Classifying the Recurrence Interval (Frequency) of Actual Storm Events using the National Weather Service Precipitation-Frequency Data Server

INTRODUCTION

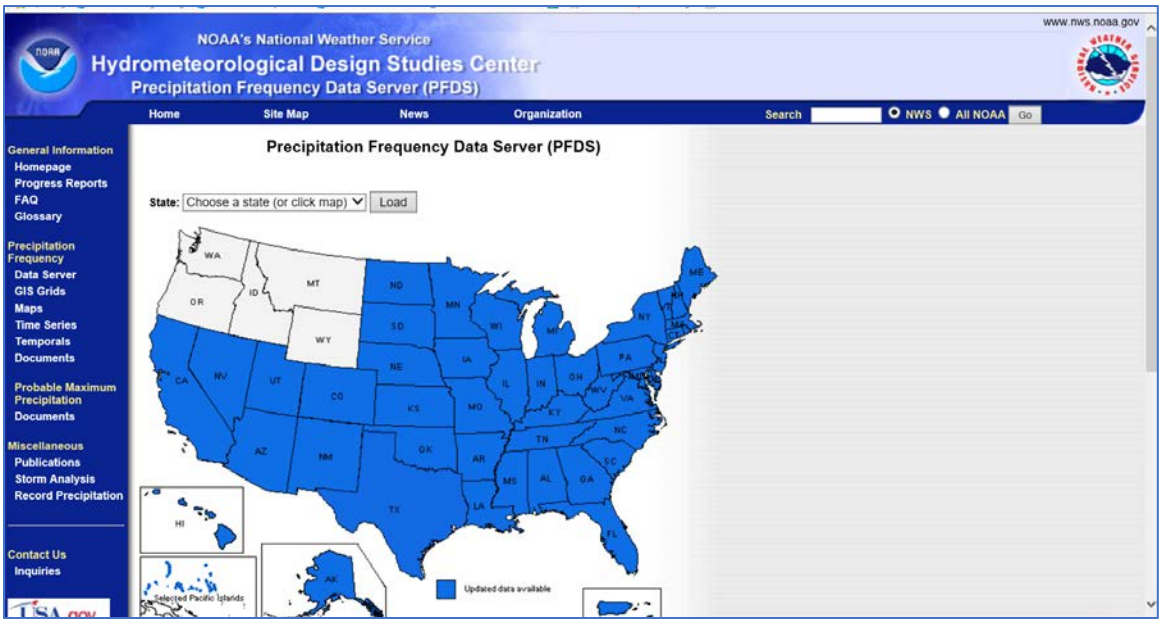
Classifying actual rainfall events as to their recurrence interval or frequency is important for many reasons including evaluating the impacts of an actual event in relation to past events at a specific location. This document provides information on:

1) Obtaining precipitation-frequency estimates for locations within the United States,
2) Sources of individual storm event rainfall amounts for actual storms, and
3) Classifying the recurrence interval or frequency of actual storm events using the precipitation-frequency data.

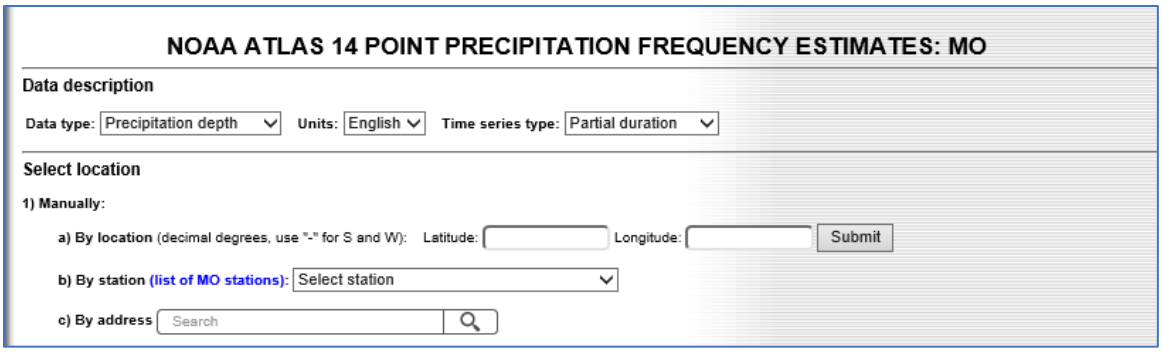
OBTAINING PRECIPITATION–FREQUENCY DATA FOR A SPECIFIC LOCATION

The National Oceanic and Atmospheric Administration (NOAA) – National Weather Service (NWS) publishes precipitation-frequency data for the United States as volumes of NOAA Atlas 14. These data are available through NOAA's NWS Hydrometeorological Design Studies Center at http://www.nws.noaa.gov/oh/hdsc/index.html.

