D4 Drainage Practices & Guidance

October 2001

CHAPTER 1 - INTRODUCTION

1.1 PURPOSE

The purpose of this document is to summarize drainage practices and guidance used in District Four, which are not documented in the State Drainage Manual or handbooks.

CHAPTER 3 – STORM DRAIN HYDROLOGY AND HYDRAULICS

3.4 DESIGN TAILWATER

Stormwater Ponds

The tail water for the storm drain system shall be taken from the 3yr-24hr flood routing utilizing the peak stage in the pond. The starting elevation in the flood routing for the pond shall be the control elevation for a wet pond, or the pond bottom for a dry pond.

Tidal Waterways

The tail water shall be the mean high tide for systems, which outfall directly to a tidal waterbody. Please check that the highest expected annual tide stage does not exceed the lowest roadway inlet grate elevation. Thus, tidal waters will not pond on the roadway. Consider that wind-generated setup may still drive tidal waters onto the roadway. If peak annual tidal elevations will flow through the bleeder or over the pond overflow, a check valve should be used.

3.6 HYDRAULIC ANALYSIS

3.6.1 Pipe Slopes

The desirable minimum pipe design velocity is 2.5 fps, but a 2.0 fps may be used if necessary for hydraulic clearance purposes. This recommendation is not applicable to 18" laterals based on low flows. Please note that the design velocity is the actual velocity the pipe experiences under design conditions, not necessarily a theoretical Manning's velocity created by the physical slope of the pipe. Thus, when the design HGL is above the inside crown of the pipe (i.e. flowing full), the design velocity is the actual HGL velocity or the design flow divided by the pipe area.

A minimum 0.1% physical trunk line pipe slope is recommended, but a steeper slope should be used wherever possible without causing overly deep cuts. Try to avoid a depth of cut that may result in the use of sheet pile. Usually, laterals can use a steeper slope unless utilities are in conflict. Install structure sumps if siltation is expected.

3.6.3 Outlet Velocity

When the outlet velocity for the design storm exceeds <u>4 fps</u>, not 6 fps, the need for special channel lining and/or energy dissipation shall be considered for protection against bank erosion. Consideration should be given to soil conditions, vegetation, and slope steepness at the outlet.

3.7 HYDRAULIC OPENINGS

3.7.1 Entrance Location and Spacing

3.7.1.1. Inlets

Inlet type, location and spacing shall consider the following:

1 – 7. Same as Drainage Manual

8. Potential for created low points at turn lanes and bus bays

3.8 GRADES

3.8.1 Longitudinal Gutter Grade

Super elevation transitions should have a minimum longitudinal slope of 0.5% through the area where the roadway cross slope is flat.

3.9 SPREAD STANDARDS

When storm water drains towards the median on an urban section, a minimum of 8 ft. of drivable lane shall be provided without impact from spread. For a normal 12 ft. lane, this would amount to a 4 ft. spread on the through lane plus another 1.5 ft. spread in the gutter. Spread should be considered during construction where the through lanes are immediately adjacent to temporary or permanent barrier wall.

3.10 CONSTRUCTION AND MAINTENANCE CONSIDERATIONS

3.10.1 Pipe Size and Length

Minimum pipe size is 18" where hubcaps may enter the system. This will often result in laterals with very low design velocity. In such cases, use a steeper pipe slope on the lateral to gain an open channel velocity to help clean out pipes.

3.10.1.1 French Drain Considerations

1. A 4 ft. sump is required upstream of all French drain runs. Consideration should be given to the use of deeper sumps in areas of greater sediment capture. Weep holes should be used only for non-floatation during installation or when above the water table.
2. French drains greater than 24" are hard to clean. The larger pipes take a longer time to clean, and efficiency goes down. Pipes must be above the water table to be cleaned effectively. The French drain pipe should be sloped to facilitate cleaning, even if the trench rock is level.
3. The manhole access from Type 1 - 4 inlet tops are desirable when using french drain.
4. Landscaping with large trees and/or plants with deep root systems should not be used above french drain systems.
5. Maintenance prefers that access at both ends be provided when the French drain length is greater than 50 ft.
6. Bleeders are not allowed in French drain control structures.

