Stormwater Management Criteria for Brevard County, Florida

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STORMWATER MANAGEMENT CRITERIA

PURPOSE & AUTHORITY

The purpose of these Standards is to establish the minimum criteria for the design, construction, operation and maintenance of all Stormwater Management Systems and any activity which affects a Stormwater Management System within Brevard County. Any land alteration activity, modification of existing stormwater management system, or modification of existing site other than subdivisions, site plans, or single family homes which results in stormwater quality degradation or flooding, must be approved by the Surface Water Improvement Division. Subdivisions and site plans must be coordinated with Surface Water Improvement Division and approved by the Engineering Department Director or his designee (known hereafter as the Reviewer).

These criteria do not apply to Agricultural zoned properties which are under or entering into a Soil Conservation Service Conservation Plan or a St. Johns River Water Management District (SJRWMD) agricultural discharge permit.

WAIVERS

1. General: Where the Board finds that undue hardship or unreasonable practical difficulty may result from strict compliance with this ordinance, the Board may approve a waiver to the requirements of this ordinance if the waiver serves the public interest.

2. Conditions: An applicant seeking a waiver will submit a written request to the Board stating the reasons for the waiver and the facts which support such waiver. The Board shall not approve a waiver unless it determines as follows:

a) The particular physical conditions, shape, or topogra phy of the specific property involved causes an undue hardship to the applicant if the strict letter of ordinance is carried out.
b) The granting of the waiver will not be injurious to the other adjacent property or water body.
c) The conditions, upon which a request for waiver are based, are peculiar to the property for which the waiver is sought and are not generally applicable to other property and do not result from actions of the applicant; and,
d) The waiver is consistent with the intent and purpose of the Brevard County Zoning Ordinance, the Brevard County Comprehensive Plan, and the requirements of this ordinance.

If the Board approves a waiver, the Board may attach such conditions to the waiver as will assure that the waiver will comply with the intent and purpose of this ordinance.

GENERAL

1.0 Background

The problems associated with stormwater runoff in rapidly urbanizing areas have become well known. These problems relate to both the quantity and quality of stormwater runoff. Major problems include the increased runoff and flooding magnitude and frequency, accelerated erosion of the land and stream channels, and water quality degradation, wetland mismanagement, and under utilization of prime aquifer recharge areas.

The basic underlying cause of these problems is not difficult to understand. The hydrologic systems which have reached a natural equilibrium over centuries simply cannot adjust gracefully to the sudden impact of urban development. Flooding occurs because the increased volume and peak rate of runoff exceeds the natural carrying and/or storage capacity of natural or manmade water bodies. Erosion is accelerated by the decrease of natural vegetation and increase in the volume of runoff which increases flow velocities and flooding frequency. The water quality itself is degraded by the pollutants of urbanization, decrease in natural vegetation, and increase in erosion of soil which is washed off the land surfaces into the streams, lagoon and lakes. In order to minimize the future degradation of the environment, the designer will be required to work within the guidelines of the following general criteria:

The drainage system for each phase of a development shall be capable of standing on its own if subsequent areas planned for development are not developed.

The stormwater management system for new development shall have the capacity to carry existing upstream runoff through or around the development.

The storage and controlled release or retention on site and infiltration into the ground of excess stormwater runoff rate from any new commercial, industrial, and residential developments will be required so that runoff rate therefrom will not be greater than it was prior to such development as specified in Section 4.1.

d) No site alteration shall allow water to become a health hazard.

e) shall be required from the applicant to prove the adequacy of the stormwater system.

f) While the following design and construction criteria are given, it is not the intention to discourage innovative

designs or construction techniques. Such innovations shall be submitted to the Reviewer prior to plan preparation to determine their applicability on a case by case basis.

g) In the event the applicant chooses to discharge offsite, the applicant shall provide the necessary facilities to drain site run-off to positive outfalls. Those outfalls shall be public drainage systems with adequate capacity, direct discharge to natural creeks, rivers or major wetland systems, or positive outfalls that can be legally maintained in permanent use. If the applicant elects to drain the site into a public drainage system, the applicant must have the consent of the governmental entity which exercises control over the public drainage system. See Section 2.2C for more details on easement requirements and Section 4.1 for properties with no outfalls.

1.1 Water Quantity

All site alteration activities shall provide for such stormwater control structures as may be necessary to insure that the post-development runoff rates will not be greater than the pre-development runoff rates for designated storm events shown in Section 4.

No site alteration shall adversely affect the existing surface water flow pattern. Watershed boundaries shall be maintained in order to conform with existing conditions where practical.

1.2 Water Quality

Site alterations shall minimize siltation and pollution of Class 1, 2, or 3 or Outstanding Florida Waters (OFW) waters of the State and shall optimize the natural retention and filtering capabilities of wetlands. Surface water discharges of chemicals, hazardous materials, concentrated pollutants, or other substances deemed improper by Chapter 14 of the Brevard County Codes shall be prohibited.

1.3 Recharge

Drainage facilities shall be designed to promote the infiltration of natural rainfall into the soil and to minimize direct overland runoff into adjoining streets and watercourses. Stormwater runoff from roofs and other impervious surfaces should be diverted into vegetated areas whenever possible.

Certain areas of the County have soils which are considered to be Aquifer Recharge Zones and have additional drainage requirements. Consult the Brevard County Office of Natural Resources Management Division for specific details of the Aquifer Recharge Ordinance.

1.4 Wetlands

The use of existing wetlands for stormwater treatment rather than destruction of the wetlands is encouraged.

1.5 Flood Prone Areas

Development within the 10,25, and 100 year Floodplains has further stormwater requirements. Consult the Comprehensive Plan and Floodplain Protection Ordinance for specific details.

For subdivision and site plans altering or amending the 100 year floodplain, a Conditional Letter of Map Revision or Amendment must be initiated with FEMA prior to final plan approval.

