STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

DRAINAGE HANDBOOK
DRAINAGE CONNECTION PERMITS

OFFICE OF DESIGN, DRAINAGE SECTION
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TALLAHASSEE, FLORIDA

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Purpose

This handbook has been prepared to assist applicants in complying with the Florida Department of Transportation (Department) Rule 14-86, F.A.C. hereafter called the Rule. As a secondary feature, some of the reasoning and logic behind the Rule and its requirements will be explained.

The Department recognizes that there are numerous methodologies and techniques for designing surface water management systems. The methods and techniques discussed in this handbook are provided as suggestions. The handbook is not incorporated by reference in the Rule; therefore, any final determinations of the appropriate procedures to be followed shall be based on the Rule.

Within this handbook, there is reference to the Department's Drainage Manual, Drainage Design Guide (DDG), and design information. These documents are available from the Department's State Drainage Office website shown below. The District Drainage Office websites can also be accessed from this site.

http://www.fdot.gov/roadway/Drainage/Default.shtm

The Rule and application form are available from the Department's One-Stop Permitting Site.

https://osp.fdot.gov

1.0 History

The Rule was originally developed in the mid-1980s and implemented on November 12, 1986. It was developed primarily because of court rulings made in preceding years. One case in particular [Hanes v. Silgain, 448 So.2d 1130 (FL 1st DCA 1984)] involved the flooding of property downstream of the Department's drainage system. The Department asserted that various land owners developed their property and cast unreasonable quantities of surface water into the Department's drainage system, thus contributing to the downstream property flooding. The court ruled that the Department was solely responsible for its drainage system and commercial developments draining into the Department's system did not share in the responsibility. From this ruling, the Department felt the only reasonable recourse was to develop a rule that would regulate the transfer of stormwater to its systems. Refer to the Drainage Law Appendix of the FDOT Drainage Manual for additional information on this and other court cases.

The Rule remained unchanged until January 20, 2009. The purpose of the revision was to address issues raised over the years and to clarify certain items. Some of the changes worth noting are listed below:

- Definition of Adjacent Property is limited to properties sharing a boundary with the Department [14-86.002(1)].
- Fewer design storms are required for basins with positive outlets. Discharges to basins with positive outlets now require evaluation of up through the 3-day duration storm [14-86.002(6)].
- A permit is now required even if the 100-year runoff is retained [14-86.003(1)(b)]. The permit is the means by which the applicant provides assurances to the Department that the proposed improvements do, in fact, retain the 100-year runoff.
- Changes to inflow patterns may require evaluation of the Department's facilities to ensure the safety and integrity of those facilities are not compromised [14-86.003(2)(a)3].
- Licensed professional certifications are now included as part of the application form.
- Exceptions do not apply if the drainage connection threatens the safety and integrity of the Department's facilities, creates an unreasonable burden on lower properties, or violates applicable water quality standards [14-86.003(4)].
- Previously permitted improvements can become pre-conditions for subsequent improvements [14-86.002(19)].

2.0 Frequently Asked Questions

1) Why is my water management district permit not good enough?

The Department is concerned with the safety and integrity of its facilities and with preventing unreasonable burden to lower properties. The water management districts are typically concerned with the burden to lower properties and with water quality, but not the Department's facilities. Another reason is that the Department has adopted the critical design storm concept of the Suwannee River Water Management District. Therefore the design storms of the other water management districts are not typically accepted. See discussion of critical duration approach in Section 4.

2) What design storms events do I evaluate?

There are two aspects to design storms, frequency and duration. The Department requires the 3-, 5-, 10-, 25-, 50-, and 100-year frequencies be evaluated for all sites. The required number of storm durations varies depending if the site discharges to a watershed with a positive outlet or not. All sites are required to evaluate the 1-, 2-, 4-, 8-, 24-, and 72-hour duration events. For discharges to watersheds without positive outlets, commonly called closed basins, the 7- and 10-day events must also be evaluated.

3) Why do I need a Drainage Connection Permit if I retain the 100-year runoff?

Although you are not proposing to discharge to the Department up to the 100-year storm event, you must provide assurances that the proposed improvements will retain the runoff. The permit and associated documentation are the mechanism to provide that assurance to the Department.

4) Why do I need a Drainage Connection Permit and a Driveway Connection Permit?

You may not need both. The Drainage Connection Permit authorizes the improvements to the adjacent property and the work within the Department's right of way that is necessary to make the drainage connection. The work within the right of way is typically interpreted as construction of a spillway, overflow device, pipes to structures or pipes to ditches with appropriate end treatments and erosion protection. Any other work within the Department's right of way such as driveway and turn lane construction and relocation of existing drainage structures is authorized by a Driveway Connection Permit.

5) Do I need a drainage connection permit to construct a side drain pipe for a new driveway?

Constructing side drain pipes does not warrant a Drainage Connection Permit. If the improvement does not warrant a Drainage Connection Permit for other reasons, size and construction of the side drain pipe is addressed through the Driveway Connection Permit.

6) What are the Department's water quality standards?

The Department does not have established water quality standards. The design should meet the design and performance standards of the appropriate water management district (WMD), the Florida Department of Environmental Protection (FDEP), or applicable local government.

3.0 Exceptions

When determining the need for a drainage connection permit, the first thing to consider is whether the project is regulated under Rule 14-86 F.A.C. If regulated, the next step is to determine if it qualifies for an exception[1]. If it does not qualify for an exception, a drainage connection permit is required.

There are several issues or conditions that determine if the project is regulated. First, the Rule regulates improvements to property. Improvements are defined as "any man-made change(s) to adjacent properties". But only those improvements made on or after November 12, 1986 are regulated. The Rule defines man-made change as "any intentional physical change to or upon adjacent property resulting from intentional physical change which establishes or alters the rate, volume, or quality of stormwater".

Second, the Rule regulates only those improvements that are made to adjacent properties. The Rule defines adjacent properties as "any real property or easement with a shared boundary to the Department's right of way". The Department's right of way could be associated with such things as roads, stormwater ponds, access easements, drainage easements, or borrow pits. If a boundary is not shared, the Rule does not regulate the site.

In short: ***"A site is regulated by this Rule if any man-made change is proposed or has occurred to property that shares a boundary with the Department."***

The Rule regulates the transfer of stormwater to the Department's right of way. Stormwater is defined in the Rule as the flow of water that results from or occurs immediately following a rainfall event. The Rule does not regulate dewatering activities or groundwater flow. A permit may be required when there is a potential for transfer of stormwater, even when it is not intended to transfer stormwater. Furthermore, a drainage connection permit may be required even if a driveway permit is not.

If the site is regulated, the next step is to determine if it qualifies for an exception. If you believe the project qualifies for an exception, you are encouraged to request verification from the Department, especially in the case where the project drains away in the pre-improvement and post-improvement condition. In this situation, the Department would like the applicant to provide assurances that the drainage patterns remain unchanged and that the proposed stormwater pond would not overtop toward the Department's right of way. Verification can be obtained by sending a complete permit application to the applicable district office. When doing so check the box noted as ☐ Exception on page two of the application form.

[1] The first version of the Rule used the term "exemption" instead of "exception". There is no significance to the name change.

There are four (4) categories of exceptions [14-86.003(3)] generally grouped as follows:

a) Improvements to adjacent properties not draining to the Department's right-of-way in the pre-improvement and post-improvement condition
b) Single-family residential improvements which are not part of a larger common plan of development or sale.
c) Agricultural and silvicultural improvements
d) Minor improvements

Discharges to tidal influenced areas and sites that retain runoff up to the 100-year event of critical duration are often thought to qualify for an exception, but they do not. Unless the project qualifies for one of the exception categories noted above, these situations would require a drainage connection permit.

An exception shall not apply if the drainage connection threatens the safety and integrity of the Department's facilities, creates an unreasonable burden on lower property owners, or causes violations of water quality standards [14-86.003(4)].

A questionnaire is provided in Appendix B to help determine if the site is regulated under the Rule and if it qualifies for an exception. Complete the questionnaire and submit it with all verifications of exceptions.

4.0 Critical Duration Approach

The Department uses the critical duration approach to designing stormwater ponds which requires that multiple storms be evaluated to compare the post-improvement runoff to the pre-improvement runoff. The Suwannee River Water Management District and several local governments have also adopted this approach.

This is different than all the other water management districts that use a single design storm approach. The single storm typically has a duration and distribution developed by the National Resource Conservation Service (NRCS). Some of these water management districts have modified the NRCS distributions slightly; nevertheless, all of the single storms are "nested" storms, meaning peak intensities are grouped or nested around a certain hour of the design storm. These empirical relationships do not reflect actual rainfall patterns and, subsequently, produce inaccurate representations of actual rainfall-runoff relationships. These relationships have been acceptable in the past for the design of conveyance systems because they give conservatively high runoff estimates; however, when these relationships are used to determine the pre-improved discharge rate for proposed stormwater ponds they can result in downstream flooding because they overestimate the pre-improvement runoff.

Another important consideration is system response. Different types of drainage systems fail under different types of rainfall events. More specifically, urban storm drains and collection ditches can usually accommodate events characterized by high volume, long duration, and low to moderate intensity whereas short duration, low volume, and high intensity events usually result in system overload for some period of time which is considered a failure. Conversely, large canal systems and primary creek systems will fail under high-volume, long-duration events but can usually accommodate short intense events. Large river systems and static water systems such as lakes reach critical stages when extreme antecedent conditions exist and are generally unaffected by variations in rainfall intensity.

The concept of design based on a critical duration storm was developed to address the system response consideration and the shortcomings of many of the existing empirical relationships. Essentially, this concept involves analyzing a system under various duration storm events (for a given frequency) to determine which duration is critical or most demanding to the system. A problem posed by such a concept is the limited availability of published and accepted rainfall distributions for events of various durations, in addition to the fact that for any given frequency an infinite number of durations actually exist.

The Suwannee River Water Management District developed rainfall distribution relationships for the 1-, 2-, 4-, 8-, 24-hour and 3-, 7-, 10-day durations. National Oceanic and Atmospheric Administration hourly and sub-hourly data were used to develop these distributions. They are dimensionless and are tabulated in two forms: "time vs. accumulative mass" and "time vs. intensity". These distributions are considered by the Department to be appropriate for the entire state and are available from the Department's web site.

4.1 Design Storms

The required number of storms to be evaluated varies depending on if the site discharges to a watershed with a positive outlet or not. Watersheds with positive outlets drain to surface waters that ultimately drain to the Gulf of Mexico or the Atlantic Ocean. Watersheds without positive outlets are typically those that drain to sinks, closed lakes, or drainage wells. These watersheds are commonly called closed basins. Occasionally watersheds contain up to a certain event like the 10-year or 25-year, but then "pop-off" and discharge to a creek or other positive outlet for greater (less frequent) storm events. For improvements in these watersheds, the project would be evaluated as a closed basin up to the "pop-off" event and as a basin with positive outlet for greater events.

The storms to be evaluated are shown in Table 4-1. Note that the 7-day and 10-day durations are required only for discharges to watersheds without positive outlets (closed basins). In certain situations district staff may allow evaluation of fewer storms.

Table 4-1

Design Storms

Duration	**Frequency**					
	3-Year	**5-Year**	**10-Year**	**25-Year**	**50-Year**	**100-Year**
1-Hour	Required	Required	Required	Required	Required	Required
2-Hour	Required	Required	Required	Required	Required	Required
4-Hour	Required	Required	Required	Required	Required	Required
8-Hour	Required	Required	Required	Required	Required	Required
1-Day	Required	Required	Required	Required	Required	Required
3-Day	Required	Required	Required	Required	Required	Required
7-Day	Closed Basin	Closed Basin	Closed Basin	Closed Basin	Closed Basin	Closed Basin
10-Day	Closed Basin	Closed Basin	Closed Basin	Closed Basin	Closed Basin	Closed Basin

4.2 Comparing Pre-Improvement and Post-Improvement Runoff

The post-improvement runoff for a particular design storm (frequency and duration) is compared to the pre-improvement runoff of the same design storm to ensure no increase. This is referred to as the "storm for storm" approach in the Department's DDG. In certain situations, district staff may allow a different comparison of storms.

5.0 Rainfall

The Department's rainfall data consists of statistical rainfall depth data from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 Rainfall Data and DOT Intensity-Duration-Frequency (IDF) curves. These are available at the following locations:

Rainfall:

http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=fl

IDF Curves:

https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/roadway/drainage/files/idfcurves.pdf?sfvrsn=1babf202_4

Example: To determine the rainfall in Gainesville, Florida, the user must first enter in the lat/long, a predetermined station from the drop-down menu or an address as shown in Figure 5-1.

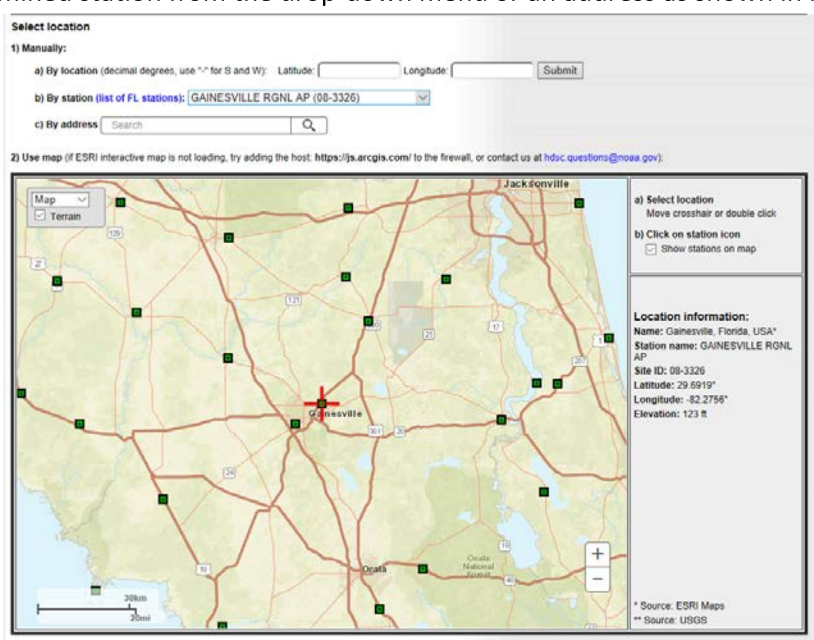


Figure 5-1

Once the location has been determined, the rainfall estimates are populated below the map as shown in Figure 5-2.

