LiDAR FOA vs. IfSAR FOA: A Case Study for Base Level Engineering (formerly First Order Approximation)

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ASFPM 2016 Annual Conference "GREAT LAKES – GREAT PARTNERS" Grand Rapids, Michigan , June 18–24

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ASFPM 2016 Annual Conference June 19-24 – Grand Rapids GREAT LAKES – GRAND PARTNERS

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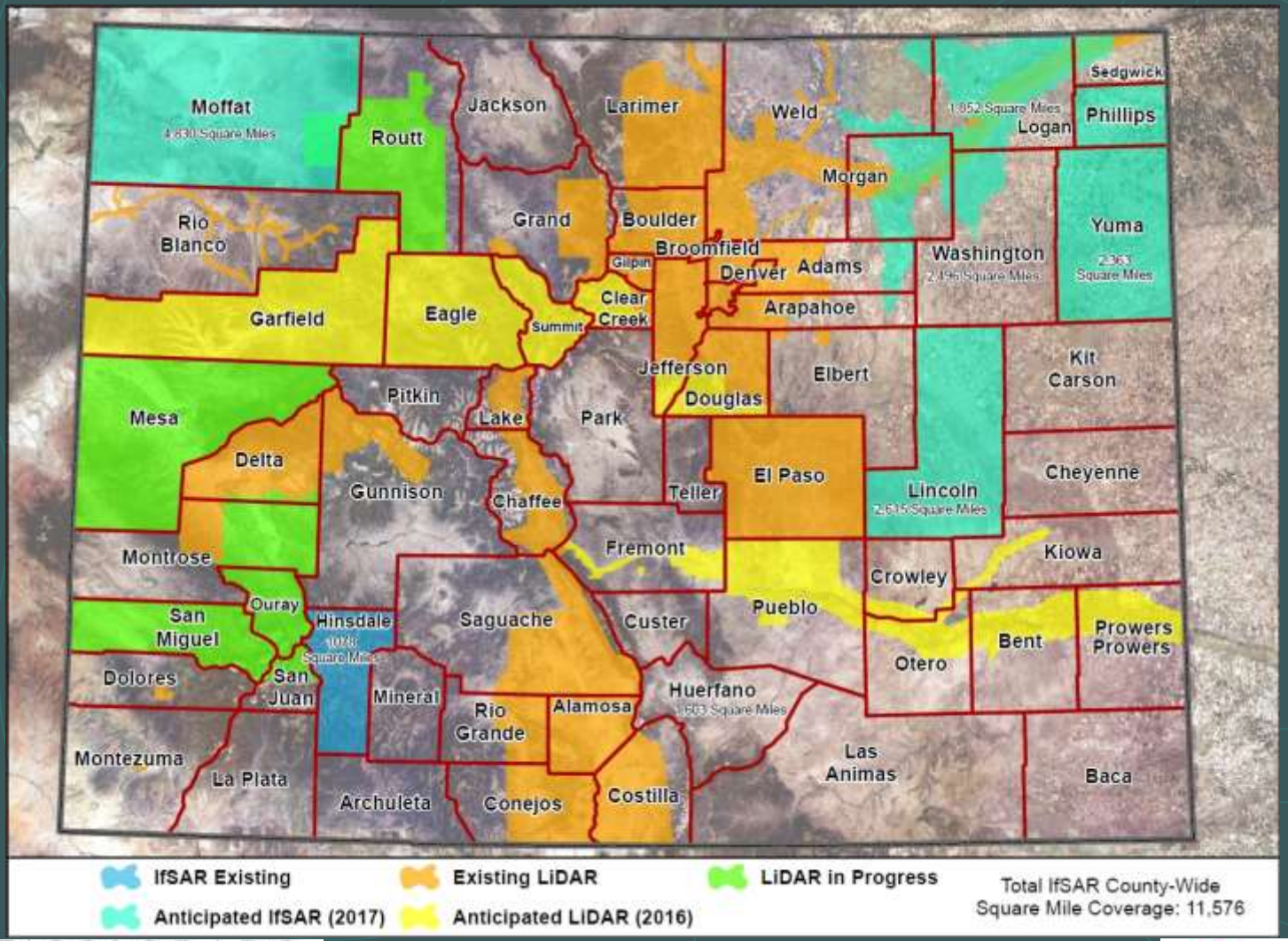
Agenda

- Background
  - Topo availability
  - NVUE Status for Colorado
  - Hazard Mapping Program
  - IFSAR vs. LiDAR
- Project Overview
  - Scope of Work
  - AMEC FOA Tool
  - Validation Process
  - FEMA Guides and Standards
- Results/Summary
- Challenges

Topo Availability



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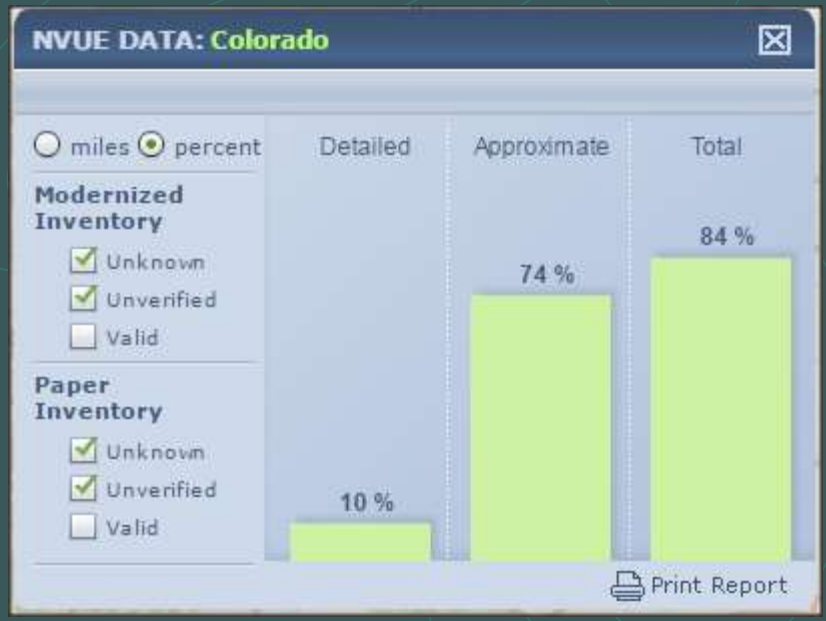
NVUE/CNMS Summary for Colorado