1.6 Off-Site Improvements

Developments may require off-site drainage improvements in order to insure the proper functioning of the on-site system.

2.0 Easements

2.1 Purpose

Easements for storm water facilities are needed for maintenance purposes. Conveyance facilities such as pipes, inlets, ditches, and weirs need to be kept open and functional to prevent flooding. Water treatment facilities such as ponds need to be maintained to their design standards to insure the stormwater is cleaned before leaving the system.

Generally, for County maintained systems, i.e. public roads and ditches, the County will maintain the conveyance facilities to prevent flooding. These conveyance facilities include the roads, ditches, inlets, pipes, and outfall structures that carry water into and out of a pond.

The County generally will not maintain the treatment systems because they are not necessary to prevent flooding within the subdivision. It is up to the property owners to maintain the pond or other treatment facilities.

2.2 Requirements

Easements for stormwater facilities shall be provided as follows.

Retention/Detention Ponds in Subdivisions.

A drainage easement over the pond will be dedicated to the maintenance entity who will be responsible for maintaining the pond to meet the water quality and quantity design standards of the approved plans.

Deed restrictions shall be written making the maintenance entity responsible for maintaining the pond to meet the water quality and quantity design standards of the approved

plans. See Section 7 for maintenance entity requirements.

A driveable stabilized access easement a minimum of 12 feet wide shall be provided for emergency access from a road to the pond control structure.

a) Fences

Fences shall not be constructed in drainage easements if the fence interferes with the function of the drainage pipes, swales, or ditches in the easement. If the County removes fences in drainage easements in order to maintain drainage facilities, the County shall not be required to replace or pay for said fences.

b) Easement Dimensions

Drainage easements shall be given over any portion of a stormwater system not within a right-of way and necessary the functioning of the system. The easement shall include the facility plus any required access area to be used for maintenance.

The facility width for open systems shall be measured from top of bank to top of bank. The following criteria establishes the required minimum width of drainage easement.

Drainage System (Other than swales)	Minimum Width Stabilized Maintenance Access Easement
Open Drainage Systems	
Top Width 20' or less	15' on one side
Top Width 20' to 40'	15' on both sides
Top Width greater than 40'	20' on both sides
Pipe Systems	Diameter + 4 feet +2 D D=depth from finished grade to pipe invert, in feet. Minimum width = 15 feet

For County maintained ponds	
With Fencing	25' around pond perimeter
Without Fencing	20' around pond perimeter
Other Ponds	None required

The maintenance easement shall have a cross slope no steeper than 10:1.

The minimum allowable width of drainage easements or Right-of-Way may be increased. Any administrative waiver to the above easement width must be approved by the Reviewer.

Private Development

The property owner is responsible for maintaining the stormwater system to meet the water quality and quantity standards of the approved plans.

Public drainage facilities which are located within a private development shall be located in a public drainage easement.

Unplatted Land

Developments may contain drainage systems which traverse property outside the project limits. These may be adjacent lands which were not platted, future phases of the development to be platted at a later date, part of an overall master plan, as in a Planned Unit Development or site plan, or other circumstances. A drainage easement for the system per Section 2.2(b) and its maintenance must be provided to the entity responsible for maintenance.

2.3 Computer Software

Computer programs used for drainage calculations shall meet the approval of the Reviewer. Stormwater systems with more than one pond should use multiple pond routing software. The Reviewer shall maintain a list of approved software which shall be kept at the office of Engineering Design and Review Division and may be viewed during normal business hours. Software not on this list shall be submitted to the Reviewer along with any documentation and manuals prior to plan submittal. The software will be evaluated against approved software to determine its applicability.

3.0 Plan Preparation

(a) Master Drainage Map

The applicant shall include in the construction plans a Master Drainage Map showing all existing and proposed features. The map is to be prepared on a twenty-four inch by thirty-six inch (24" X 36") sheet on a scale not less than one inch equaling one hundred feet (1" = 100'). Size and scale may be adjusted for the larger development if approved by the Reviewer. The review of said plans shall be made by or under the direct supervision of a Professional Engineer. Said drainage map shall include the following features:

1)Delineation of all areas draining to the proposed subdivision, all areas tributary to existing structures, and all areas tributary to proposed structures. The pervious, impervious,

and total acreage of each area must be stated.

2) Topographical information with sufficient elevations to verify the location of all ridges, depressions, conveyances and other water resources. Direction of flow shall be clearly labeled.

3) Existing and high water data on existing structures upstream and downstream from the subdivision.

4) Notes indicating sources and date of high water data.

5) Notes pertaining to existing standing water, areas of heavy seepage, or springs.

6) Existing and proposed drainage features such as ditch es, swales, roadways, and ponds. Ponds shall have dimensions and be tied to property lines for construction staking purposes.

(b) Plans

In addition to the drainage map the following information shall be provided:

(1)Cross sections and details of proposed control structures in ponds shall be drawn to determine feasibility of construction.

(2) Plan and profiles shall be drawn for all roads with storm sewers at a maximum scale of 1"-50'. The plan view and profile view for a road shall be drawn on the same sheet of paper. Profiles of all storm sewers in the road shall be shown. Other existing or proposed utilities shall also be shown in such a manner as to easily check for conflicts and minimum cover.

c) Drainage Calculations

Drainage calculations shall be attached providing the following information:

1) Pre-development and post development hydrographs, storage available and required, and minimum and maximum water elevations, stage-discharge calculations, and aquifer recharge calculations.

2) Culvert calculations.

(3) Storm sewer calculations.

4) A subsoil investigation report following ASTM standards and performed by a geotechnical engineer shall be submitted with the construction plans and shall include:

a. Test borings at 500 foot intervals along roadways to a depth sufficient to locate the ground water table or to a depth five feet (5') below the proposed centerline grade, whichever is greater. Additional bores may be required in muck areas to determine the limits of muck areas.

b. Test bores in all stormwater ponds to determine seasonal high groundwater levels to the satisfaction of the Reviewer. If dry ponds are proposed, the test bore should extend to 10 feet below existing ground to determine the presence of hardpan or impermeable layers. Permeability tests are required where infiltration calculations are used.

