Revisions to the Delaware Sediment & Stormwater Regulations

Technical Subcommittee Meeting
September 1, 2010

DURMM v.2

DURMM_v2_2010-06-15.xls [Compatibility Mode] - Microsoft Excel

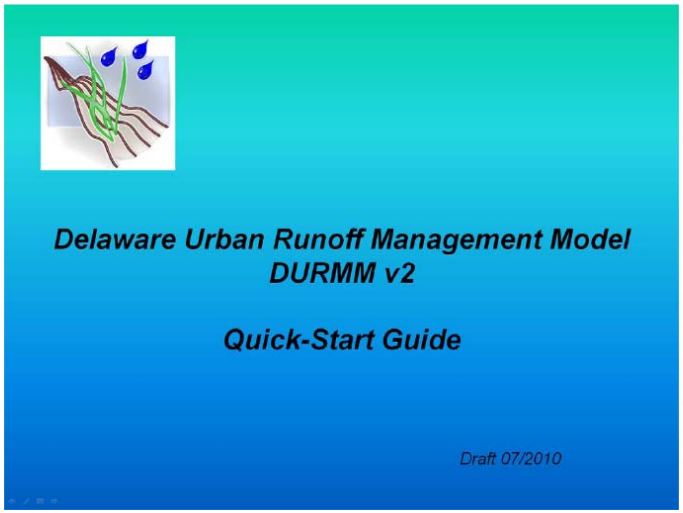
PROJECT:
DRAINAGE SUBAREA ID:
LOCATION (County):
UNIT HYDROGRAPH:

Cover Type	Treatment	Hydrologic Condition	A Acres	A RCN	B Acres	B RCN	C Acres	C RCN	D Acres	D RCN
			Curve Numbers for Hydrologic Soil Type							
FULLY DEVELOPED URBAN AREAS (Veg Established)										
Open space (Lawns,parks etc.)										
	Poor condition; grass cover < 50%			68		79		86		89
	Fair condition; grass cover 50% to 75 %			49		69		79		84
	Good condition; grass cover > 75%			39		61		74		80
Impervious Areas										
	Paved parking lots, roofs, driveways			98		98		98		98
	Streets and roads									
	Paved; curbs and storm sewers			98		98		98		98
	Paved; open ditches (w/right-of-way)			83		89		92		93
	Gravel (w/ right-of-way)			76		85		89		91
	Dirt (w/ right-of-way)			72		82		87		89
Urban Districts		Avg % impervious								
	Commercial & business	85		89		92		94		95
	Industrial	72		81		88		91		93
Residential districts by average lot size		Avg % impervious								
	1/8 acre (town houses)	65		77		85		90		92
	1/4 acre	38		61		75		83		87
	1/3 acre	30		57		72		81		86
	1/2 acre	25		54		70		80		85
	1 acre	20		51		68		79		84
	2 acre	12		46		65		77		82
	User defined urban			**		**		**		**
DEVELOPING URBAN AREA (No Vegetation)										
	Newly graded area (pervious only)			77		86		91		94
			0		0		0		0	
			Total Acres				0			
	Weighted Runoff Curve Number (RCN)						0			

CLEAR TABLE

C.A. RCN | LOD | OLOD | RPv | TMDL | Cv | Fv | DURMM Report

DURMM v2 Quick-Start Guide



Delaware Urban Runoff Management Model
DURMM v2

Quick-Start Guide

Draft 07/2010

Introduction

This Quick-Start Guide has been developed as an overview of the basic use of the 2nd version of the Delaware Urban Runoff Management Model (DURMM). It is not intended to serve as a detailed description of each cell in the spreadsheet or the algorithms used in those cells. A separate User's Guide has been developed to serve that purpose. The Quick-Start Guide first describes the general workflow and data input, then continues with two examples illustrating typical uses of the model to meet the requirements of the Delaware Sediment & Stormwater Regulations (DSSR).

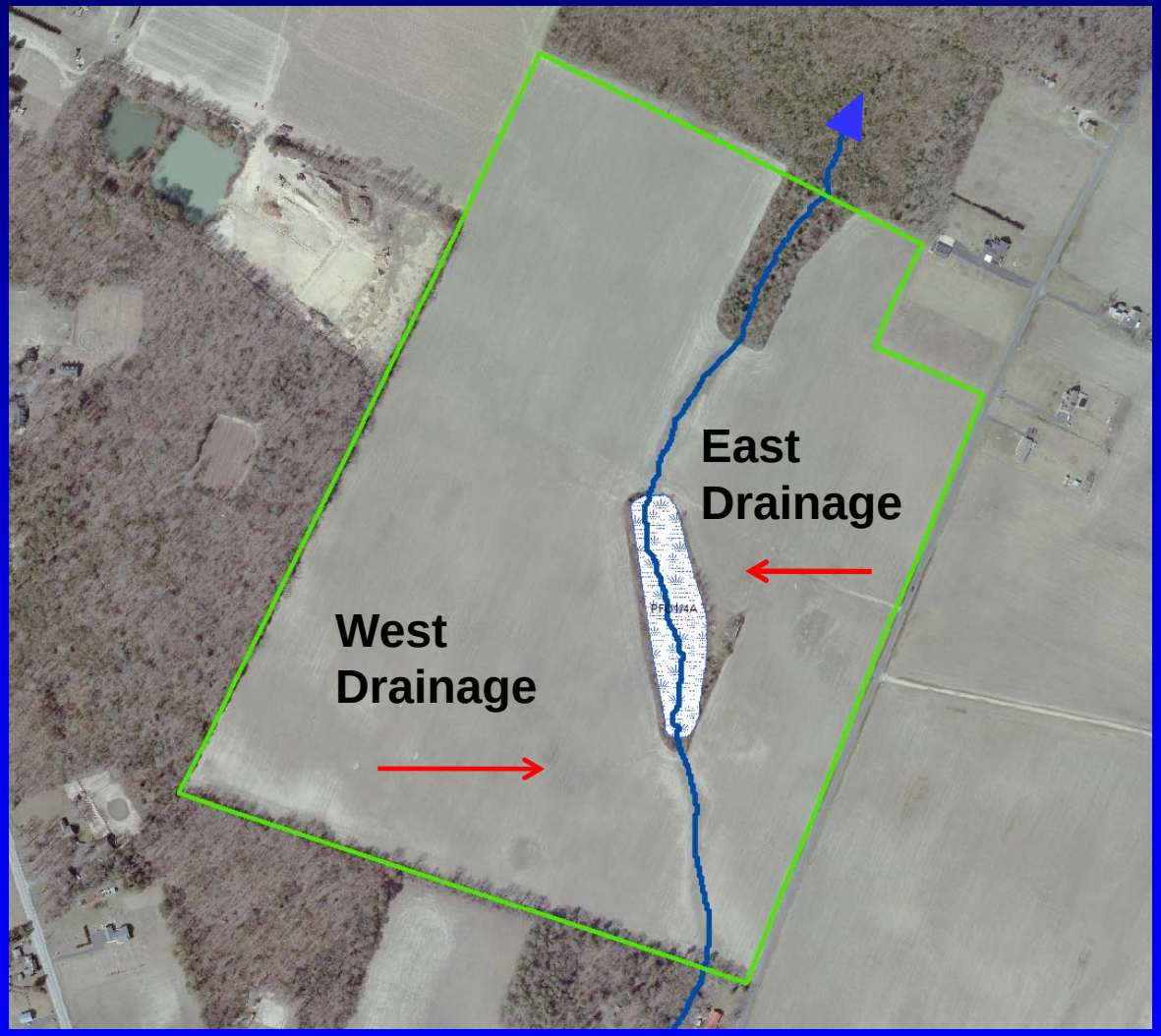
1 Draft 07/2010

Proposed Revisions to the Delaware Sediment & Stormwater Regulations: Quantity Management Methodology

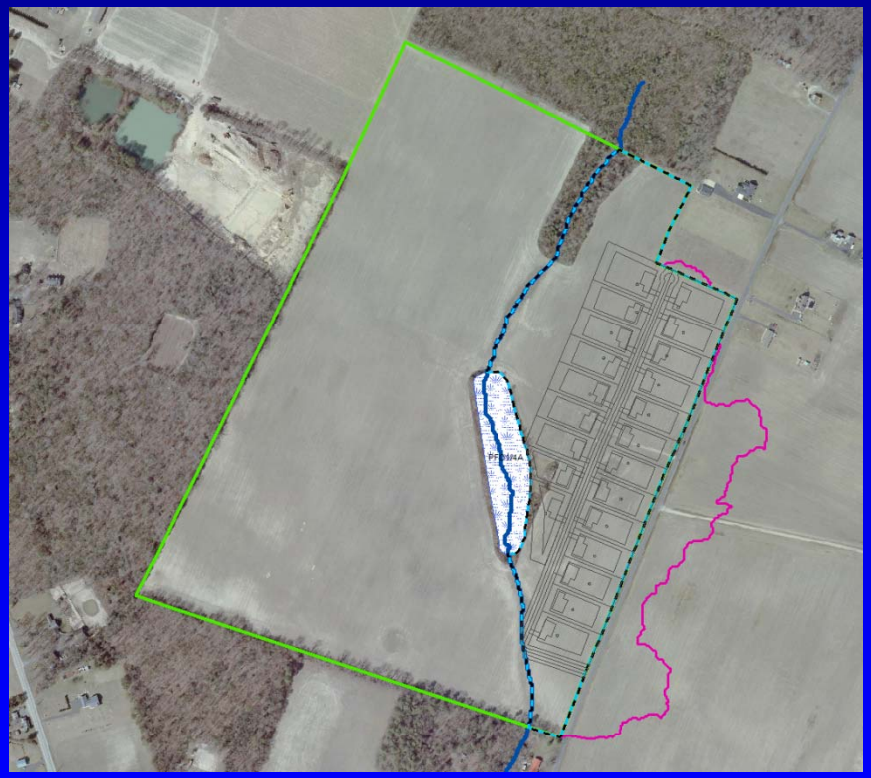
“Broadkill Estates” Example Site

Design Level Analysis

Design Level Analysis

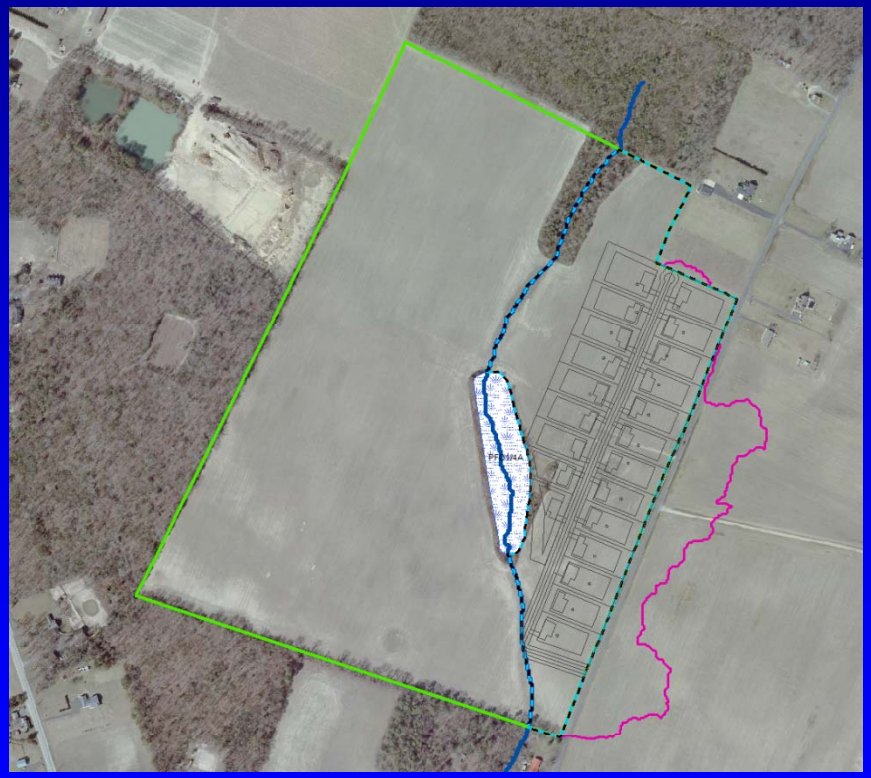


Design Level Analysis
East Drainage: Site Data



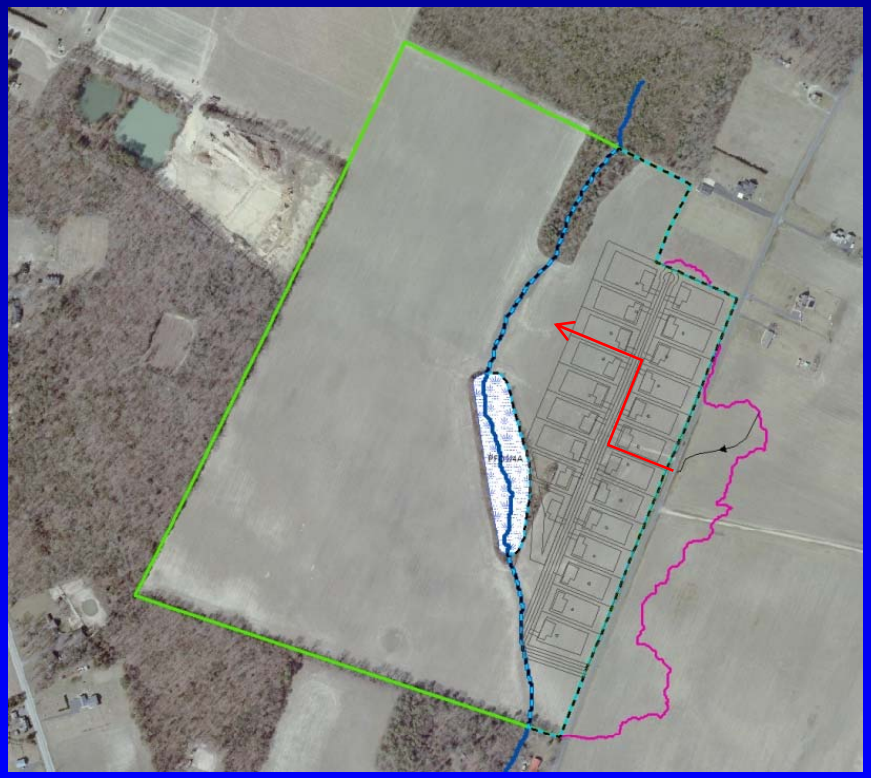
- C.A. RCN Tab
  - 1-ac. residential (20 % imperv.)
    - HSG A: 21.17 ac.
    - HSG B: 0.73 ac
  - Open space
    - HSG A: 8.06 ac.
    - HSG B: 2.26 ac
  - Row Crops, SR + Crop Residue
    - HSG A: 9.68 ac.

Design Level Analysis
East Drainage: Site Data (cont.)



