

Appendix F - Examples

Example 1:

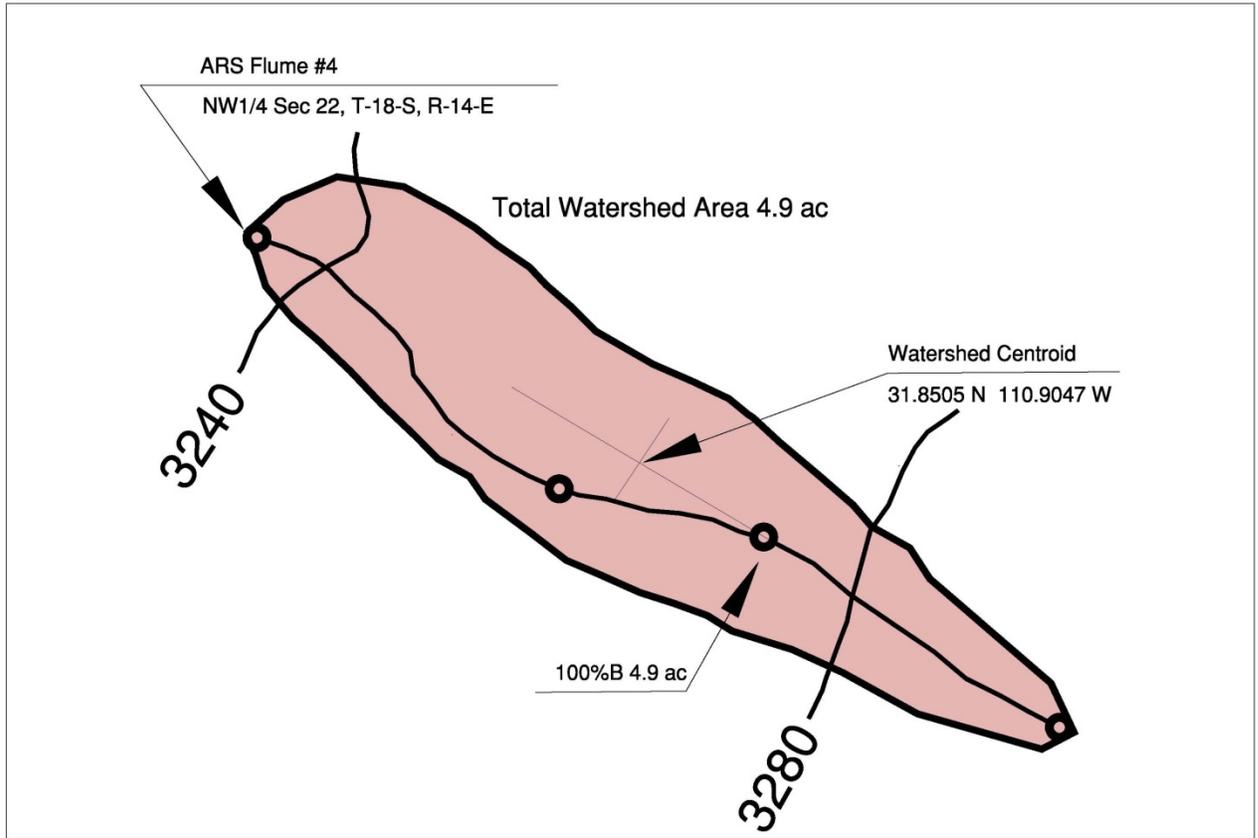
Santa Rita Experimental Watershed #4

Example #1: Santa Rita Experimental Watershed #4

Description of the Watershed: Santa Rita Experimental Watershed #4 is one of 8 experimental watersheds located in south-central Pima County at the base of the Santa Rita Mountains on the University of Arizona's Santa Rita Experimental Range. Watershed #4 is 4.9 acres and has a recording rain gage and a Replogle flume that can measure discharges up to 50 cfs (Kidwell et al, 2001). The watershed is maintained by the USDA Southwest Watershed Research Center, and is located in the shrub-dominated lower portion of the experimental range. Rainfall and runoff records for this experimental watershed have been maintained since 1975. The highest discharge yet recorded was 23.9 cfs on July 23, 2004. Based on Log Pearson III analysis of annual peak, this event exceeding the 100 yr expected discharge of 23.3 cfs.

The slope of the longest watercourse ranges from about 4.6% near the mouth, to about 3.0% near the uppermost watershed divide. The Mannings N-values for the main channel were visually estimated, and ranged from 0.04 near the mouth to 0.08 within and along the upper reach. This wash appears to be competent and can carry the entire 100-year peak discharge without overtopping.

There is only one Vegetation Type within this watershed, and it can be characterized as Desert Brush with a 30% average cover density.



Legend:

-  Hydrologic Soil Group 100 % B
-  Slope Length
-  Topographic Contour (CI =40')



7.5 Min. Topographic Quad.
Green Valley, AZ, 1981
Scale: 1"=200'

Santa Rita Experimental Range
Experimental Watershed #4

Pima County, Arizona

Watershed Boundary Map

Example #1

Summary of Watershed Data:

Watershed Area (A) = 4.9 acres
 Watershed Type = 100 % Undeveloped Foothills
 Length of the Longest Watercourse (Lc) = 1,015 feet
 Length to the Center of Gravity (Lca) = 507 feet (measured)

Summary of Watercourse Data By Reach:

Reach No.	Starting Elevation (feet)	Ending Elevation (feet)	Height, Hi (feet)	Length, Li (feet)	Slope, Si (ft/ft)	Channel Mannings N-Value	Basin Factor, nb
1	3264	3254	10	325	0.03	0.07	0.070 ²
2	3254	3246	8	230	0.036	0.04	0.035 ¹
3	3246	3235	21	460	0.046	0.04	0.035 ¹
				Lc=1,015			

¹ Basin Factor for average undeveloped foothills (Table 4-1)

² Basin Factor for normal shallow sheetflow in natural conditions (Table 4-3).

Summary of Rainfall Data: Rainfall Depths are determined by entering the Latitude and Longitude of the Watershed Centroid or Center of Gravity, which was measured to be: Latitude 31.8505 N, and Longitude 110.9047 W.

Summary of Soil and Vegetation Data:

Vegetation Cover Types and Densities: 100% of the watershed is Desert Brush Vegetation with a Cover Density of 30%

Soil Data (summary of watershed subareas by Hydrologic Soil Type and Curve Number):

	Desert Brush, 30% Cover Density				
Soil Types	Total	A	B	C	D
--	Curve Number	--	83.2 ²	--	--
100% B	4.9 ac	--	4.9 ac	--	--
Total	4.9 ac	--	4.9 ac	--	--

² Calculated using historic data (HAVE EVAN ELABORATE)

Percentage of the Watershed Occupied by each Hydrologic Soil Group:

$$\text{Type B Soils} = 100\% \text{ (CN=83.2}^2\text{)}$$

The future Impervious Cover is estimated to be 0%.

Summary of Computed Flood Peaks for Return Periods Ranging from 2-years to 100-years:

Return Period, Years	Flood Peak Calculated by PC-HYDRO, cfs	Flood Peak Predicted from Gage Data, cfs ¹	Ratio of Flood Peaks Calculated by PC-HYDRO and by Statistical Analysis of Gage Data
2	1.9	6.0	0.32
5	6.4	10	0.64
10	10.7	13	0.78
25	17.9	17	1.05
50	24.2	20	1.21
100	31.3	23	1.36

¹ Calculated using Log Pearson III distribution from USDA-ARS Data for the Santa Rita Experimental Watershed # 4 <http://www.tucson.ars.ag.gov/dap/>

As can be seen, there is a relatively good comparison between the flood peaks calculated using PC-HYDRO and those calculated from the Gage Data, particularly for the less frequent events. The ratios between these sets of calculated flood peaks range from 0.32 for the 2-year event, to 1.36 for the 100-year flood peak.



