Drainage Department Review Checklists
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Pond Siting Report Review Checklist

The primary purpose of a Pond Siting Report is to identify potential stormwater management alternatives and secondarily to estimate the size of each alternative for budgeting. An alternative could include stormwater treatment/attenuation ponds, Flood plain Compensation ponds, French Drains, retention/detention swales or any combination of these components. Alternatives may also include ideas such as combining basins, compensatory treatment, various conveyance schemes, etc. The FDOT Stormwater Management Facility Handbook is an excellent source for Pond Siting Reports.

GENERAL REPORT REQUIREMENTS

- Three (3) stormwater management alternatives should be developed for each basin.

- Every Pond Siting Report must have an Alternative(s) Evaluation Matrix. The alternative(s) evaluation matrix should include the following items: Pond Site/Stormwater Alternative Name, Pond Site/Stormwater Alternative Location, Pond Size Required (acres) at the tie in points to natural ground, the total parcel required for acquisition (this can occur if uneconomical remainders would be created), Total Cost of each alternative including wetland impacts (see next checklist item), FEMA Flood Zone, Wetland Impacts (acres), Habitat Impacts, Other Environmental Impacts, Archaeological Impacts, Historic Site Impacts, Social Impacts, Utility Conflicts, Current Land Use Zoning, Future Land Use Zoning, and Recommendations/Rankings.

- The Special Estimates provided by FDOT Right-of-Way personnel are **NOT** to be included in the Pond Siting Report as supporting documentation. Simply put, these estimates are not public record and use inflated factors for budgetary purposes. In lieu of including the Special Estimates as supporting documentation in the Pond Siting Report, instead include a statement referencing the document(s) as the source of parcel acquisition figures. The following statement can be placed on the Evaluation Matrix Sheet: *The cost evaluation for the stormwater management facility alternatives in this report includes stormwater management facility construction costs, costs associated with wetland impacts, and parcel acquisition costs. The stormwater management facility construction costs include cost of installed drainage structures, drainage pipes and outfalls, clearing and grubbing, earthwork excavation and grading, berm construction, erosion protection, fencing, access accommodations and sodding. The associated parcel acquisition costs for each alternative evaluated include the estimated cost of land and any impacted improvements, administrative costs and legal fees.*

- The Pond Siting Report narrative should discuss the project specifics, describe the existing and proposed basin limits, describe the type of basin (open or closed) and its receiving water body (if open), discuss any special basin, treatment (including water quality and TMDL's), or attenuation criteria, and discuss each proposed stormwater alternative/concept for each basin.

- An Executive Summary should be provided at the beginning of the PSR stating the reasons each preferred Stormwater Management Alternative was selected. The Alternatives Evaluation Matrix should immediately follow the Executive Summary.

- The Pond Siting Report should include the following visual documents: A Location Map with the project limits, Quad Maps with all pond alternates outlined on them, FEMA Maps with all pond alternates outlined on them, Typical Sections, Straight Line Diagrams, Soils Maps with all pond alternates outlined on them, aerials with all pond alternates dimensioned on them, Property/Tax Maps with all pond alternates dimensioned on them, and existing and proposed drainage maps.

COMPUTATIONS AND APPENDICES

- Stormwater Management Facility sizing computations must be submitted for all stormwater alternates. The Stormwater Management Facility Handbook (Chapter 5) discusses several alternatives for sizing stormwater management facilities. Preferably, each stormwater management facility will be flood routed with the design storm (as defined in the next checklist item) and the best geometric information available or sized based on Section 5.2.1 of the Stormwater Management Facility Handbook. The final size needs to also account for treatment volume if it exceeds the attenuation volume, diversion shelves (to increase residence time), the berm, freeboard, tie-down slopes, offsite by-pass swales around the pond, and an additional 10-20% for contingencies. It is preferred to downsize the pond later in design than to upsize it.

- The design storm is the storm that ultimately controls the stormwater management facility's size. The storm might be an FDOT 14-86 storm or matrix of storms or a jurisdictional agency's storm. For open basins, the design storm will most likely be a water management district storm or one of FDOT's 100-year matrix storms. The FDOT is not required to meet the design storm requirements of local municipalities but would accept locally developed IDF curves if the Engineer feels these local IDF curves are more applicable.

- For landlocked basins, the FDOT 100-year, 240-hour storm will most likely control the stormwater management facility sizing.

- Because of good soils, it may be prudent to propose an alternate that provides 100% retention of all stormwater runoff for the FDOT 100-year 240-hour design storm. These alternates must also satisfy the recovery requirements of the governing water management district and the FDOT (1/2 the retention volume must be recovered in 7 days and all of the retention volume must be recovered in 30 days with a Factor of Safety of 2 on the permeabilities).

- The Peak Discharge Approach as discussed in Section 5.1.2.1 of the FDOT Stormwater Management Facility Handbook is advocated by District Five.

- Because of certain permitting agency requirements, separation of offsite discharges from the Department's stormwater facility may be more economically feasible. If stormwater separation is proposed, the additional costs associated with the offsite conveyance system should be evaluated.

- Though a basin may have multiple discharge points, the post-development discharge rate must be limited to the pre-development discharge rate at each of these discharge points. Furthermore, if, in the proposed condition one stormwater management facility will serve multiple basins or a stormwater management facility is proposed to discharge to a single outfall though the pre-development basin had multiple outfalls, the post-development discharge is capped by the pre-development discharge through the exact same discharge point.

- Documentation must be provided that all possibly affected property owners have been contacted. Samples of the three letters (a.k.a. strike letters) that each property owner should receive can be found on the State FDOT website for drainage design. Even if an owner responds to one of the letters, the subsequent letters should still be sent to that owner – but the letters should be tailored more to that owner's previous response. Strike letters shall be copied to FDOT-D5's Project Manager, Drainage Design and ROW Cost Estimate/Design Support as .pdf files containing the strike letters and map attachments showing the pond locations.

- For design level Pond Siting Reports, documentation must be provided that all jurisdictional agencies have been contacted. Include any meeting minutes with those agencies. For PD&E level Pond Siting Reports, contact with the jurisdictional agencies is project dependent and may or may not be required.

- If a stormwater management facility is located adjacent to the roadway, the base clearance may need to be verified with respect to the anticipated design stage. Base clearance requirements can be found in Volume 1, Chapter 2 of the PPM. Specifically, the design stage of the pond should not encroach within the base clearance zone for more than 24 hours. For French Drain Systems, the top of the rock trench should not extend into the base clearance zone and the design stage should not exceed the top of the rock trench.

- For pond alternates, there should be a comparison between the pond elevations and the proposed low edge of pavement draining to the pond to determine if it is feasible to convey water to the pond and to determine if piping costs for one alternative will be higher than another. Chapter 2 of the Stormwater Management Facility Handbook provides methodology for estimating the minimum EOP height above a pond. However, the designer is free to use a different methodology as long as it is based on sound engineering judgement.

- All assumptions should be clearly stated and documented.

- If alternates are flood routed, the TW conditions must be properly documented.

SPECIFIC REQUIREMENTS FOR RETENTION SWALES

Retention swales can only be used in District Five under certain conditions because, historically, these swales have not recovered as predicted by the Engineer. This lack of recovery introduces an unnecessary safety hazard, maintenance issues, and a non-compliant system that could require future right-of-way acquisition as a remedy. These issues can be minimized by adhering to the following requirements:

- Retention swales are only permitted for use with in situ soils identified by an appropriate NRCS Soils Survey as Hydrologic Soil Group ‘A’.

- The bottom of any retention swale must be located a minimum of 2’ above the prevailing SHGWT elevation.

- If a ditch bottom inlet system conveying stormwater to a pond surcharges into the swale above due to the design stage of the pond, then the swale above the ditch bottom inlet system becomes a retention swale and must meet all of the special requirements for retention swales.

- The FDOT Standard Specifications for Road and Bridge Construction indicate an implied freeboard of 0.30 feet for all retention swales. If a swale is surcharged by the design stage of the downstream pond, the surcharge must be contained within the swale with at least 0.30 feet of clearance.

- If a ditch bottom inlet system underlying a swale surcharges due to its pond’s design stage, base clearance may become an issue. In short, the pond stage needs to recover to an elevation below the base clearance zone within 24 hours.

- If no other alternative is available and if the requirements above cannot be met, retention swales might be considered by District Five on a case-by-case basis.

LOCATING PONDS

- Use existing FDOT properties or other State owned property where feasible.

- Minimize the number of parcels required. For example, avoid using part of two parcels if a pond will fit within one.

- Generally, property owners prefer to have ponds placed toward the rear of their property because the portion of the property adjacent to the highway is usually more valuable. This is not always the case because local ordinances may impose setbacks that may make the front of the property a more logical place for a pond. The exact location of the pond on private property should be negotiated with the owner of the property if possible.

- Avoid splitting a parcel, thus creating two independent parcel remainders. Also, though sometimes it is unavoidable, try to avoid leaving uneconomical property remainders.

- Consider the parcels identified by the Right of Way office. Even if a parcel is not large enough to provide all the stormwater management, it may be large enough to provide the treatment for stormwater quality. Or it could replace treatment and attenuation for parcels adjacent to the road that will have their ponds removed because of the road improvements.

- Avoid wetlands.

- Avoid archaeological sites and historic structures/sites listed on or eligible for listing on the National Register of Historic places.

- Consider a joint-use facility or regional pond as an alternate, if feasible. While joint-use with a developer should not be ruled out, it is preferable that a local municipality at least operate and maintain the stormwater management facility, if not own it outright. If an alternate requires joint-use with a developer without municipality involvement, the final design should be such that lack of maintenance of the proposed stormwater management facility by the developer will result in flooding of the developer's property only – not the highway.
- DO NOT consider an option that requires water quality monitoring because it is expensive.

- Stormwater treatment systems must be located at least 100 feet from any public water supply well. (Chapter 62-555, F.A.C.)

- Avoid sites with billboards or at least sculpt the pond around the billboard and maintain access to the billboard.

- Ponds should not be located in overhead utility easements – especially power line easements.

