leaving, or flowing through construction sites shall be controlled in a manner consistent with the approved stormwater management plan and shall not adversely affect the drainage of the adjacent properties.

- 4.1.9 Certificate of Occupancy: Except as may be established by alternative County policy or procedure, no certificate of occupancy (C.O.) shall be issued unless and until all site work indicated on the approved plan, along with appropriate auxiliary requirements has been completed and satisfactorily verified. These items may include but are not limited to; engineer of record certification, certified record drawings of completed construction, properly permitted and inspected work within public rights-of-way or easement, delivery of easements and/or other agreements. Phased development must have the improvements complete for the phase of the development for which certificates are being sought.
- 4.1.10 Permits for Work in Public Rights-of-Way: Any work within existing or proposed public rights-of-way or easements will require a right-of-way permit. Some examples of stormwater management improvements that would require a permit are:
 - 4.1.10.1 Connection of a private stormwater system to the County's storm sewer or ditch system both within and without an easement or right-of-way;
 - 4.1.10.2 Driveway culvert installation;
 - 4.1.10.3 Changes and/or additions to any County storm sewer system;
 - 4.1.10.4 Changes and/or additions (including regrading) to any County ditch system;
 - 4.1.10.5 Driveway construction or modification;
 - 4.1.10.6 Changes and/or additions to any existing County pavement; or
 - 4.1.10.7 Any construction, modification, or removal of items that occur within the limits of any County right-of-way or easement. Permit requirements for construction within public rights-of-way may be obtained from the County Administrator as provided in the Hillsborough County Utilities Accommodations Guide.
- 4.1.11 Review of Offsite Improvements Associated with Commercial and Residential Development
 - 4.1.11.1 In the event that public stormwater management improvements are necessary and are to be constructed by private development concerns, notification must be provided to the County Administrator.
 - 4.1.11.2 All public improvements shall require conformance to design standards for public improvements, which are described in Section 6.0 - Large Site Design Criteria.
 - 4.1.11.3 Applicable sets of plans should be submitted to the County Administrator and include the following:
 - a) Plan and profile of the existing and proposed storm sewers or ditch (including affected drainage structure sizes - such as manholes, inlets, etc.) showing all existing utilities at scale acceptable to the County Administrator or his designee. Existing ditch cross sections shall be provided that include the most constricted areas.
 - b) Letters of "No Conflict" for all utilities and/or construction notes on plans identifying responsibility and proposed resolution for conflicts.
 - c) Construction notes for restoring right-of-way (shoulder, sidewalk, pavement, etc.) after the hook-up. Cross sections shall conform the standards of the Hillsborough County Transportation Technical Manual, latest edition, unless approved by the County Engineer.
 - d) Erosion Control Plan
 - e) For further criteria to be used for improvements in the public rights-of-way, refer to Section 6.0 - Large Site Design Criteria.



- f) Upon completion of work, one set of reproducible and one set of hard copies of the "As-Built" plans or record drawings, signed and sealed by a Professional Engineer registered in the State of Florida, shall be submitted to the County Administrator.
 - g) Upon completion of work, digital drawing files (CAD) of the As-builts shall be submitted to the Development Services Department and to the Stormwater Management Section of the Public Works Department on compact disk.
 - h) Upon completion of work, a video tape of the internal features of the entire storm sewer system shall be provided to the Stormwater Management Section of the Public Works Department.
- 4.1.11.4 NOTE: All work in the right-of-way shall be inspected by an authorized agent of the County Administrator.
- 4.1.12 Protection of County Stormwater Management Systems
- 4.1.12.1 Structures in Drainage Easements: No permanent structures or improvements such as (but not limited to) sidewalks, driveways, impervious surfaces, patios, decks, air conditioners, structures, utility sheds, poles, fences, sprinkler systems, trees, shrubs, hedges, landscaping plants (other than grass), concrete foundations, pools, walls or buildings may be constructed in any County drainage easement or right-of-way, except for the landscaping of stormwater detention and retention ponds as required by the Land Development Code (landscaped littoral shelves and vines on required safety fences). If in the process of retrofitting, replacing and/or otherwise maintaining a stormwater management facility within a drainage easement or right-of-way, an illegally constructed permanent structure(s) or improvement(s) is encountered, the cost of removal and replacement (elsewhere) of the structure or improvement shall be borne by the affected property owner.
- 4.1.12.2 Ditch Relocation: If an existing ditch within the County accepts stormwater runoff from public rights-of-way, then crosses private property prior to discharging to a receiving body or other public system, the County Administrator will require any proposed onsite relocation or alteration of such private property ditches to be accomplished using suitably sized pipes or ditches for the full length of the relocation or alteration. Review and approval of such proposed relocations or alterations along with dedication of an appropriately sized drainage easement will be required by the County Administrator. Easement requirements for ditches are found in Section 4.1.15.
- 4.1.13 Discharge to Sinkholes: No new discharges will be permitted into known sinkholes without water quality treatment and approval from the appropriate regulatory agencies.
- 4.1.14 Maintenance of Private Drainage Facilities
- 4.1.14.1 Any portion of a drainage system, including onsite and offsite facilities located in easements and/or rights-of-way, that is specifically constructed to serve a particular development will be continuously maintained by the owner(s) or an entity identified by the developer such as a homeowner's association unless it is officially dedicated and accepted by the County for maintenance.
- 4.1.14.2 In addition, where debris or sediment has accumulated in such a manner as to interfere with the free flow of water or adequate functioning of stormwater management facilities, the County Administrator shall require the owner of such properties to clear and remove the debris or obstruction so as to permit the stormwater management system to function effectively.
- 4.1.14.3 After notice and reasonably diligent efforts to have the owner of the property remove the debris or obstruction, County forces may be authorized to enter upon such drainage



ways and clear or remove the debris or obstructions. The cost thereof shall be charged to the owner of the property where said debris and/or obstruction was generated.

4.1.15 Easement Requirements: Drainage easements shall be granted to Hillsborough County for all stormwater management facilities to be maintained by Hillsborough County. Off-site drainage easements may be required in cases where the performance of minimum maintenance activities associated with roads and stormwater management facilities to be dedicated to Hillsborough County would not be practical without such easements. Hillsborough County will not accept the dedication of easements that are not needed to protect existing or future, county maintained roads and/or county maintained stormwater management facilities. For subdivisions and multi-family developments, which are to be privately maintained, the design and maintenance requirements are the same as those for stormwater management facilities that are to be dedicated to Hillsborough County, with the exception that privately owned, multi-family developments may have a minimum 10 foot maintenance berms around ponds.

4.1.15.1 Enclosed Stormwater Conveyance Systems

- a) Enclosed stormwater conveyance systems shall be located in drainage easements or road right-of-ways dedicated to Hillsborough County if they are to be maintained by Hillsborough County.
- b) For enclosed stormwater conveyance systems not within road rights-of-way, the drainage easement width shall be sufficient to encompass a work trench having 1:1 sideslopes (measured from the proposed ground surface to the proposed invert of the enclosed stormwater conveyance system) and a bottom width two feet wider than the total width of the installed conveyance system.
- c) The drainage easement width shall not be less than 20 feet unless otherwise approved by the County Engineer.

4.1.15.2 Canals and Ditches

- a) Canals and ditches shall have sufficient drainage easement dedicated to Hillsborough County to allow for installation of the canal or ditch including an unobstructed 20-foot wide maintenance area on both sides, measured from the top of the bank, unless otherwise approved by the County Engineer. Additionally, unless otherwise approved by the County Administrator, a proposed canal shall be aligned, relative to a parallel roadway, so that the minimum distance from the top of bank of the canal to the edge of pavement of the road is as follows:

Design Speed (mph)	Distance (feet)
Under 50	40 (urban highway) 50 (rural highway)
50 or Greater	60

- b) For a proposed canal which will not be constructed parallel to an adjacent roadway: a minimum distance of 20 feet shall be provided between the toe of the roadway front slope, for roadways on fill sections, and the top of the canal side slope nearest the roadway; or a minimum distance of 15 feet shall be provided between the inside edge of the roadside ditch bottom, for roadways in cut sections or with adjacent ditches, and the top of the canal side slope nearest the roadway. Deviations from these criteria must be approved by the County Engineer.

4.1.15.3 Detention and Retention Ponds: If the pond is to be maintained by Hillsborough County, sufficient drainage easements shall be dedicated to Hillsborough County to include the area of the pond within the perimeter of the inside top of bank, and an unobstructed 10-foot wide maintenance area around the entire perimeter of the inside



top of bank except for clear access to the control structure which shall be at least 20-foot wide. Alternatives to the width or extent of the maintenance area shall be approved by the County Engineer if it can be demonstrated that proper maintenance practices will not be impaired. If the maintenance area is on an embankment, the drainage easement shall extend to the external toe of slope of the embankment.

- 4.1.15.4 Ingress/Egress: Sufficient perpetual, legal access shall be conveyed to Hillsborough County to provide ingress to and egress from a drainage easement. This access shall be unobstructed and at least 20 feet in width.

4.1.16 Development in 100-Year Floodplains

4.1.16.1 Criteria for Development

- a) The criteria for development in 100-year floodplains shall pertain to all such floodplains and not be limited to just those floodplains identified on FEMA maps. All areas which convey or store stormwater will have an associated 100-year floodplain due to stormwater runoff and flows, including those conveyance and storage facilities in storm surge areas. The Engineer-of-Record shall be responsible for determining the on-site 100-year flood elevations if not defined by a FEMA study. The Engineer-of-Record is required to submit a Letter of Map Amendment or Map Revision to FEMA for any changes in flood zone designations as determined by a detailed study of the area.
- b) No development (structures or fill) shall be allowed in the conveyance portion of any 100-year frequency floodplain associated with a freshwater stream, channel, lake or waterway unless provisions are made to compensate for any reduction in conveyance caused by the development.
- c) No development (structures or fill) shall be allowed in any 100-year frequency non-tidal floodplain and any floodplain associated with riverine flooding in a tidally influenced area unless provisions are made to compensate for the reduction in storage volume due to the proposed development.
 - 1) Any compensation storage volumes shall be provided in addition to stormwater detention or retention volumes otherwise required to reduce peak runoff rates from the development. An exception to this criteria may be provided for large sites (greater than 10 acres) if it is demonstrated by computer modeling that the timing is such that all of the required attenuation and compensation volumes can be provided by the same storage area. If timing is utilized, the computer model must also demonstrate that full recovery of the required attenuation volume can be achieved, by gravity flow, within 72 hours after the storm event.
 - 2) No earthen fill shall be placed within a 100-year floodplain area unless an equal amount of flood storage volume is created by excavation below the 100-year flood elevation and above the controlled seasonal high groundwater table elevations. In those cases where the provided flood storage compensation volume is to be located contiguous with an existing surface water body, the seasonal high surface water elevation, rather than groundwater table, elevation shall be used as the lower limit reference. An exception to this criteria may be provided for large sites (greater than 10 acres) if it is demonstrated by computer modeling that the timing is such that all of the required attenuation and compensation volumes can be provided by the same storage area. If timing is utilized, the computer model must also demonstrate that full recovery of the required attenuation volume can be achieved, by gravity flow, within 72 hours after the storm event.



- 3) Exceptions shall be allowed if the floodplain is associated with a landlocked waterbody and is under one ownership.
- 4.1.16.2 If the development is a highway or similar facility requiring a "causeway" type encroachment across a floodplain, a small cumulative increase (0.1± foot) in upstream off-site elevations may be allowed. The 0.1± foot off-site elevations allowance must be approved by the FEMA and the SWFWMD. Also, all upstream affected property owners must agree, via deed restrictions, to accept the increased flooding.
 - 4.1.16.3 No encroachment shall be allowed in a regulatory floodway, as designated on the FEMA Floodway Maps, unless approved by FEMA and accepted by Hillsborough County.
 - 4.1.16.4 All development in the 100-year floodplains of the Alafia, Hillsborough and Little Manatee Rivers shall provide a minimum 50 feet buffer from the landward extent of wetlands.
- 4.1.17 Interagency Jurisdiction: If a conflict exists between these requirements and the Hillsborough County Flood Damage Control Ordinance (contained in the Land Development Code), or Southwest Florida Water Management District criteria, etc., the most restrictive requirements shall apply.
- 4.1.18 Maintenance for Retention/Detention Ponds, Vaults and Drain Fields
- 4.1.18.1 Maintenance: The maintenance of any privately owned stormwater management system included as part of an approved site plan shall be the responsibility of the owner. This includes, but is not limited to, any scarifying or sediment removal in percolation ponds which is necessary to continue the specified infiltration rates and storage volume. Every project must provide a plan which shall include:
 - a) A program for proper maintenance of the bottom and sides of the retention basin to preclude silting up of the basin which would reduce its capacity or reduce the rate of percolation, and to prevent the basin from becoming a nuisance. Ponds with vegetation plans must have a maintenance element to those plans.
 - b) A program for proper maintenance of the interior of the vault or drainfield to preclude reducing its capacity or the rate of percolation, and to prevent the facility from becoming a nuisance.
 - c) A statement designating the entity which will be responsible for the operation and maintenance of the stormwater management system. Attached to the statement should be a defined maintenance program to ensure said system will function for the purpose for which it was intended. If the entity responsible for the operation and maintenance is not the entity for whom the engineering plans, specifications, and design analysis were submitted, then a letter should also be attached stating who the entity will be and its agreement to conform to the defined maintenance program.
- 4.1.19 Vaults: Floatation calculations shall be provided for all vaults. In order for maintenance of covered vaults to be realistic, a minimum vertical clearance of four feet at all points inside the vault must be provided. At least one access point shall be required for the first 250 square feet in the area; additional access points shall be provided for each additional 1,000 square feet, or part thereof. Spacing locations should be designed for effective cleaning, ventilation, maintenance, and inspection. All access points shall be adequate for adult ingress and egress.
- 4.1.20 French Drain Standards: Underground french drains employing filter gravel or rock bed and perforated pipe shall be designed according to the following general design criteria:



- 4.1.20.1 Thirty percent of the rock bed measured from the bottom of the rock to the design high water (DHW) elevation may be used for storage.
 - 4.1.20.2 Forty percent of an expanded shale rock bed may be used for storage as above provided appropriate test documentation is provided by a reputable test lab.
 - 4.1.20.3 The entire inside pipe area shall be allowed for storage if the crown is below the DHW.
 - 4.1.20.4 The entire outer perimeter (including a 12-inch minimum overlap) of the rock bed shall be encased with a suitable membrane filter material in order to prevent silting of the voids in the rock bed. No filter membrane shall be used to encase the exfiltration pipe (i.e., no filter "sock" will be permitted around the pipe).
 - 4.1.20.5 The discharge of the required volume by percolation through the french drains or other means shall be completed in a maximum of 72 hours after the end of the storm event.
 - 4.1.20.6 Design high water elevation shall be established in consideration of adjacent properties and facilities, but normally one foot below the ground surface adjacent to the facility. If necessary, a minimum of one-half foot at the basin may be combined with the remaining half-foot elsewhere on the property for sites with positive outfalls.
 - 4.1.20.7 Inlets shall be a sumped open bottom design (to a depth of four-feet below pipe inverts, where feasible) to trap sediment before it can enter the french drain.
 - 4.1.20.8 The distance between the trench bottom and the seasonal high groundwater table shall be at least one foot.
 - 4.1.20.9 Aggregate for exfiltration trench shall comply with current Florida Department of Transportation (FDOT) Standard Specifications for Road and Bridge Construction for coarse aggregate size number 5 (one to 1/2 inch), except that no limestone, dolomites, or sandstones shall be used.
- 4.1.21 Erosion and Sedimentation Control Plans: The submitted plans shall contain a systematic and comprehensive erosion and sedimentation control plan for both the construction phase and the completed project. Refer to Section 13.0.

4.2 DATA REQUIREMENTS

4.2.1 Stormwater Management Data Requirements

- 4.2.1.1 Stormwater Management Plan Maps: The Site Designer shall include with the construction plan submittal a Master Stormwater Management Plan Map showing all existing and proposed land features. An appropriate scale shall be used to adequately represent the information on the map. A Stormwater Management System Design Report shall be prepared as the technical backup for the Master Stormwater Management Plan. The following information shall be included in either the Stormwater Management System Design Report or on the Master Stormwater Management Plan:
 - a) Vicinity sketch and legal description.
 - b) Basin and sub-basin boundaries, including all on-site and off-site areas contributing to the site, and the breakdown of the subarea(s) contributing to each inlet in the internal stormwater collection system.
 - c) Topographic Site Data showing existing contours and spot elevations based on NAVD 1988, unless otherwise approved by the County Surveyor. Contours must be shown to a minimum one foot interval to at least 25 feet outside the project boundaries. The Engineer of Record must give the source of such topographic data and certify its currency. The project benchmark shall be referenced and described on the grading and drainage plans, along with any NGVD/NAVD conversion equations.



- d) Flow paths used to determine the basin and sub-basin times-of-concentration.
- e) Existing stormwater management system features (ditches, ponds, etc.) are to be shown within and downstream of the proposed development. The Site Designer shall investigate drainage patterns and stormwater management facilities within at least 1,000 feet of the site or to a point where the capacity conditions can be determined, whichever is greater. A description of different capacity conditions can be found in Section 6.1.3. The Site Designer shall also demonstrate that the assumed design tailwater conditions are appropriate. This information shall be included in the stormwater management documents.
- f) Notes pertaining to standing water, springs, areas of seepage or seepage slopes and sources of highwater data.
- g) Proposed development layout with vertical controls. Vertical datum shall be NAVD 88, unless otherwise approved by the County Surveyor. The topographic datum, along with an appropriate conversion equation shall be included on the grading plan sheets.
- h) Proposed stormwater management system features including, but not limited to, the locations of inlets, swales, ponds, conveyance systems, easements, etc.
- i) General soil characteristics obtained from the Hillsborough County Soil Survey (Soil Conservation Service) and existing land uses/ground cover.
- j) Flood zone designation determined from the FIRM. Elevations of the flood zone along with the Flood Hazard boundary shall be delineated on the Master Stormwater Management Plan and on all Grading and Drainage Plans.
- k) For Master Stormwater Management Plans, drawings shall provide sufficient information and references for use with future phases of the masterplan development.
 - 1) For projects which are part of a masterplan development, related drainage information for both the proposed project and the existing master stormwater management plan must be provided to demonstrate compliance with the Stormwater Management Technical Manual. Such information to be provided shall include a drawing of the proposed drainage basins and proposed drainage calculations for design values for C or CN (signed and sealed by the EOR), as well as sufficient information from the master stormwater management plan (excerpts from the approved calculations for post-development C or CN, list of the included drainage basins with approved elevations for the DHW and freeboard).
 - 2) Revisions made to a phased project shall require updating of the Master Stormwater Management Plan Map and the Stormwater Management System Design Report before processing/project review of the revised and/or future phases commences or continues, as deemed appropriate by the County Administrator. Concurrent submittal of the updated documents with the proposed phase construction plans and other support reports/data is acceptable.
 - 3) When revisions are not necessary, the previously approved Master Stormwater Management Plan Map shall be provided for all future phases.
 - 4) For projects which are part of a masterplan development, the EOR shall certify that the drainage has been designed within the previously approved limits, and that existing infrastructure conforms to the previously approved construction plans. Such certification should be supported by a summary of the related previously approved and proposed stages and rates of discharge for future phases for comparison, and shall indicate the datum that all elevations



refer to.

4.2.1.2 Stormwater Management System Design Calculations

a) Stormwater Management System Design Report

- 1) Stormwater design calculations shall be submitted in a bound report. The report shall contain all hydrologic and hydraulic calculations and assumptions used to design the proposed development. The hydrologic and hydraulic calculations shall include support information such as: stage-storage data, stage-discharge data (if applicable), inflow hydrographs, outflow hydrographs, etc. A soils report shall be included, as an attachment, per Sections 6.1.5 and 6.1.5 requirements. The stormwater management system design report shall be signed and sealed by a professional engineer registered in the state of Florida. When a separate geotechnical report is provided with the stormwater design calculations, it shall be signed and sealed by the responsible professional engineer.
- 2) A build-out groundwater table analysis, utilizing generally accepted methodology, for ponds located above adjacent properties shall be required. This analysis shall demonstrate that design storms up to and including a 100-year storm will not adversely impact down gradient properties. An exception may be made for detention ponds that are adjacent to an open conveyance system or sufficiently far from other private properties. Use of this exception requires certification from a geotechnical engineer or the engineer of record that there will be no adverse impacts. The County reviewer may in any case require the build-out groundwater table analysis if there is any doubt regarding the potential to impact off-site properties.

- b) Computer Programs: All reports containing computer generated information shall include input and output data. Input data, when computerized flood routing techniques are utilized, shall include, but not be limited to: basin areas, curve numbers, rational coefficients, inflow hydrographs, Soil Conservation Service (SCS) peak rate factor, time of concentration values, rainfall distribution data, stage/storage information, etc. Any calculation generated by a program not recognized by Hillsborough County may be checked by accepted programs. The Site Designer shall be responsible for clarifying any discrepancies between programs. Input and output data must also be provided on appropriate computer disks, if requested by the County.

4.2.1.3 As-Builts

- a) Upon completion of work, one set of reproducible and one set of prints of the "As-Built" plans or record drawings, signed and sealed by a Professional Engineer registered in the State of Florida, shall be submitted to the County Administrator.
- b) Upon completion of work, digital drawing files (CAD) of the as-builts shall be submitted to the Development Services Department and to the Stormwater Management Section of the Public Works Department on compact disk.
- c) Upon completion of work, a video tape of the internal features of the entire storm sewer system shall be provided to the Stormwater Management Section of the Public Works Department.



SECTION 5.0 SMALL SITE DESIGN CRITERIA

All projects with a total site area, or cumulative alteration area, of less than or equal to 10 acres are subject to all applicable requirements of this Section. Please refer to Section 3.0 for specification of applicable criteria and to Section 4.0 for general development requirements. Applicability of additional criteria in Section 6.0 may be determined by the County Administrator.

5.1 DESIGN STANDARDS

5.1.1 Exceptions: The following projects are permitted to deviate from the standard small-site stormwater attenuation and treatment requirements defined in Section 5.1.3. All projects must still comply with pertinent Southwest Florida Water Management District (SWFWMD) and all other applicable agency stormwater rules. The General Development requirements (Section 4.1), including: erosion and sedimentation controls, provisions for flow through water, control of discharge from roof downspouts, offsite drainage, etc. shall still apply.

5.1.1.1 Discharges to Basins with Adequate Stormwater Management Facilities: Projects which discharge to stormwater management systems constructed to accommodate the proposed project's intensity of development and five-year (Rational Method or the NRCS(SCS) Method) discharge and which have water quality treatment for same are exempt from the standard small-site retention/detention requirements. For information on this exemption contact the County Engineer.

5.1.1.2 Minimum Retention/Detention Requirement Projects

- a) The following projects are also allowed a deviation from the standards located in Section 5.1.3. In lieu of the standard requirements the following will be applied:
- b) The minimum retention/detention requirement is the retention of a volume equal to 1/2-inch of runoff over the entire site.
- c) Those projects eligible for the minimum requirements are:
 - 1) Small Commercial Projects: New development of a parcel less than or equal to 10,000 s.f. of total site area which is not part of any larger development or redevelopment. Subsequent additions to the site will not be approved unless the entire site is brought into compliance with current standards found in Section 5.1.3.
 - 2) New Developments With Outfalls Directly to Receiving Waters: Attenuation is not required for projects which have their own direct outfalls to the Tampa By-Pass Canal or Tampa Bay. Projects with discharges in close proximity to an adequate County outfall may qualify for the Capacity Adjustment in Section 5.1.1.3.

5.1.1.3 Capacity Adjustment: Stormwater attenuation and discharge rates may be adjusted based on a drainage capacity analysis of the receiving waters performed by a registered engineer. A capacity analysis of specific drainage systems will be reviewed at the time of plan submittal. Such analysis will conform to standard engineering practice and must prove the proposed discharge will have no negative offsite impacts to the receiving system.

5.1.2 Residential Standards

5.1.2.1 Single Family Residential and Single Duplex Exemption: The construction of one single family residence or duplex is exempt from standard small-site stormwater treatment and attenuation requirements. However, the General Development Requirements and Lot Grading Standards are still applicable.



- a) Platted No Improvement Subdivisions are required to provide a drainage analysis, prepared by a professional engineer. This analysis shall demonstrate that the post developed discharge during a mean annual/24-hour storm is no greater than the pre-developed discharge rate for the mean annual/24 hour storm. A current topographic survey of the site must be submitted along with the drainage analysis.

5.1.2.2 Small Subdivision Standards: All Subdivisions with total site areas of 10 acres or less are subject to the Commercial Standards found in Section 5.1.3. Exceptions for the attenuation requirements may only be made for small residential subdivisions which have been certified by the County for affordable housing. This exception includes farm worker housing that has acquired a conditional use or special use permit, as defined in the Hillsborough County Land Development Code Section 6.11.39., provided that there will be no adverse off-site stormwater impacts and that the farm worker housing adheres to all limitations for small affordable housing subdivisions. Small affordable housing subdivisions may also be exempted from having a stormwater retention/detention facility located within a common area and establishing a Homeowners Association.

- a) Definition of Applicable Developments
 - 1) Subdivision certified by Hillsborough County as an Affordable Housing Project and so noted on the final plat and,
 - 2) Subdivision must be comprised of less than 10 detached single family platted lots and,
 - 3) Subdivision is not:
 - A. Located in a Stormwater Management Program Red Line Area or,
 - B. Located in a volume or sensitive basin or Flood Hazard Area or,
 - C. Contributory to an identified flooding problem.
- b) Requirements
 - 1) For subdivisions located on an existing paved roadway - no stormwater attenuation or retention provided it can be demonstrated per 5.1.2.1.a that there are no adverse downstream impacts.
 - 2) If subdivision includes new roadway:
 - A. Water quality treatment for entire subdivision and analysis per 5.1.2.1.a.
 - B. Roadway to meet all County standards and be dedicated to the County.
 - C. Water quality treatment to be provided in swales in the right-of-way. The County will assume responsibility for hydraulic maintenance. Normal maintenance (mowing, trash removal etc.) will be the responsibility of individual homeowners.

5.1.3 Commercial Standards

5.1.3.1 Requirements for Redevelopment Projects (With Cumulative Alteration Areas Less Than or Equal to 10 Acres): Redevelopment and expansion projects are required to address stormwater management issues to varying degrees, depending on the size of the cumulative alteration area for a site. The following standards identify the County stormwater retention and detention requirements for the minor and major redevelopment project sizes (refer to Section 3.2 for definitions of minor and major redevelopment sites).

- a) Minor Redevelopment Sites
 - 1) Project must retain or provide appropriate stormwater treatment for a volume equal to 1/2 inch of runoff from the cumulative alteration area to satisfy water quality requirements. This requirement is in addition to the attenuation and treatment capacity of any existing site stormwater pond(s), unless the

cumulative alteration area was appropriately included (i.e., a like or more intense use was considered in the original design(s) for the pond(s)).

- 2) If the cumulative alteration area is greater than 10,000 square feet and the site still qualifies as a minor redevelopment site, in addition to the above water quality volume requirement, detention must be provided for the cumulative alteration area according to the criteria in Section 5.1.3.2.
- b) Major Redevelopment Sites
- 1) Project must retain or provide appropriate stormwater treatment for a volume equal to one inch of runoff from the area of cumulative alteration, including the existing site, if no stormwater treatment facilities are in place, to satisfy water quality requirements. This requirement is in addition to the attenuation and treatment capacity of any existing site stormwater pond(s), unless the cumulative alteration area was appropriately included (i.e., a like or more intense use was considered in the original design(s) for the pond(s)).
 - 2) If the cumulative alteration area is greater than 10,000 square feet and the site still qualifies as a major redevelopment site, in addition to the above attenuation and water quality volume requirement, detention must be provided for the cumulative alteration area according to the criteria in Section 5.1.3.2.
 - 3) Existing stormwater management system attenuation, discharge, and treatment capacity shall not be reduced due to redevelopment or expansions of existing development.
 - 4) Site alterations are cumulative with time, as indicated in the redevelopment site definitions. Therefore, a particular site might transition from an exempt redevelopment site, to a minor redevelopment site, and then to a major redevelopment site as further expansion and redevelopment occurs. The site design criteria will also transition accordingly.
 - 5) Redevelopment and expansion projects may include stormwater management facilities other than retention and/or detention ponds. Therefore, the other design requirements and standards contained in Section 5.1.3 also apply to these projects.

5.1.3.2 Discharge/Retention/Retention/Water Quality Requirements

- a) Discharge Requirements – Allowable Discharge: The maximum allowable discharge into a County system utilized in the design of systems to serve new developments and redevelopments shall be limited to the peak discharge based on the five-year FDOT Zone VI storm and the predeveloped condition. The time of concentration shall be determined utilizing the FDOT overland flow velocity chart (APPENDIX C) or other methods approved by the County Engineer. For purposes of the County's small-site design criteria, the "predeveloped" condition is defined as follows for:
 - 1) New Development Projects: raw land in a pervious condition or natural state before alteration (i.e., runoff coefficient approximately 0.20).
 - 2) Redevelopment Projects: predeveloped conditions include permanent impervious surfaces (not shell or clay) on the site which existed as of 1988 and are identifiable on the 1988 (or earlier) County Aerial Maps.
- b) On-Site Detention/Retention Requirements: On-site attenuation will be required for those project sites which exceed 10,000 square feet in area. Design criteria to be adhered to is outlined in the following for several County system outfall scenarios. Please note the County Engineer may impose more or less restrictive requirements based on the best available stormwater management studies and data.

- 1) Stormwater Management Systems Designed with a Positive Outfall: If adequate stormwater management facilities are available to allow for the design of a detention system with a positive outfall into the County drainage system or gutter flow, the following criteria apply. A positive outfall, for purposes of this small-site design criteria, is described as a direct pipe connection to the County stormwater system or direct discharge to a contiguous County street which meets the requirements of 5.1.3.6.
 - A. Detention requirements shall be based on the difference between the allowable discharge and the calculated post-development runoff.
 - B. Allowable discharge is based on a five-year FDOT Zone VI storm and predeveloped conditions.
 - C. Post-development runoff is calculated for a 25-year, 24-hour, Zone VI storm and proposed impervious conditions.
 - D. If the appropriate data is supplied (5.1.3.8), percolation can be used to decrease the detention requirements.
 - E. The stored water shall be drawn down by a system within a 72 hour period.
 - F. Volumes for water quality requirements shall be retained, or otherwise appropriately treated, below the five-year discharge weir. Water quality volumes to be set by the SWFWMD and 5.1.3.2.c
- 2) Stormwater Management Systems Designed Without a Positive Outfall: If adequate stormwater management facilities are not available, a retention system must be designed to provide for the storage of the stormwater runoff volume. The following criteria applies:
 - A. Retention systems shall be sized to store the difference in runoff volume, comparing the postdeveloped condition to the predeveloped condition.
 - B. Post-developed runoff is calculated for a 100-year, 24-hour, Zone VI storm.
 - C. A design percolation rate, as determined in accordance with the Percolation and Soils Investigation Criteria Section 5.1.3.8, shall be used to draw down the stored water within a 72 hour period.
- 3) Stormwater Management Systems Designed in Volume Sensitive Basins: Volume sensitive areas have been, and continue to be identified, with major known areas delineated on a County drainage basin map which is available for reference. Volume sensitive criteria is necessary to protect those drainage basins which are internally drained (lacking a positive outfall) although those areas may or may not have extensive system coverage.
 - A. Stormwater Management System Designed With a Positive Outfall in a Volume Sensitive Area.
 - Detention requirements shall be based on the difference between the predevelopment allowable discharge and the calculated post-development runoff.
 - Retention of the difference in volume between the predeveloped 100-year, 24-hour runoff and the post-developed 100-year, 24-hour runoff will be required prior to an allowable discharge from the site. This is the minimum retention requirement.
 - After the above volume has been retained, discharge will be allowed at no greater than the predeveloped five-year rate for the remainder of the 100-year storm.



- If appropriate data is supplied (5.1.3.8), percolation can be used to decrease retention/detention requirements in excess of the minimum retention requirement.
 - The stored water shall be drawn down by a system within a 72 hour period.
- B. Stormwater Management Systems Designed Without a Positive Outfall in a Volume Sensitive Area
- Retention of the post-development runoff of a 100-year, 24-hour, Zone VI storm will be required.
 - A design percolation rate, determined in accordance with the Percolation and Soils Investigation Criteria Section 5.1.3.8, shall be used to draw down the stored water within a 72 hour period after the end of the design storm event.
 - Provisions must be made in the site design to ensure that any potential pond overflows can be conveyed or otherwise accommodated with minimal potential damage to adjacent properties, and minimal potential danger to public safety.
- c) Water Quality Requirements
- 1) Private developments will provide treatment in accordance with the SWFWMD regulations; however, the minimum water quality treatment required by Hillsborough County for new development is the retention or otherwise appropriate treatment, of 1/2 inch of runoff from the entire site.
 - 2) Baffles or other appropriate devices for control of floating material must be provided, with further provision of adequate protection against the growth of vegetation between the baffles and the control structures (e.g., by constructing an appropriate impervious apron around the control structure).
- 5.1.3.3 Design Standards for Other Stormwater Management Facilities: Refer to Sections 8.0 through 12.0 for Hillsborough County design criteria for culverts, bridges, storm sewers, roadway underdrains, non-roadway ditches, and roadway pavement drainage design standards for all development sites.
- 5.1.3.4 Stormwater System Criteria and Design
- a) Flow Generation: The County requires the Rational Method or the NRCS(SCS) Method to be used for sites less than or equal to 10 acres in size. Other methods may be utilized for sites that are larger than five acres and less than 10 acres when it is necessary to model a dynamic condition, if approved by the County Administrator. For sites larger than ten acres, other methods shall be used as specified in Section 6.0 - Large Site Design Criteria. Additional information and background on the Rational Method can be found in APPENDIX A.
 - b) Rainfall Curves: Design storms are to be obtained from the Florida Department of Transportation Zone VI Rainfall Intensity Curves.
 - c) Runoff Coefficients
 - Water Areas at Design High Water 1.00
 - Concrete Paved Areas 0.95
 - Roof Areas 0.95
 - Asphalt Paved Areas 0.95
 - Grassed and Landscaped Areas 0.20
- 5.1.3.5 Outfall Pipes: Outfall pipes are to be no larger than necessary to flow the allowable capacity at the design high water (DHW) head. The maximum velocity of discharge into the County system for any outfall (including roof drains) is eight feet per second



(for County storm sewer systems) and six feet per second (for County ditches/canals, provided appropriate erosion controls are included).

5.1.3.6 Discharge to Public Streets: A positive outfall to a public "curb and gutter" street can be claimed if gutter flow does not intrude onto other private property or encroach into the following areas. The minimum street width to be unobstructed by stormwater shall be as follows:

Street Classification	Minimum Width in Either Direction
Arterial or Collector (Multi-lane)	one driving lane
Local (Two-lane)	1/2 of one driving lane

Should the developer desire to discharge into a public "curb and gutter" street, his engineer must:

- a) Provide a survey profile of the path of the gutter flow in 50-foot increments and provide cross sections at every change in the typical section and every 50 feet to the point of inlet into the County system.
- b) Provide calculations (suggest a modified storm sewer tabulation form) to document the quantity of stormwater runoff entering the road from the last point of inlet to the system (or the basin boundary). The quantities will be calculated at the time of concentration corresponding to the maximum rate of discharge from the proposed project reaching that specific point.
- c) Solve the equation $T = (nQ/0.56Sx^{5/3}So^{1/2})^{3/8}$ (for standard type "F" curb - see standard hydraulic text books or FDOT Drainage Manual for other curb and gutter types) for every location identified in item b.