HYDROLOGIC DATA SHEET FOR PIMA COUNTY FLOOD PEAK PROCEDURE
 Generated using methods provided by Pima County Regional Flood Control District

Client:	<u>PCRFC</u>	Prepared by:	<u>JMT/HEC/RHW</u>
Project Name:	<u>PC-HYDRO User Guide Example #1</u>	Date:	<u>8/14/2006</u>
Concentration Point:	<u>Santa Rita Exp. Range, Watershed #4, Existing Condit., Q100</u>	Job #	<u>PDOT</u>
Watershed Area:	<u>4.9 Acres</u>	Watershed Type	<u>Undeveloped-Foothills</u>

Watercourse Data By Reach

Reach No.	Height (Hi)	Length (Li)	Slope (Si)	Basin Factor (Nb)
1	10	325	0.0308	0.07
2	8	230	0.0348	0.035
3	21	460	0.0457	0.035

Length of Watercourse (Lc):	<u>1015</u> feet	Mean Slope:	<u>0.0375</u>
Length to Cen. of Gravity (Lca):	<u>507</u> feet	Weighted Basin Fac:	<u>0.035</u>
Veg. Cover Type(s):	<u>Desert Brush</u>	Veg. Cover Density:	<u>30</u>

RETURN PERIOD: 100-years NOAA Data Obtained: 2017-05-05 11:34:14 AM

Rainfall Depths:	<u>NOAA Atlas 14 (90% UCL) @</u> Latitude: <u>31.8505</u> Longitude: <u>-110.9047</u>									
Duration:	<u>5-min</u>	<u>10-min</u>	<u>15-min</u>	<u>30-min</u>	<u>1-hr</u>	<u>2-hr</u>	<u>3-hr</u>	<u>6-hr</u>	<u>12-hr</u>	<u>24-hr</u>
Point Values (in):	<u>0.917</u>	<u>1.4</u>	<u>1.73</u>	<u>2.33</u>	<u>2.88</u>	<u>3.21</u>	<u>3.32</u>	<u>3.78</u>	<u>4.11</u>	<u>4.43</u>

Soil Type	Percent	Curve # (CN)	Adj. Curve # (CN*)	Runoff Coef. (C)
B	100	83.2	89.04	0.707
C	-	-	-	-
D	-	-	-	-
Imp.	0	99	99	0.97

Weighted Runoff Coef. (Cw):	<u>0.58</u>
Time of Concentration:	<u>5.1</u> min
Rainfall Intensity (i) @ Tc:	<u>10.91</u> in/hr
Runoff Supply Rate (q) @ Tc:	<u>6.34</u> in/hr
PEAK DISCHARGE:	<u>31.3</u> cfs

Calculation performed 2017-05-05 11:37:20 AM by PC-Hydro V6.1

Example 2:

Paseo Del Rio Subdivision

Example #2: Paseo Del Rio Subdivision

Description of the Watershed: Example #2 examines a 5-acre portion of an existing medium to high-density residential subdivision located along River Road, near La Canada Drive. This subdivision was constructed in 2005, and the adjoining roadways and channels are believed to be able to convey the 100-year design floods without overtopping.

The slope of the longest watercourse is relatively mild, and ranges from about 0.5% to 0.7%. The Mannings N-values for the water-carrying street and collector channel were visually estimated to be 0.016 and 0.015, respectively.

There is only one Vegetation Types within this watershed, and it can be characterized as Urban Lawn, with average cover density.

Summary of Watershed Data:

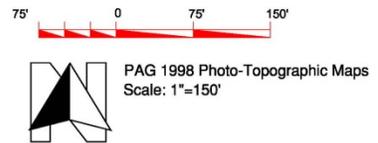
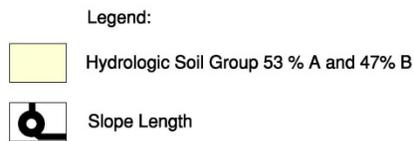
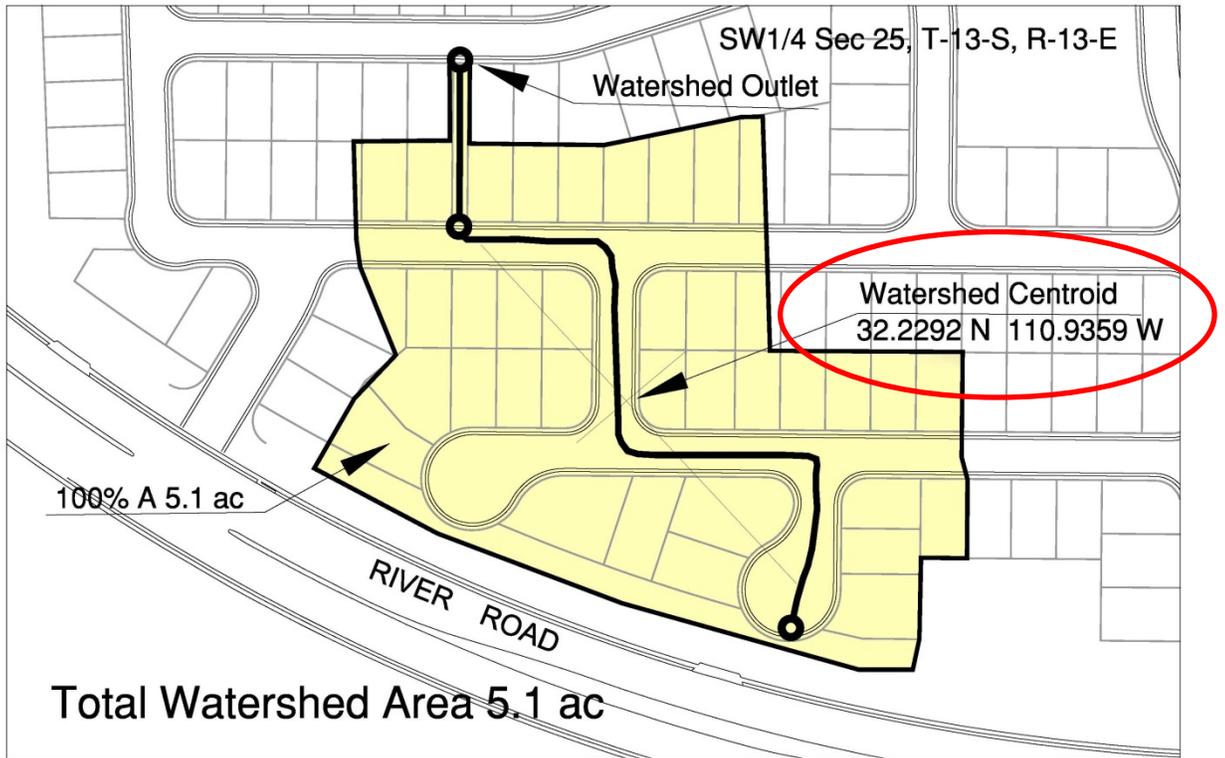
Watershed Area (A) =	5.1 acres
Watershed Type =	100 % Medium Density Urbanized
Length of the Longest Watercourse (Lc) =	850 feet
Length to the Center of Gravity (Lca) =	425 feet (calculated)

Summary of Watercourse Data By Reach:

Reach No.	Starting Elevation (feet)	Ending Elevation (feet)	Height, Hi (feet)	Length, Li (feet)	Slope, Si (ft/ft)	Channel Mannings N-Value	Basin Factor, n_b
1	2283.4	2288.6	5.2	695	0.007	0.016	0.020 ²
2	2282.6	2283.4	0.8	155	0.005	0.015	0.018 ¹
				Lc=850			

Note: The Basin Factors listed above were representative of (1) minimum Highly Urbanization for the concrete line channel, and (2) average Highly Urbanization for the paved street.

