WATERSHED MANAGEMENT ORDINANCE

Public Training Session #1

Presented by:

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April 16, 2014

SEMINAR OUTLINE

- Introduction to the Watershed Management Ordinance (WMO)
- Differences between the Sewer Permit Ordinance (SPO) and the WMO
- WMO applicability
- New forms and submittal requirements
- Authorized municipalities
- Stormwater management design requirements
- Requirements for flood protection areas (FPAs)
- Resources for stakeholders
- Example stormwater design calculations

WATERSHED MANAGEMENT ORDINANCE (WMO)

- Replaces the Sewer Permit Ordinance (SPO), which was adopted in 1972
- WMO becomes effective May 1, 2014
- WMO applies to all development within Cook County, except for the City of Chicago (some City of Chicago developments will require District approval)

SPO VS WMO

Sewer Permit Ordinance (SPO)

- Sanitary Sewers
- Stormwater Detention
  - TP-40 Rainfall Data
  - Modified Rational Method

Watershed Management Ordinance (WMO)

- Sanitary Sewers
- Stormwater Detention
  - Bulletin 70 Rainfall Data
  - Flat Release Rate
  - Event Hydrograph Methods
- Volume Control
- Erosion & Sediment Control
- Flood Protection Areas
  - Floodplain
  - Floodway
  - Isolated Wetlands
  - Riparian Environments

Do I need a WMO Permit…… Even Here?

OLD AND NEW PERMIT FORMS

- **Current Permit Schedules**
  - Schedule A – Project Summary
  - Schedule B – Sewer Summary
  - Schedule C – Sewer Connections
  - Schedule D – Detention
  - Schedule E – Lift Station / Force Main
  - Schedule F – Characteristics of Waste Discharge
  - Schedule G – Treatment / Pretreatment Facilities
  - Schedule K – Affidavit of Disclosure of Property Interests
  - Schedule L – Notice of Requirements for Stormwater Detention
  - Exhibit A – Current Survey of Property Interests
- **New/Revised Permit Schedules**
  - Schedule D – WMO and Schedule D-Legacy - Detention
  - Schedule H – Hazard Areas (Floodplain/Floodway/Riparian)
  - Schedule O – Outfalls, Direct Connections, District Property
  - Schedule P – Erosion Control
  - Schedule R – Recording and Maintenance
  - Schedule W – Wetlands and Buffer Areas

DEVELOPMENT/REDEVELOPMENT

Development:

"Any human-induced activity or change to real estate (including, but not limited to, grading, paving, excavation, dredging, fill, or mining; alteration, subdivision, change in land use or practice; building; or storage of equipment or materials) undertaken by private or public entities that affects the volume, flow rate, drainage pattern or composition of stormwater, or the substantial improvement of an existing building in a Special Flood Hazard Area. The term development shall include redevelopment and shall be understood to not include maintenance."

Redevelopment:

"Any human-induced activity or change to an existing developed property (including but not limited to, grading, paving, excavation, dredging, fill, or mining; alteration, subdivision, change in land use or practice; building; or storage of equipment or materials) undertaken by private or public entities that affects the volume, flow rate, drainage pattern, or composition of the site stormwater runoff on the previously developed land. The term shall not be understood to include maintenance."

WATERSHED MANAGEMENT PERMIT

Permit is required when one of the following is triggered:

1) Development is located in a Flood Protection Area (FPA) or causes an indirect wetland impact.
2) Development disturbs 0.5 acres or more
3) Development proposes drainage improvements in combined sewer area or in conjunction with previously permitted detention facility
4) Development involves an outfall to waterway or Lake Michigan
5) Development involves sewer or connection to District interceptor or TARP structure

*Permits for 1 & 2 may be issued by District or authorized municipality.
Permits for 3, 4 & 5 can only be issued by District.

DEVELOPMENTS EXEMPT FROM WMO PROVISIONS

1) Proposed development was issued Sewerage System Permit before May 1, 2014*
2) A complete Sewerage System Permit application for the proposed development has been accepted by the District prior to May 1, 2014*
3) Development with active Sewerage System Permit issued prior to May 1,2014, but has not been fully constructed by May 1, 2014*
4) Development is on existing development plans list*
5) Development is located within a multi-county municipality that has adopted the other county's ordinance**

*Must meet standards of Sewer Permit Ordinance (SPO)
**Some permits will still be issued by District

DEVELOPMENTS EXEMPT FROM WMO PROVISIONS

6) Agricultural, maintenance, and public utility activities that meet conditions of §201.1.D of the WMO

7) Development involves the modification of a septic system, potable water service line, or utility that serves an existing structure

8) Development within the City of Chicago, unless it involves:
    - Outfall to waterway or Lake Michigan
    - Stormwater discharges to District property
    - Connections to District sewer, interceptor, or TARP structure

9) Development undertaken solely by state or federal agencies (the District, IDOT, Corps, Illinois Tollway Authority, etc.)

10) Public flood control projects

DEVELOPMENT IN COMBINED SEWER AREA

- Developments permitted under the Sewer Permit Ordinance (SPO) are not required to provide stormwater detention

- Developments permitted under the WMO must provide both volume control and stormwater detention
  - For volume control practices, underdrains must be 3.5 ft above seasonal groundwater level
  - Detention facilities must be constructed with backflow prevention device
  - Detention facility must be lined if bottom is < 3.5 ft above seasonal groundwater level

QUALIFICATIONS FOR AUTHORIZED MUNICIPALITIES

For a community to qualify as an authorized municipality, it must meet the following requirements:

A. Have legal authority to perform all requirements of an authorized municipality as specified in the WMO

B. Adopt the WMO, including all amendments, by reference

C. Participate in the National Flood Insurance Program (NFIP)

D. Have the ability to review and issue Watershed Management Permits for development activities in separate sewer areas listed in §201.1 of the WMO and within its corporate boundaries in conformance with the WMO

E. Employ or retain by contract, adequate staff for all of the following positions:

1) An enforcement officer

2) Professional Engineer(s)

3) Wetland specialist(s)

(continued on next slide)

QUALIFICATIONS FOR AUTHORIZED MUNICIPALITIES, CONT.

F. Timely review Watershed Management Permit applications and respond within:

1) Fifteen (15) working days of an initial submittal for developments not involving flood protection areas (floodplains/wetlands/buffers/riparian environments)
2) Thirty (30) working days of an initial submittal for developments involving flood protection areas
3) Ten (10) working days of a resubmittal

G. Maintain all of the following records:

1) Watershed Management Permits
2) Record drawings
3) Structure improvement data
4) Elevation certificates
5) Base flood data and base flood maps
6) LOMC, LOMR, etc.

(continued on next slide)

QUALIFICATIONS FOR AUTHORIZED MUNICIPALITIES, CONT.

H. Transmit all records specified in §1402.2.G of the WMO to the District upon receipt

I. Issue watershed management permits for development activities listed in §201.1 within its corporate boundaries in conformance with the WMO

J. Inspect the construction of all developments which require a watershed management permit from the authorized municipality

K. Notify the District promptly for any violation within the authorized municipality

L. Issue local stop work orders for all violations, when appropriate

M. Establish watershed management permit fees for watershed management permits reviewed and issued by the authorized municipality

AUTHORIZED MUNICIPALITIES

How to become authorized:

1) Submit a letter of intent (with supporting documentation) to the District to become an authorized municipality

   Template available at:
   http://www.mwrd.org/irj/portal/anonymous/managementordinance

2) Enter into intergovernmental agreement with the District

   Template available at:
   http://www.mwrd.org/irj/portal/anonymous/managementordinance

3) Provide contact information for enforcement officer, Professional Engineer, and wetland specialist for the municipality

AUTHORIZED MUNICIPALITIES

Supporting documentation with letter of intent:

- A statement of intent to adopt the WMO by reference
- A legal opinion indicating the authorized municipality has legal authority to perform all obligations required by the WMO including:
  1) The regulation of erosion and sediment control, stormwater management, floodplains, isolated wetlands, and riparian environments
  2) The ability to conduct inspections
  3) The issuance of Watershed Management Permits
  4) The enforcement of the WMO
  5) The ability to enter into an intergovernmental agreement with the District
- A verified statement of financial capability to perform and adequately fund the obligations of the authorized municipality
- Designation of an enforcement officer
- An implementation plan
- Proposed staffing (enforcement officer, PE, wetland specialist)

WETLAND SPECIALIST

For a person to qualify as a wetland specialist, he/she must meet the requirements of a), b), c), or d) below:

a) Certified as an Environmental Scientist in DuPage County or a Certified Wetland Specialist (CWS) in Lake County;

b) Professional Wetland Scientist certification by the Society of Wetland Scientists (SWS);

c) Minimum of a bachelor's degree in a biologic science or earth science and at least one of the following:

i. Three (3) years cumulative (full-time) wetlands experience in the Upper Midwest Region on wetland-related projects; or

ii. Completion of at least 100 wetland delineation projects in the Upper Midwest Region;

d) Six (6) years cumulative (full-time) wetlands experience in the Upper Midwest Region on wetland-related projects without a degree type noted above.

ARTICLE 14 – AUTHORIZED MUNICIPALITIES

Authorized municipalities do not have the authority to issue permits for certain types of projects. The permits must be issued by the District, and the developments include:

- Development that is located within a combined sewer area
- Development that involves modification to the drainage system of a previously permitted detention facility
- Any development that is considered qualified sewer construction
- Development that involves a sewer or connection to District sewer, interceptor, or TARP structure
- Development that involves new or reconstructed outfalls to a waterway* or Lake Michigan

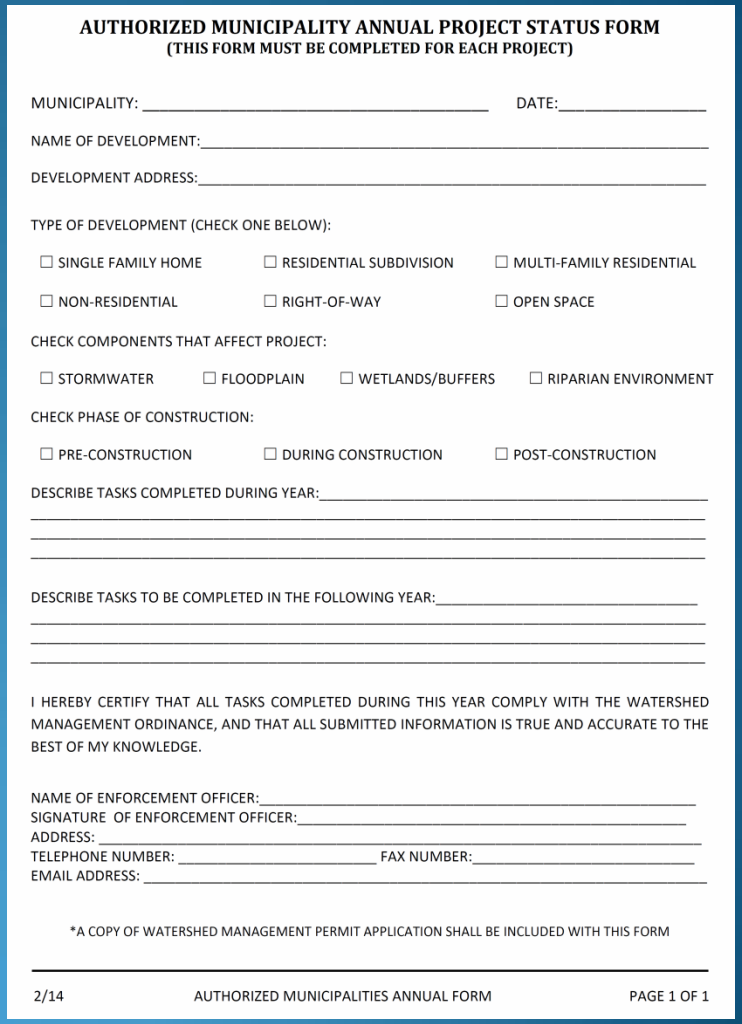
*WMO defines waterway as a "navigable body of water such as a stream, creek, canal, or river"

AUTHORIZED MUNICIPALITIES PERMIT NUMBERING SYSTEM

- When a new application is submitted, the authorized municipality should contact the District to obtain an MWRD permit number for the project. The authorized municipality may adopt its own separate permit numbering system, but the MWRD permit number must be included on all documentation associated with the project
- The MWRD permit number should not be reassigned or consolidated by the Authorized Municipality

ANNUAL PROJECT STATUS FORM

- The enforcement officer of an authorized municipality must complete an annual project status form for each development permitted by the community.
- The purpose of this form is to provide an inventory of all developments permitted within the authorized municipality, the status of the projects (pre-construction, during construction, and post-construction), as well as the permitting components of the project (stormwater, floodplain, wetland/buffers, and riparian environments).
- The form will be available on-line through the District's website.



AUTHORIZED MUNICIPALITY ANNUAL PROJECT STATUS FORM
(THIS FORM MUST BE COMPLETED FOR EACH PROJECT)

MUNICIPALITY: _____ DATE:_____

NAME OF DEVELOPMENT:_____

DEVELOPMENT ADDRESS:_____

TYPE OF DEVELOPMENT (CHECK ONE BELOW):

☐ SINGLE FAMILY HOME ☐ RESIDENTIAL SUBDIVISION ☐ MULTI-FAMILY RESIDENTIAL

☐ NON-RESIDENTIAL ☐ RIGHT-OF-WAY ☐ OPEN SPACE

CHECK COMPONENTS THAT AFFECT PROJECT:

☐ STORMWATER ☐ FLOODPLAIN ☐ WETLANDS/BUFFERS ☐ RIPARIAN ENVIRONMENT

CHECK PHASE OF CONSTRUCTION:

☐ PRE-CONSTRUCTION ☐ DURING CONSTRUCTION ☐ POST-CONSTRUCTION

DESCRIBE TASKS COMPLETED DURING YEAR:_____

_____

_____

_____

DESCRIBE TASKS TO BE COMPLETED IN THE FOLLOWING YEAR:_____

_____

_____

_____

I HEREBY CERTIFY THAT ALL TASKS COMPLETED DURING THIS YEAR COMPLY WITH THE WATERSHED MANAGEMENT ORDINANCE, AND THAT ALL SUBMITTED INFORMATION IS TRUE AND ACCURATE TO THE BEST OF MY KNOWLEDGE.

