Evaluating Antecedent Precipitation Conditions

Using Climate Data Available in Minnesota

May, 2015

Purpose: This document describes procedures that can be used to evaluate antecedent precipitation using climate data and tools available in Minnesota.

Audience: Those involved in jurisdictional wetland delineation, restoration, mitigation, regulation, or any other activity requiring the use of hydrologic data, observations, or imagery.

Use: These accepted methods can be used to compare antecedent precipitation conditions between different dates for sites in Minnesota. They make the best use of data and tools readily available via the web from the Minnesota State Climatology Office. The ability to compare antecedent precipitation conditions is often relevant to assessing wetland hydrology.

Contents (with hyperlinks to sections)

1. Introduction

The publications Accessing and Using Meteorological Data to Evaluate Wetland Hydrology (Sprecher and Warne, 2000), and USDA-NRCS Engineering Field Handbook – Chapter 19 – Hydrology Tools for Wetland Determination (NRCS, 1997 and draft update 2011), are important resources for nationwide application. They describe techniques for evaluating the precipitation preceding a particular date to determine whether observations made on that date are representative of relatively normal, wet, or dry conditions.

In Minnesota, we have the additional resource of an outstanding State Climatology Office, whose web-available climate data and tools greatly enhance the application of these procedures. Together with the capabilities of spreadsheet programs, these data and tools make the procedures accessible and straightforward.

The first method uses monthly precipitation data and the WETS Tables (or their Minnesota equivalents) and is derived from the method presented in Hydrology Tools for Wetland Determination (NRCS, 1997). The State Climatology Office web site has a built-in tool for applying this method. The second method evaluates daily precipitation data on the basis of 30-day rolling totals. These methods can also be combined as a 3rd "hybrid" method.

2. Three-Prior-Month Method for Evaluating Antecedent Precipitation

2.1. Background

This method, commonly referred to as the "NRCS method," has long been used for interpreting wetland signatures on air photos (**Figure 1**). The method considers precipitation data from the three months prior to the date of interest and weighs those data for length of time since the precipitation contributed to the water budget (**Figure 2**). Several assumptions are made when using the method:

- Rain was evenly distributed for the month of observation.
- Three months is the proper length of time to evaluate antecedent precipitation even though hydrologic systems vary considerably in their "lag time."
- Snowmelt contributes to wetland hydrology in the same way as rainfall.

Figure 1: *Examples of aerial images showing wetland hydrology signatures.*

The method can be used in two ways:

- **With the tool available on State Climatology Office website**. For older observation or photo dates, the procedure is completely automated on the website. The tool populates a table like **Figure 2**. It uses geostatistical interpolation to derive precipitation data from surrounding gauge sites, thereby negating the need to select the "closest" precipitation gauging station; and
- **Without the tool** - manually or with a spreadsheet. There are several reasons you may need to do this - for example for recent hydrologic observation dates for which the appropriate monthly precipitation data have not yet been updated to the built-in tool. In this case you still make use of the data on the State Climatology Office website, but you must put the precipitation data in a table yourself.

NRCS method - Rainfall Documentation Worksheet
Hydrology Tools for Wetland Determination EFH Chapter 19

Date	18-Sep-2014		
Weather Station	Little Falls	Landowner/ Project	WDCP Course - Crane Meadows
County	Morrison	State	MN
Soil Name		Growing Season	5/13 - 9/20
Photo/obs Date	15-Sep-2014		

	Long-term Rainfall Records							
	Month	WETS 3 years in 10 less than	Normal	WETS 3 years in 10 more than	Rainfall	Condition Dry, Wet, Normal	Condition Value	Month Weight Value	Product of Previous 2 Columns
1st Prior Month*	August	2.57	3.46	4.03	7.51	W	3	3	9
2nd Prior Month*	July	2.88	3.58	4.27	3.53	N	2	2	4
3rd Prior Month*	June	3.46	4.37	5.41	5.71	W	3	1	3
	*compared to photo/obs date							Sum	16

Note: If sum is	
6 - 9	prior period has been drier than normal
10 - 14	prior period has been normal
15 - 18	prior period has been wetter than normal

Condition value:
Dry =1
Normal =2
Wet =3

Figure 2: *Completed Rainfall Documentation Worksheet for the Three-Prior-Month method, as used for photo interpretation.*

2.2. Three-Prior-Month Method Using the State Climatology Office Monthly Precipitation Data Retrieval Web Tool for Wetland Delineation

a. Go to http://climate.umn.edu . Select: **Retrieve Past Climate Data**

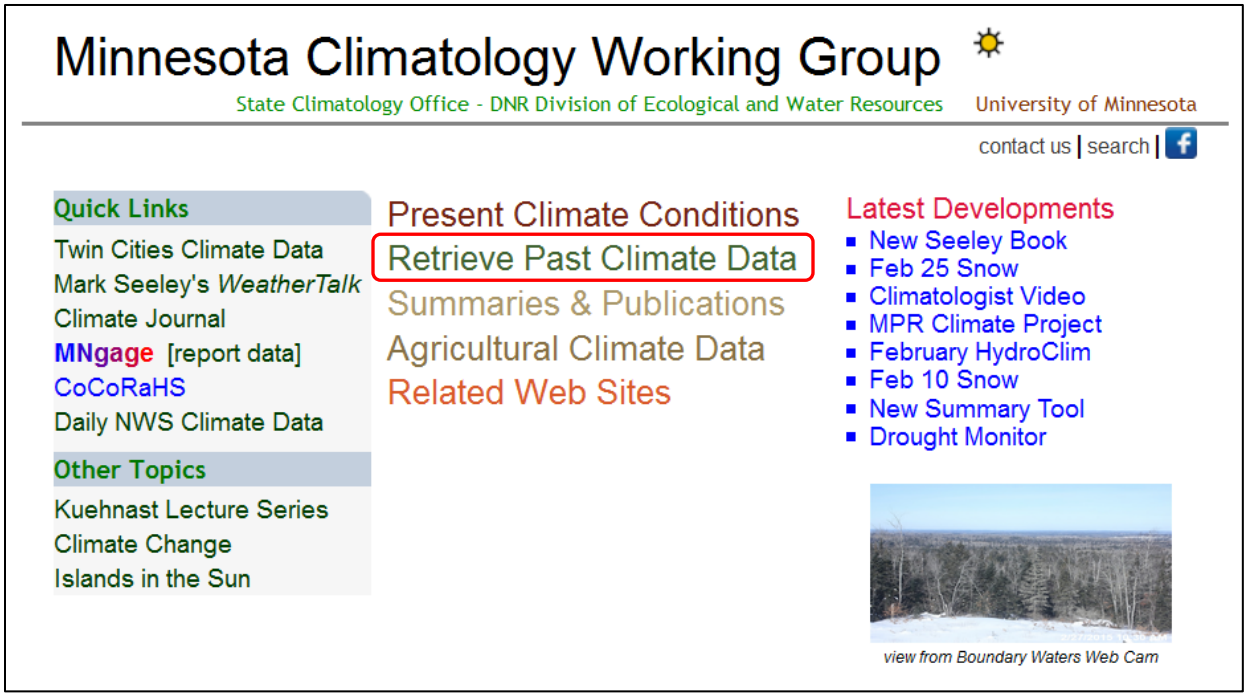

Figure 3

b. Select: **Monthly**.

Figure 4

c. Select: **Monthly Precipitation Data from Gridded Database (for Wetland Delineators)**

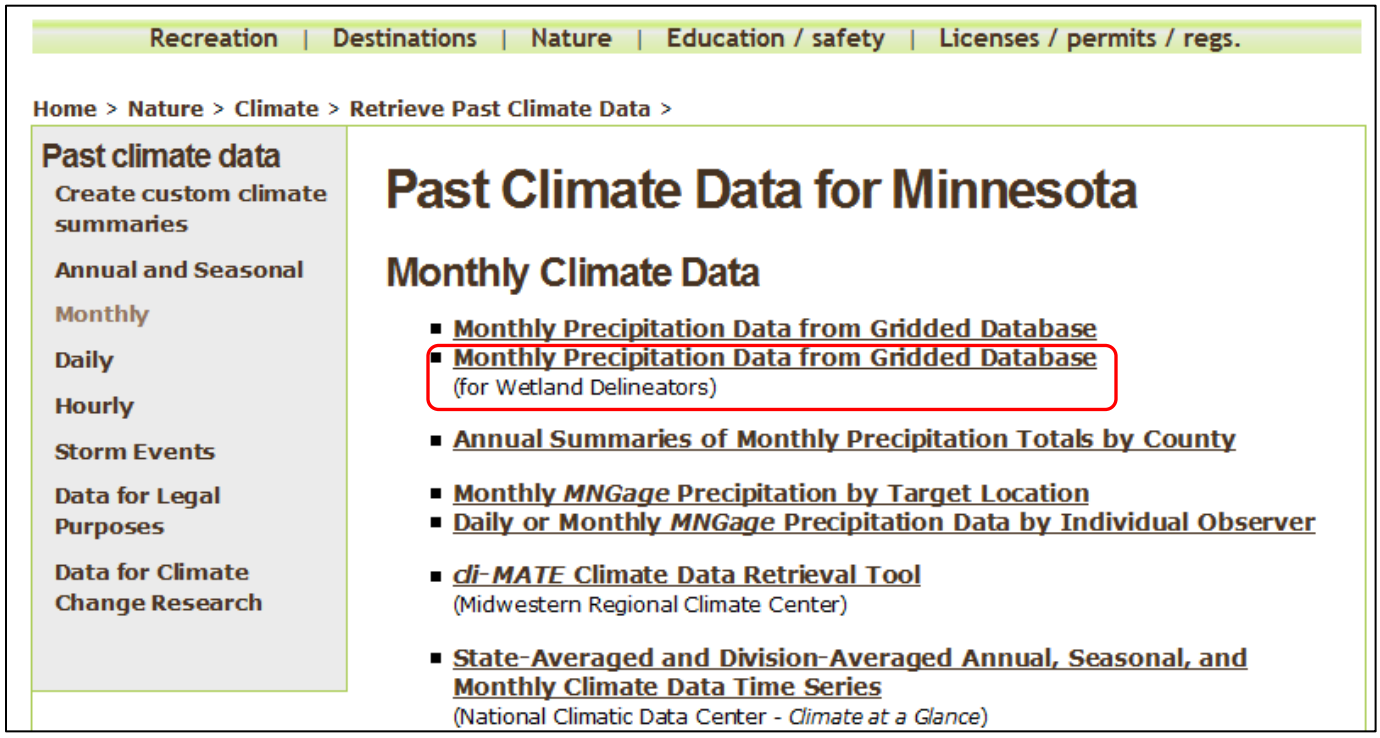

Figure 5

d. Choose select a wetland location.

