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Impacts to Sizing of Conservation Practices in Pennsylvania from Implementation of NOAA14 Rainfall Data

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Abstract.

Since its release in May 1960, the USDA-Natural Resources Conservation Service (NRCS) has used the National Weather Service Technical Paper No. 40 (TP-40) as the primary reference to establish design rainfall volumes for various frequency storms. The standard NRCS Type II design rainfall distribution is most widely used across the USA. Developed using the TP-40 data, it is coupled with the rainfall volumes and is used with predictive hydrology models to size conservation practices for agricultural applications. The National Weather Service has recently updated TP-40 with newer and more comprehensive data in the form of NOAA Atlas 14 for select portions of the U.S., including Pennsylvania (PA). This produces new design storm volumes and distributions (per frequency).

Various counties in PA have been analyzed to determine the typical magnitude of change (if any) to predicted design peak discharge rates and related impact to sizing of agricultural conservation practices when switching from TP-40/Type II distribution to NOAA Atlas 14 rainfall volume/distribution. The primary focus is on surface water conveyance practices such as diversions and waterways. The NRCS runoff estimation method and grassed waterway design procedure (NRCS Engineering Field Handbook), PA conservation practice design standards (NRCS Field Office Technical Guide, Section IV), and NRCS Win TR20 hydrology model serve as the basis for evaluation of design peak discharge and hydraulic capacity of the practices.

Keywords. Agricultural Conservation Practices, National Weather Service NOAA14 Rainfall, National Weather Service TP-40 Rainfall, Design Rainfall Distribution, Pennsylvania

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Introduction

Since its release in May 1960, the USDA-Natural Resources Conservation Service (NRCS) has used the National Weather Service Technical Paper No. 40 (TP-40) as the primary reference to establish design rainfall volumes for various frequency storms. The standard NRCS Type II design rainfall distribution is most widely used across the USA. Developed using the TP-40 data, it is coupled with the rainfall volumes and is used with predictive hydrology models to size conservation practices for agricultural applications. The National Weather Service has recently updated TP-40 with newer and more comprehensive data in the form of NOAA Atlas 14 (NOAA14) for select portions of the U.S., including Pennsylvania (PA). This produces new design storm volumes and the ability to construct new distributions (per storm frequency).

Questions arise as to what impacts to size of agricultural conservation practices are anticipated in PA with the advent of these new design rainfall amounts and distributions. Various counties in PA have been analyzed to determine the typical magnitude of change (if any) to predicted design peak discharge rates and related impact to sizing of agricultural conservation practices when switching from TP-40/Type II distribution to NOAA14 rainfall volume/distribution. The primary focus is on surface water conveyance practices such as diversions and waterways. The NRCS runoff estimation method and grassed waterway design procedure (NRCS Engineering Field Handbook), PA conservation practice design standards (NRCS Field Office Technical Guide, Section IV), and NRCS Win TR20 hydrology model serve as the basis for evaluation of design peak discharge and hydraulic capacity of the practices.

Predicted runoff volume alone does not directly affect the design of typical agricultural conservation practices. As such, the anticipated impacts upon runoff volume prediction from adopting NOAA14 design rainfall amounts in Pennsylvania were not investigated. This feature is likely of interest to those involved with urban stormwater management in Pennsylvania where recent emphasis has been placed on the capture of increased runoff volume predicted as a result of land development. The NRCS Runoff Curve Number method could be used to compare predicted runoff volumes when changing from TP-40 to NOAA14 design rainfall amounts.

Study Methodology

The sizing of engineered agricultural conservation practices such as grassed waterways and diversions is based on the hydrology of the watershed draining to them. These water conveyance practices are designed based upon predicted peak discharge from a specific frequency rainfall event. The design rainfall amount, along with the design rainfall distribution, plays a direct role in the resulting predicted peak discharge that becomes the basis for conveyance practice design. So a representation of comparisons between TP-40 and NOAA14 24-hour duration rainfall amounts in various counties throughout Pennsylvania is a logical place to begin when looking for anticipated impacts to sizing of these conveyance practices.