PF tabular | PF graphical | Supplementary information | Print page

PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.502** (0.405-0.627)	**0.568** (0.457-0.709)	**0.674** (0.541-0.843)	**0.761** (0.607-0.954)	**0.879** (0.678-1.12)	**0.969** (0.732-1.25)	**1.06** (0.773-1.39)	**1.15** (0.805-1.53)	**1.26** (0.854-1.72)	**1.35** (0.891-1.86)
10-min	**0.736** (0.592-0.918)	**0.832** (0.669-1.04)	**0.987** (0.792-1.23)	**1.12** (0.889-1.40)	**1.29** (0.993-1.64)	**1.42** (1.07-1.83)	**1.55** (1.13-2.03)	**1.68** (1.18-2.24)	**1.85** (1.25-2.52)	**1.98** (1.31-2.73)
15-min	**0.897** (0.723-1.12)	**1.01** (0.816-1.27)	**1.20** (0.966-1.51)	**1.36** (1.08-1.70)	**1.57** (1.21-2.00)	**1.73** (1.31-2.23)	**1.89** (1.38-2.48)	**2.05** (1.44-2.74)	**2.25** (1.53-3.07)	**2.41** (1.59-3.32)
30-min	**1.38** (1.11-1.72)	**1.57** (1.26-1.95)	**1.86** (1.49-2.33)	**2.10** (1.68-2.63)	**2.42** (1.87-3.09)	**2.67** (2.01-3.44)	**2.91** (2.13-3.81)	**3.15** (2.21-4.20)	**3.46** (2.34-4.70)	**3.68** (2.43-5.08)
60-min	**1.80** (1.45-2.24)	**2.05** (1.65-2.56)	**2.46** (1.98-3.08)	**2.81** (2.24-3.53)	**3.30** (2.55-4.22)	**3.67** (2.78-4.75)	**4.05** (2.97-5.33)	**4.45** (3.13-5.95)	**4.97** (3.37-6.78)	**5.37** (3.55-7.41)
2-hr	**2.22** (1.79-2.75)	**2.53** (2.05-3.14)	**3.07** (2.47-3.81)	**3.52** (2.82-4.39)	**4.17** (3.24-5.32)	**4.68** (3.56-6.02)	**5.20** (3.83-6.80)	**5.74** (4.07-7.65)	**6.48** (4.42-8.80)	**7.05** (4.69-9.67)
3-hr	**2.42** (1.96-2.98)	**2.76** (2.24-3.41)	**3.36** (2.72-4.16)	**3.89** (3.13-4.83)	**4.65** (3.65-5.95)	**5.28** (4.04-6.79)	**5.93** (4.39-7.76)	**6.63** (4.72-8.83)	**7.59** (5.21-10.3)	**8.36** (5.58-11.4)
6-hr	**2.79** (2.28-3.42)	**3.16** (2.57-3.87)	**3.83** (3.11-4.70)	**4.44** (3.59-5.48)	**5.39** (4.27-6.90)	**6.20** (4.79-7.97)	**7.07** (5.28-9.24)	**8.03** (5.77-10.7)	**9.39** (6.50-12.7)	**10.5** (7.06-14.3)
12-hr	**3.24** (2.65-3.95)	**3.59** (2.94-4.38)	**4.28** (3.50-5.23)	**4.96** (4.03-6.08)	**6.05** (4.84-7.74)	**7.01** (5.46-9.00)	**8.07** (6.09-10.5)	**9.26** (6.72-12.3)	**11.0** (7.68-14.8)	**12.4** (8.42-16.8)
24-hr	**3.70** (3.05-4.48)	**4.13** (3.39-5.00)	**4.95** (4.06-6.01)	**5.76** (4.70-7.01)	**7.07** (5.69-9.00)	**8.22** (6.45-10.5)	**9.51** (7.21-12.3)	**10.9** (7.98-14.4)	**13.0** (9.17-17.5)	**14.8** (10.1-19.8)
2-day	**4.19** (3.47-5.04)	**4.80** (3.97-5.77)	**5.93** (4.89-7.15)	**7.00** (5.74-8.46)	**8.66** (6.99-10.9)	**10.1** (7.93-12.8)	**11.7** (8.87-15.0)	**13.4** (9.80-17.5)	**15.9** (11.2-21.1)	**17.9** (12.3-23.8)
3-day	**4.62** (3.84-5.54)	**5.28** (4.37-6.32)	**6.49** (5.37-7.79)	**7.65** (6.29-9.21)	**9.46** (7.66-11.9)	**11.0** (8.69-13.9)	**12.7** (9.73-16.3)	**14.6** (10.8-19.0)	**17.4** (12.3-23.0)	**19.6** (13.5-26.0)
4-day	**5.05** (4.20-6.03)	**5.68** (4.72-6.79)	**6.89** (5.70-8.24)	**8.05** (6.63-9.66)	**9.90** (8.05-12.4)	**11.5** (9.11-14.5)	**13.3** (10.2-17.0)	**15.3** (11.3-19.9)	**18.2** (12.9-24.0)	**20.5** (14.2-27.2)
7-day	**6.22** (5.20-7.39)	**6.75** (5.63-8.02)	**7.81** (6.50-9.30)	**8.89** (7.36-10.6)	**10.7** (8.74-13.3)	**12.3** (9.78-15.4)	**14.1** (10.9-17.9)	**16.1** (12.0-20.9)	**19.1** (13.7-25.2)	**21.7** (15.0-28.5)
10-day	**7.16** (5.99-8.48)	**7.67** (6.42-9.09)	**8.71** (7.26-10.3)	**9.77** (8.10-11.6)	**11.5** (9.43-14.3)	**13.1** (10.4-16.3)	**14.8** (11.5-18.8)	**16.8** (12.5-21.7)	**19.8** (14.2-25.9)	**22.2** (15.5-29.1)
20-day	**9.50** (7.99-11.2)	**10.3** (8.66-12.1)	**11.7** (9.82-13.8)	**13.0** (10.8-15.4)	**14.9** (12.1-18.1)	**16.4** (13.1-20.1)	**18.1** (14.0-22.5)	**19.9** (14.8-25.2)	**22.4** (16.1-28.9)	**24.4** (17.1-31.7)
30-day	**11.5** (9.72-13.5)	**12.6** (10.7-14.8)	**14.5** (12.2-17.0)	**16.0** (13.4-18.8)	**18.1** (14.7-21.7)	**19.8** (15.7-23.9)	**21.4** (16.5-26.4)	**23.1** (17.2-29.0)	**25.3** (18.2-32.4)	**27.0** (19.0-35.0)
45-day	**14.3** (12.1-16.7)	**15.8** (13.4-18.4)	**18.1** (15.3-21.2)	**20.0** (16.8-23.4)	**22.4** (18.2-26.6)	**24.2** (19.3-29.1)	**25.9** (20.1-31.7)	**27.6** (20.6-34.4)	**29.7** (21.4-37.7)	**31.1** (22.0-40.2)
60-day	**16.9** (14.3-19.7)	**18.6** (15.8-21.7)	**21.3** (18.0-24.8)	**23.4** (19.7-27.4)	**26.1** (21.2-30.9)	**28.1** (22.4-33.6)	**29.9** (23.2-36.4)	**31.7** (23.7-39.3)	**33.8** (24.4-42.8)	**35.3** (25.0-45.4)

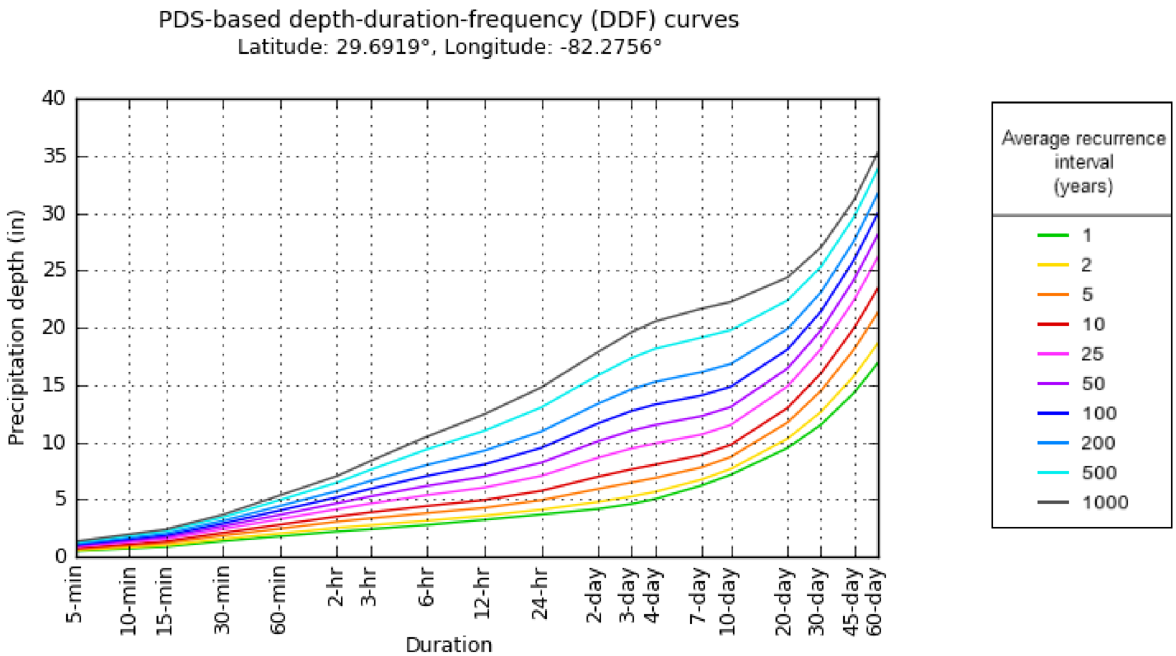
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Estimates from the table in CSV format: Precipitation frequency estimates | Submit

Figure 5-2



The NOAA precipitation-frequency (PF) table does not provide rainfall data for the 3-year frequency storm as well as for the 4- and 8-hour duration storms. The rainfall depths for these storms will need to be interpolated from the NOAA PF table. Rainfall for the 3-year frequency storm can be interpolated from the 2- and 5-year frequency storms. Rainfall for the 4-hour duration storm can be interpolated from the 3-hour and 6-hour duration storms. Similarly, rainfall for the 8-hour duration storm can be interpolated from the 6-hour and 12-hour duration storms.

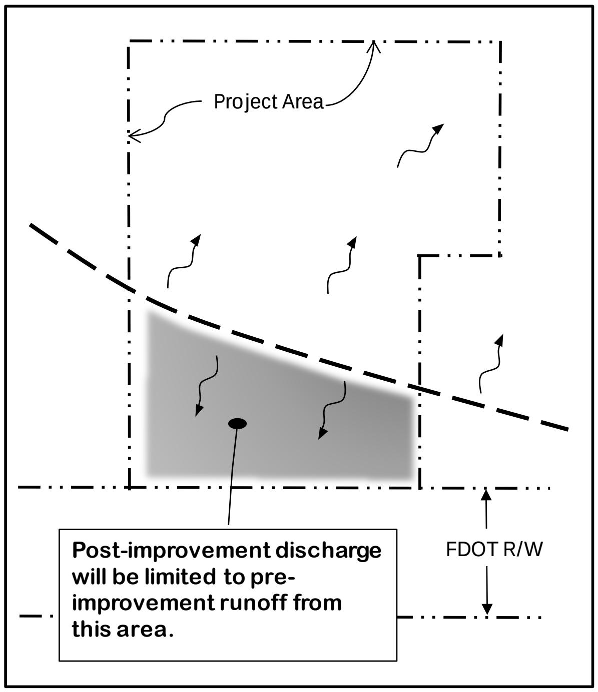
6.0 Pre-improvement Conditions

Usually the pre-improvement conditions are the site conditions that exist at the time of permit application. The Rule defines pre-improvement conditions as those that existed before November 12, 1986 or the conditions previously permitted under the Rule (or other rule equal to or more stringent than 14-86 F.A.C.). If the site was improved after November 12, 1986, a drainage connection permit should have been obtained. The permitted conditions establish the pre-improvement conditions for future improvements. If the site was improved without a drainage connection permit, the pre-improvement conditions would be that which existed prior to November 12, 1986.

To establish the pre-improvement conditions, you will need to identify the basin divides and any offsite contributing areas.

Identify the basin divides on the grading plan or drainage map. USGS quad maps are rarely adequate and water management district 1-foot contour aerials maps are often not sufficient to define the basin breaks in flat terrain. Obtain enough spot survey shots in flat terrain to clearly demonstrate the basin divides. Delineate the area that drains to the Department's right of way because it establishes the post-improvement allowable discharge.

Figure 6-1



Identify any and all offsite areas that drain through the property. This is the first step to ensure that runoff is accommodated and not blocked or re-directed in a harmful way. Contour information shall extend from the property far enough to clearly define the watershed that drains to the Department's right of way. For large watersheds, it may not be practical to show this information on the grading (construction) plans. Providing drainage maps with the drainage calculations will suffice in this case. At a minimum, contour information shall extend 50 feet beyond the property boundaries.

Properties downstream of the Department's right of way can also block and re-direct runoff in a harmful way. In the past, some improvements downstream of the Department's right of way have blocked runoff and created flooding issues for the Department and properties farther upstream. This is contrary to common drainage law which implies that downstream properties must accept upstream runoff. Although this situation does not typically require a drainage connection, you should consider the potential impacts.

Identify substantial surface storage that exists on the site. Occasionally depressional storage is easily visible from the contours. Substantial surface storage can reduce or prevent runoff from common storms like the 3-year or 5-year events. This storage should be accounted for in the pre-improvement runoff calculations.

After establishing the pre-improvement conditions, compute the pre-improvement runoff for the required storms. For discharges to closed basins you will have to compute runoff volume in addition to flow rates. Refer to the DDG for additional information.

7.0 Post-improvement Conditions

The post-improvement conditions are generally the conditions of the property after the man-made changes. The post-improvement runoff will be limited to pre-improvement runoff comparing each storm event (frequency & duration). Appendix D contains sample calculations. In addition to the runoff limitations, there are several issues listed below that can potentially affect the Department's facilities. Some may involve a detailed evaluation of the Department's drainage facilities.

Water quality	Section 7.0
Offsite runoff	Section 7.0
Diversions	Section 7.0
Connections to storm drains	Section 7.1
Tailwater	Section 7.2
Peak pond stage relative to inlet elevations	Section 7.3
Changed inflow patterns	Section 7.4

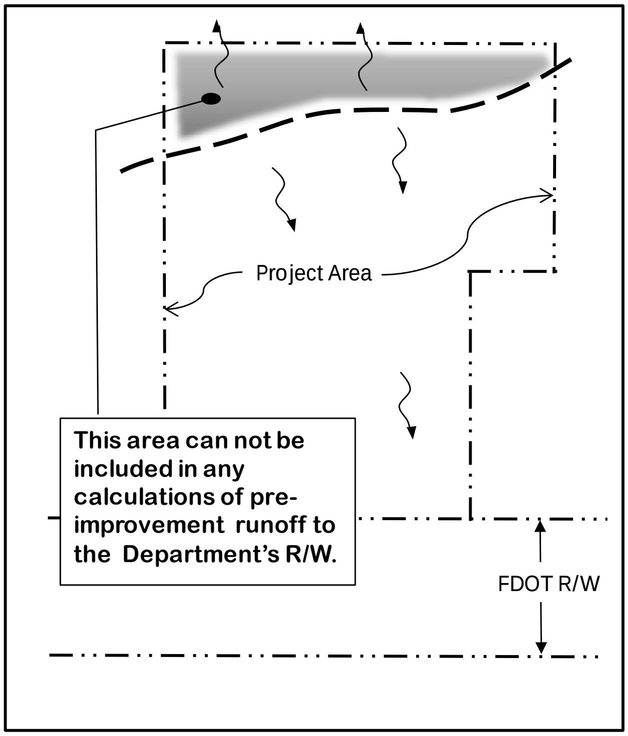
Throughout Section 7 there is reference to certain Department drainage documentation. Refer to Section 8.2 for a discussion of available Department documentation.

Incorporate water quality aspects in the design. Although the basic requirement is to not exceed pre-improvement runoff, the plans and calculations should reflect that water quality standards are met. The water quality standards are established by local government, the appropriate water management district or the Florida Department of Environmental Protection.

Offsite runoff must be collected and conveyed through the site. Offsite runoff that currently drains through the site must not be blocked or re-directed in a harmful manner. It can be commingled with the site runoff and incorporated in the site's treatment and attenuation system. Another option is to convey it around the site in a bypass pipe or swale system to its original watershed. Changing the conveyance can change the travel time and time of concentration. This can increase the peak runoff and should be accounted for in the design.

Be careful with diversions. Occasionally you may find it desirable to divert small portions of the site that drain away from the Department's right of way in the pre-improvement condition, to the Department's right of way in the post-improvement condition. This should be avoided to the fullest extent practical because it will change the historical drainage pattern. However, small diversions are usually acceptable as long as the post-improvement runoff is limited to the runoff from the area draining to the Department's right of way in the pre-improvement condition. This may be difficult where the Department's stormwater facility discharges to a closed basin, because the runoff volume equivalent to that from the diverted area will need to be retained on site.

Figure7-1



7.1 Connections to the Department's Storm Drain System

If proposing to connect to the Department's storm drain system, an additional constraint may apply. The post-improvement runoff rate to the storm drain may be limited to the pre-improvement Rational Method runoff for the design frequency of the storm drain[2], typically a 3-year event. The Department's Drainage Manual provides the standard design frequencies. For example: if the pre-improvement Rational Method runoff is four cubic feet per second (cfs) for the storm drain design frequency, then no more than four cfs can discharge directly to the storm drain pipe or inlet for any storm event. All runoff greater than four cfs would need to be conveyed overland to the gutter as in the pre-improvement condition.

Limiting the post-improvement runoff to the pre-improvement runoff of a single frequency event is necessary because roadways with storm drain systems have two means of conveyance: the storm drain pipes and the gutter. The inlet capacity controls the distribution of flow between the pipes and the gutter. In the pre-improvement condition runoff flows over the sidewalk to the gutter. The nearest downstream inlet may not be sufficient to capture extreme event runoff and bypass occurs to inlets farther downstream. This bypass could occur even if the hydraulic gradient in the pipe is below the gutter. If limited inlet capacity creates bypass, the hydraulic gradient does not reflect flows greater than the inlet

[2] In certain situations, district staff will accept runoff from greater storm events to the storm drain system. These are typically situations where runoff over the sidewalk is felt to create a greater nuisance than potential impacts to the system hydraulics.

can capture. The bypass would continue in the gutter to an inlet that has capacity or to a sag location before entering the pipe.

If in the post-improvement condition extreme event flows are directed by pipe to the structure bottom of the nearest inlet, the flow to the structure could be greater than the inlet could capture. This would increase the hydraulic gradient in the pipe segment downstream of the inlet and possibly farther downstream. In some cases, this additional flow may not create a problem downstream. In other cases, adding the flow to the upper end of a system changes the hydraulics enough to create or worsen flooding to an adjacent property.

The Rational Method should be used to compute the storm drain design event runoff rate because it is consistent with the Department's approach to storm drain design. The computed runoff will establish the allowable discharge rate to the storm drain. Determine the site area draining to the proposed connection location and calculate the design event pre-improvement peak flow to this point. If the site spans several of the Department's inlets, be careful of changed inflow patterns (See Section 7.4). Avoid using the areas noted on the Department's storm drain tabulations because these include roadway area and possibly other adjacent properties.

The issue of limiting the flow to the design frequency of the Department's facility does not apply to connections to roadside ditches, because the ditch is the only means of conveyance compared to storm drain systems that have pipe and gutter conveyance.

7.2 Tailwater Considerations

As with any stormwater management system, consider how the downstream conditions will affect the operation of the site's stormwater management system. For projects involving a drainage connection, the Department's stormwater facilities will usually create the downstream conditions or tailwater for the project.

For connections to roadways with curb and gutter, the tailwater is typically created by the hydraulic gradient in the storm drain system. For connections to rural roadways, the tailwater is typically the flow depth in the roadway ditch.

> Historically, the concern has been that a realistic high tailwater was not considered during design. Then once constructed the site's stormwater pond overtops the berm or flows out of an inlet and discharges in an uncontrolled manner. This is not acceptable.

7.2.1 Worst Case High and Low Tailwater

One common approach of designing for appropriate tailwater conditions is similar to a sensitivity analysis. Two conditions are evaluated: a high and a low tailwater. The low tailwater is used to check that pre-improvement rates are not exceeded because low tailwater will result in the highest discharge from the site's stormwater pond. The high tailwater is used to check the peak pond stage, but not necessarily discharge, because high tailwater will result in less discharge than the low tailwater condition. The peak stage of the high tailwater condition is compared to the berm and low inlet elevations to ensure the pond does not discharge in an uncontrolled manner.

Low tailwaters can be set at an arbitrarily low level like zero or below any adjacent pipe inverts. Worst case high tailwaters can be estimated as described in Table 7.1.