- In areas where protected lands (4F), such as State or Federally owned forestry lands, lie adjacent to both sides of the highway, consider the option of NO stormwater treatment facility. The Water Management Districts typically have provisions in their rules that could make this option feasible and this option will require direct negotiations with the regulatory agencies and the stewards of the protected lands. These negotiations should focus on the impacts of providing stormwater treatment versus other environmental impacts that might be borne by constructing such a facility like habitat destruction, wetland destruction, etc.

- In some instances, especially landlocked basins with no realistic chance of discharge, it may be prudent to explore the alternative of obtaining flood rights over that part of a property where stormwater runoff would naturally be collected and impounded. Flood rights are usually purchased on land in a natural state, which already floods under certain conditions from non-highway sources. This alternative might be best suited along 4F properties, properties that have no plans to develop and whose owners do not want a manmade pond (popular with race horse farms), or properties with natural sinks or depressional areas that are largely un-developable.

- Single ponds that can serve multiple basins should be evaluated whenever possible.

- In general, French Drains should not be considered in Karst areas or Interstates. They might be considered on a case-by-case basis if no other option is available.

MAINTENANCE CONSIDERATIONS

- Per Section 5.3.4.2 of the Drainage Manual, ponds shall be designed to provide a minimum of 20 feet of horizontal clearance between the top edge of the normal pool elevation and the right-of-way line.

- The minimum berm width shall be 15'.

- The maximum berm slope shall be 1:8.

- The minimum radius of the inside berm corners shall be 30'. 35' would be better.
- Pond slopes (above the water line) and tie down slopes should not exceed 1:4. See figure 5-1 of the Drainage Manual.
- One foot of freeboard must be provided between the design storm peak stage and the low edge of the maintenance berm. See figure 5-1 of the Drainage Manual.
- The design storm peak stage should not exceed the lowest curb inlet edge of pavement elevation for the storm sewer system supplying the pond.
- In general, fences should be placed around all ponds since most ponds are located in populated areas. Fences are valuable in rural areas, too.
- It is preferred to make ponds serving Interstate highways and other limited access facilities part of the limited access facility by wrapping the limited access fence around the back side of the pond omitting the fencing directly adjacent to the highway for easy maintenance access.
- Gates should be located in pond corners and should be sufficiently wide to allow for heavy equipment access. The grades of the driveway access through the gate should be flat enough to easily allow tractor/mower combinations or top heavy Grad-All type vehicles to access the pond.
- Access easements need to be provided when ponds are not accessible directly from a road right-of-way. The width of the easement needs to be sufficient to allow for heavy vehicle access.
- Drainage inflow and/or outflow easements must be sufficient in width for maintenance vehicles to excavate a standard trench without a trench box <u>and</u> an adequate maintenance work zone or berm adjacent to this trench. Figure 3-2 of the FDOT Stormwater Management Facility Handbook is an excellent tool for determining adequate drainage easement widths for pipes and ditches. In general, the bottom width of the trench is determined by the swale width or pipe size, the trench slopes are 1:2, and the maintenance berm is 15 feet. **Because of the maintenance berm requirement, a pipe or ditch should never be centered within an easement. It should be centered in the portion of the easement remaining after deduction of the 15' maintenance berm.**
- When possible, it is preferred to have the ingress/egress easement and the drainage easement coincide together. This would imply the access is generally provided where the maintenance berm is planned.
- Ideally, pond outfalls will be directed back to FDOT right-of-way where stormwater will then be conveyed to the desired outfall point.
- Avoid placing easements near buildings because of maintenance equipment vibration and the swing arc of large equipment booms.

- Access and drainage easements should follow along existing property lines. This will prevent future developers from approaching the Department about relocating these easements.

- Pond sumps of any kind should be avoided. If absolutely necessary, pond sumps should be extremely large to prevent sediment buildup and the eventual blockage of the inflow pipe.
- Ponds with underdrain recovery systems should be avoided. One place the Department might entertain such a system would be within 10,000 feet of airports where wet ponds are discouraged by the FAA.

- Stormwater alternates that require pumping of any kind shall not be considered.

- Stormwater alternates that would result in siphons within the storm sewer system should be avoided.

- Ponds should not be proposed where excessive berm heights could occur with respect to natural ground of adjacent properties. Aside from the possibility of a catastrophic failure, seepage from these ponds can cause failure to adjacent septic systems, French Drain systems, parking lots, and roadway pavements.

Drainage Maps Review Checklist

Most of the items in this checklist can be found in the Plans Preparation Manual Volume II in Chapter 5.

Plan

- Aerials may be used on the Drainage Maps up to final plans. Aerial backgrounds must be removed for final plans.

- Are the Drainage Maps legible? Occasionally, Drainage Maps will not be legible and the design consultant will state it was the negotiated scale. It does not matter what scale was negotiated. The Drainage Maps must be legible.

- Insets shall be used to show areas that are of such magnitude that the boundaries cannot be plotted at the selected scale. So, if the drainage basin boundaries extend beyond the limits of the Drainage Map, insets must be added, at a larger scale if necessary, to show the remaining drainage boundaries.

- If a cross drain is included in the Flood Data Box, the contributing drainage areas must be shown on the Drainage Maps.

- Station equations and exceptions shall be shown. Begin and end stations of the project, construction, bridge and bridge culverts shall also be shown.

- Existing physical land features, such as lakes, streams and swamps, shall be clearly labeled by name and direction of flow. Past high water elevations and date of occurrence, if available, and present water elevations along with the dates the readings were taken shall also be shown.

- All basins shall be tabulated in acres and all drainage divides and pop-off elevations and locations must be shown.

- Existing road numbers and street names, existing ponds that FDOT proposes to drain to, existing and proposed flow arrows, stationing, Section, Township and Range lines, county lines, a north arrow, and the scale shall be shown on all Drainage Maps Sheets.

- Existing drainage structures with type, size and flow lines must be shown. If the scale is such that the information for each existing drainage structure cannot be shown, the existing drainage structure information may be compiled into table format and shown in the plan or profile section of the Drainage Maps or on a separate sheet amongst the Drainage Maps Sheets. The existing drainage structures still must be plotted if tabularized.

- Check all existing drainage structures for accuracy. It is common for surveyors to specify, for instance, a pipe of a size or material that does not exist.

- Proposed drainage structures, pipes, outfall structures, and pond locations shall be shown. All structures and pipes shall be noted by structure number and all ponds by pond name or number.

- All contributing areas or sub-basins to each proposed drainage structure must be shown. A table may be used to summarize the contributing areas to each structure if legibility might be an issue. These areas must match the areas used in the storm sewer tabulations.

- If time permits, a field review should be conducted to validate the drainage areas shown on the Drainage Maps. Furthermore, if you have any historical knowledge of drainage patterns or flooding problems, validate this knowledge against the Drainage Maps provided.

- Note 1 of Exhibit 5-1 on page 5-9 of the PPM Volume II must be included on each Drainage Map Sheet. *DO NOT USE THE INFORMATION ON THIS SHEET FOR CONSTRUCTION PURPOSES. This sheet is in the plans for documentation and to assist construction personnel with drainage concerns.*

Profile

- The profile of the existing natural ground shall be plotted and labeled and the existing elevation noted at each end.

- The proposed profile grade shall be plotted. If multiple profile grades lines are designed, all must be shown. Percent of grade need not be shown. Special gutter grades and special ditches should not be plotted.

- Begin and end project, bridge and bridge culvert stations, and station equations and exceptions, shall be flagged.

- Profile grade line elevations shall be shown at begin and end project stations and at the beginning and end of each sheet.

- Proposed cross drains shall be plotted by structure number with the invert and location at the point the cross drain crosses the centerline of construction.

- For projects with storm sewer systems, only the mainline structures and pipes shall be shown. Laterals need not be shown. Each structure shall be flagged with its appropriate structure number, and the flow line elevations noted for all incoming and outgoing pipes. All pipe flow line elevations must exactly match the Drainage Structures Sheets.

- All high water elevations affecting base clearance or roadway grades shall be shown.

- Make sure that visually the elevations shown in the drawing line up with the grid on the side of each sheet.

- Are the Drainage Maps legible? Occasionally, Drainage Maps will not be legible and the design consultant will state it was the negotiated scale. It does not matter what scale was negotiated. The Drainage Maps must be legible.

Flood Data Box Review Checklist

Cross Drains include pipes and box culverts. A bridge culvert is a box culvert with a total span length of at least 20' (e.g. a double 12' x 5' box has a total span of 24')

- The structure number should match the cross drain structure number in the Summary of Drainage Structures and the Drainage Structures Sheets.
- Side Drains under a side street are cross drains for that side street and must be analyzed as such and included in the Flood Data Box.
- Bridges and bridge culverts are not to be included in the Flood Data Box despite Section 5.1.3 of the PPM Volume II requiring this. If a bridge or bridge culvert is part of the project, all pertinent information for that bridge or bridge culvert will be shown on the BHRS.
- Cross drains that function exclusively as wildlife crossings do not need to be shown in the Flood Data Box.
- Make sure the proper Design Flood was used per Section 4.3 of the Drainage Manual.
- The Base Flood is always the 100-year Flood Elevation and corresponding discharge for each structure and the Greatest Flood is always the 500-year Flood Elevation and corresponding discharge for each structure. The Base flood should not be higher than the PGL.
- Note 2 of Exhibit 5-1 on page 5-9 of the PPM Volume II must be included with the Flood Data Box. Make sure the correct datum is listed – NGVD 29 or NAVD 88.
- The Definitions for Design Flood, Base Flood, Overtopping Flood, and Greatest Flood must be included.
- The PPM requires the Flood Data Box to be included on the Drainage Map. If the Drainage Map is not included in the plans set, then the Flood Data Box should be on a Summary of Quantities Sheet or the first Plan/Profile Sheet per Section 5.1.3 of the PPM Volume II.
- All new, replaced, or extended cross drains must be included in the Flood Data Box.
- All cross drains that have a history of flooding or other hydraulic problems, even if the cross drain is not modified in any way, must be included in the Flood Data Box.
- Cross Drains that are not being modified but are impacted by the modification of another cross drain within the same drainage basin must be included in the Flood Data Box.
- The Overtopping Flood will only be filled out if the road would be overtopped before the 500-year flood. If so, the Overtopping Flood would be filled out but the Greatest Flood would be left blank. For other cases of overtopping, see page 9 of the Culvert Handbook.
- The Design Flood should not exceed the lowest edge of pavement within the basin containing the cross drain (District Policy). A lower Design Flood Elevation may be necessary if adjacent properties would be impacted with the allowable design flood.