Generally all of the above information is necessary to perform an effective review. Submittals without the above information will not be reviewed until such information is provided.

d) Record Drawings

After construction of the required improvements, one (1) copy of Record Drawings signed and sealed by a Professional Land Surveyor shall be provided to the Surface Water Improvement Division by the Land Development Division for Subdivisions and Site plans. Said Record Drawings shall provide elevations, dimensions, and sizes of the constructed stormwater facilities.

4.0 Design Criteria

4.1 Design Storm (Minimum)

Facility	Design Storm
Retention/Detention Ponds (w/positive outfall)	25 Year, 24 Hour
Retention/Detention Ponds (Landlocked w/no positive outfall)	25 Year, 96 Hour Total Retention
Roadside Swales, Swales, Channels	10 Year, 24 Hour
Arterial and Collector Street Pipe Systems	10 Year, Hydraulic Gradient Line 1.0 feet below gutter line
Local Street Pipe Systems	10 Year, Hydraulic Gradient Line 0.5 feet below gutter line
Canals, Outfall Ditch or Outfall Channels	25 Year, 24 Hour
Bridges	100 Year, 24 Hour

Streets shall be designed so that the lowest crown elevation is at or above the 25 year peak flood stage.

Rainfall amounts shall be as follows:

10 year 24 hour storm = 7.9"
25 year 24 hour storm = 9.0"
100 year 24 hour storm = 11.0"

25 year 96 hour storm = 12.5"

In order to protect upstream or downstream properties, the retention/detention requirements may be increased if site specific drainage problems are known by the County.

4.2 Retention Volume

Stormwater facilities shall meet SJRWMD Criteria for retention volumes, treatment methods, and pond design criteria unless otherwise noted.

4.3 Pond Flow Calculation Methods

The following methods shall be used to design retention/detention facilities.

a) Santa Barbara Urban Hydrograph

b) SCS Synthetic Unit Hydrograph - Use peaking factors as recommended by SJRWMD.

c) Overland Flow Model - Appropriate for flat, rural areas.

d)TR 55 - Appropriate for sites 10 acres or less. Use the modified tables shown in "Appendix A."

e) Other approved hydrograph methods

4.3.1 Calculation Variables

a) Rainfall Distribution

For hydrograph methods, use the SCS Type II Modified rainfall distribution.

b) The Soil Survey of Brevard County, Florida, published by the U.S. Department of Agriculture, shall be the document to determine soil classifications. Curve Numbers used in hydrograph calculations shall be deter mined using Exhibit 4-2.

c) Soil Storage

Post development curve numbers may be calculated by either of the following methods:

1)Curve numbers from the developed urban section of Exhibit 4-2.

2) Under post development conditions, the pervious areas generally will not percolate water as well as in predevelopment conditions due to compacted yard fill, topsoil additions, sodded grass, and other conditions. Therefore, when calculating a composite post development CN, the pervious areas shall use a CN value based on a 25% reduction in soil storage capability. This is accomplished using the following formula:

Soil Storage = $\frac{1000}{CN}$ - 10

3.) Wet ponds shall be considered impervious areas and dry ponds shall be considered pervious areas.

d) Time of Concentration

The time of concentration should be divided into various components of flow conditions, i.e. sheet flow, channelized flow, gutter flow, pipe flow, etc. The individualized components will be summed for a total time of concentration.

The following equations from TR-55 shall be used for time of concentration calculations:

1. Sheet flow for a maximum of 300 feet use the Kinematic Wave Equation.

$$Tt = \frac{.007 (nL)^{0.8}}{(P2)^{0.5} s^{0.4}}$$

where: Tt = travel time in hours
n = Mannings coefficient from Exhibit 4-5
L = flow length
P2 = rainfall depth for a 2 year storm (5")
s = land slope in ft./ft.

2.Shallow concentrated flow in small swales and gutters.
Unpaved V = 16.13 (s)^0.5
Paved V = 20.33 (s)^0.5

$$Tc = \frac{L}{V \times 60}$$

where: Tc = travel time in minutes
V = velocity in f/s
s = land slope in ft./ft.

3. Other conveyance systems shall use the velocity calculated from Manning's equation.

4.4 Retention-Detention Facilities

a) Design Criteria

Peak Attenuation:

Detention facilities shall be designed so that the peak discharge computed for the post development conditions, resulting

from the design storm shown in Section 4.1, shall not exceed the predevelopment peak discharge resulting from the design storm.

b) Outfall

Retention/detention ponds shall be required to have an outfall structure. The location of the structure and the shape of the pond shall be designed such that no "short-circuiting" of flow occurs and that maximum retention of suspended solids is achieved.

Unless otherwise approved by the Reviewer outfall structures shall be as simple as possible and shall employ fixed control elevations (i.e., no valves, removable weirs, etc.). The outfall structure shall have a skimmer blade to filter floating trash and oils. The gap between the skimmer and structure will be designed as a free flow, non restricting orifice to meet peak flow rates. It should extend 6" above the design highwater elevation and 6" below the weir or orifice.

c) Recovery Rates

The retention volume recovery systems should be designed to comply with St. Johns River Water Management District (SJRWMD) Criteria from F.A.C. 40C-42. Land locked systems shall infiltrate 1" of runoff in 72 hours and the remaining volume in 14 days. All other systems shall recover the required retention volume in 72 hours. See "Exhibit 4-1" for typical underdrain calculations. A safety factor of 2 shall be used in the design of infiltration or underdrain systems for retention volume recovery.

d) Groundwater Table

The seasonal high groundwater table may be lowered to the normal groundwater table depth with the following exceptions:

1. When a lowering of the groundwater table results in adverse impacts to the hydrology and beneficial functions of adjacent wetlands.

