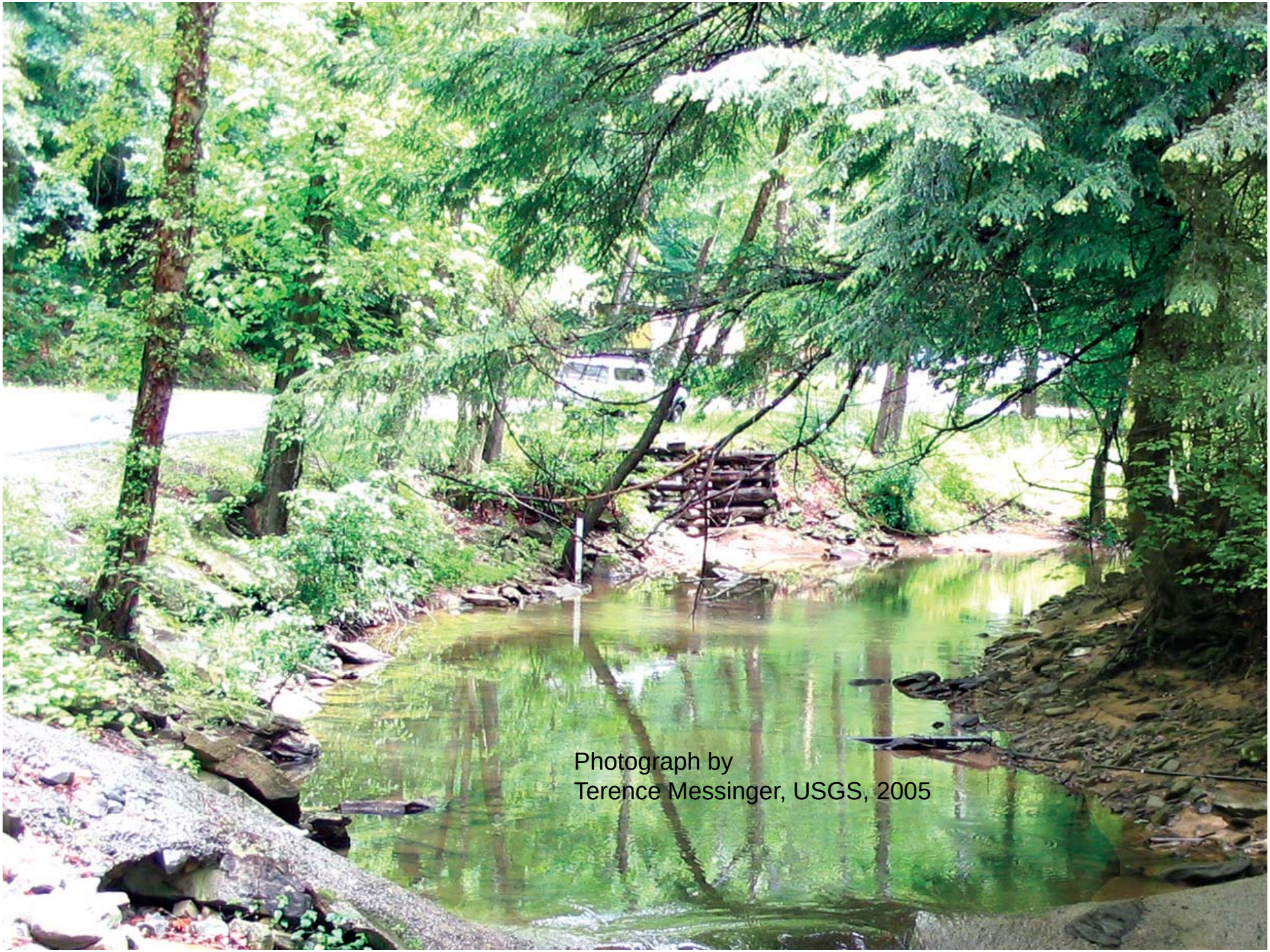

Photograph by
Terence Messinger, USGS, 2005


100-year flood?
No. It's a 5-year flood.
And what is this?
Photograph by
G.R. Crosby, USGS, 2003
2003/02/22

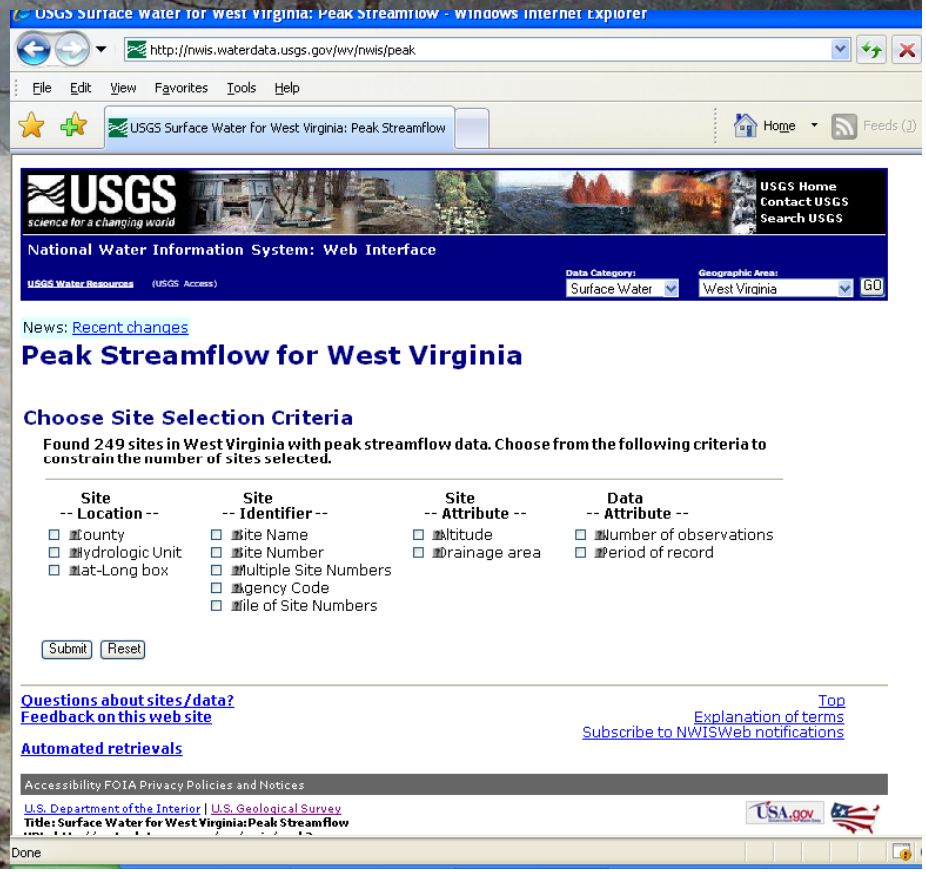

10-year flood last week?
Where do all these terms,
"*T-year flood*", come from?