Summary of Rainfall Data: Rainfall Depths are determined by entering the Latitude and Longitude of the Watershed Centroid or Center of Gravity, which was measured to be: Latitude 32.2292 N, and Longitude 110.9359 W.



Paseo Del Rio Subdivision
A Tributary to Roller Coaster Wash
Near La Canada Drive
Pima County, Arizona

Watershed Boundary Map

Example #2

Summary of Soil and Vegetation Data:

Vegetation Cover Types and Densities:

100% of the watershed is Desert Brush Vegetation with a poor Cover Density.

Soil Data (summary of watershed subareas by Hydrologic Soil Type and Curve Number):

	Desert Brush, 30% Cover Density				
Soil Types	Total	A	B	C	D
--	Curve Number	--	83	--	--
100% B	5.1 ac	--	5.1 ac	--	--
Total	5.1 ac	--	5.1 ac	--	--

Percentage of the Watershed Occupied by each Hydrologic Soil Group:

Type B Soils = 100% (CN=83)

Percentage of Impervious Cover: From Table 3, the future Impervious Cover is estimated to be 55 %.

Summary of Computed Flood Peaks for Return Periods Ranging from 2-years to 100-years:

Return Period, Years	Flood Peak Calculated by PC-HYDRO, cfs	Ratio of Flood Peak and Drainage Area, cfs/acre
2	11.6	2.3
5	17.7	3.5
10	22.3	4.4
25	29.4	5.8
50	35	6.9
100	41.1	8.1



HYDROLOGIC DATA SHEET FOR PIMA COUNTY FLOOD PEAK PROCEDURE
 Generated using methods provided by Pima County Regional Flood Control District

Client:	PCRFC	Prepared by:	JMT/RHW
Project Name:	PC-HYDRO User Guide	Date:	8/14/2006
Concentration Point:	Paseo Del Rio Subdivision, Existing Conditions	Job #	PDOT
Watershed Area:	5.1 Acres	Watershed Type	High Density Urbanized

Watercourse Data By Reach

Reach No.	Height (Hi)	Length (Li)	Slope (Si)	Basin Factor (Nb)
1	5.2	695	0.0075	0.02
2	0.8	155	0.0052	0.018

Length of Watercourse (Lc):	850	feet	Mean Slope:	0.0108
Length to Cen. of Gravity (Lca):	425	feet	Weighted Basin Fac:	0.018
Veg. Cover Type(s):	Urban Lawns		Veg. Cover Density:	20

RETURN PERIOD: 100-years NOAA Data Obtained: 2017-04-07 02:17:04 PM

Rainfall Depths:	NOAA Atlas 14 (90% UCL) @										Latitude: 32.2985	Longitude: -111.0014
Duration:	5-min	10-min	15-min	30-min	1-hr	2-hr	3-hr	6-hr	12-hr	24-hr		
Point Values (in):	0.86	1.31	1.62	2.18	2.7	3	3.14	3.39	3.64	4.29		

Soil Type	Percent	Curve # (CN)	Adj. Curve # (CN*)	Runoff Coef. (C)
B	100	83	88.79	0.686
C	-	-	-	-
D	-	-	-	-
Imp.	55	99	99	0.968

Weighted Runoff Coef. (Cw):	0.77
Time of Concentration:	5 min
Rainfall Intensity (i) @ Tc:	10.32 in/hr
Runoff Supply Rate (q) @ Tc:	7.99 in/hr
PEAK DISCHARGE:	41.1 cfs

Calculation performed 2017-04-07 02:28:23 PM by PC-Hydro V6.01

Example 3:
Santa Rita Retail

Example #3: Santa Rita Retail Shopping Center

Description of the Watershed: Example #3 examines a 3-acre portion of a proposed commercial development located near Sahuarita Road and Houghton Road.

The slope of the longest watercourse is a moderate 1.5%. The Mannings N-values for the water-carrying parking areas was estimated to be 0.015.

There is only one Vegetation Types within this watershed, and it can be characterized as Desert Brush, with poor cover density.

Summary of Watershed Data:

Watershed Area (A) = 3.2 acres
 Watershed Type = 100 % Highly Urbanized (Commercial)
 Length of the Longest Watercourse (Lc) = 570 feet
 Length to the Center of Gravity (Lca) = 260 feet

Summary of Watercourse Data By Reach:

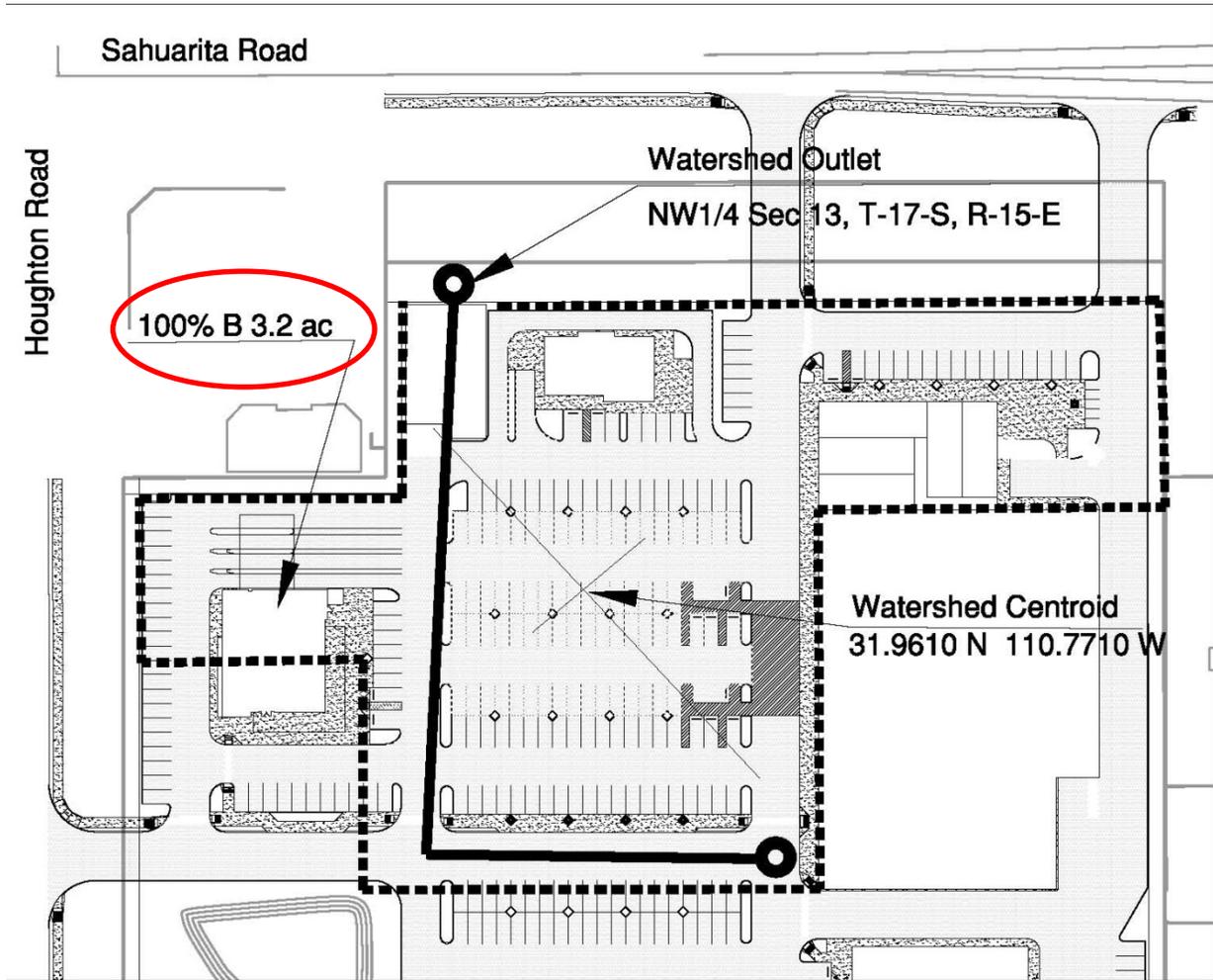
Reach No.	Starting Elevation (feet)	Ending Elevation (feet)	Height, Hi (feet)	Length, Li (feet)	Slope, Si (ft/ft)	Channel Mannings N-Value	Basin Factor, n_b
1	3220	3228	8	570	0.014	0.015	0.018 ¹
				Lc=570			

