AEPD Spreadsheet - Usage Guide

Contents:

1. General

The spreadsheet calculates Annual Exceedence-Probability Discharges (AEPD) for ungaged sites in Iowa using Regional Regression Equations (RRE) from the last three USGS AEPD/RRE publications as follows:

- "Methods for Estimating Annual Exceedence-Probability Discharges for Streams in Iowa, based on Data through Water Year 2010", USGS Scientific Investigations Report 2013-5086 (13-5086).

- "Techniques For Estimating Flood-Frequency Discharges For Streams In Iowa", USGS Water Resources Investigations Report 00-4233 (00-4233).

- "Method For Estimating The Magnitude And Frequency Of Floods At Ungaged Sites On Unregulated Rural Streams In Iowa", USGS Water Resources Investigation Report 87-4132 (87-4132).

The spreadsheet also can calculate AEPD's for ungaged sites on gaged streams per the procedures outlined in the 13-5086 report.

The spreadsheet consists of three worksheets as follows:

- RRE: RRE calculations for ungaged sites.

- Gage: Weighted estimates for ungaged sites on gaged streams.

- References: References used, notes and version history (information only).
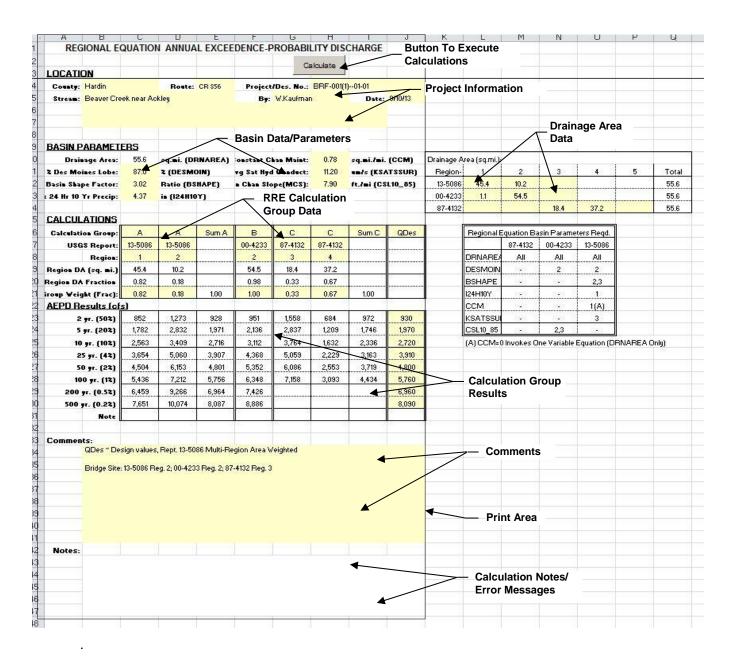
General characteristics of the spreadsheet are as follows:

- All data input cells have a yellow fill.

- When data has changed that requires recalculation of results, a red box noting "RECALC REQUIRED" will appear next to the "Calculate" button.

- Error conditions for input data will result in a red highlighted cell depending on the context of the error. Some error conditions will not be flagged until the "Calculation" button is pressed.

- Where possible drop down (DD) select boxes are provided for cell data entry to limit input to appropriate values and minimize typing required. The DD arrow will appear on entering the cell.

For the gage weighted estimates the spreadsheet makes use of a support spreadsheet that generally eliminates the need to enter gage data. This spreadsheet consists of two worksheets that represent Tables 1 and 4 as referenced in the 13-5086 report.

2. Regional Regression Equation Sheet

The RRE worksheet is shown on the next page. Note that only the outlined area of the sheet is printed. The sheet is formatted to print on a letter (8.5" x 11") sheet in portrait orientation.

