APFO's Historical Treasures:

How Aerial Imagery Can Track Agricultural Change

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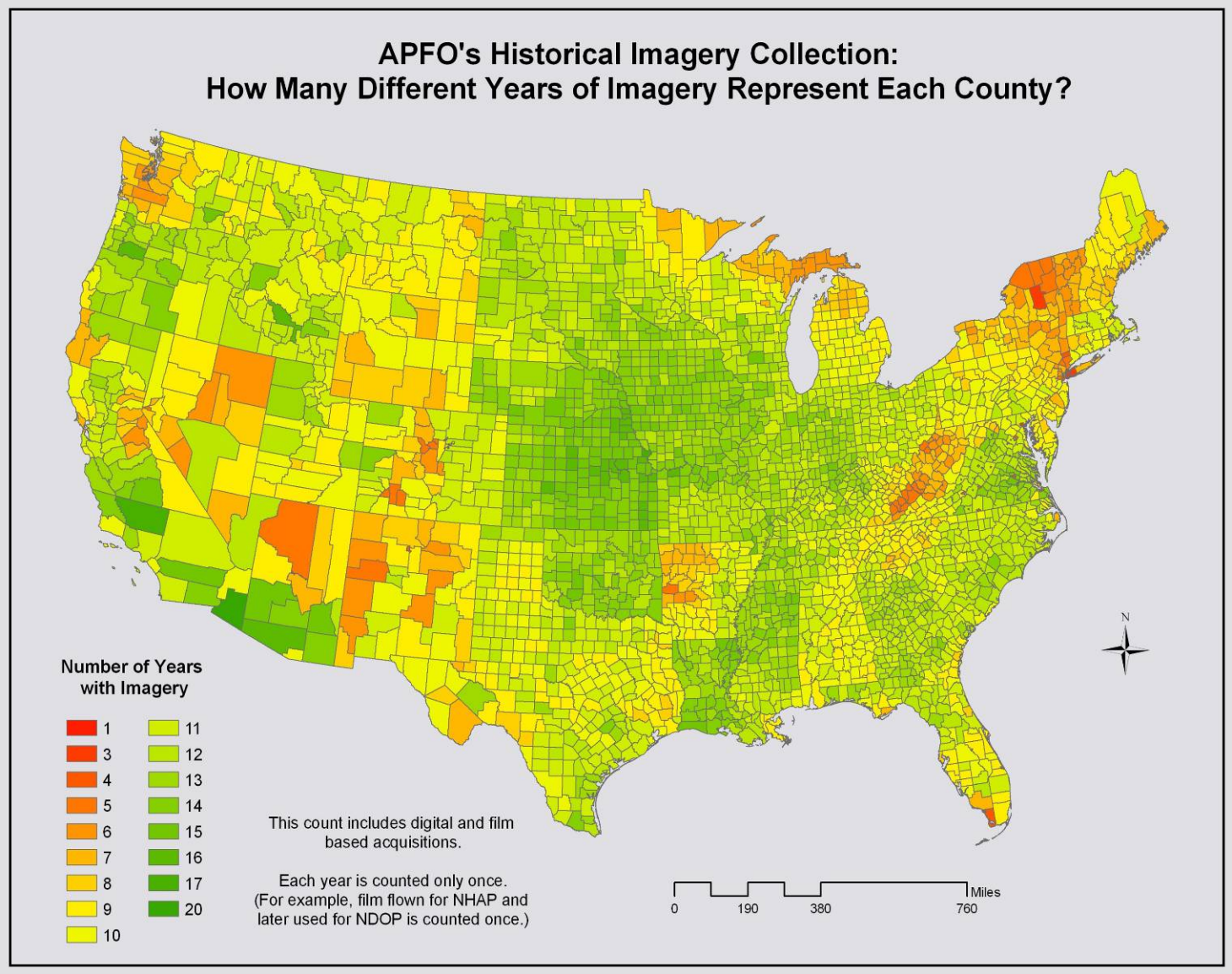
The Aerial Photography Field Office is part of the U.S.D.A. Farm Service Agency.

It has one of the largest collections of historical aerial photography in the nation.

Nearly every county in the lower 48 states is represented by at least 3 years of aerial photography.



APFO's History

- USDA was created May 15, 1862 as a non-cabinet level department
  - Became cabinet level in 1889
- Agricultural Adjustment Act of 1933
  - Created new programs to help farmers
- Aerial photo labs were created in 1937
  - Initially in Washington, D.C. and Salt Lake City.
  - Established to provide rectified aerial photography for accurate field measurements, in support of the newly created farm programs.

- **Rectified Film Enlargements**
  - **24” x 24” Photo Maps**
  - **Technicians drew field boundaries on photo enlargements; these hand drawn boundaries were predecessors to CLU (Common Land Units) boundaries used in GIS projects.**

Field acreages were measured with a planimeter.

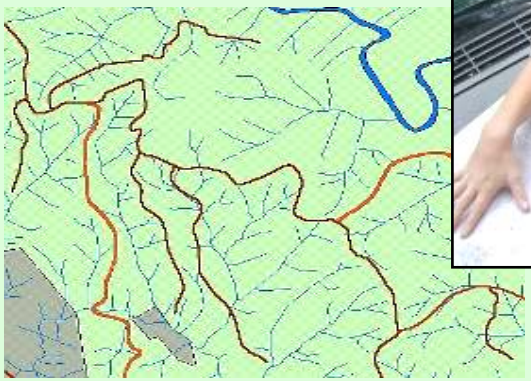
APFO Was Part of Interagency Aerial Photography Programs

- National High Altitude Program (NHAP); 1980 – 1989
  - USGS coordinated interagency program
  - 48 continental states
  - 5 year cycle
- National Aerial Photography Program (1987 – 2003)
  - USGS coordinated interagency program
  - 48 continental states + Hawaii
  - 5 – 7 year cycle

Since 1977, APFO has been authorized to contract any USDA imagery project larger than 100 square miles.

U.S. Forest Service uses imagery:

