Oklahoma Oilfields From the Air: Historical Aerials and LiDAR

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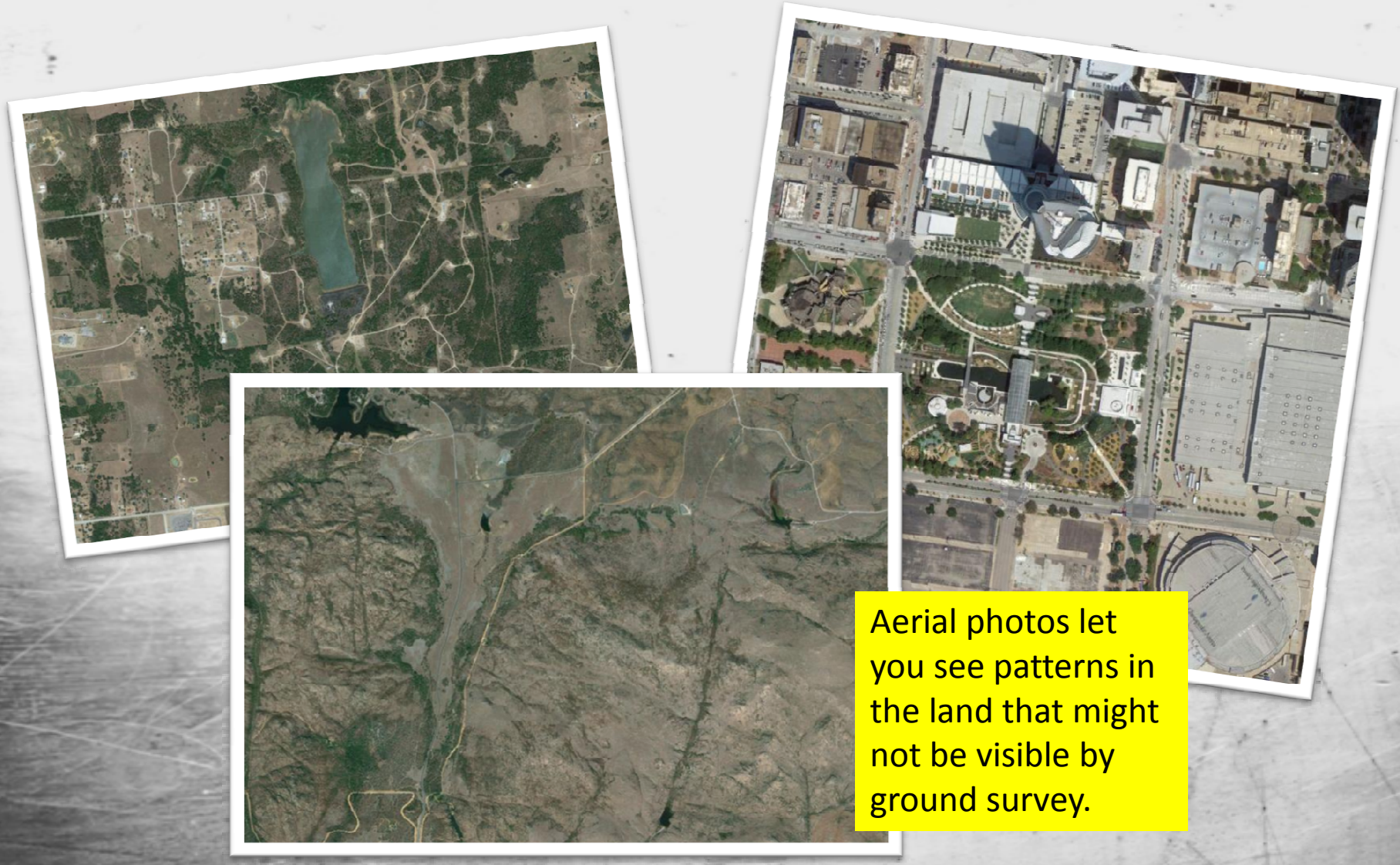
Oklahoma Corporation Commission

Oklahoma from the ground

Oklahoma from the air



Aerial photos let you see patterns in the land that might not be visible by ground survey.

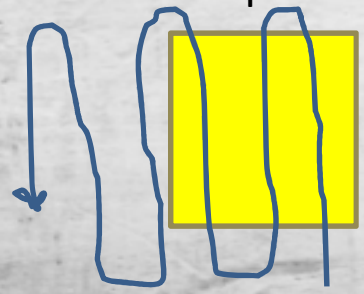
Aerial photos from Google Maps

Part I: Historical Aerial Photos

Their Creation

- May 12, 1933 – President Franklin D. Roosevelt signed the USDA Agricultural Adjustment Act into law
- Since the 1930s, the USDA-AAA, now the Farm Services Agency, has been acquiring aerial photos of the United States, by county

- Photos mostly used to assess nation's agricultural resources, *but they have many other uses*
- North-south "flights" over counties, ~3 flyovers per township, 1:20,000 scale
- Planes were flown by private companies based in Tulsa and Oklahoma City, for the most part



Many of the negatives have been lost, and the hard copy prints are becoming worn, faded, and lost to forgetful borrowers

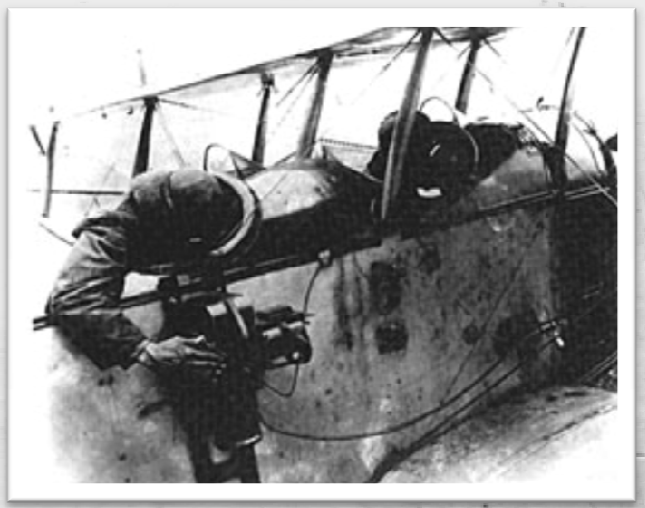
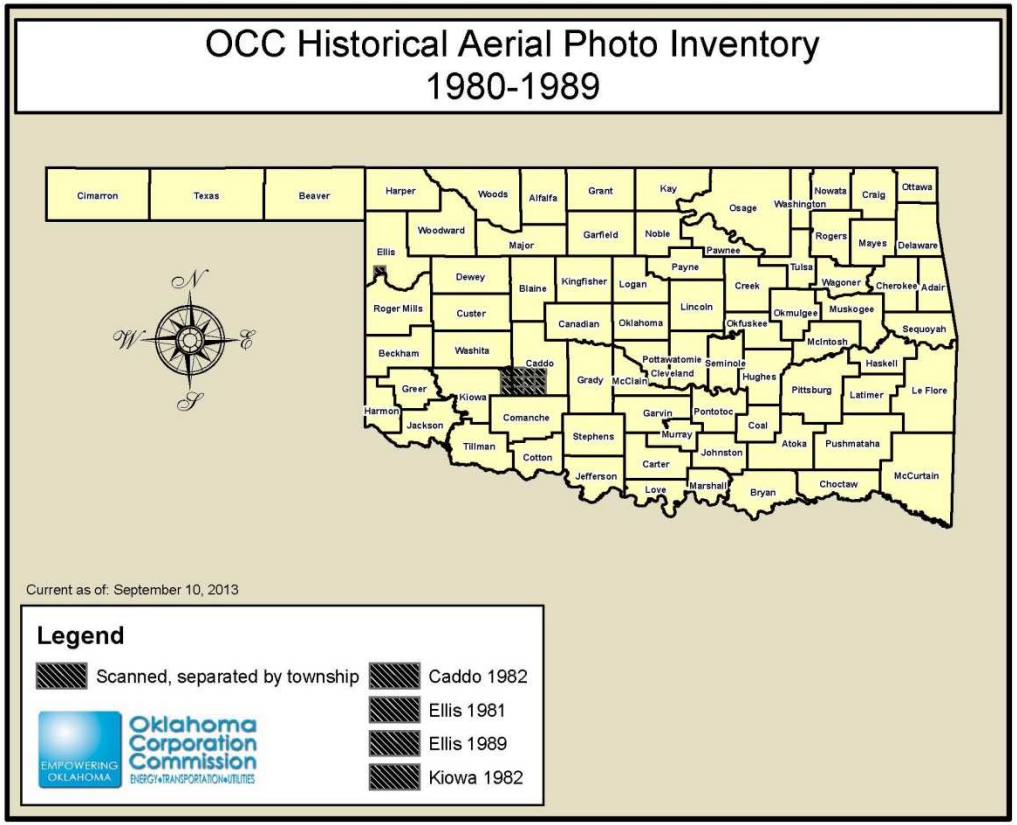


Photo and history:
http://www.isgs.uiuc.edu/nsdihome/webdocs/ilhap/history.html

The OCC's Aerial Photo Collection

Our goal is to scan, georeference, and DIGITALLY PRESERVE the state's aerial photos for public and OCC use.