National NVUE Attained Summary Table: FY16 - Q2
by State

State	Region	Within Full Inventory		
		VALID Miles *Total Inventory*	Full Inventory Denominator Miles *As of 3/31/2016*	NVUE % Attained *Total Inventory*
New Mexico	06	6,725	22,430	30.0%
Oklahoma	06	13,428	38,103	35.2%
Texas	06	18,298	116,938	15.6%
Iowa	07	21,548	42,789	50.4%
Kansas	07	14,453	51,358	28.1%
Missouri	07	31,570	53,513	59.0%
Nebraska	07	11,261	47,285	23.8%
Colorado	08	2,357	14,611	16.1%
Montana	08	1,177	11,850	9.9%
North Dakota	08	3,150	6,754	46.6%
South Dakota	08	2,328	13,044	17.9%
Utah	08	1,104	6,635	16.6%
Wyoming	08	1,301	11,049	11.8%
American Samoa	09	1	4	19.3%
Arizona	09	14,848	23,947	62.0%
California	09	13,113	29,344	44.7%
Guam	09	59	84	69.7%
Hawaii	09	355	519	68.3%
N. Marianas Islands	09	0	0	0.0%
Nevada	09	7,422	8,262	89.8%
Alaska	10	175	1,387	12.6%
Idaho	10	204	11,831	1.7%



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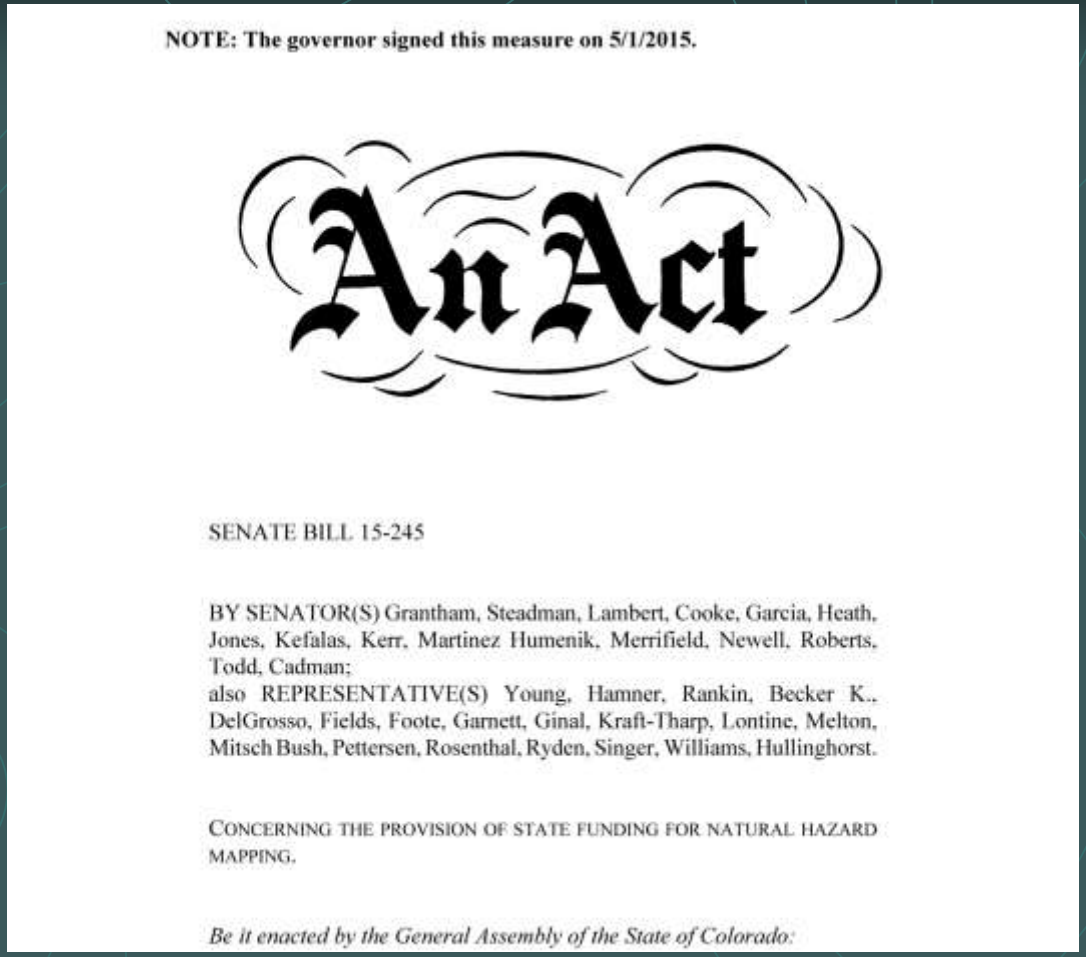
- Includes funding to map unmodernized counties in Colorado



NOTE: The governor signed this measure on 5/1/2015.

An Act

SENATE BILL 15-245

BY SENATOR(S) Grantham, Steadman, Lambert, Cooke, Garcia, Heath, Jones, Kefalas, Kerr, Martinez Humenik, Merrifield, Newell, Roberts, Todd, Cadman;
also REPRESENTATIVE(S) Young, Hamner, Rankin, Becker K., DelGrosso, Fields, Foote, Garnett, Ginal, Kraft-Tharp, Lontine, Melton, Mitsch Bush, Pettersen, Rosenthal, Ryden, Singer, Williams, Hullinghorst.

CONCERNING THE PROVISION OF STATE FUNDING FOR NATURAL HAZARD MAPPING.

