Teton County
City of Choteau
Hydrology Meeting

April 30, 2024, 1:00 – 3:00 PM

Agenda

- 1:00 – 1:10 **Welcome & Introductions**
- 1:10 – 1:30 **Meeting Overview & Goals**
- 1:30 – 2:40 **Flow Calculations**
  - **FEMA Hydrology Process**
  - **Observed Peak Flow Method**
  - **Rainfall-Runoff Method**
- 2:40 – 3:00 **Next Steps**

INTRODUCTIONS 1:00 – 1:10

- DNRC and Partners
- City of Choteau
- Teton County
- Additional Attendees

Overview And Goals 1:10 – 1:30

1. Make sure community's concerns about the flow calculations are clear
2. Explain the flow calculations (hydrology) for the new floodplain maps
   - The delineation of the maps (hydraulics) won't be the focus of today's meeting
   - Any concerns not addressed today can be followed-up later
3. Discuss Next Steps

Community Concerns

- Main concern is that the flows are too high
  - How can the Teton river, normally seeing its highest flow of the year as less than 1,000 cubic feet per second (cfs), be expected to have 23,000 cfs in a flood?
  - What kind of assumptions were made in the 23,000 cfs calculation?
    - Type of storm event
    - Loss to groundwater

Overview And Goals 1:10 – 1:30

Community Concerns

- Other Concerns?

- Presentation will break often for Q&A

Overview And Goals 1:10 – 1:30

Background

- Role of flood risk mapping
  - Based on the 1% chance flood
- DNRC program background

Choteau, June 11, 1964 – Great Falls Tribune File Photo

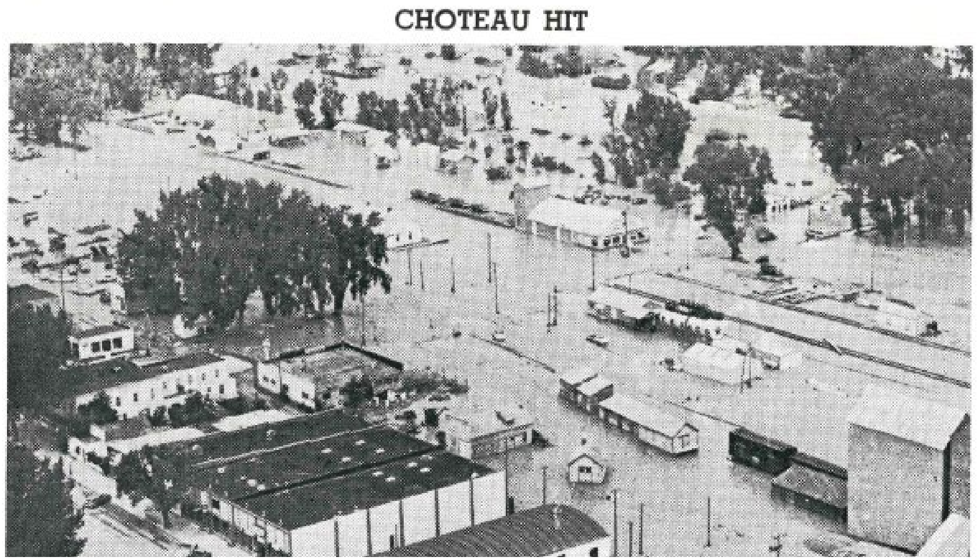
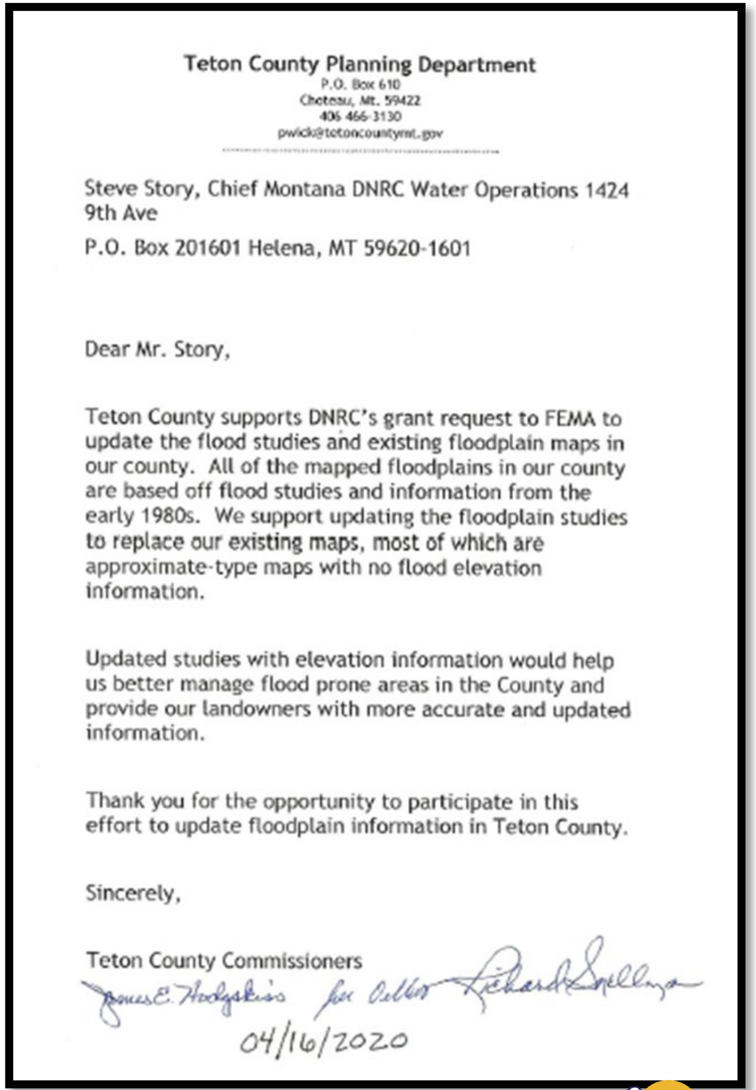


Image from "1964 Flood" (Great Falls Tribune) showing flooding in downtown Choteau

Overview And Goals 1:10 – 1:30

Background

- 2020 Request and support for new mapping
- 2020-2023 Data Collection, Model development
- 2023 Draft data available
  - Increase in 1% floodplain prompted community concerns
- 10/25/23 Virtual Meeting – "Flood Risk Review"
  - Required meeting for floodplain mapping updates
  - Community concerns with floodplain increase
  - DNRC initiated additional review of studies to ensure accuracy, address concerns
- 2/21/23 Virtual Meeting – Results of additional review
  - Review determined no change to flow calculations.
  - Several specific concerns about the flow calculation were raised, prompted today's meeting to discuss
- **4/29/23 – Today's In-Person Meeting on Hydrology**
- 5/29/23 – Open house for property owners
  - Discussions specific to individual properties



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406 466-3130
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Steve Story, Chief Montana DNRC Water Operations 1424 9th Ave

P.O. Box 201601 Helena, MT 59620-1601

Dear Mr. Story,

Teton County supports DNRC's grant request to FEMA to update the flood studies and existing floodplain maps in our county. All of the mapped floodplains in our county are based off flood studies and information from the early 1980s. We support updating the floodplain studies to replace our existing maps, most of which are approximate-type maps with no flood elevation information.

Updated studies with elevation information would help us better manage flood prone areas in the County and provide our landowners with more accurate and updated information.

Thank you for the opportunity to participate in this effort to update floodplain information in Teton County.