NAME OF ENFORCEMENT OFFICER:_____
SIGNATURE OF ENFORCEMENT OFFICER:_____
ADDRESS: _____
TELEPHONE NUMBER: _____ FAX NUMBER:_____
EMAIL ADDRESS: _____

*A COPY OF WATERSHED MANAGEMENT PERMIT APPLICATION SHALL BE INCLUDED WITH THIS FORM

2/14 AUTHORIZED MUNICIPALITIES ANNUAL FORM PAGE 1 OF 1

ARTICLE 14 – DISTRICT OVERSIGHT

The District can inspect any development within an authorized municipality, and can, at any time, audit an authorized municipality. During an audit, the District may:

- Inspect and copy pertinent records kept by an authorized municipality
- Inspect Watershed Management Permits issued by an authorized municipality
- Meet with staff of an authorized municipality
- Conduct field inspections of developments permitted by an authorized municipality
- Request and copy financial records of the authorized municipality
- Verify that an authorized municipality complies with all requirements listed in §1402.2 of the WMO
- Verify that an authorized municipality does not violate any provision listed in §1402.3 of the WMO

MULTI-COUNTY MUNICIPALITIES

- The WMO provides the option for multi-county municipalities to adopt and enforce the adjacent county's stormwater ordinance
- Municipality must enter into IGA with the District
- Certain development activities would still require a Watershed Management Permit from the District (same as authorized municipalities)

WMO PERMIT SUBMITTAL FLOW CHART

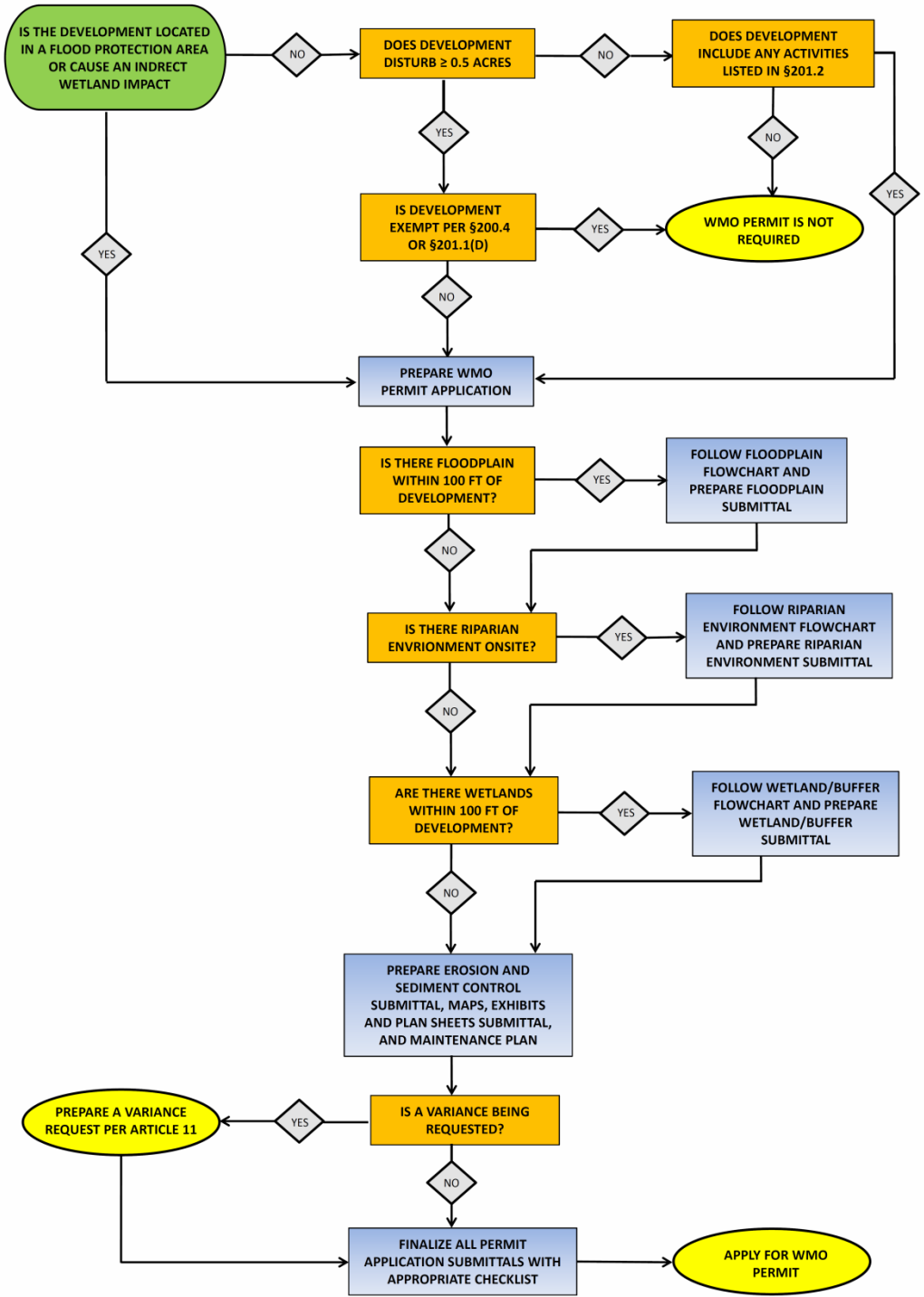


Table 2.
Summary of Site Stormwater Management Requirements*

Development Type (See Appendix A for definitions)	§502 Runoff Requirements	§503 Volume Control Requirements	§504 Storage Requirements
Single-Family Home	Exempt	Exempt	Exempt
Residential Subdivision	**Parcels** ≥ 1 acre	**Parcels** ≥ 1 acre	**Parcels** ≥ 5 acres
Multi-Family Residential	**Parcels** ≥ 0.5 acre	**Parcels** ≥ 0.5 acre	**Parcels** ≥ 3 acres ‡
Non-Residential	**Parcels** ≥ 0.5 acre	**Parcels** ≥ 0.5 acre	**Parcels** ≥ 3 acres ‡
Right-of-Way	**New Impervious Area** ≥ 1 acre	**New Impervious Area** ≥ 1 acre †	**New Impervious Area** ≥ 1 acre †
Open Space	**Parcels** ≥ 0.5 acre	Not Applicable	Not Applicable

* **Site stormwater** management requirements are not required for **maintenance activities** as defined in Appendix A.

† Where practicable.

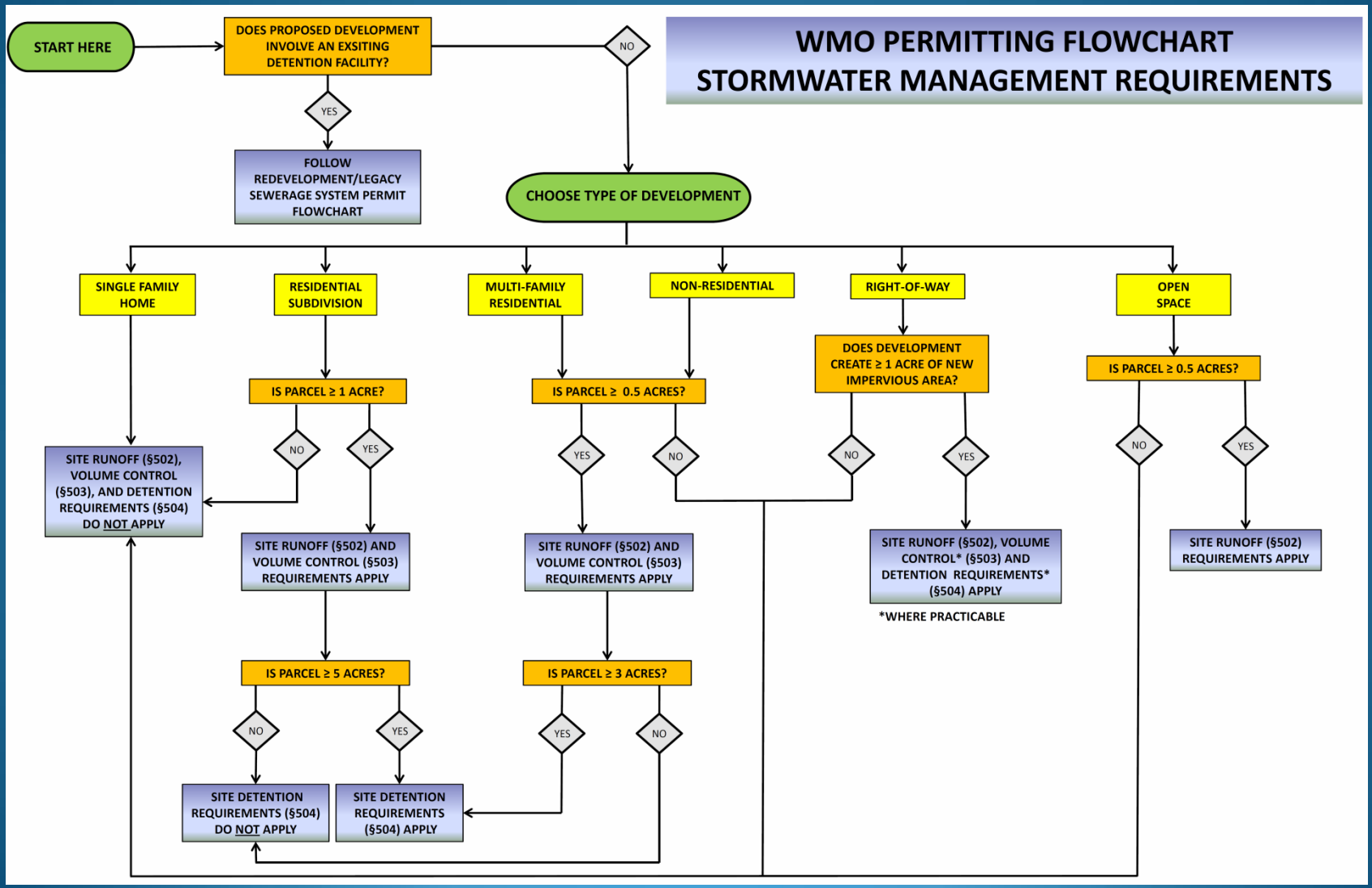
‡ Starting the effective date of this **ordinance,** any new **development** on the **parcel** that totals either individually or in the aggregate to more than one-half (0.5) of an acre.

WHEN IS VOLUME CONTROL REQUIRED?

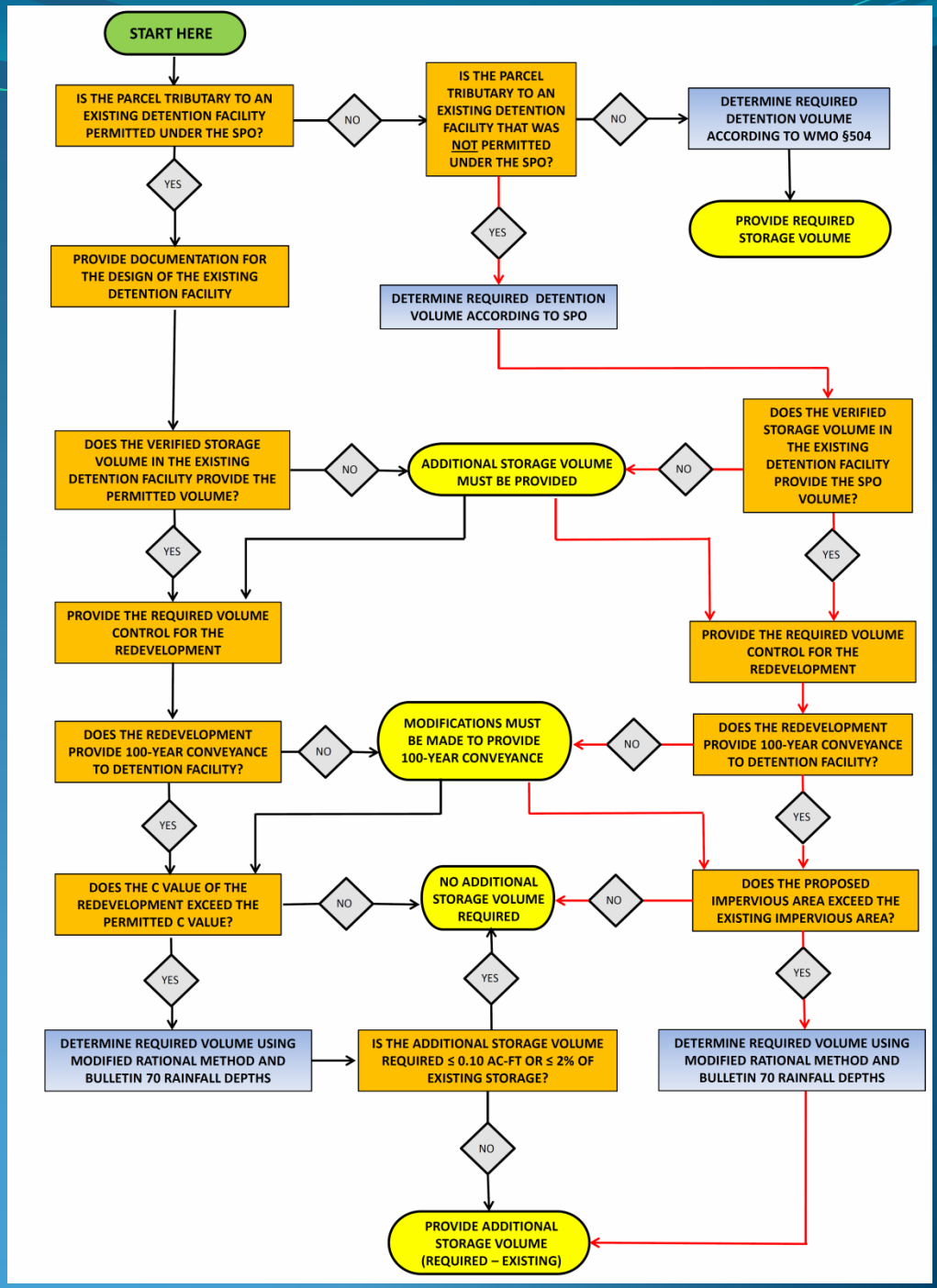
WHEN IS DETENTION REQUIRED?

CHECK TABLE 2 IN WMO...OWNERSHIP AREA STILL USED AS DETERMINING FACTOR

ARTICLE 3 – STORMWATER MANAGEMENT REQUIREMENTS FLOWCHART



STORMWATER MANAGEMENT REQUIREMENTS FOR REDEVELOPMENT FLOW CHART



MINOR STORMWATER SYSTEM DESIGN

- Rational Method in conjunction with Intensity-Duration-Frequency (IDF) curves based on Bulletin 70 sectional rainfall depths
- Select land use values for runoff coefficients

Surface Type	Runoff Coefficient, C
Native Plantings	0.15
Pervious Area	0.45
Gravel (loose, unbound)	0.75
Wetlands	0.79
Impervious area (Roads, roofs, sidewalks, etc.)	0.90
Water Surface (open water)	1.00
Green Infrastructure:	
Bioswale	0.15
Rain Garden	0.15
Pervious Surfaces (Porous Asphalt, Pervious Concrete, Permeable Pavers)	0.75

MAJOR STORMWATER SYSTEM DESIGN

- Event Hydrograph Method
  - HEC-1, HEC-HMS, or TR-20
  - Critical Duration Analysis
  - CN and t_c calculated using SCS (NRCS) methodology
  - Assume fully developed conditions
  - Design for peak 100-year flowrate
  - Only two Manning's n values for overland flow routes

Surface Type	Manning's n Value
Paved Channels (asphalt or concrete roadways)	0.013
Unpaved Channels (grassed)	0.035

CALCULATION OF RUNOFF CURVE NUMBER (CN)

Land use values will be limited to the following table:

Cover Type and Hydrologic Conditions	Curve Numbers for Hydrologic Soil Group	
	C	D
Native Plantings	70	75
Pervious area (open space, mostly grassed areas)	74	80
Gravel (railroad yards, roads, parking lots)	89	91
Newly graded areas (pervious areas only, no vegetation)	91	94
Wetlands	91	94
Impervious area (roads, roofs, sidewalks, etc.)	98	98
Water surface (open water)	100	100
Green Infrastructure:		
Bioswale	63	70
Rain Garden	63	70
Pervious Surfaces (Porous Asphalt, Pervious Concrete Permeable Pavers)	91	91

CALCULATION OF TIME OF CONCENTRATION

Using NRCS Methodology,
Time of Concentration (t_c) is combination of:

(1) Sheet Flow:

$$T_t = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5}S^{0.4}}$$

Overton and Meadows Equation
Maximum length = 100 ft

(2) Shallow Concentrated Flow:

$$T_t = \frac{L}{3600V}$$

V is calculated based on paved or unpaved surface

(3) Open Channel Flow:

$$T_t = \frac{L}{3600V}$$

V is calculated using Manning's equation, assuming bankfull conditions

VOLUME CONTROL

- One inch of volume over total impervious area
- Can be provided in several ways:
  - Infiltration Trenches
  - Infiltration Basins
  - Porous Pavement (storage in the voids below the pavement)
  - Bio-Retention Systems
  - Dry Wells
  - Cisterns
  - Open Channel Practices Fitted With Check Dams
  - Storage Below the Outlet of a Site Detention Facility
- Credit toward required detention volume (CN reduction)

VOLUME CONTROL DESIGN

- When providing storage in void space of aggregate, stone must be angular cut and cleaned/washed free of fines. Different aggregate sizes are acceptable
- Underdrains are required, must be offset at least 2” from bottom of volume control storage
- Bottom of storage must be 3.5 ft above seasonal groundwater level in combined sewer areas, 2 feet in separate sewer areas
  - Groundwater level established through soil borings
- One monitoring well per 40,000 ft^2 of area