REGIONAL EQUATION ANNUAL EXCEEDENCE-PROBABILITY DISCHARGE — Button To Execute Calculations

Calculate

LOCATION

| County: Hardin | Route: CR S56 | Project/Des. No.: BRF-001(1)--01-01 |
| Stream: Beaver Creek near Ackley | By: W.Kaufman | Date: 9/10/13 |

Project Information

Drainage Area Data

BASIN PARAMETERS — Basin Data/Parameters

Drainage Area: 55.6	sq.mi. (DRNAREA)	Constant Chan Maint: 0.78	sq.mi./mi. (CCM)
% Des Moines Lobe: 87.0	% (DESMOIN)	Avg Sat Hyd Conduct: 11.20	um/s (KSATSSUR)
Basin Shape Factor: 3.02	Ratio (BSHAPE)	Chan Slope(MCS): 7.90	ft./mi (CSL10_85)
24 Hr 10 Yr Precip: 4.37	in (I24H10Y)		

Drainage Area (sq.mi.)

Region-	1	2	3	4	5	Total
13-5086	45.4	10.2				55.6
00-4233	1.1	54.5				55.6
87-4132			18.4	37.2		55.6

RRE Calculation Group Data

CALCULATIONS

Calculation Group:	A	A	Sum A	B	C	C	Sum C	QDes
USGS Report:	13-5086	13-5086		00-4233	87-4132	87-4132		
Region:	1	2		2	3	4		
Region DA (sq. mi.)	45.4	10.2		54.5	18.4	37.2		
Region DA Fraction	0.82	0.18		0.98	0.33	0.67		
Group Weight (Frac)	0.82	0.18	1.00	1.00	0.33	0.67	1.00	

AEPD Results (cfs)

2 yr. (50%)	852	1,273	928	951	1,558	684	972	930
5 yr. (20%)	1,782	2,832	1,971	2,136	2,837	1,209	1,746	1,970
10 yr. (10%)	2,563	3,409	2,716	3,112	3,764	1,632	2,336	2,720
25 yr. (4%)	3,654	5,060	3,907	4,368	5,059	2,229	3,163	3,910
50 yr. (2%)	4,504	6,153	4,801	5,352	6,086	2,553	3,719	4,800
100 yr. (1%)	5,436	7,212	5,756	6,348	7,158	3,093	4,434	5,760
200 yr. (0.5%)	6,459	9,266	6,964	7,426				6,960
500 yr. (0.2%)	7,651	10,074	8,087	8,886				8,090
Note								

Calculation Group Results

Regional Equation Basin Parameters Reqd.

	87-4132	00-4233	13-5086
DRNAREA	All	All	All
DESMOIN	-	2	2
BSHAPE	-	-	2,3
I24H10Y	-	-	1
CCM	-	-	1(A)
KSATSSUR	-	-	3
CSL10_85	-	2,3	-

(A) CCM=0 Invokes One Variable Equation (DRNAREA Only)

Comments:

QDes ~ Design values, Rept. 13-5086 Multi-Region Area Weighted

Bridge Site: 13-5086 Reg. 2; 00-4233 Reg. 2; 87-4132 Reg. 3

Comments

Print Area

Notes:

Calculation Notes/ Error Messages

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2.1 RRE Data Input

Data input generally required is as follows. Note that sequence of input is not set since calculations are not invoked until the "Calculate" button is pressed.

A) Enter general project information and comments in the project information section. Note that this data is carried over to the Gage worksheet.

B) Enter drainage area (DA) data. Note that the total DA is carried over to the Basin Parameters section. The DA hydrologic region breakdown for all RRE reports that will be used in calculations must be entered. If only one report will be used (say 13-5086) and only one hydrologic region is applicable, only a single DA need be entered in the appropriate cell of the matrix.

C) Enter basin data / parameters as determined from StreamStats or other sources as appropriate. A matrix of required parameters for report/region combinations is shown.

D)   Set up the RRE calculation groups as required. Eight (8) columns are available for use, therefore a maximum of eight separate calculations are available. A calculation group code (A-F), report, hydrologic region, and group weight are required.