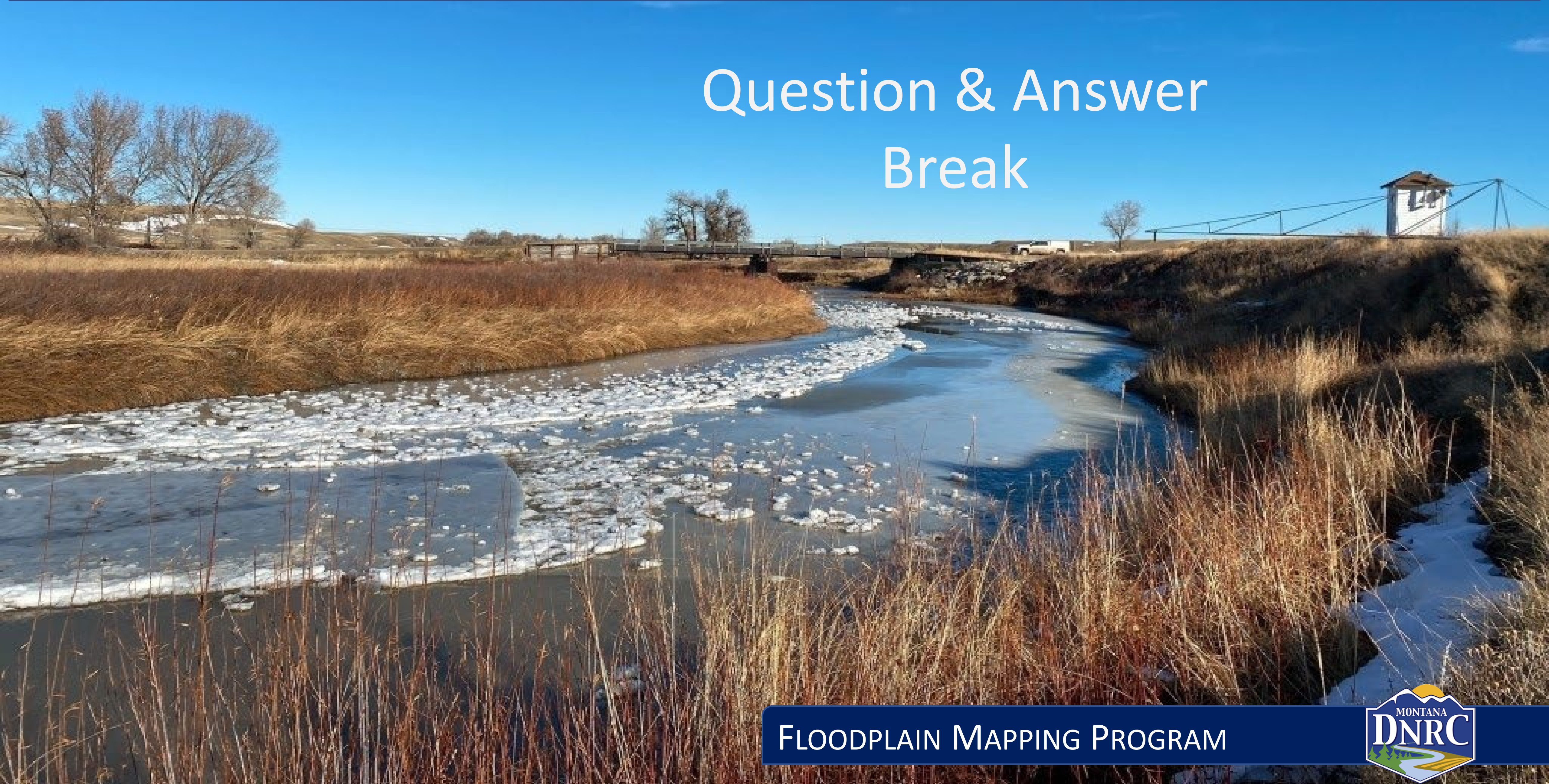
Sincerely,

Teton County Commissioners

04/16/2020

Montana DNRC

Question & Answer
Break



Flow Calculations

1:30 – 2:40

FEMA Hydrology Process 1:30 – 1:50

Observed Peak Flow Method 1:50 – 2:20

Rainfall-Runoff Method 2:20 – 2:40

FEMA HYDROLOGY PROCESS 1:30 – 1:40

“The Mapping Partner performing the hydrologic analysis shall apply frequency analysis of flow data at gaging stations, using procedures provided in Bulletin 17B (Interagency Committee on Water Data, 1982) wherever possible.”

FEMA’s Guidelines and Specifications for Flood Hazard Mapping Partners – Appendix C: Guidance for Riverine Flooding Analyses and Mapping (2003), Section C.1.2.1 – Preliminary Hydrologic Analysis – Choice of Methodology

“For gaged streams, if sufficient stream gaging station data reflecting existing conditions is available, and the data is applicable to developing peak flow discharges along the study reach, this data should be used to estimate the flood discharge-frequency relations. Gaging station data are applicable to all study types if the record length is 10 years or longer.”

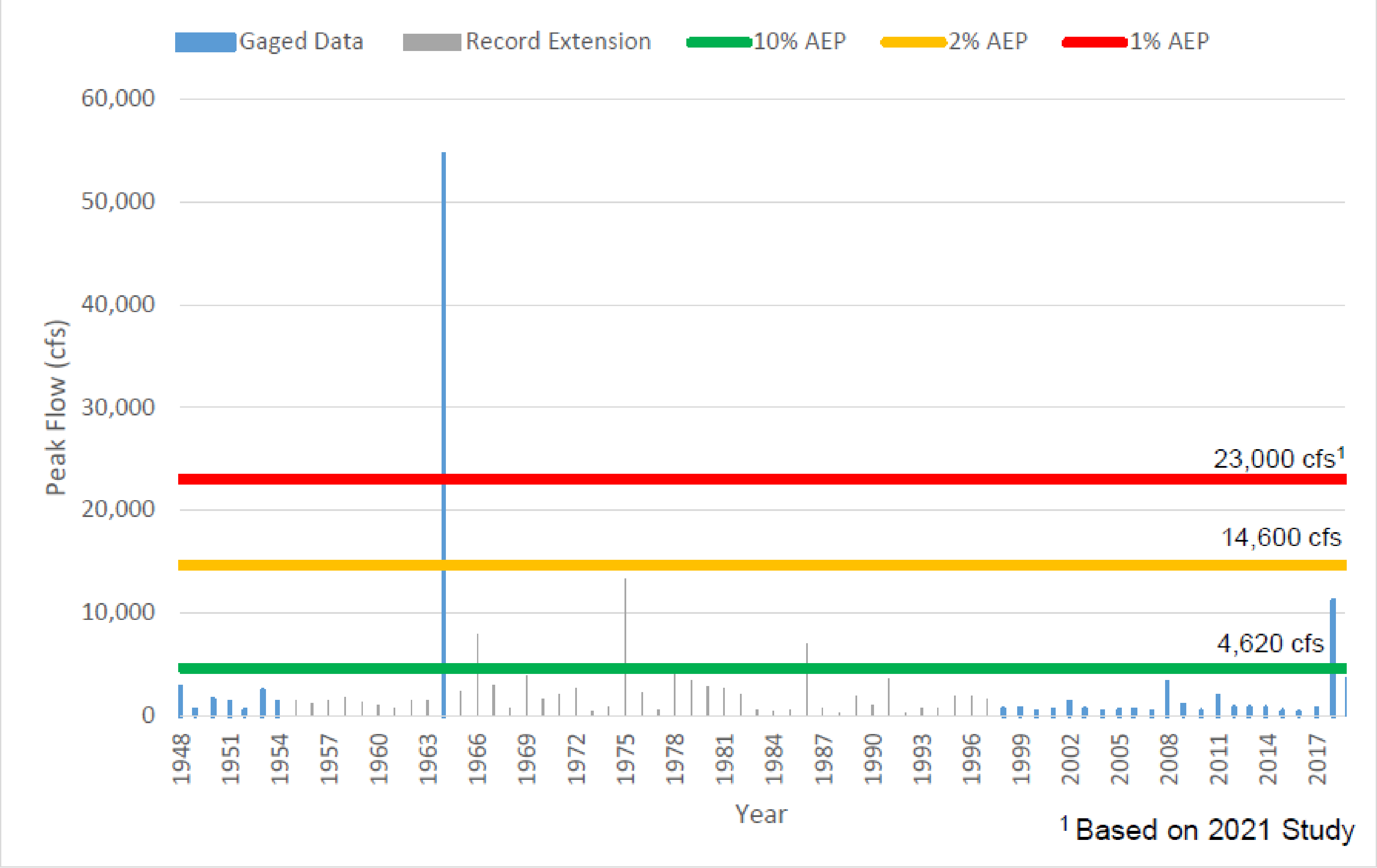
Guidance for Flood Risk Analysis and Mapping – General Hydrologic Considerations (2016), Section 4.1- Stream Gage Analysis

“For ungaged streams, regression equations are recommended for estimating existing-conditions flood discharges if a flood hydrograph is not required and the regression equations are applicable to the streams.”