These data are publicly available. Anyone can obtain the most up-to-date precipitation frequency data through the Precipitation Frequency Data Server (PFDS) at https://hdsc.nws.noaa.gov/hdsc/pfds/index.html.



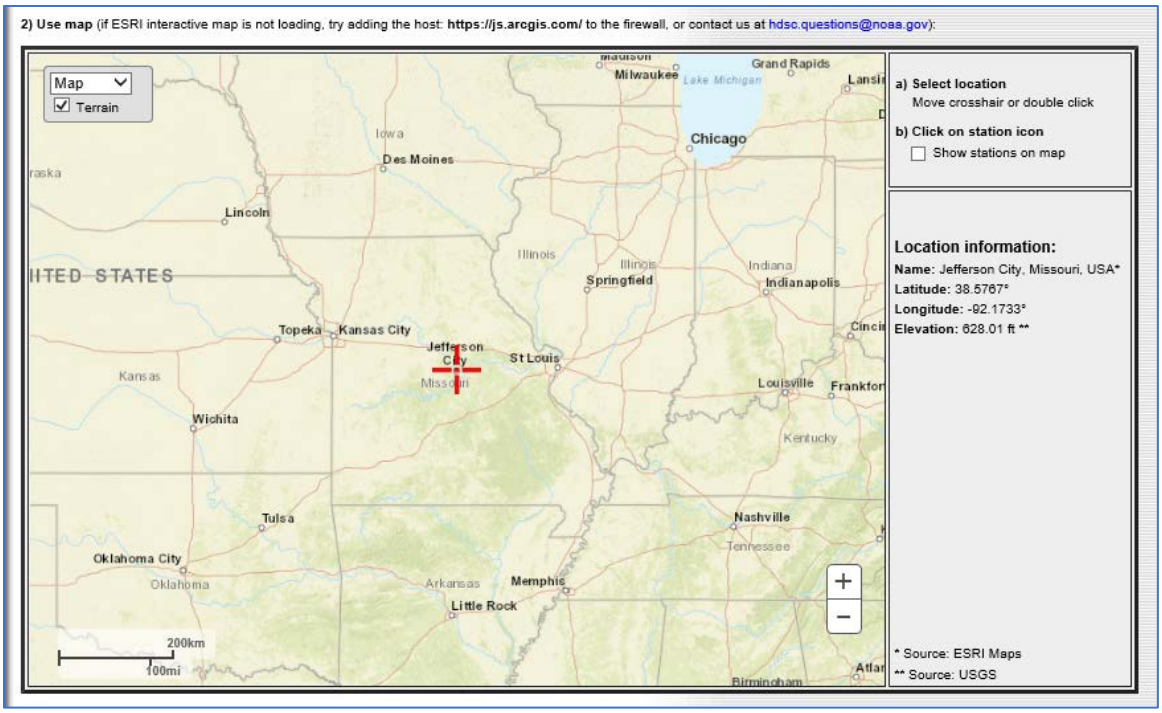
To find precipitation-frequency data for a specific location either select the State name from the dropdown list and click the Load button or click on the State of interest on the map. This opens the NOAA Atlas 14 Point Precipitation Frequency Estimates map for the State of interest.



Under the Data description, ensure that Data type is set to Precipitation depth; Units is set to English; and Time series type is set to Partial duration.

Select a specific location using one of the following methods:

1) Manually:
    a) By location, by entering latitude and longitude,
    b) By station, by selecting National Weather Service station location using the dropdown list, or
    c) By address. This option is very flexible. It allows a range of inputs from street address to something like County Name, State.



a) Use the ESRI interactive map by selecting a location moving the red map crosshairs or double clicking on the desired location.

Note that entering the location manually when using method 1 centers the map to the location entered.

Scroll to the bottom of the page to see the Point Precipitation Frequency (PF) Estimates table. These estimates are based on a partial duration series analysis and includes 90 percent confidence intervals. Confidence intervals indicate with 90 percent confidence that actual rainfall amount for a specific recurrence will fall between the two defined values.

