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Bringing Historical Imagery Datasets to the Digital Age

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www.AyresAssociates.com

Quick History of Aerial Photography

As early as the mid-1800s, imagery was being collected from kites and air balloons

In the early 1900s and during World War I we saw:

- Reconnaissance
- Start of the military's development of aerial cameras and mounts in aircraft

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Quick History of Aerial Photography

WE CONDUCT Business WITH Integrity
AYRES Est. 1959

- First commercial aerial photography firms – 1930s
  - Built off the success of WWI aerial photography
  - Photography from this era is the start of the national archive

- World War II – 1940s
  - Advances in stereoscopic imagery and photogrammetry
  - Many veterans returned home to work in commercial and academic/research careers

- Start of federal imagery and elevation dataset programs
  - NAIP
  - NDOP
  - National Map
  - Etc.

Imagery as We Know it Today

- Film cameras through the 20th Century
  - Black and white to color film
  - Infrared and near infrared film
  - More commercial applications
    - Advances in viewing platforms
    - Accuracy and resolution improvements
      - ABGPS/IMU
      - Ground control
    - More affordable

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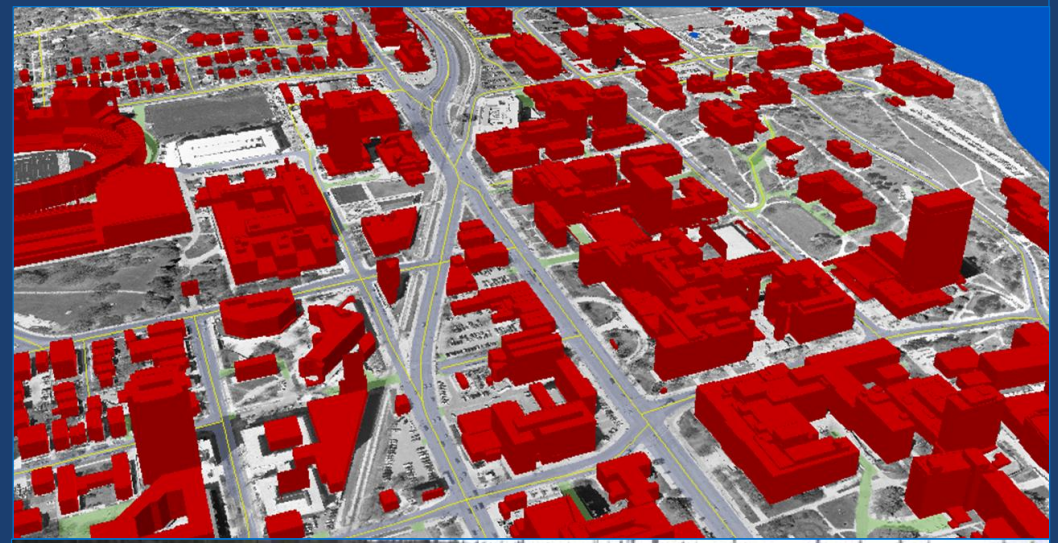
Imagery as We Know it Today

- Film cameras to digital sensors
  - Film eventually phased out
  - Efficiency and quality improvements
  - RGBI (4-band)
  - Thermal
  - Simultaneous collection with lidar
  - Satellite imagery
  - Oblique collection
  - UAS
  - Mobile mapping
  - Applications are endless!



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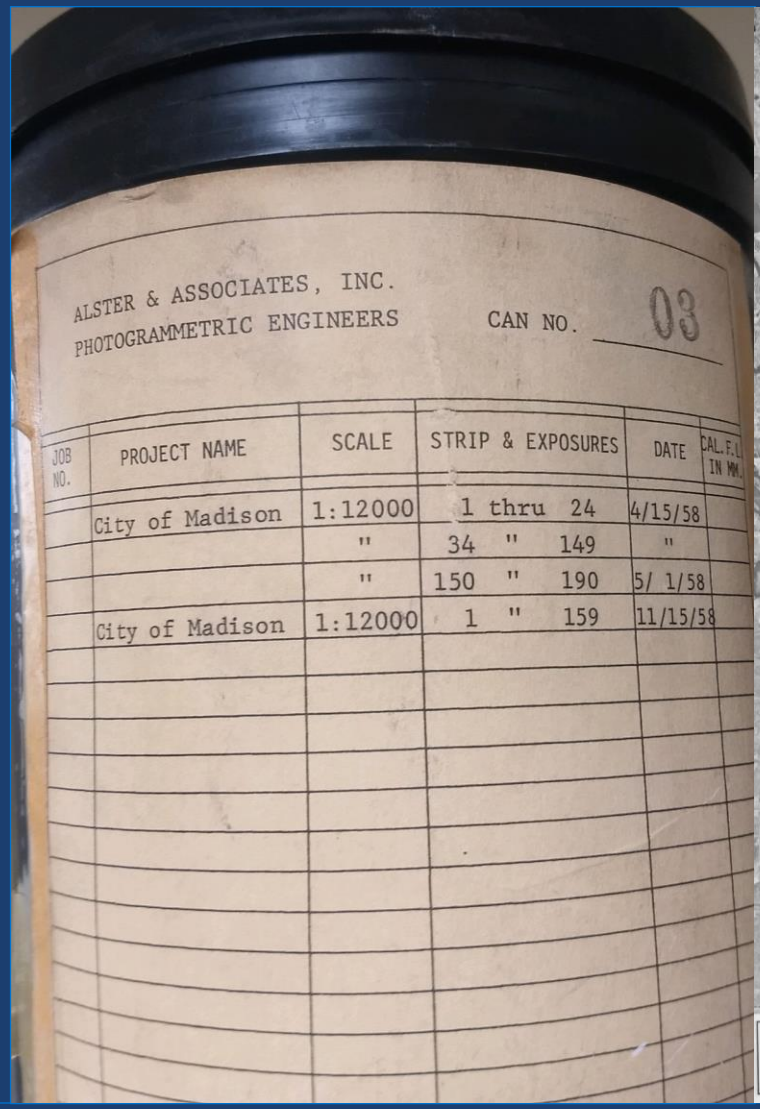
What is Historic Aerial Imagery?

- Archived imagery, usually in a rolled film negative format and prints, that may not yet be converted to a digital format.
- Once converted to a standard digital format, this imagery can be run through a series of geo-referencing, rectification, and image mosaic processes.
- The final product can be used in modern GIS viewers and web mapping services.



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Digital Image Scanner

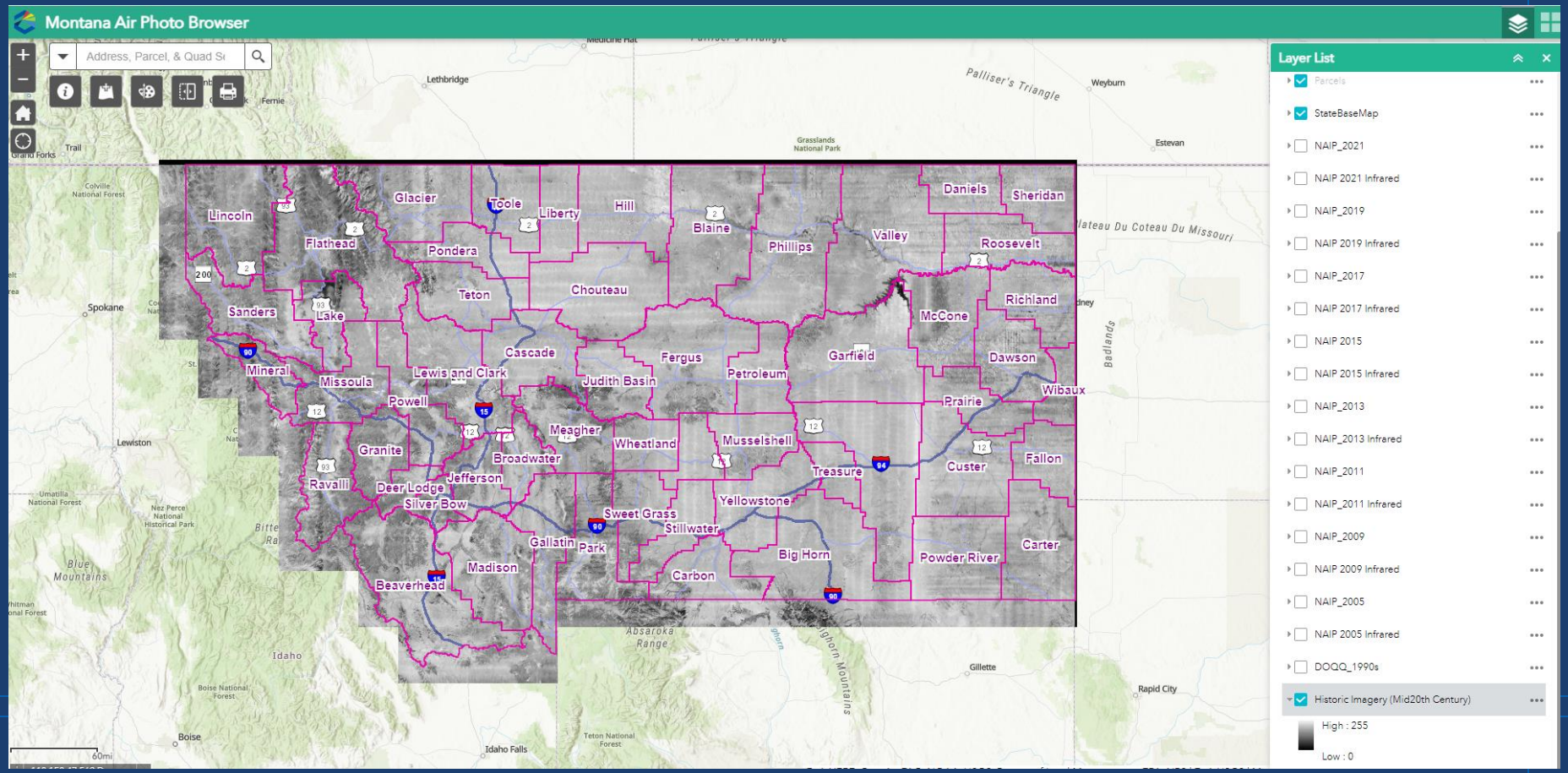
http://www.wihttps://ncap.org.uk/sites/default/files/NCAP_Leica_DSW600.2.jpgld-heerbrugg.com/images/SNAGHTMLdd4df4.PN

Specialized digital image scanners are capable of capturing the geometry of the original aerial film and prints to micron levels of accuracy. Using this type of scanner creates digital scans that can be used to create orthoimages, which require high radiometric and geometric accuracy as well as very high optical resolution.

Microns vs. DPI

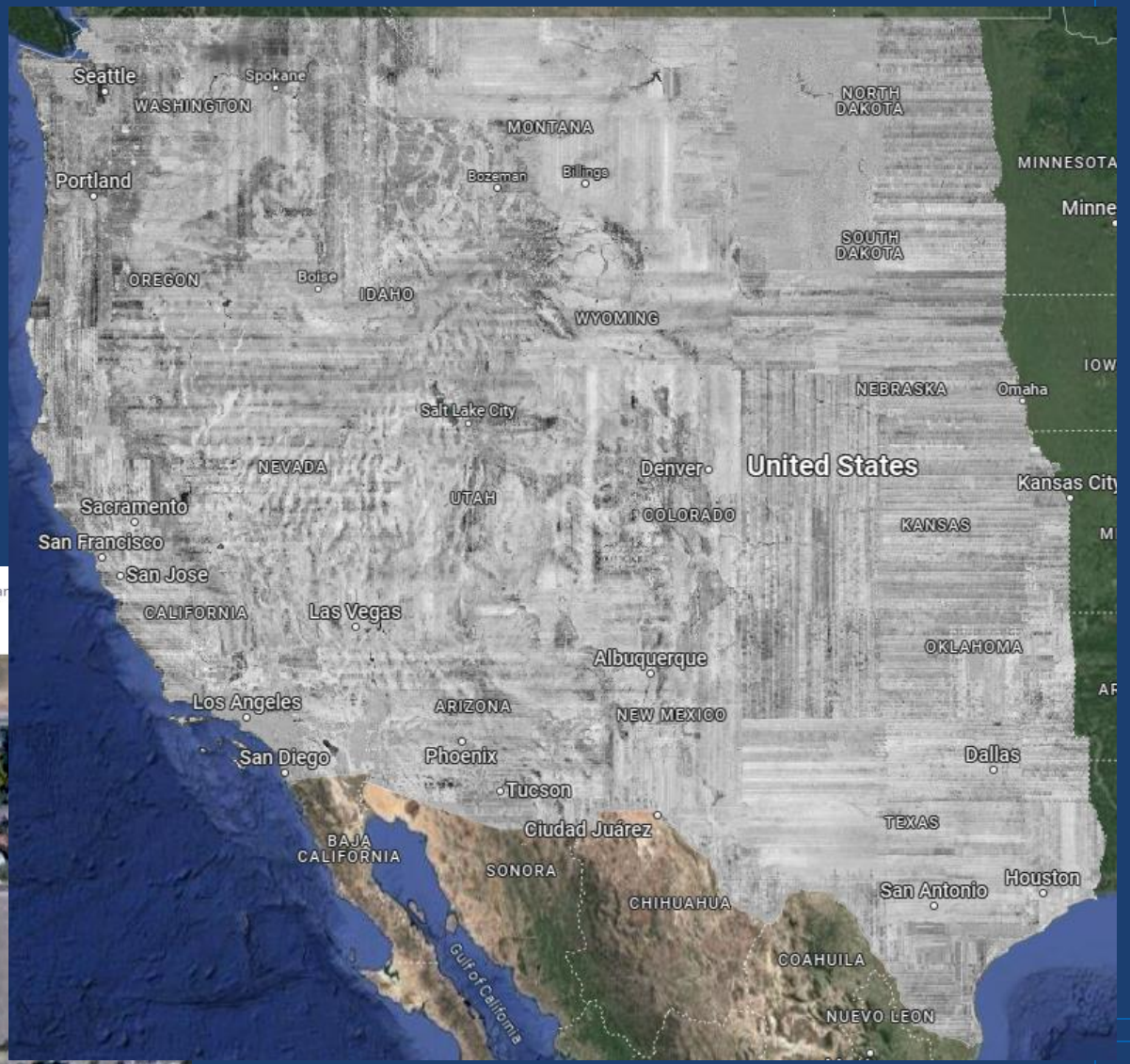
Where can we find historical aerial imagery in MT?

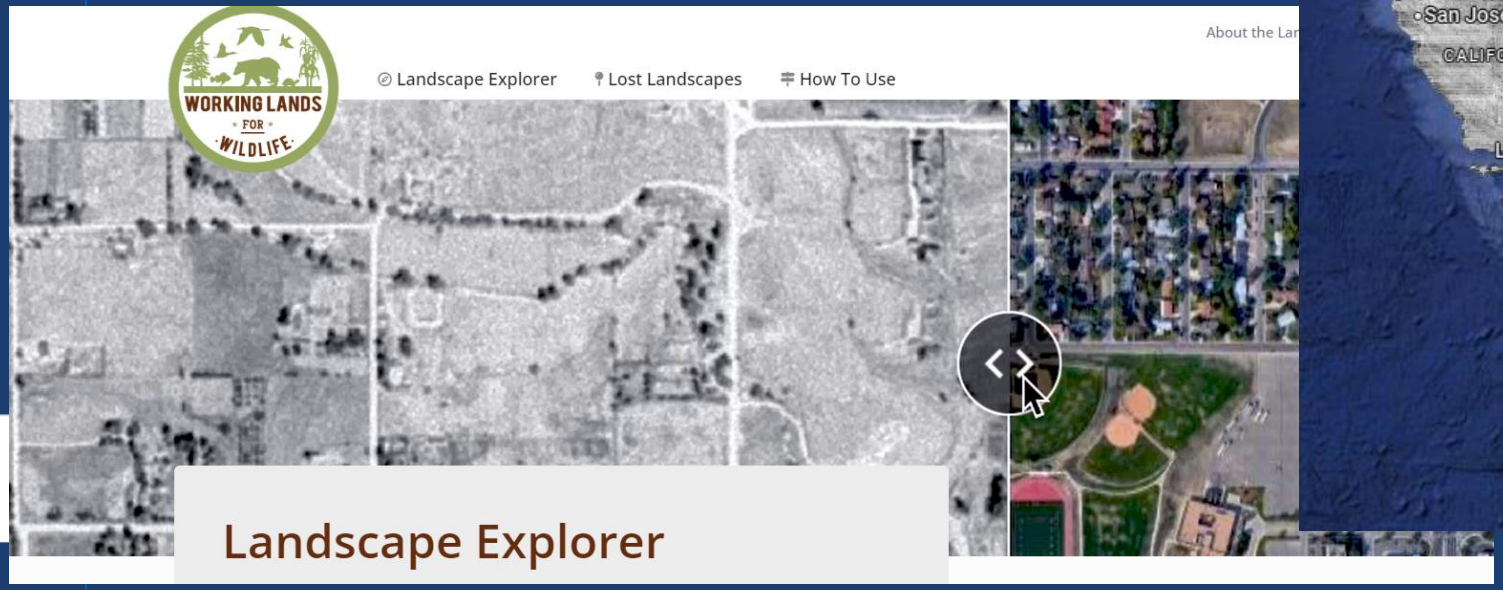
- Montana Air Photo Browser
  - Downloadable NAIP County mosaics (2005-2021) - .sid format - 3 band



Where can we find historical aerial imagery in MT?