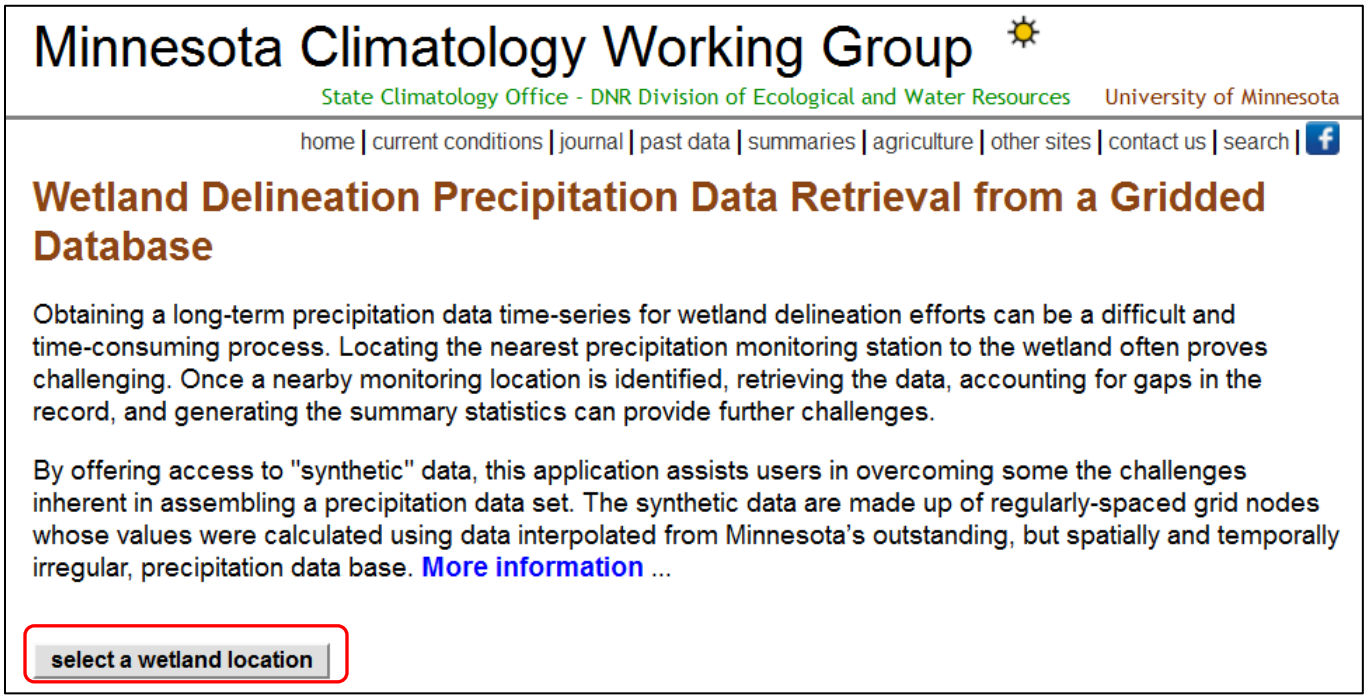

Figure 6

e. Click to continue to zoom in to your location. If desired, the map settings can be adjusted to display different background layers, including USGS 1:24K topo maps at appropriate scales.

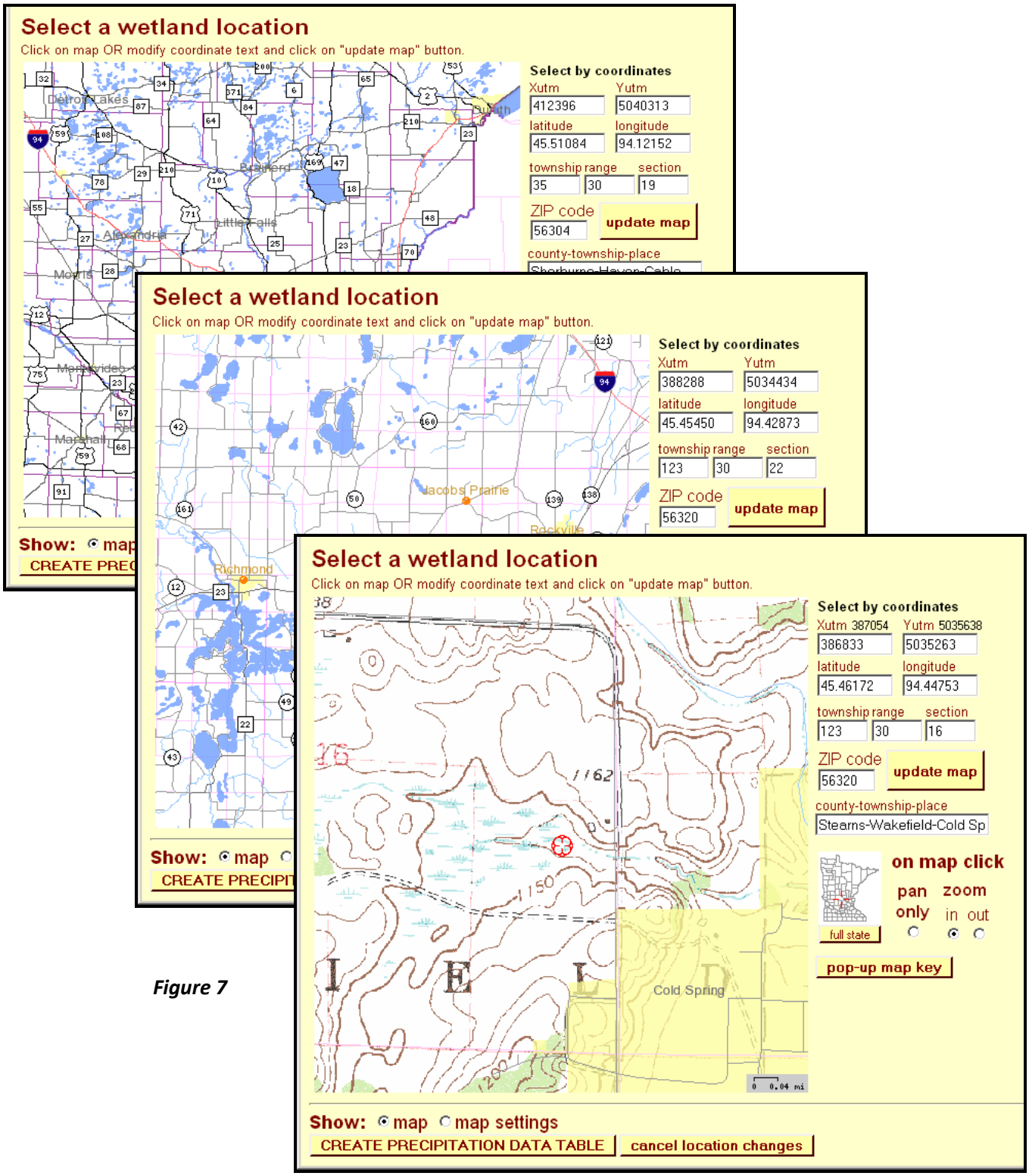

Figure 7

f. When you've zoomed in to the desired location, click CREATE PRECIPITATION DATA TABLE.

The result will be tables showing the range of normal monthly precipitation for the site based on **Period-of-record statistics**, **1971-2000 summary statistics**, and **1981-2010 summary statistics** (**Figure 8**). These are derived by geostatistical interpolation between precipitation data from surrounding gages. Below these is a year-to-year table of monthly precipitation data for the site. These are derived from precipitation data from surrounding gage sites, also using geostatistical interpolation techniques. They are color-coded for wet, normal, and dry months.

Precipitation data for target wetland location:

county: **Stearns**
township name: **Wakefield**
nearest community: **Cold Spring**
township number: **123N**
range number: **30W**
section number: **16**

To create a **precipitation documentation worksheet** using USDA-NRCS methodology, select the date of the site visit or aerial photograph and click on "create worksheet".

2014 | July | 1 | create worksheet

precipitation totals are in inches

color key:
total is in lowest 30th percentile of the period-of-record distribution
total is => 30th and <= 70th percentile
total is in highest 30th percentile of the period-of-record distribution

multi-month totals:
WARM = warm season (May thru September)
ANN = calendar year (January thru December)
WAT = water year (Oct. previous year thru Sep. present year)

Period-of-Record Summary Statistics

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	WARM	ANN	WAT
30%	0.42	0.32	0.84	1.48	2.22	3.07	2.27	2.31	1.80	1.05	0.57	0.34	13.76	23.06	22.71
70%	0.91	0.98	1.60	2.63	3.94	5.42	3.84	4.50	3.67	2.64	1.52	1.05	20.15	29.03	30.30
mean	0.75	0.75	1.38	2.21	3.30	4.34	3.37	3.57	2.84	1.98	1.21	0.77	17.42	26.41	26.50

1971-2000 Summary Statistics

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	WARM	ANN	WAT
30%	0.46	0.30	1.11	1.15	2.41	3.36	2.76	2.88	2.05	1.21	0.78	0.37	16.83	25.22	25.22
70%	0.96	0.88	2.06	2.55	3.79	6.45	4.39	4.84	2.97	2.90	2.04	1.08	21.28	31.51	32.11
mean	0.86	0.71	1.64	2.03	3.16	4.92	3.73	3.95	2.99	2.29	1.54	0.78	18.74	28.59	28.66

1981-2010 Summary Statistics

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	WARM	ANN	WAT
30%	0.42	0.32	1.18	1.30	2.15	3.33	2.76	2.81	2.25	1.27	0.62	0.41	16.12	25.35	26.77
70%	0.83	0.98	1.91	2.87	3.61	5.89	4.30	4.61	4.15	3.33	2.03	1.32	21.56	34.17	31.88
mean	0.74	0.72	1.71	2.48	3.16	4.74	3.60	4.00	3.45	2.58	1.47	0.92	18.96	29.59	29.40

Year-to-Year Data

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	WARM	ANN	WAT
2014	1.10	1.14	0.94	4.24	6.10	6.90	1.52	5.53	2.41	0.49			22.46		35.46
2013	0.36	1.24	2.11	3.21	5.19	5.74	2.55	1.30	2.44	4.32	0.27	0.99	17.22	29.72	27.23
2012	0.45	1.05	1.86	2.63	7.17	4.08	2.61	1.25	0.13	0.75	1.07	1.27	15.24	24.32	22.88
2011	0.99	1.23	1.99	2.30	5.36	4.41	9.22	4.71	0.78	1.16	0.23	0.26	24.48	32.64	38.09
2010	0.75	0.98	1.33	1.32	2.56	7.61	3.38	7.35	4.73	3.84	1.02	2.24	25.63	37.11	39.16
2009	0.68	0.99	4.72	1.48	1.11	4.60	3.31	7.86	1.20	7.07	0.33	1.75	18.08	35.10	32.62

Figure 8

g. To generate a completed Rainfall Documentation Worksheet using the Three-Prior-Month ("NRCS") method, select the date of the site visit or aerial photo, and then select create worksheet. The result will be two Precipitation Documentation Worksheets, one using the **1971-2000** normal period and one using the **1981-2010** normal period (**Figure 9**). There is a several-month delay in data entry for the monthly precipitation data. To evaluate recent months you may need to use the procedure described in Section 2.3 below.