FLOW-THROUGH PRACTICES

- Required for portion of volume control not being provided by volume control practices
- Common flow-through practices are:
  - Vegetated Filter Strips
  - Bio Swales
  - Constructed Wetlands
  - Catch Basin Inserts
  - Oil and Grit Separators
- No stormwater detention volume credit for flow-through practices

VOLUME CONTROL STORAGE CREDIT (CN REDUCTION)

- Reduction in composite CN for determining required detention volume

RUNOFF CURVE NUMBER ADJUSTMENT CALCULATOR

Site Information:

Total Site Area, A_w (ac) =	10	Total Impervious Area, A_i (ac) =	3
Runoff, R (in) =	5.00		
P = rainfall depth (in) =	7.58		
CN =	78		
S =	2.82		
Runoff Volume Over Watershed, V_w (ac-ft) =	4.17		

Volume of GI Provided:

Control Volume, V_R =	0.25	ac-ft	1" of volume over impervious area
Additional Volume, V_{GI} =	0.00	ac-ft	Additional volume over the required 1"

Adjusted Volume Over Watershed, $V_{ADJ} = V_W - V_R - V_{GI}$

V_{ADJ} (ac-ft) =	3.92
Adjusted Runoff Over Watershed, $R_{ADJ} = \frac{V_{ADJ}}{A_W}$	
R_{ADJ} (in) =	4.70
S_{ADJ} =	3.28
Adjusted CN for detention calcs, CN_{ADJ} =	75.32

*Blue values are entered by user

CN REDUCTION METHODOLOGY

- Reduce overall runoff volume of the site by the volume provided in retention-based volume control practices
- Use NRCS runoff equation to calculate CN that translates to adjusted runoff volume
- Adjusted CN is used in stormwater detention calculations
- Applicants will use spreadsheet that computes adjusted CN

CN REDUCTION METHODOLOGY

Start with selection of CN for developed site:

Cover Type and Hydrologic Conditions	Curve Numbers for Hydrologic Soil Group	
	C	D
Native Plantings	70	75
Pervious area (open space, mostly grassed areas)	74	80
Gravel (railroad yards, roads, parking lots)	89	91
Newly graded areas (pervious areas only, no vegetation)	91	94
Wetlands	91	94
Impervious area (roads, roofs, sidewalks, etc.)	98	98
Water surface (open water)	100	100
Green Infrastructure:		
Bioswale	63	70
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Pervious Surfaces (Porous Asphalt, Pervious Concrete Permeable Pavers)	91	91

Table 5-7 from TGM

CN REDUCTION METHODOLOGY

The NRCS Runoff Curve Number (CN) method is described in detail in the National Engineering Handbook (NEH-10). The NRCS runoff equation is:

$$R_W = \frac{(P - 0.2S)^2}{(P + 0.8S)} \qquad 1.0$$

where,

R_W = runoff depth (in) from Area, A_W
P = rainfall depth used to calculate runoff (in),
S = potential maximum retention after runoff begins (in), and is calculated by:

$$S = \frac{1000}{CN_W} - 10 \qquad 1.1$$

where,

CN_W = composite runoff curve number for the watershed to be developed

The volume of runoff (acre-feet), V_W, from watershed A_W (acres) can then be calculated by:

$$V_W = A_w \times \frac{R_W}{12} \qquad 1.2$$

CN REDUCTION METHODOLOGY

The total volume of runoff from the site can be reduced by the volume control required and the extra green infrastructure volume that may be provided:

$$V_{ADJ} = V_W - V_R - V_{GI} \qquad 1.3$$

where,

V_{ADJ} = adjusted runoff volume from site (acre-feet)
V_R= volume of control volume (1" over impervious area of development)
V_{GI} = volume of green infrastructure provided in addition to the required 1"

This reduced volume of runoff can be reflected in an overall reduction to the CN used in detention basin sizing by using:

$$12 \times \frac{V_{ADJ}}{A_W} = R_{ADJ} = \frac{(P - 0.2S)^2}{(P + 0.8S)} \qquad 1.4$$

Since we know R_{ADJ}, and we know that P = 7.58" for the 100-year, 24-hour storm event, we can solve for S, which then translates to the adjusted CN.

CN REDUCTION EXAMPLE

Example 1

For a 10-acre proposed residential area with a developed CN of 78, and 3 acres of impervious area, find the revised CN resulting from the 1" volume control provisions of the WMO.

The future 100-year runoff volume for the proposed development without volume control can be calculated using equation 1.0 and 1.1.

$$R_W = \frac{(7.58"-0.2S)^2}{(7.58+0.8S)}$$

$$S = \frac{1000}{78} - 10 = 2.82"$$

$$R_W = \frac{(7.58" - (0.2)(2.82"))^2}{7.58" + 0.8(2.82")}$$

$$R_W = 5.00"$$

CN REDUCTION EXAMPLE

The total volume is therefore:

$$V_W = \frac{R_W}{12} \times A_W = \frac{5}{12} \times 10 \text{ acres} = 4.17 \text{ acre-feet}$$

The volume associated with the total impervious area that must be stored is:

$$V_R = 3 \text{ acres} \times \frac{1"}{12} = 0.25 \text{ acre feet}$$

For this example, $V_{GI} = 0$, so using Equation 1.3:

$$V_{ADJ} = 4.17 \text{ acre-feet} - 0.25 \text{ acre feet} = 3.92 \text{ acre-feet}$$

And using Equation 1.4:

$$12 \times \frac{V_{ADJ}}{A_W} = \frac{(P - 0.2S)^2}{(P + 0.8S)} = 4.70"$$

CN REDUCTION EXAMPLE

Since P=7.58":

$$4.70 \text{ inches} = \frac{(7.58" - 0.2S)^2}{(7.58" + 0.8S)}$$

Solving this equation iteratively:

S = 3.28

And from Equation 1.1

CN = 75.32

The curve number is reduced from 78 to 75.32. This procedure reflects the stormwater volume reduction and allows for hydrologic routing through proposed stormwater management facilities.

To simplify this procedure, an Excel spreadsheet (next slide) has been provided which reflects the analysis described in this memorandum. The applicant would only have to provide areas, developed CN and the depth of storage being provided. The equation would be solved for the user.

CN REDUCTION CALCULATOR

RUNOFF CURVE NUMBER ADJUSTMENT CALCULATOR

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*Blue values are entered by user

REQUIRED DETENTION VOLUME

- Determined using event hydrograph method*
  - HEC-1, HEC-HMS, or TR-20
  - Reduced CN for site based on provided volume control storage
  - Allowable release rate of 0.30 cfs/acre
    - Account for depressional storage and unrestricted releases
  - 100-Year, 24-Hour Rainfall Depth of 7.58”
  - Antecedent Moisture Condition (AMC) of II
  - Tailwater elevation of receiving stream
    - 100-Year flood elevation or HGL

*Simple sites may use detention nomograph

UNRESTRICTED RELEASES

Can be handled in three ways:

1) Divert equivalent undetained upstream tributary area

2) Reduce allowable release rate by 100-year, 24-hour flowrate of unrestricted area
   - Determined using event hydrograph method

3) Plant the unrestricted flow area with deep-rooted vegetation approved by the District or authorized municipality
   - Allowable release rate based on tributary area to detention facility

BYPASS FLOWS

Recommended design guidance:

- Upstream tributary area ≤ 5:1 of the development area
  → Bypass flow through weir of detention facility

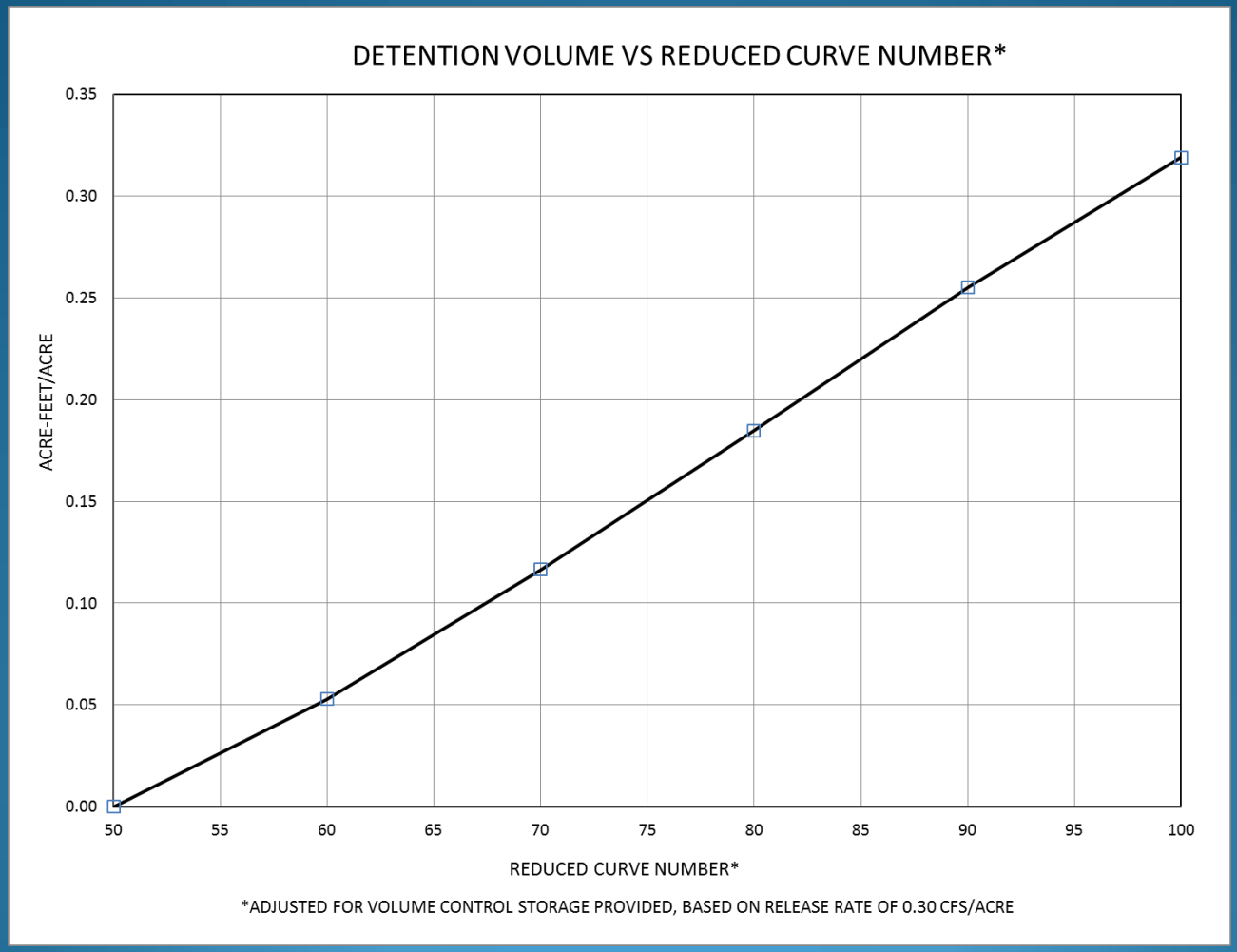
- Upstream tributary area is ≥ 5:1 of the development area
  → Bypass flow around detention facility

DETENTION VOLUME NOMOGRAPH

May be used instead of event hydrograph method for simple sites, where:

- The allowable release rate is not affected by existing on-site depressional storage.
- The allowable release rate is not affected by any unrestricted flow.
- There is no upstream tributary flow to the proposed detention facility.
- There are no tailwater conditions on the proposed detention facility's outlet control structure.
- The development provides the required volume control storage (one inch).

DETENTION VOLUME NOMOGRAPH



Detention volume as a function of reduced CN allows flexibility with varying amounts of volume control storage provided.

FLOODPLAIN REQUIREMENTS

- Allowable flood elevation increases of 0.1 ft and velocity increases of 10%
- Compensatory storage required at 1.1:1 ratio
  - Must use average end method
  - 0-10 Year Increment may be provided at 1:1
  - 10-100 Year Increment may be provided at 1:1
  - 0-100 Year Increment must be provided at 1.1:1
- Flood Protection Elevation (FPE)
  - Two feet above BFE (from FIS or project-specific study)
  - New buildings in floodplain must be elevated by fill to the FPE
    - No basement without a LOMR-F
  - New buildings outside of floodplain must have window wells/perimeter berm elevated to FPE

FLOODWAY REQUIREMENTS

- Follows IDNR-OWR Part 3708 Rules and Appropriate Uses
- Hyperlinks to IDNR-OWR forms and guidance:
  - Joint application form
  - Part 3700 & 3708 rules
  - Statewide and General Permit information
- Guidance on processes to designate/re-designate a regulatory floodway

WMO WETLAND REGULATIONS

- WMO regulates direct and indirect impacts to isolated wetlands
- The WMO does not regulate Corps jurisdictional wetlands
- District or authorized municipality must receive copies of all Corps correspondence

WETLAND DELINEATION GUIDANCE

- Wetland delineation based on USACE Manual *(Regional Supplement to the USACE Wetland Delineation Manual: Midwest Region)*
  - Hyperlink to USACE Manual provided in TGM
- Farmed wetlands delineated using the National Food Security Act Manual (NFSAM)
  - Otherwise known as the "Swamp Buster Act"
  - Hyperlink to NFSAM Manual provided in TGM
- TGM provides examples of exempt wetlands (roadside ditches, incomplete construction, detention basins, etc.)

ISOLATED WETLAND CLASSIFICATION

- Classified as either “High Quality” or “Standard”
  - Hyperlink to USACE Manual provided in TGM
- “High Quality” if one or more of these criteria is met:
  - Swink and Wilhelm Floristic Quality Index (FQI) value greater than or equal to 20 during a single season assessment, or a native mean C-value of 3.5 or higher
  - Wetland is a habitat for a state-listed threatened or endangered species
- Define buffers based on classification:

Wetland Quality	Acreage	Buffer Width (ft)		
Standard Isolated Wetland	≥0.1 to < 0.5 acre	30 ft.		
	≥ 0.5 acre		50 ft	
High Quality Isolated Wetland	No minimum			100 ft

IMPACTS TO ISOLATED WETLANDS

- Impacts to high quality and standard isolated wetlands
  - Practicable Alternatives Analysis or hazardous road condition for high quality isolated wetlands
  - Impacts to standard isolated wetlands < 0.1 ac ➡ OK
  - Impacts to standard isolated wetlands ≥ 0.1 ac ➡ Mitigation
  - TGM references federal guidance (USEPA):
    - *Memorandum: Appropriate Level of Analysis Required for Evaluating Compliance with the Section 404(b)(1) Guidelines Alternatives Requirements*
  - Addresses indirect impacts and acceptable changes to wetland hydrology (80% - 150% for 2-year, 24-hour storm event)

ISOLATED WETLAND MITIGATION

Table 5. Isolated Wetland Mitigation Requirement Ratios					
Wetland Quality	**Area**	**§604.9(A)**	**§604.9(B)**	**§604.9(C)**	**§604.9(D)**
Standard Isolated Wetland	<0.10 acre	None			
	≥0.10 acre		1.5:1		
High Quality Isolated Wetland	Any			3:1	
Impacts Prior to Issuance of Permit					3:1

DETENTION IN WETLANDS

- Detention facilities allowed in standard isolated wetlands
- Not allowed in high quality isolated wetlands
- Allowed in Corps jurisdictional wetlands only if approved by Corps