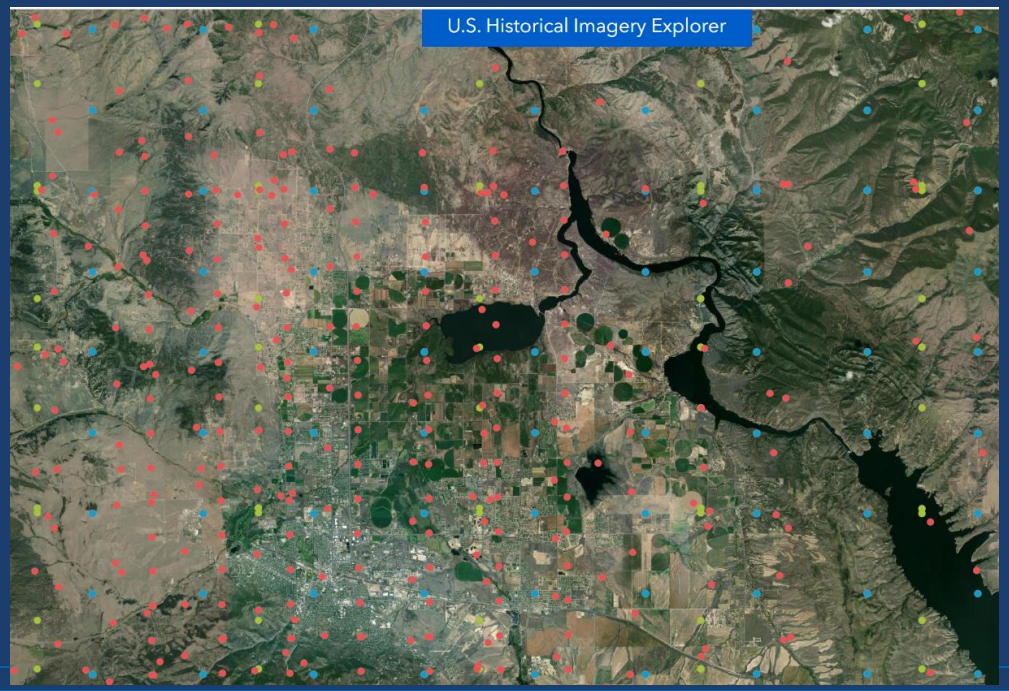
- Landscape Explorer
  - Historic imagery viewer with slider
  - Mid 1950's imagery and current google imagery
  - Can download the imagery by tile for free
  - Tile index and seamlines are also included in the gis data download option

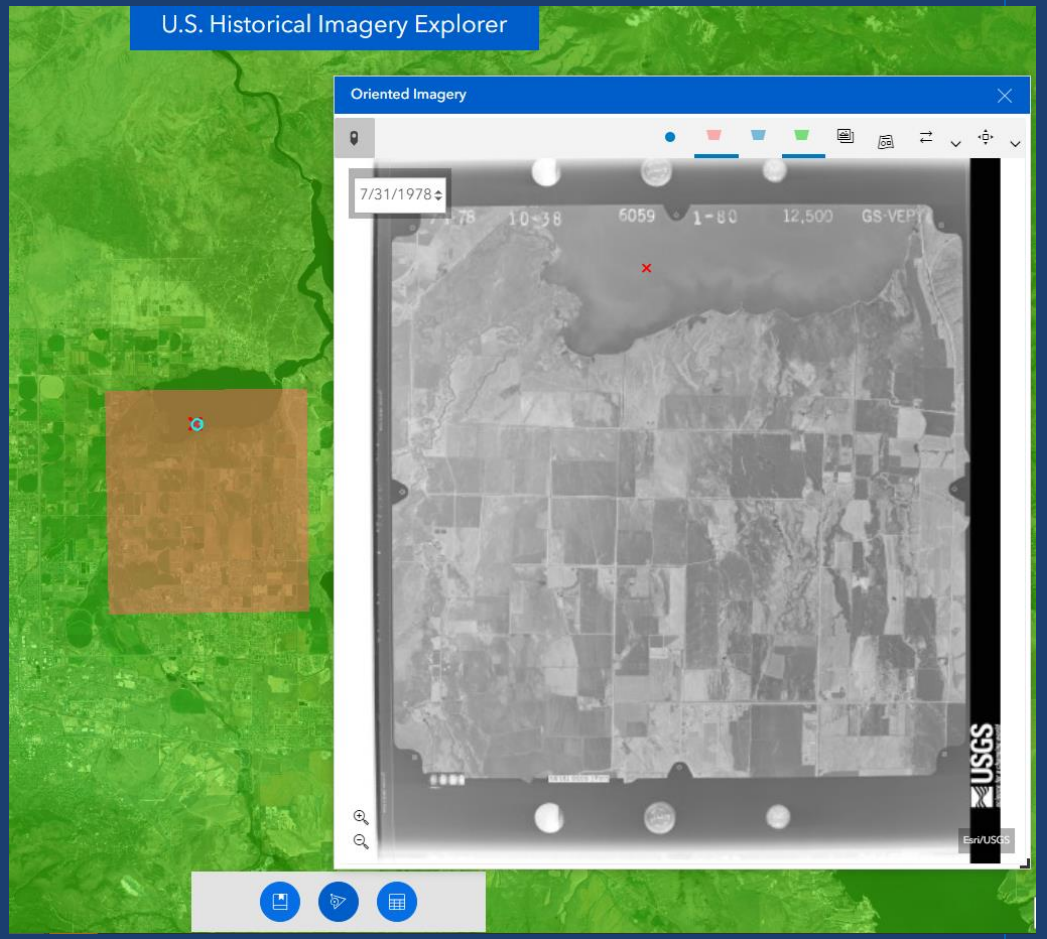




Where can we find historical aerial imagery in MT?

- US Historical Imagery Explorer
  - Historic imagery viewer of NAPP and NHAP programs
  - Raw film scanned data
  - Data from 1950 - 2000





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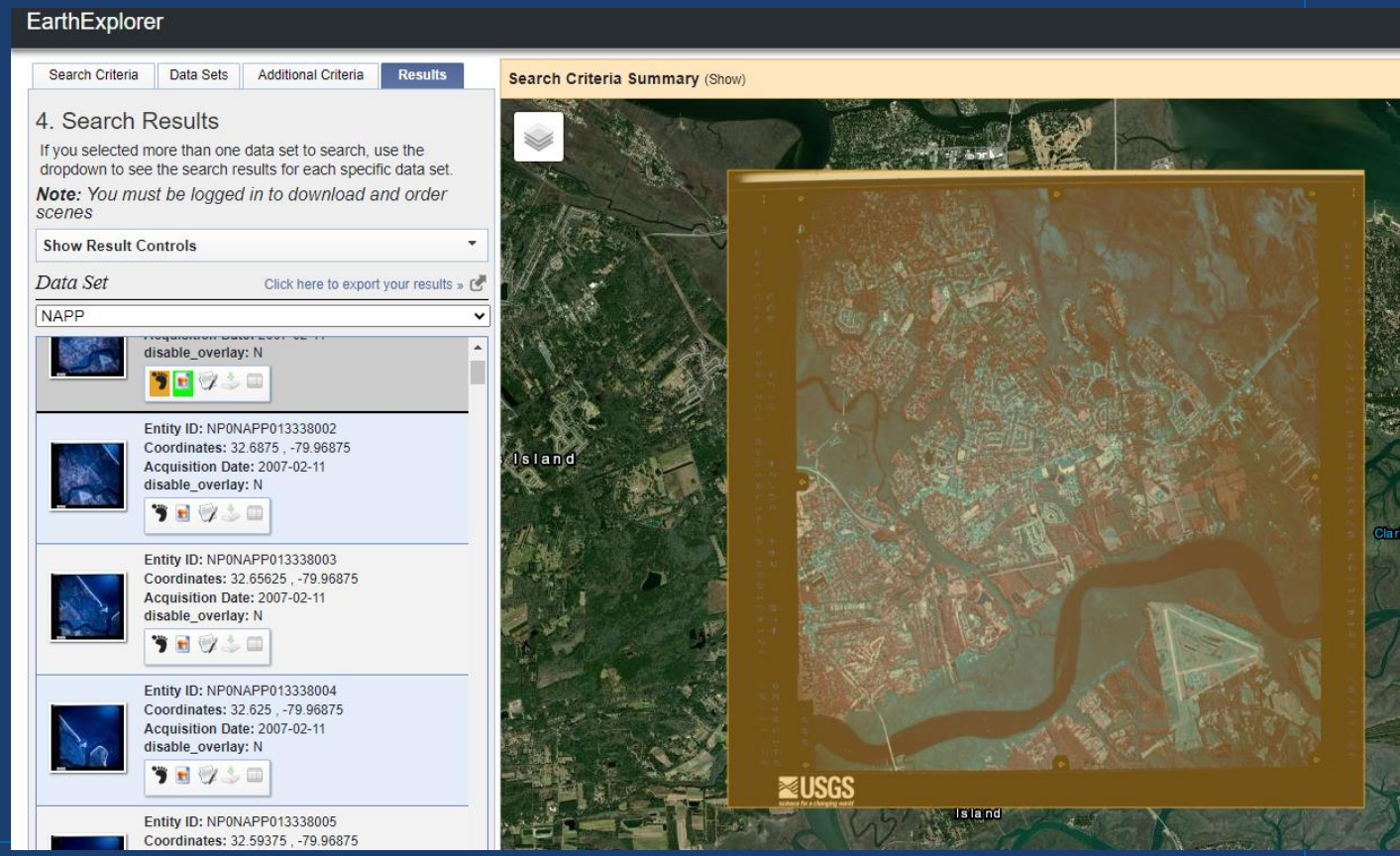
Where can we find historical aerial imagery in MT?

- Montana State Library
  - Current Aerial Imagery 2000's
  - Able to order NAIP imagery datasets
- Montana Historical Imagery
  - USGS Single Frame Archives
  - 1940s and 1950s
- Earth Explorer
  - NAIP, NHAP, NAAP, Single Frames



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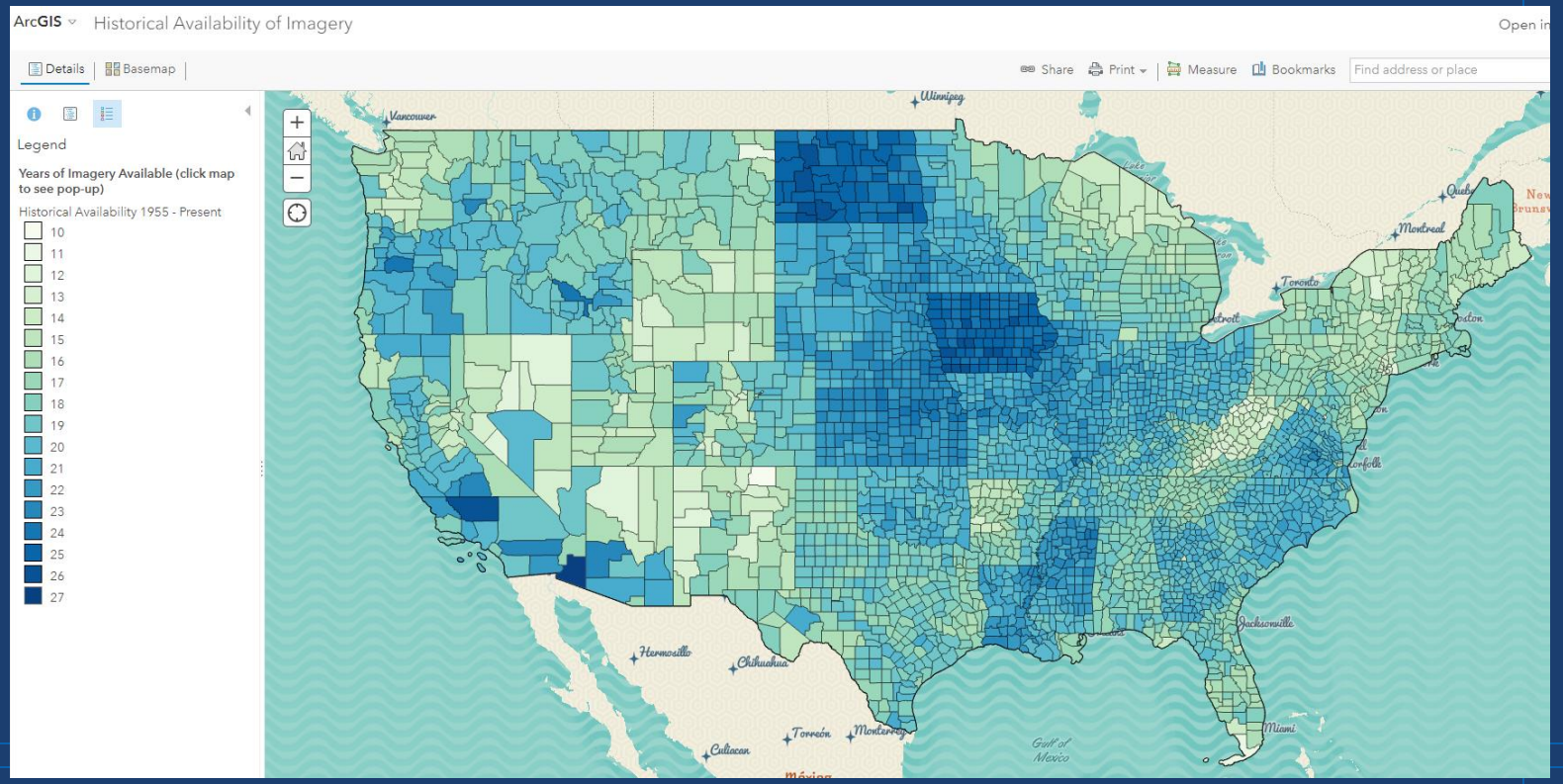
Where can we find historical aerial imagery in MT?

USDA Farm Production and Conservation Business Center
U.S. DEPARTMENT OF AGRICULTURE

- USDA GEOSPATIAL ENTERPRISE OPERATIONS
  125 S State Street Suite 6416
  Salt Lake City, UT 84138



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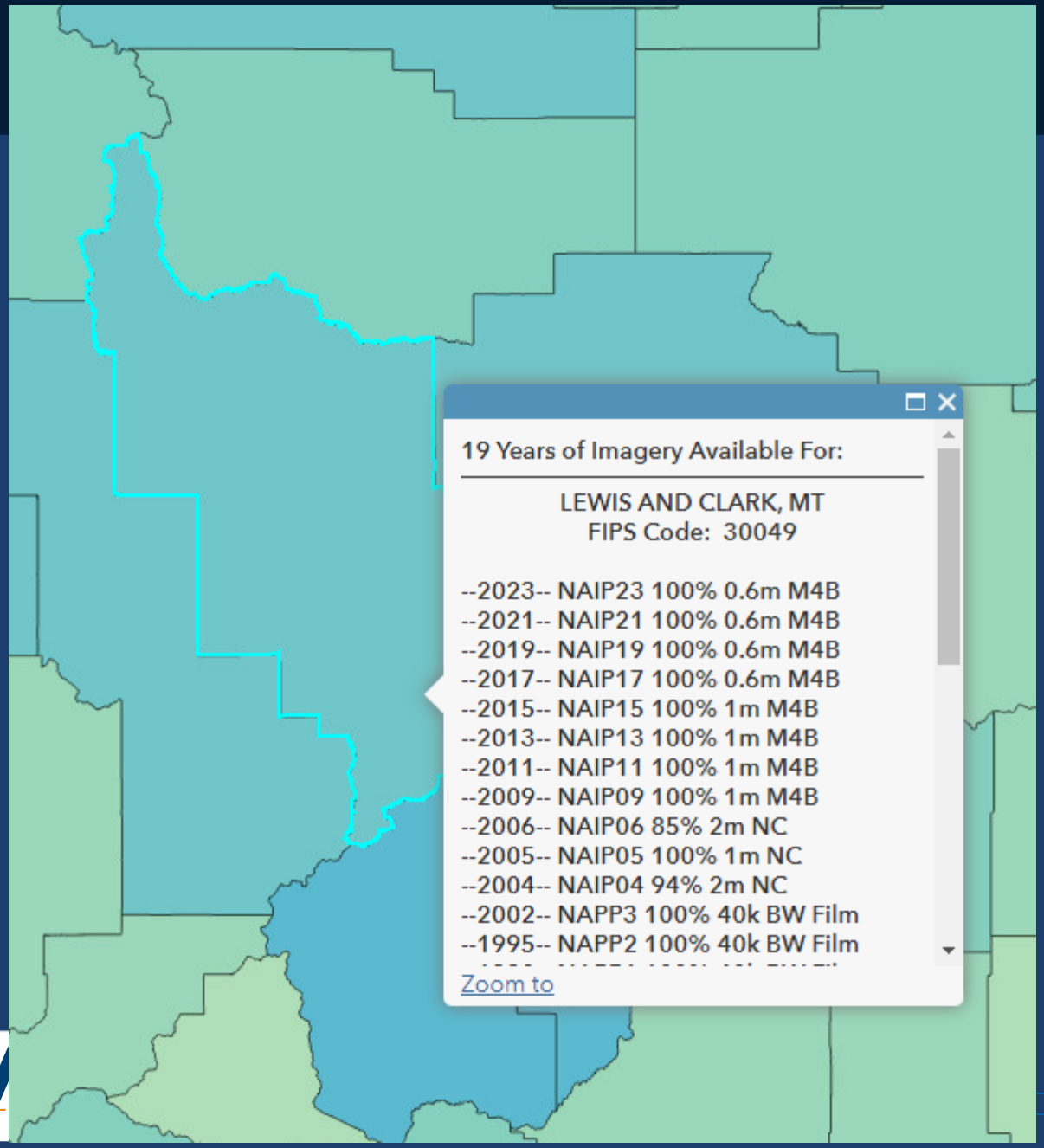

Montana

State FSA Office: http://fsa.usda.gov/FSA/stateOffices?area= MT County FSA Office: http://offices.sc.egov.usda.gov