Cross Drain Design Checklist

Cross Drains include pipes and box culverts. A bridge culvert is a box culvert with a total span length of at least 20' (e.g. a double 12' x 5' box has a total span of 24')

- Make sure the proper Design Flood was used per Section 4.3 of the Drainage Manual. Most FDOT roadways within District Five carry a design flood frequency of 50 year for analysis. If a lower frequency is used, documentation of the 20 year ADT should be included.
- Side Drains under a side street are cross drains for that side street and must be analyzed as such. The Design Flood frequency is typically 25 year unless the projected 20 year ADT exceeds 1500. For projected 20 year ADT's greater than 1500, the Design Flood frequency would be 50 year.
- The Base Flood is always the 100-year Flood Elevation and corresponding discharge for each structure and the Greatest Flood is always the 500-year Flood Elevation and corresponding discharge for each structure. The Base flood should not be higher than the PGL.
- All new, replaced, or extended cross drains must be analyzed.
- All cross drains that have a history of flooding or other hydraulic problems, even if the cross drain is not modified in any way, must be analyzed.
- Cross Drains that are not being modified but are impacted by the modification of another cross drain within the same drainage basin must be analyzed.
- The Overtopping Flood must be determined if the road would be overtopped before the 500-year flood. If so, the Overtopping Flood would be reported in the Flood Data Box and the Greatest Flood would be left blank so long as it occurs between the Base Flood and the Greatest Flood. For other less frequent cases of Overtopping Flood, see page 9 of the *Culvert Design Handbook.*
- If the Overtopping Flood would occur before the Design Flood, a risk assessment must be performed. In all likelihood, serious consideration should be given to prevent this situation from occurring. Mitigation might include raising the road, providing extra storage in the basin, performing a different analysis that takes into account percolation and existing basin storage, etc. Most frequently, this situation occurs when an existing roadway traverses across the bottom of a large natural depression.
- The Allowable High Water (AHW) coincident with the Design Flood should not exceed the lowest edge of pavement within the basin containing the cross drain (District Policy). A lower Design Flood Elevation may be necessary if adjacent properties would be impacted with the allowable Design Flood.
- The Overtopping Flood should be determined using log-log graph paper per the technique outlined in Example 1 of the *Culvert Handbook.*

- Under certain conditions, it may be appropriate to establish a level of risk allowable for a site and design to that level. When the risks associated with a particular project are significant for floods of greater magnitude than the Design Flood, a greater return interval design flood should be evaluated by use of a risk analysis. Risk analysis procedures are provided in FHWA's HEC 17 and discussed briefly in Appendix A of the *Hydrology Handbook.*

- If the cross drain is located on a monitored waterway such as a FEMA Regulatory Floodway, then a more precise backwater analysis should be performed (such as using HEC-RAS).

- The tailwater (TW) to be used in the analysis of a riverine system or ditch should be the greater of the normal depth, the crown of pipe, or the headwater (HW) of the structure immediately downstream. Other possible conditions that could produce higher TW elevations might be the mean annual stage of a lake, the design stage of a pond, a controlled elevation due to a lock or weir system downstream, or, if tidal, the mean high tide (MHT) as established by FDEP. The TW must be thoroughly documented in the computations since it is the basis for determining the HW of the cross drain.

- Avoid placing wildlife shelves within box culverts.

- To determine flood flows, the first choice should be to use the information available from an observed gage or, for regulated or controlled canals, the hydrologic data from the controlling entity. If no gage, gage information, or other hydrologic data is available, then either the regional or local regression equations developed by USGS or the Rational Method should be used. The Rational Method is limited to a maximum basin size of 600 acres.

- In general, the only known applicable Regression Equations for use in District Five are the USGS Regression Equations for Natural Flow Conditions or the USGS Nationwide Regression Equations for Urban Conditions. The latter is seldom used.

- The range of applicability for the Regression or Rational Methods should be verified.

- For gaged sites or regulated or controlled canals with available hydrologic data, all acquired records must be provided in the documentation and the determination of the flood flows clearly shown.

- If regression equations for natural conditions are used, a drainage map should be provided of sufficient scale to be legible, the 10% and 85% channel points and corresponding surveyed elevations should be identified on the drainage map, any regression constants and exponents should be documented, the region of applicability should be documented with Figure 4 of the *Hydrology Handbook*, and the computations and maps documenting how the lake percentages were derived should be provided.

- Natural depressions within the basin might be considered as lakes when using the regression equations since they would have to become lakes before contributing runoff to the cross drain.

- If the Rational Method is used, a drainage map should be provided of sufficient scale to be legible with sub-basin delineations for each applicable runoff coefficient, the time of concentration path should be clearly labeled and divided into appropriate segments (sheet flow, shallow concentrated flow, swale flow, pipe flow, etc.) with clearly defined elevations for determining land slope values, the composite runoff coefficient computations should be provided with the appropriate design source, and the design source for the intensity should be provided.

- Tidal flows must be determined per Section 4.7.2 of the Drainage Manual.

- All riverine computations must be performed using the FHWA Hydraulic Design Series #5 document. A Culvert Capacity Worksheet as shown in Figure 12 of the *Culvert Design Handbook* and the associated nomographs must be provided if performing hand calculations.

- In general, cross drain end treatments should be located outside of the clear zone.

- Each cross drain should have documentation of a field review such as photos and records of contact with the Local Maintenance Unit.

- If velocities at the outlet of a cross drain exceed 4 fps, lining or other energy dissipation, an increase in cross drain size, use of a rougher culvert, or an increase in the number of cross drains at the crossing should be considered.

- The Velocity Method may be used to analyze a cross drain ONLY when ALL of the following conditions are met: 1) No signs of scour are present on either end of the cross drain, 2) no history of problems could be determined from the local government or the appropriate maintenance unit, and 3) the cross drain is proposed ONLY to be extended. The Velocity Method is presented in Example 6 of the *Culvert Handbook*.

- Some programs used to perform the hydraulic computations for a cross drain are not equipped to handle mitered end sections and the associated entrance loss. If a program is used, the entrance loss used in the analysis should be clearly documented, otherwise hand computations should be provided.

Typical Sections and General Notes Review Checklist

- The maximum number of travel lanes with a cross slope in one direction is 3 lanes except for curb and gutter sections; 4 lanes can be sloped in one direction in curb and gutter sections.

- Figure 2.1.1 of the PPM Volume 1 should be consulted for allowable cross slope and lane configurations.

- If a lane is tilted toward a raised median, drainage structures or slots through the median must be provided. If slots are used, the number of slots should be sufficient to prevent hydroplaning per Section 12.3 of old Drainage Manual Volume 2B.

- Bridge cross slopes should be the same all the way across the bridge deck no matter how many lanes are involved. Bridges with one-way traffic should have one, uniform cross slope, while bridges with two-way traffic may be designed with a crowned bridge deck section.

- If the R/W permits, slopes on the Typical Section should be 1:4 or flatter because slopes steeper than 1:4 are more maintenance intensive.

- All pervious areas should have sod. Seed and mulch should not be specified in ditches. Seed and mulch is great for dry retention pond bottoms.

- If a bridge Typical Section is abutted by an Urban Typical Section or a Rural Typical Section with sidewalk, a proper transition must be provided to get the water off the bridge pedestrian walkways without cascading down the embankment at the end of the bridge. Remember the bridge Typical Section cross slope must be down and constant all the way across the deck including shoulders and pedestrian walkways. But the sidewalks of the abutting roadway Typical Sections are sloped in the opposite direction to direct water towards the roadway. So a proper transition and possibly a curbed backstop of sorts on the back of the roadway sidewalk may be necessary to force the bridge drainage back towards the roadway.

- The following note should be in most all plans sets: *Existing Drainage Structures Within the Construction Limits Shall Be Removed, Unless Otherwise Noted.* Alternatively, the note could read: *Existing Drainage Structures Within the Construction Limits Shall Remain, Unless Otherwise Noted.* Whichever note is used, the Plans Sheets must be checked to verify that existing structures to remain or removed, respectively, are indeed noted.

- A General Note describing the vertical datum used should be included. Make sure the computations account for this fact. FEMA Maps, Quad. Maps, and old plans are generally on 1929 Datum and proper conversions between datums may be necessary.

Summary of Drainage Structures Review Checklist

It is recommended the Summary of Drainage Structures be viewed as a sort of Table of Contents of the drainage components in the plans set. It, in itself, should be viewed as a checklist and it would be good practice to start any plans review with these sheets. Every single data field in the Summary of Drainage Structures should be verified from the rest of the plans set and vice versa.

- All structure numbers and stations should match the side sheet stations and structure numbers on the Drainage Structures Sheets.

- All structure numbers, stations, and sides should match the structure numbers, stations, and sides shown in the paragraphs for each drainage structure in the Drainage Structures Sheets. If the structure is on the centerline, i.e. it has a zero offset, the side can be listed as LT, RT, or CL/BL as long as consistency is maintained.

- The Description should match the paragraphs of each drainage structure on the Drainage Structures Sheets. Customarily, the convention for naming a structure consists of the structure itself and the existing pipe. THIS IS NOT ALWAYS THE CASE. Sometimes other pipes entering or leaving a structure must be assigned to that structure because there is no other structure for assignment. All types of inlets shown in the Drainage Structures Sheets paragraphs would be simply denoted as INLET in the Summary of Drainage Structures Description, both types of manholes would be denoted as MANHOLE, etc. So, a J-1 Inlet with a 48" Pipe exiting to another J-1 Inlet would simply be denoted as INLET, PIPE in the Summary of Drainage Structures Description. Likewise, a Type C inlet with an 18" Pipe exiting to a roadside ditch with an MES on the end would be denoted as INLET, PIPE, MES in the Summary of Drainage Structures provided all three are at the same Station.

- The Number of Barrels must match the Plans Sheets and be shown in the Drainage Structures Sheets.