Where:

T = Width of spread (feet)
 n = Manning's roughness coefficient

Asphaltic concrete pavement	=	0.016
Asphalt block pavement	=	0.025
Brick pavement	=	0.015
Concrete pavement	=	0.015

Q = Stormwater flow (CFS) - project discharge plus quantity calculated in item b. at corresponding time of concentration

Sx = Pavement cross slope

So = Longitudinal grade or slope (Ft/Ft)

- d) Verify that the street width less than the width of stormwater spread is greater than or equal to the "minimum width to be unobstructed by stormwater" as stated earlier. Freeboard, percolation, and all other applicable design criteria and code requirements will be enforced.

5.1.3.7 Retention/Detention Basin Standards: Ponds shall be designed in accordance with the criteria found in 6.1.4.10. through 6.1.4.13. Outfall design criteria is defined in 6.1.3,

- a) Design High Water of Basin and Freeboard: The design high water elevation shall be established in consideration of adjacent properties and facilities, but normally one foot below the ground surface adjacent to the facility. If the design high water of a pond is proposed to be above the ground surface within the area influenced by



the pond area, a geotechnical analysis to certify that there will be no adverse impacts due to potential seepage or change in ground water conditions will be required

- 3) For non-residential commercial sites, a minimum of six inches of freeboard is to be provided for sites less than or equal to five acres provided that the product of the rational coefficient times the area (CA) is less than or equal to two. If the area is greater than five acres or CA is greater than two, or if the site is residential commercial, then a minimum of one foot of freeboard is to be provided.
 - 4) For non-residential commercial sites only, no more than 50 percent of the required freeboard may be provided outside of the designated pond area and shall be limited to six inches.
 - 5) For non-residential, commercial sites with an area less than one acre, detention storage may be allowed on top of paved parking areas provided that:
 - C. The design high water elevation is at or below the lowest graded elevation prior to berming or curbing.
 - D. Maximum depth of parking area storage is six inches.
 - E. Water quality volume is not to be stored on paved areas.
 - F. Site freeboard may be accomplished by berming or curbing.
 - 6) For non-residential commercial sites of any size, some storage may be allowed on top of paved parking areas when designing to the volume sensitive criteria, provided:
 - A. The difference in the predeveloped and post-developed volumes due to the 25-year/24-hour volume is stored entirely in the pond.
 - B. The design high water elevation is at or below the lowest graded elevation prior to berming or curbing.
 - C. Depth of storage on the pavement does not exceed six inches.
 - D. Adequate freeboard is provided, and can be accomplished by berming or curbing.
- b) Storage Volume: The net storage volume required will be in addition to the storage volume developed for satisfaction of water quality criteria less that part which is dewatered during the first 36 hours for wet ponds and 72 hours for dry ponds. Use of a detention/retention basin or drainfield shall require that an inflow/outflow curve be submitted together with the stormwater management calculations. The elevation of the pond volume in relation to the wet season (August to September) high groundwater table (Seasonal High Water-SHW) at the exit point from the pond shall be shown. All storage shall be above this groundwater level or, if a new SHW is to be established, above the new SHW as accepted by the SWFWMD. For dry ponds, the minimum difference between the SHW and the pond bottom is one foot.
- c) Stormwater Management Systems for Water Quality Treatment
- 1) Volumes for water quality requirements shall be retained, or otherwise treated, below the five-year discharge weir for systems designed with a positive outfall.
 - 2) Storage volumes shall be drawn down within a 72 hour period by natural percolation through the soil (for retention treatment). The distance between the pond bottom and the seasonal high groundwater table shall be at least one foot.
 - 3) Detention facilities whose water quality storage volumes cannot be drawn down within a 72 hour period due to an insufficient percolation rate and/or a

high water table will be required to stack the required attenuation volume over the water quality volume.

5.1.3.8 Percolation and Soils Investigations

- a) Results of all percolation and soils investigations shall be certified by a Florida Registered Professional Engineer. However, U.S. Soil Conservation Service (SCS) soil percolation data may, on a case by case basis, be used for design purposes in lieu of site-specific field testing data. The Engineer-of-Record must accept all professional responsibility and liability for using the SCS data rather than site-specific data for design, and must also obtain specific approval from the County Administrator for waiver of the field testing requirement.
- b) Sufficient test borings shall be made by a certified testing firm to a minimum depth of ten feet below the bottom elevation of the basin or bottom of drain field in order to determine the groundwater table and soil classifications.
- c) Percolation rates at the bottom elevation of the basin or bottom of a drain field may be determined based on a Double-Ring Infiltrometer (DRI) test, ASTM Designation D3385, or other engineered test procedure approved by the County Engineer. Percolation tests shall not be made in filled ground unless the soil has been thoroughly and mechanically compacted or allowed to settle for a period of six months or more.
- d) For the DRI test, the adjusted field rate may be used on the bottom of the pond or drain field and 50 percent on the horizontal component of the sides.
- e) The percolation rate in either case in d. shall be reduced by 10 percent for each foot the water table rises above the elevation 10 feet below the bottom of the basin or bottom of drain field. The maximum allowable percolation rate after adjustment for water table elevation is 1.5 feet/hour.
- f) There shall be at least one soils investigation per 10,000 square feet of pond bottom and one infiltration test per 20,000 square feet of pond bottom placed at appropriate locations provided the entire pond area consists of the same soils type as identified in the SCS Soils Survey of Hillsborough County. If multiple ponds are used, one soil boring and infiltration test will be required per site, regardless of the size. In addition, multiple borings or tests immediately adjacent to each other will not be accepted.
- g) Where percolation from a pond bottom is to be considered, the final six inches of grading shall not be completed until the development has been constructed. This procedure shall be included in the stormwater management plan.
- h) A seepage analysis shall be performed by a Florida Registered Professional Engineer to verify that the stormwater management system does not adversely impact surrounding properties or facilities. An exception may be made for detention ponds that are adjacent to an open conveyance system or sufficiently far from other private properties. Use of this exception requires certification from a geotechnical engineer or the engineer of record that there will be no adverse impacts. The County reviewer may in any case require the analysis if there is any doubt regarding the potential to impact off-site properties.



SECTION 6.0 LARGE SITE DESIGN CRITERIA

All projects with a total site area, or cumulative area, greater than 10 acres are subject to applicable requirements of this Section. Please refer to Section 3.0 for specification of applicable criteria and to Section 4.0 for general development requirements.

6.1 DESIGN STANDARDS

6.1.1 Design Classifications

6.1.1.1 New Development: New development projects with site areas in excess of 10 acres must meet all of the requirements and criteria contained in this Section. The entire site area, and any and all offsite areas which drain to the site, shall be included in the design of the stormwater management system for the site.

6.1.1.2 Redevelopments and Expansions

- a) Cumulative alteration area less than or equal to 10 percent of the original or parent site, but greater than 10 acres; or cumulative alteration of less than or equal to 50 percent of site's remaining pervious area, but greater than 10 acres - Projects must meet all of the requirements and criteria contained in this Section. However, only the cumulative alteration area portion of the site must be included in the design of the stormwater management system for the site. Also, those offsite areas which impact, or are impacted by, the cumulative alteration area must be included in the system design.
- b) Cumulative alteration area greater than 10 percent of the original or parent site, and greater than 10 acres; or cumulative alteration of more than 50 percent of site's remaining pervious area, and greater than 10 acres - Projects must meet all of the requirements and criteria contained in this Section. The entire original or parent site area (including the cumulative alteration area or the cumulative altered pervious area), and any and all offsite areas which drain to the site, shall be included in the design of the stormwater management system for the site.
- c) Existing stormwater management system attenuation, discharge, and treatment capacity shall not be reduced due to redevelopment or expansions of existing development. Also, site alterations are cumulative with time. Therefore, a particular site might transition from less than 10 percent cumulative alteration area or less than 50 percent altered pervious area, to greater than 10 percent cumulative alteration area or greater than 50 percent altered pervious area, as further expansion and redevelopment occurs. The site design criteria will also transition accordingly.

6.1.2 Stormwater management system components shall be designed to accommodate the storm events identified in Table 6-1. All design storm durations are 24 hours, except that for the storm sewer system design storm which is related to the inlet and system times-of-concentration. Refer to APPENDIX A for appropriate design-storm rainfall data.

Table 6-1: Stormwater Management System Component Design Storm Frequencies and Freeboard Requirements

Structure Type		Frequency (Years)	Freeboard Requirement
Bridges/Culverts	Under high use or essential highway, or collector/ arterial roadway	50	(See Section 8.2.10 or Section 8.5.2.3)
	Under low use or non-essential highway, or local roadway	25	(See Section 8.2.10 or Section 8.5.2.3)
Other Structures for Conveyance of Stormwater Off-Site Improvements	Pipe Systems	25	**
	Canals/Ditches	25	(See Section 11.1.11)
Roadway Stormwater Internal Collection Systems	Arterial & Collector	10	9.2.7.3 **
	Local	5	9.2.7.3 **
Detention Ponds	Commercial	25	(See Section 6.1.4.8)
	Subdivision	25	(See Section 6.1.4.13)
Retention Ponds	Commercial	100	(See Section 6.1.4.8)
	Subdivision	100	(See Section 6.1.4.13)
Floor Elevations		100	(See Section 6.1.4.7)

* All designs shall be analyzed to verify that potential off-site flood elevations due to the post-development 100-year/24-hour storm event are less than or equal to predevelopment flood elevations for the 100-year/24-hour storm event.

** The computed hydraulic grade line elevation at each junction/inlet in a system must be below the edge of pavement elevation, gutter line elevation, top of grate elevation, or top of manhole elevation, whichever is lower, at that junction/inlet.

6.1.3 Project Outfall Design Criteria: The capacity of a "receiving waters" is classified by the County as more than adequate, adequate, peak sensitive or volume sensitive. It is the responsibility of the Site Designer to classify the capacity of the receiving waters for a particular project site based upon the following criteria; and to utilize the corresponding design standards defined in these criteria. The Site Designer shall confirm, with the County Administrator, the selection of Project Outfall Design Criteria for a particular site prior to the submission of construction plans for the site.

6.1.3.1 More Than Adequate Capacity

- a) These receiving waters are large water bodies (i.e. Tampa Bay) which have inbank storage and/or conveyance capacity significantly in excess of that required to accommodate the 100-year event, and for which an increase in flow will not cause a measurable increase in water surface elevation. The requirements for any proposed construction or upgrading of connecting facilities to these large water bodies will be established on a case-by-case basis by the County Engineer and will include a minimum design event of at least the 100-year return frequency and post-development conditions. It is recommended that the Site Designer have a pre-design meeting with the Engineering Review Manager prior to submitting the site design so that specific design frequencies and freeboard requirements can be established.



- b) The Developer must submit a stormwater management plan with his design which demonstrates, via calculation, that direct discharge to the receiving waters without attenuation of flow will not measurably raise the water surface elevation.
- c) This attenuation design standard does not relieve the Developer of meeting the stormwater treatment requirements of any other local, state or federal agency.

6.1.3.2 Adequate Capacity

- a) These receiving waters have no known inadequacies or flooding problems during the 25-year, 24-hour storm, but an increase in inflow could cause an increase (computed or actual) in water surface elevation.
- b) A development discharging into this type of receiving waters must be designed so that the computed post-development peak discharge rate, due to a 25-year, 24-hour storm event, does not exceed the predevelopment peak discharge rate for the 25-year, 24-hour storm event.
- c) Projects which do not discharge directly into a well-defined conveyance system, (i.e. ditch, storm sewer, etc.) in the predeveloped state must utilize the design standard defined in Section 6.1.3.4, unless otherwise approved by the County Engineer.

6.1.3.3 Peak Sensitive Capacity

- a) These receiving waters generally have histories of flooding problems related to resistance and restrictions within the channel and/or inadequate conveyance structures, and thus have inadequate flow capacities. Information on areas designated as having peak sensitive capacity can be obtained from the County Administrator. In addition, all storm sewer systems which are used to convey discharge from stormwater ponds are considered to have peak sensitive capacity.
- b) Developments discharging into this type of receiving waters must be designed such that downstream flooding is not worsened in terms of stage and duration.
- c) If the Site Designer wishes to demonstrate that a flow, greater than that computed by application of the appropriate level of service performance standard but less than or equal to the 25-year, 24-hour predevelopment peak flow for the site, can be used for design, an analysis of the timing of post-development peak flows will be required. The analysis shall show that the flow (which includes the proposed post-development contribution from the project site) at the receiving water's critical restriction at the time of arrival of the proposed post-development peak flow from the project site, will be less than the flood-free capacity of the critical restriction.
- d) As an alternative to the evaluation of the peak sensitive capacity criteria, the Site designer can choose to design in accordance with the criteria contained in Section 6.1.3.4.a.2.B.

6.1.3.4 Volume Sensitive Capacity

- a) These receiving waters, also referred to as "blinds", do not have positive outfall for storm events less than or equal to the 25-year, 24-hour event. In addition, sites which do not directly discharge into a well-defined conveyance system (i.e. ditch, storm sewer, etc.) are considered to have volume sensitive capacity since they do not have a positive outfall.
 - 1) Positive outfall is defined as the ability to discharge directly into a manmade or natural channel, waterway or pipe system which is part of a receiving waters which has more than adequate, adequate or peak sensitive capacity.
 - 2) In such areas the site shall be designed in accordance with either of the following criteria:
 - A. The difference between the predevelopment and post-development runoff volumes, due to the 100-year, 24-hour rainfall event, shall be retained on-

site. This design storage volume requirement cannot be reduced through the consideration of percolation or any other means of discharge. This design storage volume must be again available within 72 hours after the end of the design storm event. The Site Designer must demonstrate that percolation is sufficient to drain the design storage volume within the 72-hour period. Percolation calculations shall include analysis of both horizontal and vertical movement of water within the water table and any other effect that the seasonal high water table may have on infiltration capacity. Runoff volume in excess of the design storage volume is not to be discharged from the site during the 100-year, 24-hour storm event, at a rate greater than that corresponding to the predevelopment 10-year, 24-hour event.

- B. The total post-development runoff volume due to the 100-year, 24-hour rainfall event shall be retained or detained on site. The outfall control structure shall be designed to discharge, during the 100-year/24-hour design event, at a rate which will result in a discharge of approximately one inch of runoff from the total area contributing to the pond within 24 hours of the inception of inflow to the pond. An exception to this bleed down criteria can be made by the County Engineer when other agency bleed down criteria is more stringent. When percolation is the only means of discharge from the pond, one inch of runoff is the minimum volume to be discharged in the 24-hour period previously described. However, in no case shall a pond designed according to the requirements of this Section be any smaller than would be needed under Section 6.1.3.4.a.2.A.
 - 3) In those cases where discharge from a site under the predevelopment condition is via sheet flow, final disposal of allowable discharge under the post-development condition shall be via a spreader-swale (or some similar mechanism) to reestablish this sheet flow. However, if the adjacent, down gradient development has provided a proper point of direct entry into a well-defined conveyance system (i.e. ditch, storm sewer, etc.) within which the necessary capacity is available, the point discharge will be permitted.
- 6.1.4 General Design Criteria for Detention/Retention Ponds (Commercial and Subdivision): The purpose of detention and retention ponds is to serve as a buffer to attenuate peak flows and/or excess runoff volume from urbanized areas.
- 6.1.4.1 A detention or retention pond shall be provided in accordance with Section 6.1.3.
 - 6.1.4.2 For the design of most detention ponds, the instantaneous peak discharge expected for the undeveloped site due to a 25-year/24-hour rainfall shall not be exceeded by the instantaneous peak discharge from the developed site due to a 25-year/24-hour rainfall. However, if the receiving waters to which the site discharges is considered to have "peak sensitive", or "volume sensitive", or "more than adequate" capacity, other criteria will apply (See Section 6.1.3).
 - 6.1.4.3 Calculation of the instantaneous peak discharge from the undeveloped site shall consider the effect of existing storage in attenuating this peak. Pre- and post-development initial elevations for estimating storage shall be the seasonal high water elevation (as determined by biological indicators or other suitable methods), and controlled seasonal high water elevation, respectively.
 - 6.1.4.4 A stormwater routing analysis is required for the design of all detention ponds. A routing analysis is also required for retention ponds where percolation is considered during the runoff event. The Storage Indication Method (Modified Puls Method) and



other hydrodynamic methods are the only routing methods recognized and accepted by Hillsborough County. Tailwater conditions must be considered in the routing calculations. Straight line or constant, non-varying discharge assumptions or estimates are not acceptable for large-site pond designs.

- 6.1.4.5 If the design high water of a pond is proposed to be above the ground surface adjacent to or in the vicinity of the pond area, a geotechnical analysis to certify that there will be no adverse impacts due to potential seepage, or from induced seepage slopes, will be required. An exception may be made for detention ponds that are adjacent to an open conveyance system or sufficiently far from other private properties. Use of this exception requires certification from a geotechnical engineer or the engineer of record that there will be no adverse impacts. The County reviewer may in any case require a built-out groundwater table analysis if there is any doubt regarding the potential to impact off-site properties.
- 6.1.4.6 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. All conveyances for offsite flows shall be contained within the limits of the property/site that is currently under review. These conveyances shall be provided within appropriately sized easements.
- 6.1.4.7 The detained or retained runoff storage volume required for the 25-year/24-hour rainfall event is to be stored entirely in the pond. Freeboard containment may be provided by the pond berms and the banks of any hydraulically connected ditch or swale. This shall also be inclusive of perimeter ditches/swales serving subdivisions. The runoff associated with the 100-year/24-hour event shall be routed through the detention/retention pond to establish the minimum residential floor slab elevation, or the floodproofing elevation (commercial sites only). The routing analysis shall also confirm that the pond is not overtopped for the 100-year/24-hour event. In no case should residential floor slab elevations and flood proofing elevations be lower than any flood elevations established by FEMA. The Site Designer is referred to the Hillsborough County Flood Damage Control Regulations (Land Development Code, Section 3.06.00) for minimum floor slab and flood proofing elevation requirements. In the special case of retention ponds without an out-of-bank overflow outlet, the residential floor elevations shall be no lower than 2.5 feet above the retention pond Design High Water elevation.
- 6.1.4.8 For non-residential commercial sites only, no more than 50 percent of the required one foot freeboard for all commercial sites may be provided outside of the designated pond area.
- 6.1.4.9 For non-residential commercial sites of any size, some storage may be allowed on top of paved parking areas when designing to the volume sensitive criteria, provided:
 - a) The difference in the predeveloped and post-developed volumes due to the 25-year/24-hour volume is stored entirely in the pond.
 - b) The design high water elevation is at or below the lowest graded elevation prior to berming or curbing.
 - c) Depth of storage on the pavement does not exceed six inches.
 - d) Adequate freeboard is provided, and can be accomplished by berming or curbing.
- 6.1.4.10 For commercial sites, the maximum side slope for ponds shall be no steeper than 1:4. If, however, a request for steeper slopes is made, up to a maximum of 1:2 for a non-residential commercial site and is granted by the County Engineer, the entire area of the pond shall be protected with a, Florida Department of Transportation (FDOT) Type B Fence, or equivalent safety fence and be constructed along the outer perimeter and on top of the maintenance berm. Ingress and egress for pond maintenance shall be



provided, but restricted by lockable gates of adequate size to allow for the easy passage of necessary maintenance equipment. If chain link fencing is used, it shall be green or black vinyl coated. Side slopes for ponds in residential commercial development shall be no steeper than 1:4, except 10 feet below the normal water level where a 1:2 is allowable providing that side slope stability can be justified. As another alternative to fencing, a side slope no steeper than 1:8, from the outer edge of the maintenance berm or corridor to a depth of two feet below the normal water level, can be considered; with a side slope no steeper than 1:4 from the two feet depth to 10 feet below normal water. 1:2 side slopes are allowable beginning at 10 feet below normal water level, providing that side slope stability can be justified by a geotechnical engineer. For this case, the width of the maintenance berm or corridor is measured from the Design High Water elevation.

- 6.1.4.11 For subdivisions, the maximum side slope for ponds shall be no steeper than 1:4 (vertical: horizontal). The exception would be 10 feet below normal water level where 1:2 side slopes are allowable provided that side slope stability can be justified.
- 6.1.4.12 For commercial sites and subdivisions, man-made wet detention and wet retention ponds shall have a minimum depth of six feet below normal water level. A 1:2 side slope is allowed 10 feet below the normal water level providing that side slope stability can be justified by a geotechnical engineer.
- 6.1.4.13 For subdivisions, the minimum freeboard for ponds shall be one foot between design high water and top of bank. When the adjacent property slopes upward from the outer edge of the maintenance area, credit will be given for freeboard to the external limit of the maintenance area. The cross slope of the maintenance area shall be no steeper than 1:20 (vertical:horizontal). All points within the adjacent maintenance area shall be at or above the elevation of the top of bank. The maintenance area shall be at least 10-foot wide except for clear access to the control structure which shall be at least 20-foot wide unless otherwise approved by the County Engineer. If the maintenance area is on an embankment, the external slope of the embankment shall be no steeper than 1:4 (vertical:horizontal) and the toe of the external slope shall not extend beyond the boundary of the subdivision. The external slope of the embankment shall be grassed and mulched in accordance with FDOT Standard Specifications for Road and Bridge Construction (latest edition) except that side slopes steeper than 1:5 shall be sodded.
- 6.1.4.14 For County-maintained ponds other than those associated with subdivisions, the requirements are the same as those specified for subdivision ponds. However, if it is determined to be in the best interest of the public, in retrofit situations, to vary from subdivision criteria for design of such ponds, the following alternatives are acceptable:
 - a) Pond Side Slopes
 - 1) Side slopes as steep as 1:2 may be considered provided it is demonstrated by appropriate methods that slope stability will not be a problem, and the entire area of the pond is protected with a green or black vinyl coated, Florida FDOT Type B Fence or equivalent safety fence constructed along the outer perimeter and on top of the maintenance berm. Ingress to and egress from the pond maintenance area shall be provided, but restricted by lockable gates of adequate size (20 feet minimum opening) which will allow for the easy passage of necessary maintenance equipment. A 20-foot wide maintenance berm or corridor with no more than a 1:20 cross-slope is required for a 1:2 pond side slope.
 - 2) As another alternative to fencing, a side slope no steeper than 1:8, from the outer edge of the maintenance berm or corridor to a depth of two feet below normal water level, can be considered; with a side slope no steeper than 1:4



from the two feet depth to 10 feet below the normal water level where a 1:2 side slope is allowed, providing that side slope stability can be justified by a geotechnical engineer. For this case, the 20 foot width of the maintenance berm or corridor is measured from the Design High Water elevation.

- b) Maintenance Berm or Corridor Width: Maintenance berm or corridor widths as small as 15 feet with cross-slopes no steeper than 1:10 can be considered for ponds with side slopes no steeper than 1:3.
- 6.1.4.15 For subdivisions and County maintained detention/retention ponds, inflow into the pond shall occur by a pipe conveyance system. Mitered end and flared end sections (no endwalls) shall be used inside detention/retention ponds. Culverts entering wet ponds shall be designed to be no less than half full at the normal water elevation. Culverts entering dry ponds shall be designed with the invert elevation at the bottom elevation of the pond. Other designs, as approved by the County Engineer, may be used which account for the structural stability of the end treatment for pipe entrances and exits within ponds.
- 6.1.4.16 Recovery of attenuation volume for detention/retention ponds is required 72 hours after the end of the storm event. There is an exception to this criteria for detention ponds in volume sensitive areas. (See Section 6.1.3.4.a.2.B).
- 6.1.4.17 Vertical walled ponds are not permitted in subdivision or County-maintained ponds. They are allowed in commercial residential ponds but shall not exceed 25 percent or the perimeter of wet detention ponds. Only 50 percent of the perimeter of a dry detention pond may be walled in commercial residential areas. The entire area of the pond shall also be protected with a green or black vinyl coated FDOT Type B Fence or equivalent safety fence constructed on top of the berm.
- 6.1.4.18 Vertical walled ponds are permitted for non-residential commercial sites, provided that proper berm/embankment width exists at the top of the wall (See Section 6.1.4.19). All vertical walls shall be certified for structural integrity by a structural P.E., registered in the State of Florida. Back slopes shall not exceed 1:2 (vertical: horizontal). Freestanding walls are not permitted. The entire area of the pond shall also be protected with a green or black vinyl coated FDOT Type B Fence or equivalent safety fence constructed on top of the berm.
- 6.1.4.19 For commercial sites, a minimum berm width of five feet is to be provided for detention/retention ponds, unless otherwise approved by the County Engineer.
- 6.1.4.20 The pond maintenance area shall be grassed and mulched in accordance with the FDOT Standard Specifications for Road and Bridge Construction (latest edition).
- 6.1.4.21 All retention and detention ponds shall be grassed and mulched in accordance with the FDOT Standard Specifications for Road and Bridge Construction (latest edition). The grassing shall be to the normal water line or existing water line at time of grassing, whichever is lower. Side slopes steeper than 1:5 (vertical: horizontal) shall be sodded.
- 6.1.4.22 Plans and specifications submitted to the County Administrator shall include provisions for establishing grass on:
- a) Berms
 - b) Side slopes
 - c) Other locations as necessary to prevent erosion, silting and maintenance problems.
- 6.1.4.23 When pond side slopes or soil conditions warrant, sod should be staked to ensure stabilization.
- 6.1.4.24 The maintenance of any commercial, or otherwise privately owned, stormwater management system included as part of an approved site plan shall be the responsibility of the owner(s) or an entity identified by the developer such as a homeowner's association unless the system is officially accepted by the County for maintenance.



Every applicable project must provide a maintenance plan which shall include:

- a) A program for proper maintenance of the bottom and sides of a retention pond to preclude siltation buildup which would reduce its capacity or reduce the rate of percolation, and to prevent the pond from becoming a nuisance. Proper maintenance includes, but is not limited to, any scarifying or sediment removal which is necessary to continue the specified infiltration rates and storage volume. Ponds with landscaped littoral shelves or vines on fences must have a maintenance element as part of those plans, as well as for grassed areas.
- b) A program for proper maintenance of the interior of a stormwater vault or drainfield, to preclude reducing its capacity or the rate of percolation, and to prevent the facility from becoming a nuisance.
- c) A statement designating the entity which will be responsible for the operation and maintenance of the stormwater management system. Attached to the statement should be a defined maintenance program to ensure said system will function for the purpose for which it was intended. If the entity responsible for the operation and maintenance is not the entity for whom the engineering plans, specifications, and design analysis were submitted, then a letter should also be attached stating who the entity will be and the entity's agreement to conform to the defined maintenance program.

6.1.4.25 The practice of burying construction debris or any other unsuitable material within the limits of the detention/retention pond area is strictly prohibited.

6.1.5 Detention Ponds

6.1.5.1 Seasonal High Groundwater Table (SHGWT) Elevation

- a) At locations proposed to be utilized as detention ponds, the seasonal high groundwater table elevation shall be determined using the Soil Survey of Hillsborough County, Florida and acceptable engineering practices, based upon the United States Department of Agriculture, Soil Conservation Service (SCS) methodologies and be signed and sealed by a qualified geotechnical engineer or scientist. The results shall be included in a subsoil investigation report.
- b) No storage credit will be given below the controlled seasonal high groundwater table elevation.

6.1.5.2 Water Level Control Structures

- a) The outlets of detention ponds shall have water level control structures that enable the ponds to function as indicated in the hydraulic calculations.
 - 1) A water level control structure shall not be a pipe riser and shall not be adjustable.
 - 2) Acceptable water level control structures include:
 - A. A modified ditch bottom inlet structure constructed in accordance with the FDOT Roadway and Traffic Design Standards and the FDOT Standard Specifications for Road and Bridge Construction (latest editions).
 - B. In the event a modified ditch bottom inlet structure will not enable the pond to function as indicated in the hydraulic calculations, the water level control structure used shall meet the approval of the County Engineer.
- b) All control structures shall be designed to prohibit the entrance of floating debris into the structure. This shall be achieved by attaching a skimming device to the outfall structure. The bottom of the skimming device shall be at least six inches below the normal water level and the top no lower than the design high water elevation. An appropriate hydraulic design of the device will be required to insure that the skimming device will not control pond discharge.



- c) The control structure shall have a slot or orifice design of no less than three inches, for purposes of attenuation, unless otherwise approved by the County Engineer. The design low water elevation of the detention pond shall be at the slot or orifice invert elevation. The top of the control structure shall be at the elevation of the design high water. Since weir coefficients have been developed only for flow conditions where the length of the weir (L) is much greater than the head on the weir (H - depth of water above weir crest), losses attributed to contraction should be considered when $H/L > 1$.
- d) The water quality storage volume may also be considered for peak flow attenuation, only:
 - 1) If the pond is for retention only and meets the requirements for percolation, or if the pond is designed in accordance with Section 6.1.3.4.a.2.B.
 - 2) For that portion of the pollution abatement volume which is bled down within 36 hours after the end of the storm through a positive discharge structure such as an orifice and:
 - A. The orifice opening is at least three inches in diameter.
 - B. If rectangular, the smallest dimension is at least three inches.
 - C. If a Cipoletti weir is used, the bottom weir length shall be no less than three inches.
 - D. If a V-notch weir is used, above the elevation where the V-notch width is at least three inches.
- e) Tailwater conditions downstream of the water level control structure shall be accounted for in the design of the water level control structure.
- f) Underdrains are not considered to be a positive means of low water control, therefore, the storage volume designed to be dissipated by underdrains below the slot or orifice elevation of the outlet structure, cannot be considered for peak flow attenuation.
- g) Control structures are not to be placed within County road rights-of-way. Hillsborough County Public Works Department retrofit projects are exempted from this requirement to the extent that adequate public safety is not compromised by such an exemption, on a project by project basis.

6.1.5.3 Detention Pond Outfall Control Design

- a) Direct discharge by means of control structures into storm drains or through culverts will be permitted if the receiving systems have the capacity for such discharges. Such systems include:
 - 1) Storm sewer systems
 - 2) Manmade ditches
 - 3) Natural waterways
 - 4) Lakes
- b) When direct point discharge is expected to degrade waters of natural streams, marshes, environmentally sensitive areas, and lands naturally receiving sheet flow, the discharge structure shall direct the flow to an intermediate spreader swale system.
- c) In designing detention ponds where direct discharge is allowed, discharge may be controlled by the use of a weir or orifice structure. The designer should refer to standard hydraulic references for the theory and equations which govern weir and orifice flow.
- d) The designer must also check the capacity of the outfall or discharge pipe to determine whether this pipe controls the discharge, rather than the weir or orifice, at any time during the design runoff event. The Site Designer shall consider local



losses in the evaluation of detention pond outfall pipe systems regardless of flow velocities in the pipe(s).

- e) Where environmentally feasible, the discharge from detention ponds directly to the Hillsborough, Alafia, and Little Manatee Rivers shall flow through vegetated swales.

6.1.5.4 Natural Depressed Areas

- a) Natural depressed areas located entirely within the project boundaries may be used for detention purposes when not adversely affecting off-site water levels.
- b) Depressed areas which may be considered for detention include, but are not limited to:
 - 1) Viable wetlands (subject to permit agency approval)
 - 2) Habitat diversity systems
 - 3) Centralized preservation areas
 - 4) Environmentally sensitive areas
- c) The County Administrator shall make the final determination of suitability of natural areas for stormwater detention, subject to approval from the appropriate permitting agencies.
- d) The storage above the seasonal high water level in natural depressed areas shall be considered in the determination of predevelopment flows.

6.1.6 Retention Ponds

6.1.6.1 Seasonal High Groundwater Table Elevation

- a) The seasonal high groundwater table elevation shall be determined using the Soil Survey of Hillsborough County, Florida and acceptable engineering practices, based upon the United States Department of Agriculture, Soil Conservation Service (SCS) methodologies and be signed and sealed by a qualified geotechnical engineer or scientist. The results shall be included in a subsoil investigation report. The following factors should also be considered:
 - 1) Existing soil conditions (spodic stainlines, where applicable). NOTE: The seasonal high groundwater level is typically one to two feet above the spodic stainline (per SCS).
 - 2) Soil profiles
 - 3) Measured groundwater levels
 - 4) Measured water levels surrounding water bodies
- b) This elevation shall be included in the Stormwater Management System design plans.

6.1.6.2 Design Criteria for Retention Ponds: The following criteria shall be used to design retention ponds:

- a) A suitable overflow outlet (man-made or natural) shall be provided for retention ponds where practical. Such an overflow is to be designed so that the discharge during a post-development 100-year/24-hour storm, will not exceed the 100-year/24-hour predevelopment flow rate. The character of the predevelopment flow pattern shall be maintained by the use of spreader swales or other features.
- b) A subsoil investigation shall be conducted and shall include one boring for each one-third (1/3) acre of pond bottom, if percolation will primarily be through the pond bottom. One boring will be needed for each 500 feet of pond perimeter, if percolation will primarily be through the pond side slopes.
 - 1) There shall be a minimum of two borings per retention pond.
 - 2) The borings shall extend 20 feet below the pond bottom and shall be uniformly distributed, unless otherwise approved by the County Engineer.



- 3) The soil profile and existing ground water elevation and estimated seasonal high groundwater elevation shall be determined for each boring.
 - 4) The soils shall be sampled and classified in accordance with the American Society for Testing and Materials (ASTM) Standard Method D2487.
 - 5) The seasonal high groundwater table elevation shall be determined using the Soil Survey of Hillsborough County, Florida and acceptable engineering practices, based upon the United States Department of Agriculture, Soil Conservation Service (SCS) methodologies and be signed and sealed by a qualified geotechnical engineer or scientist. The results shall be included in a subsoil investigation report.
 - 6) Existing ground surface elevations at each boring location shall be provided.
 - 7) A subsoil investigation report shall be included with the Stormwater Management System Design Calculations.
- c) Retention ponds shall have an infiltration rate test performed for each ½ acre of pond bottom, if percolation will primarily be through the pond bottom. One infiltration rate test will be needed for each 500 feet of pond perimeter, if percolation will primarily be through the pond sideslopes.
- 1) There shall be a minimum of one infiltration rate test for each retention pond.
 - 2) The infiltration rate test (Double Ring Infiltrometer Test) shall be ASTM Standard Method D3385-09.
 - A. The representative field infiltration rate shall be the lowest rate measured.
 - B. Test results shall be included in the Stormwater Management System Design Calculations.
 - 3) The infiltration rate test shall be performed at the depth and location which will provide representative test results for use in design of the retention pond.
 - 4) The subsoil investigation report shall provide detailed information on all test procedures, test depths and locations and data measurements and results.
- d) The design infiltration rate shall be determined by a qualified soils engineer or scientist. The retention pond design shall be based on an infiltration rate that is no greater than 3/4 of the lowest infiltration rate obtained from the tests, with the maximum allowable rate not to exceed 18 inches per hour.
- e) The retention pond bottom shall be no less than 15 feet above SM, SC, ML, CL, OL, MH, CH, OH and PT soils as defined by ASTM Standard Method D2487 and shall be no less than 20 feet above bedrock. The seasonal high groundwater shall be at least five feet below the retention pond bottom for CA (C = coefficient of runoff and A = area in acres) of two or less. This clearance shall increase linearly to 10.0 feet between CA = 2.00 and CA = 4.0. For a CA of 4.0 or more, the clearance to seasonal high groundwater shall be at least 10.0 feet. If the previous specified clearances cannot be met, the Site Designer must demonstrate, by detailed calculations (i.e., by using a computer model) that the retention pond will function according to County criteria and the intended design. These calculations must take into consideration the effects of groundwater mounding and seepage slopes on percolation both during the rainfall event and during the recovery of the design storage volume.
- f) Where discontinuous restrictive layers exist or where a definable combination of restrictive and non-restrictive layers exist, the Site Designer shall consult with the County Administrator to determine the applicability of either of the previous criteria and the need for additional soils data.
- g) The retention pond bottom, for dry retention ponds, shall be uniformly graded to provide a low point 12 inches below the bottom perimeter elevation. The final



grading of the pond bottom shall remove the final six inches and shall be the last work in the construction of the site. Also, for dry retention ponds, a minimum of two feet of clearance is required between the seasonal high groundwater table and the proposed pond bottom.