2. Barrier Islands

When facilities which would negatively impact an aquifer are located in an aquifer recharge zone or when lowering of the groundwater table impacts users of the surficial aquifer as a drinking water supply.

3. When the tailwater will not allow positive outfall for retention recovery or detention discharges.

The County's Wetlands and Aquifer Recharge Ordinances shall be used as a guide in determing the above exceptions.

e)Detention Facility Outfall Weir Design

In the design of detention facilities, where direct discharge is allowed, that discharge may be controlled by the use of a weir structure. In the event that this control device is utilized, the following weir flow formulas shall apply:

1)Free Discharge $Q=CLH^{1.5}$

Discharge over the crest of a weir structure

where, Q = discharge, cfs.
* C = 3.16 for sharpcrested weirs
* C = 2.7 for broadcrested weirs
L = effective weir length, feet
H = head on weir, feet-head

*Other weir coefficients may be used if the Engineer can justify their use to the Reviewer.

2)Submerged Discharge

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

$$Q(s)=Qf[[(1- H2)^{1.5}] /H1]^{0.385}$$

where, Qs = submerged flow, cfs.
Qf = free flow,cfs.
H1 = upstream head above crest, feet-head.
H2 = downstream head above crest, feet-head.

3) Narrow Weirs

For conditions of high head and/or short weir length, end contractions can restrict flow. To account for this, use the equation:

$Leff = L (1-.1nH1)$
Leff = effective weir length
L = actual weir length
n = number of end contractions
H1 = head on weir

f) Detention Facility Bleeder Design

Bleed down devices may be used in wet detention systems. Such bleed down devices include, but are not limited to, V-notch weirs, slots, under flow gates, circular orifices, etc. All design of the above devices shall be in accordance with recognized

formulas and constants, for the bleed down configuration used. A minimum size for all orifices shall be 3 inches diameter.

g) Retention Outfall Filters

The stormwater retention volume must be treated prior to drawdown to the discharge system. Percolation is encouraged for retention systems to utilize the natural filtration of the existing site soils.

h) Side Slopes

Wet Ponds shall have side slopes no steeper than 5:1 to 2 feet below normal water surface and 2:1 to 12 foot maximum depth and 5 foot minimum depth. For non-wet detention systems, as defined by SJRWMD the 5 foot minimum depth can be waived if littoral vegetation is planted in the areas less than 5 feet deep. The littoral plant types shall follow SJRWMD criteria for littoral zones.

i)Dry Ponds shall have side slopes no steeper than 3:1.

h) Slope Protection

The disturbed areas in and around the ponds shall be revegetated as follows:

Side Slopes and Berms 5 to 1 and up=seed & mulch
4 to 1 and steeper=sod

Bottom of Dry Pond Grass (Seeded and mulched)

(j) Pond Location

It is strongly recommended that centralized retention/detention ponds be utilized rather than numerous small ponds or individual ponds on individual lots. Swales along side lot lines should be used for conveyance only, not for retention areas.

k) Dry Ponds

Dry Ponds may be used if the bottom of the pond is at least one foot above the seasonal high ground water level. In Type I and II aquifer recharge areas, as defined by the Brevard County Comprehensive Plan, the bottom of a retention pond shall be at least 2 feet above the seasonal high water table. The Reviewer may require a ground water mounding analysis where appropriate. This may occur for soils with low permeability rates, perched groundwater, high pond storage depths, or other reasons. If the bottom of a dry pond is less than one foot above the seasonal high ground water level due to physical constraints of the site, or with the approval of the Reviewer, the bottom of the pond shall be planted with the wetland vegetation to control cattail growth as follows:

COMMON NAME	SCIENTIFIC NAME

Cordgrass	Spartina bakeri
Maidencane	Panicum hemitomon
Sedges	Cyperus spp.
Wax myrtle	Myrica cerifera
Red bay	Persea borbonia

Other wetland plants may be used with Reviewer approval.

4.5 Roadway (Pavement) Drainage Design

a) General

Good pavement drainage design consists of the proper selection of grades, cross slopes, curb types, inlet location, etc., to remove the design storm runoff from the pavement in a cost effective manner while preserving the safety, traffic capacity and integrity of the highway and street system. These factors are generally considered to be satisfied when excessive spreads of the water are removed from the vehicular travel way and when siltation at pavement low points is not allowed to occur. The standards included herein are intended to accomplish these objectives.

b) Roadway Grade

The minimum allowable centerline grade for all streets with curb and gutter shall be 0.30% and 0.40% for curb radii grades.

c) Cross-Slope

The minimum allowable cross-slope for all streets shall be 1/4" per foot.

d) Drainage Structures

All drainage structures, unless specifically detailed in these guidelines, shall at a minimum conform to the latest edition of the FDOT Roadway and Traffic Design Standards.

Any drainage structure not detailed in the FDOT Design Standards shall be designed in conformance with good engineering practices and shall require approval by the Reviewer.

Where deemed necessary, the Reviewer may require a drainage structure design differing from FDOT Design Standards.

e) Swales

The use of roadside swales is encouraged to promote groundwater recharge and provide stormwater treatment.

Roadside swales shall have maximum front slope of 5:1 seeded or 4:1 sodded and maximum back slope of 3:1 sodded.

The minimum flow line grade shall be 0.10% when used for conveyance and 0.00% when used for retention.

Runoff may be accumulated and carried in the swales up to, but not above, the point where flooding of the shoulders or adjacent property would occur. Ditch blocks in roadside swales shall have a maximum height of 12" and shall not be constructed of earth.

Roadside swales can be used for retention if the flow line is a minimum of one (1) foot above the SHGWT with demonstration by approved groundwater mounding or flow net analysis that the retention volume is recovered within 24 hours.

f) Curbs and Gutters

1. Curb and gutter sections shall have a maximum run of 400 feet between on grade inlets. Distances greater than 400 feet must be substantiated with calculations.

g) Runoff Determination

The peak rates of runoff for the pavement drainage system shall be determined by the Rational Method.