- The pipe length quantities shown in each pipe size column must match the Plans Sheets. If they do not match, make sure another stray pipe was not added to the total quantity because there was no other structure for it to be assigned to (see previous item). NOTE: Sometime in the future, CD and SS pipes will be grouped together as well as certain sized pipes (e.g. 18"-24"). French Drain, gutter drains, and other types of pipe will continue to be quantified in separate columns.

- Pipe lengths should be checked to determine they do not exceed the maximum length allowed by Section 3.10.1 of the Drainage Manual.

- There should be separate columns for quantifying SD and CD MES's. SD MES's would be installed on longitudinal systems and CD MES's would be installed for transverse or crossing systems. The Description should match the Drainage Structures Sheets and the MES slope should be shown in the Remarks column.

- Other types of Remarks should include 'Eccentric Cone' for manholes, 'Alt. A' or 'Alt. B' if one or the other must be specified, J-Bottom Dimensions, 'Reticuline Grate', 'Alt. G Grate', 'Control Structure',' Slot', 'Traversable Slot', '2-Piece Cover', etc.

- J-Bottom Dimensions should meet notes 6 and 8 of Standard Index 200, Sheet 3 of 3.

- The sod quantity assigned to a structure should match the Standard Index for that structure. The Summary of Sodding should not include the sod assigned to a drainage structure.

- The concrete quantity assigned to a structure should match the Standard Index for that structure. Usually, concrete quantities are assigned to endwalls.

- Structure numbers should increase alphabetically and/or numerically. Stations should also increase numerically though there may be some exceptions.

- Make sure all proposed or modified drainage structures shown in the Plans Sheets are accounted for in the Summary of Drainage Structures and the Drainage Structures Sheets.

- Side drains should NOT be shown on the Summary of Drainage Structures as they are not usually assigned structure numbers. They are customarily shown on the Summary of Side Drains.

- Make sure each structure type from the paragraphs in the Drainage Structures Sheets is tallied in the proper column in the Summary of Drainage Structures. Pay special attention to 'Special' and 'Modified' structures to make sure they have been properly designated. A common design error is to denote a structure as 'Special' when it should be 'Modified' and vice versa.

- Verify the Sub-Totals and/or Totals on each sheet of the Summary of Drainage Structures.

Optional Pipe Materials Checklist

An Optional Pipe Materials Analysis consists of two parts: (1) the corrosion analysis with the Culvert Service Life Estimator (CSE) program and (2) the structural analysis (evaluation of minimum and maximum cover heights) with Index 205.

- The Design Service Life (DSL) used in the Culvert Service Life Estimator (CSE) program must be in accordance with Table 6-1 of the Drainage Manual unless documentation of any exception by the District Drainage Engineer is provided.

- CPE (see Index 001) is approved for a 100-year DSL under interim acceptance. It must still meet all structural requirements and it is not to be used in the following locations:

  Under the mainline travel lanes of limited access facilities, under the pavement of 8-lane urban facilities, under the pavement of roadways providing immediate access to coastal islands, within the confines of mechanically stabilized earth (MSE) walls, and in locations where the failure of the pipe would jeopardize buildings adjacent to the Department's right-of-way.

- All pipes and culverts (cross drains and side drains) require an Optional Pipe Materials Analysis. The only exception would be for pipe extensions.

- Pipes that are to be extended should match the existing material to reduce the need for a jacket (Index 280). However, if the existing pipe would fail a corrosion evaluation or shows signs of deterioration, the existing pipe should be replaced or rehabilitated (e.g. lined).

- The corrosion evaluation must document the boring selected for EACH pipe and the selected boring must be the most representative of the soil conditions encountered for the pipe being evaluated. For example, a boring 500' away from a pipe in question shows a stratum that is highly corrosive. Meanwhile this pipe is proposed to be in a stratum (boring within 50') that is less corrosive but below the more corrosive stratum and above the water table. In this case, the boring 500' away from the pipe being evaluated may be more representative of the soil conditions than the boring 50' away because infiltrated water must flow through the corrosive layer towards the pipe to seek the groundwater below the pipe.

- Under no circumstances can the worst case corrosion parameters within the project limits <u>or</u> the worst case corrosion analysis site be applied to an entire project. Each pipe should have its own corrosion and structural analysis.

- If a pipe material comes out of the CSE with a longer DSL than another material, this DOES NOT eliminate the lower DSL material from consideration since both materials meet the minimum DSL. Concrete pipe (SRCP), for instance, often comes back with a DSL > 200 years whereas Corrugated Polyethylene pipe (CPE) will only return a 100-yr DSL. If the minimum DSL is 100 years, both options are viable unless the structural evaluation eliminates one of the options.

- On smaller projects with no borings for corrosion testing, SCS data may be used for the corrosion portion of the Optional Pipe Analysis. The generalized soil maps usually classify the environment as either slightly, moderately, or extremely corrosive. All projects with new pipe must be evaluated for Optional Pipe Materials. This is evidenced by the Pay Item descriptions for pipes and culverts.

- Jack and Bore casings must have a corrosion analysis performed ONLY IF the jack and bore pipe is to function as the carrier pipe. If the jack and bore pipe is to serve only as a means for insertion of a carrier pipe, a corrosion analysis of the jack and bore pipe is not necessary as long as the interstitial space between the jack and bore pipe and the inserted carrier pipe is grouted or flowable filled. If this is the case, corrosion analysis of the carrier pipe <u>IS</u> necessary. Section 3.2 of the Optional Pipe Materials Handbook explains how to perform this computation.

- Elliptical pipes should be evaluated for corrosion as equivalent round pipes despite the differences in wall thickness (of the round equivalent). However, if a pipe is specified to be elliptical, there may only be one material that meets the elliptical size specifications. For example, there is no such thing as an elliptical 14" X 23" metal pipe.

- If during the structural evaluation a material would require a special installation or special approval, this material should be eliminated from further consideration UNLESS a minor change such as a thicker gage would allow the material to be used without any special installation or approval.

- Some pipes, such as crossings under highways or driveways, may require multiple cover evaluations because the pipe may cross under paved and unpaved areas.

- If cover cannot be achieved for any material option including elliptical pipe and pipe arches, high strength concrete pipes (SRCP or ERCP, Class III or IV) may be considered if a structural engineer approves each installation. Index 205 requires high strength pipe for ERCP depending on the cover height.

- NRCP only comes in round pipe sizes. Otherwise, by specification, NRCP can be used anywhere SRCP can be used. The District prefers not to use NRCP under pavement.

- NRCP cannot be used for crossings under Interstates. It is recommended NRCP also not be used for crossings under other facilities with heavy traffic or facilities with tight rights-of-way, e.g. buildings near the right-of-way line.

- Avoid using NRCP for French Drain as the perforations will likely weaken the pipe.

- Concrete pipes cannot be used for gutter drains because gravity will cause the pipe joints to pull apart. Concrete also should not be used for other steep sloped pipes.

- Section 6.5 of the Drainage Manual gives allowable materials for vertical drains. These types of pipe installations are rare.

- In brackish or saltwater regions, or regions classified as extremely corrosive, only aluminum, plastic, and NRCP pipes can be used depending on the DSL and cover requirements.

- If a pipe is to be placed in a fill section, a corrosion evaluation of a project's pond soils should be performed since this is the likely embankment source.

- Corrosion testing should be performed, to the extent possible, on samples obtained at the same depth the proposed pipe will be installed.

- If a corrosion evaluation for large pipes (> 48") results in no viable options, consider using double pipes of a smaller diameter as this might trigger allowance of PVC since PVC is not available in large pipe sizes.

Plan and Profile Review Checklist

Plan

- All proposed or modified drainage structures should be numbered and accounted for on the Drainage Structures Sheets.

- Depending on whether the General Note states "…all existing drainage structures...to be removed…" <u>or</u> "…to remain…", make sure the existing structures not covered by that note are properly labeled.

- Proposed guardrail should not be placed over a pipe unless the pipe is sufficiently deep.

- The north arrow and scale should be shown.

- For curves with superelevation, inlets should be placed 20' to 25' outside of the superelevation flat spot. This applies to curb and gutter sections and shoulder gutter sections.

- The edge of all curb inlets should be located a minimum of 3' from the radius return/tangent point of all driveways and side streets to allow for proper gutter transitions.

- Curb inlets should not be located in curb returns. If there is an existing inlet, the Engineer should attempt to relocate it unless scoped to do otherwise.

- Curb Inlets should not be located within pedestrian ramp or crosswalk areas.

- Inlets should be located at all sags and the correct type of inlet should be shown. Sags should depict double-throated inlets and single-throated inlets on grade should have the throat oriented in the correct direction.

- Shoulder gutter inlets must be used on all fill slopes higher than 20 feet and on fill slopes higher than 10 feet if the roadway longitudinal slope is greater than 2 percent.

- Inlets in sag vertical curves that have no outlet other than the storm drain system (such as within underpasses, between barrier walls, or depressed sections where the roadway is much lower than the surrounding ground) <u>and</u> do not have open throated inlets, should have flanking inlets on one or both sides. These flanking inlets should be located to satisfy spread criteria when the sag inlet is blocked. Even with an open throat inlet, flanking inlets should be considered when the minimum gutter grade cannot be met.

- For landlocked basins with curb wrapped driveways, inlets should be placed up-gradient of driveways that might otherwise convey flow offsite. Trench drain might be a necessary supplement across the driveway to collect as much runoff as possible.

- Pipe lengths must be labeled and should not exceed the allowable lengths shown in Section 3.10.1 of the Drainage Manual.

- Angled or skewed pipes into or out of structures should be avoided. If angled pipes are necessary, the designer should provide calculations or a separate drawing in the drainage computations documenting the angles are not excessive.

- All pipe sizes should be labeled. The minimum allowable proposed pipe size is 18" or its elliptical or pipe arch equivalent.

- J-Bottoms should be shown ghosted out and the pipes should connect to these bottoms to ensure the CADD software is properly quantifying the pipe lengths. The J-Bottoms shown should match those specified in the Drainage Structures Sheets.

- Manholes should be avoided within pavement areas and inlets should never be located in pavement areas. If manholes must be placed in pavement areas, they should be Type 8 tops (cones) and NOT be located within the wheel paths.

- Storm sewer crossings of the highway or major side streets should be minimized. It may be necessary to provide trunk lines on each side of the highway at shallower depths than one trunk line on one side of the highway at a deeper depth to minimize the number of crossings.