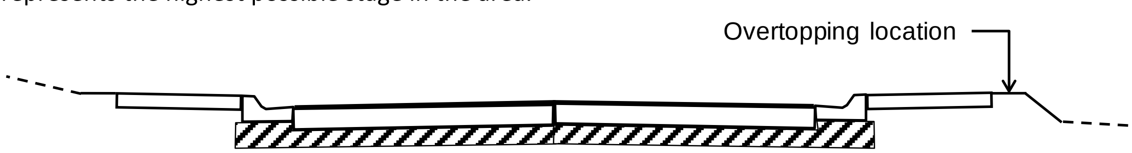
When using the worst case high tailwater, it may not be necessary or reasonable to apply this to all storm durations. If the site is located in the upper part of a watershed the tailwater of the Department's system will be the result of conveyance limitations of the storm drain pipes or the roadside ditches. At these locations the Department's systems are burdened by high intensity, short duration events. Long duration events such as the 1-day and longer do not have intensities that would create worst case tailwaters at these locations. For sites located in these areas, it is reasonable to use the worst case high tailwater for the short duration storms, perhaps up to the 8-hour.

> Example:
> A site in Flagler Beach (Zone 5) is proposing to discharge to a storm drain system at a point where the time of concentration in the system is 20 minutes.
>
> The 100-year, 20-minute intensity is 7.3 inches per hour (IPH) in Zone 5, so the 100-year peak tailwater in the system occurs when the rainfall intensity is approximately 7.3 IPH.
>
> The 100-year, 1-day rainfall in Flagler Beach is 12.5 inches which yields a peak intensity of 0.46 IPH based on the Department's 24-hour rainfall distribution.
>
> 0.46 IPH < 7.3 IPH, so the 100-year, 1-day storm event cannot produce the peak tailwater condition at this site.

If the site is located near the bottom of a watershed, near a larger river system, or near a large flat low-lying area, high tailwater would result from long duration storms. In these cases the conveyance capacity of the Department's storm drain and roadside ditches would play a small part in the establishment of the tailwater. For sites located in these areas, use the worst case high tailwater with long duration storms.

If the high and low tailwater approach is too conservative or you are not comfortable with the simplification, evaluate the Department facilities to determine the tailwater for various frequencies. This is fairly easy for roadside ditches but is more complicated for storm drains. See the following section for a discussion of evaluating the Department's facilities.

Table 7-1

<table>
<tr><th colspan="3">Worst Case High Tailwaters</th></tr>
<tr><th>Connection Location</th><th>High TW Elevation</th><th>Comment</th></tr>
<tr><td>Roadside ditches with no history of flooding.</td><td>Lower of a) outside edge of travel lane or b) top of ditch at or near right of way.</td><td>Note 1.</td></tr>
<tr><td>Storm drains where road is on continuous grade.</td><td>Top of curb.</td><td>Note 2.</td></tr>
<tr><td>Storm drains where road is at a sag.</td><td>Overtopping elevation behind sidewalk.</td><td>Note 3.</td></tr>
<tr><td>Close proximity to a Department stormwater pond.</td><td>100-year stage of the pond.</td><td>Note 4.</td></tr>
<tr><td>Close proximity to cross drain culverts.</td><td>100-year headwater for the culvert.</td><td>Note 5.</td></tr>
<tr><td colspan="3">Notes:</td></tr>
<tr><td colspan="3">1. This is based on the Department’s cross drain criterion requiring flood free travel lanes for the 50-year event on high-use facilities. Stage of 100-year event is typically not much higher in a roadside ditch, so this is reasonable to use for all events.</td></tr>
<tr><td colspan="3">2. The hydraulic gradient could be as close as 1’ below gutter for the 3-year event (10-year for interstate) when junction losses have not been computed. So when junction losses are considered, the HGL could be less than 1’ from the gutter anywhere in the system. Using top of curb is reasonable worst case tailwater for the 100-year event because the gutter & roadway can convey substantial flow even if full pipe capacity is reached. Example: Pavement at 0.02 cross slope and 1.5% longitudinal slope conveys approximately 15.5 cfs at top of curb.</td></tr>
<tr><td colspan="3">3. In sags runoff cannot continue downstream except through the pipe. The overtopping elevation represents the highest possible stage in the area.

</td></tr>
<tr><td colspan="3">4. If there are minimal conveyance facilities between the pond and the connection, the peak stage in the pond is a reasonable high TW. The peak pond stage should be available in the Department’s documentation.</td></tr>
<tr><td colspan="3">5. Cross drain headwater elevations should be available in the Department’s documentation.</td></tr>
</table>

7.2.2 Evaluating the Department’s Facilities to Determine Tailwater

Evaluating the Department’s system has the added difficulty of obtaining the pertinent information about the watershed and the Department’s systems. Historical drainage maps, calculations, and old as-built plans will provide most of this data, but these are not always available. Another concern is that the department’s conveyance systems are usually designed for one frequency so the Department’s calculations will not likely have stages for multiple storm frequencies. Regardless of these issues, evaluating the Department’s facilities may sometimes be the most practical option.

Roadside Ditches

This involves determining the flow rates and depths in the ditch. The Department’s drainage maps or contour information from local governments or the water management districts can be used to define the drainage basin area. Use the rational method to compute runoff. Typically, normal depth computations are sufficient. Chapter 2 of the Drainage Manual contains the standard format table for roadside ditch calculations that can be used for typical ditch calculations. The DDG Open Channel Chapter provides additional guidance for ditch calculations.

If the connection is close to the upstream side of a side drain pipe, culvert calculations should be performed to determine the upstream water surface (headwater) elevation. One option is to calculate the flow depth and, if appropriate, the culvert headwater of the 100-year event and use this as the worst case high tailwater. Then evaluate the site with a high and low tailwater as discussed in the previous section. Another approach is to determine the flow depths for various frequencies to create a rating curve. When evaluating the flow depths in ditches, do not rely solely on the original plans for the ditch configuration because the existing ditches and side drain pipes may be silted and partially clogged.

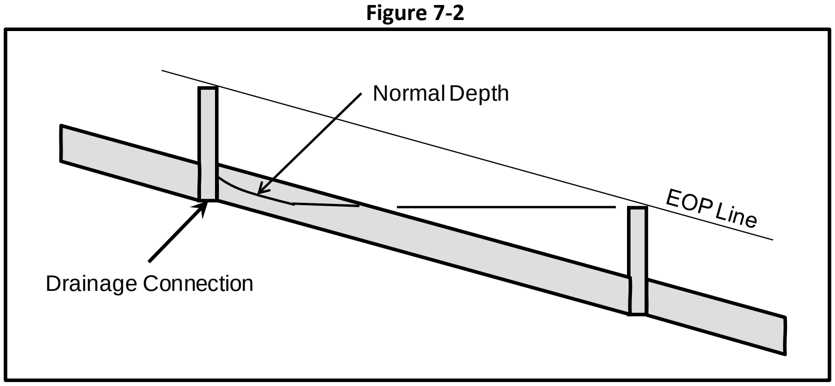
For drainage connections near cross drain culverts, assuming normal flow depth in the ditch may not be reasonable because the flood stages at the cross drain can be higher than normal depth in the ditch. Using the 100-year flood stage at the culvert as noted in the previous section or evaluating the cross drain hydraulics for several storm frequencies to determine a rating curve would be acceptable.

Storm Drains

Evaluating storm drains involves obtaining or re-creating the Department's storm drain tabulations to determine the hydraulic gradient in the system. The Department's calculations will usually be limited to the Department's standard design frequency and the system will need to be evaluated for other storm frequencies. There are proprietary software programs that can be used or the Department's DDG Storm Drain Chapter provides guidance for manual calculations. As noted for roadside ditch connections, you could evaluate only the 100-year event and use the hydraulic gradient as the worst case high tailwater. You could also evaluate several storm events to establish a rating curve.

There is a situation where you may not need to evaluate the entire system. In steep terrain the upper end of a storm drain system often operates with partially full pipes. If this situation exists, then normal flow depth in the pipe would be a reasonable estimate. Crown of pipe would be a conservative hydraulic gradient estimate in this situation. The upper end of these systems is probably flowing partially full if the pipe invert at connection location is higher than the pavement elevation at the downstream inlet. See Figure 7-2.

Figure 7-2



7.3 Peak Pond Stage versus Inlet Elevations

Compare the peak pond stage to the low inlet or “pop-off” elevation.

As noted in the tailwater discussion, uncontrolled discharge is unacceptable. Ultimately, the peak stage needs to be compared to the lowest elevation along the perimeter of the site. When possible, the Department suggests including a safety factor of 1-foot of freeboard in the pond. This may not be an issue if the flow out of the inlet is designed and accounted for in the calculations, but occasionally the flow is overlooked.

7.4 Changed Inflow Patterns

The Rule requires that changes to inflow patterns not threaten the safety and integrity of the Department right of way [14-86.003(2)3]. This generally means you must demonstrate that the Department’s drainage criteria are still met. The Department’s Drainage Manual contains the specific criteria. The May 2019 version of the Drainage Manual has been incorporated by reference as part of the Rule and is available from the Department’s web site. The pertinent chapters are listed below:

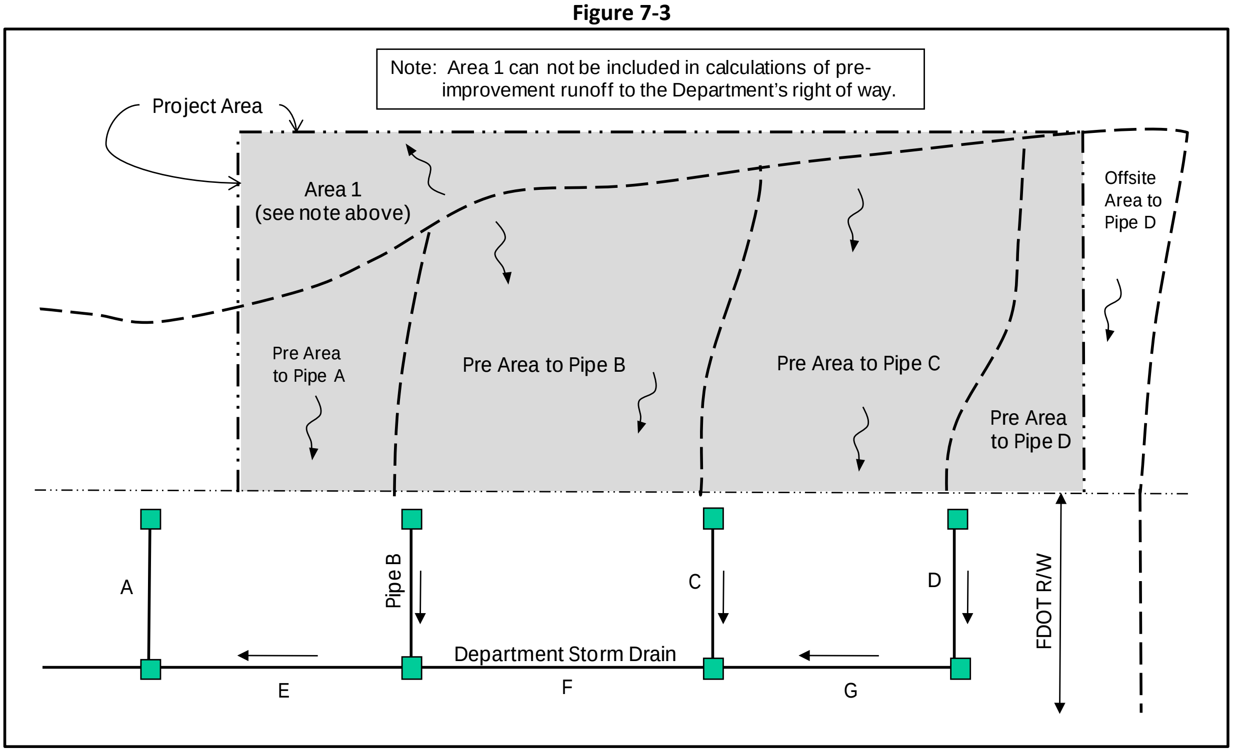
Chapter 2	Open Channels
Chapter 3	Storm Drain Hydrology and Hydraulics
Chapter 4	Cross Drain Hydraulics
Chapter 6	Optional Culvert Materials

Although many conditions could impact the Department’s facilities, two common situations of concern are projects that span several storm drain inlets and projects that span a long section of roadside ditch. These are discussed in the following sections.

7.4.1 Project Frontage Spans Several Inlets

Figure 7.3 shows the pre-condition of a site where the frontage encompasses several inlets and stub lines (laterals) of a Department storm drain system. If the post-improvement discharge is directed to only one pipe, the safety and integrity of the Department's facilities could be compromised. Discharging the entire site's pre-improvement runoff rate to Pipe B would exceed pre-improvement discharge to Pipe B and possibly cause runoff to pop-out of the inlet of Pipe B increasing the spread on the roadway. An even greater impact would occur if the entire site's pre-improvement runoff rate is discharged to Pipe D. This would increase the runoff to pipes D, E, F, and G.

Figure 7-3



If the post-improvement discharge is directed to only one pipe, the discharge would be limited to the pre-improvement discharge to that pipe. Another approach is to discharge to several pipes, but limit the post-improvement discharge to each pipe to the pre-improvement discharge to each. A less desirable approach is to re-evaluate the entire storm drain system and demonstrate that the system still meets Department criteria even with increased flow at a certain location.

The situation of a site spanning multiple inlets could also create an issue if flows are discharged over the sidewalk. In the pre-condition the site's runoff sheet flows to four inlets. Concentrating this near one inlet, even through a wide flume, could increase the spread on the roadway, exceed inlet capacity, and violate the Department's spread criterion near the discharge point.

There are two other items worth noting about the situation in Figure 7.3. First, Area 1 does not drain to the Department and cannot be included in any pre-improvement runoff calculations. Second, if any portion of the offsite area to Pipe D drains through the site in the pre-condition, the proposed site plan must accommodate this runoff. See discussion of offsite runoff in Section 7.0.

7.4.2 Project Frontage Spans Extended Length of Roadside Ditch

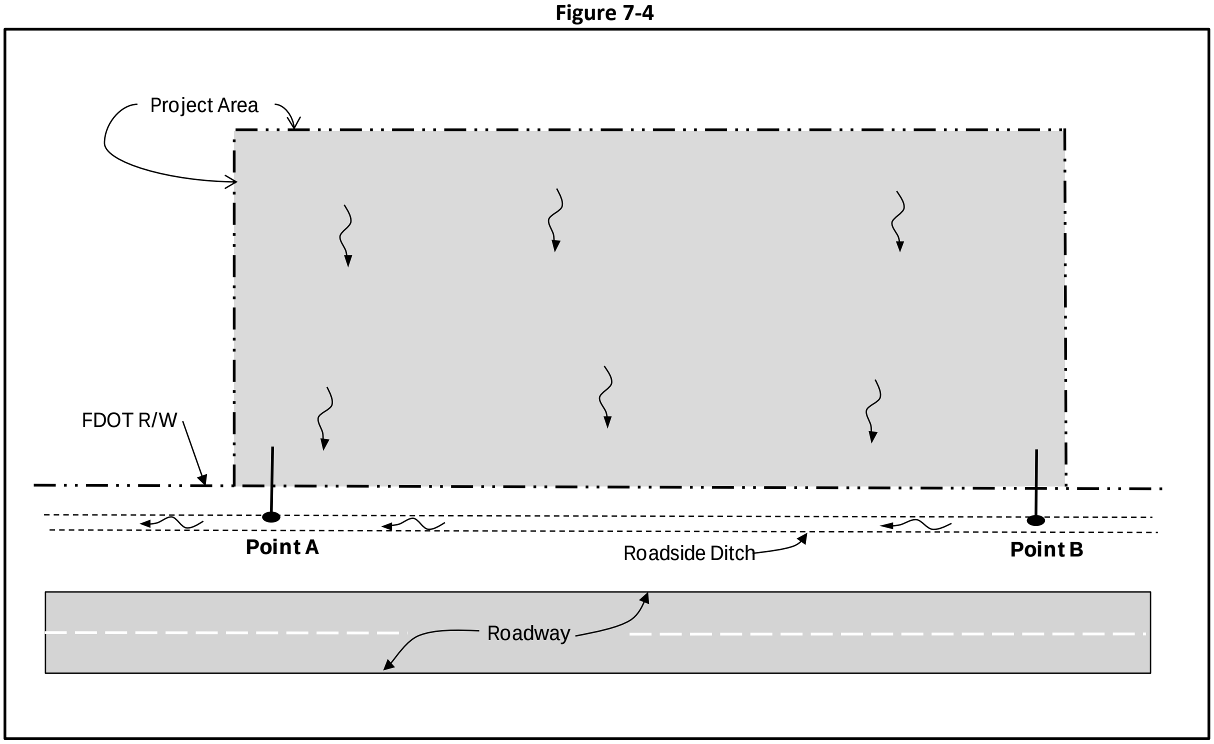
Usually a site improvement will use a pipe connection to a roadside ditch, thus changing the flow pattern from sheet flow over the entire frontage to a point discharge. This can create two issues: increased flow depth in the ditch and erosion at the outlet.

Potential Increased Flow Depth

Figure 7.4 shows a site that discharges to a roadside ditch. If the post-improvement connection is proposed near the downstream property line at Point A, the flow depths should not increase, because the flow rates at any point along the frontage would be less than or equal to the pre-condition.

Point discharges to roadside ditches should be made at the downstream end of the ditch.