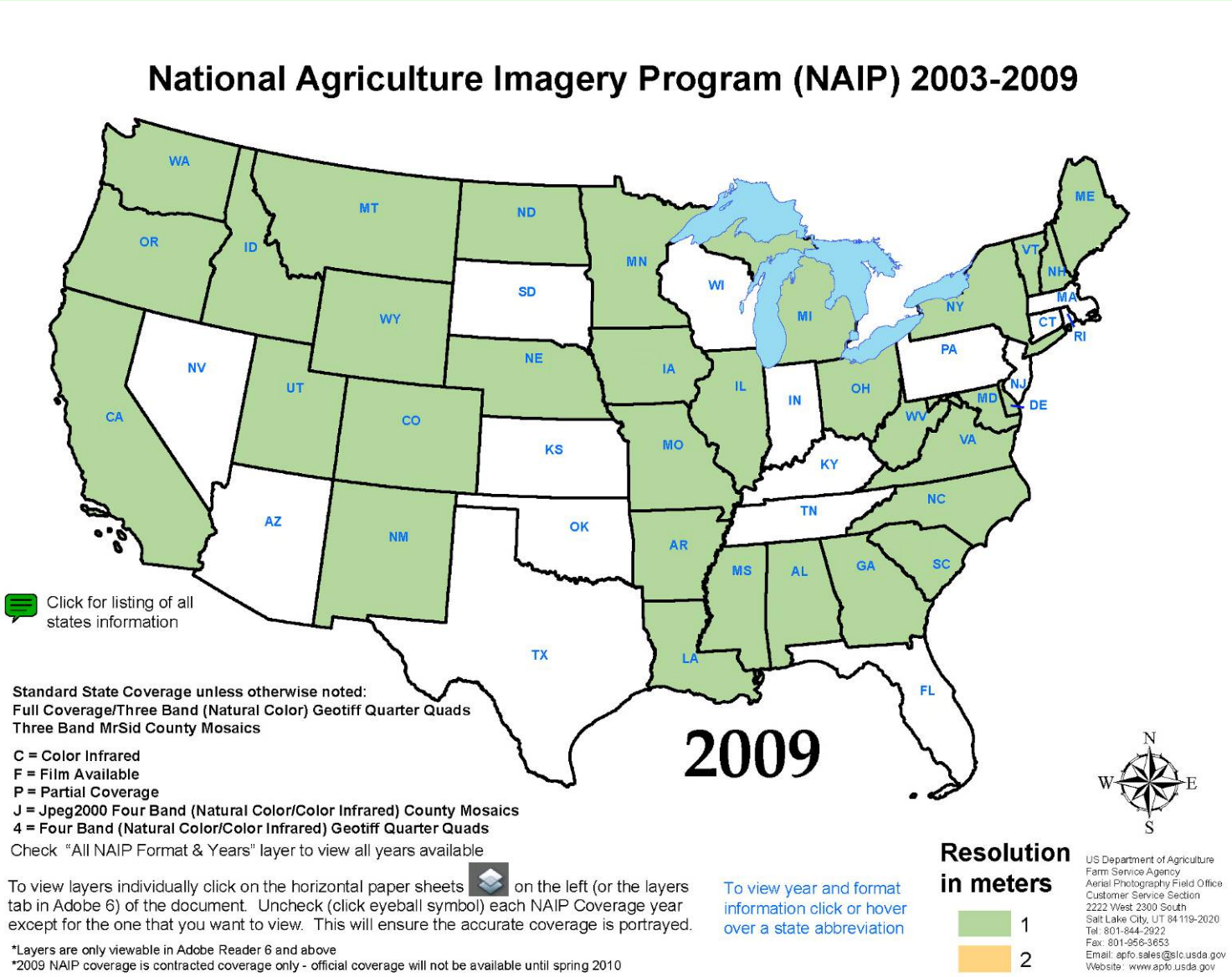
- Forest planning
- Forest heath protection
- Watershed restoration
- Disturbance processes
- Habitat
- Recreation
- Transportation
- Research
- Fire



NRCS Employees Create Information: Empowered With Imagery, GIS, GPS, and Digital Cameras

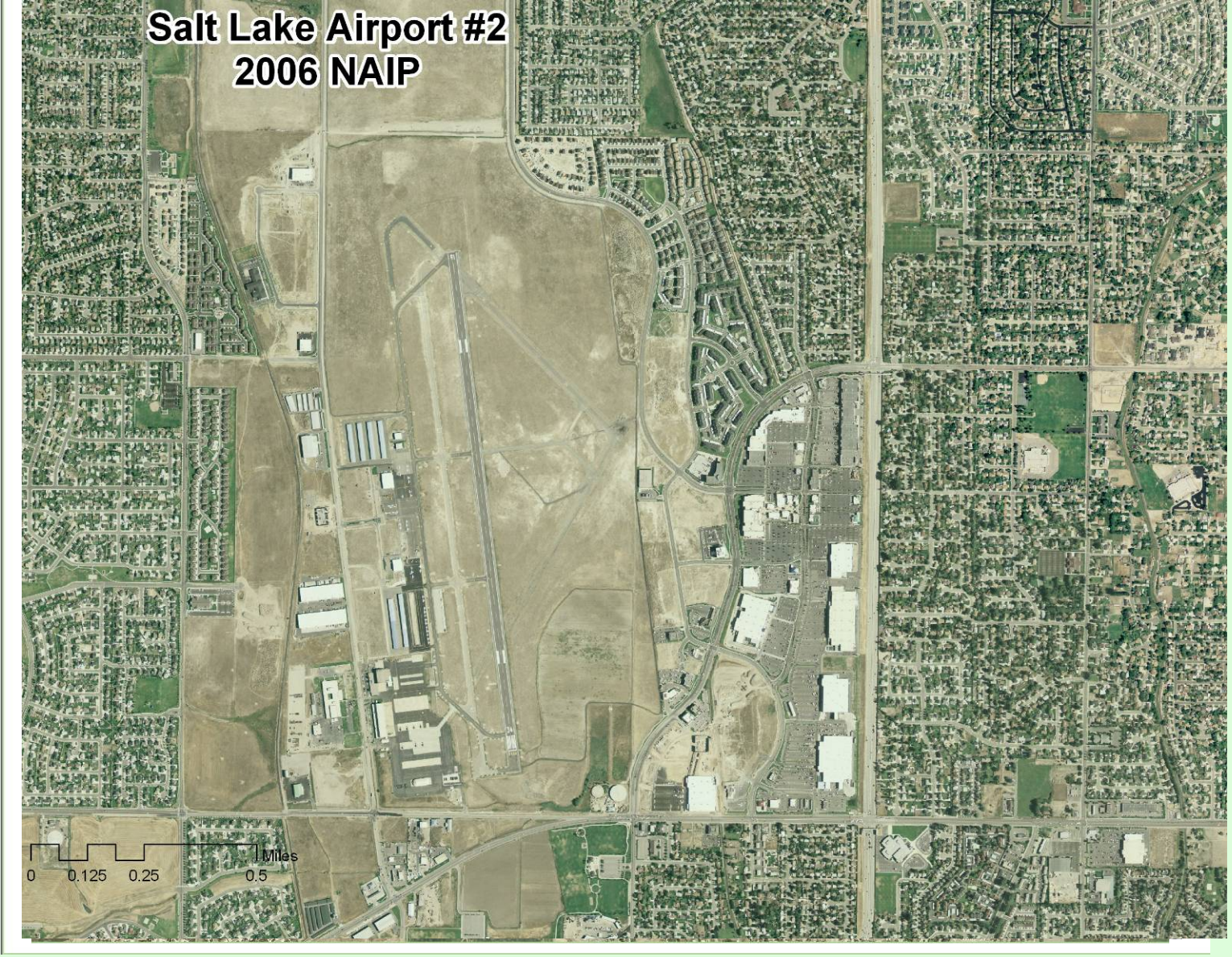
Since 2003, APFO has administered the NAIP program, delivering digital aerial imagery to Farm Service Agency service centers and partners.

As the years go by, the imagery from this "new" program will soon become part of the "historical" collection.