Lewis and Clark - 30049 (AZU) **Square Mile Land Area: 3461**

PROG	%COV	YEAR	RES SCL	BAND TYPE	FMT	QTY	REMARKS
NAIP19	100	2019		M4B	MR	1	CCM 6.557GB
NAIP19	100	2019		NC	MR	1	CCM 6.557GB
NAIP17	100	2017	0.6	NC	MR	1	CCM 6.670GB
NAIP17		2017	0.6	M4B	GT	272	QQ 114.712GB
NAIP15	100	2015	1	NC	MR	1	CCM 4.824GB
NAIP15		2015	1	M4B	GT	13	QQ 2.176GB
NAIP13	100	2013	1	NC	MR	1	CCM 4.822GB
NAIP13		2013	1	M4B	GT	329	QQ 55.391GB
NAIP11		2011	1	M4B	GT	329	QQ 54.907GB
NAIP11	100	2011	1	NC	MR	2	CCM 4.447GB
NAIP09	100	2009	1	NC	MR	2	CCM 4.599GB
NAIP09		2009	1	M4B	GT	329	QQ 55.218GB
NAIP06		2006	2	NC	GT	234	QQ 7.372GB
NAIP06	85	2006	2	NC	MR	1	CCM .741GB
NAIP05		2005	1	NC	GT	351	QQ 44.327GB
NAIP05	100	2005	1	NC	MR	2	CCM 4.694GB
NAIP04	94	2004	2	NC	MR	2	CCM .192GB
NAIP04		2004	2	NC	GT	335	QQ 10.477GB
NAPP3	100	2002	40000	BW			
NAPP3	100	2002	48	BW	TF	70	25.81 GB
NAPP2		1998	48	BW	TF	5	1.94 GB
NDOP	100	1995	1	BW	MR	2	CCM
NAPP2	100	1995	48	BW	TF	140	51.62 GB
NAPP2	100	1995	40000	BW			
NAPP1	100	1990	49	BW	TF	18	7.26 GB
NAPP1	100	1990	40000	BW	LI	3	17824-PARTIALLY RECTIFIED
NHAP1	100	1988	73	CIR	TF	6	6.91 GB
NHAP1	100	1987	71	CIR	TF	2	2.29 GB
NHAP1	100	1987	74	CIR	TF	1	1.15 GB
NHAP1	100	1987	69	CIR	TF	49	56.33 GB
NHAP1	100	1984	69	CIR	TF	75	86.49 GB
NHAP1	100	1984	71	CIR	TF	22	25.36 GB
NHAP1	100	1984	71	CIR	TF	48	55.2 GB
NHAP1	100	1984	72	CIR	TF	1	1.15 GB
NHAP1	100	1984	72	CIR	TF	9	10.33 GB
NHAP1	100	1984	73	CIR	TF	1	1.15 GB
NHAP1	100	1984	73	CIR	TF	50	57.43 GB
NHAP1	100	1984	74	CIR	TF	44	50.53 GB
FSA	(P)	1978	40000	BW	PI	11	6641 A&B
FSA	(P)	1966	20000	BW	PI	1	6640
FSA	(P)	1965	20000	BW	PI	11	6639 A&B
FSA	(P)	1965	24	BW	TF	291	105.6 GB
FSA	(P)	1964	24	BW	TF	1486	527.29 GB
FSA	(P)	1955	24	BW	TF	1322	464.2 GB

Where can we find historical aerial imagery in MT?

- Private collections
  - Universities, Map Libraries
  - Archived film and prints from 1950s to present
  - Digital imagery and elevation data
  - Do not throw away your prints!!

  - What is hiding in that flat file in your office?

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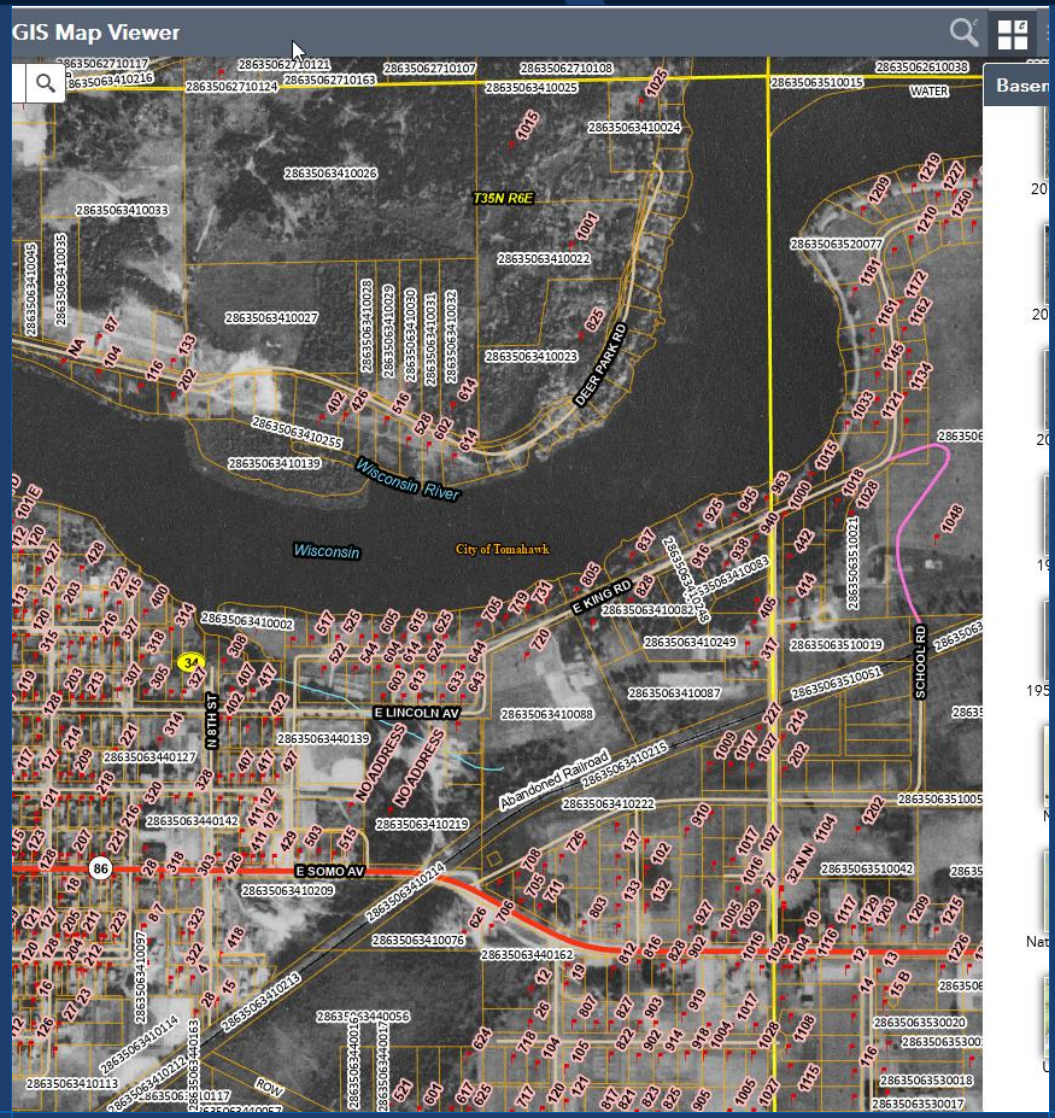
Uses for Historic Aerial Imagery

- Historic Occupation Lines
  - Helps with parcel mapping, deed calls, searching locations for old fence lines and survey markers
- Historic Land Use
  - Aiding in parcel mapping, historic survey map layouts and intentions, viewing population growth and changes with the road systems
- Road Layouts
  - Aids with old roadway calls in deeds for parcel mapping, retracing historic survey notes and gives ability to track new and historic road locations and time frames of their construction or abandonments



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Uses for Historic Aerial Imagery

- Other uses… not limited to:
  - Environmental assessments
  - Change detection
  - Land use analysis and disputes
  - Historical and cultural landmark preservation
  - Community engagement

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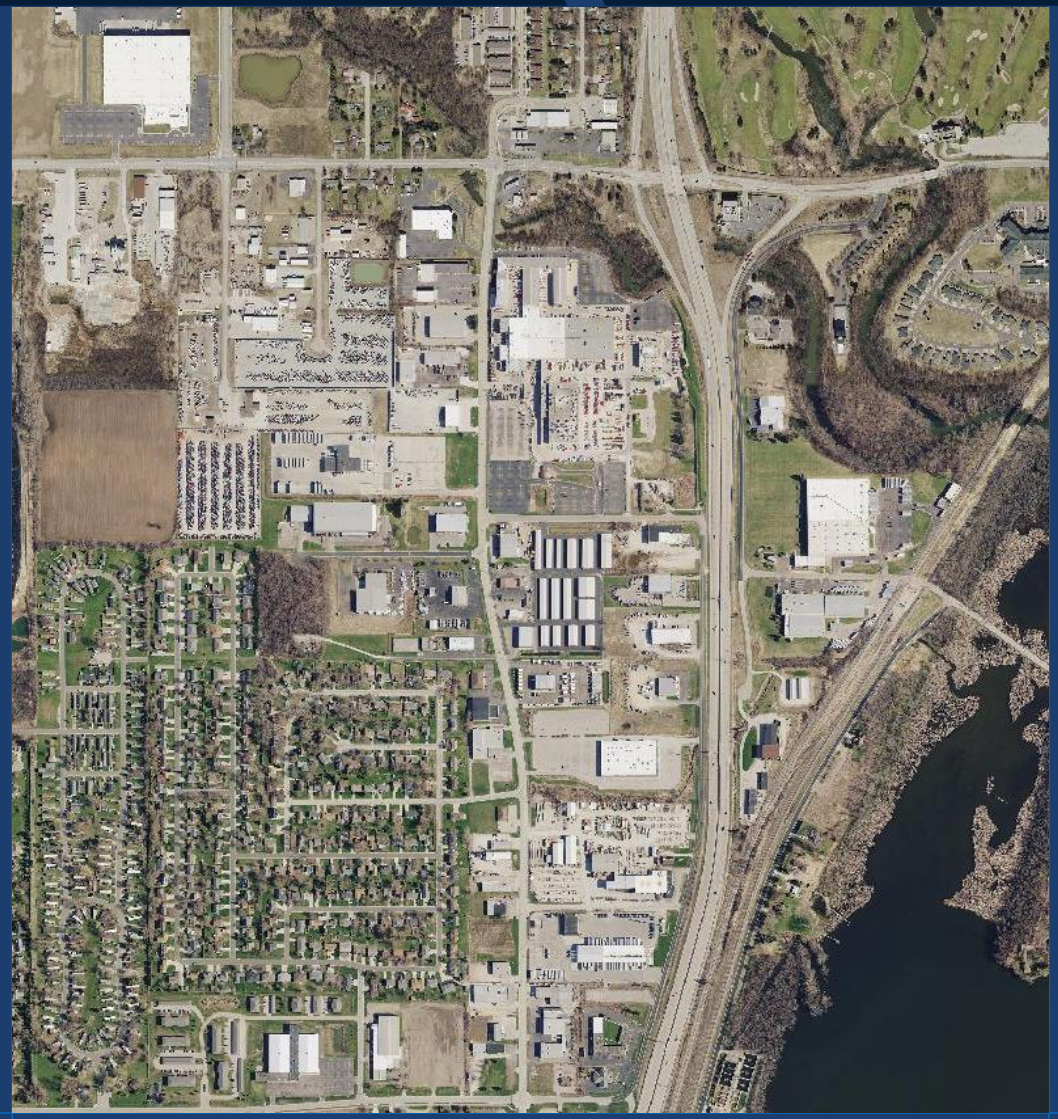
Uses for Historic Aerial Imagery



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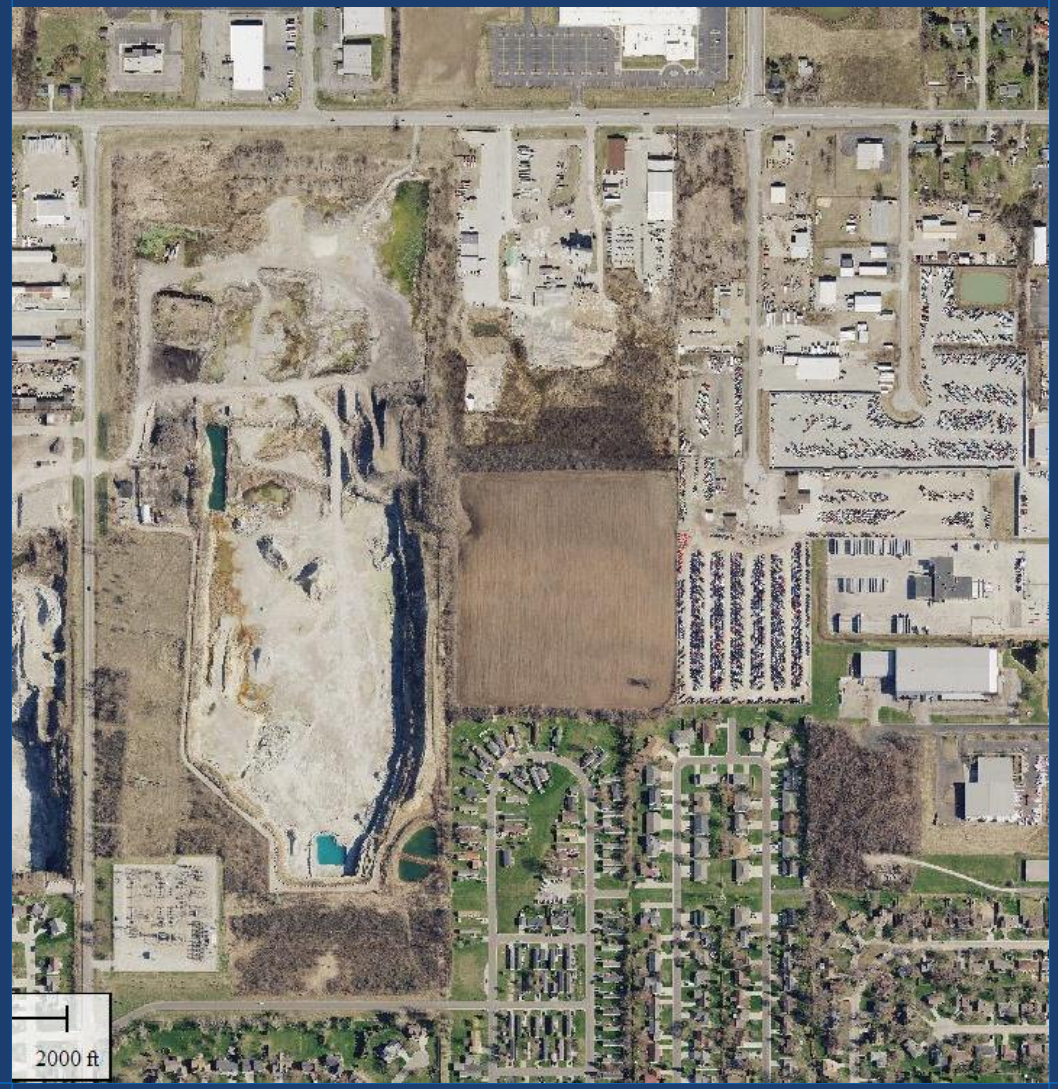
Uses for Historic Aerial Imagery



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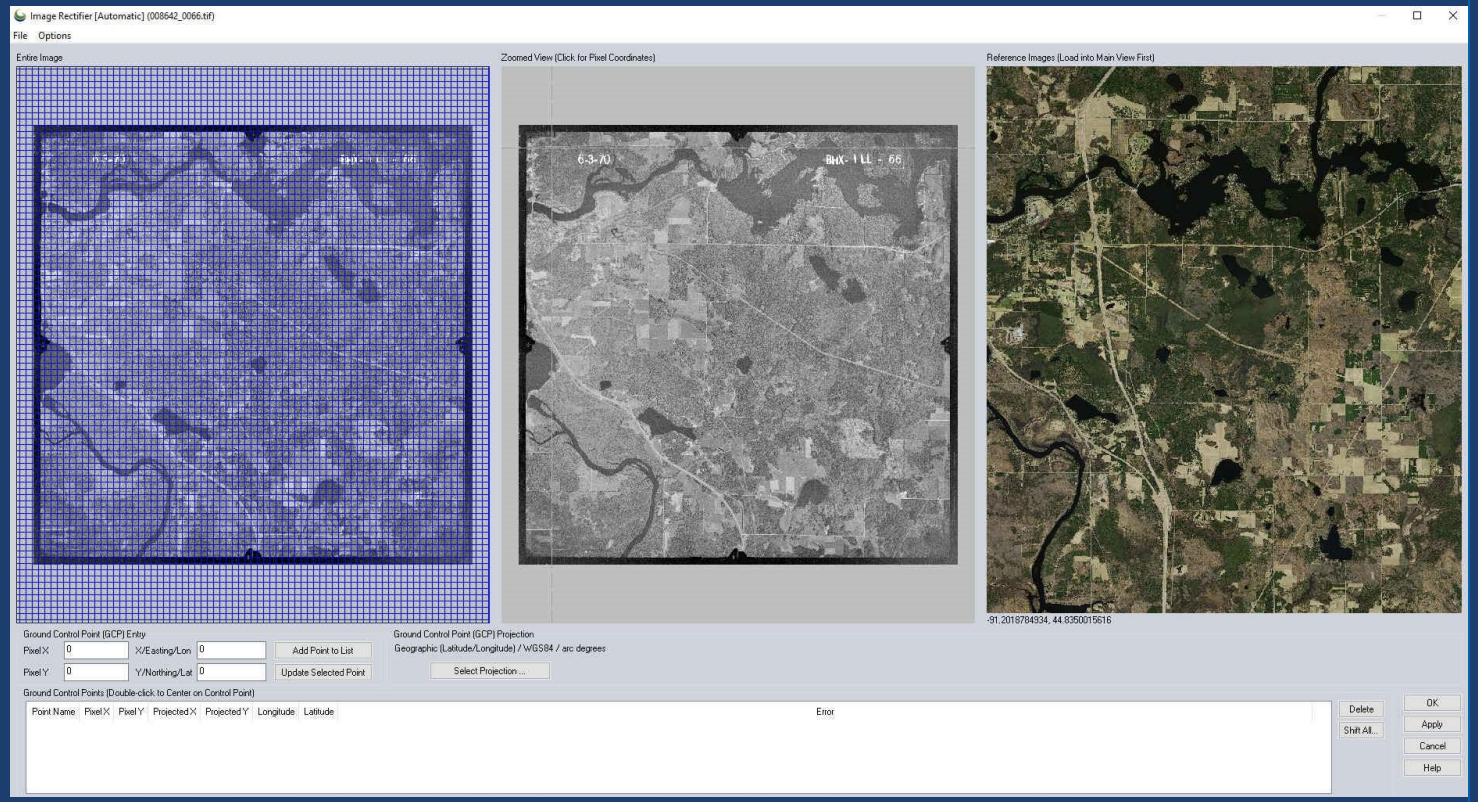
Georeferencing and Rectification Options

