CASFM 2018 Annual Conference

Floodplain Management Sessions:

Session1: Local Choices and How They Can Impact the National Flood Insurance Program

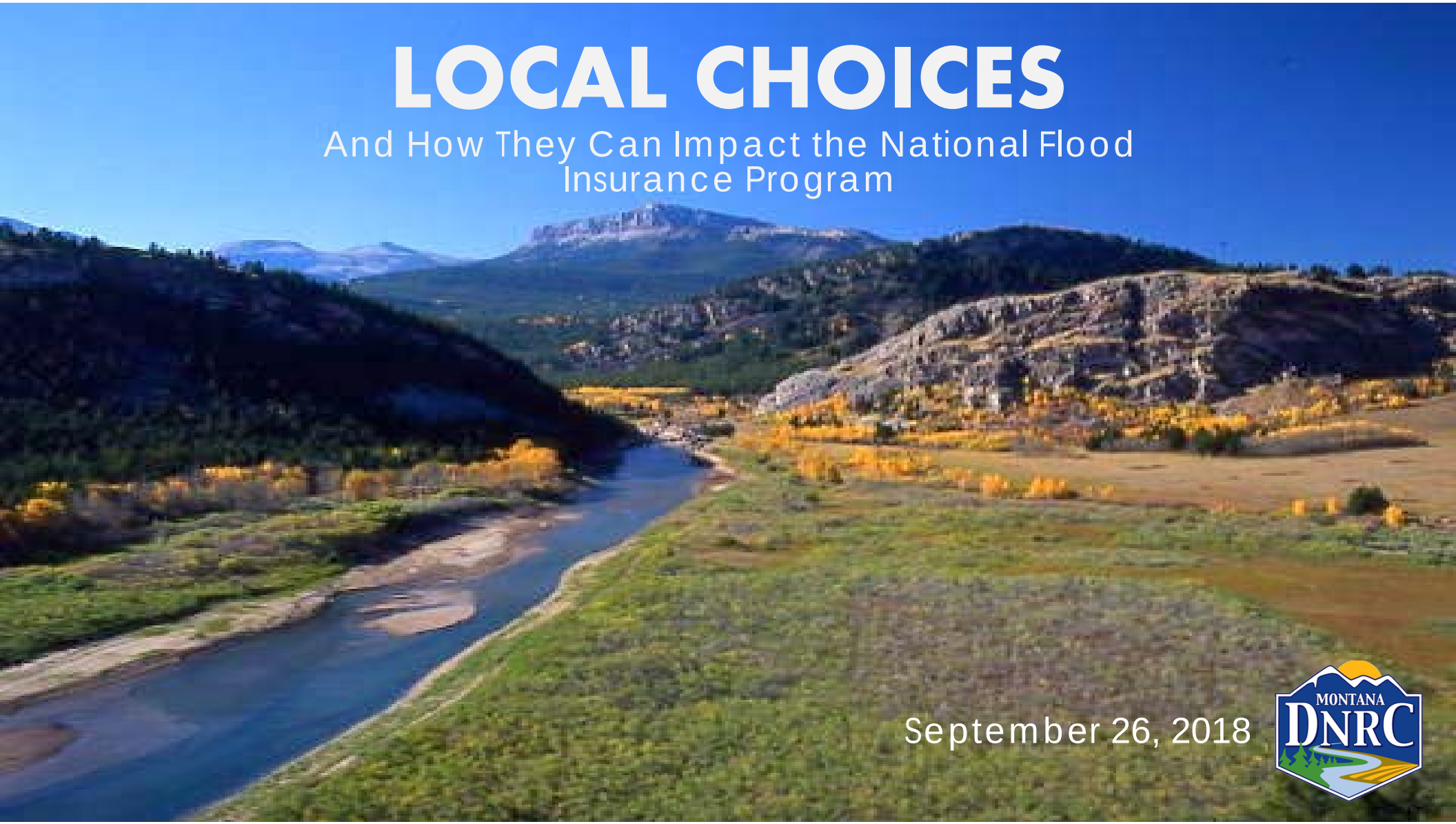
Traci Sears (Montana DNRC)

Session2: Hyper Hydrology: A Holistic View of Colorado Hydrology

Chris Ide (Wood), Joshua Hill (Wood)

Making The Most Of It: Leveraging The CHAMP Study For Other Uses

Erin Cooper (Boulder County), Olivia Cecil (Boulder County), Kevin Doyle (Michael Baker Intl.)


LOCAL CHOICES
And How They Can Impact the National Flood Insurance Program
September 26, 2018
MONTANA
DNRC

AN AGREEMENT

FEDERAL GOVERNMENT

makes subsidized flood insurance available within the community

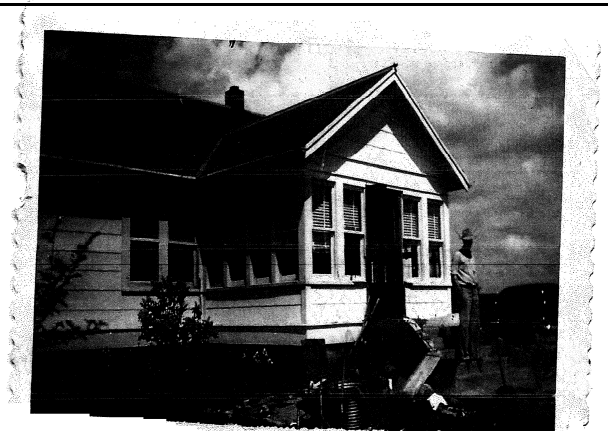
LOCAL COMMUNITIES

adopt and enforce floodplain regulations that meet FEMA requirements

(VOLUNTARY)

June 17, 1950 Flood of Alkali and Antelope Creeks

Ed S. Bacon bunkhouse on Milwaukee tracks



Rich and Sue Knudson
Box 179
Harlowton, MT59036

MTDNRC
PO Box 201601
Helena, MT 59620-1601

Traci,

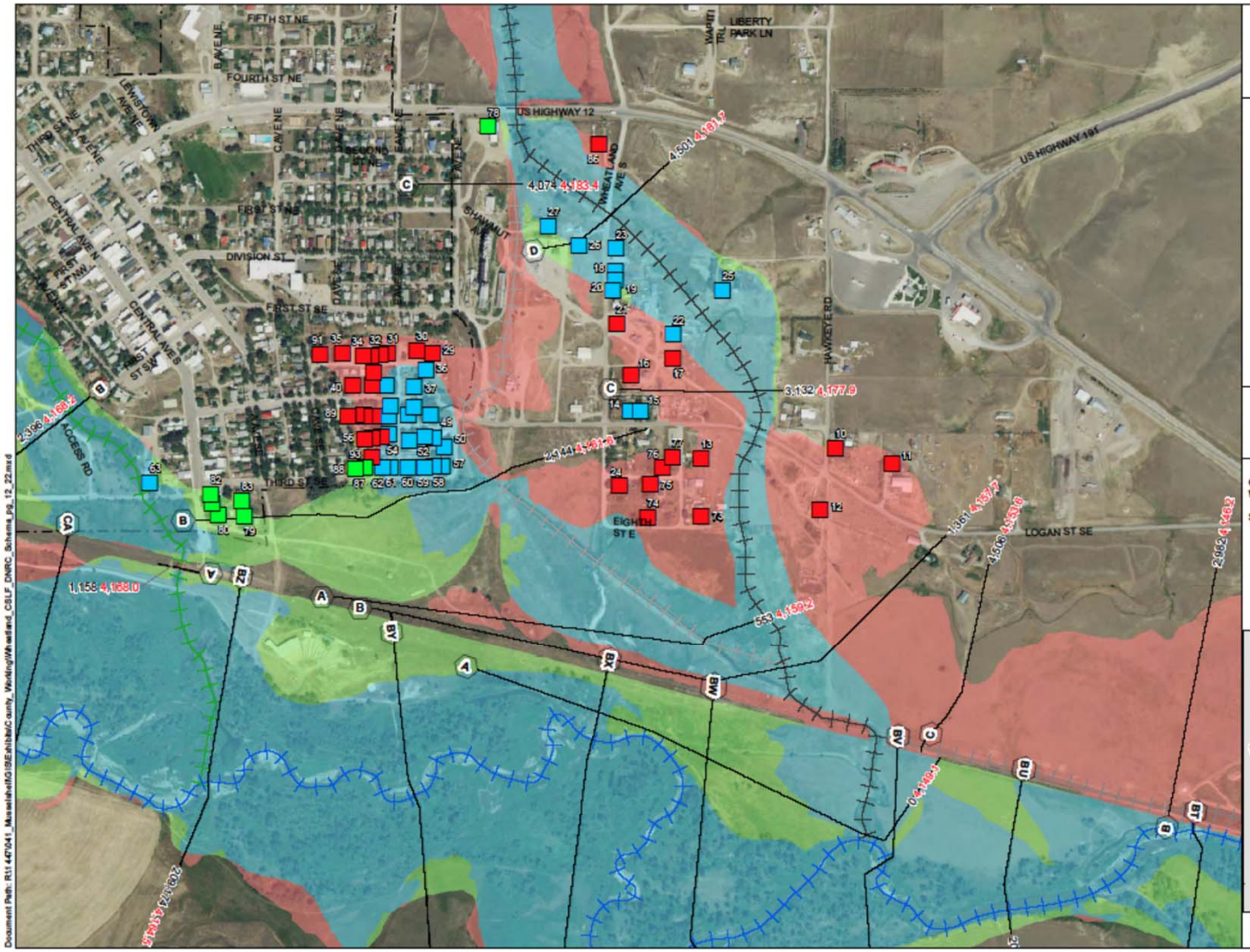
Here are copies of the letter my mom wrote to her aunt and uncle following the flood of 6/17/1950, here in Harlowton. The pictures are of her parents property a mile and a half north of town on the Old Gap Road. The house was moved into Harlo and we now live in it. My son and I still own the property north of town. According to her brother and Dad, the wall of water -9 feet high at the barn- came down Alkali Creek to start with as 9 earth dams breeched with the downpour.

Our son has added to the bunkhouse and now lives in it. After the flood, it was moved to higher ground.

Hope you might find a use for these.

Happy Thanksgiving to all of your crew!

Rich and Sue Knudson



CHANGES SINCE LAST FIRM - PROPOSED STRUCTURE CHANGES FOR FLOODPLAIN

LEGEND

- Proposed 100-yr Floodplain - Increase
- Proposed 100-yr Floodplain - Decrease
- Proposed 100-yr Floodplain - No Change
- Structure - In Increase Area
- Structure - In Decrease Area
- Structure - In No Change Area

Labels
(A) Cross Section Letter 79,726 River Station
4,700.0 Water Surface Elevation
100 Feet Along Profile Baseline

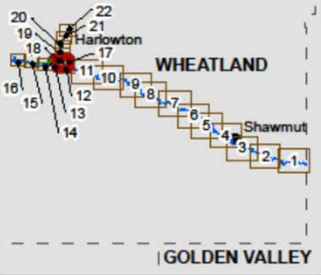
0 250 500 750 Feet

CSLF Work Map - Musselshell Watershed Project - Ph. II
Wheatland County, MT Risk MAP - MAS No. 2015-02
NAIP 2015, Horizontal Datum: NAD83
Submitted 4/25/2017

Montana DNRC

Morrison Maierle
engineers | surveyors | planners | scientists

LOCATOR MAP



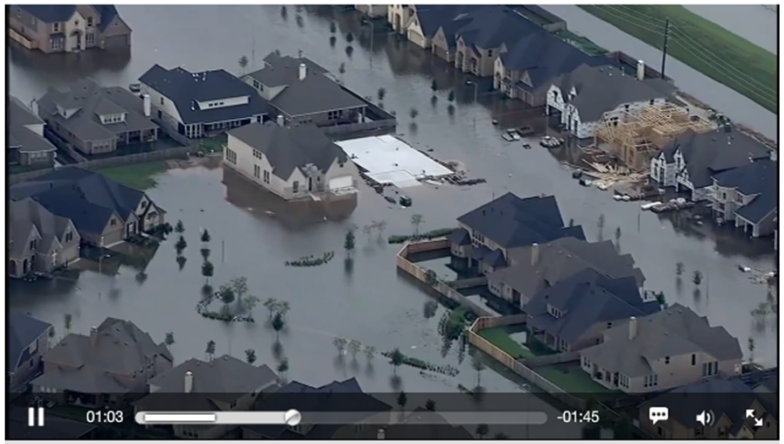
Musselshell River Map 18 of 22

Document Path: R:\1447041_MusselshellGIS\Exhibits\Counties_Working\Wheatland_CSLF_DNRC_Schema_pg_12_22.mxd

abc13 SECTIONS TRAFFIC WATCH

'Neighborhood should have not been built': Homeowners file lawsuit against developer after flooding issues

Share G+ Tweet Email



EMBED </> MORE VIDEOS

Homeowners suing developer in Sugar Land, Miya Shay reports.

Bloomberg Businessweek

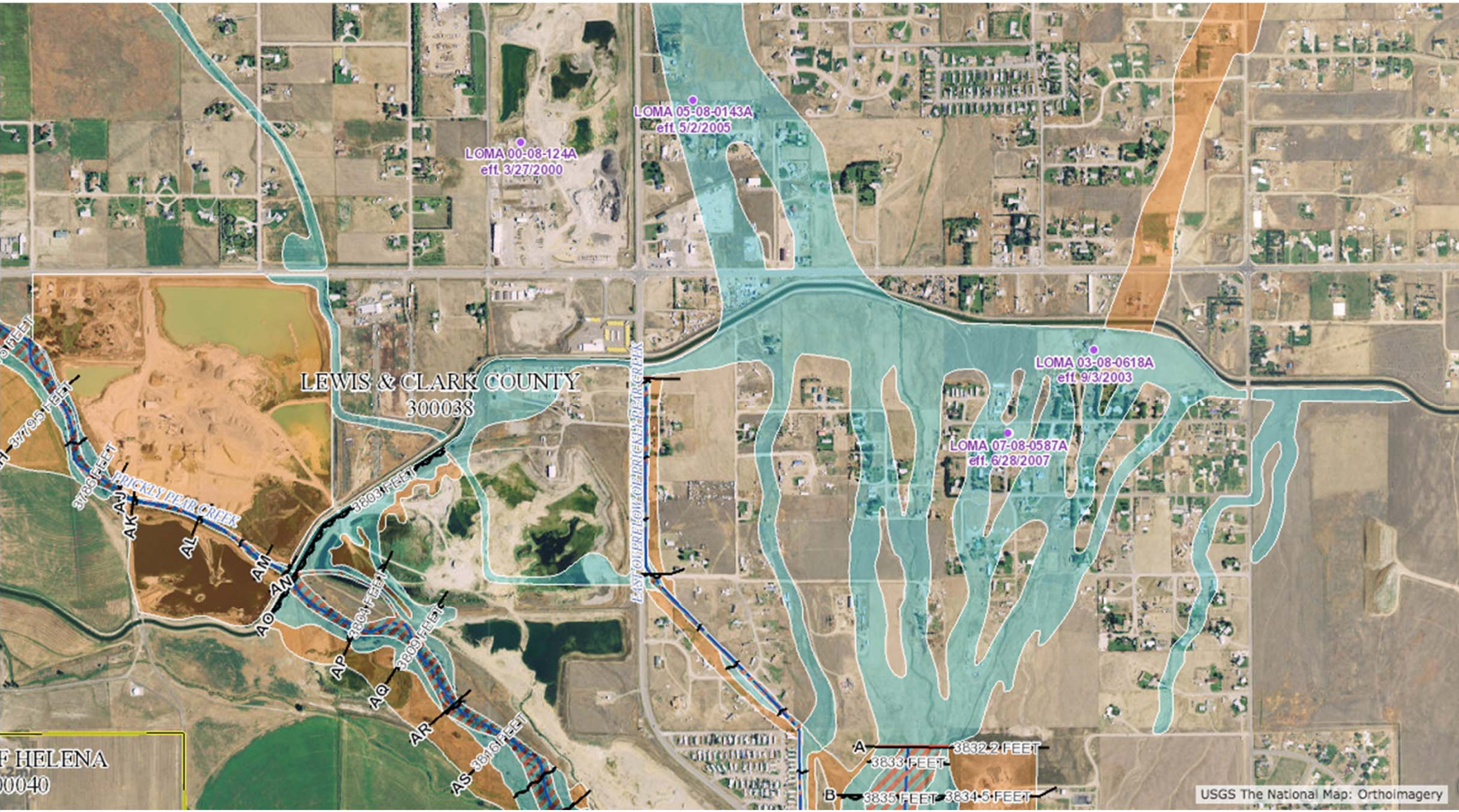
August 31, 2017, 3:00 AM MDT

Harvey Wasn't Just Bad Weather. It Was Bad City Planning

Houston exulted in sprawling, hands-off growth. That's no way to prepare for natural catastrophes.


SEPT. 22, 1938
PARTIAL FAILURE OF FORT PECK DAM AS SEEN FROM THE AIR.


Minot, ND (2011)


LOMA 00-08-124A
eff. 3/27/2000
LOMA 05-08-0143A
eff. 5/2/2005
LOMA 03-08-0618A
eff. 9/3/2003
LOMA 07-08-0587A
eff. 6/28/2007
LEWIS & CLARK COUNTY
300038
PRICKLY PEAR CREEK
EAST FORK PRICKLY PEAR CREEK
AJ
AK
AL
AM
AN
AO
AP
AQ
AR
AS
3803 FEET
3804 FEET
3803 FEET
3816 FEET
A
3832.2 FEET
3833 FEET
B
3835 FEET
3834.5 FEET
F HELENA
00040
USGS The National Map: Orthoimagery

Example Permit Application Request - Background Information

- Tongue River residential home
  - **Pre-FIRM – built in 1972**
  - **Mapped into floodplain in 2010 with new study**
  - **Since 2010 – entire home is located in AE Zone Floodway**
- In 2017, the homeowner submits floodplain application to:
  - **Add an addition to the house – one bedroom and additional bathroom**
  - **Proposed elevation of addition same as existing house**
- Permit was denied because:
  - **Existing code allows no new structures in floodway**
  - **Existing code requires New construction or substantial improvement of any residential structure …… lowest level of floor is at two feet above the base flood elevation**

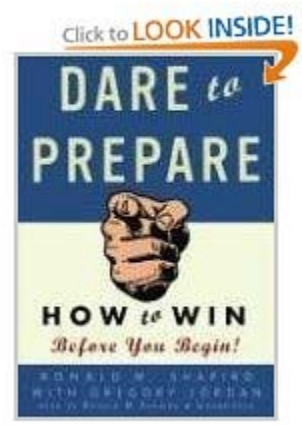
The existing residential structure is one foot below the Base Flood Elevation (BFE)

Variances

- **Proposed variances from must show the following**:
  - Good and Sufficient cause is shown
  - An exceptional hardship to the applicant exists
  - The variance provides the minimum necessary action to afford relief
  - The variance will not increase flood heights, cause additional threats to public safety, cause extraordinary public expense, create nuisances, cause fraud or victimization of the public, or conflict with local laws or ordinances.
  - If a variance is granted, the community must maintain a record of all variances
  - Variances are for floodplain management purposes only and could significantly affect insurance premium rates on affected structures.

BEST ADVICE TO DECISION MAKING BOARDS – DON'T GRANT THESE VARIANCES UNLESS ABSOLUTELY NECESSARY

Mitigation and Recovery



- Keys to Recovery Success
  - Act quickly
  - Actively plan
  - Engage the community
  - Develop partnerships, networks and effective coordination strategies

- Systematic and inclusive
- Leadership and unity of effort
- Pre-disaster & post-disaster recovery planning

Basic Enforcement Process

- Right to inspection (inspection of work in progress)
- Stop work order
- Revocation of permit
- Right to periodic inspection
- Violations to be corrected
- Actions in event of failure to take corrective actions
- Order to take corrective actions
- Appeal
- Failure to comply
- Section 1316

How is Section 1316 used?

- Intended for use primarily as a backup for local enforcement actions (i.e., if a community could not force compliance through the enforcement mechanisms in its regulations, it could use Section 1316 as additional leverage)
- Not intended merely as a mechanism to remove bad risks from the policy base
- Section 1316 will only be implemented in instances where States or communities submit declarations specifically for that purpose.