Singular points considered to be representative of the following Pennsylvania counties were used as the basis for comparison for impacts across the state: Beaver, Bradford, Bucks, Cambria, Centre, Chester, Clarion, Cumberland, Elk, Erie, Franklin, Greene, Lebanon, Luzerne, Mercer, Monroe, Northumberland, Potter, Wayne, and Westmoreland.

The design rainfall amounts using TP-40 and NOAA14 were compared for these counties. A vital part of watershed hydrology modeling by USDA/NRCS methods involves defining the

design variable intensity by which the rainfall event occurs, known as the “design rainfall distribution”. Historically, NRCS has used the Type II rainfall distribution along with the TP-40 rainfall amount to design agricultural conservation practices in Pennsylvania. The NRCS Type II distribution is based upon data from TP-40 and therefore may not be appropriate for use with NOAA14 rainfall amounts. NOAA14 offers rainfall amounts for various storm durations of 5 minutes to 24 hours and beyond for many storm frequencies. A test version of the NRCS Win TR20 computer hydrology program has been created that takes the NOAA14 rainfall data and creates various storm frequency design distributions that could be used with NOAA14 rainfall amounts when determining design peak discharges for agricultural conservation practices. Win TR20 can be run to compare the results (predicted peak discharges) of the historical TP-40/Type II distribution and pending NOAA14 amount/distribution hydrology model input parameters. Predicted peak discharges were evaluated in typical agricultural watersheds of 2 and 10.1 hectares in size for the counties listed above.

Lastly, peak discharges found in the previous step were used within the USDA/NRCS Engineering Field Handbook Chapters 7 and 9 along with USDA/NRCS Conservation Practice Standards 412 and 362 for Grassed Waterways and Diversions to determine the sizes of these practices required for the historic method and pending one for select counties within the list above.

Study Findings

Comparison of TP-40 vs NOAA14 Rainfall Amounts

Table 1 below shows the comparison of TP-40 and NOAA14 24-hr design rainfall amounts for the 1, 2, 5, and 10-year frequency storms for the Pennsylvania counties stated above.

Table 1. *Comparison of TP-40 and NOAA14 24-hr design rainfall amounts(cm) for the 1, 2, 5, and 10-year frequency storms for various Pennsylvania counties.*

	TP- 40	**NOAA14**	**TP- 40**	**NOAA14**	**TP- 40**	**NOAA14**	**TP- 40**	**NOAA14**
County	**1-yr**	**1-yr**	**2-yr**	**2-yr**	**5-yr**	**5-yr**	**10-yr**	**10-yr**
BEAVER	5.8	5.03	6.6	5.99	8.1	7.32	9.7	8.41
BRADFORD	5.8	5.33	7.1	6.38	9.1	7.77	10.7	8.92
BUCKS	6.4	6.93	8.4	8.36	10.7	10.54	12.7	12.37
CAMBRIA	6.1	5.46	7.1	6.53	8.6	8.13	10.7	9.55
CENTRE	5.8	5.69	7.1	6.81	9.1	8.46	10.9	9.78
CHESTER	6.6	6.88	8.1	8.28	10.7	10.36	12.7	12.12
CLARION	5.6	5.26	6.6	6.27	8.4	7.67	9.4	8.81
CUMBERLAND	6.1	6.20	7.4	7.44	9.7	9.25	11.9	10.87
ELK	5.8	5.38	6.9	6.45	8.6	7.87	9.9	9.07
ERIE	5.3	5.36	6.4	6.40	7.9	7.85	9.1	9.04
FRANKLIN	6.1	6.22	7.4	7.47	9.7	9.27	12.2	10.80
GREENE	5.8	5.26	6.6	6.25	8.6	7.59	9.9	8.71
LEBANON	6.4	6.45	7.6	7.77	10.2	9.83	12.2	11.61
LUZERNE	6.1	6.22	7.4	7.47	9.9	9.27	11.9	10.82
MERCER	5.6	5.16	6.4	6.17	8.1	7.54	9.4	8.66
MONROE	6.4	6.68	7.6	8.03	10.2	9.98	12.2	11.71
NORTHUMBERLAND	6.1	6.17	7.4	7.39	9.7	9.17	11.7	10.72
POTTER	5.8	5.28	6.9	6.30	8.6	7.77	10.2	9.04
WAYNE	6.1	6.17	7.4	7.39	9.9	9.17	11.9	10.69
WESTMORELAND	5.8	5.33	6.9	6.40	8.6	7.80	10.2	8.97