FEMA’s Guidelines and Specifications for Flood Hazard Mapping Partners – Appendix C: Guidance for Riverine Flooding Analyses and Mapping (2003), Section C.1.2.1 – Preliminary Hydrologic Analysis – Choice of Methodology

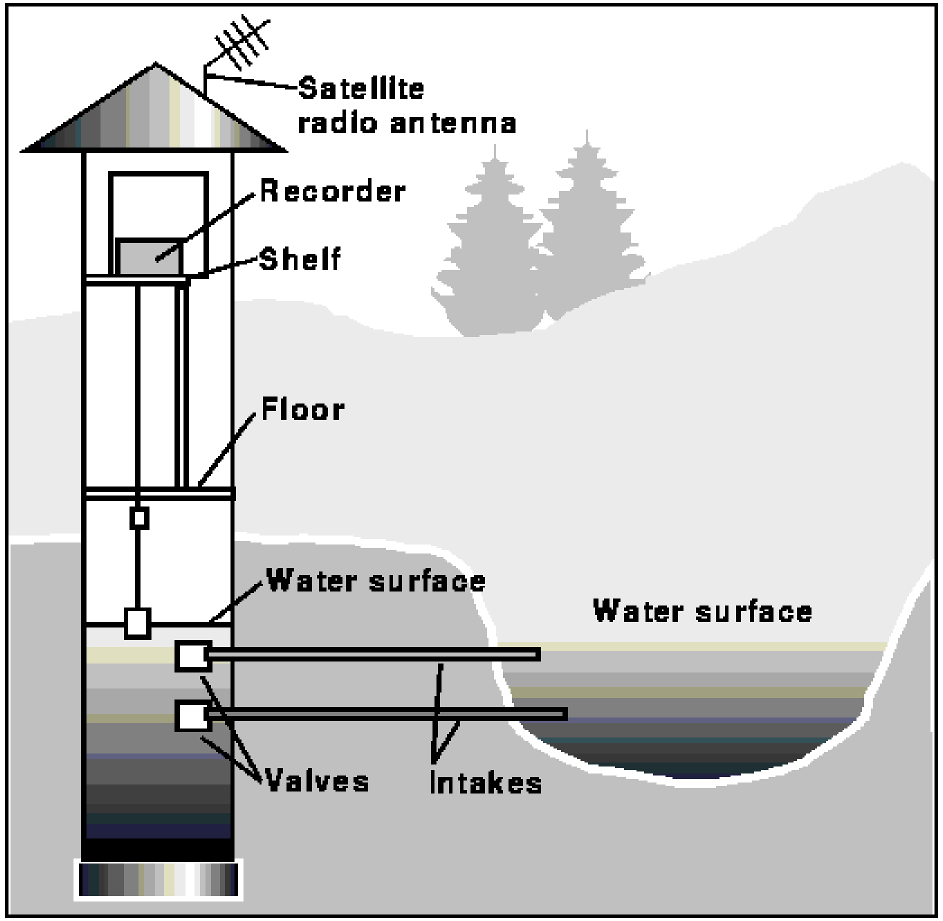
OBSERVED PEAK FLOW METHODS 1:40 – 2:20

Figure 29. USGS 06102500 Teton River below South Fork, near Choteau

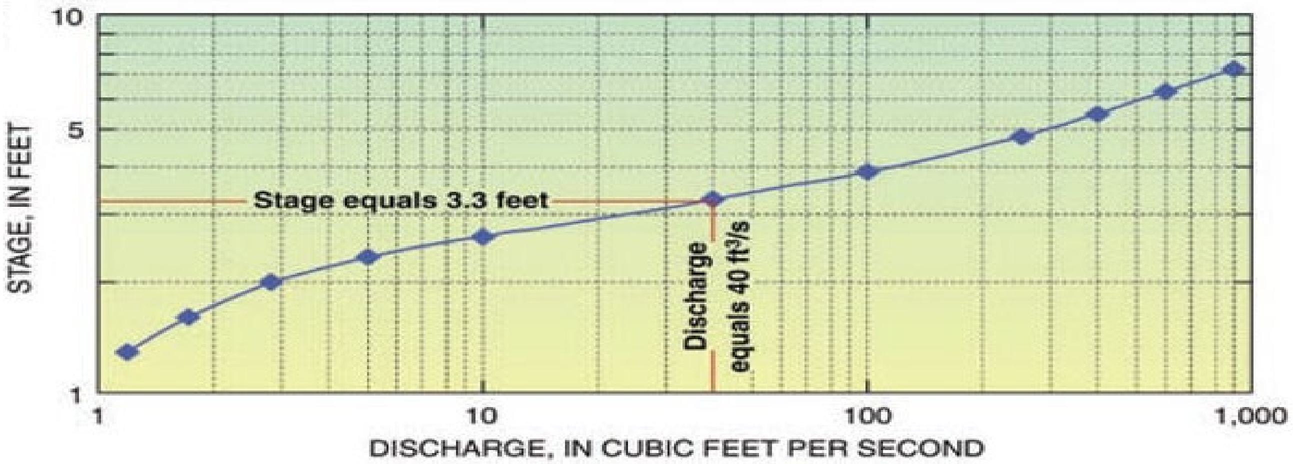


- Step one is to calculate the 1% chance flow in the river
- Where does this red line come from?
- Past floods are important, but only one source of information

OBSERVED PEAK FLOW METHODS 1:40 – 2:20

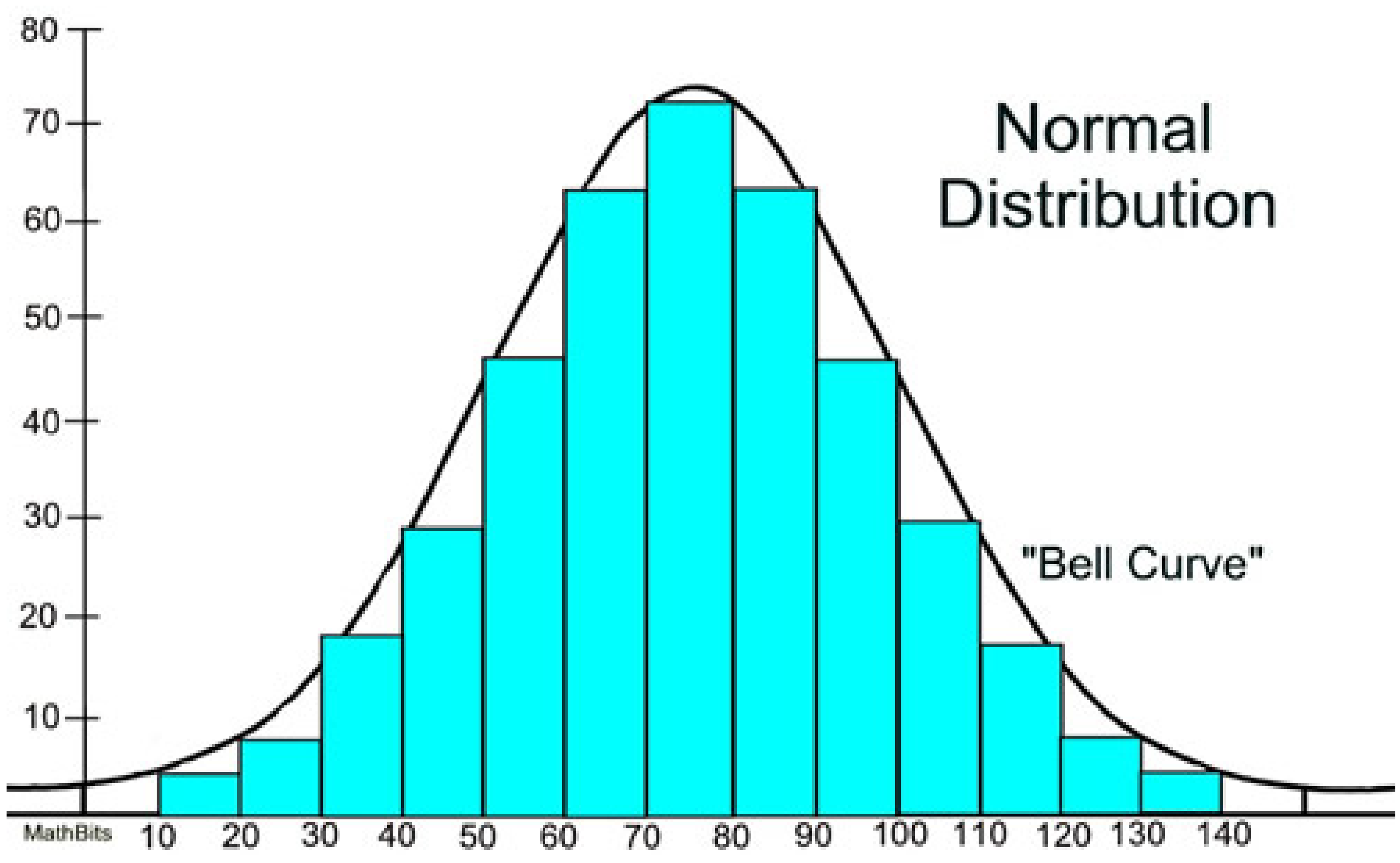


- Stream Flow Gaging Station
- Measures flow passing by a point
- Continuous monitor, we only use the highest flow each year