No Adverse Impact

Managing principle focused on the impact on others

- Protects property rights—ensures action of any property owner does not adversely impact the property rights of others
- Leads to reduced flood losses while promoting better stewardship and community mitigation efforts
- Prevention of harm is treated different legally than making the community a better place—tougher to challenge in court

Thank you!

- **Traci Sears**
  (406) 444-6654
  tsears@mt.gov

Hyper Hydrology: A Holistic View of Colorado Hydrology

Through the Colorado Hazard Mapping Program

woodplc.com

Outline

- CHAMP III Overview
- Colorado's Hydrologic Regions
- Hydrology Methods
- Hydrologic Region Specifics

THANK YOU!

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

CHAMP III

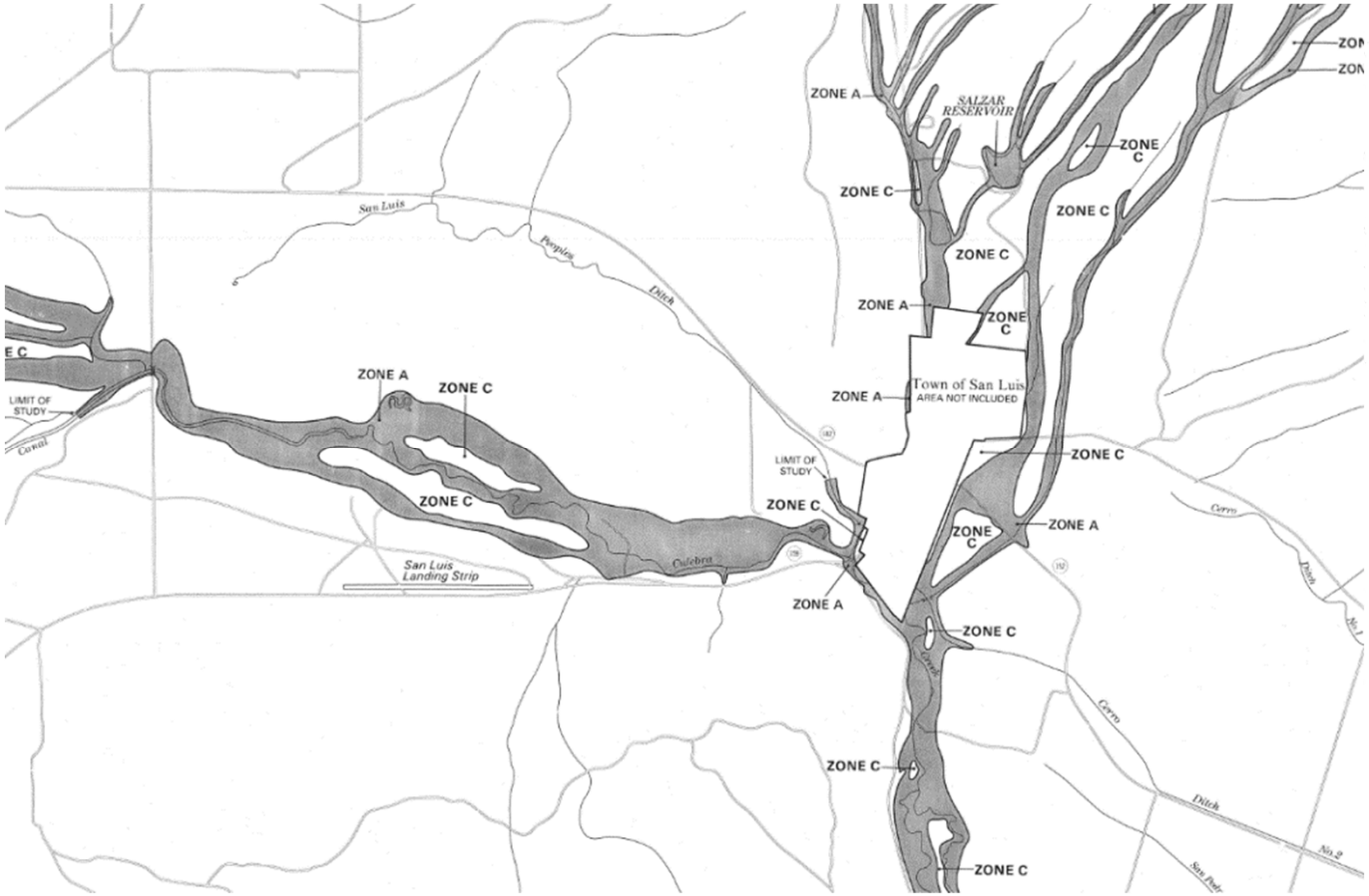
Colorado Hazard Mapping Program – Phase III

Modernized vs. Unmodernized

Modernized

Unmodernized

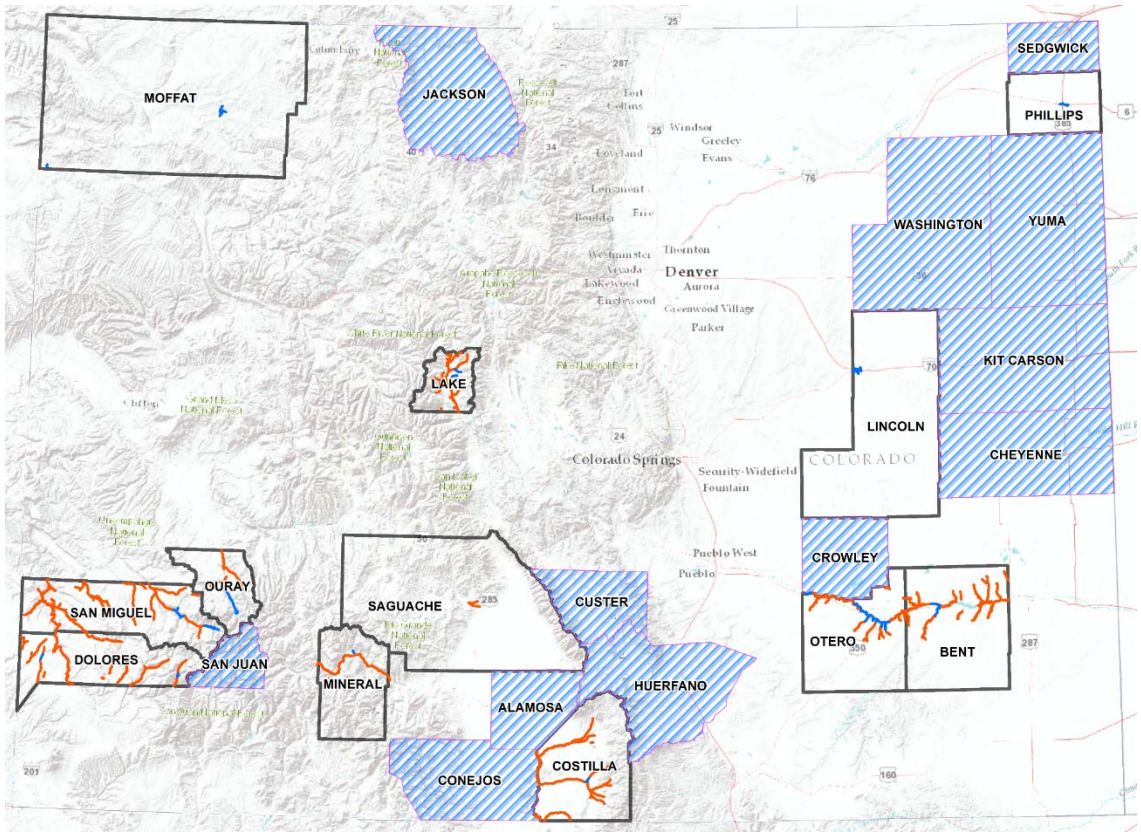
Modernized vs. Unmodernized



Phase III Goals

- Modernize 12 counties
  - LiDAR / IFSAR with Bathymetry
  - Survey
  - Hydrology
  - Hydraulics
  - Floodplain Mapping
- Digitize 12 counties

Phase III Scope



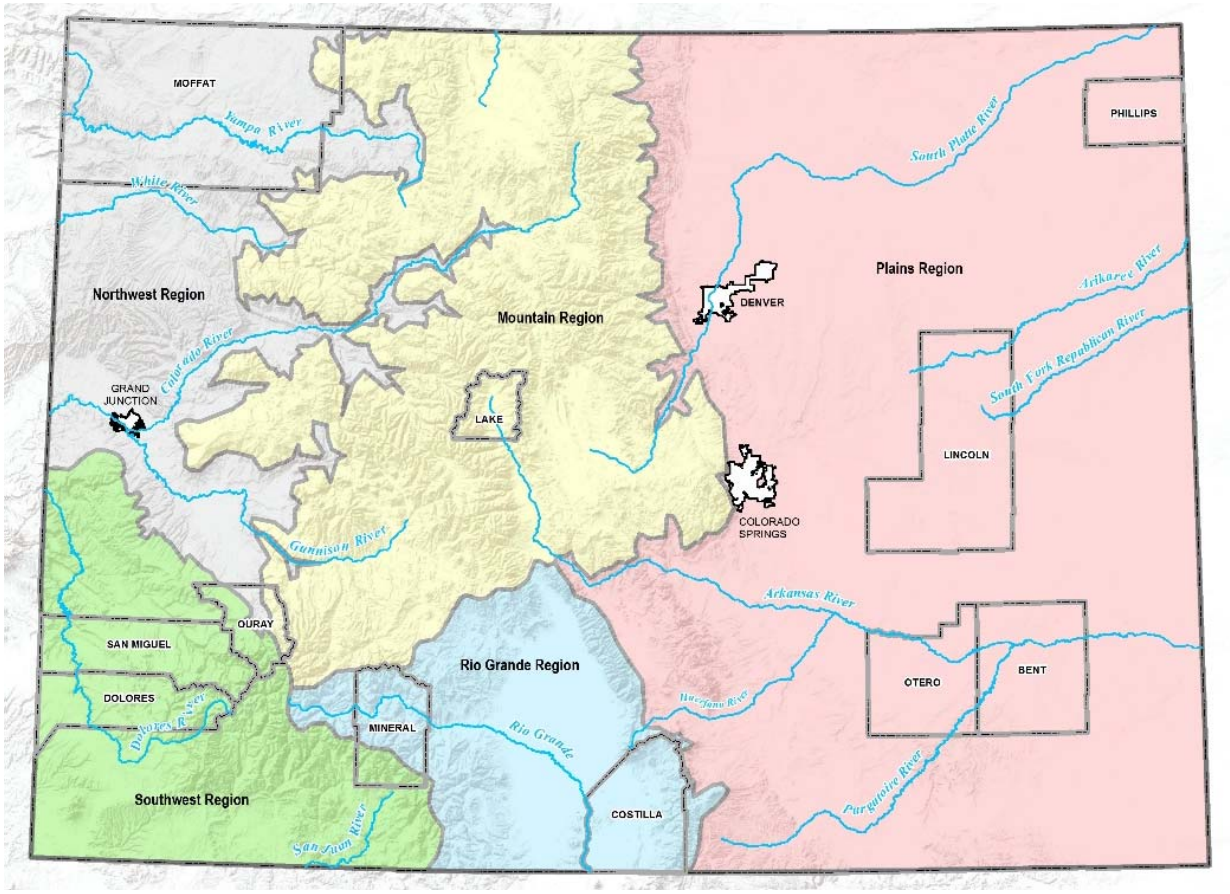
Digital Conversion

New Floodplain Mapping

A	863.5 miles
AE	112.0 miles

Colorado's Hydrologic Regions

Colorado Hydrologic Regions



Plains Regions

Paleoflood Investigations to Improve Peak-Streamflow Regional-Regression Equations for Natural Streamflow in Eastern Colorado, 2015

USGS SIR 2016-5099

West Regions

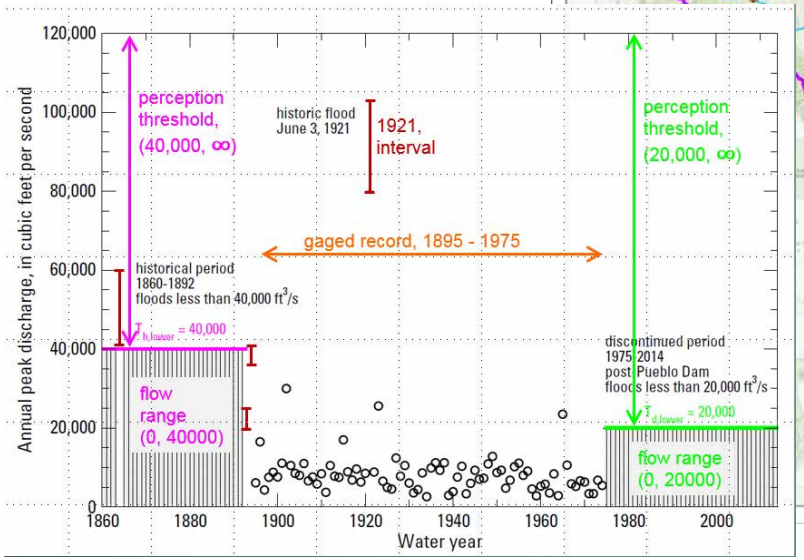
Regional Regression Equations for Estimation of Natural Streamflow Statistics in Colorado, 2009

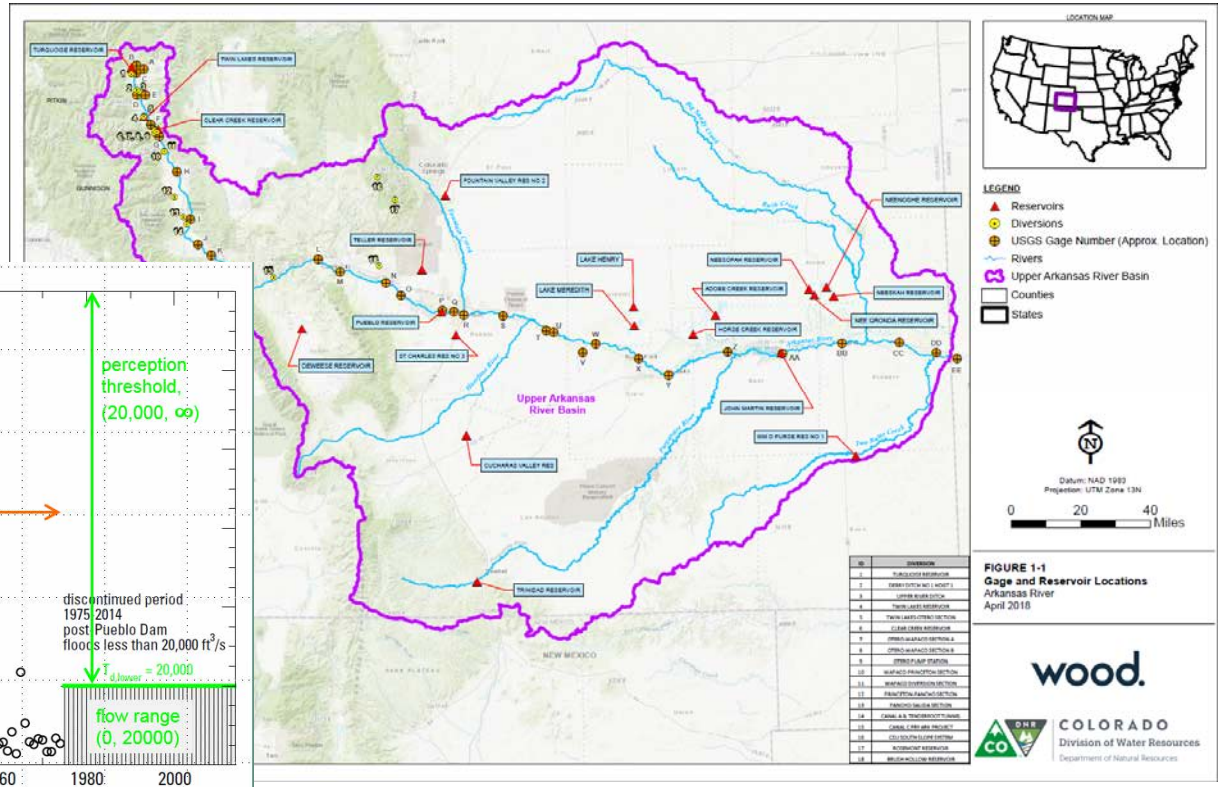
USGS SIR 2009-5136

Hydrology Methods

Bulletin 17C Gage Analysis

USGS and DWR Peak Flows

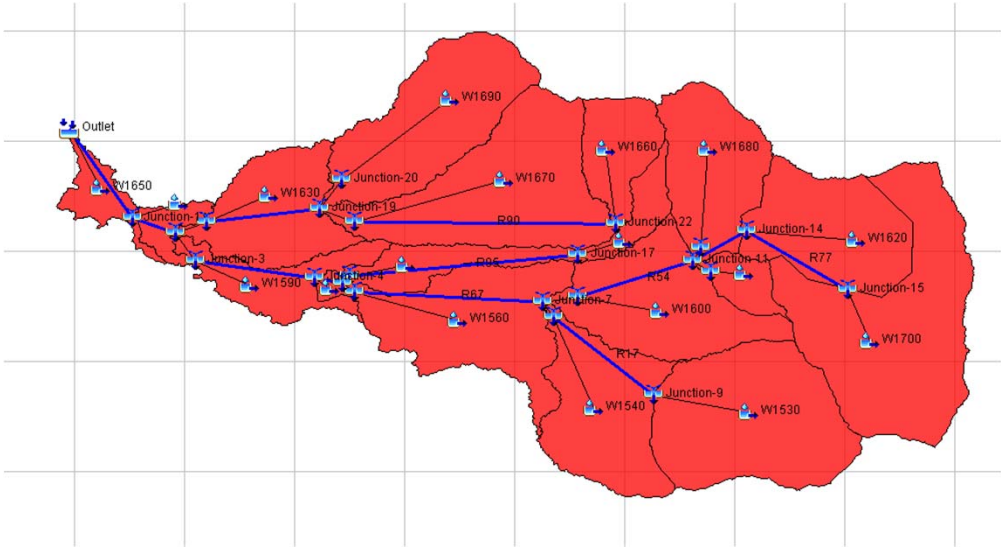




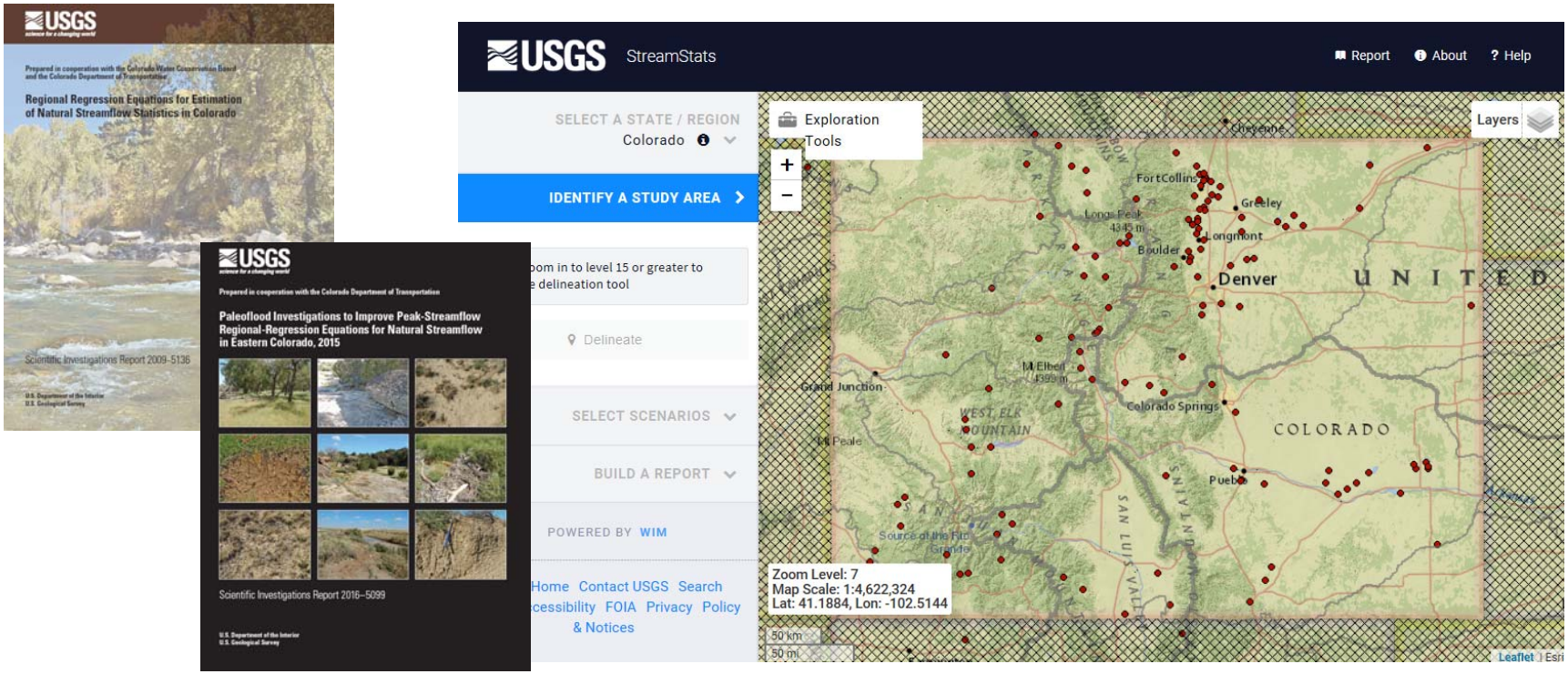
Hydrologic Modeling

HEC-HMS

- SCS Type II Rainfall Distributions
- Atlas 14 Rainfall Totals
- TR-55 Curve Number
- Wood Tools
  - Basin Delineation
  - Time of Concentration