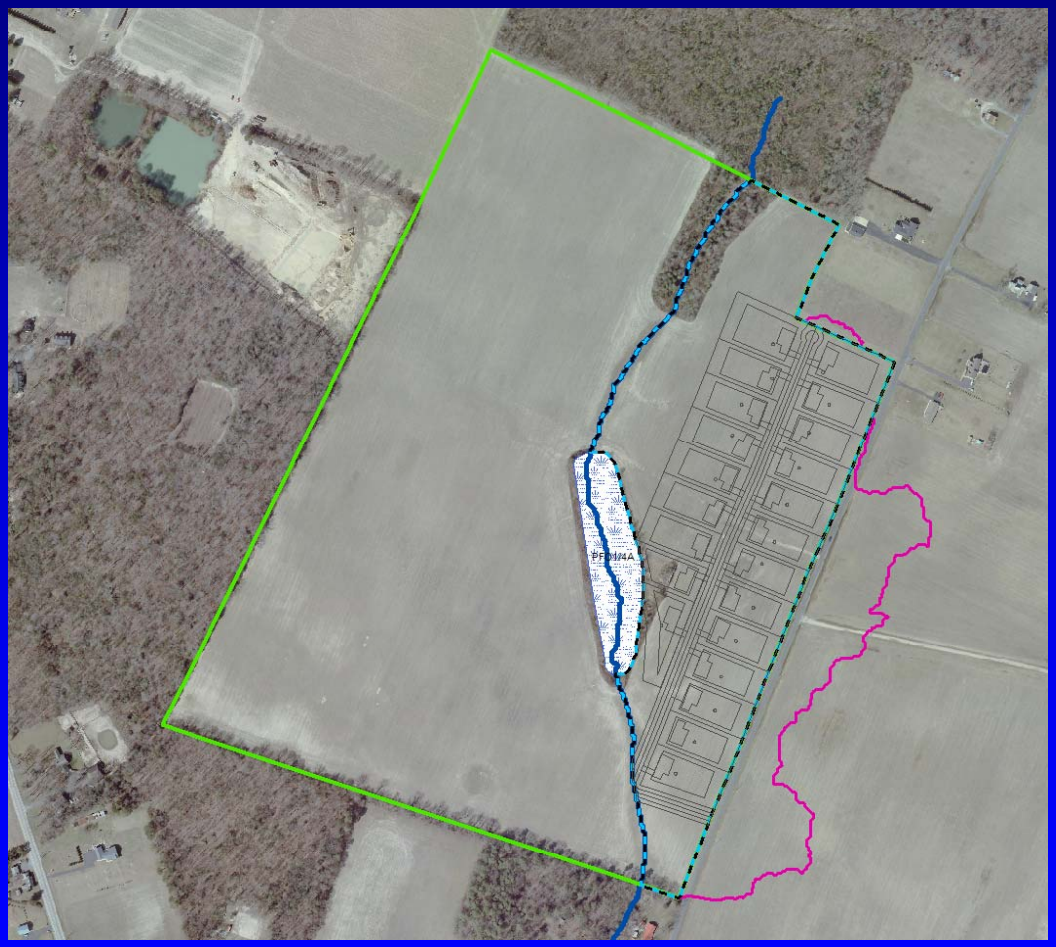
- LOD Tab
  - HSG A
    - LOD area: 29.22 ac.
    - Pre-Dev. Woods: 1.55 ac.
    - Post-Dev. Impervious: 4.23 ac.
  - HSG B
    - LOD area: 2.99 ac.
    - Pre-Dev. Woods: 0 ac.
    - Post-Dev. Impervious: 0.15 ac.

Design Level Analysis
East Drainage: Site Data (cont.)



- OLOD Tab
  - Sheet Flow, 100 ft, 0.001 ft/ft, “d”
  - Shallow Conc., 300 ft, 0.002 ft/ft, “u”
  - Open Channel, 1000 ft, 0.01 ft/ft, 1.0 fps

Example: Unit Discharge Conveyance Event (Cv)



Example: Unit Discharge Conveyance Event (Cv)

PROJECT:	Broadkill Estates
DRAINAGE SUBAREA ID:	East Drainage
TMDL Watershed:	Broadkill River

DURMM v2.2010.07.26

Site Data					
Total contributing area to BMPs (ac.)	41.9				
C.A. RCN	53				
LOD area (ac.)	32.21				
Polluant load, N (lbs)	6.25				
Pollutant load, P (lbs)	0.81				
Required pollutant load reduction , N (%)	40%				
Required pollutant load reduction , P (%)	40%				
BMP Selection	RfDiscnct	DBioswale	Infiltration	0	0

Resource Protection Event (RPV)					
RPv for Contributing Area (in)	0.33				
Req'd RPv Reduction for Contributing Area (in)	0.15				
Req'd RPv Reduction for Contributing Area (%)	46%				
C.A. allowable discharge rate (cfs)	0.34				
BMP Runoff Reduction Performance	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
RPv runoff volume after all reductions (in.)	0.31	0.29	0.18	#N/A	#N/A
Total RPv runoff reduction (in)	0.02	0.04	0.15	#N/A	#N/A
Total RPv runoff reduction (%)	6%	12%	46%	#N/A	#N/A
Req'd runoff reduction met?	No	No	OK	#N/A	#N/A
BMP TMDL Performance					
BMP pollutant reduction, N (%)	6%	11%	42%	#N/A	#N/A
BMP pollutant reduction, P (%)	6%	11%	42%	#N/A	#N/A
Reduction met, N?	No	No	OK	#N/A	#N/A
Reduction met, P?	No	No	OK	#N/A	#N/A
Effluent ≤ irreducible concentration, N?	No	No	OK	#N/A	#N/A
Effluent ≤ irreducible concentration, P?	No	No	OK	#N/A	#N/A

Conveyance Event (Cv)					
Cv runoff volume (in)	0.97				
Stds-based allowable discharge (cfs)	28.29				
BMP Performance	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
Cv runoff volume after all reductions (in.)	0.95	0.93	0.81	#N/A	#N/A

Flooding Event (Fv)					
Fv runoff volume (in)	3.33				
Stds-based allowable discharge (cfs)	84.99				
BMP Performance	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
Fv runoff volume after all reductions (in.)	3.29	3.26	3.15	#N/A	#N/A

Adjusted Subarea Data for H&H Modeling	**Rain (in)**	**RCN**
Resource Protection Event, RPv	2.7	57.63
Conveyance Event, Cv	5.3	49.86
Flooding Event, Fv	9.2	51.07

Example: Unit Discharge East Drainage: TR-55 Data

PROJECT:	Broadkill Estates
DRAINAGE SUBAREA ID:	East Drainage
TMDL Watershed:	Broadkill River

DURMM v2.2010.07.26

Site Data					
Total contributing area to BMPs (ac.)	41.9				
C.A. RCN	53				
LOD area (ac.)	32.21				
Polluant load, N (lbs)	6.25				
Pollutant load, P (lbs)	0.81				
Required pollutant load reduction , N (%)	40%				
Required pollutant load reduction , P (%)	40%				
BMP Selection	RfDiscnct	DBioswale	Infiltration	0	0

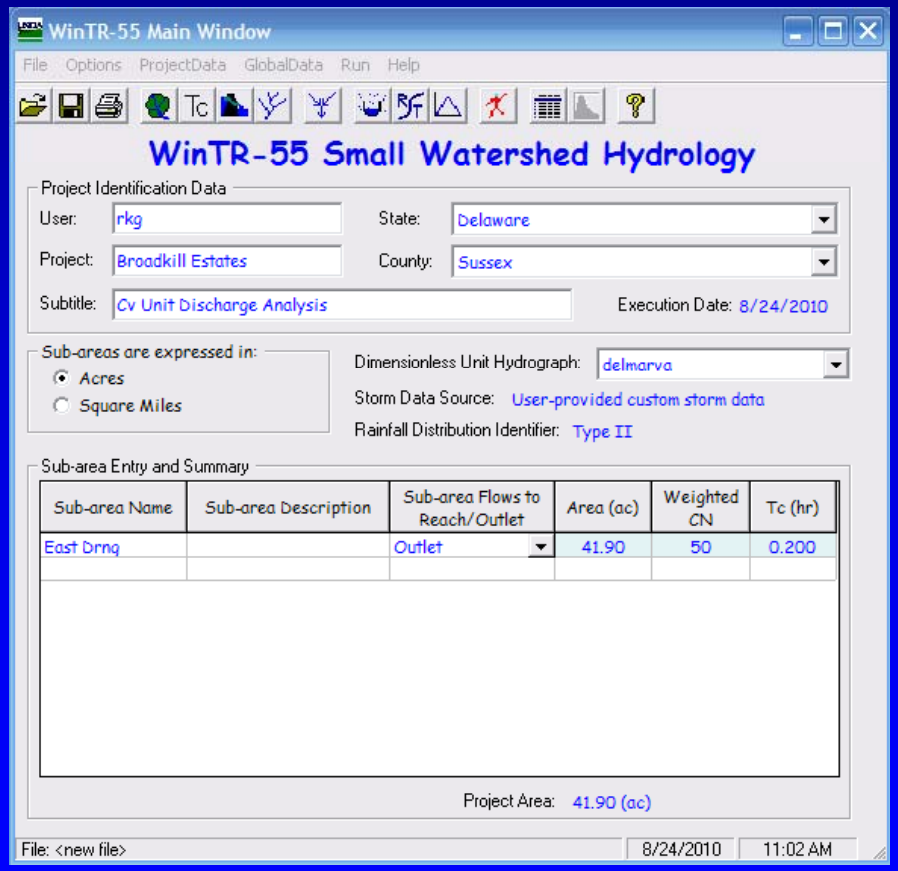
Resource Protection Event (RPV)					
RPv for Contributing Area (in)	0.33				
Req'd RPv Reduction for Contributing Area (in)	0.15				
Req'd RPv Reduction for Contributing Area (%)	46%				
C.A. allowable discharge rate (cfs)	0.34				
BMP Runoff Reduction Performance	BMP 1	BMP 2	BMP 3	BMP 4	BMP 5
RPv runoff volume after all reductions (in.)	0.31	0.29	0.18	#N/A	#N/A
Total RPv runoff reduction (in)	0.02	0.04	0.15	#N/A	#N/A
Total RPv runoff reduction (%)	6%	12%	46%	#N/A	#N/A
Req'd runoff reduction met?	No	No	OK	#N/A	#N/A
BMP TMDL Performance					
BMP pollutant reduction, N (%)	6%	11%	42%	#N/A	#N/A
BMP pollutant reduction, P (%)	6%	11%	42%	#N/A	#N/A
Reduction met, N?	No	No	OK	#N/A	#N/A
Reduction met, P?	No	No	OK	#N/A	#N/A
Effluent ≤ irreducible concentration, N?	No	No	OK	#N/A	#N/A
Effluent ≤ irreducible concentration, P?	No	No	OK	#N/A	#N/A

Conveyance Event (Cv)					
Cv runoff volume (in)	0.97				
Stds-based allowable discharge (cfs)	28.29				
BMP Performance	BMP 1	BMP 2	BMP 3	BMP 4	BMP 5
Cv runoff volume after all reductions (in.)	0.95	0.93	0.81	#N/A	#N/A

Flooding Event (Fv)					
Fv runoff volume (in)	3.33				
Stds-based allowable discharge (cfs)	84.99				
BMP Performance	BMP 1	BMP 2	BMP 3	BMP 4	BMP 5
Fv runoff volume after all reductions (in.)	3.29	3.26	3.15	#N/A	#N/A

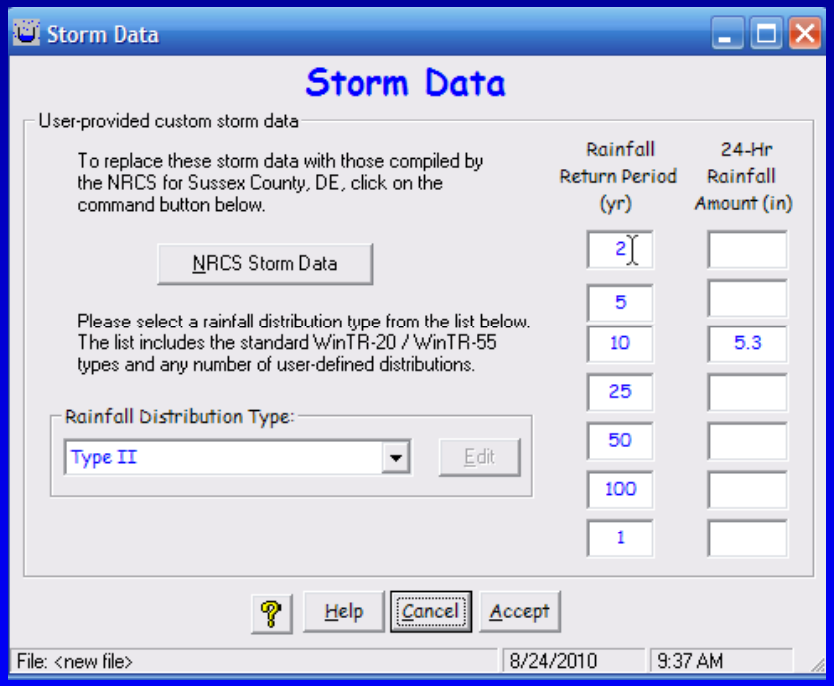
Adjusted Subarea Data for H&H Modeling	Rain (in)	RCN
Resource Protection Event, RPv	2.7	57.63
Conveyance Event, Cv	5.3	49.86
Flooding Event, Fv	9.2	51.07

Example: Unit Discharge East Drainage: TR-55 Data



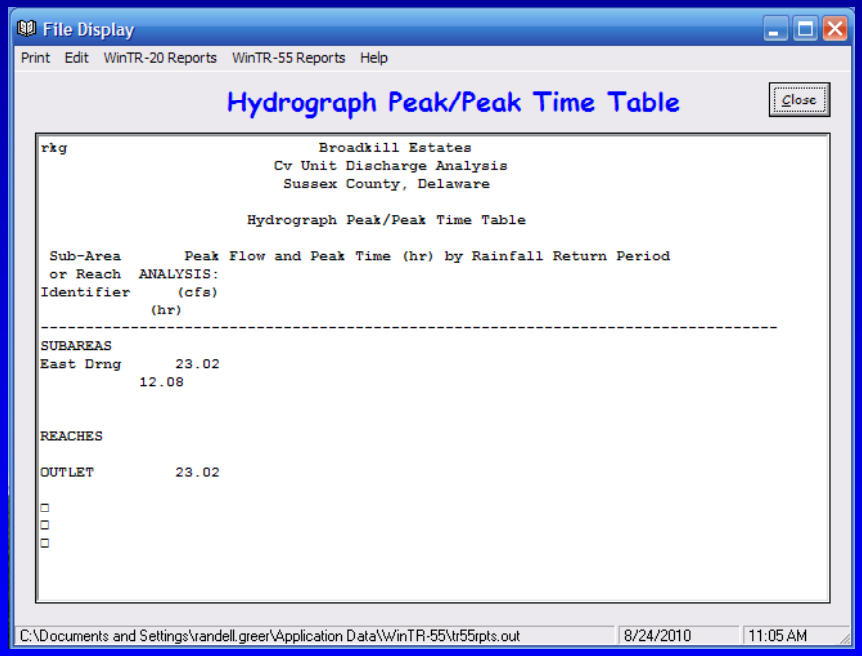
- Drainage Area: 41.9 ac.
- Adjusted RCN_{Cv} : 50
- Tc: 0.2 hrs

Example: Unit Discharge East Drainage: TR-55 Data



- Rainfall_{Cv} : 5.3 in.