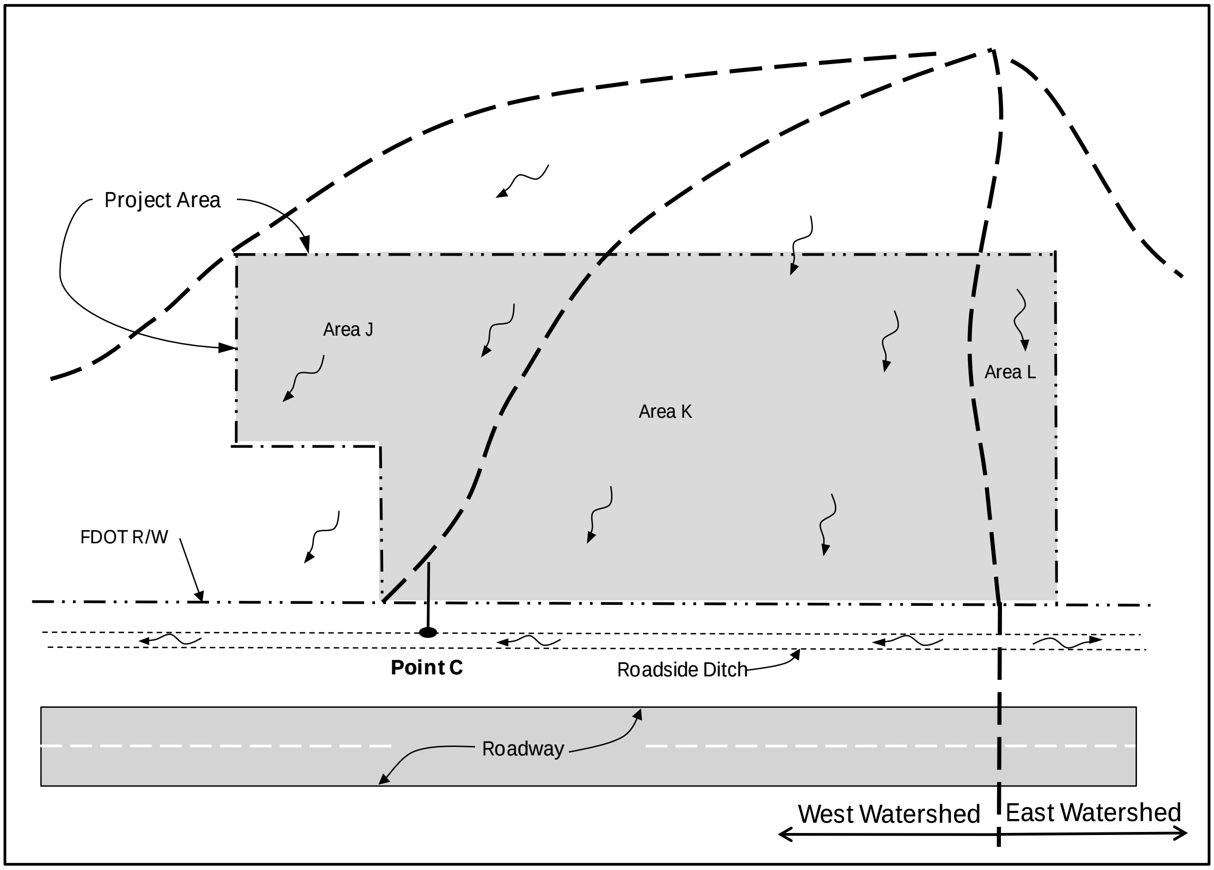
Figure 7-4



If the proposed connection is made closer to the upstream end of the ditch at Point B, the flow depths would be greater between the connection and the downstream side of the property and this could compromise the safety and integrity of the Department's facilities.

Figure 7.5 shows a slightly different configuration of a site adjacent to a roadside ditch and presents a few other issues.

Figure 7-5



The site is located near a high point and drains to two watersheds, with most of the project draining to West Watershed. Draining the entire site's post-improvement runoff to Point C could increase flow depths in the ditch and compromise the safety and integrity of the Department's facilities. The post-improvement discharge at Point C would need to be limited to the pre-improvement runoff from Area K to avoid increasing the flow depth in the roadside ditch.

The post-improvement runoff from Area J can be directed to Point C without increasing flow depths only if attenuation is provided to limit the Point C discharge to the pre-improvement runoff from Area K.

Special consideration should be given to the post-improvement runoff from Area L. Area L currently drains to the East Watershed. Diverting this to the West Watershed changes the historical drainage patterns. This may be readily handled by proper attenuation if the West Watershed has a positive outlet. If the West Watershed is a closed basin and Area L is proposed to discharge to it, the runoff volume from Area L would need to be retained on site.

Finally, increased flow depths in the ditch may be acceptable if you evaluate the entire ditch section and demonstrate that Department criteria are still met.

Potential Erosion at Pipe Outlet

Concentrating runoff that once sheet flowed over the entire frontage can threaten the safety and integrity of the Department's facilities. There may be erosion at the invert of the outlet pipe or erosion of the roadway embankment across from the connection pipe due to the "jet effect" of the exiting flow.

Check the outlet velocity for the 10-year event; this is the standard design frequency for the Department's roadside ditches. Assume a low tailwater condition unless the timing of the peak discharge from the site coincides with a high tailwater in the ditch. Even peak stages in the ditch can be low enough to allow critical depth velocities in drainage connection pipes. Critical depth velocities at culvert outlets can be in the range of 10 to 20 feet per second[3]. For grassed roadside ditches, where the pipe outlet velocities exceed the values for sod in Chapter 2 of the Drainage Manual, a riprap rubble apron at the outlet will typically suffice. Other methods of erosion control include the use of energy dissipation structures or inline drops in the drainage pipes. Outlet pipes should be terminated at the bottom of the receiving ditch, not high up the slope where the erosion potential is high. Figure 7-6 illustrates the consequence of terminating a pipe high on a slope.

Figure 7-6

For paved ditches, the momentum of the flow in the connection pipe can result in high velocities being maintained across the ditch and directed at the front slope of the road. In this case a concrete pad opposite the connection pipe may be needed to avoid erosion.

In consideration of concrete pads and other means to address high outlet velocities, avoid placing structures in the right of way that would be considered obstructions within the clear zone. The clear zone is a relatively flat unobstructed area that is to be provided for safe use by errant vehicles. Refer to the Roadside Safety Chapter of the FDOT Design Manual for additional information about clear zone issues.

For large sites or any site with high discharge rates, it may be necessary to use multiple pipes to reduce the velocity.

[3] Ref: FHWA Hydraulic Engineering Circular No.14.

7.5 Pipe Materials and Construction Methods

Pipe Material

Any pipe within the Department's right of way will be maintained by the Department as noted in the general permit conditions. As such, the connecting pipe material shall meet the requirements for pipe constructed as part of the Department's facilities. Chapter 6 of the Drainage Manual provides the design service life for various pipe applications and the evaluation process. The Culvert Service Life Estimator (CSLE) can be used to help determine service life and structural capability of the pipes. https://csle.fdot.gov

If you are proposing to connect to a storm drain that was constructed after 2000, using the same pipe material as the storm drain will usually be sufficient because the constructed storm drain likely meets the service life requirements. Confirm this with district staff.

Pipes connecting to roadside ditches can be considered side drain pipes for the purpose of design service life. Side drains have the lowest design service life (25 years), thus any of the allowable pipe materials will provide this service life for most situations.

Construction Methods

The general permit conditions require that all work within the Department's rights of way comply with latest Department standards and specifications. Some issues to be aware of are cover requirements (Drainage Manual, Appendix C), maximum skew angle for entering pipes (Index 425-010), pipe elevation relative to inlet tops, and details of standard drainage structures. In addition to the Department's standard plan indexes, the DDG provides other guidance particularly for pipe elevation relative to inlet tops.

The Department's specifications also require that precast concrete products be inspected during fabrication at the fabrication facility. The precast companies and the Department have a standard process for the inspections when they know a structure will be placed in the Department's right of way. To address this, identify in the construction plans, either as a note or in the structure tabulation the structures that will be placed in the Department's right of way.

7.6 Closed Basin Pond Recovery

There are several soil parameters that affect the groundwater flow or infiltration of retention ponds. The Rule requires that in watersheds without positive outlets, half of the retention volume must recover in seven days and all of it in 30 days [14-86.003(2)(c)3]. Refer to the Department's DDG for all stormwater management facility parameters for retention pond considerations.

8.0 Application Process

8.1 Pre-application Meeting

Pre-application meetings will be accommodated upon request but are not essential.. Often a phone call will suffice for pre-application coordination. Drainage related questions are usually answered by the drainage department at the district office, but often the maintenance personnel are experts in the drainage connection process. Some drainage related issues that may be worth discussing are Department documentation, existing and proposed flow patterns, possible diversions, drainage design methods, and handling of offsite runoff.

Certain improvements may require input from specialists outside the field of drainage; nevertheless, the primary contact should be with the local field office where you file the application. They will coordinate with the appropriate Department personnel or direct you to them.

8.2 Department Documentation

The Department may have substantial information about its drainage facilities depending on how recently the road was improved. Recently improved roadways will typically have more thorough drainage documentation. Items that may be available are listed below:

Drainage Maps:	Drainage maps are sometimes included in the construction plans, but may be filed separately. In addition to drainage basin areas, the maps usually contain flood data (stages and flows) for the cross drains on the project.
Construction Plans:	These would contain the information about the Department's conveyance systems (structure details, pipe sizes, etc) and stormwater ponds. They may provide the peak pond stages.
As-Built Plans:	These are usually kept in the local field office and would note any construction changes to the design.
Storm Drain Tabulations:	These may be filed separately or with the drainage documentation. They provide the flows and hydraulic gradient in the storm drains, as well as pipe and invert information.
Drainage Documentation:	This can be a substantial amount of data containing calculations for such things as cross drains, spread, ditch flows, floodway evaluations, and optional pipe materials. It may also contain storm tabulations and drainage maps.
Right of Way Maps:	These identify such things as roadway right of way limits, drainage easements, access easements, and former borrow areas. The local field office usually has copies and the District Right of Way office will have the originals.

The information obtained from the Department should be field verified, especially that which is critical to the project's design. For example, the construction plans may depict drainage features or drainage patterns that existed prior to nearby developments. These developments may have changed certain features adjacent to or within the Department's right of way. Another example is existing roadside ditches and pipes that have become silted and partially blocked.

It may take up to 14 days to obtain requested information. For security reasons, certain documents such as bridge plans may not be available unless you complete the Department's Exempt Documents Request Form 050-020-26. The form is available from the Department's web site at: https://fms.fdot.gov/Form

8.3 Issues That May Complicate the Process

Improvements that discharge to the Interstate right of way also require review by the Federal Highway Administration (FHWA). These permits are sent to the Tallahassee FHWA office for review and approval. This could add time to the review process.

Projects that involve more than a drainage connection such as projects with turn lane additions or changes to the Department's roadway will involve a driveway connection permit and can add complications to the permitting process. Adding or lengthening turn lanes can reduce the treatment and conveyance capacity of the Department's roadside ditches. In curb and gutter sections, additional runoff from new turn lanes can affect the storm drains and spread on the road. Appropriate design verification or redesign will be required to assure compliance with Department standards and with any existing permits the Department has with other regulatory agencies. Provide documentation that addresses these issues with the driveway connection permit. You may need to modify the Department's active permits with the regulatory agencies and submit appropriate as-built certifications to these agencies after construction.

If the project involves a right of way exchange, donation, or relocation, the process is complicated and often more time consuming than obtaining approval for the drainage connection. Coordinate with the Department to obtain conceptual approval of the right of way revisions before applying for the drainage connection permit.

8.4 Application Submittal

Refer to the Department's One Stop Permitting site https://osp.fdot.gov to obtain an application form and to determine the local field office where the application package shall be submitted.

The application form contains a list of required attachments. Appendix C provides additional information about the form and attachments.

Complete the form, prepare the necessary supporting documentation with original signatures and licensed professional seals to the appropriate local field office. They will log the application in and usually send it to the district drainage office for technical review, although certain local field offices will do the technical review. Reviews are usually completed and requests for additional information, if necessary, are sent in less than 30 days.

8.5 Permit and Construction

The permit is approved when a Department representative signs Part 7 of the application. Read and be familiar with the permit's general and special conditions. General conditions are contained in Part 6 of the application and special conditions are noted in Part 7. In particular, be aware that you must notify the Department 48 hours before starting any work authorized by the permit. Construction must begin within one year or the permit expires, unless you file a written request for time extension in accordance with the general permit conditions.

Constructing a pipe to a Department storm drain system may involve work within the travel lane. Coordinate with the Department's local field office to ensure that the appropriate Department Standard for Traffic Control through Work Zones (Index 102 Series) is used.

Small to moderate changes during construction can be handled as part of the as-built certification process. If potentially significant changes to the design concept occur during construction, please discuss these with the Department. District staff may be able to offer other solutions to the issues.

Within 15 days of project completion submit the As-Built Certification, which is part of the application form.

Appendix A

District Offices

District Offices:

District 1: 801 N. Broadway Street
Bartow, FL 33830-3809
(863) 519-2201

District 2: 1109 South Marion Avenue
Lake City, FL 32025-5874
(386) 961-7800

District 3: Highway 90 East
Chipley, FL 32428-0607
(850) 638-0250

District 4: 3400 West Commercial Blvd.
Ft. Lauderdale, FL 33309
(954) 777-4110

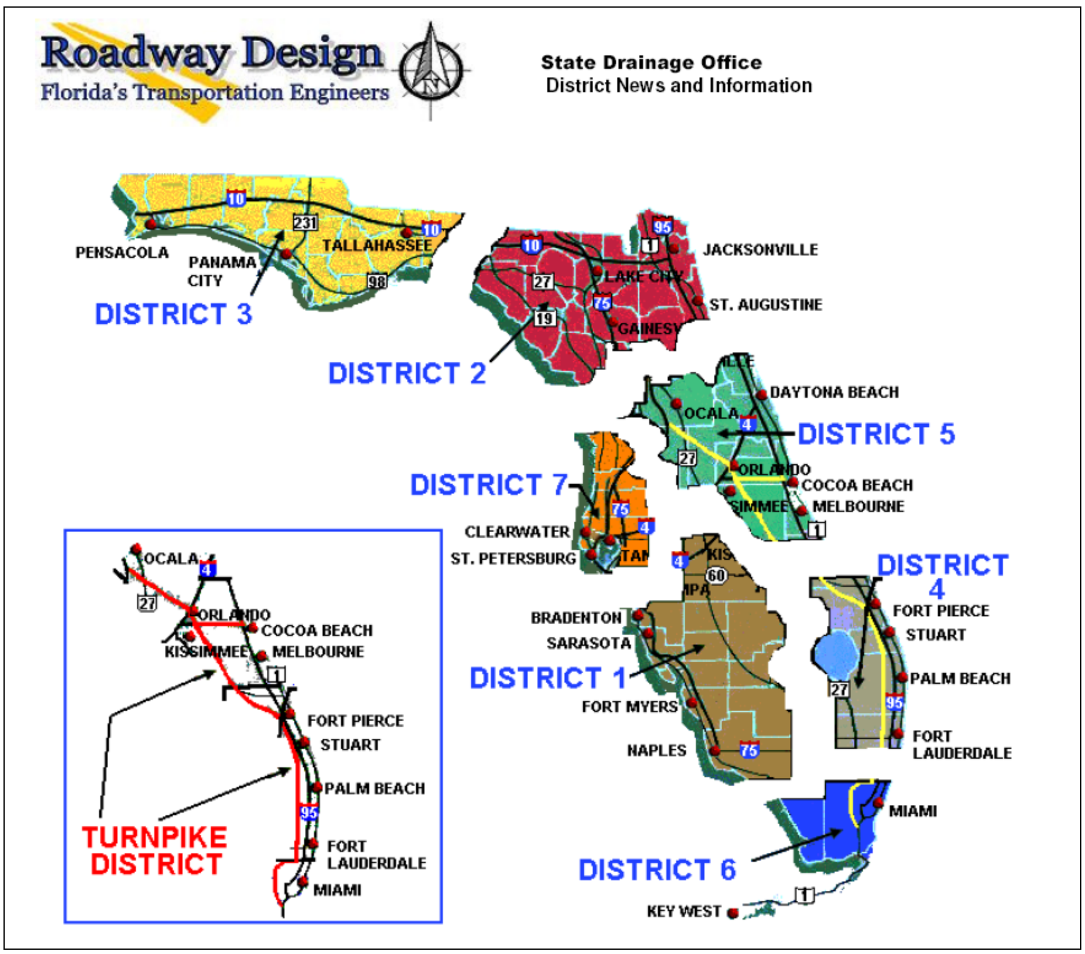
District 5: 719 S. Woodland Blvd.
DeLand, FL 32720
(386) 943-5000

District 6: 1000 N.W. 111 Avenue
Miami, FL 33172
(305) 470-5197

District 7: 11201 N. Malcolm McKinley Dr.
Tampa, FL 33612-6403
(813) 945-6000

Turnpike: Pompano Operations Center
Ft. Lauderdale, FL 33310
954-975-4855

Applications shall be submitted to the appropriate local field office identified at the Department's One-Stop Permitting Site. https://osp.fdot.gov



Appendix B

14-86 Exception Questionnaire

14-86 Exception Questionnaire

Applicant:	Project Name:

Does the project need a Drainage Connection Permit?

First, the project must be regulated by Rule 14-86 F.A.C. to require a permit. If regulated, and the project does not qualify for an exception, you will need a drainage connection permit. The following questions will help determine if the project is regulated and if it qualifies for an exception under the rule.

Is the project regulated? ***Note: Only stormwater flows are regulated under 14-86, not dewatering or groundwater flows.***

1	Are you proposing to make changes to the property or have changes already occurred since November 12, 1986?	Yes ☐	No ☐
2	Does the property share a boundary with FDOT right of way?	Yes ☐	No ☐

If "Yes" to questions 1 and 2, the project is regulated and it will either qualify for an exception or require a drainage connection permit.

Does the project qualify for an exception? There are four (4) categories of exceptions. Please indicate below which categories you believe are appropriate. You may need to answer several of the following questions to determine the appropriate category and then return here to note it.

3	14-86.003(3)(a): Improvements to property that does not drain, either directly or indirectly, to the Department's right of way.	☐
	14-86.003(3)(b): Single family residential improvements.	☐
	14-86.003(3)(c): Agricultural and Silvicultural improvements.	☐
	14-86.003(3)(d): Minor improvements.	☐

14-86.003(3)(a): Improvements to property that does not drain, either directly or indirectly, to the Department's right of way for all of the required 14-86 storms.