- Georeferencing:
  - Placing the imagery in a geographic correct position using existing basemap data such as digital orthophotos and vector layers (road centerline, PLSS data, lidar intensity images, WMS street maps etc.)
  - Generally done with source imagery from contact prints, photo enlargements, or film not scanning with a photogrammetric scanner (calibrated)



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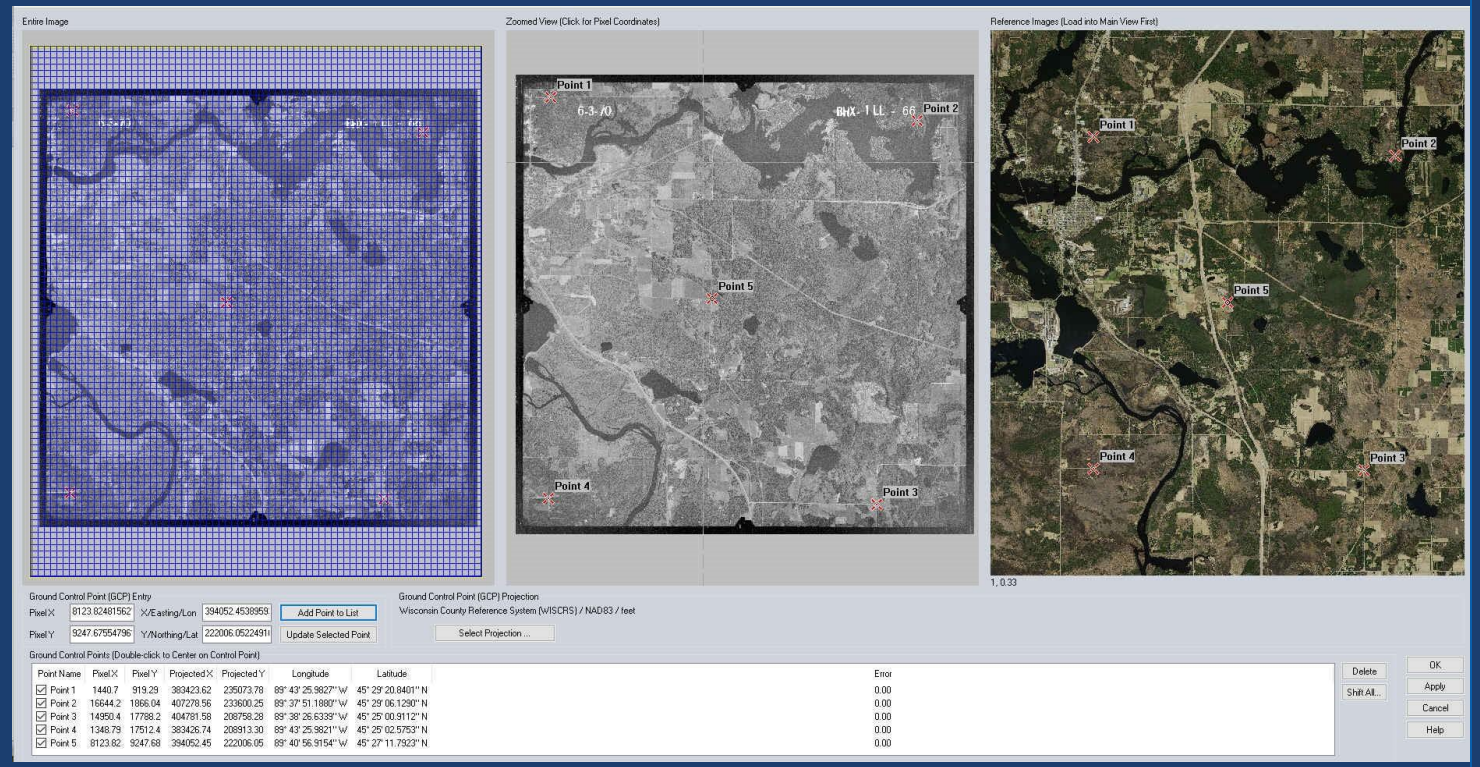
Georeferencing Option

- Rubber sheet method
  - Minimum 5 points
  - Shotgun pattern covering the corners and center
  - Coordinate reference system of source data



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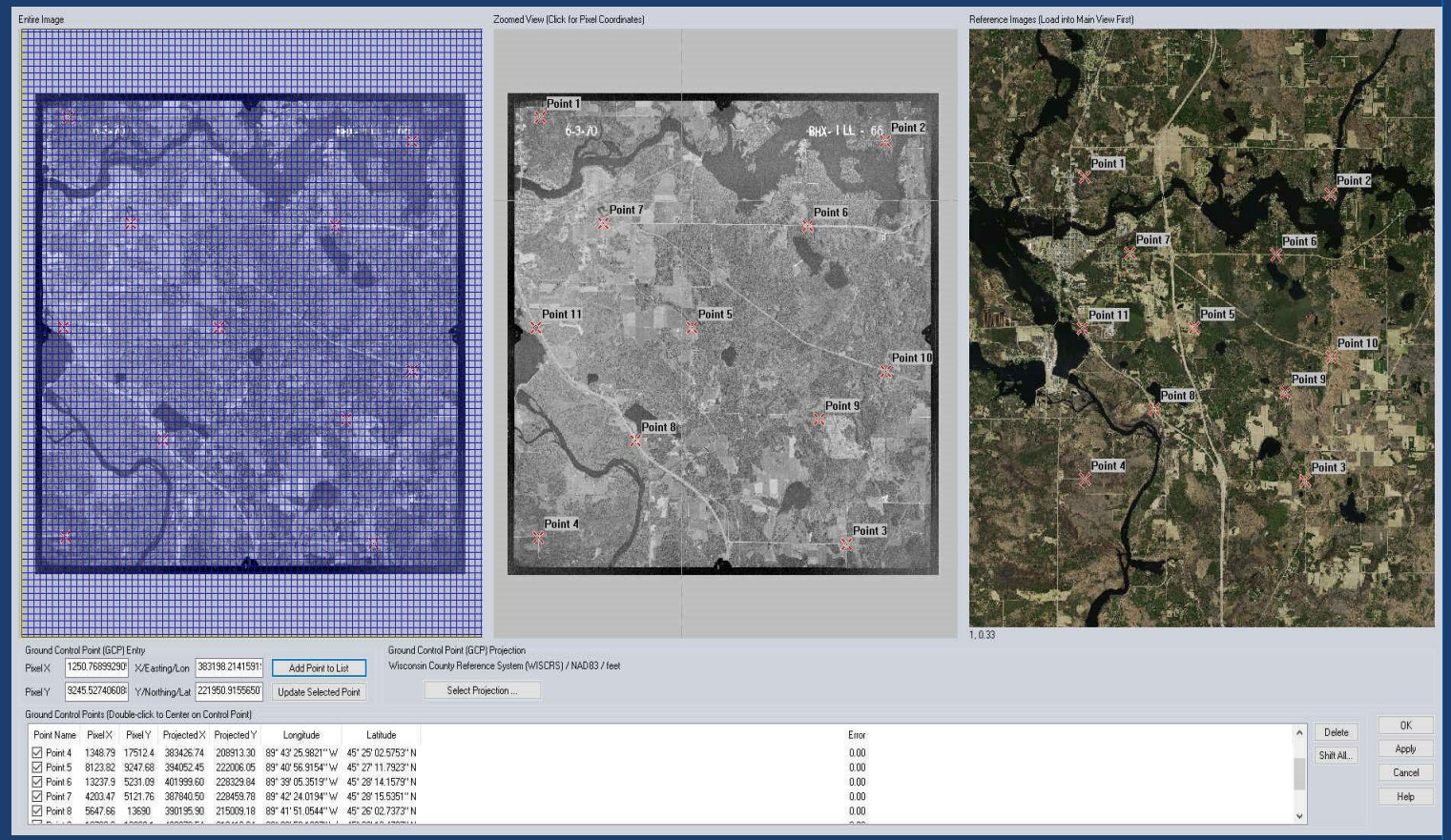
Georeferencing Option

- Rubber sheet method
  - 10+ points preferred
  - Improved accuracy within photo



Georeferencing Option

- Pros:
  - Flexibility of input data/media
  - Quick solution for smaller areas
- Cons:
  - General location accuracy
  - Time intensive for large areas
  - Limited to source data available

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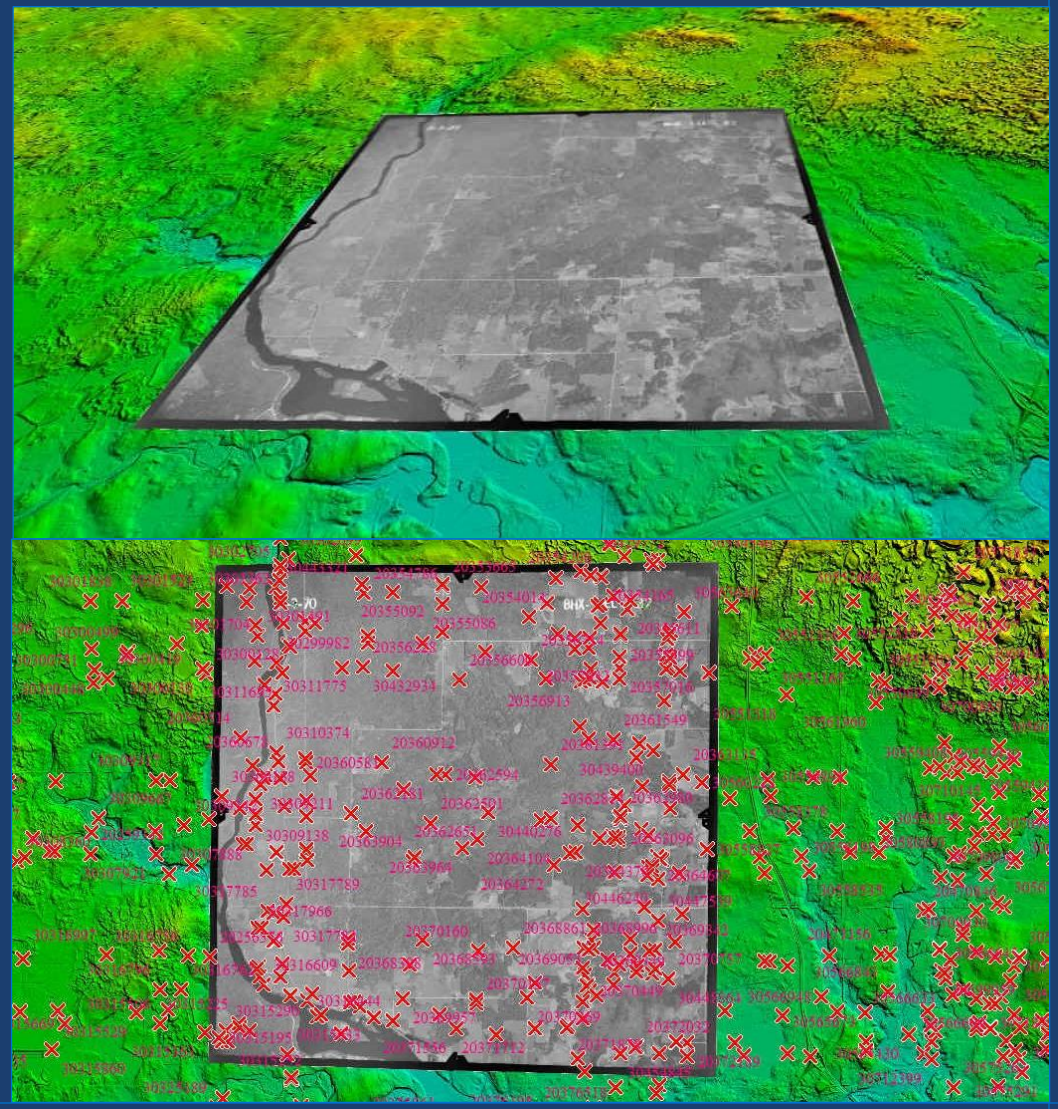
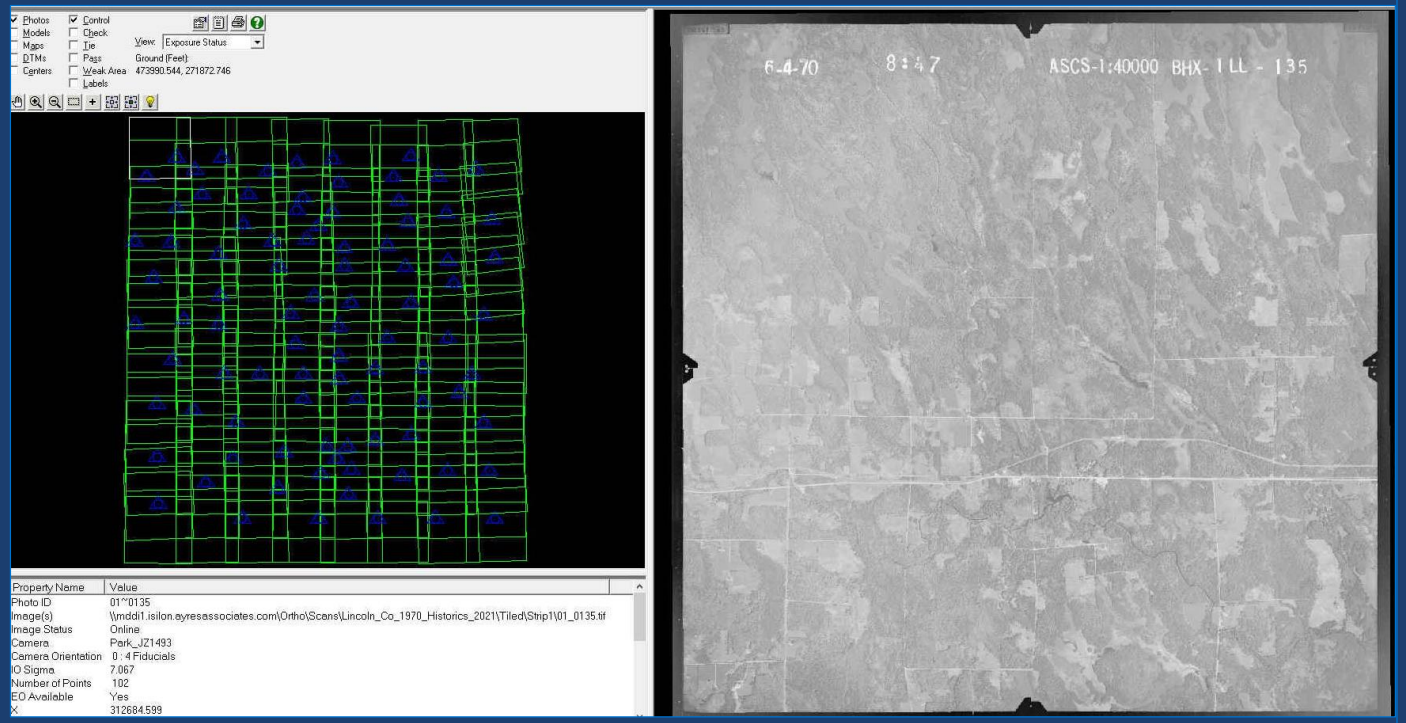
Georeferencing and Rectification Options

- Rectification:
  - Using aerial triangulation (AT) and underlying surface model to remove geometric distortions in the photo.
  - Requires negative or positive film scanned with a photogrammetric scanner.