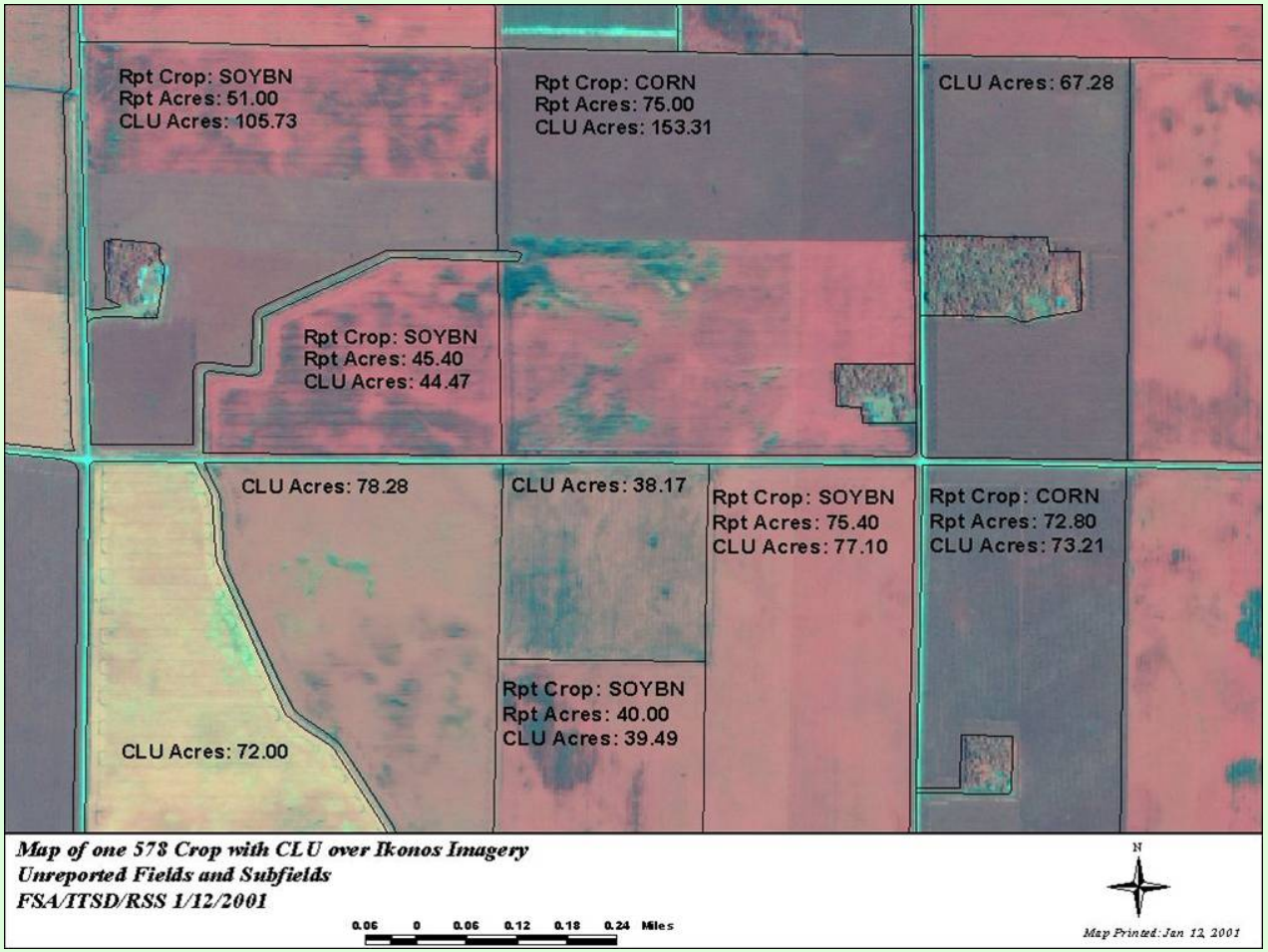
Why is this collection important? How do people use historical imagery?

- Farm program history
- Land use change studies
- Landform change studies
- Environmental restoration projects
- Site selections
- Community planning
- Real Estate
- Legal cases
- Personal interest



See the changes from 1958 to 2006 near the smaller airport in suburban Salt Lake City.

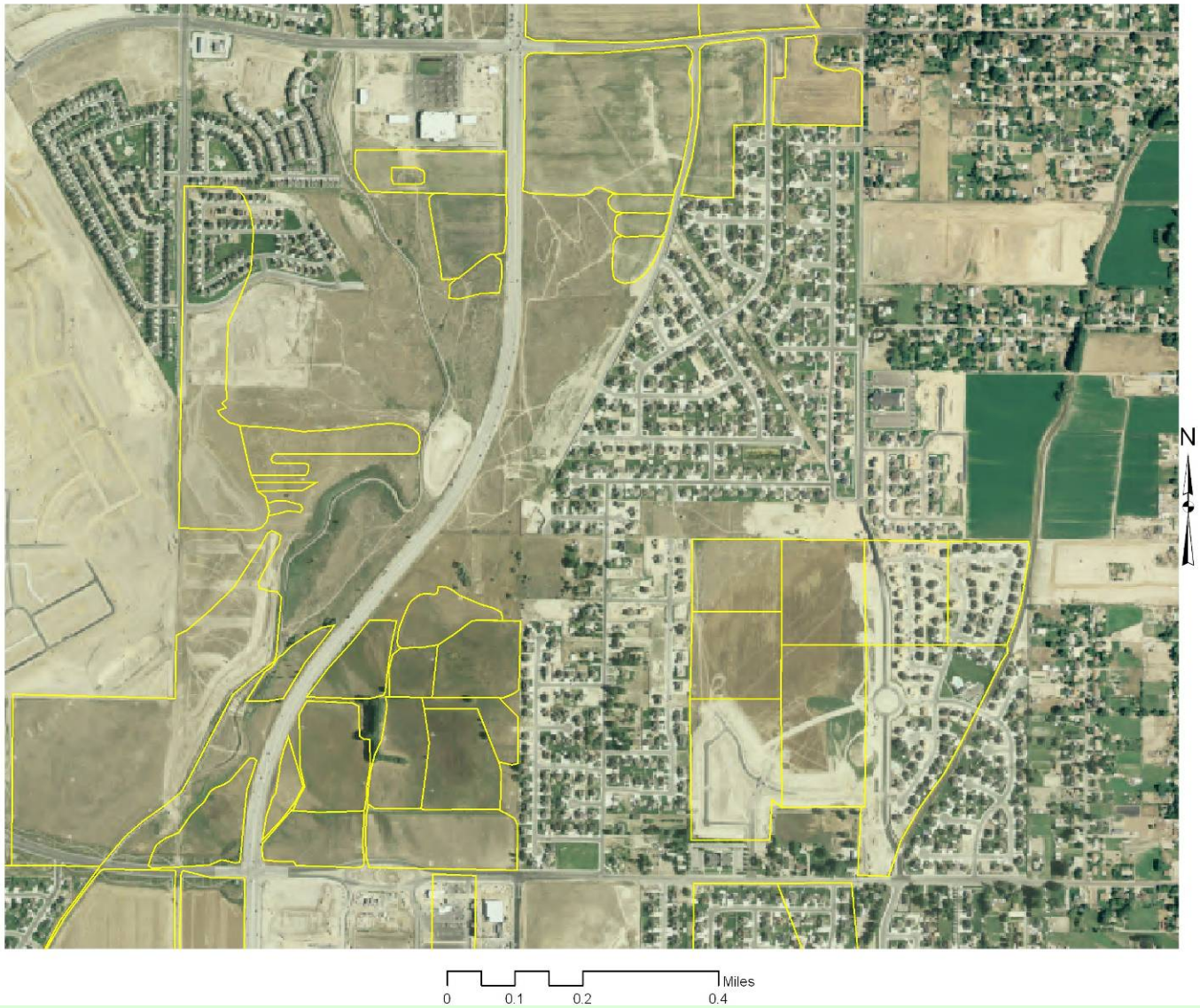
Within the past 10 years, FSA has moved from paper photo enlargements with hand drawn field boundaries to digital imagery with hand digitized field boundaries.



