Technical Memo

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To: Pelican River Watershed District Staff

From: Marlon Mackowick, PE

Date: Revised November 7, 2018

Subject: Best Practices for the Design of Stormwater Management Systems

INTRODUCTION

The purpose of this memorandum is to provide the Pelican River Watershed District (PRWD) with a list of common "best practices" for evaluating stormwater management permit applications. Besides PRWD, Wenck Associates, Inc. (Wenck) serves as the Engineer for several watershed districts throughout the state. The list is not all-inclusive, but it has been developed based on dozens of years of professional experience and the most current stormwater design guidelines.

BACKGROUND

Compared to some Minnesota watershed districts, the current Pelican River Watershed District rules could be considered vague in terms of rate control and water quality requirements. Since the rules were approved, the practice of stormwater management has been advanced by the *Minnesota Stormwater Manual*, the MPCA Minimum Impact Design Standards study, and design guidance by MnDOT, the NRCS and others. Therefore, as Watershed District Engineer, it is our responsibility to ensure water resources within PRWD are protected according to the rules and best professional practices of stormwater management.

BEST PRACTICES

Rate Control (i.e. HydroCAD, XP-SWMM)

1. Stormwater features shall be designed using the Atlas 14 rainfall depths. The *Minnesota Stormwater Manual* states precipitation frequency estimates in Atlas 14 supersede the estimates produced in Technical Paper No. 40 and NWS HYDRO-35 (read guidance here). The Minnesota Department of Transportation (MnDOT) has required Atlas 14 depths for all hydraulic design since June 30, 2014 (read memo here)
2. Verify the proposed runoff rates do not exceed existing runoff rates across all downgradient site boundaries.
3. Peak runoff rates shall not increase for the 5-, 25-, and 100-year, 24-hour storm events.
4. Time of concentration

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a. Presentation from MnDOT: http://www.dot.state.mn.us/bridge/hydraulics/atlas14/pdf/using-atlas14datafor-nrcs-hydrologyinmndot.pdf
    i. Slide 5
        1. Recommendation for ag watersheds
        2. *MN Engineering Field Handbook* Chapter 2 states Tc may be determined by Chapter 2, Chapter 15 of *NRCS National Engineering Handbook*, or Folmar & Miller equation.
        3. See page 12 of the NEH: http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=27002.wba
        4. 100 foot max

    ii. Slide 7
        1. Recommendation for urban watersheds
        2. Use *MN Drainage Manual* or TR-55
        3. *MN Drainage Manual* dated August 30, 2000. MnDOT tech memo 15-10-B-02 supersedes *Drainage Manual* as does Chapter 15 of NEH supersedes because it is dated May 2010.
        4. TR-55 dated June 1986. Superseded by MnDOT tech memo 15-10-B-02 and Chapter 15 of NEH.
        5. 100 foot max
b. A shorter time of concentration likely produces a greater runoff rate. We prefer to be conservative, so we recommend a 100 foot max rather than 300 feet.
c. If "direct entry" is used, ensure that it is reasonable or require applicant to calculate.

5. For Atlas 14 rainfall depths, use MSE 3 rainfall distribution per MnDOT slides referenced above.
6. Verify the HydroCAD is correct:
    a. For wet ponds, ensure the starting water elevation is set at the pond outlet elevation (normal water level).
    b. For infiltration or filtration basins, ensure the starting water elevation is set at the bottom of the basin.
    c. For outlet structures verify the most restrictive device is included in the model (i.e. the smallest area, flattest slope, etc.)
7. Verify curve numbers are accurate.
    a. Ensure that existing curve numbers reflect the existing land use.
    b. Increase curve numbers by ½ hydrologic soil group for greenspace that is mass-graded to account for soil compaction.
8. Verify that void ratios are assigned correctly (i.e. 40% for clean, washed, angular rock).
9. Verify HydroCAD model corresponds with existing topography and proposed plans:
    a. Verify existing drainage directions; mark/show arrows on a plan sheet or use the existing drainage area map.
    b. Do plans indicate drainage from off-site?
    c. How many acres drain onto the site from off-site?
    d. Check proposed drainage directions; any areas diverted to a new direction? How many acres? If not diverted, are stormwater facilities sized to accommodate off-site runoff?

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e. Verify the total drainage area is the same in both existing and proposed HydroCAD models.

Water Quality (i.e. P8, PondNet, WinSLAMM)

10. PRWD rules require water quality treatment using a permanent pool volume equivalent to the volume of runoff from a 3.2-inch rainfall. Alternatively, applicants can show a minimum of 90% removal of total suspended solids (TSS) and a minimum of 50% removal of total phosphorus (TP) for a 5-year, 24-hour rainfall event using Walker's Pond Net model.

