WOOLPERT

DESIGN | GEOSPATIAL | INFRASTRUCTURE

STORM WATER MANAGEMENT CALCULATIONS

TXRH WEST CHESTER
WEST CHESTER TOWNSHIP, OH

Woolpert Project No. 75566

September 2016

Methodology

Before analysis began, the composite curve numbers were calculated for the proposed and existing conditions. These calculations can be found on page 3. Hydrologic soil group C was determined to be the dominant condition for the site, and was used to determine the composite CN values. The NRCS soils map illustrating the extents of each soil group on-site can be found on pages 4 through 7.

As described in the Butler County Modified Critical Storm Method, WinTR-20 software was used to determine the total runoff from a 1 (one) year frequency, 24 (twenty-four) hour storm event for the development area before and after development. The output data for both these conditions is included in its entirety on pages 8 through 13. The amount of runoff for the existing and proposed conditions is 0.680 and 1.077 inches, respectively. This results in a runoff volume increase of approximately 58%. Per Table D-11 of Appendix D, the critical storm to be used for peak rate control is the 10-year 24-hour storm.

Included on pages 14 through 16 are the calculations for the proposed detention basin volume and total stormwater pipe and structure storage. Total proposed stormwater storage is 0.249 acre-feet. Included on page 17 are the proposed release rates corresponding to water elevation.

Next, the 10-year 24-hour storm was modeled using WinTR-20. On pages 18 through 23, the output code for this simulation is included in its entirety. For the required critical storm, a runoff amount of 2.477 inches and a peak flow rate of 16.8 cfs is established. On page 3 of the 10-year storm analysis, the peak elevation at Reach 1 is shown to be 865.26. This is significantly lower than the expected HWL of 866.00, so the proposed stormwater storage volume of 0.249 acre-feet is expected to be satisfactory.

Composite Curve Number Calculations

TXRH West Chester (EXISTING CONDITION)					
TRIBUTARY AREAS					
Tributary Area:	4.358		acres		
RUNOFF COEFFICIENT					
Impervious Area =	23,718	x	98.00	=	2324364
Pervious Area=	166,073	x	86.00	=	14282278
			Total=		16606642
			C:		87

TXRH West Chester (PROPOSED CONDTION)					
TRIBUTARY AREAS					
Tributary Area:	4.358		acres		
RUNOFF COEFFICIENT					
Impervious Area =	154,567	x	98.00	=	15147566
Pervious Area=	35,224	x	74.00	=	2606576
			Total=		17754142
			C:		94

Hydrologic Soil Group—Butler County, Ohio

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Butler County, Ohio
Survey Area Data: Version 14, Sep 26, 2015

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Aug 26, 2014—Oct 26, 2014

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Butler County, Ohio (OH017)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
DaB	Dana silt loam, 2 to 6 percent slopes	B	0.3	6.2%
Ud	Udorthents		0.4	10.7%
XeB	Xenia silt loam, Southern Ohio Till Plain, 2 to 6 percent slopes	C	3.5	83.1%
Totals for Area of Interest			**4.2**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: *None Specified*

Tie-break Rule: Higher

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WinTR-20 Printed Page File      Beginning of Input Data List
C:\Users\Iwaniuk\Desktop\TXRH West Chester__EXISTING.inp

WinTR-20: version 3.10                  0         0                   0
TX Roadhouse Ex

SUB-AREA:
         Area 1     Outlet              0.0068078 87.       .25       YY  Y


STORM ANALYSIS:
         1 year 24                      2.33      TYPE II   2
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WinTR-20 Printed Page File      End of Input Data List

                                TX Roadhouse Ex

                          Name of printed page file:
           C:\Users\Iwaniuk\Desktop\TXRH West Chester__EXISTING.out

                                    STORM 1 year 24
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Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
Area 1	0.007		0.680		12.04	6.3	930.45

Line Start Time (hr)	Flow Values @ time increment of 0.016 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
11.616	0.0	0.5	0.6	0.7	0.7	0.8	0.9
11.726	1.0	1.2	1.3	1.5	1.7	1.8	2.1
11.837	2.3	2.6	2.9	3.2	3.6	4.0	4.5
11.948	4.9	5.3	5.6	5.9	6.1	6.3	6.3
12.058	6.3	6.2	6.0	5.7	5.3	5.0	4.6
12.169	4.2	3.8	3.5	3.1	2.8	2.6	2.4
12.279	2.2	2.0	1.9	1.8	1.7	1.6	1.5
12.390	1.4	1.4	1.3	1.3	1.2	1.2	1.1
12.500	1.1	1.0	1.0	1.0	0.9	0.9	0.9
12.611	0.8	0.8	0.8	0.8	0.7	0.7	0.7
12.721	0.7	0.7	0.7	0.7	0.6	0.6	0.6
12.832	0.6	0.6	0.6	0.6	0.6	0.6	0.6
12.942	0.6	0.6	0.6	0.5	0.5	0.5	0.5
13.053	0.5	0.5	0.5	0.5	0.5	0.0	