- Traffic boxes, pull boxes, sign truss footings, lighting, etc. should not be located in ditches or retention swales or over the top of storm sewer pipes.

- Wetland lines should be shown cross referenced to the Roadway Cross Sections.

- Drainage structures should not be placed too close to the R/W line, easement line, or an immovable object (such as a home) because it may not be constructible. The trench width should be considered when placing drainage structures.

- Back of sidewalk inlets should be located anywhere concentrated flow is expected from offsite properties. The Drainage Maps should clearly define these points of interest.

- The trench drain type, begin and end stations, and outfall pipe locations must be shown per Standard Index 206 Design Note 2.

- The orientation of the drainage structure should be consistent with the size of pipe entering or leaving that structure.

- If a DBI has a traversable slot, the pavement should be shown.

- There is no need to put a headwall on a pipe that is punching through a gravity wall. The gravity wall can function as the headwall.

- The begin and end stations for ditch pavement should be shown.

- If Types 7, 8, 9, or 10 curb inlets are specified, the locations for their use are very specialized and should be evaluated per the Standard Indexes for each respective structure.

- Bridge culverts require assignment of a drainage structure number and a bridge number. The begin and end stations from outside wall to outside wall should be labeled.

- Proposed bridges and approach slabs shall be shown by simple outline and identified by bridge number. Begin and end stations of bridges and approach slabs shall be noted.

- If a bridge carrying a pedestrian path sloped to the outside connects to a roadway with a pedestrian path sloped towards the inside, how will the water within the pedestrian path area be deflected back towards the roadway or otherwise captured? If provisions are not made, this water will run off the end of the bridge and down the embankment causing erosion.

- A short section of lateral ditch/outfall centerline shall be shown together with a note referring to lateral ditch/outfall sheets for details.

- Flume inlets must be used with Type 'F' curb whether a sidewalk is present or not.

Profile

- Special gutter grades must be provided anywhere the longitudinal slope is less than 0.30%. The begin and end special gutter grade stations and elevations and the special gutter slope should be shown.

- A special ditch is one that does not match the depth of the typical section or the slope established by the roadway profile. Special ditch grades must be provided where typical ditch slopes might drop below 0.05%. The begin and end DPI stations and elevations and the special ditch slope should be shown. DPI's should also be shown at all break points. **Please also note** that special ditches are commonly used for grades in excess of 0.05%.

- For DPI's at common stations with the Roadway Cross Sections, the DPI elevation should EXACTLY match the cross sections. If a DBI is present at the same station, the DPI elevation should also EXACTLY match the grate elevation of the DBI shown in the Drainage Structures Sheets unless a non-traversable slot is present. If a non-traversable slot is present, then the DPI elevation should EXACTLY match the slot elevation shown in the Drainage Structures Sheets.

- Storm sewer pipes, inlets and manholes along the mainline trunkline shall be shown. Among these structures, sag structures should line up with the low point of the profile. Pipe sizes, structure numbers, and flow lines must be shown for all pipes entering or leaving the plotted structures including cross pipes.

- Pipe flow lines should EXACTLY match the flow lines shown on the Drainage Structures Sheets.

- The existing ground line should be shown and labeled and the existing ground elevations should be labeled at each end of each sheet.

- The grid and scale should line up with the elevations and stations shown.

- The % longitudinal grade should be shown on each tangent section. The minimum allowable grade is 0.30% for sections with curb and gutter or shoulder gutter per the Drainage Manual.

- All high water elevations affecting base clearance or roadway grades shall be shown and labeled. This includes the SHGWTE.

- The begin and end stations of the project, construction, and bridges and bridge culverts shall be shown.

- Cross drains shall be shown with stations and flow lines coinciding with the roadway centerline and should be designated with a structure number.

Drainage Structures Sheets Review Checklist

Structure Selection

- Precasters cannot build structures without top or bottom elevations. Top elevations should be the rim for manholes, grate for DBI's, and either the EOP (preferred), theoretical gutter, or top of curb elevation for CI's. Pipe flowlines define all bottom elevations. Sumps should be tagged with a floor elevation or a dimension below the lowest flowline of the structure (e.g. 4' sump).

- For structures with sumps, make sure weepholes are included. In high groundwater conditions, this prevents structure flotation due to buoyancy forces. In low groundwater conditions, this allows the sumps to drain to some degree. If the sumped structure has a weir in it, weepholes should be provided on both sides of the weir.

- If a structure has a weir in it, manhole access and sufficient room should be provided on each side of the weir. Do not allow a manhole to be located over the weir. Likewise, if the drainage structure has a drainage well in it, the center of the manhole lid needs to line up with the center of the drainage well.

- Sumps must be used on all French Drain systems or on structures with high sediment loads.

- If J-Bottoms are used, the dimensions of the bottom must be specified.

- It is recommended that structures greater than 10' deep be denoted with (>10) in the structure's paragraph.

- For P-Bottoms, Alt. A and B does not need to be specified if either will work. But if it is specified, make sure a round bottom is used in the plans for Alt. A (4') and a square bottom is used for Alt. B (3' 6"). The type of bottom depends on the skew angle of the pipes coming into it.

- Maintenance prefers CI Types 1 thru 4 vs Types 5 and 6 because they have manhole access. Types 5 and 6 are typically for avoiding utility conflicts. If the CI is part of a French Drain system, check with maintenance to see if they want a two-piece cover.

- Make sure the proper inlet is called for based on the profiles or special gutter grades. P1, P3, and P5 Curb inlets are on-grade (one way) inlets and P2, P4, and P6 are sag or sump (two way) inlets. In other words, odd numbered inlets receive flow from one direction and even numbered inlets receive flow from both directions.

- For Type 8 manholes (coned), it is recommended the height of the cone be specified. The height can be 1' to 3' (preferred). If the cone is eccentric, it should be noted.

- Alt. G grates should be specified on all drainage structures in coastal areas. These grates are galvanized and more resistant to salt water/air corrosion.

- If a reticuline grate is available and the structure will be subject to pedestrian or bicycle traffic, it should be specified.

- Bars should be shown on side drain pipes with spans greater than or equal to 30" and are inside the clear zone. Bars might be added to smaller sized pipes or to cross drains to prevent entry by children, vagrants, or wildlife.

- Slots, traversable and non-traversable, cannot be in the wall of a DBI that has a grate seat. It can be in the grate seat wall of a control structure, but the control structure cannot have a grate.

- Slots should be specified in high trash/debris areas.

- Traversable slots with non-standard slot heights (other than 7") should be labeled as such.

- The ditch should tie to the slot elevation for structures with non-traversable slots. The ditch should tie to the apron for structures with traversable slots.

- Back of sidewalk structures should have the slot height and/or slot elevation shown.

- Though the Standard Indexes allow for a pipe to come in through the corner of a box, it should be avoided. A special detail will be required in a future Index.

- Pipes connecting to pipes without an access structure should be avoided (District policy).

- Doghouse structures should be avoided (District policy).

- Standard Index 280 shows the difference between collars and jackets. These should be shown.

Fitting

- Remember the blankout hole for the pipes are cut 3" larger than the outside diameter of the pipes themselves. The blankout hole should not touch the top reducer slab of the J-Bottom. Tables 4-4 and 4-5 and Figure 4-5 of the FDOT Storm Drain Handbook provide more guidance.

- The blankout hole should not extend into the grate seats of DBI's, the riser section of Curb Inlet tops, the top slabs of Type 7 Manholes, or the cones of Type 8 manholes. Tables 4-4 and 4-5 and Figure 4-5 of the FDOT Storm Drain Handbook provide more guidance.

- While not always possible, strive for 6" of beam thickness between the blankout hole and the top of the J-Bottom, the grate seat, or the curb inlet throat. Also note that some curb inlets do not allow pipes (and blankout holes) to be constructed within certain zones. Tables 4-4 and 4-5 and Figure 4-5 of the FDOT Storm Drain Handbook provide more guidance.

- Make sure the pipe size called out will fit into the wall including the blankout hole. Tables 4-2, 4-3 and 4-6 of the FDOT Storm Drain Handbook provide more guidance.

- Check pipe spacing of multiple pipes within a structure vs. Index 200 Sheet 3 of 5.

- Pipes should typically not be offset from the structure/wall centerline. However, if no other configuration will work, the offset distance should be defined on the cross section.

- If a pipe is to cross under a railroad, see Index 280.

- Do Type 7 Manholes have sufficient ring heights to allow for pavement cross slope?

- Check the cover at each structure and cross pipe against Index 205. Use the Commercial column for determining the minimum cover.

- If a storm sewer pipe crosses another storm sewer pipe, the dimension between the outside diameters of each (clear distance) should be shown in the plans. 1' is preferred unless the designer can show less is allowed by Standard Specification. More separation may be required if the crossing occurs under traffic.

- Longitudinal installations of water and sanitary utilities have minimum separation requirements from storm sewer pipes. Those requirements are available in WMD regulations.

- Utilities crossing storm sewer pipes or vice versa should have a minimum clear distance of 1'. Electric and gas lines should NEVER come into contact with storm sewer.

- Conflict structures upstream of ponds should be avoided (District Policy) because debris will collect on the utility crossing through the structure. If conflict structures are necessary, any utility can be accommodated EXCEPT electric and gas and must be detailed per Index 201.

Plans Preparation

- Similar to cross sections, all improvements shown should be wholly contained in the R/W.

- Any ditches shown in the Drainage Structures Cross Sections should match the Roadway Cross Sections.

- Special Ditches shown on the Drainage Structure Cross Sections should be shown to two decimal places. Special Ditches are defined as those that do not follow the same longitudinal slope as the PGL.

- Check sheet references to make sure they point to the right place.

- All MES slopes should be labeled 1:2 or 1:4. 1:4 must be used on CD's and SD's in the clear zone.

- MES's should be specified as CD or SD. CD is for transverse (crossing) installations and SD is for longitudinal (parallel) installations.

- All structures should have "To Structure" and "From Structure" notes and flow arrows. French Drains should have flow arrows towards the weir. If weirs are at both ends of a French Drain System, flow arrows should be shown with heads on both ends.