Rectification Option

- Rectification
  - AT setup as block using photocenters XY
  - Ground control from existing sources including Z
  - Given coordinate reference system



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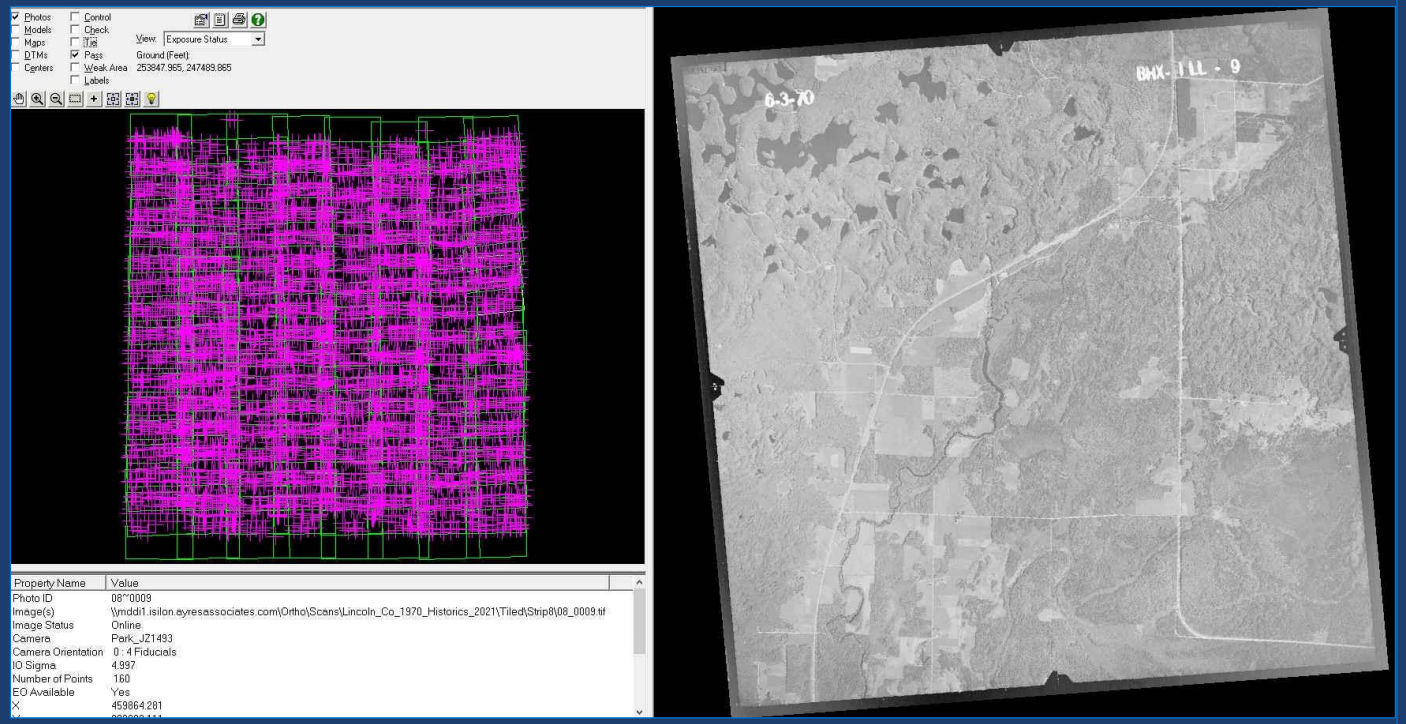
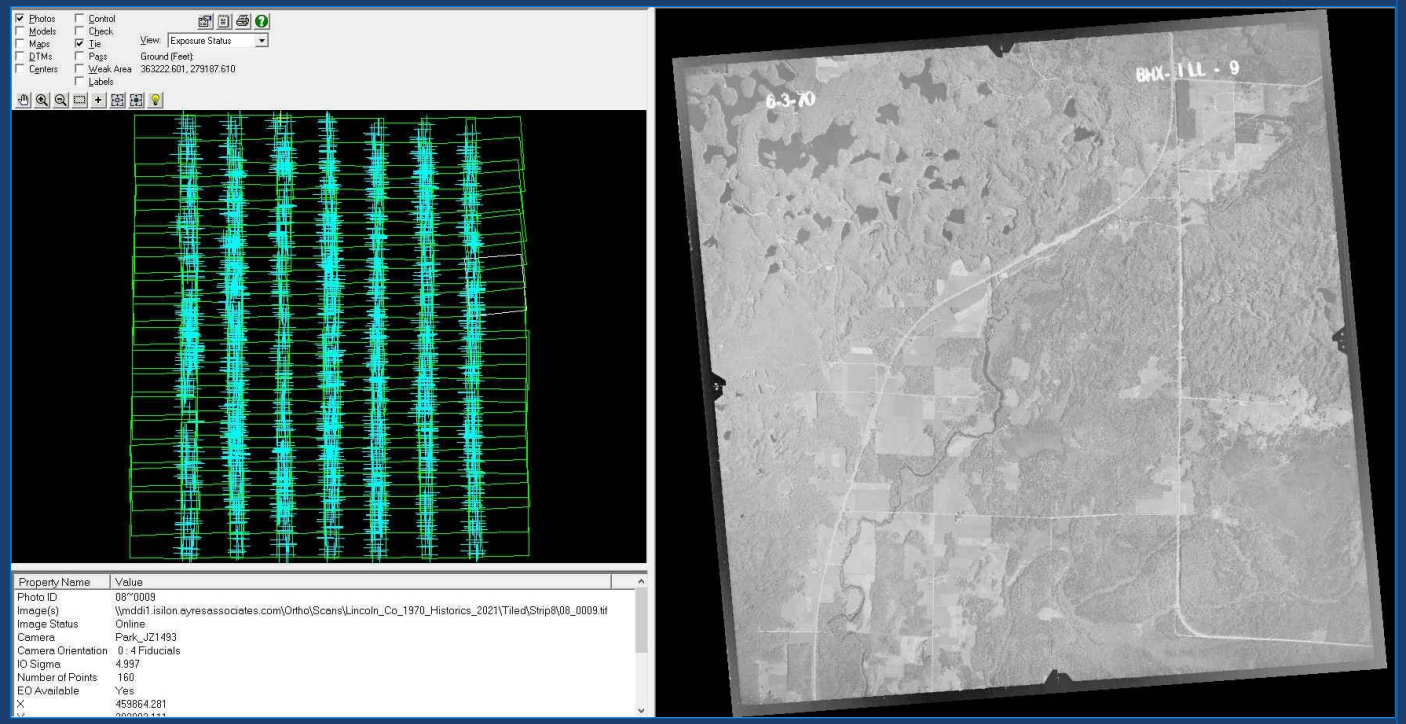
Rectification Option

- Rectification
  - Pass point generation XYZ
  - Automated with technician validation
  - Within the photo strip



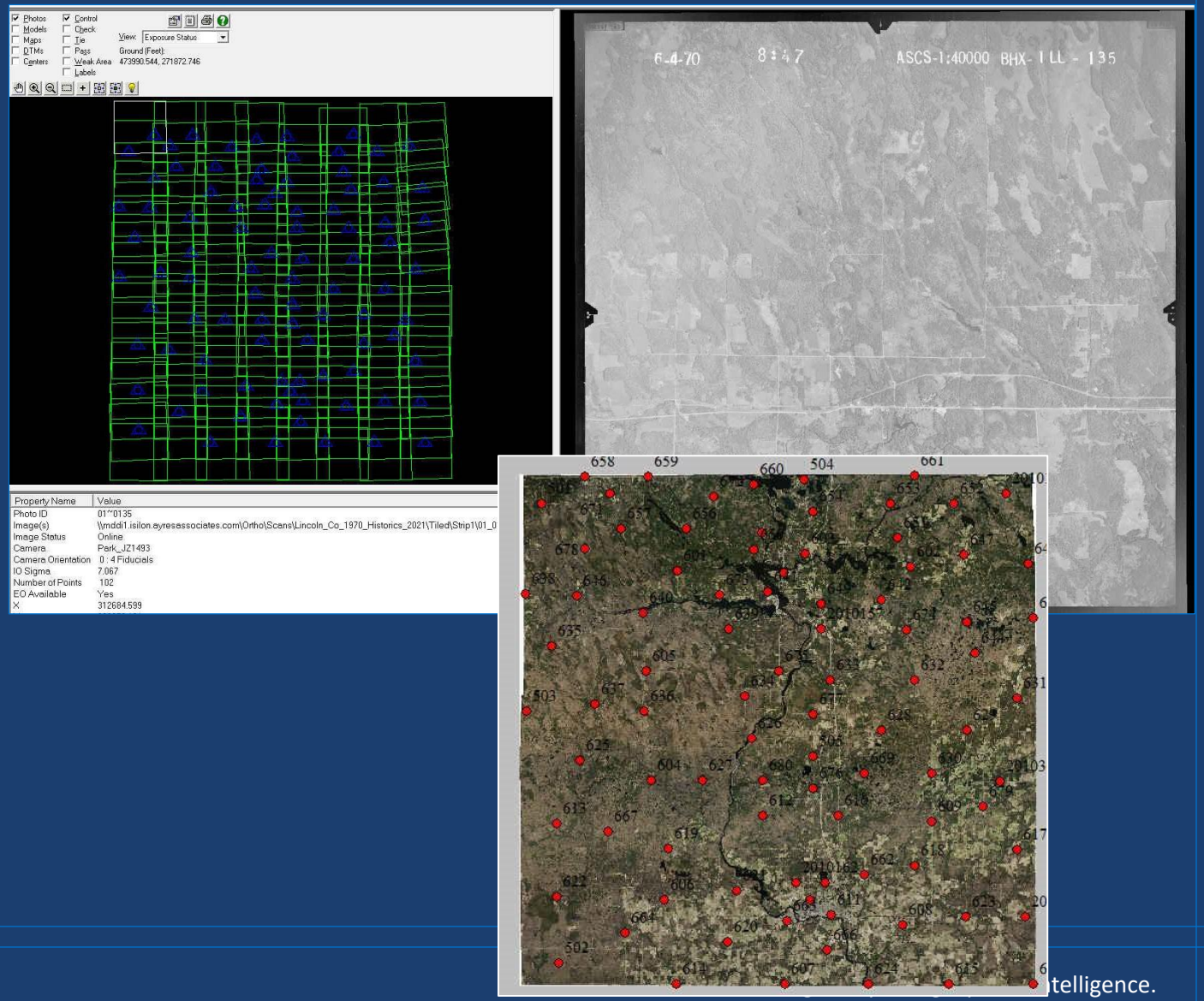
Rectification Option

- Rectification
  - Tie point generation XYZ
  - Automated with technician validation
  - Ties the photos strip together



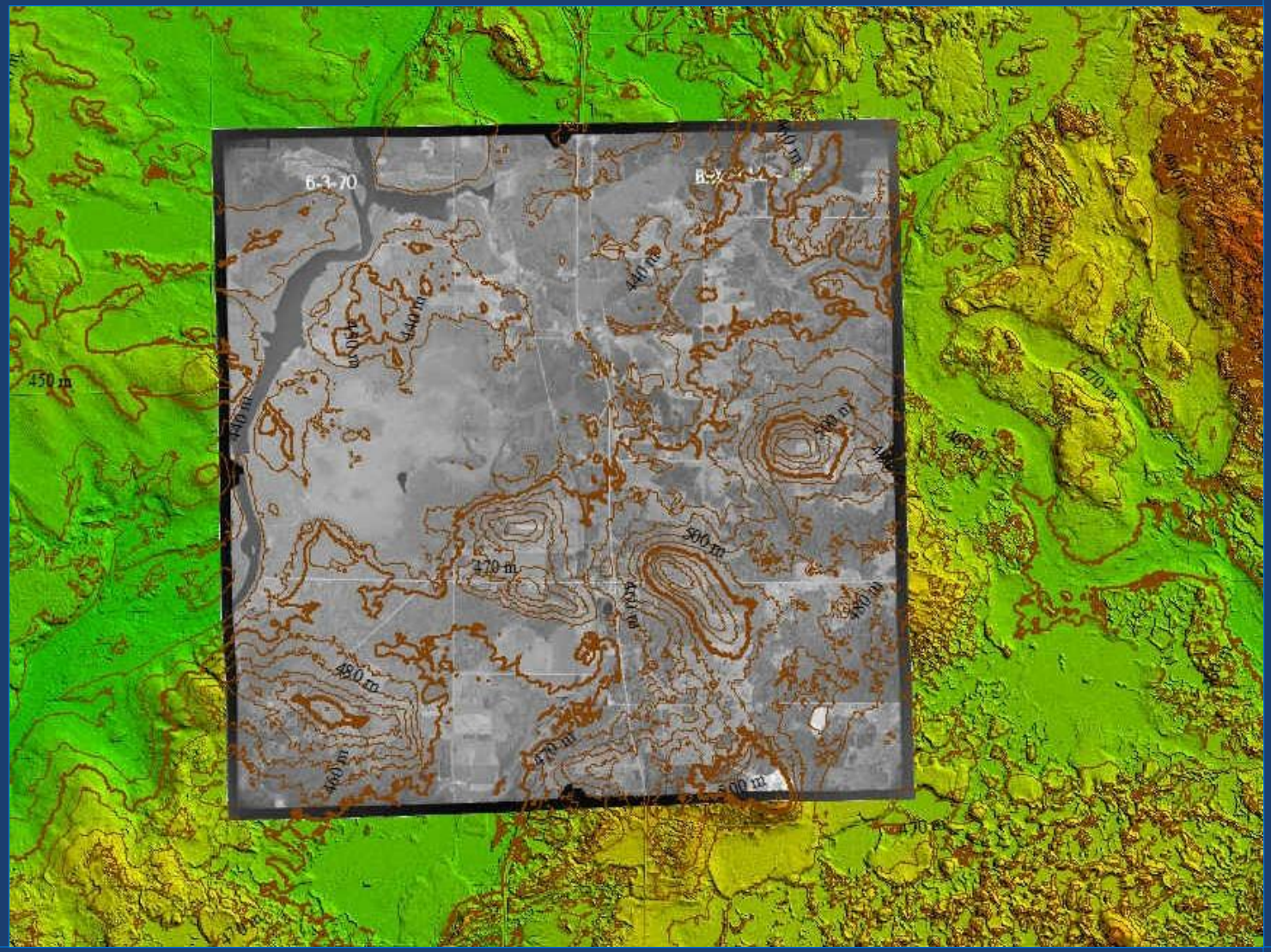
Rectification Option

- Rectification
  - Read in “ground control”
  - Manual by technician in 3D
  - Block adjustment
  - Different levels of control
    - Existing surveyed
    - Picked off existing data
    - XYZ or XY



Rectification Option

- Rectification
  - Rectify using existing or autocorrelated surface
  - Beware of changes to terrain over time: major waterways, highway corridors, developments etc.



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Rectification Option

- Pros:
  - Increased accuracy
  - Process large areas efficiently
  - Block is processed as a whole
- Cons:
  - Requires AT photogrammetric software suite
  - Requires original film scanned with photogrammetric scanner (calibrated)

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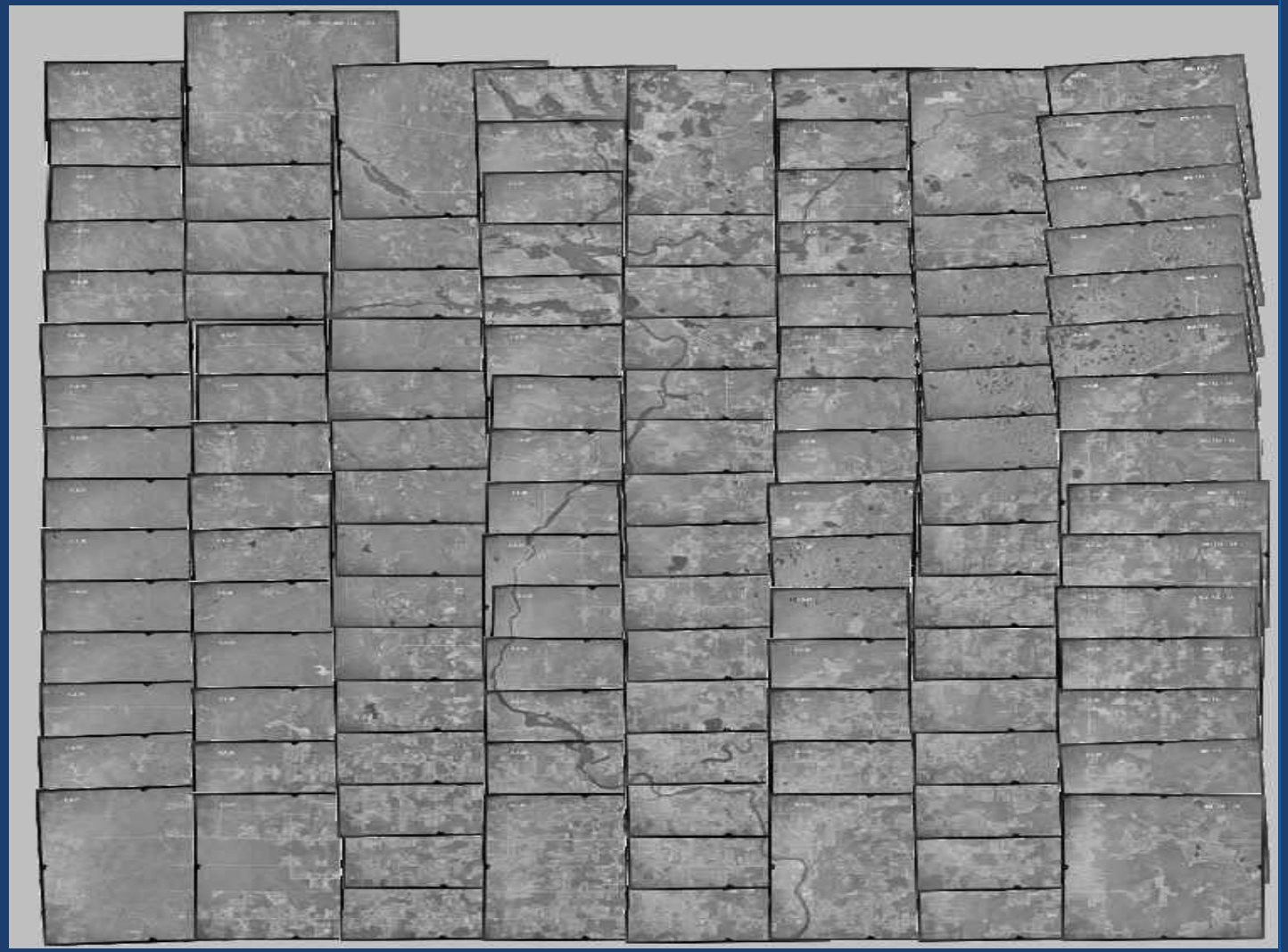
Rectification/Georeferenced Mosaic

- Mosaicing
  - Done regardless of image registration option
  - Processed as a block



