TR55/TR20 Type Drainage Analysis Review: A Reviewer's Perspective

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Introduction

- Data and information needed for TR55 – TR20 type drainage review
- Common deficiencies found in submittals
- Review of inputs and outputs that use similar commercially available software packages.

Data and Information Needed for Review of TR55/TR20 Type Drainage Analyses

Four Key Review Components

- Field Conditions
- Subwatershed Maps
- Drainage Diagram
- Drainage Analysis

Subwatershed Maps

- Provide separate existing and proposed condition maps.
- Typically try to use a 24” x 36” size, larger if necessary. Insert maps in report pocket.
- Use a typical engineering scale, no smaller than 1”=100’. Smaller scale OK for off-site areas.
- Provide 2’ topographic detail, 10’ for off-site areas. Show adequate upgradient and downgradient coverage.
- Depict the property lines .

Subwatershed Maps

- Indicate the analysis points that compare pre- and post-development flows.
- Indicate wetland areas, especially the receiving wetlands (include names).
- Indicate existing and proposed drainage features (closed drainage systems, swales, culverts, stormwater detention and/or infiltration systems, existing natural depressions/outlets).

Subwatershed Maps

- Delineate the contributing drainage areas to each analysis point.
  - On site areas.
  - Contributing upgradient areas.
- Indicate the limits of the various hydrologic soil groups (A, B, C, D) and cover types, with hydrologic condition (good, fair, poor).
- Indicate time of concentration flow path.

Drainage Narrative

- Provide design storms, including capacity of any closed drainage systems to deliver peak flows without overflow to design point .
- Describe analysis points and downgradient areas; indicate each eventual receiving watercourse.
- Describe site (cover types, slopes, critical areas, existing drainage systems, pertinent site history).
- Describe any drainage from upgradient areas.
- Analysis methods and software (versions) used.

Drainage Diagrams

- Provide existing and proposed condition drainage diagrams (node and arrow) that correspond to the subwatershed maps.
- Indicate subwatershed areas, ponds, reaches, and analysis points with nodes and connect with arrows showing flow direction.

Site Plans

- Provide existing and proposed topography.
- Clearly depict paved areas (depict any curbing), buildings, grassed areas, and natural vegetation to remain.
- Show drainage conveyance system details, especially catch basins and drainage inlets.
- Show detention and/or infiltration systems.

Profiles and Cross-sections

- Provide profiles of closed drainage systems, including pipe slopes & diameters and CB rim elevations.
- Provide cross-sections of all detention and infiltration facilities.
- Provide cross-section details for all outlet structures that control flow, including dimensions and elevations of all weirs and orifices.

Drainage Analysis:

Site Hydrology, Inputs

- Provide storm events and rainfall depths for comparative hydrologic analysis.
- Provide weighted curve number calculations.
- Provide time of concentration analysis.

Drainage Analysis:
Site Hydrology, Results

- For each subwatershed area, provide the peak runoff discharge rate, the time at which this peak occurs, and the total runoff volume of the 24-hour Type III storm hydrograph.
- DEM/FWW Program requires comparative analysis of the 2, 10, 25 and 100-year 24-hour type III storm events.

Drainage Analysis:
Detention Storage Routing, Inputs

- Provide elevation/stage vs. storage volume analysis.
- Provide elevation vs. outflow analysis for all outlet structures. Indicate weir and orifice dimensions and inverts.
- Include information on initial conditions (pond level at start of storm event).
- Include time frame.

Drainage Analysis: Detention

Storage Routing, Results

- Provide peak runoff discharge rates, time to peak, and total runoff volume for inflow and outflow of each detention basin.
- For infiltration systems, also provide the flows and total runoff volumes exfiltrated from the system.

Drainage Analysis:
Overall Comparisons

- Provide a pre-vs. post development comparison for each analysis point.
- The DEM/FWW Program requires analysis of the 2, 10, 25, and 100-year 24 -hour Type III storm events.
- Provide a comparison of the peak runoff discharge rates for each 24-hour Type III storm event, and times to peak.
- Provide the a comparison of the pre- and post total runoff volume. This is important if the receiving wetland has no surface outlet.

Hydraulic Analysis of Closed Drainage System

- Provide the hydraulic analysis of each proposed closed drainage system.
- Indicate the design storm.

Common Deficiency Issues Found in Submittals

Lack of Consistency

- Plans need to correspond to subwatershed maps.
- Subwatershed maps need to correspond to the analysis.
- Plan details need to be consistent with analysis. Example: outlet structures.
- Subwatershed maps need to be consistent with the drainage diagrams.

Lack of Consistency in Labeling

- Be sure that the subwatershed maps and drainage diagram are properly labeled.
- Often stormwater basins may be have differing labeling nomenclature from the plans, subwatershed maps,and/or analysis. Ponds A, B, and C on the plans may be referred to as Ponds 1P, 2P, and 3P in the analysis. Take the time to properly identify them in your review.

Inadequacies in Topography

- Topography needs to be of suitable quality to properly evaluate subwatershed area limits.
- Selection of appropriate analysis points is critical. Need to have an analysis point for each receiving watercourse or location where a pre- vs. post flow comparison is needed.
- A site visit may be helpful.

Improper Analysis of Weighted Curve Number (CN)

- Need to properly delineate & describe ground cover types.
- Need to properly characterize hydrologic condition (good, fair, poor).
  - A site visit helps.
- Need to provide proper soil hydro' group (A, B, C, D).
  - Often the RI Soil Survey is relied upon too heavily for the limits of D soils. Suggest use of wetland edge & site specific input.