Table 2. *Comparison of TP-40 and NOAA14 24-hr design rainfall amounts (cm) for the 25, 50, and 100-year frequency storms for various Pennsylvania counties.*

	TP- 40	**NOAA14**	**TP- 40**	**NOAA14**	**TP- 40**	**NOAA14**
County	**25-yr**	**25-yr**	**50-yr**	**50-yr**	**100-yr**	**100-yr**
BEAVER	10.9	9.93	11.9	11.20	12.4	12.50
BRADFORD	12.4	10.44	13.7	11.68	14.7	12.95
BUCKS	14.7	15.06	16.3	17.32	18.3	19.79
CAMBRIA	12.2	11.66	13.2	13.51	14.5	15.60
CENTRE	12.2	11.79	13.7	13.44	14.7	15.24
CHESTER	14.2	14.63	16.0	16.74	18.0	19.00
CLARION	11.2	10.41	12.2	11.73	13.0	13.13
CUMBERLAND	13.0	13.41	14.7	15.75	16.3	18.49
ELK	11.4	10.82	12.4	12.27	13.5	13.84
ERIE	10.4	10.74	11.7	12.17	11.9	13.67
FRANKLIN	13.0	13.11	15.0	15.11	16.3	17.35
GREENE	11.2	10.24	12.4	11.48	13.2	12.80
LEBANON	13.5	14.30	15.2	16.69	17.0	19.38
LUZERNE	13.2	13.39	14.7	15.75	16.3	18.52
MERCER	10.7	10.26	11.9	11.56	12.2	12.90
MONROE	13.7	14.48	15.5	17.07	17.3	20.17
NORTHUMBERLAND	12.7	13.21	14.5	15.52	16.0	18.21
POTTER	11.7	11.00	12.7	12.78	13.7	14.81
WAYNE	13.2	13.08	15.2	15.29	17.0	17.86
WESTMORELAND	11.7	10.62	12.7	11.96	13.7	13.41

Table 3. Ratio *of NOAA14 to TP-40 24-hr design rainfall amounts for the 1, 2, 5, 10, 25, 50, and 100-year frequency storms for various Pennsylvania counties.*

	Ratio NOAA14:TP-40 24-hr Rainfall Amounts per Storm Frequency						
County	**1-yr**	**2-yr**	**5-yr**	**10-yr**	**25-yr**	**50-yr**	**100-yr**
BEAVER	0.86	0.91	0.90	0.87	0.91	0.94	1.00
BRADFORD	0.91	0.90	0.85	0.84	0.84	0.85	0.88
BUCKS	1.09	1.00	0.99	0.97	1.02	1.07	1.08
CAMBRIA	0.90	0.92	0.94	0.90	0.96	1.02	1.08
CENTRE	0.97	0.96	0.93	0.90	0.97	0.98	1.03
CHESTER	1.04	1.02	0.97	0.95	1.03	1.05	1.05
CLARION	0.94	0.95	0.92	0.94	0.93	0.96	1.01
CUMBERLAND	1.02	1.01	0.96	0.91	1.04	1.07	1.14
ELK	0.92	0.94	0.91	0.92	0.95	0.99	1.03
ERIE	1.00	1.01	1.00	0.99	1.03	1.04	1.14
FRANKLIN	1.02	1.01	0.96	0.89	1.01	1.01	1.07
GREENE	0.90	0.95	0.88	0.88	0.92	0.92	0.97
LEBANON	1.02	1.02	0.97	0.95	1.06	1.10	1.14
LUZERNE	1.02	1.01	0.94	0.91	1.01	1.07	1.14
MERCER	0.92	0.97	0.93	0.92	0.96	0.97	1.06
MONROE	1.05	1.05	0.98	0.96	1.06	1.10	1.17
NORTHUMBERLAND	1.01	1.00	0.95	0.92	1.04	1.07	1.14
POTTER	0.90	0.92	0.90	0.89	0.94	1.01	1.08
WAYNE	1.01	1.00	0.93	0.90	0.99	1.00	1.05
WESTMORELAND	0.91	0.93	0.90	0.88	0.91	0.94	0.98
AVERAGE	**0.97**	**0.97**	**0.94**	**0.91**	**0.98**	**1.01**	**1.06**

Figure 1 below is a geographical representation of Table 3. It is possible that some of the variations found are rooted in orographic effects.