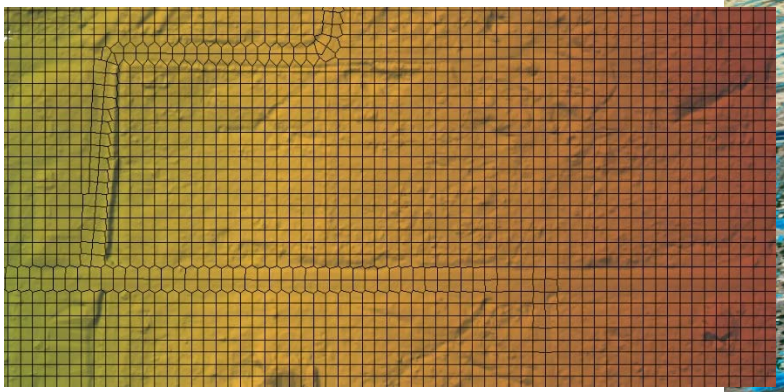


Regression Equations

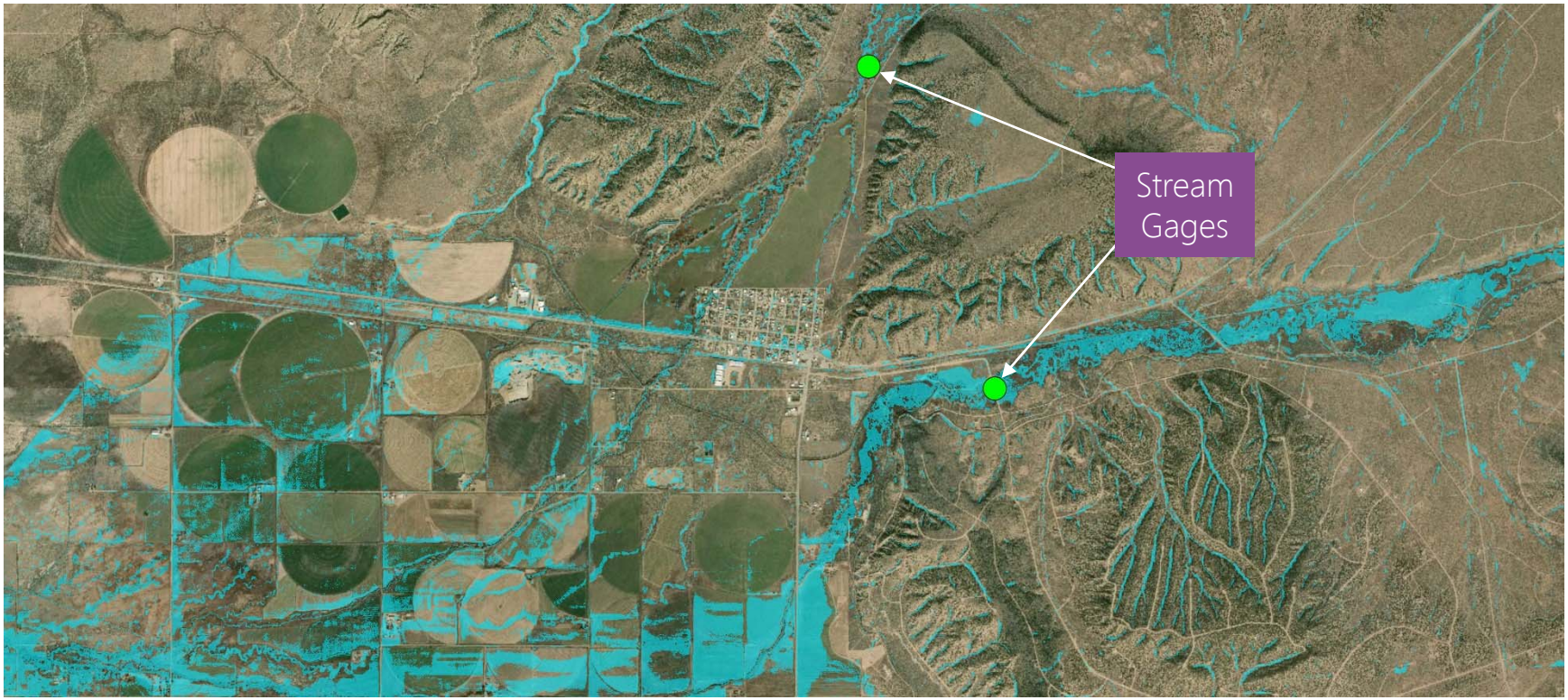


Rain-on-Grid

- HEC-RAS 5.0.5
  - HMS Parameters
  - Input Hydrographs



Rain-on-Grid



Hydrologic Region Specifics

Southwest Region

Peak Streamflow Regression Equation

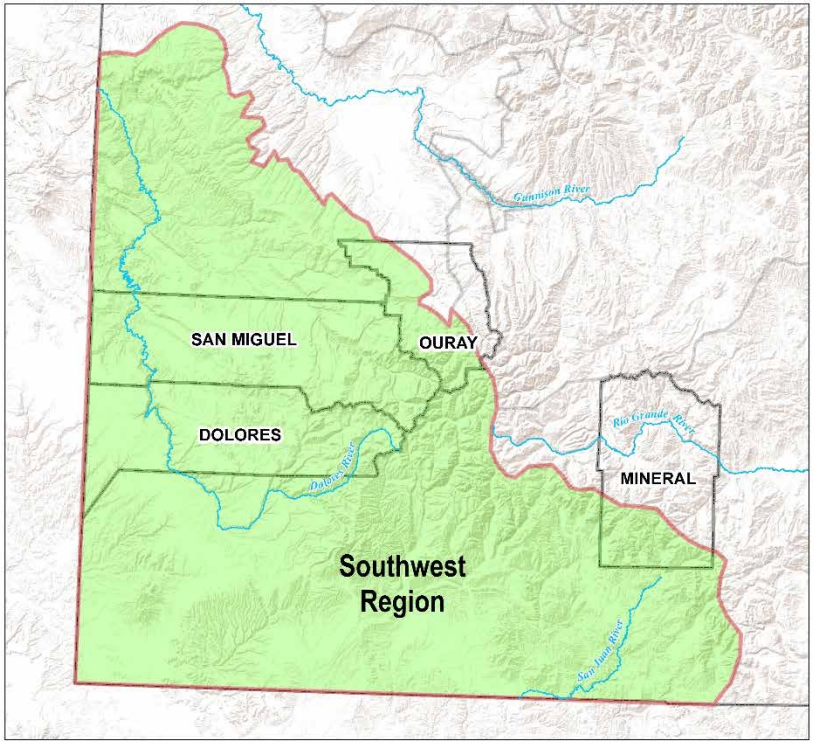
$$Q_{100} = 10^{2.91} A^{0.59} A_{7500}^{-0.33}$$

Drainage Area

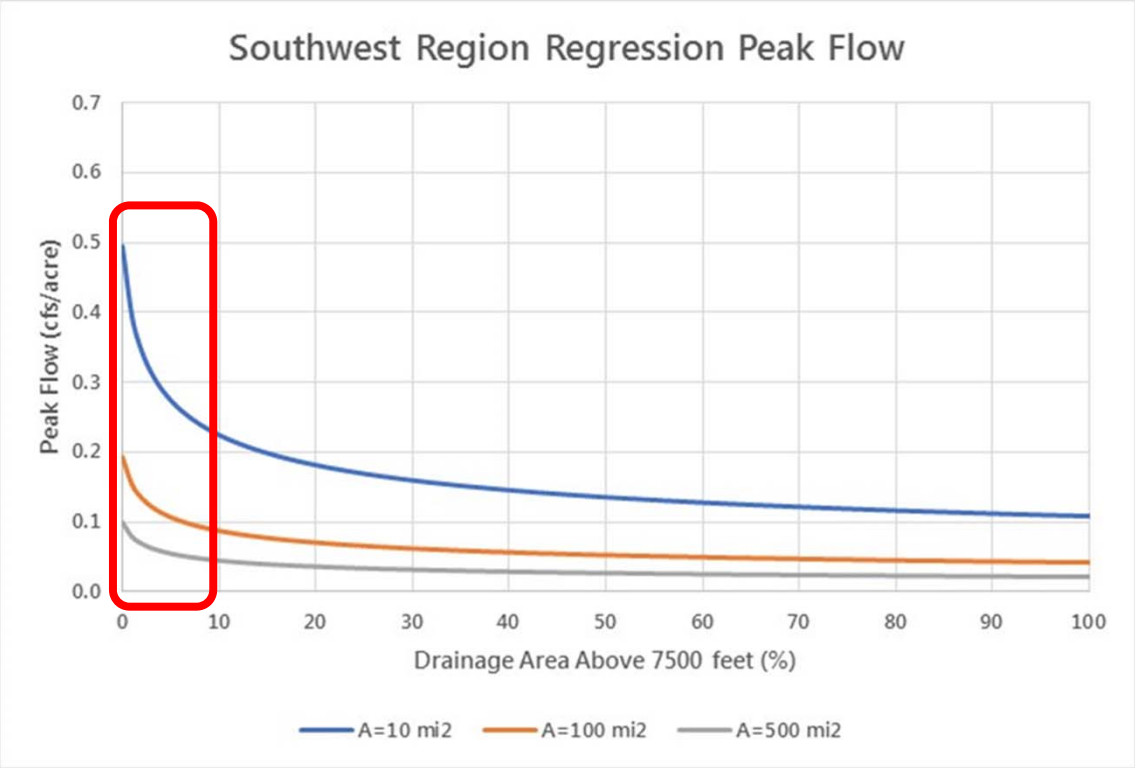
Percentage of A above 7,500 feet (plus 1)

Challenges:

- Regression was overestimating peak flows for low-lying areas.
- HEC-HMS models were overestimating runoff for high-elevation basins.

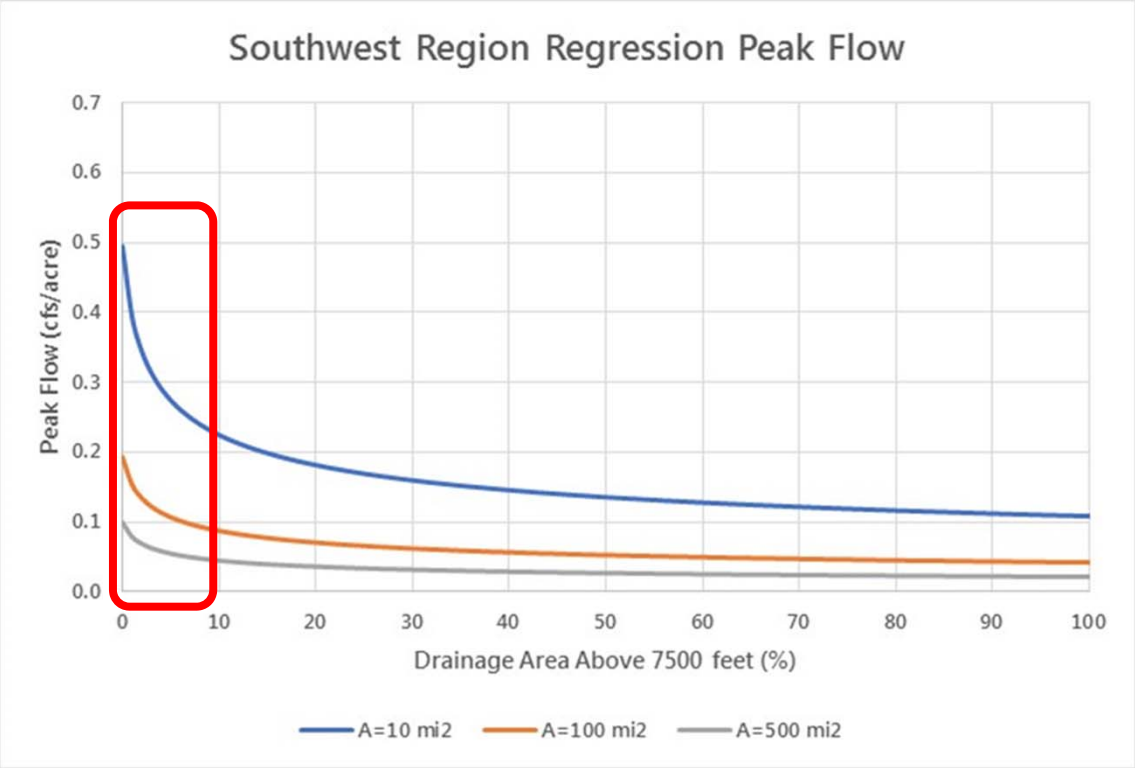


Southwest Region



The peak flow is overestimated when there is a small percentage of drainage area above 7,500 ft.

Southwest Region



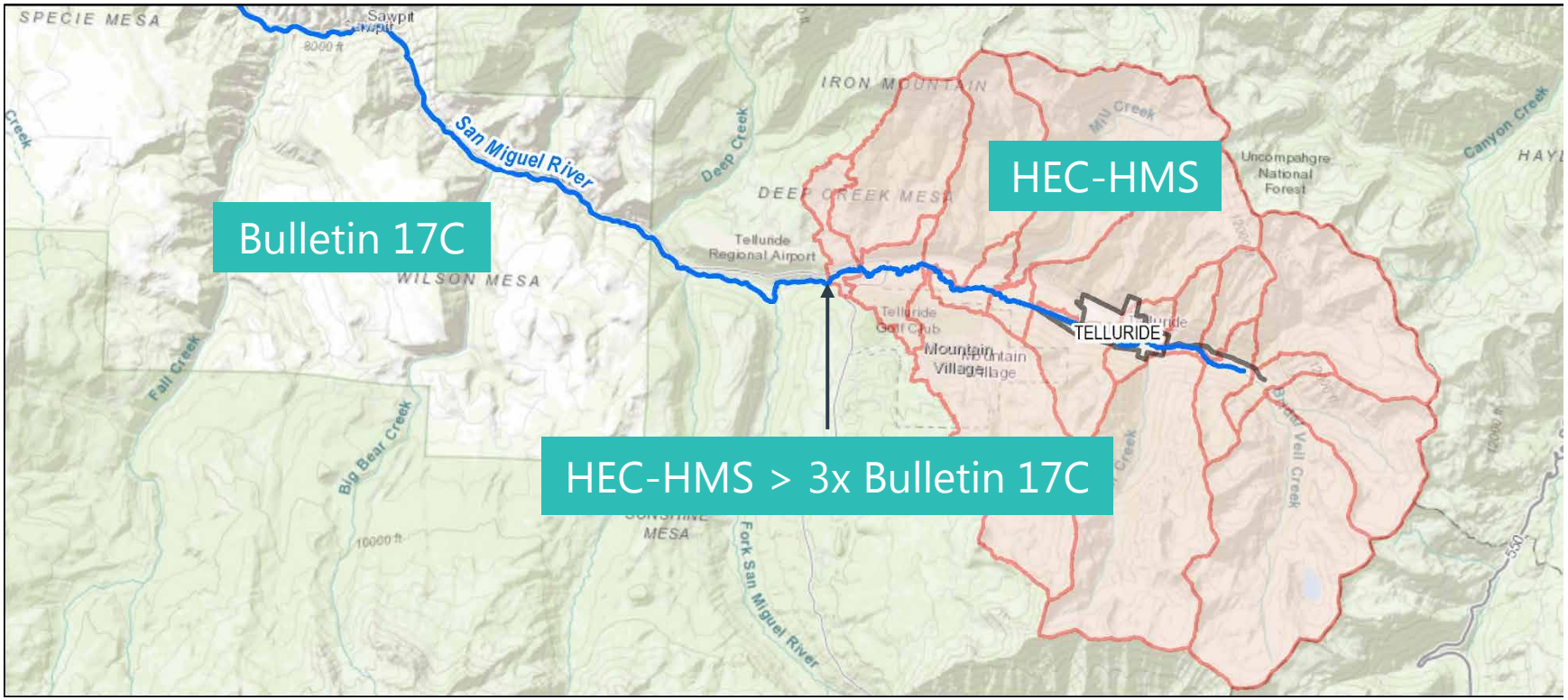
The peak flow is overestimated when there is a small percentage of drainage area above 7,500 ft.