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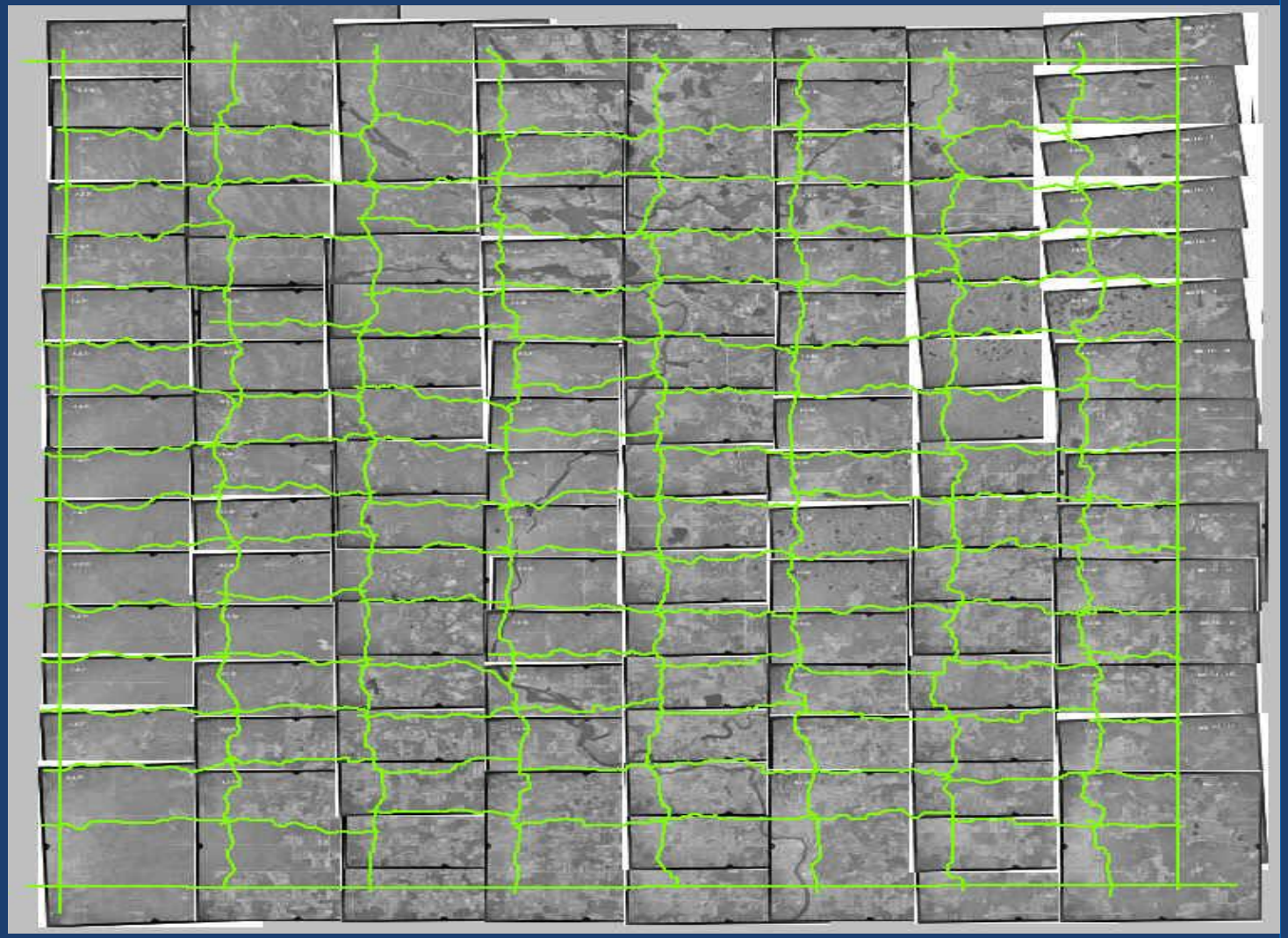
Rectification/Georeferenced Mosaic

- Mosaicing
  - Manual seamline generation
  - Looking for natural features to seam photos together
  - Try avoid water feature glare
  - Tone balance in-strip or between strips if needed



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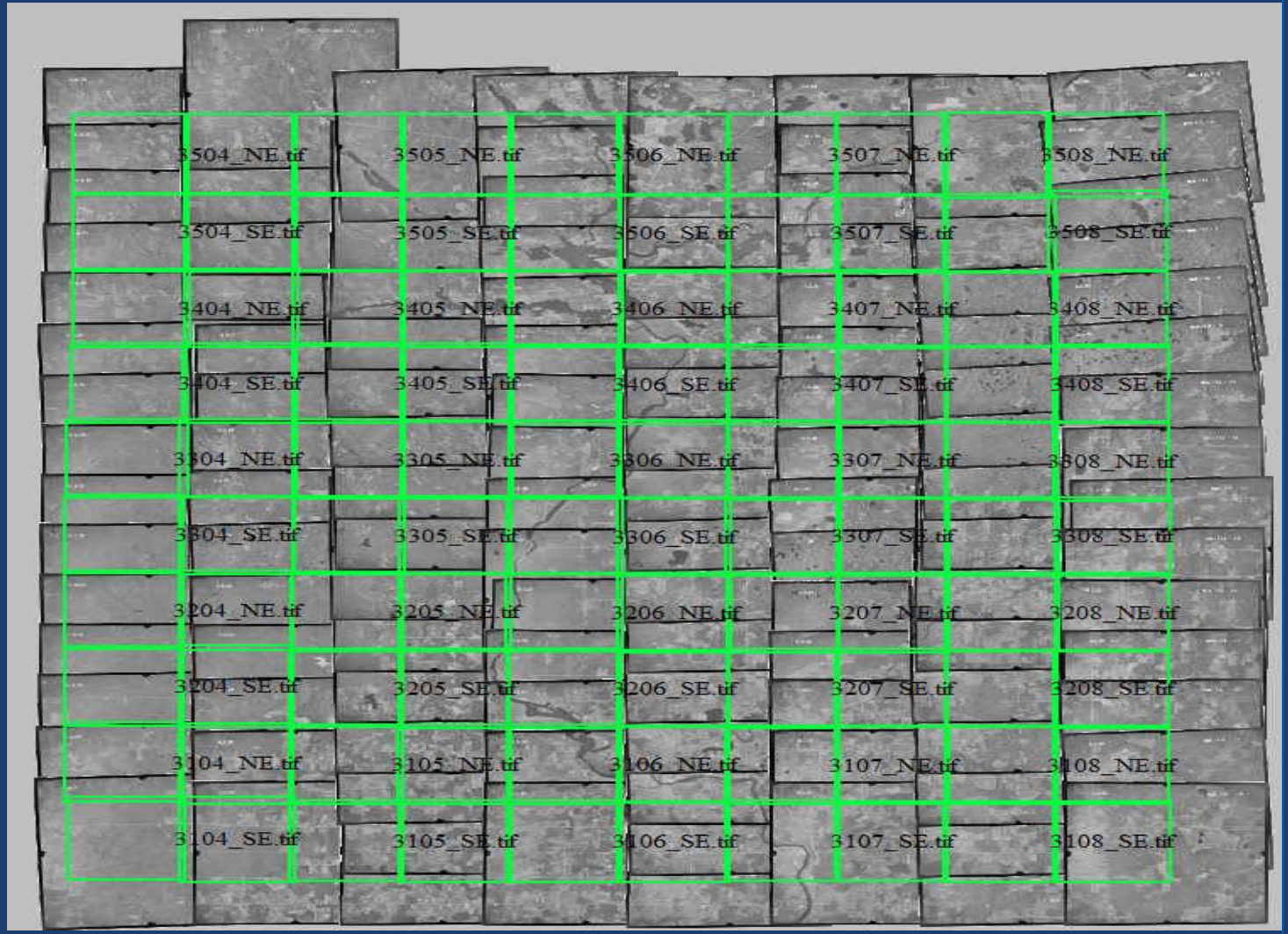
Rectification/Georeferenced Mosaic

- Mosaicing
  - Tile generation
  - Follow PLSS sections: 9 section, 4 section, 1 section
  - Custom client scheme



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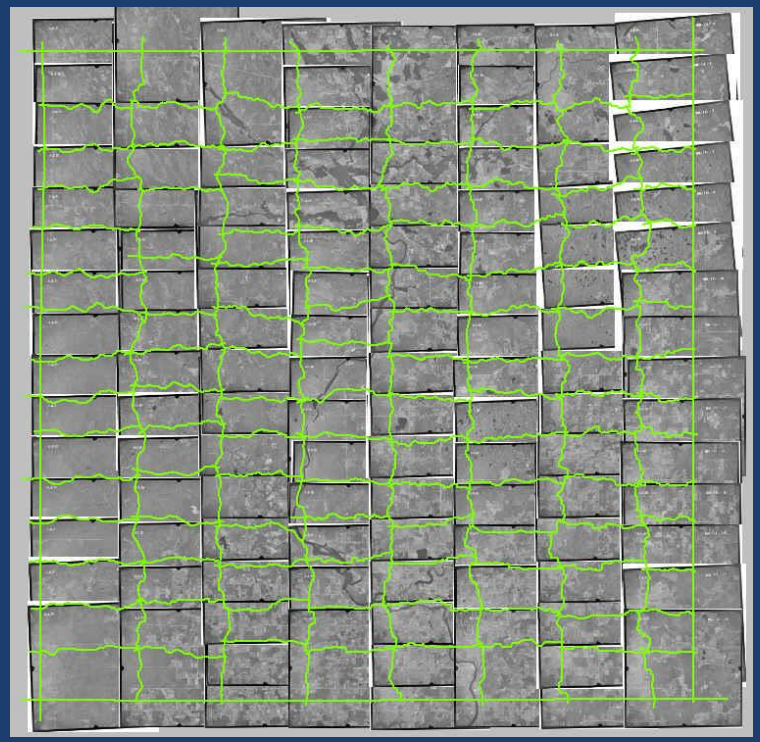
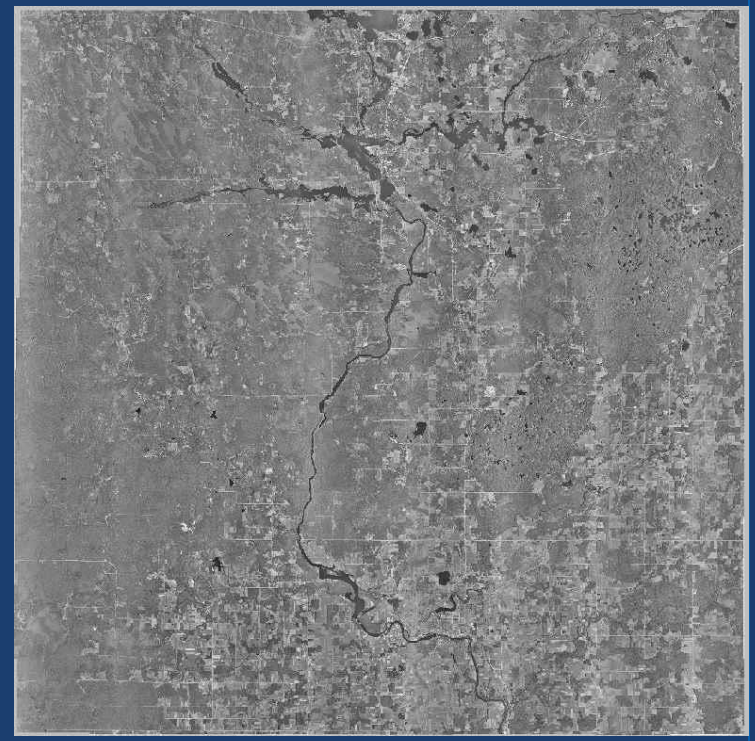
Rectification/Georeferenced Mosaic

- Mosaicing
  - Final QC by Technician
    - Image artifacts
    - Seamline issues
    - Localized tone and contrast issues
    - Expected accuracy based on registration method
  - Final Products
    - GeoTiff Tiles
    - Compressed Tiles
      - Mrsid
      - ECW
      - JPG2





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Project Summary and Results

- Lincoln County, WI 1970 Summary
  - Negative film scanned by USDA in Salt Lake City, UT
  - Flown at 1:40,000 (1”=3,333’ Negative Scale)
  - AT and rectification method
  - 2015 PID ortho control (2.4’ horizontal)
    - XY picked off imagery
    - Z applied with lidar DEM 2015
  - Rectified to generalized lidar DEM to 2’ pixel resolution
  - Manual seamlines and tone balanced
  - Tiled to 9 PLSS section tiles

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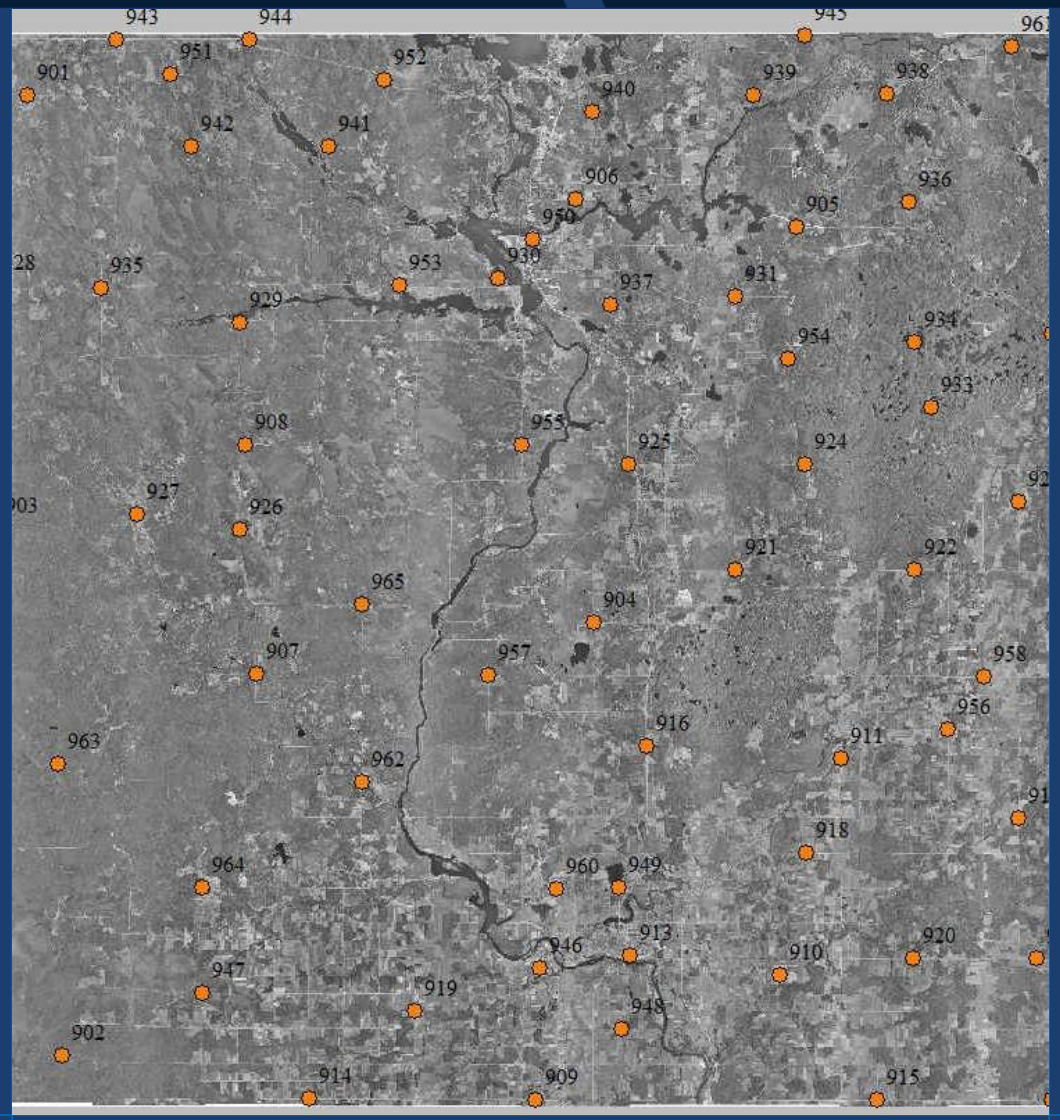
Project Summary and Results

- Lincoln County, WI 1970 Summary
  - 65 points used to verify relative accuracy
  - Relative horizontal accuracy compared to 2015 ortho = **12.4'** at 95% confidence
  - In between ASPRS Class II and Class III 60cm horizontal accuracy standard (9.6' to 14.4')

954	420690.401	211265.6587	84.479996	0.826281	85.306277
955	380780.2913	198366.8702	0.519841	39.428353	39.948194
956	444547.2057	155874.5328	5.835606	3.706010	9.541617
957	375679.0103	164042.541	20.793600	46.329804	67.123404
958	449834.6391	163727.1081	0.269465	2.068132	2.337596
959	457710.4267	121460.2947	2.443907	21.024976	23.468883
960	385990.0315	132049.0321	61.489122	0.047480	61.536603
961	454064.1863	258168.0769	20.123299	0.289767	20.413066
962	356735.2008	148029.4053	4.150184	28.053972	32.204155
963	311342.5794	150732.6998	112.262501	112.262501	224.525002
964	332891.3756	132278.8834	25.914208	193.613310	219.527518
965	356816.189	174601.0005	0.135792	0.135792	0.271584
				MEAN sq.	51.348714
				RMSE	**7.165802**
				NSSDA @ 95%	12.402570