FDOT methodology, forms, and intensity curves shall be used. Calculation of junction losses will permit the hydraulic grade line to be raised to the gutter elevation. The minimum time of concentration will be 10 minutes.

Exhibit 4-3 shall be used to determine runoff coefficients (c) for drainage areas.

h) Stormwater Spread Into Traveled Lane

Inlets shall be spaced at all low points, intersections and along continuous grades so as to prevent the spread of water from exceeding tolerable limits. The acceptable tolerable limits for multilane arterial and collector roadways is defined as one traveled lane width. The acceptable tolerable limit for interior subdivision roadways is defined as the 7 feet from the face of curb if curb and gutter is used.

i) Inlet Types

The curb inlet types and capacities to be used shall be the latest version of the Florida Department of Transportation inlets.

j) Low Point Inlets

All inlets at low points (sumps) shall be designed to intercept 100 percent of the design flow without exceeding the allowable spread of water onto the traveled lanes as defined above.

k) Inlet Capacities

Inlet capacities shall be determined using FDOT criteria and tables.

4.6 Storm Sewer and Culvert Design

a) Minimum Pipe Size

The minimum diameter pipe is 18 inches or equivalent elliptical pipe. The minimum size box culverts shall be 3' x 3'.

b) Pipe Grade

All storm sewers shall be designed and constructed to produce a minimum velocity of 2 fps when flowing full. No storm sewer system or portion thereof will be designed to produce velocities in excess of 12 fps for reinforced concrete pipe or 8 fps for metal pipe. For other pipe materials the maximum velocity shall be per the manufacturer's recommendations.

The maximum velocity at the outlet pipe shall be in accordance with Section 4.7(e) unless velocity control devices are used.

c) Pipe Cover

Unless otherwise authorized by the Reviewer, the minimum cover for all storm pipes shall be:

Description	Cover
From finished grade to outside crown of pipe	1.0 Feet

d) Pipe Materials

All pipes within public rights-of-way and saltwater or brackish outfalls shall be reinforced concrete pipe or PVC meet ing DOT approval. Other pipe materials may be used at other locations if soil conditions allow and with the approval of the Reviewer. All steel pipe shall be completely bituminous coated. Round concrete pipe shall use "O" ring joints.

e) Conflict Manholes

Conflict manholes shall be used only when there is no reasonable alternative design. Where it is necessary to allow a sanitary line or other utility to pass through a manhole, inlet or junction box, the utility shall be ductile iron.

Where utility lines pass through manholes, the utility shall be placed in such a manner as to provide a minimum of 1.0 foot clearance between the bottom of the manhole and the bottom of the shell of the utility pipe.

Conflict manholes shall be over-sized to accommodate the decreased maneuverability inside the structure and flow retardance. All holes in concrete boxes must be sealed and watertight.

f) Maximum Lengths of Pipe

The following maximum runs of pipe shall be used when spacing access structures of any type:

Pipe Size	Maximum
18 Inches	300 Feet
24 to 36 Inches	400 Feet
42 Inches and Larger	500 Feet
Box culverts	500 feet

g) Design Tailwater for Pipe Systems

The design tailwater level in a pond can be assumed to be the 10 year pond level corresponding to the time at which peak inflow occurs from the storm hydrograph into the pond. In lieu of the above analysis, an optional design tailwater estimate can be obtained by averaging the established 25 year design high pond. Culverts shall be designed taking into account the tail water of the receiving facility during design storm conditions.

h) Hydraulic Gradient Line Computations

The rational method shall be used for pipe flow calculations. The Hydraulic Gradient Line for the storm sewer system may be computed taking into consideration the design tailwater on the system and the energy losses associated with entrance into and exit from the system, friction through the system, and turbulence in the individual manholes/catch basins/junctions within the system.

The following junction losses shall be used for all inlets and manholes:

$$HL = \frac{K(V1^2)}{2g}$$

where:

HL = head loss in feet
V1 = highest velocity into or out of junction
K = Energy loss coefficient from Exhibit 4-4.

In order to minimize head losses and clogging, storm drain pipes shall not turn angles greater than 90 degrees when going through inlets and junction boxes without the approval of

the Reviewer.

i) All pipe outlets shall have headwalls or mitered end sections.

j) Inverted Syphons

Inverted syphons shall not be permitted.

k) Outfall Sumps

Storm drain pipes with outfall sumps shall not be permitted without the prior approval of the Reviewer.

l) The required culvert size shall be determined using FDOT design nomographs and procedures.

4.7 Open Channel Design

General

Grass swales and open channels may be used in lieu of a closed conduit system to convey stormwater runoff outside of dedicated roadway and street rights-of-way when sufficient drainage easements or rights-of way are available. Open conveyance systems are often desirable to assist in the mitigation of pollution problems.

The flow line of roadside and lot line swales shall be at least one (1) foot above the seasonal high groundwater elevation. It is preferred that other channels also have flow lines one (1) foot above the seasonal high groundwater level for ease of maintenance and cattail control.

a) Design discharges shall be calculated per Section 4.1

b) Design Tailwater

All open channel systems shall be designed taking into consideration the tailwater of the receiving facility or body of water. The tailwater must be determined by calculations based upon the design criteria and frequencies contained in Section 4.1.

c) Design Formula

Design of all open channel systems shall be based upon Manning's Equation.

d) Roughness Coefficients For Use in Manning's Equation.