Used Utah regression equations for low-lying areas near Colorado-Utah border.

$$PK100 = 115{,}000\ DRNAREA^{0.391}\ (ELEV/1{,}000)^{-2.58}$$

- DRNAREA: Drainage Area
- ELEV: Average Basin Elevation

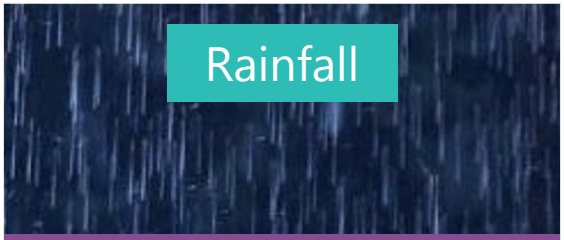
Southwest Region



Southwest Region

IC1
IC2

Southwest Region



Rainfall

Applied Aerial Reduction Factor (ARF)

ARF=0.75[1]

Land Use

Modified Land Use Classifications/Curve Numbers

Barren Land
→
Pinyon-Juniper

Initial Abstraction

Increased Initial Abstraction Ratio in High-Elevation Basins

0.2 (Default) → 0.3-0.4

1. NOAA Technical Memorandum NWS HYDRO-40 (1984)

Slide 22

IC1 Land use - Rock is not a CN 98
Ide, Christopher, 9/20/2018

IC2 Initial Abstraction - Porus rock as well.
Ide, Christopher, 9/20/2018

Northwest Region

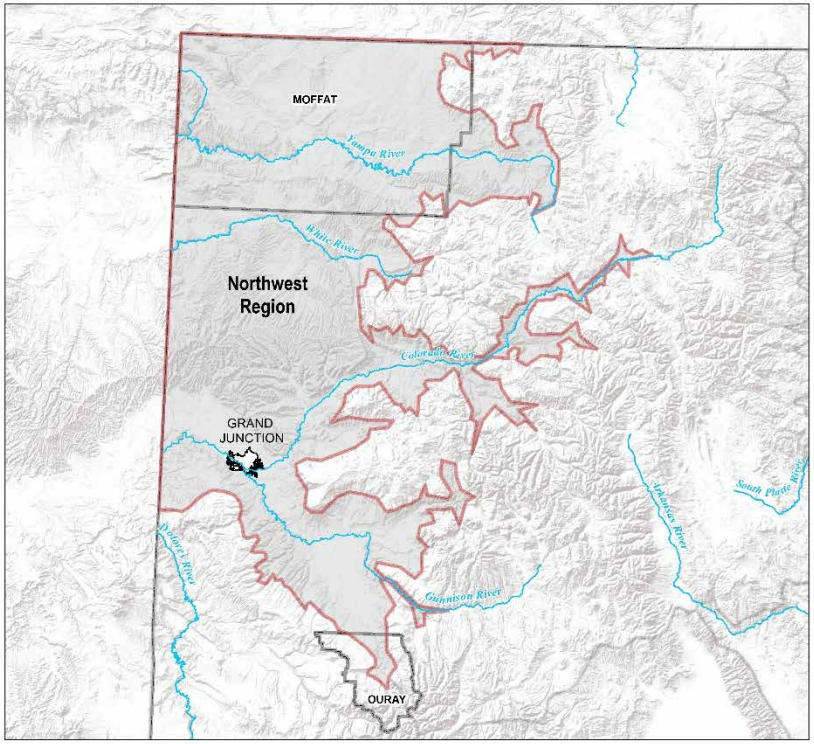
Peak Streamflow Regression Equation

$$Q_{100} = 10^{0.93} A^{0.74} A_{7500}^{-0.81} P^{1.65}$$

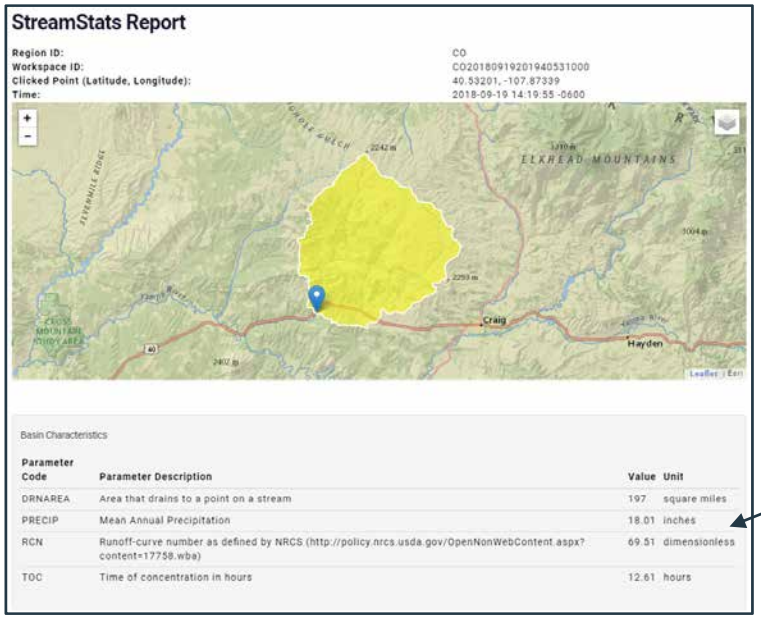
- A: Drainage Area
- A_{7500}: Percentage of A above 7,500 feet plus 1
- P: Mean Annual Precipitation

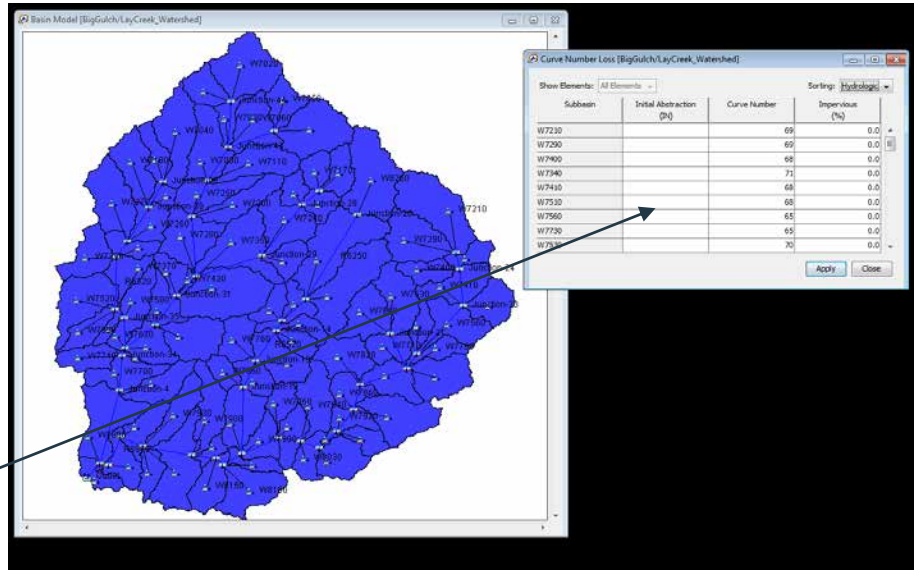
Challenges:

- Unable to calibrate HEC-HMS models using regression due to overestimation of peak flows for low-lying areas.
- Lack of nearby stream gage data to calibrate HEC-HMS models.



Northwest Region





Compared StreamStats drainage basin parameter outputs to HEC-HMS inputs

Precipitation

Time of Concentration

Curve Number

Mountain Region

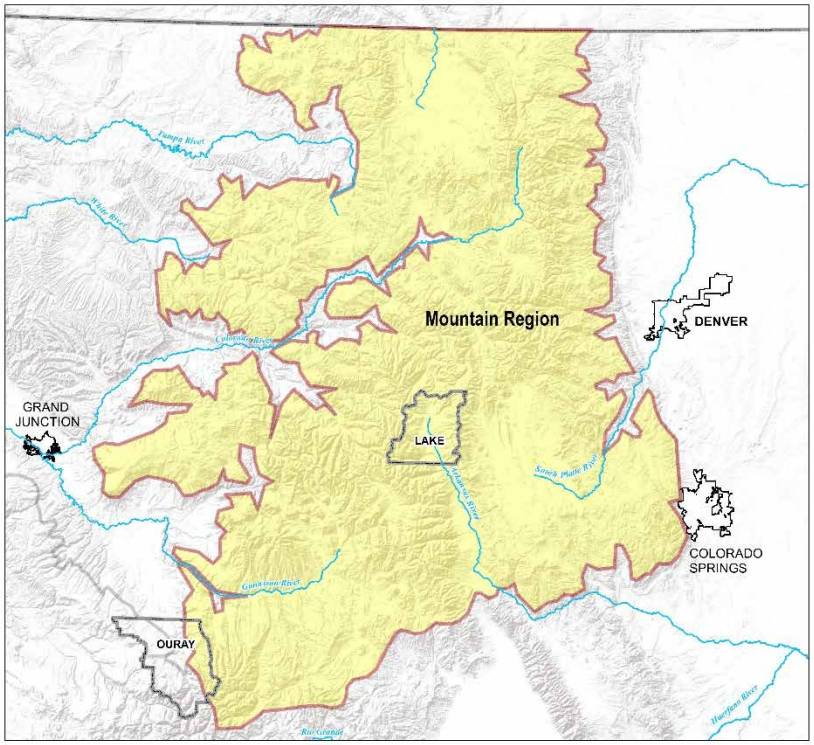
Peak Streamflow Regression Equation

$$Q_{100} = 10^{-0.46} A^{0.75} S^{0.14} P^{1.35}$$

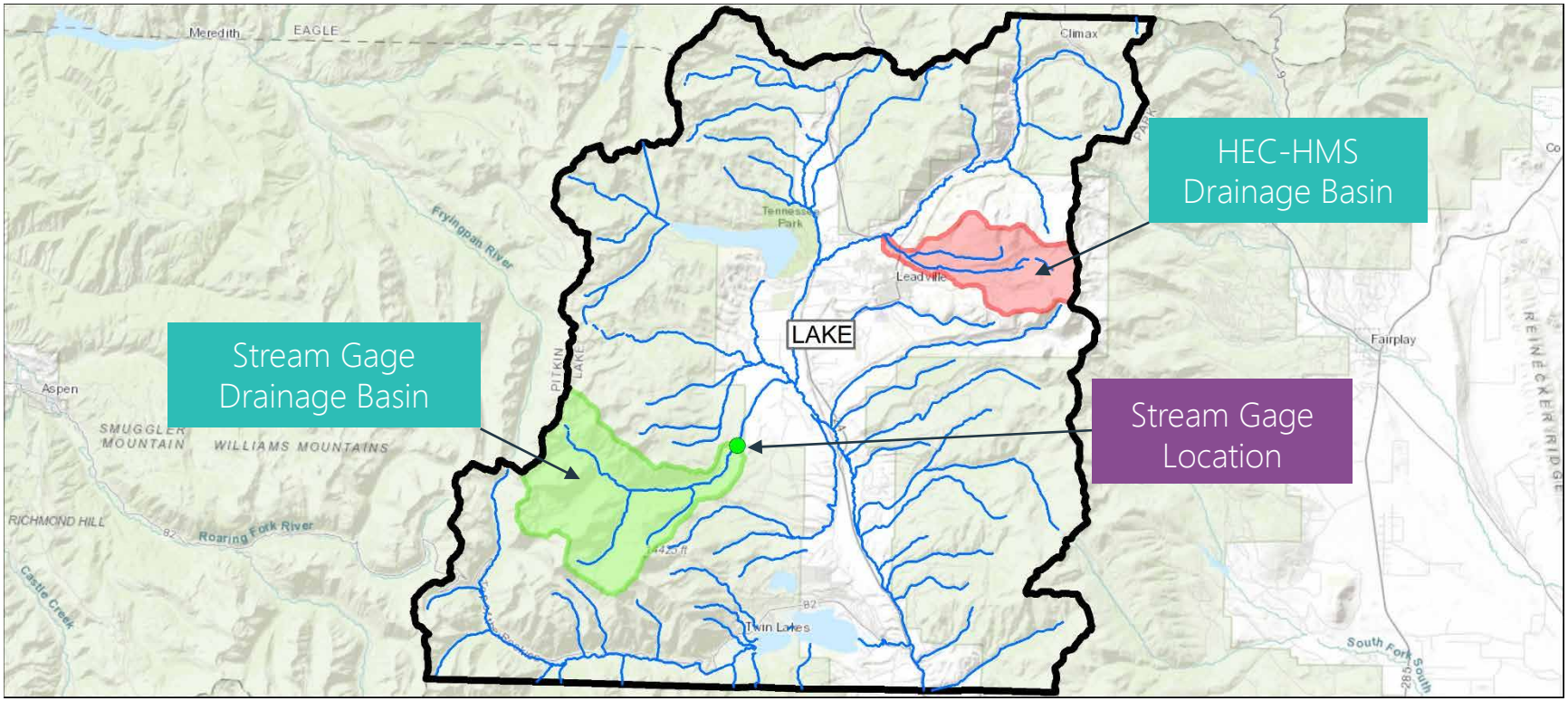
- A: Drainage Area
- S: Mean Watershed Slope
- P: Mean Annual Precipitation

Challenges:

- HEC-HMS models were overestimating runoff for high-elevation basins.



Mountain Region



Plains Region

Peak Streamflow Regression Equation

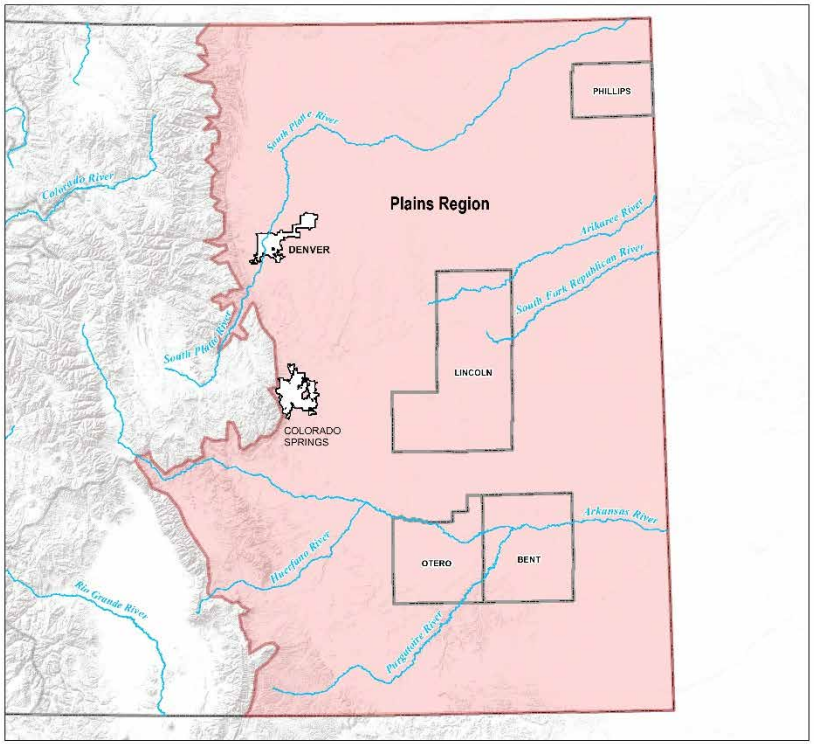
$$Q_{0.01} = 10^{-0.654} \; A^{0.403} \; S^{0.593} \; C^{2.470}$$

$$SEP = 136$$

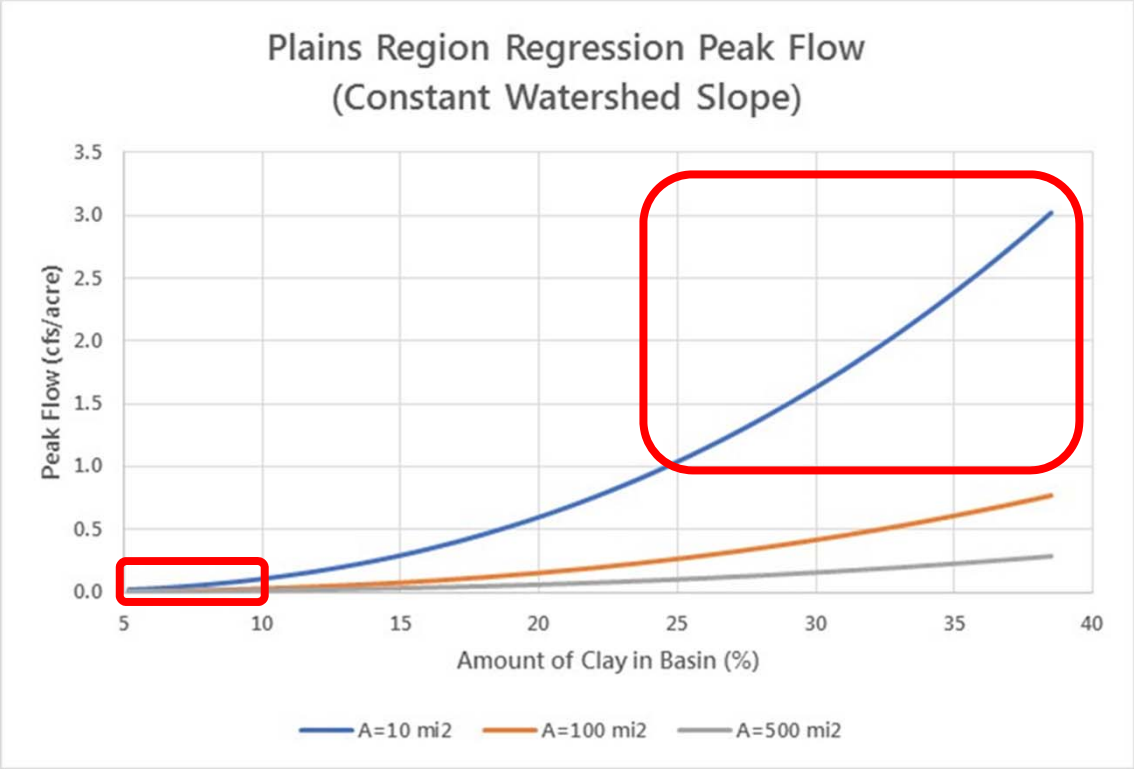
- A: Drainage Area
- S: Mean Watershed Slope
- C: Percent of Clay in Basin

Challenges:

- Regression peak flows are highly dependent of the percentage of clay in the basin. Can produce highly variable and sometimes unreasonable results.



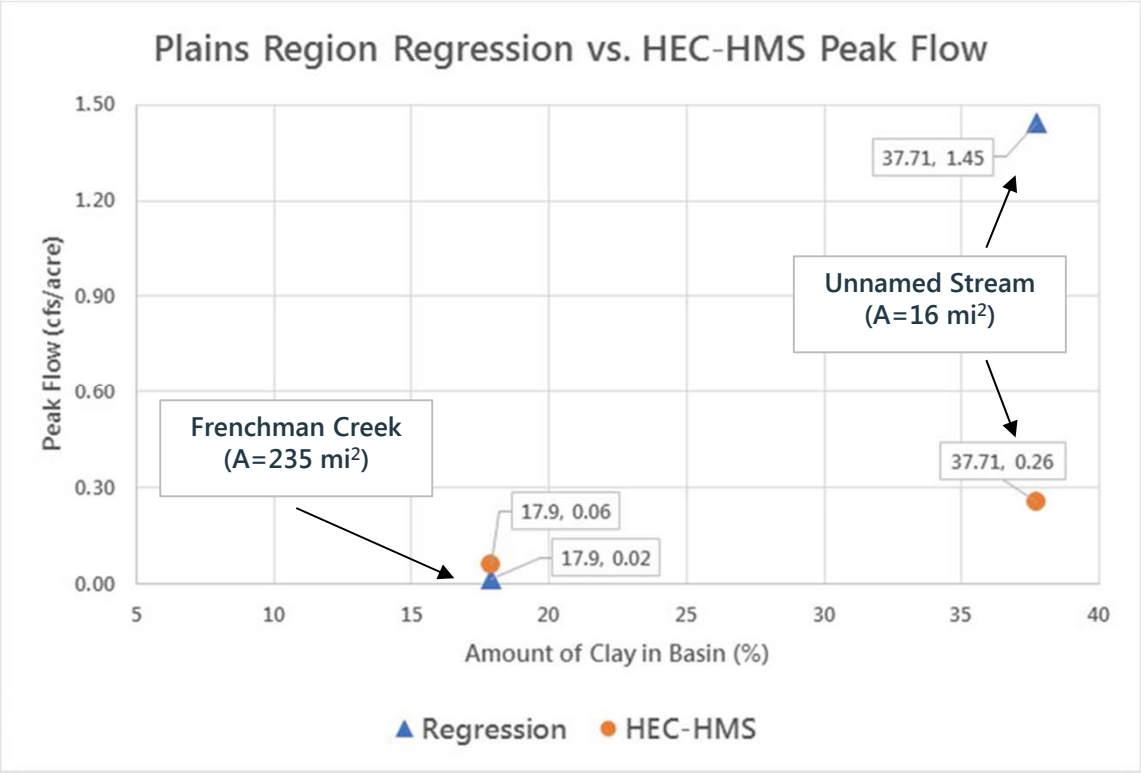
Plains Region



For smaller basins, higher percentages of clay can drastically increase peak flows

Small amounts of clay produce unreasonably low peak flows.

Plains Region



Regression results were highly variable and often did not produce reasonable results.

Verified HEC-HMS results using Kansas and Nebraska regression equations, StreamStats parameter comparisons, and other studies conducted in the area.