For watersheds that span more than one hydrologic region separate calculation columns are set up for each region. All columns for a given report are assigned to a common group and a summary column made (group code Sum A-F) for the group to obtain the weighted average. The 'Region DA Fraction' field shows the calculated area weight for each column that can then be entered as the group weight for an area weighted estimate.

To clear a calculation column, clear the group code field. A group code of 'QDes' will allow for direct input of AEPD values.

For the example shown on the previous page a calculation group for the three separate reports is set up. Calculations for reports 13-5086 and 87-4132 are multi-region so a summary column is assigned for each group. For report 00-4233 only region 2 is calculated since the majority of the basin is in this region and a group weight of 1.0 assigned. A QDes column is set up for documentation of selected design values.
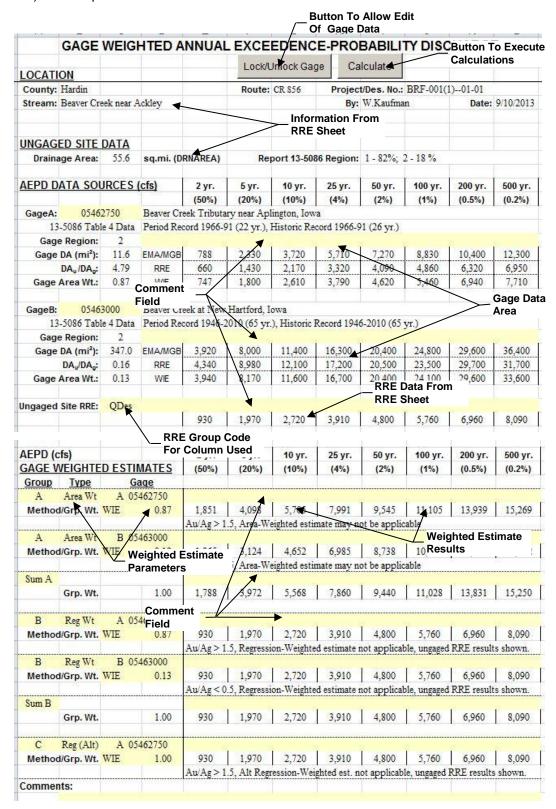
2.2   RRE Data Output / Messages

Upon pressing the "Calculate" button AEPD results will be displayed. The AEPD results for a column reflect the calculation for the region using the full basin DA. The weighted estimate is shown in the summary column.

Any error messages or calculation notes will be shown in the notes section per below. If basin parameters exceed those used for development of the RRE it will be noted in this section.

CALCULATIONS

Calculation Group:	A	A	Sum A	B	C	C	Sum C	QDes
USGS Report:	13-5086	13-5086		00-4233	87-4132	87-4132		
Region:	1	2		2	3	4		
Region DA (sq. mi.)	45.4	10.2		54.5	18.4	37.2		
Region DA Fraction	0.82	0.18		0.98	0.33	0.67		
Group Weight (Frac):	0.82	0.18	1.00	0.98	0.33	0.67	1.00	

AEPD Results (cfs)

	A	A	Sum A	B	C	C	Sum C	QDes
2 yr. (50%)	335	1,273	503		1,558	684	972	930
5 yr. (20%)	685	1,515	834		2,837	1,209	1,746	1,970
10 yr. (10%)	944	1,622	1,066		3,764	1,632	2,336	2,720
25 yr. (4%)	1,258	2,141	1,417		5,059	2,229	3,163	3,910
50 yr. (2%)	1,472	2,408	1,641		6,086	2,553	3,719	4,800
100 yr. (1%)	1,695	2,714	1,878		7,158	3,093	4,434	5,760
200 yr. (0.5%)	1,924	3,353	2,181					6,960
500 yr. (0.2%)	2,151	3,371	2,370					8,090
Note	(1)	(2)		(E1)				

Comments:

QDes ~ Design values, Rept. 13-5086 Multi-Region Area Weighted

Notes:

(E1) Group Weight<>1.0
(1) CCM>2.22 sq mi/mi study max; (2) BSHAPE>13.94 study max

3. Gage Weighting Sheet

The Gage Weighting worksheet is shown below. The sheet is formatted to print on a letter (8.5" x 11") sheet in portrait orientation.