- The Stations, Offsets, and Side of every structure should match the Summary of Drainage Structures and the Storm Sewer Tabulations.

- All pipe sizes should be labeled and should match the Plan Sheets and Summary of Drainage Structures.

- Structure numbers should increase with stationing. Each structure number typically consists of the structure and downstream pipe. Every structure located at a different station should have its own structure number.

- Flowline directions must be shown as Back (BK), Ahead (AH), LT, RT.

- All pertinent Indexes should be called out. Sumps should reference Index 201 and the elevation shown.

- Check the grid horizontal and vertical scales vs. the structure offsets and elevations.

- Closed flume inlets should be included on these sheets and dimension 'D' from the Standard Index for closed flume inlets should be shown.

Hydraulics

- All top elevations and flowline elevations must EXACTLY match the storm sewer tabulation input. Flowlines can be to either 1 or 2 decimal places.

- Make sure all flowlines result in water flowing downhill. All flowlines must be shown including underdrains and existing pipes. Utility conflict flowlines (for those passing through a structure) also must be shown.

- No siphons.

- For structures with weirs inside them, check the peak stage vs. the bottom of the top reducer slab. Will orifice flow occur? If so, did the model account for this (span and rise)?

- DBI grate elevations should match the DPI's of the Special Ditch Profiles that coincide at the same Stations. If a grate elevation falls on an even Station but outside of a Special Ditch Profile, the roadway cross section swale invert should match the grate invert. Note that for DBI's with non-traversable slots, the slot elevation should match the DPI's of the Special Ditch Profiles that coincide at the same Stations.

- If a pipe end treatment is not at the bottom of slope it will most certainly cause erosion of the slope. Can the pipe be lowered (preferred)? If not, ditch pavement or ditch rubble should be provided.

- If a pipe end treatment is at the bottom of the slope and the velocity exceeds 4 '/s, ditch pavement, ditch rubble, or energy dissipators should be used. Pipes entering water areas like ponds, lakes, or streams should come in at or below the water line.

- If energy losses were included in the Storm Sewer Tabulation Computations and the results show the grate of a DBI is exceeded, the height of water above the grate elevation (HGL minus the grate elevation) should be added to the normal depth of the swale containing the DBI and compared to the top of swale and adjacent swale flowlines to ensure the water is contained. Essentially the height of the HGL above the DBI grate plus the normal depth must be contained within FDOT owned R/W.

- If conflict boxes must be used anywhere in the system, the losses associated with the conflict must be considered whether minor losses are considered or not. Energy losses for conflict structures are in Section 5.6 of the Storm Drain Handbook. Likewise, if weirs or baffles are located in a system, the losses associated with such obstructions must be considered in the grade line analysis regardless of whether or not minor losses were considered.

Storm Sewer Tabulations Review Checklist

- Storm Sewer Tabulations must be provided for any network with a drainage structure connected to it, even if only one structure and one pipe are in the network.

- If using GEOPAK Drainage, please provide a copy of the Preferences used in the analysis. This can be obtained from within GEOPAK Drainage via *Project > Export > Preferences to ASCII* and the ASCII file printed with Notepad.

- The Storm Sewer Tabulation format MUST follow Figure 3-1 of the Drainage Manual.

- All pipe sizes should match the Plan Sheets.

- The number of barrels should match the Plan Sheets.

- The inlet elevations must EXACTLY match those shown in the Drainage Structures Sheets. Inlet elevations should be input as follows: the rim elevation for manholes, the grate elevation for DBI's, the slot elevation for DBI's with non-traversable slots, and the theoretical gutter elevation for CI's. The theoretical gutter is 1.5" below the Edge of Pavement (EOP). **Some software programs will use the EOP as the inlet elevation for CI's. This is okay, but the HGL clearance must be 1.125' from the EOP to satisfy our standards.**

- The reported HGL shall NEVER be closer than 1' to the Inlet Elevation.

- If minor losses are considered, the HGL shall NEVER exceed the Inlet Elevation of any structure except DBI's. If it exceeds the Inlet Elevation of a DBI, the height by which it exceeds the Inlet Elevation must be added to the normal depth of the swale above the structure and the summation compared to surrounding elevations for containment within the R/W. Please see the Drainage Structures Review Checklist.

- If using GEOPAK Drainage, the user can choose to simulate minor losses with Method 1 or Method 2 under *Preferences*. Effectively, Method 1 is for one or more incoming laterals connected directly to the main pipe, without a junction box and Method 2 is for one or more incoming laterals connected to the main pipe using a junction box. Page 3-9 and pages 20-22 thru 20-25 of the FDOT GEOPAK Drainage User's Manual provide further guidance on this topic.

- All flowlines must EXACTLY match the Drainage Structures Sheets.

- The incremental areas must EXACTLY match the Drainage Maps.

- Documentation should be provided for all C-values. If a Composite C is used in the Storm Sewer Tabulations, computations must be provided to show how that value was determined. The most typical C-values are 1.0 for a water surface, 0.95 for impervious surfaces, and 0.20 for pervious surfaces.

- The pipe lengths input into the analysis should be equal to or greater than those shown in the Plan Sheets. The reason is some software programs will use the hydraulic pipe length from center of structure to center of structure as opposed to the actual pipe length. This is conservative.

- Station, Offset, Side, Structure Numbers, and Structure Types should match the Drainage Structures Sheets.

- Zone 7 should be used for all counties in District 5 EXCEPT Flagler County. Flagler County is in Zone 5.

- The Design Frequency for CI's is 3 year. The Design Frequency for DBI's is 10 years. If a system has both CI's and DBI's, the DBI's should be checked for a 10 year Design Frequency and ALL structures in the mixed system should meet the 3 year Design Frequency.

- Manning's n should always be modeled as 0.012 for new pipes. If an existing pipe is used in the system, the designer may use the actual Manning's n for that pipe since the material is known. See Section 3.6.4 for required Manning's n values for different pipe materials.

- TW computations or other evidence must be provided to document the TW used in the Storm Sewer Tabulations. Of specific importance are storm sewer systems connected to ponds. The TW for this case is the flood routed stage at PEAK INFLOW with the INITIAL POND STAGE set at the WEIR and the orifice and all volume below the weir turned off or ignored. **The Engineer should provide the inflow hydrograph locating the peak inflow discharge rate, the time it occurs, and the stage over the weir at that time.** That stage over the weir is the TW for the storm sewer design. The design frequency used in this TW routing is either the 3 year or 10 year frequency; please see previous checklist items. This process will be iterative and the total time of concentration from the storm sewer tabulations should EXACTLY match the TW flood routing time of concentration. The reason we choose peak inflow is because that is when the pipes are theoretically most full of water. The reason we start the TW flood routing at the weir is if an orifice becomes clogged or a dry pond is not recovering, the pond will recover at a minimum to the weir. So designing our storm sewer systems for this criteria gives us absolute assurance the highway will not flood until Maintenance can correct the recovery issues.

- If the Time of Flow in Section is zero, make sure the pipe is submerged by looking at the reported HGL's at each end of the pipe. If a pipe is submerged, there can be theoretically a zero time of concentration through the pipe because the volume that enters one end instantaneously pushes the same volume out of the other end.

- The minimum allowable time of concentration reported should be 10 minutes. The reason for this is during data collection for generating IDF curves, the data collected during the first 10 minutes was difficult to obtain. This explains the flatness of the IDF curves during the first 10 minutes.

- Make sure the times of concentration reported make sense. For instance, if you see a high time of concentration value for a tiny basin at the head of a system, the entire system will be under-designed because this high value will snowball, i.e. get larger and larger, as water moves down the system. Likewise, for systems with large offsite areas and large times of concentration, a reduced area with a short time of concentration may actually produce a higher design flow rate (see Section 2.2.1 of the FDOT Storm Drain Handbook).

- If minor losses are used, documentation must be provided showing the values and types of minor losses applied to each structure.

- The Actual Velocity in any pipe should be kept below around 8'/s. The reason is the velocity head ($V^2/2g$) will equate to about 1' which is the assumed zone that minor losses can be maintained. If velocities exceed this amount, ask for minor losses to be considered in the analysis.

- The computed Physical Velocity MUST be greater than or equal to 2.5 '/s. There should be no need to look at the computed physical slopes if this value is realized.

- If the Actual Velocity exceeds 4'/s at the outlet, erosion protection must be provided unless the outlet is submerged.

- The Base Flow column is typically for constant flows such as from underdrains. It is also convenient for entering in a flood routed flow from an adjacent site, i.e. a flow that cannot be assumed as direct runoff or analyzed with the Rational Method. Make sure you know where it came from and make sure it was added in to the Rational Method flows.

Spread Computations Review Checklist

- A recommended Spread Tabulation form can be found in the Storm Drain Handbook in Table 3-1. An additional column should be added to denote the allowable spread for each inlet.

- The rainfall intensity to be used in most spread analyses is 4"/hr and this value is based on driver visibility. However, for shoulder gutters, the intensity is based on a 10 yr frequency storm for the appropriate rainfall zone (Zone 5 or 7) and time of concentration of the sub-basin contributing to spread at a particular inlet.

- The runoff coefficients used to determine the gutter flow rates should be adequately documented.

- The sub-basin areas used to determine the gutter flow rates should be documented and should EXACTLY match the corresponding areas on the DRAINAGE MAPS sheets.

- When determining the spread gutter flow rate, the potential for future lane additions (such as turn lanes) should be considered in the analysis.

- Manning's n shall always be 0.016 for asphalt and for concrete. This value would be increased by 0.002 for gutter profiles less than 0.3% because of sediment accumulation.

- For sag inlets in special gutter grade areas, the cross slope used to analyze the spread on each side of the sag inlet should <u>not</u> be equal to the typical cross slope of the roadway. In actuality, the cross slope at the sag will always be steeper than the typical cross slope because of the projection of the special gutter grade and it can be computed from the PGL and the low point of the special gutter grade. The computations supporting the cross slope value entered for sag inlets should be provided. Furthermore, in other areas such as superelevated areas, computations should also be provided to support the cross slope values used for inlets in such areas.

- Sag inlets MUST be evaluated for three spread conditions – spread from the left side, spread from the right side, and spread due to the sumped condition. Sumped condition graphs are available in Appendix 'A' of the Storm Drain Handbook.