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
OUTLET	0.007		0.678		12.04	6.3	930.45

Line Start Time	Flow Values @ time increment of 0.016 hr

(hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
11.616	0.0	0.5	0.6	0.7	0.7	0.8	0.9
11.726	1.0	1.2	1.3	1.5	1.7	1.8	2.1
11.837	2.3	2.6	2.9	3.2	3.6	4.0	4.5
11.948	4.9	5.3	5.6	5.9	6.1	6.3	6.3
12.058	6.3	6.2	6.0	5.7	5.3	5.0	4.6
12.169	4.2	3.8	3.5	3.1	2.8	2.6	2.4
12.279	2.2	2.0	1.9	1.8	1.7	1.6	1.5
12.390	1.4	1.4	1.3	1.3	1.2	1.2	1.1
12.500	1.1	1.0	1.0	1.0	0.9	0.9	0.9
12.611	0.8	0.8	0.8	0.8	0.7	0.7	0.7
12.721	0.7	0.7	0.7	0.7	0.6	0.6	0.6
12.832	0.6	0.6	0.6	0.6	0.6	0.6	0.6
12.942	0.6	0.6	0.6	0.5	0.5	0.5	0.5
13.053	0.5	0.5	0.5	0.5	0.5	0.0	

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WinTR-20 Printed Page File      Beginning of Input Data List
C:\Users\Iwaniuk\Desktop\TXRH West Chester__PROPOSED.inp

WinTR-20: version 3.10                  0         0                   0
TX Roadhouse West Chester PROP

SUB-AREA:
         Area 1    Outlet               0.0068078 94.       .25       YY  Y


STORM ANALYSIS:
         1 year 24h                     2.33      TYPE II   2
```

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WinTR-20 Printed Page File      End of Input Data List

                        TX Roadhouse West Chester PROP

                          Name of printed page file:
              C:\Users\Iwaniuk\Desktop\TXRH West Chester__PROPOSED.out

                                        STORM 1 year 24h

Area or     Drainage  Rain Gage     Runoff    ------------ Peak Flow ------------
 Reach        Area       ID or      Amount   Elevation    Time       Rate       Rate
Identifier  (sq mi)    Location     (in)       (ft)       (hr)      (cfs)      (csm)

Area 1        0.007                 1.077                12.03       9.0    1319.73

   Line
Start Time   ------------ Flow Values @ time increment of  0.016 hr ------------
      (hr)      (cfs)      (cfs)      (cfs)      (cfs)      (cfs)      (cfs)      (cfs)

    11.211        0.0        0.5        0.5        0.5        0.5        0.5        0.6
    11.322        0.6        0.6        0.6        0.6        0.6        0.6        0.6
    11.432        0.6        0.7        0.7        0.7        0.7        0.7        0.7
    11.543        0.8        0.8        0.8        0.9        0.9        1.0        1.1
    11.653        1.2        1.3        1.5        1.6        1.8        2.0        2.3
    11.764        2.5        2.8        3.0        3.4        3.7        4.1        4.5
    11.874        4.9        5.4        6.0        6.5        7.1        7.6        8.0
    11.985        8.4        8.7        8.9        9.0        8.9        8.8        8.5
    12.095        8.1        7.7        7.1        6.6        6.0        5.5        4.9
    12.206        4.5        4.0        3.6        3.3        3.1        2.8        2.6
    12.316        2.4        2.3        2.1        2.0        1.9        1.8        1.7
    12.427        1.6        1.6        1.5        1.4        1.4        1.3        1.3
    12.538        1.2        1.2        1.1        1.1        1.1        1.0        1.0
    12.648        1.0        0.9        0.9        0.9        0.9        0.9        0.8
    12.759        0.8        0.8        0.8        0.8        0.8        0.8        0.8
    12.869        0.7        0.7        0.7        0.7        0.7        0.7        0.7
    12.980        0.7        0.7        0.7        0.7        0.7        0.6        0.6
    13.090        0.6        0.6        0.6        0.6        0.6        0.6        0.6
    13.201        0.6        0.6        0.6        0.6        0.6        0.6        0.6
    13.311        0.5        0.5        0.5        0.5        0.5        0.5        0.5
    13.422        0.5        0.5        0.5        0.5        0.5        0.0

Area or     Drainage  Rain Gage     Runoff    ------------ Peak Flow ------------
```

Reach Identifier	Area (sq mi)	ID or Location	Amount (in)	Elevation (ft)	Time (hr)	Rate (cfs)	Rate (csm)
OUTLET	0.007		1.075		12.03	9.0	1319.73