What Else is Out There

Oklahoma Geological Survey- Aerial Photo Inventory			
County	Year(s) Available	OCC - ODL Year(s) Available	ODEQ Years(s) Available
Adair	1939, 1964	1939, 1952	1954
Alfalfa	1941*, 1954, 1966	1941*, 1961	1955
Atoka	1934, 1935, 1939, 1940, 1949,	1939, 1962	1958
Beaver	1936, 1941	1941	1959
Beckham	1941, 1950, 1955	1941	
Blaine	1941, 1951, 1957, 1964	1941, 1951	1957
Bryan	1948, 1953, 1962, 1969, 1974,	1940	1962, 1963, 1969, 1970
Caddo	1937, 1940*, 1948, 1955, 1956,	1940*	
Canadian	1937, 1941, 1951	1941	1957
Carter	Unknown Dates (8 Scans), 1935, 1936, 1937, 1940 (1 Scan), 1941, 1949, 1954, 1956, 1963 (1 Scan), 1969	1949*	1956
Cherokee	1938, 1964	1938, 1958	1964
Choctaw	1949, 1962, 1969, 1972, 1977	1942, 1955	1969
Cimarron	1959, 1960	1942*	1959, 1960
Cleveland	1937, 1940, 1949, 1951 (1 Scan	1943, 1957*	1969
Coal	1940, 1949, 1955, 1956, 1962,	1940	1955
Comanche	1930's, 1942, 1950, 1961	1942, 1957(west only)	1957
Cotton	1950, 1957	1942	1957
Craig	1935, 1941, 1952, 1958, 1964,	1941, 1958	1952
Creek	1941, 1956	1956*	1969
Custer	1940, 1955	1940, 1955	1966
Delaware	1958	1939	1952
Dewey	1941, 1951, 1957	1941	1957
Ellis	1951, 1959, 1965, 1973, 1981,	1937, 1951	1959
Garfield	1937, 1954	1937*	1954
Garvin	1937, 1940, 1949, 1956, 1963, 1969	1940*	1956
Grady	1935, 1940, 1948, 1955, 1962,	1940*	1955
Grant	1941, 1954, 1966	1941, 1954	1954
Greer	1950, 1957	1941, 1957	1957
Harmon	1943, 1950, 1957	1943, 1957	
Harper	1951	1942, 1951	1959
Haskell	1952, 1973	1939, 1952	1964
Hughes	1938, 1940, 1955, 1956, 1962,	1938/40*	1955
Jackson	1941, 1950, 1957, 1964	1941, 1957	1957
Jefferson	1940*, 1950, 1957, 1971	1940*	
Johnston	1937, 1940, 1949, 1954, 1963,	1940	1956
Kay	1938, 1966	1937*	1954
Kingfisher	1951, 1957	1937*	1957
Kiowa	1942, 1964, 1982	1942, 1957	1957, 1964
Latimer	1940, 1955, 1967, 1977	1940	1955
Le Flore	1938, 1952, 1955, 1963, 1964,	1938, 1952	1963
Lincoln	1937, 1943, 1951, 1954, 1961	1943*	1954
Logan	1937, 1951, 1957*	1937, 1951	1957
Love	1940, 1949, 1954, 1956, 1968	1949	1956
McClain	1940, 1949, 1955, 1956, 1963	1940	1969
McCurtain	1938, 1940, 1955, 1961, 1963,	1938, 1955	1955
McIntosh	1938, 1939, 1949, 1956, 1978	1938, 1949*	1956
Major	1942, 1954, 1966	1942	
Marshall	1937, 1942, 1953, 1956, 1968,	1937, 1949/56*	

Oklahoma Geological Survey- Aerial Photo Inventory			
County	Year(s) Available	OCC - ODL Year(s) Available	ODEQ Years(s) Available
Mayes	1935, 1952, 1958, 1973	1935, 1940, 1958	1952
Murray	1937, 1963, 1969	1940*, 1956	1963
Muskogee	1941 (1 Scan), 1952, 1964	1941, 1952*	1964
Noble	1937, 1954, 1961, 1966	1937, 1961	1954
Nowata	1937, 1941, 1952	1941	1952
Okfuskee	1943, 1956, 1961	1943, 1961*	1954
Oklahoma	1941, 1951, 1957	1941*, 1957*	
Okmulgee	1949, 1956, 1963	1941, 1963	1956
Osage	1936, 1954, 1961, 1966	1937, 1954	1954
Ottawa	1939	1939	
Pawnee	1938, 1954, 1961, 1966	1938	1954
Payne	1949, 1969	1938, 1956	1969
Pittsburg	1935, 1948, 1955, 1962, 1963,	1939*, 1962	1955
Pontotoc	1949, 1956*, 1967, 1977	1938/40*	1956
Pottawatomie	1943, 1954, 1956, 1968	1943*	1954
Pushmataha	1935, 1940, 1942, 1955, 1961,	1940	1955
Roger Mills	1955	1940*, 1955	1966
Rogers	1935, 1936, 1941, 1952, 1958, 1964, 1972	1941, 1952	1958
Seminole	1938, 1963, 1969	1956*	1969
Sequoyah	1938, 1952, 1958, 1964	1938	1952
Stephens	1935, 1940, 1949, 1956, 1963,	1940, 1956*	1969
Texas	1959	1941	1959
Tillman	1937, 1950, 1957, 1964	1942*, 1957	1957
Tulsa	1964	1943*	1958
Wagoner	1936, 1937, 1940, 1952, 1958,	1940, 1952	1964
Washington	1961, 1966*	1941*, 1954	1961
Washita	1937, 1940, 1950, 1955	1940	1955
Woods	1942, 1951, 1959	1937	1959
Woodward	1951	1937, 1951	
Verdigris River Watershed	1936	0	
Washita River Watershed	1937	0	

RED Font = Have on hand * = Georeferenced

Green Font = OGS Scanned Aerials

Blue Font = Scanned Aerials (Partial Files Only)

Their Use

Historical aerial photos let you identify changes in land patterns over time. For example:

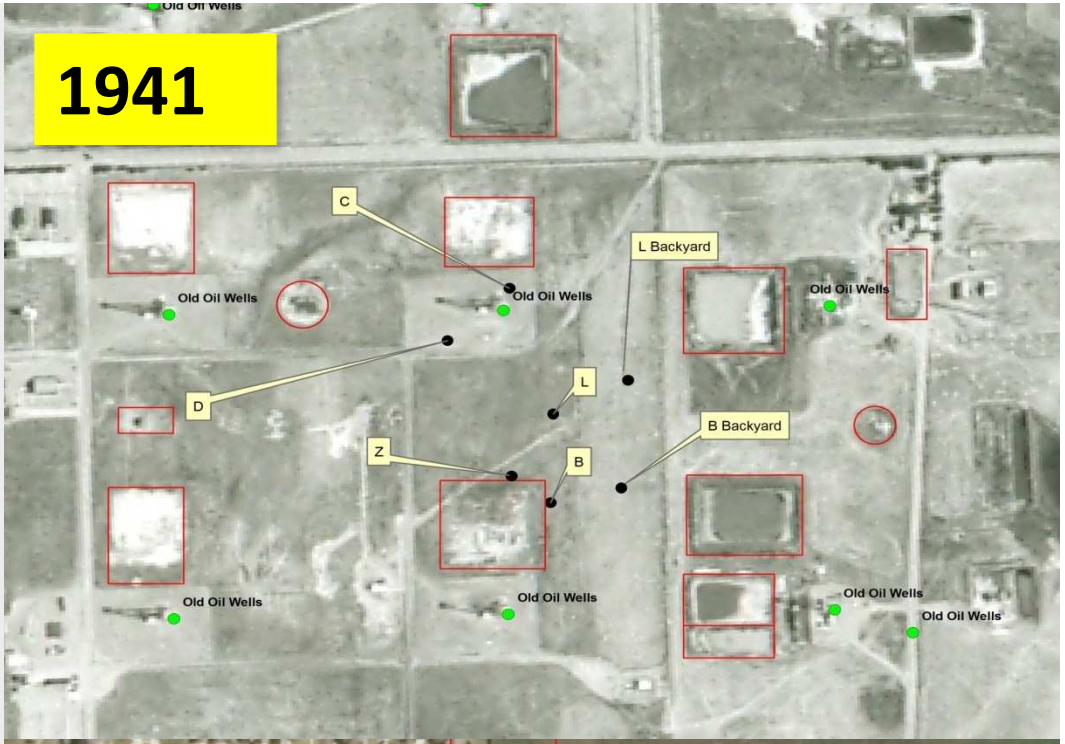
- Land cover/land use change
- Natural disaster effects
- Tracking pollution events