Unless specifically required by policy, use the 1981-2010 normal period.

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Precipitation Worksheet Using Gridded Database

Precipitation data for target wetland location:

county: **Stearns** township number: **123N**
township name: **Wakefield** range number: **30W**
nearest community: **Cold Spring** section number: **16**

Aerial photograph or site visit date:
Tuesday, July 01, 2014

Score using 1971-2000 normal period

(values are in inches)	first prior month: June 2014	second prior month: May 2014	third prior month: April 2014
estimated precipitation total for this location:	6.90	6.10	4.24
there is a 30% chance this location will have less than: *	3.02	2.28	1.13
there is a 30% chance this location will have more than: *	5.95	3.73	2.47
type of month: dry normal wet	wet	wet	wet
monthly score	3 * 3 = 9	2 * 3 = 6	1 * 3 = 3
multi-month score: 6 to 9 (dry) 10 to 14 (normal) 15 to 18 (wet)	18 (Wet)		

Score using 1981-2010 normal period

(values are in inches)	first prior month: June 2014	second prior month: May 2014	third prior month: April 2014
estimated precipitation total for this location:	6.90	6.10	4.24
there is a 30% chance this location will have less than: *	2.91	2.26	1.38
there is a 30% chance this location will have more than: *	5.74	3.74	3.02
type of month: dry normal wet	wet	wet	wet
monthly score	3 * 3 = 9	2 * 3 = 6	1 * 3 = 3
multi-month score: 6 to 9 (dry) 10 to 14 (normal) 15 to 18 (wet)	18 (Wet)		

view USDA-NRCS WETS data for Stearns County

Figure 9: *Resulting Precipitation Documentation worksheets.*
Unless specifically required by policy, use the 1981-2010 normal period.

2.3. Three-Prior-Month method using the State Climatology Office monthly precipitation data and Filling out the Rainfall Documentation Worksheet manually or with a spreadsheet

You may need to do this for recent observations, or if you want instead to use the USDA-NRCS WETS data rather than the geostatistically-derived monthly range of normal precipitation.

a. Follow all the steps outlined in Section 2.2 above to get the normal monthly precipitation range information for the three months prior to the observation date.

   If you want to use the USDA-NRCS WETS data for the monthly range of normal precipitation rather than that from the State Climatology Office, there is a link (view **USDA-NRCS WETS data**) at the bottom of the precipitation documentation worksheets (**Figure 9**). Alternatively you can go to http://www.wcc.nrcs.usda.gov/climate/wetlands.html .

b. Transfer the appropriate "normal range" numbers for the prior months to the appropriate boxes on a blank Rainfall Documentation Worksheet **–OR–** use the [**NRCS method**] sheet in the Excel spreadsheet tool available here: http://www.bwsr.state.mn.us/wetlands/wca/NRCS_%20Hybrid_Methods_Spreadsheet.xls

c. For recent observations you will need to retrieve recent monthly precipitation data. From climate.umn.edu Select: **Retrieve Past Climate Data**; then Select: **Monthly** as in Section 2.2 (**Figures 3, 4**).

d. There are several options for retrieving precipitation data. For data from the Minnesota Volunteer Precipitation Observing Program ("MNGage") Select: **Monthly *MNGage* Precipitation by Target Location** (**Figure 10**).

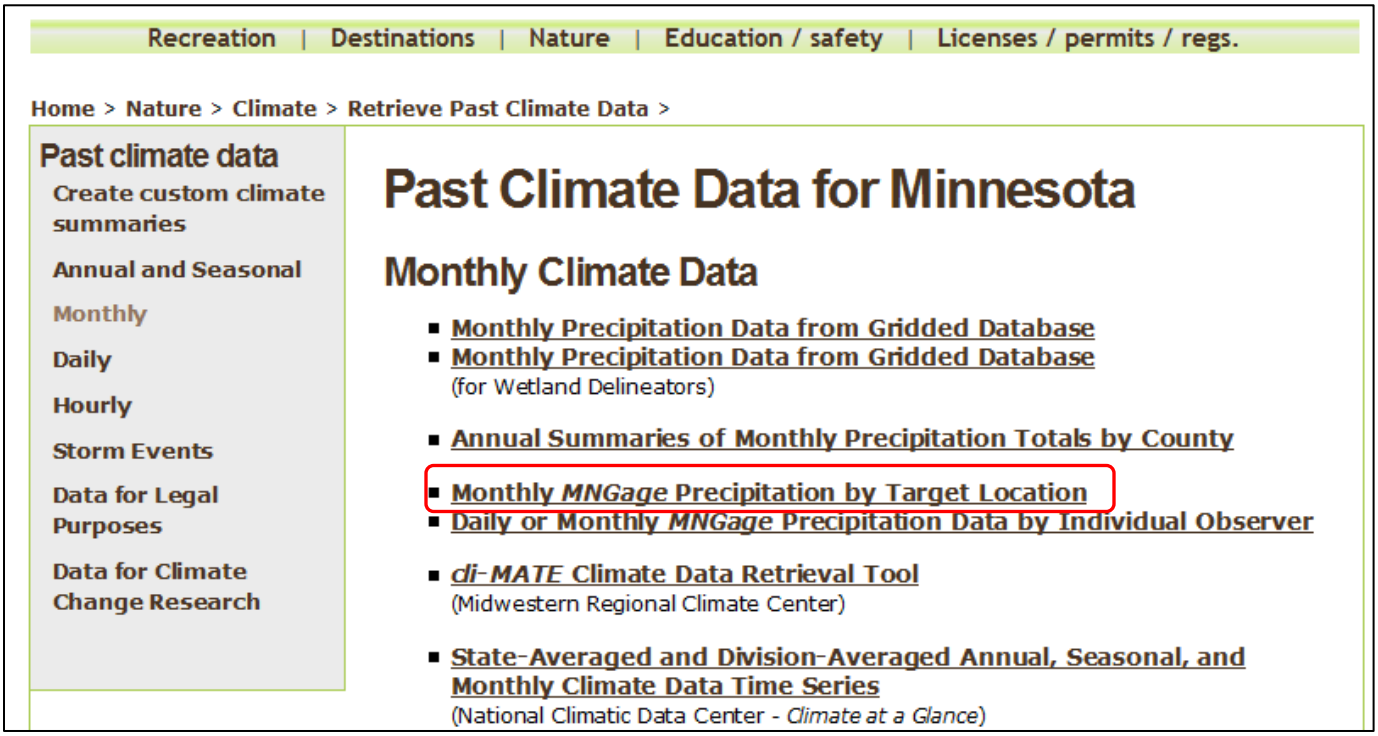
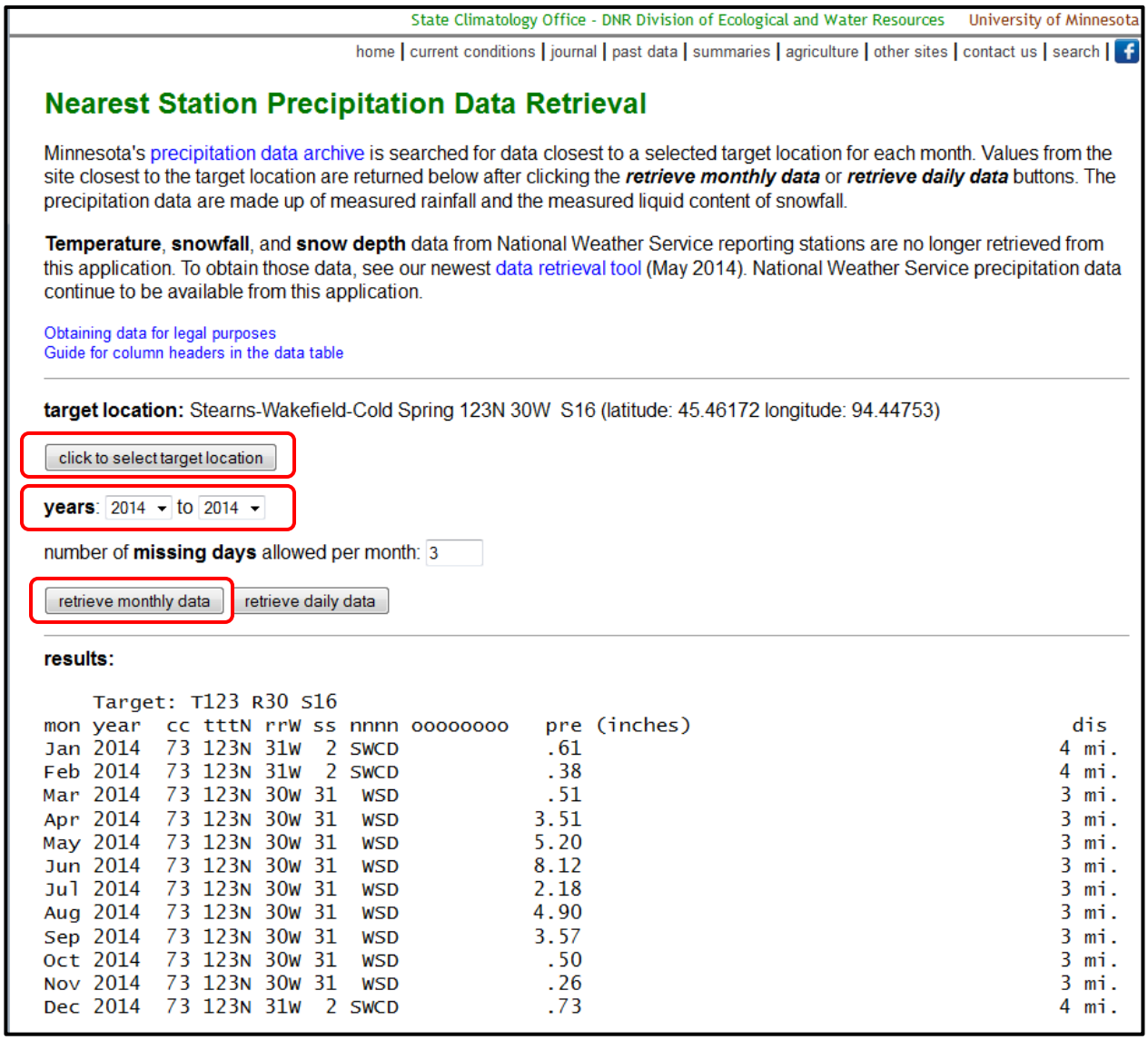


Figure 10

e. Select **click to select target location**. Zoom in to your site as described above. When you have the location in the cross-hairs, click on **DONE/return to application**.
Choose the year(s) and select **retrieve monthly data** (**Figure 11**). Daily data are also available.