4	In the pre-improvement condition, does the entire site drain away from FDOT?	Yes ☐	No ☐
5	In the post-improvement condition, will the entire site drain away from FDOT?	Yes ☐	No ☐

If "Yes" to questions 4 and 5, the project qualifies for an exception; but if the project does not qualify for an exception under another category, the Department would like to verify the exception under this category and requests you provide assurances by submitting a complete permit application package.

14-86.003(3)(b): Single family residential improvements.

6	Is the improvement a single family residence that is not part of a larger common plan of improvement or a larger common plan of sale?	Yes ☐	No ☐

If "Yes" to question 6, the improvement qualifies for an exception.

14-86 Exception Questionnaire

Applicant:	Project Name:

14-86.003(3)(c): Agricultural and Silvicultural improvements.

7	Is the project an agricultural or silvicultural improvement subject to regulation by the Florida Department of Environmental Protection or a regional Water Management District?	Yes ☐	No ☐
8	Is the project an agricultural or silvicultural improvement that is exempt under the provisions of Section 373.406?	Yes ☐	No ☐
9	Is the project an agricultural or silvicultural improvement that will implement applicable best management practices adopted by the Florida Department of Agriculture and Consumer Services in Rule 5M, F.A.C., or Rule Chapter 51-6, F.A.C.?	Yes ☐	No ☐

If "Yes" to any one of questions 7, 8, or 9, the project qualifies for an exception.

14-86.003(3)(d): Minor improvements.
These projects are felt to be small enough that they will not have a substantial impact to the Department's facilities and would not create an unreasonable burden on lower property owners.

10	Does the post-improvement condition have a total impervious area (new impervious and existing to remain) less than 5000 square feet?	Yes ☐	No ☐
11	Is the post-improvement total impervious area (existing to remain and new impervious) less than 40% of that portion of the property that drains to the Department's right of way in the pre-developed condition?	Yes ☐	No ☐
12	Will the improvement keep any existing drainage connection as it exists, i.e. not alter or modify existing drainage connections?	Yes ☐	No ☐
13	Will the stormwater flow patterns from the improvement to the Department's right of way remain unchanged?	Yes ☐	No ☐
14	Will the surface area draining to the Department's right of way remain unchanged or be reduced?	Yes ☐	No ☐
15	Does the property drain to a Department stormwater facility that has a positive outlet?	Yes ☐	No ☐
16	Does the improvement represent the entire improvement for the site, i.e. it is not part of a larger common plan of improvement or sale?	Yes ☐	No ☐

If "Yes" to all questions 10 through 16, the project qualifies for an exception.

Signature: *	Date:

***Signature shall be a licensed professional except for a minor improvement project that would otherwise not require a licensed professional. In this case, the applicant's signature with local building permit application information provided will be sufficient.**

An exception shall not apply if the drainage connection threatens the safety and integrity of the Department's facilities, creates an unreasonable burden on lower property owners, or causes violations of water quality standards [14-86.003(4)].

Appendix C

Typical Submittal Information

Contents

Contents

1.0 Less submittal information for certain minor projects, 14-86.004(4):

Soils information, calculations, and licensed professional certification are not required for certain minor improvements projects that do not meet all of the criteria for an exception. For example, a project would not qualify for an exception because it creates or alters a drainage connection to the Department's right of way, but has minimal potential impact to the Department or other downstream properties. The project must comply with the requirements of 14-86.003(3)(d)1 and 14-86.003(3)(d)4 which are summarized by the following three conditions. If your project meets these conditions, soils information, calculations, and licensed professional certification are not required.

- The post-improvement total impervious area (new impervious and existing to remain) is less than 5000 square feet.
- The post-improvement total impervious area is less than 40% of that portion of the property that drains to the Department's right of way in the pre-improvement condition.
- The property drains to a Department stormwater facility that has a positive outlet.

The following is provided as supplemental information to the required attachments listed on the application form. The list is intended to be flexible and should not be taken as an absolute requirement for all projects.

2.0 Attachments

2.1 Legal Description: Certified by professional land surveyor.

2.2 Photographs of the pre-improvement existing conditions [14-86.004(3)(c)]: These are preferred as color on 8.5" x 11" paper and should include:

- For all sites, a picture looking in each direction (North, South, East, and West) from the property.
- For all sites, photos of existing Department drainage facilities (inlets, ditches, side drains) near the property.
- For small sites, typically one or two other pictures from the road looking at the site will be sufficient.
- For large sites numerous pictures may be needed with appropriate descriptions.

2.3 Location Map [14-86.004(3)(a)]: This is typically included as one or part of the first sheets of the construction plans. The map shall be sufficient to show the location of the improvement and approximate location of the drainage connection (if one is proposed). The map shall identify the state highway number, the county, city (if applicable) and section, township and range.

2.4 Grading Plan [14-86.004(3)(b)]: This is basically the portion of the construction plans that affect drainage such as grading, stormwater conveyance and management. The plans shall be drawn to scale, be on no larger than 11" x 17" paper, and include the following:

2.4.1 Pre-improvement topography with contours and sufficient spot elevations. Contour information shall extend a minimum of 50 feet beyond the property boundaries. Where offsite runoff drains through the property to the Department's right of way the contour information shall be sufficient to define the watershed. It is realized that for large watersheds this information is better shown on drainage maps in the calculations package. Flat topography will need more spot shots than steep, especially where a drainage divide is identified.

2.4.2 Post-improvement grading with contours.

2.4.3 All Pre-improvement & Post-improvement drainage facilities on site.

2.4.4 All Pre-improvement & Post-improvement drainage facilities in the Department's right of way.

2.4.5 All Pre-improvement & Post-improvement impervious surfaces.

2.4.6 Proposed control structure details.

2.4.7 Detailed cross section of ponds.

2.4.8 Detailed cross section of drainage connection.

2.4.9 Reference to the appropriate vertical datum, whether NGVD 29 or NAVD 88.

2.4.10 If work is required in the Department right of way, include a plan note stating that all work within the Department's right of way shall conform to the most current Department Standards and Specifications.

2.5 Soils information and water table data [14-86.004(3)(d)]:

2.5.1 Soil borings.

2.5.2 Water table data: Observed and estimated Seasonal High Water Table (or Normal Water Table depending on the Water Management District).

2.5.3 In regions of the South Florida Water Management District (SFWMD), recommendations of soil storage estimates may be needed.

For sites using dry retention ponds, additional information will be needed to characterize the groundwater flow. This may include:

2.5.4 Identification of confining layers.

2.5.5 Horizontal hydraulic conductivity.

2.5.6 Vertical hydraulic conductivity.

2.5.7 Fillable porosity.

2.6 Calculations [14-86.004(3)(e)]:

The Department does not officially endorse or prohibit the use of any particular software. If proprietary programs are used, the input and output should be included in the application package.

2.6.1 Narrative: Explain the existing and proposed site conditions. Include a summary of results indicating pre-improvement and post-improvement rates (and volumes, if applicable). It will include discussion of both the site and work proposed in the Department's right of way.

2.6.2 Pre-application meeting minutes, if applicable.

2.6.3 Existing and proposed drainage maps if drainage patterns are not sufficiently defined on the grading / construction plans.

2.6.4 Areas and curve number values. Provide this for the total site area and that portion draining to the Department. Include copies of pertinent pages of National Resource Conservation Service soil books or internet pages to show Hydrologic Soil Group.

2.6.5 Rainfall depth values with reference to their source (i.e. NOAA Atlas 14, Department IDF curves).

2.6.6 Pre and post time of concentration calculations.

2.6.7 Pre-improvement runoff calculations.

2.6.8 Stage versus storage or stage versus area relationship of proposed ponds.

2.6.9 Treatment calculations.

2.6.10 Routing computations, input and results. Items like computational time increments and output print intervals need to be provided but vary with proprietary programs and are not listed here.

2.6.11 Basis for starting water surface of routing.

2.6.12 Dry retention pond recovery calculations, if applicable.

2.6.13 Pipe calculations internal to the site, if applicable, and any calculations necessary to show containment of the peak event on-site.

2.6.13 Connection pipe calculations: pipe size substantiated and outlet velocity to roadside ditches.

2.6.14 Exfiltration trench and/or underdrain calculations.

2.6.15 Tailwater evaluation. This could be an estimate of tailwater elevation or a discussion of assumptions.

2.6.16 Spread calculations. These may be required for those projects changing the inflow pattern over the sidewalk into FDOT gutters.

2.6.17 Ditch calculations. These may be required to determine tailwater or to evaluate changes to inflow patterns.

2.6.18 Side drain calculations or evaluations.

2.6.19 Department drainage maps or storm tabs.

2.7 Erosion and Sediment Control Plans

Appendix D

Sample Calculations

<u>Contents</u> <u>Page</u>

Example 1:

Drainage Calculations – Narrative

The project site is 2.90 acres of undeveloped woodlands adjacent to SR 36 in Walton County. The site will be improved with the construction of an office complex, associated parking, and a stormwater facility.

Most of the site (2.68 acres) currently drains to the roadside ditch of SR 36. There is an additional 0.42 acres of offsite area that drain through the property to SR 36. The SR 36 original construction plans (13560-3505), drainage documentation, and drainage map were obtained from the department to evaluate the ditch conditions. SR 36 drains to Farmington Creek which drains to Saltwater Bay, thus the watershed has a positive outlet.

In the post-improvement condition the entire site, including 0.22 acres that currently drains north away from SR 36 and the 0.42 acre offsite area, will be collected and conveyed to a wet-detention pond that discharges to the SR 36 roadside ditch. A 15 inch pipe on the east side of the property provides the connection.

Notes:

1) The sample calculations are intended to show the basic types of calculations commonly needed for a drainage connection permit. Some calculations such as Time of Concentration and bleed-down size determination may have other acceptable methods not shown here.

2) Water quality requirements vary between FDEP, individual water management districts, and local governments. The water quality requirements used here are not representative of a particular agency.

3) Proprietary computer program input and output are not included here, but would be required with permit calculations that use proprietary programs.

4) The Department's Drainage Design Guide provides additional information about pond design.

The pond is designed to provide water quality treatment in accordance with WMD requirements and limits the discharge to pre-improvement discharge for each of the Department's design storms. The peak stage in the pond occurs during the 100-year, 8-hour event. The results for this event are noted below. All elevations in these calculations are NAVD 88.

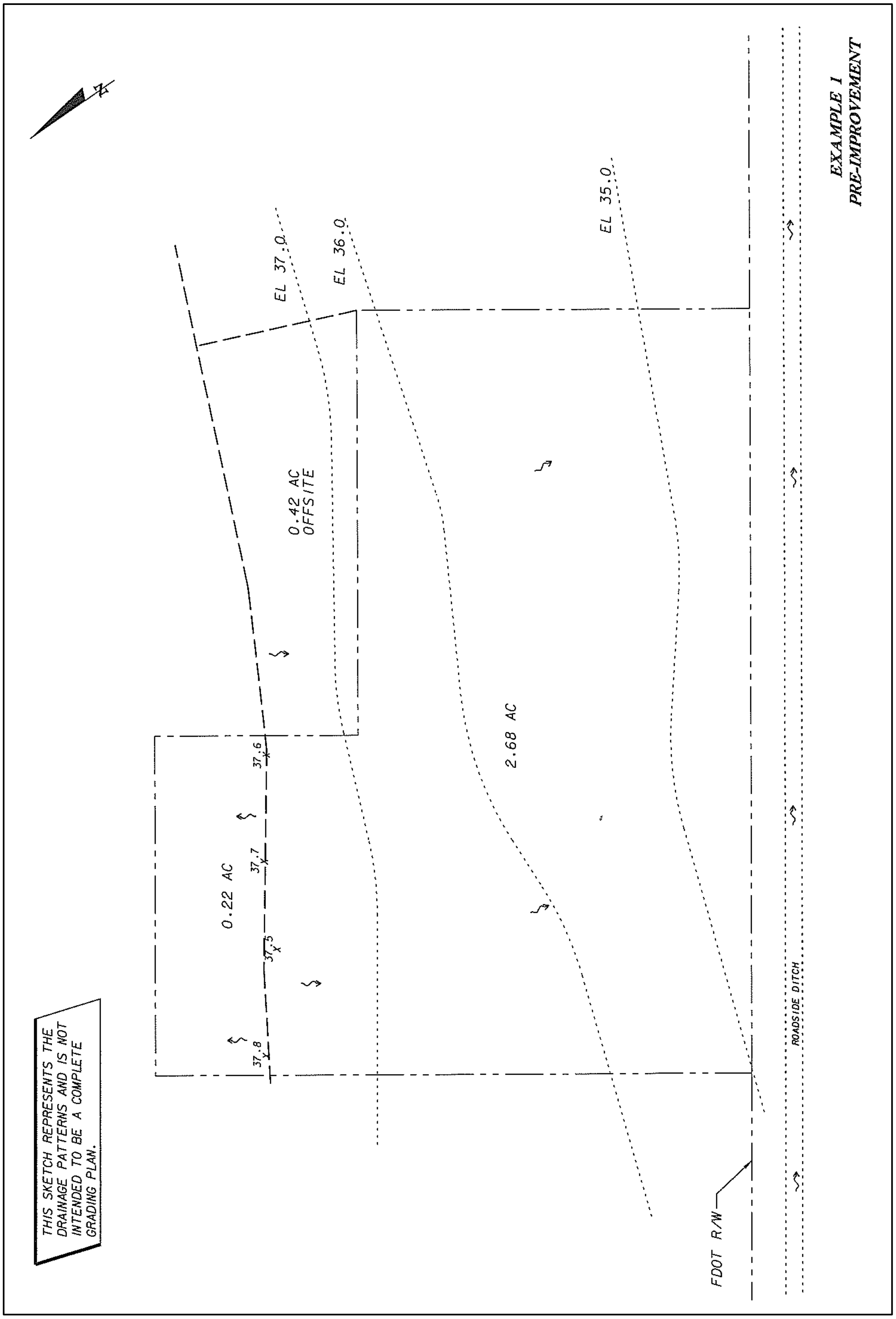
100-Year, 8-Hour Results			
Pre-improvement Runoff (cfs)	Post-improvement Runoff (cfs)	Pond Stage (feet)	Pond Berm Elev.(feet)
7.20	5.61	34.2	35.5

The peak stage will flood portions of the proposed parking but the flooding will be contained on site because the crest of the driveway is at elevation 35.0.

Two tailwater conditions were considered. Low tailwater was assumed to be the existing ditch bottom (elev. 30.0) at the connection location. High tailwater was set at normal flow depth in the ditch (elev. 31.2) for the 100-year event. Using the high tailwater did not increase the peak pond stage noted above. The roadside ditch parameters (cross section, slopes, drainage area, length, etc.) were obtained from the original construction plans for SR 36. The information was field verified as part of this project.

The calculations are ordered as follows:

Pre-improvement drainage map.
Pre-improvement runoff parameters.
Post-improvement drainage map.
Post-improvement runoff parameters.
Post-improvement treatment calculations.
Pond and outfall structure information.
Rainfall depths.
Runoff results.
Roadside ditch & outlet pipe calculations.


EXAMPLE 1
PRE-IMPROVEMENT
THIS SKETCH REPRESENTS THE DRAINAGE PATTERNS AND IS NOT INTENDED TO BE A COMPLETE GRADING PLAN.
EL 37.0
EL 36.0
EL 35.0
0.42 AC
OFFSITE
2.68 AC
0.22 AC
37.6
37.7
37.5
37.8
ROADSIDE DITCH
FDOT R/W

Pre-Improvement Runoff Parameters

Pre-Improvement Drainage Areas:

Basin Name	Basin Area	
Onsite to FDOT	2.68	ac
Offsite to FDOT	0.42	ac
Total Area	3.10	ac

Pre-Improvement Impervious and Pervious Areas:

Impervious:

Description	Area	
Existing Onsite Impervious	0	ac

Percent Impervious **0.0%**

Pervious:

Description	Area	
Existing Onsite Pervious	2.68	ac
Existing Offsite Pervious	0.42	ac

Percent Pervious **100.0%**

Pre-Improvement Runoff Coefficient:

Description	Basin Area (ac)	"C"	CA
Pervious	3.10	0.2	0.62

WTD C = **0.20**

Pre-Improvement Curve Number:

Soil Type	Hydrologic Soil Group	Land Use Description	Percent Coverage	Area (ac)	CN	WTD CN
Dothan Loamy Sand	B	Woods, Thin Stand	100	3.10	66	66
					WTD CN =	**66**

Pre-Improvement t_c, Peaking Rate Factor (PRF):

Time of Concentration (See t_c Worksheet)

Total t_c = 19 Min Note: Minimum t_c = 10 min

Peaking Rate Factor (PRF)

PRF = 323

Pre-Improvement Summary:

Basin	Area (ac)	C	CN	t_c	PRF
Pre-Improvement	3.10	0.20	66	19	323

Time of Concentration (TR-55)

Project: Drainage Connection Handbook, Example 1
Basin: Pre-Improvement Runoff
Structure:

Notes: Tables and Figures reference TR-55

Sheet Flow

	Segment ID 1	Segment ID 2	Sub-total
1. Surface Description (Table 3-1)	Woods (light underbrush)		
2. Manning's Roughness Coeff., n (Table 3-1)	0.40		
3. Flow Length, L (total <= 100 ft) (feet)	100		
4. 2-year 24-hour Rainfall, P_2 (inches)	6.40		
5. Land Slope, s (ft/ft)	0.0140		
6. $t_t = (0.007 * (nL)^{0.8})/((P_2^{0.5})*(s^{0.4}))$ (hr)	0.292		0.29