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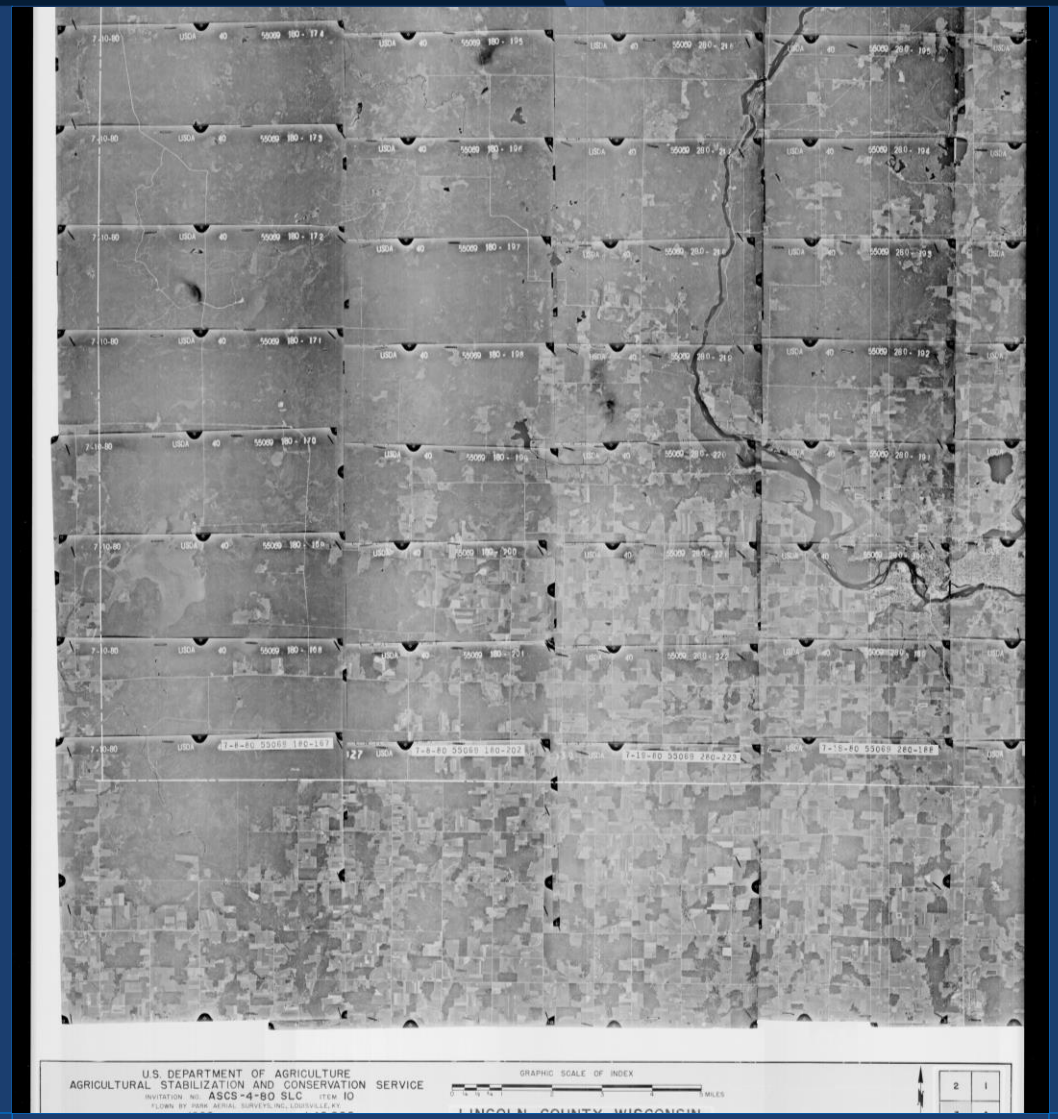

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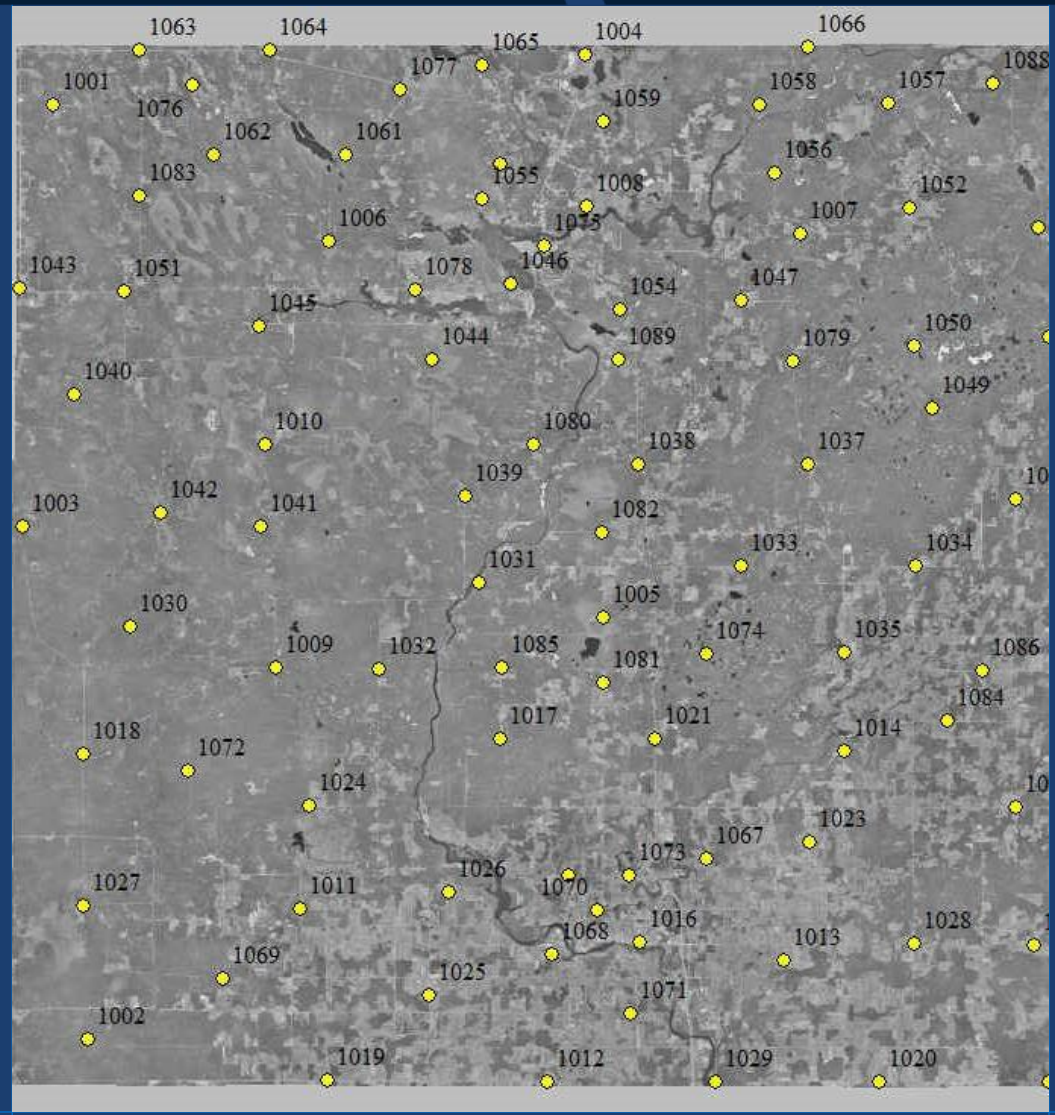
Project Summary and Results

- Lincoln County, WI 1980 Summary
  - 90 points used to verify relative accuracy
  - Relative horizontal accuracy compared to 2020 ortho = 10.8’ at 95% confidence
  - Very close to ASPRS Class II 60cm horizontal accuracy standard (9.6’)
    - 2 outlying points from meeting Class II

1081	391518.6601	161690.9031	0.199273	2.499561	2.698834
1082	391286.8241	184996.6003	69.079370	15.283408	84.362778
1083	319961.768	236763.9963	0.656748	12.212928	12.869676
1084	444544.79	155876.4579	16.578741	87.538478	104.117219
1085	375674.4503	164049.3476	1.597696	30.953645	32.551341
1086	449834.12	163725.67	4.658691	41.566388	46.225078
1087	457711.99	121464.88	12.068676	62.083368	74.152044
1088	451564.65	254019.22	56.172027	8.795970	64.967997
1089	393874.84	211582.31	10.966032	16.749375	27.715407
1090	385982.19	132049.25	1.273738	20.871192	22.144930
				MEAN sq.	39.581028
				RMSE	**6.291346**
				NSSDA @ 95%	10.889061

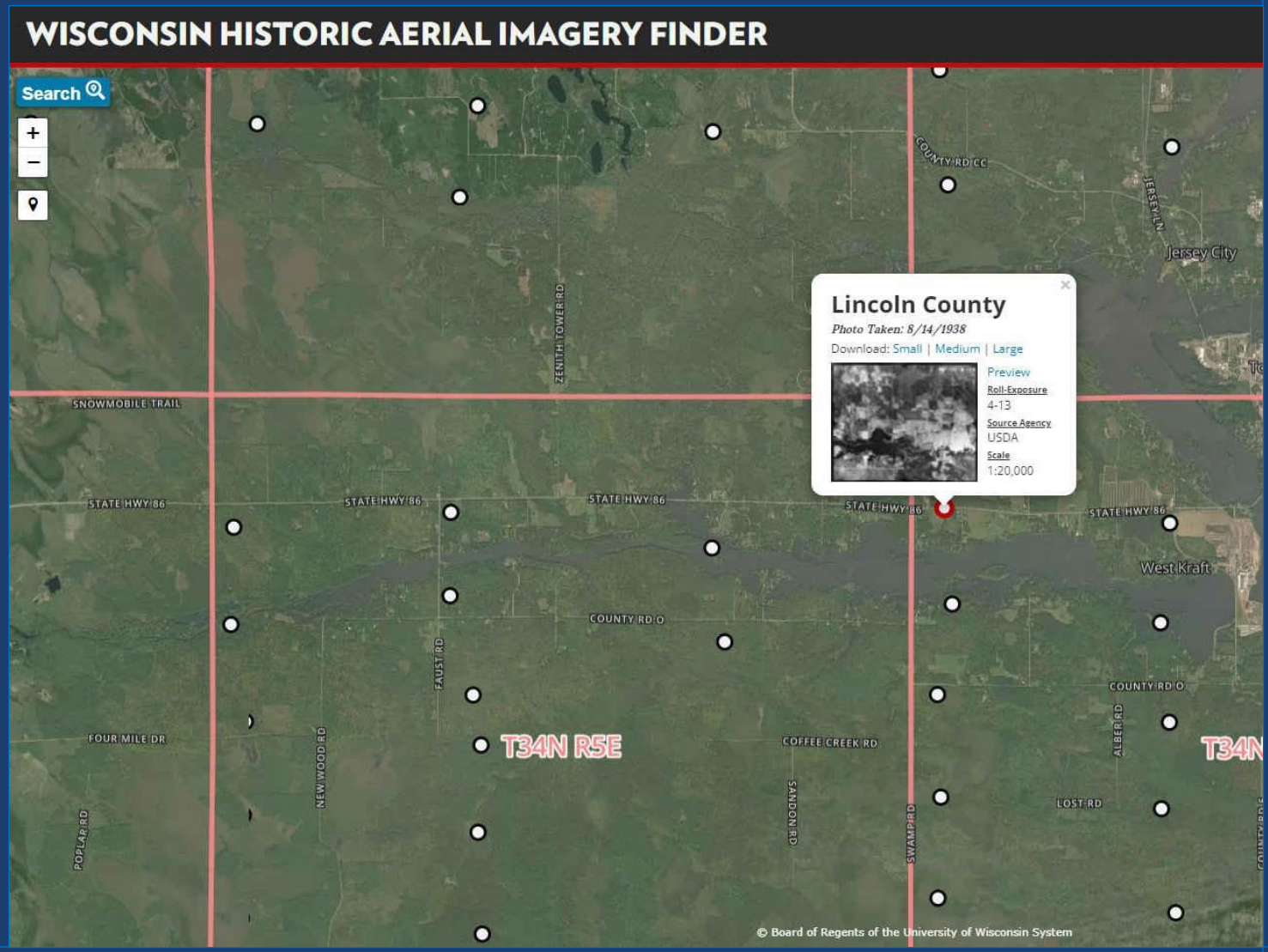


AYRES GEOSPATIAL

Ingenuity, Integrity, and Intelligence.

Project Summary and Results

- Lincoln County, WI 1938 Summary
  - Contact prints desktop scanned by Arthur H. Robinson Map Library at 600 dpi
  - 1:20,000 (1”=1,666’ negative scale)
  - Georeferencing method
  - Minimum 9 points per image used for registration
  - Manual seamlines and tonal balance
  - 1’ pixel resolution tiled to 4 PLSS section tiles.

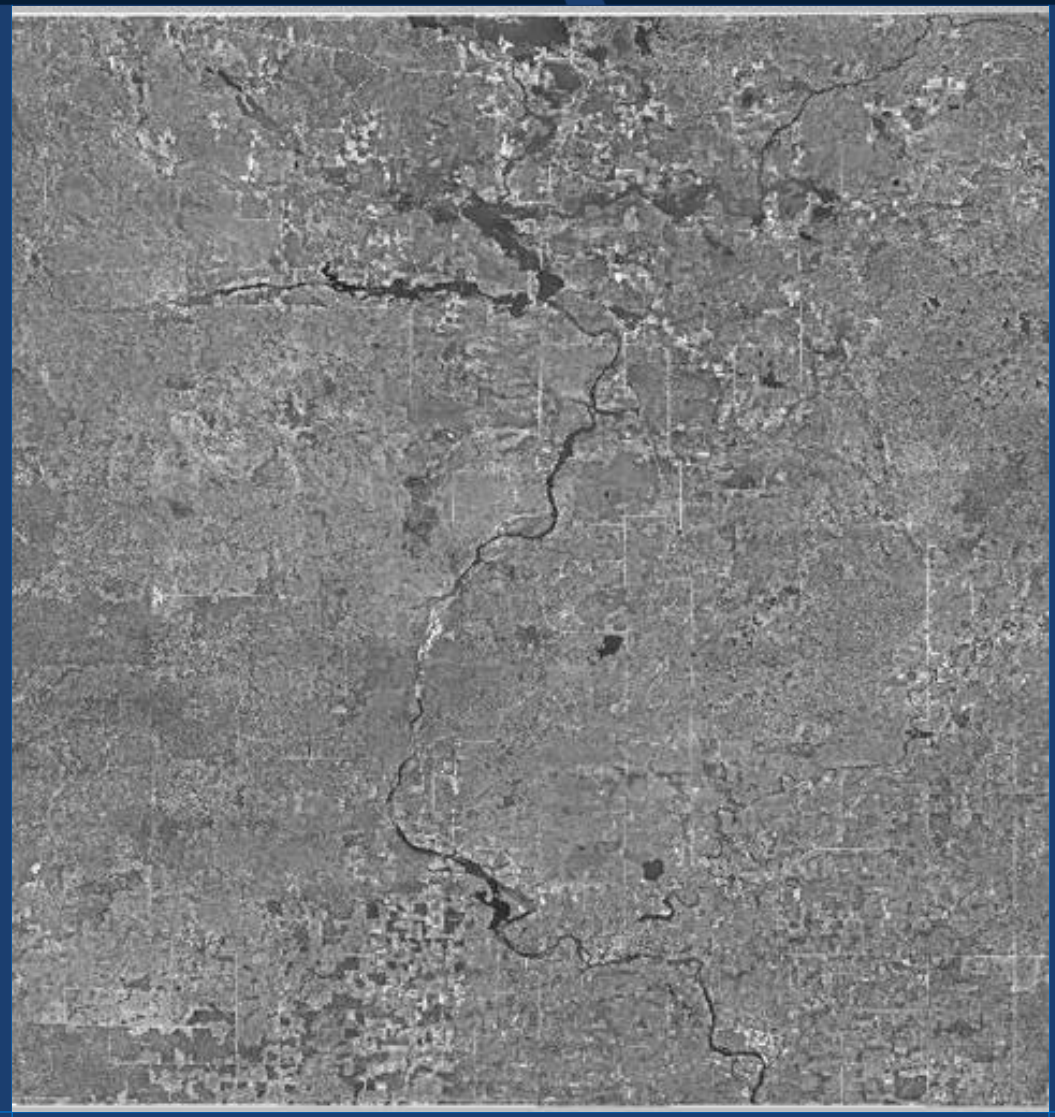


AYRES GEOSPATIAL

Ingenuity, Integrity, and Intelligence.