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Nearest Station Precipitation Data Retrieval

Minnesota's precipitation data archive is searched for data closest to a selected target location for each month. Values from the site closest to the target location are returned below after clicking the ***retrieve monthly data*** or ***retrieve daily data*** buttons. The precipitation data are made up of measured rainfall and the measured liquid content of snowfall.

Temperature, **snowfall**, and **snow depth** data from National Weather Service reporting stations are no longer retrieved from this application. To obtain those data, see our newest data retrieval tool (May 2014). National Weather Service precipitation data continue to be available from this application.

Obtaining data for legal purposes
Guide for column headers in the data table

target location: Stearns-Wakefield-Cold Spring 123N 30W S16 (latitude: 45.46172 longitude: 94.44753)

click to select target location

years: 2014 to 2014

number of **missing days** allowed per month: 3

retrieve monthly data | retrieve daily data

results:

Target: T123 R30 S16

mon	year	cc	tttN	rrW	ss	nnnn	oooooooo	pre (inches)	dis
Jan	2014	73	123N	31W	2	SWCD		.61	4 mi.
Feb	2014	73	123N	31W	2	SWCD		.38	4 mi.
Mar	2014	73	123N	30W	31	WSD		.51	3 mi.
Apr	2014	73	123N	30W	31	WSD		3.51	3 mi.
May	2014	73	123N	30W	31	WSD		5.20	3 mi.
Jun	2014	73	123N	30W	31	WSD		8.12	3 mi.
Jul	2014	73	123N	30W	31	WSD		2.18	3 mi.
Aug	2014	73	123N	30W	31	WSD		4.90	3 mi.
Sep	2014	73	123N	30W	31	WSD		3.57	3 mi.
Oct	2014	73	123N	30W	31	WSD		.50	3 mi.
Nov	2014	73	123N	30W	31	WSD		.26	3 mi.
Dec	2014	73	123N	31W	2	SWCD		.73	4 mi.

Figure 11

f. Transfer the precipitation data from the prior months of interest to the appropriate boxes on a blank Rainfall Documentation Worksheet (Appendix).

OR:

Use the [**NRCS method**] sheet in the Excel spreadsheet tool available here: www.bwsr.state.mn.us/wetlands/wca/NRCS_%20Hybrid_Methods_Spreadsheet.xls (**Figure 12**).

	A	B	C	D	E	F	G	H	I
1	**NRCS method - Rainfall Documentation Worksheet Hydrology Tools for Wetland Determination NRCS Engineering Field Handbook Chapter 19**								
2	**Date**			2/15/2015	**Landowner/Project**				example
3	**Weather Station**			Cold Spring, MN	**State**				MN
4	**County**			Stearns	**Growing Season**				4/20 - 10/15
5	**Photo/obs Date**			7/1/2014	**Soil Name**				
6									
7	shaded cells are locked or calculated	**Long-term rainfall statistics** (from WETS table or State Climatology Office)							
8		**Month**	**30% chance <**	**30% chance >**	**Precip**	Condition **Dry, Wet,** Normal	Condition Value	Month Weight Value	Product of Previous 2 Columns
9	**1st Prior Month***	June	3.02	5.95	6.90	W	3	3	9
10	**2nd Prior Month***	May	2.28	3.73	6.10	W	3	2	6
11	**3rd Prior Month***	April	1.13	2.47	4.24	W	3	1	3
12		*compared to photo/observation			date			**Sum**	**18**
13		**Note: If sum is**							
14		**6 - 9**	prior period has been drier than normal				**Condition value:**		
15							**Dry =1**		
16		**10 - 14**	prior period has been normal				**Normal =2**		
17							**Wet =3**		
18		**15 - 18**	prior period has been wetter than normal						
19									
20									
21	**Conclusions:**	**prior period has been wetter than normal**							

***Figure 12**: Example application of Three-Prior-Month method using the Excel spreadsheet tool.*

3. Method of Rolling Totals

3.1. Background

The Three-Prior-Month method compares actual precipitation with monthly ranges of normal. Precipitation patterns within a particular month are not reflected in monthly totals. Monthly totals are reset to zero at the beginning of each month and may not accurately reflect antecedent precipitation in the middle of the month. Because the period of continuous inundation required for wetland hydrology is less than a month, it is often desirable to evaluate higher frequency (daily) precipitation data.

The **30-day Rolling Total** method is particularly useful. It involves summing the prior 30-day precipitation totals for each day and plotting this "rolling total" on a daily basis. By overlaying a plot of the normal precipitation range on the daily plot, you can evaluate whether antecedent precipitation was greater or less than normal throughout a month rather than just at the beginning or end.

The method is especially easy using spreadsheet software and data from the State Climatology office. An example Microsoft Excel spreadsheet (30Day_Rolling_Total_Spreadsheet.xls) is available here: http://www.bwsr.state.mn.us/wetlands/wca/30Day_Rolling_Total_Spreadsheet.xls .

A spreadsheet such as this can be used as a template by cutting and pasting data into the appropriate spreadsheet cells. This guidance is geared toward web-available data and Microsoft Excel®. Other spreadsheet programs will work but the format of commands and formulas will be different.

3.2. Procedure

The 30-day rolling totals procedure consists of these basic steps:

- Get daily precipitation data and monthly ranges of normal for your site from the State Climatology office.
- Put the data into appropriate places in a spreadsheet.
- Calculate and plot 30-day rolling totals for the time period of interest.
- Plot monthly ranges of normal on the plot of 30-day rolling totals.
- Compare the rolling 30-day sums to the monthly ranges of normal to determine whether antecedent precipitation was within the range of normal.

3.2.1. Get Precipitation Data

a. From climate.umn.edu Select: **Retrieve Past Climate Data**; then Select: **Daily**. For data from the Minnesota Volunteer Precipitation Observing Program select: **Daily *MNGage* Precipitation by Target Location** (**Figure 13**).

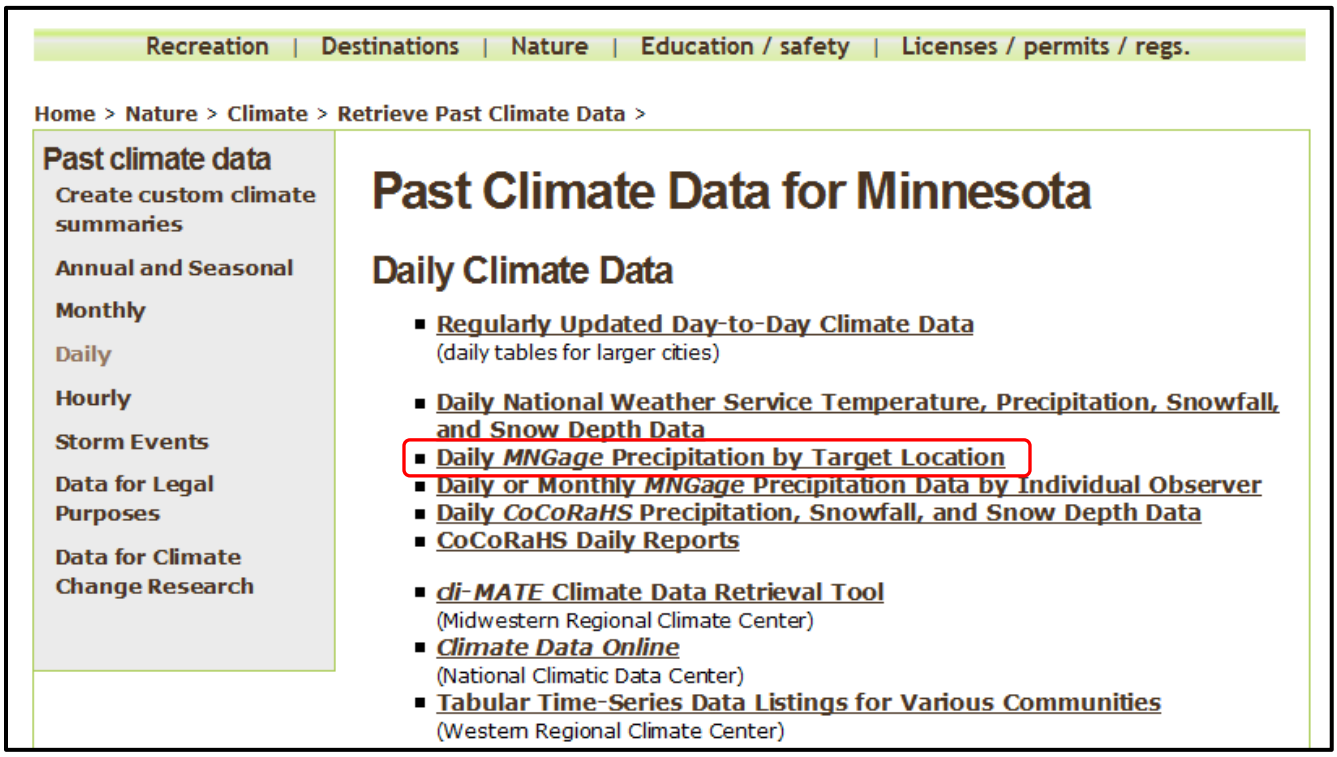


Figure 13

b. Select **click to select target location**. Zoom in to your site as described above. When you have the location in the cross-hairs, click on **DONE/return to application**. Choose the year(s) and select **retrieve daily data** (**Figure 14).**