OBSERVED PEAK FLOW METHODS 1:40 – 2:20

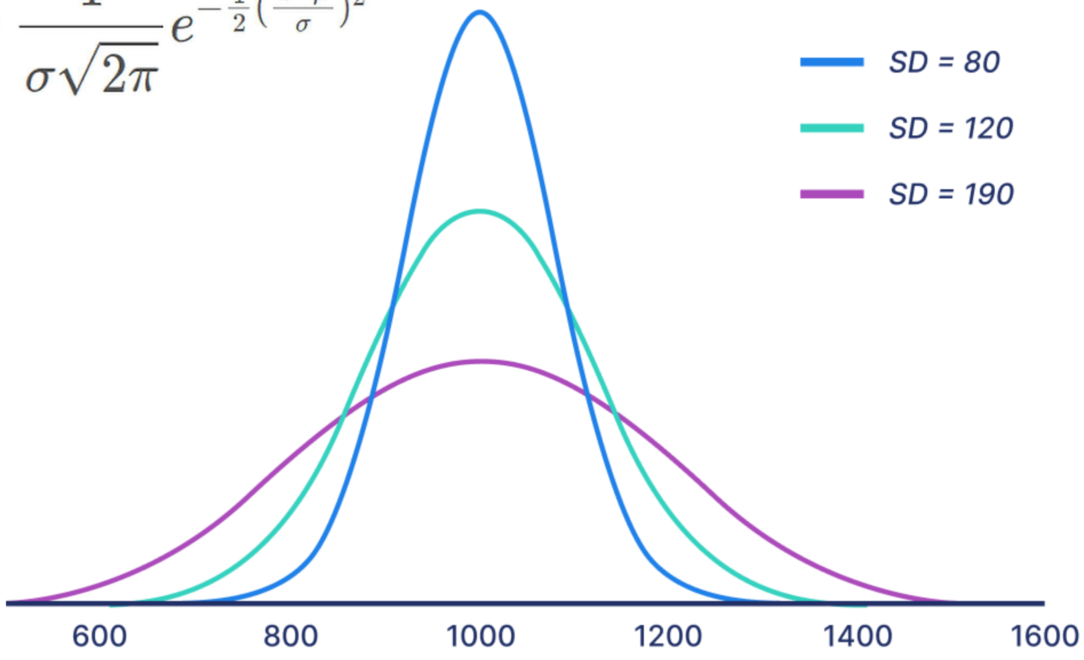
- Example – the distribution of people's height
- What are the chances a crowd includes someone over 6'6"?
- You need to start by collecting some data on the distribution of heights

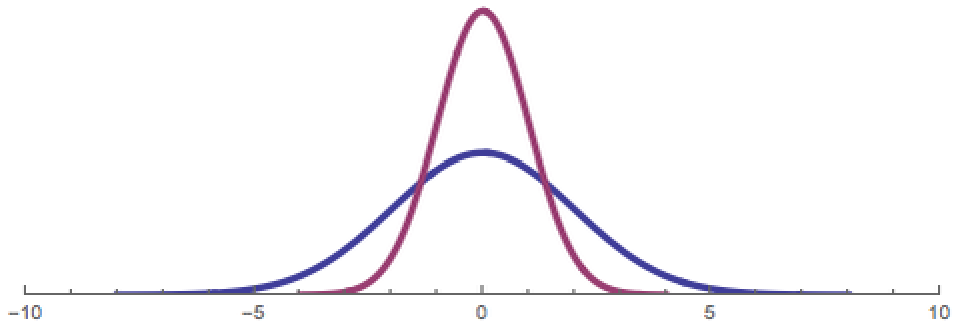


- Even if you haven't measured someone over 6'6" in your sample, you can use a mathematical function that is a close match to the data you have.
- Depends on age, location, why the crowd is there.

OBSERVED PEAK FLOW METHODS 1:40 – 2:20

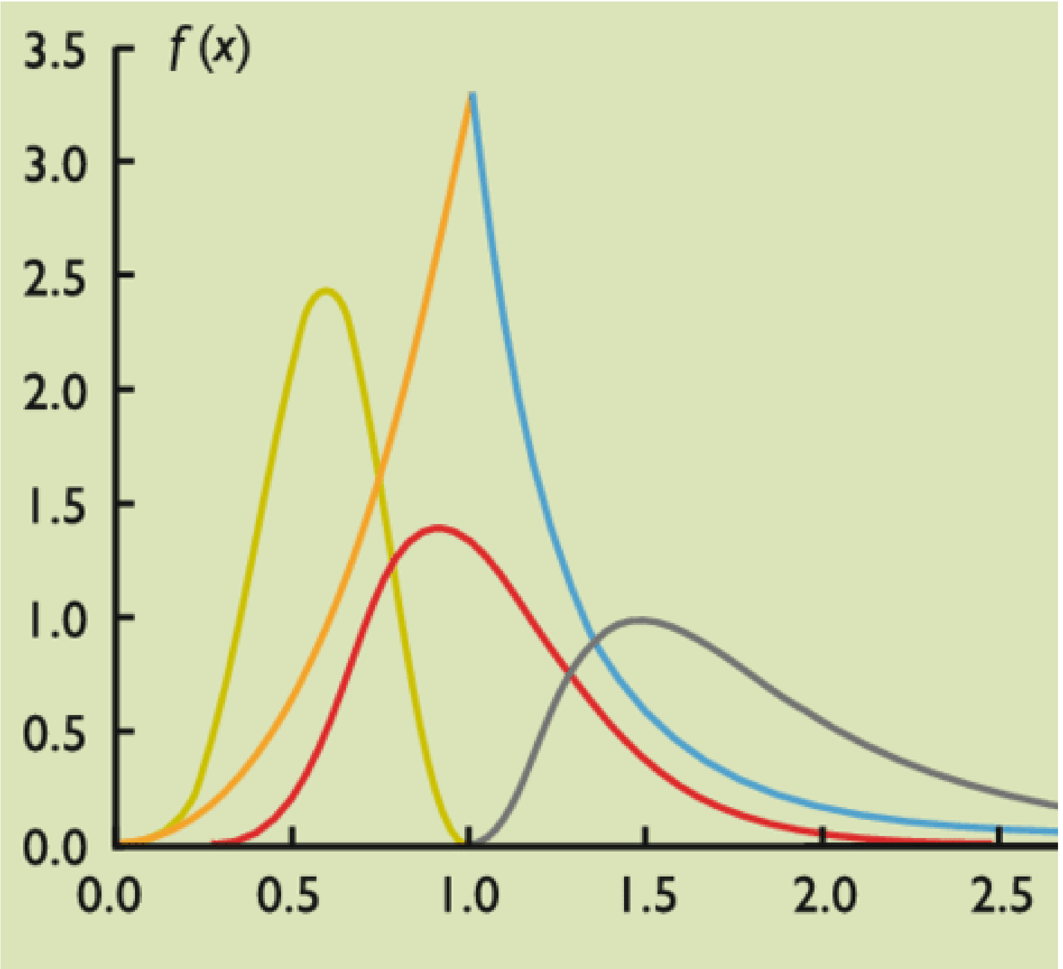
$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}$$





- The normal distribution is a complicated equation, but it only has two dials – the center and the width
- Depending on the crowd of people, you adjust those and can answer statistical questions, like what is the probability of someone over 6’6” showing up.