"Recurrence intervals" or "return periods" are always estimates.

"*T-year flood*"

Flood frequency analyses are used to predict "*design floods*" for sites along a stream, using observed annual peak flow discharge data.

http://nwis.waterdata.usgs.gov/wv/nwis/peak



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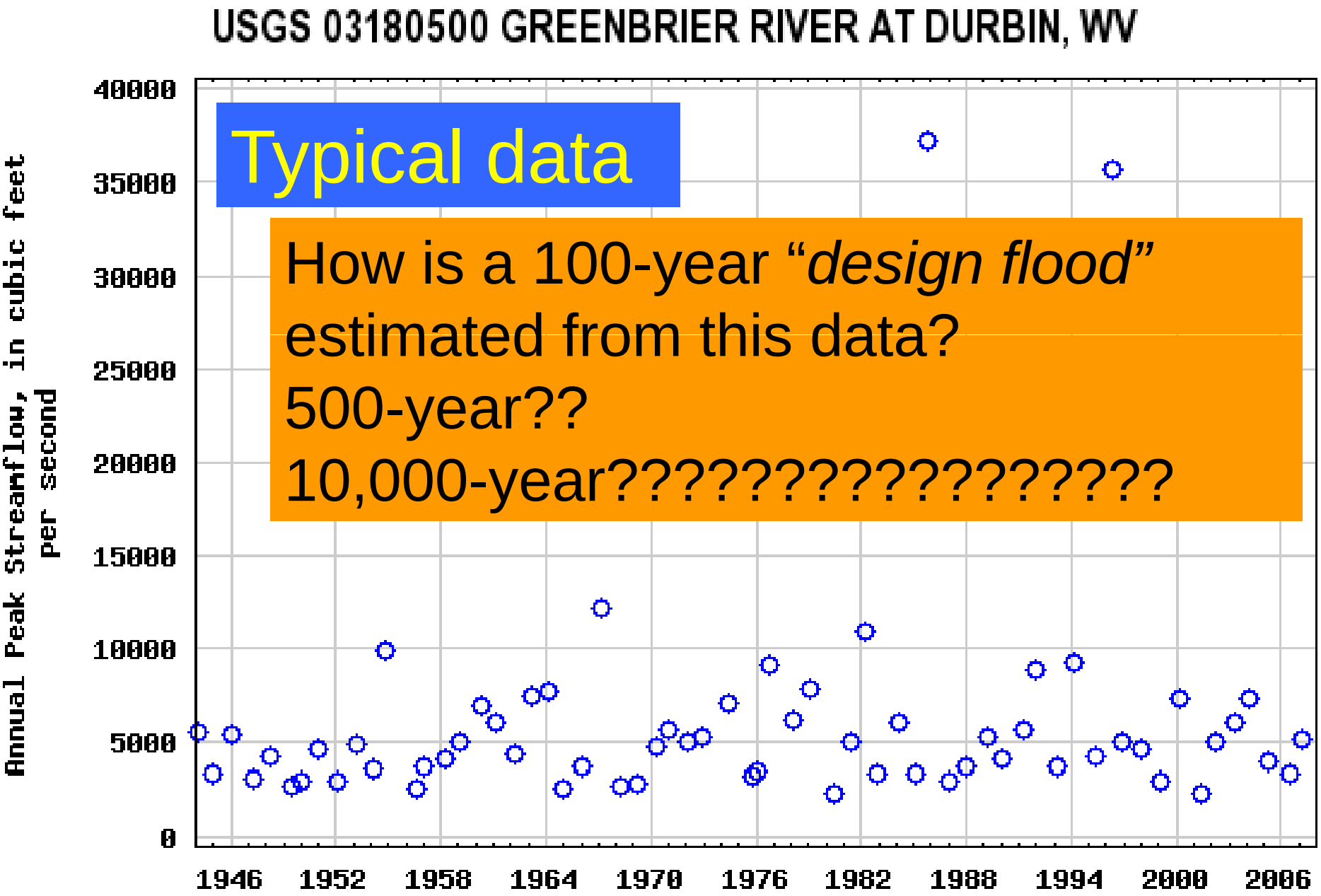
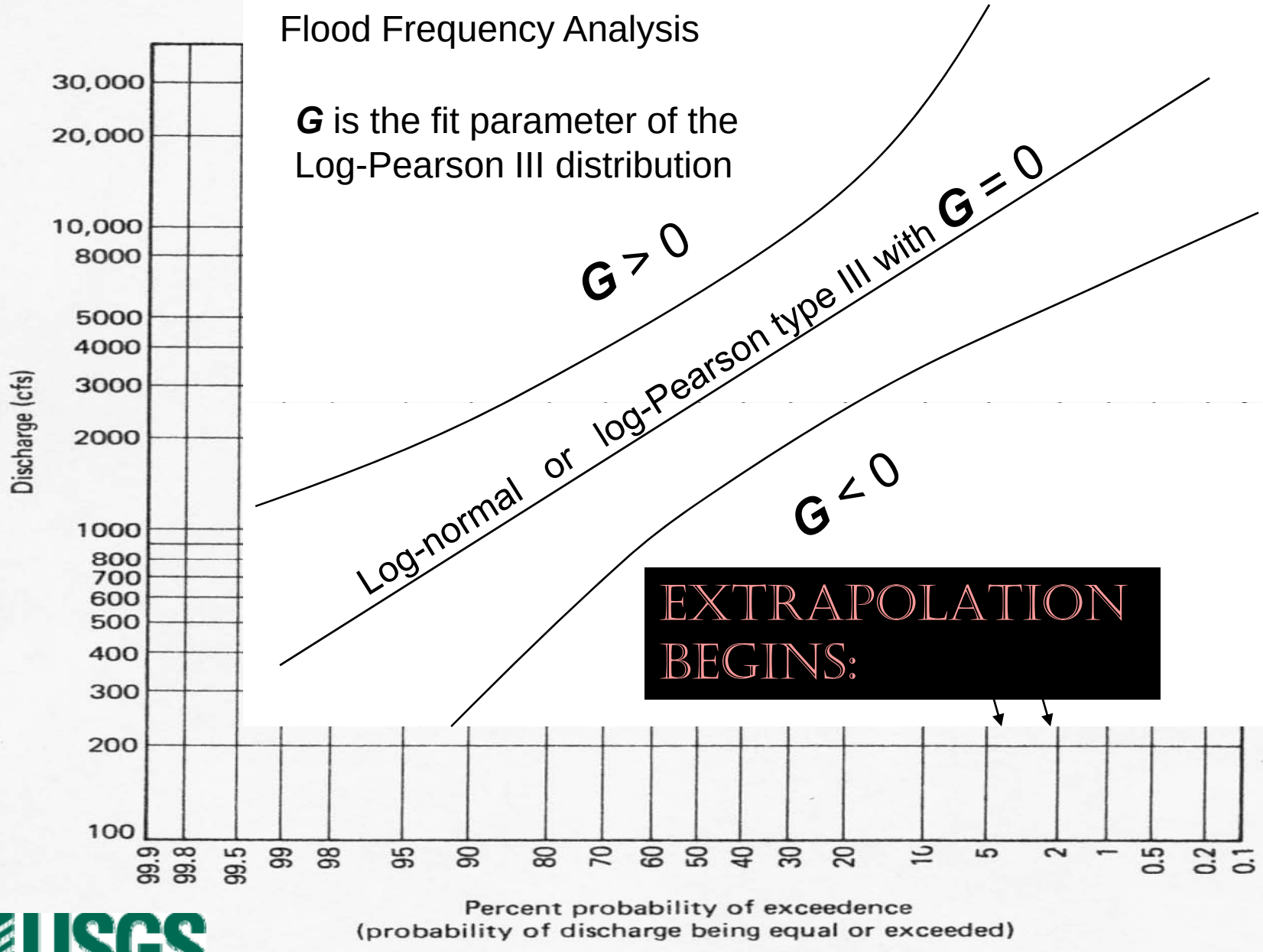