- h) Retention pond recovery must be demonstrated through the use of a computer model.
- i) All pertinent information and calculations described previously shall be included with the Stormwater Management System Design plan.
- j) Erosion and sedimentation control plans shall be submitted and contain a systematic and comprehensive erosion sedimentation control plan for both the construction phase and the completed project. Refer to Section 13.0.
- k) Proposed temporary and permanent erosion and sediment control plans shall be submitted with each application for development approval. These plans shall specify in detail the erosion and sedimentation control measures to be used during all phases of clearing, grading, filling, construction and permanent development, and accurately describe their proposed operation. In addition, these plans shall be in accordance with the latest applicable specifications and recommendations as contained in the Florida Department of Environmental Protection's (FDEP's) publication, "The Florida Stormwater, Erosion and Sedimentation Control Inspector's Manual", latest edition. Copies of this publication can be obtained from the FDEP.
- l) No clearing, grading, excavation, filling, or other disturbing of the natural terrain will be permitted until County-approved erosion and sediment control measures have been installed, except those operations needed to implement these measures. All erosion and sediment control measures shall be continuously maintained during the construction phase of the development.
- m) These erosion and sediment control measures shall apply to all features of the construction site, including street and utility installations as well as to the protection of individual lots.

SECTION 7.0 RESIDENTIAL LOT GRADING

7.1 GENERAL

Grading of the land is an essential part of any residential development. Good lot grading insures safe and convenient access to homes, livability, and protects lot improvements from flooding. Proper grading will eliminate costly corrective work and reduce the expenditures of County staff time and resources required to investigate and enforce correction of problems created by improper lot grading.

7.2 APPLICABILITY

This Section is applicable to all new platted subdivisions with improvement facilities and all individual lots in platted subdivisions, as well as all metes and bounds lots and parcels.

7.3 LOT GRADING PLAN DESIGN REQUIREMENTS

7.3.1 Lot Types: Lot Type designations should be assigned in conjunction with the drainage conveyance facilities. Type A lots can be integrated with Type B & C lots, provided yard swales are used wherever applicable, to drain the stormwater runoff flow.

7.3.2 Plan Requirements: The Lot Grading Plan must be submitted with the construction plans, along with two separate copies of the Lot Grading Plan sheets. The Lot Grading Plan shall be prepared by a Florida licensed Professional Engineer, Civil discipline, who shall sign and seal the Plan. There is certain data to be shown on the Plan that can only be obtained by a Florida licensed Professional Surveyor and Mapper, in accordance with Chapter 472, Florida Statutes. The Engineer shall obtain such data from a Professional Surveyor and Mapper. All grading and drainage plans shall have a specific note that includes the name of the Professional Surveyor and Mapper (PLS or PSM), the date of the survey and the referenced datum. The lot grading plan shall be designed in a manner that flooding on adjacent properties is not worsened.

7.3.2.1 The Lot Grading Plan shall include the following items at an appropriate scale:

- a) Name of owner(s), the address, date, and telephone number of the Engineer responsible for Plan preparation. The Plan must be referenced to NAVD 88, unless otherwise approved by the County Surveyor
- b) North arrow.
- c) All easements of record: e.g., Drainage (swales, ditches or other related drainage items), TECO, Sanitary Sewer, Water, Telephone, Cable TV. Locate existing right-of-ways and all abutting streets and/or alleys.
- d) Existing contours and Flood Zone lines. Indicate the 100-year Flood Elevation, if applicable, and the FEMA Community Panel Numbers.
- e) Identify all EPC wetland delineation boundaries, and all significant habitat areas.
- f) Property elevations at all corners and grade break points, and at 50-foot intervals to extend 25 feet beyond all property lines (minimum requirement). Properties within flood prone areas where equivalent storage is required must have a survey with elevations provided on a 25-foot interval grid.
- g) Street elevations at the high point and low point (edge of pavement, centerline, or both), and at intersection centerlines.
- h) All proposed and existing structures that are to remain (inlets, manholes, culverts, rivers, lakes, ponds, ditches, swales) showing existing ridge lines with arrows indicating direction of flow from the structures and from the lots. Include structure types and sizes.



- i) Finished Floor elevations for each dwelling must be designated, along with the lot type for each proposed lot. This Finished Floor elevation must be established in accordance with the requirements of the Hillsborough County Construction Code, applicable at the time of the application. In all cases the finish floor shall be set a minimum of six inches above the flood zone elevations of the nearest water body as recorded on the Federal Emergency Manage Agency (FEMA) panel or County floodplain maps for the area, or the 100-year Design High Water for the site's detention pond, or 2.5 feet above the 100-year Design High Water for the site's retention pond with no overflow outlet, whichever is higher. When applicable, the 100-year base flood elevation shall be designated for each lot.
 - j) Proposed drainage easements: It is specifically the intent of these survey requirements that adequate information be provided so that an accurate evaluation can be made of the potential impact on adjacent properties.
- 7.3.2.2 The following notes are required on the Lot Grading Plan and each affected deed.
- a) "Drainage easements shall not contain permanent improvements, including but not limited to sidewalks, driveways, impervious surfaces, patios, decks, pools, air conditioners, structures, utility sheds, poles, fences, sprinkler systems, trees, shrubs, hedges, and landscaping plants other than grass, except for the landscaping of stormwater detention and retention ponds as required by the Land Development Code."
 - b) "Rear yard swales along the back property lines of lots...(show lot numbers and blocks in this space)... shall be maintained by the individual lot owners according to the approved lot grading plan on file in the Hillsborough County Development Services Department. This note shall appear on each affected deed"
- 7.3.2.3 Any proposed or required detention/retention areas, perimeter swales conveyance systems along with calculations, dimensions, and cross sections as required elsewhere in this Manual.
- 7.3.2.4 Cross-sections of the property and improvements, showing relationship of swales, foundation, finished floor slab and 25 feet beyond property line.
- a) For all grading and drainage plans, cross-sections shall be provided along property boundaries with all topographic data (existing and proposed elevations) for all improvements and at least 25 feet outside of the project boundaries. Such cross-sections must demonstrate that all stormwater runoff drains in a manner no worse than that which occurred during the predevelopment condition along private property boundaries.
 - b) Spot elevations in perimeter swales and conveyances shall be provided to demonstrate positive drainage.

7.4 LOT GRADING, AS-CONSTRUCTED INFORMATION

In order to provide protection for the citizens of Hillsborough County, a lot grading as-constructed survey is to be provided for every residential unit. This survey is to be certified by a Florida licensed professional Surveyor and Mapper. The survey may be performed at the "final lot survey" stage but only after landscaping has been placed. The survey will contain all information set forth in Section 7.3.2.1 and will comply with Florida Statutes 472 and Florida Administrative Code 61G17-6. The survey will demonstrate compliance with the approved lot grading plan and that the lot grading meets or exceeds the requirements of the Florida One and Two Family Residential Code in the Florida Building Code.

7.5 INVESTIGATION OF LAND ALTERATION VIOLATIONS



7.5.1 Land Alteration Impacts on Drainage

- 7.5.1.1 Land alteration activities are not to impede or divert the flow of surface water entering or leaving land in a manner that adversely impacts offsite property. Observing the altered area from as many angles as possible is necessary. Establish the probable direction of flow by establishing the lowest point between the altered area and adjacent property. Surface water will seek the lowest area in which to settle.
- 7.5.1.2 In conducting an investigation, the task is to determine if a land alteration has occurred. It is a violation of the Hillsborough County Land Development Code if an alteration required a Natural Resources Permit and a permit was not obtained prior to the alteration activity. Typically, drainage complaints are triggered by unpermitted land alterations that have impeded or diverted surface water flow. Physical evidence or other documentation of an alteration is necessary to issue a citation for violation of the Land Development Code. If physical evidence is not present at the time of the investigation, it becomes the responsibility of the complainant to produce such evidence or documentation.
- 7.5.1.3 Prompt notification by the complainant to the Development Services Department of any alleged unpermitted land alteration activity is vital for a proper investigation. If a violation cannot be identified, or sufficient documentation by the complainant cannot be produced, the investigation will be closed. Sufficient documentation can be either photographs or video recordings that have been properly dated.

7.6 NATURAL RESOURCES AND LANDSCAPING PERMITS

Applicants for single family/duplex Natural Resources Permits, including those for lots in platted subdivisions, as well as metes and bounds lots and parcels, shall meet the submittal requirements established by the Development Services Department. These requirements include providing existing and proposed corner grades, proposed finished floor elevations, drainage flow arrows, tree surveys and location of environmental wetland lines. Erosion and sedimentation control plans shall be included and contain a systematic and comprehensive erosion sedimentation control plan for both the construction phase and the completed project. Refer to Section 13.0.



SECTION 8.0 CULVERT AND BRIDGE DESIGN

8.1 GENERAL

- 8.1.1 Culverts are required to convey surface water flows through roadway crossings, driveways and other similar obstructions to flow in ditches and other open channels. Culvert design involves the consideration of many of the same design factors considered in storm sewer system design, including the allowance for entrance, exit and manhole/junction head losses, which head losses can drastically affect the upstream (headwater) elevations and/or culvert sizes required. Additionally, particular attention should be given to the downstream water surface elevation (i.e. tailwater condition) in selecting the appropriate culvert sizes. Hillsborough County uses procedures published by the Federal Highway Administration (HEC-5, Federal Highway Administration (FHWA), 1965, or Latest Edition), and promoted by the Florida Department of Transportation (FDOT) Drainage Manual, Latest Edition for analysis and design of culverts.
- 8.1.2 Bridges are required, rather than culverts, when clearance requirements for navigation, hydraulic efficiency, constructability, environmental concerns, costs or aesthetics preclude the use of culverts. The basic design criteria for bridges presented in this Manual include: design frequency of storm event, design high water elevations, vertical and horizontal clearance requirements, and scour protection considerations for both the channel and embankments in the vicinity of a bridge.

8.2 CULVERT DESIGN CRITERIA

- 8.2.1 Design Frequency: The required design storm frequencies are shown in Table 6-1.
- 8.2.2 Design Flows: The determination of design flows for a culvert installation shall be in accordance with the methods and procedures in APPENDIX B.
- 8.2.3 Culvert Roughness: The roughness coefficients indicated in Table 8-1 shall be used for culvert design.
- 8.2.4 Minimum Culvert Size: Criteria for minimum culvert size is in Table 8-2.



Table 8-1: Manning’s n Values for Culvert and Storm Sewer Design

Pipe	N
Smooth Interior HDPE or PVC Pipe - all sizes	0.010
Concrete Pipe	0.012
Concrete Box Culvert Precast or Cast-in-Place	0.012
Spiral-Ribbed Corrugated Metal Pipe - 18" to 96"	0.012
Corrugated Metal Pipe (Annular - 2-2/3" by 1/2" Corrugation, round, all sizes)	0.024
Corrugated Metal Pipe (Annular - 3" by 1" Corrugation, round, all sizes)	0.027
Corrugated Metal Pipe (Helical - 2-2/3" by 1/2" Corrugation)	
Diameter or Span	N
15"	0.012
18"	0.014
24"	0.017
30"	0.018
36"	0.019
42"	0.020
48"	0.020
60" and larger	0.021
Corrugated Metal Pipe (Helical - 3" by 1" Corrugation)	
Diameter or Span	N
48"	0.023
54"	0.023
60"	0.024
66"	0.025
72"	0.026
78" and larger	0.027
Corrugated Metal Pipe Arch	
All Sizes:	
Corrugation Size	N
2-2/3" by 1/2"	0.024
3" by 1"	0.027
5" by 1"	0.027
Corrugated Structural Plate Pipe and Pipe Arch	
All Sizes:	
Corrugation Size	N
6" by 1"	0.030
6" by 2"	0.033
9" by 2-1/2"	0.034

Note: Refer to Section 8.4 for acceptable pipe materials.

Table 8-2: Minimum Culvert Size Criteria

Type of Culvert	Minimum Size
Cross Drains	18 inches or Equivalent (24 inches or Equivalent for Arterial Roads with area > 1ac.)
Storm Sewer	15 inches or Equivalent
Side Drains	18 inches or Equivalent
Box Culvert	3 feet by 3 feet (precast) 4 feet by 4 feet (cast-in-place)

- 8.2.5 Pipe Size Increment: Pipe sizes above 18 inches or equivalent shall be based upon six inch increment or equivalent increases.
- 8.2.6 Length: The maximum length of culvert to be used without an access structure is specified in Table 8-3.

Table 8-3: Maximum Culvert Length Criteria

Culvert Size	Maximum Length (Feet)
15" or Equivalent	100*
18" or Equivalent	300
24" to 36" Pipe or Equivalent	400
42" and Larger Pipe or Equivalent	500
Box Culvert	500

* Up to 300 feet maximum length may be used when debris control is provided at any and all inlet locations, and full-flow culvert velocity exceeds three feet/second.

- 8.2.7 Minimum Physical Slope: The minimum physical slope for a culvert shall be that which will produce a velocity of at least 2.5 feet per second when the culvert is flowing full and the hydraulic gradient is equal to the bottom slope of the culvert. The effects of the end treatment and/or the conditions of any outfall shall be considered in this hydraulic analysis. The Manning equation shall be used to calculate the velocity under these conditions.
- 8.2.8 Maximum Velocity: The maximum allowable internal velocity for culverts shall be governed by Table 9-1. The maximum allowable outlet velocity for culverts shall be governed by Tables 11-1 and 11-2 unless acceptable energy dissipation and erosion protection measures are provided. The maximum internal and outlet velocities are the same velocity, and shall be computed by dividing the design discharge by the cross sectional area of the culvert.
- 8.2.9 Design Tailwater
 - 8.2.9.1 All culvert installations shall be designed taking into consideration the tailwater of the receiving facility or body of water (inlet or outlet control). The tailwater elevation must be determined by hydrologic and hydraulic calculations based upon the design criteria and frequencies shown in Table 6-1.
 - a) When the tailwater elevation is higher than the proposed culvert crown elevation, the downstream hydraulic grade line elevation shall be at the tailwater elevation.
 - b) When the tailwater elevation is below the culvert crown elevation, the downstream



hydraulic grade line elevation shall be at or above the crown of the proposed culvert for final design.

- c) Ditch-bottom inlets or “bubbler boxes” designed to discharge as an outfall for ponds are not permitted.

8.2.9.2 For design purposes, the tailwater or hydraulic grade elevation at Tampa Bay and all adjoining bays shall be assumed to be no lower than elevation 1.6 feet NAVD 88.

8.2.10 Allowable Headwater: The following criteria should be considered when determining the allowable headwater elevation (AHW). The constraint that establishes the lowest AHW should establish the basis for hydraulic design.

8.2.10.1 The allowable headwater of a culvert installation should be determined by the Site Designer. However, it should not be set at an elevation that would violate the minimum freeboard requirements of Section 11.1.11. for the design storms specified in Table 6-1, nor should it be set above the roadway shoulder under design conditions.

8.2.10.2 When endwalls are used, the headwater shall not exceed the top of the endwall at the entrance. If the top of the endwall is inundated, then special protection of the roadway embankment and/or ditch slope may be necessary for erosion protection.

8.2.10.3 Non-damaging or permissible upstream flooding elevations (e.g., existing buildings or Flood Insurance Regulations) should be identified. Headwater should be kept below such elevations.

8.2.10.4 The allowable headwater should be checked for the base flood (100-year storm event) and, for most facilities, the culvert should be sized to maintain flood-free conditions for one-half lane of two-lane facilities and one lane of multi-lane facilities.

8.2.11 Endwalls

8.2.11.1 Endwalls shall be installed on all culverts (except side drains which shall have mitered end sections) unless other provisions are made for erosion protection.

8.2.11.2 Endwalls shall conform to the FDOT Roadway and Traffic Design Standards and the FDOT Standard Specifications for Road and Bridge Construction (latest editions).

8.2.11.3 Entrance loss coefficients (K_e) for standard inlet configurations are shown in Table 8-4. Entrance head loss is to be computed by the following equation:

$$H_e = \frac{K_e v^2}{2g} \quad (8-1)$$

where, v = flow velocity.

8.2.11.4 Endwalls shall not be used inside detention/retention ponds, unless otherwise approved by the County Engineer.

Table 8-4: Culvert Entrance Loss Coefficients Outlet Control, Full or Partially Full
 (From USDOT, FHWA, HEC-5, 1965, or Latest Edition)

Type of Structure and Design of Entrance	Coefficient K_e
Pipe, Reinforced Concrete	
Projecting from fill, socket end (groove-end)	0.2
Projecting from fill, square cut end	0.5
Straight headwall	
Socket end of pipe (groove-end)	0.2
Square-edge	0.5
Rounded (radius = 1/12D)	0.2
Mitered to conform to fill slope	0.7
End-section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side- or Slope-tapered inlet	0.2
Straight sand-cement	
U-type with grate	0.7
U-type	0.5
Winged concrete	0.3
U-type sand-cement	0.5
Flared end concrete	0.5
Side drain, mitered with grate	1.0
Pipe or Pipe-Arch, Corrugated Metal	
Straight endwall-rounded (radius = 1/12D)	0.2
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls, square-edge	0.5
Mitered to conform to fill slope	0.7
End section conforming to fill slope, paved or unpaved	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side- or slope-tapered inlet	0.2
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edged on three edges	0.5
Rounded on three edges to radius of 1/12 barrel dimension or beveled edges on three sides	0.2
Wingwalls at 30° to 75° to barrel	
Square-edged at crown	0.4
Crown edge rounded to radius of 1/12 barrel dimension, or beveled top edge	0.2
Wingwalls at 10° to 25° to barrel, square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7
Side- or slope-tapered inlet	0.2

8.2.11.5 End sections conforming to fill slope, made of either metal or concrete, are the sections

commonly available from manufacturers. From limited hydraulic tests, they are equivalent in operation to a headwall in both inlet and outlet control. Some end sections incorporating a closed taper in their design have a superior hydraulic performance.

- 8.2.12 **Minimum Clearance:** The minimum clearance for all pipe culverts are specified in Table 8-5. Exceptions to these criteria will be considered for approval by the County Administrator on a case-by-case basis.

Table 8-5: Minimum Clearance Criteria for Pipe Culverts

From	To	Clearance
Outside crown of pipe	Bottom of road base	1.0 foot
Shell of pipe	Shell of utility crossing	0.5 foot
Invert of manhole	Shell of conflict utility passing through	1.0 foot

8.3 CULVERT DESIGN PROCEDURES

8.3.1 Culvert Hydraulics

8.3.1.1 For flow in culverts, a wide range of flow regimes can occur depending on flow rate, bed slope and cross-sectional geometry as well as other factors. For a given flow rate, there are two different depths of flow that have the same energy; a high velocity with low depth (supercritical flow) and a low velocity with a high depth (subcritical flow). There is one depth for a given flow, the critical depth, which corresponds to the minimum energy of flow and depends on the shape and size of the culvert. For any given discharge and cross-section, there is a unique slope (critical slope) that will produce and maintain flow at critical depth. Generally, for most culverts, the culvert slope will not be critical, and flow will be supercritical or subcritical.

8.3.1.2 A culvert can operate under either inlet control (the barrel has a greater hydraulic capacity than the inlet) or outlet control (the inlet has a greater hydraulic capacity than the barrel). During a given storm event a culvert may operate under inlet control, outlet control, or may transition from one control to the other as the storm progresses.

- a) **Culvert Design Criteria:** Culverts shall be designed according to the "inlet and outlet control" methodology. The recommended design procedure, as adopted from the FDOT Drainage Manual, Chapter 8, Section 8.5, is provided in APPENDIX B.
- b) **Inlet Control**

- 1) Inlet control occurs when the capacity of the culvert is controlled at the culvert entrance by the depth of headwater and the entrance geometry of the culvert, including barrel shape, cross-sectional area, type of inlet edge, and shape of headwall. With inlet control, the entrance acts similar to an orifice or a weir, depending on the headwater depth. Barrel friction in the culvert is not a factor for a culvert operating under inlet control conditions. Four different configurations of inlet control are shown in Figure 8-1. When the depth of water at the culvert entrance (headwater) is less than the culvert height, the flow rate is governed by critical depth or, in general, by broad-crested weir control. As the depth of headwater increases, the entrance of the culvert will be considered submerged when the ratio of the depth of the headwater (HW) to the height of the culvert (D) exceeds 1.2. When the

entrance is submerged and the control is at the inlet, the flow will be governed, in general, by orifice flow.

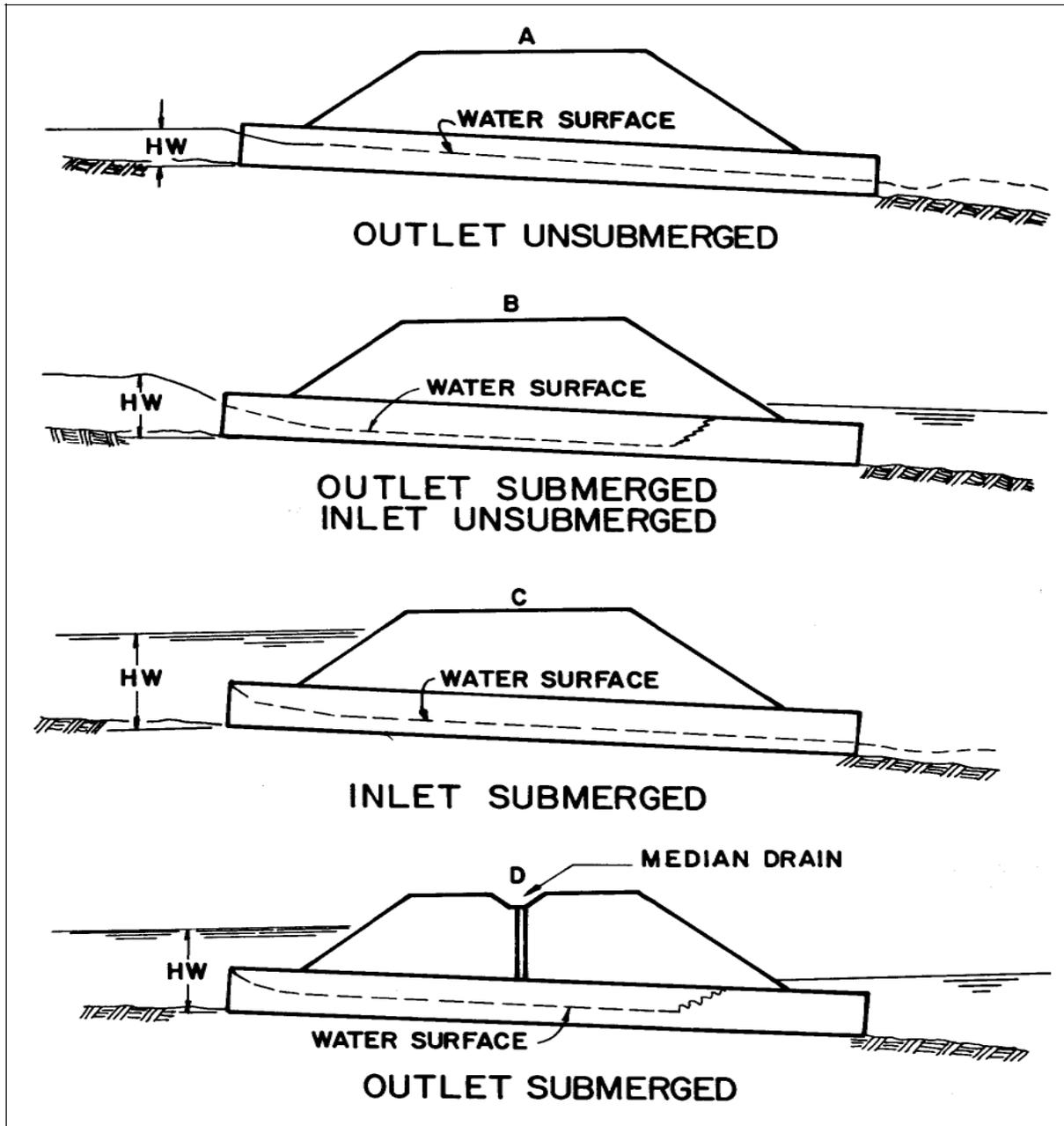


Figure 8-1: Four Inlet Control Conditions

- 2) Culvert nomographs for conventional culverts operating under inlet control have been developed by the Federal Highway Administration. Some are included in APPENDIX C, while others can be located in USDOT, FHWA, HEC-5, 1965, or latest edition.

c) Outlet Control

- 1) When a culvert is designed to efficiently operate under outlet control, the barrel typically flows full. In addition to the influences on the culvert capacity described for inlet control, outlet control involves the additional consideration of the elevation of the tailwater in the outlet channel, and the slope, roughness, and length of the culvert barrel. Culverts under outlet control can flow with the culvert barrel full or partially full for all or part of the barrel length. Full flow outlet control conditions are shown in Figure 8-2 (Parts A and B), while partially full outlet control conditions are shown in Figure 8-2 (Parts C and D).

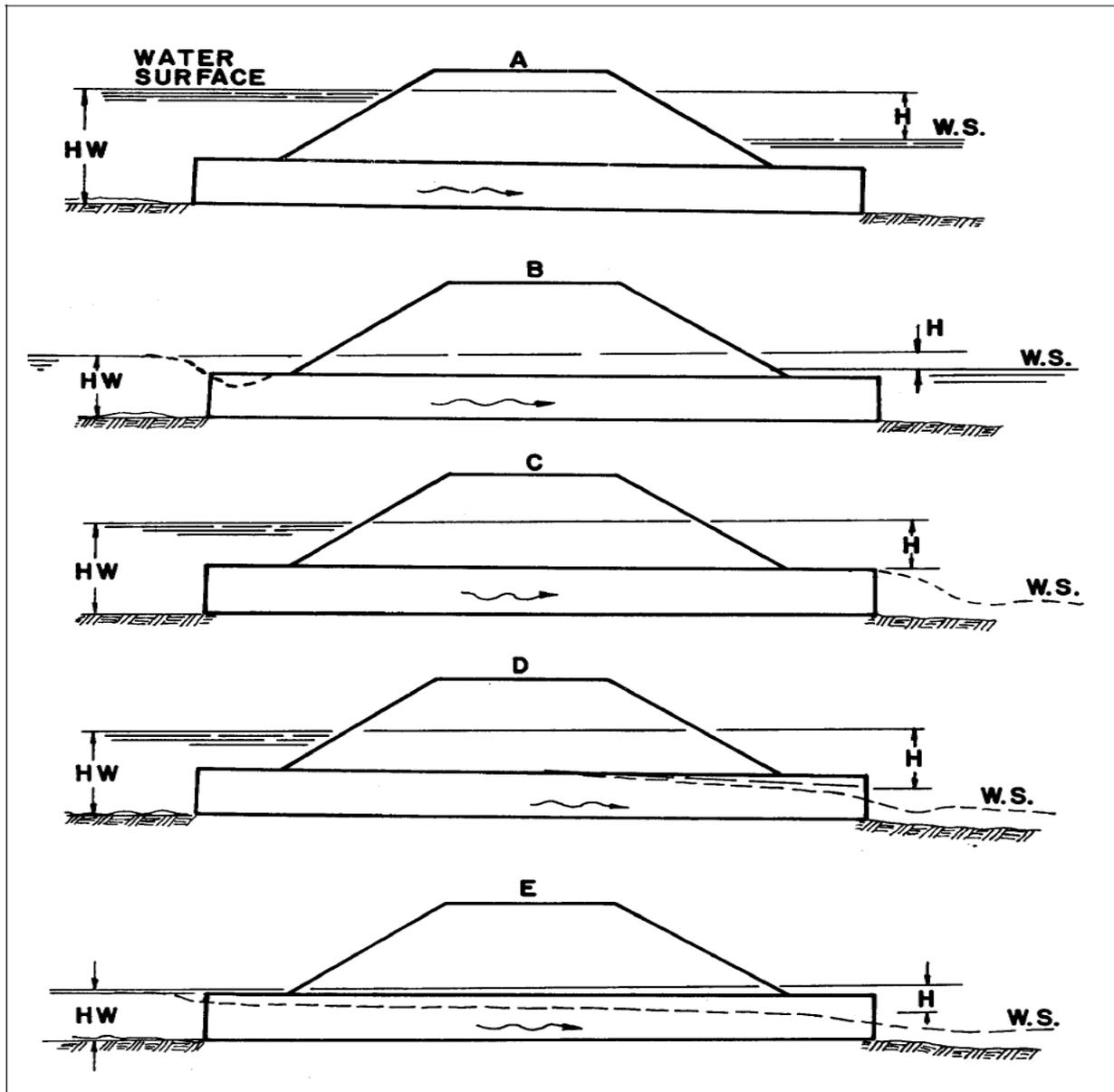


Figure 8-2: Five Outlet Control Conditions

- 2) In addition to full and partially full flow conditions, submerged and unsubmerged tailwater conditions may exist. Typical unsubmerged flow conditions are shown in Figure 8-2 (Parts C, D and E). Under outlet control conditions, the capacity of the culvert is controlled by the conveyance of the barrel and by downstream conditions.
- 3) Outlet control nomographs have been developed by the Federal Highway Administration. Some are shown in APPENDIX C, while others can be located in USDOT, FHWA, HEC-5, 1965, or latest edition.

8.3.2 Design Computation Forms: The use of the design computation form provided in APPENDIX C is a convenient method to use to obtain consistent cost-effective designs.

8.4 MATERIAL SPECIFICATIONS FOR ALL CULVERTS

Allowable culvert and other stormwater management system pipe materials shall be the same as those culvert and pipe materials allowable by the Florida Department of Transportation (FDOT). Any size, cover, location or any other constraint or limitation placed on the use of a particular material by FDOT shall also be required by Hillsborough County. The required guidance and procedures for selecting alternate culvert and pipe materials for installation in Hillsborough County shall be found in the FDOT Optional Pipe Materials Handbook, and in any and all supplemental guidance and procedures officially issued by the FDOT. Any new materials, or modifications to constrained or limited materials, shall not be allowable in Hillsborough County until such time that the FDOT has officially accepted the material for use.

8.4.1 Specifications Regarding Materials Workmanship, Joints and Installation Shall be in Accordance with FDOT Requirements

8.4.1.1 Pipe joints for other than reinforced concrete pipe when allowed under the pavement of County maintained roadways, right-of-ways and easements, shall have passed FDOT requirements for soil tight joints (two PSI maintained without leak for 24 hours). Additionally, coupling bands for corrugated pipe shall be so constructed as to lap on an equal portion of each of the pipe sections to be connected. Each end of each pipe section shall have a minimum of two annular corrugations. The connecting bands shall have a minimum of two annular corrugations and shall fully engage, over the entire periphery, one corrugation on each pipe end. If gaskets are required, they shall be either sleeve type or O-ring type:

- a) Sleeve Type: Sleeve type gaskets shall be closed-cell neoprene, skin on all four sides. They shall meet the requirements of ASTM D-1056, Grade SCE-43, and shall be of one-piece construction. The thickness shall be 3/8 inch and the width shall be 1/2 inch less than the width of the connection band required.
- b) O-ring Type: O-ring type gaskets shall meet the requirements of ASTM C 361.

8.5 BRIDGE DESIGN

8.5.1 General: It is recommended that the design of bridge structures be undertaken by engineering staff and/or subconsultants with experience in designing all phases of bridges. Bridges are used when clearance requirements for navigation, hydraulic efficiency, geometrics, constructibility, environmental concerns, costs, or aesthetics preclude the use of multiple culverts. The basic hydraulic design criteria for bridges include the frequency of the design storm event, design high water elevation, allowable backwater, vertical and horizontal clearance, and channel and



abutment protection. Any variations in meeting the bridge design criteria specified in this Manual must have prior approval in writing from the County Engineer. FDOT design criteria and procedures (Drainage Manual and Bridge Hydraulics Handbook) should be followed unless otherwise stated in this Manual.

- 8.5.2 Hydraulic Bridge Design Criteria: Each bridge requires development of site specific design criteria that will meet the needs of the crossing.
- 8.5.2.1 Design Storm Frequency: Refer to Table 6-1.
 - 8.5.2.2 Design High Water Elevation
 - a) Design high water for freshwater channels is defined as the water elevation just upstream of the bridge for the design storm event.
 - b) In tidally influenced areas, the design high water is the greater elevation of either the design frequency tidal surge event or the design frequency fresh water event superposed with the one-year tidal surge event.
 - c) The 100-year flood shall be conveyed through the structure with no rise in the preconstruction upstream, off-site 100-year water surface elevation.
 - 8.5.2.3 Vertical Clearances: For bridges on piers or piles, the minimum required freeboard clearance is measured from design high water to low chord member. For collector and arterial roads, the minimum freeboard clearance shall be two feet unless otherwise approved by the County Engineer.
 - 8.5.2.4 Horizontal Clearance: Horizontal clearance should be provided to comply with applicable Coast Guard or District requirements. In addition, environmental or fill constraints may influence the selected horizontal clearance. Bridge embankments shall not encroach into FEMA designated floodways.
 - 8.5.2.5 Scour: The effects of scour should be considered in the design of all bridge crossings. Consideration should be given for scour protection if velocities exceed three feet per second, or if highly erodible soil is encountered (See Tables 11-1 and 11-2).
 - 8.5.2.6 Erosion and Sedimentation Control Plans: The submitted plans shall contain a systematic and comprehensive erosion sedimentation control plan for both the construction phase and the completed project. Refer to Section 13.0.



SECTION 9.0 STORM SEWER DESIGN

9.1 GENERAL

The purpose of this section is to establish design criteria for storm sewer systems constructed within Hillsborough County. This criteria is intended to govern the design of new systems as well as the analysis and/or redesign of existing systems. Additional design information and criteria related to drainage of street and roadway pavement and inlet spacing along streets and roadways are included in Section 12.0.

9.2 DESIGN CRITERIA

9.2.1 Design Storm Frequency: Refer to Table 6-1.

9.2.2 Design Discharges: The determination of design flows for internal storm sewer systems shall be by the Rational Method or the NRCS(SCS) Method (individual subareas draining to inlets are typically less than 10 acres due to constraints on inlet capacity and spread-of-flow on pavement criteria - see APPENDIX A for methodology). For calculated times of concentration of 15 or less, a minimum time of concentration of 15 minutes shall be used in the storm sewer analysis. If the drainage area to an inlet is greater than 10 acres for either internal or external systems, the appropriate method for estimating design flows will be determined by the Site Designer and approved by the County Administrator.

9.2.3 Allowable Materials: Refer to Sections 8.4.

9.2.4 Roughness Coefficients for Storm Sewer Systems: Refer to Table 8.1.

9.2.5 Minimum Pipe Size and Pipe Size Increment: Refer to Table 8.2.

9.2.6 Minimum and Maximum Physical Slopes

9.2.6.1 Refer to Section 8.2.7 for minimum physical slopes.

9.2.6.2 The maximum physical slope of a pipe will usually be less than 10 percent and shall not exceed 15 percent.

9.2.7 Maximum Hydraulic Gradient and Maximum Hydraulic Grade Elevation

9.2.7.1 The maximum hydraulic gradient allowed will be that which will produce a velocity as shown in Table 9-1.

Table 9-1: Maximum Velocities for Given Types of Pipe

Type of Pipe	Maximum Velocity
O-Ring RCP	20 feet per second
Diaper Joint RCP	12 feet per second
Gasketed CMP	12 feet per second

9.2.7.2 For storm sewer outfalls, the maximum allowable velocity should be consistent with the soil stability requirements at the pipe outlet. If the velocities exceed permissible velocities for the outlet soil conditions (see Section 11.1.7), the installation of staked sod, pavement or structural energy dissipaters may be required.

9.2.7.3 The maximum hydraulic grade elevation shall be no higher than the edge of pavement at the inlet throat for roadway stormwater collection systems.