Note: The Basin Factor listed above was representative of (1) average Highly Urbanization for the paved street.

Summary of Rainfall Data: Rainfall Depths are determined by entering the Latitude and Longitude of the Watershed Centroid or Center of Gravity, which was measured to be: Latitude 31.9610 N, and Longitude 110.7710 W.

Summary of Soil and Vegetation Data:

Vegetation Cover Types and Densities: 100% of the watershed is Desert Brush Vegetation with a poor Cover Density.



Legend:

-  Watershed Boundary
-  Slope Length



PAG 1998 Photo-Topographic Maps
Scale: 1"=100'

Santa Rita Retail
A Tributary to upper Fagan Wash
Near Sahuarita Road and Houghton Road
Pima County, Arizona

Watershed Boundary Map

Example #3

Soil Data (summary of watershed subareas by Hydrologic Soil Type and Curve Number):

	Desert Brush, 30% Cover Density				
Soil Types	Total	A	B	C	D
--	Curve Number	--	83	88	--
60% A 40% C	3.2 ac	1.9 ac		1.3 ac	--
Total	3.2 ac	1.9 ac		1.3 ac	--

Percentage of the Watershed Occupied by each Hydrologic Soil Group:

Type A/B Soils = 60% (CN=83)
 Type C Soils = 40% (CN=88)

Percentage of Impervious Cover: From Table 3, the future Impervious Cover is estimated to be 90 %.

Summary of Computed Flood Peaks for Return Periods Ranging from 2-years to 100-years:

Return Period, Years	Flood Peak Calculated by PC-HYDRO, cfs	Ratio of Flood Peak and Drainage Area, cfs/acre
2	13.5	4.2
5	18.1	5.7
10	21.6	6.8
25	26.6	8.3
50	30.1	9.4
100	34.1	10.7



HYDROLOGIC DATA SHEET FOR PIMA COUNTY FLOOD PEAK PROCEDURE

Generated using methods provided by Pima County Regional Flood Control District

Client:	PCRFC	Prepared by:	JMT/RHW
Project Name:	PC-HYDRO User Guide Example #3	Date:	6/11/2006
Concentration Point:	Santa Rita Retail, Proposed Conditions, Q100	Job #	PDOT
Watershed Area:	3.23 Acres	Watershed Type	High Density Urbanized

Watercourse Data By Reach

Reach No.	Height (Hi)	Length (Li)	Slope (Si)	Basin Factor (Nb)
1	8	570	0.014	0.018

Length of Watercourse (Lc):	570 feet	Mean Slope:	0.014
Length to Cen. of Gravity (Lca):	260 feet	Weighted Basin Fac:	0.018
Veg. Cover Type(s):	Desert Brush	Veg. Cover Density:	20

RETURN PERIOD: 100-years NOAA Data Obtained: 2017-04-07 02:46:47 PM

Rainfall Depths:	NOAA Atlas 14 (90% UCL) @ Latitude: 31.9605 Longitude: -110.7699									
Duration:	5-min	10-min	15-min	30-min	1-hr	2-hr	3-hr	6-hr	12-hr	24-hr
Point Values (in):	0.94	1.44	1.78	2.4	2.97	3.33	3.45	3.88	4.28	4.5

Soil Type	Percent	Curve # (CN)	Adj. Curve # (CN*)	Runoff Coef. (C)
B	60	83	89.13	0.714
C	40	88	92.49	0.796
D	-	-	-	-
Imp.	90	99	99	0.971

Weighted Runoff Coef. (Cw):	0.93
Time of Concentration:	5 min
Rainfall Intensity (i) @ Tc:	11.28 in/hr
Runoff Supply Rate (q) @ Tc:	10.46 in/hr
PEAK DISCHARGE:	34.1 cfs

Calculation performed 2017-04-07 03:19:20 PM by PC-Hydro V6.01

Example 4:

Enchanted Hills Wash at Mission Road

Example #4: Enchanted Hills Wash at Mission Road

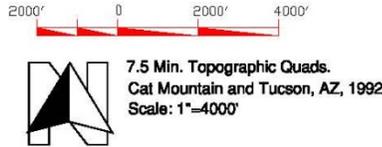
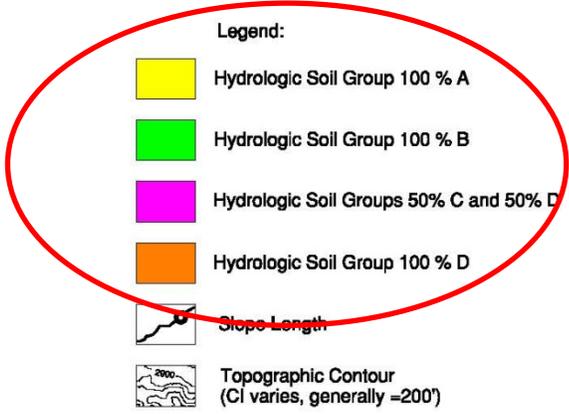
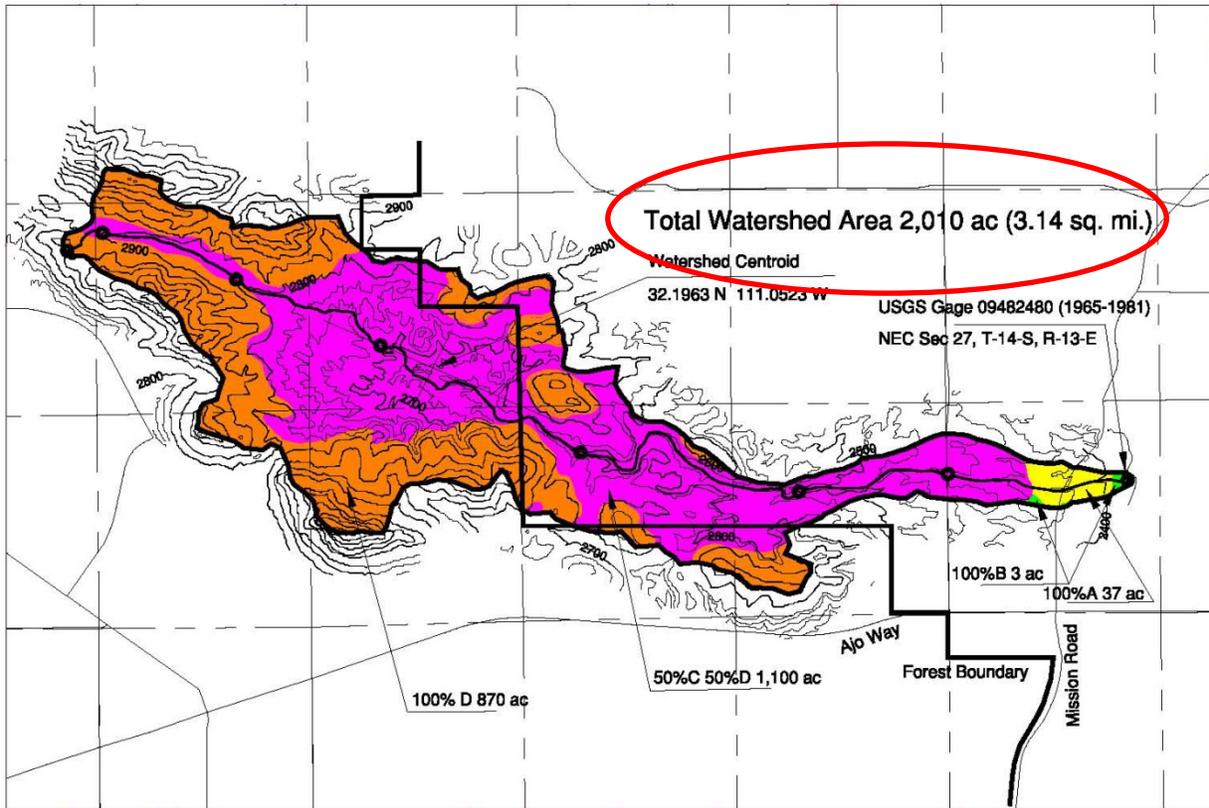
Description of the Watershed:

The Enchanted Hills Wash is a Rural Foothills and Undeveloped Mountain watershed with the upper 60% of the watershed located inside the Tucson Mountain County Park. Areas outside the parks are within incorporated City of Tucson. Additionally, the mouth or concentration point of this 3.0 square mile watershed is located at the former USGS stream gage # 09482480, which was in service for the 17 year period between 1965 and 1981. This wash is also known as Big Wash. Additionally, this particular wash was included in the original Pima County Hydrology Manual as Example #6.

The slope of the longest watercourse ranges from about 1.7% near the mouth, to about 25% near the uppermost watershed divide. The Mannings N-values for the main channel were visually estimated, and ranged from 0.030 near the mouth to 0.045 or greater within and along the upper mountainous reaches. This wash appears to be competent and can carry the entire 100-year peak discharge without overtopping.

According to the City of Tucson Zoning Maps, the areas outside the Tucson Mountain Park are planned for Medium Density Residential (R-1 and MH-1), and Low Density Residential (SR), and will have maximum future development densities of about 1 to 3 houses per acre. Also, this segment of Enchanted Hills Wash has been identified as an ERZ-wash with Xeroriparian Intermediate Habitat, and therefore it is unlikely to be channelized in the foreseeable future.

There is only one general Vegetation Type within this watershed, and it is Desert Brush with an estimated 20% cover density.



Enchanted Hills Wash
A Tributary to the Santa Cruz River
at Mission Road
Pima County, Arizona

Watershed Boundary Map

Example #4

Summary of Watershed Data:

Watershed Area (A) = 1,944 acres
 Watershed Type = 60% Undeveloped Mountain,
 40% Rural Foothills
 Length of the Longest Watercourse (Lc) = 29,560 feet
 Length to the Center of Gravity (Lca) = 19,580 feet (measured)

Watercourse Data By Reach:

Reach No.	Starting Elevation (feet)	Ending Elevation (feet)	Height, Hi (feet)	Length, Li (feet)	Slope, Si (ft/ft)	Channel Mannings N-Value	Basin Factor, n _b
1	3140	2900	240	1000	0.240	0.080	0.080 ⁴
2	2900	2800	100	3400	0.029	0.045	0.035 ³
3	2800	2700	100	4060	0.025	0.040	0.035 ³
4	2700	2600	100	6200	0.016	0.035	0.030 ²
5	2600	2500	100	6700	0.015	0.035	0.030 ²
6	2600	2460	40	3600	0.011	0.030	0.030 ²
7	2460	2380	80	4600	0.017	0.030	0.030 ¹
				Lc=29,560			

Note: The Basin Factors listed above were representative of (1) existing Normal Suburban Valley; (2) existing Normal Undeveloped Valley; (3) existing Average Undeveloped Foothills; or (4) existing Rough Overland Flow.

Basin Factors: The Basin Factors listed above were selected for Future Conditions, assuming no future channelization of the main watercourse. Values were selected from the values given in Tables 4.1, 4.2 and 4.3 based on a visual inspection of the Mannings n-value of the primary channel. All of the existing channels are believed to be competent relative to the 100-year peak discharge.

Summary of Rainfall Data: Rainfall Depths are determined by entering the Latitude and Longitude of the Watershed Centroid or Center of Gravity, which was measured to be: Latitude 32.1963 N, and Longitude 111.0523 W.

Summary of Soil and Vegetation Data:

Vegetation Cover Types and Densities: 100% of the watershed has Desert Brush Vegetation with a Cover Density of 20%

Soil Data (summary of watershed subareas by Hydrologic Soil Type and Curve Number):

	Desert Brush, 20% Cover Density				
Soil Types	Total	A	B	C	D
--	Curve Number	--	83	--	91
100% A	21 ac	21ac	--	--	--
100% B	6 ac	--	6 ac	--	--
47% B 53% D	25 ac	--	12 ac	--	13ac
100% D	1,892 ac	--	--	--	1,892 ac
Total	1,944 ac	21 ac	18 ac	--	1,905 ac

Percentage of the Watershed Occupied by each Hydrologic Soil Group:

Type B Soils = 2 % (39 acres, including those with Type A Soils, CN=83)
 Type D Soils = 98 % (1,905 acres with CN=91)

Percentage of Impervious Cover: From Table 3, The future Impervious Cover is estimated to be 35% for the 400 acres of the watershed located near Mission Road having R-1 Zoning, 10% for the 400 acres with SR Zoning, and 0% Impervious Cover for the remaining 1,144 acres located above the Park Boundary. The area-weighted Impervious Cover is thus calculated to be 9 %.

Summary of Computed Flood Peaks for Return Periods Ranging from 2-years to 100-years:

Return Period, Years	Flood Peak Calculated by PC-HYDRO, cfs	Flood Peak Predicted by the USGS from Gage Data, cfs ¹	Ratio of Flood Peaks Calculated by PC-HYDRO and the USGS Gage Data
2	340.2	63	5.40
5	870.4	390	2.23
10	1,394.6	887	0.97
25	2,247.2	1,940	1.16
50	3045.6	3,060	1.00
100	3931.1	4,460	0.94

¹ Pope et al. 1998.