3.10.2 Minimum Clearances

1. Same as Drainage Manual
2. Use a minimum 0.5 ft. clearance between the roadway base and the outside crown of the RCP storm drain. No extra base for pipe protection is needed for high roadway ADT or design speed as discussed in Index 205, Roadway and Traffic Design Standards.

3. Utility Clearances:

a. Utility conflict structures should provide manholes on both sides of the conflict when the conflicting utility is large (≥12"), or the conflict is close to the top of the structure. Maintenance vactor trucks have a rigid suction pipe that cannot bend around obstructions. If the degree of access is uncertain, contact the local FDOT maintenance office for direction.

b. The distance between the bottom of the utility and the conflict structure bottom should be no less than the internal diameter of the outlet pipe. Possible use of a sump should be considered in areas where sedimentation is expected.

3.10.3 General Maintenance Considerations

1. Vactor hose access behind wall-attached skimmers is important. Use a cleanout access hole on the top of the skimmer or a flap top.
2. For dry ponds, a minimum 3" bleeder should be provided at the SHGWT to facilitate storage recovery. A 6" thick concrete apron should be constructed in the ditch immediately adjacent to this bleeder to facilitate removal of sediment and reduce clogging potential from overgrown grass.
3. Manholes should be placed in the middle of lanes rather than on the lane lines to facilitate MOT during entry. If entry is expected, then the two-piece, 3 ft. manhole covers should be used unless the 2 ft. manholes are approved by Maintenance.
4. Chain link fence above weirs is desirable to capture floating debris, but tends to clog. Therefore, do <u>not</u> use fencing in structures unless downstream aesthetics are critical. When fence is used, the top portion of the fence section should be open to provide hydraulic relief in case the fence becomes clogged. Maintenance should be consulted on these structures, which include fence.
5. Multi-chambered control structures and sedimentation structures should provide manholes between skimmers and/or weirs.

CHAPTER 4 - CROSS DRAIN HYDRAULICS

4.2 GENERAL

1. 1– 4. Same as Drainage Manual
5. For large cross drains (60" and greater), the economic order of preference is as follows:
    a. Pipe
    b. Concrete Box Culvert
    c. Bridge
6. Metal pipe has some additional advantages:
    - Elimination of de-watering may provide cheaper installation costs.
    - Sections of metal pipe may be banded together offsite and laid in large sections to minimize disruption to traffic.
    - Metal pipe may be cantilevered, eliminating the need for end treatment, and survive erosion at an outfall.
7. In consideration of pipe costs: Elliptical concrete pipe is about 40% more costly than round pipe due to both increased materials and labor costs. Also, round concrete pipe joints are less likely to leak than elliptical pipe joints. Metal arch pipe is about 10% more costly in materials than round metal pipe, but with no significant difference in difficulty of installation.

8. Pipe materials recommended for a salt-water environment include: aluminum, non-reinforced concrete, or fiber-reinforced pipe. The final recommendations will be based on the corrosion analysis completed for the project.
9. When replacing an existing bridge with a culvert, consider pulling metal culverts under the existing bridge to reduce MOT efforts.
10. Use the minimum number of culverts to reduce costs and minimize debris problems; i.e., use a single 72" pipe rather than 2 - 60" pipes.
11. Keep box culvert dimensions at 12 ft. or less to avoid the need for a special design (structure standards are available up to 12 ft.).
12. Maximize box culvert heights, targeting the difference between the waterway flow line and the DHW elevation before adding increased span width. Increases in span width dramatically increase reinforcing steel to support the span.
13. MOT considerations may override economics and should be considered when selecting between a bridge, box culvert, and a pipe culvert.

4.6 CLEARANCES

4.6.1 Vertical Clearance

The minimum debris clearance of 2.0 ft. may be reduced in areas with minimal concern. The District Drainage Engineer must verify a reduction in clearance. Additionally, the bridge designer should be alerted to consider horizontal loading.