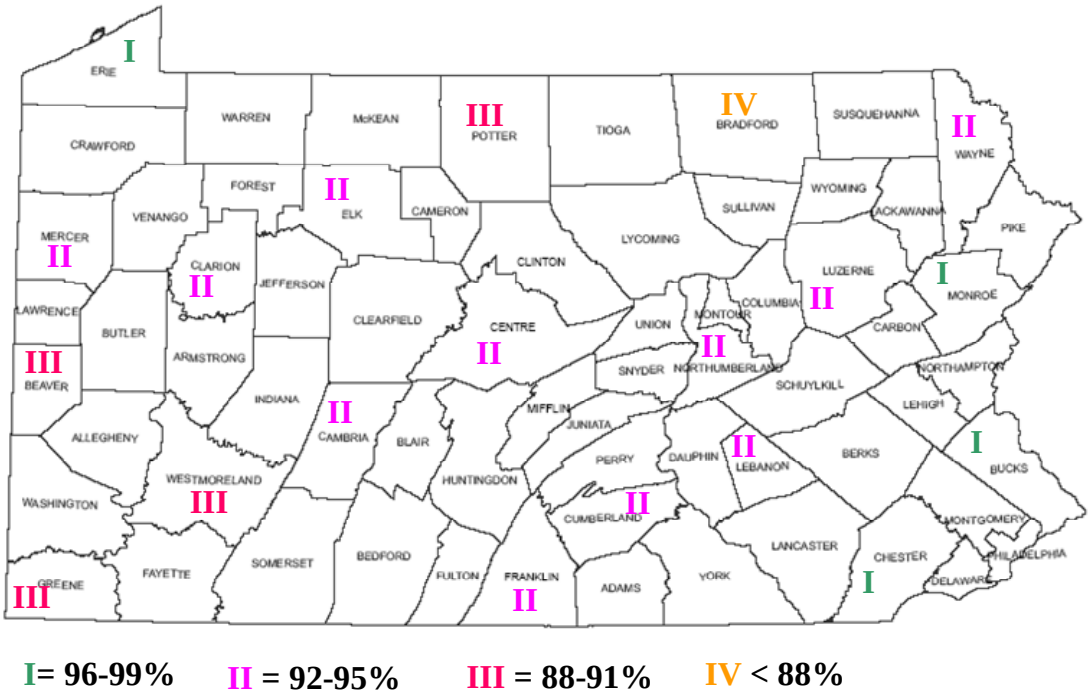
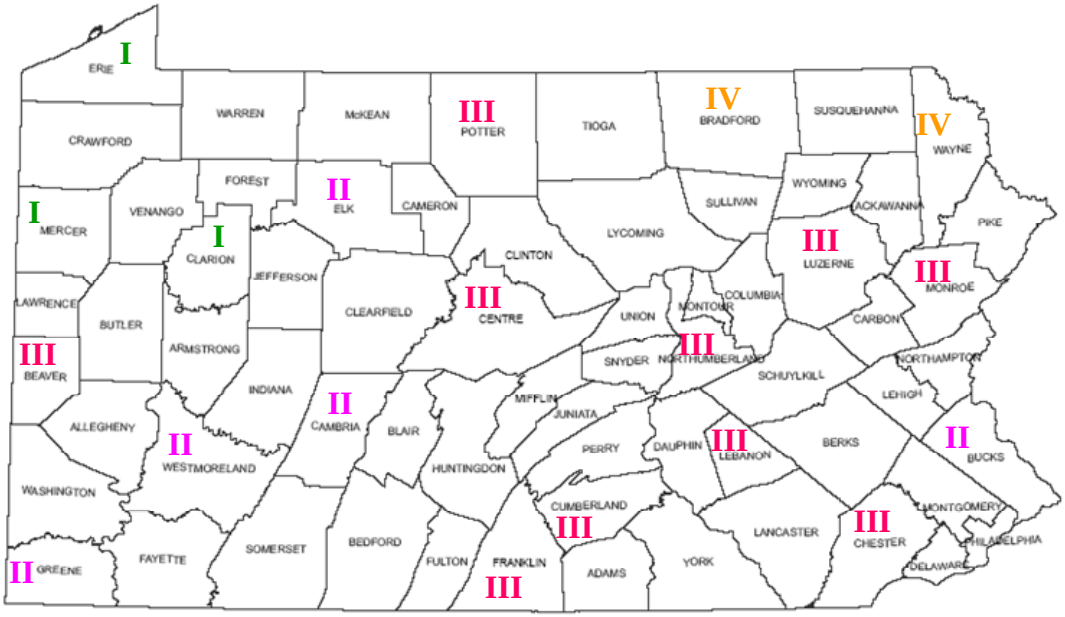