- The cross slopes for non-sag inlets should match one of the TYPICAL SECTIONS in the roadway plans.

- Longitudinal slopes less than 0.30 % will require the addition of special gutter grades to comply with Section 3.8.1 of the Drainage Manual. The longitudinal slopes recorded in the spread computations should EXACTLY match the slopes shown on the PROFILES sheets in the roadway plans.

- Allowable spread values are shown in Table 3.9 of the Drainage Manual. The spread criteria applies to all travel, turn, auxiliary, and other lanes adjacent to barrier wall or curb in normal or superelevated sections.

- The allowable spread in a shoulder gutter section shall not exceed 1'3" outside the gutter in the direction toward the front slope. This distance limits the spread to the face of the guardrail posts. In the absence of guardrail, the spread shall be limited to a distance toward the front slope sufficient to prevent discharge over the side of the embankment.

- The standard spread equation is $Q=\frac{0.56}{n} S_x^{5/3} SL^{1/2} T^{8/3}$ where

  Q = Gutter flow rate (cfs)
  n = Manning's roughness coefficient
  S_x = Pavement cross slope (ft/ft)
  SL = Longitudinal slope (ft/ft)
  T = Spread (ft)

  The gutter depression is ignored with this equation though it does provide some extra capacity.

- To compute the allowable spread at a shoulder gutter inlet, it is helpful to compute the conveyance (K) of the shoulder gutter cross section and substitute $(K)SL^{1/2}$ for Q in the preceding spread equation. $SL^{1/2}$ will drop out and the allowable spread width for an equivalent curb section can be determined. Please see Figure 3-3 of the Storm Drain Handbook. Once the allowable spread is determined, use the actual flow rate to determine actual spread.

- For landlocked basins or other critical areas where drop curb is to be placed across a driveway and the driveway slopes downward from the roadway, trench drain might be necessary to supplement the somewhat limited flow capacity of the drop curb and convey flow to a receiving inlet on the other side of the driveway. However, contractors are not fond of trench drain. Another option to prevent gutter flow from overloading the drop curb section and flowing down a driveway onto private property might be to raise the driveway between the drop curb and the R/W line to force the flow to the receiving inlet.

- Bypass flow is determined from the difference between the computed gutter flow rate and the intercepted flow for a particular inlet. Intercepted flows can be determined from the graphs in Appendix A of the Storm Drain Handbook. It is uncommon to see bypass flows in District 5 because the grades throughout most of the District are not steep.

- If bypass occurs, make sure it is added to the computed gutter flow rate of adjacent downstream inlet. NO bypass will be permitted for the terminal shoulder gutter inlet.

Pond Details Sheet and Pond Cross Sections Review Checklist

Pond Details Sheet

- All borings should be shown and labeled and a legend provided.
- The (Seasonal High Groundwater Table Elevation) SHGWTE and (Control Water Level) CWL, if different from the SHGWTE, should be labeled.
- If a pond is adjacent to wetlands, the CWL should be equal to the SHGWTE to prevent drawing down the wetlands. This might be permitted if sufficient distance between the pond and the wetland is provided, but computations must be provided to demonstrate the CWL has no effect on the wetland water levels.
- Existing ground contours and topography should be shown and labeled.
- Proposed pond contours should be shown and labeled. The contour elevations shown should match the elevations of the stage-area/storage relationship in the computations.
- Do the contours indicate a need for a bypass swale around the pond to prevent offsite flows from entering the pond?
- The design storm peak stage should be shown.
- All dry pond bottoms should be seeded & mulched to allow for maximum infiltration.
- All slopes and berms of dry retention and wet detention ponds should be sodded. Wet ponds should be sodded no more than 2' vertically below the CWL.
- Berm widths should be 15' per Section 5.3.4.2 of the Drainage Manual. Also, there should be 20' between the edge of the top of the normal pool and the R/W line.
- The radii of all inside curves/corners of the maintenance berm should be at least 30'. 35' would be better.
- There should be 1' of freeboard between the design stage and the low edge of the front of berm.
- All slopes to be mowed should not be steeper than 1:4. For wet ponds, the 1:4 slope (or flatter) must extend below the CWL to a depth of 2' before changing into a 1:2 slope.
- In general, all non-Limited Access R/W ponds should be fenced. Exceptions might be made for extremely rural areas, but the overwhelming majority will require fences. If no fence is specified, please work with the Assistant District Drainage Engineer to determine the need for a fence on a case by case basis. Ponds in interchanges, regardless of R/W type, should not be fenced. Ponds in L/A R/W should be fenced if adjacent to the highway on three sides because the L/A R/W will usually jog around the pond; this means the fourth side will be open for maintenance access.

- Does the gate access location for a fenced pond make sense? Generally, these gate access points should be in a corner. Make sure the heavy equipment can traverse the ground through the gate to get onto the berm. If a bypass swale is constructed around the pond, was a driveway built across it for maintenance access? The area through the access area should be sufficiently flat to allow for access.

- One or two pond typical cross sections should be shown.

- If the pond is bermed up above adjacent property, could the design stage result in seepage onto that property? Could there be berm stability issues? If the adjacent properties are on septic systems, ponds bermed above adjacent ground could cause septic failure.

- The pond must be located some distance from a public water supply well.

- The scale, north arrow, and table of control points should be shown.

- The R/W lines or L/A R/W lines should be shown.

- A note should be added to the Pay Item for pond excavation to cover the addition of a benchmark at <u>each</u> pond. The benchmark is to be used to perform the As-Built survey. The benchmark would ideally be located outside the fence near a corner and adjacent to already developed property.

- Are all pond drainage structures shown and labeled by drainage structure number?

- If a weir is constructed in the berm, is it traversable by heavy equipment?

- Ponds adjacent to roadways and sidestreets should be evaluated for base clearance. In District Five, the pond stage can encroach into the base clearance zone for no more than 24 hours. The computations (typically in the form of an adICPR time-series report) should demonstrate this requirement has been met.

- To prevent erosion of the pond berm or slopes, the flow line of the inflow pipe of a dry pond should coincide with the pond bottom. Likewise, the flow line of the inflow pipe of a wet pond should coincide with the CWL or be submerged. It is preferable the pipe be submerged for wet ponds to prevent erosion in periods of drought.

- For all pond types, the inflow pipe should be positioned as far away as possible from the control structure to maximize pollutant removal. If the inflow and outlet are near each other, a dyke should be constructed out into the pond between the two structures to maximize the distance between them.

Pond Cross Sections

- Make sure all proposed improvements fit within the proposed R/W. R/W lines should be shown on both sides unless match lines are used.
- Make sure each Cross Section correlates with the plan view on the Pond Details Sheets.
- Make sure that any fencing is shown on each section.
- Front and Backslopes steeper than 1:4 should be avoided because maintenance cannot mow them with standard equipment.
- Front and Backslopes steeper than 1:2 might require staked sod or geosynthetics.
- Make sure the scale and the grid make sense.
- Borings must be shown and the SHGWTE and encountered water table labeled.
- The baseline that the POND CROSS SECTIONS reference should be shown.

Control Structure Details Review Checklist

- The top of the skimmer should extend to at least above the highest design stage and the bottom of skimmer should extend to at least below the weir. If an orifice is present and the orifice does not have a turn down elbow or tee, the skimmer should extend to at least below the orifice.

- Standard skimmers are shown in Standard Index 240. Any other type of skimmer arrangement requires a special detail.

- Design note 2 on Index 240 requires the flow area under the skimmer be at least three times larger then the flow area of the weir slot. It also requires 1' minimum between the bottom of skimmer and the pond bottom.

- Aluminum skimmers should not be specified due to theft.

- Concrete should be poured around the bottom of structure in dry ponds or retention swales and extend far enough out to prevent vegetation growth that could block a skimmer or orifice.

- The weir dimensions, orifice dimensions, outfall pipe information, and any other pertinent geometric data should EXACTLY match the model input.

- If grates are used and the design stage exceeds the grate elevation, the grate must be modeled as a series of orifices. If the pond is fenced, grates are not necessary unless the location of the control structure is such that an inspector needs to stand on the structure to inspect it.

- If a control structure requires a grate, the weir slots should be cut into walls that do not have grate seats.

- For the majority of installations, orifices should have tees on them with the orifice drilled in the bottom and a twist-off clean-out cap on top.

- Orifices and V-notches should never be oriented towards the pond banks.

- DBI control structures should be located along the bank slope such that sufficient cover can be provided over the outfall pipe <u>and</u> a Maintenance worker or inspector can easily walk out onto it.

- Some ponds will have weirs in their berms. These weirs need to be detailed and, more importantly, need to be traversable by 15' mowers. To be traversable, these weirs should be trapezoidal and the side slopes should be around 10:1. If the pond berm is on fill, sufficient protection of the tie down slope MUST be provided.

French Drain Review Checklist

Much of the French Drain design requirements can be derived from Index 285. FDOT District Five can provide a spreadsheet that computes the stage-storage relationship of a French Drain system with weirs upon request.

- Typically, for Plans Production and for computing stage-storage of French Drain systems, concrete pipe is assumed to be conservative. Concrete pipe would occupy more space in a trench due to its thickness than, say, a PVC pipe. So, the stage-storage computations of the trench must assume concrete pipe. And the plans typically assume concrete pipes for plotting reasons. However, for non-typical French Drain trenches, this poses a problem during construction if the Computational Book assumes concrete pipe to quantify the rock for the trench because the Contractor may select a thinner walled Optional Pipe like SRAP. So, the Computational Book needs to quantify rock assuming a thin-walled pipe, or conservatively a pipe of no thickness, so the Contractor does not come up short on rock in the field. The amount of volume of rock needed to occupy the space difference between a thin-walled and thick-walled pipe can be enormous.

- For non-typical French Drain trenches, make sure the volume of rock properly accounts for the porosity of the rock trench. Otherwise, for say a design porosity value of 0.40, your computed rock volume could result in a significant underrun of rock on the job site of at least 40%.

- Per Index 285, there is a 4' section of non-slotted pipe adjacent to the drainage structure where rock is not to be installed. These zones should be correctly accounted for in the rock volume computations or stage-storage relationship of the French Drain Trench.