OBSERVED PEAK FLOW METHODS 1:40 – 2:20

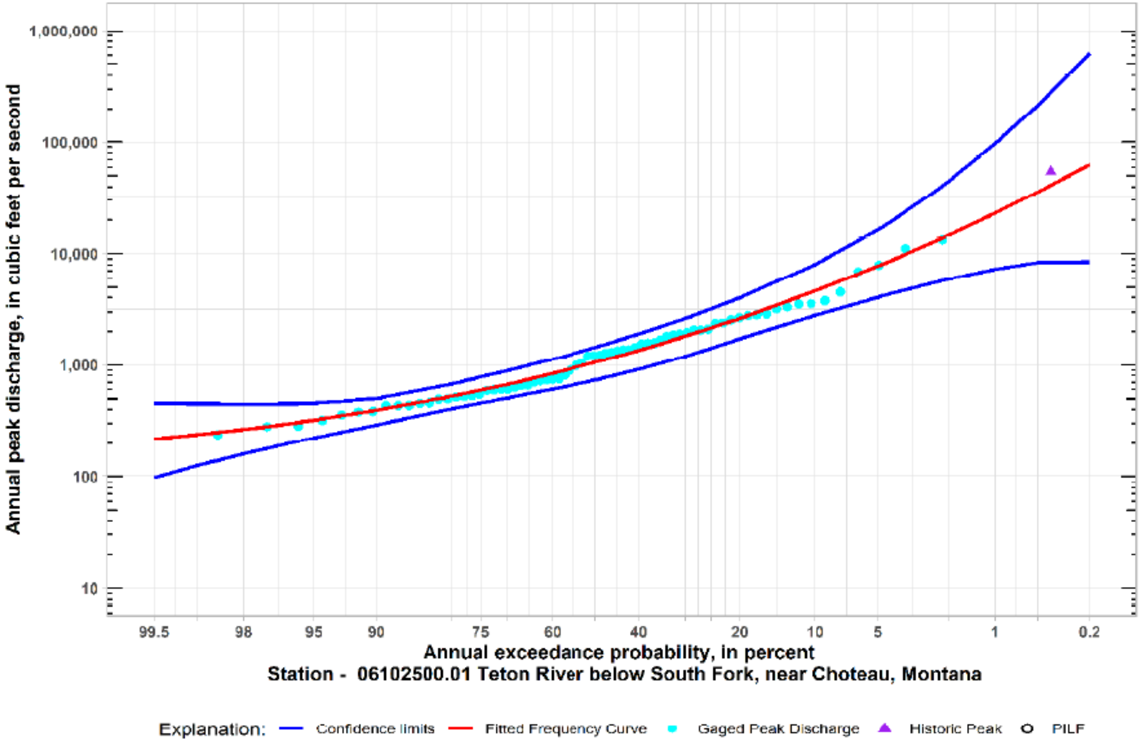


$$f(x) = \frac{1}{|a|\Gamma(b)}\left(\frac{x-m}{a}\right)^{b-1} e^{-\left(\frac{x-m}{a}\right)}$$

- The normal distribution is just one type of these statistical tools, it isn't a good fit for flooding
- The "Log-Pearson Type 3" distribution is adjusted to match observations, like with the height example.
- More data is better, but 10 years is the minimum
- You don't need to have seen a 1% flood to estimate it.

OBSERVED PEAK FLOW METHODS 1:40 – 2:20

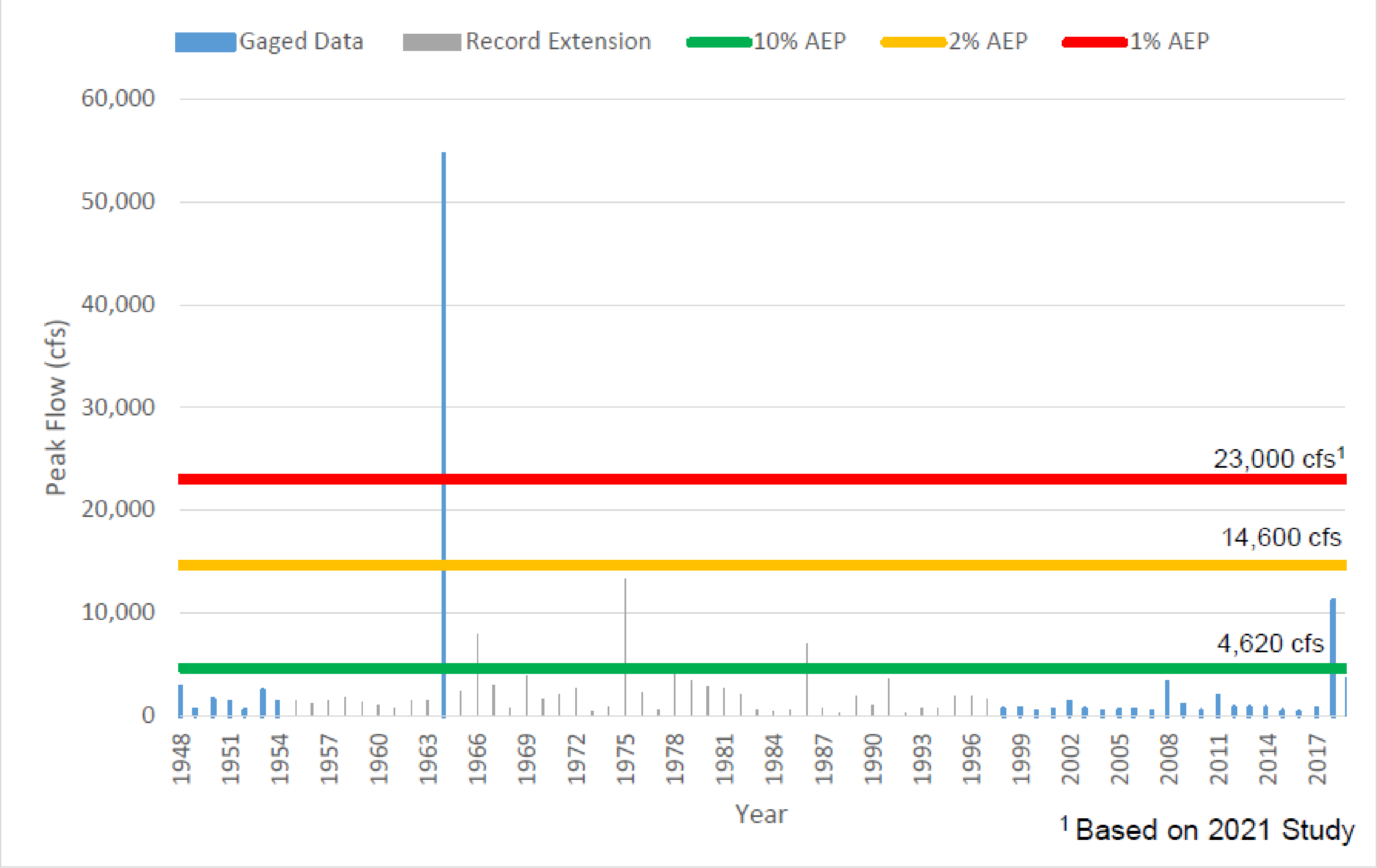
Contributing drainage area, in square miles	Number of recorded peak flows used in the analysis	Skew type used in analysis	Type of PILF threshold[1]	PILF threshold, in cubic feet per second			Type of peak-flow frequency analysis[2]		
110	72	Station	MGBT	--			MOVE3		
Peak flow, in cubic feet per second, for indicated annual exceedance probability (bold values), in percent									
66.7	**50**	**42.9**	**20**	**10**	**4**	**2**	**1.0**	**0.5**	**0.2**
722	1,060	1,260	2,620	4,620	9,070	14,600	23,000	35,800	63,000
Upper and lower 90-percent confidence intervals, in cubic feet per second, for indicated annual exceedance probability, in percent									
66.7	**50**	**42.9**	**20**	**10**	**4**	**2**	**1.0**	**0.5**	**0.2**
960	1,450	1,750	4,010	8,030	20,800	44,400	97,000	215,000	623,000
540	734	853	1,720	2,800	4,470	5,880	7,260	8,360	8,470