Example: Unit Discharge East Drainage: TR-55 Data

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rkg                                Broadkill Estates
                                 Cv Unit Discharge Analysis
                                  Sussex County, Delaware

                            Hydrograph Peak/Peak Time Table

 Sub-Area        Peak Flow and Peak Time (hr) by Rainfall Return Period
 or Reach   ANALYSIS:
Identifier      (cfs)
             (hr)
--------------------------------------------------------------------------------
SUBAREAS
East Drng       23.02
           12.08


REACHES

OUTLET          23.02

□
□
□
```

- $Peak_{Cv}$: 23.02 cfs

Example: Unit Discharge Conveyance Event (Cv)

PROJECT:	Broadkill Estates
DRAINAGE SUBAREA ID:	East Drainage
TMDL Watershed:	Broadkill River

DURMM v2.2010.07.26

Site Data					
Total contributing area to BMPs (ac.)	41.9				
C.A. RCN	53				
LOD area (ac.)	32.21				
Polluant load, N (lbs)	6.25				
Pollutant load, P (lbs)	0.81				
Required pollutant load reduction , N (%)	40%				
Required pollutant load reduction , P (%)	40%				
BMP Selection	RfDiscnct	DBioswale	Infiltration	0	0
Resource Protection Event (RPV)					
RPv for Contributing Area (in)	0.33				
Req'd RPv Reduction for Contributing Area (in)	0.15				
Req'd RPv Reduction for Contributing Area (%)	46%				
C.A. allowable discharge rate (cfs)	0.34				
BMP Runoff Reduction Performance	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
RPv runoff volume after all reductions (in.)	0.31	0.29	0.18	#N/A	#N/A
Total RPv runoff reduction (in)	0.02	0.04	0.15	#N/A	#N/A
Total RPv runoff reduction (%)	6%	12%	46%	#N/A	#N/A
Req'd runoff reduction met?	No	No	OK	#N/A	#N/A
BMP TMDL Performance					
BMP pollutant reduction, N (%)	6%	11%	42%	#N/A	#N/A
BMP pollutant reduction, P (%)	6%	11%	42%	#N/A	#N/A
Reduction met, N?	No	No	OK	#N/A	#N/A
Reduction met, P?	No	No	OK	#N/A	#N/A
Effluent ≤ irreducible concentration, N?	No	No	OK	#N/A	#N/A
Effluent ≤ irreducible concentration, P?	No	No	OK	#N/A	#N/A
Conveyance Event (Cv)					
Cv runoff volume (in)	0.97				
Stds-based allowable discharge (cfs)	28.29				
BMP Performance	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
Cv runoff volume after all reductions (in.)	0.95	0.93	0.81	#N/A	#N/A
Flooding Event (Fv)					
Fv runoff volume (in)	3.33				
Stds-based allowable discharge (cfs)	84.99				
BMP Performance	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
Fv runoff volume after all reductions (in.)	3.29	3.26	3.15	#N/A	#N/A

Adjusted Subarea Data for H&H Modeling	**Rain (in)**	**RCN**
Resource Protection Event, RPv	2.7	57.63
Conveyance Event, Cv	5.3	49.86
Flooding Event, Fv	9.2	51.07

- Computed: 23.02 cfs
- Allowable: 28.29 cfs

✓ Computed ≤ Allowable

Check Compliance for Flooding Event (Fv)

Example: Unit Discharge East Drainage: TR-55 Data

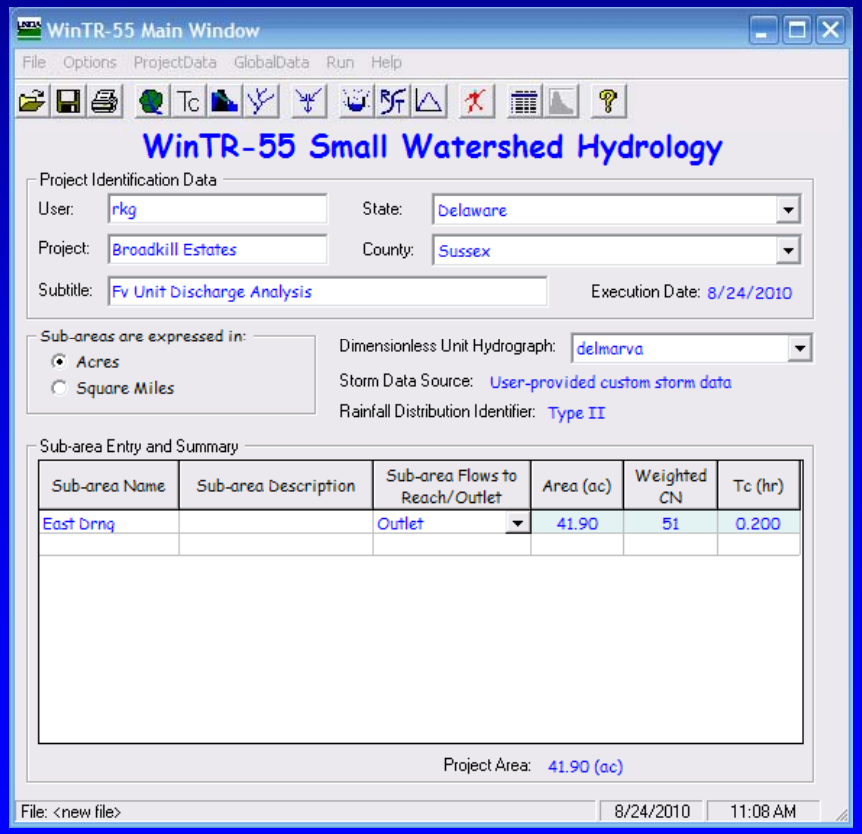
PROJECT:	Broadkill Estates
DRAINAGE SUBAREA ID:	East Drainage
TMDL Watershed:	Broadkill River

DURMM v2.2010.07.26

Site Data					
Total contributing area to BMPs (ac.)	41.9				
C.A. RCN	53				
LOD area (ac.)	32.21				
Polluant load, N (lbs)	6.25				
Pollutant load, P (lbs)	0.81				
Required pollutant load reduction , N (%)	40%				
Required pollutant load reduction , P (%)	40%				
BMP Selection	RfDiscnct	DBioswale	Infiltration	0	0
Resource Protection Event (RPV)					
RPv for Contributing Area (in)	0.33				
Req'd RPv Reduction for Contributing Area (in)	0.15				
Req'd RPv Reduction for Contributing Area (%)	46%				
C.A. allowable discharge rate (cfs)	0.34				
BMP Runoff Reduction Performance	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
RPv runoff volume after all reductions (in.)	0.31	0.29	0.18	#N/A	#N/A
Total RPv runoff reduction (in)	0.02	0.04	0.15	#N/A	#N/A
Total RPv runoff reduction (%)	6%	12%	46%	#N/A	#N/A
Req'd runoff reduction met?	No	No	OK	#N/A	#N/A
BMP TMDL Performance					
BMP pollutant reduction, N (%)	6%	11%	42%	#N/A	#N/A
BMP pollutant reduction, P (%)	6%	11%	42%	#N/A	#N/A
Reduction met, N?	No	No	OK	#N/A	#N/A
Reduction met, P?	No	No	OK	#N/A	#N/A
Effluent ≤ irreducible concentration, N?	No	No	OK	#N/A	#N/A
Effluent ≤ irreducible concentration, P?	No	No	OK	#N/A	#N/A
Conveyance Event (Cv)					
Cv runoff volume (in)	0.97				
Stds-based allowable discharge (cfs)	28.29				
BMP Performance	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
Cv runoff volume after all reductions (in.)	0.95	0.93	0.81	#N/A	#N/A
Flooding Event (Fv)					
Fv runoff volume (in)	3.33				
Stds-based allowable discharge (cfs)	84.99				
BMP Performance	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
Fv runoff volume after all reductions (in.)	3.29	3.26	3.15	#N/A	#N/A

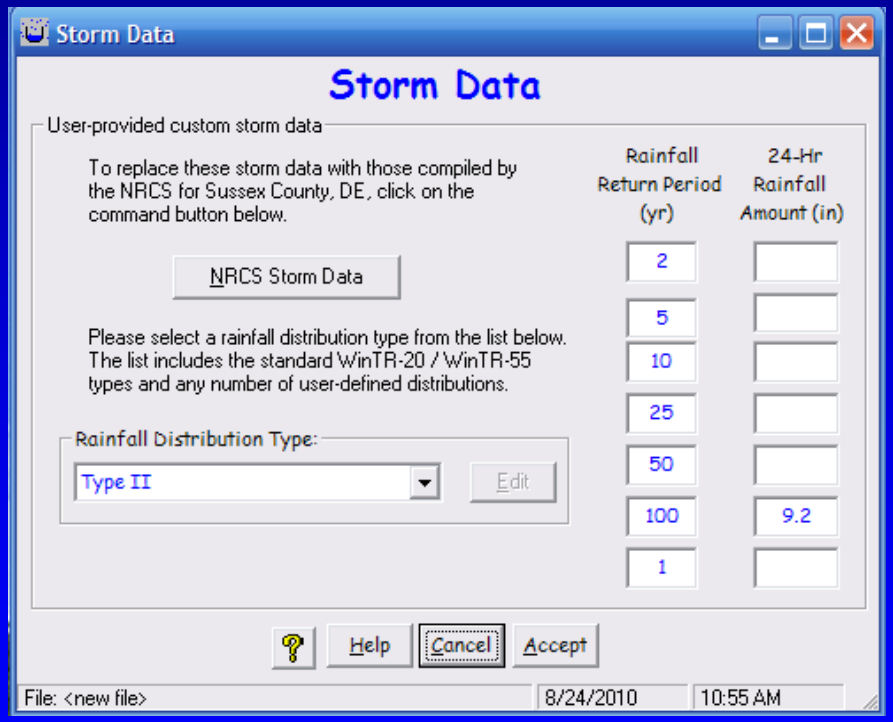
Adjusted Subarea Data for H&H Modeling	**Rain (in)**	**RCN**
Resource Protection Event, RPv	2.7	57.63
Conveyance Event, Cv	5.3	49.86
Flooding Event, Fv	9.2	51.07

Example: Unit Discharge East Drainage: TR-55 Data



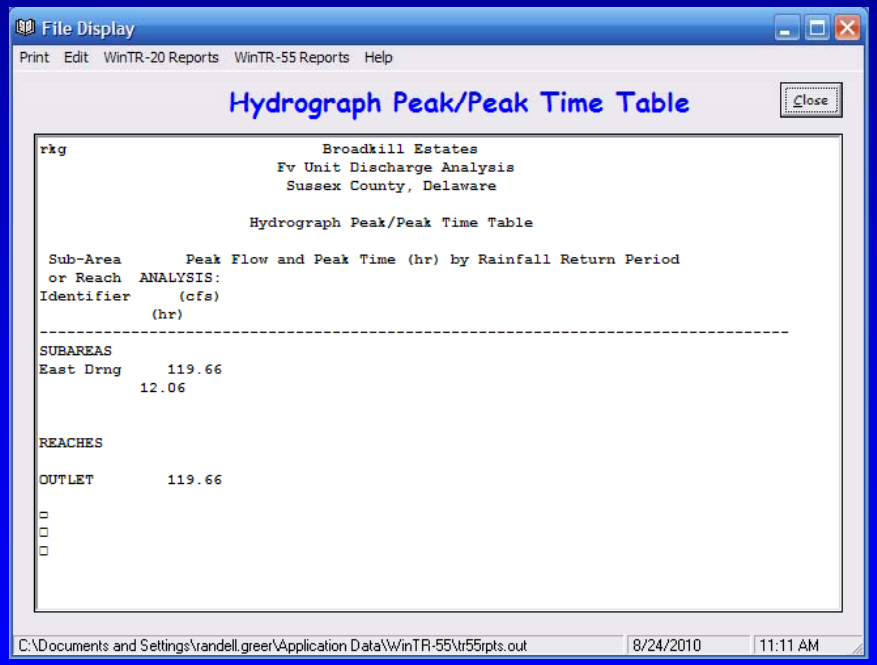
- Drainage Area: 41.9 ac.
- Adjusted RCN_{FV} : 51
- Tc: 0.2 hrs

Example: Unit Discharge East Drainage: TR-55 Data



- Rainfall_{FV} : 9.2 in.

Example: Unit Discharge East Drainage: TR-55 Data




```
rkg                                Broadkill Estates
                                 Fv Unit Discharge Analysis
                                  Sussex County, Delaware

                            Hydrograph Peak/Peak Time Table

 Sub-Area        Peak Flow and Peak Time (hr) by Rainfall Return Period
 or Reach   ANALYSIS:
Identifier      (cfs)
             (hr)
--------------------------------------------------------------------------------
SUBAREAS
East Drng      119.66
            12.06