RIPARIAN ENVIRONMENT

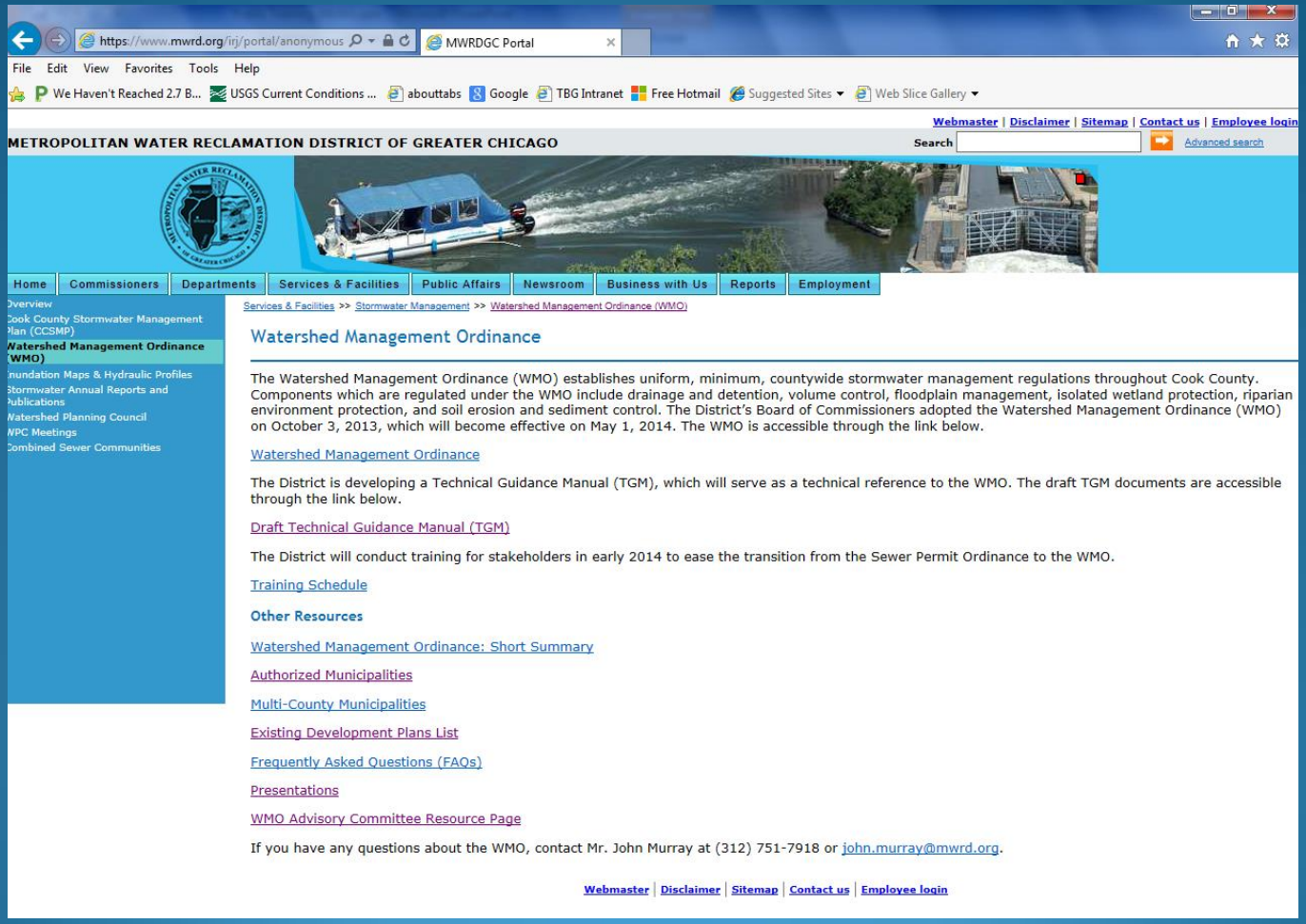
- Goal is to protect riparian environments that provide functional value
  - TGM makes distinction between areas adjacent to stream that provide a riparian environment function from those that do not
- TGM provides guidance on identifying limits of riparian environment
  - Biological Stream Characterization (BSC) of “A” or “B” (100 feet from OHWM)
  - Biologically Significant Stream (BSS) (100 feet from OHWM)
  - Jurisdictional Waters of the US (50 feet from OHWM)
- Examples of exempt riparian environments
- Guidance on mitigation for riparian environment impacts

MWRD WMO WEBSITE

On-line resources include:

- Answers to FAQs
- Authorized Municipalities Documents
- Technical Guidance Manual (TGM)
- Presentations from WMO Advisory Committee meetings and public trainings
- Stormwater calculation spreadsheets
- Template hydrologic models (TR-20, Win TR-20, and HEC-HMS)

MWRD WMO WEBSITE



https://www.mwrd.org/irj/portal/anonymous/managementordinance

TGM CONTENTS

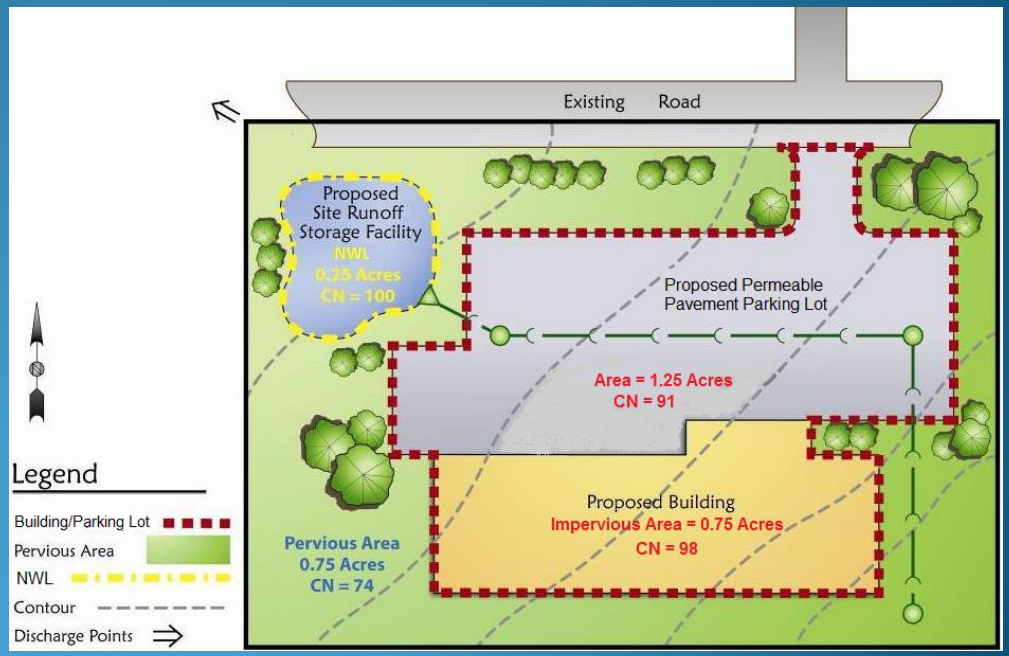
- Article 2 – Applicability and General Provisions
- Article 3 – Watershed Management Permit Requirements and Submittals
- Article 4 – Erosion and Sediment Control Requirements
- Article 5 – Requirements for Stormwater Management
- Article 6 – Requirements for Flood Protection Areas
- Article 7 – Requirements for Sewer Construction
- Article 9 – Maintenance
- Article 10 – Inspections
- Article 14 – Administration
- Appendices

DETENTION VOLUME EXAMPLE PROBLEMS (FROM ARTICLE 5 OF TGM)

- Example 5.7 – Simple (Detention Nomograph)
- Example 5.8 – Offsite and Unrestricted Areas (HEC-HMS)
- Example 5.9 – Ponds in Series w/ Tailwater (HEC-HMS)
- Example 5.10 – Redevelopment I (Modified Rational Method)
- Example 5.11 – Redevelopment II (Modified Rational Method)

EXAMPLE 5.7 (SIMPLE)

- Determine the required detention volume for the 3-acre site shown below using the detention nomograph. It is assumed that the proposed site will provide the required volume control storage in the aggregate voids under the permeable pavement parking lot. It is also assumed there is no offsite tributary area or unrestricted flow area for the site.
  - 3-Acre site
  - CN = 89; impervious area = 1 acre
  - No offsite tributary area
  - No unrestricted releases
  - No tailwater conditions
  - Volume control storage = 1”



EXAMPLE 5.7 – Step 1

Step 1: Determine the required volume control storage for the site.

The Curve Number for the site is 89, with a total impervious area (open water and building) of 1 acre. The required volume control storage, V_c, for the site is calculated as:

$$V_c = 1'' \times \frac{1 \text{ foot}}{12 \text{ inches}} \times 1 \text{ acre} = 0.083 \text{ acre-feet}$$

EXAMPLE 5.7 – Step 2

Step 2: Determine the CN reduction corresponding to volume control calculated in Step 1.

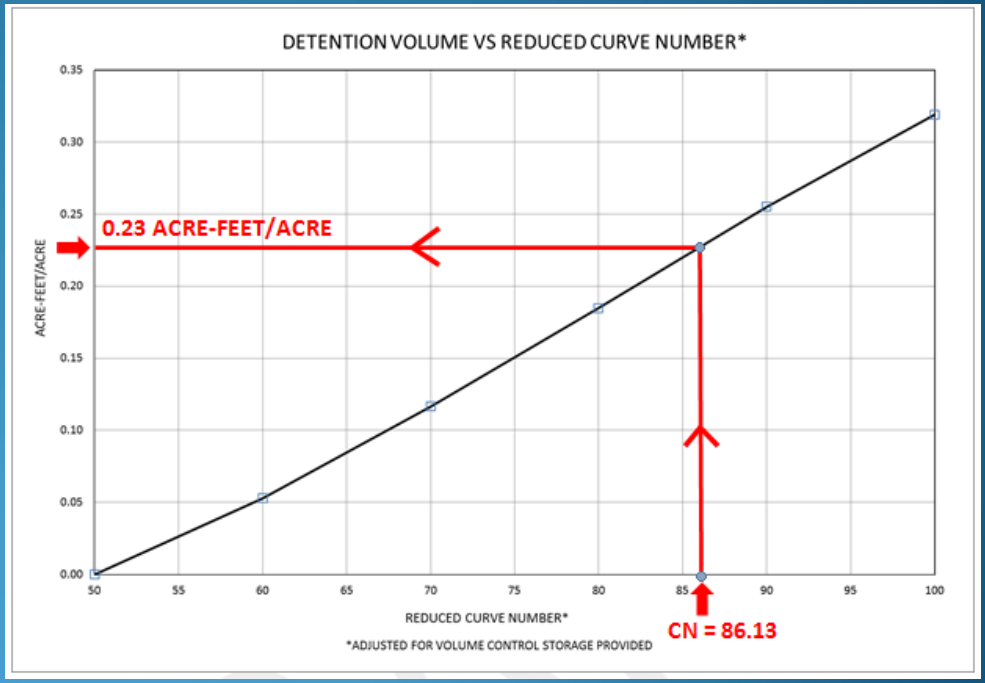
Using the CN Adjustment Calculator spreadsheet, the adjusted curve number is 86.13 (it was assumed that only the required 1" of volume control storage would be provided).

RUNOFF CURVE NUMBER ADJUSTMENT CALCULATOR				
Site Information:				
Total Site Area, A_w (ac) =	3		Total Impervious Area, A_I (ac) =	1
Runoff, R (in) =	6.28			
P = rainfall depth (in) =	7.58			
CN =	89			
S =	1.24			
Runoff Volume Over Watershed, V_w (ac-ft) =	1.57			
Volume of GI Provided:				
Control Volume, V_R =	0.08	ac-ft	1" of volume over impervious area	
Additional Volume, V_{GI} =	0.00	ac-ft	Additional volume over the required 1"	
Adjusted Volume Over Watershed, $V_{ADJ} = V_W - V_R - V_{GI}$				
V_{ADJ} (ac-ft) =	1.49			
Adjusted Runoff Over Watershed, $R_{ADJ} = V_{ADJ} / A_W$				
R_{ADJ} (in) =	5.94			
S_{ADJ} =	1.61			
Adjusted CN for detention calcs, CN_{ADJ} =	86.13			
*Blue values are entered by user				

EXAMPLE 5.7 – Step 3

Step 3: Using the adjusted CN determined in Step 2, use the detention nomograph from the TGM to determine the required detention volume.

0.23 acre-feet of detention volume is required for every acre of development, based on the adjusted CN of 86.13. By multiplying this value times the development area of 3 acres, the required detention volume is calculated to be 0.69 acre-feet.



*Event hydrograph methods are still required to size overland flow routes in and out of detention basin

EXAMPLE 5.8 (COMPLEX)

A proposed 5-acre commercial development has a curve number (CN) of 93 (80% impervious) and a time of concentration (t_c) of 15 minutes. Based on Cook County one-foot topography, it was determined there are 3 acres of offsite tributary area to the project site. The offsite tributary area has a CN of 89 and a t_c of 12 minutes. The proposed development will provide the 1" of volume control storage in the void space of aggregate under a permeable parking lot. There is a 0.2-acre area with a CN of 74 and a t_c of 10 minutes that will release undetained from the site.

Determine the stormwater detention requirements for the site.

EXAMPLE 5.8 – PROBLEM OVERVIEW

- 5-acre site
- Offsite tributary area = 3 acres
- Unrestricted area = 0.2 acres
- No tailwater conditions
- Volume control storage = 1”

EXAMPLE 5.8 – PROBLEM OVERVIEW

Development Area = 5 acres (0.00781 square miles)

CN = 93 (80% impervious area)

T_c = 15 minutes (Lag time = 9 minutes)

Volume control storage provided = required 1”

Unrestricted Area = 0.2 acres (0.00031 square miles)

CN = 74

Tc = 10 minutes (Lag time = 6 minutes)

Offsite Tributary Area = 3 acres (0.00469 square miles)

CN = 89

Tc = 12 minutes (Lag time = 7.2 minutes)

EXAMPLE 5.8 – Step 1

Step 1: Determine the required volume control storage for the site.

The curve number for the site is 93, with a total impervious area of 4 acres. The required volume control storage, V_c, for the site is calculated as:

$$V_c = 1'' \times \frac{1 \text{ foot}}{12 \text{ inches}} \times 4 \text{ acres} = 0.33 \text{ acre-feet}$$

EXAMPLE 5.8 – Step 2

Step 2: Determine the CN reduction corresponding to volume control calculated in Step 1.

Using the CN Adjustment Calculator spreadsheet, the adjusted curve number is 86.22 (it was assumed that only the required 1" of volume control storage would be provided).

RUNOFF CURVE NUMBER ADJUSTMENT CALCULATOR				
Site Information:				
Total Site Area, A_w (ac) =	5		Total Impervious Area, A_I (ac) =	4
Runoff, R (in) =	6.75			
P = rainfall depth (in) =	7.58			
CN =	93			
S =	0.75			
Runoff Volume Over Watershed, V_w (ac-ft) =	2.81			
Volume of GI Provided:				
Control Volume, V_R =	0.33	ac-ft	1" of volume over impervious area	
Additional Volume, V_{GI} =	0.00	ac-ft	Additional volume over the required 1"	
Adjusted Volume Over Watershed, $V_{ADJ} = V_W - V_R - V_{GI}$				
V_{ADJ} (ac-ft) =	2.48			
Adjusted Runoff Over Watershed, $R_{ADJ} = V_{ADJ} / A_W$				
R_{ADJ} (in) =	5.95			
S_{ADJ} =	1.60			
Adjusted CN for detention calcs, CN_{ADJ} =	86.22			
*Blue values are entered by user				

EXAMPLE 5.8 – Step 3

Step 3: Determine the allowable release rate for the site, accounting for the unrestricted area. The allowable release rate from the site is initially 1.5 cfs (0.3 cfs/acre x 5 acres) but should be adjusted to account for the 0.2-acre undetained area (which was delineated based on the proposed grading plan).

Net allowable release rate = maximum allowable release rate – unrestricted release rate

The unrestricted area must be modeled using HEC-HMS to determine the 100-year, 24-hour flowrate leaving the site

EXAMPLE 5.8 – Step 3

Set up HEC-HMS model to determine unrestricted release rate.