SOURCES FOR OBTAINING RAINFALL DATA FOR ACTUAL STORM EVENTS

When classifying the recurrence interval (frequency) of actual storm events, it is important to use actual data recorded at an hourly or, if possible, sub-hourly interval. While NRCS typically uses a 24-hour rainfall event for a specified frequency when designing conservation practices, rain normally only falls in short intervals within that 24-hour period. The design tools NRCS uses take this phenomenon into account. The intent is to design a practice to control a particular frequency event (in many cases for NRCS practices, a 10-year event), and not an event of a specific duration.

Even though rainfall is often reported as daily values, the frequency classification of an actual storm event cannot be determined solely by looking at the 24-hour rainfall amount. Duration must also be considered. The examples presented in the following section of this document illustrate this.

The following are potential sources for rainfall data from actual events. This document will not go through the process of obtaining data.

1) *AgACIS*. The Agricultural Applied Climate Information System (AgACIS) module within the NRCS Field Office Technical Guide. The NOAA Northeast Regional Climate Center (NRCC) developed the AgACIS module in conjunction with NRCS to serve NOAA official climate data, housed at NOAA's

National Centers for Environmental Information (NCEI) for NRCS use. See item 3 below for more information on NCEI. Through AgACIS, NRCS users (and others – AgACIS is publicly available) can obtain daily climate data as well as a variety of reports customized for NRCS use. Note that only daily (24-hour) rainfall amounts are available through AgACIS; and they are not typically beneficial for classification of storm event purposes.

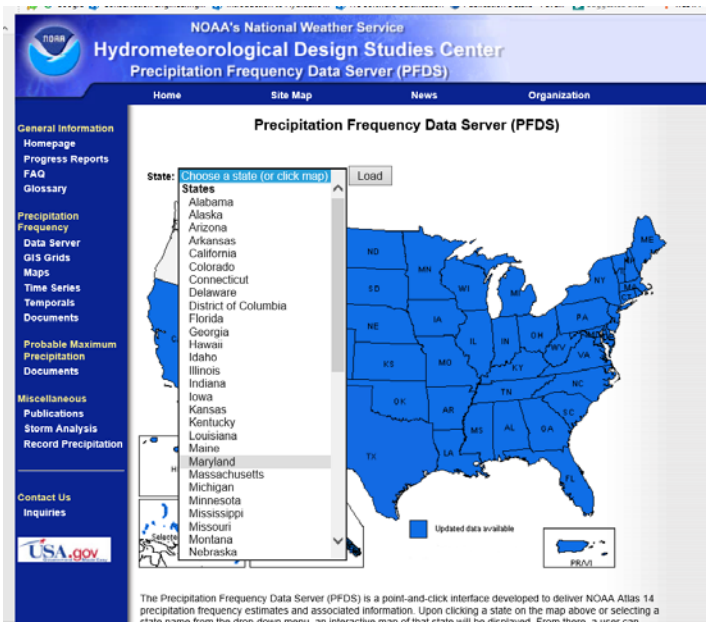
2) *State Climatologist.* Each State has a designated state climatologist, typically located at a land-grant university. It is the state climatologist's job to provide climatological data and they can typically provide provisional data shortly after a storm event, prior to NOAA's official certification of the data. NRCS employees should work through their state hydraulic engineer or state conservation engineer to request data from State Climatologists.
3) *NOAA National Centers for Environmental Information (www.ncei.noaa.gov).* The NCEI is the official data warehouse for NOAA data. They are responsible for preserving, monitoring, assessing, and providing public access to the Nation's climate and historical weather data and information.
4) *Data from other weather networks and stations.* There are many other sources of rainfall data. However, many of them do not go through the stringent quality control process used by NWS. Use caution when using data from any source other than the first 3 listed above.

