Strategies for Success

Wetlands Training Workshop for Consultants

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Please Note: This presentation is for a training workshop only and is not meant to be a substitute for the Freshwater Wetlands Act or the *Rules and Regulations Governing the Administration and Enforcement of the Freshwater Wetlands Act*.

Drainage Analysis and Drainage Plan Submittals

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Introduction

- Data and information needed for TR55 – TR20 type drainage submittals
- Drainage Information & Details needed on Site Plans
- Common deficiencies found in submittals

Data and Information Needed for TR55/TR20 Type Drainage Submittals

Key Components

- Subwatershed Maps
- Drainage Narrative
- 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 (Continued)

- 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 (Continued)

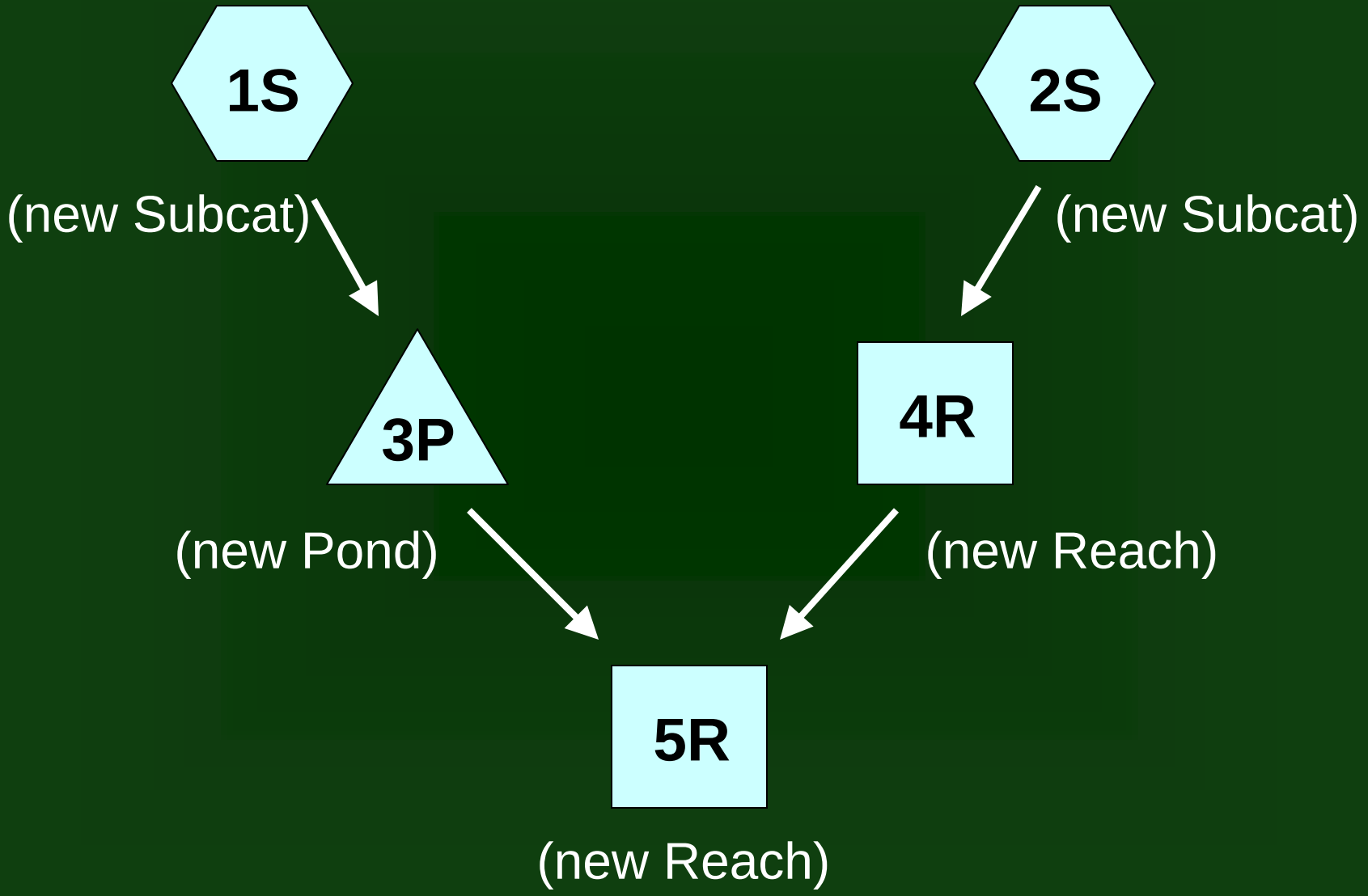
- Delineate the contributing drainage areas to each analysis point.
  - On site areas.
  - Contributing upgradient areas.
- Indicate the limits of the various hydrologic soil groups (A, B, C, D) and cover types, with hydrologic condition (good, fair, poor).
- Indicate time of concentration flow path.

Drainage Narrative

- Provide design storms, including capacity of any closed drainage systems to deliver peak flows without overflow w/o mitigation 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.
- Adequately label and annotate the nodes as needed to explain the location on the plans and in the analysis.