- 9.2.8 Maximum Length of Pipe: Refer to Table 8-3.
- 9.2.9 Minimum Pipe Clearances: The minimum clearances listed in Table 8-5 shall be used when determining pipe elevations. Should it be impossible to maintain these separations, then adequate means (i.e., concrete encasement, etc.) must be utilized to protect both the storm sewer system and the obstructing facility. In addition, utility lines passing through conflict structures shall be a minimum of one foot above the bottom of the structure and any energy losses created by the presence of the utility shall be calculated and accounted for in the storm sewer tabulations of the hydraulic grade line. Such minor loss, due to a utility line crossing located between the invert(s) and crown(s) of the major storm sewer pipes entering/exiting the conflict junction, shall be no less than one velocity head unless smaller losses can be documented.
- 9.2.10 Design Tail Water: A design tailwater elevation for each outfall of a storm sewer system must be determined. The design tailwater elevation is the initial downstream elevation for the computed hydraulic grade line. The tailwater elevation must be determined from measured data (if appropriate) or by hydrologic and hydraulic calculation, considering the same design storm frequency used to estimate the design storm sewer flows. In the case where the storm sewer system outfalls to a stormwater pond, if a tailwater elevation cannot be calculated, the hydraulic gradient shall begin at the crown of the discharge pipe at the stormwater pond, or at an elevation equal to the average of the design high water and normal pool elevations of the stormwater pond, whichever elevation is higher. Also, for storm sewers outfalling to Tampa Bay and all adjoining bays, the design tailwater or hydraulic grade elevation shall be assumed to be no lower than elevation 1.6 feet NAVD 88.
- 9.2.11 Storm Sewer Tabulations: In developments where storm sewers are planned, the Stormwater Design Calculations shall include a Storm Sewer Tabulation Form similar to that contained in APPENDIX C, and a map containing the individual sub-basin delineations and any inlet/junction and pipe numbering system used.
- 9.2.12 Inlets, Manholes and Junction Boxes: All inlets, manholes and junction boxes shall conform to the FDOT Roadway and Traffic Design Standards, the FDOT Standard Specifications for Road and Bridge Construction and the Hillsborough County Transportation Technical Manual, latest editions. All inlets are to have manhole lids for maintenance access. All manhole lids are to state "Dump no waste, waste drains to the waterway" or similar language and shall cite Hillsborough County Ordinance #94-15. All pipes are to be cut flush with the inside walls of inlets, manholes and junction boxes. Conflict structures shall be included in the design where conflicts occur with other utilities.
- 9.2.13 Storm Sewer Alignment: All storm sewer layouts shall avoid abrupt changes in direction or slope and shall maintain reasonable consistencies in flow velocity. Where abrupt changes in direction or slope are encountered, provisions shall be made for the resulting headlosses. Any changes in alignment shall take place within manholes or junction boxes. It is preferred to locate pipes outside the edge of pavement. In those limited cases where it is unavoidable to place long sections of pipe under pavement, approval of the County Engineer is required. In addition, the pipe shall be oriented such that maintenance can be accomplished within one lane of the roadway. The width of the maintenance area shall be determined from Section 4.1.15
- 9.2.14 Determination of Design Hydraulic Gradient Line
- 9.2.14.1 Local losses at structures shall be determined for all inlets, manholes, wye branches and bends in the design of closed conduits. When more than one discharge enters a



manhole, the pipes should not be oppositely aligned. If directly opposite discharge pipes are necessary, a deflector shall be placed within the manhole in order to reduce the losses caused by the discharge jets impinging upon each other. Deflector installations must have prior approval of the County Administrator.

- 9.2.14.2 The energy losses associated with the turbulence in the individual manholes are minor for an open channel or gravity storm sewer system and can typically be compensated for by adjusting (increasing) the upstream pipe invert elevations in a manhole by a small amount. However, the energy losses associated with turbulent flow in individual manholes can be significant for a pressure or surcharged storm sewer system and must be accounted for in establishing an accurate hydraulic gradient line. A table of acceptable head loss coefficients (K) for various types of surcharged manholes/catch basins/junctions is given in Figure 9 1.

9.2.15 Inlet Capacities

- 9.2.15.1 Maximum inlet capacities shall be determined utilizing drainage calculations that demonstrate that the spread of flow will not exceed the criteria found in 12.10.1.
- 9.2.15.2 FDOT inlet capacity charts may be utilized to determine the inlet capacities of FDOT standard inlets.
- 9.2.15.3 On a case by case basis, the effects of inlet bypass may be required. If required by the County's reviewer, calculations shall be provided that include a 25-year analysis that demonstrates the effects of inlet by-pass, in order to eliminate the potential for structural flooding.

- 9.2.16 Inlet Location: The location and spacing of inlets and manholes shall be based on maximum allowable pipe lengths (Table 8-3), inlet capacity and spread-of-flow criteria. Stormwater shall not be transported across major intersections or in gutters for distances exceeding 500 feet from each inlet approach, unless otherwise approved by the County Engineer.

9.3 DESIGN PROCEDURE

Refer to APPENDIX B for recommended design procedures, and for a description of the recommended design aid: FDOT Storm Sewer Tabulation Form.

- 9.3.1 Erosion and Sedimentation Control Plans: The submitted plans shall contain a systematic and comprehensive erosion sedimentation control plan for both the construction phase and the completed project. Refer to Section 13.0.

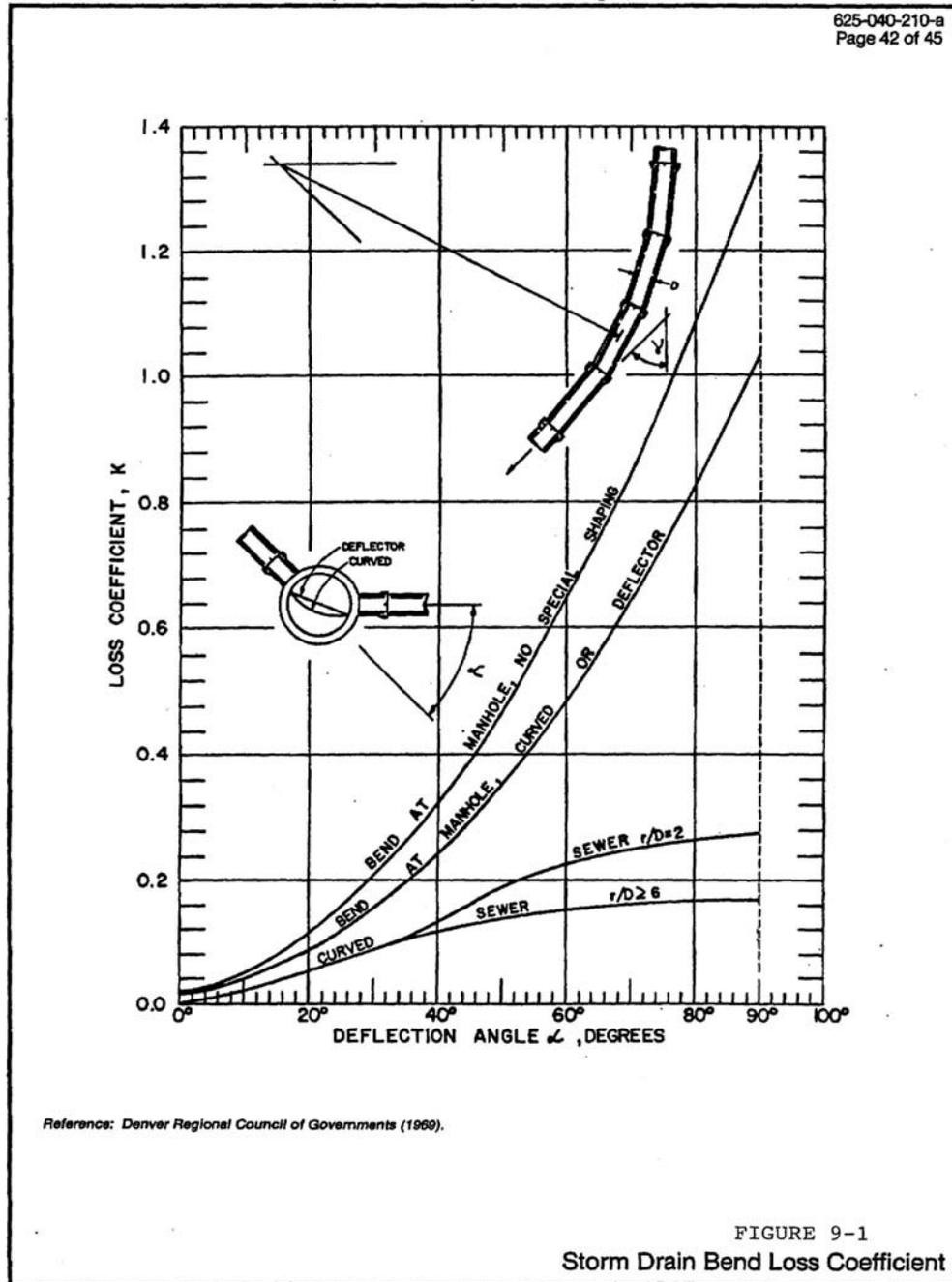


Figure 9-1: Storm Drain Bend Loss Coefficient



SECTION 10.0 ROADWAY UNDERDRAIN DESIGN

10.1 ROADWAY UNDERDRAIN CRITERIA

10.1.1 General

- 10.1.1.1 Underdrains may be required to facilitate groundwater control for roadways which are to be maintained by Hillsborough County and also for private subdivision roadways. For privately owned and maintained townhome subdivisions, a Letter of Certification from the Engineer of Record may be submitted. A copy of the Letter of Certification can be found at the end of this Section. Arterial and collector roadways shall be designed so that the SHGWT is at least three feet below the low edge of pavement.
- 10.1.1.2 When the use of underdrains is required, the site construction plans shall include all details necessary to indicate the underdrain locations and design/construction parameters.
- 10.1.1.3 Underdrains are considered to be permanent controls of the groundwater table. The design of the roadway may be based on long term groundwater level control through the use of underdrains. However, the underdrain system must be designed by a qualified professional with experience in groundwater analysis.
- 10.1.1.4 The use of roadway underdrains is dependent on soil types, seasonal high groundwater table (SHGWT) elevation, landslope, elevation of the roadway base, and outfall conditions. Roadway underdrains are required as follows:
- SHGWT within three feet of low edge of pavement - underdrain on one side of road.
 - SHGWT within two feet of low edge of pavement - underdrain on both sides of road.
 - SHGWT less than one foot below low edge of pavement - elevate roadway.
- 10.1.1.5 If a "controlled" SHGWT level (i.e., a SHGWT level controlled by a manmade system to be lower than the estimated predevelopment "normal" value) is considered in determining the need to elevate a proposed roadway, an analysis of the sustainability of the controlled SHGWT will be required. The analysis must include the continuous evaluation of the functioning of the proposed control system for an entire, typical "wet season" pattern of rainfall on the proposed roadway, project area and receiving waters, to determine if it is likely that the controlled SHGWT elevation can be reasonably maintained throughout the season. Recommendations made by the geotechnical consultant shall be included on the plans.
- 10.1.1.6 The underdrains shall be centered 24 inches outside of the curb and a minimum of 24 inches below the bottom of the curb, and shall have a positive slope to a positive outfall.

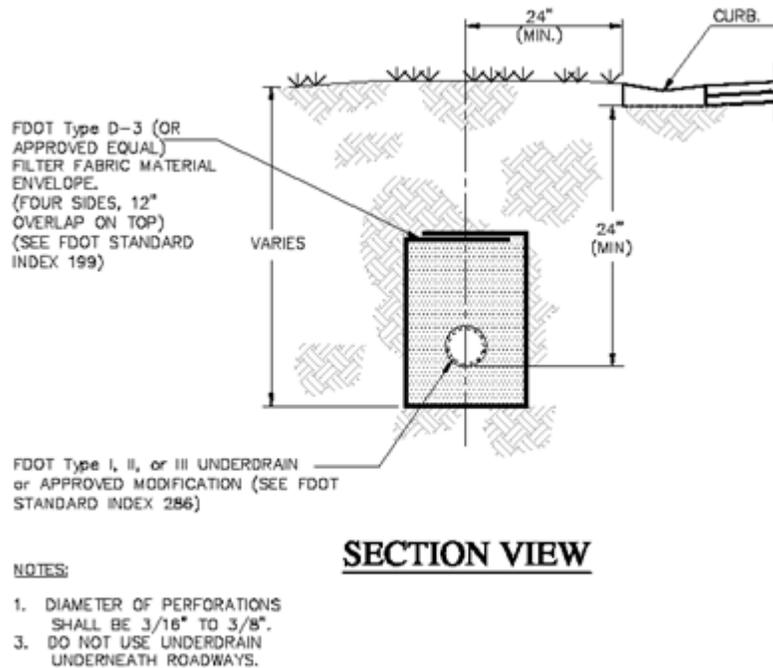


Figure 10-1: Roadway Underdrain

- 10.1.1.7 All underdrain designs shall utilize filter fabric, underdrain pipe, and filter aggregate.
- 10.1.1.8 When an underdrain is required to control high groundwater adjacent to proposed roadways, the roadway base shall not be limerock.

10.1.2 Filter Fabric

- 10.1.2.1 A filter fabric envelope shall be used with underdrains and shall be an appropriate strong, porous nylon, polyester, polypropylene or other fabric approved by the County Engineer (i.e., FDOT Type D-3 geotextile material or filter fabric) which completely envelops the underdrain aggregate surface in such a way as to prevent infiltration of surrounding material.
- 10.1.2.2 The filter envelope shall weigh a minimum of 2.5 ounces per square yard, shall retain soil particles larger than two hundred twelve (212) microns (No. 70 sieve) and shall pass particles finer than 25 microns.
- 10.1.2.3 When tested in accordance with ASTM D1682, the grab strength (wet) of the filter fabric shall not be less than 100 pounds and the grab elongation shall not be less than 60 percent.
- 10.1.2.4 Storage and handling of the filter fabric shall be in accordance with the manufacturer's recommendation.
- 10.1.2.5 Torn or punctured filter fabric shall not be used.
- 10.1.2.6 The filter fabric shall not be exposed to sunlight for periods exceeding the manufacturer's recommendation, or six weeks, whichever is shorter.
- 10.1.2.7 The filter fabric is to be placed around the aggregate and, if appropriate and approved by the County Administrator, around the underdrain pipe.



10.1.3 Underdrain Pipe

- 10.1.3.1 Underdrain pipe shall be of sufficient size (six-inch minimum) to effectively control and convey the anticipated flow. Calculations are to be submitted to justify proposed underdrain size.
- 10.1.3.2 The length is not to exceed 500 feet without increasing pipe size to the next larger diameter. Cleanouts are to be spaced no greater than every 250 feet and at the ends of the underdrain. Cleanouts are to extend to the ground and all cleanout locations shall be marked, in a permanent manner, along the roadway curb or on other appropriate and permanent fixtures as approved by the County Administrator. The cleanout cap is to be enclosed in a Standard Concrete Meter Box with Cast Iron Cover.
- 10.1.3.3 Underdrain pipe slopes should be sufficient to maintain velocities at or above two feet per second for design flow conditions. Underdrain shall typically be constructed on a grade parallel with the edge of pavement profile, but in no case shall the minimum underdrain slope be less than 0.10 percent).
- 10.1.3.4 Underdrain pipe shall be concrete, corrugated aluminum, polyvinyl-chloride, corrugated polyethylene or other material approved by the County Engineer.
 - a) Underdrain materials shall be in accordance with the FDOT Roadway and Traffic Design Standards and the FDOT Standard Specifications for Road and Bridge Construction, latest editions.
 - b) Corrugated aluminum underdrain pipe may be used in tidal areas but shall not be used near dissimilar metals that may cause galvanic action.
 - c) Corrugated polyethylene tubing underdrain installations shall conform to the following:
 - 1) Corrugated polyethylene tubing and fittings shall meet the requirements of AASHTO M252-09, latest edition.
 - 2) The minimum wall thickness of the crown, sidewalls or valley shall be 0.025 inches.
 - 3) Coiling of tubing is only permitted during shipment.
 - d) The tubing shall not be exposed to sunlight for periods exceeding the manufacturer's recommendation, or six weeks, whichever is shorter.
 - e) Tubing shall be placed and maintained true to line and grade until secured with compacted backfill.
 - f) Perforated tubing shall not be placed under street pavement. When tubing must be extended beneath the crossroad, a non-perforated section shall be used.
 - g) Underdrain sections which deflect or collapse greater than five percent shall be rejected.

10.1.4 Aggregate

- 10.1.4.1 Fine aggregate for cement concrete, in accordance with the FDOT Standard Specifications for Road and Bridge Construction, latest edition, shall be used to backfill the trench above and around the underdrain aggregate envelope, except that the County Engineer may approve other backfill material provided tests are submitted indicating the material will adequately serve as a filter.
- 10.1.4.2 The minimum density of the backfill shall be 95 percent of the standard laboratory density determined in accordance with AASHTO T99 (Method A).
- 10.1.4.3 The underdrain cross-section is to be in accordance with FDOT Design Standards, latest edition. Unless otherwise approved, FDOT Type II will be the only underdrain design allowed for arterial and collector roadways within Hillsborough County.
- 10.1.4.4 Erosion and Sedimentation Control Plans: The submitted plans shall contain a systematic and comprehensive erosion sedimentation control plan for both the



construction phase and the completed project. Refer to Section 13.0.

CERTIFICATION OF TOWNHOME SUBDIVISION UNDERDRAIN DESIGN

I hereby certify that based upon the evaluation of site specific seasonal high groundwater information for (PROJECT NAME), hereafter referred to as the “Development”, underdrain is / is not (circle one) necessary to protect the pavement base material from impacts that may be attributed to continued inundation by an elevated groundwater table. I have followed best engineering practices in making this determination. All proposed pavement grades, including the lowest edge of pavement, are at a minimum of six inches above the design high water of the receiving stormwater pond where soil-cement or crushed concrete has been specified as the pavement base material. A minimum of one foot of separation has been provided where other base materials are specified. The six inches or one foot minimum separations will be increased when the design process or site conditions warrant it.

When depicted on the site development construction plans (“plans”) for the Development, the underdrain dimensions and materials detailed on said plans have been provided in accordance with FDOT minimum standards.

I further certify that a copy this certification along with an appropriate maintenance schedule (attached) has been provided to the property owner/applicant of the Development.

Signed and sealed this _____ day of _____, 20__.

Signature

Florida Professional Engineer No. _____

Affix Seal

Figure 10-2: Certification of Townhome Subdivision Underdrain Design Form



SECTION 11.0 NON-ROADWAY DITCH DESIGN

11.1 GENERAL DESIGN CRITERIA

11.1.1 Design Storm Frequency: Refer to Table 6-1.

11.1.2 Design Discharge: The determination of design flows for an open channel system shall be by the methods and procedures included in APPENDIX A, for the appropriate design storms.

11.1.3 Design Methodology

11.1.3.1 A ditch shall be initially sized using Manning's formula. The initial ditch size shall then be evaluated relative to additional potential energy losses (i.e. bends, expansions, constrictions, etc.) and the impacts of tailwater (backwater). If required, the initial ditch section shall be increased or otherwise modified to properly accommodate the design flow. In all cases, data including drainage area, velocity and depth of flow shall be provided in the Stormwater Management System Design Calculations along with typical sections. The Site Designer is referred to standard hydraulics texts for the definitions and application of Manning's Equation.

11.1.3.2 No credit for stormwater storage will be allowed for ditches. A ditch is considered to be a means of conveyance only. Hillsborough County Public Works Department retrofit projects are exempted from this requirement to the extent that adequate public safety is not compromised by such an exemption, on a project by project basis

11.1.3.3 No ditch blocks will be permitted in road right-of-ways for internal subdivision drainage. Hillsborough County Public Works Department retrofit projects are exempted from this requirement to the extent that adequate public safety is not compromised by such an exemption, on a project by project basis

11.1.4 Maximum Side slope: The maximum side slope shall be 1:4 for all non-roadway ditches except in cases of overriding public interest where necessity deems it appropriate for steeper side slopes to be constructed.

11.1.5 Minimum Bottom Width: The minimum bottom width for ditches shall be three feet.

11.1.6 Design Tail Water

11.1.6.1 All open channel systems shall be designed taking into consideration the tailwater of the receiving facility or body of water.

11.1.6.2 The appropriate tailwater elevations must be determined by hydrologic and hydraulic calculations based upon the design criteria and frequencies contained in Table 6-1.

11.1.7 Maximum Allowable Velocities for Unlined and Line Open Channels

11.1.7.1 The maximum allowable velocities for unlined open channels (bare soil condition) are listed in Table 11-1.

Table 11-1: Maximum Allowable Velocities for Unlined Open Channels

Soil Type	Allowable Velocity For a Flow Depth of About 3 Ft. (f.p.s.)
Silt or Fine Sand	1.50
Sandy Loam	1.75
Silt Loam	2.00
Firm Loam	2.50
Stiff Clay	3.75
Hardpans	6.00

11.1.7.2 The maximum allowable velocities for lined open channels are listed in Table 10-2.

Table 11-2: Maximum Allowable Velocities for Lined Open Channels

Type	Allowable Velocity (f.p.s.)
Grassing & Mulching	Same as Unlined Channels (Table 10-1)
Standard Sod	4.0
Lapped Sod (25% overlap)	5.5
Asphaltic Concrete	8.0
Concrete Ditch Paving	10.0

11.1.8 Minimum Longitudinal Grade: For open channels that are intended to remain dry except during runoff conditions, the minimum grade allowable shall be 0.10 percent.

11.1.9 Ditch Alignment: The alignment of existing ditches should be preserved whenever practical. For skewed ditch crossings, the culvert shall be skewed to maintain the existing ditch alignment.

11.1.10 Channel Curvature: A minimum centerline radius of 50 feet or 10 times the bottom width, whichever is larger, shall be utilized. Channel protection shall be provided when channel curvature produces erosive velocities in excess of those shown in Section 11.1.7.

11.1.11 Minimum Freeboard: A minimum freeboard of one foot shall be maintained between design high water surface elevation and the adjacent top of bank, except in cases of overriding public interest where a lesser freeboard may be appropriate.

11.1.12 Ditch Erosion Protection

11.1.12.1 Ditches shall be provided with permanent erosion protection. Erosion protection may be turf, using an approved type grass, or an approved type of liner.

11.1.12.2 When turf protection is used, ditches shall be sodded, sprigged or seeded for a lateral distance extending from within one foot of the road pavement to the top of the swale ditch backslope.

11.1.12.3 Ditches shall be grassed and mulched or sodded in accordance with the Florida Department of Transportation (FDOT) Standard Specifications for Road and Bridge Construction, latest edition. Side slopes steeper than 1:5 shall be sodded.

11.1.12.4 Ditch pavement shall be in accordance with the FDOT Design Standards and the FDOT Standard Specifications for Road and Bridge Construction, latest editions.

11.1.12.5 Side slopes above the paved section shall be shaped and sodded on a slope of one vertical to four horizontal or flatter, except in cases of overriding public interest where



steeper slopes may be appropriate.

11.1.13 Grading Adjacent to Ditches: Areas adjacent to ditches shall be graded to preclude the entrance of excessive stormwater runoff except at locations provided for such purpose.

11.2 UTILITIES CROSSING DITCHES

Where it is necessary for a utility to cross a ditch, the following minimum requirements shall be adhered to:

11.2.1 Aerial Crossing: Utilities crossing ditches shall have a minimum of one-foot clearance above design high water with the area underneath the crossing to be concrete lined to prevent vegetative growth.

11.2.2 Underground Clearance: A utility crossing a ditch shall have a minimum of a two-foot clearance below the invert of the ditch.

11.2.3 Utility Identification: Utilities shall be adequately marked to protect against accidental damage during maintenance operations.

11.2.4 Aerial Supports: No aerial supports shall be allowed in the confines of the ditch cut unless authorized by the County Administrator.

11.2.5 Underground Crossings: Underground utility crossings of all floodways, open channels and ditches shall be clearly labeled on-site with suitable markers or permanent signs.

11.2.6 Erosion and Sedimentation Control Plans: The submitted plans shall contain a systematic and comprehensive erosion sedimentation control plan for both the construction phase and the completed project. Refer to Section 13.0.



SECTION 12.0 ROADWAY (PAVEMENT) DRAINAGE DESIGN

12.1 GENERAL

Good pavement drainage design consists of the proper selection of design factors (i.e. grades, cross slopes, curb types, inlet locations, etc.) to effectuate removal of the design storm rainfall from the pavement in a cost-effective manner. In addition, the design should provide for the preservation of safety, traffic capacity and integrity of the highway and street system.

12.2 LOW ROADWAY BASE CLEARANCE AND EDGE OF PAVEMENT ELEVATION

Design criteria for roadway base clearance and low edge of pavement elevation are specified in Table 12-1, found at the end of this Section. Also refer to Section 10.0 for additional criteria related to controlling the seasonal high groundwater table (SHGWT) elevation.

12.3 MINIMUM ROADWAY GRADES

The Site Designer is referred to the Hillsborough County Transportation Technical Manual as the source for acceptable minimum roadway grades.

12.4 MINIMUM ROADWAY CROSS-SLOPE

The Site Designer is referred to the Hillsborough County Transportation Technical Manual as the source for acceptable cross slope.

12.5 DESIGN STORM FREQUENCY

Refer to Table 6-1 for the design storm frequency to be utilized for the design of pavement drainage.

12.6 STORMWATER RUNOFF DETERMINATION

The peak rates of stormwater runoff for the design of the pavement drainage system shall be determined by the Rational Method or the NRCS(SCS) Method (see APPENDIX A).

12.7 CONCRETE CURB, GUTTER AND SIDEWALKS

12.7.1 Design Details: Details of concrete curb, gutter and sidewalks shall conform to the latest editions of the Hillsborough County Transportation Technical Manual and the Florida Department of Transportation (FDOT) Design Standards.

12.7.2 Materials and Installation: Materials and installation shall conform to the FDOT Standard Specifications for Road and Bridge Construction and the Hillsborough County Transportation Technical Manual, latest editions.

12.8 GRASSING, MULCHING AND SODDING

The site designer is referred to the Hillsborough County Transportation Manual as the source for acceptable grassing, mulching and sodding.

12.9 ROADWAY DITCHES

12.9.1 Design

12.9.1.1 Roadway ditches shall be sized using the criteria in Section 10.1.

12.9.1.2 In all cases, drainage area, velocity, and depth of flow data shall be included in the



Stormwater Management System Design Calculations.

- 12.9.1.3 The minimum bottom width shall be three feet unless otherwise approved by the County Engineer.
- 12.9.1.4 The maximum side slope shall be 1:4, unless otherwise approved by the County Engineer.
- 12.9.1.5 Standard ditch sections shall be provided along external roadways.
- 12.9.2 Maximum Allowable Velocity: The maximum allowable velocities for unlined and lined open channels are listed in Tables 11-1 and 11-2, respectively.
- 12.9.3 Roadway Ditch Grades
 - 12.9.3.1 Minimum: A 0.10 percent grade, or the minimum required to provide for the design flow, whichever is greater, shall be the minimum allowable grade.
 - 12.9.3.2 Maximum: Maximum allowable ditch grades will be governed by maximum allowable velocities as listed in Tables 10-1 and 10-2.
 - 12.9.3.3 Ditch Protection: Ditch protection is required when the design velocities exceed allowable velocities for unlined channels. Refer to Tables 10-1 and 10-2.
- 12.9.4 Depth of Roadway Ditches
 - 12.9.4.1 Minimum Depth: Two feet from the low edge of shoulder unless otherwise approved by the County Engineer
 - 12.9.4.2 Maximum Depth: 3.5 feet from the low edge of shoulder unless otherwise approved by the County Engineer.
- 12.9.5 Grassing and Mulching, Sodding: All roadway ditches shall be grassed and mulched or sodded in accordance with the FDOT Standard Specifications for Road and Bridge Construction, latest edition. Side slopes steeper than 1:5 shall be sodded.

12.10 STREET DRAINAGE

12.10.1 Design Criteria

- 12.10.1.1 The maximum length of gutter prior to the need for an inlet shall be controlled by the allowable spread of flow on the pavement, or 500 feet, whichever is smaller.
 - 12.10.1.2 The spread of flow for local roads (<1500 annual Average Daily Traffic - AADT) shall not exceed the crown of the road. The spread of flow for two-lane collectors (>1500 AADT) is 1/2 lane. For four-lane collectors the spread shall not exceed the outer lane and calculations shall be submitted. The rainfall intensity for calculating spread of flow shall be four inches per hour. No spread of flow calculations shall be required for inlet spacing that is less than 300 feet. The time of concentration for spread of flow calculations shall be equal to the appropriate overland flow travel time
 - 12.10.1.3 Stormwater shall not be transported across major street intersections, unless otherwise approved by the County Engineer.
 - 12.10.1.4 Streets that exceed a one percent longitudinal or gutter slope shall have inlets constructed at intersections to intercept upstream flow.
- 12.10.2 Gutter Flow Calculations: The designer is referred to standard hydraulic texts (or Section 5.1.3.6.c) for the proper use of Manning's Equation in determining the spread of flow in gutters.



Table 12-1: Design Criteria for Roadway Base Clearance and Low Edge of Pavement Elevation

Location	Freeboard from DHW to Low Edge of Pavement Elevation	Basis for Determining the Design High Water (DHW) Elevation	Minimum Standard Roadway Base Clearance (1)	Required Roadway Base Courses
Near Hillsborough Bay Old Tampa Bay & Tampa Bay	> 0 foot	5.1 feet NAVD 88	None	Crushed Concrete (4) or Asphalt Base
Near Retention Ponds	> 1.0 foot	100-year storm	2.0 feet (2)(3)	Other Roadway Bases
Near Detention Ponds & Streets with crushed concrete (4) Roadway Bases	> 0.5 foot	25-year	2.0 feet (2)(3)	Other Roadway Bases
Streets with Other Roadway Bases	> 1.0 foot	25-year storm	2.0 feet (2)(3)	Other Roadway Bases

- (1) *The roadway base clearance is defined as the distance between the seasonal high groundwater table (SHGWT) elevation and the roadway base course (bottom of base). The SHGWT elevation shall be determined using the Soil Survey of Hillsborough County, Florida and acceptable engineering practices based upon the United States Department of Agriculture, Soil Conservation Service (SCS) methodologies and be signed and sealed by a qualified soils engineer or scientist. The results shall be included in a subsoil investigation report.*
- (2) *This criteria can be reduced to greater than or equal to one foot if a crushed concrete or soil cement base (4) is utilized. However, underdrains shall be installed on each side of the roadway and designed to maintain a 1.0 foot minimum roadway base clearance. Refer to Section 10.0 for roadway underdrain design and criteria. In addition, 0.5 foot of select sand (S) or special select sand (S+) as defined in Index No.505 of the FDOT Design Standards, latest edition, shall be placed below the crushed concrete or soil cement base to provide positive drainage.*
- (3) *Asphalt base may be utilized with the approval from the County engineer. The placement of select sand (S) or special select sand (S+) is not required when an asphalt base is used.*
- (4) *Crushed concrete or soil cement may be used as allowed by the Hillsborough County Transportation Technical Manual.*



SECTION 13.0 WATER QUALITY PROTECTION AND IMPROVEMENT

13.1 GENERAL

- 13.1.1 The protection, and the improvement of water quality, as well as the control of stormwater and sediment runoff into receiving waters are primary concerns for Hillsborough County. The management of stormwater runoff is essential for flood control and for the containment of pollutants which might otherwise result in water quality degradation of Tampa Bay and other receiving waters. Additionally, the County requires that any water entering the Municipal Separate Storm Sewer System (MS4) meet Class III water quality standards, as established by the Florida Department of Environmental Protection.
- 13.1.2 In order to minimize the potential water quality impacts of new development, both during and after site construction, design and management requirements are specified herein in the areas of:
- 13.1.2.1 Stormwater treatment/pond design
 - 13.1.2.2 Erosion and sediment control
 - 13.1.2.3 Construction site operation and maintenance
 - 13.1.2.4 Stormwater management facility operation and maintenance
- 13.1.3 The need to impose these requirements is established in the Future OF Hillsborough County Comprehensive Plan, the Hillsborough County National Pollutant Discharge Elimination System (NPDES) Permit and the Hillsborough County Stormwater Quality Management Ordinance (Ordinance # 94-15). The Florida Department of Environmental Protection and the U.S. Environmental Protection Agency have identified certain water bodies or parts of water bodies that are impaired in that they are not meeting state water quality standards. New construction that discharges to these impaired water bodies are must make every effort to reduce the expected increases in pollutant loading. These requirements are applicable to all new development and redevelopment, and to all infrastructure retrofitting and maintenance activities within Hillsborough County.
- 13.1.4 In general, reasonable assurance that a proposed land alteration activity does not negatively impact the water quality of receiving water bodies must be provided. This reasonable assurance regarding water quality must be provided for both the short term and the long term, addressing the proposed land alteration, both during and after site construction, as well as the construction, alteration, operation, maintenance, removal and abandonment of the stormwater management system.
- 13.1.4.1 Stormwater Treatment and Pond Design
 - a) The long term protection of water quality can be provided by the proper design, construction, operation and maintenance of effective stormwater treatment systems. Such systems, usually ponds, are required for new and redeveloped sites within Hillsborough County, as identified in Sections 5.0 and 6.0. The Southwest Florida Water Management District (SWFWMD) also requires the construction of a stormwater treatment system as part of a permitted site's overall stormwater management system. Therefore, the submittal to the Development Services Department of a copy of the appropriate SWFWMD permit for a site is sufficient to demonstrate that reasonable stormwater treatment provisions will be provided. Submittal of the approved SWFWMD permit to the County is required before final construction plan approval can be authorized.



- b) The integration of maintainable sediment sumps into the design of a stormwater pond is recommended. These sumps should be located at the outlet ends of the stormsewer pipes or other stormwater conveyance structures which discharge into a pond.
- 13.1.4.2 Erosion and Sediment Control: The site development construction plans and associated documentation shall include a detailed plan to control soil erosion and sedimentation, both during and after the construction phase of the development. Erosion and sedimentation control provisions and plans shall be in accordance with the latest applicable specifications and recommendations as contained in the Florida Department of Environmental Protection's (FDEP's) publication, "The Florida Stormwater, Erosion and Sedimentation Control Inspector's Manual", latest edition. Copies of this publication can be obtained from FDEP. Such provisions shall address:
- a) Methods of Controls: Erosion shall be minimized and sediment retained on the site of development through the application of best management practices approved as part of the Natural Resources permit. Methods of control shall be suitable for site size, vegetative cover, soil type, slope, design features and proposed construction sequence and activities. Allowable methods include, but are not limited to, the following:
- 1) Providing turbidity barriers or similar devices for the duration of dewatering and other construction activities in or adjacent to wetlands or other surface waters;
 - 2) Stabilizing newly created slopes or surfaces in or adjacent to wetlands and other surface waters to prevent erosion and turbidity;
 - 3) Construction sequencing, to maximize the retainage of sediments onsite (see Chapter 4 of FDEP manual).
 - 4) Limiting the amount of clearing necessary;
 - 5) Staging clearing activities to minimize the length of time any area is left unstabilized and to minimize the total area cleared at any one time;
 - 6) Temporary gravel construction entrances;
 - 7) Straw bale barriers;
 - 8) Silt fences;
 - 9) Storm drain inlet protections;
 - 10) Temporary diversion dikes;
 - 11) Temporary sediment traps;
 - 12) Temporary sediment basins;
 - 13) Temporary stream crossings;
 - 14) Seeding so as to establish an appropriate vegetative ground cover;
 - 15) Sodding;
 - 16) Erosion control and seeding mats; or
 - 17) Other suitable methods as approved by the County Engineer.

Where the previously mentioned allowable methods will not, or do not, sufficiently control erosion and sediment runoff, installation of part or all of the final stormwater treatment system components, including internal grading to direct stormwater toward the system, shall be required. The construction plans must specify that the contractor is responsible for successfully controlling erosion and sediment runoff. If the recommended or specified techniques do not sufficiently control erosion and sediment runoff, then the contractor shall implement alternative techniques, which are successful.

- b) Installation of Controls: No clearing, grading, cutting, or filling shall commence

until erosion and sedimentation control devices have been properly installed, in accordance with an approved plan, between the area to be disturbed and adjacent property, water bodies, watercourses (including inlets and culverts), and wetlands. Clearing and excavation required for installation of erosion and sedimentation control devices is allowed provided no activity occurs beyond five feet from the control devices as specified in an approved plan.