GAGE WEIGHTED ANNUAL EXCEEDENCE-PROBABILITY DISC

Button To Allow Edit Of Gage Data

Button To Execute Calculations

Lock/Unlock Gage — Calculate

LOCATION

County: Hardin	Route: CR 856	Project/Des. No.: BRF-001(1)--01-01
Stream: Beaver Creek near Ackley		By: W.Kaufman	Date: 9/10/2013

Information From RRE Sheet

UNGAGED SITE DATA

Drainage Area: 55.6 sq.mi. (DRNAREA)   Report 13-5086 Region: 1 - 82%; 2 - 18 %

AEPD DATA SOURCES (cfs)			2 yr. (50%)	5 yr. (20%)	10 yr. (10%)	25 yr. (4%)	50 yr. (2%)	100 yr. (1%)	200 yr. (0.5%)	500 yr. (0.2%)
GageA: 05462750	Beaver Creek Tributary near Aplington, Iowa									
13-5086 Table 4 Data	Period Record 1966-91 (22 yr.), Historic Record 1966-91 (26 yr.)									
Gage Region: 2										
Gage DA (mi²): 11.6	EMA/MGB	788	2,230	3,720	5,710	7,270	8,830	10,400	12,300
DA$_u$/DA$_g$: 4.79	RRE	660	1,430	2,170	3,320	4,090	4,860	6,320	6,950
Gage Area Wt.: 0.87	WIE	747	1,800	2,610	3,790	4,620	5,460	6,940	7,710
GageB: 05463000	Beaver Creek at New Hartford, Iowa									
13-5086 Table 4 Data	Period Record 1946-2010 (65 yr.), Historic Record 1946-2010 (65 yr.)									
Gage Region: 2										
Gage DA (mi²): 347.0	EMA/MGB	3,920	8,000	11,400	16,300	20,400	24,800	29,600	36,400
DA$_u$/DA$_g$: 0.16	RRE	4,340	8,980	12,100	17,200	20,500	23,500	29,700	31,700
Gage Area Wt.: 0.13	WIE	3,940	8,170	11,600	16,700	20,400	24,100	29,600	33,600
Ungaged Site RRE: QDes		930	1,970	2,720	3,910	4,800	5,760	6,960	8,090

Comment Field

Gage Data Area

RRE Data From RRE Sheet

RRE Group Code For Column Used

AEPD (cfs) GAGE WEIGHTED ESTIMATES			(50%)	(20%)	10 yr. (10%)	25 yr. (4%)	50 yr. (2%)	100 yr. (1%)	200 yr. (0.5%)	500 yr. (0.2%)
Group	Type	Gage								
A	Area Wt	A 05462750								
Method/Grp. Wt.	WIE	0.87	1,851	4,098	5,766	7,991	9,545	11,105	13,939	15,269
			Au/Ag > 1.5, Area-Weighted estimate may not be applicable							
A	Area Wt	B 05463000								
Method/Grp. Wt.	WIE				3,124	4,652	6,985	8,738	10		
			Area-Weighted estimate may not be applicable							
Sum A										
	Grp. Wt.	1.00	1,788	3,972	5,568	7,860	9,440	11,028	13,831	15,250
B	Reg Wt	A 0546...								
Method/Grp. Wt.	WIE	0.87	930	1,970	2,720	3,910	4,800	5,760	6,960	8,090
			Au/Ag > 1.5, Regression-Weighted estimate not applicable, ungaged RRE results shown.							
B	Reg Wt	B 05463000								
Method/Grp. Wt.	WIE	0.13	930	1,970	2,720	3,910	4,800	5,760	6,960	8,090
			Au/Ag < 0.5, Regression-Weighted estimate not applicable, ungaged RRE results shown.							
Sum B										
	Grp. Wt.	1.00	930	1,970	2,720	3,910	4,800	5,760	6,960	8,090
C	Reg (Alt)	A 05462750								
Method/Grp. Wt.	WIE	1.00	930	1,970	2,720	3,910	4,800	5,760	6,960	8,090
			Au/Ag > 1.5, Alt Regression-Weighted est. not applicable, ungaged RRE results shown.							