    Practices besides wet ponds can be used to achieve the water quality standard (90% TSS removal and 50% TP removal) if it meets the Minimal Impact Design Standard (MIDS) performance goal. The MIDS performance goal is a design standard that was set by the MPCA to achieve a minimum of 90% removal of total suspended solids and a 50% total phosphorous removal. Information on the MIDS standard can be found here. Alternative practices may include but are not limited to infiltration systems, filtration systems, iron-enhanced filtration systems, and water reuse systems.

    Applicants using alternative practices may demonstrate the PRWD water quality standard is satisfied by submitting:
    - Calculations showing that 1.1" of rainfall on impervious areas of the site will be fully infiltrated or filtered within 48 hours.
    - Results from an acceptable model showing at least 90% TSS and 50% TP removal.

    The following equation should be used to design stormwater features to meet the MIDS standard:

    Required Treatment Volume (ft^3) =
    Impervious Surfaces (ft^2) * 1.1 (in) * 1/12 (ft/in)

    The following resources can be used to calculate TSS and TP removal:
    - P8 computer model (use NURP50 particle file)
    - WinSLAMM computer model
    - MIDS Calculator – download here
    - Ramsey-Washington Metro Watershed District Stormwater Calculator – download here
11. The siting of infiltration practices shall concur with the *Minnesota Stormwater Manual* (i.e. follow recommended setbacks from buildings, guidance for wellhead protection areas, maximum drainage areas).
12. All stormwater entering an infiltration/filtration practice must be pretreated.
    a. Pretreatment is an integral part of best management practices. Pretreatment will help to prevent a stormwater feature from being overloaded by coarse sediment and reduce maintenance. The MN NDPES permit requires pre-treatment before stormwater enters an infiltration/filtration system (pre-treatment requirements in the MN NPDES permit can be found here). General information about pretreatment can be found here.

b. Pretreatment options include, but are not limited to: filter strips, SAFL Baffles, and manhole sumps. Filter strips shall comply with the *Minnesota Stormwater Manual's* design standards.

13. If an infiltration or filtration practice is proposed, soil borings should be provided to demonstrate infiltration capacity of the native soils.
    a. The number of soil borings per practice is prescribed by the *Minnesota Stormwater Manual.*
    b. Soil borings shall be advanced at the location of the proposed practice and to a depth of at least five feet below the proposed bottom of the practice.
    c. Soil borings are necessary for filtration practices to demonstrate why infiltration is not practical (i.e., contamination, poor soils, high groundwater).
14. Verify the bottom of the infiltration or filtration practice is at least three feet from seasonally high groundwater.
15. Verify design infiltration rate based on least permeable soil type within five feet of bottom of practice.
16. Ensure the required treatment volume will drain within 48 hours.
17. Pollutant removal calculations (TSS and TP) shall be calculated using an area-weighted average. Project areas not routed to a proposed water quality practices shall be assigned 0% removal for the area-weighted calculation.
18. Calculate the provided treatment volume. Obtain volume by using either the submitted HydroCAD results or create a HydroCAD model. The volume provided is the volume under the lowest outlet and the bottom of the system. For filtration practices, only the volume provided below the low outlet of the BMP will be credited; perforated drain pipes for filtration will not be considered the low overflow outlet.
19. Ensure adequate maintenance access is provided (such as manholes or cleanouts).
20. For pervious pavement, *MN Stormwater Manual* recommends 5:1 or less ratio of typical to pervious pavement.
21. Use bioretention soil mixtures recommended by *MN Stormwater Manual*. 80% sand with 20% compost is most common.
22. For filtration practices, provide a filtration layer of at least 18" depth.
23. For iron-enhanced filters, provide a minimum of 5% iron by weight and ensure it is uniformly blended.
24. Is upstream or off-site runoff directed to the pond or basin? If so, it must be included in the calculations.
25. For traditional stormwater ponds:
    a. No infiltration below normal water level (pond outlet).
    b. Use the greater volume from the composite curve number or runoff from impervious areas to calculate the required treatment volume.

<u>Site Plans</u>

26. Verify existing and proposed drainage area maps. The drainage maps should include drainage arrows, areas, and labels that match the routing of the HydroCAD diagrams.
27. The plans shall contain property lines, existing and proposed grading, and all onsite or receiving waterbodies and streams should be identified.
28. The plans shall provide for permanent stabilization of all areas subject to land disturbance according to the NPDES permit.
29. Evaluate the proposed grading plan and drainage area to ensure stormwater will drain into the proposed practices as desired.