Figure 1. Average ratio of 10 and 25-yr, 24-hr NOAA14 : TP40 rainfall amounts in select Pennsylvania Counties.

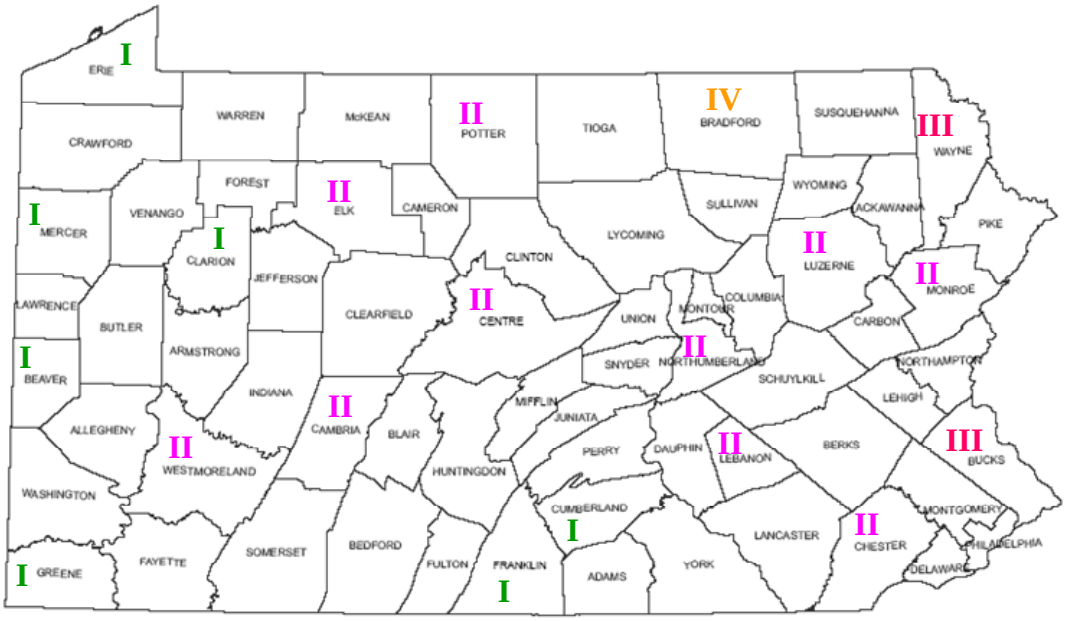
Comparison of TP-40 vs NOAA14 Predicted Peak Discharges

By taking the design rainfall amounts for the 10-yr and 25-yr, 24-hr storm per county listed in Figure 1 (for both TP-40 and NOAA14) and coupling with the referenced design storm distribution as previously described, the predicted peak discharges can be determined and compared. The 10 and 25-yr storms were selected since they are the basis for design as defined by Grassed Waterway and Diversion Practice Standards. This hydrologic modeling was done using the Win TR20 model. Typical values of RCN (75) and time of concentration (based on watershed size) were used. Figures 2 and 3 below shows the results of this analysis for each county listed in Figure 1. The results show the ratio of predicted peak discharges (NOAA14:TP-40). Figure 2 portrays this for the 10-yr frequency storm and Figure 3 is for the 25-yr storm.