CLU files contain attributes relating to fields enrolled in FSA programs

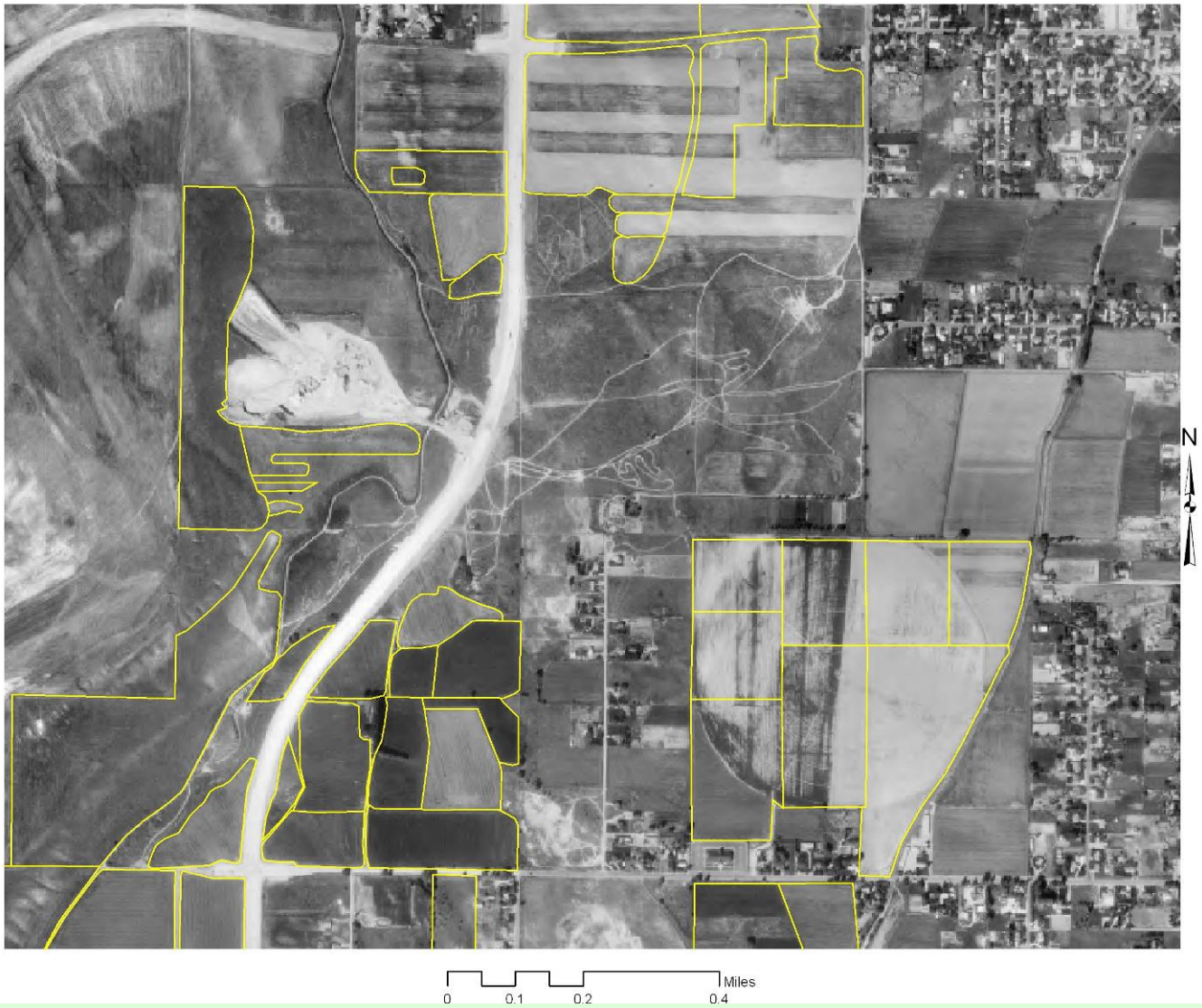
They are not available to the general public.

CLU polygons with NAIP (2006)



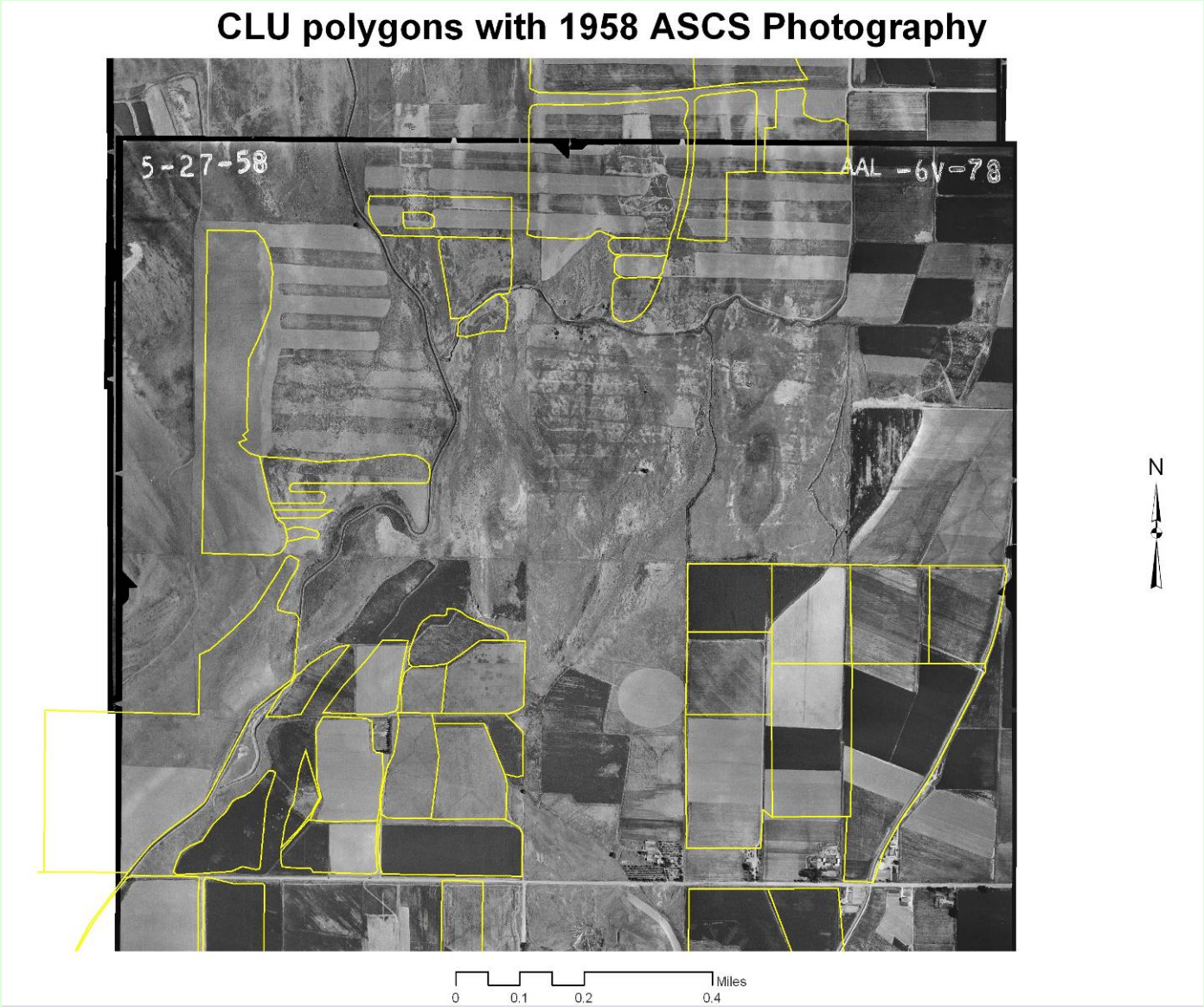
The current CLU file is displayed against MDOQ imagery, flown in 1997.

Digital aerial imagery in GIS can show the effects of suburban sprawl.



Historical aerial imagery can be scanned and georeferenced, then compared to current vector data.

A few fields retain the same dimensions they had 50 years ago.