4.7 HYDRAULIC ANALYSIS

4.7.2. Tidal Flow

When hurricane surge boundary conditions are used to drive bridge or culvert hydraulics, FDEP 50, 100, and 500 year storm surge elevations should be used rather than the ADCIRC station results published by the FHWA, and included in the FDOT Hydrology Handbook. Also, check with the District Drainage Engineer to determine if the proposed crossing is within or near the District 4 Tidal Model.

4.9 SPECIFIC STANDARDS RELATING TO BRIDGES

Try to use a single span opening or reduce the number of spans, if possible, by increasing the beam depth. Beam depth may be increased by raising the profile (potentially expensive) or by compromising the drift clearance when debris is not expected to be a problem (i.e., highly urbanized watershed, pump immediately upstream, etc.).

4.9.1 Berms for Spill Through Abutment Bridges

The minimum berm width of 10' is typically not used on controlled canals unless requested by the maintaining agency.

4.9.2 Scour Estimates

4.9.2.1 Coordination

When predicted scour depths encounter hard soil strata, the Central Drainage Office in Tallahassee should be contacted to consider Dr. Sheppard's procedure for predicting scour in resistant materials. This should be done in coordination with the District Drainage Engineer.

4.9.2.3 Scour Components

For total scour estimations greater than 10 ft., Sheppard's pier scour equation should be used for predicting pier scour.

4.9.3 Scour Protection Considerations

1. Use S.G. = 2.65 rubble or other extra heavy revetment where large wave attack is expected, typically in coastal applications. Avoid corrodible metal cabling or baskets in coastal environments; even if coated, the coating may be marred and allow corrosion. Follow ACOE Shore Protection Manual for design of coastal revetment.
2. Bedding stone should be used on all bank and shore rubble installations to guard against tearing of the filter fabric during placement of the rubble.
3. For revetment installations where wave attack is not expected to be significant, include all options (i.e. fabric-formed concrete, standard rubble, or cabled interlocking block, etc.), which are appropriate based on site conditions. All options shown to be inappropriate for the site should be documented in the BHR. A Technical Specification should be written based on the use of the most desirable revetment material, with the option to substitute the other allowable materials at no additional expense to the Department. This recommendation will help in eliminating revetment VECPs during construction.

4.9.4 Bridge Deck Drainage

Preference for bridge deck drainage:

1. Carrying storm water to the end of the bridge for collection in standard roadway inlets.
2. If a spread problem is unavoidable, use direct discharge scuppers and provide compensatory roadway water quality treatment. This option must be approved by the permitting agency, and should be done so early in the design process.
3. If a significant collection system is required by the permitting agency, fiberglass pipe (FRP) is generally the best choice. DIP, PVC, and HDPE are also acceptable, but have some disadvantages as discussed below.
   a. DIP is heavy with very large expansion and contraction
   b. PVC has less resistance to abrasion and requires more frequent supports than FRP
   c. HDPE has greater expansion and contraction than FRP
4. Regardless of pipe selection, special attention must be given to the design of a hanger system that will work with the differential expansion and contraction between the bridge and the pipe – see Drainage staff for guidance. If the bridge collection system is discharged to a roadway structure, a resilient connector should be used to allow longitudinal pipe movement within the stationary roadway drainage structure.

4.11 DOCUMENTATION

4.11.2 Bridges

Use short format BHR on controlled canals not affected by hurricane surge. This format is available from the District Drainage Office for active projects.

CHAPTER 5 – STORMWATER MANAGEMENT

5.2 REGULATORY REQUIREMENTS

To compute a basin discharge limitation as required by the South Florida Water Management District (SFWMD), the pre-development peak discharge from the existing right of way is added to the discharge limitation applied to the new right of way. The post-development peak discharge from the total proposed project area must be less than or equal to this combined pre-development discharge amount.

5.2.1 Chapter 14-86, Florida Administrative Code

Critical Duration Design is not required. Rather, proposed offsite discharges from FDOT right of way are accepted on the basis of meeting permittable discharges (i.e. post-development less than or equal to pre-development) with the usual 1 ft. desirable freeboard. Permitting agency rainfall curves should be used in determining rainfall depths for FDOT acceptance.