REACHES

OUTLET         119.66
```

- $Peak_{Fv}$: 119.66 cfs

Example: Unit Discharge Flooding Event (Fv)

PROJECT:	Broadkill Estates
DRAINAGE SUBAREA ID:	East Drainage
TMDL Watershed:	Broadkill River

DURMM v2.2010.07.26

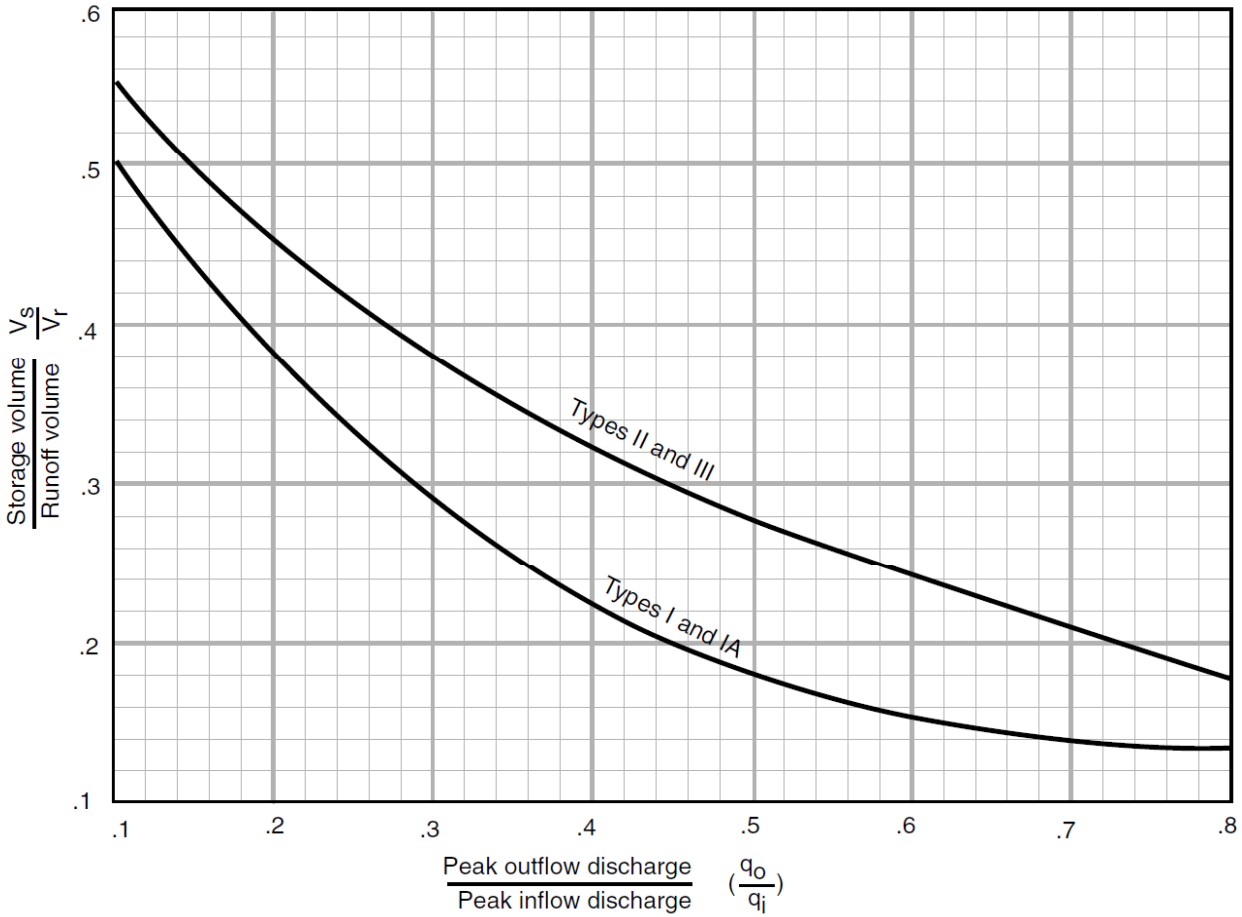
Site Data					
Total contributing area to BMPs (ac.)	41.9				
C.A. RCN	53				
LOD area (ac.)	32.21				
Polluant load, N (lbs)	6.25				
Pollutant load, P (lbs)	0.81				
Required pollutant load reduction , N (%)	40%				
Required pollutant load reduction , P (%)	40%				
BMP Selection	RfDiscnct	DBioswale	Infiltration	0	0
Resource Protection Event (RPV)					
RPv for Contributing Area (in)	0.33				
Req'd RPv Reduction for Contributing Area (in)	0.15				
Req'd RPv Reduction for Contributing Area (%)	46%				
C.A. allowable discharge rate (cfs)	0.34				
BMP Runoff Reduction Performance	BMP 1	BMP 2	BMP 3	BMP 4	BMP 5
RPv runoff volume after all reductions (in.)	0.31	0.29	0.18	#N/A	#N/A
Total RPv runoff reduction (in)	0.02	0.04	0.15	#N/A	#N/A
Total RPv runoff reduction (%)	6%	12%	46%	#N/A	#N/A
Req'd runoff reduction met?	No	No	OK	#N/A	#N/A
BMP TMDL Performance					
BMP pollutant reduction, N (%)	6%	11%	42%	#N/A	#N/A
BMP pollutant reduction, P (%)	6%	11%	42%	#N/A	#N/A
Reduction met, N?	No	No	OK	#N/A	#N/A
Reduction met, P?	No	No	OK	#N/A	#N/A
Effluent ≤ irreducible concentration, N?	No	No	OK	#N/A	#N/A
Effluent ≤ irreducible concentration, P?	No	No	OK	#N/A	#N/A
Conveyance Event (Cv)					
Cv runoff volume (in)	0.97				
Stds-based allowable discharge (cfs)	28.29				
BMP Performance	BMP 1	BMP 2	BMP 3	BMP 4	BMP 5
Cv runoff volume after all reductions (in.)	0.95	0.93	0.81	#N/A	#N/A
Flooding Event (Fv)					
Fv runoff volume (in)	3.33				
Stds-based allowable discharge (cfs)	84.99				
BMP Performance	BMP 1	BMP 2	BMP 3	BMP 4	BMP 5
Fv runoff volume after all reductions (in.)	3.29	3.26	3.15	#N/A	#N/A

Adjusted Subarea Data for H&H Modeling	Rain (in)	RCN
Resource Protection Event, RPv	2.7	57.63
Conveyance Event, Cv	5.3	49.86
Flooding Event, Fv	9.2	51.07

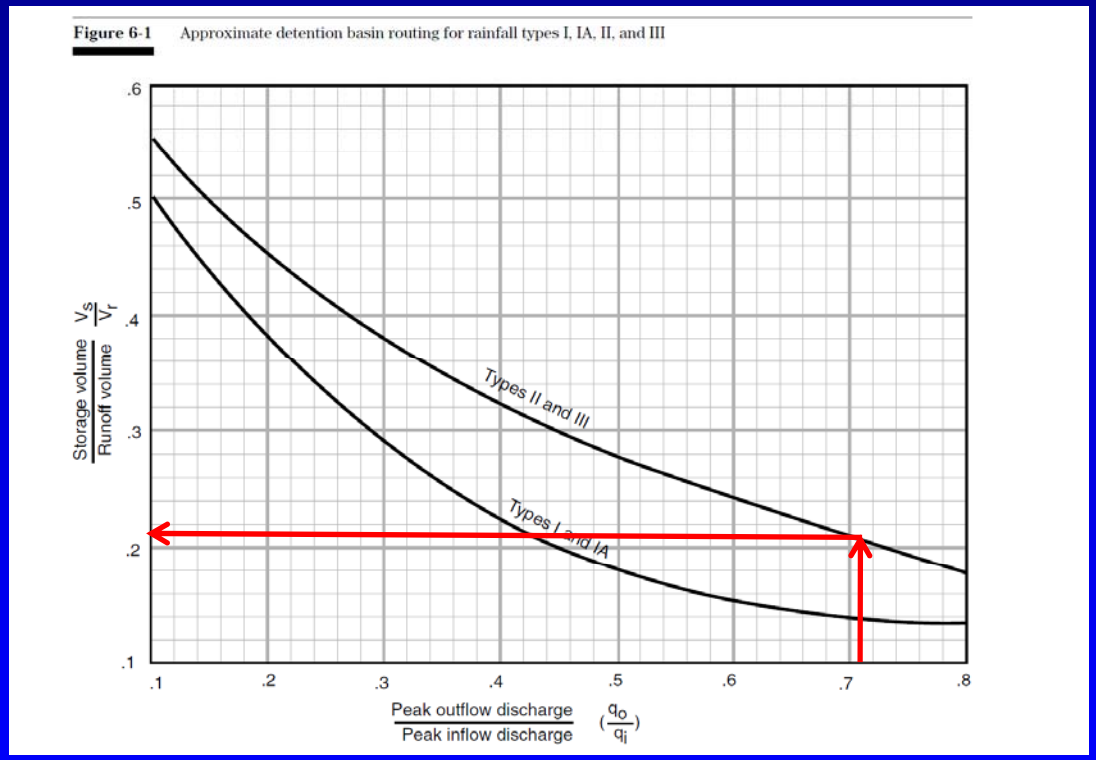
- Computed: 119.66 cfs
- Allowable: 84.99 cfs
- ✗ Computed > Allowable

Example: Unit Discharge Flooding Event (Fv)

Figure 6-1 Approximate detention basin routing for rainfall types I, IA, II, and III



Example: Unit Discharge Flooding Event (Fv)



- qo = 85 cfs
- qi = 120 cfs
- qo/qi = 0.71
- Vs/Vr = 0.21

Example: Unit Discharge Flooding Event (Fv)

PROJECT:	Broadkill Estates
DRAINAGE SUBAREA ID:	East Drainage
TMDL Watershed:	Broadkill River

DURMM v2.2010.07.26

Site Data					
Total contributing area to BMPs (ac.)	41.9				
C.A. RCN	53				
LOD area (ac.)	32.21				
Polluant load, N (lbs)	6.25				
Pollutant load, P (lbs)	0.81				