Project Summary and Results

- Lincoln County, WI 1938 Summary
  - Estimated accuracy of +/- 30’ horizontal relative to 2020 ortho
  - Very good in spots close to registration areas
  - Not as tight in areas in between registration areas
  - Limited accuracy based on number of registration points
  - Still a good product for reference given input media and era of flight



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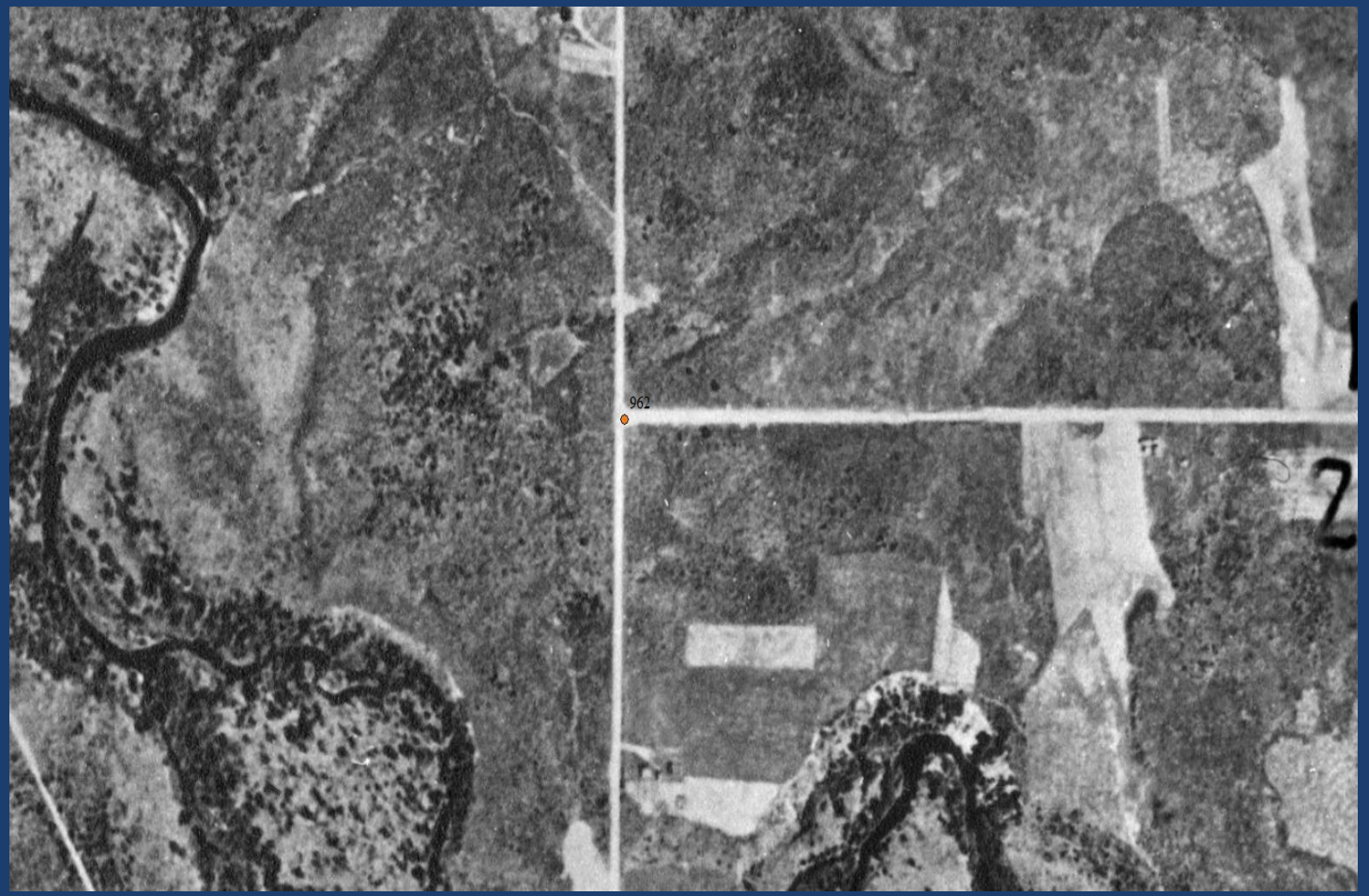
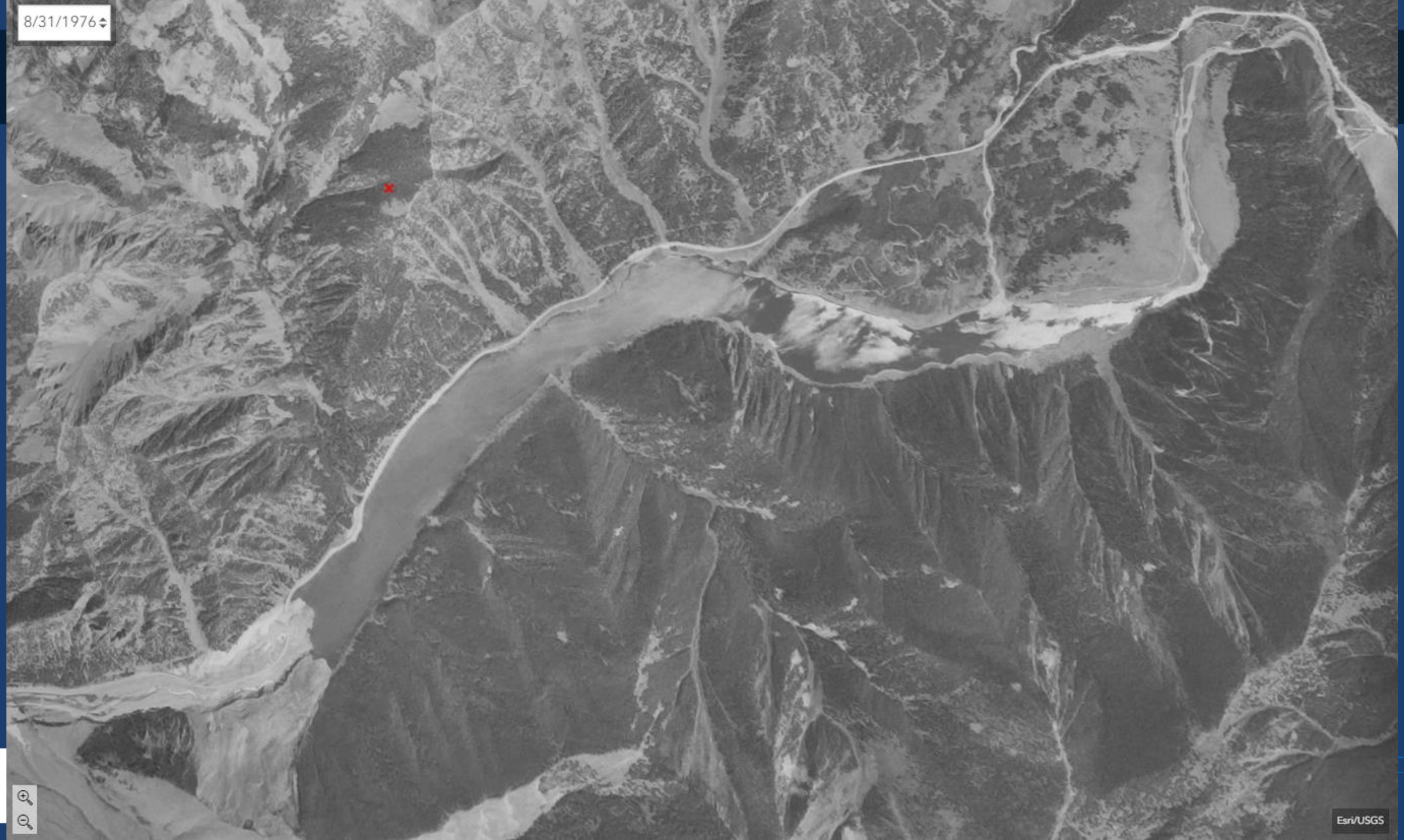
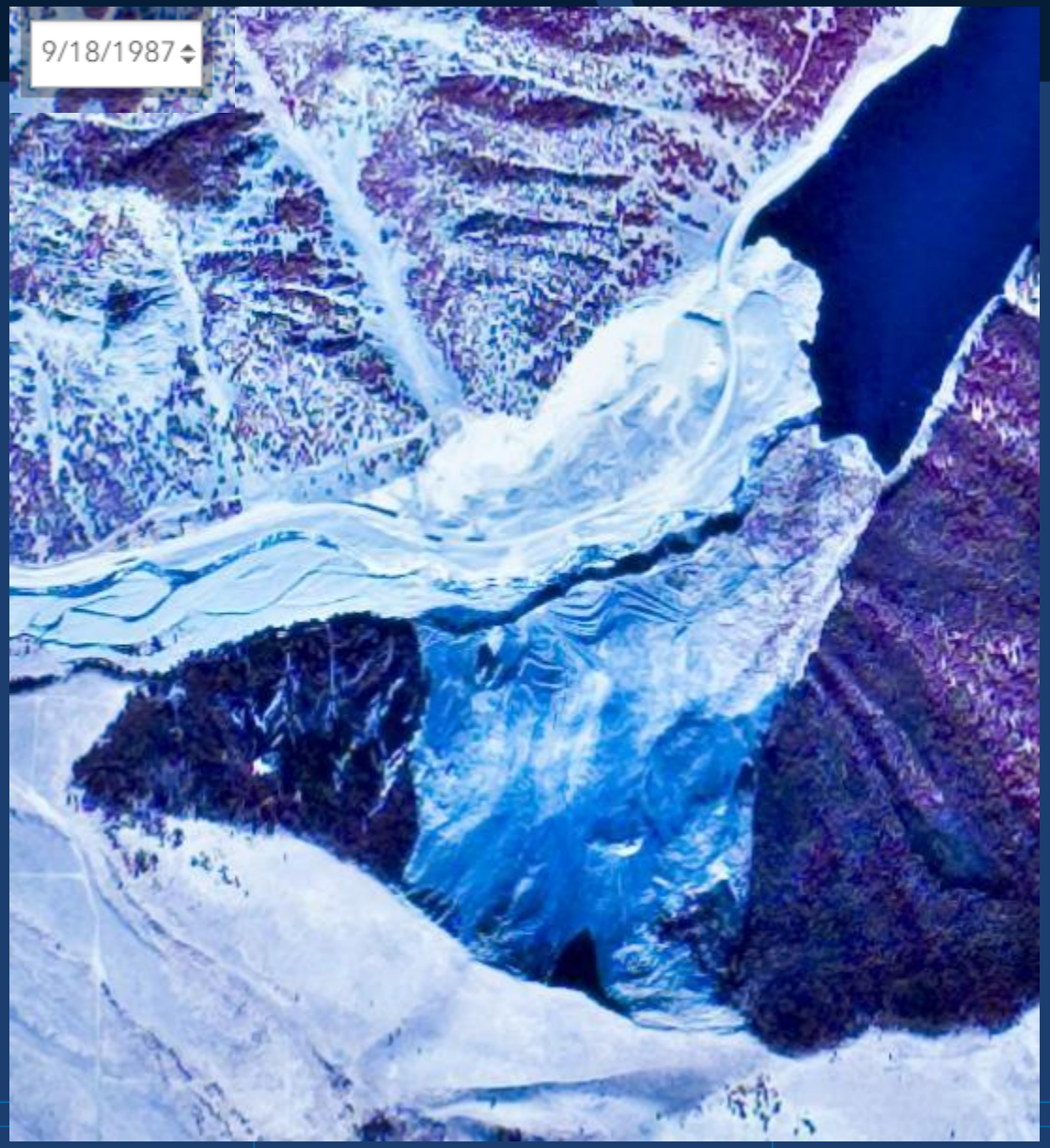



9/13/1954


8/31/1976
Esri/USGS


Campfire
Lodge Resort
Hwy 287
287
Beaver Creek
Campground
Earthquake Lake
287
Montana Spirit
Guest Lodge


7/11/1947


9/18/1987

Prairie River Dam Removal

1938

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Prairie River Dam Removal

1970

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Prairie River Dam Removal

2020

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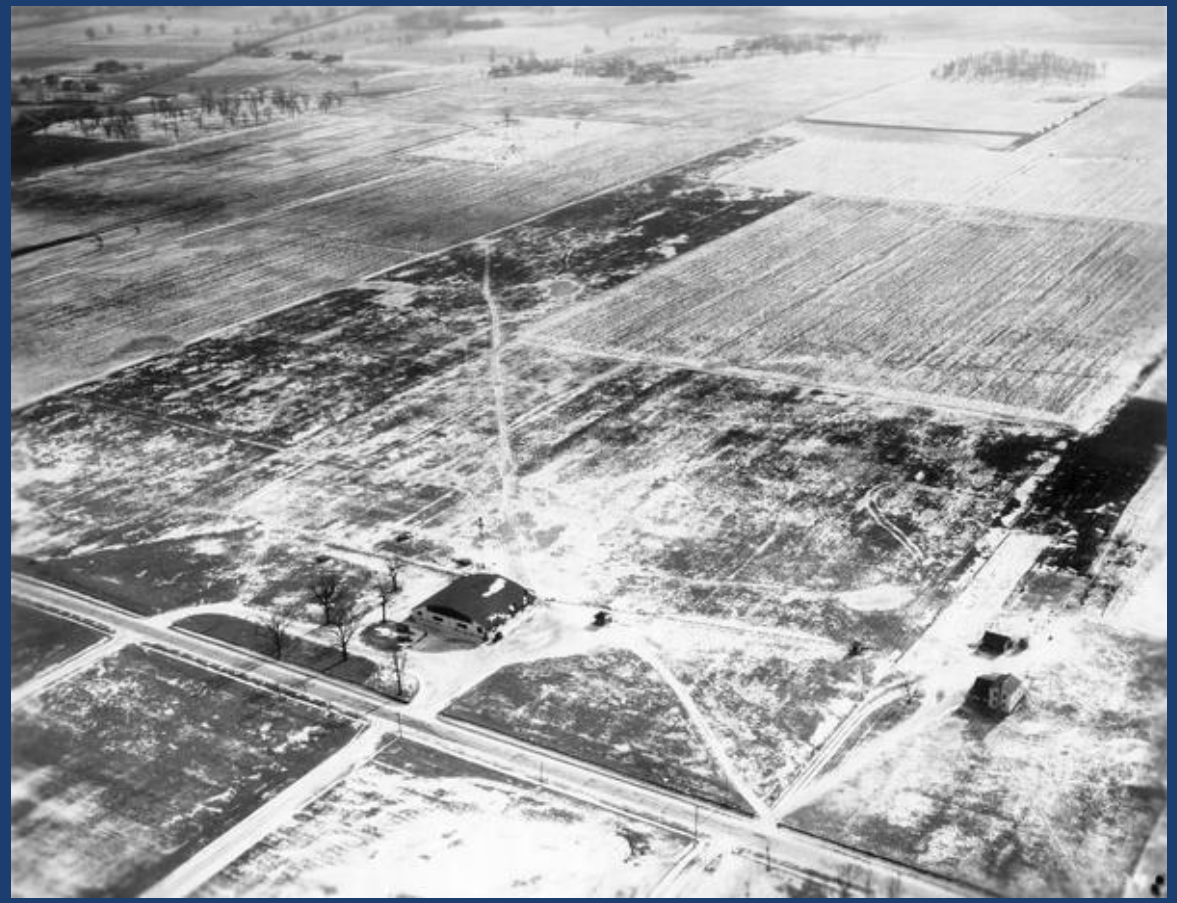
Wittman Regional Airport- Winnebago Co., WI

1934-37



https://www.wisconsinhistory.org/Records/Image/IM11373

Wittman Regional Airport- Winnebago Co., WI 1957

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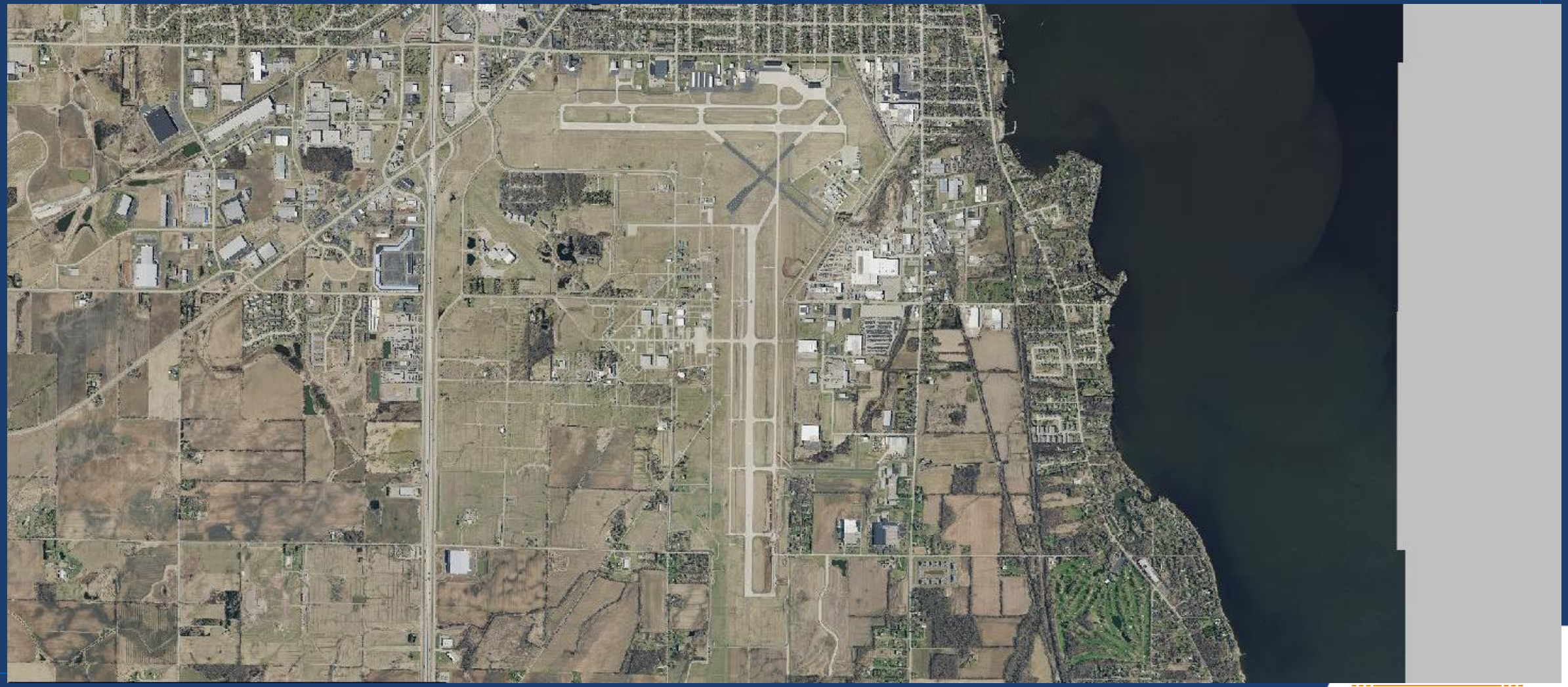
Wittman Regional Airport- Winnebago Co., WI 2020



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Questions?

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