CLASSIFYING RECURRENCE INTERVAL (FREQUENCY) OF ACTUAL STORM EVENTS

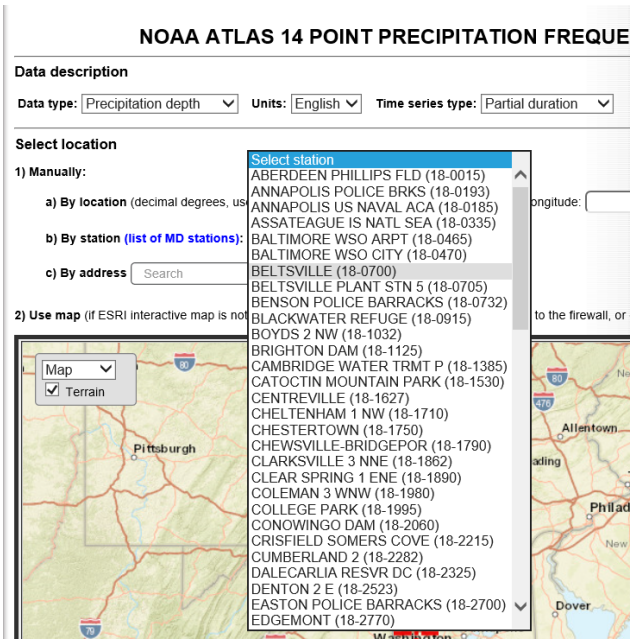
EXAMPLE 1: Classifying a Short Duration Storm

The NWS cooperative weather station at Beltsville, Maryland (Station ID: Beltsville 18-0700) recorded 2.9 inches of rainfall from between the hours of 12:15 am and 1:15 am on June 26, 1975. (Source: 15-minute Precipitation Data from NCEI). Classify the return interval (frequency) for this 1-hour duration storm.

Step 1: From the PFDS page, either click on the state of Maryland, or select it from the drop-down list and click Load.



Step 2: From the Select station drop-down list, select the Beltsville (18-0700) station name:



Step 3: Scroll to the bottom of the page to find the Point Precipitation Frequency Estimates for this station.

PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.346 (0.314-0.382)	0.414 (0.376-0.456)	0.493 (0.447-0.544)	0.551 (0.498-0.608)	0.624 (0.560-0.688)	0.678 (0.605-0.749)	0.732 (0.649-0.810)	0.782 (0.690-0.870)	0.847 (0.739-0.948)	0.896 (0.776-1.01)
10-min	0.553 (0.502-0.610)	0.662 (0.601-0.729)	0.790 (0.716-0.871)	0.882 (0.797-0.972)	0.994 (0.892-1.10)	1.08 (0.964-1.19)	1.16 (1.03-1.29)	1.24 (1.09-1.38)	1.34 (1.17-1.50)	1.41 (1.22-1.59)
15-min	0.691 (0.628-0.763)	0.833 (0.756-0.917)	1.00 (0.905-1.10)	1.12 (1.01-1.23)	1.26 (1.13-1.39)	1.37 (1.22-1.51)	1.47 (1.30-1.63)	1.56 (1.38-1.74)	1.69 (1.47-1.89)	1.77 (1.54-2.00)
30-min	0.948 (0.861-1.05)	1.15 (1.04-1.27)	1.42 (1.29-1.57)	1.62 (1.46-1.78)	1.87 (1.68-2.06)	2.06 (1.84-2.28)	2.25 (2.00-2.49)	2.44 (2.15-2.71)	2.68 (2.34-3.00)	2.87 (2.49-3.23)
60-min	1.18 (1.07-1.30)	1.44 (1.31-1.59)	1.82 (1.65-2.01)	2.10 (1.90-2.32)	2.49 (2.23-2.74)	2.79 (2.49-3.08)	3.10 (2.75-3.43)	3.42 (3.01-3.80)	3.85 (3.36-4.31)	4.19 (3.63-4.72)
2-hr	1.41 (1.28-1.55)	1.72 (1.56-1.89)	2.17 (1.98-2.39)	2.52 (2.29-2.77)	3.02 (2.72-3.32)	3.43 (3.07-3.77)	3.85 (3.43-4.25)	4.30 (3.79-4.75)	4.93 (4.30-5.49)	5.44 (4.70-6.10)
3-hr	1.52 (1.39-1.68)	1.85 (1.68-2.04)	2.34 (2.13-2.58)	2.74 (2.47-3.01)	3.30 (2.96-3.63)	3.76 (3.35-4.14)	4.25 (3.75-4.69)	4.77 (4.17-5.29)	5.52 (4.76-6.15)	6.13 (5.22-6.88)
6-hr	1.88 (1.72-2.09)	2.28 (2.08-2.52)	2.89 (2.62-3.19)	3.38 (3.05-3.73)	4.11 (3.67-4.54)	4.74 (4.19-5.24)	5.41 (4.75-6.00)	6.15 (5.34-6.84)	7.23 (6.17-8.12)	8.15 (6.85-9.21)
12-hr	2.30 (2.07-2.59)	2.78 (2.50-3.13)	3.53 (3.17-3.97)	4.18 (3.73-4.69)	5.17 (4.56-5.80)	6.04 (5.27-6.79)	7.01 (6.04-7.90)	8.10 (6.88-9.16)	9.76 (8.11-11.1)	11.2 (9.14-12.8)
24-hr	2.65 (2.42-2.93)	3.20 (2.93-3.55)	4.12 (3.76-4.55)	4.92 (4.47-5.42)	6.16 (5.54-6.75)	7.26 (6.48-7.92)	8.50 (7.52-9.25)	9.92 (8.67-10.8)	12.1 (10.4-13.1)	14.0 (11.9-15.1)
2-day	3.07 (2.81-3.38)	3.72 (3.40-4.09)	4.76 (4.35-5.23)	5.66 (5.14-6.21)	7.01 (6.33-7.67)	8.19 (7.35-8.94)	9.51 (8.46-10.4)	11.0 (9.66-12.0)	13.2 (11.4-14.4)	15.1 (12.9-16.5)
3-day	3.24 (2.97-3.57)	3.92 (3.59-4.32)	5.02 (4.58-5.52)	5.96 (5.42-6.55)	7.37 (6.67-8.07)	8.61 (7.73-9.41)	9.98 (8.89-10.9)	11.5 (10.2-12.6)	13.8 (12.0-15.1)	15.8 (13.6-17.3)
4-day	3.41 (3.13-3.76)	4.12 (3.78-4.55)	5.27 (4.82-5.81)	6.25 (5.70-6.88)	7.73 (7.00-8.48)	9.02 (8.11-9.88)	10.5 (9.32-11.4)	12.1 (10.7-13.2)	14.5 (12.6-15.8)	16.5 (14.2-18.1)
7-day	3.96 (3.64-4.34)	4.77 (4.39-5.23)	6.02 (5.54-6.60)	7.10 (6.52-7.77)	8.72 (7.94-9.51)	10.1 (9.15-11.0)	11.6 (10.5-12.7)	13.4 (11.9-14.5)	15.9 (14.0-17.4)	18.1 (15.7-19.8)
10-day	4.51 (4.16-4.93)	5.42 (5.00-5.93)	6.77 (6.24-7.40)	7.90 (7.26-8.62)	9.54 (8.72-10.4)	10.9 (9.93-11.9)	12.4 (11.2-13.5)	14.0 (12.6-15.3)	16.4 (14.5-17.8)	18.4 (16.1-20.0)
20-day	6.10 (5.67-6.57)	7.25 (6.75-7.82)	8.77 (8.14-9.44)	10.00 (9.26-10.8)	11.7 (10.8-12.6)	13.1 (12.1-14.1)	14.5 (13.3-15.6)	16.0 (14.6-17.2)	18.1 (16.4-19.5)	19.8 (17.7-21.3)
30-day	7.53 (7.03-8.07)	8.91 (8.32-9.56)	10.6 (9.89-11.4)	12.0 (11.1-12.8)	13.8 (12.9-14.8)	15.3 (14.2-16.4)	16.8 (15.5-18.0)	18.4 (16.9-19.7)	20.6 (18.7-22.1)	22.2 (20.1-23.9)
45-day	9.48 (8.90-10.1)	11.2 (10.5-11.9)	13.1 (12.3-13.9)	14.5 (13.6-15.4)	16.4 (15.4-17.4)	17.9 (16.7-19.0)	19.3 (18.0-20.5)	20.7 (19.2-22.0)	22.5 (20.8-24.0)	23.9 (22.0-25.5)
60-day	11.3 (10.6-11.9)	13.3 (12.5-14.0)	15.3 (14.4-16.2)	16.9 (15.9-17.8)	18.9 (17.8-20.0)	20.4 (19.2-21.6)	21.8 (20.5-23.1)	23.2 (21.7-24.6)	25.0 (23.2-26.5)	26.2 (24.4-27.9)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Step 4: Locate the line for a 60-minute duration.

PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)[1]										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.346 (0.314-0.382)	0.414 (0.376-0.456)	0.493 (0.447-0.544)	0.551 (0.498-0.608)	0.624 (0.560-0.688)	0.678 (0.605-0.749)	0.732 (0.649-0.810)	0.782 (0.690-0.870)	0.847 (0.739-0.948)	0.896 (0.776-1.01)
10-min	0.553 (0.502-0.610)	0.662 (0.601-0.729)	0.790 (0.716-0.871)	0.882 (0.797-0.972)	0.994 (0.892-1.10)	1.08 (0.964-1.19)	1.16 (1.03-1.29)	1.24 (1.09-1.38)	1.34 (1.17-1.50)	1.41 (1.22-1.59)
15-min	0.691 (0.628-0.763)	0.833 (0.756-0.917)	1.00 (0.905-1.10)	1.12 (1.01-1.23)	1.26 (1.13-1.39)	1.37 (1.22-1.51)	1.47 (1.30-1.63)	1.56 (1.38-1.74)	1.69 (1.47-1.89)	1.77 (1.54-2.00)
30-min	0.948 (0.861-1.05)	1.15 (1.04-1.27)	1.42 (1.29-1.57)	1.62 (1.46-1.78)	1.87 (1.68-2.06)	2.06 (1.84-2.26)	2.25 (2.00-2.48)	2.44 (2.15-2.71)	2.68 (2.34-3.00)	2.87 (2.49-3.23)
60-min	1.18 (1.07-1.30)	1.44 (1.31-1.59)	1.82 (1.65-2.01)	2.10 (1.90-2.32)	2.49 (2.23-2.74)	2.79 (2.49-3.08)	3.10 (2.75-3.43)	3.42 (3.01-3.80)	3.85 (3.36-4.31)	4.19 (3.63-4.72)
2-hr	1.41 (1.28-1.55)	1.72 (1.56-1.89)	2.17 (1.98-2.39)	2.52 (2.29-2.77)	3.02 (2.72-3.32)	3.43 (3.07-3.77)	3.85 (3.43-4.25)	4.30 (3.79-4.75)	4.93 (4.30-5.49)	5.44 (4.70-6.10)
3-hr	1.52 (1.39-1.68)	1.85 (1.68-2.04)	2.34 (2.13-2.58)	2.74 (2.47-3.01)	3.30 (2.96-3.63)	3.76 (3.35-4.14)	4.25 (3.75-4.69)	4.77 (4.17-5.29)	5.52 (4.76-6.15)	6.13 (5.22-6.88)
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Step 5: Read across the 60-minute duration line and find the value closest to the value you are trying to classify. In this case, the 2.90 inches of rainfall measured at the gauge falls between the 2.79 inches table value, corresponding to a 50-year recurrence interval, and the 3.10 inches table value, corresponding to a 100-year event. The actual storm rainfall of 2.90 inches also falls within the confident interval for each of those recurrence intervals. The confidence intervals show that a 50-year recurrence interval event can range anywhere from 2.49 to 3.08 inches; while a 100-year recurrence interval event can range anywhere from 2.75 to 3.43 inches.

CONCLUSION***:*** Based on this information, the recurrence interval (frequency) of the 2.90-inch rainfall that fell within a 1-hour time span on June 26, 1975 is between a 50-year and 100-year storm event.

EXAMPLE 2: Classifying a Long Duration Storm

The NWS cooperative weather station at Beltsville, Maryland (Station ID: Beltsville 18-0700) recorded 4.8 inches of rainfall from between the hours of 6:30 am on July 13, 1975 and 6:30 am on July 14, 1975. (Source: 15-minute Precipitation Data from NCEI). Classify the return interval (frequency) for this 24-hour duration storm.

Steps 1 through 3: The same as for Example 1 above.

Step 4: Locate the line for a 24-hour duration.

PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)[1]										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.346 (0.314-0.382)	0.414 (0.376-0.456)	0.493 (0.447-0.544)	0.551 (0.498-0.608)	0.624 (0.560-0.688)	0.678 (0.605-0.749)	0.732 (0.649-0.810)	0.782 (0.690-0.870)	0.847 (0.739-0.948)	0.896 (0.776-1.01)
10-min	0.553 (0.502-0.610)	0.662 (0.601-0.729)	0.790 (0.716-0.871)	0.882 (0.797-0.972)	0.994 (0.892-1.10)	1.08 (0.964-1.19)	1.16 (1.03-1.29)	1.24 (1.09-1.38)	1.34 (1.17-1.50)	1.41 (1.22-1.59)
15-min	0.691 (0.628-0.763)	0.833 (0.756-0.917)	1.00 (0.905-1.10)	1.12 (1.01-1.23)	1.26 (1.13-1.39)	1.37 (1.22-1.51)	1.47 (1.30-1.63)	1.56 (1.38-1.74)	1.69 (1.47-1.89)	1.77 (1.54-2.00)
30-min	0.948 (0.861-1.05)	1.15 (1.04-1.27)	1.42 (1.29-1.57)	1.62 (1.46-1.78)	1.87 (1.68-2.06)	2.06 (1.84-2.28)	2.25 (2.00-2.49)	2.44 (2.15-2.71)	2.68 (2.34-3.00)	2.87 (2.49-3.23)
60-min	1.18 (1.07-1.30)	1.44 (1.31-1.59)	1.82 (1.65-2.01)	2.10 (1.90-2.32)	2.49 (2.23-2.74)	2.79 (2.49-3.08)	3.10 (2.75-3.43)	3.42 (3.01-3.80)	3.85 (3.36-4.31)	4.19 (3.63-4.72)
2-hr	1.41 (1.28-1.55)	1.72 (1.56-1.89)	2.17 (1.98-2.39)	2.52 (2.29-2.77)	3.02 (2.72-3.32)	3.43 (3.07-3.77)	3.85 (3.43-4.25)	4.30 (3.79-4.75)	4.93 (4.30-5.49)	5.44 (4.70-6.10)
3-hr	1.52 (1.39-1.68)	1.85 (1.68-2.04)	2.34 (2.13-2.58)	2.74 (2.47-3.01)	3.30 (2.96-3.63)	3.76 (3.35-4.14)	4.25 (3.75-4.69)	4.77 (4.17-5.29)	5.52 (4.76-6.15)	6.13 (5.22-6.88)
6-hr	1.88 (1.72-2.09)	2.28 (2.08-2.52)	2.89 (2.62-3.19)	3.38 (3.05-3.73)	4.11 (3.67-4.54)	4.74 (4.19-5.24)	5.41 (4.75-6.00)	6.15 (5.34-6.84)	7.23 (6.17-8.12)	8.15 (6.85-9.21)
12-hr	2.30 (2.07-2.59)	2.78 (2.50-3.13)	3.53 (3.17-3.97)	4.18 (3.73-4.69)	5.17 (4.56-5.80)	6.04 (5.27-6.78)	7.01 (6.04-7.86)	8.10 (6.88-9.18)	9.76 (8.11-11.1)	11.2 (9.14-12.8)
24-hr	2.65 (2.42-2.93)	3.20 (2.93-3.55)	4.12 (3.76-4.55)	4.92 (4.47-5.42)	6.16 (5.54-6.75)	7.26 (6.48-7.92)	8.50 (7.52-9.25)	9.92 (8.67-10.8)	12.1 (10.4-13.1)	14.0 (11.9-15.1)
2-day	3.07 (2.81-3.38)	3.72 (3.40-4.09)	4.76 (4.35-5.23)	5.66 (5.14-6.21)	7.01 (6.33-7.67)	8.19 (7.35-8.94)	9.51 (8.46-10.4)	11.0 (9.66-12.0)	13.2 (11.4-14.4)	15.1 (12.9-16.5)
3-day	3.24	3.92	5.02	5.96	7.37	8.61	9.98	11.5	13.8	15.8

Step 5: Read across the 24-hour duration line and find the value closest to the value you are trying to classify. In this case, the 4.8 inches of rainfall measured at the gauge falls between the 4.12 inches table value corresponding to a 5-year recurrence interval and the 4.92 inches table value corresponding to a 10-year event. Additionally, 4.80 inches falls within the confident interval for the 10-year event (between 4.47 inches and 5.42 inches).

CONCLUSION***:*** Based on this information, the recurrence interval (frequency) of the 4.80-inch rainfall that fell within a 24-hour time span on July 13 and 14, 1975 is a 10-year storm event.

SUMMARY: As illustrated by Examples 1 and 2 above, it is obvious that storm duration is critical to properly classify an actual storm event recurrence interval (frequency). Short duration events with smaller rainfall amounts than much longer events can be as damaging as longer duration storms with large rainfall amounts.