I= +5 to -9% **II = -10 to -19%** **III = -20 to -29%** **IV = -30 to -35%**

Figure 2. Change in predicted peak discharge from TP-40 rain amount and Type II Distribution to NOAA14 rainfall amount and distribution for the 10-yr storm on small agricultural watersheds in select Pennsylvania Counties.



I= +5 to -9% **II = -10 to -19%** **III = -20 to -29%** **IV = -30 to -35%**

Figure 3. Change in predicted peak discharge from TP-40 rain amount and Type II Distribution to NOAA14 rainfall amount and distribution for the 25-yr storm on small agricultural watersheds in select Pennsylvania Counties.

Comparison of Resulting Grassed Waterway and Diversion Sizes

The sizes (width and depth) of the sample grassed waterways and diversions were found by taking the predicted peak discharges from three of the counties listed in Figure 3 (Bradford, Luzerne, and Cumberland) and applying the design methods found in EFH 7 and 9,.

Table 4. Changes in design sizes of grassed waterways and diversions in small agricultural watersheds in Bradford County, PA as a result of switching from TP-40 / Type II to NOAA14 rainfall definition.

Practice	Drainage Area (ha))	Design Storm	Rainfall Basis, TP-40 or NOAA14	Peak Q (m^3/s)	Slope (%)	Topwidth (m)	Depth (m)	Peak Q NOAA14: TP-40	Practice Size NOAA14:TP-40
Diversion-(parabolic)	2	10-yr	TP-40	0.34	1.5%	7.3	0.24	**68%**	**88%**
Diversion-(parabolic)	2	10-yr	NOAA14	0.23	1.5%	6.4	0.21		
Grassed Waterway	10.1	10-yr	TP-40	1.60	5%	11.0	0.21	**66%**	**65%**
Grassed Waterway	10.1	10-yr	NOAA14	1.05	5%	7.2	0.21		
Diversion-(parabolic)	2	25-yr	TP-40	0.44	1.5%	7.3	0.24	**68%**	**100%**
Diversion-(parabolic)	2	25-yr	NOAA14	0.30	1.5%	7.3	0.24		
Grassed Waterway	10.1	25-yr	TP-40	2.10	5%	14.3	0.21	**65%**	**66%**
Grassed Waterway	10.1	25-yr	NOAA14	1.37	5%	9.4	0.21		

Table 5. Changes in design sizes of grassed waterways and diversions in small agricultural watersheds in Cumberland County, PA as a result of switching from TP-40 / Type II to NOAA14 rainfall definition.

Practice	Drainage Area (ha)	Design Storm Frequency	Rainfall Basis, TP-40 or NOAA14	Peak Q (m^3/s)	Slope (%)	Topwidth (m)	Depth (m)	Peak Q NOAA14: TP-40	Practice Size NOAA14/TP-40
Diversion-(parabolic)	2	10-yr	TP-40	0.41	1.5%	7.3	0.24	**80%**	**100%**
Diversion-(parabolic)	2	10-yr	NOAA14	0.33	1.5%	7.3	0.24		
Grassed Waterway	10.1	10-yr	TP-40	1.96	5%	13.4	0.21	**77%**	**77%**
Grassed Waterway	10.1	10-yr	NOAA14	1.52	5%	10.4	0.21		
Diversion-(parabolic)	2	25-yr	TP-40	0.48	1.5%	7.3	0.24	**93%**	**100%**
Diversion-(parabolic)	2	25-yr	NOAA14	0.44	1.5%	7.3	0.24		
Grassed Waterway	10.1	25-yr	TP-40	2.24	5%	15.3	0.21	**91%**	**92%**
Grassed Waterway	10.1	25-yr	NOAA14	2.04	5%	14.0	0.21		

Table 6. Changes in design sizes of grassed waterways and diversions in small agricultural watersheds in Luzerne County, PA as a result of switching from TP-40 / Type II to NOAA14 rainfall definition.