- The rock volume computations should be based on No. 4 coarse aggregate per Index 285 and the design porosity value should typically not exceed 0.40.

- The top of the rock trench must meet the requirements for base clearance of Table 2.6.3 of the Plans Preparation Manual Volume 1. The top of the rock trench should NEVER encroach into the base.

- The routed peak stage of the French Drain system should not be higher than the top of the rock trench for systems with weirs constructed inside structures with manhole access.

- Percolation should only be considered in a French Drain flood routing if the governing Water Management District will permit its consideration. Otherwise, percolation should only be considered in the recovery analysis of the French Drain system.

- The typical French Drain system consists of a single pipe with a rectangular rock envelope extending 1' out from either side of the OUTSIDE of the pipe, 6" above the OUTSIDE of the pipe, and 2' below the OUTSIDE of the pipe. If the typical French Drain system is incorporated into the plans, it can simply be paid for as FRENCH DRAIN.

- Non-typical French Drain rock trench dimensions are acceptable as are multiple runs of pipe within a French Drain rock trench. However, non-typical installations must be paid for as a sum of the parts: SLOTTED or PERFORATED PIPE, BALLAST ROCK, and PLASTIC FILTER FABRIC. Please see General Note 9 of Index 285.

- If the French Drain trench must be detailed in the plans, Filter Fabric shall be shown to wrap the trench cross section and overlap on the top side by a minimum of 1'.

- The French Drain pipe invert should be located vertically at or above the seasonal high groundwater table. This implies that the rock trench below the pipe could be below the water table, so rock volume computations should commence at the water table elevation for this type of installation.

- Only Cast Iron and Ductile Iron Sanitary Sewer and Cast Iron, Ductile Iron, and Steel Water Mains will be allowed to pass through the French Drain Trench without a sleeve. There should be a minimum of 6" clearance between the French Drain pipe(s) and the crossing utility.

- 4' sumps are required on all French Drain structures for debris to settle out as the system recovers.

- Weep holes shall be constructed in ALL French Drain structures regardless of the water table elevation. If the water table is high, it should relieve buoyancy issues and if the water table is low, it will help evacuate any standing water in the sump.

- It is strongly recommended to layout non-typical French Drain systems, especially those with more than one pipe run in a trench, to make sure they will fit into the proposed structures. Special attention should be paid to the pipe thickness and blankout holes of the precaster.

- French Drain systems in series with weir structures between systems should provide a minimum of two manhole access points per control structure, one on either side of the weir. The size of the bottom should be adequate to accommodate a man comfortably on either side of the weir.

- Based on experience, when flood routing French Drain systems, it is generally better to increase the length of weir than to raise or lower it in a system. Because volumetrically, the system is so confined compared to a pond, the long weir evacuates all of the stormwater more quickly in the earlier part of the synthetic storm while still not exceeding the allowable rate. This quick evacuation will allow for the peak of the storm to run through the system more efficiently because the attenuation volume will be almost completely available above the weir.

- Weirs should only be incorporated into structures with manhole access. Grated structures allow for runoff to drop into the structure on the wrong side (downstream side) of the weir.

Roadway Cross Sections Review Checklist

- Make sure all proposed improvements fit within the proposed R/W. If a Cross Section does not show a R/W line and that particular section did not capture a side street, the R/W line must be shown.

- Make sure each Cross Section correlates with the plan views. For instance, often Cross Sections will show a full depth ditch or swale when clearly the plan view at that Cross Section's station indicates a piped ditch or driveway should have clearly prevented a ditch from being drawn.

- Make sure that any fencing shown on each section makes sense. For example, the plan view may indicate a wildlife crossing in some location but the Cross Sections show the fence would block wildlife access to the crossing.

- Look at the Drainage Maps to determine the stations where offsite water would enter the proposed R/W. Then, verify on the Cross Sections that a conveyance system was put in place for this offsite water. Likewise, check all remaining Cross Sections for indications of offsite flow that may not have been properly noted on the Drainage Maps.

- For sidewalk projects, make sure the proposed sidewalk will not cut off offsite drainage towards FDOT R/W. This occurs too often, especially on projects with rural Typical Sections.

- If an existing ditch is shown to be partially filled in, computations must be provided to demonstrate that the remaining conveyance is adequate. This is very common in sidewalk and turn lane projects.

- Front and backslopes between logical termini need to be consistent and if different from the Typical Section, they must be labeled. Logical termini might be driveways, side streets, or cross drains.

- Bottom widths may vary between logical termini but the width must be labeled if different from the Typical Section. Bottom widths less than 5' are discouraged. V-Bottom ditches will not be used per Section 2.5 of the Drainage Manual.

- Front and Backslopes steeper than 1:4 should be avoided because maintenance cannot mow them with standard equipment.

- Front and Backslopes steeper than 1:2 might require staked sod or geosynthetics.

- If double ditches are specified, typically one is for on-site drainage conveyance and the other is for offsite drainage conveyance. The berm between the two ditches should be typically 10' for maintenance access. The berm should be 15' if the ditches are wet.

- Verify the ditch bottoms are above the SHGWT. The SHGWT should be plotted on the Cross Sections.

- Verify the base clearance has been satisfied per Table 2.6.3 of the PPM Volume 1. Black Base may need to be shown if the values in this table cannot be achieved.

- Verify that cross slopes in Special Gutter areas differ from the Typical Sections.
- Per Section 4.2.1 of the PPM Volume 1, a canal is defined as an open ditch parallel to the roadway for a minimum distance of 1000' and with a seasonal water depth in excess of 3' for extended periods of time (24 hours or more). If it is suspected canal criteria applies, the horizontal clearance must meet Exhibits 4-A or 4-B of the PPM Volume 1.
- Any ditch that does not follow the PGL of the roadway is a Special Ditch. The flow lines of all Special Ditches must be specified in the Cross Sections to 2 decimal places. Furthermore, the DPI's shown in the Cross Sections must EXACTLY MATCH the DPI's shown in the Profiles.
- If the ditch computations indicate velocities greater than 4'/s, channel lining must be provided per Table 2.4 of the Drainage Manual to protect the ditch from erosion. Please note that concrete linings are not recommended on clay.
- Any ditch pavement shown on the Cross Sections should match the Plans view.
- Make sure the scale and the grid make sense.
- If a drainage structure or cross drain is captured by a roadway Cross Section, verify it is accurately shown just as if it were a Drainage Structures Cross Section.
- For Cross Sections covering Special Gutter Grade areas, the cross slope should be shown.

Ditch Design and Side Drain Review Checklist

- The minimum allowable slope for a ditch is 0.05% or 0.0005 ft/ft. No roadway profile should be less than 0.05% unless a special ditch profile is provided to supplement it. Side drains can be placed at a slope of 0.00%.

- Vee bottom ditches should not be allowed. Ditches should typically be at least 5' wide and must be at least wide enough to accommodate a MES.

- If ditches are designed with raised berms or spoil banks, provisions must be made to either accept any offsite flows or convey those offsite flows in a separate system.

- The primary design frequencies for ditch design are 10 yr for roadside swales and side drains and 25 yr for outfall ditches and canals.

- A ditch that has been replaced with a series of DBI's should be designed based on the same design frequencies as for the ditch itself. In other words, the hydraulic grade analysis for the DBI system must be the 10 yr or 25 yr design frequencies depending on its use. Furthermore, if a shallow swale system exists above the DBI system, the swale system still must be analyzed for the required design frequency.

- The TW to be used for side drain computations must be documented. The TW used should be the higher of one of the following: 1) The downstream crown of the pipe being analyzed, 2) the normal depth of the ditch receiving the water from the side drain, or 3) the computed HW of the side drain immediately downstream.

- Manning's n should be documented. Table 2.1 of the Drainage Manual lists typical design values of Manning's n for most ditch design applications. Please note that for sodded or grassed swales in urban areas, Manning's n must be reduced to 0.042 from 0.06 if the depth exceeds 0.70'. Likewise, for rural areas, Manning's n must be reduced to 0.14 from 0.20 if the depth exceeds 0.70'. If the depth exceeds 1.5', composite computations should be provided to compute Manning's n.

- If computed ditch velocities exceed those shown in Tables 2.3 and 2.4 of the Drainage Manual, linings must be used. This usually occurs in ditches on steep grades. Typical linings can be found in Standard Indexes 199 and 281. Conveyance ditches should never be seed and mulched.

- Channel protection should also be provided if the outlet velocity of a side drain exceeds the design velocity of the channel's lining.

- Concrete linings should not be placed on clay soils.

- Ditches should not be constructed with bottoms below the SHGWT. This will cause the ditch to be constantly wet, be difficult to maintain, and constantly convey intercepted groundwater flows onto possible downstream property owners. It also creates conditions that could result in that ditch becoming classified as a wetland.

- Ditch computations should be provided for all changes in ditch slope, cross section, lining type, or quantity of flow. Make sure that the flow shown as contributing to the point of interest includes all contributions upstream of that point of interest.
- Side drain computations should be provided for all proposed or extended side drains. **Please note** that side drains under side streets are classified as cross drains and have a different design frequency.

- The input data used in all ditch computations should EXACTLY match the plans. The drainage areas should match the Drainage Map unless another drainage map is provided in the computations. The Rainfall Zone should be Zone 5 for Flagler County or Zone 7 for the rest of District 5. Composite runoff coefficient computations should be provided and the values used in the computations should be documented with a design source.

- The computed depth must be contained within the ditch. There is an implied freeboard of 0.30' per the Standard Specifications (120-12.1). Therefore, the allowable depth is the total swale depth for the section analyzed less the 0.3' of freeboard. This value should be reported alongside the computed normal depth for comparison purposes.

- The velocity computed should not exceed the maximum allowed for the selected lining.

- Per Section 4.2.1 of the FDOT Plans Preparation Manual Volume 1, a canal is defined as an open ditch parallel to the roadway for a minimum distance of 1000 feet and with a seasonal water depth in excess of 3' for extended periods of time (24 hours or more). This seasonal water depth could be tidal. The minimum distance from the edge of travel lane to the edge of the canal ranges from 40 feet to 60 feet, depending on the speed limit and typical section. If these minimum distances cannot be accommodated, guardrail or some other physical barrier must be provided.