As can be seen above, there is a good comparison between the less frequent flood peaks calculated using PC-HYDRO and those calculated by the U. S. Geological Survey using gage data. In this case the 100-year flood peak based on the statistical analysis of the gage data is greater than the estimate from PC Hydro. Conversely, PC Hydro predicts a much greater discharge for the more frequent storms, such as the two year storm, which is approximately five times greater than that determined from gage data.



HYDROLOGIC DATA SHEET FOR PIMA COUNTY FLOOD PEAK PROCEDURE
 Generated using methods provided by Pima County Regional Flood Control District

Client:	PCRFC	Prepared by:	JMT/RHW
Project Name:	PC-HYDRO User Guide Example #4	Date:	5/9/2006
Concentration Point:	Enchanted Hills Wash, Future Conditions, Q100	Job #	PDOT
Watershed Area:	1944 Acres	Watershed Type	Undeveloped-Foothills

Watercourse Data By Reach				
Reach No.	Height (Hi)	Length (Li)	Slope (Si)	Basin Factor (Nb)
1	240	1000	0.24	0.08
2	100	3400	0.0294	0.035
3	100	4060	0.0246	0.035
4	100	6200	0.0161	0.03
5	100	6700	0.0149	0.03
6	40	3600	0.0111	0.03
7	80	4600	0.0174	0.03

Length of Watercourse (Lc):	29560 feet	Mean Slope:	0.018
Length to Cen. of Gravity (Lca):	19580 feet	Weighted Basin Fac:	0.03
Veg. Cover Type(s):	Desert Brush	Veg. Cover Density:	20

RETURN PERIOD: 100-years NOAA Data Obtained: 2017-04-17 08:51:05 AM

Rainfall Depths:	NOAA Atlas 14 (90% UCL) @ Latitude: 32.1963 Longitude: -111.0523									
Duration:	5-min	10-min	15-min	30-min	1-hr	2-hr	3-hr	6-hr	12-hr	24-hr
Point Values (in):	0.88	1.34	1.66	2.24	2.77	3.08	3.21	3.48	3.77	4.36

Soil Type	Percent	Curve # (CN)	Adj. Curve # (CN*)	Runoff Coef. (C)
B	2	83	88.89	0.694
C	-	-	-	-
D	98	91	94.37	0.835
Imp.	9	99	99	0.969

Weighted Runoff Coef. (Cw):	0.76
Time of Concentration:	63.5 min
Rainfall Intensity (i) @ Tc:	2.63 in/hr
Runoff Supply Rate (q) @ Tc:	2.01 in/hr

Calculation performed 2017-05-05 03:31:08 PM by PC-Hydro V6.1

PEAK DISCHARGE: 3931.1 cfs

Example 5:

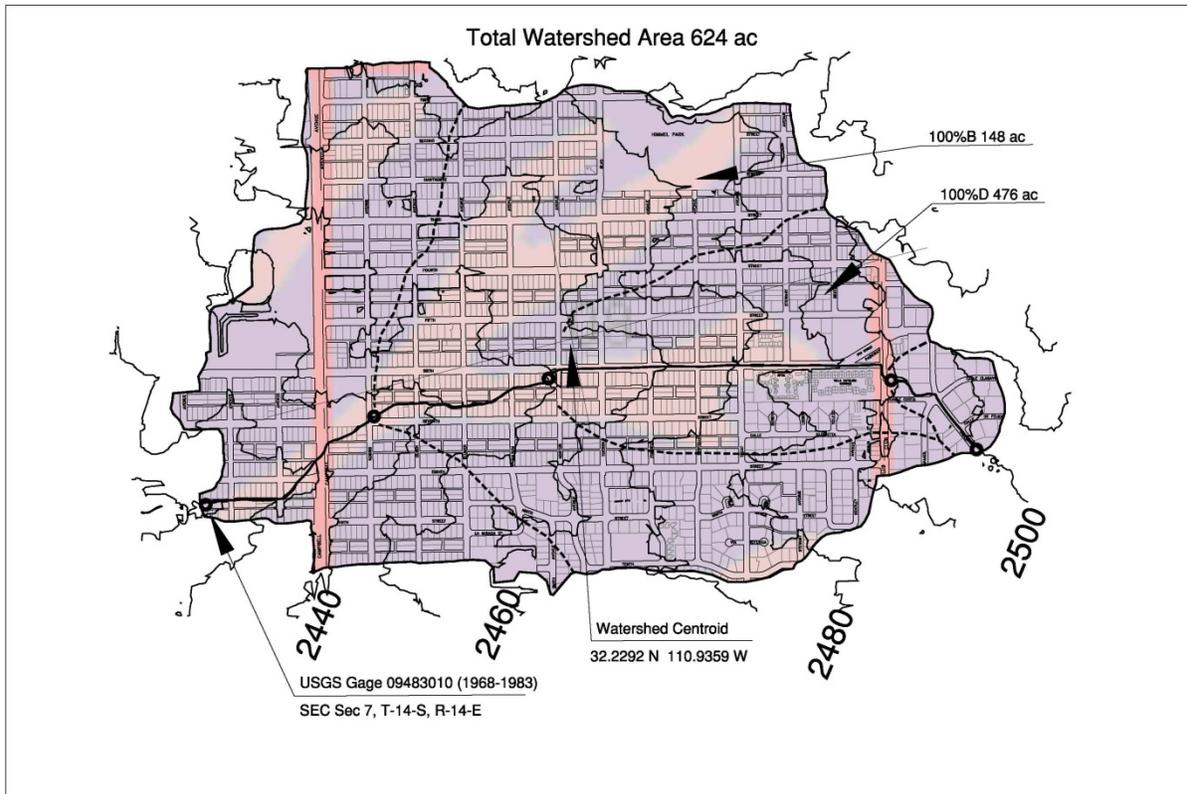
High School Wash at Vine Avenue

Example #5: High School Wash at Vine Avenue

Description of the Watershed:

High School Wash is a Moderately Urban watershed with Shallow Sheetflow. It is fully developed with an estimated urban density of 3.1 residences per acre, and the existing unimproved drainageways are unable to contain the 100-year peak discharge. This watershed is located within incorporated City of Tucson. Additionally, the mouth or concentration point of this 0.9 square mile watershed is located at the former USGS stream gage # 09483010, which was in service for the 16 year period between 1968 and 1983. This particular wash was included in the original Pima County Hydrology Manual as Example #7.

The longest watercourse is about 1.5 miles long, and it has a main channel that follows open channels (28%), a series of box culverts (17%), and paved streets (55%). None of these drainages are able to transport the 100-yr peak discharge. Additionally, the contribution of tributary flow from the adjoining urban areas is significant. The Mannings N-values for the main channel were visually estimated, and ranged from 0.050 along the open-channel segments, to 0.020 for paved urban streets. Based on inspection of the Flood Insurance Rate Map of this area, this wash does not appear to be competent and cannot carry the entire 100-year peak discharge without overtopping. This segment of High School Wash has been identified as a WASH Ordinance watercourse, and therefore it is unlikely to be channelized in the foreseeable future. The Vegetation Type within this watershed is Urban Lawn, with an Average cover density.