Channel Lining	Description	Design "n"
Bare Earth, Fairly Uniform	Clean, recently completed	0.022
Bare Earth, Fairly Uniform	Short grass and some weeds	0.028
Dragline Excavated	No vegetation	0.030
Dragline Excavated	Light Brush	0.040

Channels not Maintained	Dense Weeds to Flow Depth	0.10
Channels not Maintained	Clean bottom, brush sides	0.08
Maintained Grass or Sodded Ditches	Good stand, well maintained	0.035
Maintained Grass or Sodded Ditches	Fair stand, length 12 - 24"	0.20*
Concrete Paved	No finish	0.016
Concrete Paved	Finished	0.015
Rip-Rap	Fairly uniform	0.03

*Decrease 30% for flows greater than 0.7' depth

e) Maximum Allowable Velocities for Unlined Open Channels on Bare Soils.

Soil Type	Allowable Velocity (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

f) Maximum Allowable Velocities For Lined Open Channels.

Type	Allowable Velocity (f.p.s.)
Sod	4.0
Concrete Ditch Paving	10.0

g) Open Channel Geometry

Open channels may be designed as either a trapezoidal or "V" cross section.

h) Minimum Longitudinal Grade

For open channels the minimum grade allowable shall be 0.10%.

i) Channel Curvature

Channel protection shall be provided when curvature produces erosive velocities as shown above.

j) Minimum Freeboard

A minimum freeboard of 1.0 foot shall be maintained between peak water surfaces designed from Section 4.1 and the top of slope for all open channels.

k) The use of serpentine channel geometry rather than straight channels is encouraged.

l) Erosion Protection

All open channels shall be seeded or sodded for erosion and silt control. If side slopes are steeper than 5:1 they must be sodded. Side slopes steeper than 3:1 may only be used with Reviewer approval.

4.8 Exfiltration Trenche

Exfiltration trenches may only be used with the approval of the Reviewer. The feasibility of long term maintenance and effectiveness must be demonstrated to the satisfaction of the

5.0 Material Specifications

5.1 Pipe

All pipe materials shall conform to the latest edition of the FDOT Standard Specifications for Road and Bridge Construction.

All pipes not employing a water tight band at the joints shall have all joints wrapped with filter fabric.

5.2 Inlets, Manholes and Junction Boxes

All materials used in the construction of inlets, manholes and junction boxes shall conform to the latest editions of the FDOT Roadway and Traffic Design Standards and the FDOT Standard Specifications for Road and Bridge Construction. Inlets shall have poured inverts.

5.3 Underdrains/Exfiltration Systems

The following is a list of underdrain materials acceptable for use in Brevard County.

a) Perforated Corrugated Tubing

Corrugated, polyethylene tubing perforated throughout and meeting the requirements of AASHTO M-252.

b) Perforated PVC Pipe

Polyvinyl-chloride pipe conforming to the requirements of ASTM D-3033. The perforations shall meet the requirements of ASTM C-508.

c) Exfiltration Pipe

The following is a list of pipe materials acceptable for use in exfiltration systems:

1. Aluminum Pipe Perforated 360 degrees, meeting the requirements of AASHTO M-196.

2. Perforated Class III Reinforced Concrete Pipe with Perforations meeting the requirements of ASTM C-444.

3. Polyvinyl-chloride Pipe Perforated 360 degrees, meeting the requirements of ASTM D-3033.

d) Fine Aggregate

Sand filter media shall be of a quality sufficient to satisfy the following requirements:

Washed (Less than 1% silt, clay and organic matter)
Uniformity Coefficient - 1.5 or greater
Effective Grain Size - 0.2-0.55 mm

e) Coarse Aggregate

Clean noncalcarious stone containing no friable materials and a gradation equivalent to FDOT size number 56 or 57.

f) Filter Fabric Envelope (Sock)

Strong, porous polyester knitted fabric. The envelope shall be a continuous one-piece material that fits over the tubing like a sleeve. It shall be knitted of continuous 100-200 denier yarn and shall be free from chemical treatment or coating that might significantly reduce porosity and permeability. The fabric envelope shall conform to the following minimum properties:

Equivalent Opening Size (U.S. Std. Sieve)	100 (0.150 mm)
Tensile Strength	50
Bursting Strength (PSI)	90-125

g) Filter Fabric

Pervious sheet of monofiliment yarn woven, knitted or bonded to form a fabric with the following minimum properties:

Equivalent Opening Size (U.S. Std. Sieve)	100 (0.150 mm)
Tensil Strength (Lbs)	50
Bursting Strength (PSI)	200
Puncture Strength (lbs)	32

h) Impermeable Liner

8 mil Visqueen or approved equal.

5.4 Drainage Structures

All materials used in the construction of drainage

structures shall conform to the latest editions of the FDOT Roadway and Traffic Design Standards and the FDOT Standard Specifications for Road and Bridge Construction.

Sand cement is not an acceptable material for drainage structures, but can be used for erosion control.

5.5 Fencing

Unless otherwise approved by the Reviewer, all fencing around ponds shall be 6-foot chain link fence with a minimum 15 foot wide double gate opening conforming to the FDOT specifications.

5.6 Sod, Seed and Mulch

All sod, seed and mulch materials and installation shall conform to the latest edition of the FDOT Standard Specifications for Road and Bridge Construction.

5.7 Skimmer Blades

Skimmer blades shall be made of aluminum, fiberglass, or other material approved by the Reviewer.

6.0 Erosion and Sediment Control

Construction activities can result in the generation of significant amounts of pollutants which may reach surface or ground waters. One of the primary pollutants of surface waters is sediment due to erosion. Excessive quantities of sediment which reach water bodies of floodplains have been shown to adversely affect their physical, biological and chemical properties. Transported sediment can obstruct stream channels, reduce the hydraulic capacity of water bodies of floodplains, reduce the design capacity of culverts and other works, and eliminate benthic invertebrates and fish spawning substrates by siltation. Excessive suspended sediments reduce light penetration and, therefore, reduce primary productivity.

Therefore, the following minimum standards shall apply to any construction or maintenance activities within Brevard County.