30. Confirm the HydroCAD, utility plan, and design details correspond. Design details may include: inlet/outlet inverts, pipe sizes and slopes, weir elevations, top and bottom elevations, and length, width and depth dimensions.
31. Verify detail to ensure it meets the following technical standards:
    a. No fabric below infiltration practices;
    b. Specify washed, angular, non-carbonate rock;
    c. At least 18” of filtration media;
    d. Iron-enhanced media has a minimum of 5% fillings by weight and is uniformly blended;
    e. At least 2” of chocking stone shall surround underdrain washed stone on the top and the sides; and
    f. No sock on drain tiles.
32. Erosion and sediment control plans or SWPPP:
    a. Basin perimeter control and erosion control practices shall remain in place until the final completion of the project or vegetation has been established (whichever is later).
    b. Installation of infiltration/filtration practices shall be done during periods of dry weather and completed before a rainfall event. Placement of engineered soils shall be on dry native soil only.
    c. Excavation of infiltration areas shall be completed using a backhoe with a toothed bucket.
    d. Native soils in infiltration areas shall be de-compacted to a minimum depth of 18 inches prior to placing engineered soil.
    e. The bottom excavation surface of infiltration areas shall be level without dips or swales.
    f. Engineered soil shall remain uncontaminated (not mixed with other soil) before and during installation.
    g. During construction, stormwater must be routed around infiltration areas until all construction activity has ceased and tributary surfaces are cleaned of sediment.
    h. Erosion control (i.e. silt fence) at perimeter of site where runoff is expected to occur.
    i. Erosion control (i.e. silt fence, erosion control blanket, biorolls) at perimeter of basins to prevent erosion of sediment into bottom of basin. The erosion control should limit construction activity on top of the infiltration basin to prevent sediment deposition and compaction of subsoils.
    j. Sediment control in ditches and swales.
    k. Rock construction entrance/exit.
    l. Inlet protection for existing and proposed catchbasins on site and immediately downstream of disturbed areas. Straw bales and silt fence are not recommended.
    m. Energy dissipation (i.e. riprap) at all pipe outlets.
    n. Calculate shear stress at outlets to ensure proper BMP is placed for erosion control that can manage appropriate shear stress.
33. Provide plans signed by a professional engineer per the Minnesota Board of AELSLAGID.

34. Provide a landscaping plan to include the following:
    a. Specify potted plants or plant plugs to vegetate infiltration/filtration areas. Basin seeding should be avoided.

   b. Specify deep rooted, salt tolerant, native plants according to _Plants for Stormwater Design_ (Shaw and Schmidt, 2003).
   c. Provide signage that deters snow management from using the infiltration/filtration basin for snow storage.

35. Analyze outlet structure details. Ensure that detail corresponds to model input. Ensure at least 6" depth below NWL for floatable control.
36. Ensure that calculated NWL & HWL from model output corresponds with plans. Basins should be labeled with the NWL & 100-year HWL. Recommend an additional 0.5-foot of freeboard from the 100-year HWL to the top as a factor of safety due to construction practices.
37. Check stormsewer entrance locations to ponds. Inlets and outlet distances shall be maximized to the extent possible. MPCA recommends a minimum of 80 feet.
38. Check FEMA Flood Insurance Rate Map (FIRM) or Flood Insurance Study (FIS) for 1% chance flood elevation.
39. Check 100-year HWL, emergency overflow routes, road elevations, and building elevations for freeboard requirements.
40. Check backyard drainage swales. Swales used to convey runoff (instead of installing stormsewer) should be graded within a drainage easement to ensure drainage rights.
41. Check for land-locked basins. If land-locked, execute model for the back-to-back 100-year storm event to ensure structures are protected and roads are accessible.
42. How is each point discharge directed to a public conveyance system: tile, ditch, stream, lake, or wetland?
43. If there is a point discharge at property line with no public conveyance system, permission from adjacent property owner? Identify potential impacted downstream properties.
44. Verify capacity of downstream tiles or ditches.
45. If a ditch, evaluate ownership or right to discharge.
46. Verify that outlet is not submerged, or if submerged that calculations reflect this.

<u>Maintenance</u>

47. Provide a site-specific plan, schedule and narrative for maintenance of the proposed stormwater management practices that includes the following:
    a. Inspect in winter months to ensure plowed snow is not being stored on infiltration/filtration practices.
    b. Establish a watering plan that extends a minimum of one year after planting.
    c. At a minimum, require annual maintenance of infiltration areas to include trimming vegetation, replacing vegetation where needed, mulch replacement, and removal of accumulated sediment and debris.
48. Adequate maintenance access (manholes or cleanouts) is not provided.

References

Introduction to Stormwater Modeling. *Minnesota Stormwater Manual*. May 17, 2016. http://stormwater.pca.state.mn.us/index.php/Introduction_to_stormwater_modeling

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