Typical data

How is a 100-year "*design flood*" estimated from this data?
500-year??
10,000-year??????????????????

Flood Frequency Analysis

G is the fit parameter of the Log-Pearson III distribution



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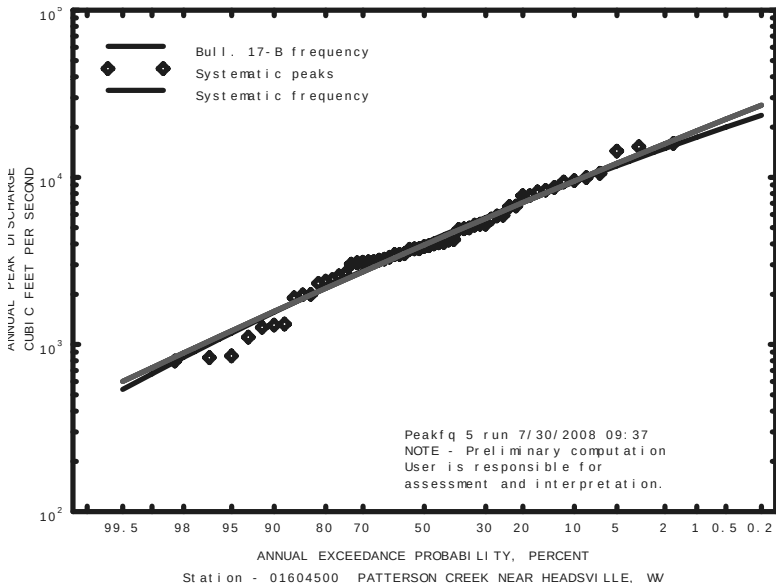
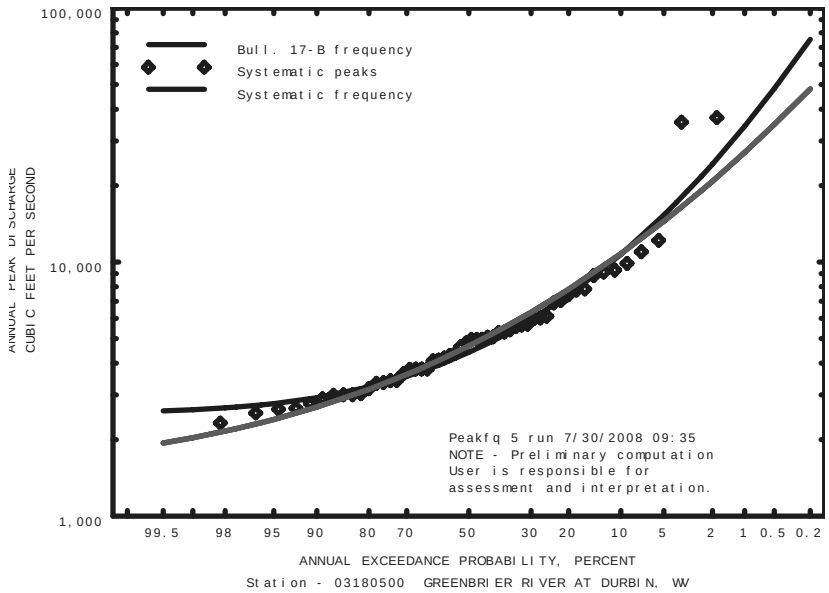
In the United States, the Log-Pearson Type III Distribution is widely used to calculate flood recurrences by fitting this distribution to annual series of observed peak flows.