Practice	Drainage Area (ha)	Design Storm Frequency	Rainfall Basis, TP-40 or NOAA14	Peak Q (m^3/s)	Slope (%)	Topwidth (m)	Depth (m)	Peak Q NOAA14: TP-40	Practice Size NOAA14/TP-40
Diversion-(parabolic)	2	10-yr	TP-40	0.41	1.5%	7.3	0.24	**78%**	**100%**
Diversion-(parabolic)	2	10-yr	NOAA14	0.32	1.5%	7.3	0.24		
Grassed Waterway	10.1	10-yr	TP-40	1.96	5%	13.4	0.21	**75%**	**75%**
Grassed Waterway	10.1	10-yr	NOAA14	1.48	5%	10.1	0.21		
Diversion-(parabolic)	2	25-yr	TP-40	0.49	1.5%	7.6	0.24	**87%**	**96%**
Diversion-(parabolic)	2	25-yr	NOAA14	0.42	1.5%	7.3	0.24		
Grassed Waterway	10.1	25-yr	TP-40	2.32	5%	15.8	0.21	**84%**	**84%**
Grassed Waterway	10.1	25-yr	NOAA14	1.95	5%	13.3	0.21		

Discussion of Results

Table 3 compares the ratio of NOAA14 to TP-40 rainfall frequency amounts per storm frequency for various PA counties. Some trends that emerge from this data are as follows:

1. NOAA 14 amounts per storm frequency are largely, though not always, less than their TP-40 counterpart.
2. The lowest NOAA14:TP-40 ratio typically occurs for the 10-yr frequency storm. These were all less than 1.0 with a minimum value found to be 0.84, in Bradford County. This means that the NOAA14 value is 84% of the TP-40 rainfall amount. The largest value of this ratio for the 10-yr storm was 0.99, or that the NOAA14 value is 99% of the TP-40 value and was in Erie County. The average ratio for this study found a 9% decrease in 10-yr, 24-hr rainfall depth from TP-40 to NOAA14.
3. The largest NOAA14:TP-40 ratio typically occurs for the 100-yr frequency storm and is most often greater than 1.0. This means that the NOAA14 100-yr values are largely greater than the TP-40 ones across PA. The largest value found in this investigation was a 17% increase in Monroe County for the 100-yr rainfall amount. The lowest value ratio for the 100-yr showed a 12% decrease from TP-40 to NOAA14 rainfall depth in Bradford County. The average ratio for this study found a 6% increase in 100-yr rainfall depth from TP-40 to NOAA14.
4. Figure 1 shows the geographical placement of the 10-yr and 25-yr rainfall ratios (averaged) on a map of PA counties. These two design storms are the basis for the majority of agricultural conservation practices applied. The mapped display of these ratios by similar grouping may reveal trends applicable to surrounding counties not studied by this work. This map shows the northwest and south east corners of the state to have ratios of NOAA14 to TP-40 rainfall depths of near 1.0 for these two storms. This means that there is the lowest change in design rainfall amounts to take place in the entire state. A band that runs the diagonal from inside the northwest corner to the southeast corner contains the group of counties that show a five to eight percent decrease from TP-40 to NOAA14 for the storms as described above. The southwest corner and north-central part of the state show nine to twelve percent decreases in this ratio. The northeast corner showed the lowest value of this ratio with greater than a twelve percent reduction found. Design rainfall amounts and any changes to them directly affect the predicted runoff depth. Predicted peak rates of runoff are influenced by design rainfall amounts as well but are also based upon the assumed design rainfall distribution, or varying rate of rainfall within the storm.
5. Figure 2 shows the anticipated change in predicted peak discharge from the 10-yr, 24hr rainfall on small agricultural watersheds. The pattern of influence across the state is not the same as found when examining rainfall amounts only. The reason for this is that county-specific, rainfall frequency-specific, design rainfall distribution is likely different in comparison to each other and when compared to the NRCS Type II design rainfall distribution that has been used across the state in conjunction with TP-40 rainfall data. A trial version of Win TR20 has been created that constructs storm frequency specific design rainfall distributions for any site specified in NOAA14. The rainfall distribution is combined with rainfall amount, drainage area, runoff curve number, and time of concentration to predict peak discharge. Typical values for the last three variables listed, relating to small agricultural practices, were assumed and input into Win TR20 to determine design predicted peak discharges for these practices. The same Win TR20 files were modified to include TP-40 rainfall amounts and the Type II distribution. This