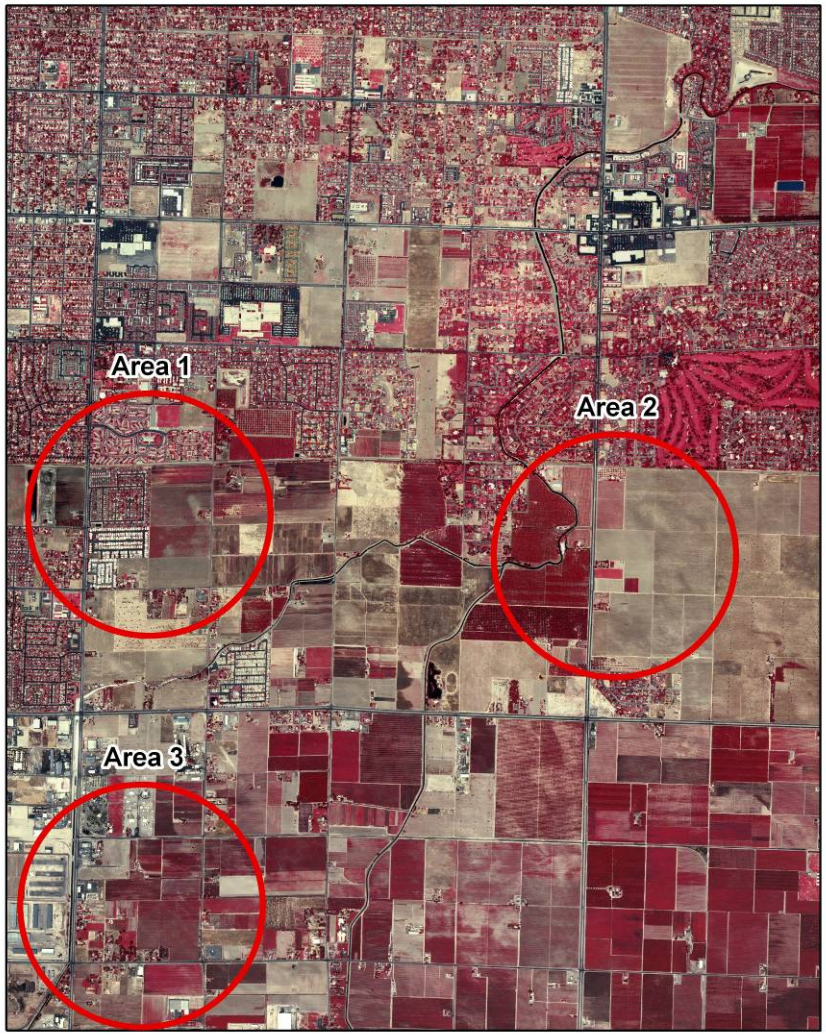
This series of slides shows the progression of land use change in the Fresno area.

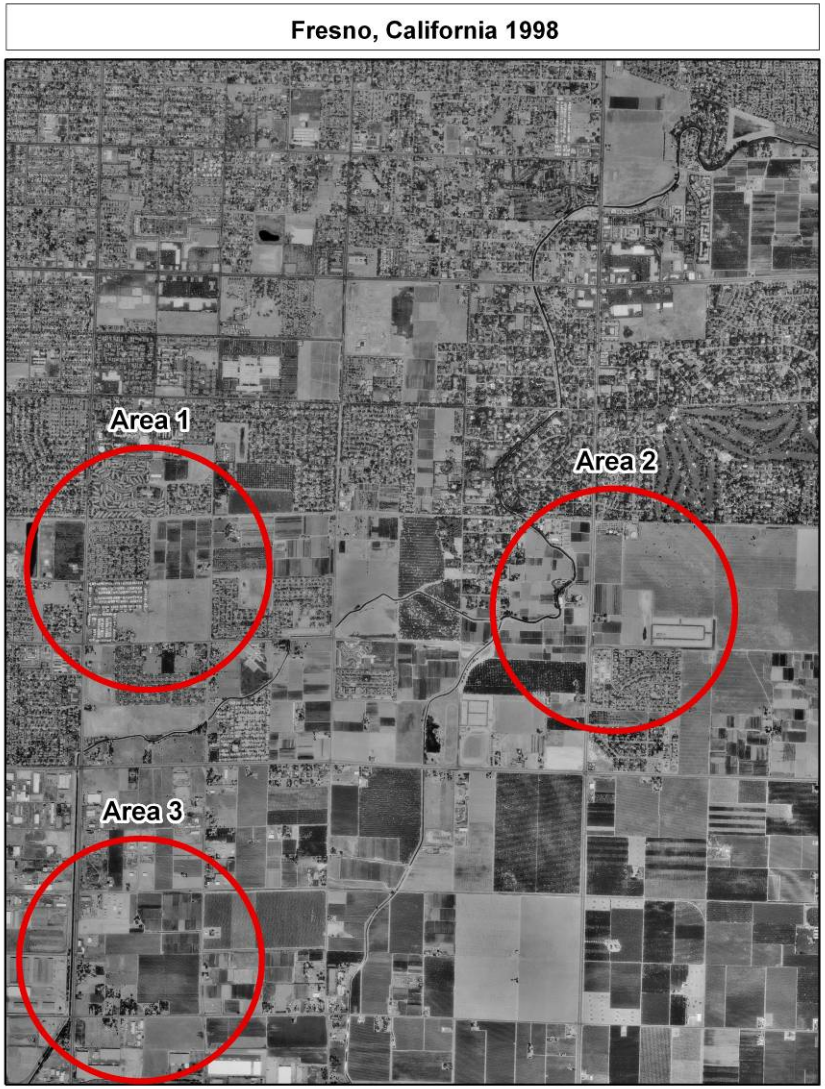
The three circled areas will be shown in greater detail later.

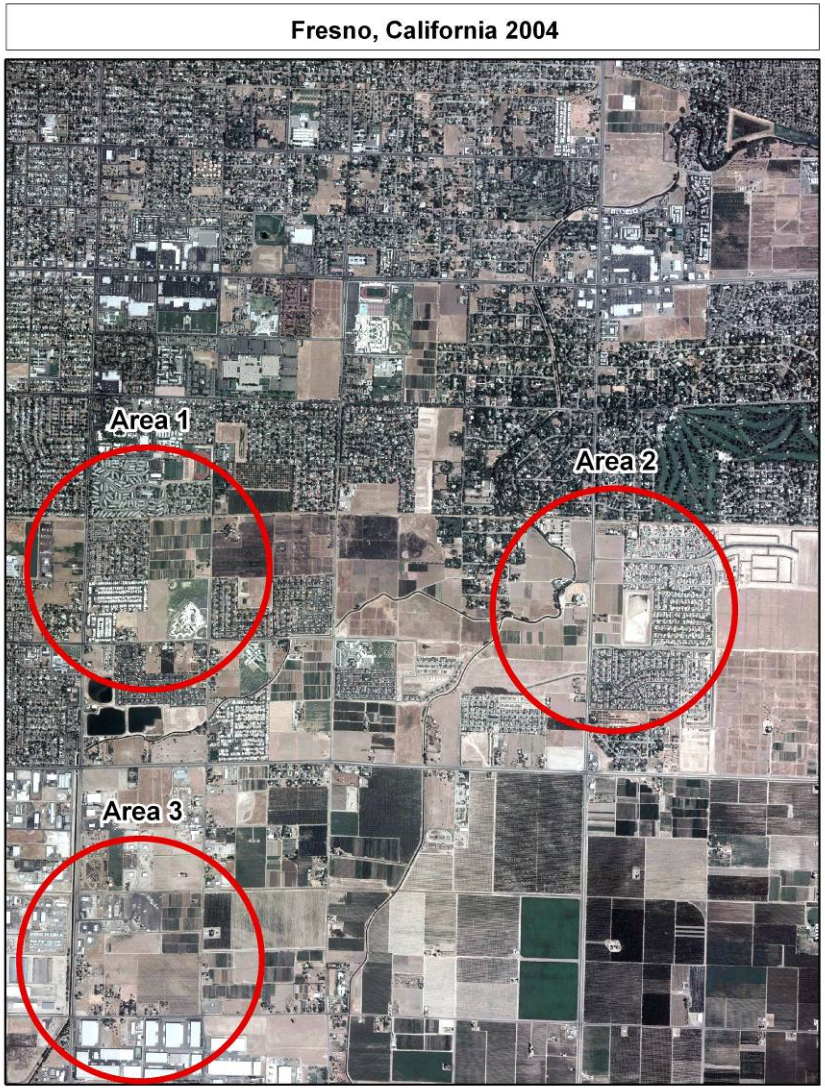
The loss of farmland is an area of concern throughout the country.