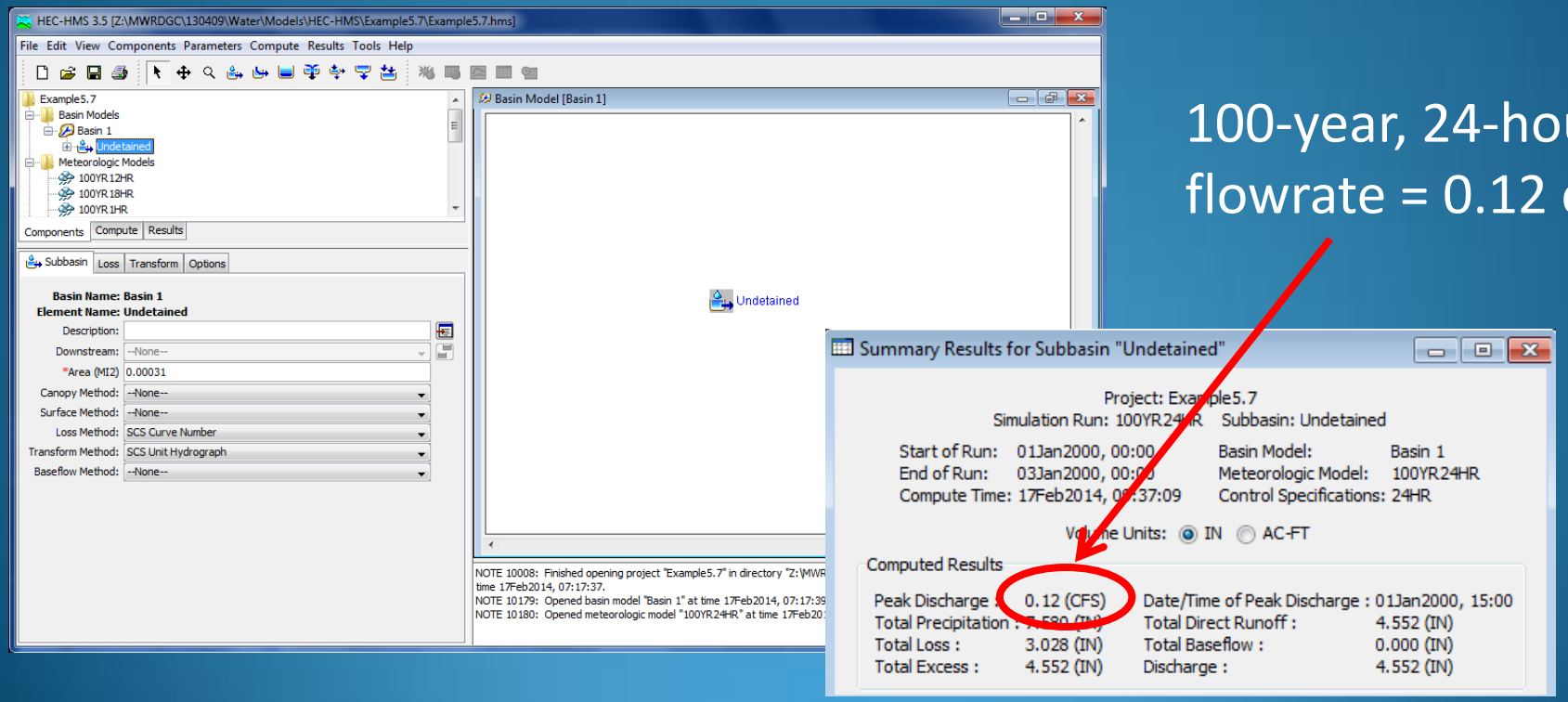
Create a new *Basin Model* to add the watershed components. In this case, there is one subbasin that represents the undetailed area of the project site (*Undetained*).

The *Meteorological Model* contains the rainfall depth information, which is the 100-year, 24-hour from Table 5-3 (7.58 inches). The *Time-Series Data* contains the time distribution of rainfall, which is the Huff 3rd quartile distribution for the 24-hour storm duration.

For Subbasin *Undetained*, enter the information :
Area = 0.00031 square miles (0.2 acres)
CN = 74
Lag time = 6 minutes (0.6 * t_c)
Specify SCS CN and Unit Hydrograph Methodology

EXAMPLE 5.8 – Step 3

Run the 100-year, 24-hour storm event to determine the unrestricted flowrate leaving the site.

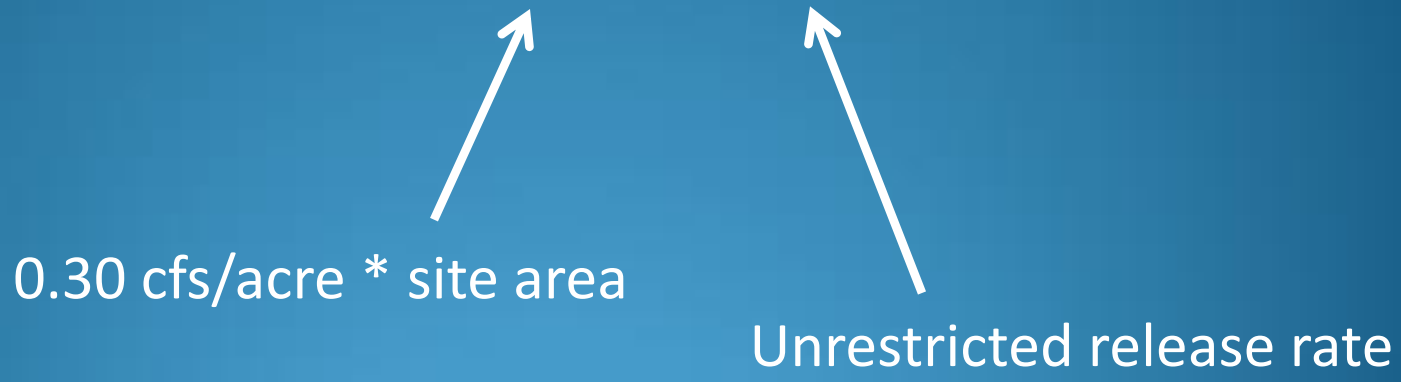


100-year, 24-hour flowrate = 0.12 cfs

EXAMPLE 5.8 – Step 3

Net allowable release rate = maximum allowable release rate – unrestricted release rate

Net allowable release rate = 1.5 cfs – 0.12 cfs = 1.38 cfs



EXAMPLE 5.8 – Step 4

Step 4: Use the orifice equation spreadsheet to size the restrictor. Using the elevation-discharge spreadsheet, a 4.9-inch diameter restrictor is needed to pass the net allowable release rate of 1.38 cfs at the HWL of 605 ft.

PROPOSED CONDITIONS
ORIFICE/WEIR STRUCTURE RATING ANALYSIS

PROJECT NAME:	Technical Guidance Manual
PROJ. NO.:	13-0409
DESCRIPTION:	Example 5.7
FILENAME:	Orifice.xlsx
DATE:	9-Feb-14

OUTLET:	ORIFICE #1:	4.86	IN. DIA. @ ELEV	600
	ORIFICE #2:	N/A	IN. DIA. @ ELEV	N/A
	WEIR #1:	N/A	FEET WIDE @ ELEV	N/A
	WEIR #2:	N/A	FEET WIDE @ ELEV	N/A

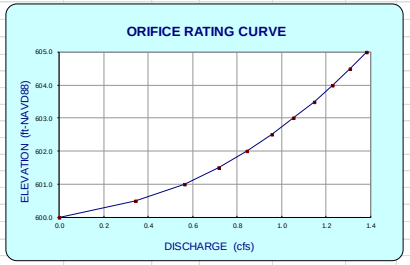
HYDRAULIC DIMENSIONS

	# 1	#2
ORIFICE AREA (ft^2)	0.1288	
ORIFICE DIAMETER (in)	4.9	
ORIFICE DISCHARGE COEFFICIENT	0.61	
ORIFICE ELEV. (ft-NAVD88)	600.00	
TAILWATER OR CENTROID (ft-NAVD88)	600.20	
WEIR LENGTH (ft)		
WEIR COEFFICIENT		
WEIR ELEV. (ft-NGVD)		

ORIFICE FLOW EQUATION: $Q = 0.6A(2gH)^{0.5}$
WEIR FLOW EQUATION: $Q = 3.0L(H)^{1.5}$

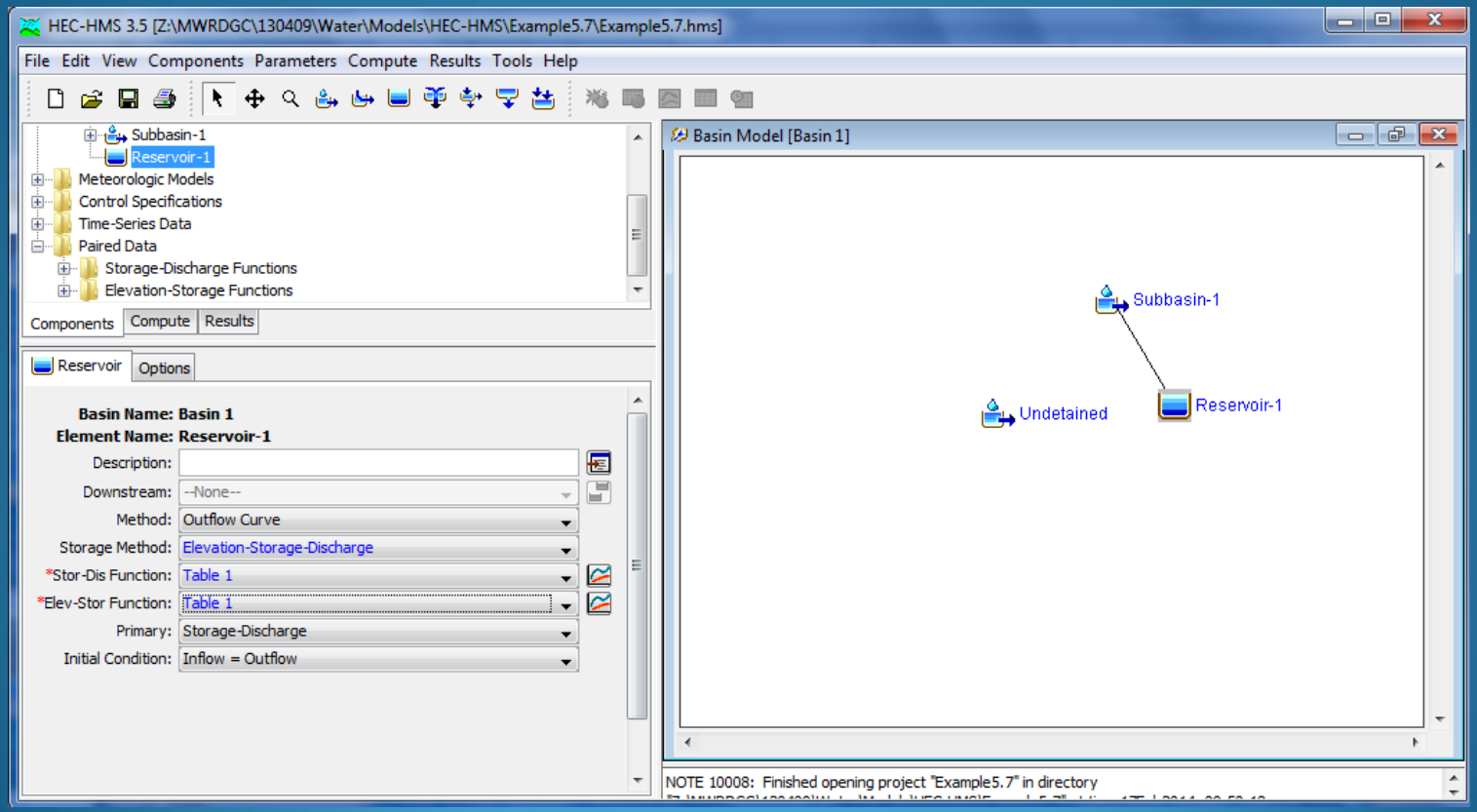
ELEVATION-DISCHARGE RELATIONSHIP

Elevation (feet)	Q-orifice #1 (cfs)	Q-orifice #2 (cfs)	Q-weir #1 (cfs)	Q-weir #2 (cfs)	Q-total (cfs)
600.0	0.00	0.00	0.00	0.00	0.00
600.5	0.34	0.00	0.00	0.00	0.34
601.0	0.56	0.00	0.00	0.00	0.56
601.5	0.72	0.00	0.00	0.00	0.72
602.0	0.85	0.00	0.00	0.00	0.85
602.5	0.96	0.00	0.00	0.00	0.96
603.0	1.05	0.00	0.00	0.00	1.05
603.5	1.15	0.00	0.00	0.00	1.15
604.0	1.23	0.00	0.00	0.00	1.23
604.5	1.31	0.00	0.00	0.00	1.31
605.0	1.38	0.00	0.00	0.00	1.38



EXAMPLE 5.8 – Step 5

Update the *Basin Model* to include the onsite area and proposed detention basin. In this case, there is one subbasin that represents the project site (Subbasin-1) and one storage area that represents the proposed detention pond (Reservoir-1).



EXAMPLE 5.8 – Step 5

Since the elevation-discharge relationship is fixed, the elevation-storage spreadsheet can be used to obtain the appropriate relationship to enter into HEC-HMS.

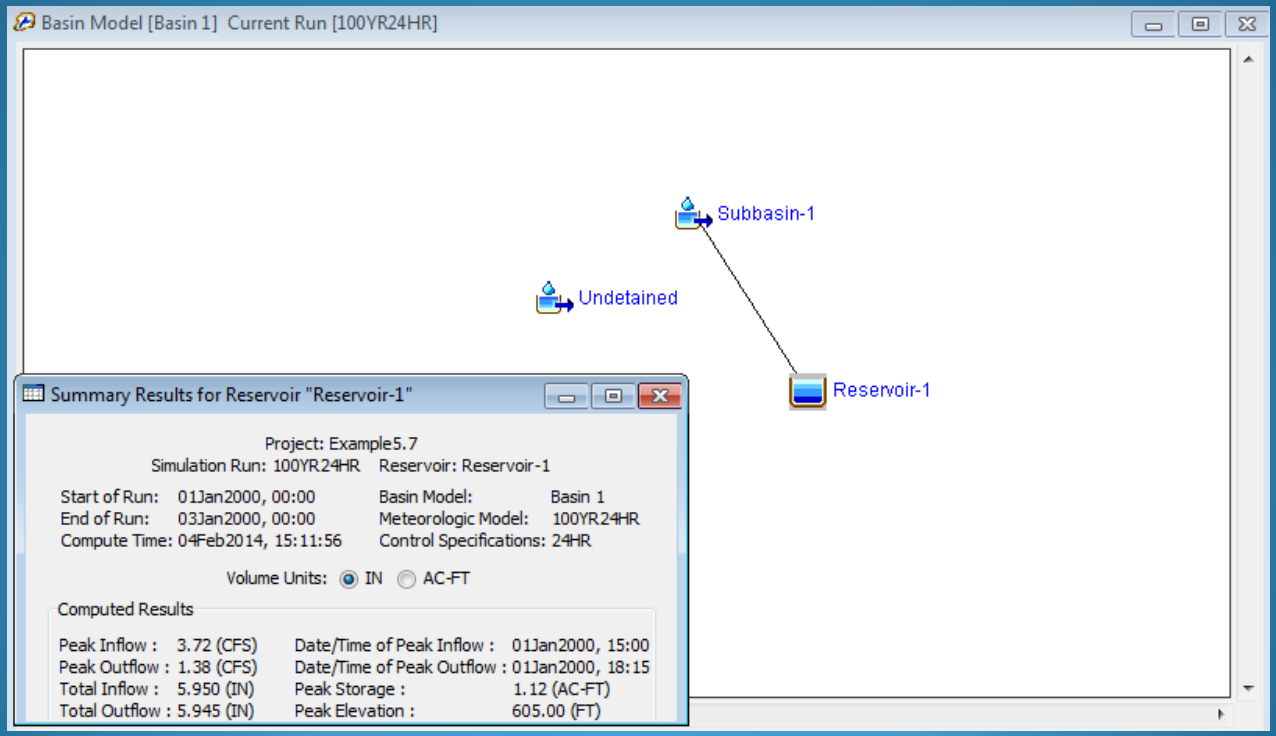
Using the elevation-storage spreadsheet, iteratively enter the elevation-storage relationship until the proposed basin fills up for the 100-year, 24-hour storm event. As shown in the figure to the right, a volume of 1.12 acre-feet is required for this site.