Rio Grande Region

Peak Streamflow Regression Equation

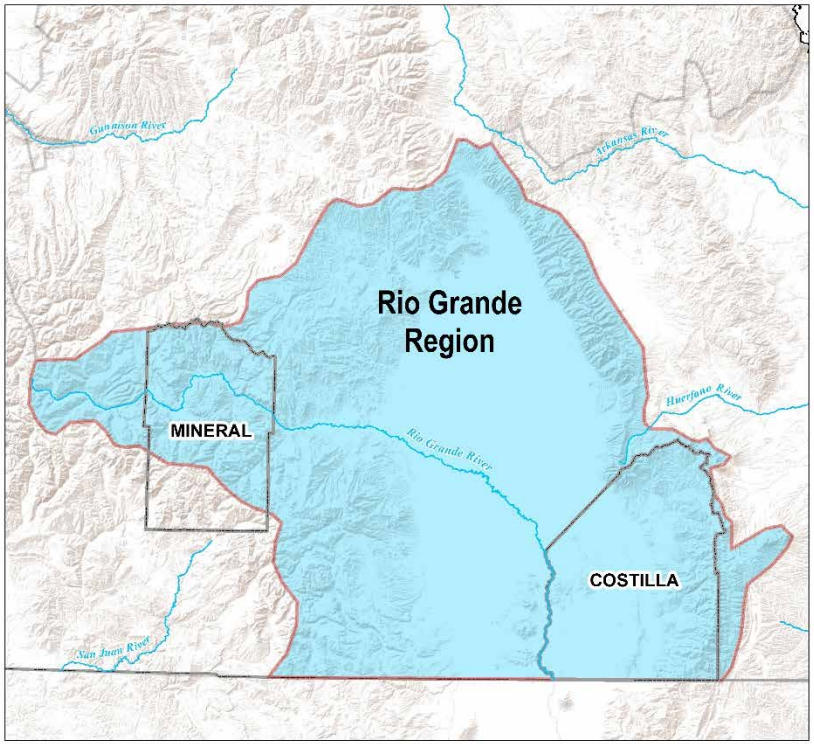
$$Q_{100} = 10^{-0.19} A^{0.87} P^{1.17}$$

Drainage Area

Mean Annual Precipitation

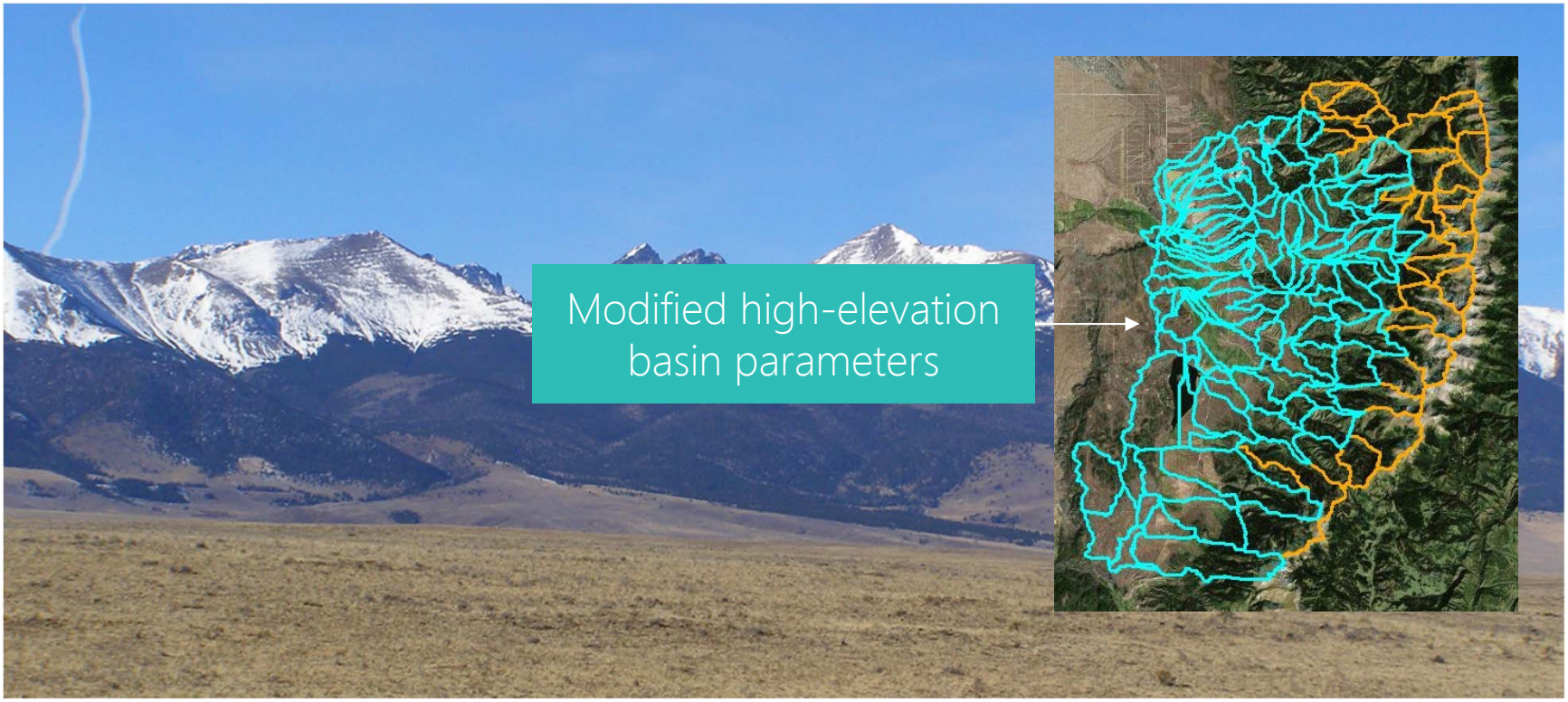
Challenges:

- HEC-HMS models were overestimating runoff for high-elevation basins.
- Difficult to model hydraulics in flat areas.

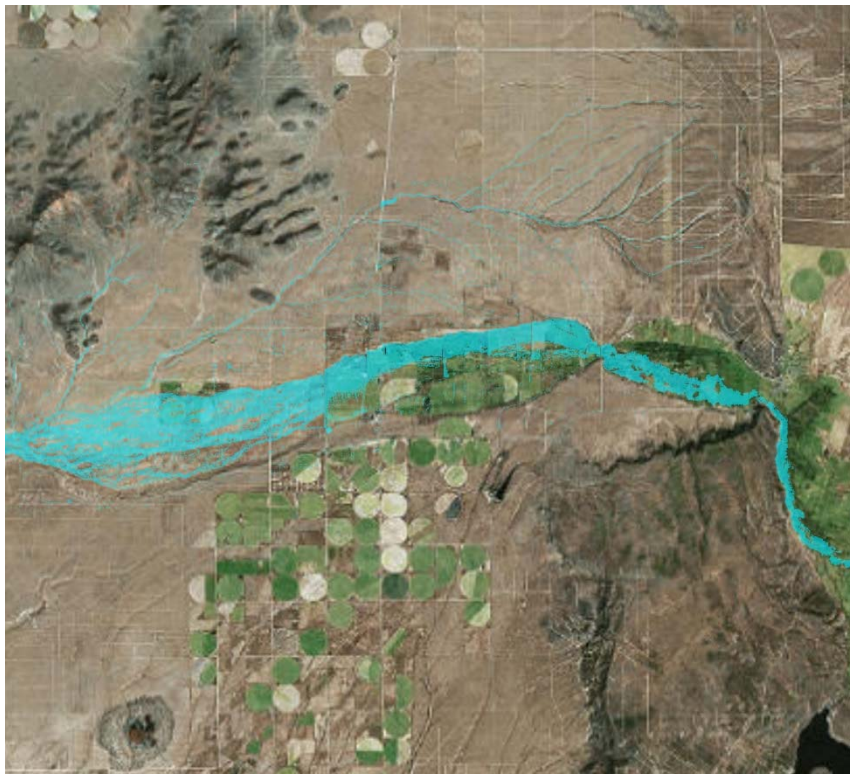


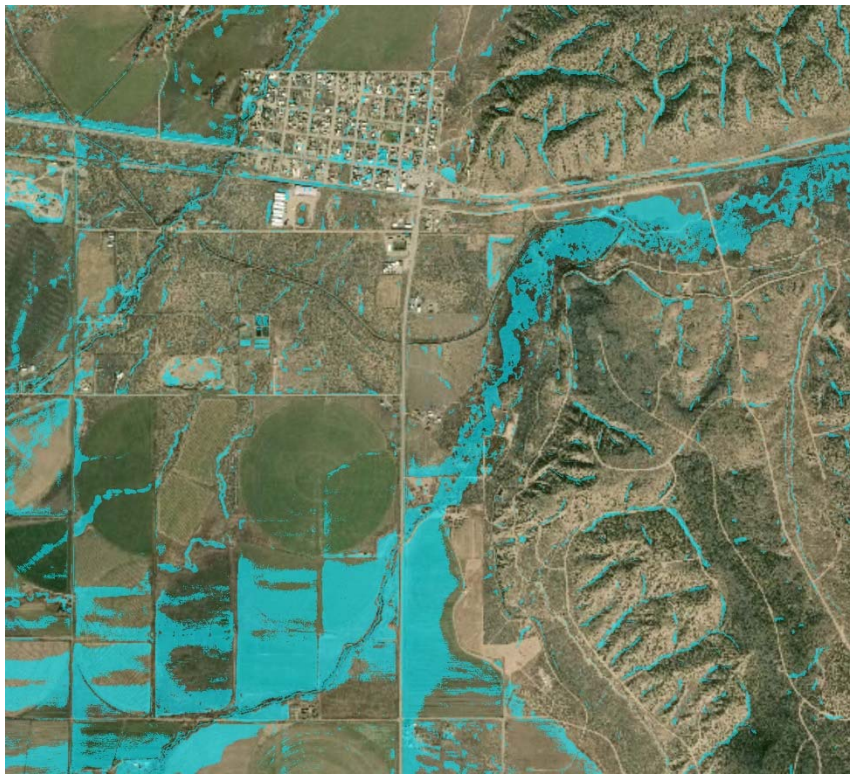
Rio Grande Region

Rio Grande Region

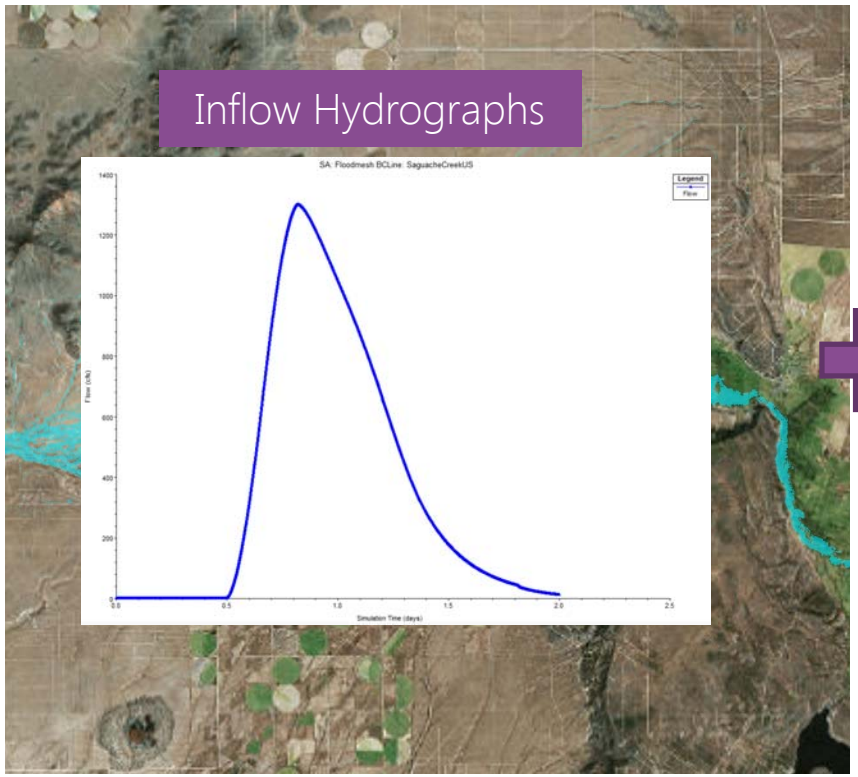


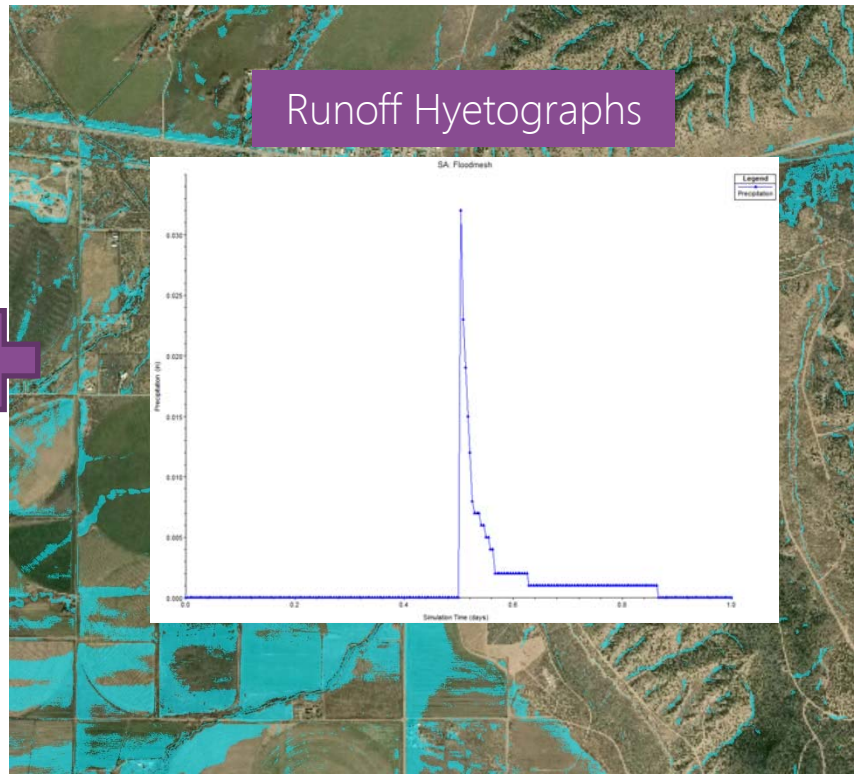
Rio Grande Region





Rio Grande Region





Summary

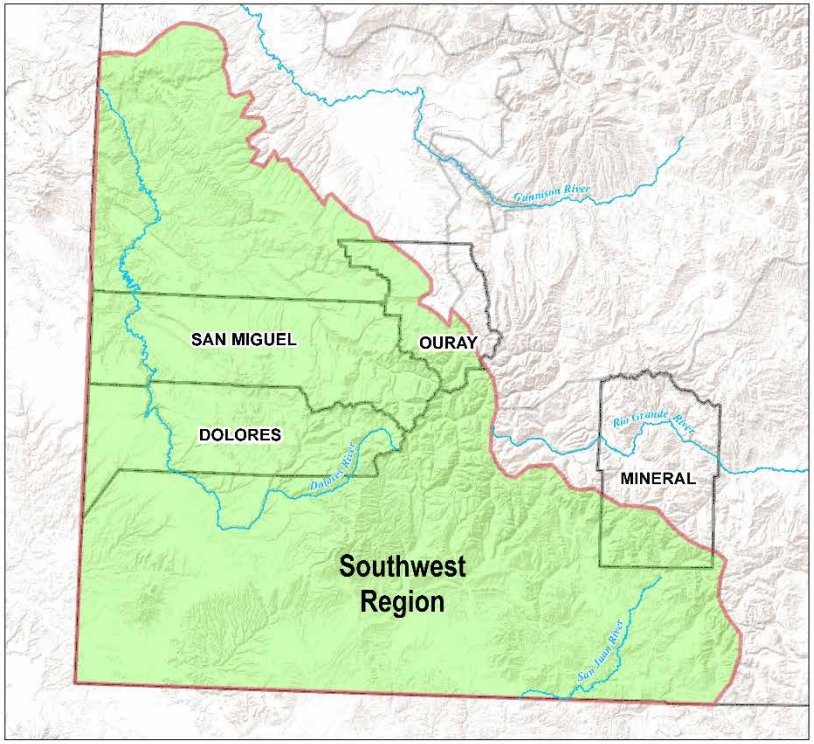
Summary – Southwest Region

Challenges:

- Regression was overestimating peak flows for low-lying areas.
- HEC-HMS models were overestimating runoff for high-elevation basins.

Solutions

- Used neighboring state regression equations (when appropriate).
- Modified HEC-HMS input parameters for high-elevation basins and calibrated to downstream stream gages.



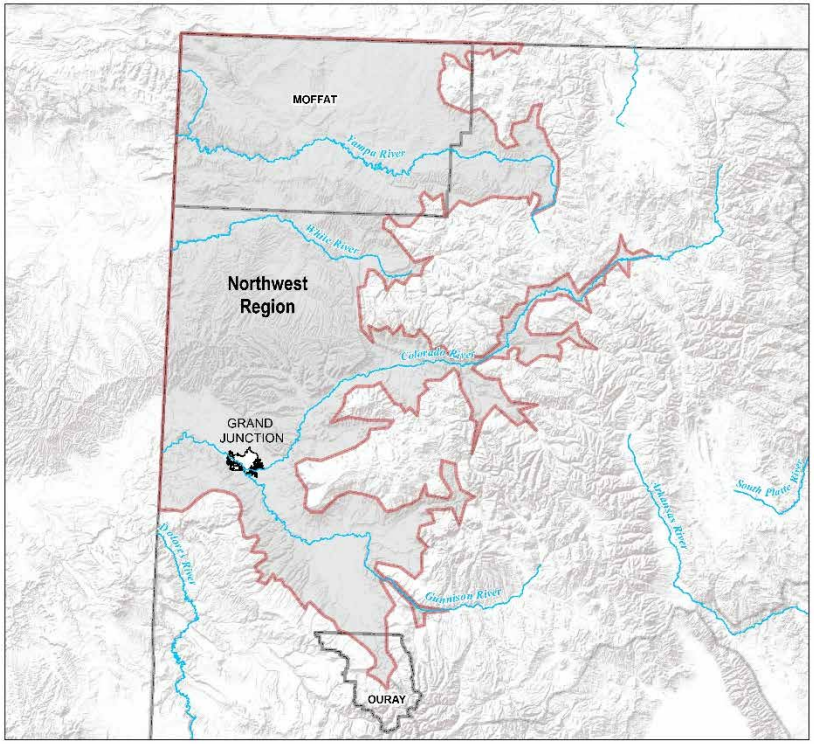
Summary – Northwest Region

Challenges:

- Unable to calibrate HEC-HMS models using regression due to overestimation of peak flows for low-lying areas.
- Lack of nearby stream gage data to calibrate HEC-HMS models.

Solutions

- Compared StreamStats drainage basin parameter outputs for HEC-HMS calibration.



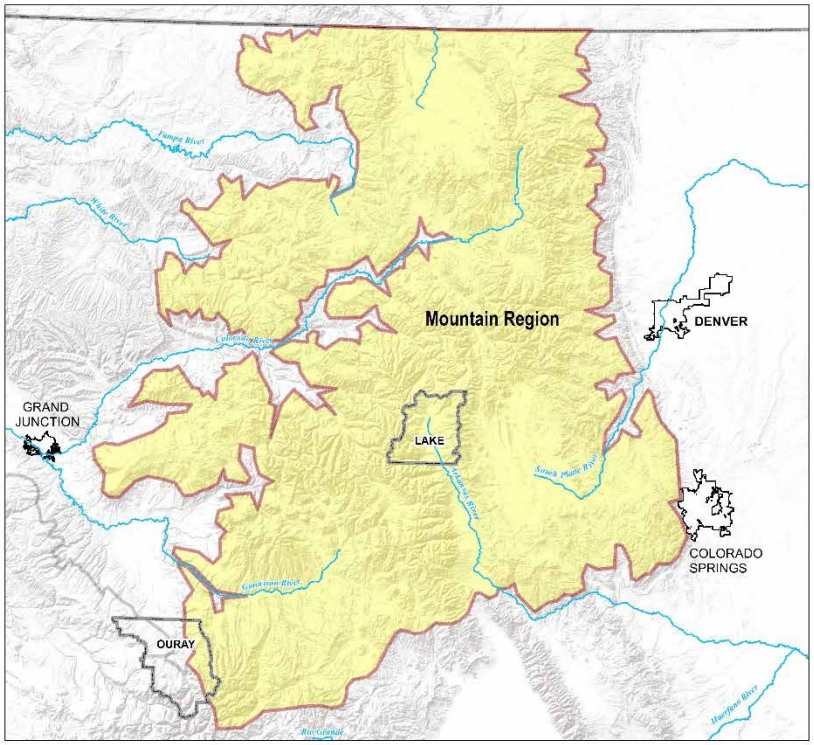
Summary – Mountain Region

Challenges:

- HEC-HMS models were overestimating runoff for high-elevation basins.