Legend:

- Hydrologic Soil Group 100 % B
- Hydrologic Soil Group 100 % D
- Slope Length
- Topographic Contour (CI = 10')
- Section Lines



PAG 1998 Photo-Topographic Maps
Scale: 1"=1500'

High School Wash
at Vine Avenue
Pima County, Arizona

Watershed Boundary Map

Example #5

Summary of Watershed Data:

Watershed Area (A) = 624 acres
 Watershed Type = 100% Medium Density Urban
 Length of the Longest Watercourse (Lc) = 7,830 feet
 Length to the Center of Gravity (Lca) = 3,700 feet (measured)

Watercourse Data By Reach:

Reach No.	Starting Elevation (feet)	Ending Elevation (feet)	Height, Hi (feet)	Length, Li (feet)	Slope, Si (ft/ft)	Channel Mannings N-Value	Basin Factor, nb
1	2500	2488	12	1,050	0.014	0.05	0.050 ¹
2	2488	2450	38	3,290	0.012	0.05	0.050 ¹
3	2450	2430	20	1,670	0.017	0.025	0.025 ²
4	2430	2414	16	1,820	0.009	0.025	0.025 ²
				Lc=7,830			

Note: The Basin Factors listed above were representative of (1) existing Moderately Urban Shallow Sheetflow Areas (2) Light to Moderately Urban (3-5 houses/acre) maximum value for 3 houses/acre.

Basin Factors: The Basin Factors listed above were selected for Paved Sheet Flow Areas (table 4.3) because the existing watercourse and tributary channels are hydraulically rough and under sized for the 100-year event. Additionally, application of a Basin Factor of 0.022, representative of Light to Moderate Urbanization, will result in 2-, 10-, and 100-year flood peaks of 449 cfs, 872 cfs, and 3058 cfs, respectively, and which do not agree with flood peaks predicted using stream-gage data.

Summary of Rainfall Data: Rainfall Depths are determined by entering the Latitude and Longitude of the Watershed Centroid or Center of Gravity, which was measured to be: Latitude 32.2292 N, and Longitude 110.9359 W.

Summary of Soil and Vegetation Data:

Vegetation Cover Types and Densities: 100% of the watershed is Urban Lawn with an Average Cover Density.

Soil Data (summary of watershed subareas by Hydrologic Soil Type and Curve Number):

	Urban Lawn, Average Cover Density				
Soil Types	Total	A	B	C	D
--	Curve Number	--	--	86	90
100% C	148 ac	--	--	148 ac	--
100% D	476 ac	--	--	--	476 ac
Total	624 ac	0 ac	0 ac	148 ac	476 ac

Percentage of the Watershed Occupied by each Hydrologic Soil Group:

Type C Soils = 24 % (148 acres with CN=86)
 Type D Soils = 76 % (476 acres with CN=90)

Percentage of Impervious Cover: Based on information published by the Water Resources Research Center, the Impervious Cover of this watershed is estimated to be 30 %.

Summary of Computed Flood Peaks for Return Periods Ranging from 2-years to 100-years:

Return Period, Years	Flood Peak Calculated by PC-HYDRO, cfs	Flood Peak Predicted by the USGS from Gage Data, cfs ¹	Ratio of Flood Peaks Calculated by PC-HYDRO and the USGS Gage Data.
2	281	261	1.08
5	582.9	454	1.28
10	857.4	606	1.41
25	1,291.5	827	1.56
50	1,677.2	1,010	1.66
100	2,130.1	1,210	1.76

¹ Pope et al. 1998

As can be seen, there is a good comparison between the flood peaks calculated using PC-HYDRO and those calculated by the U. S. Geological Survey using gage data. Additionally, the ratios between these sets of calculated flood peaks range from 1.76 for the 100-year event, to 1.08 for the

2-year flood peak.



HYDROLOGIC DATA SHEET FOR PIMA COUNTY FLOOD PEAK PROCEDURE
 Generated using methods provided by Pima County Regional Flood Control District

Client:	<u>PCRFC</u>	Prepared by:	<u>JMT/RHW</u>
Project Name:	<u>PC-HYDRO User Guide Example #5</u>	Date:	<u>5/9/2006</u>
Concentration Point:	<u>High School Wash, Existing/Future Condit., Q100</u>	Job #	<u>PDOT</u>
Watershed Area:	<u>624 Acres</u>	Watershed Type	<u>Shallow Streetflow-Paved</u>

Watercourse Data By Reach

Reach No.	Height (Hi)	Length (Li)	Slope (Si)	Basin Factor (Nb)
1	12	1050	0.0114	0.05
2	38	3290	0.0116	0.05
3	20	1670	0.012	0.025
4	16	1820	0.0088	0.025

Length of Watercourse (Lc):	<u>7830</u> feet	Mean Slope:	<u>0.0109</u>
Length to Cen. of Gravity (Lca):	<u>3700</u> feet	Weighted Basin Fac:	<u>0.025</u>
Veg. Cover Type(s):	<u>Urban Lawns</u>	Veg. Cover Density:	<u>0</u>

RETURN PERIOD: 100-years NOAA Data Obtained: 2017-04-17 10:12:36 AM

Rainfall Depths:	<u>NOAA Atlas 14 (90% UCL) @</u>										Latitude:	<u>32.2292</u>	Longitude:	<u>-110.9359</u>
Duration:	<u>5-min</u>	<u>10-min</u>	<u>15-min</u>	<u>30-min</u>	<u>1-hr</u>	<u>2-hr</u>	<u>3-hr</u>	<u>6-hr</u>	<u>12-hr</u>	<u>24-hr</u>				
Point Values (in):	<u>0.87</u>	<u>1.32</u>	<u>1.64</u>	<u>2.21</u>	<u>2.73</u>	<u>3.03</u>	<u>3.18</u>	<u>3.39</u>	<u>3.67</u>	<u>4.17</u>				

Soil Type	Percent	Curve # (CN)	Adj. Curve # (CN*)	Runoff Coef. (C)
B	-	-	-	-
C	24	86	90.9	0.741
D	76	90	93.6	0.812
Imp.	30	99	99	0.969

Weighted Runoff Coef. (Cw):	<u>0.77</u>
Time of Concentration:	<u>30.3</u> min
Rainfall Intensity (i) @ Tc:	<u>4.39</u> in/hr
Runoff Supply Rate (q) @ Tc:	<u>3.39</u> in/hr
PEAK DISCHARGE:	<u>2130.1</u> cfs

Calculation performed 2017-04-17 10:25:29 AM by PC-Hydro V6.01

Example 6:

Hot Shot Arroyo near Ajo, Arizona

Example #6: Hot Shot Arroyo near Ajo, Arizona

Description of the Watershed: Hot Shot Arroyo is an undeveloped desert watershed near Ajo, Arizona. The mouth of this 0.5-square mile watershed is located at the former USGS stream gage # 09520110, which was in service for the 16 year period between 1966 and 1981.

The slope of the longest watercourse is extremely steep near the top (18%), and less steep (<1%) in the lower half of the watershed. The main channel itself is mapped as Xeroriparian C and tends to be brushy. Because of the steep, mountainous terrain in the upper part, Mannings N-values for the overland flow part are estimated at 0.08. For the lower two reaches, vegetation along the channel tends to keep roughness values high. There is only one Vegetation Type within this watershed, and it can be characterized as Desert Brush.