Be it enacted by the General Assembly of the State of Colorado:

Colorado Hazard Mapping Program

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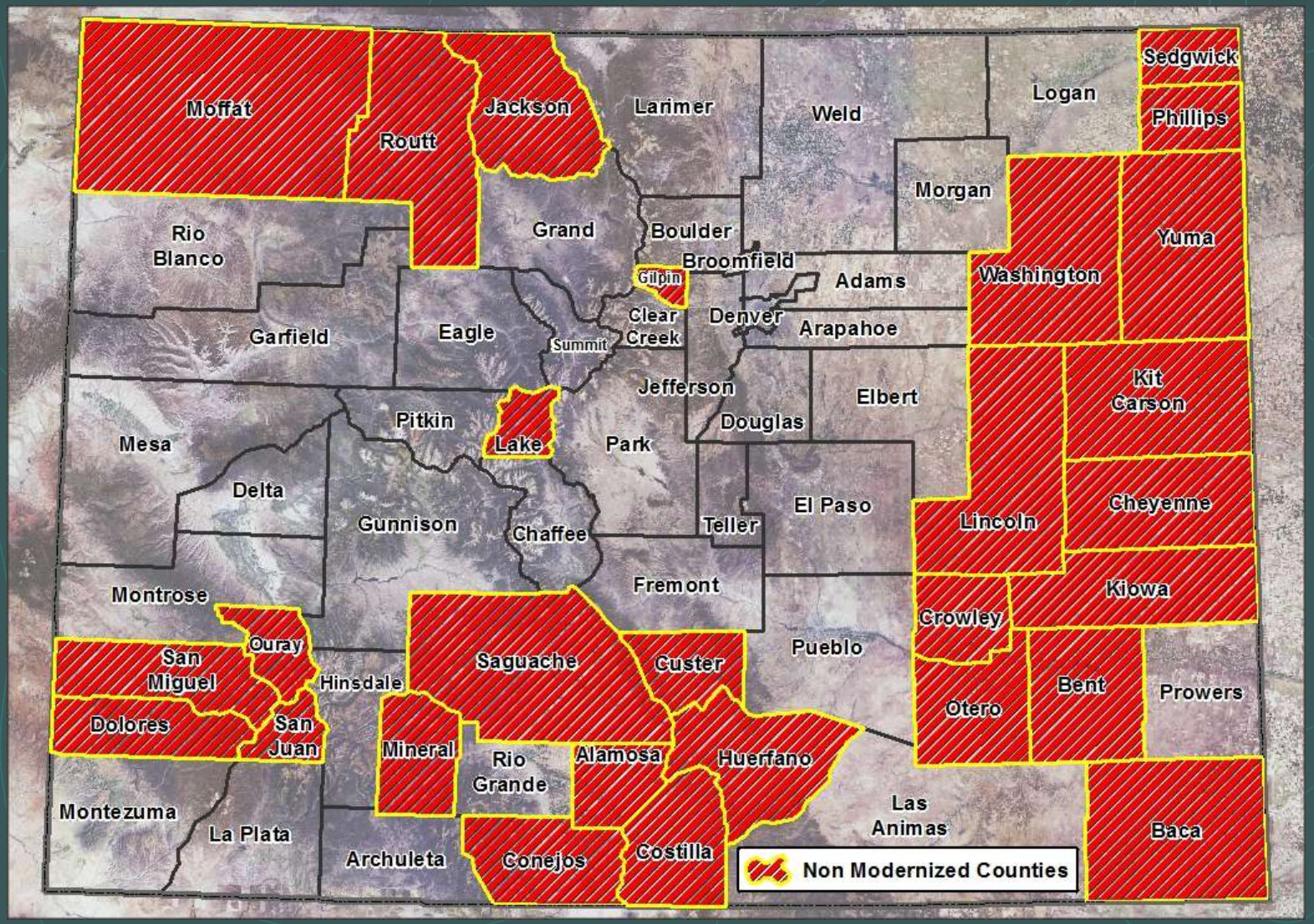

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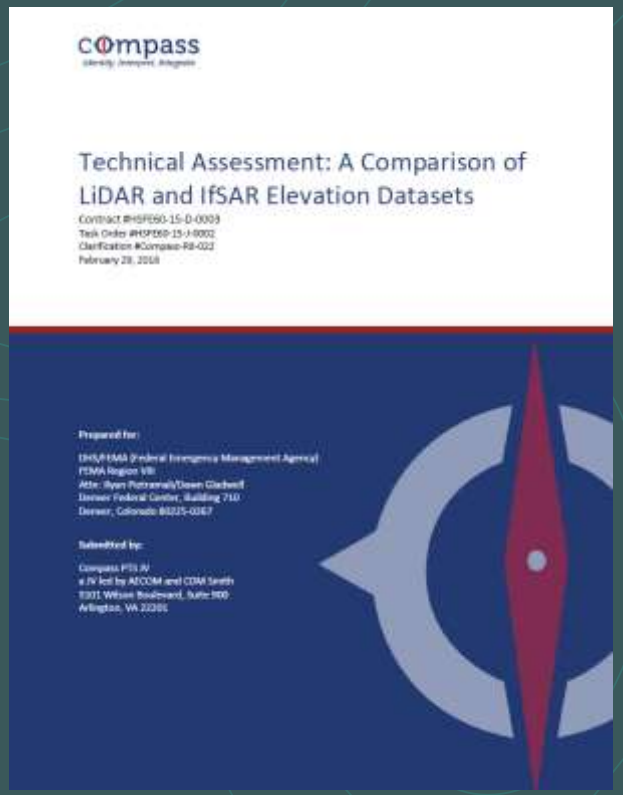
Quality Level

Elevation Quality Levels (QL)	Source	Horizontal Resolution Terms			Vertical Accuracy Terms	
		Point Density	Nominal Pulse Spacing (NPS)	DEM Post Spacing	Vertical RMSEz	Equivalent Contour Accuracy
QL 1	LiDAR	8 pts/m^2	0.35 m	1/27 arc-sec ~1 meter	9.25 cm	1-ft
QL 2	LiDAR	2 pts/m^2	0.7 m	1/27 arc-sec ~1 meter	9.25 cm	1-ft
QL 3	LiDAR	1 – 0.25 pts/m^2	1 – 2 m	1/9 arc-sec ~3 meters	≤18.5 cm	2-ft
QL 4	Imagery	0.04 pts/m^2	5 m	1/3 arc-sec ~10 meters	46.3 cm – 139 cm	5 – 15 ft
QL 5	IFSAR	0.04 pts/m^2	5 m	1/3 arc-sec ~10 meters	92.7 cm – 185 cm	10 – 20 ft