served as a basis for comparison of the values that were typically obtained by the former method. Figure 3 shows the same thing but for the 25-yr, 24-hr storm. The differences shown on these figures between NOAA14 and TP-40 are due largely to both the changes in rainfall amounts and rainfall distributions assumed. There may also be some influence attributed to RCN assumed (75 in all trials for this study), time of concentration (defined by the NRCS Lag method) and drainage areas tried. Other trials using different RCN's and/or watershed areas (and the influence on time of concentration commensurate with these assumptions) could produce different results. The standard NRCS Dimensionless Unit Hydrograph (peak factor 484) was assumed for all trials performed.

6. Tables 3, 4, and 5 show the impact that the changes in predicted peak discharge will have on the sizing of water conveyance practices in small agricultural watersheds in Bradford, Cumberland, and Luzerne counties. The assumptions made for these trials were that a 2 hectare watershed drained to a Diversion practice and a 10.1 hectare watershed drained to a Grassed Waterway practice (both practices of parabolic shape). A 5% slope was assumed to be present where the Grassed Waterway practice was applied and the Diversion practice was assumed to be constructed on typical slope of 1.5%.

   Standard NRCS principles for design of these practices involving dual retardance friction for capacity and stability were utilized. A typical implementation guideline of many conservation engineers and technicians was used. This guideline maintains a minimum topwidth to maximum depth ratio of 30:1 for the parabolic section. This shape allows for easy passage of farm equipment thereby making the practice more practical to apply. A maximum allowable flow velocity of 1.2 m/s was used in these sample designs. The Grassed Waterway practice designs in this study were sized based on this maximum velocity. The combination of 5% slope and 30:1 (W:D) ratio brought this about.

   The Diversion practice designs in this study typically achieved a maximum flow velocity of only 0.6 m/s and were somewhat inefficient in this regard. The 30:1 (W:D) shape and 1.5% slope lead to this. The difference in performance of these two practices just stated is what leads to the anticipated changes in their sizing through the influence of NOAA14 related peak discharge changes. For a Grassed Waterway, it was observed that percent change in design size (topwidth) was exactly whatever the NOAA14 induced percent change in predicted peak discharge was. Diversion sizing was affected in some cases but to a much lesser extent and most frequently not at all.

   Bradford County (the county from this study that showed the most significant decrease in NOAA14 induced predicted peak discharge) showed a NOAA14 induced 32% reduction in peak discharge for both a 10-yr and 25-yr frequency event on a 2 hectare watershed yet the design topwidth for the Diversion for the 10-yr storm decreased by only 12% and did not decrease at all for the 25-yr event. The other two counties (Cumberland and Luzerne) checked for this phenomena showed virtually no change in required Diversion sizing based upon NOAA14 induced changes to peak discharge for both the 10-yr and 25-yr frequency storms. The observations of these trends from these three counties are believed to be indicative of the rest of the state.

Conclusion

The sizes of water conveyance conservation practices on small agricultural watersheds in Pennsylvania will typically either decrease or remain unchanged due to recent changes in assumed design rainfall amounts and related distribution. Any change in practice size is directly

related to changes in predicted peak discharge brought. The change in rainfall defining assumptions used in hydrologic modeling related to the recent switch from TP-40 and Type II distribution to that based on NOAA14 amount and distribution will affect predicted peak discharge.

Parabolic Grassed Waterway sizes (topwidths) will likely change according to the change in predicted peak discharge for either the NOAA14-based 10 or 25-yr storm, whichever is applicable to practice constraints. The observed predicted changes are mostly decreased from the current TP-40 and Type II distribution based values, ranging from a 5% increase to a 38% decrease.

Parabolic Diversions designs will not be strongly influenced by the NOAA14-based changes to predicted peak discharge. This is largely due to their typical constructed bedslope of 1.5% and 30:1 topwidth : maximum depth ratio typically sought by designers. This arrangement is not sensitive to the typical changes in peak discharge brought about by switching over to the NOAA14-based hydrologic analysis.

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