- c) **Maintenance of Controls:** Once properly installed, erosion and sediment controls must be continuously maintained until a permanent vegetative ground cover is established. Any site or portion thereof where work is not being performed as part of the current phase of development, and which remains, or is projected to remain, cleared for over seven days, shall be stabilized to minimize the occurrences of both water and wind erosion through measures such as the establishment of appropriate vegetative ground cover. All disturbed areas shall be permanently stabilized through the establishment of appropriate vegetative ground cover upon completion of development activities on the site.

13.1.4.3 **Construction Site Operation and Maintenance:** Proper management and operation of construction site activities, and continuous maintenance of safeguards will further reduce the potential for water quality impacts attributable to development. Construction plans or associated documentation must address issues such as:

- a) Providing proper construction access for barges, boats and equipment to ensure that propeller dredging and rutting from vehicular traffic does not occur.
- b) Maintaining construction equipment to ensure that oils, greases, gasoline, or other pollutants are not released into the wetlands or other surface waters.
- c) Controlling the discharge from spoil disposal sites.
- d) Providing measures to minimize the tracking of soil, mud, concrete, etc., onto public roadways or other offsite paved areas.
- e) Providing measures to control dust generation and movement.
- f) Preventing any other discharge or release of pollutants during construction or alteration that will cause violations of any state or local water quality standard, including but not limited to:
 - 1) The rules of the Environmental Protection Commission of Hillsborough County.
 - 2) The rules of FDEP.
 - 3) The rules of SWFWMD.
 - 4) The Hillsborough County Stormwater Quality Management Ordinance # 94-15, and amendments thereto.

13.1.4.4 **Stormwater Management Facility Operation and Maintenance**

- a) A recommended operation and maintenance plan shall be developed and submitted along with the site construction plans and associated documentation.
- b) All stormwater inlets, pipes and ponds shall be cleaned of accumulated sediments upon completion of site construction activities, and prior to final project closeout or final approval and acceptance of facilities for maintenance by the County.
- c) The final grading for ponds shall not be completed until all other construction activities, including the cleaning of inlets and pipes has been completed.



APPENDIX A: DETERMINATION OF STORM RUNOFF



DETERMINATION OF STORM RUNOFF

A.1 GENERAL

This appendix outlines the approved methods available to the Site Designer for estimating storm runoff. Of the many methods available, this manual makes use of three (listed below), which have proved convenient and reliable. In addition, other recognized methods may be used if their applicability can be demonstrated to the County Engineer.

- * THE RATIONAL METHOD (for areas of ten acres or less)
- * THE MODIFIED RATIONAL METHOD (for areas of ten acres or less)
- * SCS SYNTHETIC UNIT HYDROGRAPH METHOD (SCS)

These methods should be used to calculate the discharge and runoff volumes resulting from rainfall events of specified design frequency and duration.

A.2 RAINFALL CRITERIA

A. RAINFALL INTENSITY-DURATION-FREQUENCY RELATIONSHIPS

The FDOT Rainfall Intensity-Duration-Frequency (IDF) Curves for Zone 6 (Figure A-14) shall be used in Hillsborough County when designing by the Rational or Modified Rational Methods. For application to these methods, the duration used should be subject to a minimum of 15 minutes.

B. RAINFALL DEPTHS AND DISTRIBUTIONS

1. The SWFWMD rainfall depths shown in Figures A-2 through A-8 are to be used for projects in Hillsborough County when designing by SCS Methods.
2. The only allowable rainfall distribution for design use in Hillsborough County is the SCS Type II Florida Modified rainfall distribution. This distribution can be found in Table A-6. It can be used in the calculation of both the pre- and post-development runoff hydrographs.

A.3 TIME-OF-CONCENTRATION

The time-of-concentration is defined as the time required for stormwater runoff to travel from the hydraulically most remote point in the watershed or subbasin to the design point. It is recommended that the time-of-concentration be determined by the velocity method. The velocity method is a segmental approach that is used to account for overland flow, shallow channel flow, and main channel flow by computing the average velocity for each flow segment and then calculating a corresponding travel time using the following equation:



$$t_i = \frac{L_i}{(60)V_i} \quad (A-1)$$

Where:

t_i = Travel time for velocity segment (i), in minutes

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

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

The methodology used to compute average velocity for each segment varies with the hydraulic characteristics of the segment.

The time-of-concentration is then calculated by summing the individual segment travel times as follows:

$$t_c = t_1 + t_2 + t_3 \quad (A-2)$$

Where:

t_c = Time of concentration, in minutes

t_1 = Overland flow travel time, in minutes

t_2 = Shallow channel travel time (typically shallow swale or gutter flow), in minutes

t_3 = Main channel travel time (typically storm sewer, ditch, canal, etc.), in minutes

A. OVERLAND FLOW

The Kinematic Wave method is the recommended method for calculating the time of concentration for the first 100 feet of overland flow. Any significant differences in the calculation of the time of concentration for overland flow by methods other than the Kinematic Wave Equation must be approved by the County Administrator. The Kinematic Wave equation, which is expressed below, can be solved through a trial and error procedure described below. The Kinematic Wave equation, as defined in Chapter 5 of the FDOT Drainage Manual, is:

$$t_1 = 0.93 \frac{L^{0.6} N^{0.6}}{I^{0.4} S^{0.3}} \quad (A-3)$$

Where:

t_1 = Overland flow travel time, in minutes



- L = Overland flow length, in feet
- N = Surface roughness coefficient for overland flow (See Table A-1)
- I = Rainfall intensity, in inches/hour, corresponding to the design storm frequency
- S = Average slope of the overland flow path, in feet/feet

The length of the overland flow segment generally should be limited to 300 feet. Also, the surface roughness coefficient values shown in Table A-1 were determined specifically for overland flow conditions and are not to be used for conventional open channel flow calculations.

Table A-1: Acceptable “N” Values for Used in the Kinematic Wave Equation
(Condensed from the FDOT Drainage Manual)

Land Use	N-Value
Pavement (Asphalt)	0.012
Bare Sand	0.010
Range (Natural)	0.13
Dense Grass	0.24
Woods	0.45

The Kinematic Wave Equation is solved by a trial and error process, either by calculation or by using the nomograph presented in Figure C-2 (APPENDIX C), as follows:

- a. Assume a trial value of rainfall intensity (I).
- b. Determine the corresponding overland travel time (t_1), using Figure C-2 or Equation A-3.
- c. Use t_1 from Step b as the critical storm duration and determine the actual rainfall intensity for this critical storm duration. Select from the appropriate intensity-duration-frequency (IDF) curve contained in Figure A-1.
- d. Compare the trial and actual rainfall intensities. If they are different, select a new trial rainfall intensity and repeat the process.



B. SHALLOW CHANNEL FLOW (e.g. shallow swale, gutter, etc.)

Average velocities for shallow channel flow can be calculated using Manning's Equation or Figure C-3 (APPENDIX C).

C. MAIN CHANNEL FLOW (e.g. ditch, pipes, etc.)

Average velocities for main channel flow can be calculated using Manning's Equation. For large channels the use of a hydrologic routing technique or hydrodynamic model should be considered.

A.4 RATIONAL METHOD

A. GENERAL

1. The Rational Method is an empirical method which is used to estimate peak discharges for small drainage areas (less than 10 acres).
2. This method relates peak rate of runoff or discharge to rainfall intensity, drainage area, and soil and land use/cover characteristics by the equation:

$$Q = CiA \quad (A-4)$$

Where:

Q = Peak rate of runoff, in cubic feet per second.

C = Runoff coefficient representing a ratio of runoff rate to rainfall intensity (dimensionless).

I = Rainfall intensity, in inches/hour, which is expected to occur for a duration equal to the time of concentration of the drainage area represented by A.

A = Area of the drainage basin, in acres

B. ASSUMPTIONS

1. The peak rate of runoff at any point is a direct function of the average uniform rainfall intensity which occurs for a duration equal to the time-of-concentration to that point in the drainage basin.
2. The time-of-concentration of the drainage basin refers to the travel time required for the runoff to flow along the representative basin flowpath which is typically defined to be from the most hydraulically remote point of the drainage basin to the point of interest. Overland flow, swale flow, gutter flow, storm sewer or pipe flow and channel flow are commonly used in computing travel time.
3. The storm duration equals or exceeds the time of concentration of the basin.



- a. The Rational Method, in general, tends to overestimate the rates of flow for larger areas, therefore the application of a more sophisticated runoff computation technique is usually warranted for large drainage areas.
- b. Utilizing the Rational Method for determining predevelopment discharge conditions and a hydrograph method for determining post-development discharge conditions is not acceptable by Hillsborough County because of differences in the methodologies used for determining peak discharge.
- c. Uniform rainfall distribution and intensity assumptions become less appropriate as the drainage area increases.

C. COMPONENTS

1. Peak runoff rate, (Q)

- a. The peak runoff rate occurs when the duration of the precipitation event equals or exceeds the time of concentration of the drainage basin for a uniform rainfall intensity.

2. Runoff coefficient, (C)

- a. The Runoff coefficient, (C), accounts for abstractions (losses) between precipitation (rainfall) and runoff.
- b. Losses may result from:
 1. interception by vegetation
 2. infiltration into permeable soils
 3. surface water retention
 4. evapotranspiration

Additional considerations in determining C include:

1. climatological and seasonal variations
 2. antecedent moisture conditions
 3. intensity and frequency of the design storm
 4. surface slope
- d. Runoff coefficients should be estimated by using the values listed in Table A-2 for the 2- to 10-year design frequency storms. For 25- to 100-year frequency storms a correction factor (Table A-3) is to be applied to the pervious areas unless flood routing computations are appropriate for

the basin. Other values may be used, however, the design will be checked using Table A-2 and Table A-3.

- e. When using these tables one should consider the following conditions:
1. level of development
 2. surface types and percentages
 3. soil type
 4. slope
- f. For basins with varying cover, a weighted Rational coefficient can be determined for the basin by the following equation:

$$\text{Weighted } C = \frac{\sum C_i A_i}{A_{Total}} \quad (\text{A-5})$$

Where:

C_i = Rational coefficient for area (dimensionless)

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

3. Rainfall Intensity, (I)
 - a. Rainfall intensity, (I), is the average rate of rainfall in inches per hour.
 - b. Design rainfall intensity is selected according to:
 1. design frequency of occurrence
 2. critical storm duration
 - c. Critical storm duration equals the time of concentration of the drainage basin.
 - d. Rainfall intensity is determined through the utilization of the FDOT Zone 6 rainfall curves (Figure A-1).
4. Drainage Area, (A)

A specified portion of the hydrologic system which is bounded by drainage divides.



Table A-2: Runoff Coefficients^a for a Design Flow Return Period of 10 Years or Less
(from FDOT Drainage Manual, 1987)

Slope	Land Use	Sandy Soils		Clay Soils	
		Min.	Max.	Min.	Max.
--	Water areas at design high water *	1.0	1.0	1.0	1.0
Flat (0-2%)	Woodlands	0.10	0.15	0.15	0.20
	Pasture, grass & farmland ^b	0.15	0.20	0.20	0.25
	Rooftops and pavement	0.95	0.95	0.95	0.95
	SFR: ½ acre lots & 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, townhouse 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 & farmland ^b	0.20	0.25	0.25	0.30
	Rooftops and pavement	0.95	0.95	0.95	0.95
	SFR: ½ acre lots & 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 & farmland ^b	0.25	0.35	0.30	0.40
	Rooftops and pavement	0.95	0.95	0.95	0.95
	SFR: ½ acre lots & 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

^aWeighted coefficient based on percentage of impervious surfaces and green areas must be selected for each site.

^bCoefficients assume good ground cover and conservation treatment.

* Addition to table by Hillsborough County

NOTE: SFR - Single Family Residential
MFR - Multi-Family Residential

Table A-3: Antecedent Participation Factor for Pervious Area Rational Coefficients in the Rational Formula
(from FDOT Drainage Manual, 1987)

Recurrence Interval (Years)	Adjustment Factor Cf
2 to 10	1.0
25	1.1
50	1.2
100	1.25

- NOTE: 1. Adjustment factors for pervious areas only. For impervious areas the values in Table A-2 are to be used for storm events greater than the 10-year.
2. Due to the increase in the time that the peak or near peak discharge rate is released from stormwater management systems, the use of these adjustment factors are not appropriate for flood routing computations.

A.5 MODIFIED RATIONAL METHOD INFLOW HYDROGRAPH APPROACH

For small drainage areas (less than 10 acres) an inflow hydrograph represented by a cumulative inflow mass curve can be developed by utilizing the Modified Rational Method. Using the project drainage area (A), the project runoff coefficient (C), and the rainfall intensities (I) taken from the FDOT Zone 6 intensity-duration-frequency curves (Figure A-1), an inflow hydrograph can be developed. The following table can be utilized to develop the inflow hydrograph.

Table A-4: Computation Format for the Modified Rational Method Inflow Hydrograph

(1)	(2)	(3)	(4)	(5)
Rainfall	Rainfall	Rainfall	Accumulated	Inflow
Duration	Intensity	Duration	Rainfall	
(Min)	(In/Hr)	(Hrs)	(In)	(Ac-ft)

- Column (1) is a sequence of times ranging from zero to 24 hours in increments corresponding to the values of duration shown on the IDF curves (Figure A-1) expressed in minutes.
- Column (2) is the rainfall intensity (I) for each rainfall duration tabulated in column (1). The rainfall intensity values are obtained from the FDOT Zone 6 IDF curves (Figure A-1).
- Column (3) represents time from the beginning of the design storm; it is the value shown in column (1) expressed in hours.
- Column (4) represents the accumulated rainfall for the time in column (3). It is obtained by multiplying the value in Column (2) by the value in Column (3).
- Column (5) is the calculated cumulative inflow at each time; it is expressed in Ac-ft. Column (5) is obtained by multiplying the drainage area (A) by the runoff coefficient © and by the value in Column (4) and then dividing by 12 to convert inches to feet.



A.6 SCS SYNTHETIC UNIT HYDROGRAPH METHOD

A. GENERAL

The unit hydrograph of a drainage basin (watershed) is defined as the runoff hydrograph which represents one inch of rainfall excess (runoff) distributed uniformly over the basin during a specified period of time (time step).

1. Rainfall excess is the portion of the rainfall remaining after all losses or abstractions have been subtracted.
2. The specified period of time (time step) is the duration of the rainfall excess which, when chosen for design purposes should be a fraction of the basin time of concentration.

B. DETERMINATION OF RAINFALL EXCESS (RUNOFF)

Rainfall excess (runoff) by the SCS method can be expressed mathematically as:

$$R = \frac{(P - 0.2S)^2}{P + 0.8S} \quad (A-6)$$

$$S = \frac{1000}{CN} - 10 \quad (A-7)$$

Where:

R = total rainfall excess for design storm event, in inches

P = total precipitation for design storm, in inches

S = soil storage parameter, in inches

CN = SCS Curve Number

Note: The 0.2S parameter represents the standard SCS "initial abstraction" (I_a) estimate.

C. SCS CURVE NUMBERS

The curve number is a dimensionless parameter that reflects vegetative cover condition, hydrologic soil group, land use, and antecedent moisture condition.

The recommended procedure for determining the SCS curve numbers for project areas within Hillsborough County is as follows:



1. Identify soil types within the project boundaries using the Hillsborough County Soil Survey (SCS).
2. Assign a hydrologic soil group classification to each soil type using the appropriate table in the Hillsborough County Soil Survey (SCS).
3. Identify areas with uniform soil type and land use conditions.
4. Use Table A-5 (a-c) to select the SCS runoff curve number values for each homogeneous area based on land use, vegetative cover, and hydrologic soil group.
5. If the project area is composed of variable land uses and/or hydrologic soil groups, a composite CN can be computed as follows:

$$CN = \frac{A_i(CN_i) + A_{i+1}(CN_{i+1}) + \dots + A_n(CN_n)}{A_t} \quad (A-8)$$

Where:

CN = composite curve number for the watershed

CN_i = curve number for each sub-area

A_i = land area for each sub-area

A_t = total land area for the subbasin.



Table A-5a: Runoff Number for Urban Areas¹
 (SCS 210-VI-TR-55, Second Edition, June 1986)

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) (includes unimproved required parking)		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
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 (Townhouses)	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) ⁴		77	86	91	94
Idle Lands (CN's are determined using cover types similar to those in Table A-5c)					

¹ Average runoff antecedent moisture condition (AMC II) and Ia = 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.

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 to use for the design of temporary measures during grading and construction should be computed based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Table A-5b: Runoff Curve Numbers for Cultivated Lands¹
(SCS 210-VI-TR-55, Second Edition, June 1986)

Cover Description:			Curve Numbers for Hydrologic Soil Group			
Cover Type	Treatment ⁵	Hydrologic Condition ⁶	A	B	C	D
Fallow	Bare soil	--	77	86	91	94
	Crop residue (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 ©	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 SR 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

⁵ Crop residue cover applies only if residue is on at least five percent of the surface throughout the year.

⁶ Hydrologic condition is based on combination of factors that affect infiltration and runoff, included (a) density and canopy of vegetative areas, (b) amount of year-round cover, © amount of grass or close-



seeded legumes in rotation, (d) percent of residue cover on the land surface (good >20 percent), and (e) degree of surface roughness.

Poor: Factors impair infiltration and tend to increase runoff.

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

Table A-5c: Runoff Curve Numbers for Other Agricultural Lands¹
(SCS 210-VI-TR-55, Second Edition, June 1986)

Cover Description:		Curve Numbers for Hydrologic Soil Group			
Cover Type	Hydrologic Condition ⁶	A	B	C	D
Pasture, grassland, or range-continuous forage for grazing ⁷	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 with brush the major element ⁸	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30 ⁹	48	65	73
Woods--grass combination (orchard or tree farm) ¹⁰	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods ¹¹	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30 ⁹	55	70	77
Farmsteads--buildings, lanes, driveways, & surrounding lots	--	59	74	82	86

⁷ Poor: <50 percent ground cover or heavily grazed with no mulch.

Fair: 50 to 75 percent ground cover and not heavily grazed.

Good: >75 percent ground cover and lightly or only occasionally grazed.

⁸ Poor: <50 percent ground cover.

Fair: 50 to 70 percent ground cover.

Good: >75 percent ground cover.

⁹ Actual curve number is less than 30; use CN = 30 for runoff computations.

¹⁰ CN's shown were computed for areas with 50 percent woods and 50 percent grass (pasture) cover.

Other combinations of conditions may be computed from the CN's for woods and pasture.

¹¹ 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.

Table A-6: SCS Type II Florida Modified – Rainfall Distribution (24-Hours)

Time (hrs)	Rainfall Ratio	Time (hrs)	Rainfall Ratio
0.0	0.000	12.5	0.719
0.5	0.006	13.0	0.757
1.0	0.012	13.5	0.785
1.5	0.019	14.0	0.807
2.0	0.025	14.5	0.826
2.5	0.032	15.0	0.842
3.0	0.039	15.5	0.857
3.5	0.047	16.0	0.870
4.0	0.054	16.5	0.882
4.5	0.062	17.0	0.893
5.0	0.071	17.5	0.904
5.5	0.080	18.0	0.913
6.0	0.089	18.5	0.923
6.5	0.099	19.0	0.931
7.0	0.110	19.5	0.940
7.5	0.122	20.0	0.948
8.0	0.134	20.5	0.955
8.5	0.148	21.0	0.962
9.0	0.164	21.5	0.969
9.5	0.181	22.0	0.976
10.0	0.201	22.5	0.983
10.5	0.226	23.0	0.989
11.0	0.258	23.5	0.995
11.5	0.308	24.0	1.000
12.0	0.607		

D. SCS SYNTHETIC UNIT HYDROGRAPH PROCEDURE

1. The SCS has derived a general dimensionless unit hydrograph from a large number of observed unit hydrographs for watersheds of various sizes and geographic locations. The SCS standard shape factor is 484. For areas such as Florida where the unit hydrograph shape is generally flatter and wider a different dimensionless unit hydrograph is required. Such is the case in Hillsborough County where a 256 shape factor is the acceptable value for predevelopment conditions. Once the time to peak and peak flow for a particular unit hydrograph have been defined, the entire shape of the unit hydrograph can be estimated using the appropriate dimensionless unit hydrograph. The dimensionless unit hydrograph for the 256 shape factor is found in Table A-7.

The County shall only accept a 256 shape factor for predevelopment conditions unless the site designer demonstrates that another shape factor is more appropriate. Shape factors other than 256 must be approved by the County Engineer. For the post-development condition, the shape factor shall be no



smaller than 256, but may be higher (at the designer's discretion) if design conditions warrant a higher value.

A more detailed analysis of the unit hydrograph procedure can be found in "SCS National Engineering Handbook", Section 4, Hydrology, (SCS, Revised 1969) and other publications.

2. The Soil Conservation Service dimensionless unit hydrograph procedure requires peak discharge and time-to-peak values. The peak discharge value is calculated by the following equation:

$$q_p = \frac{P_f AR}{T_p} \quad (\text{A-9})$$

Where:

q_p = the peak unit hydrograph discharge, in cubic feet per second

A = the area of the drainage basin, in square miles

R = the total unit hydrograph runoff = one inch

P_f = unit hydrograph peak-rate or shape factor (256-flat areas, to 484-moderately steep areas, to 600±-very steep areas). In Hillsborough County, the 256 value shall be used for predevelopment conditions unless an alternative value is approved by the County Engineer. If an alternative value is approved for a particular application, the Site Designer should be aware that the shape factor must be appropriate to the dimensionless unit hydrograph used. Procedures for developing dimensionless unit hydrographs and their corresponding shape factors can be found in NEH-4 (SCS).

T_p = the time of rise or time-to-peak of the unit hydrograph; it is the time from the inception of rainfall excess to the peak of the unit hydrograph, in hours.

In the SCS procedure, the time to peak, T_p , in hours is computed by the following equation:

$$T_p = \frac{D}{2} + L \quad (\text{A-10})$$

Where:



D = the duration of the rainfall excess, in hours (typically in the range of $0.1 T_c$ to $0.2 T_c$ for small urban basins)

L = the lag time, in hours (time between the centroid of rainfall excess and the peak of the unit hydrograph)

For purposes of computing T_p , the lag time (L) can be approximated by $0.6T_c$. Substituting for L in the equation, one obtains equation A-11:

$$T_p = \frac{D}{2} + 0.6T_c \quad (\text{A-11})$$

T_c = the time of concentration for the drainage basin, in hours

Substituting into equation (4-9), one can compute the peak of the SCS unit hydrograph using the following equation (equation A-12):

$$q_p = \frac{P_f A}{\frac{D}{2} + 0.6T_c} \quad (\text{A-12})$$

Equations A-11 and A-12 are used to compute the peak discharge (q_p) and time-to-peak (T_p) of the unit hydrograph. The values are used to develop a unit hydrograph from the dimensionless unit hydrograph values given in Table A-7 (for a 256 shape factor). The Time Ratios (t/T_p) are multiplied by the T_p value computed from equation A-11 and the Mass Curve Ratios (q/q_p) are multiplied by the q_p value computed from equation A-12.

In this procedure, the time-of-concentration of the drainage basin is computed by the methods described in Section A.3.

E. GENERATION OF SCS RUNOFF HYDROGRAPH

1. The SCS unit hydrograph described above is used with a design rainfall depth from Figures A-2 to A-8, a rainfall distribution from Tables A-6, and a composite runoff curve number from Equation A-8 to generate a runoff hydrograph for a specific design storm event. This procedure usually requires a computer program such as HEC-1 (Corps of Engineers) or TR-20 (SCS). The procedure for generating runoff hydrographs is described in NEH-4.
2. The following conditions apply to the use of SCS runoff hydrograph generation in Hillsborough County:
 - a. For allowable rainfall depths and distributions, refer to Section A.2.B.
 - b. In Hillsborough County a shape factor of 256 shall be used for predevelopment conditions unless an alternative value is approved by the



County Engineer. The minimum shape factor for post-development conditions shall also be the 256 value.

- c The computational time step shall be in the range of $0.1T_c$ to $0.2T_c$.
- d The value of initial abstraction shall be $0.2S$.

Table A-7: Dimensionless Unit Hydrograph Ratios
(256 Shape Factor, Advanced Engineering Technologies)

Time Ratios (t/Tp)	Mass Curve Ratios (q/qp)
0.00	0.000
0.20	0.150
0.40	0.320
0.60	0.600
0.80	0.930
1.00	1.000
1.20	0.960
1.40	0.880
1.60	0.780
1.80	0.690
2.00	0.590
2.20	0.520
2.40	0.480
2.60	0.430
2.80	0.390
3.00	0.350
3.20	0.320
3.40	0.290
3.60	0.260
3.80	0.230
4.00	0.210
4.20	0.200
4.40	0.190

Time Ratios (t/Tp)	Mass Curve Ratios (q/qp)
4.60	0.180
4.80	0.170
5.00	0.160
5.20	0.150
5.40	0.140
5.60	0.130
5.80	0.120
6.00	0.110
6.20	0.100
6.40	0.090
6.60	0.080
6.80	0.070
7.00	0.060
7.20	0.050
7.40	0.045
7.60	0.040
7.80	0.035
8.00	0.030
8.20	0.025
8.40	0.020
8.60	0.015
8.80	0.010
9.00	0.000

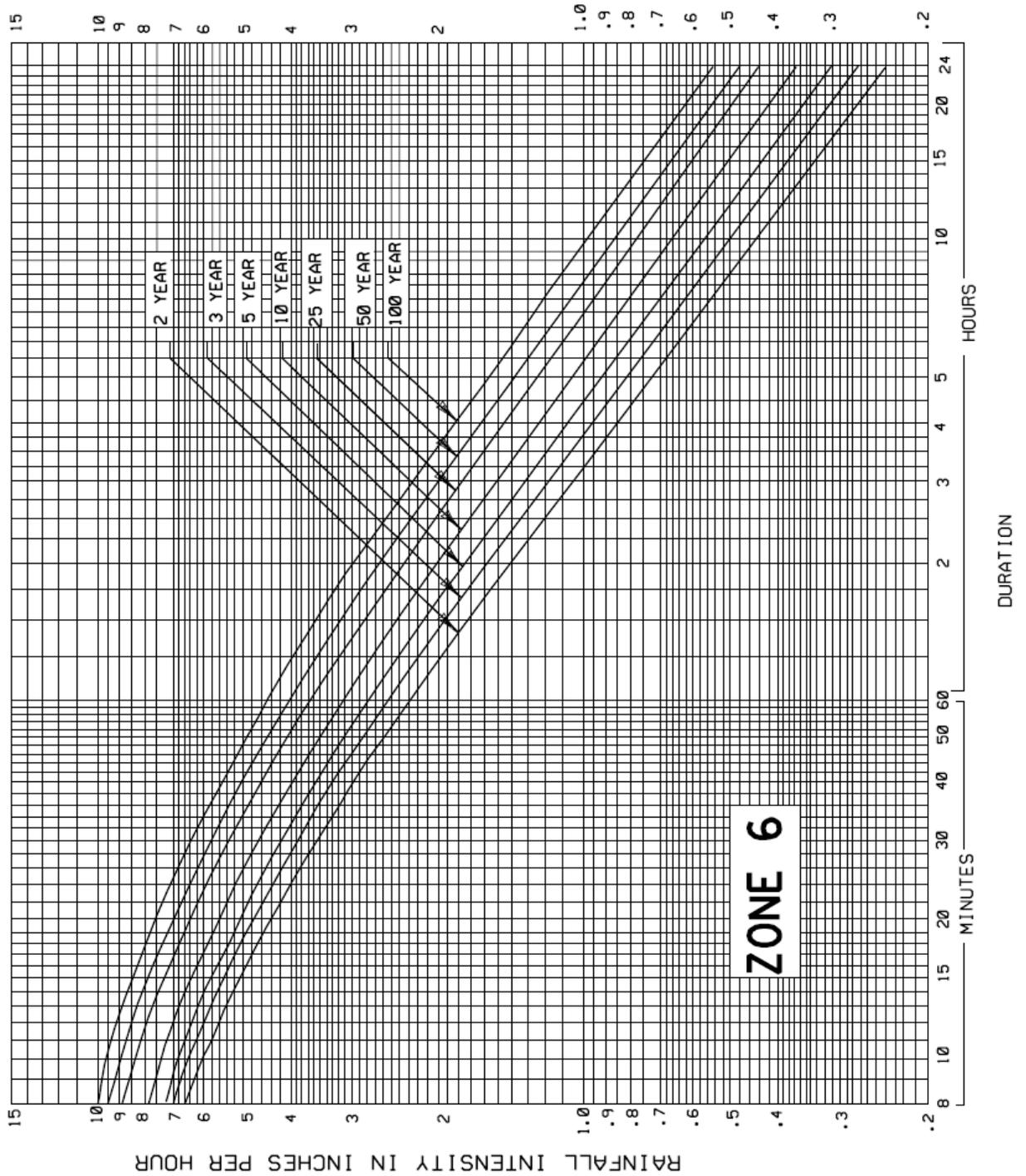
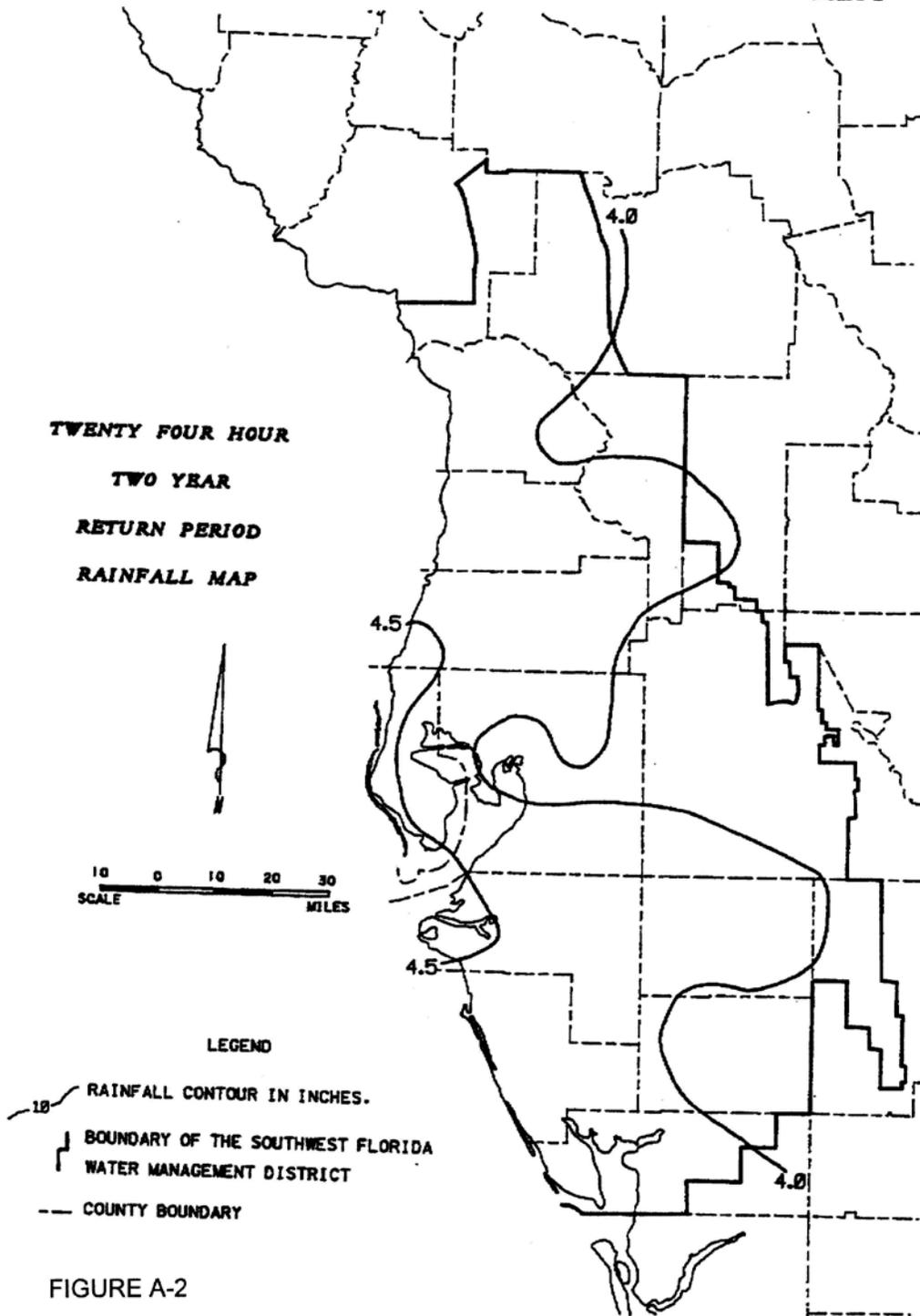
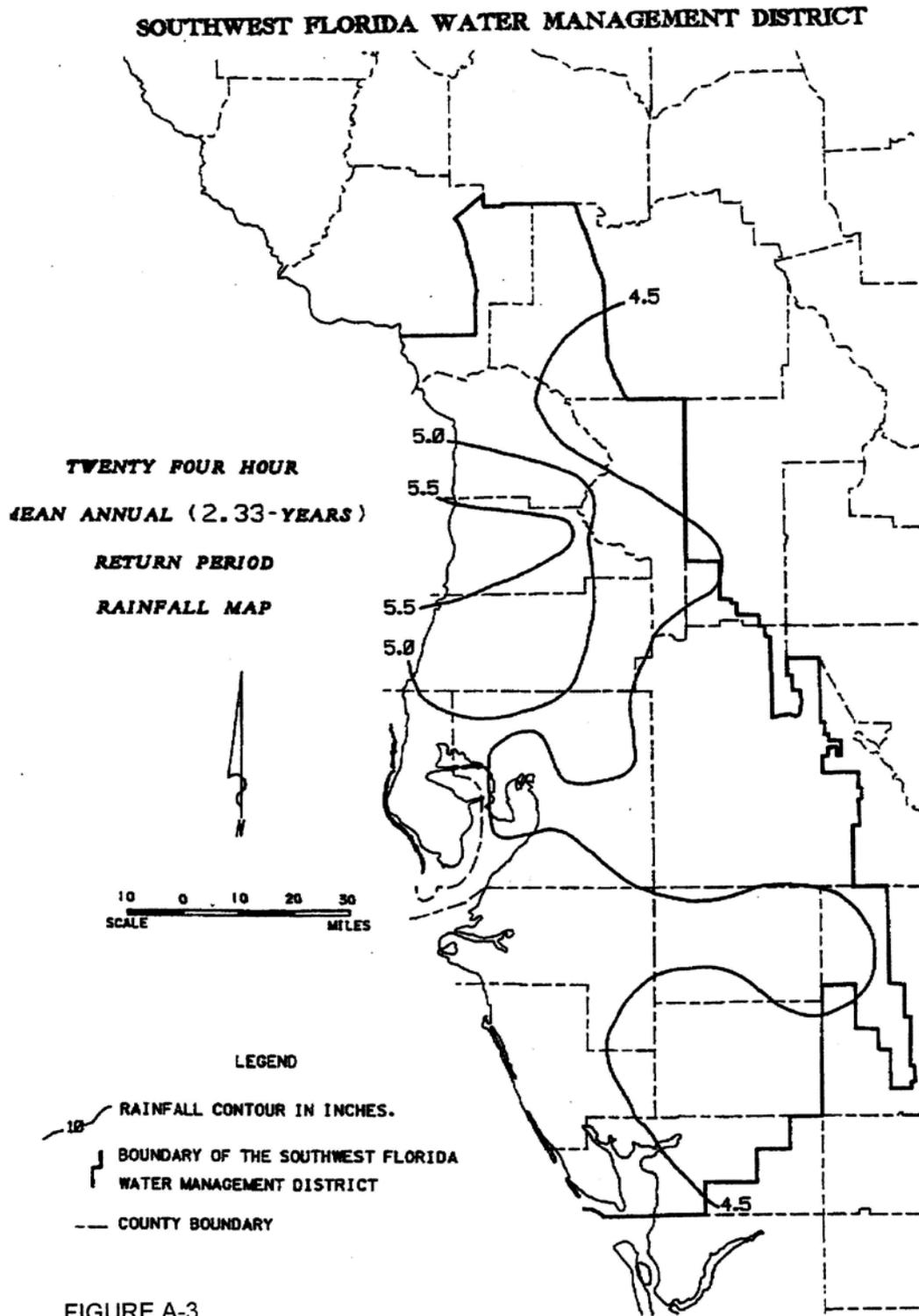