- After fitting the distribution function to the data, we extract the discharge for the given probability
- Can only be used at the gage site, or a specific “distance” upstream/downstream
  - Distance upstream and downstream depends on drainage area
- Each of the calculations are available for review
- Collaborative effort between USGS, DNRC, and project contractors

OBSERVED PEAK FLOW METHODS 1:40 – 2:20

Figure 29. USGS 06102500 Teton River below South Fork, near Choteau

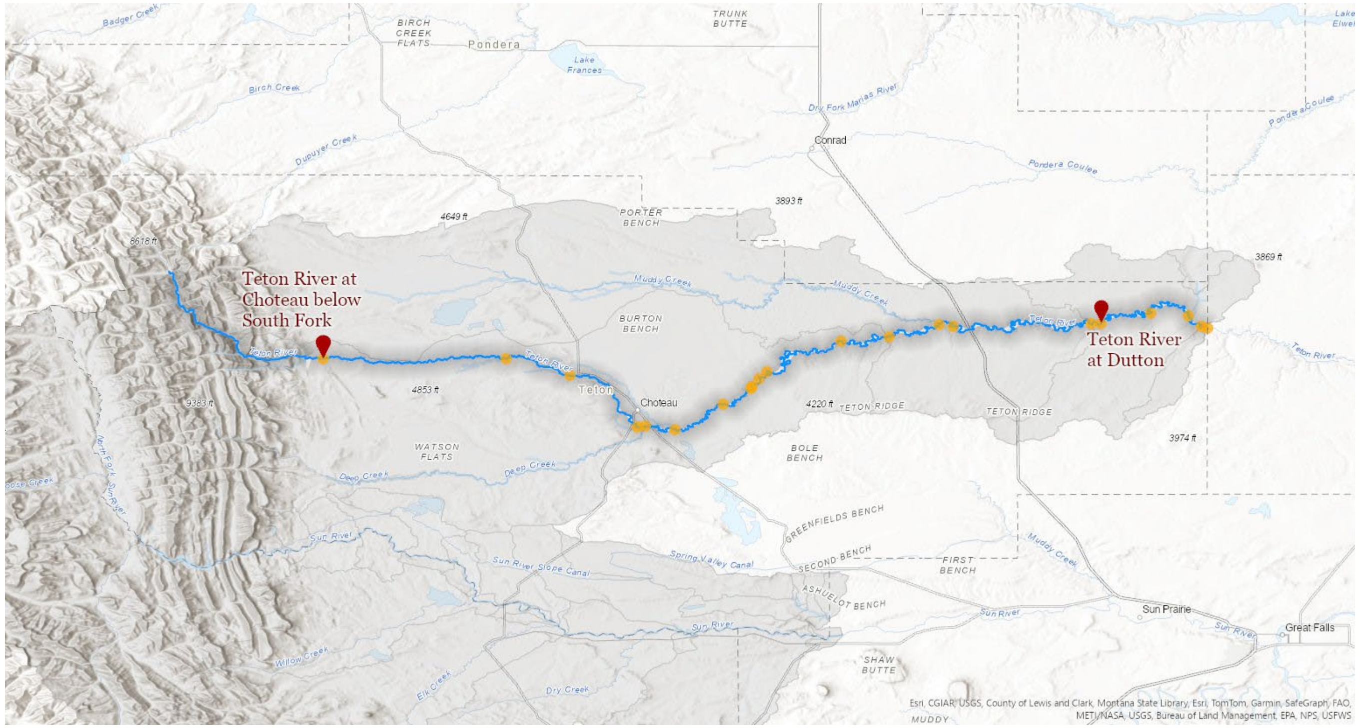


- Without data for a specific river, you can only make an educated guess based on similar rivers, which is much less accurate
- The 1% chance flow is the basis for the floodplain map

OBSERVED PEAK FLOW METHODS 1:40 – 2:20

Flow Calculation between gages

- Once the 1% flow has been determined at two gages, the flow calculations in-between are adjusted as the drainage area increases



Equation 1:

$$logQ_{AEP,U} = logQ_{AEP,G1} + \left[\frac{(logQ_{AEP,G2} - logQ_{AEP,G1})}{(logDA_{G2} - logDA_{G1})}\right](logDA_U - logDA_{G1})$$

where:

$Q_{AEP,U}$ is the AEP-percent peak flow at ungaged site *U*, in cubic feet per second;
$Q_{AEP,G1}$ is the AEP-percent peak flow for the upstream gaging station *G1*, in cubic feet per second;
$Q_{AEP,G2}$ is the AEP-percent peak flow at the downstream gaging station *G2*, in cubic feet per second;
DA_{G2} is the drainage area at the downstream gaging *G2*, in square miles;
DA_{G1} is the drainage area at the upstream gaging station *G1*, in square miles; and
DA_{U} is the drainage area at ungaged site *U*, in square miles.

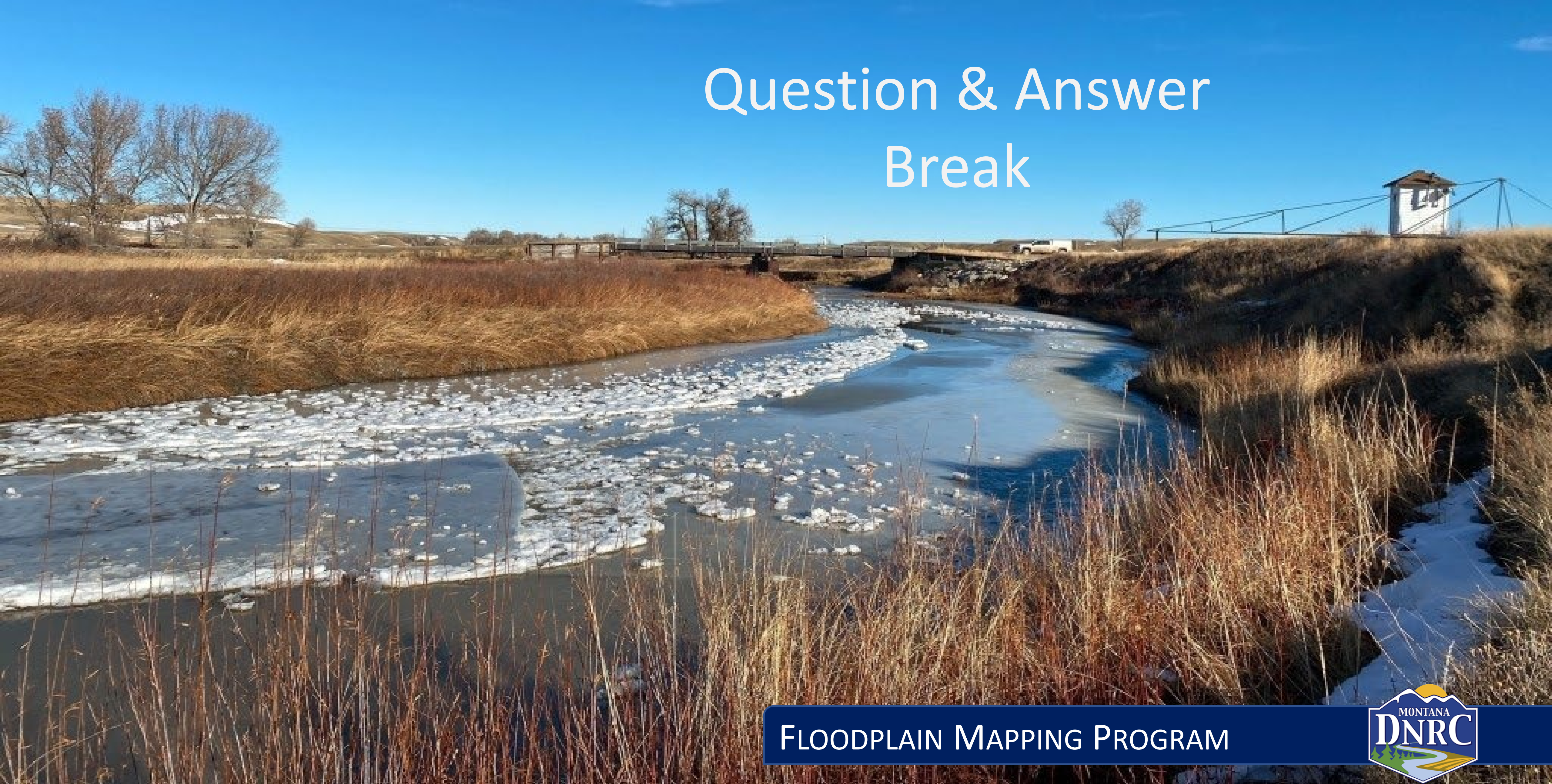
OBSERVED PEAK FLOW METHODS 1:40 – 2:20

Flow Calculation between gages

https://baker.maps.arcgis.com/apps/instant/interactivelegend/index.html?appid=3a3f2974b7bc4545bde761f5d50db414 – link to view flow nodes for entire project