Solutions

- Modified HEC-HMS input parameters for high-elevation basins and calibrated to similar, nearby stream gage basins.



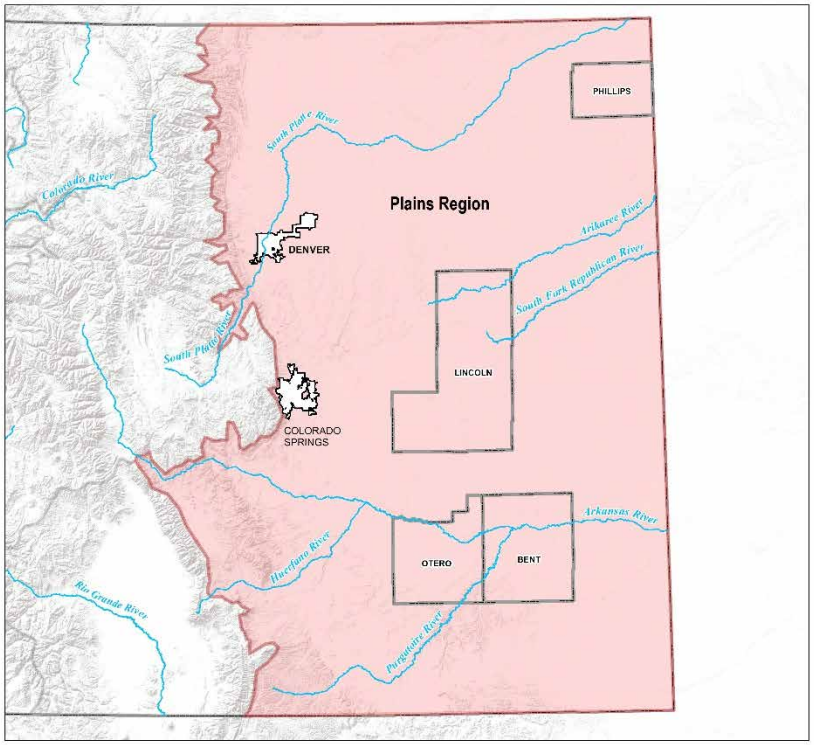
Summary – Plains Region

Challenges:

- Regression peak flows are highly dependent of the percentage of clay in the basin. Can produce highly variable and sometimes unreasonable results.

Solutions

- Use regression equations with caution when the percentage of clay is on either end of the allowable range.
- Use neighboring state regression equations (when appropriate) and StreamStats drainage basin parameter outputs for HEC-HMS calibration.



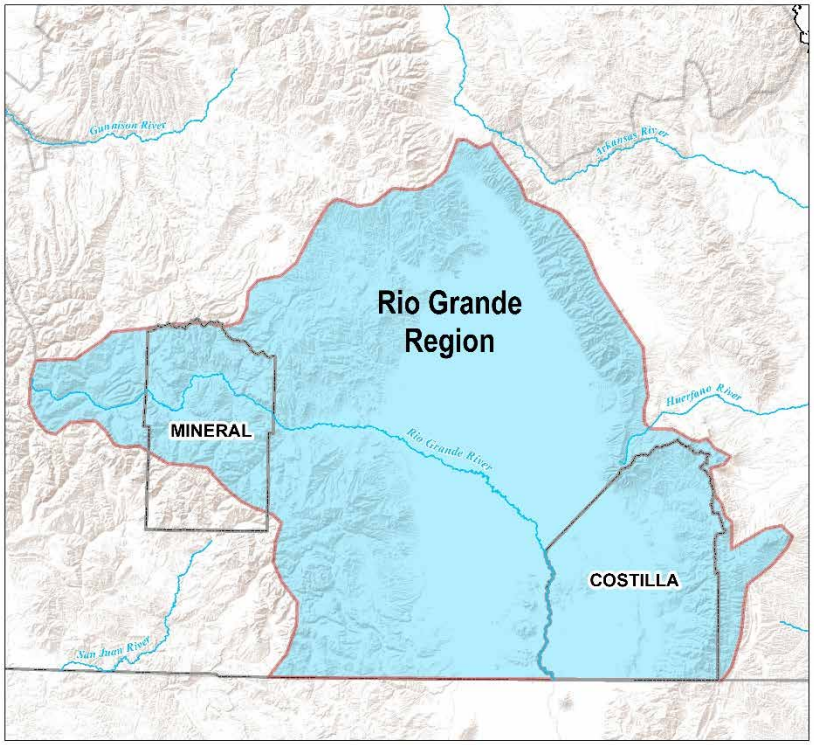
Summary – Rio Grande Region

Challenges:

- HEC-HMS models were overestimating runoff for high-elevation basins.
- Difficult to model hydraulics in flat areas.

Solutions

- Modified HEC-HMS input parameters for high-elevation basins and calibrated to similar, nearby stream gage basins.
- Modeled hydrology/hydraulics for streams in the flat San Luis Valley using 2-D methodologies.



Summary

Hydrologic Region	Challenges	Solutions
Southwest	Regression was overestimating peak flows for low-lying areas. HEC-HMS models were overestimating runoff for high-elevation basins.	Used neighboring state regression equations (when appropriate). Modified HEC-HMS input parameters for high-elevation basins and calibrated to downstream stream gages.
Northwest	Unable to calibrate HEC-HMS models using regression due to overestimation of peak flows for low-lying areas. Lack of nearby stream gage data to calibrate HEC-HMS models.	Compared StreamStats drainage basin parameter outputs for HEC-HMS calibration.
Mountain	HEC-HMS models were overestimating runoff for high-elevation basins.	Modified HEC-HMS input parameters for high-elevation basins and calibrated to similar, nearby stream gage basins.
Plains	Regression peak flows are highly dependent of the percentage of clay in the basin. Can produce highly variable and sometimes unreasonable results.	Use regression equations with caution when the percentage of clay is on either end of the allowable range. Use neighboring state regression equations (when appropriate) and StreamStats drainage basin parameter outputs for HEC-HMS calibration.
Rio Grande	HEC-HMS models were overestimating runoff for high-elevation basins. Difficult to model hydraulics in flat areas.	Modified HEC-HMS input parameters for high-elevation basins and calibrated to similar, nearby stream gage basins. Modeled hydrology/hydraulics for streams in the flat San Luis Valley using 2-D methodologies.

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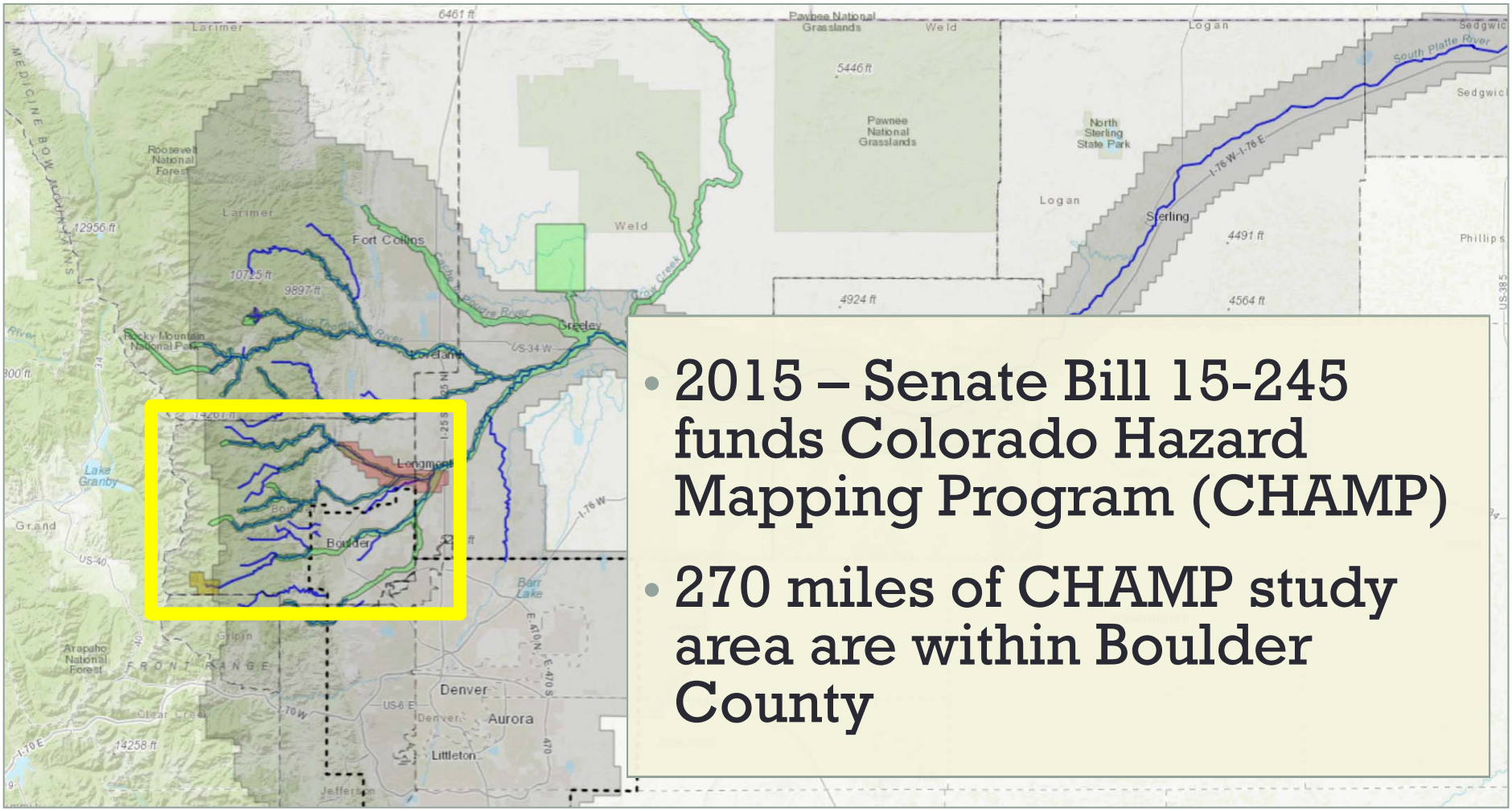
MAKING THE MOST OF IT: Leveraging The CHAMP Study For Other Uses

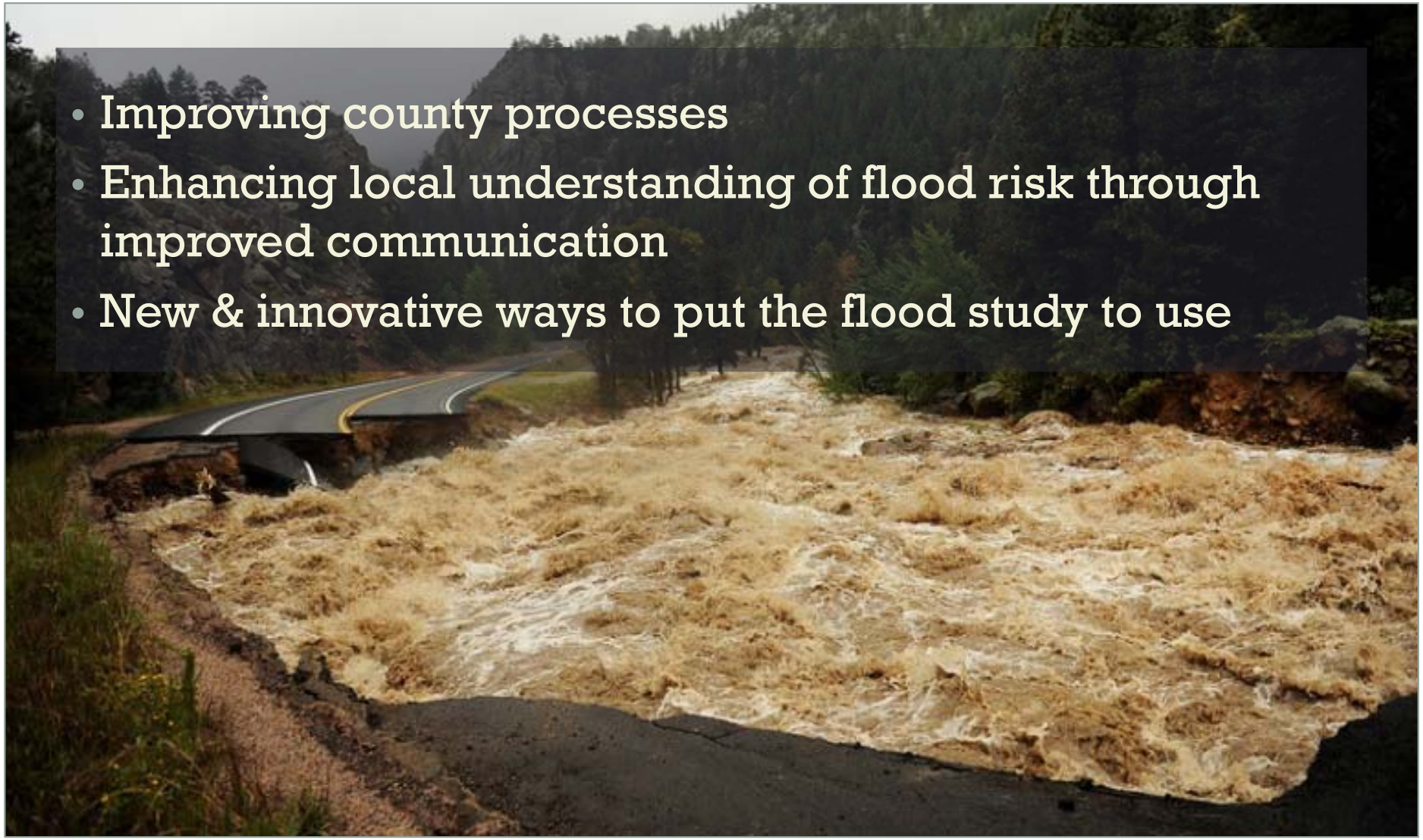
Erin Cooper, Boulder County
Olivia Cecil, Boulder County
Kevin Doyle, Michael Baker Intl.

CHAMP & Boulder County



- 2015 – Senate Bill 15-245 funds Colorado Hazard Mapping Program (CHAMP)
- 270 miles of CHAMP study area are within Boulder County

Benefits from CHAMP study



- Improving county processes
- Enhancing local understanding of flood risk through improved communication
- New & innovative ways to put the flood study to use

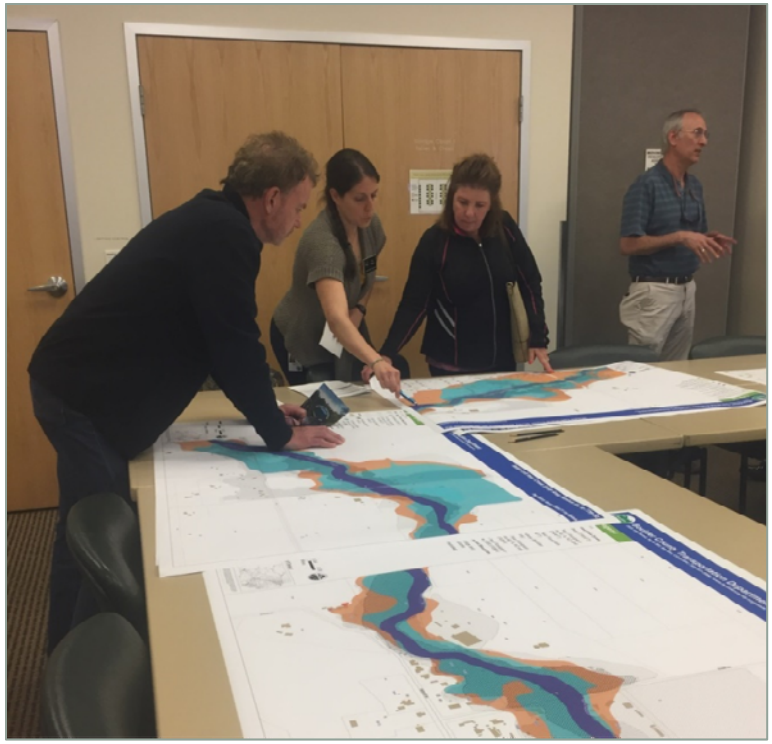
Putting CHAMP to Use

Some of the ways Boulder County has leveraged the CHAMP study:

1. Best Available Information
2. Planning & Permitting
3. FEMA CRS Credits
4. LiDAR LOMAs
5. Overtopping
   - Depth & Velocity Grids
   - Capacity
6. Evacuation Priorities

1. Best Available Information

Extensive outreach & early guidance on revised predictions for flood risk – powerful information to help property owners understand the coming changes