Improper Modeling of Outlet Devices

- Check for errors of inconsistency between plans and analysis.
- Check for inadequacies in the proper use of formulas for weir and orifice flow.
  - Check for proper weir and orifice coefficients
  - Check for double counting flows in compound weirs.
- Check for potential flow in interstices of riprap in emergency overflow weirs.
- Check the infiltration rates used,if any.

Improper Modeling of Ponds/Storage Volumes

- Check for proper calculation of storage volumes.
  - Review areas vs. elevation inputs.
- Need to properly select initial pond elevation.
  - For a wet pond, the normal wet pond elevation needs to be used as input in model.
- Need to properly select the time span of the routing analysis. Too short a span may improperly show less total runoff volume.

Improper Selection of Rainfall Events.

- For the 2, 10, 25, and 100-year 24-hour Type III storms, use:
  - For Northern RI: 3.3, 4.8, 5.6, 7.0 inches
  - For Southern RI : 3.4, 5.0, 5.8, 7.2 inches
  - For Eastern RI : 3.4, 4.9, 5.7, 7.1 inches

Inadequate Delineation of Isolated Low Areas

- The existing condition subwatershed map needs to delineate the contributing subwatershed areas to isolated upland or wetland low spots.
- Failure to do this will allow the analysis to show unrealistically high peak runoff discharge rates to another analysis point.
- Often local micro-topography will dictate whether a low area is isolated or not.
- Review existing condition topography carefully. Make a site visit if necessary.

Improper Comparison of Contributing Areas

- Make sure that submittal accounts for all contributing runoff to each design point.
- Be sure that direct runoff is included.
- Include any contributing off-site drainage areas.
- Rooftop areas that will be infiltrated can be properly excluded.
- Check overall pre. vs. post overall area totals. Pre total should equal post total. (Allow for exclusion of roof areas that will be infiltrated.)

Failure to Provide Hydrologic Comparisons to Design Points

- The evaluation may show an overall decrease in peak runoff rates from the site as a whole, but may not identify an increase to a particular design point.
- Review needs to think in terms of potential impacts to each receiving watershed.

Improper Time of Concentration Analysis

- Review for potential inadequacies in Tc flow path selection. They should be reasonably accurate in depiction of hydraulically longest flow path of each subwatershed.
- Review for improper use of sheet flow lengths.
- Review for improper selection of slopes and ground covers (n-values).

Failure to Account for Effects of SHGWT

- The location of the Seasonal High Groundwater Table (SHGWT) is a critical concern in the overall design of proposed stormwater detention and/or infiltration systems.
- Potential inadequacies in depiction of the SHGWT elevation on the plans/cross-sections.
- Potential inadequacies of supporting information (test pit data).

Unclear Drainage Design Parameters

- Often the design of a stormwater detention pond may show the mitigation of peak runoff discharge rates for a 100-year event, but the collection system hydraulic design may be for a 10 or 25-year event. Consider whether the overall design allows for the higher flows to eventually reach the detention pond.
- May employ overflow swales or design the lower portion of system for the larger event.
- This item should be discussed in narrative.

Comments Regarding Some Common Used Hydrologic Software Packages

Common Software Received to the DEM/FWW Program

- Bentley Systems/Haestad methods
- Eagle Point
- HydroCAD
- Intellisolve
- Some others, submitted less frequently

Common Features

- All use either TR-55 or TR-20 methodology. (Use weighted CN's, Tc calculation method of sheet, shallow concentrated, and channel flow.)
- All use the storage-indication method for detention storage routing.
- Most provide a drainage diagram.
- All allow for printout of elevation-area-cumulative volume analysis of detention storage.
- All provide summary sheets for output data.

Hydrograph

- Most or all provide some form hydrograph printout and/or graph.
- This is often a drawback due to the additional printout involved. Often it may be helpful to request that hydrographs not be presented expect in cases of where the reviewer needs to view the inputs and/or output results of the addition of hydrographs.
- Typically, the key values of peak runoff discharge rate, time to peak, and total runoff volume suffice.

Modeling and Setup Issues to Consider

- Rainfall amounts.
- Review consistency of drainage diagram with subwatershed maps / site hydrology.
- Review time span and time increment for storage routing.
- Review initial conditions on basins.
  - For example, initial water level on wet pond.
- Review any infiltration rates used.

Runoff Volume (cf) Output Issues

- The programs will typically provide the TRV associated with the input time span for the subwatershed hydrographs.
- For pond outflows, the volume TRV totals represent the total volume discharged from the basin in the input time span. (Does not include volume that remains in the basin.)
- Most will also include a value total that equates to the peak volume total stored in a detention pond at its highest storage point for each storm.
- Most methods will provide the TRV exfiltrated.

Examples of Modeling Errors

- Double counting a portion of a compound weir of a detention basin outlet.
- For a 1” extended detention drain out orifice, using the pipe length of the 6” PVC pipe that feed the orifice.
- Assuming a wet pond to be empty at beginning of storm event.

Review Tips

- Find the Summary Sheets.
- Find the Drainage Diagrams and compare with subwatershed maps.
- Find the inputs of all existing and proposed subwatershed areas. Review and compare with info' on subwatershed maps.
- Find and review the inputs for all detention storage routing.
- Find outputs, especially outputs for design/analysis points and review pre-vs. results.

Some Examples of Typical Software Inputs and Outputs

Please feel free to call with any questions.

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