Summary of Watershed Data:

Watershed Area (A) = 305 acres

Watershed Type = 80% Undeveloped Foothills,
20 % Undeveloped- Mountain

Length of the Longest Watercourse (Lc) = 9,029 feet

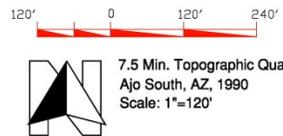
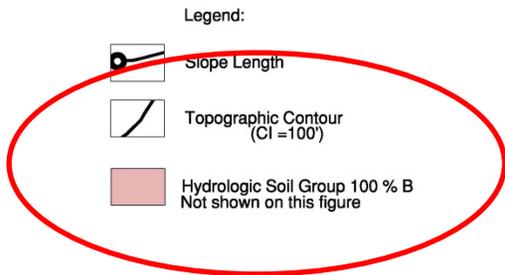
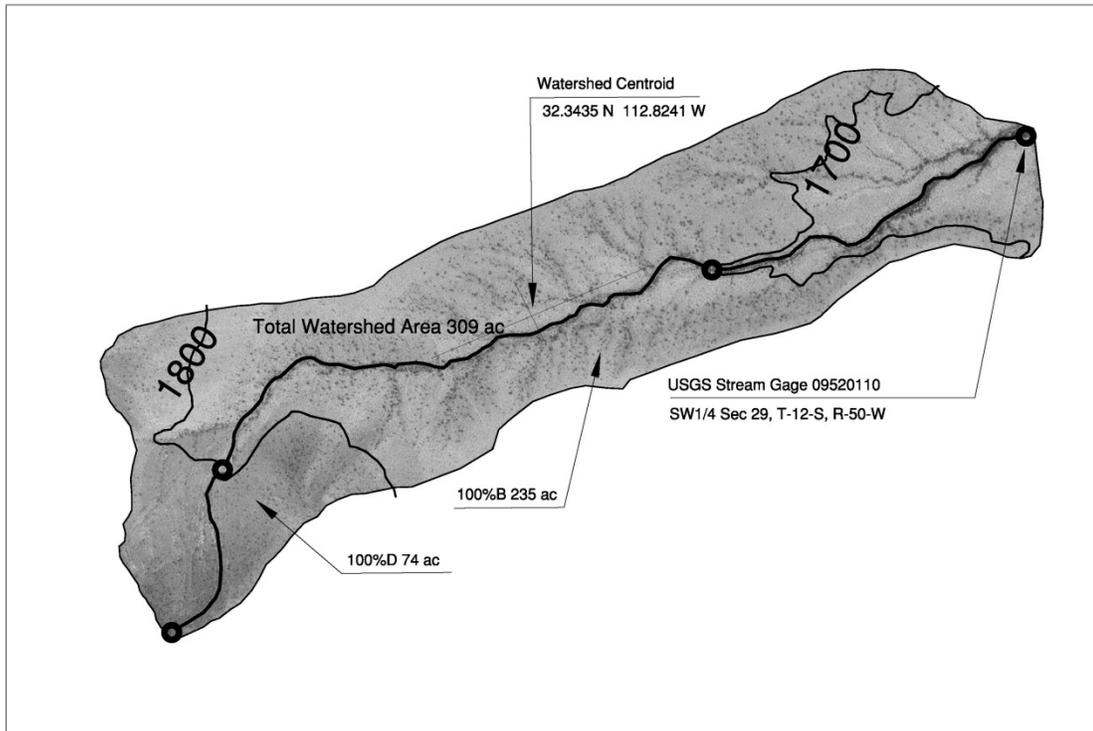
Length to the Center of Gravity (Lca) = 4,565 feet

Summary of Watercourse Data By Reach:

Reach No.	Starting Elevation (feet)	Ending Elevation (feet)	Height, Hi (feet)	Length, Li (feet)	Slope, Si (ft/ft)	Channel Mannings N-Value	Basin Factor, nb
1	2150	1760	390	2,151	0.1813	0.080	0.080 ¹
2	1760	1720	40	2,200	0.0182	0.040	0.040 ²
3	1720	1682	38	4,678	0.0081	0.040	0.045 ³
				Lc=9,029			

Note: The Basin Factors listed above were representative of (1) maximum rough Overland Flow (2) maximum foothills (3) average to rough valley roughness.

Summary of Rainfall Data: Rainfall Depths are determined by entering the Latitude and Longitude of the Watershed Centroid or Center of Gravity, which was measured to be: Latitude 32.3435 N, and Longitude 112.8241 W.



Hot Shot Arroyo Near Ajo, AZ
 U.S.G.S. Stream Gage 09520110 (1966-1981)
 Pima County, Arizona

Watershed Boundary Map

Example #6

Summary of Soil and Vegetation Data: Vegetation Cover Types and Densities: 100% of the watershed is Desert Brush Vegetation with good Cover Density.

Soil Data (summary of watershed subareas by Hydrologic Soil Type and Curve Number):

	Desert Brush, 30% Cover Density				
Soil Types	Total	A	B	C	D
--	Curve Number	--	82	--	90
100% A	143 ac	143	--	--	--
100% D	98 ac	--	--	--	98 ac
67% B 33% D	64 ac	--	43 ac	--	21 ac
Total	305 ac	143 ac	43 ac	--	119 ac

Percentage of the Watershed Occupied by each Hydrologic Soil Group:

Type B Soils = 60.8% (CN=82)

Type D Soils = 39.2% (CN=90)

Percentage of Impervious Cover: 0%

Summary of Computed Flood Peaks for Return Periods Ranging from 2-years to 100-years:

Return Period, Years	Flood Peak Calculated by PC-HYDRO, cfs	Flood Peak Predicted by the USGS from Gage Data, cfs ¹	Ratio of Flood Peaks Calculated by PC-HYDRO and the USGS Gage data
2	21	136	0.15
5	85.4	191	0.45
10	162.1	226	0.72
25	301	268	1.12
50	429.2	298	1.44
100	620.9	327	1.90

¹ Pope et al. 1998.



HYDROLOGIC DATA SHEET FOR PIMA COUNTY FLOOD PEAK PROCEDURE
 Generated using methods provided by Pima County Regional Flood Control District

Client:	PCRFC	Prepared by:	HEC/JMT/RHW
Project Name:	PC-HYDRO User Guide Example #6	Date:	8/30/2006
Concentration Point:	Hot Shot Arroyo near Ajo, Existing Conditions, Q100	Job #	PDOT
Watershed Area:	305 Acres	Watershed Type	Undeveloped-Mountain

Watercourse Data By Reach

Reach No.	Height (Hi)	Length (Li)	Slope (Si)	Basin Factor (Nb)
1	390	2151	0.1813	0.08
2	40	2200	0.0182	0.04
3	38	4678	0.0081	0.045

Length of Watercourse (Lc):	9029 feet	Mean Slope:	0.0152
Length to Cen. of Gravity (Lca):	4565 feet	Weighted Basin Fac:	0.045
Veg. Cover Type(s):	Desert Brush	Veg. Cover Density:	30

RETURN PERIOD: 100-years NOAA data user generated

Rainfall Depths:	NOAA Atlas 14 (90% UCL) @ Latitude: 32.3435 Longitude: -112.8241									
Duration:	5-min	10-min	15-min	30-min	1-hr	2-hr	3-hr	6-hr	12-hr	24-hr
Point Values (in):	0.9	1.37	1.7	2.29	2.83	3.25	3.44	3.79	4.08	4.53

Soil Type	Percent	Curve # (CN)	Adj. Curve # (CN*)	Runoff Coef. (C)
B	60.8	82	88.2	0.674
C	-	-	-	-
D	39.2	90	93.6	0.812
Imp.	0	99	99	0.969

Weighted Runoff Coef. (Cw):	0.62
Time of Concentration:	48.5 min
Rainfall Intensity (i) @ Tc:	3.24 in/hr
Runoff Supply Rate (q) @ Tc:	2.02 in/hr
PEAK DISCHARGE:	620.9 cfs

Calculation performed 2017-05-08 12:16:01 PM by PC-Hydro V6.1