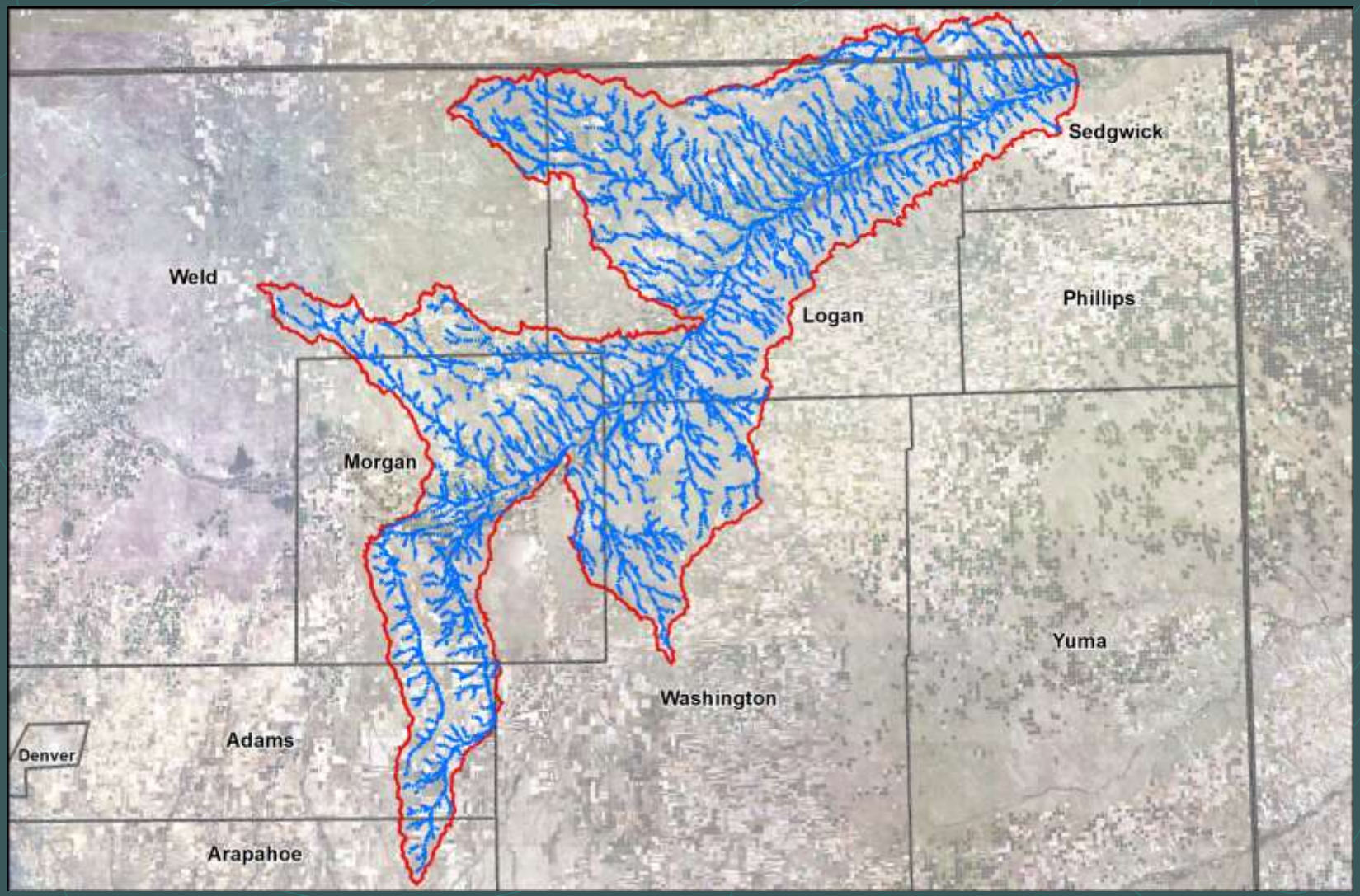
The five pre-defined topographic Quality Levels (QLs), NEEA Final Report 3.29.12

IfSAR and LiDAR Technical Assessment (Region VIII)

- 2015 South Dakota Pilot Study
- Validate quality of IfSAR within Region 8
- Conclusions:
  - Requires survey QC checkpoints for regulatory studies
  - No mention of specific requirements for FOA analysis



Scope of Work



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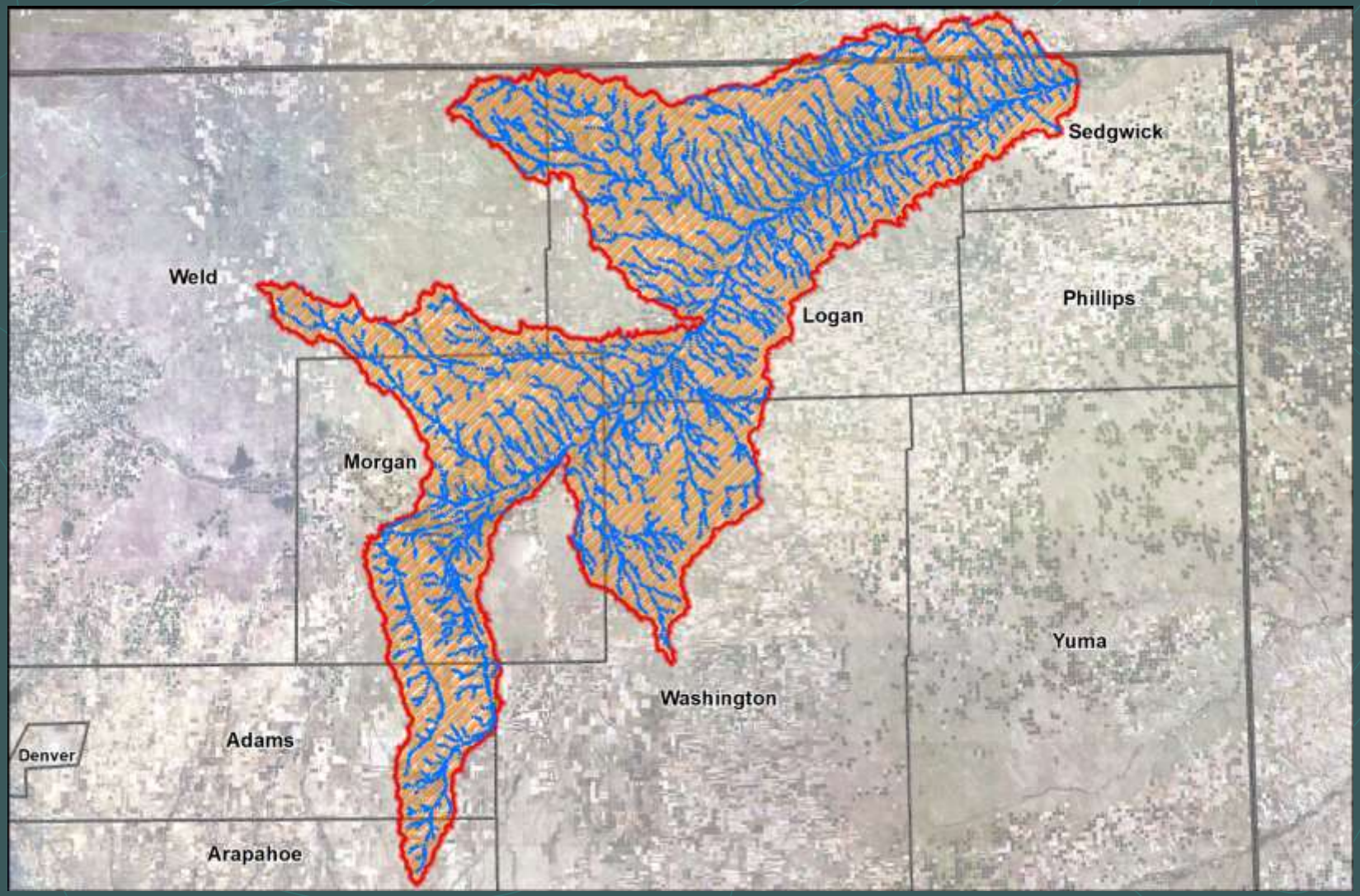
Scope of Work