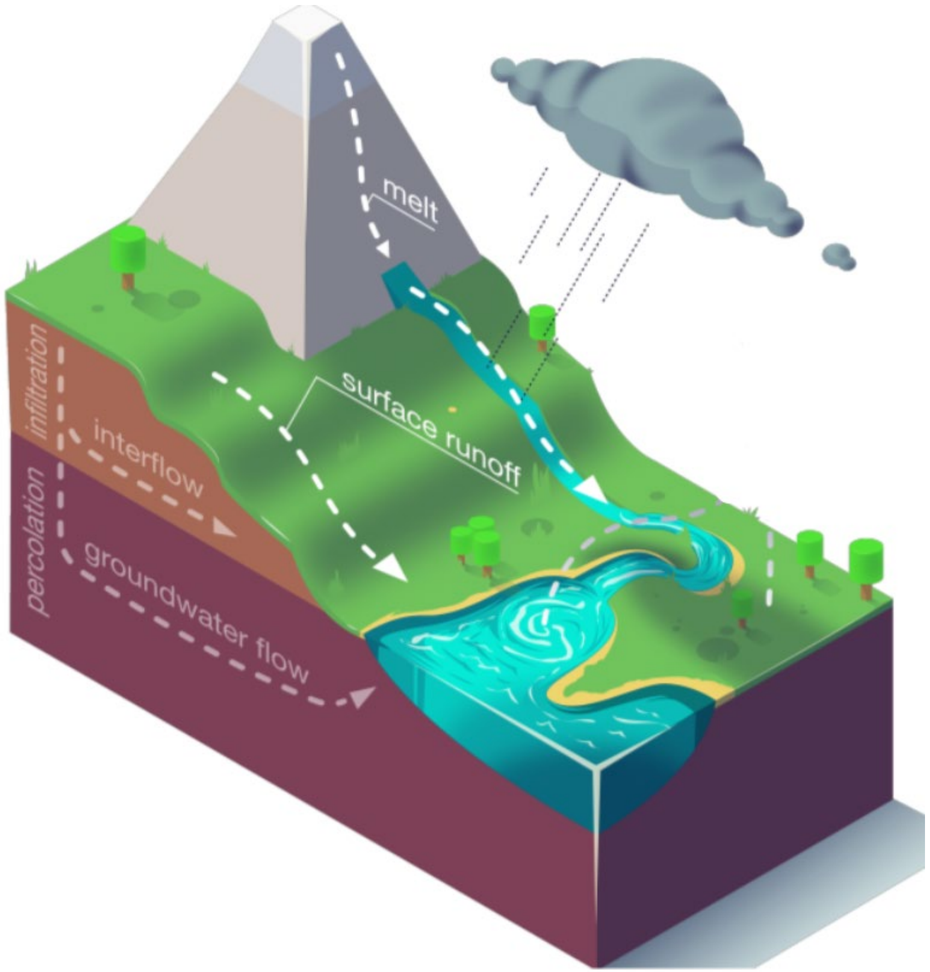
HYDROLOGY NODE DISCHARGE TABLE										
Stream	Latitude	Longitude	Node ID	Drainage Area (mi^2)	Peak Discharge (cfs) for Annual Exceedance Probability Flows 10%	4%	2%	1%	1% plus	0.20%
Teton River										
USGS Gage 06108000 Teton River nr Dutton	**47.9303**	**-111.5529**	**TR-18.3**	**1,238**	**4,710**	**9,960**	**16,600**	26,800	**48,800**	**74,500**
Teton River Flow change nodes between the two gages	47.9295	-111.5663	TR-19.4	1,236	4,710	9,960	16,600	26,800	48,800	74,500
	47.9267	-111.7544	TR-40.0	1,130	4,710	9,930	16,500	26,600	48,900	74,000
	47.9292	-111.7741	TR-42.1	702	4,690	9,740	16,100	25,900	49,200	71,600
	47.9126	-111.8414	TR-49.7	677	4,690	9,730	16,100	25,800	49,200	71,400
	47.9059	-111.9067	TR-56.5	656	4,690	9,720	16,000	25,700	49,200	71,300
	47.8649	-112.0080	TR-68.9	575	4,680	9,670	15,900	25,500	49,300	70,600
	47.8553	-112.0184	TR-70.5	551	4,680	9,650	15,900	25,500	49,300	70,400
	47.8446	-112.0284	TR-72.1	538	4,680	9,640	15,900	25,400	49,300	70,300
	47.8422	-112.0293	TR-72.4	520	4,680	9,630	15,900	25,400	49,400	70,200
	47.8202	-112.0676	TR-76.6	507	4,680	9,620	15,800	25,300	49,400	70,000
	47.7862	-112.1331	TR-85.2	475	4,670	9,600	15,800	25,200	49,400	69,700
	47.7909	-112.1732	TR-89.2	193	4,640	9,270	15,000	23,800	50,000	65,500
	47.7894	-112.1838	TR-90.1	181	4,640	9,250	15,000	23,700	50,100	65,200
	47.8593	-112.2755	TR-99.7	164	4,630	9,210	14,900	23,600	50,100	64,800
	47.8822	-112.3628	TR-105.6	127	4,630	9,120	14,700	23,200	50,300	63,600
USGS Gage 06102500 Teton River blw South Fork	**47.8831**	**-112.6120**	**TR-121.4**	**110**	**4,620**	**9,070**	**14,600**	23,000	**50,400**	**63,000**