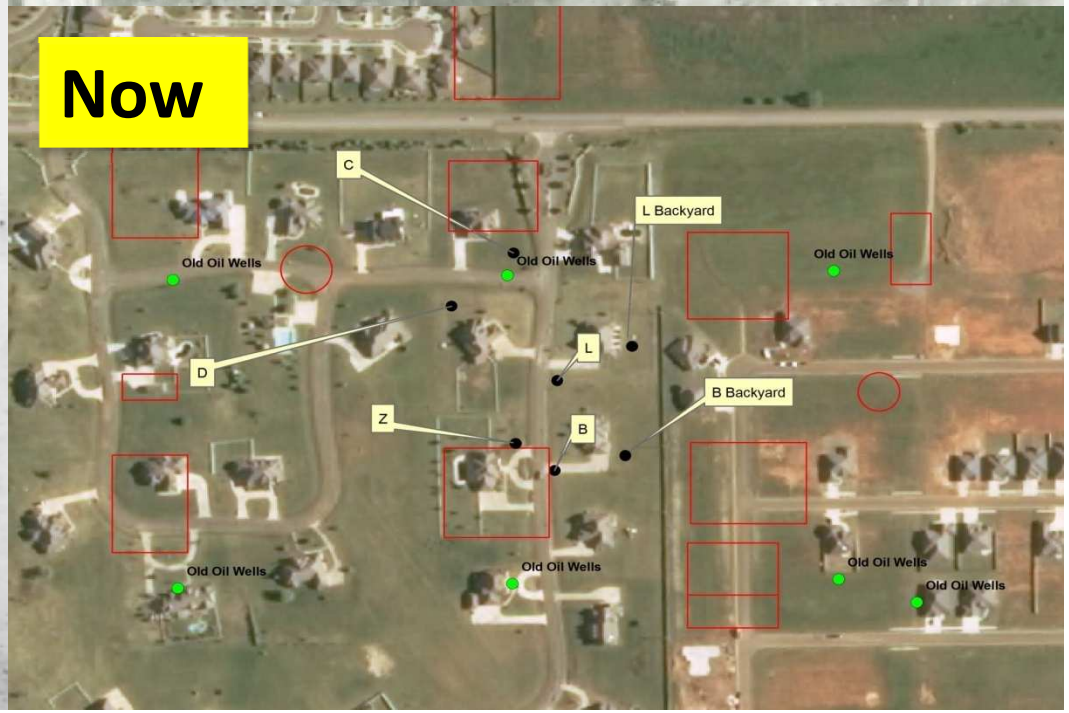
Example 1: "Why does my water taste salty?"

New neighborhood's water wells showed unusually high levels of salt.

OCC checked the historical aerial photo and found old, unlined saltwater disposal pits, where very expensive homes with gravel-pack water wells are now located.

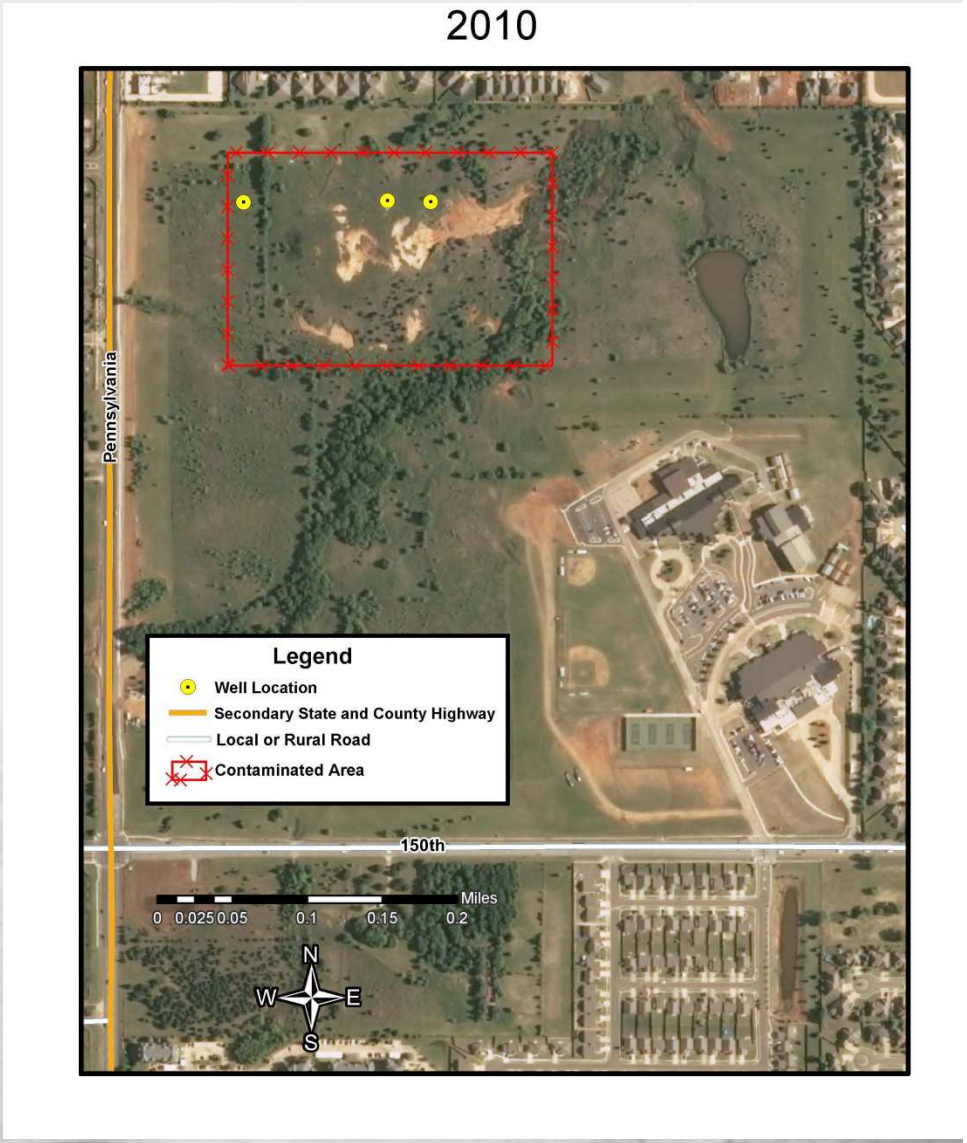
It would have been good for developers to know this ahead of time!