Line Start Time (hr)	Flow Values @ time increment of 0.016 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
11.211	0.0	0.5	0.5	0.5	0.5	0.5	0.6
11.322	0.6	0.6	0.6	0.6	0.6	0.6	0.6
11.432	0.6	0.7	0.7	0.7	0.7	0.7	0.7
11.543	0.8	0.8	0.8	0.9	0.9	1.0	1.1
11.653	1.2	1.3	1.5	1.6	1.8	2.0	2.3
11.764	2.5	2.8	3.0	3.4	3.7	4.1	4.5
11.874	4.9	5.4	6.0	6.5	7.1	7.6	8.0
11.985	8.4	8.7	8.9	9.0	8.9	8.8	8.5
12.095	8.1	7.7	7.1	6.6	6.0	5.5	4.9

TX Roadhouse West Chester PROP

Line Start Time (hr)	Flow Values @ time increment of 0.016 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
12.206	4.5	4.0	3.6	3.3	3.1	2.8	2.6
12.316	2.4	2.3	2.1	2.0	1.9	1.8	1.7
12.427	1.6	1.6	1.5	1.4	1.4	1.3	1.3
12.538	1.2	1.2	1.1	1.1	1.1	1.0	1.0
12.648	1.0	0.9	0.9	0.9	0.9	0.9	0.8
12.759	0.8	0.8	0.8	0.8	0.8	0.8	0.8
12.869	0.7	0.7	0.7	0.7	0.7	0.7	0.7
12.980	0.7	0.7	0.7	0.7	0.7	0.6	0.6
13.090	0.6	0.6	0.6	0.6	0.6	0.6	0.6
13.201	0.6	0.6	0.6	0.6	0.6	0.6	0.6
13.311	0.5	0.5	0.5	0.5	0.5	0.5	0.5
13.422	0.5	0.5	0.5	0.5	0.5	0.0	

Detention Basin Storage (PROPOSED)

Surface Ponding
Volume = (1/3)*(EL2-EL1)*[A1+A2+sqrt(A1*A2)]

DETENTION AREA ELEVATION (ft)	AREA (SF)	INCREMENTAL (SF)	INCREMENTAL VOLUME (CF)	TOTAL VOLUME (CF)	TOTAL VOLUME (AC-FT)
862.67	0.00	0.00	0.00	0.000	0.000
863.00	1622.76	1622.76	178.50	178.504	0.004
864.00	2503.92	6142.43	2047.48	2225.981	0.051
865.00	3574.37	9069.93	3023.31	5249.293	0.121
866.00	4800.85	12517.68	4172.56	9421.854	0.216

PROPOSED DETENTION BASIN VOLUME =	**0.2163**	**AC-FT**
	9421.85	**CF**

STORMWATER STORAGE

Upstream	Downstream	Material	Diameter (in)	Length (ft)	Capacity (cf)	Capacity (ac-ft)
1.9	1.5	PVC	6	87	17.1	0.0004
1.8	1.7	RCP	12	25	19.7	0.0005
1.7	1.6	RCP	12	169	132.7	0.0030
1.6	1.5	RCP	12	63	49.5	0.0011
1.5	1.4	RCP	12	201	157.6	0.0036
1.4	1.3	RCP	12	247	193.7	0.0044
1.3	1.2	RCP	12	214	167.6	0.0038
1.2	1.1	RCP	12	254	199.6	0.0046
1.11	1.1	RCP	12	61	47.9	0.0011

Pipe total:	**985.55 CF**
	0.02 AC-FT

Structure #	Internal Diam (ft)	HWL or RIM	Invert	Depth (HWL-Invert)	Volume (CF)	Volume (Ac-Ft)
1.10	2	866	862.00	4.00	9.6	0.000
1.7	4	866	862.45	3.55	32.7	0.001
1.6	4	866	861.94	4.06	39.2	0.001
1.5	6	866	861.75	4.25	93.5	0.002
1.4	4	866	861.15	4.85	49.1	0.001
1.3	4	866	860.41	5.59	58.4	0.001
1.2	4	866	859.75	6.25	66.7	0.002
1.1	4	866	858.99	7.01	76.2	0.002

Structure Total:	**425.31 CF**
	0.01 AC-FT

PIPE + STR TOTAL:	**1410.86 CF**
	0.03 AC-FT

Summary

Pipe Storage	986 CF	0.02 AC-FT
Structure Storage	425 CF	0.01 AC-FT
Surface Storage	9,422 CF	0.22 AC-FT
TOTAL PROVIDED STORAGE	10,833 CF	0.249 AC-FT

Proposed Release Rate

Q. = (DIA/2)^2 x C x pi (2 x g x H)^0.5

g = 32.2 FT/S

DIA. = 12 IN

C = 0.6

OUTLET ELEVATION= 858.99 FEET

WATER ELEVATION	HEAD	DISCHARGE
866.00	6.51	**9.65**
865.00	5.51	**8.88**
864.00	4.51	**8.03**
863.00	3.51	**7.08**

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WinTR-20 Printed Page File      Beginning of Input Data List
C:\Users\Iwaniuk\Desktop\TXRH West Chester__PROPOSED__10yr storm.inp