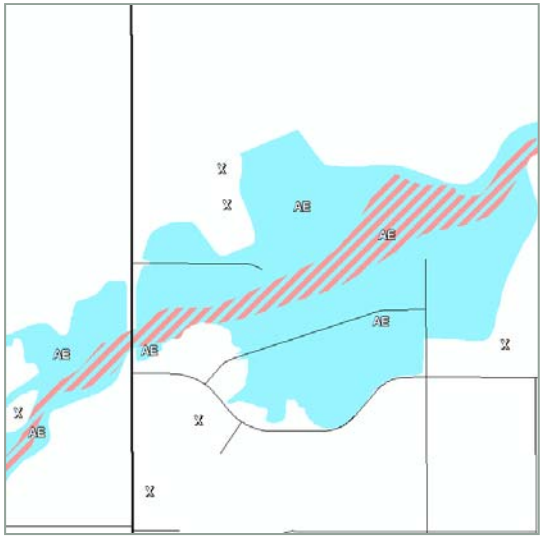
Boulder County "FO District" =

FEMA Floodplain + Boulder County Floodplain

1. Best Available Information

Floodplain maps now show
two flood studies as one regulatory tool

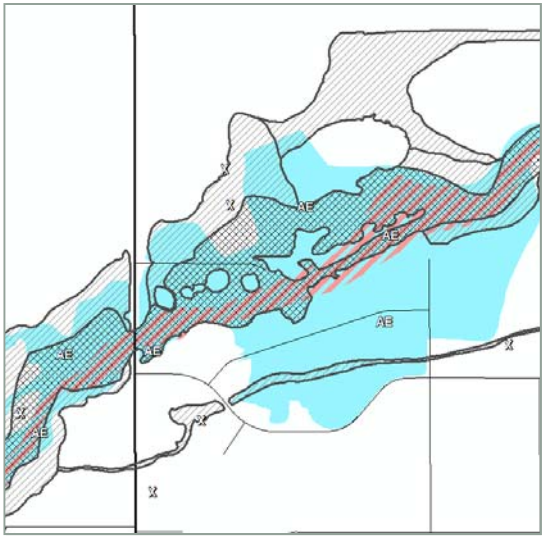
FEMA Regulatory Floodplain



FEMA Floodplain

FEMA Floodway

Boulder County Floodplain



CHAMP Floodplain

CHAMP Floodway

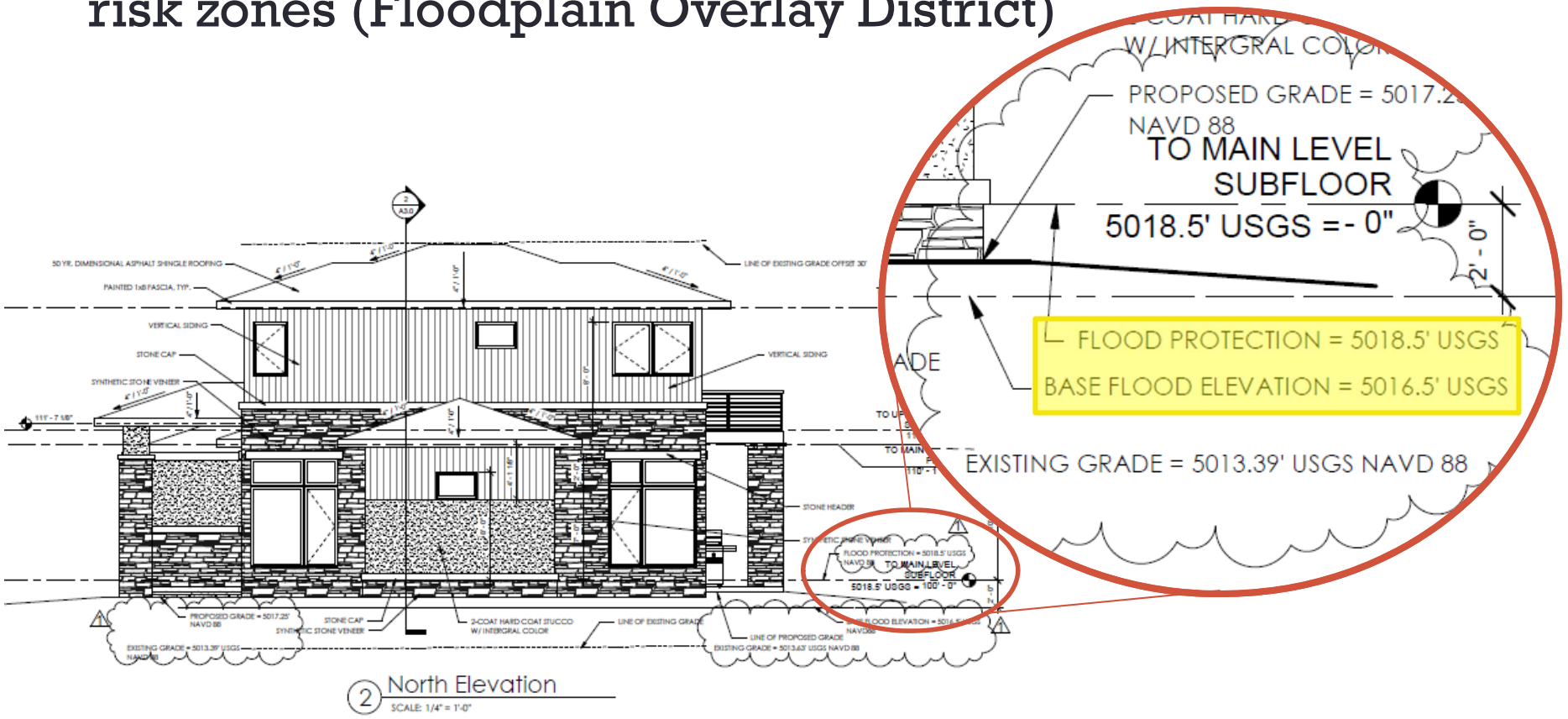
Floodplain Overlay District

Composite Floodplain

Composite Floodway

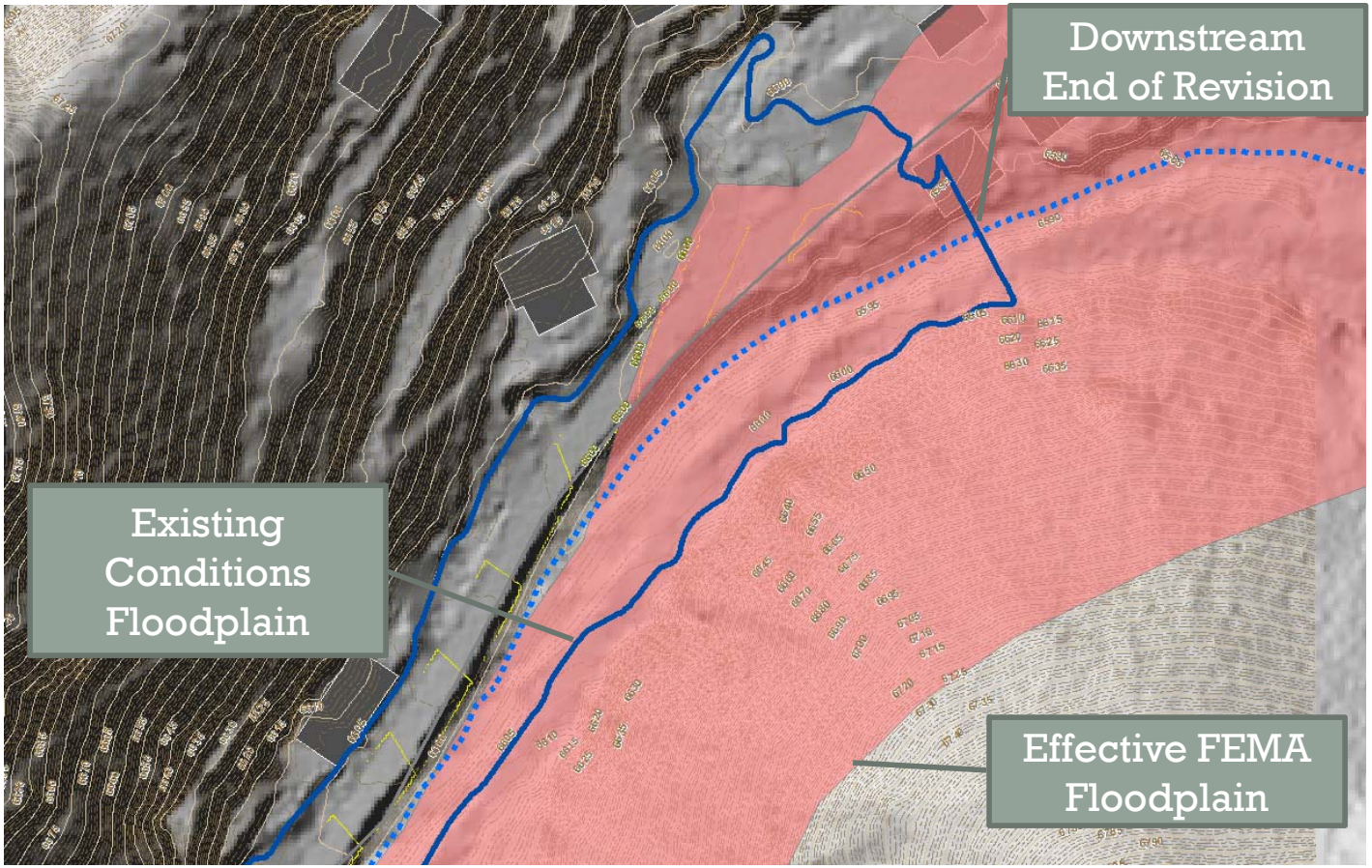
2. Permitting Decisions using BFEs

- New structures built above CHAMP BFE
- Permitting approved/denied based on CHAMP flood risk zones (Floodplain Overlay District)



2. Permitting Decisions – comparing to CHAMP vs. Effective

No-rise & CLOMR/LOMR analyses compared to CHAMP vs compared to effective



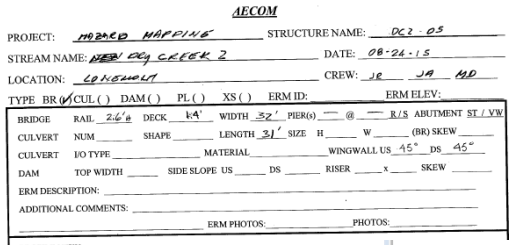
3. FEMA Community Rating System

- Credit for early regulation to the CHAMP study
  - New Study credit
  - Floodway Standard
- Community discounts on flood insurance premiums

410 FLOOD HAZARD MAPPING

The OBJECTIVE of this activity is to improve the quality of the mapping that is used to identify and regulate development at risk from flood hazards.

What else can we do with all this data


AECOM

PROJECT: MODIFIED MAPPING STRUCTURE NAME: DC2-05

STREAM NAME: NBB DCA CREEK 2 DATE: 08-24-15

LOCATION: LONGMONT CREW: JE JA MD

TYPE BR (X) CUL ( ) DAM ( ) PL ( ) XS ( ) ERM ID: ERM ELEV:

BRIDGE RAIL 2.6'8 DECK k4' WIDTH 32' PIER(S) — @ — R/S ABUTMENT ST / VW

CULVERT NUM — SHAPE — LENGTH 31' SIZE H — W — (BR) SKEW —

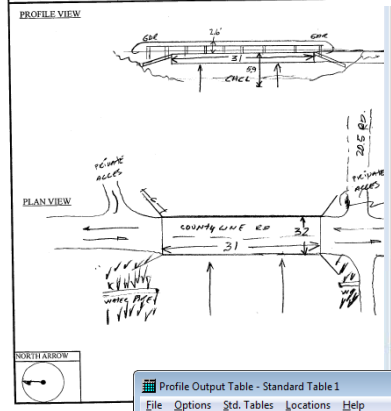
CULVERT I/O TYPE — MATERIAL — WINGWALL US 45° DS 45°

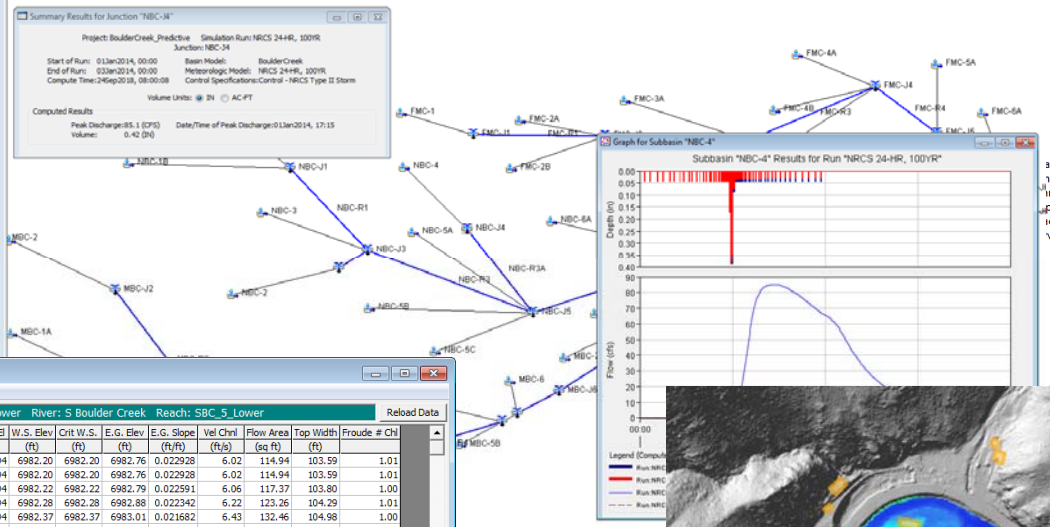
DAM TOP WIDTH — SIDE SLOPE US — DS — RISER — x — SKEW —

ERM DESCRIPTION:

ADDITIONAL COMMENTS:

ERM PHOTOS: PHOTOS:



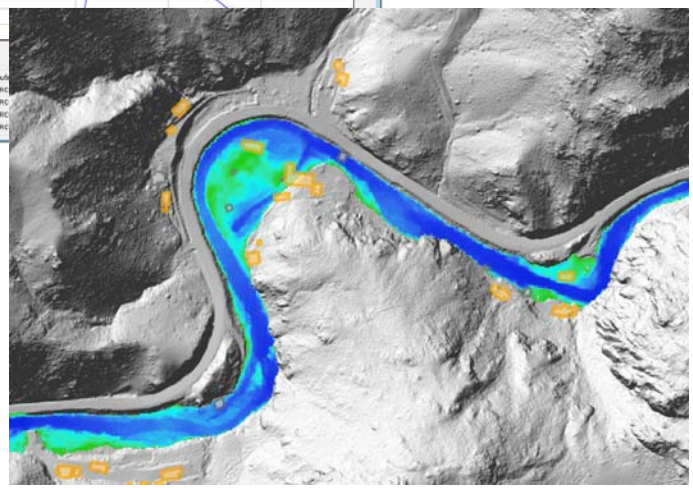


Profile Output Table - Standard Table 1

File Options Std. Tables Locations Help

HEC-RAS Plan: SBC_5_Lower River: S Boulder Creek Reach: SBC_5_Lower Reload Data

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
SBC_5_Lower	40550	10%	692.00	6980.94	6982.20	6982.20	6982.76	0.022928	6.02	114.94	103.59	1.01
SBC_5_Lower	40550	4%	692.00	6980.94	6982.20	6982.20	6982.76	0.022928	6.02	114.94	103.59	1.01
SBC_5_Lower	40550	2%	711.00	6980.94	6982.22	6982.22	6982.79	0.022591	6.06	117.37	103.80	1.00
SBC_5_Lower	40550	1%	767.00	6980.94	6982.28	6982.28	6982.88	0.022342	6.22	123.26	104.29	1.01
SBC_5_Lower	40550	1% PLUS	851.00	6980.94	6982.37	6982.37	6983.01	0.021682	6.43	132.46	104.98	1.00
SBC_5_Lower	40550	0.2%	1139.00	6980.94	6982.64	6982.64	6983.42	0.020189	7.07	161.77	107.14	1.00
SBC_5_Lower	40309	10%	692.00	6965.06	6968.83		6969.26	0.006336	5.23	132.24	55.09	0.60
SBC_5_Lower	40309	4%	692.00	6965.06	6968.83		6969.26	0.006336	5.23	132.24	55.09	0.60
SBC_5_Lower	40309	2%	711.00	6965.06	6968.87		6969.31	0.006359	5.29	134.29	55.28	0.60
SBC_5_Lower	40309	1%	767.00	6965.06	6968.98		6969.45	0.006380	5.46	140.44	55.84	0.60
SBC_5_Lower	40309	1% PLUS	851.00	6965.06	6969.13	6968.32	6969.64	0.006497	5.73	148.81	56.58	0.61
SBC_5_Lower	40309	0.2%	1139.00	6965.06	6969.62	6968.79	6970.27	0.006686	6.49	176.90	59.02	0.64
SBC_5_Lower	39979	10%	692.00	6963.17	6965.22	6965.22	6966.04	0.020185	7.25	95.40	58.77	1.00
SBC_5_Lower	39979	4%	692.00	6963.17	6965.22	6965.22	6966.04	0.020185	7.25	95.40	58.77	1.00
SBC_5_Lower	39979	2%	711.00	6963.17	6965.25	6965.25	6966.08	0.019997	7.31	97.24	58.92	1.00
SBC_5_Lower	39979	1%	767.00	6963.17	6965.33	6965.33	6966.21	0.019955	7.53	101.86	59.31	1.01
SBC_5_Lower	39979	1% PLUS	851.00	6963.17	6965.46	6965.46	6966.40	0.019103	7.75	109.96	59.98	1.00
SBC_5_Lower	39979	0.2%	1139.00	6963.17	6965.85	6965.85	6966.99	0.018105	8.57	133.82	61.69	1.00
SBC_5_Lower	39885	10%	692.00	6957.32	6959.99	6959.99	6961.04	0.019145	8.21	84.28	40.91	1.01
SBC_5_Lower	39885	4%	692.00	6957.32	6959.99	6959.99	6961.04	0.019145	8.21	84.28	40.91	1.01
SBC_5_Lower	39885	2%	711.00	6957.32	6960.04	6960.04	6961.10	0.018816	8.26	86.13	41.11	1.00
SBC_5_Lower	39885	1%	767.00	6957.32	6960.14	6960.14	6961.26	0.018658	8.49	90.40	41.53	1.01
SBC_5_Lower	39885	1% PLUS	851.00	6957.32	6960.30	6960.30	6961.50	0.018145	8.77	97.17	42.17	1.00
SBC_5_Lower	39885	0.2%	1139.00	6957.32	6960.81	6960.81	6962.26	0.016881	9.64	119.28	44.16	1.00

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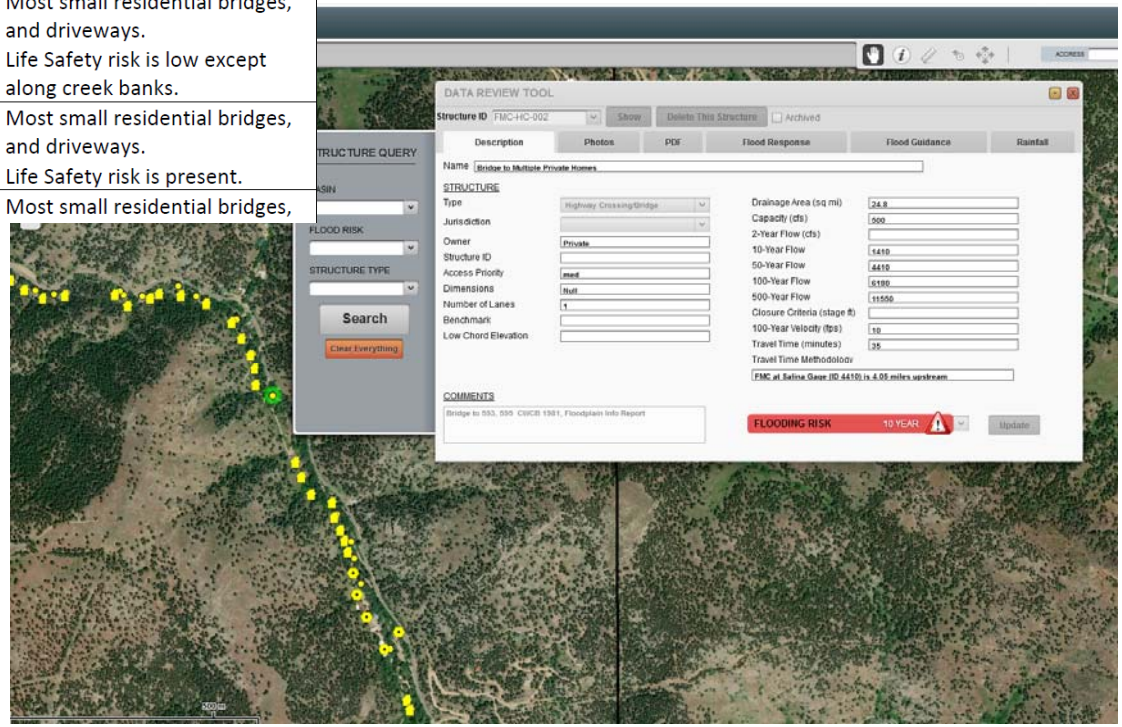
abase management technology make it possible to protect this
was possible in the past. The minimum requirement for
ind spatial datasets that are needed to implement the models.
pping.)</abstract>
ce elevations for floodplain mapping requires significant
vey data including cross-section and bridge surveys.</purpose>