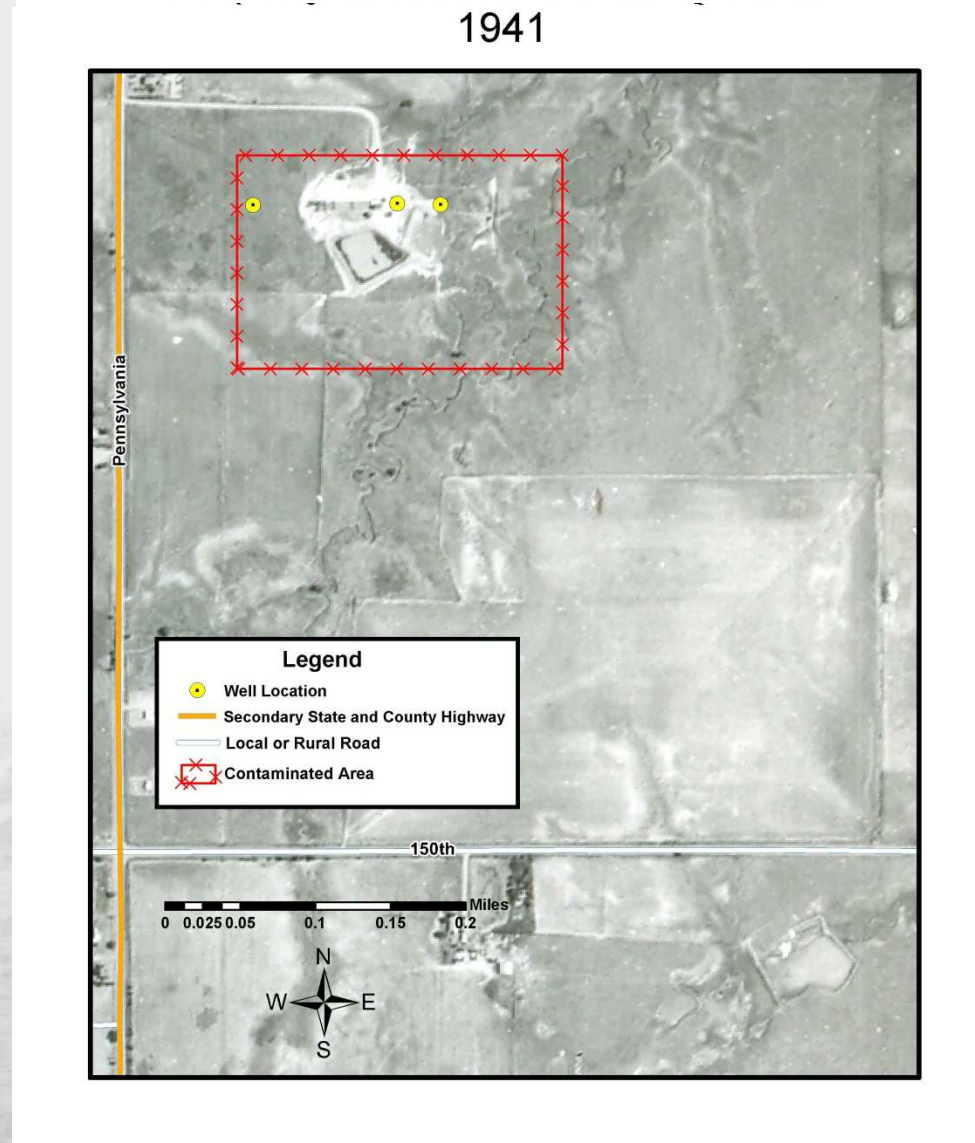


Example 2: Finding a Responsible Party

- Brownfields site
- Open to new development (commercial shopping malls, residential neighborhoods, etc.)
- We did some research into the site history to find when the damage occurred.



- Using aerial photos, we tracked the damage (bald spots) back to the 1950's when X Oil Company had a disposal well and pit on the site (visibly had spills).

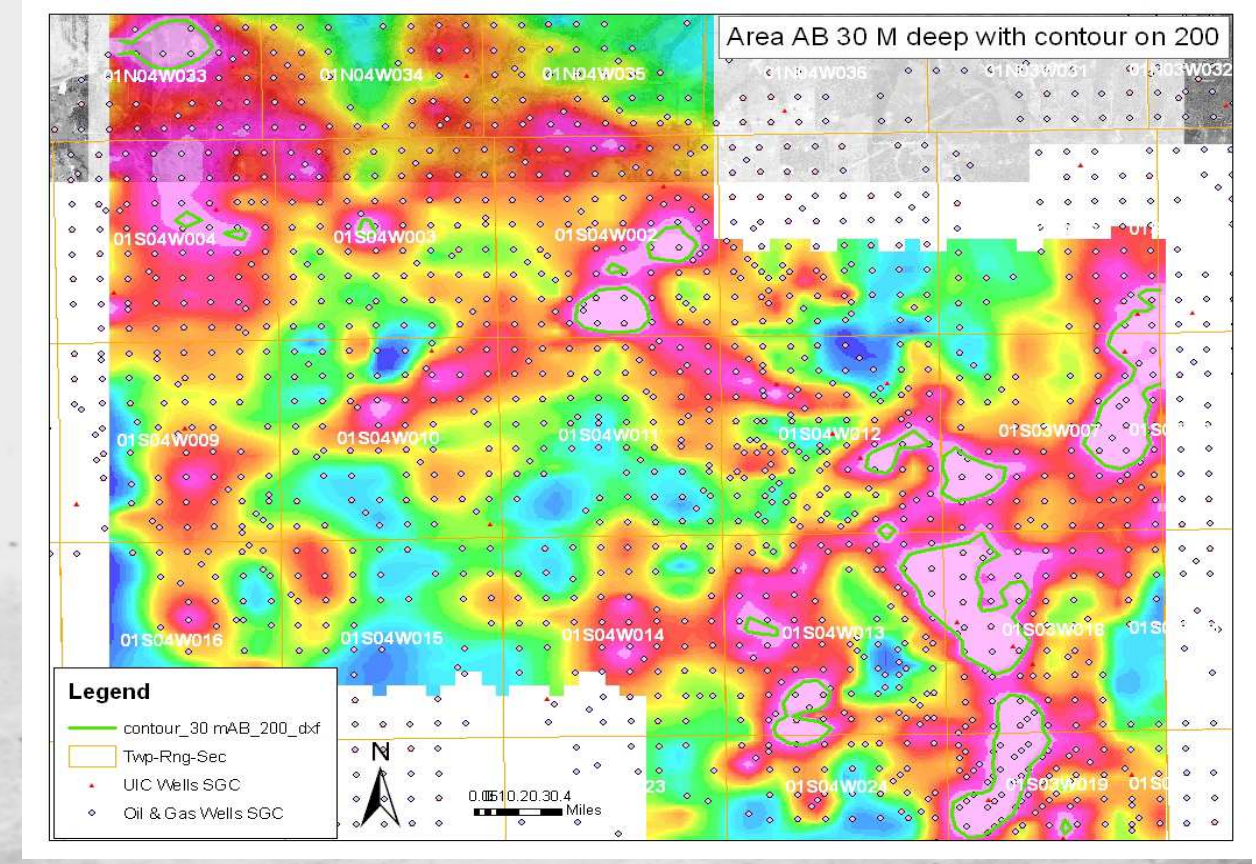


- Knowing what era to look for documents in, legal then found a document at the courthouse where the company had paid the adjoining landowner (just south of the pit, downhill) for damaging his agricultural property by letting salt water brine run across it.

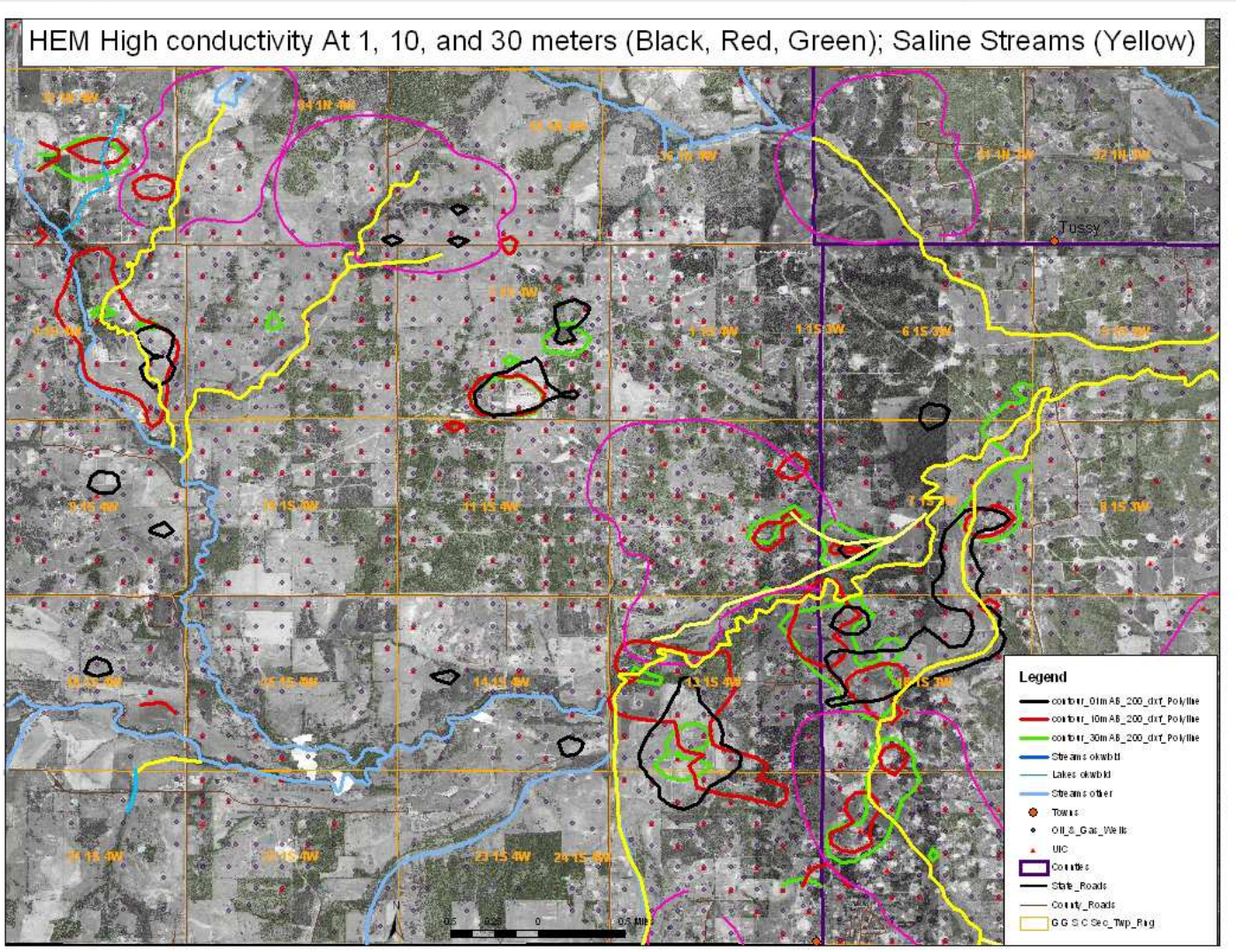
- We found a responsible party to clean up the mess and make the area ***safe*** for development!