WinTR-20: version 3.10                  0         0                    0
TX Roadhouse - Proposed Conditions - 10year storm

SUB-AREA:
          Area 1    Reach 1             .0068078  94.       .25        YY  Y


STREAM REACH:
          Reach 1   Outlet              Pond                           YY  Y


STORM ANALYSIS:
          10yr 24hr                     3.99      TYPE II   2


STRUCTURE RATING:
          Pond      862.67
                    862.67    0.        .00001
                    863.      7.08      .011
                    864.      8.03      .058
                    865.      8.88      .128
                    866.      9.65      .249
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WinTR-20 Printed Page File      End of Input Data List

                TX Roadhouse - Proposed Conditions - 10year storm

                          Name of printed page file:
     C:\Users\Iwaniuk\Desktop\TXRH West Chester__PROPOSED__10yr storm.out

                                      STORM 10yr 24hr
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Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
Area 1	0.007		2.477		12.03	16.8	2471.55

Line Start Time (hr)	Flow Values @ time increment of 0.016 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
10.132	0.0	0.5	0.5	0.5	0.5	0.5	0.5
10.243	0.5	0.5	0.5	0.5	0.6	0.6	0.6
10.353	0.6	0.6	0.6	0.6	0.6	0.6	0.6
10.464	0.6	0.6	0.6	0.6	0.6	0.6	0.6
10.574	0.7	0.7	0.7	0.7	0.7	0.7	0.7
10.685	0.7	0.7	0.7	0.7	0.7	0.7	0.8
10.795	0.8	0.8	0.8	0.8	0.8	0.8	0.8
10.906	0.8	0.8	0.9	0.9	0.9	0.9	0.9
11.016	0.9	0.9	0.9	0.9	0.9	1.0	1.0
11.127	1.0	1.0	1.0	1.0	1.0	1.1	1.1
11.237	1.1	1.1	1.1	1.2	1.2	1.2	1.2
11.348	1.3	1.3	1.3	1.3	1.3	1.4	1.4

11.458	1.4	1.4	1.5	1.5	1.5	1.6	1.6
11.569	1.7	1.8	1.9	2.0	2.2	2.4	2.7
11.679	2.9	3.3	3.6	4.0	4.4	4.9	5.4
11.790	5.9	6.5	7.1	7.8	8.5	9.3	10.2
11.901	11.2	12.2	13.2	14.2	15.0	15.8	16.3
12.011	16.7	16.8	16.8	16.5	16.1	15.4	14.5
12.122	13.5	12.5	11.4	10.4	9.4	8.5	7.7
12.232	6.9	6.3	5.8	5.3	4.9	4.6	4.3
12.343	4.0	3.8	3.6	3.4	3.2	3.0	2.9
12.453	2.8	2.7	2.6	2.5	2.4	2.3	2.2
12.564	2.1	2.0	2.0	1.9	1.8	1.8	1.7
12.674	1.7	1.6	1.6	1.6	1.5	1.5	1.5
12.785	1.4	1.4	1.4	1.4	1.4	1.3	1.3
12.895	1.3	1.3	1.3	1.3	1.3	1.2	1.2
13.006	1.2	1.2	1.2	1.2	1.1	1.1	1.1
13.116	1.1	1.1	1.1	1.1	1.1	1.1	1.0
13.227	1.0	1.0	1.0	1.0	1.0	1.0	1.0
13.337	1.0	1.0	1.0	0.9	0.9	0.9	0.9
13.448	0.9	0.9	0.9	0.9	0.9	0.9	0.9
13.558	0.9	0.9	0.9	0.8	0.8	0.8	0.8
13.669	0.8	0.8	0.8	0.8	0.8	0.8	0.8
13.779	0.8	0.8	0.8	0.8	0.8	0.7	0.7
13.890	0.7	0.7	0.7	0.7	0.7	0.7	0.7
14.001	0.7	0.7	0.7	0.7	0.7	0.7	0.7
14.111	0.7	0.7	0.7	0.6	0.6	0.6	0.6
14.222	0.6	0.6	0.6	0.6	0.6	0.6	0.6
14.332	0.6	0.6	0.6	0.6	0.6	0.6	0.6
14.443	0.6	0.6	0.6	0.6	0.6	0.6	0.6
14.553	0.6	0.6	0.6	0.6	0.6	0.6	0.6

Line Start Time (hr)	Flow Values @ time increment of 0.016 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
14.664	0.6	0.6	0.6	0.6	0.6	0.6	0.6
14.774	0.6	0.6	0.6	0.6	0.6	0.6	0.6
14.885	0.5	0.5	0.5	0.5	0.5	0.5	0.5
14.995	0.5	0.5	0.5	0.5	0.5	0.5	0.5
15.106	0.5	0.5	0.5	0.5	0.5	0.5	0.5
15.216	0.5	0.5	0.5	0.5	0.5	0.5	0.0