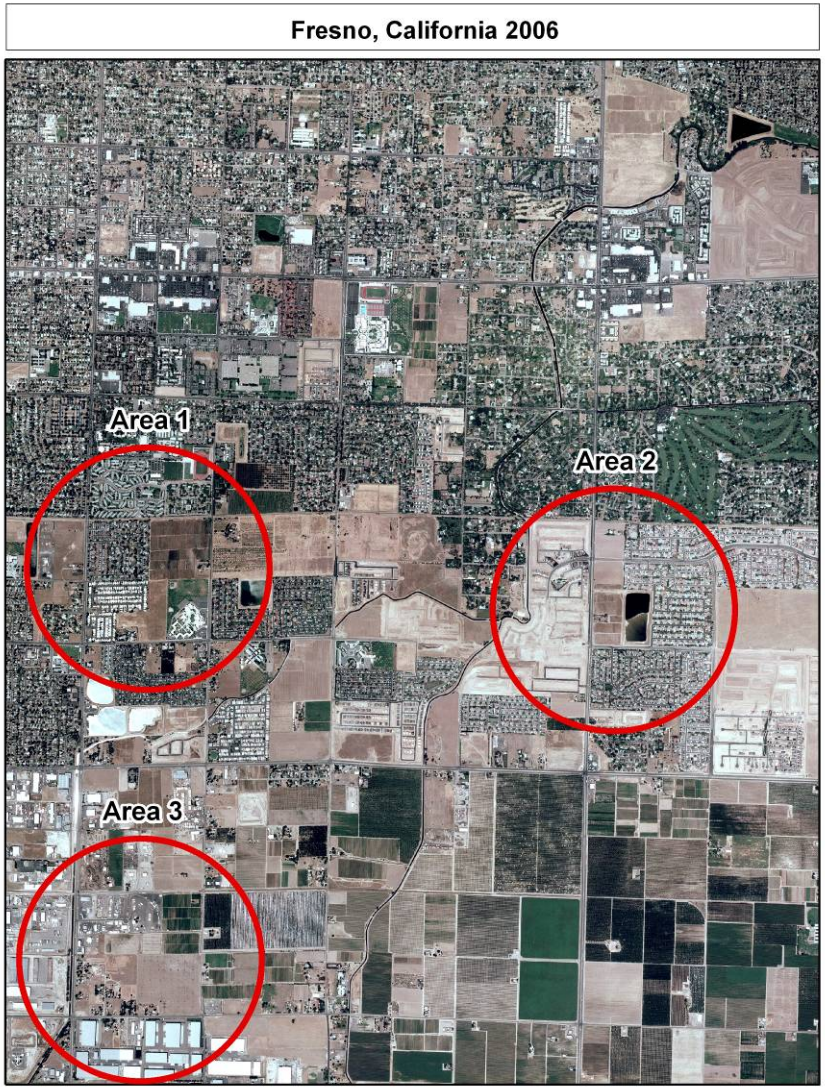
It can be studied and quantified with aerial imagery.