5.3 DESIGN STANDARDS

5.3.1 Design of Systems

5.3.1.1 General

Offsite inflows should be brought into the FDOT storm water management system to avoid the expense of building parallel systems unless (1) the stages in our proposed system will reduce the flood protection of the upstream owner (i.e. reduced freeboard), and/or (2) the storage necessary to meet water quality or quantity permitting requirements is compromised.

5.3.4 Construction and Maintenance Considerations

5.3.4.1 General

1. Check the highest expected annual tide level to make sure that tidal waters will not back flow into the pond, resulting in landscape kill. A tide flex valve may be used on the pond bleeder orifice or the control structure outlet pipe as needed.

5.3.4.2 Detention and Retention Ponds

1. **Maintenance Berm**

Do NOT automatically design Maintenance truck access around the full pond perimeter. This berm should be coordinated with Maintenance to accommodate truck access and turn around areas.

2. **Corners** – no comment
3. **Freeboard**
    1. A minimum of 1 ft. of freeboard shall be provided in the pond above the peak stage from the flood routing utilizing the permit required pre-post storm event. If the pond is immediately adjacent to a receiving waterbody, then designing for overtopping may reduce this 1 ft. freeboard. A section of the pond perimeter adjacent to the receiving waterbody should be lowered and armored to allow for overflow during the design event. This lowered section shall remain above the peak stage for the pond.
    2. The 1 ft. of freeboard may only be reduced in areas where overtopping will not create the potential for upstream damage. Clogging must be considered in these areas with reduced freeboard. The District Drainage Engineer must approve a reduction in this 1 ft. of freeboard.

4. Fencing

Fencing can be eliminated based on documented site considerations.

5. Access Easements

All easements shall be coordinated with the both the maintenance and Drainage Department to ensure sufficient width is provided for construction and future access needs.

6. General

1. For wet ponds, a minimum 6 ft. permanent pool depth is desirable to prevent aquatic weed growth. A maximum 10 – 12 ft. depth will provide greater pollutant dilution, and is desirable when fill is needed.
2. Roadway ditches are often used as linear dry detention ponds. In urban areas where aesthetics are of prime consideration, a minimum longitudinal slope should be incorporated in the pond to convey the water more directly towards the outfall structure. Where aesthetics is not an issue, but storage is then the ponds should be designed with a flat longitudinal slope to maximize storage and stepped with ditch blocks if the land is sloping.
3. If the location of the SHGWT is uncertain, the clearance from the pond bottom to the SHGWT should be increased from the required 1.0 ft. to 1.5 ft.
4. For dry detention ponds, a note should be added to the plans to require scarification, after the limerock base is sealed and before the installation of sodding, to a depth of 1.0 ft. below the bottom of the pond.
5. Use a 4 ft. sump in the structures immediately upstream of all dry and wet ponds to collect any sedimentation in the system prior to outfall.

GENERAL INFORMATION:

1. Location Hydraulic Reports (LHR)

For most projects, the NEPA process LHR requirement can be satisfied with a brief response to the questions posed in the P.D.& E. Manual, chapter 24. An example of such a succinct report is available from the District Drainage Office on active projects. Since significant floodplain impacts are avoided as a matter of policy in District Four, detailed LHR's are typically used only to document significant regional cross drain design and/or to set rural roadway profiles where roadway overtopping is currently occurring.

2. Typical Section Issues

For eight lane urban typical sections, consideration for sloping all through lanes to the outside should be considered. Elimination of a split cross slope will result in the following benefits: avoiding spread problems at intersections, fewer inlets on the storm drain system, and avoiding spread problems within the high-speed (inside) travel lane. *Please note that this requires a variance as the current Plans Preparation Manual requires a split of three lanes sloped to the outside with 1 lane sloped towards the inside.

3. Roadway Base Clearance

1. Current practice is to select a long-term stage (3 – 7 days which is usually either long term flooding or SHGWT), and use the appropriate clearances from that stage.
2. The ongoing FSU study is expected to provide a much more refined procedure within the next few years.