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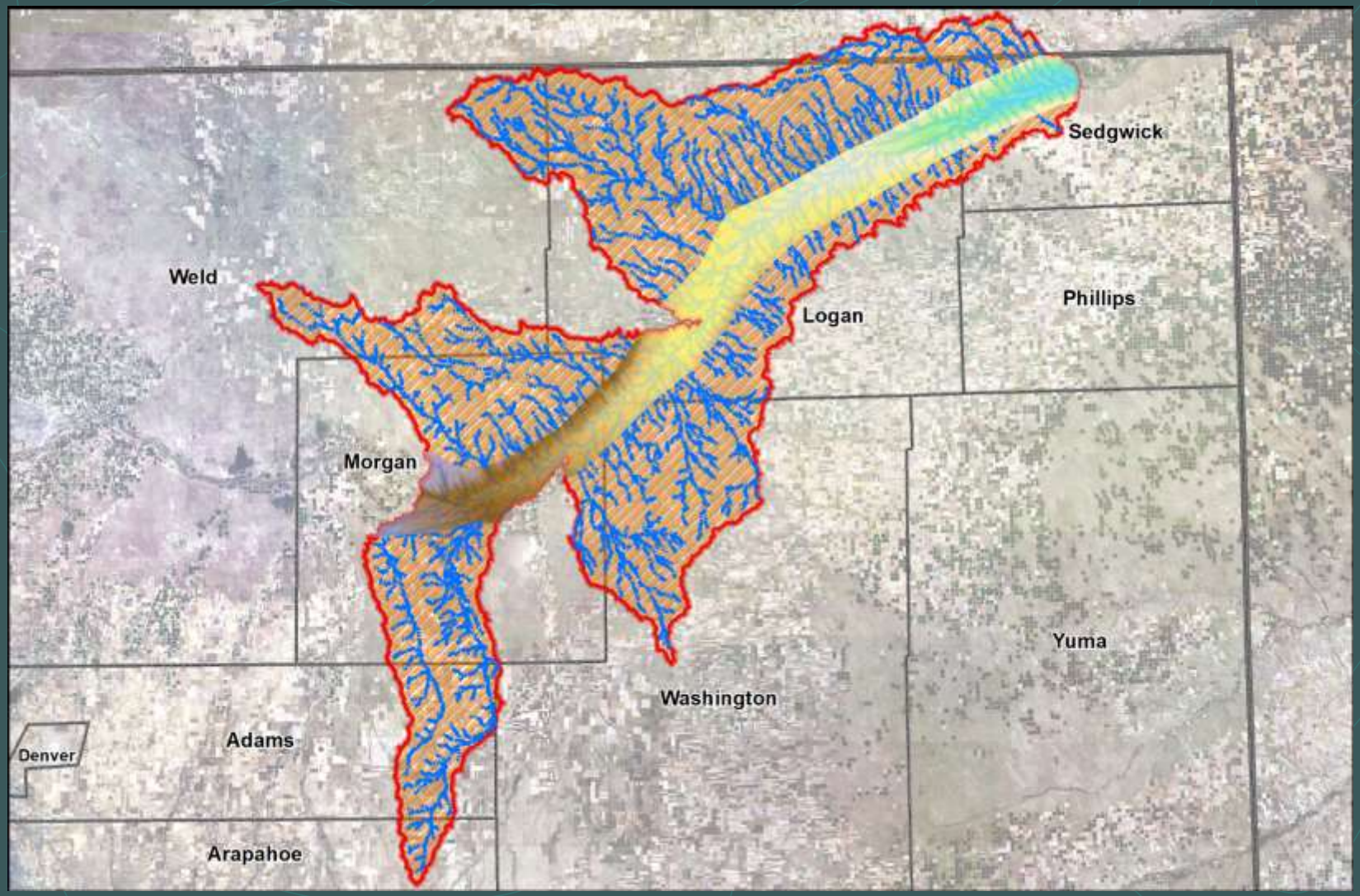