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Time (hr)	Rate (cfs)	Rate (csm)
Reach 1	0.007	Upstream	2.475		12.03	16.8	2471.55

Line Start Time (hr)	Flow Values @ time increment of 0.016 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
10.132	0.0	0.5	0.5	0.5	0.5	0.5	0.5
10.243	0.5	0.5	0.5	0.5	0.6	0.6	0.6
10.353	0.6	0.6	0.6	0.6	0.6	0.6	0.6
10.464	0.6	0.6	0.6	0.6	0.6	0.6	0.6
10.574	0.7	0.7	0.7	0.7	0.7	0.7	0.7
10.685	0.7	0.7	0.7	0.7	0.7	0.7	0.8
10.795	0.8	0.8	0.8	0.8	0.8	0.8	0.8
10.906	0.8	0.8	0.9	0.9	0.9	0.9	0.9
11.016	0.9	0.9	0.9	0.9	0.9	1.0	1.0
11.127	1.0	1.0	1.0	1.0	1.0	1.1	1.1
11.237	1.1	1.1	1.1	1.2	1.2	1.2	1.2
11.348	1.3	1.3	1.3	1.3	1.3	1.4	1.4
11.458	1.4	1.4	1.5	1.5	1.5	1.6	1.6
11.569	1.7	1.8	1.9	2.0	2.2	2.4	2.7
11.679	2.9	3.3	3.6	4.0	4.4	4.9	5.4
11.790	5.9	6.5	7.1	7.8	8.5	9.3	10.2
11.901	11.2	12.2	13.2	14.2	15.0	15.8	16.3
12.011	16.7	16.8	16.8	16.5	16.1	15.4	14.5
12.122	13.5	12.5	11.4	10.4	9.4	8.5	7.7
12.232	6.9	6.3	5.8	5.3	4.9	4.6	4.3
12.343	4.0	3.8	3.6	3.4	3.2	3.0	2.9
12.453	2.8	2.7	2.6	2.5	2.4	2.3	2.2
12.564	2.1	2.0	2.0	1.9	1.8	1.8	1.7
12.674	1.7	1.6	1.6	1.6	1.5	1.5	1.5
12.785	1.4	1.4	1.4	1.4	1.4	1.3	1.3
12.895	1.3	1.3	1.3	1.3	1.3	1.2	1.2
13.006	1.2	1.2	1.2	1.2	1.1	1.1	1.1
13.116	1.1	1.1	1.1	1.1	1.1	1.1	1.0
13.227	1.0	1.0	1.0	1.0	1.0	1.0	1.0
13.337	1.0	1.0	1.0	0.9	0.9	0.9	0.9
13.448	0.9	0.9	0.9	0.9	0.9	0.9	0.9
13.558	0.9	0.9	0.9	0.8	0.8	0.8	0.8
13.669	0.8	0.8	0.8	0.8	0.8	0.8	0.8
13.779	0.8	0.8	0.8	0.8	0.8	0.7	0.7
13.890	0.7	0.7	0.7	0.7	0.7	0.7	0.7

Line Start Time (hr)	Flow Values @ time increment of 0.016 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
14.001	0.7	0.7	0.7	0.7	0.7	0.7	0.7
14.111	0.7	0.7	0.7	0.6	0.6	0.6	0.6
14.222	0.6	0.6	0.6	0.6	0.6	0.6	0.6
14.332	0.6	0.6	0.6	0.6	0.6	0.6	0.6
14.443	0.6	0.6	0.6	0.6	0.6	0.6	0.6
14.553	0.6	0.6	0.6	0.6	0.6	0.6	0.6
14.664	0.6	0.6	0.6	0.6	0.6	0.6	0.6
14.774	0.6	0.6	0.6	0.6	0.6	0.6	0.6
14.885	0.5	0.5	0.5	0.5	0.5	0.5	0.5
14.995	0.5	0.5	0.5	0.5	0.5	0.5	0.5
15.106	0.5	0.5	0.5	0.5	0.5	0.5	0.5
15.216	0.5	0.5	0.5	0.5	0.5	0.5	0.0

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Time (hr)	Rate (cfs)	Rate (csm)
Reach 1	0.007	Downstream	2.470	865.26	12.18	9.1	1334.35