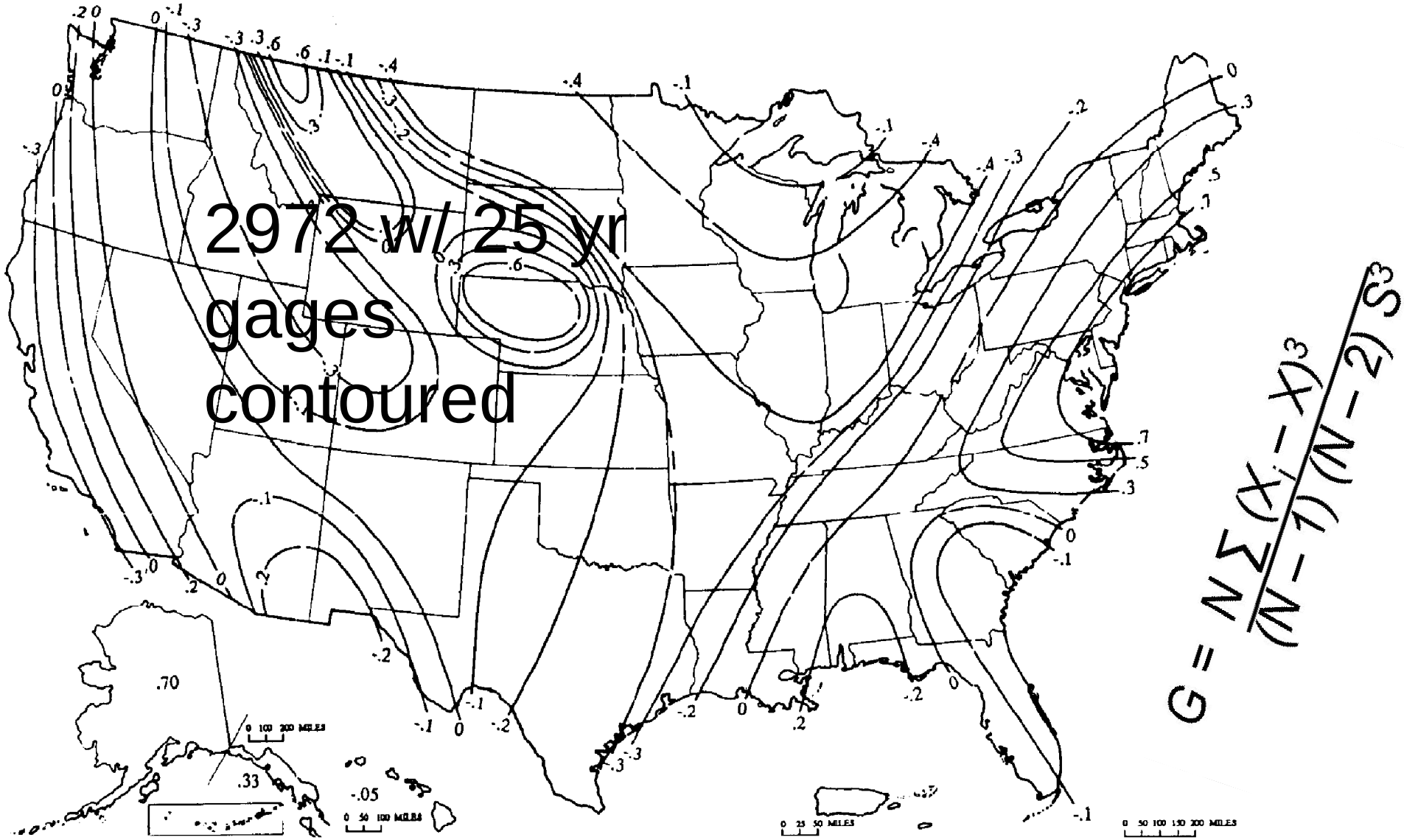
None of these curves is a curve-fit of the data.

$$X = \frac{\sum X_i}{N}$$

$$S = \sqrt{\frac{\sum (X_i - X)^2}{(N-1)}}$$

$$G = \frac{N \sum (X_i - X)^3}{(N-1)(N-2) S^3}$$

Guidelines for Determining Flood Flow Frequency, Bulletin 17B



Generalized skew coefficients of annual maximum streamflow

Source: Guidelines for determining flood flow frequency, Bulletin 17B, Hydrology Subcommittee, Interagency Advisory Committee on Water Data, March 1982

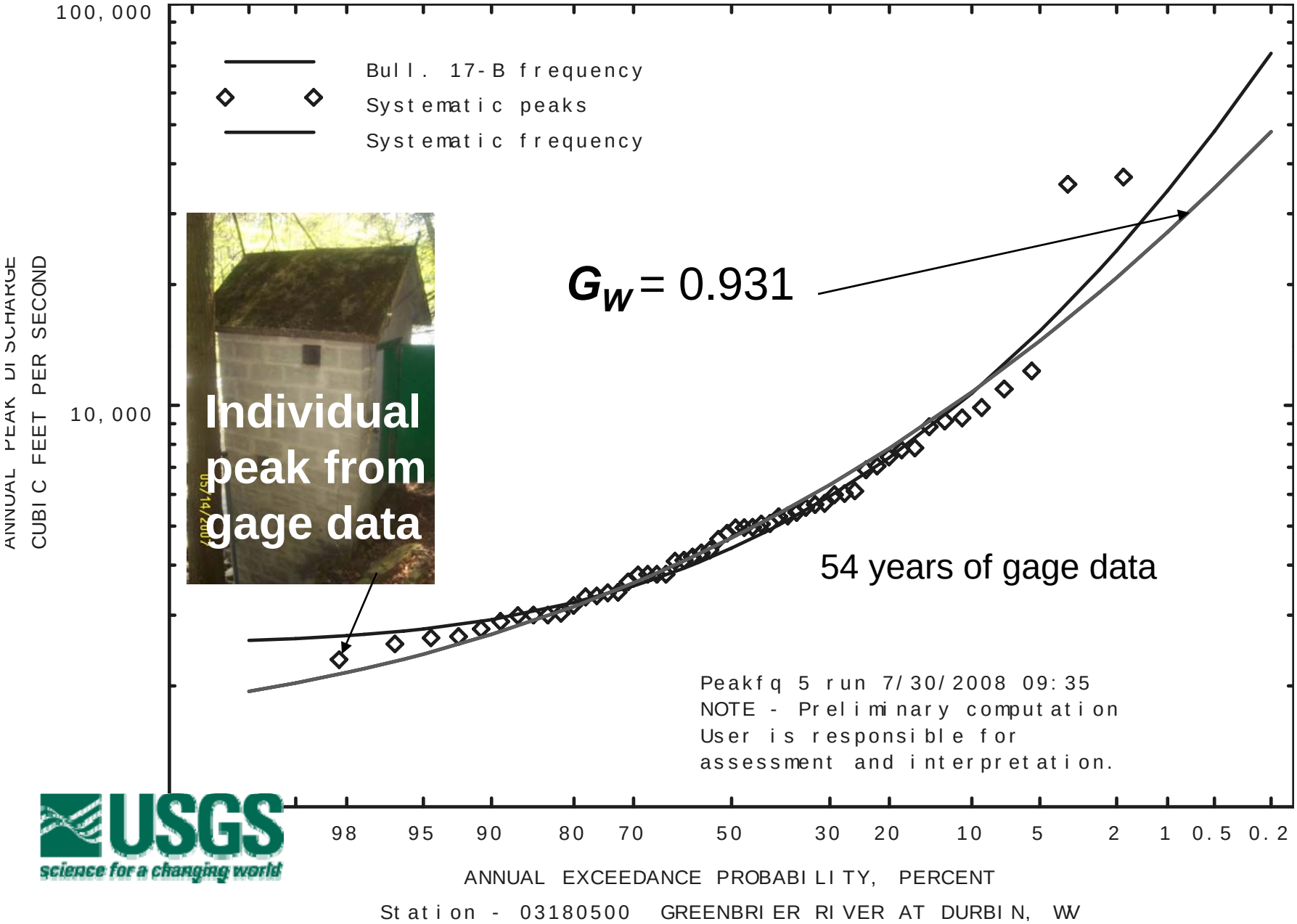
U.S. Water Resources Council has recommended the use of the log-Pearson type III distribution *with <u>a</u> generalized skew coefficient*.