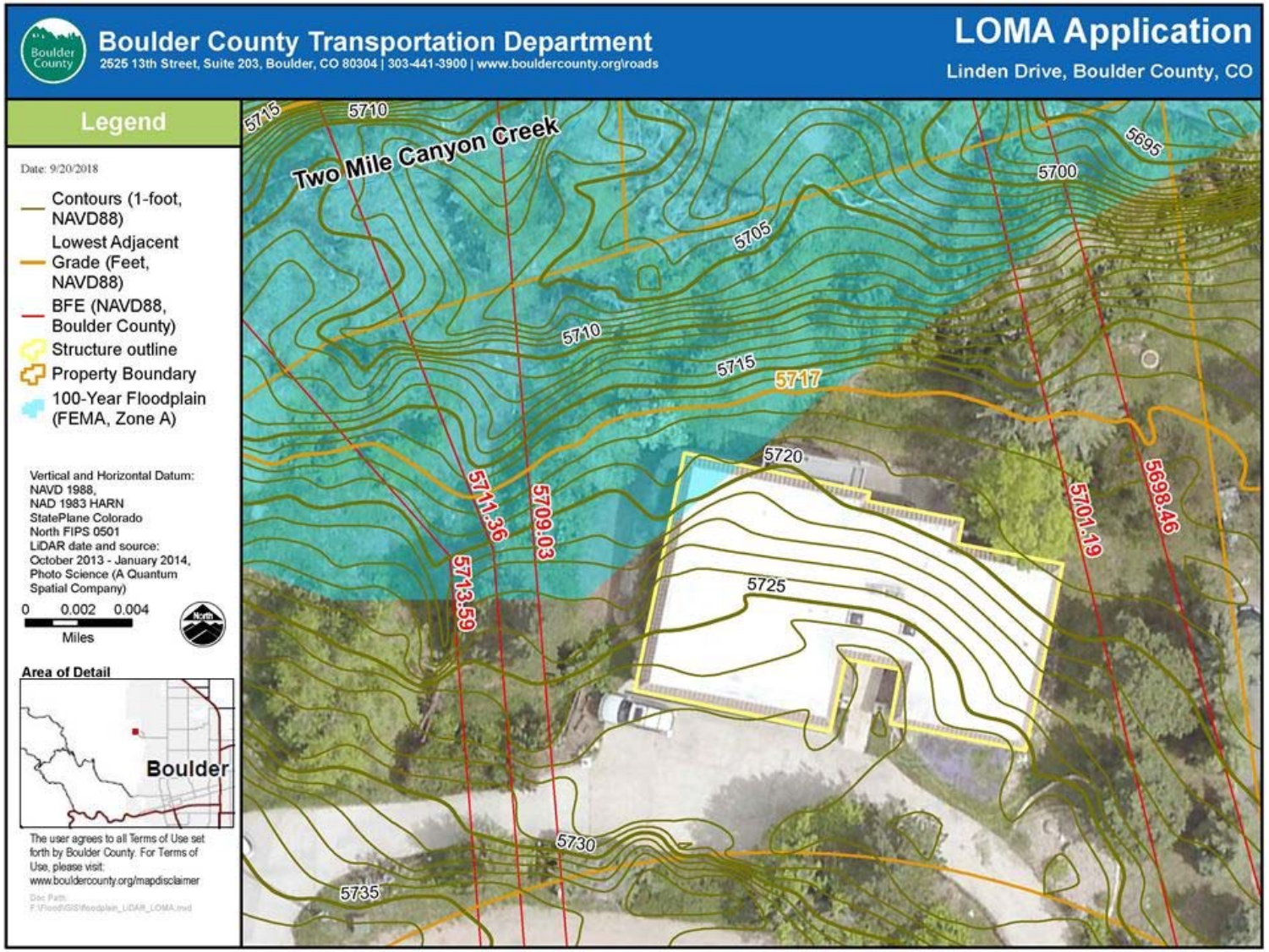
What other groups could use the data

Location	1-Hour Rainfall Threshold (inches)	Peak Flow Rate (cubic feet/ second)	Homes at Risk	Flood Affects Bridges & Roads Affected. Life Safety Risk
Fourmile Canyon Creek below burn area	3/4"	300 to 700	N/A	• Most small residential bridges, and driveways. • Life Safety risk is low except along creek banks.
Fourmile Canyon Creek below burn area	1"	600 to 1,000	N/A	• Most small residential bridges, and driveways. • Life Safety risk is low except along creek banks.
Fourmile Canyon Creek below burn area	1 ¼"	900 to 1,400	N/A	• Most small residential bridges, and driveways. • Life Safety risk is low except along creek banks.
Fourmile Canyon Creek below burn area	1½"	1,200 to 1,700	N/A	• Most small residential bridges, and driveways. • Life Safety risk is present.
Fourmile Canyon	1¾"	1,600	N/A	• Most small residential bridges,

- Floodplain Department
- OEM
- Transportation
- Land Use Planning
- Public Health



4. LiDAR LOMAs



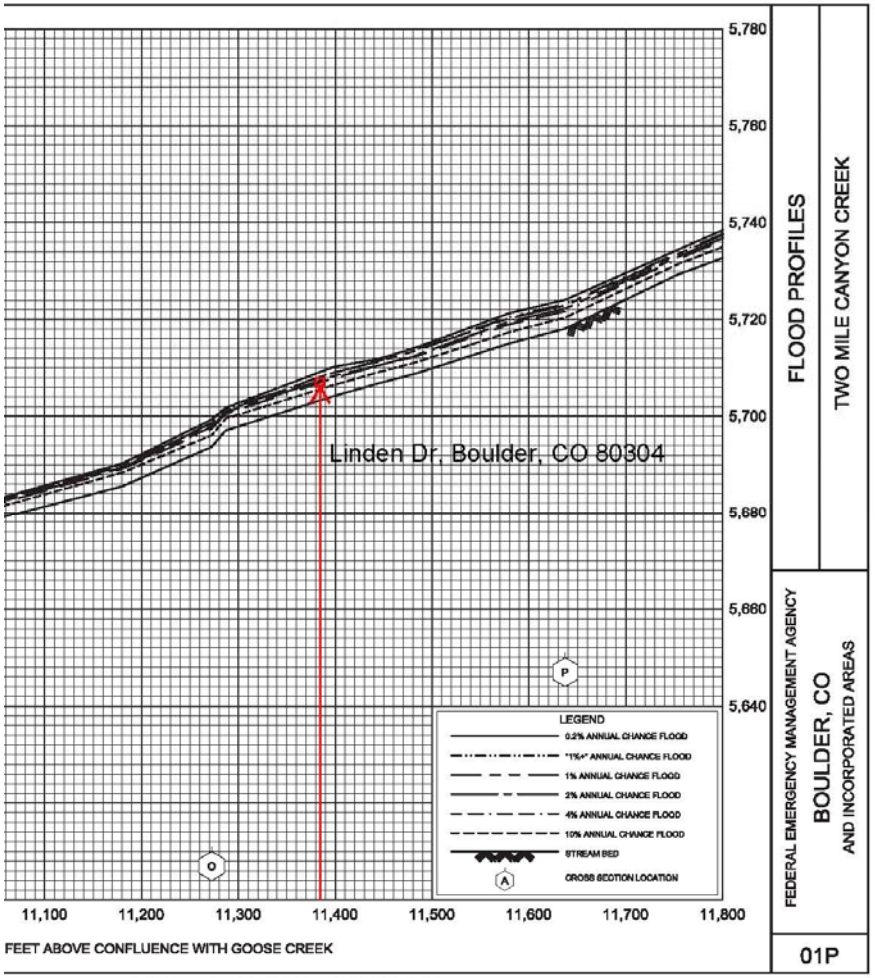
4. LiDAR LOMAs

Boulder County Successes:

- 10+ LiDAR LOMAs approved for residents
- Residents are eligible for a flood insurance reimbursement

Data included in LOMA submittal:

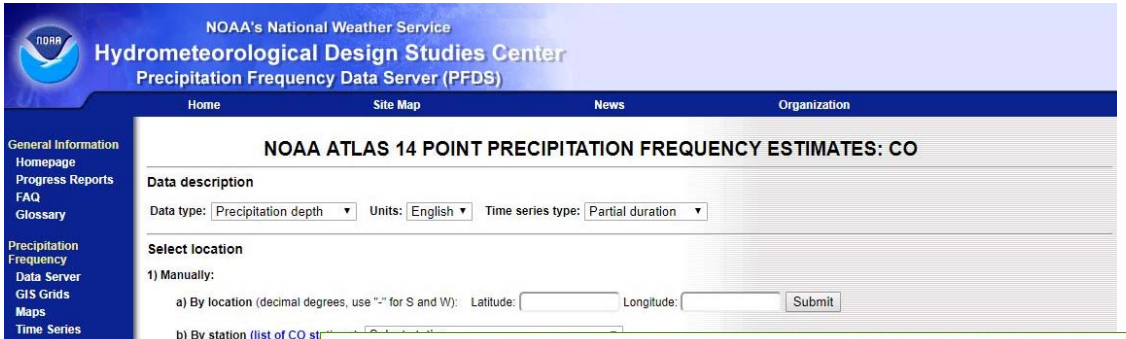
- Annotated FIRM, FIRMette
- CHAMP FIS profile with BFE shown
- LiDAR Final Accuracy Report
- Topographic Map
- Subdivision Plat Map
- CHAMP Phase I data for reach
- Memo to FEMA from Boulder County

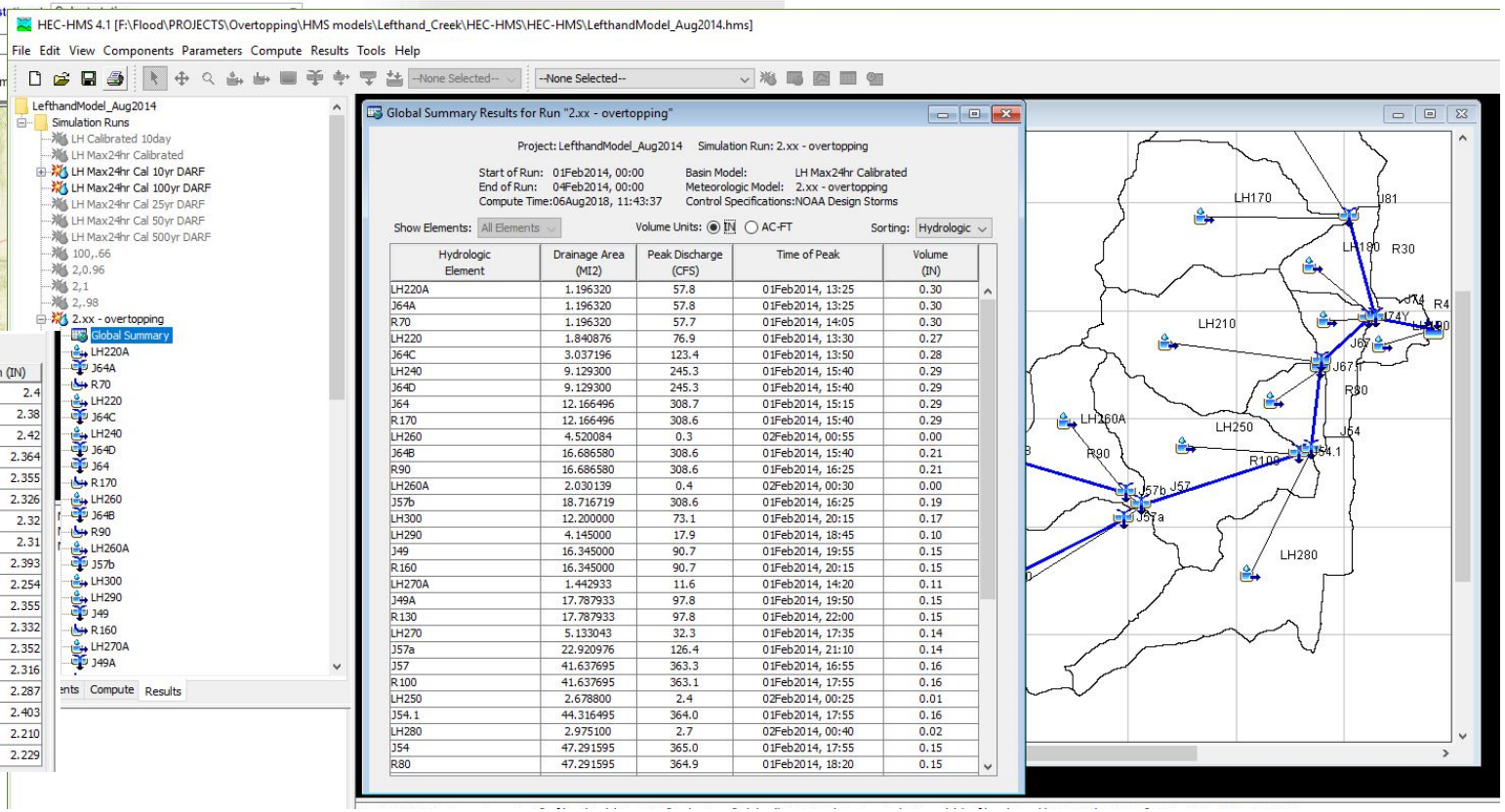


BFE = 5707.0 feet NAVD88
11,385 feet above confluence

5 & 6. Overtopping and Evacuation

Lower Recurrence Intervals added to HMS models



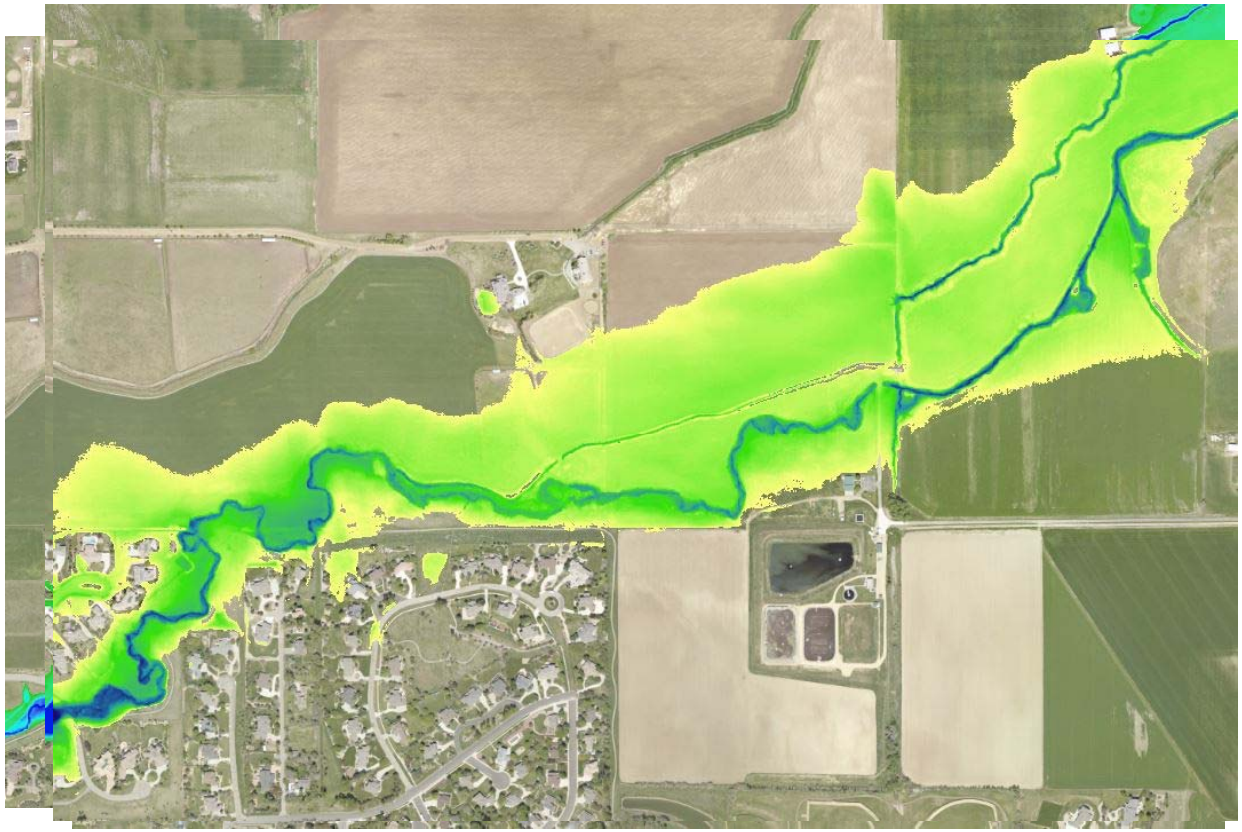


Met Name: 5.xx - overtopping

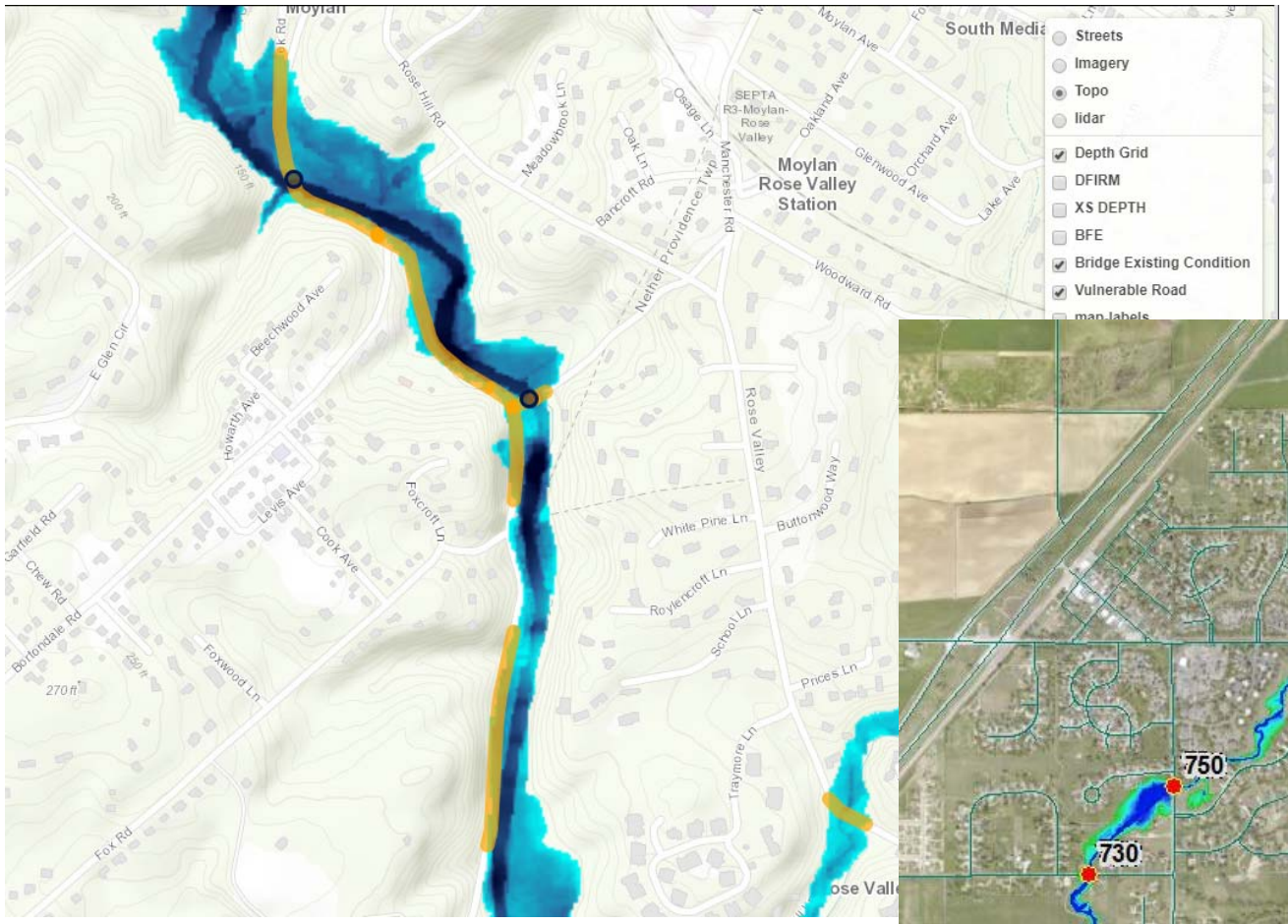
Subbasin Name	Gage	Total Depth (IN)
LH160	SCS Type 2 Dist	2.4
LH170	SCS Type 2 Dist	2.38
LH180	SCS Type 2 Dist	2.42
LH190	SCS Type 2 Dist	2.364
LH200	SCS Type 2 Dist	2.355
LH210	SCS Type 2 Dist	2.326
LH220	SCS Type 2 Dist	2.32
LH220A	SCS Type 2 Dist	2.31
LH230	SCS Type 2 Dist	2.393
LH240	SCS Type 2 Dist	2.254
LH250	SCS Type 2 Dist	2.355
LH260	SCS Type 2 Dist	2.332
LH260A	SCS Type 2 Dist	2.352
LH270	SCS Type 2 Dist	2.316
LH270A	SCS Type 2 Dist	2.287
LH280	SCS Type 2 Dist	2.403
LH290	SCS Type 2 Dist	2.210
LH300	SCS Type 2 Dist	2.229

5 & 6. Overtopping and Evacuation

Additional Products
created with existing 10,
25, and 50 year flow data



5 & 6. Overtopping and Evacuation



Vulnerable Roads & Bridge Spatial Files

Bridge Capacity Spatial Files

Closing

- Applying CHAMP data and products to the benefit of existing County processes, plans, and programs.
- Developing new ways to put flood study data to work to benefit the County & residents and build Resilience.
- "Standing on the Shoulders of Giants"

Thank you!

Boulder County

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Michael Baker International

Kevin Doyle, PE
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