Required pollutant load reduction , N (%)	40%				
Required pollutant load reduction , P (%)	40%				
BMP Selection	RfDiscnct	DBioswale	Infiltration	0	0
Resource Protection Event (RPV)					
RPv for Contributing Area (in)	0.33				
Req'd RPv Reduction for Contributing Area (in)	0.15				
Req'd RPv Reduction for Contributing Area (%)	46%				
C.A. allowable discharge rate (cfs)	0.34				
BMP Runoff Reduction Performance	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
RPv runoff volume after all reductions (in.)	0.31	0.29	0.18	#N/A	#N/A
Total RPv runoff reduction (in)	0.02	0.04	0.15	#N/A	#N/A
Total RPv runoff reduction (%)	6%	12%	46%	#N/A	#N/A
Req'd runoff reduction met?	No	No	OK	#N/A	#N/A
BMP TMDL Performance					
BMP pollutant reduction, N (%)	6%	11%	42%	#N/A	#N/A
BMP pollutant reduction, P (%)	6%	11%	42%	#N/A	#N/A
Reduction met, N?	No	No	OK	#N/A	#N/A
Reduction met, P?	No	No	OK	#N/A	#N/A
Effluent ≤ irreducible concentration, N?	No	No	OK	#N/A	#N/A
Effluent ≤ irreducible concentration, P?	No	No	OK	#N/A	#N/A
Conveyance Event (Cv)					
Cv runoff volume (in)	0.97				
Stds-based allowable discharge (cfs)	28.29				
BMP Performance	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
Cv runoff volume after all reductions (in.)	0.95	0.93	0.81	#N/A	#N/A
Flooding Event (Fv)					
Fv runoff volume (in)	3.33				
Stds-based allowable discharge (cfs)	84.99				
BMP Performance	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
Fv runoff volume after all reductions (in.)	3.29	3.26	3.15	#N/A	#N/A

Adjusted Subarea Data for H&H Modeling	**Rain (in)**	**RCN**
Resource Protection Event, RPv	2.7	57.63
Conveyance Event, Cv	5.3	49.86
Flooding Event, Fv	9.2	51.07

- Vs/Vr = 0.21
- Vr = 3.33 in.
- Vs = (0.21)(3.33)

  = 0.70 in.

  = (0.06 ft)(41.9 ac)

  = 2.4 ac-ft

Example: Level 1 H&H Analysis

Example: Level 1 H&H Analysis

DRAFT – 04/10

Procedure for Conducting Hydrologic & Hydraulic Analyses For Preliminary Sediment & Stormwater Plans

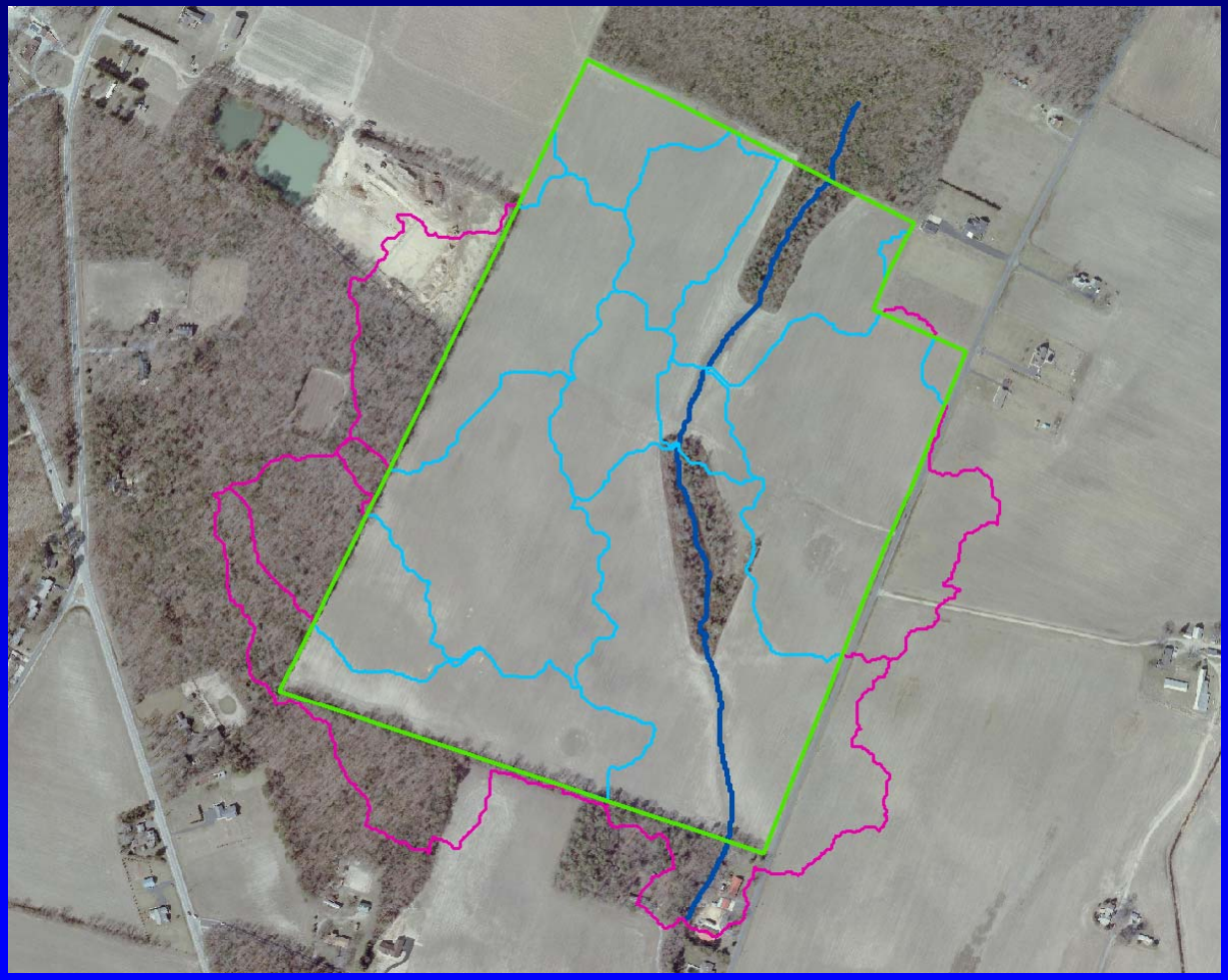
Background

The Hydrologic & Hydraulic (H&H) Analysis couples field collected data with desktop watershed modeling methodology to provide a tool for stormwater management agencies to help determine the most appropriate method to manage stormwater runoff from developing sites based on "No Adverse Impact" principles. The general approach is one of increasing level of detail and analysis depending on the complexity of the watershed. It is NOT intended to be a substitute for detailed Watershed Master Plans. When such detailed plans are available, the Watershed Master Plan shall take precedence. Additionally, the methodologies used for this analysis are not considered to be precise enough to be applied at the site level.

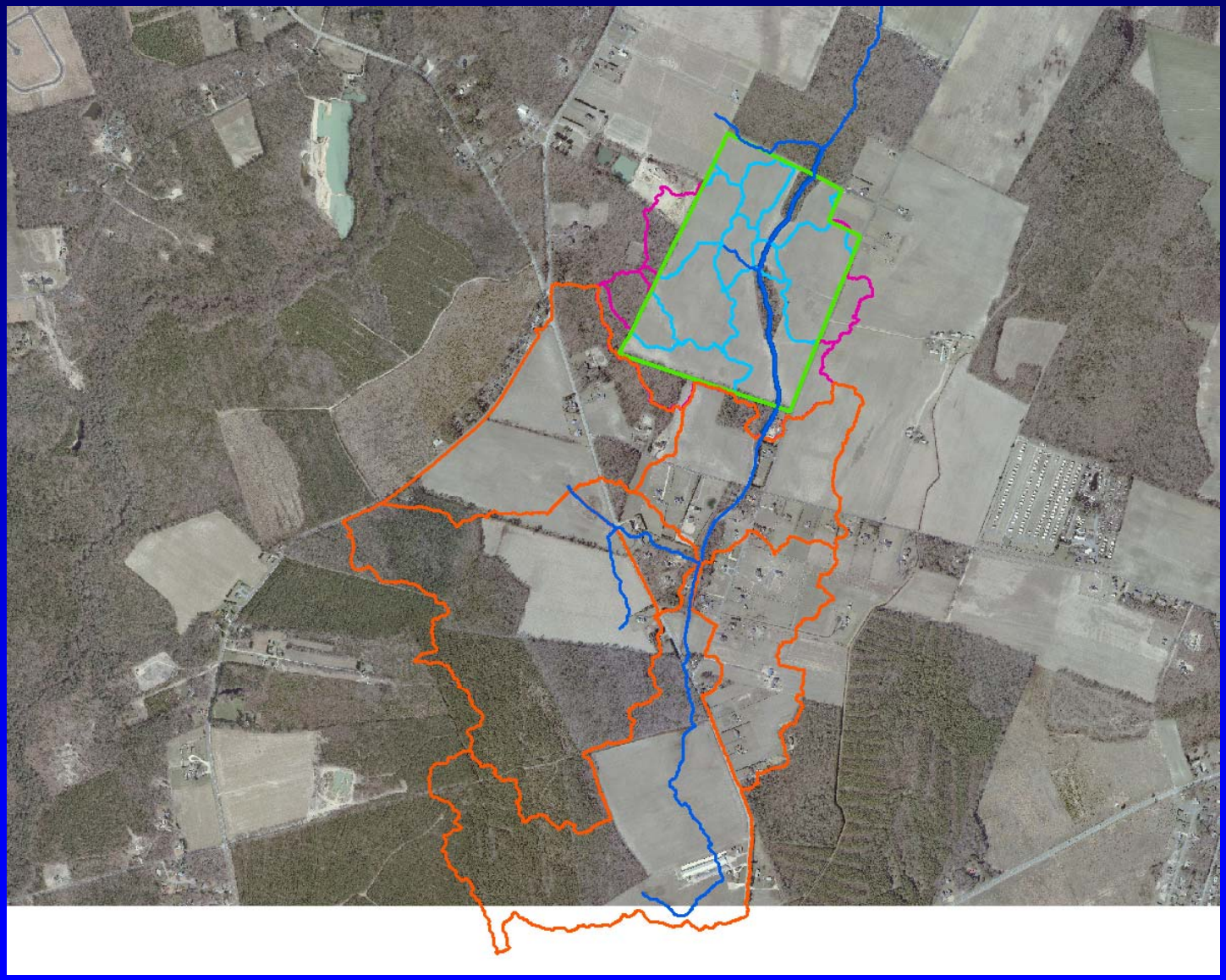