Generalized skews are used to average with an individual station skew to stabilize flood-frequency estimations.

P	G =0.0	G =0.1	G =0.2	G =0.3	G =0.4	G =0.5	G =0.6
0.9999	-3.71902	-3.50703	-3.29921	-3.09631	-2.89907	-2.70836	-2.52507
0.9995	-3.29053	-3.12767	-2.96698	-2.80889	-2.65390	-2.50257	-2.35549
0.9990	-3.09023	-2.94834	-2.80786	-2.66915	-2.53261	-2.39867	-2.26780
0.9980	-2.87414	-2.75706	-2.63672	-2.51741	-2.39942	-2.28311	-2.16884
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-2.20092	-2.10825	-2.01644
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-2.02933	-1.95472	-1.88029
0.9800	-2.05375	-1.99973	-1.94499	-1.88959	-1.83361	-1.77716	-1.72033
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-1.71366	-1.66253
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-1.56740	-1.52830
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-1.49101	-1.45762
0.9000	-1.28155	-1.27037	-1.25824	-1.24516	-1.23114	-1.21618	-1.20028
0.8000	-0.84162	-0.84611	-0.84986	-0.85285	-0.85508	-0.85653	-0.85718
[illegible]	[illegible]	-0.53624	-0.54757	-0.55839	-0.56867	-0.57840	-0.58757
[illegible]	[illegible]	-0.26882	-0.28403	-0.29897	-0.31362	-0.32796	-0.34198
0.5704	-0.17733	-0.19339	-0.20925	-0.22492	-0.24037	-0.25558	-0.27047
0.5000	0.0	-0.01662	-0.03325	-0.04993	-0.06651	-0.08302	-0.09945
0.4296	0.17733	0.16111	0.14472	0.12820	0.11154	0.09478	0.07791
0.4000	0.25335	0.23763	0.22168	0.20552	0.18916	0.17261	0.15589
0.3000	0.52440	0.51207	0.49927	0.48600	0.47228	0.45812	0.44352
				0.82377	0.81638	0.80829	0.79950
				1.30936	1.31671	1.32309	1.32850
				1.72562	1.75048	1.77428	1.79701
				1.84949	1.88039	1.91022	1.93896
				2.09795	2.14202	2.18505	2.22702
				2.21081	2.26133	2.31084	2.35931
				2.54421	2.61539	2.68572	2.75514
				2.85636	2.94900	3.04102	3.13232
				3.24371	3.36566	3.48737	3.60872
				3.52139	3.66608	3.81090	3.95567
				3.78820	3.95605	4.12443	4.29311
				4.37394	4.59687	4.82141	5.04718

$$G_W = \frac{MSE_{\overline{G}}(G) + MSE_G(\overline{G})}{MSE_{\overline{G}} + MSE_G}$$

The skew coefficient is the fit parameter of the Log-Pearson Type III Distribution



Station - 03180500 GREENBRIER RIVER AT DURBIN, WV

Why are flood frequency estimates important?

- Major design decisions
- A large number of smaller design decisions
- Floods place the lives of all West Virginians at risk, influencing public, business, and personal decisions.

Stable, consistent estimates optimize investment in infrastructure

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Seeking a new generalization--

$$G = \frac{N \sum (X_i - X)^3}{(N-1)(N-2)S^3}$$

Generalized Skew Coefficients of Annual Peak Flows for Rural, Unregulated Streams in West Virginia, U.S. Geological Survey Open-File Report TBP