6.1 Minimum Standards

Sediment basins and traps, perimeter dikes, sediment barriers and other measures intended to trap sediment shall be constructed as a first step in any land-disturbing activity and shall be made functional before upslope land disturbance takes place.

All sediment control measures are to be adjusted to meet field

conditions at the time of construction and be constructed prior to any grading or disturbance of existing surface material on balance of site. Perimeter sediment barriers shall be constructed to prevent sediment or trash from flowing or floating on to adjacent properties.

Permanent or temporary soil stabilization shall be applied to denuded areas within seven days after final grade is reached on any portion of the site. Temporary soil stabilization shall be applied within seven days to denuded areas that may not be at final grade but will remain undisturbed for longer than 30 days. Permanent stabilization shall be applied to areas that are to be left undisturbed for more than one year.

During construction of the project, soil stock piles shall be stabilized or protected with sediment trapping measures. The applicant is responsible for the temporary protection and permanent stabilization of all soil stockpiles on site as well as soil intentionally transported from the project site. Brevard County Code Chapter 14 Section 20.17 should be consulted for protection of stockpiles from wind.

A permanent vegetative cover shall be established on denuded areas not otherwise permanently stabilized. Permanent vegetation shall not be considered established until a ground cover is achieved that, in the opinion of the Reviewer, is uniform, mature enough to survive and will inhibit erosion.

Stabilization measures shall be applied to earthen structures such as dams, dikes and diversions immediately after installation.

Surface runoff from disturbed areas that is comprised of flow from drainage areas greater than or equal to three acres shall be controlled by a sediment basin. The sediment basin shall be designed and constructed to accommodate the anticipated sediment loading from the land-disturbing activity. The outfall device or system design shall take into account the total drain age area flowing through the disturbed area to be served by the basin.

After any significant rainfall, sediment control structures will be inspected for integrity. Any damaged devices shall be corrected immediately.

Concentrated runoff shall not flow down cut or fill slopes unless contained within an adequate temporary or permanent channel, flume or slope drain structure.

Whenever water seeps from a slope face, adequate drain age or other protection shall be provided.

Sediment will be prevented from entering any storm drain system, ditch, or channel. All storm sewer inlets that are made operable during construction shall be protected so that sediment-laden water cannot enter the conveyance system without

first being filtered or otherwise treated to remove sediment.

Before temporary or newly constructed stormwater conveyance channels are made operational, adequate outlet protection and any required temporary or permanent channel lining shall be installed in both the conveyance channel and receiving channel.

When work in a live watercourse is performed, precautions shall be taken to minimize encroachment, control sediment transport and stabilize the work area to the greatest extent possible during construction. Nonerodible material shall be used for the construction of causeways and cofferdams. Earthen fill may be used for these structures if armored by nonerodible cover materials.

When a live watercourse must be crossed by construction vehicles, a temporary stream crossing constructed of nonerodible material shall be provided.

The bed and banks of a watercourse shall be stabilized immediately after work in the watercourse is completed.

Periodic inspection and maintenance of all sediment control structures must be provided to ensure intended purpose is accomplished. The Developer, owner, and/or contractor shall be continually responsible for all sediment leaving the property. Sediment control measures shall be in working condition at the end of each working day.

Underground utility lines shall be installed in accordance with the following standards in addition to other applicable criteria:

(a) No more than 500 linear feet of trench may be opened at one time.

(b) Excavated material shall be placed on the uphill side of trenches.

(c) Effluent from dewatering operations shall be filtered or passed through an approved sediment trapping de vice, or both, and discharged in a manner that does not adversely affect flowing streams or off-site property.

(d) Restabilization shall be accomplished in accordance with these regulations.

Where construction vehicle access routes intersect paved public roads, provisions shall be made to minimize the transport of sediment by tracking onto the paved surface. Where sediment is transported onto a public road surface with curbs and gutters, the road shall be cleaned thoroughly at the end of each day. Sediment shall be removed from the roads by shoveling or sweeping and transported to a sediment control disposal area. Street washing shall be allowed only after sediment is removed in this manner. This provision shall apply to individual subdivision

lots as well as to larger land-disturbing activities.

All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization or after the temporary measures are no longer needed, in the opinion of the Reviewer. Disturbed soil areas resulting from the disposition of temporary measures shall be permanently stabilized to prevent further erosion and sedimentation.

Properties and waterways downstream from construction sites shall be protected from sediment deposition and erosion.

Phased projects should be cleared in conjunction with construction of each phase.

Erosion control design and construction shall follow the requirements in Index Nos. 101, 102, and 103 of FDOT Roadway and Traffic Design Standards.

The Reviewer may approve modifications or alternate plans to these erosion control criteria due to site specific conditions.

7. Maintenance Entity

A maintenance entity must be established to maintain the stormwater system. The maintenance entity shall meet the qualifications of the St. Johns River Water Management District rules (Chapter 40C-42 F.A.C. as may be occasionally amended) regardless of whether a St. Johns River Water Management District permit is required or not.

The maintenance entity shall maintain the stormwater management system so that it functions according to the original design intent. Stormwater Management systems which are improperly maintained as determined by the Surface Water Improvement Division may be subject to having their stormwater utility mitigation credits revoked and the maintenance entity may be subject to the penalties set forth in this ordinance.

Proper maintenance of a stormwater treatment system shall include at a minimum the following items.

1. Pond side slopes shall be vegetated for erosion control.

2. Pond storage volume and geometry shall be maintained to the dimensions shown on the approved plans.

3. Littoral zone coverage with wetland plants shall be maintained to SJRWMD standards.

4. Vegetation shall be mowed frequently enough to provide access to the ponds for inspections and maintenance.

5. Weirs and orifices shall be kept clear of debris to

allow their proper functioning.

6. Skimmer blades shall be maintained to minimize floating debris and oils from leaving the ponds and allow unrestricted flow through the control structure.