POND:	Proposed Detention Facility			Centerline Elevation	
JOB NO.	130409		Side Slopes	Orifice Radius:	
PROJECT:	Example 5.7		1	Orifice Coeff:	
FILE:	Storage.xls		4	Weir Elevation:	
DATE:	2/4/2014			Length of Weir	
DA				Weir Coeff	

Elevation (ft)	INC	Area (ft2)	Area (ac)	Average Area (ac)	Incremental Storage (ac-ft)	Cummulative Storage (ac-ft)
600.00		6,080	0.140			
				0.155	0.15	
601.00		7,392	0.170			0.155
				0.186	0.19	
602.00		8,831	0.203			0.341
				0.221	0.22	
603.00		10,399	0.239			0.562
				0.258	0.26	
604.00		12,094	0.278			0.820
				0.299	0.30	
605.00		13,918	0.320			1.118

EXAMPLE 5.8 – Step 5

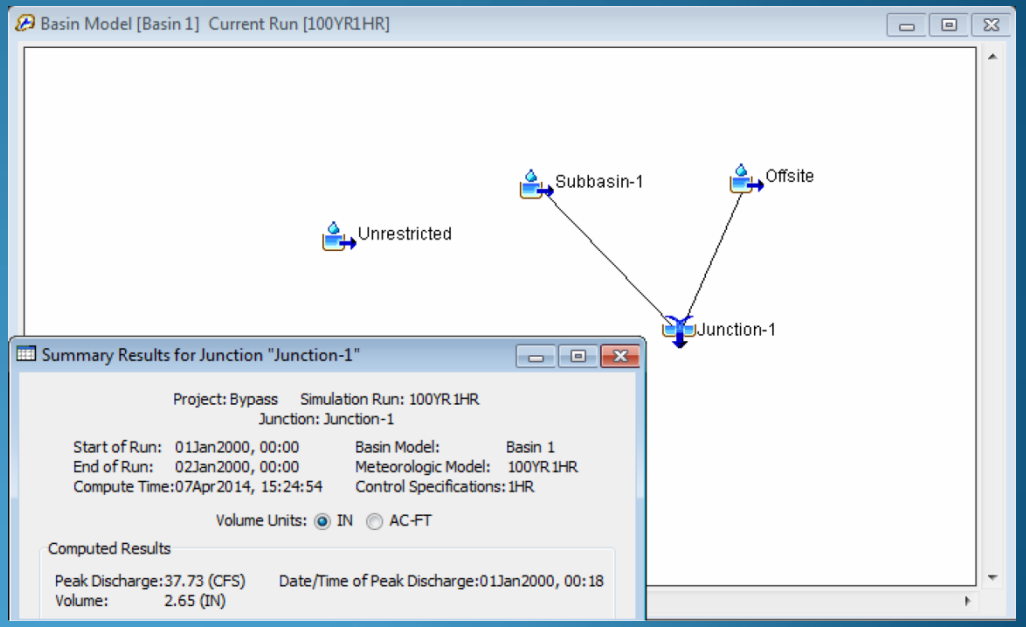
From the results of the HEC-HMS analysis for the 100-year, 24-hour storm event, the HWL of the proposed detention facility is 605.00 ft. Note the results indicate that the detention basin releases 1.38 cfs (net allowable release rate) at the HWL.



EXAMPLE 5.8 – Step 6

Step 6: Determine the 100-year peak flowrate (critical duration analysis) from offsite and onsite tributary areas to the detention facility to size emergency overflow weir.

A new subbasin (*Offsite*) is required to determine the peak flowrate of the offsite tributary area to the detention facility and a *junction (Junction-1)* is required to add the runoff hydrographs from the onsite and offsite tributary areas.



Critical Duration = 1-Hour Duration

Q_{CRIT} = 37.7 cfs

37.7 cfs = 4.7 cfs/acre > 1 cfs/acre → OK

EXAMPLE 5.8 – Step 7

Step 7: Size the overflow weir to handle the peak 100-year flowrate to the detention facility.

$$Q = C \times L \times H^{3/2}$$

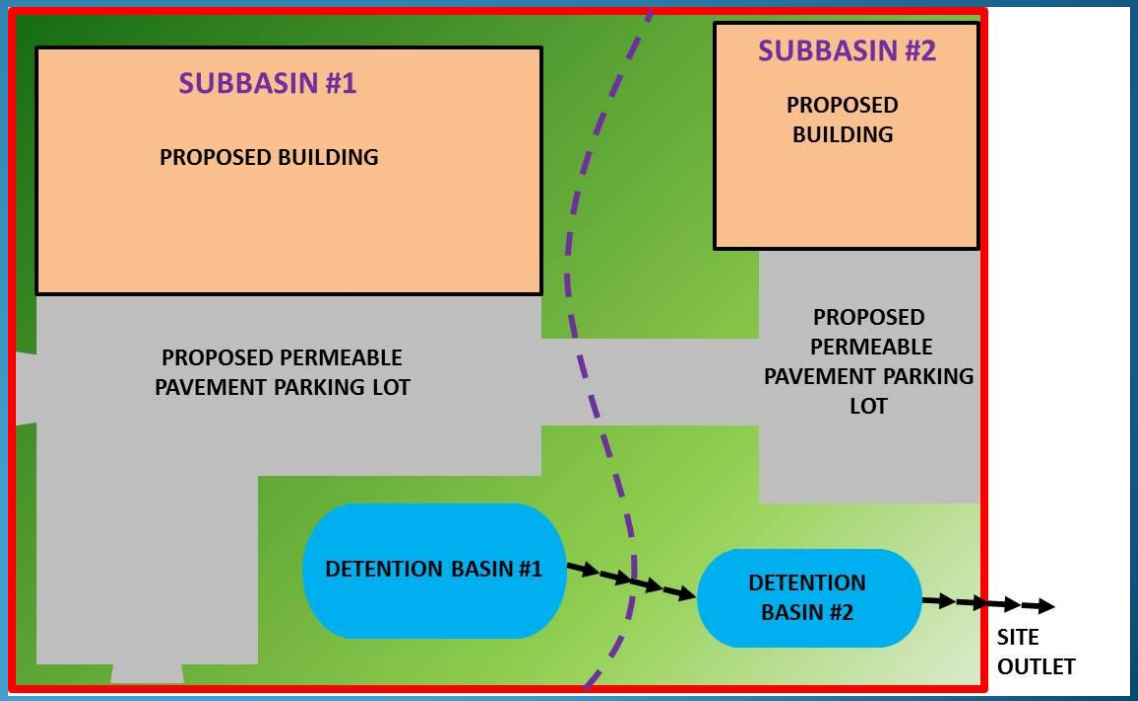
Where,
Q = flowrate (37.7 cfs)
C = weir coefficient (assume 3.0)
L = length of weir (ft)
H = head on weir (ft, assume 1 ft)

Solving for L,
L = 12.6 ft, which is the minimum length of weir required to pass the 100-year peak flowrate (with one foot of head) for the onsite and offsite area.

EXAMPLE 5.9 – PONDS IN SERIES W/ TAILWATER

As shown in the figure below, the required detention volume for a proposed 10-acre commercial development will be provided in two detention basins in series. Based on Cook County one-foot topography, there is no offsite tributary area to the project site. However, Detention Basin 2 will discharge to a receiving stream with a 100-year flood elevation of 699 ft. Based on the proposed grading plan, the site is separated into two subbasins.

Determine the requirements of the two detention basins based on the WMO and TGM.



EXAMPLE 5.9 – PROBLEM OVERVIEW

- 10-acre site
- Two detention ponds in series
- No offsite tributary area
- No unrestricted releases
- Tailwater (100-year) = 699 ft
- Volume control storage = 1”

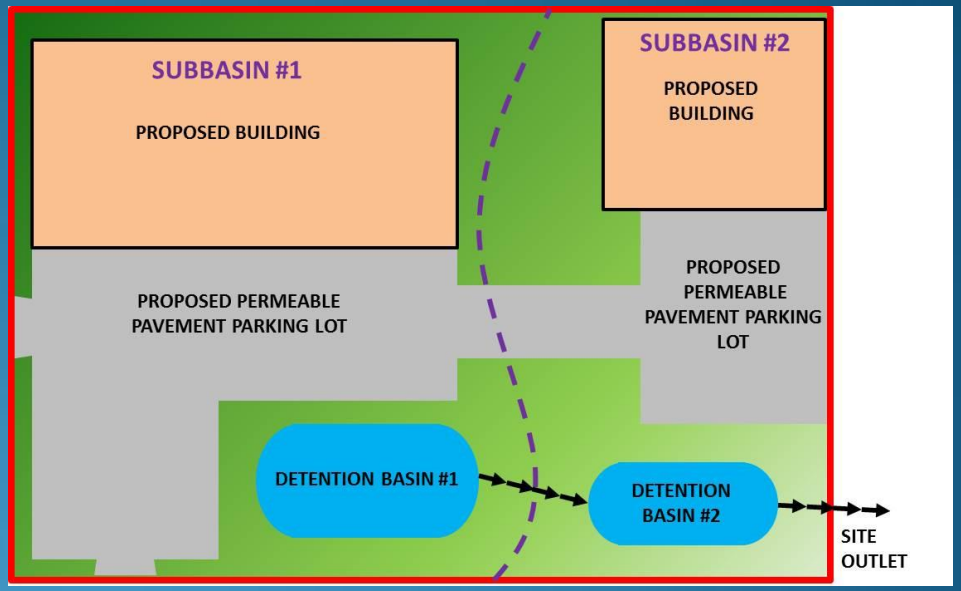
EXAMPLE 5.9 – PROBLEM SUMMARY

Subbasin 1
Area = 0.009375 square miles (6 acres)
Impervious Area = 2.25 acres
Curve Number = 92
Adjusted Curve Number = 88.79 (assumes 1” on volume control storage)
SCS Lag Time = 9 minutes

Subbasin 2
Area = 0.00625 square miles (4 acres)
Impervious Area = 1.25 acres
Curve Number = 88
Adjusted Curve Number = 85.36 (assumes 1” on volume control storage)
SCS Lag Time = 6 minutes

EXAMPLE 5.9 – PROBLEM SUMMARY, CONT.

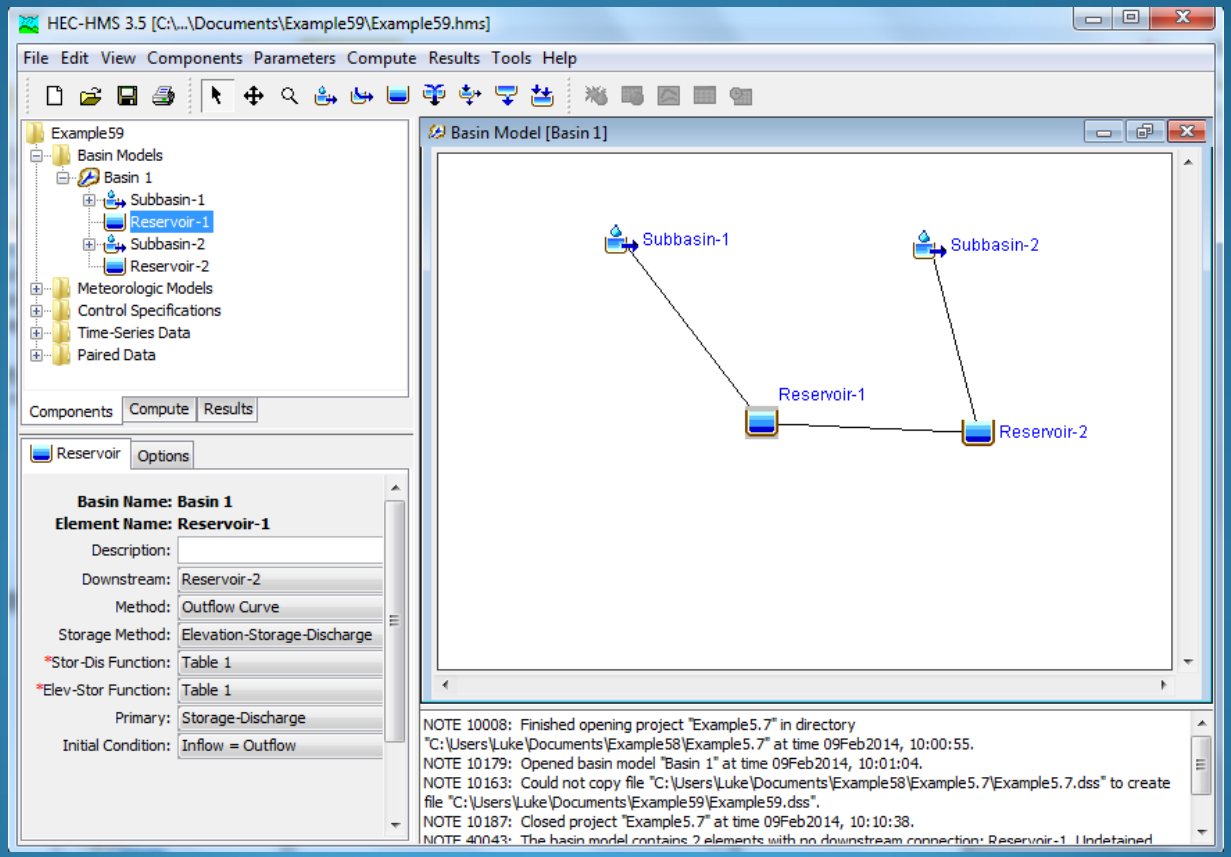
<u>Detention Basin 1 (Reservoir-1)</u>
Normal Water Level (NWL) = 700 ft
High Water Level (HWL) = 704 ft
Tailwater Condition = none



<u>Detention Basin 2 (Reservoir-2)</u>
Normal Water Level (NWL) = 698 ft
High Water Level (HWL) = 702 ft
Tailwater Condition = 699 ft (100-year flood elevation of receiving stream)

EXAMPLE 5.9 – STEP 1

Step 1: Set up a HEC-HMS model for the project. As shown below, Subbasin-1 drains to Reservoir-1, and the outflow of Reservoir-1 then drains into Reservoir-2, along with Subbasin-2.



EXAMPLE 5.9 – STEP 2

Step 2: Since the configuration of *Reservoir-2* depends on the outflow from *Reservoir-1*, *Reservoir-1* must be configured first.

It should be noted that as long as the release rate at the site's outlet (*Reservoir-2* outflow) is less than or equal to 3 cfs (0.30 cfs/acre x 10 acres), the proposed detention configuration is flexible. For example, if site conditions prevent *Reservoir-1* from detaining *Subbasin-1* at 0.30 cfs/acre, *Reservoir-1* can be sized to underdetain its tributary area, so long as *Reservoir-2* is oversized to meet the allowable release rate for the site.

In this example, it is assumed that *Reservoir-1* can be sized to detain its onsite tributary at the allowable release rate of 0.30 cfs/acre.

EXAMPLE 5.9 – STEP 2

Step 2: Determine the orifice size necessary to release 1.80 cfs (0.30 cfs/acre x 6 acres) at the HWL of Reservoir-1.

From the orifice equation spreadsheet (shown to the right), a 5.9-inch diameter restrictor is needed to convey 1.8 cfs at the HWL of 704 ft.