OBSERVED PEAK FLOW METHODS 1:40 – 2:20



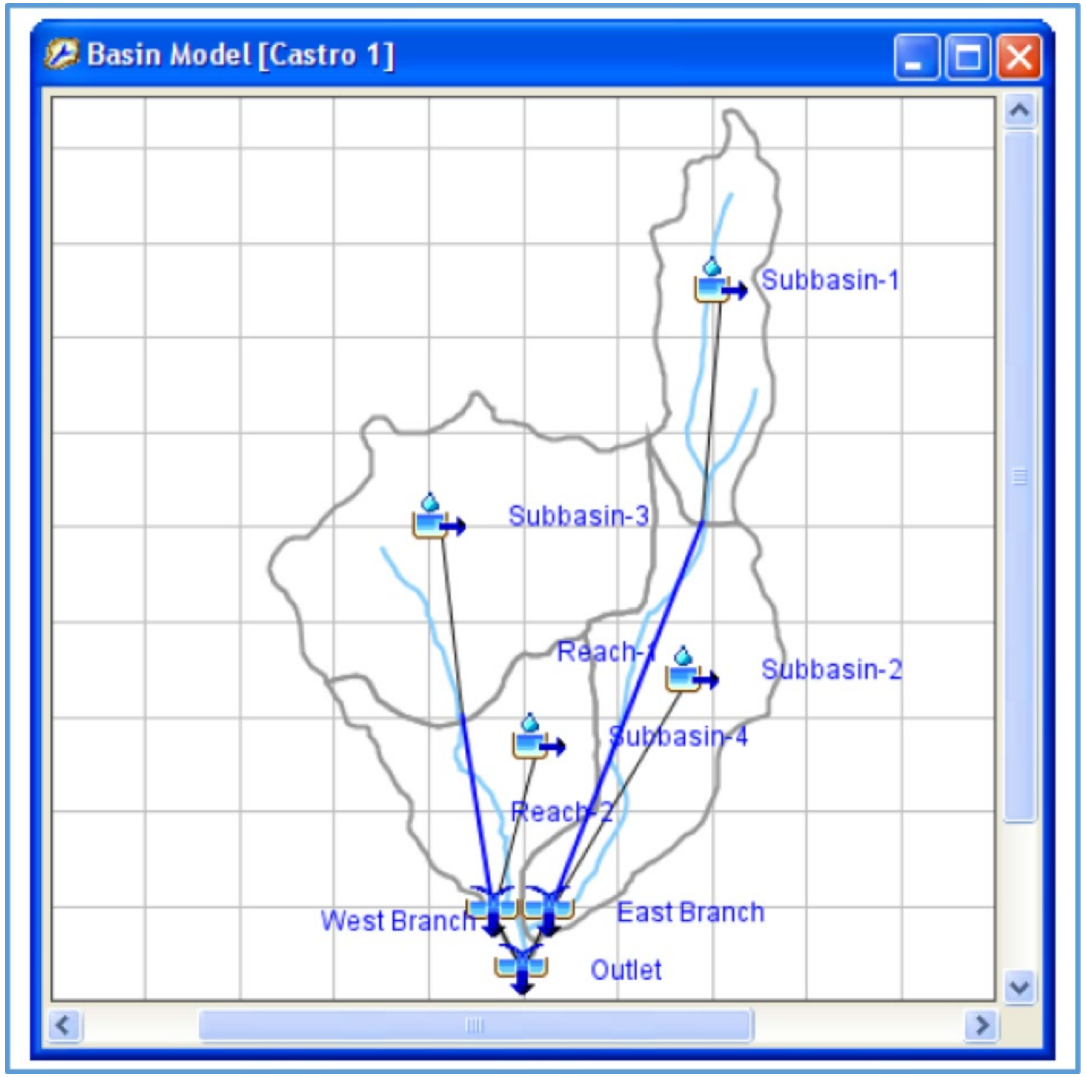
Question & Answer
Break

RAINFALL-RUNOFF METHODS 2:20 – 2:40



- This is the method being assumed given the community's concerns
- While this is an intuitive way to understand flow calculations, it comes with many challenges

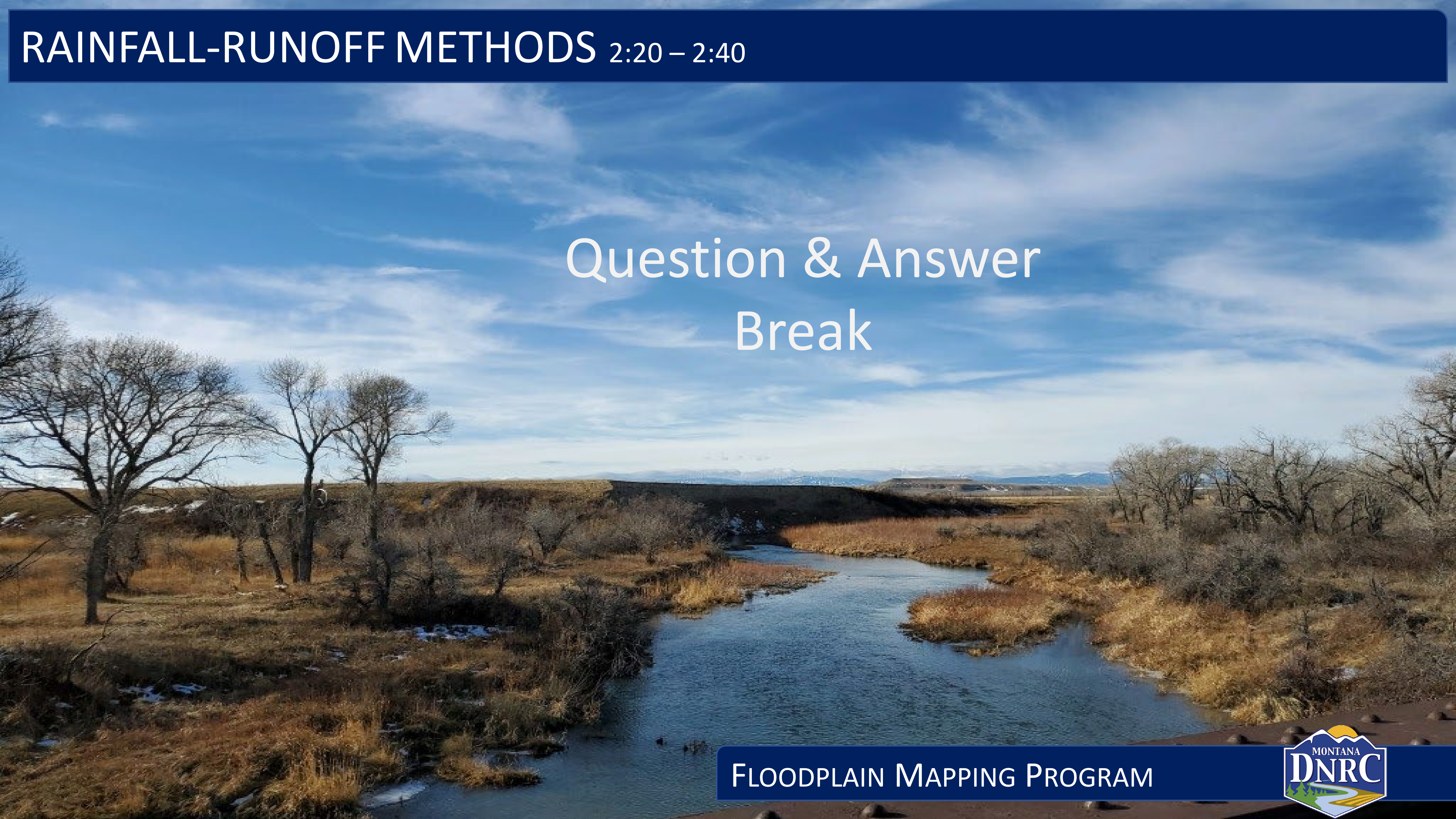
RAINFALL-RUNOFF METHODS 2:20 – 2:40



- Pros
  - Intuitive
  - Spatial details
  - Good for understanding low flow, groundwater
- Cons
  - Have to start with determining the storm
  - Have to calibrate
  - A lot of the details in these computer models aren't important during a flood event

RAINFALL-RUNOFF METHODS 2:20 – 2:40

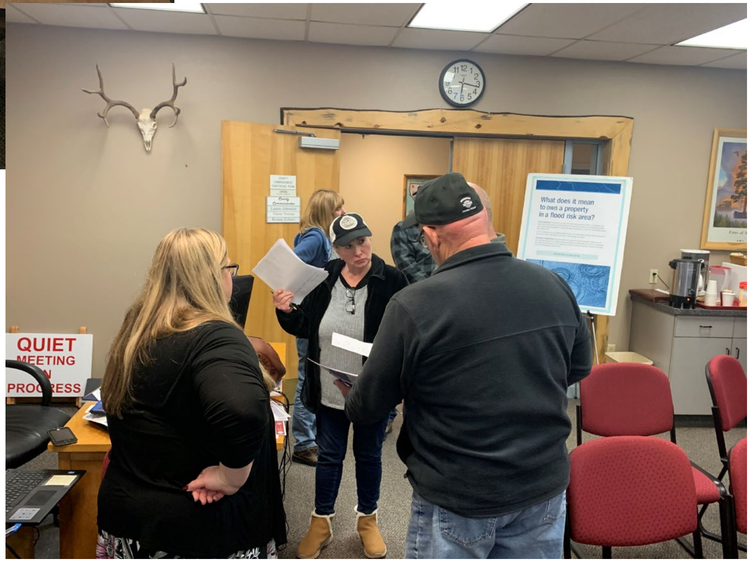
Question & Answer Break



Next Steps

2:40 – 3:00

Next Steps 2:40 – 3:00



*Photos From: Mineral County Open Houses

- FEMA's appeal period, estimated spring 2025
- 5/29/23 – Open house for property owners
  - Discussions specific to individual properties
- Hydraulics – shape of floodplain
  - Survey review complete, no errors but will prepare material for public review
  - Floodway modifications pending, potential for reduced floodway along Spring Creek