John T. Atkins Jr., Jeffrey B. Wiley, and Katherine S. Paybins

To improve flood frequency estimates

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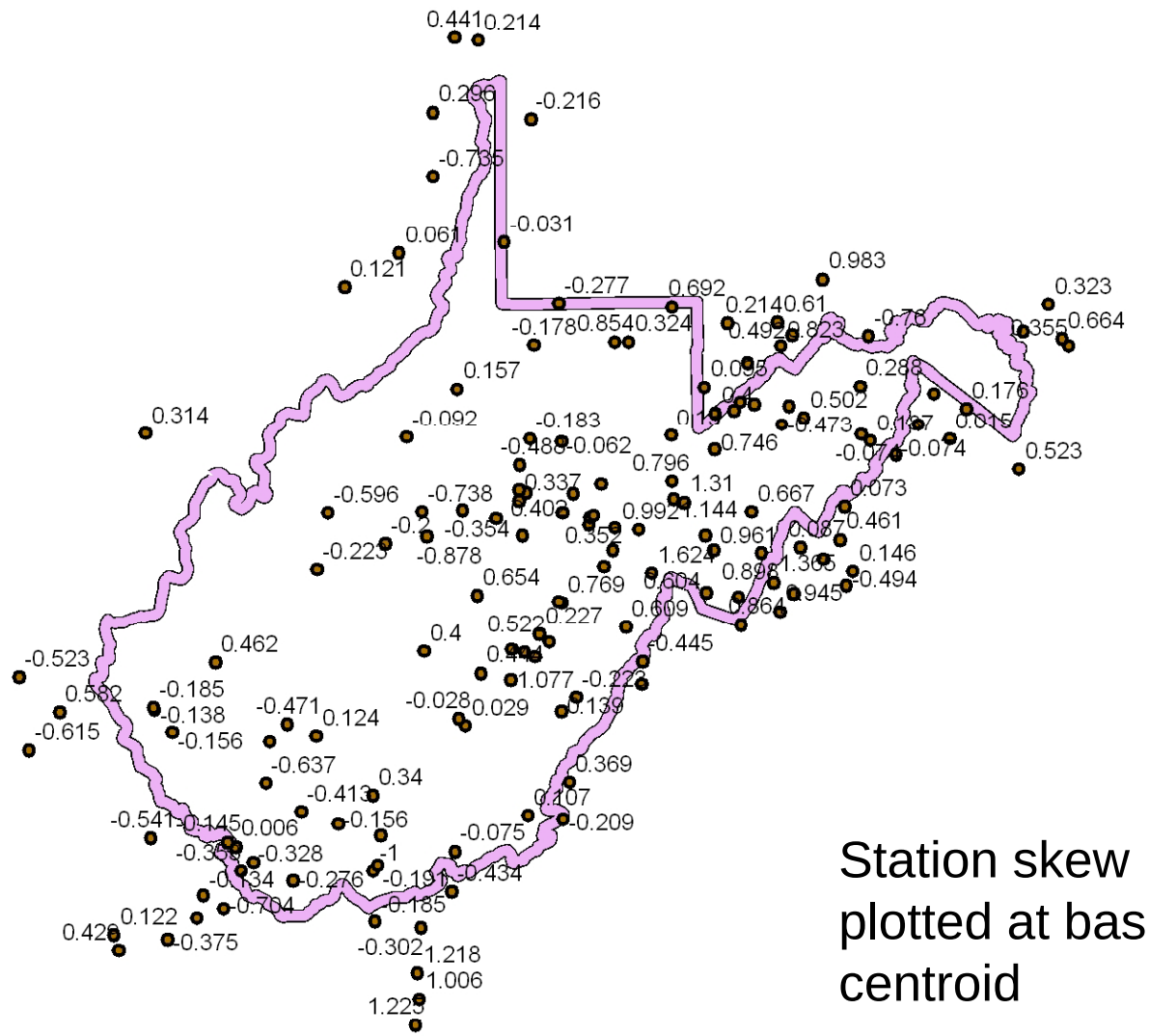

Station skew plotted at basin centroid

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DATASET: West Virginia peak stage stations with at least 25 years of record and 59 nearby stations for a total of 147 sites

ARE SHORT-HALF AND LONG-HALF FROM SAME POPULATION?: means of 75 sites with >= 50 years of record and 72 sites >= 25 and <50 years of record differ by 0.1834

TEST: A Wilcoxon Two-Sample Test of stations skews of these as samples.

RESULT: Reject HO at alpha = 0.05

For best reliability, station skews for the group of 75 sites with 50 or more years of record were used to develop procedures

To avoid bias the original selection criteria is retained: The full 147-site mean square error was used for comparing all procedures.

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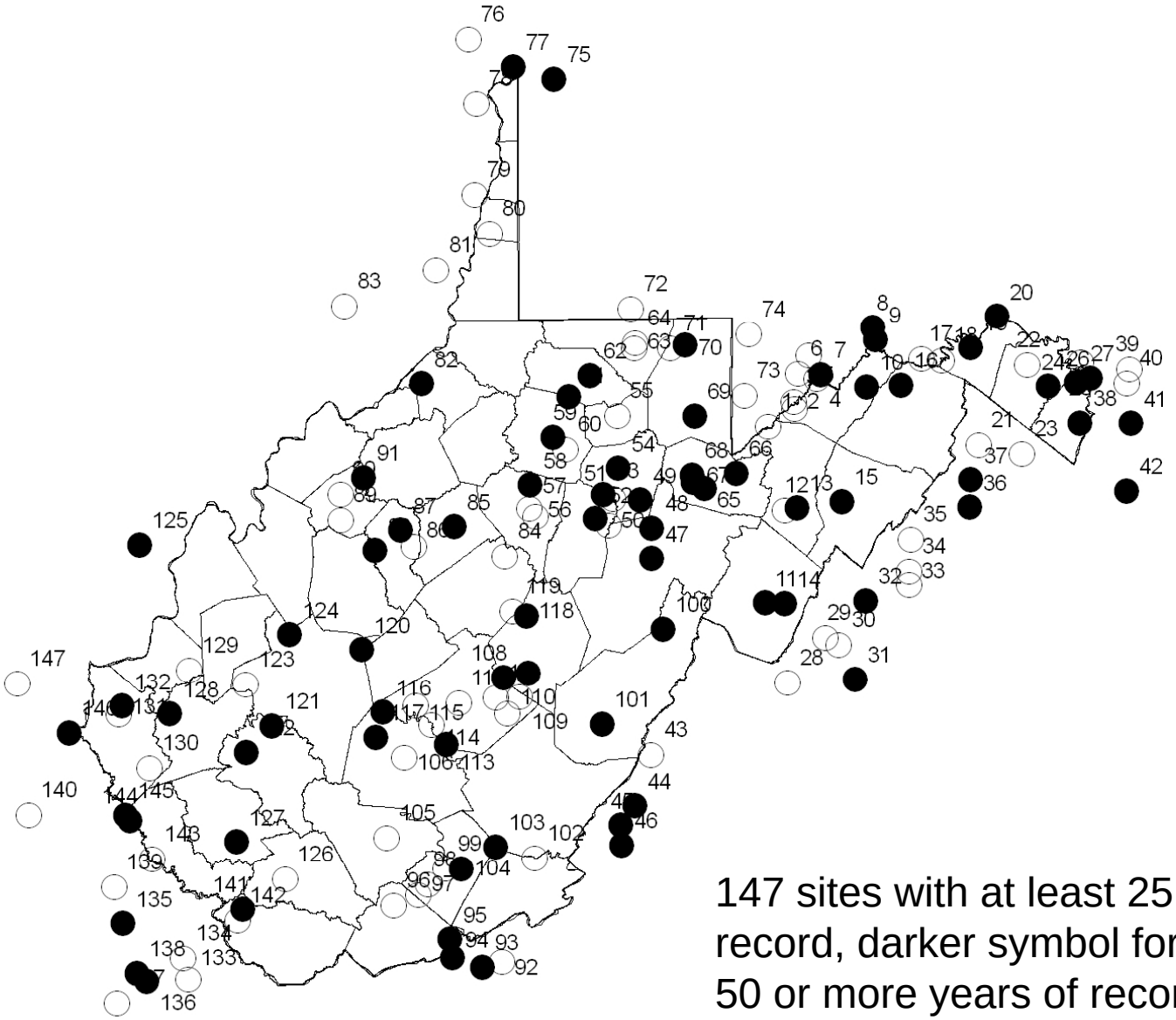

147 sites with at least 25 years of record, darker symbol for sites with 50 or more years of record

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Which method is best?