PROPOSED CONDITIONS
ORIFICE/WEIR STRUCTURE RATING ANALYSIS

PROJECT NAME:	Example 5.9
PROJ. NO.:	13-0409
DESCRIPTION:	Detention Basin 1
FILENAME:	Orifice.xlsx
DATE:	9-Feb-14

OUTLET:

ORIFICE #1:	5.9	IN. DIA. @ ELEV	700
ORIFICE #2:	N/A	IN. DIA. @ ELEV	N/A
WEIR #1:	N/A	FEET WIDE @ ELEV	N/A
WEIR #2:	N/A	FEET WIDE @ ELEV	N/A

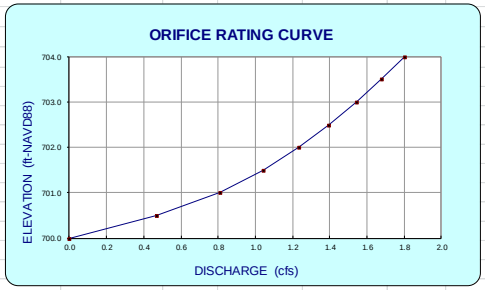
HYDRAULIC DIMENSIONS

	# 1	#2
ORIFICE AREA (ft^2)	0.1899	
ORIFICE DIAMETER (in)	5.9	
ORIFICE DISCHARGE COEFFICIENT	0.61	
ORIFICE ELEV. (ft-NAVD88)	700.00	
TAILWATER OR CENTROID (ft-NAVD88)	700.25	
WEIR LENGTH (ft)		
WEIR COEFFICIENT		
WEIR ELEV. (ft-NGVD)		

ORIFICE FLOW EQUATION: $Q = 0.6A(2gH)^{0.5}$
WEIR FLOW EQUATION: $Q = 3.0L(H)^{1.5}$

ELEVATION-DISCHARGE RELATIONSHIP

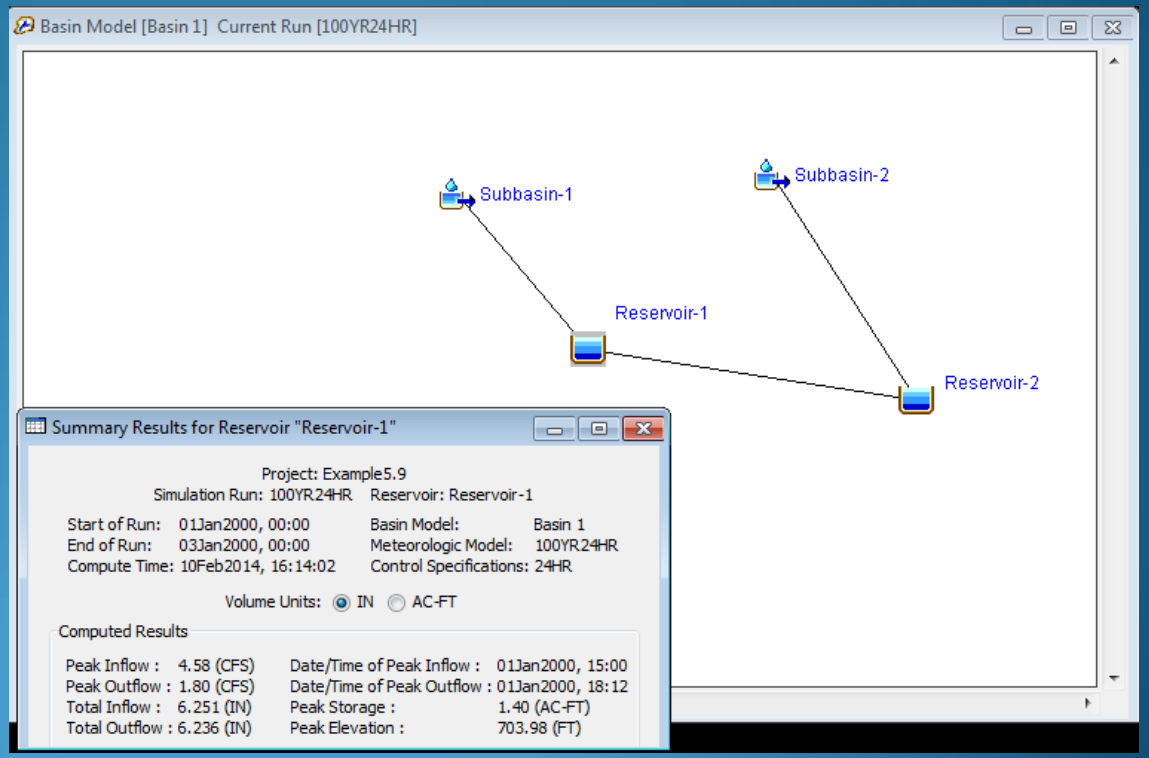
Elevation (feet)	Q-orifice #1 (cfs)	Q-orifice #2 (cfs)	Q-weir #1 (cfs)	Q-weir #2 (cfs)	Q-total (cfs)
700.0	0.00	0.00	0.00	0.00	0.00
700.5	0.47	0.00	0.00	0.00	0.47
701.0	0.81	0.00	0.00	0.00	0.81
701.5	1.04	0.00	0.00	0.00	1.04
702.0	1.23	0.00	0.00	0.00	1.23
702.5	1.40	0.00	0.00	0.00	1.40
703.0	1.54	0.00	0.00	0.00	1.54
703.5	1.68	0.00	0.00	0.00	1.68
704.0	1.80	0.00	0.00	0.00	1.80



EXAMPLE 5.9 – STEP 3

Step 3: Determine the stage-storage relationship so that *Reservoir-1* fills up for the 100-year, 24-hour storm event.

Using the elevation-storage spreadsheet and solving iteratively, it is determined that 1.40 acre-feet of storage volume is required for *Reservoir-1*.



EXAMPLE 5.9 – STEP 4

Step 3: Size the restrictor for Reservoir-2 so that it releases 3.0 cfs at the HWL assuming full release conditions. As shown on the next slide, a 7.7-inch diameter restrictor is needed to convey the allowable release rate.

However, since there is a tailwater condition on this restrictor, the detention volume must be sized assuming the 100-year tailwater of the receiving stream (699 ft). Therefore, another stage-discharge spreadsheet needs to be developed to determine the outflow assuming the 100-year tailwater of 699 ft. This relationship will be used as the input to HEC-HMS to determine the required volume.

EXAMPLE 5.9 – STEP 4

PROPOSED CONDITIONS
ORIFICE/WEIR STRUCTURE RATING ANALYSIS

PROJECT NAME:	Example 5.9
PROJ. NO.:	13-0409
DESCRIPTION:	Detention Basin 2
FILENAME:	Orifice.xlsx
DATE:	9-Feb-14

OUTLET:

ORIFICE #1:	7.65	IN. DIA. @ ELEV	698
ORIFICE #2:	N/A	IN. DIA. @ ELEV	N/A
WEIR #1:	N/A	FEET WIDE @ ELEV	N/A
WEIR #2:	N/A	FEET WIDE @ ELEV	N/A

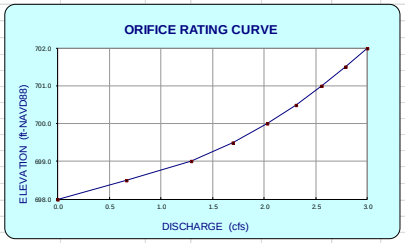
HYDRAULIC DIMENSIONS

	# 1	#2
ORIFICE AREA (ft^2)	0.3192	
ORIFICE DIAMETER (in)	7.7	
ORIFICE DISCHARGE COEFFICIENT	0.61	
ORIFICE ELEV. (ft-NAVD88)	698.00	
TAILWATER OR CENTROID (ft-NAVD88)	698.32	
WEIR LENGTH (ft)		
WEIR COEFFICIENT		
WEIR ELEV. (ft-NGVD)		

ELEVATION-DISCHARGE RELATIONSHIP

ORIFICE FLOW EQUATION: $Q = 0.6A(2gH)^{0.5}$
WEIR FLOW EQUATION: $Q = 3.0L(H)^{1.5}$

Elevation (feet)	Q-orifice #1 (cfs)	Q-orifice #2 (cfs)	Q-weir #1 (cfs)	Q-weir #2 (cfs)	Q-total (cfs)
698.0	0.00	0.00	0.00	0.00	0.00
698.5	0.67	0.00	0.00	0.00	0.67
699.0	1.29	0.00	0.00	0.00	1.29
699.5	1.70	0.00	0.00	0.00	1.70
700.0	2.03	0.00	0.00	0.00	2.03
700.5	2.31	0.00	0.00	0.00	2.31
701.0	2.56	0.00	0.00	0.00	2.56
701.5	2.79	0.00	0.00	0.00	2.79
702.0	3.00	0.00	0.00	0.00	3.00



Restrictor for *Reservoir-2*
(no tailwater)
(used for design)

PROPOSED CONDITIONS
ORIFICE/WEIR STRUCTURE RATING ANALYSIS

PROJECT NAME:	Example 5.9
PROJ. NO.:	13-0409
DESCRIPTION:	Detention Basin 2
FILENAME:	Orifice.xlsx
DATE:	9-Feb-14

OUTLET:

ORIFICE #1:	7.65	IN. DIA. @ ELEV	698
ORIFICE #2:	N/A	IN. DIA. @ ELEV	N/A
WEIR #1:	N/A	FEET WIDE @ ELEV	N/A
WEIR #2:	N/A	FEET WIDE @ ELEV	N/A

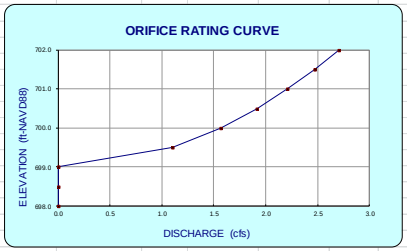
HYDRAULIC DIMENSIONS

	# 1	#2
ORIFICE AREA (ft^2)	0.3192	
ORIFICE DIAMETER (in)	7.7	
ORIFICE DISCHARGE COEFFICIENT	0.61	
ORIFICE ELEV. (ft-NAVD88)	698.00	
TAILWATER OR CENTROID (ft-NAVD88)	699.00	
WEIR LENGTH (ft)		
WEIR COEFFICIENT		
WEIR ELEV. (ft-NGVD)		

ELEVATION-DISCHARGE RELATIONSHIP

ORIFICE FLOW EQUATION: $Q = 0.6A(2gH)^{0.5}$
WEIR FLOW EQUATION: $Q = 3.0L(H)^{1.5}$

Elevation (feet)	Q-orifice #1 (cfs)	Q-orifice #2 (cfs)	Q-weir #1 (cfs)	Q-weir #2 (cfs)	Q-total (cfs)
698.0	0.00	0.00	0.00	0.00	0.00
698.5	0.00	0.00	0.00	0.00	0.00
699.0	0.00	0.00	0.00	0.00	0.00
699.5	1.10	0.00	0.00	0.00	1.10
700.0	1.56	0.00	0.00	0.00	1.56
700.5	1.91	0.00	0.00	0.00	1.91
701.0	2.21	0.00	0.00	0.00	2.21
701.5	2.47	0.00	0.00	0.00	2.47
702.0	2.71	0.00	0.00	0.00	2.71

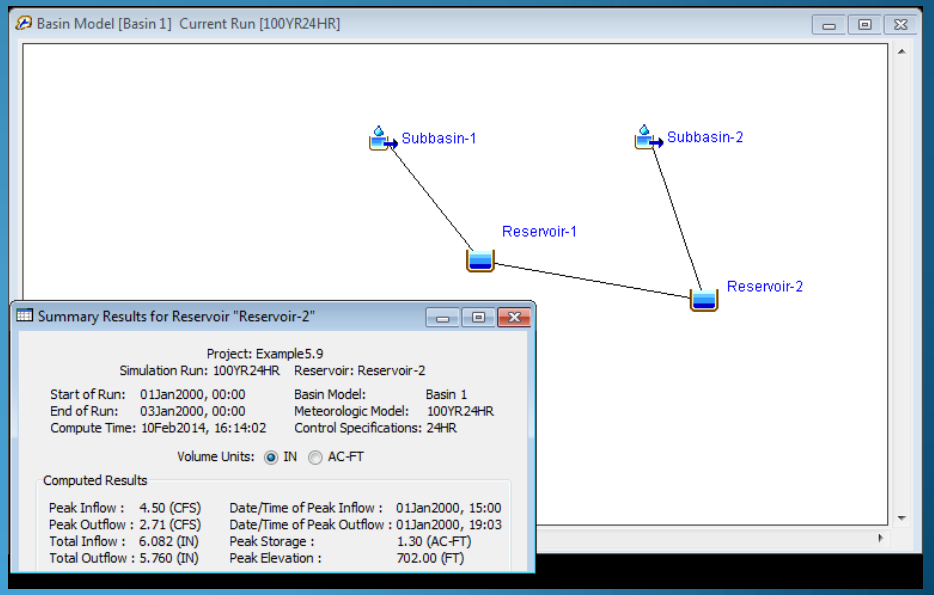


Restrictor for *Reservoir-2*
(tailwater = 699 ft)
(used to size detention volume)

EXAMPLE 5.9 – STEP 5

Using the elevation-storage spreadsheet and solving iteratively, it is determined that 1.30 acre-feet of storage volume is required for *Reservoir-2*, which allows the basin to fill up to its HWL of 702 ft and release at the allowable release rate. Note that when there is a 100-year tailwater on the detention basin, the release rate is only 2.7 cfs. When there is no tailwater condition, the outflow of the detention basin will be no greater than the maximum allowable release rate of 3.0 cfs.

POND:	Proposed Detention Facility 2			Centerline Elevation		
JOB NO.		130409		Side Slopes	Orifice Radius:	
PROJECT:		Example 5.7		1	Orifice Coeff:	
FILE:		Storage.xls		4	Weir Elevation:	
DATE:		2/10/2014			Length of Weir	
DA					Weir Coeff	
		Area		Average	Incremental	Cummulative
Elevation	INC			Area	Storage	Storage
(ft)	0.25	(ft2)	(ac)	(ac)	(ac-ft)	(ac-ft)
698.00		10,522	0.242			
				0.261	0.26	
699.00		12,228	0.281			0.261
				0.302	0.30	
700.00		14,061	0.323			0.563
				0.345	0.35	
701.00		16,022	0.368			0.908
				0.392	0.39	
702.00		18,112	0.416			1.300



EXAMPLE 5.10 - REDEVELOPMENT

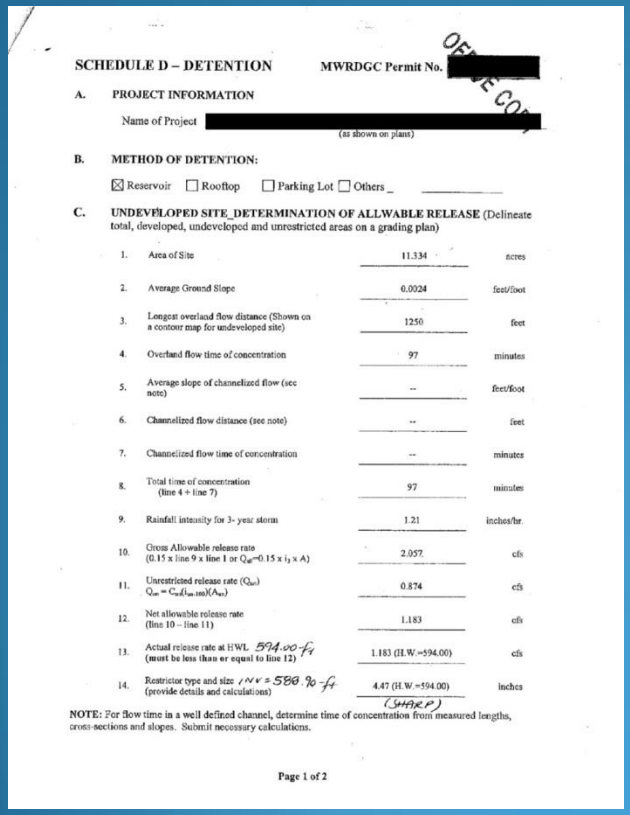
An existing 11.3-acre industrial area is to be redeveloped into a shopping mall. The original development contains a detention facility that was permitted under the Sewer Permit Ordinance (SPO). The proposed development has a C value of 0.90, with 8.0 acres of impervious area. It is assumed that the proposed development will provide the 1” of volume control storage. Determine the required detention volume for the site.

EXAMPLE 5.10 – PROBLEM OVERVIEW

- 11.33-acre site
- Onsite detention facility permitted under SPO
- No known drainage problems associated with upstream drainage area
- Allowable release rate = previously permitted (Schedule D)
- No tailwater conditions
- Volume control storage = 1”

EXAMPLE 5.10 – Step 1

Step 1: Obtain the Schedule D form for the original development to determine the composite runoff coefficient (C value) and required detention volume that was permitted. As shown on Page 2 of the Schedule D form, the permitted development in this example has a C value of 0.88 and a required detention volume of 3.07 acre-feet.