Shallow Concentrated Flow

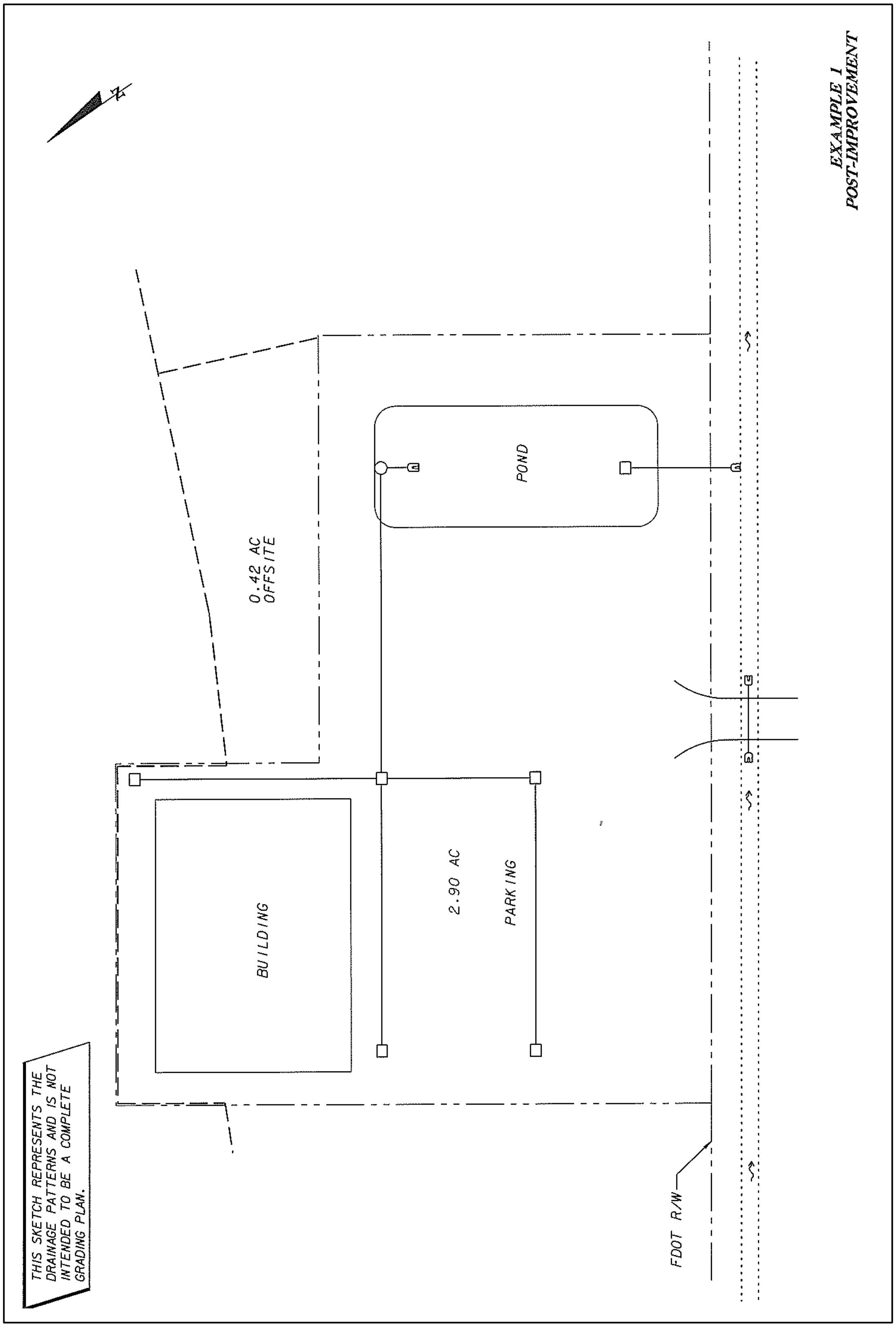
	Segment ID 3	Segment ID 4	Sub-total
7. Surface Description (paved or unpaved)	Unpaved		
8. Flow Length, L (feet)	200		
9. Watercourse Slope, s (ft/ft) [=(13.5-13.1)/360]	0.0140		
10. Average Velocity, V (figure 3-1) (ft/s)	1.91		
11. $t_t = (L/(3600*V)$ (hr)	0.03		0.03

Channel Flow

	Segment ID 5	Segment ID 6	Sub-total
12. Cross Section Flow Area, a (ft^2)			
13. Wetted Perimeter, P_w (ft)			
14. Hydraulic Radius, $r = a/P_w$ (ft)			
15. Channel Slope, s (ft/ft)			
16. Manning's Roughness Coeff., n			
17. $V = (1.49*(r^{2/3})*(s^{1/2}))/n$ (ft/s)			
18. Flow Length, L (ft)			
19. $t_t = (L/3600*V)$ (hr)			0.00

Total

		Total
20. Total t_c (hr)		0.32
21. Total t_c (min)		**19.3**
22. Total Flow Length	300 feet	


EXAMPLE 1
POST-IMPROVEMENT
N
0.42 AC
OFFSITE
POND
BUILDING
2.90 AC
PARKING
FDOT R/W
THIS SKETCH REPRESENTS THE
DRAINAGE PATTERNS AND IS NOT
INTENDED TO BE A COMPLETE
GRADING PLAN.

Example 1

Post-Improvement Runoff Parameters

Post-Improvement Drainage Areas:

Basin Name	Basin Area
Onsite to FDOT	2.90 ac
Offsite to FDOT	0.42 ac
Total Area	3.32 ac

Post-Improvement Impervious and Pervious Areas:

Impervious:

Description	Area
Parking and Building	1.60 ac
Pond	0.40 ac

Pond area is water surface area at Elevation 33.0. This is approx. 1/2 way between control elevation and max stage. Although not required to use this area, it represents an average impervious area over a storm's duration.

Percent Impervious **60.2%**

Pervious:

Description	Area
Onsite	0.90 ac
Offsite	0.42 ac

Percent Pervious **39.8%**

Post-Improvement Runoff Coefficient:

Description	Basin Area (ac)	"C"	CA
Open space lawn	0.90	0.20	0.18
Pond WS	0.40	1.00	0.40
Parking & Bldg.	1.60	0.95	1.52
Offsite	0.42	0.20	0.08
Total Area =	3.32		
	WTD C =	**0.66**	

Post-Improvement Runoff Parameters, cont.

Post-Improvement Curve Number:

Soil Type	Hydro. Soil Gr.	Land Use Description	Area (ac)	CN	CN*A
Dothan Loamy Sand	B	Open Space Lawn	0.90	61	54.9
		Pond WS	0.40	100	40.0
		Parking & Bldg.	1.6	98	156.8
		Offsite	0.42	66	27.7
		Total Area	3.32		
			WTD CN =	**84.2**	

Post-Improvement t_c, Peaking Rate Factor (PRF):

Time of Concentration:

Total t_c = 10 Min   Note: Minimum t_c = 10 min

Peaking Rate Factor (PRF):

PRF = 484

Post-Improvement Basin Summary:

Basin	Area (ac)	C	CN	t_c	PRF
Site & Offsite	3.32	0.66	84.2	10	484

Post Improvement Treatment Calculations Required Treatment Volume:

1" over the contributing area

Area (ac)	Treatment Vol. (ac-ft)	Treatment Vol. (cf)
3.32	0.277	12052

Required Permanent Pool Volume (PPV):

		Units	
Drainage Area, DA	3.32	ac	
Runoff Coeff., C	0.66		
Wet Season Rain Depth, R	28	in	from WMD
Length of Wet Season, WS	122	days	June through September
Avg. Flow Rate, FR = DA*C*R/WS	0.04	ac-ft/day	
Residence Time, RT	14	days	as required by WMD
Required PPV = (RT)(FR)	**0.58**	**AF**	

Pond and Outfall Structure Information

Pond Information

Geotechnical information indicates SHWT is approx. 4 feet below grade at pond. Use elevation 31.0 for SHWT and control elevation.

Pond Stage-Area-Storage Above Control

Elevation	Area (sf)	Area (ac)	Elev. Inc.	Inc. Storage (cf)	Total Storage (cf)	Total Storage (af)
31.0	11671	0.268	0	0	0	0.000
32.0	14506	0.333	1	13089	13089	0.300
33.0	17573	0.403	1	16040	29128	0.669
34.0	20864	0.479	1	19219	48347	1.110
35.0	30079	0.6905	1	25472	73818	1.695

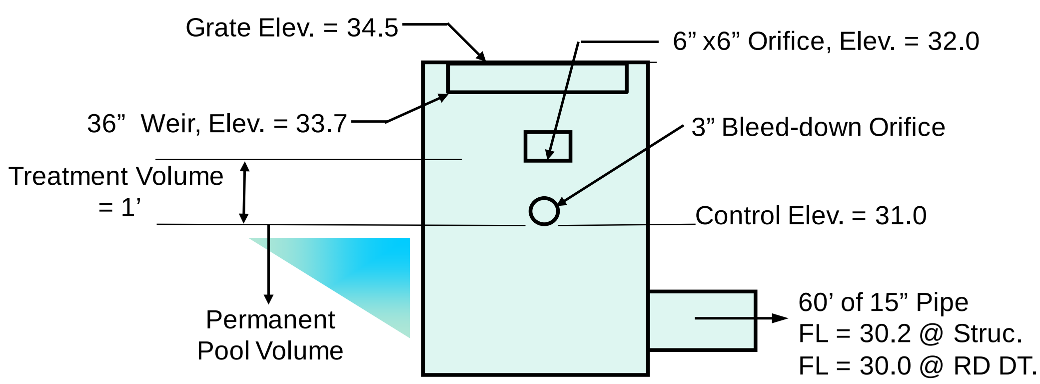
Required Treatment volume of 0.28 acre-feet captured at elevation 32.0.
Starting water surface set at 31.5 to account for antecedent rainfall.

Pond Stage-Area-Storage Below Control

Elevation	Area (sf)	Area (ac)	Elev. Inc.	Inc. Storage (cf)	Total Storage (cf)	Total Storage (af)
25.0	2147	0.049	0	0	0	0.000
27.0	4441	0.102	2	6588	6588	0.151
29.0	7444	0.171	2	11885	18473	0.424
30.0	9059	0.208	1	8252	26725	0.614
31.0	11671	0.268	1	10365	37090	0.851

Required Perm Pool Volume of 0.58 af stored below control elevation of 31.0.
Permanent Pool Volume exceeds required (0.85>0.58).

Outfall Structure Information



Type D Ditch Bottom Inlet

Incremental Drawdown for Circular Orifice

Project: Drainage Connection Handbook

Subject: Example 1

Facility Information:

Basin Side Slope,(h:v)	6:1
Top of Treatment Volume, (ft)	32.0
Bottom of Treatment Volume, (ft)	31.0
Total Treatment Vol., (cf)	12052
1/2 Treatment Vol., (cf)	6026
1/2 Treatment Elev, (ft)	31.50

Bleed Down Orifice:

Invert, (ft)	31.0
Diameter, (in)	1.25
CL Orifice, (ft)	31.05

Elevation (ft)	Storage (cf)	Storage Incr. (V) (cf)	Head (H) (ft)	Flow Area (A) (sf)	Instantaneous Discharge (Q) (cfs)	Average Discharge Per Increment (Q_{avg}) (cfs)	Drawdown Time Per Increment (t) (hrs)
32.0	13089		0.95	0.0085	0.0399		
		2845				0.0377	21.0
31.8	10244		0.75	0.0085	0.0355		
		2731				0.0329	23.0
31.6	7513		0.55	0.0085	0.0304		
		1323				0.0289	12.7
31.5	6190		0.45	0.0085	0.0274		
	Total:	**6899.0**				**Total:**	**56.7**

1.25" diameter orifice meets WMD criterion, but 3" minimum size controls.

Rainfall (Inches)

Duration	Frequency													
	2-Year		3-Year		5-Year		10-Year		25-Year		50-Year		100-Year	
	Intensity	Depth	Intensity	Depth	Intensity	Depth	Intensity	Depth	Intensity	Depth	Intensity	Depth	Intensity	Depth
1 -Hour			2.6	2.6	2.85	2.85	3.2	3.2	3.7	3.7	4.2	4.2	4.6	4.6
2 -Hour			1.7	3.4	1.85	3.7	2.1	4.2	2.4	4.8	2.7	5.4	3	6.0
4 -Hour			1.05	4.2	1.15	4.6	1.3	5.2	1.5	6.0	1.7	6.8	1.9	7.6
8 -Hour			0.64	5.1	0.7	5.6	0.8	6.4	0.94	7.5	1.1	8.6	1.18	9.4
1 -Day		6.4		7.2		8.0		9.5		11.0		12.0		14.0
2 -Day		7		8.0		9.0		10.4		12.3		13.7		14.6
3 -Day		7.6		8.6		9.6		11.2		13.2		14.6		15.6
4 -Day		8.2				10.2		12.0		14.0		15.5		16.6

Notes:
1) 1-hour thru 8-hour intensities from FDOT IDF Curve Zone 1 (Walton County).
2) 1-day, 2-day, 4-day depths from FDOT Rainfall Maps, with 3-day values being interpolated between 2-day and 4-day.
3) 3-year, 1-, 2-, and 3-day depths are an average of the 2-year and 5-year depths of the same duration.

Results With Low Tailwater (EL 30.0)

Design Storm		Discharge Rate (CFS)	Peak Pond Stage (ft)
FDOT 3-yr, 1-hr	Pre	1.45	32.42
	Post	0.71	
FDOT 3-yr, 2-hr	Pre	1.67	32.69
	Post	1.10	
FDOT 3-yr, 4-hr	Pre	2.08	32.97
	Post	1.34	
FDOT 3-yr, 8-hr	Pre	2.45	33.07
	Post	1.42	
FDOT 3-yr, 24-hr	Pre	1.20	32.80
	Post	1.20	
FDOT 3-yr, 72-hr (3-day)	Pre	1.04	32.63
	Post	1.03	
FDOT 5-yr, 1-hr	Pre	1.87	32.55
	Post	0.93	
FDOT 5-yr, 2-hr	Pre	2.07	32.83
	Post	1.23	
FDOT 5-yr, 4-hr	Pre	2.51	33.16
	Post	1.48	
FDOT 5-yr, 8-hr	Pre	2.96	33.27
	Post	1.56	
FDOT 5-yr, 24-hr	Pre	1.42	32.97
	Post	1.34	
FDOT 5-yr, 72-hr (3-day)	Pre	1.20	32.74
	Post	1.14	
FDOT 10-yr, 1-hr	Pre	2.51	32.74
	Post	1.14	
FDOT 10-yr, 2-hr	Pre	2.79	33.08
	Post	1.42	
FDOT 10-yr, 4-hr	Pre	3.17	33.43
	Post	1.66	
FDOT 10-yr, 8-hr	Pre	3.80	33.59
	Post	1.76	
FDOT 10-yr, 24-hr	Pre	1.87	33.30
	Post	1.58	
FDOT 10-yr, 72-hr (3-day)	Pre	1.46	32.91
	Post	1.29	

Design Storm		Discharge Rate (CFS)	Peak Pond Stage (ft)
FDOT 25-yr, 1-hr	Pre	3.52	33.01
	Post	1.38	
FDOT 25-yr, 2-hr	Pre	3.74	33.37
	Post	1.63	
FDOT 25-yr, 4-hr	Pre	4.10	33.78
	Post	2.09	
FDOT 25-yr, 8-hr	Pre	5.01	33.93
	Post	2.99	
FDOT 25-yr, 24-hr	Pre	2.33	33.64
	Post	1.79	
FDOT 25-yr, 72-hr (3-day)	Pre	1.79	33.12
	Post	1.46	
FDOT 50-yr, 1-hr	Pre	4.63	33.28
	Post	1.57	
FDOT 50-yr, 2-hr	Pre	4.75	33.66
	Post	1.81	
FDOT 50-yr, 4-hr	Pre	5.07	34.03
	Post	3.78	
FDOT 50-yr, 8-hr	Pre	6.27	34.08
	Post	4.26	
FDOT 50-yr, 24-hr	Pre	2.65	33.80
	Post	2.21	
FDOT 50-yr, 72-hr (3-day)	Pre	2.02	33.27
	Post	1.56	
FDOT 100-yr, 1-hr	Pre	5.56	33.50
	Post	1.71	
FDOT 100-yr, 2-hr	Pre	5.82	33.89
	Post	2.72	
FDOT 100-yr, 4-hr	Pre	6.08	34.20
	Post	5.39	
FDOT 100-yr, 8-hr	Pre	7.20	34.22
	Post	5.61	
FDOT 100-yr, 24-hr	Pre	3.28	34.01
	Post	3.01	
FDOT 100-yr, 72-hr (3-day)	Pre	2.18	33.38
	Post	1.63	

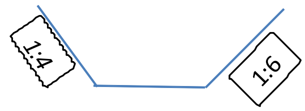
Basin & Pond Config Info	
Basin Information	
Pre Area (ac)	3.1
Pre CN	66
Pre T_c (min)	19
Pre PRF	323
Post Area (ac)	3.32
Post CN	84.2
Post T_c	10
Post PRF	484
Pond Information	
Top of Pond	35.5
Bot of Pond	25
SHWT	31

Notes:

1. Routings were checked using the high tailwater (EL 31.2). The peak pond stage for the 100-yr, 8-hr event did not increase (remained Elev 34.22); however, the post discharge rate for some of the storms did decrease.

Roadside Ditch and Outlet Pipe Calculations

Ditch cross section as shown below.



5' Bottom

Cross-Sectional Area: (for TC calc) - Assume max. stacking height of 1.5'

(5*1.5)+(0.5[(1.5)(4*1.5)]+(0.5[(1.5)(6*1.5)]) = 18.75 sf

Wetted Perimeter: (for TC calc)

Assume max. stacking height of 1.5'

5+9.1+6.2 = 20.3 ft

Flow Rate in Ditch:

Flow rate was calculated at the connection point, not incrementally along the ditch.

Q = CIA

A = 6.9 ac (From S.R. 36 Drainage Map)

TC = 10 min. See attached calculation. This assumes constant flow in ditch and ignores incremental increases in flow and travel time.