Example 3: Combining Data Layers

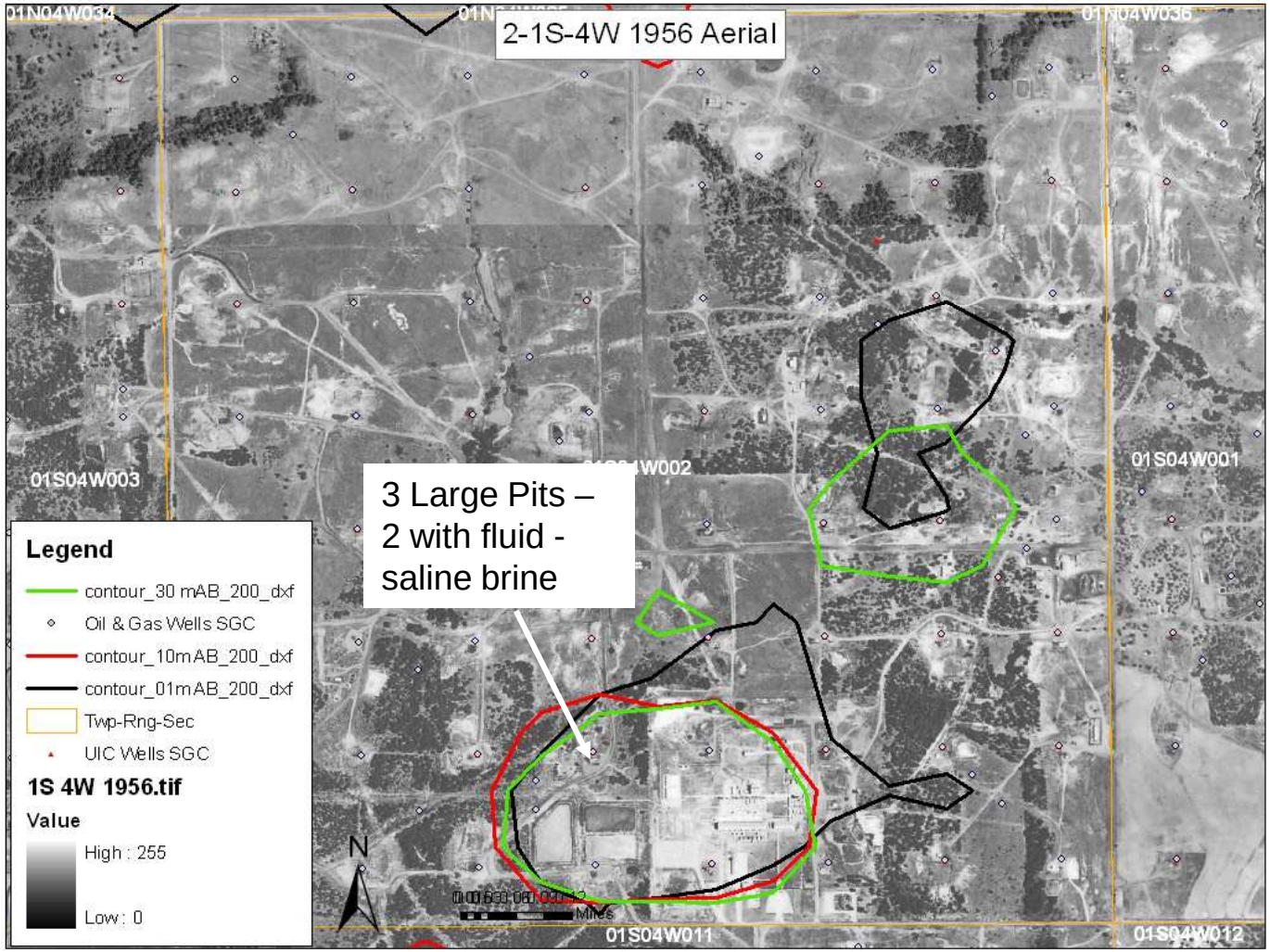
- Possible groundwater salinity problem at this site, a natural gas condensation plant (not known for salt problems).
- USGS made Helicopter ElectroMagnetic (HEM) maps for Corp Comm at 1, 5, 10, 20, 30, and 40 meters deep



- Using these, Bruce Smith (USGS) extracted outlines of high-conductivity anomalies at 1, 10, and 30 meters deep that exceed certain values (e.g. >200 mS/m)

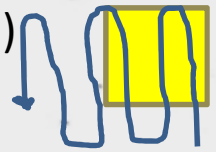


- Corp Comm overlaid the anomaly outlines on historic aerial photos to check for obvious potential sources

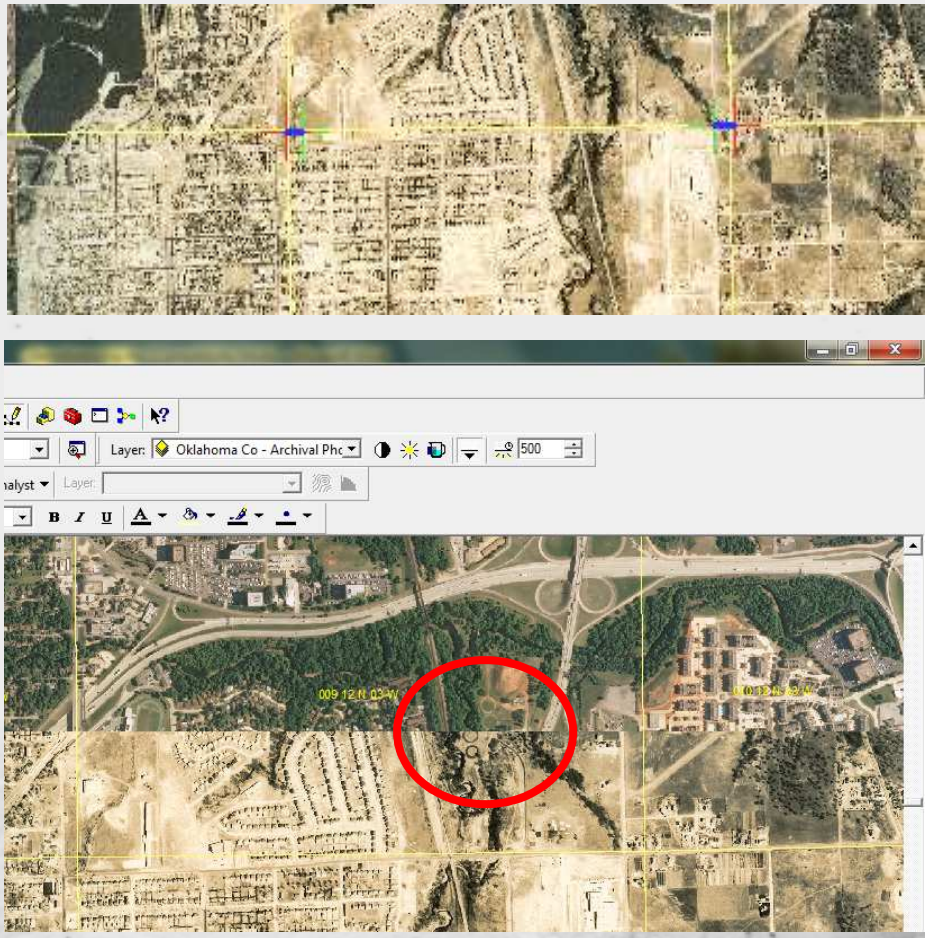


Our Process

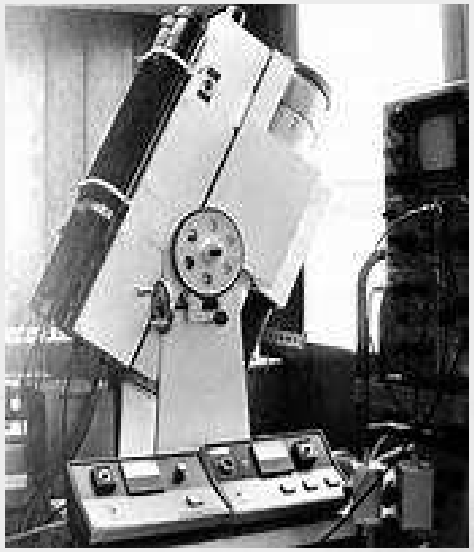
- Request hard-copy photos from ODL, OGS, ODEQ
- Scan them individually (4-section photos, 9 will cover a township)



- Georectify them
  - Look for landmarks
    - ***WE USE:*** *Roads, trees, small streams, buildings, visible forks in streams, whorls in the earth, city streets*
    - ***WE DO NOT USE****: Rivers, lake boundaries*
  - Use at least 4 control points
  - Use Nearest Neighbor resampling (fastest, works fine for our purposes)
  - Use 1st Order Polynomial (Affine) transformation
  - No specific RMSE, use “Swipe” tool instead



LiDAR (light detection and ranging)



LiDAR is a remote sensing technique. It uses laser light pulses rather than radio waves to collect data. It was developed in the 70's and implemented by NASA to measure atmospheric and oceanic properties.