SCHEDULE D – DETENTION MWRDGC Permit No. [redacted]

A. PROJECT INFORMATION

Name of Project [redacted] (as shown on plans)

B. METHOD OF DETENTION:

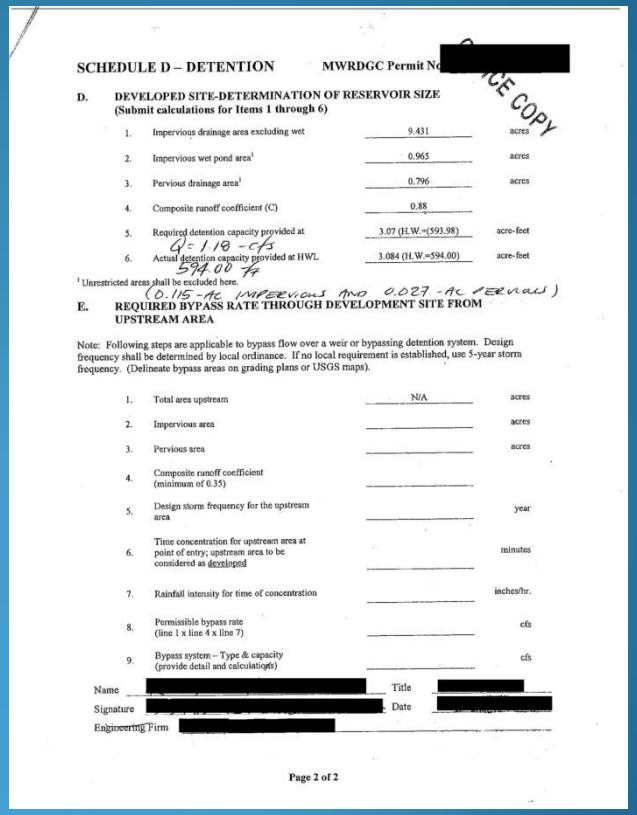
☒ Reservoir ☐ Rooftop ☐ Parking Lot ☐ Others _____

C. UNDEVELOPED SITE DETERMINATION OF ALLWABLE RELEASE (Delineate total, developed, undeveloped and unrestricted areas on a grading plan)

1.	Area of Site	11.334	acres
2.	Average Ground Slope	0.0024	feet/foot
3.	Longest overland flow distance (Shown on a contour map for undeveloped site)	1250	feet
4.	Overland flow time of concentration	97	minutes
5.	Average slope of channelized flow (see note)	--	feet/foot
6.	Channelized flow distance (see note)	--	feet
7.	Channelized flow time of concentration	--	minutes
8.	Total time of concentration (line 4 + line 7)	97	minutes
9.	Rainfall intensity for 3- year storm	1.21	inches/hr.
10.	Gross Allowable release rate (0.15 x line 9 x line 1 or Q_{all}=0.15 x i_3 x A)	2.057	cfs
11.	Unrestricted release rate (Q_{un}) $Q_{un} = C_{un}(i_{un\ min})(A_{un})$	0.874	cfs
12.	Net allowable release rate (line 10 – line 11)	1.183	cfs
13.	Actual release rate at HWL 594.00-ft (must be less than or equal to line 12)	1.183 (H.W.=594.00)	cfs
14.	Restrictor type and size INV=588.90-ft (provide details and calculations)	4.47 (H.W.=594.00) (SHARP)	inches

NOTE: For flow time in a well defined channel, determine time of concentration from measured lengths, cross-sections and slopes. Submit necessary calculations.

Page 1 of 2



SCHEDULE D – DETENTION MWRDGC Permit No. [redacted]

D. DEVELOPED SITE-DETERMINATION OF RESERVOIR SIZE
(Submit calculations for Items 1 through 6)

1.	Impervious drainage area excluding wet	9.431	acres
2.	Impervious wet pond area[1]	0.965	acres
3.	Pervious drainage area[1]	0.796	acres
4.	Composite runoff coefficient (C)	0.88	
5.	Required detention capacity provided at Q= 1.10 - cfs	3.07 (H.W.=593.98)	acre-feet
6.	Actual detention capacity provided at HWL 594.00 ft	3.084 (H.W.=594.00)	acre-feet

[1] Unrestricted areas shall be excluded here. (0.115-AC IMPERVIOUS AND 0.027-AC PERVIOUS)

E. REQUIRED BYPASS RATE THROUGH DEVELOPMENT SITE FROM UPSTREAM AREA

Note: Following steps are applicable to bypass flow over a weir or bypassing detention system. Design frequency shall be determined by local ordinance. If no local requirement is established, use 5-year storm frequency. (Delineate bypass areas on grading plans or USGS maps).

1.	Total area upstream	N/A	acres
2.	Impervious area		acres
3.	Pervious area		acres
4.	Composite runoff coefficient (minimum of 0.35)		
5.	Design storm frequency for the upstream area		year
6.	Time concentration for upstream area at point of entry; upstream area to be considered as developed		minutes
7.	Rainfall intensity for time of concentration		inches/hr.
8.	Permissible bypass rate (line 1 x line 4 x line 7)		cfs
9.	Bypass system – Type & capacity (provide detail and calculations)		cfs

Name [redacted] Title [redacted]

Signature [redacted] Date [redacted]

Engineering Firm [redacted]

Page 2 of 2

EXAMPLE 5.10 – Step 2

Step 2: Determine if the redevelopment can meet the conditions for detention allowances provided in Section §505.3 of the WMO. The four conditions are:

- Design of the existing detention facility is documented and approved under an existing sewerage system permit;
- The actual storage volume is verified to meet the required permitted volume (3.07 acre-feet in this example) by a survey;
- The redevelopment will meet the volume control requirements of the WMO; and
- The redevelopment provides adequate conveyance to convey the 100-year peak flowrates to the detention facility.

EXAMPLE 5.10 – Step 3

Step 3: Assuming the redevelopment can meet the four conditions outlined in the previous slide, calculate the redevelopment's C value.

Using the values provided in Table 5-2 of the TGM, the redeveloped C value is 0.90. Because the redeveloped C value (0.90) is greater than existing (0.88), additional detention storage is required.

Note: If the redeveloped C value matched the permitted C value of 0.88, no additional storage volume would be required.

EXAMPLE 5.10 – Step 4

Step 4: Determine the required storage volume for the redevelopment using the modified rational method and Bulletin 70 rainfall depths. Since the existing detention facility was previously permitted under the SPO, the original release rate and restrictor can be used. From Page 1 of the Schedule D form, the allowable release rate is 1.183 cfs.

The required detention volume for the redevelopment is 4.44 ac-ft. Since the provided detention storage for the original development was 3.08 ac-ft, the additional storage that is required is 1.36 acre-feet. The provided volume control storage (0.67 ac-ft) is credited toward this total, therefore only 0.69 ac-ft of additional detention volume is required.

DETENTION STORAGE CALCULATIONS
(Bulletin 70 NE Sectional Rainfall Intensities)

PROJECT:	Example 5.10
JOB NO.:	Technical Guidance Manual
FILENAME:	ModRatB70.xlsx
DATE :	5-Feb-14

TRIBUTARY AREA =	11.33	acres
COMPOSITE RUNOFF COEFFICIENT =	0.90	
ALLOWABLE RELEASE RATE =	1.18	cfs

COMPUTED DETENTION STORAGE = **4.441 acre-ft**

DURATION (hours)	TIME (min.)	RAINFALL INTENSITY (in/hr)	INFLOW RATE (cfs)	STORED RATE (cfs)	RESERVOIR SIZE (ac-ft)
0.08	5	10.90	111.19	110.01	0.758
0.17	10	10.02	102.21	101.03	1.392
0.25	15	8.20	83.64	82.46	1.704
0.33	20	7.30	74.46	73.28	2.019
0.50	30	5.60	57.12	55.94	2.311
0.67	40	4.58	46.72	45.54	2.509
0.83	50	3.97	40.50	39.32	2.708
1	60	3.56	36.31	35.13	2.903
1.5	90	2.68	27.34	26.16	3.243
2	120	2.24	22.85	21.67	3.581
3	180	1.62	16.52	15.34	3.803
4	240	1.40	14.28	13.10	4.330
5	300	1.17	11.93	10.75	***4.441*** ←
6	360	0.95	9.69	8.51	4.218
7	420	0.83	8.47	7.29	4.216
8	480	0.75	7.65	6.47	4.276
9	540	0.68	6.94	5.76	4.282
10	600	0.63	6.43	5.25	4.336
11	660	0.59	6.02	4.84	4.397
12	720	0.55	5.61	4.43	4.390
18	1080	0.39	3.98	2.80	4.161
24	1440	0.32	3.26	2.08	4.120
36	2160	0.22	2.24	1.06	3.145
48	2880	0.17	1.73	0.55	2.170

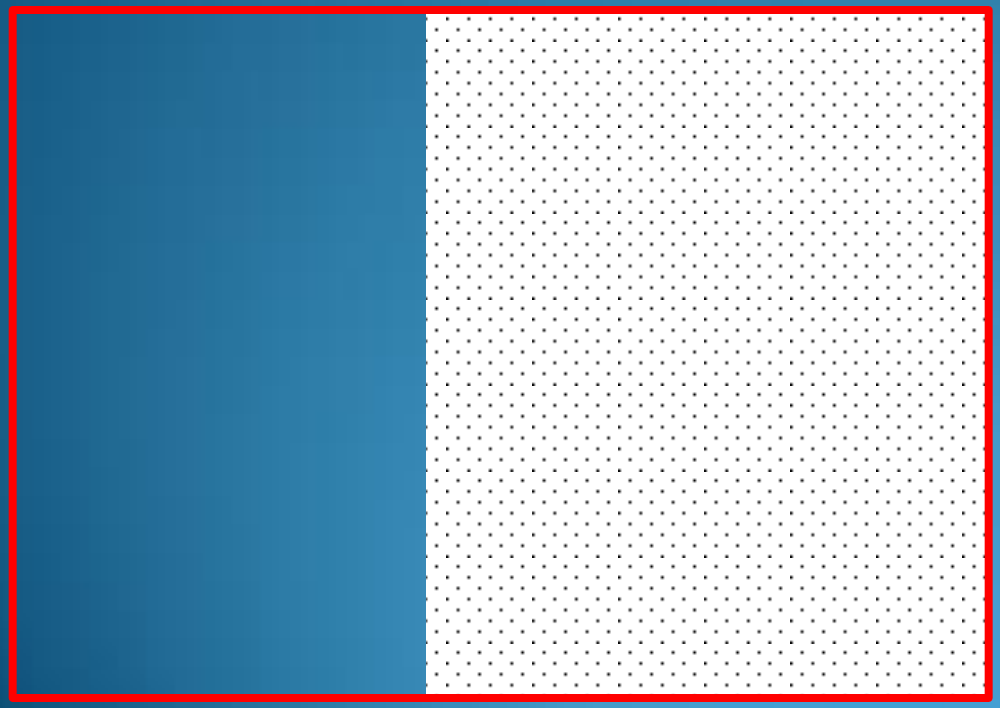
EXAMPLE 5.10 – ADDITIONAL NOTES

- The allowable release rate calculated for the original development included unrestricted releases; if the redevelopment causes additional unrestricted releases, or if the applicant wants to use a larger release rate because unrestricted areas have been reduced, a modification to the outlet control structure would be required.

- The overflow weir for the detention facility may need to be retrofitted to meet the design requirements of the WMO if there is a known drainage problem associated with the upstream drainage area to the development.

EXAMPLE 5.11 - REDEVELOPMENT

For the site in Example 5.10, determine the required detention volume if only a 6-acre portion of the site is to be redeveloped.



PERMITTED DEVELOPMENT
= 11.33 ACRES

AREA OF REDEVELOPMENT
= 6 ACRES

EXAMPLE 5.11 – STEP 1

Step 1: Calculate the proposed C value of entire development, C_{REDEV}, which includes redeveloped parcel. If C_{REDEV} > permitted C value for the development, C_{PERMIT}, additional storage volume is required.

C_{PERMIT} = 0.88 (from Schedule D form for original development)

C_{REDEV} = 0.89 (entire development including redeveloped 6-acre parcel)

Since C_{REDEV} > C_{PERMIT}, additional storage volume is required.

EXAMPLE 5.11 – STEP 2

Step 2: Determine the pro-rated permitted detention volume for the 6-acre parcel.

From the Schedule D for the original development, 3.07 acre-feet is required for the 11.33 acre-feet development. The pro-rated detention volume for the 6-acre parcel is:

$$\frac{V_{PERMIT}}{A_{PERMIT}} \times A_{PARCEL} = \text{Permitted Storage Volume Allocated for Redeveloped Parcel}$$

$$\frac{3.07 \text{ acre-feet}}{11.33 \text{ acres}} \times 6 \text{ acres} = 1.63 \text{ acre-feet}$$

EXAMPLE 5.11 – STEP 3

Step 3: Using the modified Rational Method w/ Bulletin 70 rainfall depths, determine the pro-rated required detention volume for the 6-acre parcel.

$$\frac{V_{REDEV}}{A_{PERMIT}} \times A_{PARCEL} = \text{Required Storage Volume for Redeveloped Parcel}$$

$$\frac{4.39 \text{ acre-feet}}{11.33 \text{ acres}} \times 6 \text{ acres} = 2.32 \text{ acre-feet}$$

DETENTION STORAGE CALCULATIONS
(Bulletin 70 NE Sectional Rainfall Intensities)

PROJECT:	Example 5.10
JOB NO.:	Technical Guidance Manual
FILENAME:	ModRatB70.xlsx
DATE :	5-Feb-14

TRIBUTARY AREA =	11.33	acres
COMPOSITE RUNOFF COEFFICIENT =	0.89	
ALLOWABLE RELEASE RATE =	1.18	cfs

COMPUTED DETENTION STORAGE = **4.387 acre-ft**

DURATION (hours)	TIME (min.)	RAINFALL INTENSITY (in/hr)	INFLOW RATE (cfs)	STORED RATE (cfs)	RESERVOIR SIZE (ac-ft)
0.08	5	10.90	109.91	108.73	0.749
0.17	10	10.02	101.04	99.86	1.375
0.25	15	8.20	82.69	81.51	1.684
0.33	20	7.30	73.61	72.43	1.995
0.50	30	5.60	56.47	55.29	2.285
0.67	40	4.58	46.18	45.00	2.479
0.83	50	3.97	40.03	38.85	2.675
1	60	3.56	35.90	34.72	2.869
1.5	90	2.68	27.02	25.84	3.203
2	120	2.24	22.59	21.41	3.538
3	180	1.62	16.34	15.16	3.758
4	240	1.40	14.12	12.94	4.277
5	300	1.17	11.80	10.62	***4.387*** ←
6	360	0.95	9.58	8.40	4.164
7	420	0.83	8.37	7.19	4.158
8	480	0.75	7.56	6.38	4.216
9	540	0.68	6.86	5.68	4.223
10	600	0.63	6.35	5.17	4.270
11	660	0.59	5.95	4.77	4.334
12	720	0.55	5.55	4.37	4.331
18	1080	0.39	3.93	2.75	4.086
24	1440	0.32	3.23	2.05	4.060
36	2160	0.22	2.22	1.04	3.085
48	2880	0.17	1.71	0.53	2.091

EXAMPLE 5.11 – STEP 4

Step 4: Determine the additional storage volume required.

Additional Storage Volume required = $V_{REDEV} - V_{PERMIT}$

Additional Storage Volume required = 2.32 ac-ft – 1.63 ac-ft

Additional Storage Volume required = 0.69 ac-ft

Since additional storage volume required > 0.10 ac-ft and is not within 2% of the existing volume, the additional storage volume must be provided. Assuming 0.45 ac-ft of volume control storage was provided as part of the redevelopment of the parcel, the net volume that is required is 0.24 ac-ft.