Line Start Time (hr)	Flow Values @ time increment of 0.016 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
10.195	0.0	0.5	0.5	0.5	0.5	0.5	0.5
10.306	0.5	0.6	0.6	0.6	0.6	0.6	0.6
10.416	0.6	0.6	0.6	0.6	0.6	0.6	0.6
10.527	0.6	0.6	0.6	0.6	0.7	0.7	0.7
10.637	0.7	0.7	0.7	0.7	0.7	0.7	0.7
10.748	0.7	0.7	0.7	0.8	0.8	0.8	0.8
10.858	0.8	0.8	0.8	0.8	0.8	0.8	0.8
10.969	0.9	0.9	0.9	0.9	0.9	0.9	0.9
11.079	0.9	0.9	1.0	1.0	1.0	1.0	1.0
11.190	1.0	1.0	1.1	1.1	1.1	1.1	1.1
11.301	1.2	1.2	1.2	1.2	1.2	1.3	1.3
11.411	1.3	1.3	1.4	1.4	1.4	1.4	1.5
11.522	1.5	1.5	1.6	1.6	1.7	1.8	1.9
11.632	2.0	2.2	2.4	2.6	2.9	3.2	3.6
11.743	4.0	4.4	4.8	5.3	5.8	6.4	7.0
11.853	7.1	7.2	7.2	7.3	7.4	7.6	7.7
11.964	7.9	8.1	8.2	8.3	8.5	8.6	8.7
12.074	8.8	8.9	9.0	9.0	9.0	9.1	9.1
12.185	9.1	9.1	9.1	9.1	9.0	9.0	9.0
12.295	9.0	8.9	8.9	8.8	8.7	8.7	8.6
12.406	8.5	8.4	8.3	8.2	8.1	8.1	7.9
12.516	7.8	7.6	7.5	7.4	7.2	7.1	4.3
12.627	2.9	2.3	2.0	1.8	1.7	1.7	1.6
12.737	1.6	1.5	1.5	1.5	1.5	1.4	1.4
12.848	1.4	1.4	1.4	1.3	1.3	1.3	1.3
12.958	1.3	1.3	1.2	1.2	1.2	1.2	1.2
13.069	1.2	1.2	1.1	1.1	1.1	1.1	1.1
13.179	1.1	1.1	1.1	1.0	1.0	1.0	1.0
13.290	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Line Start Time (hr)	Flow Values @ time increment of 0.016 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
13.401	1.0	0.9	0.9	0.9	0.9	0.9	0.9
13.511	0.9	0.9	0.9	0.9	0.9	0.9	0.9
13.622	0.8	0.8	0.8	0.8	0.8	0.8	0.8
13.732	0.8	0.8	0.8	0.8	0.8	0.8	0.8
13.843	0.8	0.8	0.7	0.7	0.7	0.7	0.7
13.953	0.7	0.7	0.7	0.7	0.7	0.7	0.7
14.064	0.7	0.7	0.7	0.7	0.7	0.7	0.7
14.174	0.6	0.6	0.6	0.6	0.6	0.6	0.6
14.285	0.6	0.6	0.6	0.6	0.6	0.6	0.6
14.395	0.6	0.6	0.6	0.6	0.6	0.6	0.6
14.506	0.6	0.6	0.6	0.6	0.6	0.6	0.6
14.616	0.6	0.6	0.6	0.6	0.6	0.6	0.6
14.727	0.6	0.6	0.6	0.6	0.6	0.6	0.6
14.837	0.6	0.6	0.6	0.6	0.5	0.5	0.5
14.948	0.5	0.5	0.5	0.5	0.5	0.5	0.5
15.058	0.5	0.5	0.5	0.5	0.5	0.5	0.5
15.169	0.5	0.5	0.5	0.5	0.5	0.5	0.5
15.279	0.5	0.5	0.0				

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Time (hr)	Rate (cfs)	Rate (csm)
OUTLET	0.007		2.468		12.18	9.1	1334.35

Line Start Time (hr)	Flow Values @ time increment of 0.016 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
10.195	0.0	0.5	0.5	0.5	0.5	0.5	0.5
10.306	0.5	0.6	0.6	0.6	0.6	0.6	0.6
10.416	0.6	0.6	0.6	0.6	0.6	0.6	0.6
10.527	0.6	0.6	0.6	0.6	0.7	0.7	0.7
10.637	0.7	0.7	0.7	0.7	0.7	0.7	0.7
10.748	0.7	0.7	0.7	0.8	0.8	0.8	0.8
10.858	0.8	0.8	0.8	0.8	0.8	0.8	0.8
10.969	0.9	0.9	0.9	0.9	0.9	0.9	0.9
11.079	0.9	0.9	1.0	1.0	1.0	1.0	1.0
11.190	1.0	1.0	1.1	1.1	1.1	1.1	1.1
11.301	1.2	1.2	1.2	1.2	1.2	1.3	1.3
11.411	1.3	1.3	1.4	1.4	1.4	1.4	1.5
11.522	1.5	1.5	1.6	1.6	1.7	1.8	1.9
11.632	2.0	2.2	2.4	2.6	2.9	3.2	3.6
11.743	4.0	4.4	4.8	5.3	5.8	6.4	7.0
11.853	7.1	7.2	7.2	7.3	7.4	7.6	7.7
11.964	7.9	8.1	8.2	8.3	8.5	8.6	8.7
12.074	8.8	8.9	9.0	9.0	9.0	9.1	9.1
12.185	9.1	9.1	9.1	9.1	9.0	9.0	9.0
12.295	9.0	8.9	8.9	8.8	8.7	8.7	8.6
12.406	8.5	8.4	8.3	8.2	8.1	8.1	7.9
12.516	7.8	7.6	7.5	7.4	7.2	7.1	4.3
12.627	2.9	2.3	2.0	1.8	1.7	1.7	1.6