	MSE
• Nationwide skew map	0.302
• Best regional means	0.255
• Best 1 variable equation	0.233
• Best 2 variable equation	0.222
• Contouring-- WV skew map	0.217

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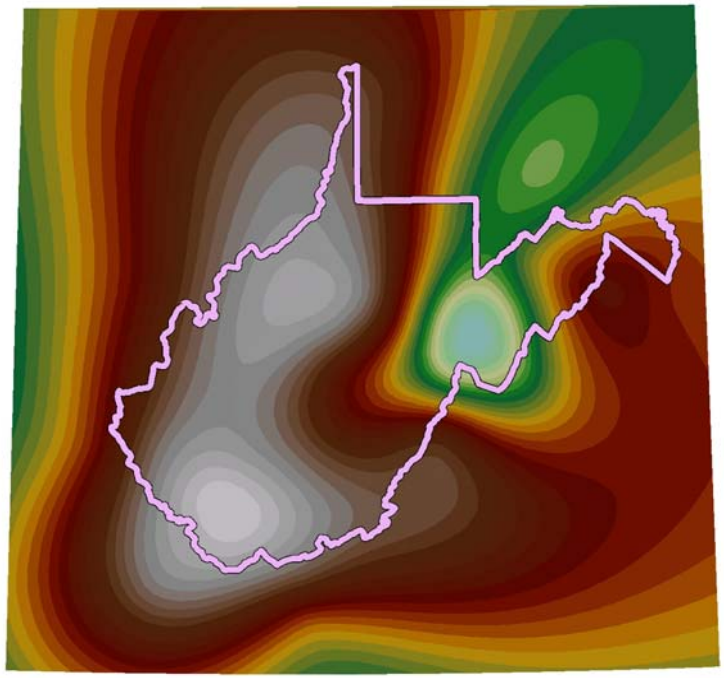