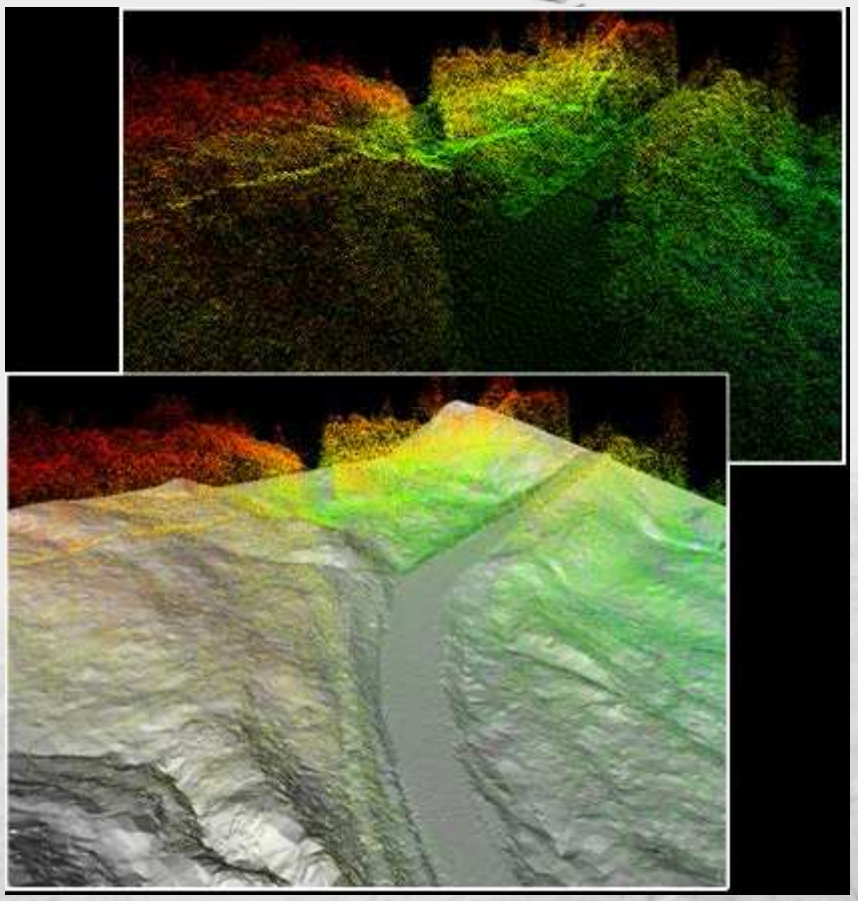
It was not used for topographic reasons until the mid 90's. Most software could not process the volume of data precisely.

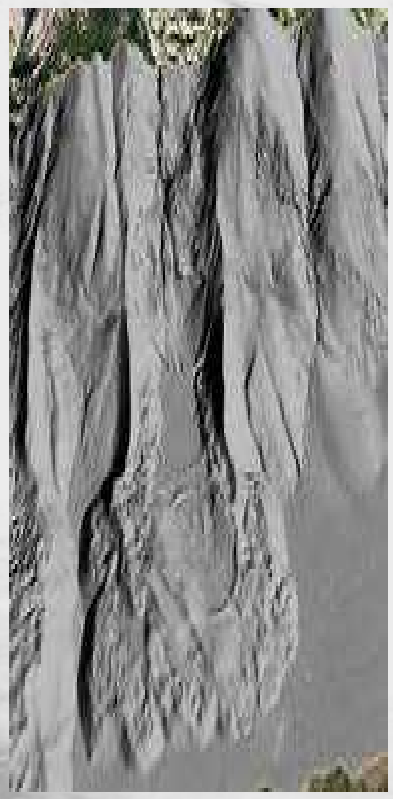
How does LiDAR work?

- Shines lights on a surface and measures the time it takes to return to the source.

- LiDAR uses pulses of laser light. Some up to 150,000 pulses per second

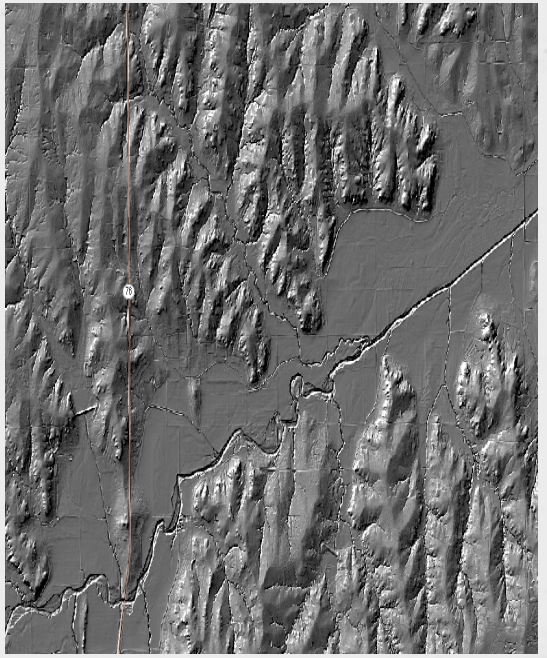
- Distance = (Speed of light * time of flight)/2



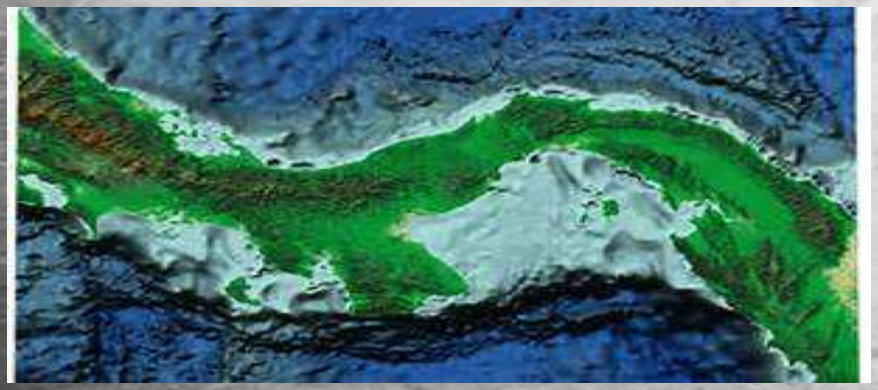


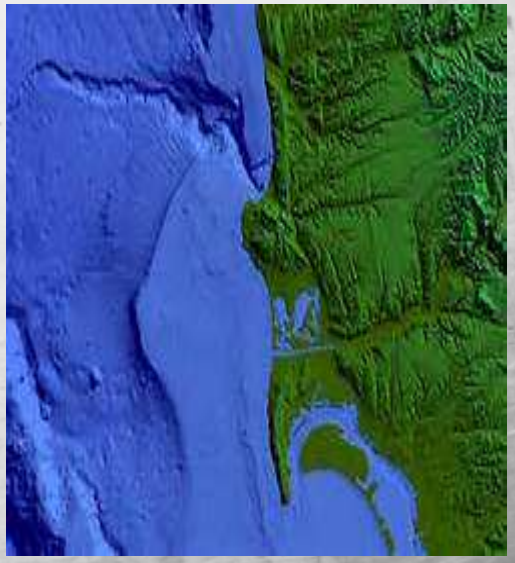
Two types of LiDAR

- **Topographic**
  - **near-infrared laser to map land**



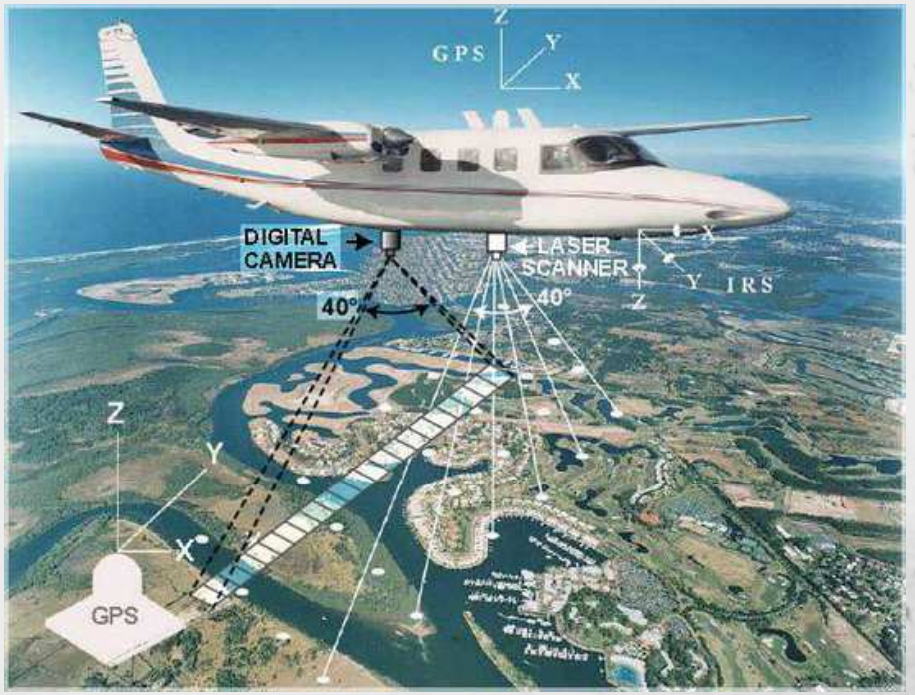
- **Bathymetric**
  - **water penetrating green light to measure seafloor and riverbed elevations**