Figure A-1 Rainfall Intensity-Duration-Frequency Curves

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT





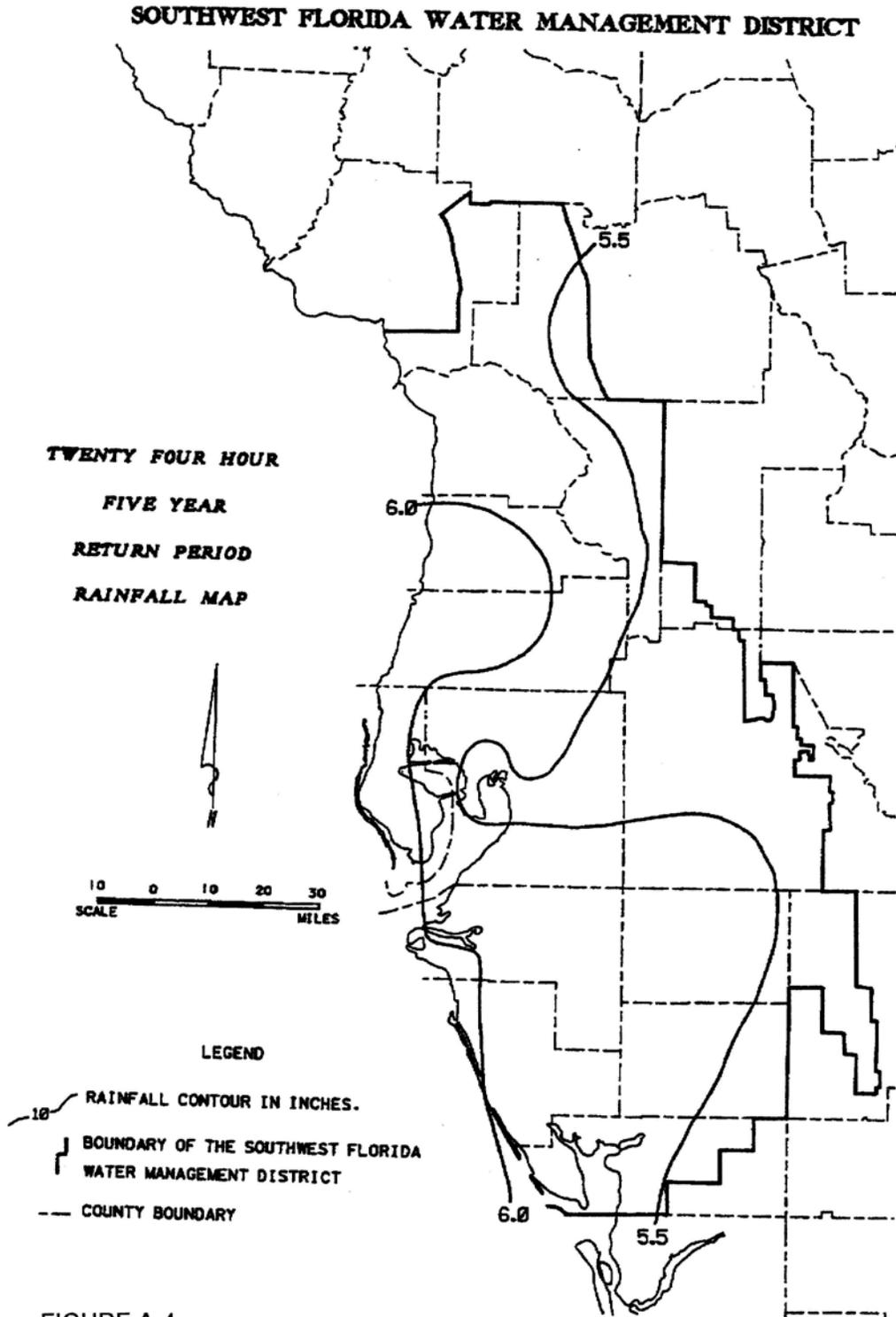


FIGURE A-4

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

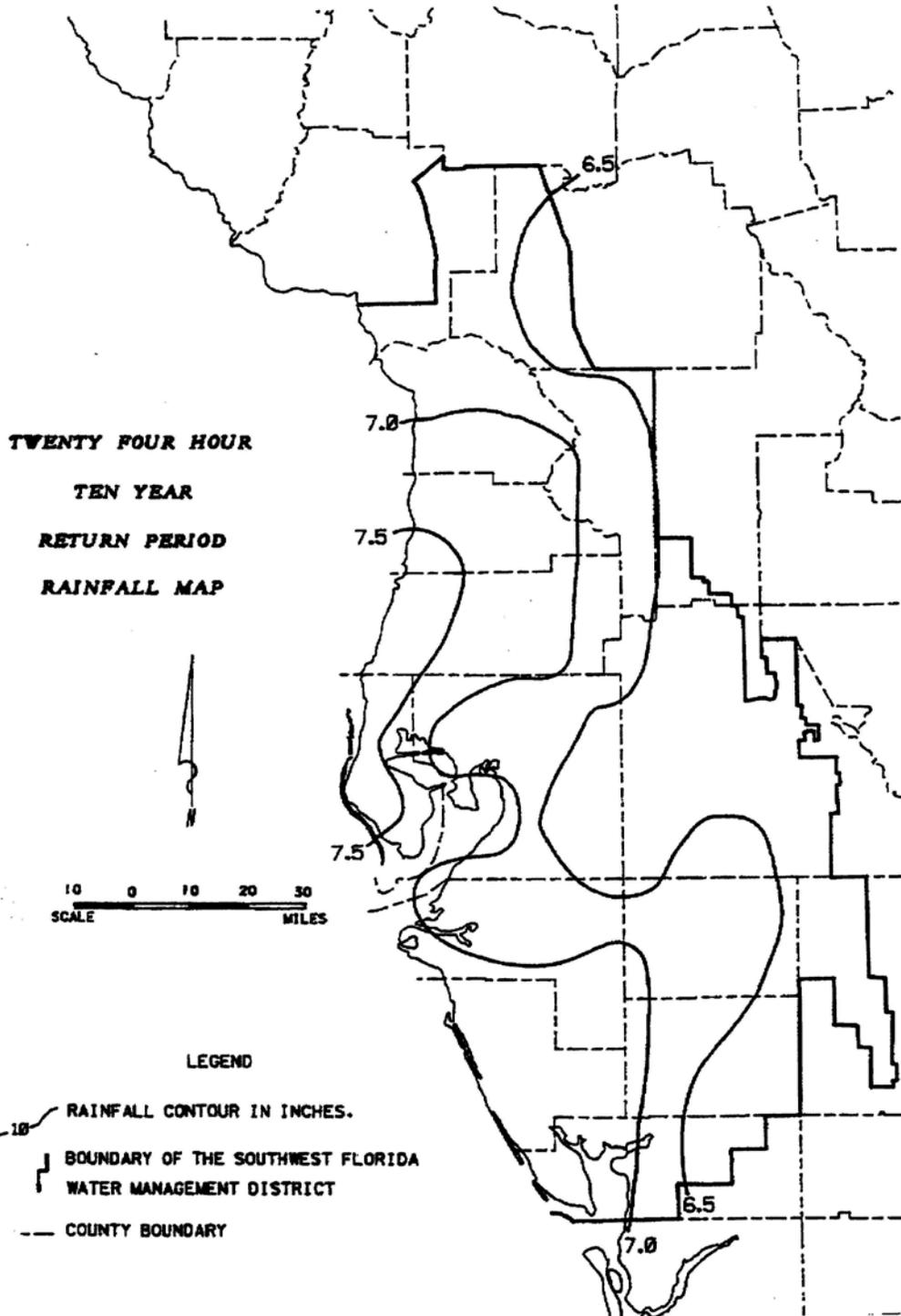


FIGURE A-5

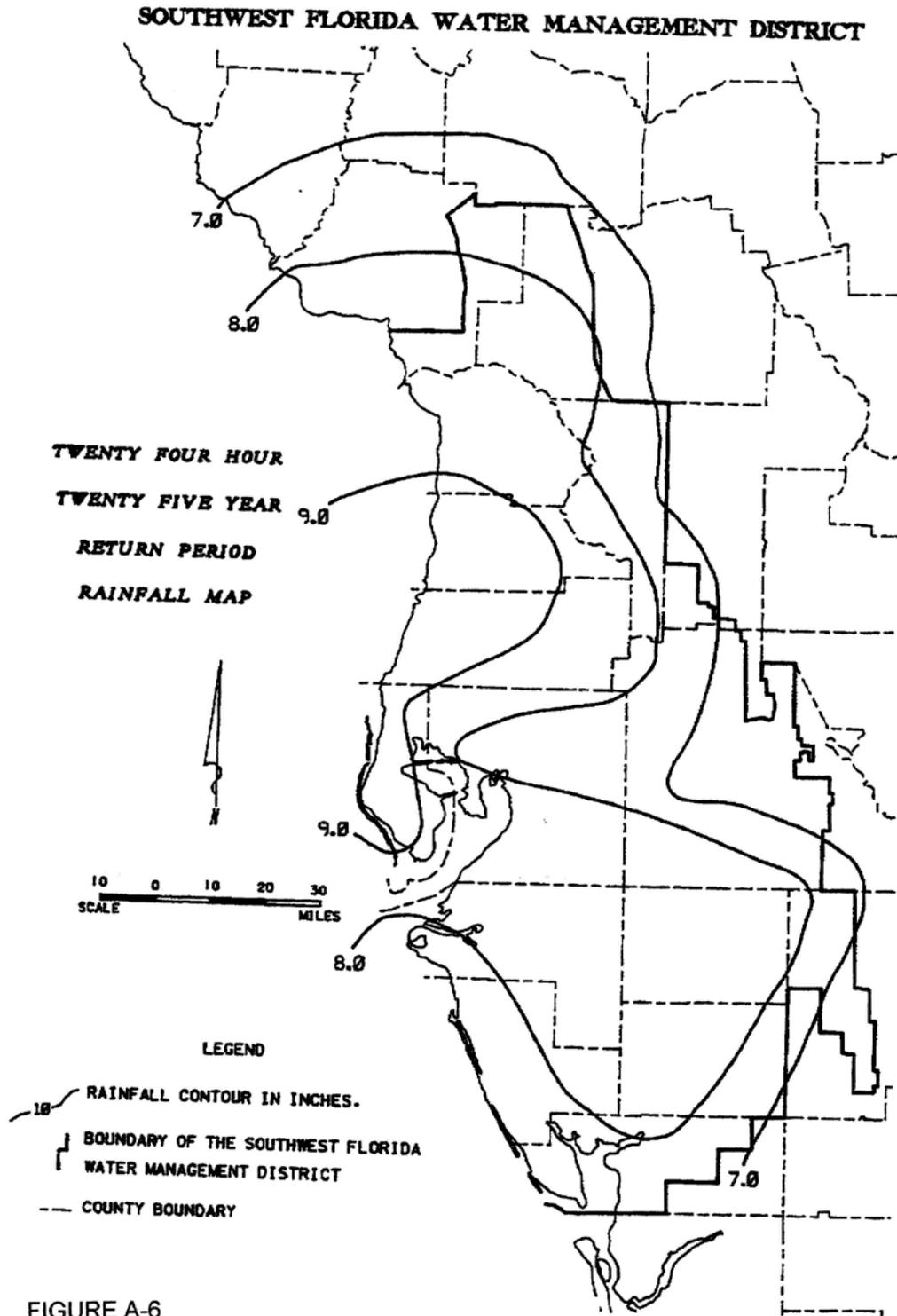


FIGURE A-6

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

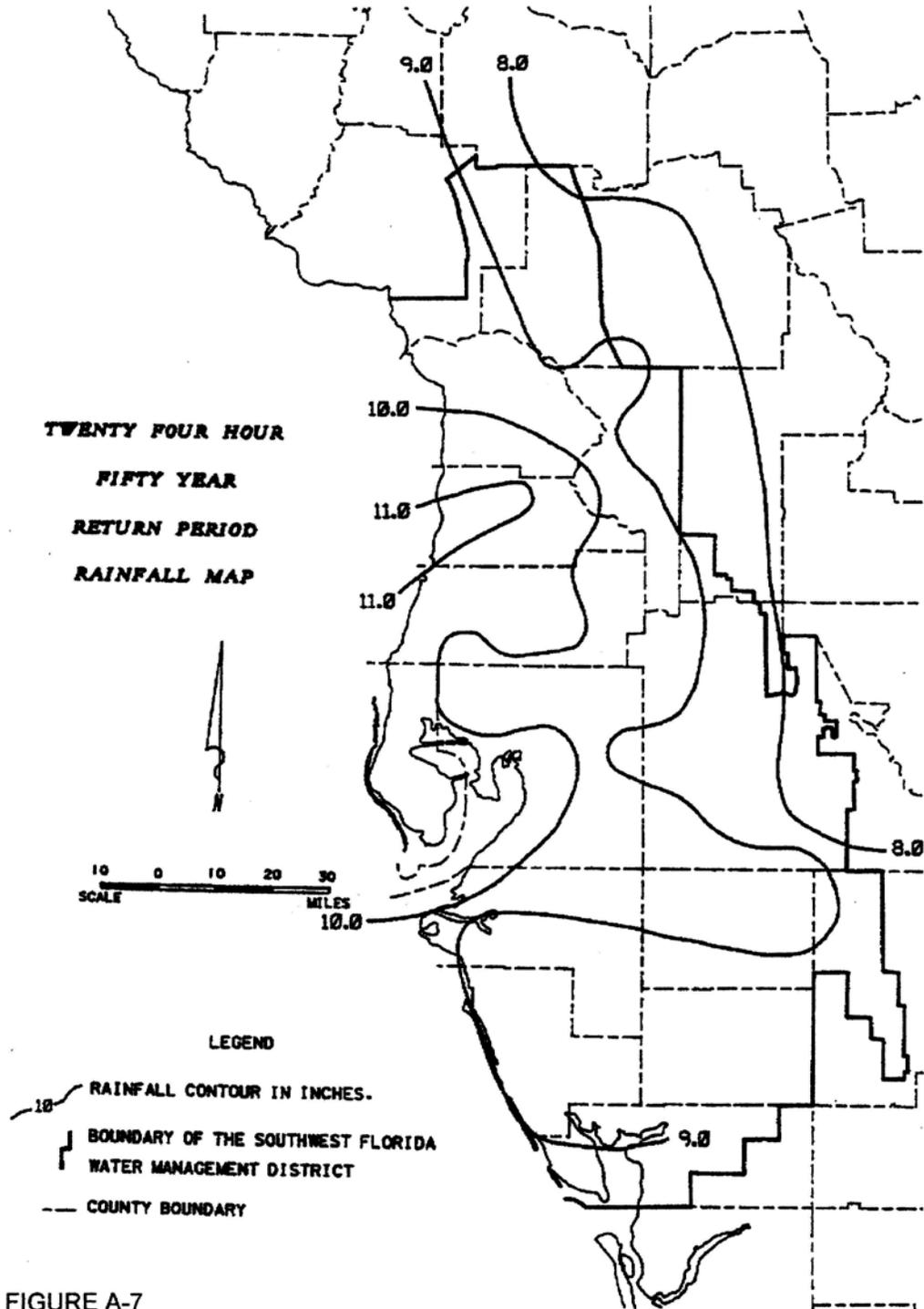


FIGURE A-7

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

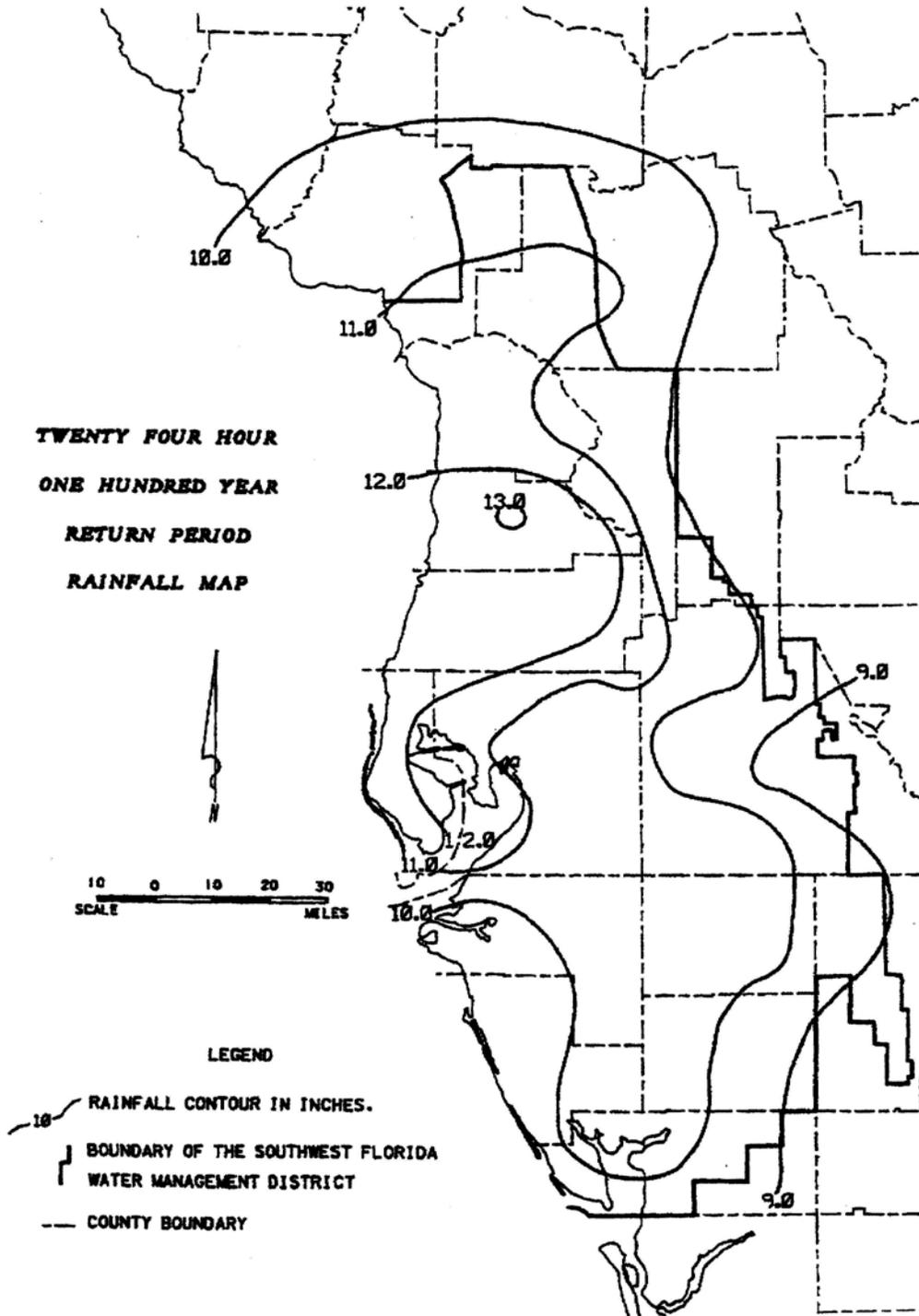


FIGURE A-8



APPENDIX B: RECOMMENDED DESIGN PROCEDURE FOR CULVERTS

RECOMMENDED DESIGN PROCEDURES

B.1 RECOMMENDED DESIGN PROCEDURE FOR CULVERTS

Seven inlet nomographs, seven outlet nomographs, and six critical depth charts from HEC-5 (USDOT, FHWA, 1965, or Latest Edition) are available for performing culvert capacity calculations (Figures C-4 through C-11, APPENDIX C). The following culvert types are considered:

- Box Culverts (BC)
- Reinforced Concrete Pipe (RCP)
- Elliptical (Oval) Concrete Pipe--Long Axis Horizontal
- Elliptical (Oval) Concrete Pipe--Long Axis Vertical
- Corrugated Metal Pipe--Round (CMP)
- Corrugated Metal Pipe--Arch (CMAP)
- Circular Pipe with Beveled Ring--Inlet Control
- Corrugated Metal Pipe--Structural Plate, Outlet Control
- Corrugated Metal Pipe (18-inch Corner Radius)--Structural Plate, Outlet Control

Similar design aids are often available from suppliers for culvert sizes and configurations not covered above.

A. SELECTION PROCEDURE

The following trial and error procedure is recommended to select a culvert size with the nomographs from HEC-5:

1. List the following design data (see the suggested tabulation form contained on Figure C-12, APPENDIX C):
 - a. Design discharge (Q), in feet³/second, with average return period (e.g., Q₂₅). When more than one barrel is used, show Q divided by the number of barrels.
 - b. Approximate length (L) of culvert, in feet
 - c. Slope of culvert (if grade is given in percent, convert to slope in feet/feet).



- d. Allowable headwater depth (AHW), in feet; i.e., the vertical distance from the culvert invert (flow line) at the entrance to the water surface elevation permissible in the headwater pool or approach channel upstream from the culvert.
 - e. Mean and maximum flood velocities in natural stream (optional).
 - f. Type of culvert, including barrel material, barrel cross-sectional shape, and inlet configuration.
2. Choose a trial culvert size. The Manning equation can be used to estimate preliminary size.
 3. Find headwater (HW) depth for the trial culvert size:
 - a. Analyze the trial culvert for inlet control as follows:
 - 1.) Select the appropriate inlet control nomograph (Figures C-4 through C-9, and Figure C-11, APPENDIX C). Enter the inlet chart with the design discharge (Q), and the culvert size; read the value of HW/D.
 - 2.) Headwater depth (HW) is then found by multiplying the HW/D value obtained from the inlet chart by the height of culvert (D).
 - b. Analyze the trial culvert for outlet control as follows:
 - 1.) Select the appropriate outlet control nomograph (Figures C-4 through C-10, APPENDIX C).
 - 2.) Enter the outlet chart with the Length (L), size, and design discharge (Q); read the head loss (H).
 - 3.) Determine the design tailwater depth (DTW); it is the larger of 1) the height of the computed tailwater elevation for the receiving waters above the downstream invert of the culvert (TW EL. - DS INV ELEV), and 2) the approximate hydraulic grade depth at the downstream end of the culvert computed by the following equation:
Where:

$$h_o = \frac{(d_c + D)}{2} \quad (\text{B-1})$$

h_o = approximate hydraulic grade depth, in feet



d_c = critical flow depth corresponding to the design discharge, Q , for the trial culvert size, in feet

D = height of trial culvert, in feet

- 4.) Calculate the upstream headwater depth by the following formula:

$$HW = H + DTW - LS_0 \quad (B-2)$$

Where:

HW = Headwater depth, feet

H = Total head loss, feet

DTW = Design tailwater depth, feet

L = Barrel length, feet

S_0 = Barrel slope, feet/feet

- 5.) If the TW elevation determined above is less than the top of the culvert at the outlet, the headwater depth determined by Equation B-2 becomes increasingly less accurate as this computed value falls below the value:

$$HW \leq D + (1 + k_e) \frac{v^2}{2g} \quad (B-3)$$

Where:

D = Height of culvert opening, in feet

k_e = Entrance loss coefficient

v = Average velocity of flow, in feet/second

g = Acceleration due to gravity, 32.2 feet/second²

- c. Compare the headwater depths found in B.1.A.3.a (inlet control) and B.1.A.3.b (outlet control). The higher headwater governs and indicates the type of flow control existing under the given design conditions for the trial size and inlet configuration selected.
- d. If outlet control governs and the HW is higher than the acceptable AHW, select a larger trial size and find HW as instructed under B.1.A.3.b.



(Inlet control does not need to be checked, since the smaller size should be satisfactory for this control as determined under B.1.A.3.a.)

4. Select a culvert of another type or shape and determine size and HW by the above procedure.
5. Compute outlet velocities for size and types to be considered in selection:
 - a. If outlet control governs in B.1.A.3.c above, calculate the outlet velocity by the below equation. If d_c or TW is less than the height of the culvert barrel, use the cross-sectional area corresponding to d_c or TW depth, whichever gives the greater area of flow. The total cross-sectional area (A) of the culvert barrel should not be exceeded.

$$v = \frac{Q}{A} \quad (\text{B-4})$$

Where:

Q = design discharge, in cubic feet/second

A = culvert flow area, in feet²

v = culvert velocity, in feet/sec

- b. If inlet control governs in B.1.A.3.c above, the outlet velocity can be assumed to equal the mean velocity for open channel flow conditions in the barrel, computed by the Manning equation for the rate of flow, barrel size, roughness, and slope of culvert selected.
6. Determine whether channel protection should be considered.
7. Record final selection of culvert with size, type, required headwater, outlet velocity, and channel protection specified.

B. INLET CONTROL

Inlet nomographs from HEC-5 are presented in Part A of Figures C-4 through C-9 and Figure C-11 (APPENDIX C). The following three types of inlet calculations can be performed using these nomographs:

1. To determine the headwater (HW), given Q and size for selected culvert type and inlet configuration:
 - a. Use a straightedge to connect the culvert diameter or height (D) scale and the discharge (Q) scale, or Q/B for box culverts. Note the point of intersection of the straightedge of the HW/D scale marked (1).
 - b. If the HW/D scale marked (1) represents the inlet configuration used, read HW/D on this scale. When either of the other two inlet

configurations listed on the nomograph is used, extend the point of intersection obtained above horizontally to scale (2) or (3) and read HW/D.

- c. Compute HW by multiplying HW/D by D.

Note: The approach velocity is assumed to be zero by this procedure. If the approach velocity is considered significant, the HW can be decreased by subtracting the velocity head.

2. To determine Q per barrel, given HW and size for selected culvert type and inlet configuration:
 - a. Compute HW/D for given conditions.
 - b. Located HW/D on scale for appropriate inlet configuration. If scale (2) or (3) is used, extend the HW/D point horizontally to scale (1).
 - c. Use a straightedge to connect the point on HW/D scale (1) obtained above with the culvert size of the far left scale. Read Q or Q/B at the intersection of this line with the middle discharge scale.
 - d. If Q/B is read in c above, multiply by B (span of box culvert) to find Q.
3. To determine culvert size, given Q, AHW, and type of culvert with desired inlet configuration:
 - a. Using a trail size, compute HW/D.
 - b. Located HW/D on the scale for the appropriate inlet configuration. If scale (2) or (3) is used, extend the HW/D point horizontally to scale (1).
 - c. Use a straightedge to connect the point on HW/D scale (1) obtained above with the given discharge on the middle scale and read diameter, height, or size of culvert required at the intersection of this line with the culvert size scale on the far left.
 - d. If D is not as originally assumed, repeat procedure with a new D.

C. OUTLET CONTROL

Outlet nomographs are presented in Part B of Figures C-4 through C-9 and Figure C-10 (APPENDIX C). The following steps outline use of these nomographs:

1. To determine H for a given culvert and Q:
 - a. Locate the appropriate nomograph for the type of culvert selected. Find k_e for the inlet configuration using data from Table 8-4.



- b. Begin nomograph solution by locating the proper starting point on the length scale:
 - 1.) If the n value of the nomograph corresponds to that of the culvert being used, select the proper length curve for an assigned k_e value and locate the starting point at the given culvert length. If a curve is not shown for the selected k_e , see B.1.C.1.b.2 below. If the n value for the culvert selected differs from that of the nomograph chart, see B.1.C.1.b.3 below.
 - 2.) For the n value of the nomograph and a k_e intermediate between the scales given, connect the given length on adjacent scales by a straight line and select a point on this line spaced between the two scales in proportion to the k_e values.
 - 3.) For a different roughness coefficient (n_1) than that of the chart (n), use the length scales shown with an adjusted length (L_1) calculated as:

$$L_1 = L \left(\frac{n}{n_1} \right)^2 \quad (B-5)$$

- C. Use a straightedge to connect the point on the length scale to the size of the culvert barrel and mark the point of crossing on the turning line. See instruction B.1.C.3 below for size considerations for a rectangular box culvert.
- D. Pivot the straightedge of this point on the turning line and connect with the given discharge rate. For multiple barrels, divide Q by the number of barrels before using the nomograph. Read head in feet on the H scale located on the far right. For values beyond the limit of the printed scales, find H by solving the equation:

$$H = (1 + k_e + 29n^2 L \text{ over } R^{1.33}) \frac{v^2}{2g} \quad (B-6)$$

Where:

- H = Total head loss, or the elevation difference between HW and DHW, in feet
- k_e = Entrance loss coefficient
- n = Manning's roughness coefficient
- L = Barrel length, in feet
- R = Hydraulic radius of the culvert, in feet



$v =$ Average velocity of flow, in feet/second

$g =$ Acceleration due to gravity, 32.2 ft/second²

2. Values of n , which are the basis for the nomographs from HEC-5, are presented on each nomograph. Recommended design values for Manning's n are presented in Table 8-1.
3. To use the box culvert nomograph (Figure C-3) for full flow for other than the configurations shown:
 - a. Compute cross-sectional area of the rectangular box.
 - b. Use a straightedge to connect the proper point (see instruction B.1.C.1) on the length scale to barrel area and mark the point on the turning line. Note that the area scale on the nomograph is calculated for barrel cross-sections with span B twice the height D ; its close correspondence with the area of square boxes ensures that it may be used for all sections intermediate between square and $B = 2D$ or $B = \frac{1}{2} D$. For other box proportions, use Equation B-6 for more accurate results.

B.2 RECOMMENDED DESIGN PROCEDURE FOR STORM SEWERS

Adapted from the Omaha Metropolitan Stormwater Management Design Manual

A. GENERAL

There are several general rules to be observed when designing storm sewer systems. These rules are as follows:

1. Select pipe size and slope so that the velocity of flow will increase progressively, or at least will not appreciably decrease, at inlets, bends, or other changes in geometry or configuration.
2. Do not discharge the contents of a larger pipe into a smaller one.
3. In gravity systems where changes in pipe size occur, the Site Designer should match the crowns of the two pipes at the same level rather than matching flow lines. (When necessary for minimal fall, match the "0.8 x Diameter" point of each pipe.)
4. Conduit slope should be less than critical slope if at all possible.

B. PRELIMINARY DESIGN PROCEDURE

1. Prepare a drainage map of the entire area to be drained by proposed improvements using topographic maps and field reconnaissance.



2. Make a preliminary layout of the proposed stormwater collection system, locating all inlets, manholes, mains, laterals, ditches, culverts, etc.
3. Delineate the drainage area to each proposed inlet.
4. Label each drainage area and include the size of area, the direction of surface runoff by small arrows, and the coefficient of runoff (rational coefficient - see APPENDIX A) for the area.
5. Show all existing underground facilities.
6. Establish design rainfall frequency (Table 6-1).
7. Establish minimum inlet time-of-concentration (APPENDIX A).
8. Establish the typical cross section of each street.
9. Establish permissible spread of flow on all streets within the drainage area (See Section 12.10.1.2).
10. Include 1 through 9 on the paving and drainage plans to be submitted for review.

C. INLET SYSTEM

The following steps will serve as a guide to the procedure of locating inlets along a storm sewer street:

1. Beginning at the upstream end of the project drainage basin, choose a trial inlet location and calculate the expected flow to that location using the Rational Method (APPENDIX A).
2. Compare the calculated flow to allowable street/gutter capacity.
 - a. If the calculated flow is greater than the allowable street/gutter capacity, choose a different trial inlet location with a smaller drainage area.
 - b. If the calculated flow is less than street/gutter capacity, choose a different trial inlet location with a larger drainage area.
 - c. Repeat this procedure until the calculated flow equals the allowable street/gutter capacity. The inlet location that results from this procedure represents the first point at which a portion of the flow must be removed from the street by an inlet.
3. Record the drainage area, time of concentration, Rational coefficient and calculated flow for the subarea. This information should be recorded in the storm sewer tabulation form (See Section B.2.E).



4. Determine the inlet size, type, amount of intercepted flow, and amount of flow to be carried over (bypassing the inlet) to the next inlet. The carry over must be accounted for in sizing and locating the next downstream inlet.
5. Continue the above procedure for other subareas until a complete system of inlets has been established.
6. Adjust the inlet layout resulting from the above analysis of inlet drainage areas, for other inflows and for variations of street alignments and grades.
7. Record information as in B.2.C.3 and B.2.C.4 for all proposed inlets.
8. After the inlets have been located and sized the pipes can be designed.

D. STORM SEWER SYSTEM

After the computation of the rate of storm runoff entering each inlet, the storm sewer system required to carry the flow is designed. The rate of flow to be carried by any particular section of the storm sewer system is not the sum of the contributing inlet design flows to that section, but is a value less than this arithmetic total. The lesser flow value results from the fact that the individual inlet design flows do not necessarily enter concurrently and instantaneously move through the storm sewer system.

1. Preliminary sizing - Assumption of Gravity System

All storm sewers can be preliminarily designed by the application of the continuity equation and Manning's Equation either through appropriate charts and nomographs or by direct solution of the equations:

(Continuity)	$Q = AV, \text{ and}$	(B-7)
(Manning's)	$Q = \frac{1.49 AR^{2/3} S_f^{1/2}}{n}$	(B-8)

Where:

- Q = Pipe Flow, in cubic feet per second
- A = Cross-sectional area of pipe, in square feet
- V = Velocity of flow, in feet per second
- n = Coefficient of roughness for pipe (Table 8-1)
- R = Hydraulic radius of pipe = A/W_p in feet
- S_f = Friction or energy slope for flow in pipe, in foot per foot
- W_p = Wetted perimeter within pipe, in feet

2. Final Design - Determination of Expected Hydraulic Grade Line



The designer is referred to standard texts for theory and equations describing energy grade line (EGL) and hydraulic grade line. It is recommended that the EGL be computed first and then used to determine the hydraulic grade line. The effects of tailwater must be accounted for in the calculations. The Site Designer is referred to Figure 8-1 for criteria on calculating appropriate energy losses through manholes/junctions.

E. **STORM SEWER TABULATION FORM** (From FDOT Drainage Manual, most recent version)

The form for tabulating the results of hydrologic and hydraulic calculations for storm sewer systems is presented in Figure C-13 (APPENDIX C). This form is for representative purposes only. A large scale form is available from the County Administrator. The items to be recorded on this form have been identified by number on the figure and are briefly described below:

NOTE: All elevations should be given to the nearest 0.1 foot.

1. Selection of Rational Coefficients

Various contributing areas for each inlet should be broken down into high and low rational coefficient areas. Guidance for selecting rational coefficients is presented in APPENDIX A.

2. Notes

This space should contain information such as the design storm frequency, roughness coefficients, minimum cover for culverts, and other pertinent information.

3. Station

This column should show the survey station number for the structure in question.

4. Distance (Dist)

This column should give the distance of the centerline of the structure from the reference station.

5. Side (S)

This column should give the side, right (Rt) or left (Lt), of the reference station.

6. Structure No.

This column gives the sequential numbers of the drainage structures in the system (S-1, S-2, etc.).

7. Type of Structure



The type of structure is usually indicated by abbreviations such as Type 1, 2, or 3 for inlets; ditch bottom inlets (DBI); manhole (MH). For standard FDOT structures, the inlet or manhole type should be specified as indicated in the FDOT Roadway and Traffic Design Standards, latest edition.

8. Type of Line

The type of line is shown as (M) for mainline and (S) for stub-line.

9. Length (Feet)

This is the length, in feet, from the centerline of the structure in question to the centerline of the next structure.

10. Increment

Increment refers to the incremental area (in acres) corresponding to the rational coefficient being used. It is normally an area of overland flow contributing to the particular inlet. However, a contribution through an existing pipe should also be noted in this column.