Procedure

1. **Applicability**
   1.1. The H&H analysis will be required for all projects using the performance-based option and/or where a sump condition exists.
2. **Methodology**
   2.1. Level 1 Analysis
      2.1.1. The Level 1 Analysis combines field reconnaissance data with hydrologic modeling of the upstream watershed and site using latest soils, LULC, and terrain data. Hydrographs are then compared to check for coincidental peaking effects.
      2.1.2. Limit of study shall be the most-downstream junction of the site and the upstream contributing area.
      2.1.3. To comply at this level of analysis, hydrologic modeling must indicate no adverse impact due to coincidental peaking effects. For purposes of this policy, "no adverse impact" shall mean that the developed site hydrograph peak is less than, and the inflection point occurs before, the peak of the upstream hydrograph OR that it can be demonstrated that on-site detention would exacerbate downstream impacts. If compliance cannot be demonstrated, proceed to Level 2.
   2.2. Level 2 Analysis
      2.2.1. The Level 2 Analysis combines field measurement data with hydraulic modeling of structures, channels, etc. using an expanded hydrologic model.
      2.2.2. Limit of the study shall be the point downstream where the site is 10% of the total contributing drainage area. Points of Analysis

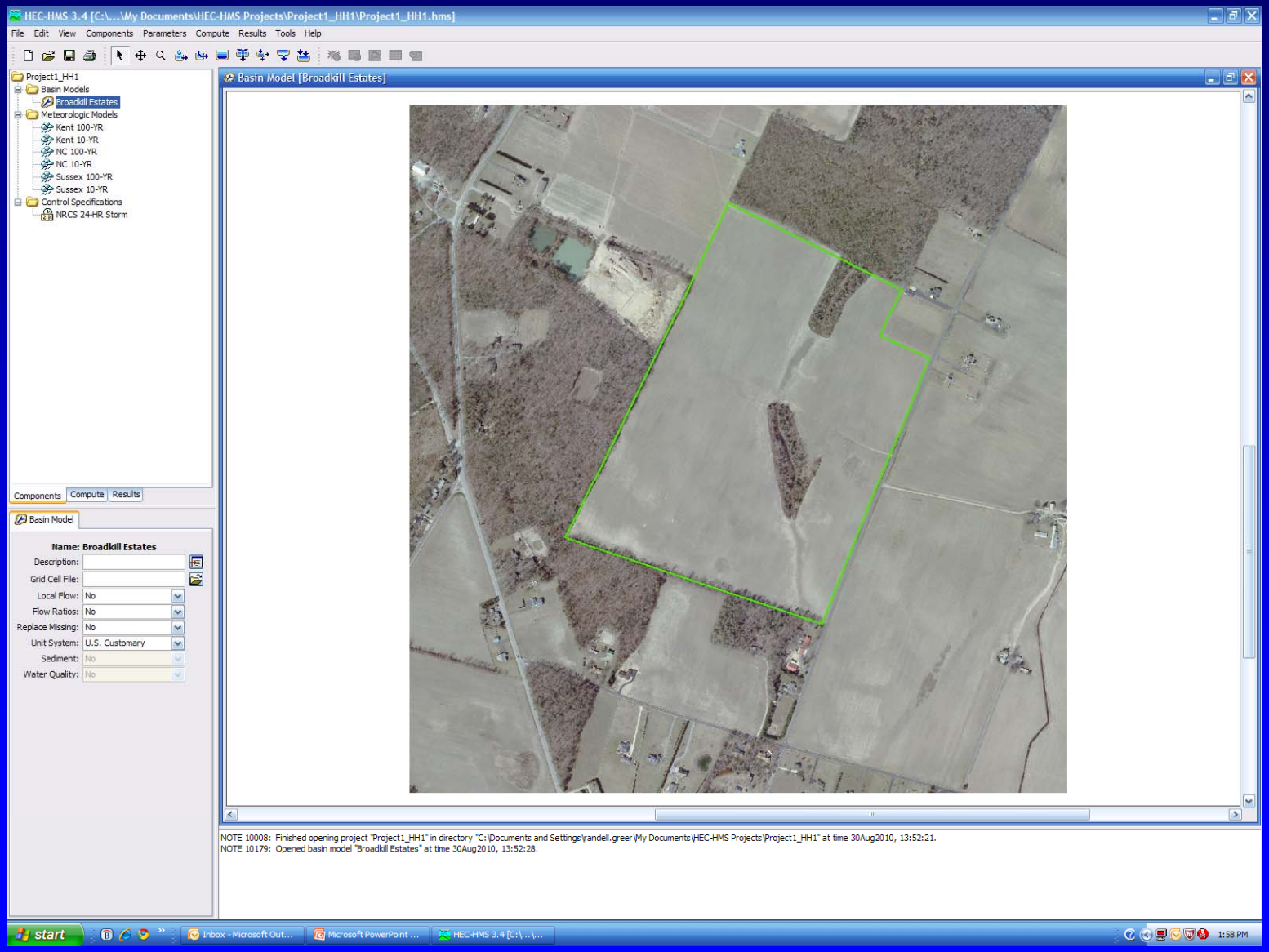
Example: Level 1 H&H Analysis



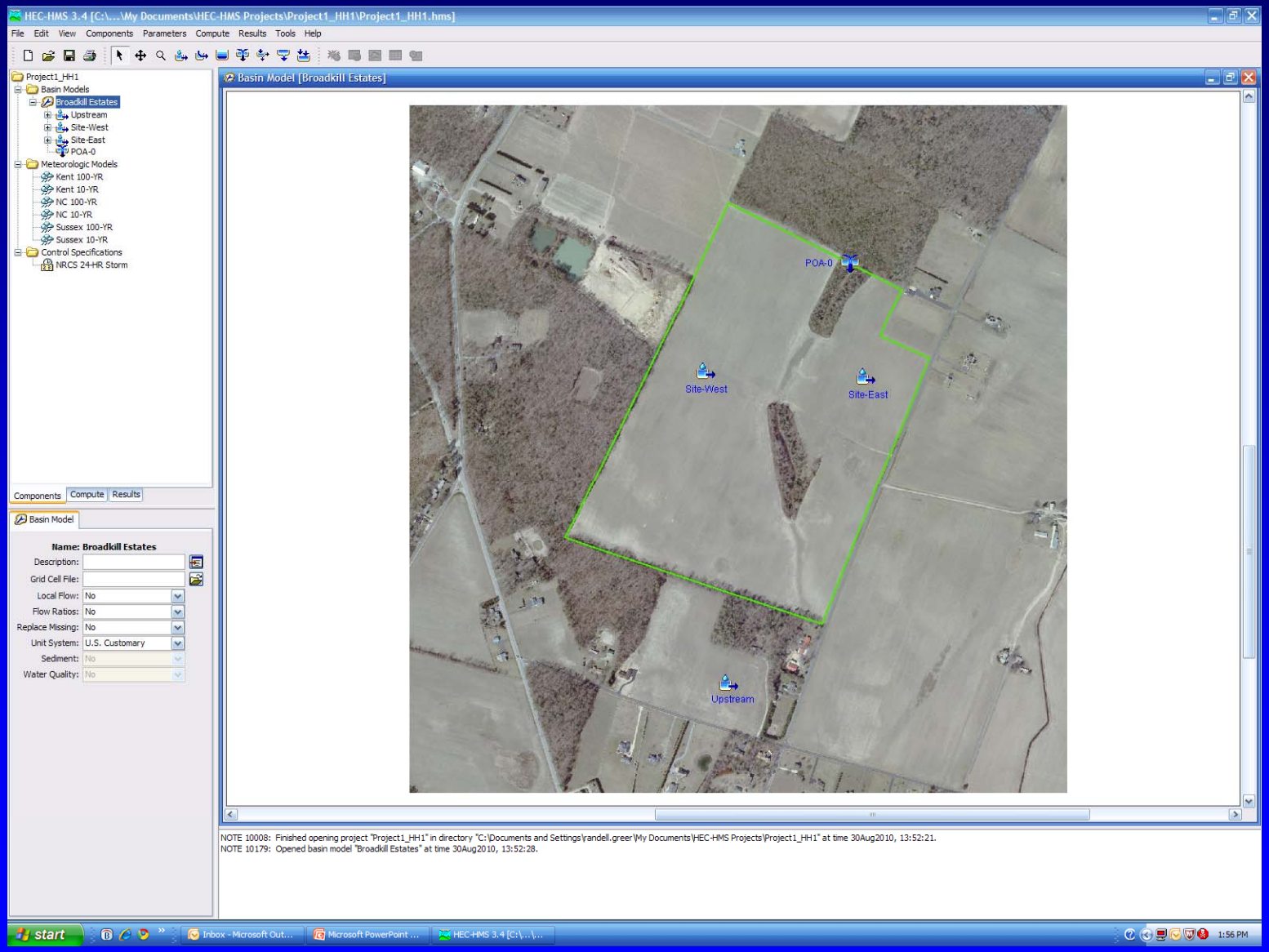
Example: Level 1 H&H Analysis



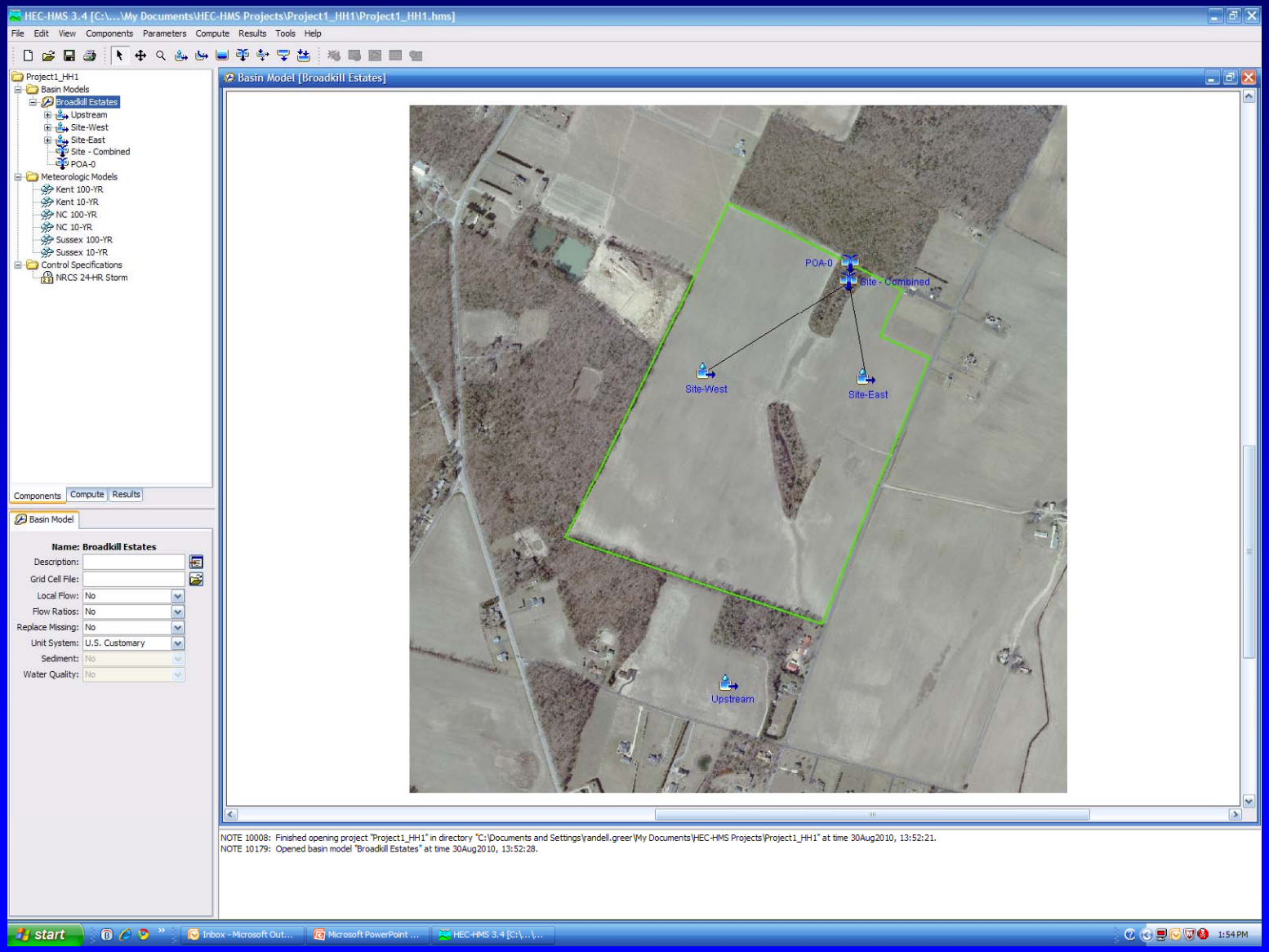
HEC-HMS Hydrologic Model



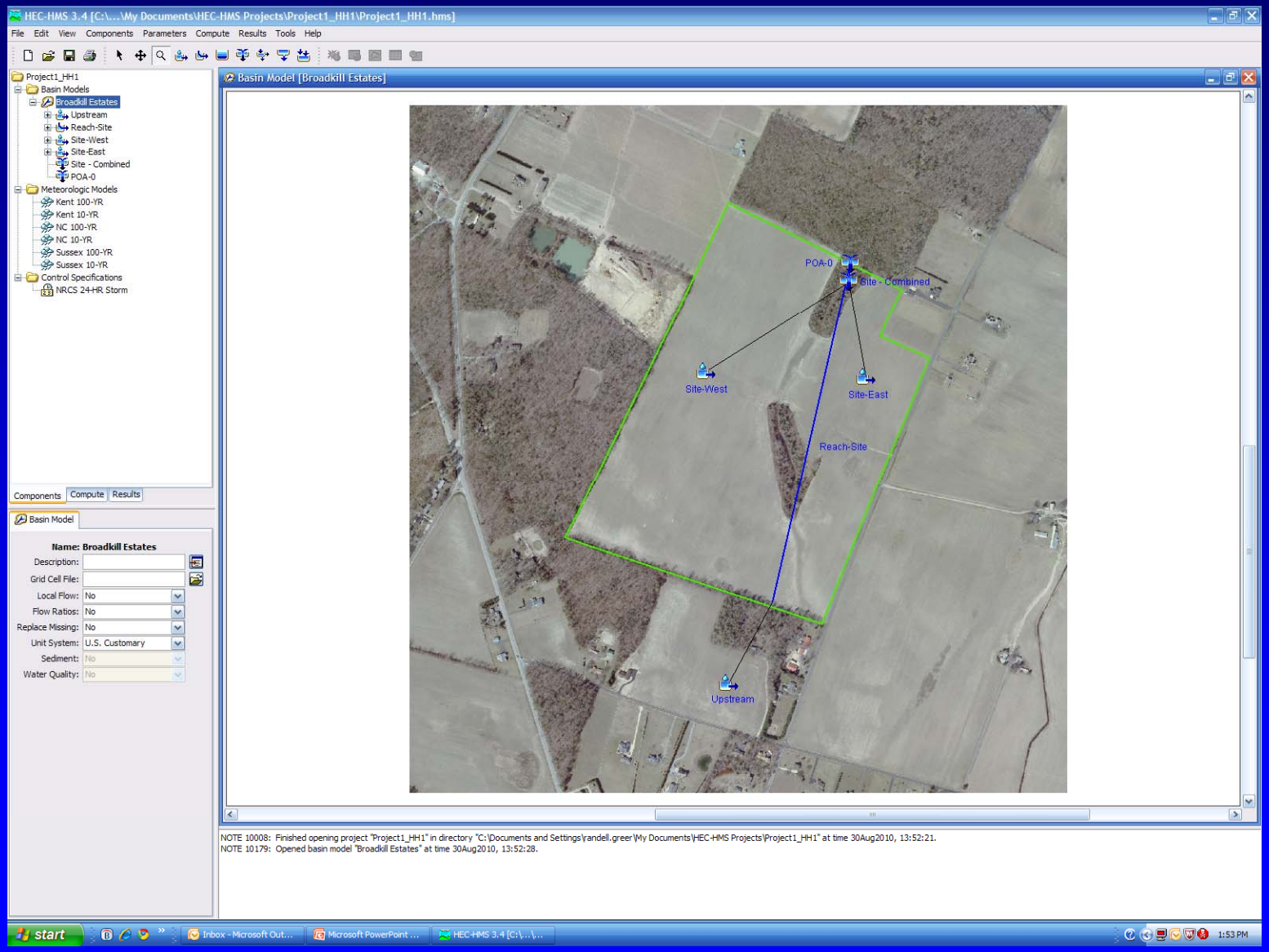
HEC-HMS Hydrologic Model



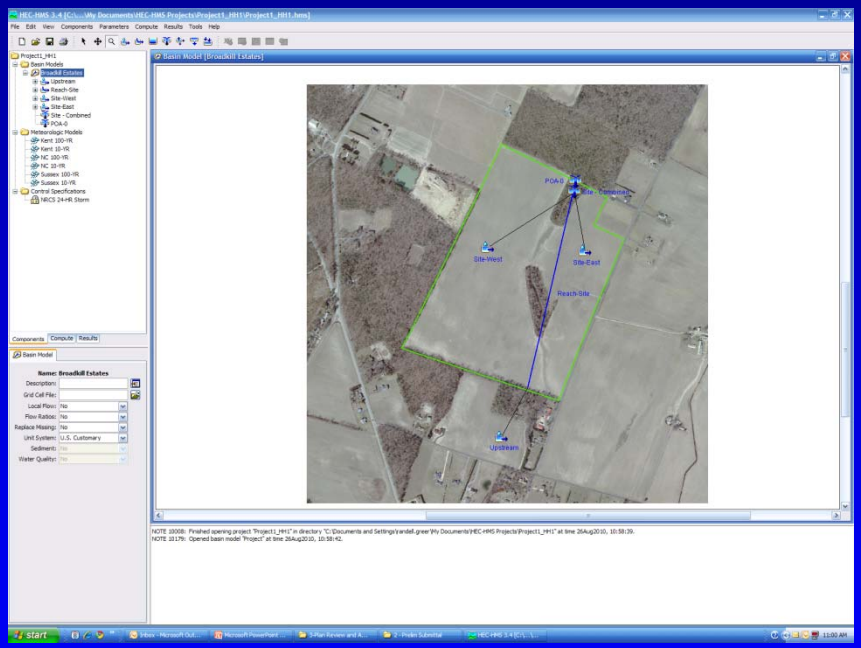
HEC-HMS Hydrologic Model



HEC-HMS Hydrologic Model

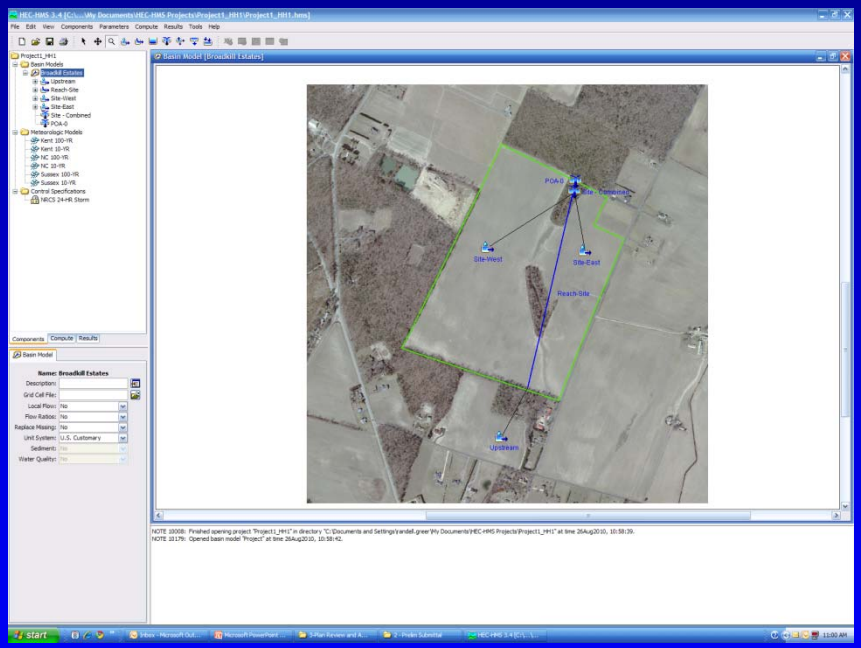


Level 1 H&H Analysis
Hec-HMS Input Data



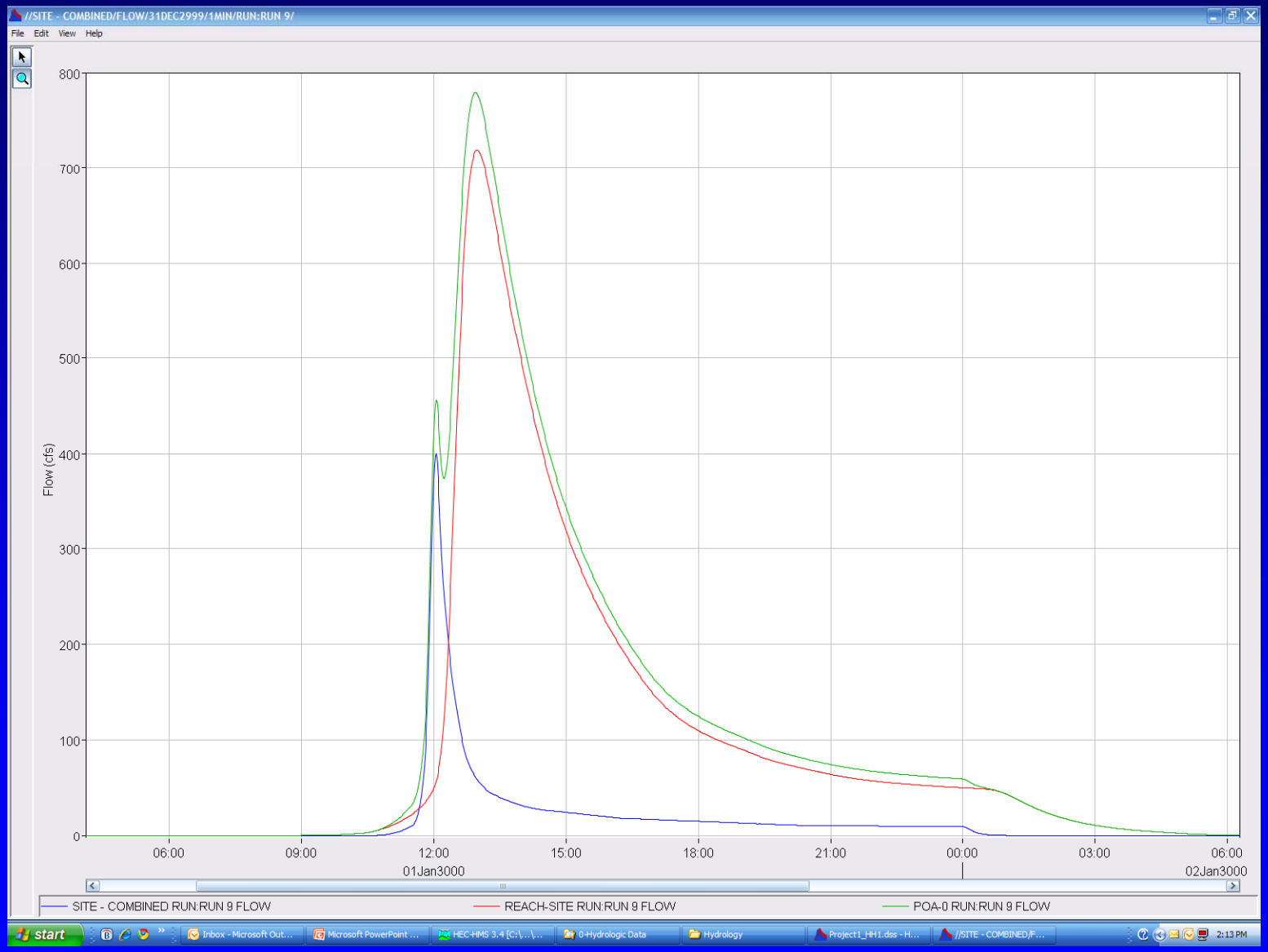
- Site – West
  - Area: 0.14216 mi^2
  - RCN: 51
  - Lag: 7.2 min.
- Site – East
  - Area: 0.06547 mi^2
  - RCN: 51
  - Lag: 7.2 min.

Level 1 H&H Analysis
Hec-HMS Input Data (*cont.*)



- Upstream
  - Area: 0.84688 mi^2
  - RCN: 63
  - Lag: 43 min.
- Reach - Site
  - Length: 2765 ft.
  - Slope: 0.002 ft/ft
  - Manning's "n": 0.06
  - Geometry: Trapezoid
    - BW = 10 ft.
    - Z = 10:1

Example: Level 1 H&H Analysis

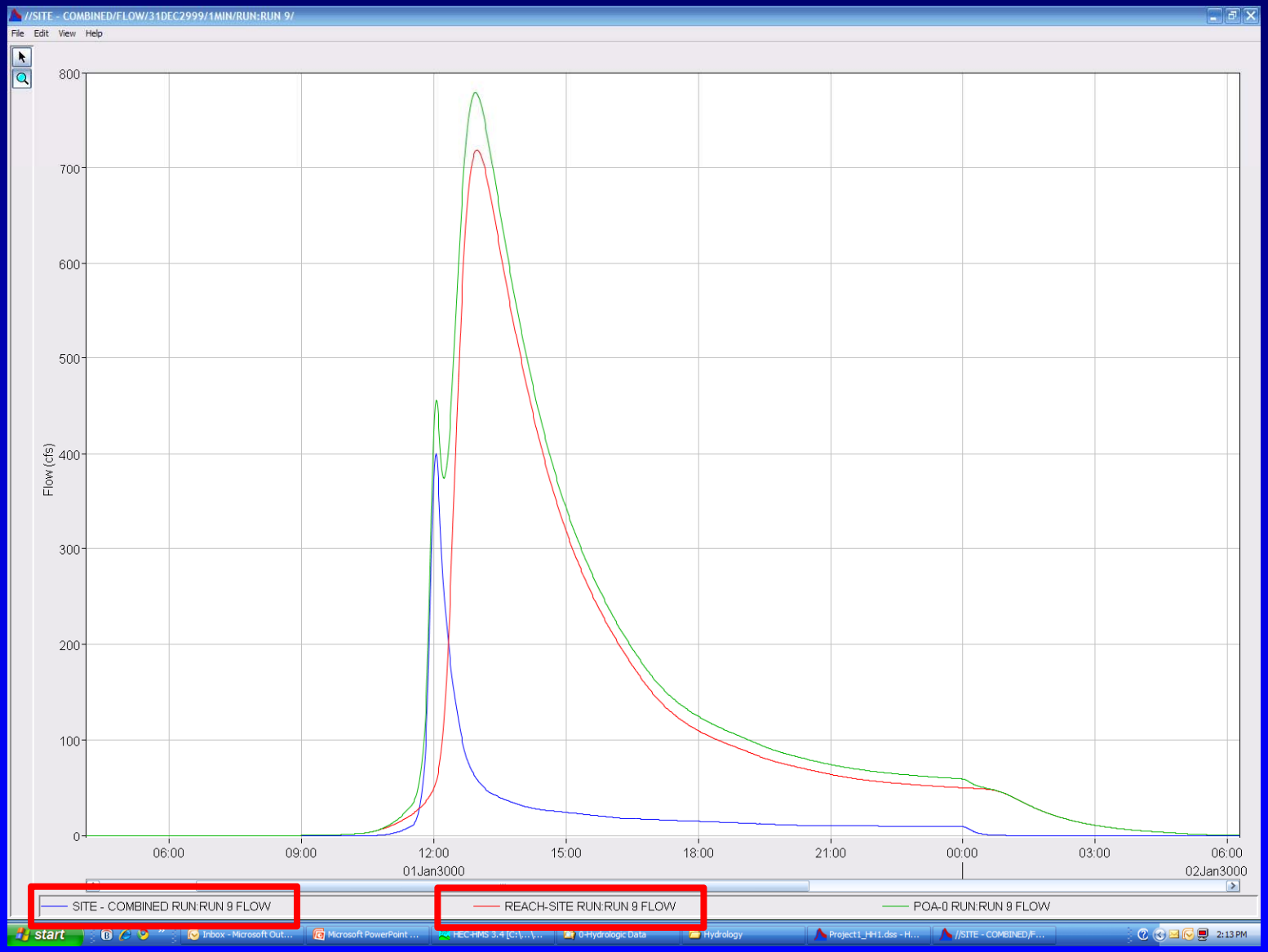


Example: Level 1 H&H Analysis

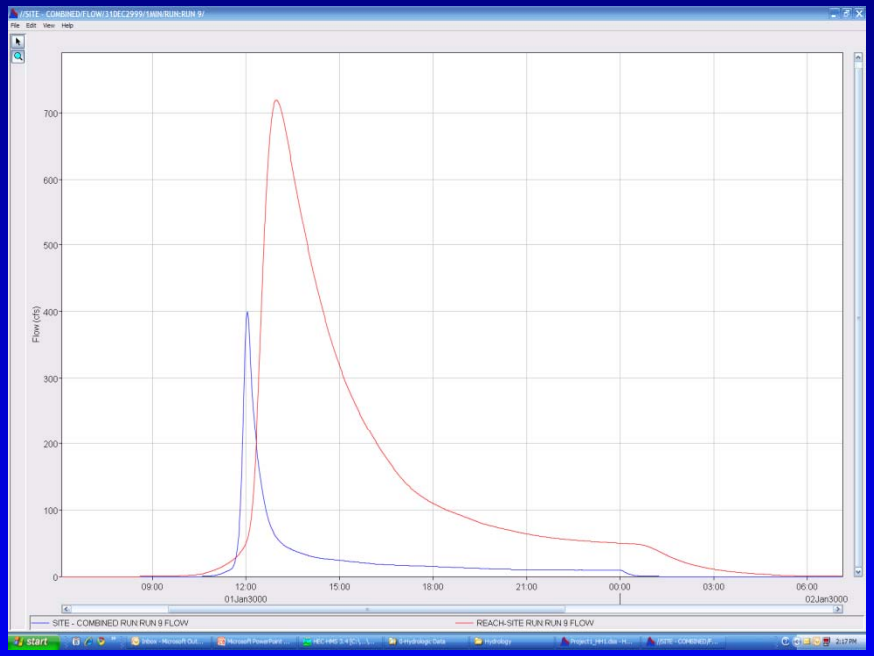
Procedure for Conducting Hydrologic & Hydraulic Analyses for Preliminary Sediment & Stormwater Plans, Sect. 2.1.3:

To comply at this level of analysis, hydrologic modeling must indicate no adverse impact due to coincidental peaking effects. For purposes of this policy, "no adverse impact" shall mean that the developed site hydrograph peak is less than, and the inflection point occurs before, the peak of the upstream hydrograph OR that it can be demonstrated that on-site detention would exacerbate downstream impacts.

Example: Level 1 H&H Analysis



Example: Level 1 H&H Analysis

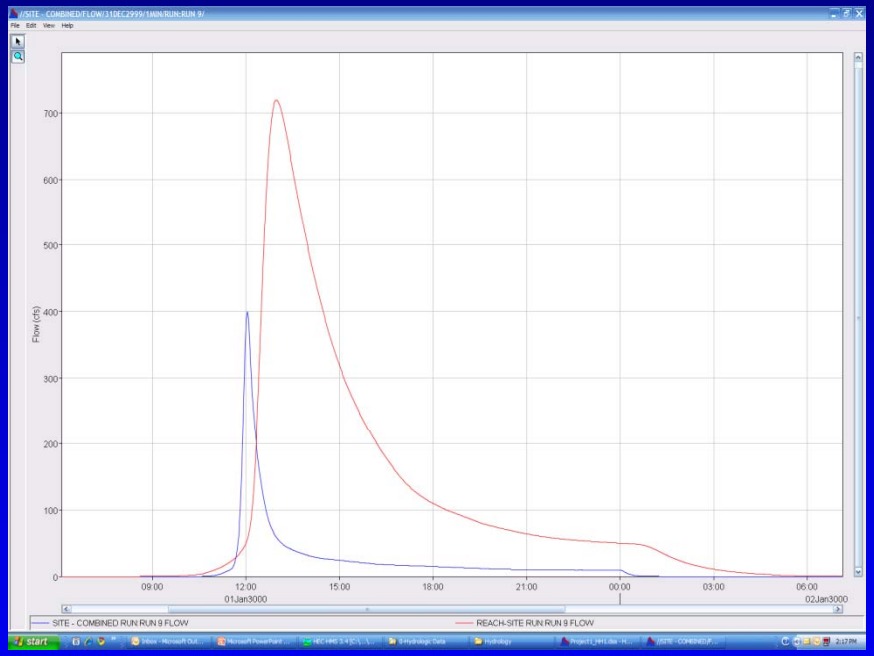


✓ Developed site hydrograph peak less than peak of upstream hydrograph

AND…

? Developed site hydrograph inflection point occurs before peak of the upstream hydrograph

Significance of the Inflection Point



- Volume @ T_p
  - Std. UH: 37.5%
  - DMV UH: 22%
- Volume @ T_{inf}
  - Std. UH: ~79%
  - DMV UH: ~63%

NRCS Hydrograph Theory

Appendix 16A — Elements of a Unit Hydrograph

The dimensionless curvilinear unit hydrograph (fig. 16–1) has 37.5 percent of the total volume in the rising side, which is represented by one unit of time and one unit of discharge. This dimensionless unit hydrograph also can be represented by an equivalent triangular hydrograph having the same units of time and discharge, thus having the same percent of volume in the rising side of the triangle (fig. 16A–1). This allows the base of the triangle to be solved in relation to the time to peak using the geometry of triangles. Solving for the base length of the triangle, if one unit of time T_p equals 0.375 per cent of volume:

$$T_b = \frac{1.00}{.375} = 2.67 \text{ units of time}$$

$$T_r = T_b - T_p = 1.67 \text{ units of time or } 1.67\,T_p$$

where:

T_b = time from beginning to end of the triangular hydrograph

T_r = time from the peak to the end of the triangular hydrograph

T_p = time from the beginning of the triangular hydrograph to its peak

These relationships are useful in developing the peak rate equation for use with the dimensionless unit hydrograph.

Peak rate equation

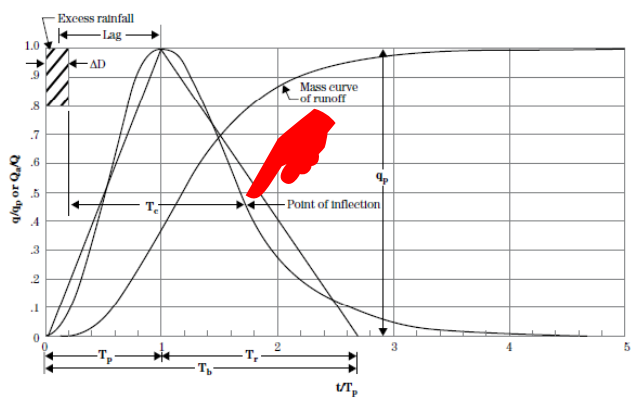
From figure 16A–1 the total volume under the triangular unit hydrograph is:

$$Q = \frac{q_p T_p}{2} + \frac{q_p T_r}{2} = \frac{q_p}{2}\left(T_p + T_r\right) \qquad [16A–1]$$

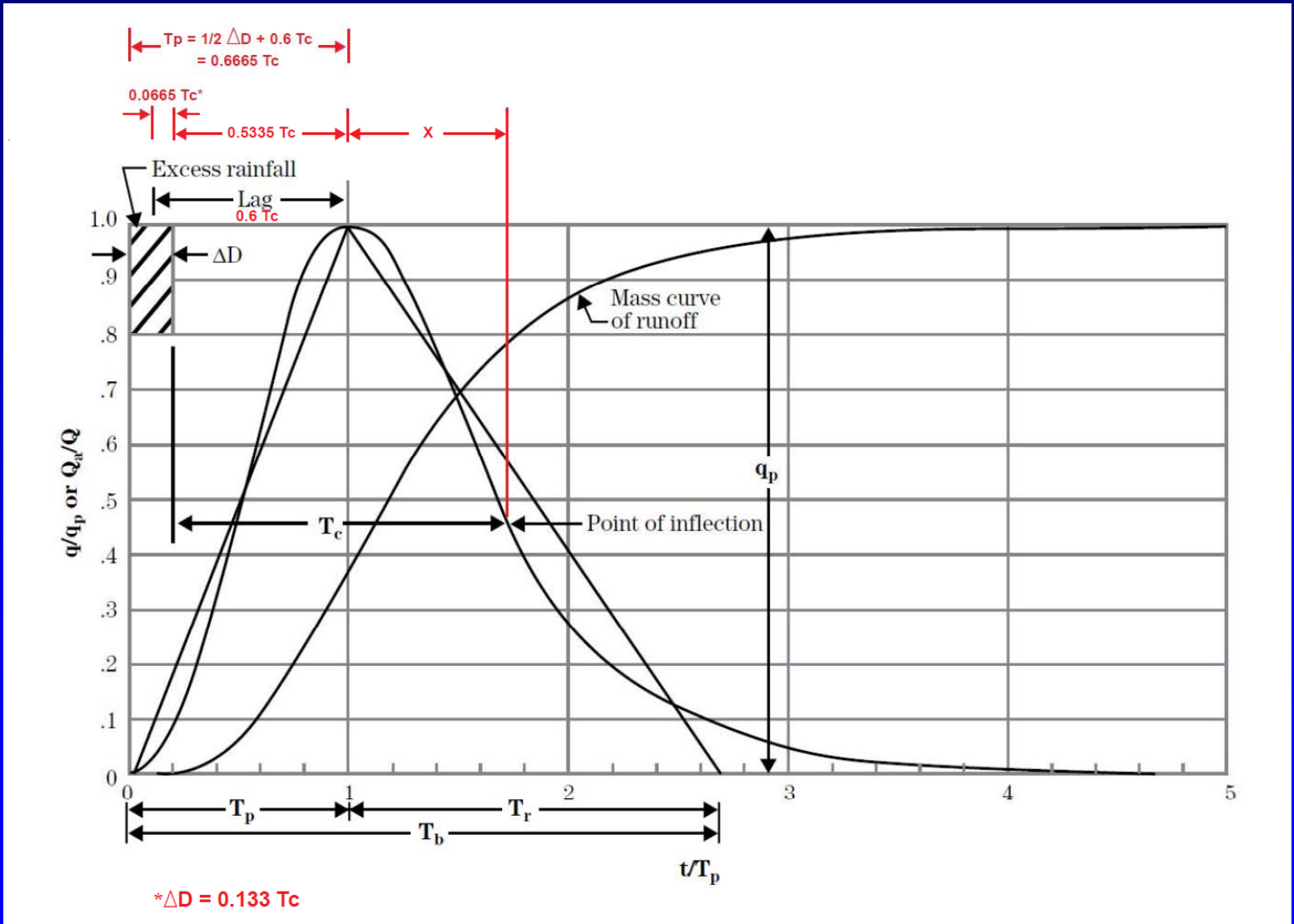
With Q in inches and T in hours, solve for peak rate q_p in inches per hour:

$$q_p = \frac{2Q}{T_p + T_r} \qquad [16A–2]$$

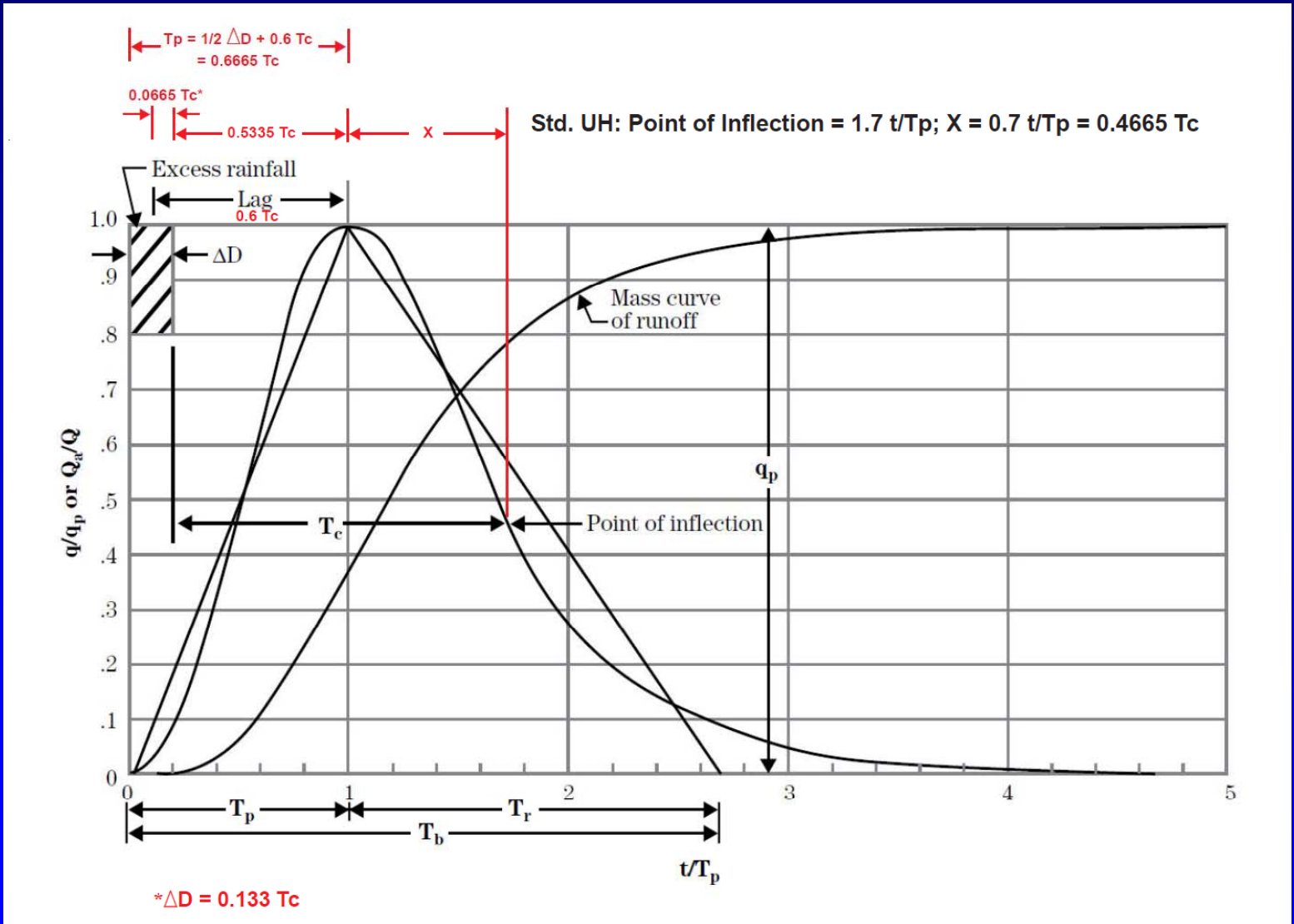
Figure 16A–1 Dimensionless curvilinear unit hydrograph and equivalent triangular hydrograph



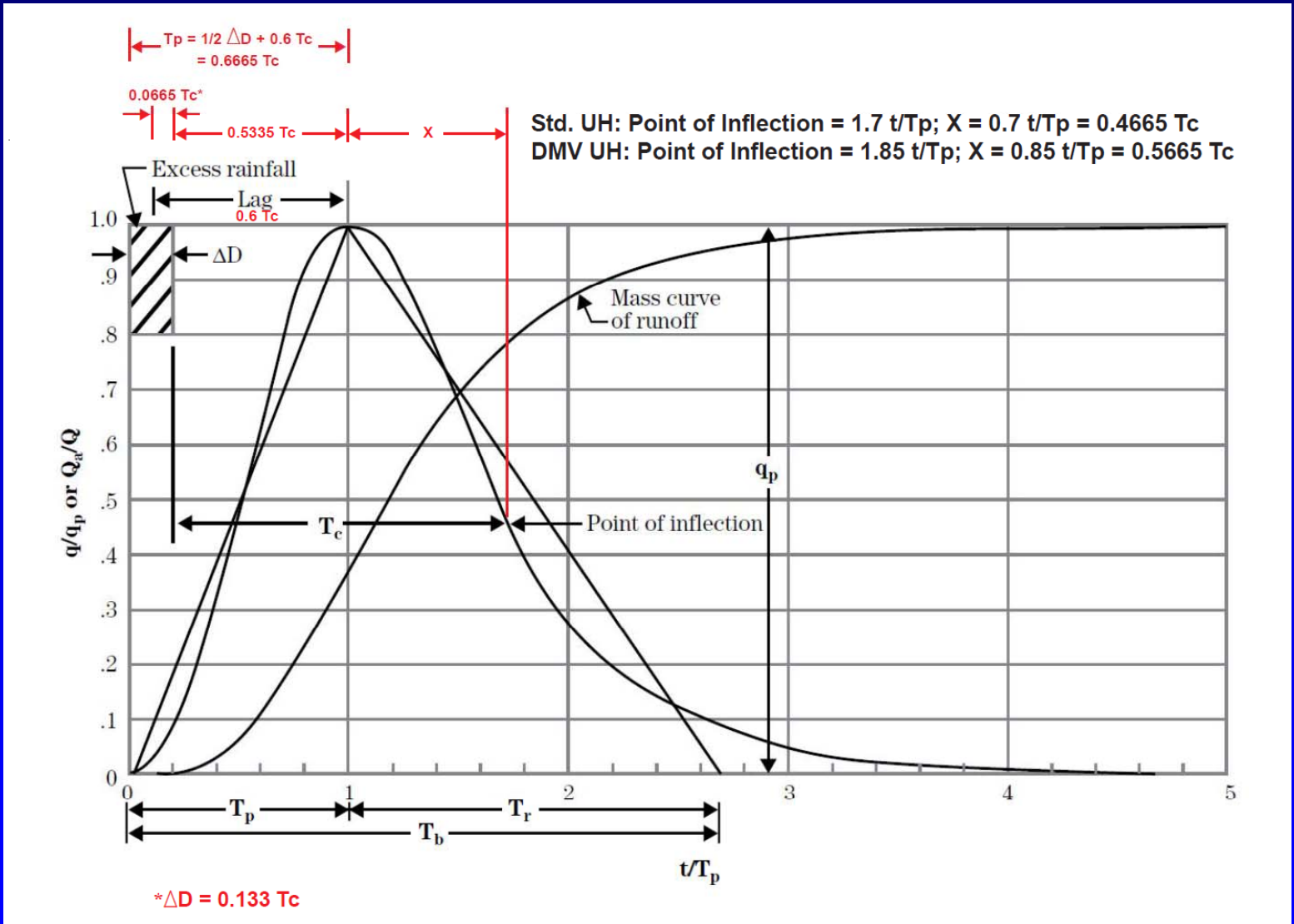
NRCS Hydrograph Theory



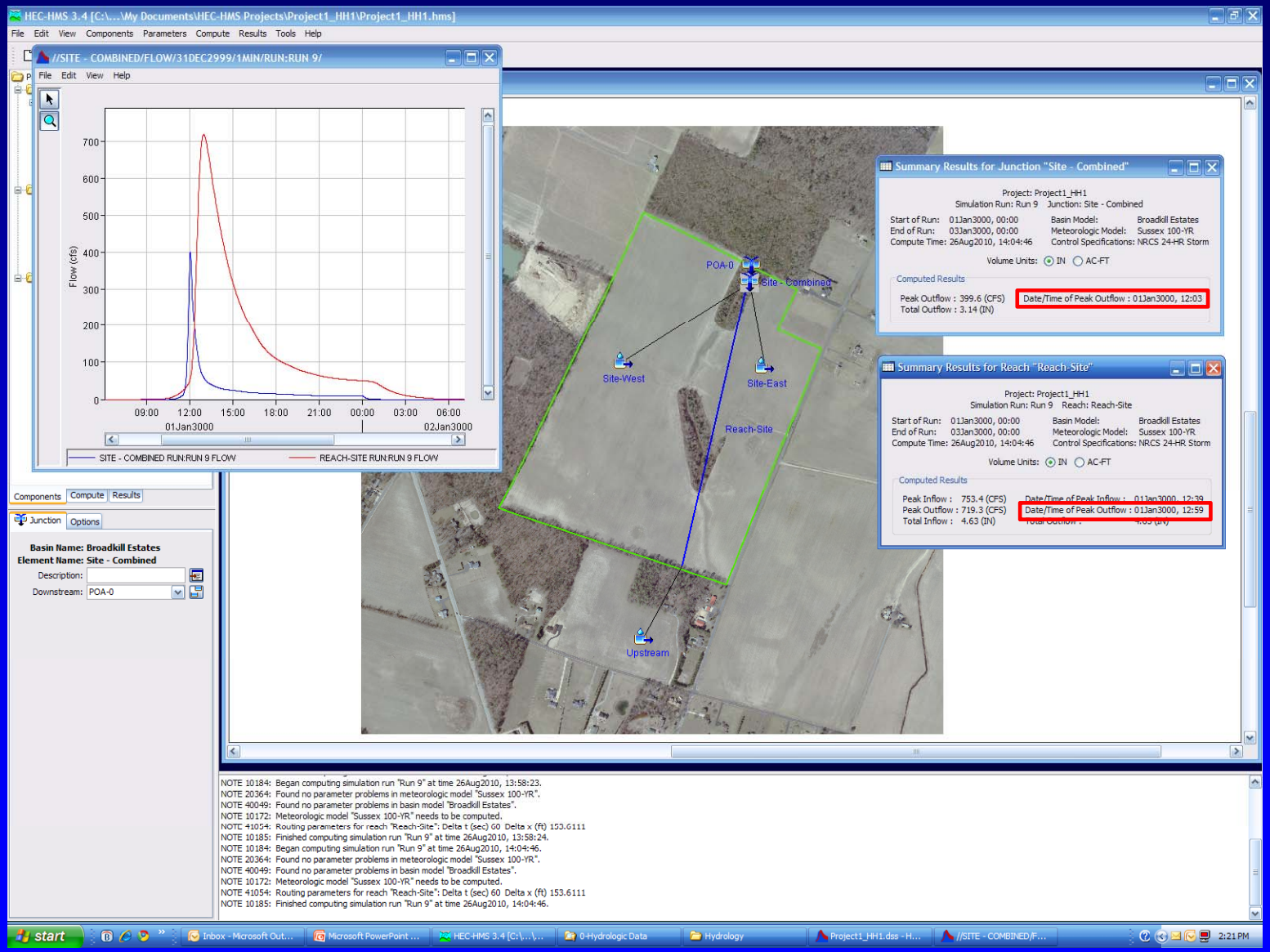
NRCS Hydrograph Theory



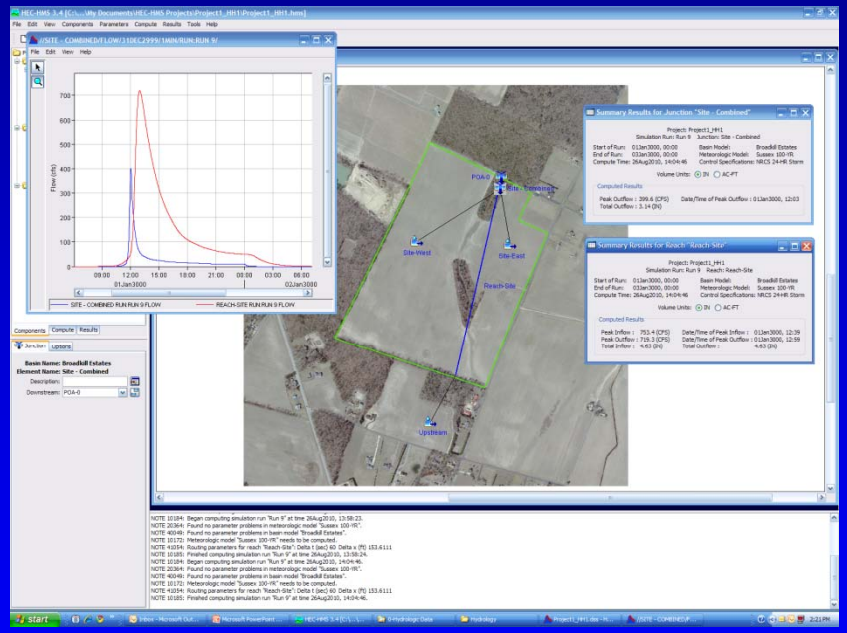
NRCS Hydrograph Theory



HEC-HMS Hydrologic Model



HEC-HMS Hydrologic Model



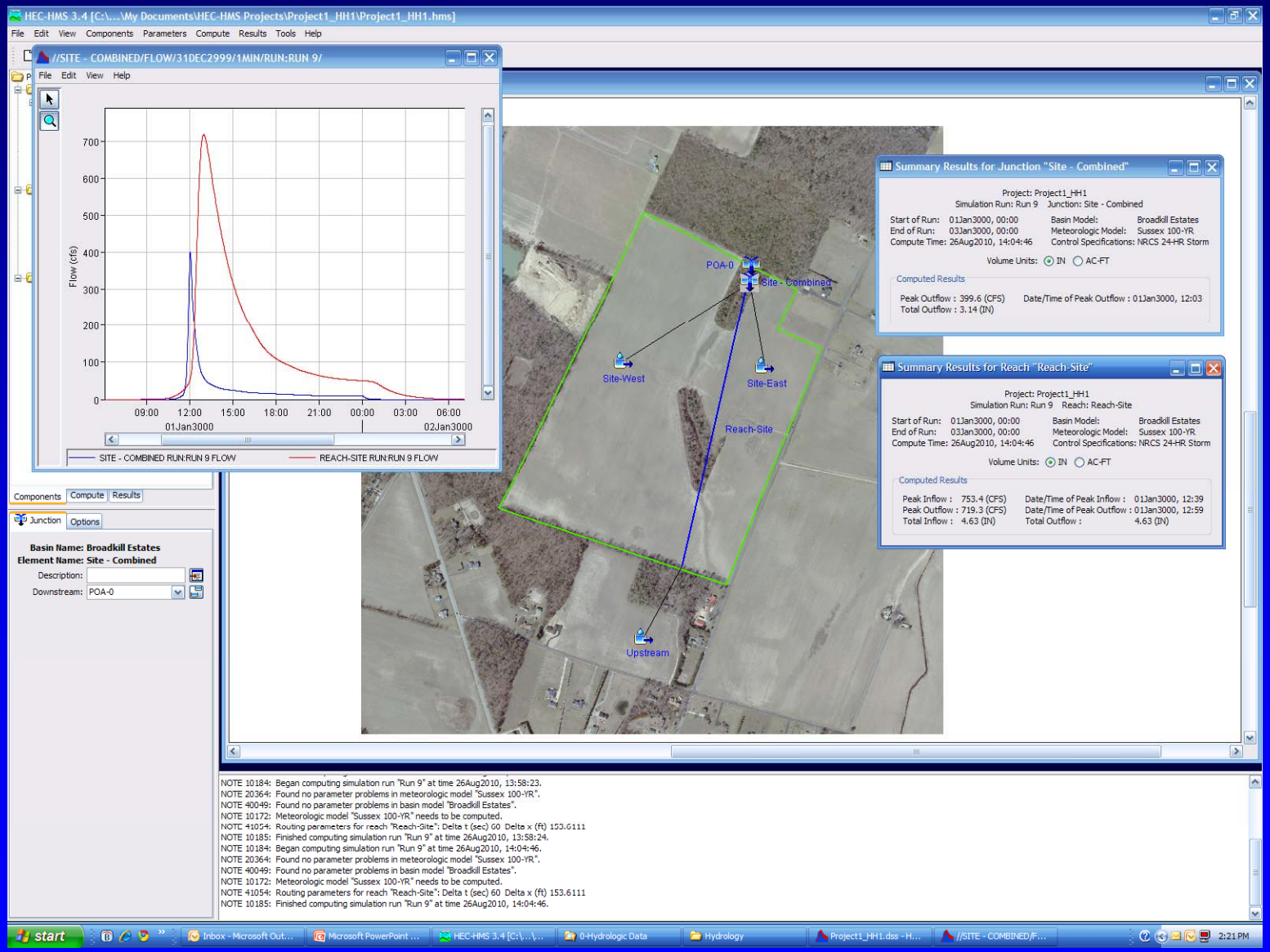
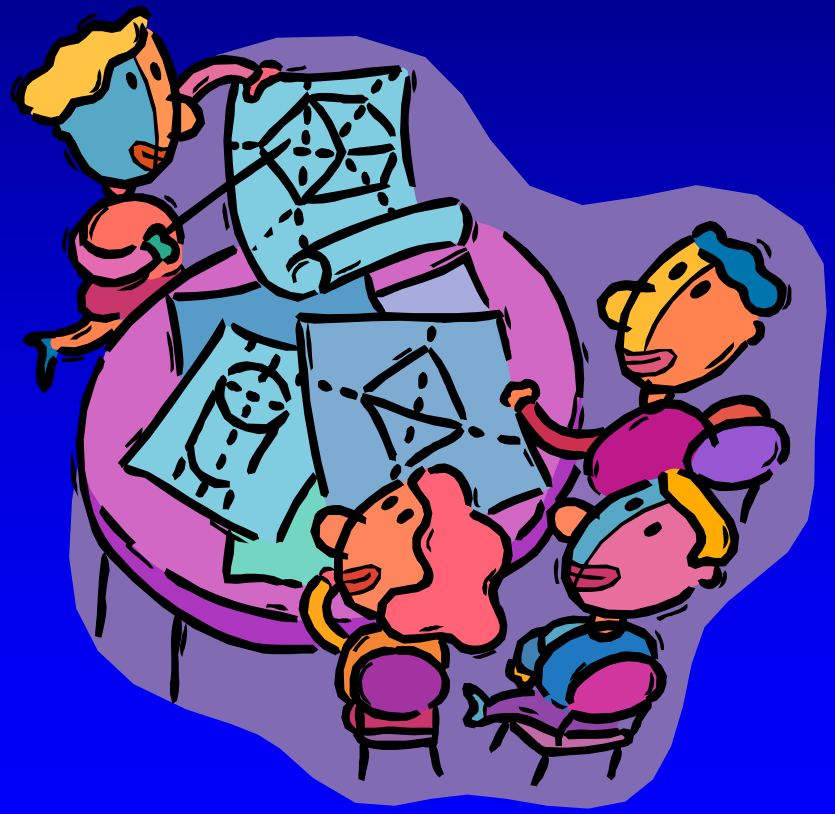
- Site – Combined
  - T_p = 12:03