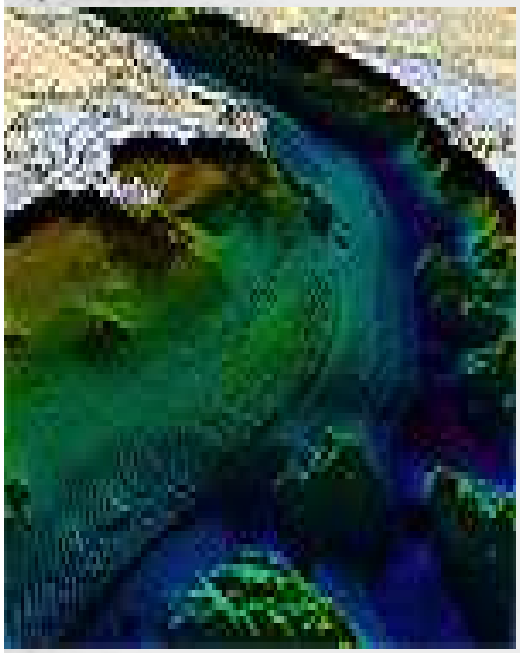




Methods of collecting LiDAR data

- **Airplanes or Helicopters**
- **Satellites**
- **Hand-Held Devices**
- **Robots/Rovers**





Uses for LiDAR

Mapping and Cartography

- high resolution and accuracy
- 3D aspect maps complex topography

Urban Planning

- digital city models

Coastline Management

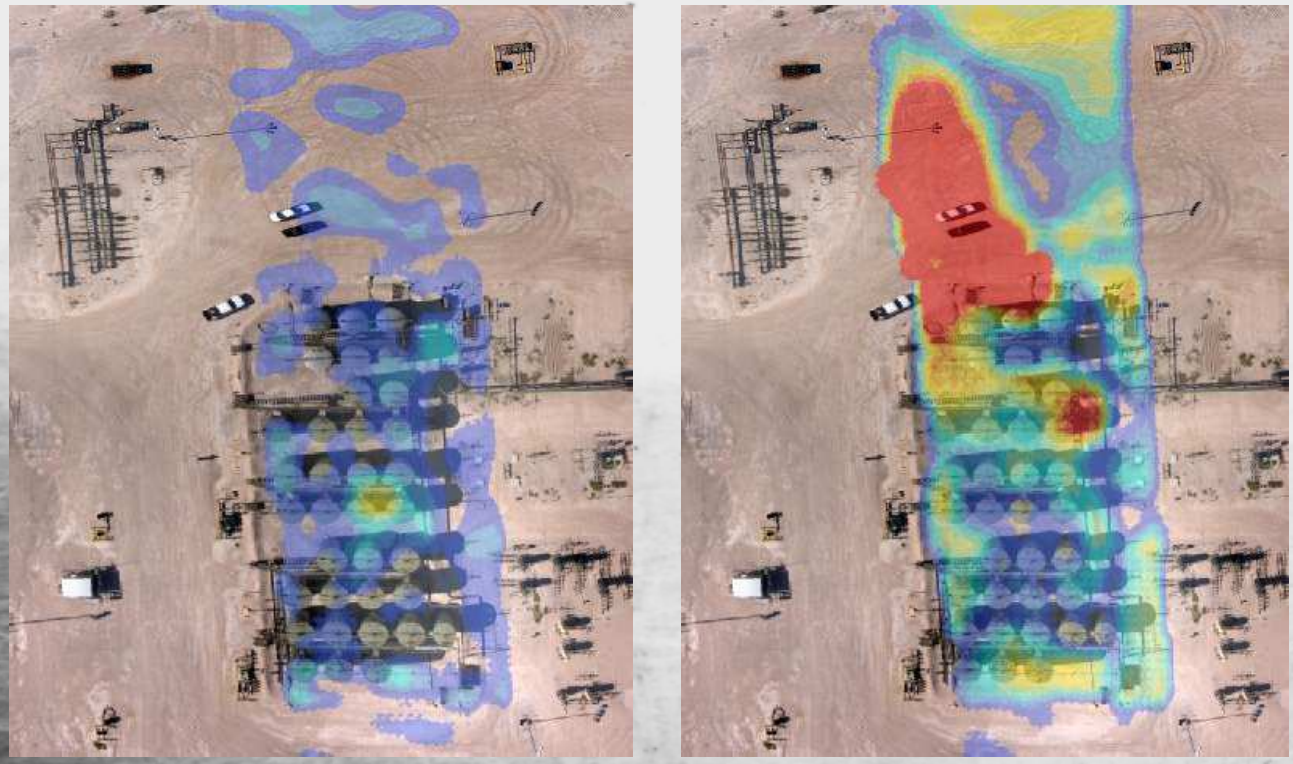
- takes into account water movement

Oil and Gas

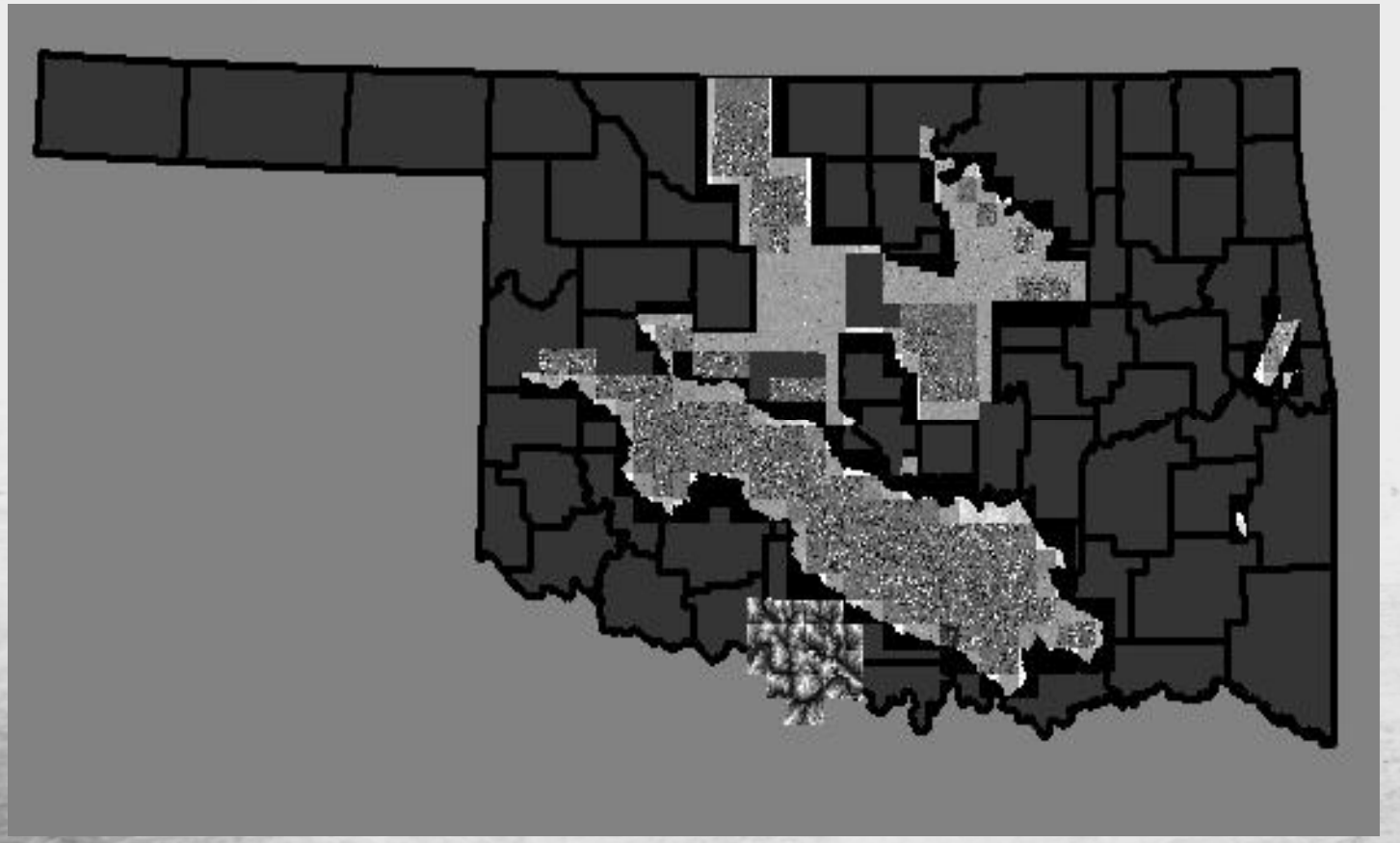
- accurate terrain models lead to less environmental impacts