Fresno, California 1987

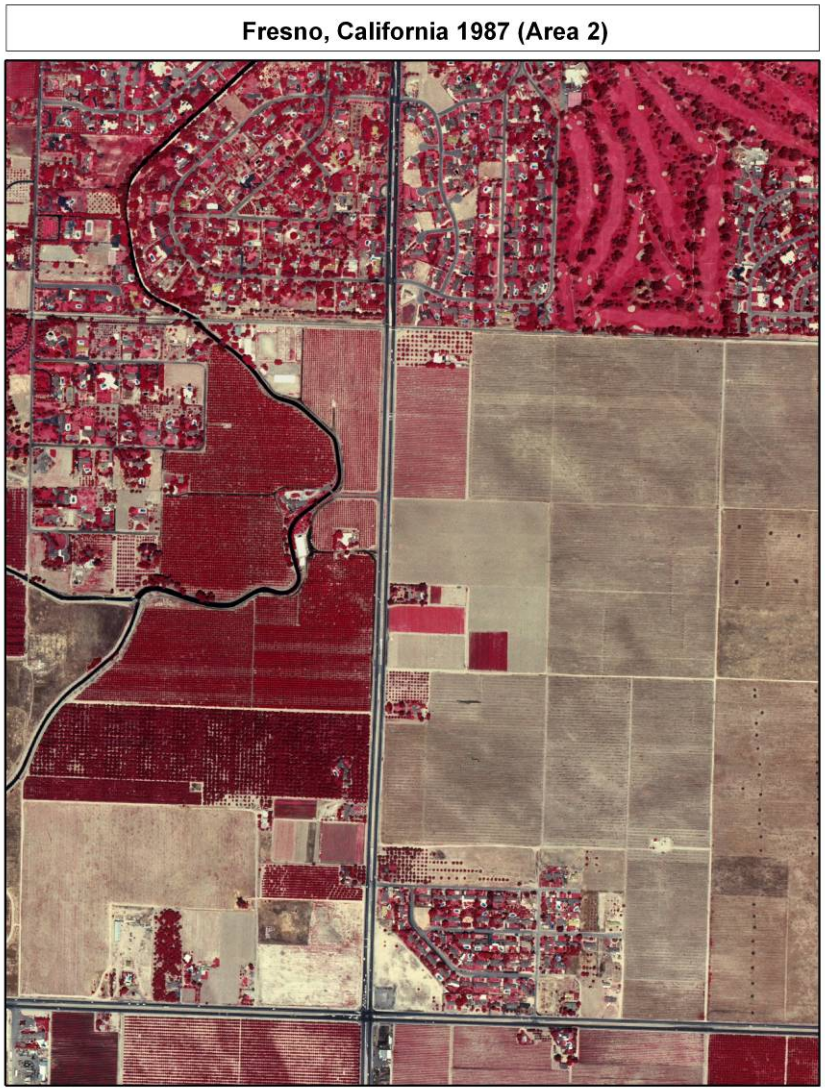



Fresno, California 1998
Area 1
Area 2
Area 3


Fresno, California 2004
Area 1
Area 2
Area 3


Fresno, California 2006
Area 1
Area 2
Area 3

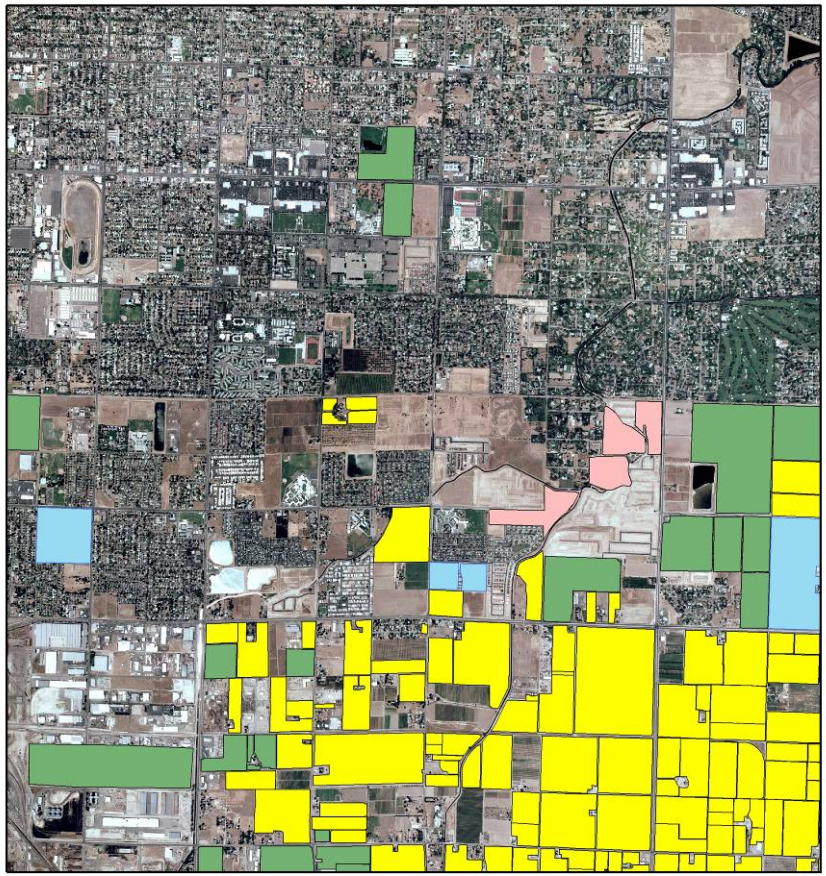
Compare
1987 to 2006



Compare 1987 to 2006

Fresno, California 2006 (Area 2)

Fresno, California CLU



2004
2005
2006
Current CLU

CLU Lost by year

N

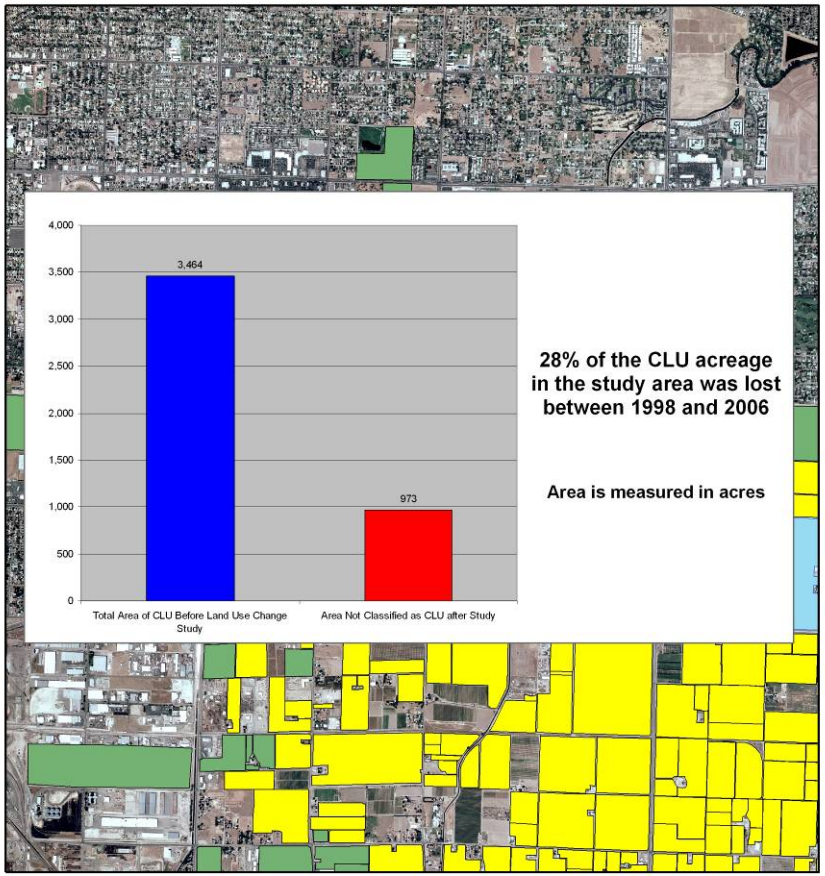
Data Sources: APFO

USDA

APFO

0 0.125 0.25 0.5 0.75 Miles

Fresno, California CLU



2004
2005
2006
Current CLU

CLU Lost by year

N

Data Sources: APFO

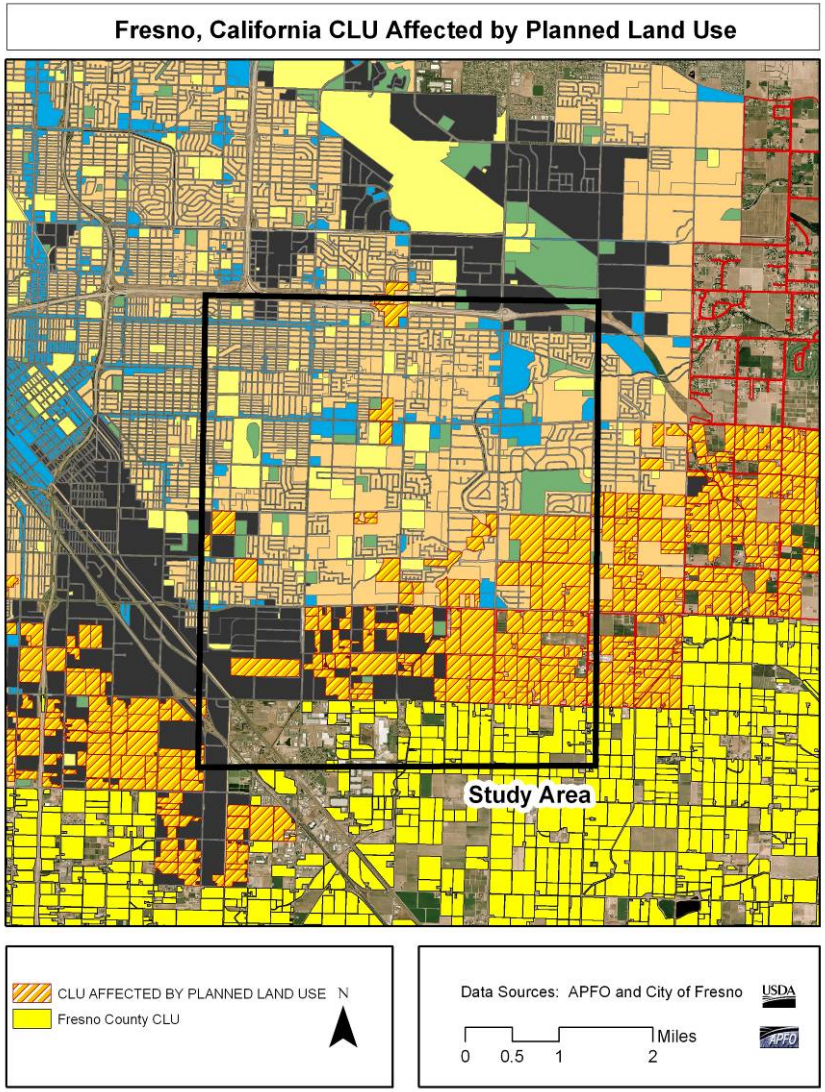
USDA

APFO

0 0.125 0.25 0.5 0.75 Miles

Farmland is disappearing at a rapid pace.

Farmland will continue to disappear in the future, according to the city's land use plans.



Using aerial imagery for historical analysis in GIS often involves hand digitizing vector layers.

This is especially true with older Black and White imagery.