Weighted Estimate Results

Weighted Estimate Parameters

Comment Field

Comments:

3.1 Gage Weighting Input

Data input generally required is as follows. Sequence of input is not set since calculations are not invoked until the "Calculate" button is pressed. However, stream gages to be used should be entered before setting up weighted estimates so the gage names are available.

A) Project information and ungaged site drainage area is carried over from the RRE worksheet. For an Area-Weighted calculation (RRE estimate not required) enter site data and ungaged site drainage areas on the RRE worksheet.

B) For a Regression-Weighted estimate, enter the RRE group code for the column (calculation) to be used from the RRE sheet. The data from the RRE sheet is copied into the gage sheet. To clear the RRE data, clear the RRE group code field.

C) Enter the gage data. Data for two separate gages can be entered. Generally gage data will be copied directly from Tables 1 and 4 of Rept. 13-5086. A support spreadsheet containing both of these tables has been created (13-5086_tables1&4.mmddyy.xlsx). An option is provided for editing of loaded gage data.

Gage data entry is as follows:

1) Open the Table 1 and 4 spreadsheet.

2) Enter the gage number, gage data will be loaded (or message noting gage not found displayed). To clear the gage data, clear the gage no. field.

3) Edit gage data by unlocking data cells. To unlock a cell select the cell, then press the "Lock/Unlock Gage" button (selection of a flow data cell will unlock the entire flow data row). The cell fill will change to yellow. Cells that can be unlocked are shown below. After edit, cells can be locked by selecting the cell, then pressing the "Lock/Unlock Gage" button. Edited data displays as bold/italic as shown below.

D) Set up the Gage Weighted Estimate calculation groups as required. Seven (7) separate calculations, arranged in row sets, are available for use. A calculation group code (A-F), weighting type, gage, gage AEPD method, and group weight are required.

For ungaged sites with two gages within drainage area ratio limitations a common group can be set up for both gages with a summary calculation made (group code Sum A-F) for the group to obtain a weighted average. The 'Gage Area Wt.' field for each gage indicates the weight of the gage relative to the ungaged site (DA proximity of gage to ungaged site). This value can generally be entered as the group weight for a gage in a weighted estimate using two gages.

To clear a calculation set, clear the group code field. A group code of 'QDes' will allow for direct input of AEPD values.

Gage weighted estimate set up considerations are as follows:

1) The three types of weighting methodologies are as follows. Refer to Sect. 4.0 for commentary regarding selection of a weighting type.

Area Wt - Area-Weighted estimate per Rept. 13-5086, Eq. 12.

Reg Wt -   Regression-Weighted estimate per Rept. 13-5086, Eq. 11.

Reg (Alt) - Alternate Regression-Weighted estimate per USGS Bk. 4, Ch. 6, Pg. 9.

2)   The gage AEPD method selected should generally be WIE which uses the gage WIE AEPD row. When use of the gage EMA/MGB AEPD results are indicated, EMA can be selected to use the EMA/MGB row.

3)   The gage weighting methodologies, per USGS recommendations, are applicable for drainage area ratios of $0.5 \leq A_u/A_g \leq 1.5$ (A_u - ungaged site DA, A_g - gage DA). The ratio for each gage is shown with the gage data. For the regression-weighted methodologies, if the DA ratios are exceeded, the ungaged site RRE AEPD estimate is displayed.

For the example shown on the previous page three separate calculation groups have been set up for each of the weighting types.