7. The dimensions and elevations of control structures shall be preserved.

8. Underdrains shall be properly functioning.

9. Channel dimensions and geometry shall be maintained to approved designs.

10. Vegetation in dry ponds and channels shall be kept to a minimum so as to maintain flow and storage capacities.

GLOSSARY

AERIAL SUPPORT - Structural supports used to suspend utility lines above the ground.

ARTERIAL STREETS - Streets and highways which are used primarily for arterial traffic and defined as such by Florida Statutes.

BRIDGE - A traversing work for vehicular traffic which maintains the basic cross-section of the waterway below it.

STORM SEWER SYSTEM - A stormwater collection and transmission system consisting primarily of inlets and storm sewers.

CONSTRUCTION - Any activity including land clearing, earthmoving or the erection of structures which will result in the creation or alteration of a stormwater management system or the existing ground.

DESIGN HIGH WATER - The elevation of the water surface as determined by the flow conditions of the design storm.

DESIGN STORM - A selected rainfall pattern of specified amount, intensity, duration and frequency that is used as a basis for design.

DETENTION - The collection and temporary storage of stormwater with subsequent release, at a specified rate, into a downstream system.

DRAWDOWN - Lowering the water surface, water table or piezometric surface resulting from a withdrawal of water.

EFFECTIVE GRAIN SIZE - The diameter of filter sand or other aggregate that corresponds to the 10 percentile finer by dry weight on the grain size distribution curve.

ENGINEER - A Professional Engineer registered in Florida, or other person exempted pursuant to the provisions of Chapter 471, Florida Statutes.

EXFILTRATION - A stormwater management procedure which stores runoff in a subsurface collection system and dispose of it by percolation into the surrounding soil.

FILTRATION - The selective removal of suspended matter from stormwater by passing the water through at least 2 feet of suitable fine textured granular media such as porous soil, uniformly graded sand and gravel or other natural or artificial aggregate, which may be used in conjunction with filter fabric and underdrain pipe.

FREEBOARD - A vertical distance between elevation of the design highwater and the lowest elevation of the top of the bank, levee or berm.

IMPERVIOUS - Land surfaces which do not allow, or minimally allow, the penetration of water; included as examples are building roofs, normal concrete and asphalt pavements and some fine grained soils such as clays.

LEGAL POSITIVE OUTFALL - The point at which a stormwater system discharges off the project site; which must be lower than the upstream pipes, ditches, or waterbodies. The discharge point must be in, or flow to, a County or City maintained ditch, pipe, or waterbody.

MAINTENANCE - Routine custodial maintenance needed to ensure the functioning of a stormwater management system to meet original design criteria.

NONSTRUCTURAL - A method or methods of stormwater management which attempts, to the greatest degree possible, to employ natural and self-maintaining systems and limit the use of man-made, maintenance intensive structures.

OPEN DRAINAGE SYSTEM - A stormwater collection and transmission system consisting primarily of swales, ditches, and canals.

OUTFALL - The point, location or structure where stormwater runoff discharges from a surface water management system to a receiving body of water or other system.

OUTFALL STRUCTURE - The structure or structures which control receiving water body.

PEAK DISCHARGE - The maximum instantaneous flow from a given storm condition at a specific location.

PERMANENT SOIL STABILIZATION - The use of sodding, seed and mulch, rip rap, or other approved methods to prevent erosion during and after construction activities.

PROJECT AREA - The area being modified or altered in conjunction with a proposed activity.

RECHARGE - Replenishment of ground water reservoirs by infiltration and transmission through permeable soils.

RETENTION - The prevention of discharge of a given volume of stormwater runoff by complete on-site storage with subsequent release through accepted water treatment facilities or underdrains.

RIPRAP - Man-made or natural materials placed against an embankment or other work for protection against the action of water. Materials may include sand-cement bags, concrete block, rubble, or formed concrete.

ROADWAY - A designated travel pathway, either public or private, which is designed for vehicular traffic and is not used primarily as a driveway access to a property.

SEASONAL HIGH WATER TABLE - The highest level of the saturated zone in the soil in a year with normal rainfall.

SHORT-CIRCUITING - Flow characteristics of a detention pond in which a direct flow path exists between the inflow and outflow points, thus diminishing the velocity reduction and settling capability of the pond.

STABILIZED MAINTENANCE BERM - A maintenance pathway stabilized to a LBR of 15.

STORMWATER - The flow of water which results from, and which occurs immediately following, a rainfall event.

STORMWATER MANAGEMENT SYSTEM - The designed features of the property which collect, convey, channel, hold, inhibit or divert the movement of stormwater.

SUB-BASIN - A physical division of a larger watershed associated with one reach of the storm drainage system.

TAILWATER DEPTH - The depth of flow immediately downstream from the discharge structure, or at the point of discharge.

TEMPORARY SOIL STABILIZATION - The use of seeding, mulching, netting, blankets, or other approved methods to prevent erosion during construction activities.

TOTAL LAND AREA - Land holdings under common ownership which are contiguous or land holdings which are served by common surface water management facilities.

TRAVERSING WORK - Any artificial structure or construction that is placed in or across a stream, or other watercourse, or an impoundment.

UNDERDRAIN - A system of pipes, gravel, sand, and filtercloth used to recover retention volumes from stormwater ponds or lower the water table under roads or stormwater ponds.

UNIFORMITY COEFFICIENT - The number representing the degree of homogeneity in the distribution of particle sizes of filter sand or other granular material. The coefficient is calculated by determining the D60/D10 ratio where D10 and D60 refer to the particle diameter corresponding to the 10 and 60 percentile of the material which is finer by dry weight.

WATERSHED - A geographical area or region that is so sloped either by man or nature that surface runoff is carried away by a single drainage system by gravity to a common outlet or outlets. Also referred to as a drainage basin or drainage area.

WATER TABLE - The upper surface of the free ground water in a zone of saturation; locus of points in the soil water at which hydraulic pressure is equal to atmospheric pressure.