1S
2S
(new Subcat)
(new Subcat)
3P
4R
(new Pond)
(new Reach)
5R
(new Reach)

Drainage Analysis:

Site Hydrology, Inputs

- Provide storm events and rainfall depths for comparative hydrologic analysis.
- Provide weighted curve number calculations. Indicate cover types, hydrologic soil groups (A, B, C, D), hydrologic condition (good, fair, poor).
- Provide time of concentration analysis. Use maximum 100’ of sheet flow as per latest NRCS guidance.

Subwatershed Area, Curve Number Analysis Summary:

Subwatershed Number: xxxxx

Cover type	Hydro-logic condition	Hydro-logic Soil Group	Area	CN
Woods	good	B	12.50	55
Grass	good	B	2.55	61
Existing gravel driveways			0.55	85
Existing dwellings and accessory buildings			0.35	98
Total area, Weighted CN			15.95	57.94 (58)

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.

Subwatershed; Area; Curve Number; Time of Concentration inputs; Peak runoff discharge rate, to peak, total runoff volume outputs for 2, 10, 25, and 100-year 24-hour Type III storm event summary.

Summary of Designer's Pre-development

Subarea	Area (acres	CN	Tc (min utes)	2-year (3.3") (cfs, at time t, acre feet)	10- year (4.8") (cfs, at time t, acre feet)	25-year (5.6") (cfs, at time t, acre feet)	100-yr (7.0") (cfs, at time t, acre feet)
1, Pre	15.95	58	12.5	3.02	13.32	20.39	34.37
				@12.32	@12.21	@12.20	@12.19
				0.431	1.259	1.813	2.920

Summary of Designer's Post-Analysis:

Subare	Area (acres	CN	Tc (min utes	2-year (3.3") (cfs, at time t, acre feet)	10- year (4.8") (cfs, at time t, acre feet)	25-year (5.6") (cfs, at time t, acre feet)	100-yr (7.0") (cfs, at time t, acre feet)
1, Post	15.95	72	8.0	15.68	34.71	45.75	65.98
				@12.13	@12.12	@12.12	@12.12
				1.198	2.506	3.286	4.740

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; pertinent weir/orifice coefficients.
- Indicate any infiltration rates, (substantiated).
- Include information on initial conditions (pond level at start of storm event).
- Include time frame and time increment.

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.

Peak runoff discharge rate, time to peak, total runoff volume inputs outputs for detention pond routing, along with peak pond elevations and peak volumes stored for the 2, 10, 25, and 100-year 24-hour Type Type III storm event summary.

Example: Summary of Detention Pond Routing

Subare	Area (acres	CN	Tc (minutes)	2-year (cfs, at time t, acre feet)	10- year (cfs, at time t, acre feet)	25-year (cfs, at time t, acre feet)	100-yr (cfs, at time t, acre feet)
Inflow				15.68	34.71	45.75	65.98
				@12.13	@12.12	@12.12	@12.12
				1.198	2.506	3.286	4.740
Outflow				2.22	11.65	16.93	23.85
				@13.03	@12.49	@12.44	@12.44
				0.837	2.110	2.870	4.277
			Peak elev./ peak sto	122.77	123.78	124.21	125.03
				23,555	43,051	53,275	75,699

Typical Results of Pond Routing

Summary Table - Example

	Storm Event			
	2 yr	10 yr	25 yr	100 yr
Peak Flow In, Qin (cfs)	4.30	9.87	12.96	18.70
At Time, t (hr)	@12.31 h	@12.15 h	@12.12 h	@12.12 h
Total Volume (ac-ft)	.258 AF	.734 AF	1.001 AF	1.50 AF
Peak Flow Out, Qout (cfs)	0.43	1.18	4.15	11.50
At Time, t (hr)	@14.25	@13.14	@12.54	@12.30
Total Volume (ac-ft)	.258 AF	.734 AF	1.001 AF	1.50 AF
Max Vol Stored in Basin (cf)	.213 AF	.418 AF	.490 AF	.558 AF
Max Elevation in Basin (ft)	301.77’	303.11’	303.52’	303.90’

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.

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.

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.
- Submittal needs to address potential impacts to each receiving watershed.

Improper Time of Concentration Analysis

- Properly select Tc flow paths. They should be reasonably accurate in depiction of hydraulically longest flow path of each subwatershed.
- Use proper sheet flow lengths; NRCS guidance is for use of 100’ maximum.
- Review for improper selection of slopes and ground covers (n-values).

Properly Address Effects of SHGWT & Associated Impacts

- 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.
- Depiction the SHGWT elevation on the plans/cross-sections.
- Provide adequate test pit data.

Avoid 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.

Modeling and Setup Issues to Consider

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

Avoid Common Modeling Errors

- Avoid double-counting a portion of a compound weir of a detention basin outlet.
- Properly model the extended detention outlet orifices. Avoid modeling the orifice diameter as the (typically larger) pipe diameter.
- Assume that wet ponds are full, not empty, at beginning of storm event.

Submittal Tips

- Include Summary Sheets of the Drainage Analysis.
- Include Drainage Diagrams, and ensure consistency with with subwatershed maps.
- Ensure consistency of depicted subwatershed areas with drainage analysis info’.
- Ensure consistency of detention storage inputs and plan details.
- Ensure that pre-vs. post analysis and narrative is given for each design point.