$I_{100\text{-yr}}$ = 9.4 in/hr

$I_{10\text{-yr}}$ =7.0 in/hr

C = 0.35 (small amount of offsite development & roadway pavement)

$Q_{100\,=}$ 0.35*9.4*6.9 = 22.7 cfs

Q_{10} = 0.35*7.0*6.9 = 16.9 cfs

Normal Flow Depth in Ditch:

Conveyance = K'

$$K' = \frac{Q}{(1/n)b^{8/3}S^{1/2}}$$

$$K' = \frac{22.7}{(1/0.06)5^{8/3}0.007^{1/2}}$$

$$K' = 0.22$$

From Conveyance Factor Tables

d/b = 0.23

$d_{n\ 100\text{-yr}}$ = (0.23)(5) = 1.15 ft

Then 100-yr stage in ditch = 30.0 (Dt. Bot.) + 1.15 = 31.15, use 31.2 = High TW

Discharge Pipe Outlet Velocity (15 inch pipe):

Peak 10-yr discharge = 1.76 cfs

Peak 100-yr discharge = 5.61 cfs

$D_{N\ (10\text{-yr})}$ = 0.58ft , V=3.17 fps

$D_{critical\ (10\text{-yr})}$ = 0.53 ft, V = 3.58 fps (FHWA HDS 5 executable program)

$D_{critical\ (100\text{-yr})}$ = 0.96 ft, V = 5.55 fps (FHWA HDS 5 executable program)

Velocities are less than required for sod in Chapter 2 of the Drainage Manual so no riprap rubble is needed.

Time of Concentration (TR-55)

Project: Drainage Connection Handbook, Example 1
Basin: Roadside ditch
Structure:

Notes: Table and Figures Ref TR-55

Sheet Flow

	Segment ID 1	Segment ID 2	
1. Surface Description (Table 3-1)			
2. Manning's roughness coeff., n (Table 3-1)			
3. Flow Length, L (total <= 100 ft) (feet)			
4. 2-year 24-hour rainfall, P_2 (inches)			
5. Land slope, s (ft/ft)			**Sub-total**
6. T_t =(0.007 * $(nL)^{0.8}$)/(($P_2^{0.5}$)*($s^{0.4}$)) (hr)			0.00

Shallow Concentrated Flow

	Segment ID 3	Segment ID 4	
7. Surface description (paved or unpaved)			
8. Flow length, L (feet)			
9. Watercourse slope, s (ft/ft) [=(13.5-13.0)/240]			
10. Average velocity, V (figure 3-1) (ft/s)			**Sub-total**
11. T_t = (L/(3600*V) (hr)			0.00

Channel Flow

	Segment ID 5	Segment ID 6	
12. Cross section flow area, a (ft^2)	18.75		
13. Wetted perimeter, P_w (ft)	20.3		Assumed 1.5' Stacking
14. Hydraulic radius, r = a/P_w (ft)	0.92		Height
15. Channel slope, s (ft/ft)	0.007		
16. Manning/s roughness coeff., n	0.06		
17. V = (1.49*($r^{2/3}$)*($s^{1/2}$))/n (ft/s)	1.97		
18. Flow length, L (ft) ***From Orig Const. Plans***	1200		**Sub-total**
19. T_t = (L/3600*V) (hr)	0.170		0.17

Total

		Total
20. Total T_c (hr)		0.17
21. Total T_c (min)		**10.2**
22. Total Flow Length	1200 feet	

Example 2:

Drainage Calculations – Narrative

The project site is 2.90 acres of undeveloped woodlands adjacent to SR 236 in Walton County. The site will be improved with the construction of an office complex, associated parking, and a stormwater facility.

Most of the site (2.68 acres) currently drains over the sidewalk of SR 236. There is an additional 0.42 acres of offsite area that drain through the property to SR 236. The SR 236 original construction plans (15360-3505), drainage documentation, and drainage map were obtained from the department to determine the storm drain configuration and design. SR 236 drains to Farmington Creek which drains to Saltwater Bay, thus the watershed has a positive outlet.

In the post-improvement condition, the entire site including 0.22 acres that currently drains north and the 0.42 acre offsite area will be collected and conveyed to a wet-detention pond that discharges to the SR 236. A 15 inch pipe on the east side of the property is proposed to connect to inlet S-52 as identified on the original construction plans. Flows that exceed the 3-year pre-improvement runoff to S-52 are directed through a 7-foot wide spillway to the sidewalk. Only 25-year frequency and greater events discharge over the sidewalk. Inlet S-50 also exists along the project frontage, but no runoff from the proposed site will be directed to it.

Notes:

1) Example 2 has the same site conditions (areas, TC, soil conditions, etc.) as Example 1. As such several of the pages are duplicates of Example 1. The difference is that Example 2 has an urban typical section (curb and gutter) for the roadway.

2) The sample calculations are intended to show the basic types of calculations commonly needed for a drainage connection permit. Some calculations such as Time of Concentration and bleed-down size determination may have other acceptable methods not shown here.

3) Water quality requirements vary between FDEP, individual water management districts, and local governments. The water quality requirements used here are not representative of a particular agency.

4) Proprietary computer program input and output are not included here, but would be required with permit calculations that use proprietary programs.

5) The Department's Drainage Design Guide provides additional information about pond design.

The pond is designed to provide water quality treatment in accordance with WMD requirements and limits the discharge to pre-improvement discharge for each of the Department's design storms. The peak stage in the pond occurs during the 100-year, 8-hour event. The results for this event are noted below. All elevations in these calculations are NAVD 88.

Pre-improvement Runoff		100-Year, 8-Hour Results w/ Low TW [El. 27.5]			
100-yr (cfs)	3-yr to S-52 (cfs)	Post-improvement Runoff thru Pipe (cfs)	Post-improvement Runoff, Pipe and Spillway (cfs)	Pond Stage El. (feet)	Pond Berm El.(feet)
7.20	1.37	1.25	4.7	34.5	35.5

The peak stage will flood portions of the proposed parking but the flooding will be contained on site because the crest of the driveway is at elevation 35.0.

Two tailwater conditions were considered: low tailwater for peak discharge and high tailwater for checking peak stage. Low tailwater was assumed to be the existing pipe invert (elev. 27.5) at S-52. High tailwater was assumed at top of curb (elev. 33.1). This is believed to represent a worst case tailwater because the roadway is on a continuous grade in front of and immediately downstream of the site. The high tailwater was evaluated for only the 1-hour and 2-hour storms, because the intensities of the longer duration storms will not create the high tailwater. The original storm tabulations indicate that the time of concentration (T_c) to S-52 is 27 minutes. The 100-year intensity associated with this T_c is approximately 6.8 inches per hour (IPH). Only the 1-hour and 2-hour storms have intensities at or higher than this as shown below, so the assumed high tailwater would not exist during longer duration storms.

Storm Duration	100-yr Rainfall Depth, Inches (P)	Peak I/P from Rainfall Distribution	Intensity (iph)
1-Hour	4.6	2.15	9.9
2-Hour	6	1.25	7.5
4-Hour	7.6	0.52	4.0
8-Hour	9.4	0.42	3.9
1-Day	14	0.1	1.4
3-Day	15.6	0.05	0.8

Note: This is a fictitious project therefore an actual NOAA Atlas 14 location is unavailable. The data shown in this table can be obtained from: https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=fl

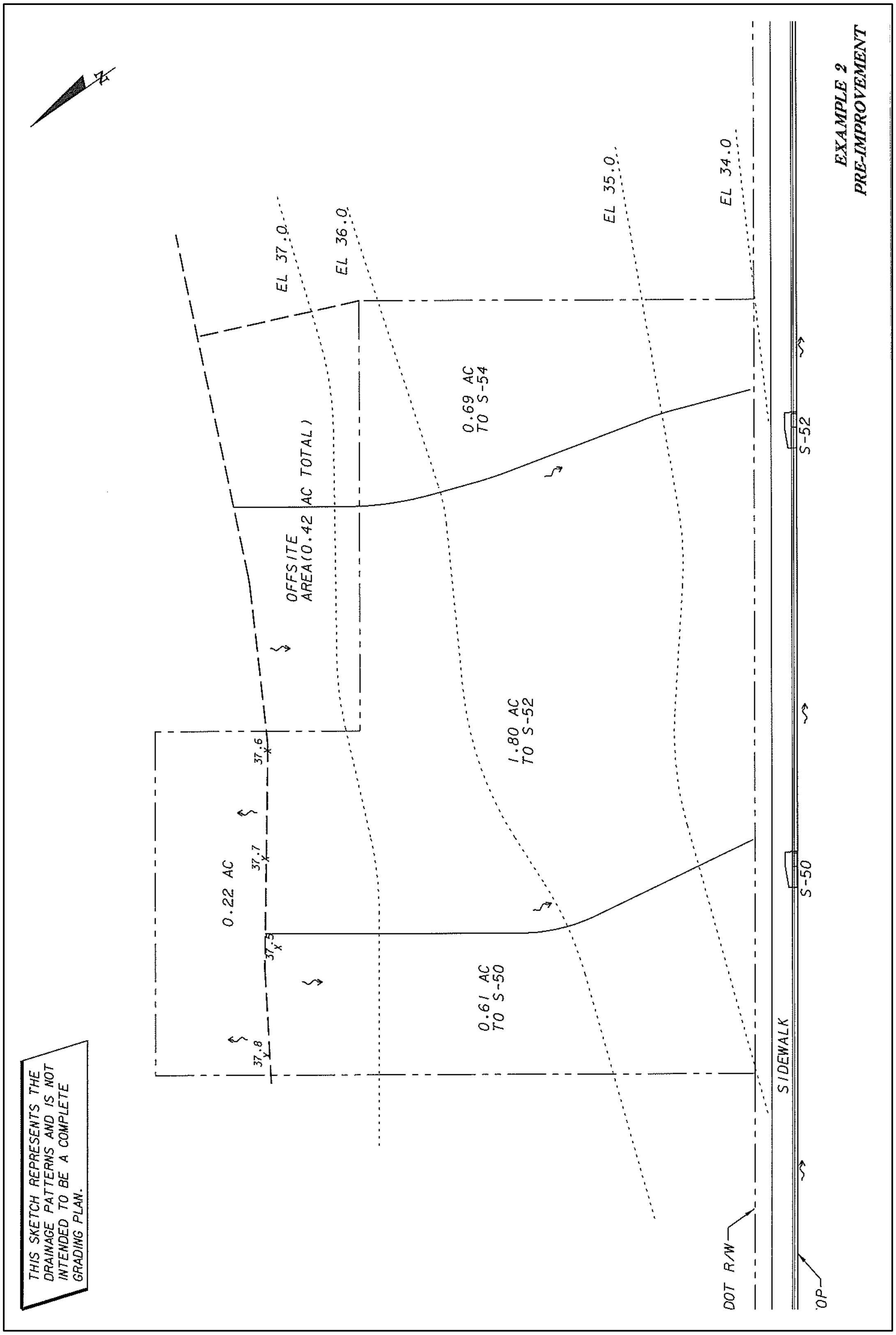
The 100 year stage at Farmington Creek is approximately 10 feet lower than the site based on the original construction plan's Flood Data Table, thus the creek will not influence the peak tailwater at the site.

Results of the high tailwater condition indicates that the pond stage is contained below the spillway (to sidewalk), thus there is no unanticipated discharge.

Information from the Department's original plans and documentation was used to evaluate the spread on the road. The spillway discharges over the sidewalk to S-52, but it is assumed all this flow bypasses S-52 to the downstream inlet S-54. The changed inflow patterns did change the spread on SR 236, but the spread still meets FDOT criterion. The spread at S-54 is 10.8 feet compared to an allowable 11.5 feet.

The calculations are ordered as follows:

- Pre-improvement drainage map.
- Pre-improvement runoff parameters.
- Post-improvement drainage map.
- Post-improvement runoff parameters.
- Post-improvement treatment calculations.
- Pond and outfall structure information.
- Rainfall depths.
- Runoff results.
- Roadway spread calculations.


EXAMPLE 2
PRE-IMPROVEMENT
THIS SKETCH REPRESENTS THE DRAINAGE PATTERNS AND IS NOT INTENDED TO BE A COMPLETE GRADING PLAN.
N
EL 37.0
EL 36.0
EL 35.0
EL 34.0
OFFSITE AREA(0.42 AC TOTAL)
0.69 AC TO S-54
1.80 AC TO S-52
0.61 AC TO S-50
0.22 AC
37.6
37.7
37.5
37.8
S-52
S-50
SIDEWALK
DOT R/W
TOP

Pre-Improvement Runoff Parameters

Pre-Improvement Drainage Areas:

Basin Name	Basin Area
Onsite to FDOT	2.68 ac
Offsite to FDOT	0.42 ac
Total Area	3.10 ac

Pre-Improvement Impervious and Pervious Areas:

Impervious:

Description	Area
Existing Onsite Impervious	0 ac

Percent Impervious **0.0%**

Pervious:

Description	Area
Existing Onsite Pervious	2.68 ac
Existing Offsite Pervious	0.42 ac

Percent Pervious **100.0%**

Pre-Improvement Runoff Coefficient:

Description	Basin Area (ac)	"C"	CA
Pervious	3.10	0.2	0.62

WTD C = 0.20

Pre-Improvement Runoff Parameters, cont.

Pre-Improvement Curve Number:

Soil Type	Hydrologic Soil Group	Land Use Description	Percent Coverage	Area (ac)	CN	WTD CN
Dothan Loamy Sand	B	Woods, Thin Stand	100	3.10	66	66
					WTD CN =	**66**

Pre-Improvement T_c, Peaking Rate Factor (PRF):

Time of Concentration

Total T_c = 19 Min   Note: Minimum T_c = 10 min

Peaking Rate Factor (PRF)

PRF = 323

Pre-Improvement Summary:

Basin	Area (ac)	C	CN	T_c	PRF
Pre-Improvement	3.10	0.20	66	19	323

Pre-Improvement Runoff Rate (3-yr) to S-52

Q = CIA

C = 0.2

A = 1.8 ac

I = 4.7 in/hr   based on 19 min T_c, Zone 1 IDF curve

Q = 1.65 cfs

Time of Concentration (TR-55)

Project: Drainage Connection Handbook, Example 2
Basin: Pre-Improvement Runoff
Structure:

Notes: Tables and Figures reference TR-55

Segment ID

Sheet Flow

	1	2	Sub-total
1. Surface Description (Table 3-1)	Woods (light underbrush)		
2. Manning's roughness coeff., n (Table 3-1)	0.40		
3. Flow Length, L (total <= 100 ft) (feet)	100		
4. 2-year, 24-hour rainfall, P_2 (inches)	6.40		
5. Land slope, s (ft/ft)	0.0140		
6. T_t =(0.007 * $(nL)^{0.8}$)/(($P_2^{0.5}$)*($s^{0.4}$)) (hr)	0.292		0.29

Segment ID

Shallow Concentrated Flow

	3	4	Sub-total
7. Surface description (paved or unpaved)	unpaved		
8. Flow length, L (feet)	200		
9. Watercourse slope, s (ft/ft) [=(13.5-13.1)/360]	0.0140		
10. Average velocity, V (figure 3-1) (ft/s)	1.91		
11. T_t = (L/(3600*V) (hr)	0.03		0.03

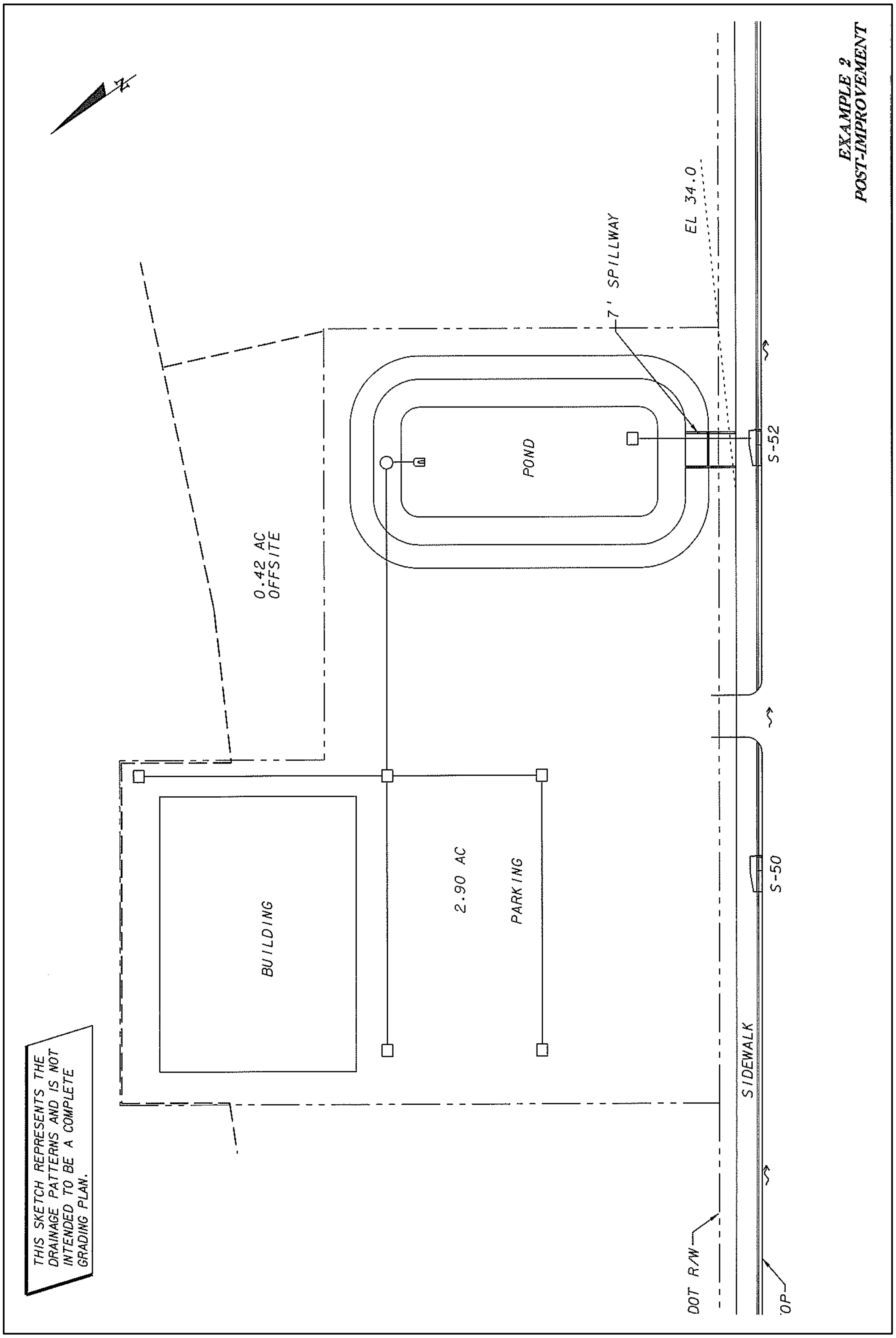
Segment ID

Channel Flow

	5	6	Sub-total
12. Cross section flow area, a (ft^2)			
13. Wetted perimeter, P_w (ft)			
14. Hydraulic radius, r = a/P_w (ft)			
15. Channel slope, s (ft/ft)			
16. Manning/s roughness coeff., n			
17. V = (1.49*($r^{2/3}$)*($s^{1/2}$))/n (ft/s)			
18. Flow length, L (ft)			
19. T_t = (L/3600*V) (hr)			0.00

Total

		Total
20. Total T_c (hr)		0.32
21. Total T_c (min)		**19.3**
22. Total Flow Length	300 feet	


THIS SKETCH REPRESENTS THE DRAINAGE PATTERNS AND IS NOT INTENDED TO BE A COMPLETE GRADING PLAN.
N
0.42 AC OFFSITE
POND
7' SPILLWAY
EL 34.0
S-52
S-50
BUILDING
2.90 AC
PARKING
SIDEWALK
DOT R/W
EXAMPLE 2
POST-IMPROVEMENT

Post-Improvement Runoff Parameters

Post-Improvement Drainage Areas:

Basin Name	Basin Area
Onsite to FDOT	2.90 ac
Offsite to FDOT	0.42 ac
Total Area	3.32 ac

Post-Improvement Impervious and Pervious Areas:

Impervious:

Description	Area
Parking and Building	1.60 ac
Pond	0.40 ac

Pond area is water surface area at Elev 33.0. This is approx. 1/2 way between control elevation and max stage. Although not required to use this area, it represents an average impervious area over a storm duration.