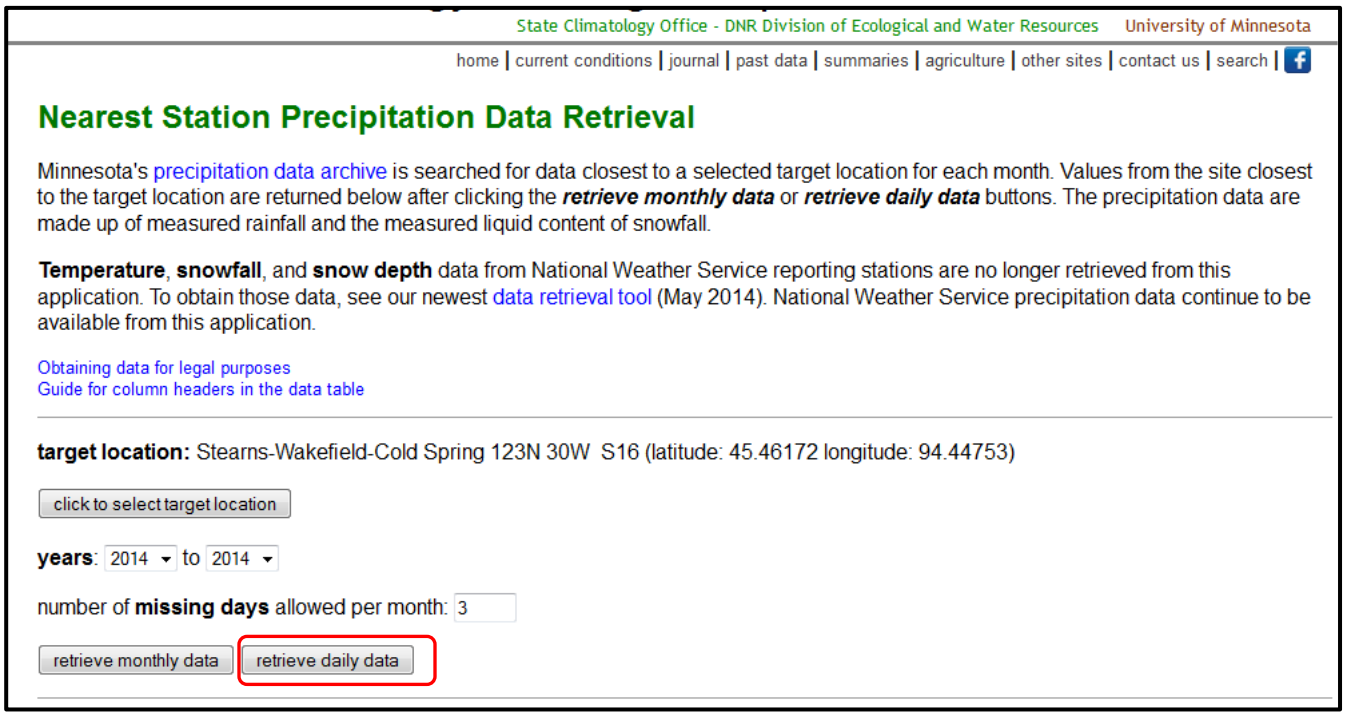


Figure 14

c. The data will appear on the bottom of the screen. Highlight the data you want and copy, and paste it into the spreadsheet (**Figure 15**).

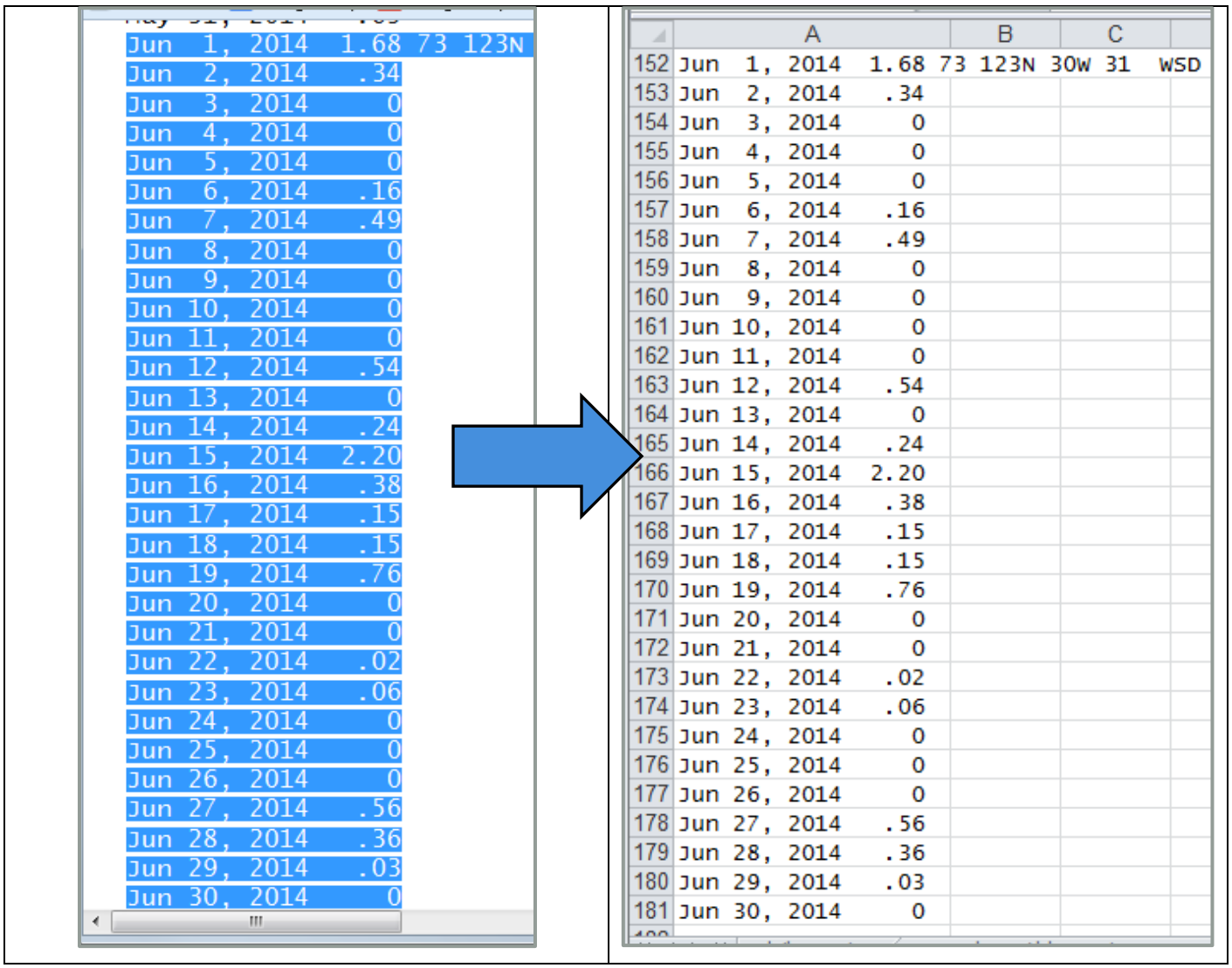


***Figure 15**: Copying resulting daily precipitation data into spreadsheet*

d. Do a "text-to-columns" conversion. In Excel, highlight the entire column containing the pasted data. Select "**Data**", then "**Text to Columns**". Choose "**Fixed Width**." Then use break lines to delineate 2 columns, one for date and one for precipitation (**Figure 16**).

e. Change the "**Column data format**" for the date column to "**Date: MDY**." The column data format for the data after the precipitation column can be set to "skip" (**Figure 16**).

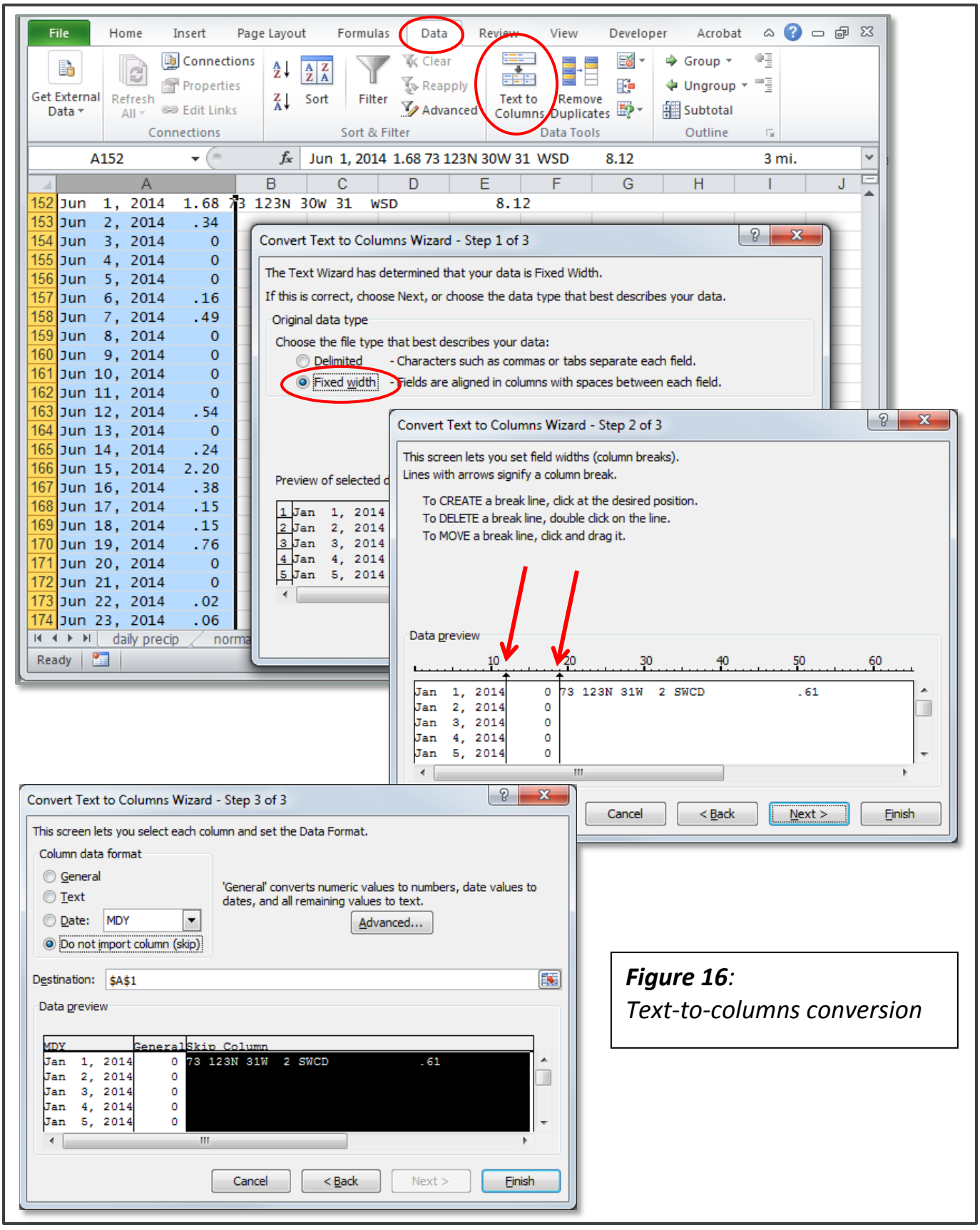
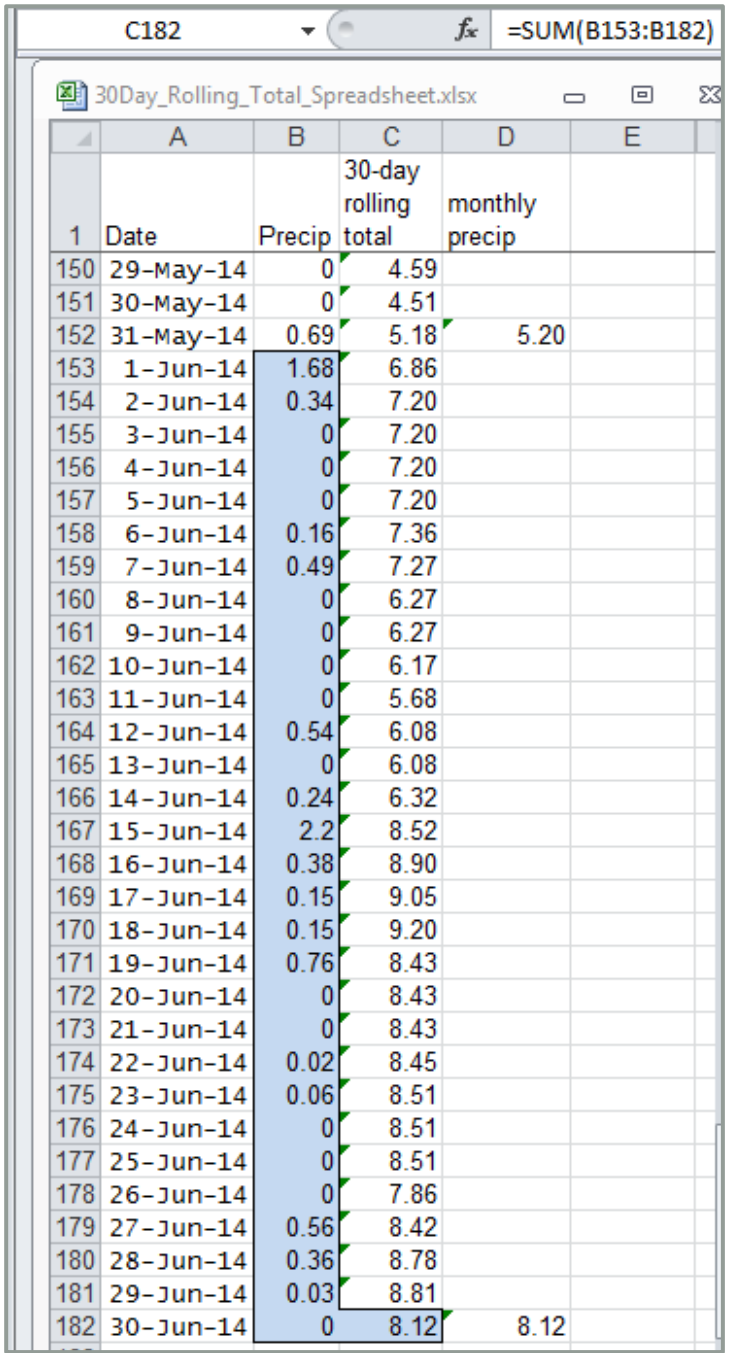