TX Roadhouse - Proposed Conditions - 10year storm

Line Start Time (hr)	Flow Values @ time increment of 0.016 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
12.737	1.6	1.5	1.5	1.5	1.5	1.4	1.4
12.848	1.4	1.4	1.4	1.3	1.3	1.3	1.3
12.958	1.3	1.3	1.2	1.2	1.2	1.2	1.2
13.069	1.2	1.2	1.1	1.1	1.1	1.1	1.1
13.179	1.1	1.1	1.1	1.0	1.0	1.0	1.0
13.290	1.0	1.0	1.0	1.0	1.0	1.0	1.0
13.401	1.0	0.9	0.9	0.9	0.9	0.9	0.9
13.511	0.9	0.9	0.9	0.9	0.9	0.9	0.9
13.622	0.8	0.8	0.8	0.8	0.8	0.8	0.8
13.732	0.8	0.8	0.8	0.8	0.8	0.8	0.8
13.843	0.8	0.8	0.7	0.7	0.7	0.7	0.7
13.953	0.7	0.7	0.7	0.7	0.7	0.7	0.7
14.064	0.7	0.7	0.7	0.7	0.7	0.7	0.7
14.174	0.6	0.6	0.6	0.6	0.6	0.6	0.6
14.285	0.6	0.6	0.6	0.6	0.6	0.6	0.6
14.395	0.6	0.6	0.6	0.6	0.6	0.6	0.6
14.506	0.6	0.6	0.6	0.6	0.6	0.6	0.6
14.616	0.6	0.6	0.6	0.6	0.6	0.6	0.6
14.727	0.6	0.6	0.6	0.6	0.6	0.6	0.6
14.837	0.6	0.6	0.6	0.6	0.5	0.5	0.5
14.948	0.5	0.5	0.5	0.5	0.5	0.5	0.5
15.058	0.5	0.5	0.5	0.5	0.5	0.5	0.5
15.169	0.5	0.5	0.5	0.5	0.5	0.5	0.5
15.279	0.5	0.5	0.0				

APPENDIX D, TABLE D-2

The Rational Method - The basic formula is $Q=ACI$ where:

Q = *Peak rate of runoff in cubic feet per second (CFS)*
A = *The drainage area in acres*
C = *Runoff coefficient representing the characteristics of drainage areas*
I = *Average intensity of rainfall in inches per hour for a selected storm frequency and given time of concentration*

(1) Runoff Coefficient (c) - Please refer to Appendix D, Table D-3 for average acceptable runoff coefficients for use with the Rational Method.

(2) Rainfall Intensity (I) - The value for rainfall intensity can be calculated using the following precipitation formulas:

Frequency	Formula
2	I = 106/(Tc + 17)
5	I = 131/(Tc + 19)
10	I = 170/(Tc + 23)
25	I = 230/(Tc + 30)
50	I = 250/(Tc + 27)
100	I = 300/(Tc + 31)

(3) Time of Concentration (Tc) - Appendix D, Table D-4 provides a graphical method for estimating overland flow time. The minimum time of concentration to a street inlet is 10 minutes. Channel flow time (length divided by average velocity) may be used to calculate the remaining Tc to the inlet or to the point of reference downstream.