Manholes usually do not have an associated incremental area as they are handling areas which have already been tabulated. Bypass caused by insufficient inlet capacity would be adjusted for in the total runoff column (Item 17).

11. Subtotal

This is the subtotal of the total area, for each Rational coefficient value used, contributing flow to or through the structure in question.

12. Subtotal (CA)

To arrive at this figure, the individual subtotal areas are multiplied by their corresponding Rational coefficients.

13. Time of Concentration (Min)

The time of concentration is the time required for runoff to travel from the most representative hydraulically distant point of the total area drained, to the point of the storm sewer system under consideration. This time consists of overland flow, gutter flow, and pipe flow time within the system.

See APPENDIX A for procedures to estimate time of concentration.

14. Time of Flow in Section (min)

This is the time it takes the flow to pass through the section of pipe in question; it depends on the computed velocity in the pipe segment.



15. Intensity (Rainfall)

Rainfall intensity values are determined from the intensity duration-frequency (IDF) curves (Zone 6) developed by the FDOT (Figure A-1). Design Rainfall Intensity at any point in the system depends on the design frequency and the time of concentration to that point in the system.

16. Total (CA)

The total (CA) is the sum of the subtotal CAs.

17. Total Runoff (cfs)

Total runoff is the product of the intensity and the total CA, plus or minus any anticipated inlet bypass flows.

18. Inlet Elevation (feet)

This column lists the elevation of the edge of pavement at the inlet throat if the structure is a curb inlet. In the case of manholes and ditch bottom inlets, either the top or grate elevation, and any slot elevation are shown.

19. Upper End (Hydraulic Gradient)

This column shows the elevation of the hydraulic gradient at the upper end of the pipe section.

20. Lower End (Hydraulic Gradient)

The elevation of the hydraulic gradient at the lower end of the pipe section is shown.

21. Upper End (Crown Elevation)

This elevation is the inside crown elevation at the upper end of the pipe section being designed.

22. Lower End (Crown Elevation)

This is the inside crown elevation at the lower end of the pipe section being designed.

23. Upper End (Flow Line)

This elevation is the flow line of the pipe section at the upper end.

24. Lower End (Flow Line)

This elevation is the flow line of the pipe section at the lower end.



25. Fall (Feet)

The hydraulic gradient fall is shown (to the closest one-tenth of a foot).

26. Fall (Feet)

The total physical fall of the pipe section is shown (to the nearest one-tenth of a foot).

27. Diameter (inches)

This column shows the diameter of the pipe used for the section, (in inches) or, if a box culvert is used, the width and height (in feet).

28. Slope (percent)

The hydraulic gradient slope is shown above the physical slope of the pipe.

29. Velocity (fps)

The velocity produced by the gradient slope is shown above the velocity produced by the physical slope of the pipe.

30. Capacity (cfs)

The capacity of the pipe on the hydraulic gradient slope is shown above the physical slope.

31. Remarks

This space is available to record specific remarks on the storm sewer system design. The anticipated design flow rate for the typical drainage area should be provided and the intercepted flow used to establish the pipe size. The by-pass flow should be recorded and accounted for. Energy Grade Line elevations and structure loss coefficient/values should also be noted.

B.3 RECOMMENDED NEIGHBORHOOD GRADING PLAN DESIGN PROCEDURE

A. GENERAL RECOMMENDATIONS

The design professional, in developing the neighborhood grading and drainage plan, should follow certain basic steps. The objective is to establish the street elevations, finished floor elevations and lot grades in proper relation to each other, and to the existing topography, with the goals of protecting the property from flood stages and flows, while creating an appealing and functional site.

1. The street layout is the first factor which must be considered. If the street layout is still subject to design or adjustment, it should be fitted to the existing



topography with proper consideration of seasonal high water table elevations, and the existing directions of stormwater flow.

2. The second factor is to determine the grading for each separate block with reference to Lot Grading Types (A, B or C, or modifications of these types) by establishing an appropriate block cross-section to provide a suitable drainage pattern to the block collection points. Then determine any easements or other provisions needed for adequate block drainage around the selected lot types.
3. Determine the general site limitations such as the minimum gradients for grass swales based on the anticipated volume of water to be conveyed.

B. BLOCK GRADING PLAN DESIGN RECOMMENDATIONS

Begin by laying out the blocks along the streets to provide appropriate drainage volumes to the proposed stormwater conveyance structures. Block Grading Plans must be a part of the Construction Plans and include the following:

1. Flood Zone lines and elevations - indicate the 100-year flood elevation, and delineate the area of floodplain encroachment and the proposed mitigation area, when applicable.
2. Identify all EPC delineated wetland boundaries, and all significant habitat areas (as defined on the County GIS Habitat Maps) within the entire site.
3. Indicate all subbasin boundaries and outfall points, and include drainage patterns denoted with flow arrows.
4. Provide a complete breakdown of the post-development Runoff Coefficients and/or Curve Numbers (CN), as applicable, and areas for all subcatchments noted within subbasin areas.
5. Provide grading plan details depicting all new elevations and contoured features to provide for flows into proposed stormwater collection system. Plan must distinguish existing and proposed elevations, structures and other drainage features.
6. Provide adequate cross-sections for each proposed block, whenever lot types change. The maximum side slope shall be no steeper than 1:4. Depict typical lot layout with approximate finish floor elevations defined in relation to proposed Block Grading on cross-section.
7. Provide adequate cross-sections of all proposed drainage swales, with the maximum side slope no steeper than 1:4, and minimum depth of six inches. Indicate any modifications which must be completed with lot grading and house construction.
8. Provide yard swales, wherever applicable, between lot grading types A, B & C. Insure adequate slopes to drain the stormwater runoff flow to roadway catch basins, or other proposed stormwater collection facilities. Include proper



drainage easement for these yard swales whenever swales run for more than a single lot. Yard swales should be dedicated to the Home Owners Association unless they serve a County right-of-way.

C ADDITIONAL LOT GRADING PLAN RECOMMENDATIONS

1. Excavation/Fill Requirements.

- a. The maximum side slope for any fill shall be one foot vertical to four feet horizontal. Adequate swales and/or other features must be shown to ensure that adjacent property is not impacted.
- b. The act(s) of stockpiling material, grading, filling, excavating and other acts affecting drainage shall not change the surface or subsurface drainage patterns to the detriment of neighboring properties or public right-of-way.
- c. Proper erosion protection measures to control water borne and wind blown erosion, including erosion caused by vehicles entering and leaving the site, shall be provided during all stages of construction.
- d. All disturbed areas will be permanently revegetated with sod, or seed and mulch in accordance with the FDOT Standard Specifications for Road and Bridge Construction (latest edition). Slopes steeper than 1:5 shall be sodded.

2. Special Conditions

Some project locations may require special requirements. Stormwater detention/retention, special controls and/or administrative procedures may be involved. Special requirements may be required for projects located within areas determined to be flood prone by a history of flooding and/or by stormwater management masterplans, adopted by Hillsborough County. These areas include but are not limited to

- a. Development in Existing Low Lots - Lots that are lower than the street and receive runoff from the road and/or adjacent properties may be subject to special fill/storage requirements.



APPENDIX C: DESIGN AIDS

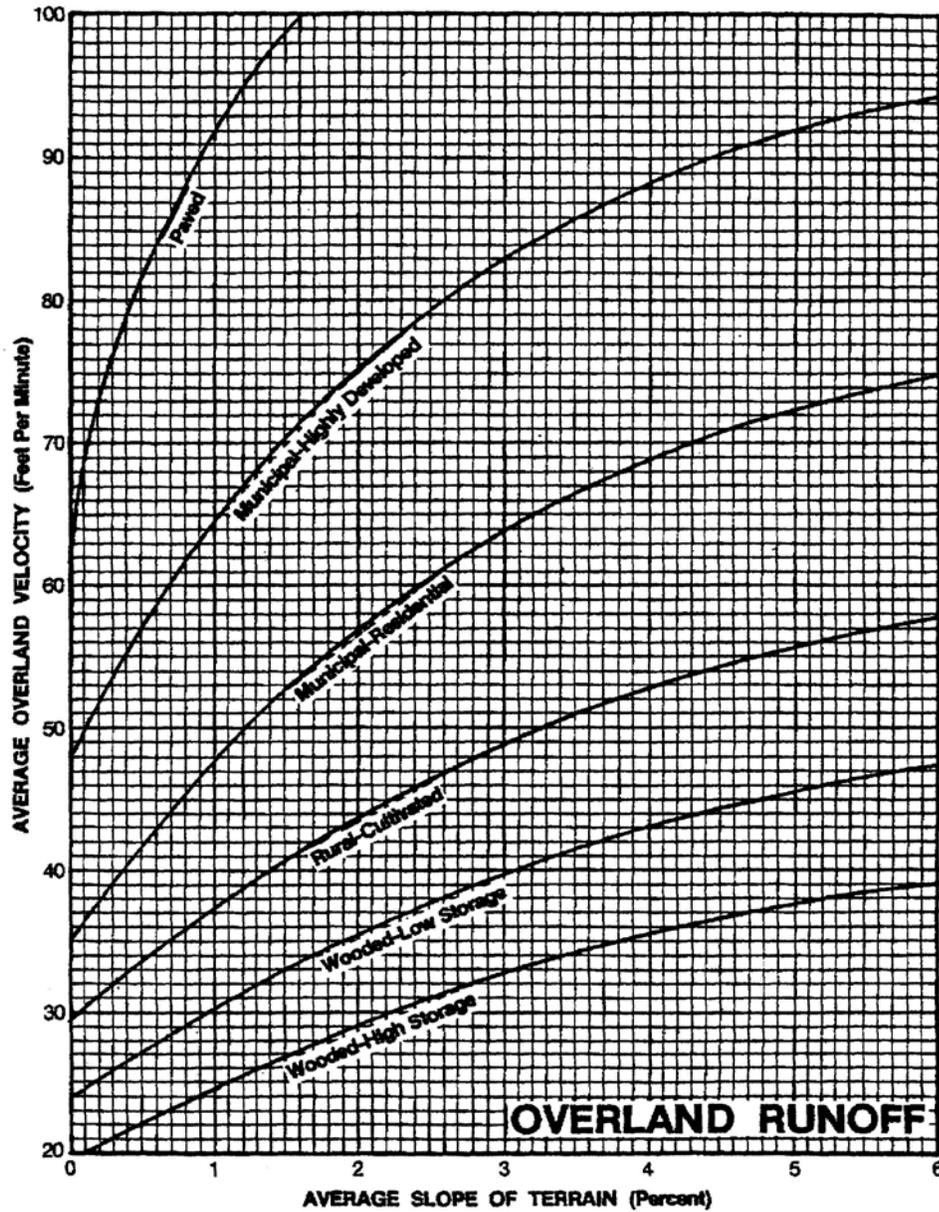


FIGURE C-1
Overland Flow Velocities for Various Land Use Types

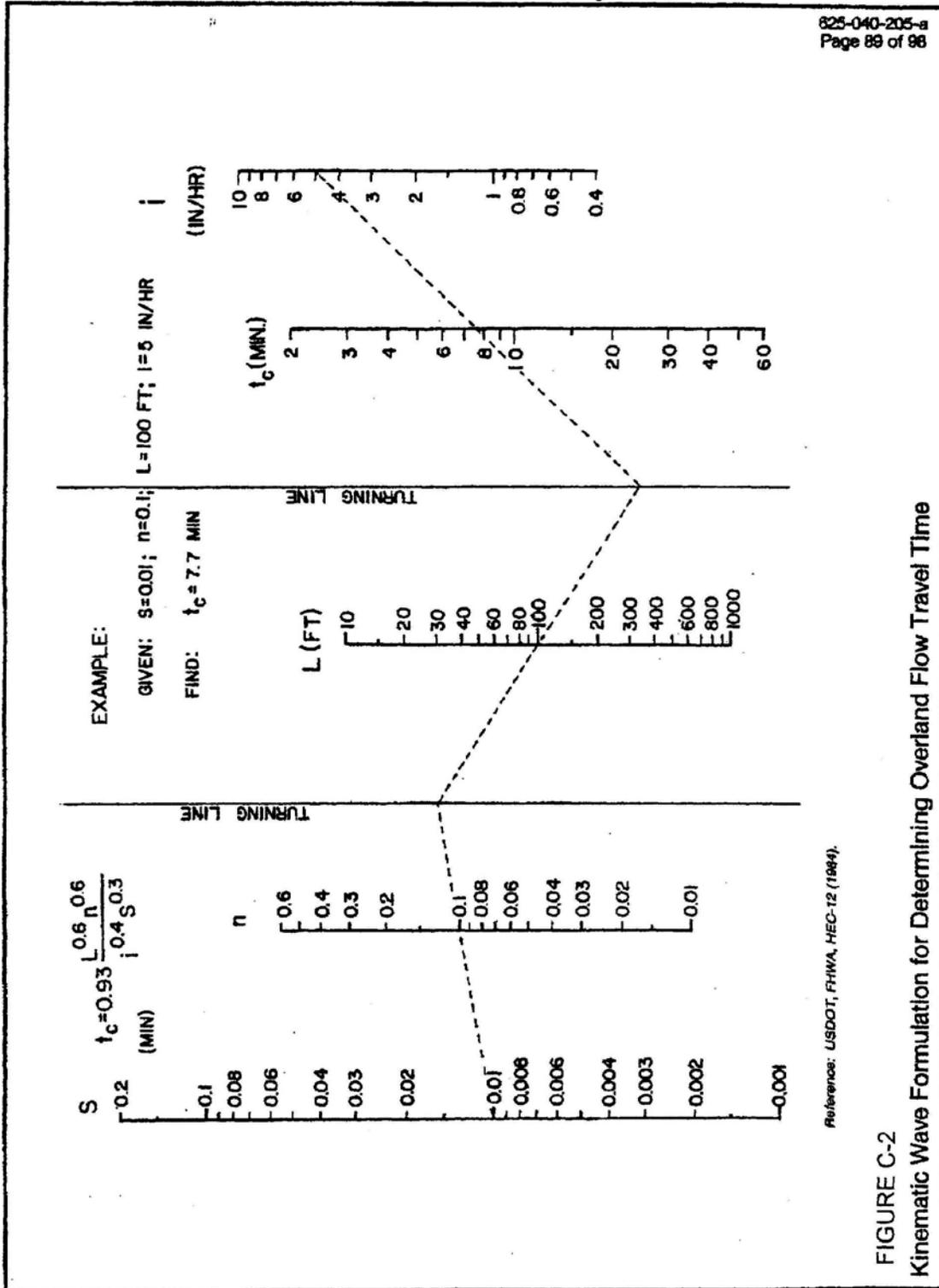
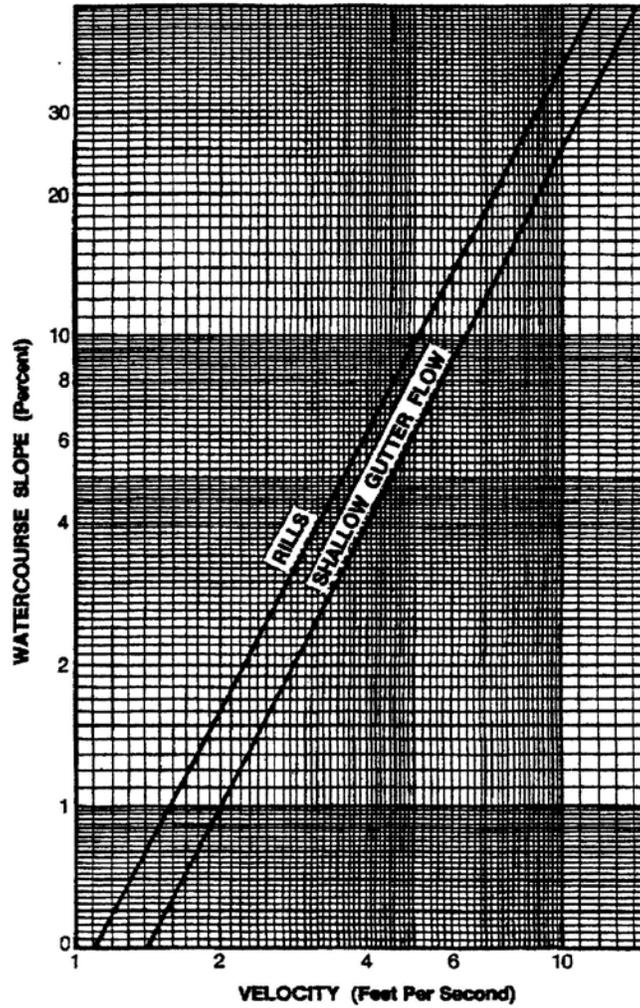


FIGURE C-2
Kinematic Wave Formulation for Determining Overland Flow Travel Time



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

FIGURE C-3

Average Velocities for Estimating Travel Time for Small Channel Flow

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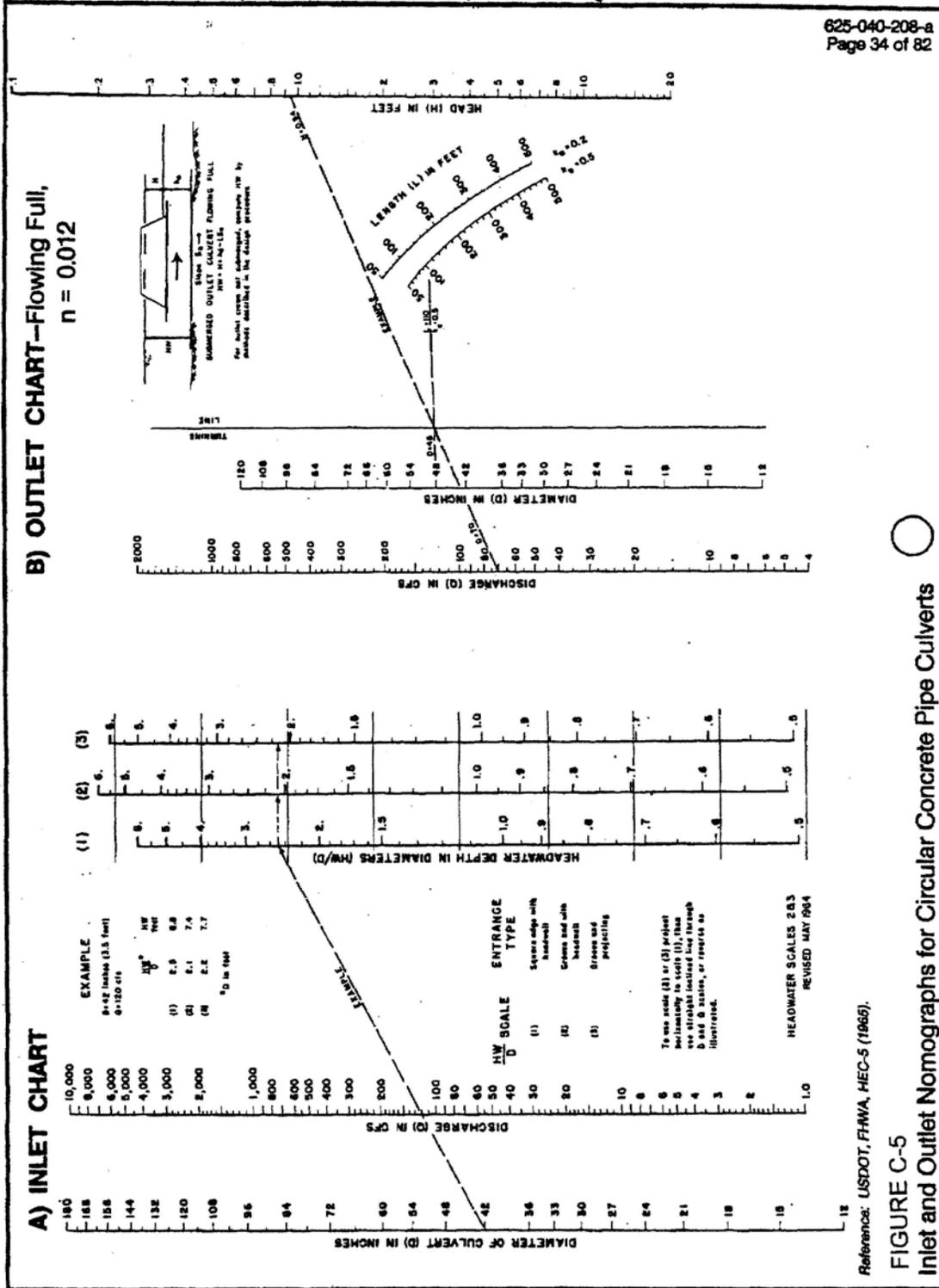
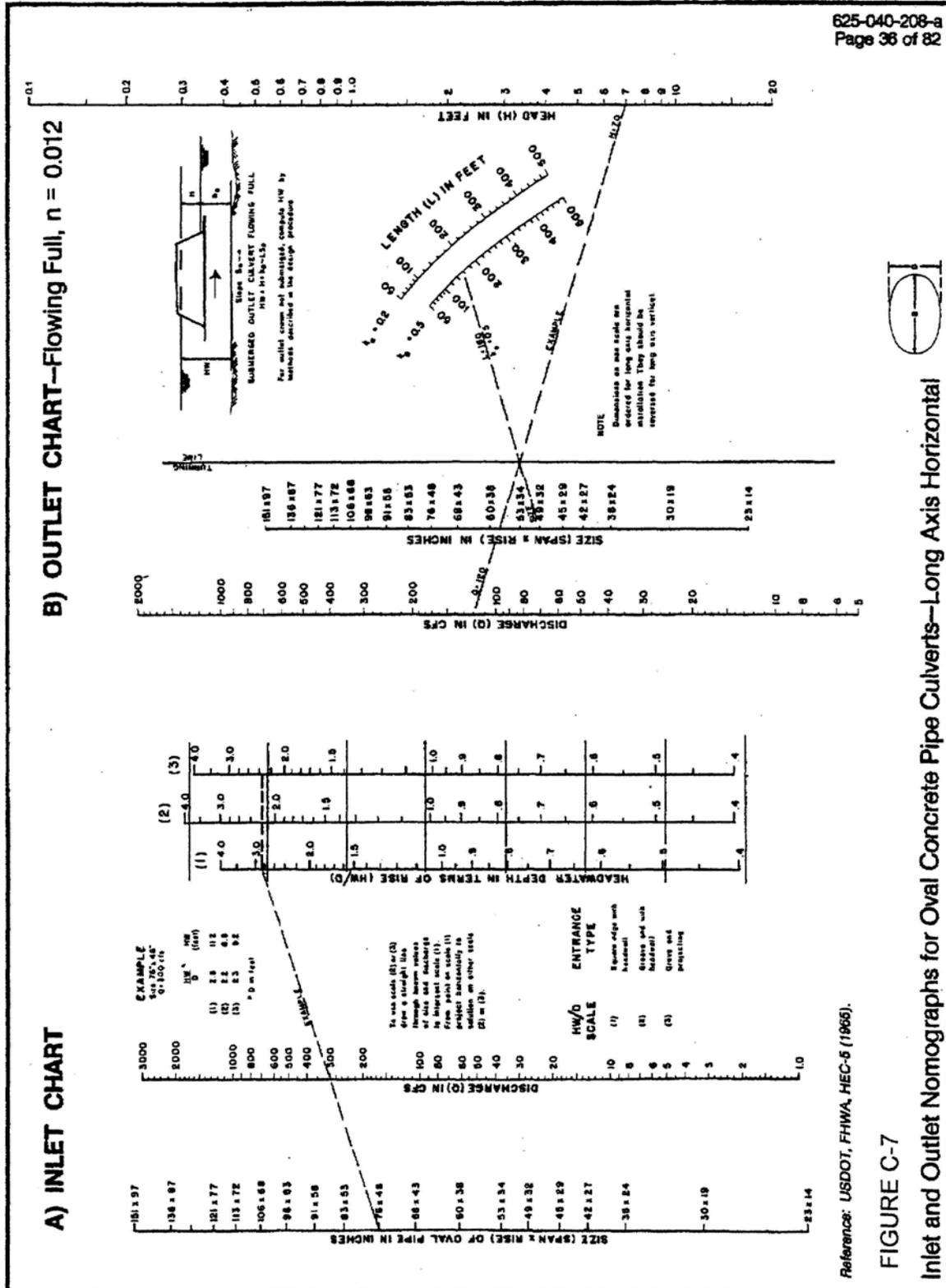


FIGURE C-5
Inlet and Outlet Nomographs for Circular Concrete Pipe Culverts

Reference: USDOT, FHWA, HEC-5 (1965).

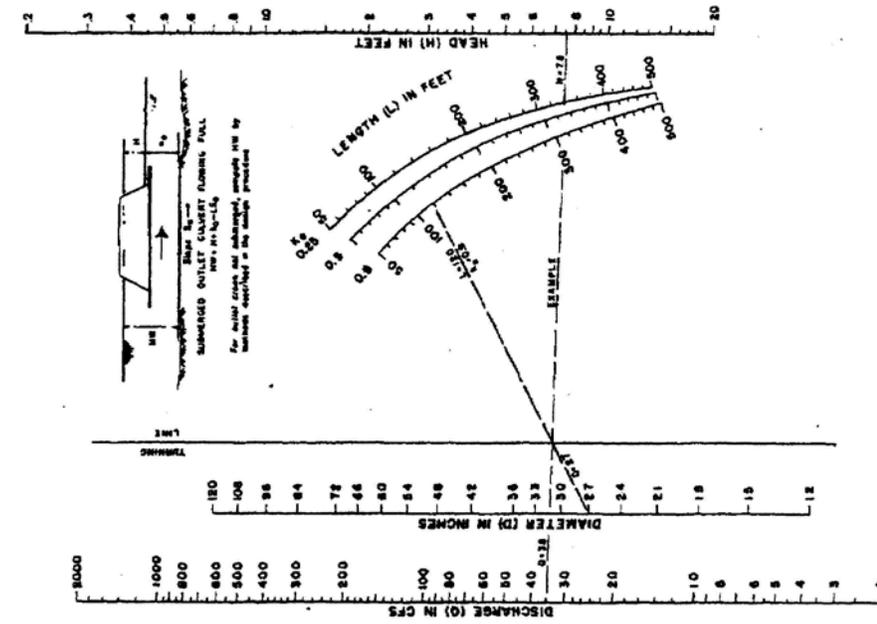


Reference: USDOT, FHWA, HEC-5 (1965).

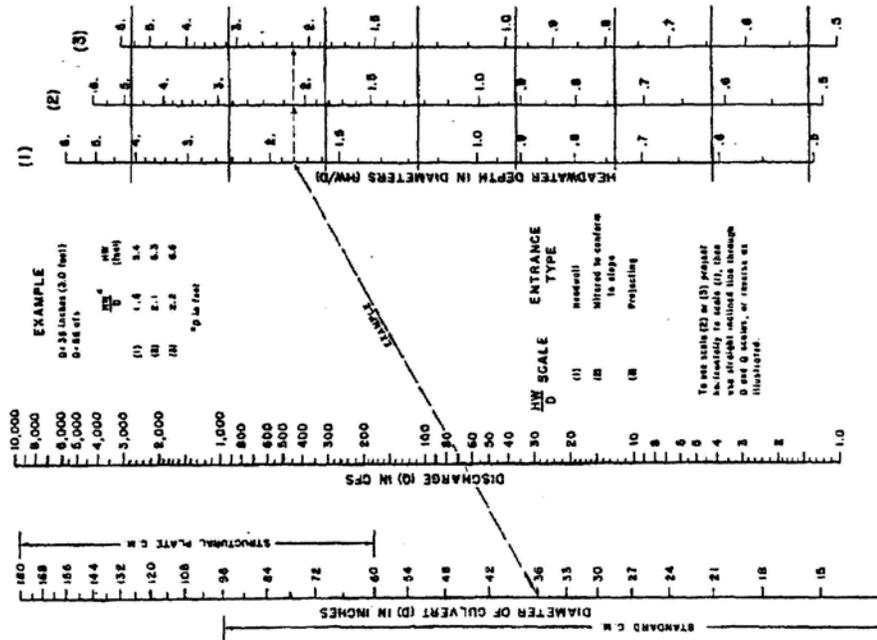
FIGURE C-7

Inlet and Outlet Nomographs for Oval Concrete Pipe Culverts—Long Axis Horizontal

B) OUTLET CHART—Flowing Full, $n = 0.024$



A) INLET CHART



Reference: USDOT, FHWA, HEC-5 (1965).

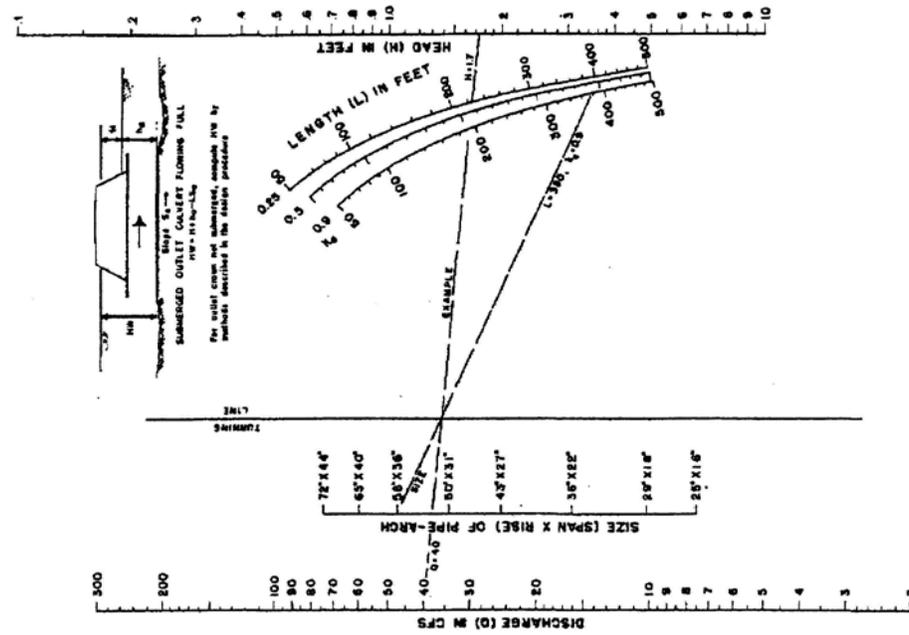
FIGURE C-8

Inlet and Outlet Nomographs for Circular Corrugated Metal Pipe Culverts

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B) OUTLET CHART--Flowing Full, $n = 0.024$



A) INLET CHART

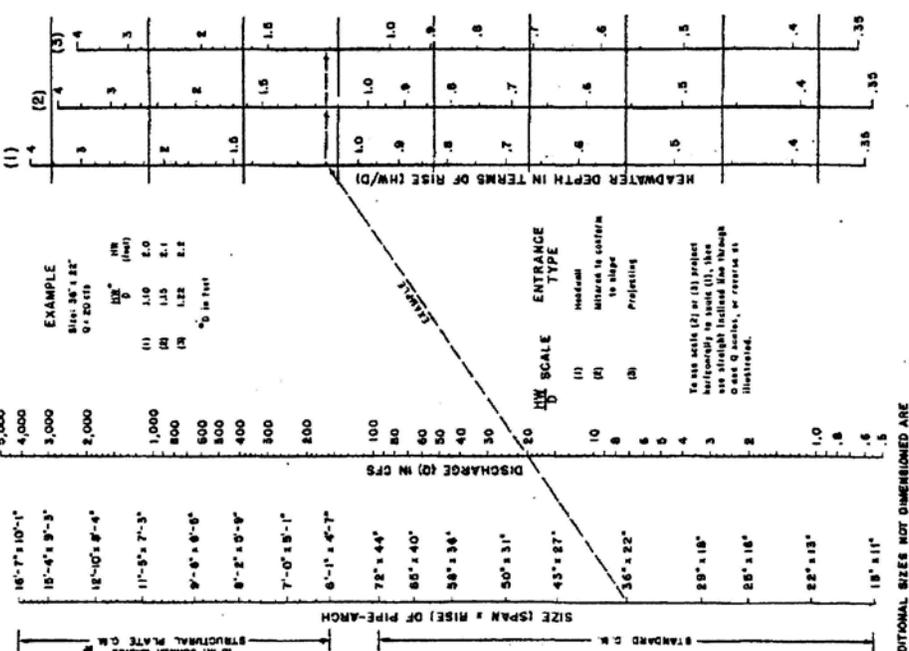
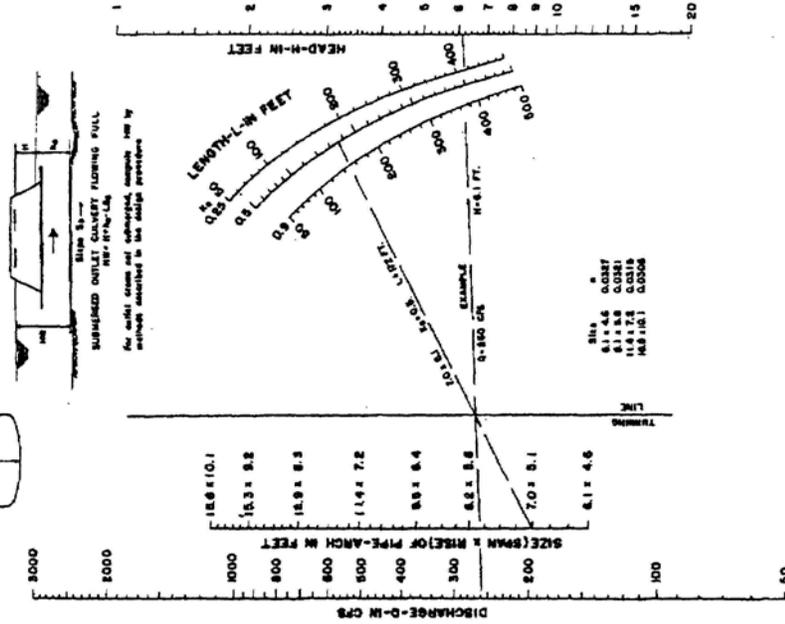
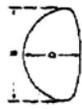


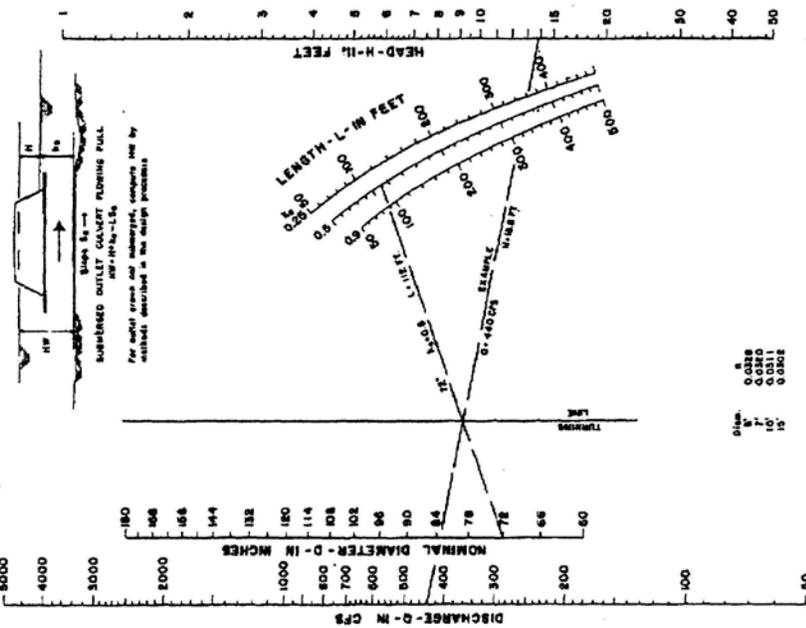
FIGURE C-9
Inlet and Outlet Nomographs for Corrugated Metal Pipe-Arch Culverts

B) OUTLET CHART—Pipe-Arch, 18 in. Corner Radius, Flowing Full, $n = 0.0327$ to 0.0306



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A) OUTLET CHART—Circular Pipe Flowing Full, $n = 0.0328$ to 0.0302



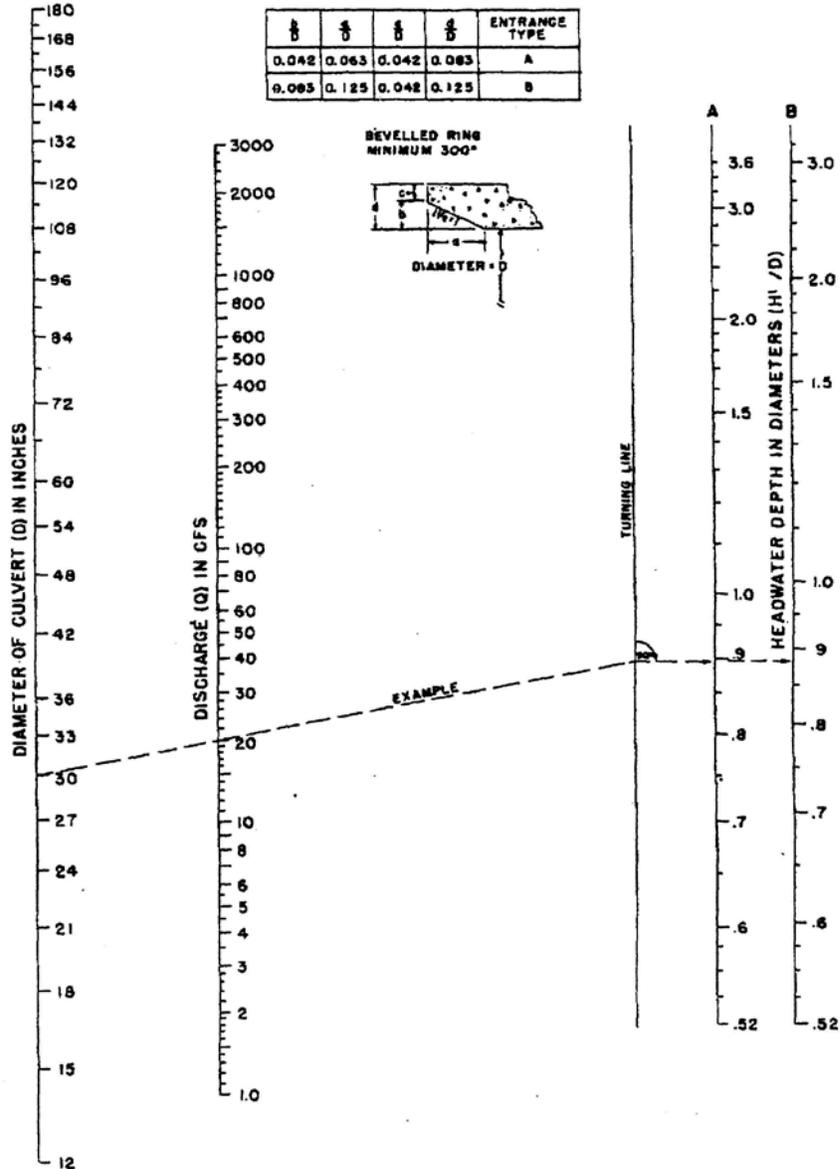
Reference: LISDOT, FHWA, HEC-5 (1985).