***Figure 16**:*
Text-to-columns conversion

f. You now have a two-column spreadsheet. For ease of use, insert a new row at the top and label the columns. Then go to the 1st column, 2nd row and click "**Window**" > "**Freeze panes**." Also, use "**Edit-Find-Replace**" to replace all the '**T**' values in the precipitation column with zeros.

Create a third column and label it "**30-day rolling total**". The value in this column for each day will be the sum of the precipitation amounts for that day and the preceding 29 days. The calculation is easily automated in the spreadsheet by copying and pasting the first instance of the formula into the other rows of the third column. An example Microsoft Excel formula is **=SUM(B153:B182)**. It is also helpful to create a monthly total precipitation column by totaling the daily precipitation values for each month (**Figure 17**).



	A	B	C	D	E
1	Date	Precip	30-day rolling total	monthly precip	
150	29-May-14	0	4.59		
151	30-May-14	0	4.51		
152	31-May-14	0.69	5.18	5.20	
153	1-Jun-14	1.68	6.86		
154	2-Jun-14	0.34	7.20		
155	3-Jun-14	0	7.20		
156	4-Jun-14	0	7.20		
157	5-Jun-14	0	7.20		
158	6-Jun-14	0.16	7.36		
159	7-Jun-14	0.49	7.27		
160	8-Jun-14	0	6.27		
161	9-Jun-14	0	6.27		
162	10-Jun-14	0	6.17		
163	11-Jun-14	0	5.68		
164	12-Jun-14	0.54	6.08		
165	13-Jun-14	0	6.08		
166	14-Jun-14	0.24	6.32		
167	15-Jun-14	2.2	8.52		
168	16-Jun-14	0.38	8.90		
169	17-Jun-14	0.15	9.05		
170	18-Jun-14	0.15	9.20		
171	19-Jun-14	0.76	8.43		
172	20-Jun-14	0	8.43		
173	21-Jun-14	0	8.43		
174	22-Jun-14	0.02	8.45		
175	23-Jun-14	0.06	8.51		
176	24-Jun-14	0	8.51		
177	25-Jun-14	0	8.51		
178	26-Jun-14	0	7.86		
179	27-Jun-14	0.56	8.42		
180	28-Jun-14	0.36	8.78		
181	29-Jun-14	0.03	8.81		
182	30-Jun-14	0	8.12	8.12	

Figure 17

3.2.2. Get Normal Monthly Precipitation Range Data

a. Follow all the steps outlined in Section 2.2 above to get the normal monthly precipitation range information for the location.

If you want instead to use the USDA-NRCS WETS data for the monthly range of normal precipitation rather than that from the State Climatology Office, there is a link (view **USDA-NRCS WETS data**) at the bottom of the precipitation documentation worksheets (**Figure 9**). Alternatively you can go to www.wcc.nrcs.usda.gov/climate/wetlands .

b. Transfer the appropriate "normal range" values (**Figure 8**) for the months of interest to the spreadsheet. For ease of use put the data in a new spreadsheet tab. Create another column with the last dates of the month for the months of interest. Why the last dates? We will be plotting the ranges of normal for each month at the end of that particular month, rather than the beginning or middle, because the range of normal is for the preceding 28/29, 30, or 31 days of the month (**Figure 18**).

30Day_Rolling_Total_Spreadsheet.xlsx

	A	B	C	D
1	month	date	30% chance <	30% chance >
2	Jan	1/31/14	0.41	0.83
3	Feb	2/28/14	0.32	0.98
4	Mar	3/31/14	1.18	1.91
5	Apr	4/30/14	1.3	2.87
6	May	5/31/14	2.15	3.61
7	Jun	6/30/14	3.33	5.88
8	Jul	7/31/14	2.76	4.3
9	Aug	8/31/14	2.81	4.61
10	Sep	9/30/14	2.25	4.15
11	Oct	10/31/14	1.27	3.33
12	Nov	11/30/14	0.62	2.03
13	Dec	12/31/14	0.41	1.32

1981-2010 Summary Statistics from State Climatology web site:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
30%	0.41	0.32	1.18	1.3	2.15	3.33	2.76	2.81	2.25	1.27	0.62	0.41
70%	0.83	0.98	1.91	2.87	3.61	5.88	4.3	4.61	4.15	3.33	2.03	1.32

daily precip | normal monthly precip range | Chart1

Figure 18

3.2.3. Plot the Data

There are many options for plotting and many ways to approach formatting dates, curves, axes, etc. Here are the basics, assuming some familiarity creating graphs using spreadsheet software. These directions are based on Microsoft Excel ®; other spreadsheet or graphing programs will have different formatting of commands.

- Create an X-Y (Scatter) plot with date as the X-axis and precipitation as the Y.
- Select the source data (**Figure 19**). The source data series will be:
  - 30-day rolling total plotted as a curve (column '**C**' against column '**A**', **Figure 17**)
  - Upper and lower boundaries of the range of normal, plotted at the end of each month as lines (Columns '**C**' and '**D**' against column '**B**' in **Figure 18**).
- Don't forget to format the X and Y axes, specifying maximum, minimum, and units for each so that the desired data plot the way you want!
- It is also helpful to plot:
  - Daily precipitation "spike graph" to provide details of the distribution of rainfall within the months of interest (column '**B**' against column '**A**', **Figure 17**).
  - Monthly precipitation totals as points (column '**D**' against column '**A**', **Figure 17**).