3.2   Gage Weighting Output

Upon pressing the "Calculate" button AEPD results will be displayed. The AEPD results for a calculation set reflect the weighted estimate for the gage selected. The weighted estimate for ungaged sites utilizing two gages is shown in the summary groups.

4.   Gage Weighting Methodologies

Governing equations are as follows:

Area Wt - Area-Weighted estimate per Rept. 13-5086, Eq. 12.

$$Q_{uaw} = \left(\frac{A_u}{A_g}\right)^b Q_{gw} \qquad (1)$$

Reg Wt - Regression-Weighted estimate per Rept. 13-5086, Eq. 11.

$$Q_{urw} = \left(\frac{2\Delta A}{A_g}\right) Q_{ur} + \left(1 - \frac{2\Delta A}{A_g}\right)\left(\frac{Q_{ur}}{Q_{gr}}\right) Q_{gw} \qquad (2)$$

Reg (Alt) - Alternate Regression-Weighted estimate per USGS Bk. 4, Ch. 6, Pg. 9 (Ref. 1).

$$Q_{urw} = \left(\frac{2\Delta A}{A_g}\right) Q_{ur} + \left(1 - \frac{2\Delta A}{A_g}\right)\left(\frac{A_u}{A_g}\right)^b Q_{gw} \qquad (3)$$

Drainage area ratio limits for above equations: $0.5 \leq A_u/A_g \leq 1.5$

A_u = Ungaged site drainage area.

A_g = Gaged site drainage area.

$\Delta A = |A_u - A_g|$

b = Regional exponent (Rept. 13-5086, Table 15).

Q_{ur} = Ungaged site RRE estimate.

Q_{gr} = Gaged site RRE estimate.

Q_{gw} = Gaged site WIE estimate (or EMA/MGB per commentary Sect. 3.1(D)(2) above) .

Q_{uaw}, Q_{urw} = Ungaged site weighted estimate.

Guidelines for selection of the gage weighting methodology to utilize are as follows.

A)   For ungaged sites where only one gaged site falls within drainage area ratio limits one of the regression-weighted metholigies (Eq. 2 or 3) should be used to ensure a smooth transition from gage-weighted AEPD's to RRE AEPD's for a stream basin.

B)   For ungaged sites where two gaged sites, one upstream and one downstream, fall within drainage area ratio limits, the area-weighted methodology (Eq. 1) should be used.

C)   For the Regression-Weighted methodology per Rept. 13-5086 (Eq. 2) the gaged site RRE estimate from Table 4 should be reviewed for consistency with the ungaged site RRE estimate. Issues that may result in inconsistencies are as follows:

- The ungaged site RRE estimate is based on a multi-region area weighted estimate.

- The basin parameters obtained from the current version of Streamstats varies from those used to determine the published gaged site RRE estimate.

   Basin parameters used to develop the gaged site RRE estimate are shown in Table 3 of Rept. 13-5086. If the support spreadsheet containing this table (13-5086_table3.mmddyy.xlsx) is open when gage data is loaded, the row for the selected gage will be displayed.

In the event of an inconsistency, the gaged site RRE estimate should be recalculated using consistent basin parameters, and the revised RRE values entered for the gage data.

Alternately, Eq. 3 could be utilized (drainage area used in lieu of gaged site RRE estimate).

D)   For the Alternate Regression-Weighted methodology per USGS Bk. 4 (Eq. 3) the gaged site drainage area from Table 4 should be reviewed for consistency with the ungaged site. In the event of an inconsistency, the gaged site drainage area should be recalculated (generally using Streamstats) and the revised drainage area entered in the gage data.

References:

(1)   USGS Bk. 4, Ch. 6 - "The National Streamflow Statistics Program: A Computer Program for Estimating Streamflow Statistics for Ungaged Sites", Chapter 6 of Book 4, Hydrologic Analysis and Interpretation, Section A, Statistical Analysis. USGS Techniques and Methods 4-A6.

Revisions:

9/17/13 – Initial Document

12/04/13 – Editorial changes to Sect. 4.