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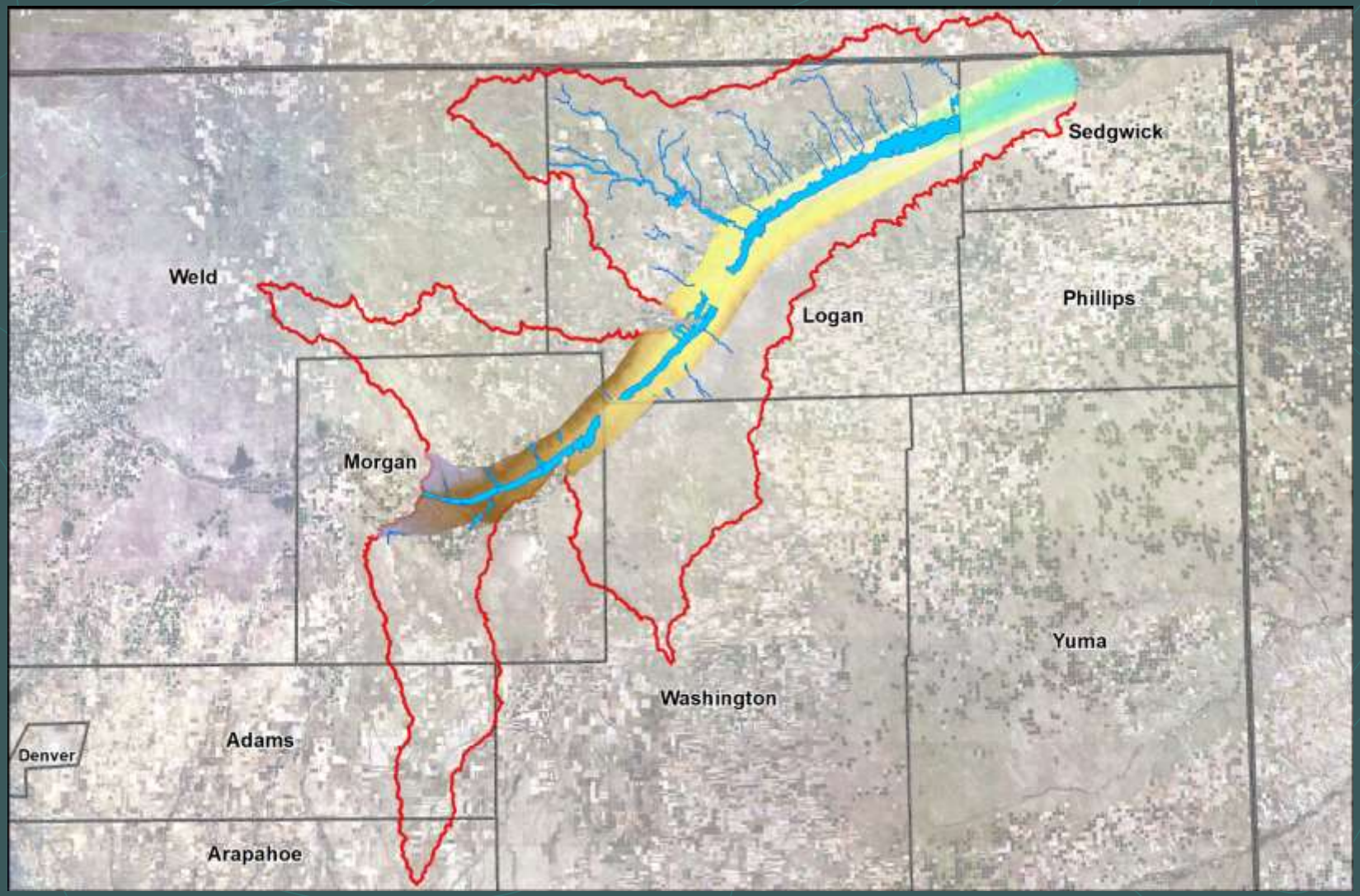

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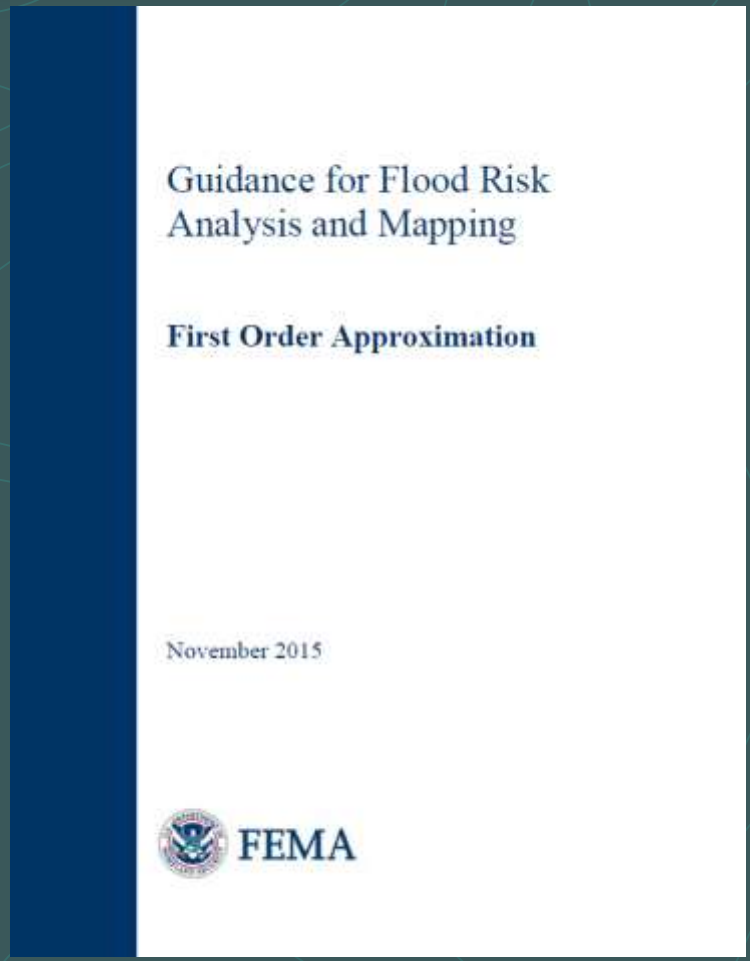
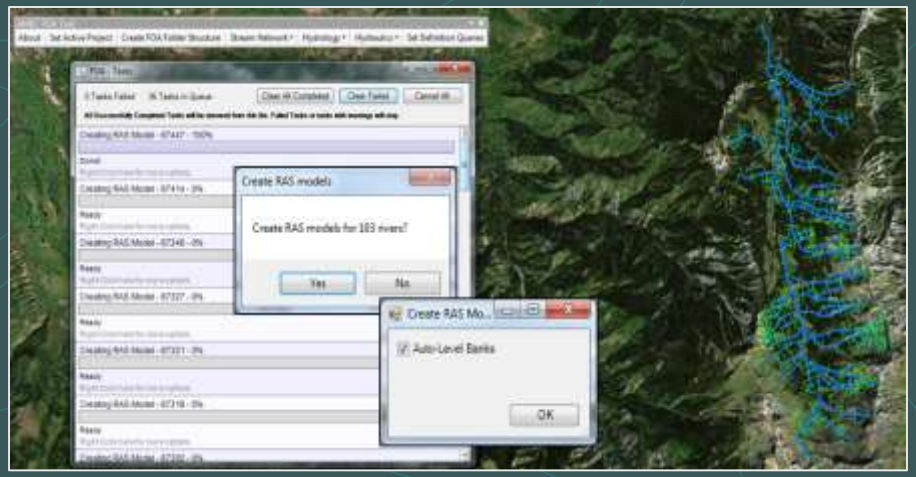
First Order Approximates