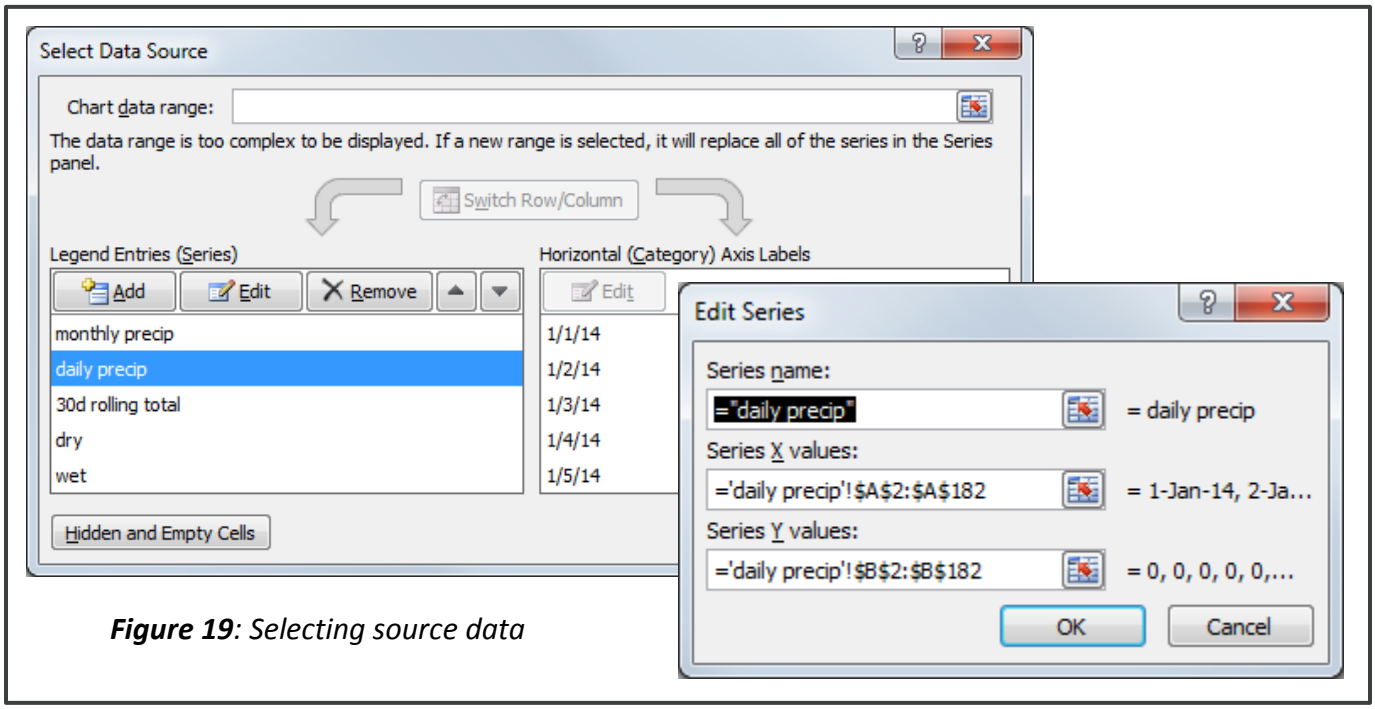


***Figure 19**: Selecting source data*

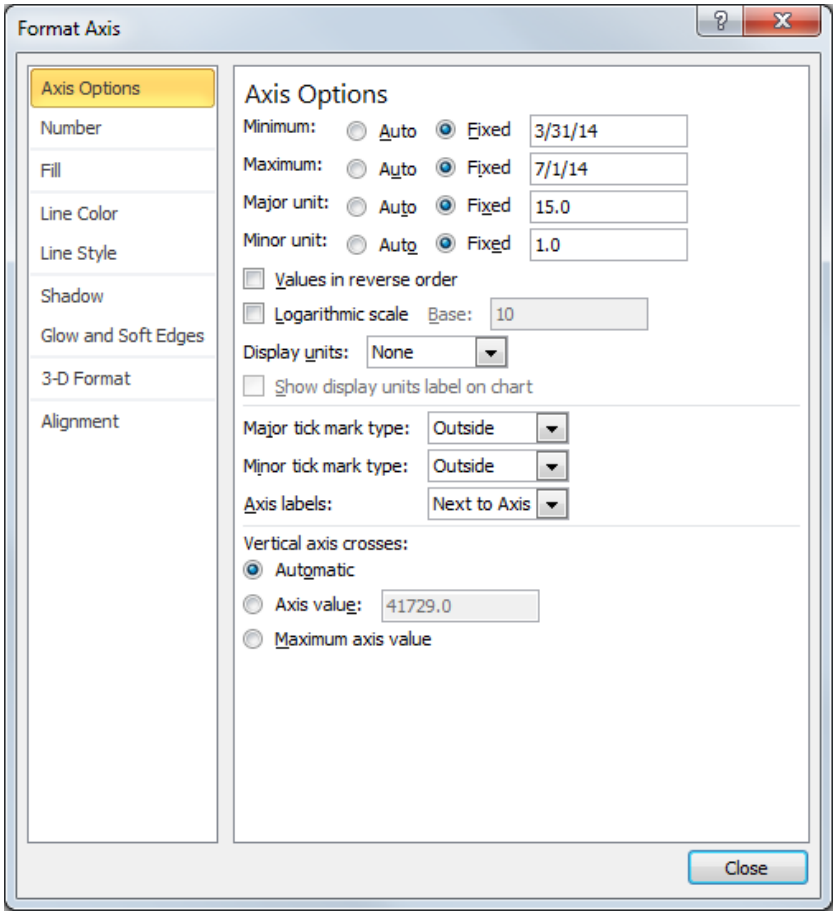


***Figure 20**: Formatting Axes.*

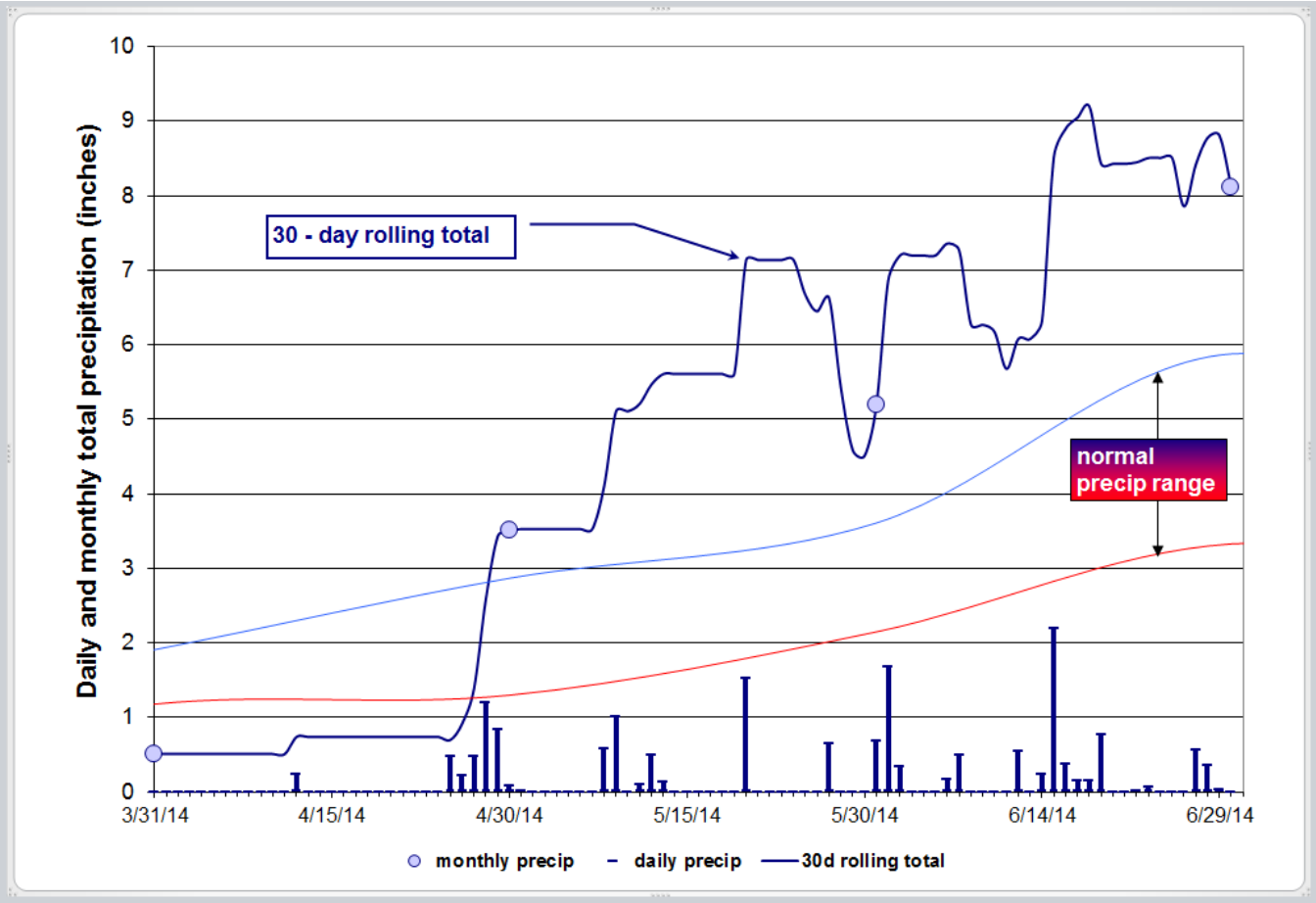


***Figure 21**:*
Resulting plot of 30-Day Rolling Total of Precipitation, Daily and Monthly Precipitation, and Range of Normal.

3.2.4. Determine Whether Precipitation Was Within Range of Normal

Deviation from the range of normal precipitation is determined by using the superimposed plots of 30-day rolling totals and ranges of normal precipitation for the period of interest (**Figure 21**). Including daily precipitation data on the plot helps show how the 30-day rolling totals evolved.

In the example in Figure 21, we see that in 2014, rainfall events at the end of April caused the 30-day total to rise from below normal to well above normal.

The strength of the method of 30-day rolling totals can be seen by comparing it to the monthly totals. The monthly totals indicate that April was significantly wetter than normal. However, the more detailed method of 30-day rolling totals detected that the heavy rains did not occur until the end of April. Detailed knowledge of rainfall distributions in early- to mid-April could have been important as that is at the beginning of the regulatory growing season (Sprecher and Warne, 2000).

3.3. Remarks on the Method

The method of 30-day rolling totals provides a more accurate assessment of antecedent moisture conditions at a site than do monthly totals, which artificially zero rainfall totals at the beginning of each month. However, the method of rolling sums also artificially zeroes rainfall after 30 days (*Sprecher and Warne, 2000*).

Note in **Figure 21** that 30-day rolling precipitation total makes a sudden drop in late May. This is a direct consequence of the method of calculating a 30-day rolling sum. A large input remains within the rolling sum for exactly 30 days, and then abruptly drops out of the rolling total.

In loamy and finer textured soils, changes in water tables are unlikely to be so abrupt.

Rolling totals are often used to track the influence of antecedent precipitation on water levels in monitoring wells. This works because each well reading can be compared to an updated tally of antecedent precipitation (*Sprecher and Warne, 2000*).

4. Combining the 30-Day Rolling Total and Three-Prior-Month Methods: "Hybrid Method"

The 30-Day Rolling Total and Three-Prior-Month methods can be effectively combined. This is particularly useful when the observation date or date of interest falls later in the month – in this case the Three-Prior-Month method alone would ignore the precipitation in the early part of the month.

a. On the plot of 30-day rolling totals, mark off 30-day blocks starting backward from the observation date or date of interest (**Figure 22**).