Percent Impervious **60.2%**

Pervious:

Description	Area
Onsite	0.9 ac
Offsite	0.42 ac

Percent Pervious **39.8%**

Post-Improvement Runoff Coefficient:

Description	Basin Area (ac)	"C"	CA
Open space lawn	0.9	0.20	0.18
Pond WS	0.40	1.00	0.40
Parking & Bldg.	1.60	0.95	1.52
Offsite	0.42	0.20	0.08
Total Area =	3.32		
	WTD C =	**0.66**	

Post-Improvement Runoff Parameters, cont.

Post-Improvementment Curve Number:

Soil Type	Hydrol. Soil Gr.	Land Use Description	Area (ac)	CN	CN*A
Dothan Loamy Sand	B	Open Space Lawn	0.90	61	54.9
		Pond WS	0.40	100	40.0
		Parking & Bldg.	1.6	98	156.8
		Offsite	0.42	66	27.7
		Total Area	3.32		
			WTD CN =	**84.2**	

Post-Improvement TC, Peaking Rate Factor (PRF):

Time of Concentration

Total Tc = 10 Min   Note: Minimum Tc = 10 min

Peaking Rate Factor (PRF)

PRF = 484

Post-Improvement Basin Summary:

Basin	Area (ac)	C	CN	TC	PRF
Site & offsite	3.32	0.66	84.2	10	484

Post-Improvement Treatment Calculations

Required Treatment Volume

1" over the contributing area

Area (ac)	Trt Vol. (af)	Trt Vol. (cf)
3.32	0.277	12052

Required Permanent Pool Volume (PPV)

		Units	
Drainage Area, DA	3.32	ac	
Runoff Coeff., C	0.66		
Wet Season Rain Depth, R	28	in	from WMD
Length of Wet Season, WS	122	days	June through September
Avg Flow Rate, FR = DA*C*R/WS	0.04	ac-ft/day	
Residence time, RT	14	days	as required by WMD
Required PPV = (RT)(FR)	**0.58**	**AF**	

Pond and Outfall Structure Information

Pond Information

Geotechnical information indicates SHWT is approx. 4 feet below grade at pond. Use elevation 31.0 for SHWT and control elevation.

Pond Stage-Area-Storage Above Control

Elevation	Area (sf)	Area (ac)	Elev. Inc.	Inc. Storage (cf)	Total Storage (cf)	Total Storage (af)
31.0	11671	0.268	0	0	0	0.000
32.0	14506	0.333	1	13089	13089	0.300
33.0	17573	0.403	1	16040	29128	0.669
34.0	20864	0.479	1	19219	48347	1.110
35.0	30079	0.6905	1	25472	73818	1.695

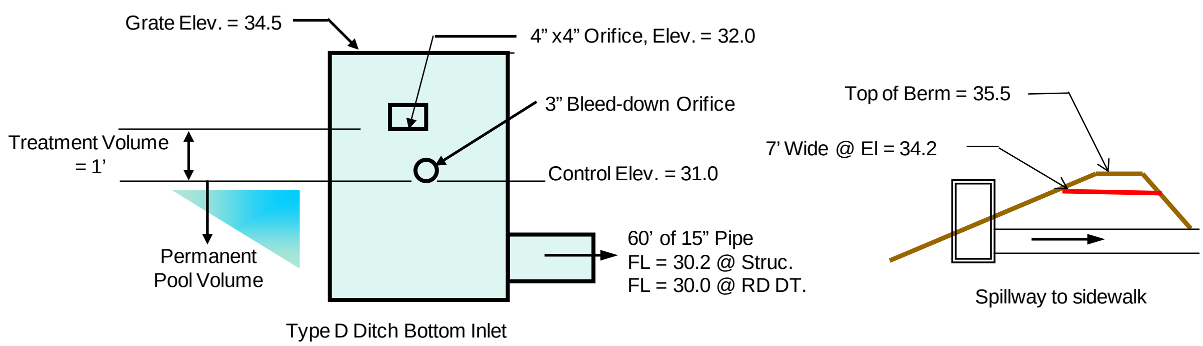
Treatment volume of 0.28 acre-feet captured at elevation 32.0

Pond Stage-Area-Storage Below Control

Elevation	Area (sf)	Area (ac)	Elev. Inc.	Inc. Storage (cf)	Total Storage (cf)	Total Storage (af)
25.0	2147	0.049	0	0	0	0.000
27.0	4441	0.102	2	6588	6588	0.151
29.0	7444	0.171	2	11885	18473	0.424
30.0	9059	0.208	1	8252	26725	0.614
31.0	11671	0.268	1	10365	37090	0.851

Required Permanent Pool Volume of 0.58 af stored below control elevation of 31.0.
Permanent Pool Volume exceeds required (0.85 > 0.58).

Outfall Structure Information



Incremental Drawdown for Circular Orifice

Project: Drainage Connection Handbook

Subject: Example 2

Condition:

Facility Information

Basin Side Slope,(h:v)	6:1
Top of Treatment Volume, (ft)	132.0
Bottom of Treatment Volume, (ft	131.0
Total Treatment Vol., (cu-ft)	12052
1/2 Treatment Vol., (cu-ft)	6026
1/2 Treatment Elev, (ft)	131.50

Bleed Down Orifice

Invert, (ft)	131.0
Diameter, (in)	1.25
CL Orifice, (ft)	131.05

Elevation (ft)	Storage (cf)	Storage Increment (V) (cf)	Head (H) (ft)	Flow Area (A) (sf)	Instantaneous Discharge (Q) (cfs)	Average Discharge Per Increment (Qavg) (cfs)	Drawdown Time Per Increment (t) (hrs)
132.0	13089		0.95	0.0085	0.0399		
		2845				0.0377	21.0
131.8	10244		0.75	0.0085	0.0355		
		2731				0.0329	23.0
131.6	7513		0.55	0.0085	0.0304		
		1323				0.0289	12.7
131.5	6190		0.45	0.0085	0.0274		
		6899.0				**Total**	**56.7**

1.25" diameter orifice meets WMD criterion, but 3" minimum size controls.

Note: This is a fictitious project therefore an actual NOAA Atlas 14 location is unavailable. The data shown in this table can be obtained from: https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=fl

Rainfall (Inches)

	Frequency													
	2-Year		3-Year		5-Year		10-Year		25-Year		50-Year		100-Year	
Duration	Intensity	Depth	Intensity	Depth	Intensity	Depth	Intensity	Depth	Intensity	Depth	Intensity	Depth	Intensity	Depth
1 -Hour			2.6	2.6	2.85	2.85	3.2	3.2	3.7	3.7	4.2	4.2	4.6	4.6
2 -Hour			1.7	3.4	1.85	3.7	2.1	4.2	2.4	4.8	2.7	5.4	3	6.0
4 -Hour			1.05	4.2	1.15	4.6	1.3	5.2	1.5	6.0	1.7	6.8	1.9	7.6
8 -Hour			0.64	5.1	0.7	5.6	0.8	6.4	0.94	7.5	1.1	8.6	1.18	9.4
1 -Day		6.4		7.2		8.0		9.5		11.0		12.0		14.0
2 -Day		7		8.0		9.0		10.4		12.3		13.7		14.6
3 -Day		7.6		8.6		9.6		11.2		13.2		14.6		15.6
4 -Day		8.2				10.2		12.0		14.0		15.5		16.6

Notes:
1) 1-hour thru 8-hour intensities from FDOT IDF Curve Zone 1 (Walton County).
2) 1-day, 2-day, 4-day depths from FDOT Rainfall Maps, with 3-day values being interpolated between 2-day and 4-day.
3) 3-year, 1-, 2-, and 3-day depths are an average of the 2-year and 5-year depths of the same duration.

Results With Low Tailwater (EL 27.5)

Design Storm		Discharge Rate (CFS)	Peak Pond Stage (ft)	Design Storm		Discharge Rate (CFS)	Peak Pond Stage (ft)	Basin & Pond Config Info	
FDOT 3-yr, 1-hr	Pre	1.45	32.43	FDOT 25-yr, 1-hr	Pre	3.52	33.06	**Basin Information**	
	Post	0.55			Post	0.83		Pre Area (ac)	3.1
FDOT 3-yr, 2-hr	Pre	1.67	32.77	FDOT 25-yr, 2-hr	Pre	3.74	33.51	Pre CN	66
	Post	0.72			Post	0.99		Pre T_c (min)	19
FDOT 3-yr, 4-hr	Pre	2.08	33.09	FDOT 25-yr, 4-hr	Pre	4.10	33.99	Pre PRF	323
	Post	0.85			Post	1.12			
FDOT 3-yr, 8-hr	Pre	2.45	33.22	FDOT 25-yr, 8-hr	Pre	5.01	34.24	Post Area (ac)	3.32
	Post	0.89			Post	1.40		Post CN	84.2
FDOT 3-yr, 24-hr	Pre	1.18	33.17	FDOT 25-yr, 24-hr	Pre	2.33	34.27	Post T_c	10
	Post	0.87			Post	1.58		Post PRF	484
FDOT 3-yr, 72-hr (3-day)	Pre	1.04	32.82	FDOT 25-yr, 72-hr (3-day)	Pre	1.79	33.62		
	Post	0.74			Post	1.02		Pond Information	
FDOT 5-yr, 1-hr	Pre	1.86	32.57	FDOT 50-yr, 1-hr	Pre	4.63	33.34	Top of Pond	35.5
	Post	0.63			Post	0.93		Bot of Pond	25
FDOT 5-yr, 2-hr	Pre	2.07	32.93	FDOT 50-yr, 2-hr	Pre	4.75	33.82	SHWT	31
	Post	0.78			Post	1.08		TW EL	27.5
FDOT 5-yr, 4-hr	Pre	2.51	33.30	FDOT 50-yr, 4-hr	Pre	5.07	34.31		
	Post	0.92			Post	1.97			
FDOT 5-yr, 8-hr	Pre	2.96	33.44	FDOT 50-yr, 8-hr	Pre	6.27	34.44		
	Post	0.96			Post	3.82			
FDOT 5-yr, 24-hr	Pre	1.42	33.43	FDOT 50-yr, 24-hr	Pre	2.65	34.33		
	Post	0.96			Post	2.21			
FDOT 5-yr, 72-hr (3-day)	Pre	1.20	33.00	FDOT 50-yr, 72-hr (3-day)	Pre	2.02	33.85		
	Post	0.81			Post	1.08			
FDOT 10-yr, 1-hr	Pre	2.51	32.77	FDOT 100-yr, 1-hr	Pre	5.57	33.56		
	Post	0.72			Post	1.00			
FDOT 10-yr, 2-hr	Pre	2.79	33.20	FDOT 100-yr, 2-hr	Pre	5.82	34.12		
	Post	0.88			Post	1.16			
FDOT 10-yr, 4-hr	Pre	3.17	33.60	FDOT 100-yr, 4-hr	Pre	6.08	34.48		
	Post	1.01			Post	4.52			
FDOT 10-yr, 8-hr	Pre	3.80	33.80	FDOT 100-yr, 8-hr	Pre	7.20	34.49		
	Post	1.07			Post	4.70			
FDOT 10-yr, 24-hr	Pre	1.87	33.92	FDOT 100-yr, 24-hr	Pre	3.28	34.38		
	Post	1.10			Post	2.96			
FDOT 10-yr, 72-hr (3-day)	Pre	1.46	33.28	FDOT 100-yr, 72-hr (3-day)	Pre	2.18	34.02		
	Post	0.91			Post	1.13			

Note: Post discharge rate is total of pipe and spillway. See next page for spillway discharge values.

Results With High Tailwater (EL 33.1)

Design Storm		Discharge Rate (CFS)	Peak Pond Stage (ft)	Basin & Pond Config Info	
FDOT 3-yr, 1-hr	Pre	1.45	32.48	**Basin Information**	
	Post	0.57		Pre Area (ac)	3.1
FDOT 5-yr, 1-hr	Pre	1.86	32.62	Pre CN	66
	Post	0.65		Pre T_c (min)	19
FDOT 10-yr, 1-hr	Pre	2.51	32.81	Pre PRF	323
	Post	0.74			
FDOT 25-yr, 1-hr	Pre	3.52	33.10	Post Area (ac)	3.32
	Post	0.85		Post CN	84.2
FDOT 50-yr, 1-hr	Pre	4.63	33.37	Post T_c	10
	Post	0.94		Post PRF	484
FDOT 100-yr, 1-hr	Pre	5.56	33.59		
	Post	1.01		Pond Information	
FDOT 3-yr, 2-hr	Pre	1.67	32.84	Top of Pond	35.5
	Post	0.75		Bot of Pond	25
FDOT 5-yr, 2-hr	Pre	2.07	33.00	SHWT	31
	Post	0.81		TW EL	33.1
FDOT 10-yr, 2-hr	Pre	2.79	33.26		
	Post	0.90			
FDOT 25-yr, 2-hr	Pre	3.74	33.57		
	Post	1.00			
FDOT 50-yr, 2-hr	Pre	4.75	33.87		
	Post	1.09			
FDOT 100-yr, 2-hr	Pre	5.82	34.17		
	Post	1.17			

Notes:
1) All post discharge is thru the pipe to S-52
2) The high tailwater was modeled in the program as 3 point rating curve starting at a low elevation at time zero, reaching the peak at the peak intensity of the design storm, then returning to low elevation at the end of the storm.

Discharge Through Spillway @ Low TW (EL 27.5)

Design Storm	CFS
FDOT 25-yr, 8-hr	0.21
FDOT 25-yr, 24-hr	0.38
FDOT 50-yr, 4-hr	0.76
FDOT 50-yr, 8-hr	2.58
FDOT 50-yr, 24-hr	1.00
FDOT 100-yr, 4-hr	3.28
FDOT 100-yr, 8-hr	3.45
FDOT 100-yr, 24-hr	1.74

Notes
1) No other storms discharge through the spillway.

Spread Calculations

n = 0.016

Allowable Spread = 1/2 lane + bike lane + gutter = 6 + 4 + 1.5 = 11.5'

Inlet No.	Orig. C	Orig. Area ac	Prop. C	Prop. Area ac	C x A	Direct flow cfs	Previous Bypass cfs	Total Flow cfs	Cross Slope ft/ft	Longit slope ft/ft	Spread ft	Intercepted Flow cfs	Bypass Flow cfs	Bypass to Inlet No.
46	0.35	1.30	0.35	1.3	0.46	1.82	0	1.82	0.03	0.008	7.3	1.82	0.00	48
48	0.35	1.50	0.35	1.5	0.53	2.10	0	2.10	0.03	0.008	7.7	2.1	0.00	50
50	0.35	2.00	0.4	1.39	0.56	2.22	0	2.22	0.03	0.008	7.9	2.22	0.00	52
52	0.35	2.09	0.9	0.29	0.26	1.04	0	1.04	0.03	0.008	5.9	1.04	0.00	54
54	0.35	1.80	0.4	1.11	0.44	1.78	3.45	5.23	0.03	0.008	10.8	4.3	0.93	56
56	0.35	0.62	0.35	0.62	0.22	0.87	0.93	1.80	0.03	0.008	7.3	2.3	0	58

Notes:
1) Previous bypass flow for S-54 is the flow over the spillway for the 100-yr, 8-hr event.
2) Intercepted flow from Figure A-2, Storm Drain HB.
3) The proposed changes do not affect spread beyond S-56 because it has no bypass.
4) Cross slope, longitudinal slope, original C factors and areas from SR 236 documentation and plans.