"a cost-effective approach for evaluating Zone A studies has been needed to address Zone A study miles in the CNMS inventory that are currently "unknown" or that are approaching their 5-year expiration and require revalidation. Assessing and evaluating these miles places increased demands on the Regions in a resourceconstrained environment.

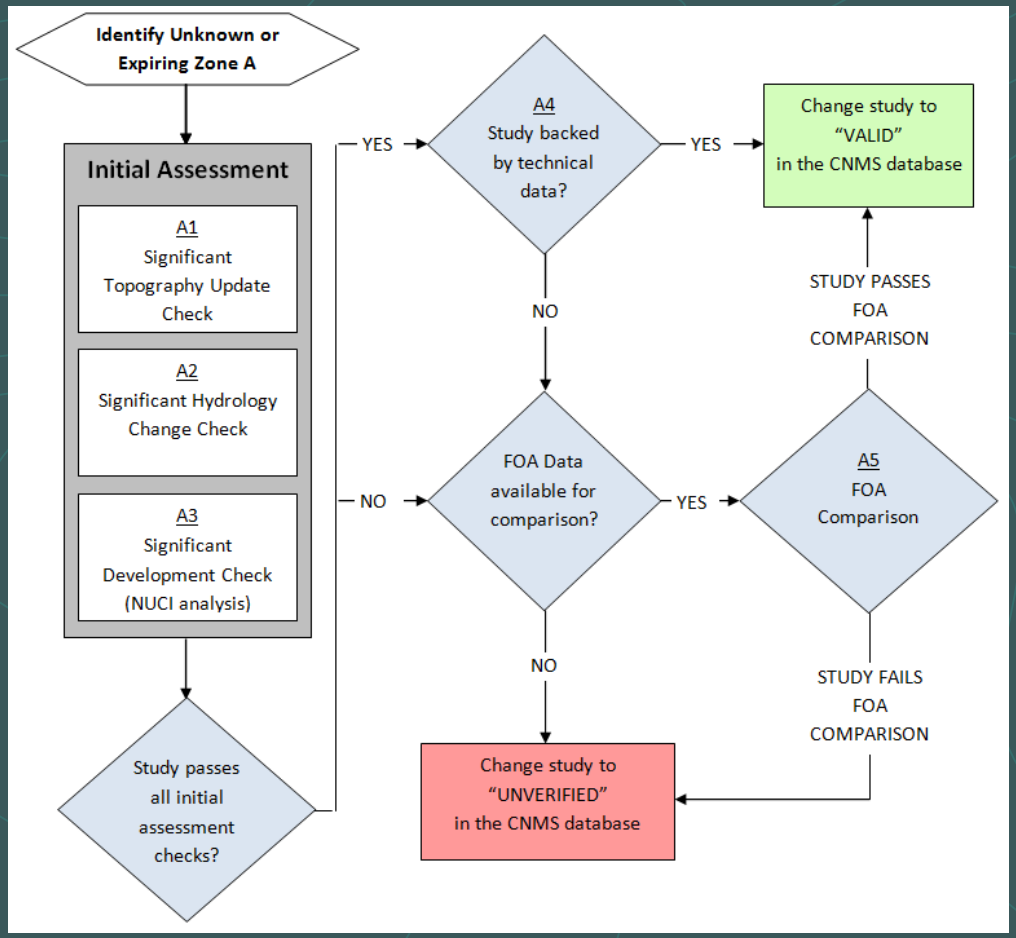


Amec Foster Wheeler FOA Tool

- ESRI add-in
- Automated Tool
  - Estimated Parameters
    - Cross Section Spacing
    - Cross Section Width
    - Bank Widths
    - Flow Path Buffer
    - Manning's N
- HEC-RAS Engineering Judgement Upfront and QC



Validation Process



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Validation Process

- Comparison of FOA and Effective Zone A
  - Data Inputs
    - 100 Year +
    - 100 Year –
    - Effective Zone A Boundary
    - FOA topographic data
    - Vertical Tolerance – ½ contour interval of effective topographic data
    - Horizontal Tolerance – 75 feet

Validation Process

- FBS analysis of 100-Year + and 100-Year -

Risk Class	Characteristics	Floodplain Delineation Reliability[1]: Zone A	Floodplain Delineation Reliability[1]: All Other Zones
A	High population and densities within the floodplain and/or high anticipated growth	+/- 1/2 contour 95%	+/- 1.0 foot / 95%
B	Medium population and densities within the floodplain and/or modest anticipated growth	+/- 1/2 contour 90%	+/- 1.0 foot / 90%
C	Low population and densities within the floodplain, small or no anticipated growth	+/- 1/2 contour 85%	+/- 1.0 foot / 85%
D	Undetermined risk; likely subject to flooding	N/A	N/A
E	Minimal risk of flooding; area not studied	N/A	N/A

Results/Summary

Length (mi)	Stream Name	Number of Pts	IfSAR %Pass (5 ft V.T)	LiDAR % Pass (5 ft V.T)
5.45	Wildcat Creek	112	62.5%	75.0%
10.80	South Platte River	448	89.7%	99.6%
9.03	South Platte River	243	97.5%	100.0%
8.87	South Platte River	305	94.8%	98.0%
13.52	South Platte River	457	71.1%	73.7%
7.52	South Platte River	291	87.6%	94.5%
0.78	South Platte River	38	84.2%	78.9%
2.51	South Platte River	89	89.9%	93.3%
7.86	South Platte River	218	84.4%	78.4%
8.56	South Platte River	254	71.7%	82.7%
4.83	South Platte River	152	82.9%	77.0%
1.83	South Platte River	59	83.1%	91.5%
2.07	South Platte River	66	72.7%	77.3%
1.65	Dead Horse Draw	58	62.1%	55.2%
1.80	Cris Lee Draw	44	77.3%	81.8%
2.27	Cris Lee Draw	29	75.9%	75.9%
0.61	Antelope Draw	38	86.8%	92.1%
3.21		39	94.9%	100.0%
3.26		56	100.0%	100.0%
2.10		46	100.0%	100.0%
5.96		115	87.8%	84.3%
0.39		8	37.5%	75.0%