FIGURE C-10

Outlet Nomographs for Circular and Pipe-Arch Structural Plate Corrugated Metal Culverts

INLET CHART

$\frac{b}{D}$	$\frac{a}{D}$	$\frac{b}{D}$	$\frac{a}{D}$	ENTRANCE TYPE
0.042	0.063	0.042	0.083	A
0.083	0.125	0.042	0.125	B

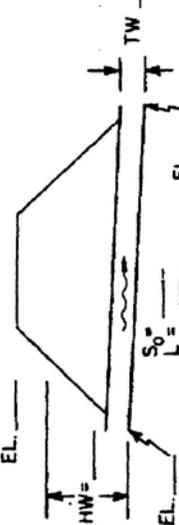
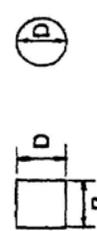


Reference: USDOT, FHWA, HEC-5 (1985).



FIGURE C-11

Inlet Nomograph for Circular Pipe Culverts with Beveled Ring

PROJECT: _____ DESIGNER: _____ DATE: _____		STATION: _____ 		MEAN STREAM VELOCITY = _____ MAX. STREAM VELOCITY = _____		COMMENTS							
HYDROLOGIC AND CHANNEL INFORMATION D = Diameter or Height B = Span  $Q_1 =$ _____ $Q_2 =$ _____ $TW_1 =$ _____ $TW_2 =$ _____ (Q_1 = DESIGN DISCHARGE, SAY Q_{25} Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})		HEADWATER COMPUTATION $HW = H + DTW - LS_0$		CONTROLLING HW VELOCITY		COST							
CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE		INLET CONTROL		OUTLET CONTROL		HEADWATER COMPUTATION		CONTROLLING HW	VELOCITY	COMMENTS	
		D	B	$\frac{HW}{D}$	HW	K_0	H	d_c	$\frac{d_c + D}{2}$				TW
SUMMARY & RECOMMENDATIONS:													

Design by _____ Checked by _____ Approved by _____

FIGURE C-12
Worksheet for Culvert Capacity Calculations



STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION
STORM DRAIN TABULATION FORM

DATE	P.L. No.	LOCATION OF UPPER END	STATION	DIST S	STRUCTURE NO.	TYPE OF STRUCTURE	TYPE OF PIPE	LENGTH (FT.)	DRAINAGE AREA (ACRES)			SUB-TOTAL	(12)	TIME TO TRAVEL FROM SOURCE TO POINT OF MEASUREMENT	(13)	TIME TO TRAVEL FROM SOURCE TO POINT OF MEASUREMENT	(14)	MISSISSIPPI	(15)	TOTAL	(16)	TOTAL	(17)	TOTAL	(18)	ELEV. OF H.G.			DRAINAGE	COUNT	BY	SHEET NO. OF																																																																				
									C	I	M															AREA	AREA	AREA					AREA																																																																			
			3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100

FIGURE C-13
Recommended Storm Drain Tabulation Form



APPENDIX D: GLOSSARY



GLOSSARY

The following definitions are for the purpose of making clear and distinct the intentions of the language used in this Manual except where specific definitions are used within specific sections. For the purpose of such sections, the following terms, phrases, words and their derivation shall have the meaning given herein and not be inconsistent with the text. Throughout the Manual and herein, words used in the present tense include the future tense; words used in the plural number include the singular number; and words used in the singular number include the plural number.

ADEQUATE OUTFALL

Outfall which has no known inadequacies or flooding problems during a 25-year/24-hour storm, but an increase in inflow could cause an increase (actual or computed) in water surface elevations.

ADVERSE IMPACT

Any modification, alteration, or effect on a feature or characteristic of stormwater management systems/facilities, other water bodies, groundwater and natural resources, or flood prone lands, including their quality, quantity, hydrodynamics, surface area, species composition, living resources, aesthetics or usefulness for human or natural uses, which are or potentially may be harmful or injurious to human health, welfare, safety or property, biological productivity, diversity or stability, or which reasonably interfere with the enjoyment of life or property including outdoor recreation or cause damage to adjacent property owners, due to development and other construction activities. The term includes secondary, indirect and cumulative as well as direct impacts.

ANGLE OF REPOSE

Maximum angle at which a sideslope in natural bare soil will not have a high risk of failure due to gravitational forces.

ANTECEDENT MOISTURE CONDITIONS

The degree of moisture within, or the wetness of, a drainage basin and/or watershed at the beginning of a storm. Generally, for design purposes, this condition is defined in terms of the quantity of rainfall which can be expected to occur during a specified period of time prior to the inception of the design storm. Antecedent Moisture Condition II is assumed in Hillsborough County for the SCS Unit Hydrograph Methodology.

AREA OF SPECIAL FLOOD HAZARD

Land in the floodplain within a community subject to a one percent or greater chance of flooding in any given year.

ARTERIAL STREET

A road or thoroughfare that has been or may be designated for the movement of large volumes of traffic between points in the County, which said road will ordinarily have controlled or limited rights of access.

ATTENUATION

The reduction of stormwater discharge through the provision of storage volume, to minimize downstream impacts. (See also Detention Pond)

AVERAGE (or MEAN) ANNUAL FLOOD

A flood which has a statistical recurrence interval of 2.33 years.



BASE FLOOD

A flood having a one percent chance of being equaled or exceeded in any given year.

BASEFLOW

Surface water recharge which originates from ground water seepage during low flow conditions.

BASIN (DRAINAGE BASIN or AREA)

Surface drainage area which is defined by topographic boundaries that direct stormwater runoff to a common point or receiving waters, and is a subdivision of a watershed.

BEST MANAGEMENT PRACTICES (BMPs)

Schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce pollutants from entering Hillsborough County's Municipal Separate Storm Sewer System (MS4) or being discharged from the MS4. BMPs include, but are not limited to, both structural and nonstructural treatment methods and practices to control the discharge of pollutants.

BRIDGE

A structure required to carry traffic or other moving loads across a channel, ditch or other conveyance way when a culvert or culverts are not suitable, due to clearance requirements for navigation, hydraulic efficiency, geometrics, constructability, environmental concerns, costs or aesthetics.

CAPACITY

The limiting volume or flow that the conveyance channel, pond, pipe or other hydraulic structure can manage, without causing adverse impact, in accordance with the criteria specified in this Manual.

CAPACITY ANALYSIS

A determination of a Stormwater Management facility's ability to provide a given Level of Service, or the determination of the Level of Service of the facility.

CAPITAL IMPROVEMENT

The acquisition of land or property and/or the construction of, or improvements to public facilities including, but not limited to, the following: Building or structure, stormwater or surface water management facility, utility, road, park, open area or other public place requiring the expenditure of public monies.

CATCH BASIN

Inlet structure that is usually built at the curb line of a street which permits surface water runoff to flow into a storm sewer while retaining grit and debris below the invert elevations of the storm sewer pipes.

CATCHMENT OR SUBAREA

Small area of surface drainage which is a subdivision of a drainage basin.

CHANNEL

A natural or artificial watercourse of perceptible extent, with a definite bed and banks to confine and convey continuously or periodically flowing water. Channel flow thus is that water which is flowing within the limits of the defined channel.

CHANNELIZATION

Creation of a new channel, or alteration of an existing channel's width, depth, length, lining, and/or geometry in order to improve flow capacity and or channel storage.



CLOSED DRAINAGE BASIN OR BLIND

A drainage basin which does not have a positive outfall for storm events less than or equal to the 25-year, 24-hour event. The receiving waters in such drainage basins are considered to have "volume sensitive" capacity, and the allowable discharges from new developments or redevelopments in such drainage basins at least partially rely upon percolation (and other groundwater flow), evaporation, and evapotranspiration.

COLLECTOR STREET

A roadway designated under the Hillsborough County Functional Classification System.

COMPENSATING STORAGE

Constructed or otherwise provided new flood storage volume required to compensate for storage volume lost due to filling, within the portions of the 100-year floodplain associated with the storage and/or conveyance of stormwater.

CONSTRUCTION

The act of altering land or vegetation in preparation for development, or any action or activity which results in an alteration of either land, vegetation, or existing structures or the building of new structures.

CONSTRUCTION ACTIVITIES (FOR NPDES REQUIREMENTS ONLY)

Includes clearing, grading, and excavation activities except operations that result in the disturbance of less than five (5) acres of total land area which are not part of a larger common plan of development or sale.

CONSTRUCTION PERMIT

Surface water management permit issued by the Southwest Florida Water Management District authorizing construction, alteration or abandonment of a surface water management system in accordance with the terms and conditions of the permit. Also, a permit obtained from the Building Department to construct in County rights-of-way or easements.

CONTROL ELEVATION

The crest elevation of a control structure's overflow weir, the weir through which the detention volume of a pond or lake is discharged.

CONTROL (or WATER LEVEL CONTROL or DISCHARGE) STRUCTURE

A structural device, usually of concrete, metal, etc., which regulates the release of water from a project to the receiving waters.

CONTROLLED SEASONAL HIGH GROUNDWATER ELEVATION

The elevation to which the groundwater can be expected to rise during a normal wet season after modifications to the surface and groundwater regime have occurred in the area.

CONVEYANCE

The transport of stormwater via pipe and/or open channel system(s).

CONVEYANCE WAY

A path for water to move from one place to another in a continuous flow.

COUNTY ADMINISTRATOR

The Chief Executive Officer and administrator of Hillsborough County, or his designee.



COUNTY ENGINEER

The Director of the Public Works Department's Engineering Division, or his designee.

CRITICAL DEPTH

Depth at which the specific energy (sum of depth and velocity head) is minimum.

CRITICAL SLOPE

Slope required to maintain uniform flow at critical depth.

CULVERT

Enclosed structure which conveys stormwater discharge under roadways, driveways, and other similar obstructions to flow in ditches and other open channels.

CUT AND FILL

Alteration of land surface by excavating part of an area and using the excavated material for adjacent embankments or fill areas.

DAM or DIKE

A barrier created to impound or restrain the flow of water or fluid materials for storage, diversion, or detention.

DEPRESSION STORAGE

Capacity of a watershed, catchment or drainage basin to retain water in small puddles and depressions.

DESIGN CAPACITY

The amount of flow and/or storage a stormwater facility is designed to manage, usually expressed in cubic feet per second for flow and cubic feet or acre feet for storage.

DESIGN HIGH WATER

Peak water surface elevation of a surface water body (e.g., detention or retention facility) which is determined according to the flow conditions of a specified design storm(s).

DESIGN LIFE

Period of time for which a facility is intended to perform its designated function.

DESIGN LOW WATER

Water surface elevation of a surface water body (e.g., detention or retention facility) typically corresponding to the top of the stormwater treatment pool, and below which no credit is allowed for meeting Hillsborough County's attenuation and storage requirements.

DESIGN STORM

An adopted amount, intensity, duration, distribution, and frequency of rainfall used as the basis of design criteria and specifications.

DETENTION or TO DETAIN

To temporarily store stormwater runoff in such a way as to reduce its flow, for the purpose of either limiting downstream impacts or providing treatment for water quality, or both.



DETENTION POND/BASIN

A stormwater management facility designed to temporarily delay stormwater runoff and attenuate peak flow prior to discharge into a receiving system/pond.

DETENTION TIME

Theoretical time required to displace a given volume of water at a given rate of discharge.

DETENTION VOLUME

Volume of water equal to the potential pond storage volume available between the design high water elevation and the control elevation of the discharge structure.

DEVELOPER

Owner or agent of the owner of land on which land alteration or development activities are proposed, and who shall have the legal right to bind the owner to all legal obligations. This includes the person or persons, corporation, or other entity applying for a permit.

DEVELOPMENT

The act of building, engineering, mining or other operations in, on, over, or under land or the making of any material change in the use of any building or other land. Also, any man-made change to real property, including but not limited to dredging, filling, grading, paving, excavating, clearing, timbering, ditching or draining.

DISCHARGE (FOR NPDES REQUIREMENTS ONLY)

Any release, spill, leakage, seepage, pouring, emission, emptying or dumping of any substance or material.

DRAIN

An open or closed conduit which transports stormwater runoff.

DRAINAGE

A general term applied to the removal of surface water or ground water from a given area either by drains, grading or other artificial or natural means.

DRAINAGE BASIN

See definition for "Basin".

DRAINAGE DIVIDE

Physical boundary which separates two drainage basins, and away from which stormwater runoff flows on either side.

DRAWDOWN

Lowering the level of surface water, groundwater or the potentiometric surface as a result of changes in outflow in the system.

EASEMENT

An interest in land owned by another that entitles its holder to a specific limited use or enjoyment.

EMBANKMENT

Man-made fill, constructed of soil, rock or other material, which is supported by banks or sideslopes.



ENCROACHMENT

Infringement into the floodplain/floodway by development causing a reduction in volume and/or conveyance.

ENERGY GRADE LINE

Line showing the total estimated energy needed at any point in a conveyance system to cause given stormwater discharges to flow through the system.

ENGINEER OF RECORD

An individual registered by the State of Florida as a Professional Engineer. Further, the individual must be registered to perform engineering assignments in the discipline of Civil Engineering

ENVIRONMENTALLY SENSITIVE AREAS

Conservation Areas and Preservation Areas pursuant to the Conservation Element of the Hillsborough County Comprehensive Plan. Conservation Areas include the following types of wetlands (w), natural water bodies (nwb), and uplands (u): freshwater marshes (w), wet prairies (w), hardwood swamps (w), cypress swamps (w), natural shorelines other than natural beaches and dunes (w), Class III Waters (w, nwb), and significant wildlife habitat (w, nwb, u). Preservation Areas include the following types of wetlands, natural water bodies and uplands: coastal marches (w), mangrove swamps (w), marine grassbeds (w, nwb), natural beaches and dunes (w, u), Class I and II Waters (w, nwb), aquatic preserves (w, nwb), essential wildlife habitat (w, nwb, u), and natural preserves (w, nwb, u).

EROSION

The general process whereby soils and sediments are moved by flowing surface water, wind, or mechanical action.

EROSION CONTROL PLAN

A plan to control on-site soil that may ordinarily be moved by flowing surface water, wind, or movement of vehicles. The erosion control plan may consist of a separate and distinct plan or details and notes on the site plan as appropriate for the location and proposed activity.

EVAPOTRANSPIRATION

Loss of water which results from evaporation from soil, water, vegetation and other surfaces in combination with transpiration from plants.

EXFILTRATION TRENCH

A subsurface facility designed to convey stormwater into the underlying soil, providing both treatment through filtration and volume reduction.

FILTER FABRIC

Water-permeable material (i.e., geotextile) which prevents the movement of fine-grained soils into a subsurface drainage system.

FIRST FLUSH

First portion of stormwater runoff which is generated by a rainfall event and contains the bulk concentration of contaminants which are washed into the drainage network by the storm.

FLASHBOARD

Temporary barrier placed along the crest of the control-structure's overflow weir, which allows the surface water elevation in a reservoir or pond to be raised above the normal control level. The installation



of flashboards or other water-level adjustment devices on control structures is prohibited, unless specifically and formally authorized by both Hillsborough County and the Southwest Florida Water Management District.

FLOOD

A general and temporary condition of partial or complete inundation of normally dry land areas from: (1) the overflow of inland or tidal waters; and/or (2) the unusual and rapid accumulation or runoff of surface waters from any source.

FLOOD HAZARD AREA

An area that has experienced flooding in 1979 or later or is recorded in either the FEMA Flood Insurance Rate Maps or the current floodplain maps of the Hillsborough County Stormwater Management Master Plan.

FLOOD HAZARD BOUNDARY MAP (FHBM)

An official map of a community, issued by the Federal Emergency Management Agency, where the boundaries of the area of special flood hazards have been designated.

FLOOD INSURANCE RATE MAP (FIRM)

An official map of a community, on which the Federal Emergency Management Agency has delineated both the special hazard areas and the risk premium zone applicable to the community.

FLOOD PEAK

Highest value of discharge or stage which a flood attains for a given frequency event.

FLOOD ROUTING

Determination of changes in flood water elevation and flow throughout the course of a stream, channel, lake, reservoir, pond, or other conveyance way.

FLOOD STAGE

Stage or elevation at which surface water begins to overflow from the natural banks or other confining boundaries of a stream, channel lake reservoir pond or other conveyance way.

FLOOD ZONE

A special flood hazard area depicted on the FIRM.

FLOODPLAIN

Land which has been or may be covered by water as a result of a storm event, including but not limited to the 100-year storm.

FLOODPRONE

Any land area susceptible to being inundated by water from any source, including: the floodplain associated with the 100-year flood; those lands frequently subjected to inundation; and those lands identified as "Red Line" lots due to frequent localized flooding problems.

FLOODPROOFING

Any combination of structural and nonstructural additions, changes or adjustments to structures which reduce or eliminate flood damage to real property or improved real property, water and sanitary facilities, structures, and their content.



FLOODWAY

The conveyance portion of a water course and its adjacent floodplain areas that must be reserved in order to discharge the 100-year flood without increasing flood heights by a specified amount.

FLOWPATH

The direction or course which stormwater would move or flow due to natural or modified land surface elevations.

FLUME

A usually steeply inclined, lined channel.

FREEBOARD

A vertical distance between the elevation of the design highwater or hydraulic grade line and the inside top of bank, top of dam/dike/levee, ground level or edge of pavement, as applicable.

GRADING

The action or process of changing the elevation contours of a specified site.

GRADING PLAN

A plan to accurately show the proposed change in elevations of a specific site, or portion of a site.

GROUNDWATER RECHARGE OR RECHARGE

Addition of water to the subsurface saturated zone by subsurface inflow, or by surface water infiltration, percolation or seepage, as a result of natural and/or artificial means.

HEAD LOSS

Loss of energy available or needed to cause flow, which results from friction, eddies, and changes in velocity and direction of flow.

HEADWATER

Source of a water course or the water upstream from a control structure or culvert.

HYDRAULICS

Study of the mechanics of water movement.

HYDRAULIC GRADE LINE

The line showing the pressure head, or piezometric head as an elevation above a datum at any point in a pipe.

HYDROGRAPH

Graph of the stage or discharge of a water body versus time.

HYDROLOGIC CYCLE

The continuous circulation of a particle of water from the ocean to the atmosphere, to the land, and ultimately discharging back into the ocean.

HYDROLOGY

Study of the occurrence and movement of water on the surface and beneath the surface of the earth.



ILLICIT DISCHARGE

Any discharge to a MS4 or to waters of the U.S. that is not composed entirely of stormwater, with the exception of discharges which are exempt pursuant to Section 6-1 of the Stormwater Management Ordinance. Any discharge in violation of a NPDES permit shall constitute an illicit discharge.

IMPERVIOUS SURFACE

A surface which has been compacted or covered with a layer of material so that it is highly resistant to infiltration by water.

INDUSTRIAL ACTIVITIES (FOR NPDES REQUIREMENTS ONLY)

Activities which are conducted on properties designated for Industrial Land Use in accordance with the Hillsborough County Comprehensive Plan and/or at facilities identified by the U.S. EPA as requiring a NPDES stormwater permit under the definition of "Storm Water Discharge Associated with Industrial Activity" in Title 40, Section 122.26 of the Code of Federal Regulations or any amendment thereto.

INFILTRATION

Movement of water through the ground surface and into the soil zone.

INITIAL ABSTRACTION

Amount of precipitation that is infiltrated into the ground, intercepted by plant cover, and stored in depressions prior to the inception of runoff.

INLET

A structure which allows stormwater to flow into a conveyance system.

INSIDE TOP OF BANK

The "waterward" or internal top of bank at the lowest of the high points on the sideslope of a pond.

INSPECTION (FOR NPDES REQUIREMENTS ONLY)

Includes, but is not limited to, any on-site physical examination of facilities and grounds which may discharge to a MS4, a review of records on operation and maintenance of facilities and the results of any monitoring performed for compliance with state, federal, and local regulations or permit conditions.

INTERNALLY DRAINED

See "Landlocked Area".

LAG TIME

The time from the center of mass of rainfall excess to the peak of a unit hydrograph.

LAND ALTERATION

Any activity which removes vegetation from or changes the topography of the land by grubbing, tree removal, clearing, grading, filling, or excavating, except for activities undertaken to maintain existing features.

LANDLOCKED AREA

An area in which runoff does not have a surface outfall up to and including the 25-year flood elevation.



LEVEL OF SERVICE

An indicator of the extent or degree of stormwater management facility function or ability; the potential capacity or potential performance of the facility in terms of level of protection provided (e.g., 25-year/24-hour design storm protection).

LOCAL STREET

A street of limited continuity used primarily for access to abutting property and the local needs of the neighborhood.

LOT

A platted portion of land identified as a single unit in a subdivision and intended for lease, transfer of ownership, use or improvements, or a combination thereof. The term lot includes the terms "plot", "parcel", and "tract".

MANHOLE

A structure which allows access to a stormwater management facility but is not designed to allow the input of stormwater directly from the surface.

MUNICIPAL SEPARATE STORM SEWER SYSTEM (MS4)

A conveyance or system of conveyances (including, but not limited to, roads with drainage systems, streets, catch basins, curbs, gutters, ditches, manmade channels or storm drains) owned or operated by local government that discharges to waters of the United States or connects to other MS4s, that is designed solely for collecting or conveying stormwater, and that is not part of a publicly owned treatment works (POTW) as defined by 40 CFR 122.2 or any amendment thereto.

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

The federal program for issuing, modifying, revoking, reissuing, terminating, monitoring, and enforcing permits, and imposing and enforcing re-treatment requirements, under Sections 307, 402, 318, and 405 of CWA. The term includes an "approved program".

NON-POINT SOURCE POLLUTION

Pollution that enters a water body from diffused origins in the watershed and/or drainage basin.

NORMAL WATER LEVEL

The typical water elevation of a surface water body or wetland. This elevation is at or below the design low water elevation and below the seasonal high water elevation.

OBSTRUCTION

Any dam, wall, wharf, embankment, levee, dike, pile, abutment, projection, excavation, channel rectification, bridge, conduit, culvert, building, wire, fence, rock, gravel, refuse, fill, structure, or matter in, along, across, or projecting into any channel, watercourse, flow path or flood plain area which may impede, retard, or change the direction of the flow of water, either by itself or by catching or collecting debris carried by such water, or that is placed where the flow might carry the same downstream to the damage of life or property.

100-YEAR STORM EVENT

A storm event which has a one percent chance of occurring in any year.

ORIFICE

An opening with a closed perimeter through which a fluid flows.



OUTFALL

The point, location or structure where stormwater runoff discharges from a stormwater management facility to a receiving body of water.

OUTLET

Point at which stormwater runoff discharges from a stream, river, lake or other receiving body of water.

OUTSIDE TOP OF BANK

The "landward" or external top of bank which is typically the lowest of the high points at the external limit of the maintenance area.

OPERATION PERMIT

Surface water management permit issued by the Southwest Florida Water Management District authorizing the operation and maintenance of a surface water management system in accordance with the terms and conditions of the permit.

OVERFLOW

Structure which transports excess stormwater into receiving water after the maximum capacity of a limited (or stormwater treatment volume) discharge device has been exceeded.

PARENT SITE

The original development site plus any adjoining properties onto which the original development was or is to be expanded.

PEAK DISCHARGE

Maximum instantaneous flow from a given storm event for a specific location, or the maximum instantaneous outflow from a stormwater management facility during a given storm event.

PEAK SENSITIVE AREAS

Areas where the receiving waters are sensitive to changes in timing and/or magnitude of peak flows.

PERCOLATION

Movement of water through the soil.

PERMISSIBLE VELOCITY

Maximum velocity at which water may be transported through an open channel, storm sewer or other stormwater management system without excessive damage or erosion.

PHREATIC SURFACE

The phreatic surface, or water table, is an imaginary surface that bounds the saturated zone from the unsaturated zone above. It is defined as the surface at every point of which the water pressure is atmospheric.

PLAN OR SMMP

This term refers to the Hillsborough County Stormwater Management Master Plan.

POINT SOURCE POLLUTION

Pollution that enters a water body at a discernible, confined or discrete location, and from a discrete location in the watershed and/or drainage basin.



POLLUTANT

Dredged spoil, solid waste, incinerator residue, filter backwash, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive material (except those regulated under the Atomic Energy Act of 1954, as amended (42 U.S.C. 2011 et seq.)), heat, wrecked or discharged equipment, rock, sand, and industrial, municipal, and agricultural waste discharged into water.

POPOFF

Elevation at which discharge occurs from a water body.

POSITIVE OUTFALL

Positive outfall is defined as the ability to discharge directly into a manmade or natural channel, waterway or pipe system which is part of receiving waters which has more than adequate, adequate or peak sensitive capacity.

POROSITY

Ratio of the volume of pore space to the total unit volume of a soil or rock.

PREDEVELOPED CONDITIONS

For new development, raw land in a natural state before alteration (i.e., Rational coefficient approximately 0.20). For redevelopment projects "predeveloped conditions" include those permanent impervious surfaces on the site on or before October 1, 1988 (or permitted improvements after this time).

REACH

Specified portion or segment of a watercourse.

RECEIVING WATERS

Bodies of water, and ancillary facilities thereof, which serve as the receptacles for stormwater discharges. Generally, receiving waters include significant wetland areas, lakes, rivers/streams, other major stormwater conveyance or storage systems, bays, etc.

RECHARGE BASIN

Retention pond/basin which is underlain by an unconfined aquifer composed of deep sands, gravels and cobbles that is specifically designed to induce replenishment of groundwater supplies.

RED LINE PROPERTY

Those properties which experience or may be reasonably expected to experience frequent localized flooding problems or which may have other problems associated with stormwater management.

REDEVELOPMENT

The modification or further development of a parcel with existing improvements on the site. Existing improvements include those on the site on or before October 1, 1988, or permitted improvements after this time.

RETENTION or TO RETAIN

To store stormwater to prevent its discharge into receiving waters or to provide a storage facility for stormwater where no outfall is available.

RETENTION POND

A pond which is designed to retain, without surface discharge, a specified volume of stormwater runoff, and in which recovery of the available storage volume occurs only by percolation and evapotranspiration.



RIGHT-OF-WAY

Land dedicated, deeded, used or to be used for a street, alley, walkway, boulevard, drainage or stormwater management facility, access for ingress, egress or other purpose by the public, certain designated individuals or governing bodies.

ROADWAY BASE CLEARANCE

The distance between the Seasonal High Groundwater Table (SHGWT) elevation and the roadway base course.

RUNOFF

That portion of rainfall which is not evaporated, transported, infiltrated, intercepted or retained in small depressions.

SCOUR

Abrasive action of flowing water on soils and sediments in pipes, channels or ponds causing the soils and sediments to move from their existing location.

SEASONAL HIGH GROUNDWATER TABLE (SHGWT) ELEVATION

The elevation to which the groundwater can be expected to rise during a normal wet season.

SEEPAGE SLOPE

The change in the phreatic surface elevation over a horizontal distance resulting from a water body, either natural or man made.

SEDIMENT

Fine particulate material, whether mineral or organic, that is in suspension or has settled in a water body or has been deposited by flowing water, wind, or other sources.

SETTLING POND/AREA

Area of a stream, channel or pond which has been physically altered and enlarged to permit suspended sediment and debris to settle out from discharging surface water.

SHEET FLOW

Uniform overland flow of water in a thin layer over a sloping surface.

SINKHOLE

A depression in karst terrain caused by the collapse of the underlying rock and soil or the migration of the underlying soil into an underground cavern. May be dry or wet, depending on the characteristics of the soils/sediments at the bottom of the sink, and the potentiometric surface elevations of the underlying and surrounding aquifers in relation to the bottom of the sink. A common feature of closed drainage basins.

SITE

Any tract, lot or parcel of land or combination of tracts, lots or parcels of land which are in one ownership, or are contiguous and in diverse ownership where development is to be performed as part of a unit, subdivision, or project. Included in the definition of a site are parking and other areas used by the site even if not contiguous.

SITE DESIGNER

An individual registered by the State of Florida as a Professional Engineer. Further, the individual must be registered to perform engineering assignments in the discipline of Civil Engineering.



SPILLWAY

A channel for surplus water to be transmitted over and around a structure or dam.

SPODIC STAINLINE

Soil stainline indicating presence of groundwater at some point in time.

STORM FREQUENCY

The statistical, long-term average number of years within which a particular storm event of specified magnitude will be equaled or exceeded (e.g., 25-year/24-hour storm).

STORM SEWER SYSTEM

Underground pipeline system that collects and conveys surface water discharge and stormwater runoff to receiving waters.

STORMWATER

Flow of surface runoff water which results from and which occurs during and immediately after a rainfall event.

STORMWATER MANAGEMENT SYSTEM

The surface and subsurface system for the removal of water from or control of water on the land, including both the natural elements of streams, marshes, swales and ponds, whether of an intermittent or continuous nature, and man-made elements which include culverts, ditches, channels, piping, and storage facilities. Any system which collects, conveys, channels, holds, inhibits, diverts or treats stormwater. The storm sewer system may be referred to as a stormwater management facility, conveyance system, etc.

STORMWATER TREATMENT FACILITY

A structural Best Management Practice (BMP) designed to reduce pollutant loading to receiving waters by reducing the volume of stormwater discharge, providing for the biological uptake of pollutants, and/or inducing pollutants to settle out of stormwater flow. Structural BMPs include, but are not limited to, detention basins, retention basins, open bottom inlets, undercut ditches, exfiltration trenches, and swales.

SURCHARGE

Flow condition which occurs in a closed conduit when the hydraulic grade line is above the crown of the sewer. Also, flow out of any stormwater management facility at a point upstream from the facility's outfall resulting from inflow into the system in excess of its designed capacity.

SURFACE WATER MANAGEMENT SYSTEM

A stormwater management system, dam, impoundment, reservoir, appurtenant work, or works, or any combination thereof. The term includes dredged or filled areas.

SURFACE WATER MANAGEMENT PERMIT

Letter of conceptual approval, construction permit or operation permit issued by the Southwest Florida Water Management District.

SWALE

A generally shallow grassed waterway which has a cross-sectional ratio for depth to top width of at least one to 11 and a maximum sideslope ratio at 1:4 (vertical: horizontal), and has been designed to resist soil erodibility, slumpage and contamination which may result from stormwater runoff.



SWFWMD

Southwest Florida Water Management District. One of five regional water management districts organized by the state to oversee the management of surface and subsurface water resources in the State of Florida. SWFWMD is the local district for Hillsborough County.

TAILWATER ELEVATION

Water surface elevation of the receiving waters at the discharge end (most downstream end) of a stormwater management facility outfall. Tailwater depth is then the height of the tailwater elevation above the invert of the outfall at this discharge or downstream end.

TIME OF CONCENTRATION

Travel time required for the surface runoff from the most hydraulically distant point of the drainage basin to reach the measurement or collection point, or otherwise to the point of interest of the basin.

25-YEAR STORM EVENT

A storm event which has a four percent chance of occurring in any year.

UNIT HYDROGRAPH

Time distribution of runoff from a basin representing the basin response to one inch of direct runoff distributed uniformly over the basin in space and time.

URBAN RUNOFF

Surface water runoff from an intensely developed drainage area which typically discharges into, or is collected by, a storm sewer system or other man-made or modified watercourse.

VARIANCE

Authorization for the construction or maintenance of a building or structure, or for the establishment, maintenance or operation of a use of land, which is prohibited by the Code (LDC) without such authorization, except as otherwise provided. A relaxation by the Board of Adjustment of the dimensional regulations of the Code where such action will not be contrary to the public interest and where, owing to conditions peculiar to the property and not the result of actions or the situation of the applicant, a literal enforcement of this Code would result in unnecessary and undue hardship.

VOLUME SENSITIVE AREAS

Areas where the receiving waters do not have positive outfall for storm events less than or equal to the 25-year/24-hour event, and areas which do not directly discharge into a well defined conveyance system (i.e., ditch, storm sewer, etc.).

WATER SURFACE ELEVATION

Surface water elevation expressed in terms of feet above mean sea level according to the North American Vertical Datum (1988 NAVD 88).

WATERS OF THE UNITED STATES (U.S.)

As defined by the U.S. Environmental Protection Agency (EPA) in Title 40, Section 122 of the Code of Federal Regulations or any amendment thereto.

WATERCOURSE

Any natural or artificial channel, ditch, canal, stream, river, creek, waterway or wetland through which water flows in a definitive channel, bed, bank or other discernible boundary.



WATERSHED

The land area which contributes to the flow of water into a receiving body of water.

WEIR

A notch of regular form through which, or a barrier on the bottom of a conveyance way over which, water flows with a free, unconfined surface. A weir structure is typically used for measuring or regulating/controlling surface water discharge.

WETLANDS

Land that is inundated or saturated by surface or ground water in years of normal water conditions at a frequency and duration sufficient to support and that, under normal circumstances, does support a dominance of vegetation typically adapted for life in saturated soil conditions. Wetland also includes non-vegetated beaches, mudflats and salt barriers.