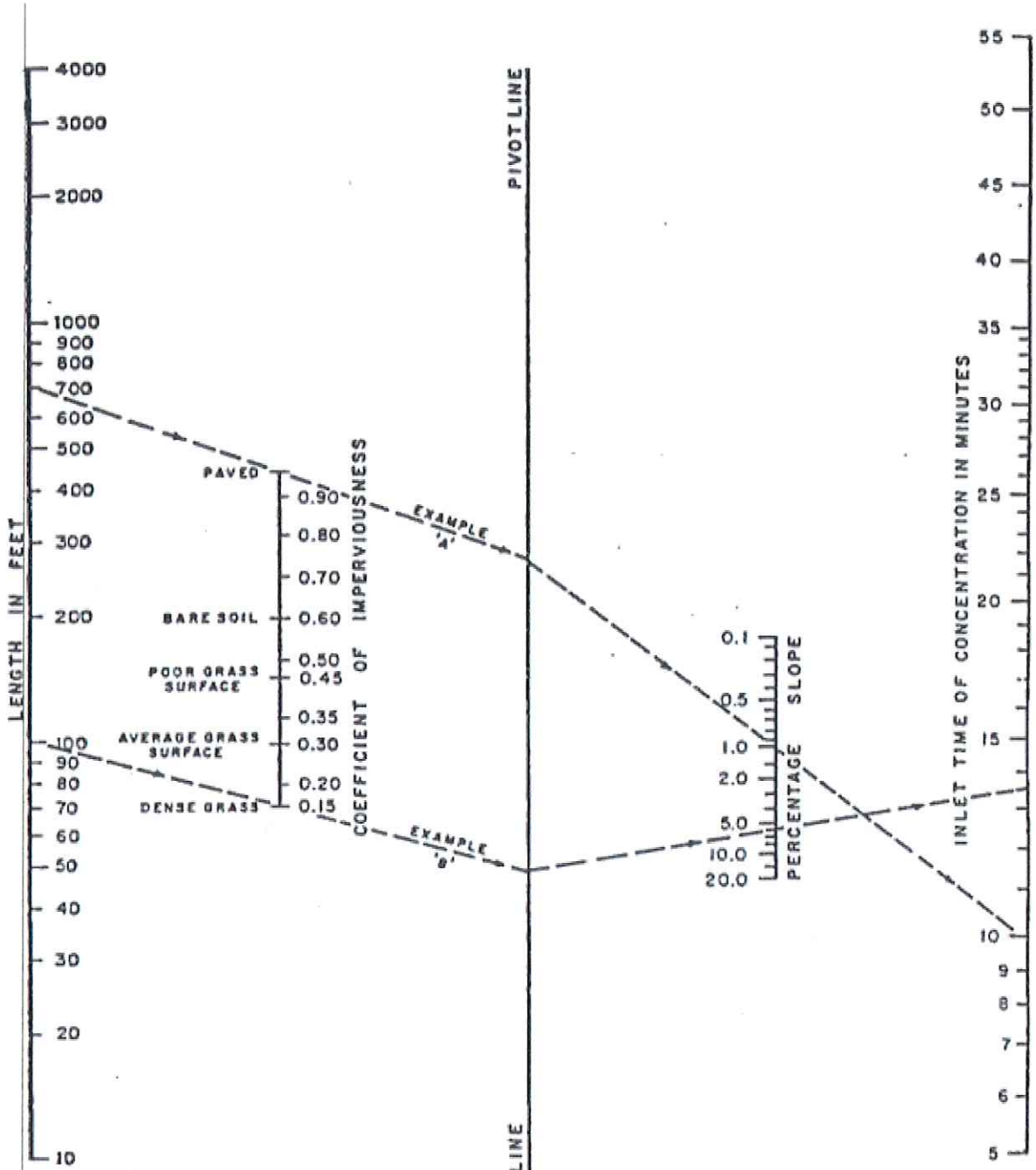
APPENDIX D, TABLE D-3

Runoff Coeffecient

RUNOFF COEFFICIENT General Slope					
Description of Area	< 2%	3%	4%	5%	7%>
Commercial	.75	.78	.81	.84	.90
Residential					
Single Family	.40	.42	.44	.46	.50
Multi Units	.60	.63	.66	.69	.75
Apartments	.60	.64	.68	.72	.80
Industrial					
Light	.60	.64	.68	.72	.80
Heavy	.75	.78	.81	.84	.90
Cropland (rowcrop)	.40	.42	.44	.46	.50
Grassland	.25	.28	.31	.34	.40
Woodland	.20	.24	.28	.32	.40
Parks, Cemeteries	.25	.28	.31	.34	.40

Composite Runoff Coefficient	
Pavement	
Asphalt and Concrete	.95
Roofs	.95
Slopes 1 to 2%	
Impervious soils (heavy)	.40 to .65
Impervious soils (with turf)	.30 to .55
Slightly pervious soils	.15 to .40
Slightly pervious soils (with turf)	.10 to .30
Moderately pervious soils	.05 to .20
Moderately pervious soils (with turf)	.00 to .10

APPENDIX D, TABLE D-4



EXAMPLE 'A'
LENGTH: 700 FEET
PAVED
SLOPE: 1.0 %
TIME: 10 MINUTES

EXAMPLE 'B'
LENGTH: 100 FEET
DENSE GRASS
SLOPE: 6.0 %
TIME: 13 ½ MINUTES

SEELYE CHART

TIME OF CONCENTRATION

APPENDIX D, TABLE D-11

Butler County Modified Critical Storm Method

Using TR-55 determine the total volume of runoff from a 1 (one) year frequency, 24 (twenty-four) hour storm event for the development area before and after development. Then determine the percentage increase in the volume of runoff due to development, and using the chart below, select the 24 (twenty-four) hour critical storm.

Runoff Volume Increase (%)		**Critical Storm**
Equal to or greater than	**And less than**	**Peak Rate Control**
--	10	1-year
10	20	2-year
20	50	5-year
50	100	10-year
100	250	25-year
250	500	50-year
500	--	100-year

Stage 1 OEPA Water Quality Volume Orifice
Stage 2 Critical Storm Event Orifice
Stage 3 Subsequent Frequency Storms
Stage N Emergency Spillway