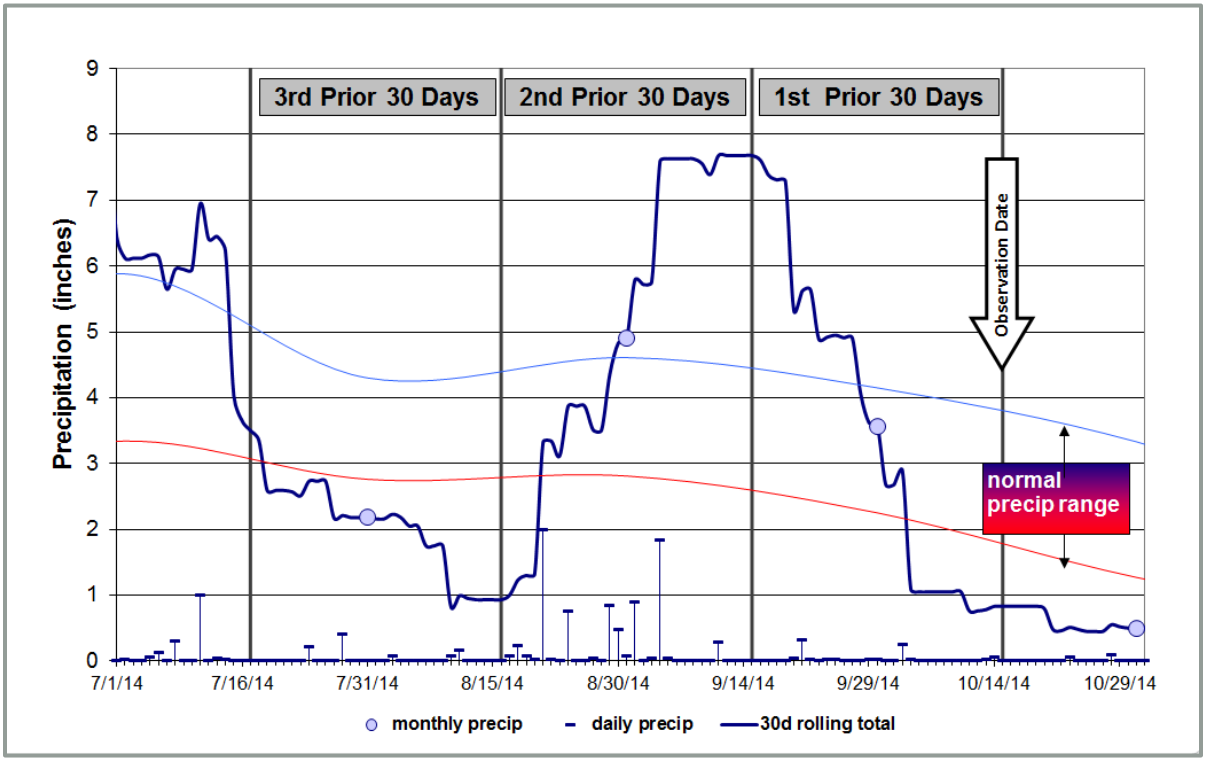
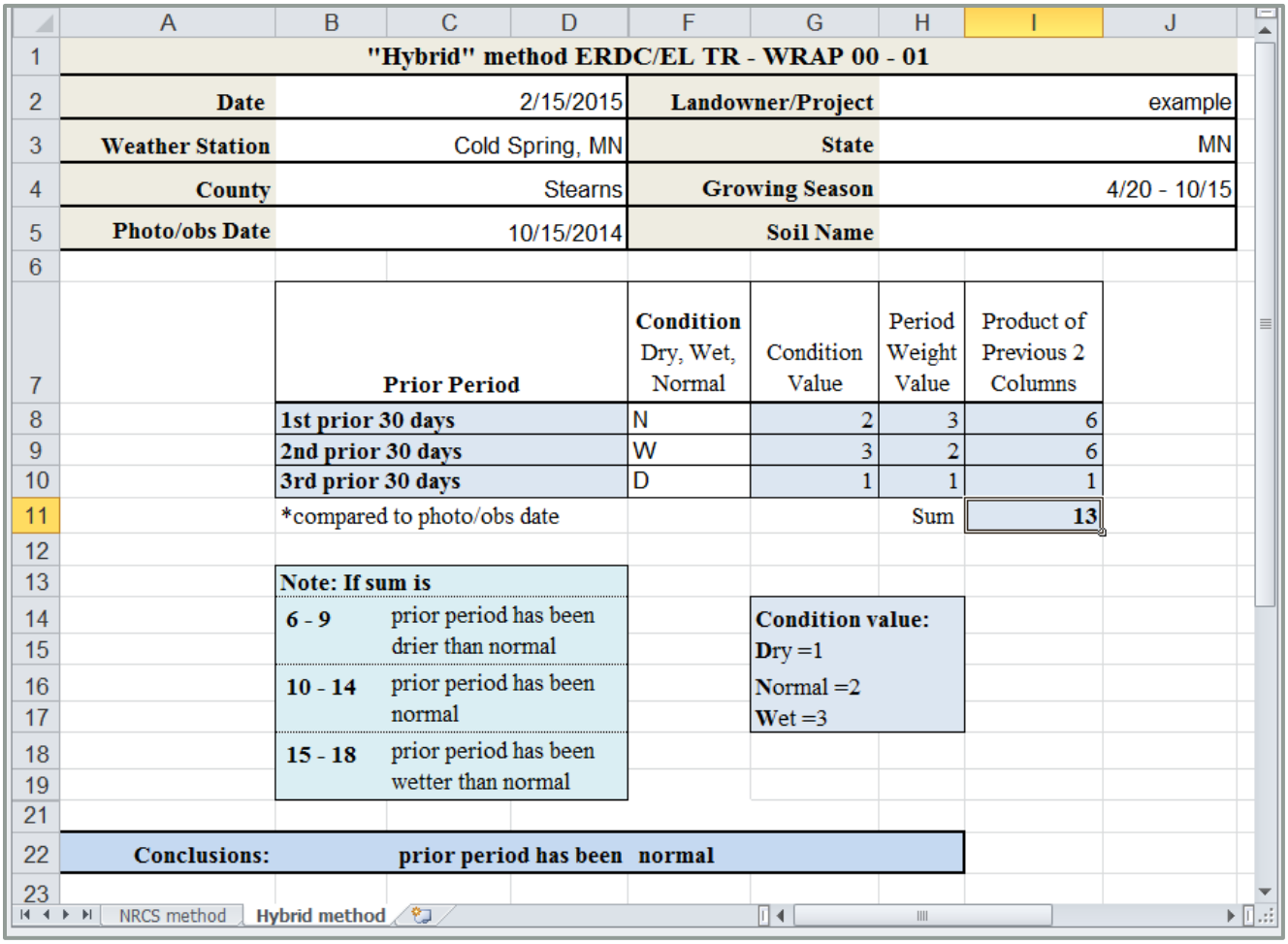


***Figure 22**: Three 30-day periods prior to the observation date or October 15, 2014.*

b. Decide whether the 30-day blocks reflect normal, drier than normal, or wetter than normal precipitation by comparing the 30-day rolling totals with the ranges of monthly normal. This will require professional judgment!

c. Record your decisions for the 30-day blocks in the Rainfall Documentation Worksheet in the column labeled "Condition dry, wet, normal" (**Figure 2**). Use these decisions to complete the Three-Prior-Month method as

described above. The [**Hybrid method**] sheet in the Excel spreadsheet available here: www.bwsr.state.mn.us/wetlands/wca/NRCS_%20Hybrid_Methods_Spreadsheet.xls automates the calculation- requiring inputs to the "Condition dry, wet, normal" column for the 3 prior 30-day periods (**Figure 23**).



	A	B	C	D	F	G	H	I	J
1	"Hybrid" method ERDC/EL TR - WRAP 00 - 01								
2	**Date**			2/15/2015	**Landowner/Project**			example	
3	**Weather Station**			Cold Spring, MN	**State**			MN	
4	**County**			Stearns	**Growing Season**			4/20 - 10/15	
5	**Photo/obs Date**			10/15/2014	**Soil Name**				
6									
7		**Prior Period**			**Condition** Dry, Wet, Normal	Condition Value	Period Weight Value	Product of Previous 2 Columns	
8		**1st prior 30 days**			N	2	3	6	
9		**2nd prior 30 days**			W	3	2	6	
10		**3rd prior 30 days**			D	1	1	1	
11		*compared to photo/obs date					Sum	**13**	
12									
13		**Note: If sum is**							
14		**6 - 9**	prior period has been drier than normal			**Condition value:**			
15						**Dry =1**			
16		**10 - 14**	prior period has been normal			**Normal =2**			
17						**Wet =3**			
18		**15 - 18**	prior period has been wetter than normal						
19									
21									
22	**Conclusions:**		**prior period has been normal**						
23									

NRCS method | Hybrid method

***Figure 23**: Example Application of Hybrid Method Using the Excel Spreadsheet Tool*

The "Hybrid Method" may rate the three-months' precipitation prior to the observation date differently than the Three-Prior-Month method, depending on professional judgment. The difference is the ability to calculate 30-day increments starting on any date rather than only at the beginning of the calendar month.

5. Observation on Assessments of Antecedent Precipitation (Sprecher and Warne, 2000)

- Using the Normal Monthly Precipitation Range data alone is quickest and OK for simple generalizations about long-term trends.
- The simple method of 30-day rolling totals is readily used with long sets of monitoring well data because of ease of plotting information. These plots, when superimposed on a daily precipitation spike graph, provide a powerful tool for explaining water well fluctuations.
- The hybrid method is useful for making decisions regarding individual dates of observation at a site. Whenever feasible, the monthly analyses should be interpreted using the daily data from which the monthly summaries were aggregated.
- The Three-Prior-Month and rolling total methods can be used in conjunction with indices of longer term hydrologic input, such as the Palmer drought indices.
- The Normal Monthly Precipitation Range data evaluate the range of normal precipitation in monthly increments. Antecedent precipitation probably does not affect wetland hydrology in monthly or 30-day increments.
- Antecedent precipitation is only one part of the water budget. The other parts of the water budget need to be considered when interpreting observed levels of ground or surface water.
- The duration of impact of antecedent precipitation typically varies with the seasons. In the early spring, when evapotranspiration (ET) is low, there is probably a longer duration impact of prior precipitation than later in the summer when ET is high.
- The duration of influence of antecedent precipitation on wetland hydrology can be quite site-specific. NRCS hydrologists chose three months as a reasonable length of time to evaluate antecedent precipitation for Food Security Act programs. In the absence of site-specific information to the contrary, three months preceding a date of site monitoring seems to be a reasonable length of time to evaluate whether precipitation was within the range of normal.
- There is no way to remove professional judgment in borderline situations. The limits of the range of normal (30th and 70th percentiles) are themselves professional judgments. Moreover, when antecedent precipitation levels are close to thresholds of normal, uncertainties about other parts of the water budget become major considerations.

6. References

Sprecher, S.W. and Andrew G. Warne, A.G., 2000. ***Accessing and Using Meteorological Data to Evaluate Wetland Hydrology***. WRAP Technical Notes Collection, ERDC/EL TR-WRAP-00-1. U.S. Army Engineer Research and Development Center, Vicksburg, MS. (http://el.erdc.usace.army.mil/elpubs/pdf/wrap00-1/wrap00-1.pdf)

Natural Resources Conservation Service, 1997. ***Hydrology tools for wetland determination***. Chapter 19, Engineering field handbook. D. E. Woodward, ed. USDA-NRCS, Fort Worth, TX. (http://www.info.usda.gov/CED/ftp/CED/EFH-Ch19.pdf)