  - T_c = 0.2 hr = 12 min
  - $T_{inf} = T_p + 0.5665T_c$
    $= T_p + 7$ min
    = 12:10
- Reach – Site
  - T_p = 12:59

✓ Site T_{inf} < Reach T_p

Summary: Quantity Mgt. Compliance

- Conveyance (Cv)
  - ✓ Compliance achieved based on unit discharge analysis
- Flooding (Fv)
  - ✓ Compliance achieved based on Level 1 H&H analysis

Questions???


HEC-HMS 3.4 [C:\...\My Documents\HEC-HMS Projects\Project1_HH1\Project1_HH1.hms]
File Edit View Components Parameters Compute Results Tools Help
//SITE - COMBINED/FLOW/31DEC2999/1MIN/RUN:RUN 9/
Flow (cfs)
01Jan3000
02Jan3000
SITE - COMBINED RUN:RUN 9 FLOW
REACH-SITE RUN:RUN 9 FLOW
Basin Name: Broadkill Estates
Element Name: Site - Combined
Downstream: POA-0
POA-0
Site - Combined
Site-West
Site-East
Reach-Site
Upstream
Summary Results for Junction "Site - Combined"
Project: Project1_HH1
Simulation Run: Run 9 Junction: Site - Combined
Start of Run: 01Jan3000, 00:00
End of Run: 03Jan3000, 00:00
Compute Time: 26Aug2010, 14:04:46
Basin Model: Broadkill Estates
Meteorologic Model: Sussex 100-YR
Control Specifications: NRCS 24-HR Storm
Volume Units: IN AC-FT
Computed Results
Peak Outflow : 399.6 (CFS)
Total Outflow : 3.14 (IN)
Date/Time of Peak Outflow : 01Jan3000, 12:03
Summary Results for Reach "Reach-Site"
Project: Project1_HH1
Simulation Run: Run 9 Reach: Reach-Site
Start of Run: 01Jan3000, 00:00
End of Run: 03Jan3000, 00:00
Compute Time: 26Aug2010, 14:04:46
Basin Model: Broadkill Estates
Meteorologic Model: Sussex 100-YR
Control Specifications: NRCS 24-HR Storm
Volume Units: IN AC-FT
Computed Results
Peak Inflow : 753.4 (CFS)
Peak Outflow : 719.3 (CFS)
Total Inflow : 4.63 (IN)
Date/Time of Peak Inflow : 01Jan3000, 12:39
Date/Time of Peak Outflow : 01Jan3000, 12:59
Total Outflow : 4.63 (IN)
NOTE 10184: Began computing simulation run "Run 9" at time 26Aug2010, 13:58:23.
NOTE 20364: Found no parameter problems in meteorologic model "Sussex 100-YR".
NOTE 40049: Found no parameter problems in basin model "Broadkill Estates".
NOTE 10172: Meteorologic model "Sussex 100-YR" needs to be computed.
NOTE 41054: Routing parameters for reach "Reach-Site": Delta t (sec) 60 Delta x (ft) 153.6111
NOTE 10185: Finished computing simulation run "Run 9" at time 26Aug2010, 13:58:24.
NOTE 10184: Began computing simulation run "Run 9" at time 26Aug2010, 14:04:46.
NOTE 20364: Found no parameter problems in meteorologic model "Sussex 100-YR".
NOTE 40049: Found no parameter problems in basin model "Broadkill Estates".
NOTE 10172: Meteorologic model "Sussex 100-YR" needs to be computed.
NOTE 41054: Routing parameters for reach "Reach-Site": Delta t (sec) 60 Delta x (ft) 153.6111
NOTE 10185: Finished computing simulation run "Run 9" at time 26Aug2010, 14:04:46.

Discussion