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Results/Summary

	IfSAR (5 foot V.T.)	LiDAR (5 foot V.T.)
% Valid Streams >=85% (Risk Class C)	52.1%	52.1%
Total Valid Miles	77.5	74.3
Total Invalid Miles	59.8	61.6

Results/Summary

Length (mi)	Stream Name	Number of Pts	IfSAR % Pass (2ft V.T.)	IfSAR % Pass (5ft V.T.)	IfSAR % Pass (10ft V.T.)	LiDAR % Pass (2ft V.T.)	LiDAR % Pass (5ft V.T.)	LiDAR % Pass (10ft V.T.)
5.45	Wildcat Creek	112	30.4%	62.5%	97.3%	39.3%	75.0%	98.2%
10.80	South Platte River	448	67.9%	89.7%	100.0%	60.9%	99.6%	100.0%
9.03	South Platte River	243	44.0%	97.5%	100.0%	59.7%	100.0%	100.0%
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2.51	South Platte River	89	52.8%	89.9%	96.6%	41.6%	93.3%	100.0%
7.86	South Platte River	218	39.4%	84.4%	91.3%	38.1%	78.4%	95.9%
8.56	South Platte River	254	38.2%	71.7%	96.9%	53.5%	82.7%	98.4%
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3.26		56	83.9%	100.0%	100.0%	80.4%	100.0%	100.0%
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0.39		8	25.0%	37.5%	100.0%	0.0%	75.0%	100.0%

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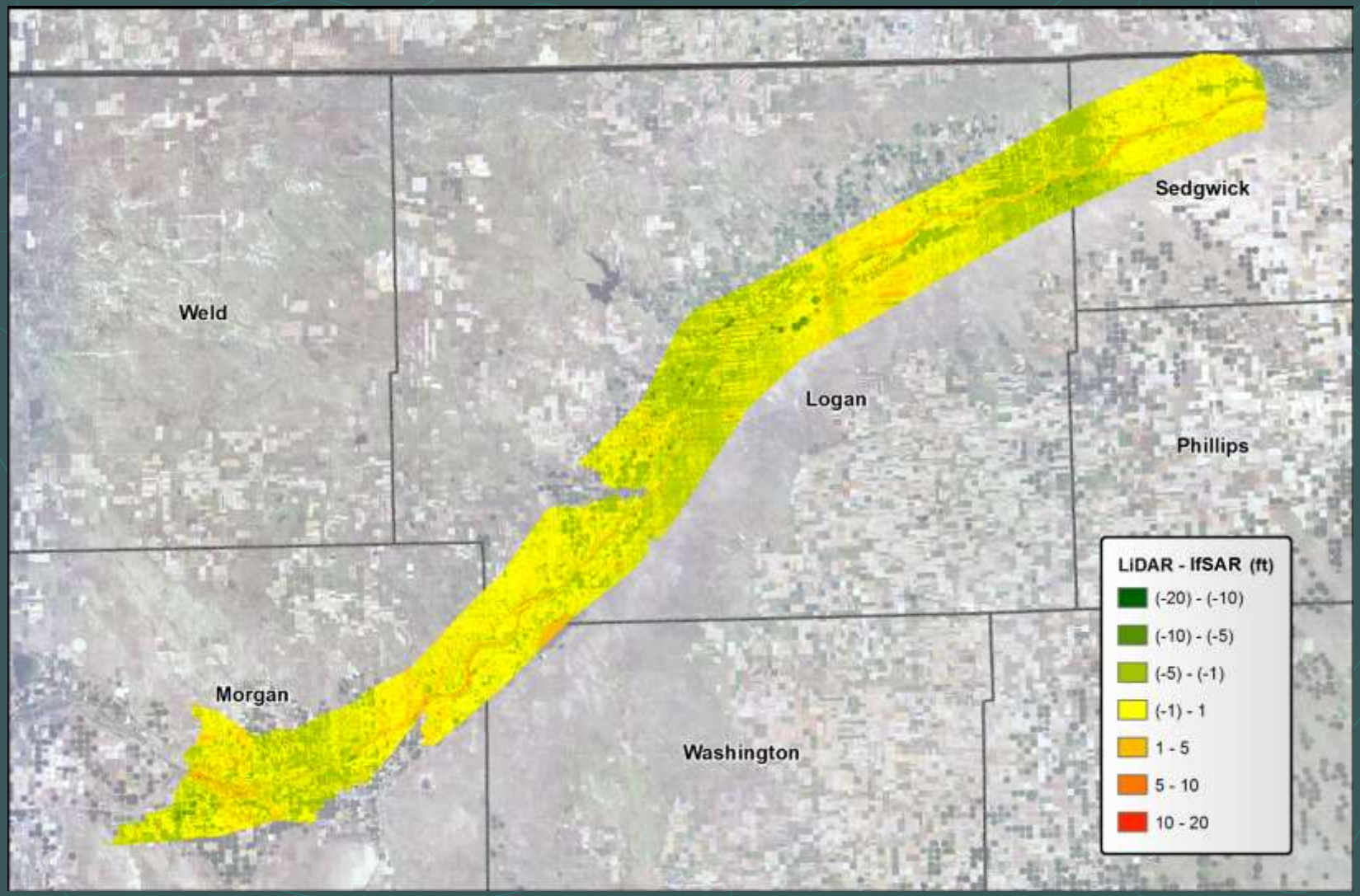
Elevation Difference Analysis



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Challenges/Takeaway

- LiDAR cost/Availability
- IfSAR vertical accuracy requirements
- LiDAR Batch Processing for large FOA areas
- Lower resolution with the IfSAR resulting in more engineering QC time
- **Validation Gap between unverified/unknown historic Zone A's and modernized Zone A's**

Questions or Comments?