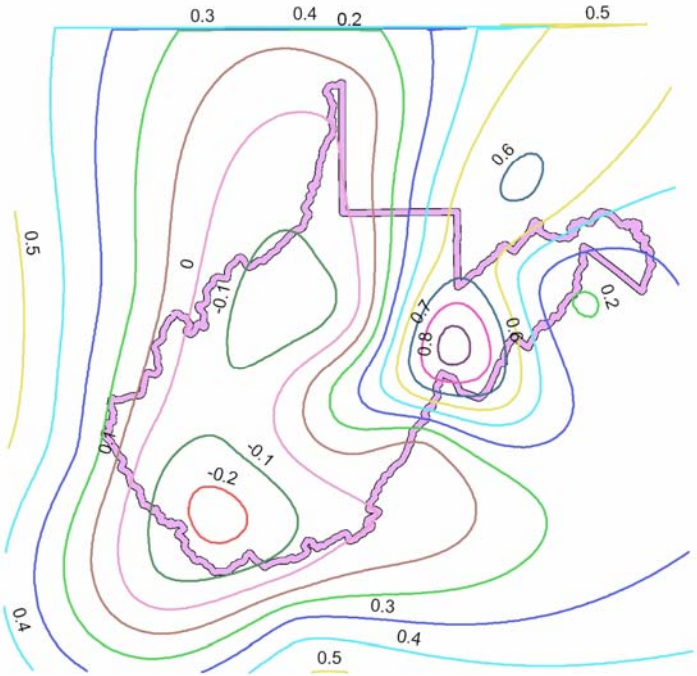

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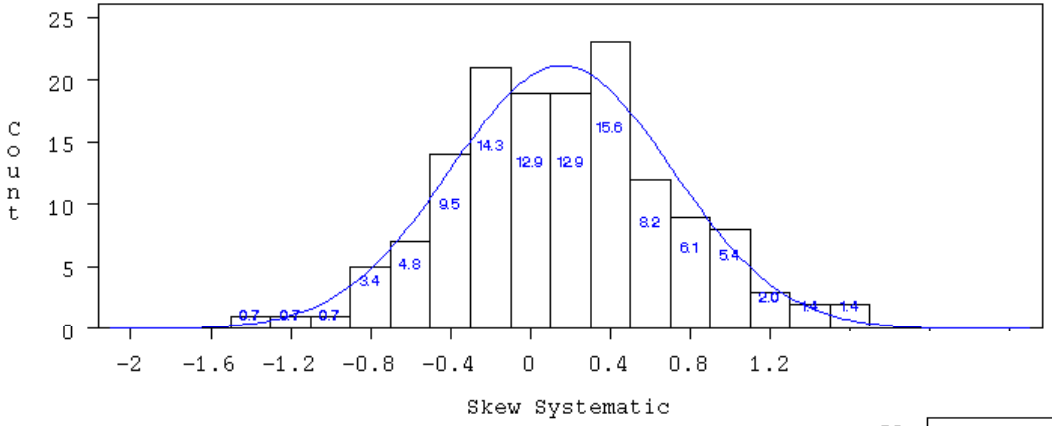
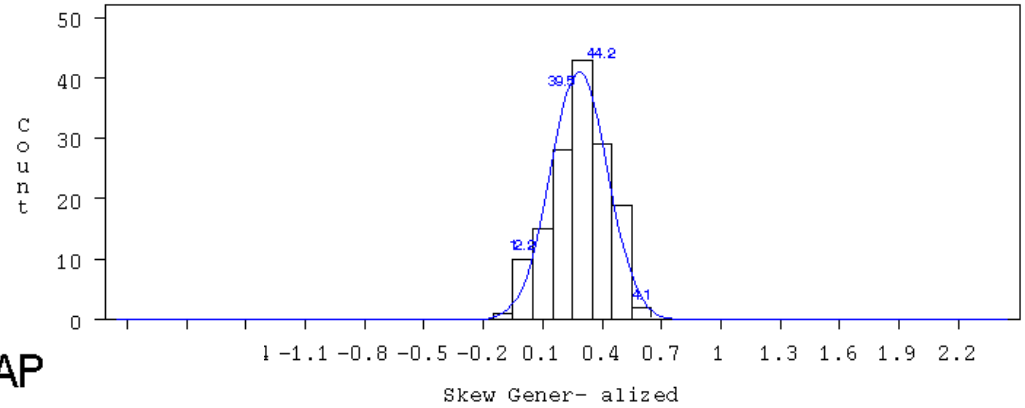
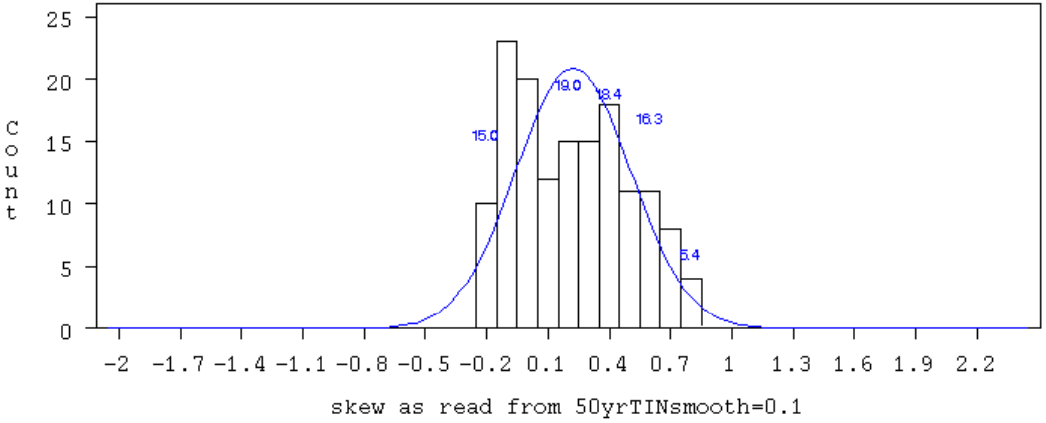
STATION SKEW

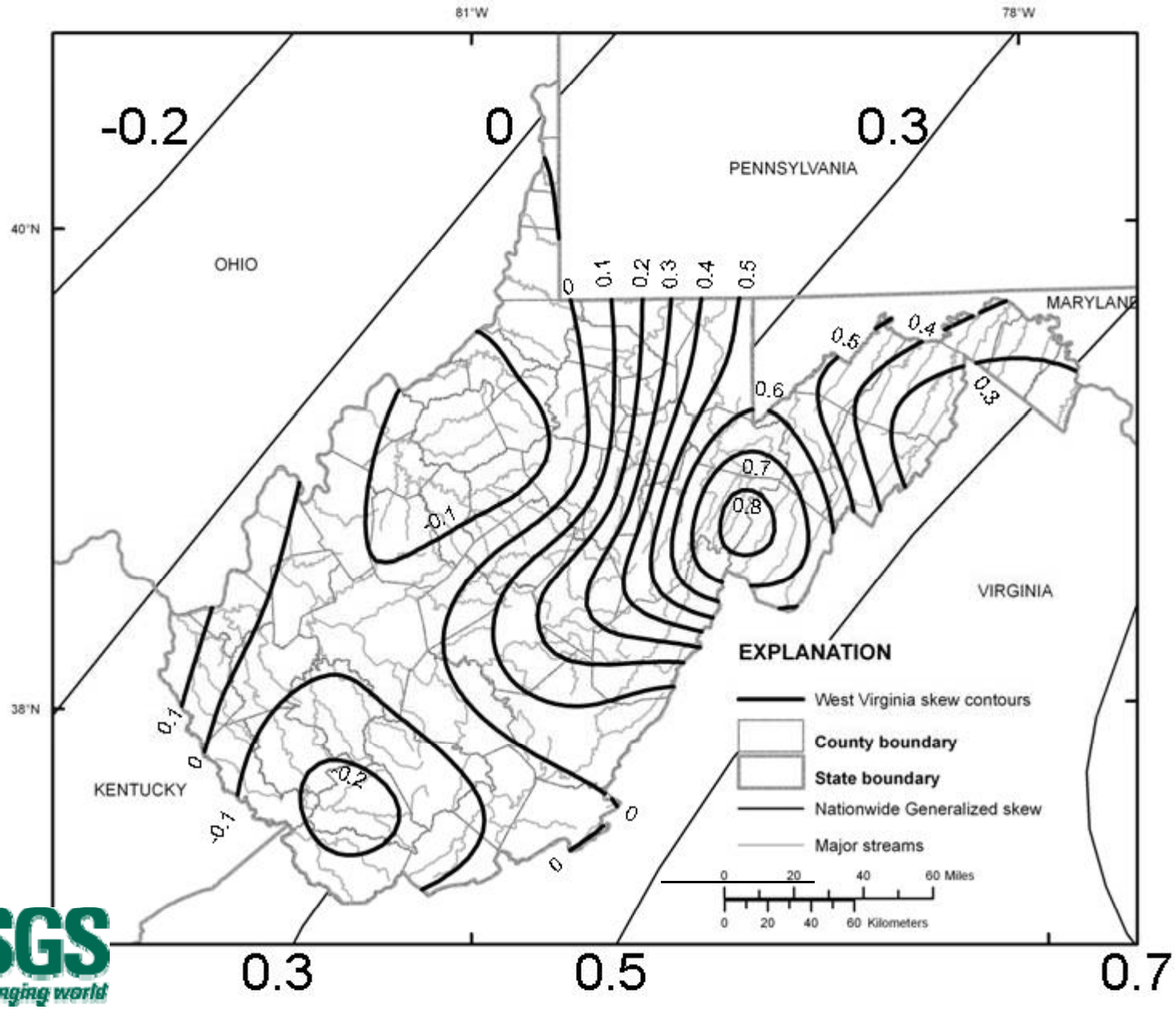


GENERALIZED SKEW



SKEW READ FROM SKEW MAP





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Photograph by
Terence Messinger, USGS, 2005

QUESTIONS:

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