More Oil and Gas Uses

- DTM Models
- Better than hiring a survey crew
- Hydrocarbon sensors

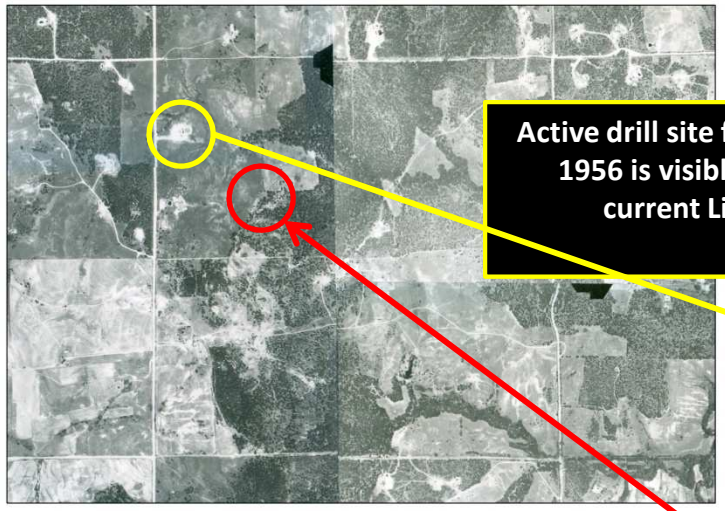


Oklahoma has approximately 25% Coverage



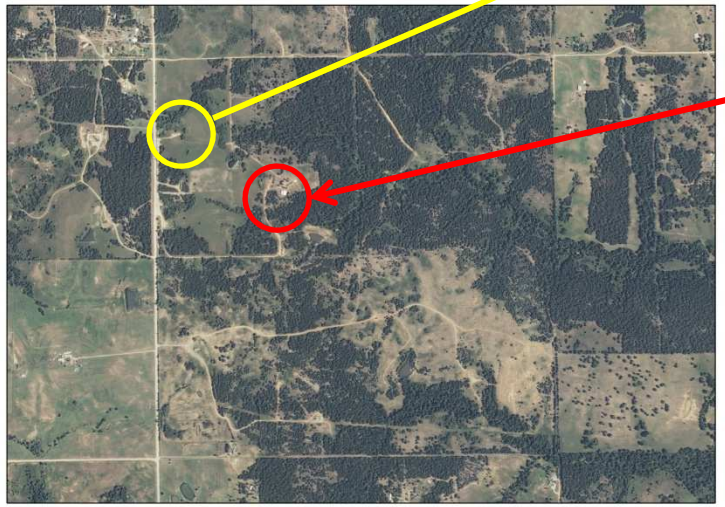
LiDAR

Creek County 1956 Aerial Map for 26-17N-R8E

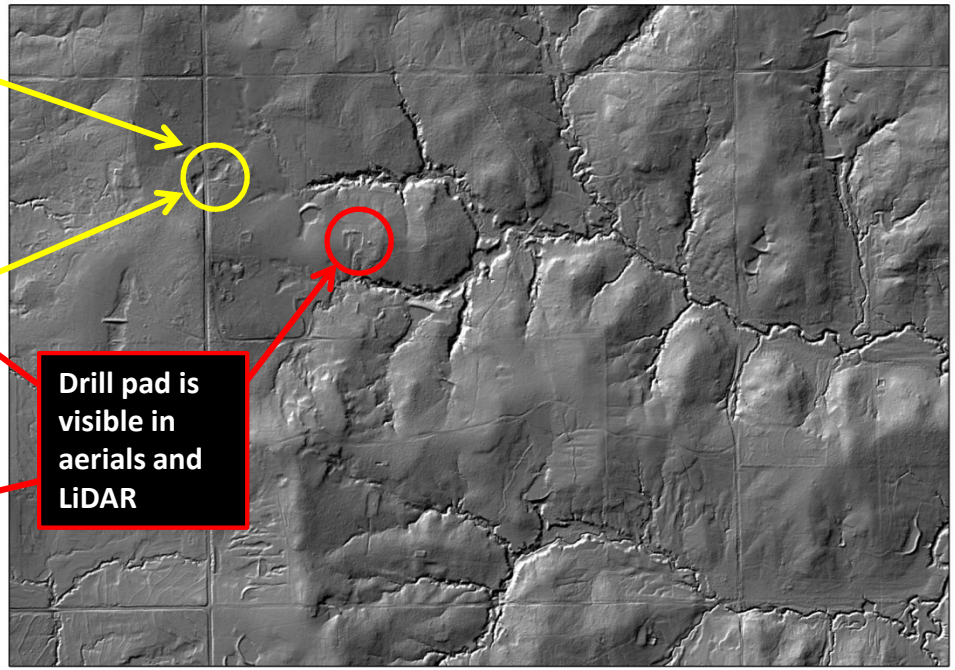


Active drill site from 1956 is visible on current LiDAR

Creek County 2010 Aerial Map for 26-17N-R8E

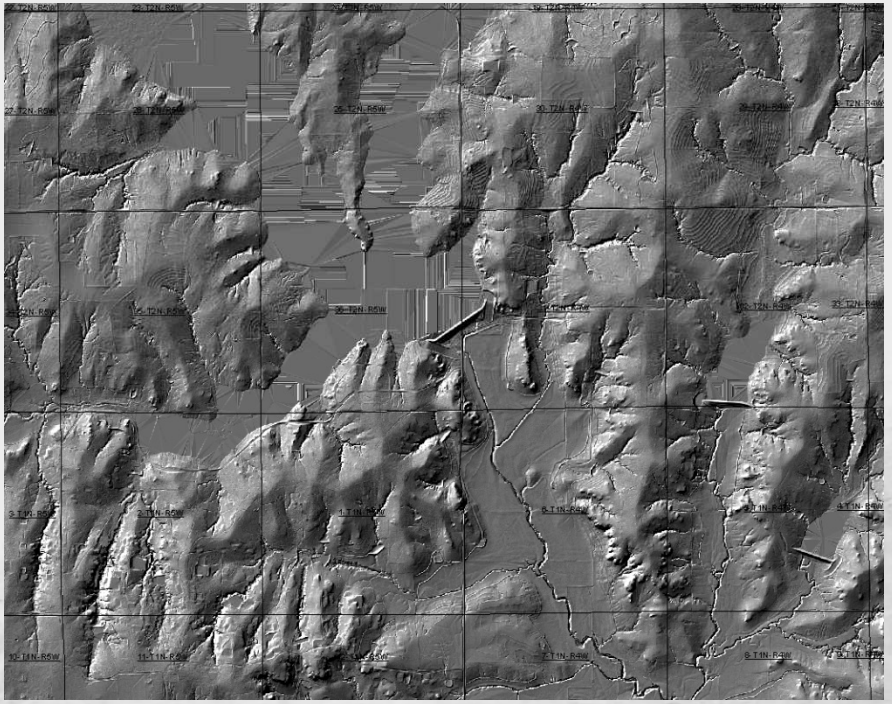


Creek County LiDAR Map for 26-17N-R8E



Drill pad is visible in aerials and LiDAR

Stephens County 2010 Aerial and LiDAR



Carter county LiDAR and 2010 Aerial

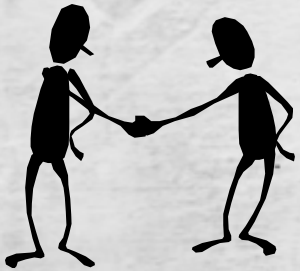
If you would like our aerial photos, please contact us!

For large requests, send us or bring us an external hard drive.
For small requests, we can use Google Drive or Dropbox.

County-years run from 2 GB to 5 GB, depending on how big the county is, and how complete its coverage is.

We have nearly 700 GB of ungeoreferenced aerial photos. New photos are scanned every day, and we just hired a full-time GIS person to georeference our collection.

In the future, we hope to host these photos online, but as of now we do not have the means to do so.



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