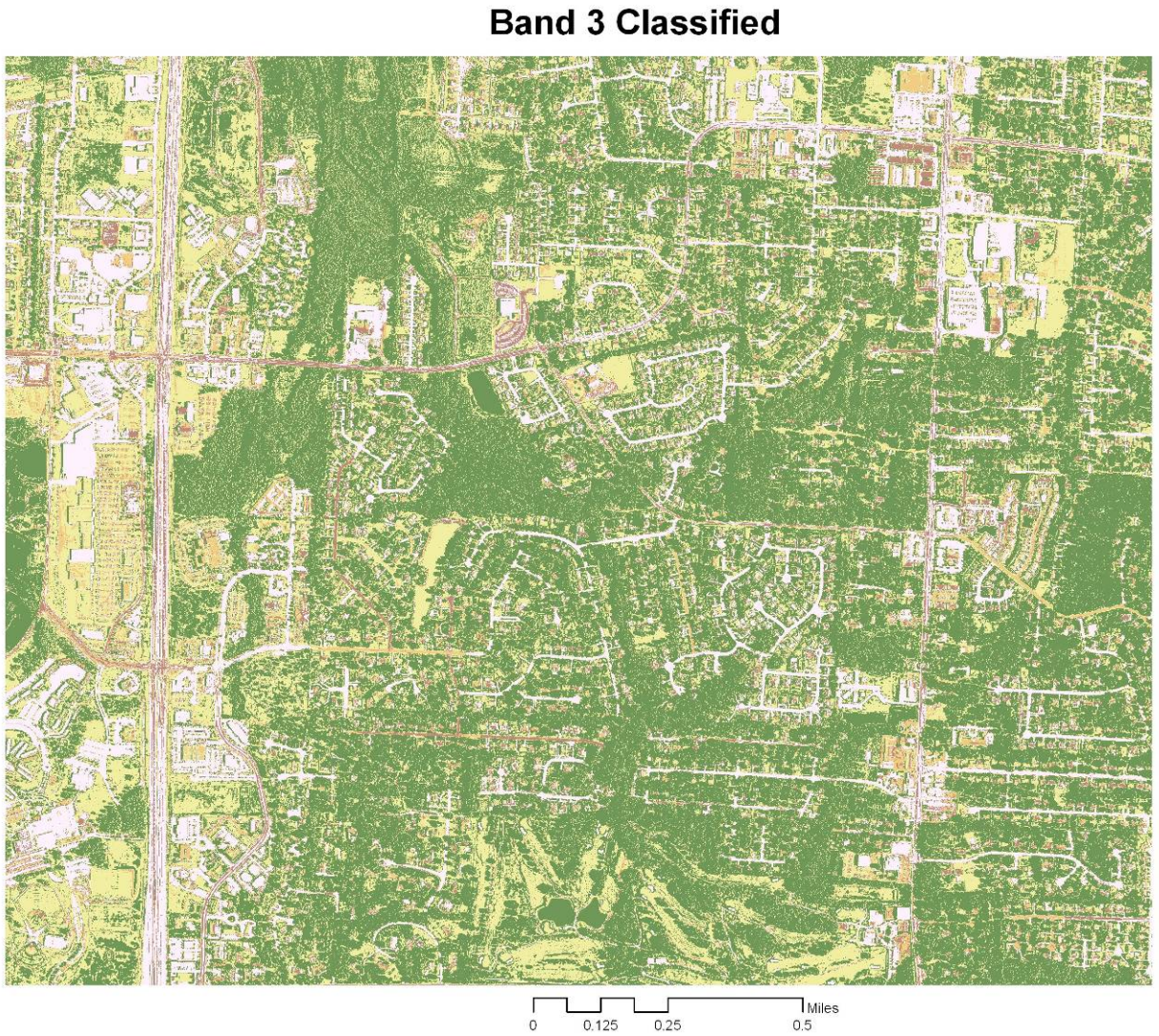
A polygon file digitized from earlier imagery can be used to locate areas of change when viewed with newer imagery.

Land Use Feature Class from MDOQ with NAIP

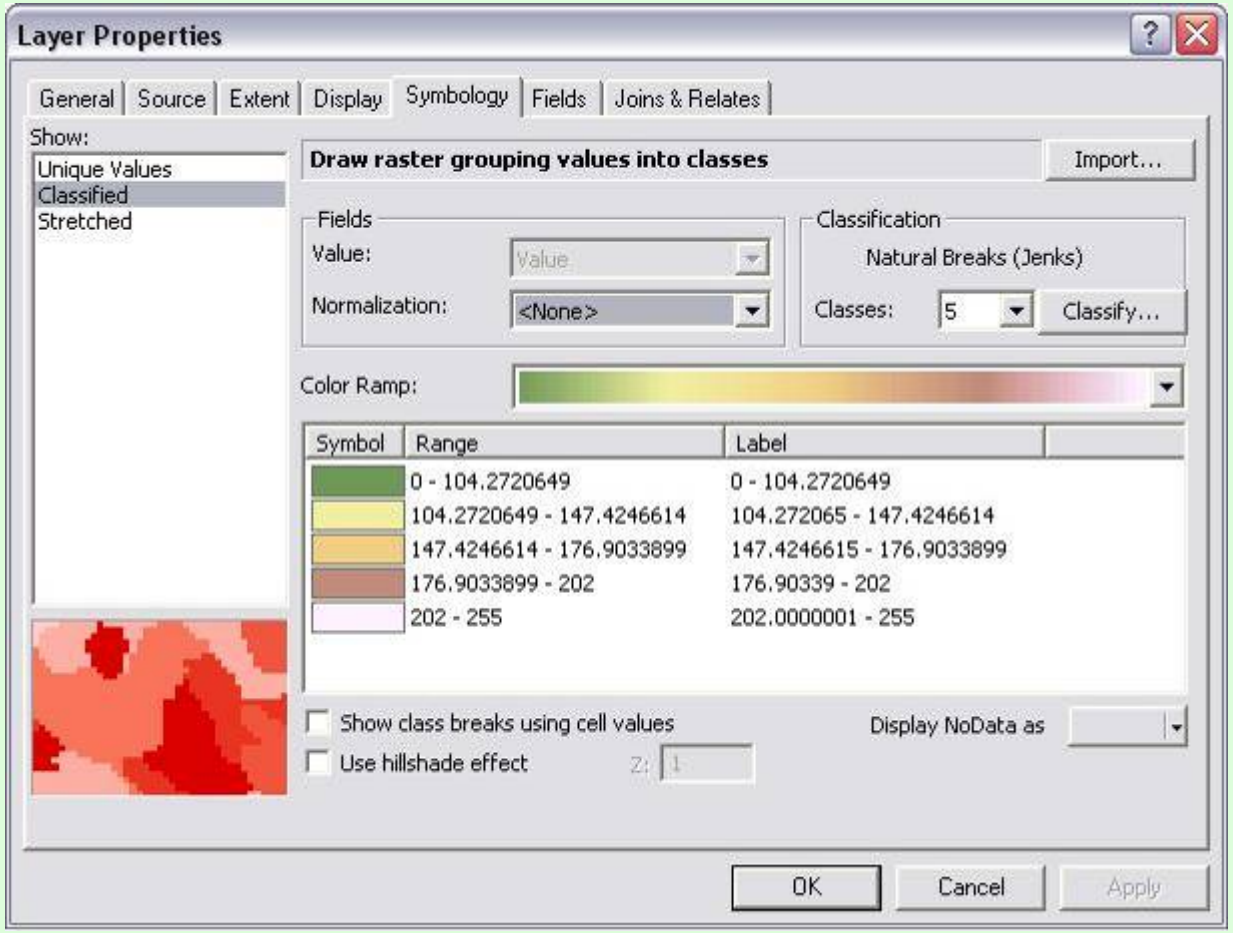
- **Many different methods can be used when setting up a change detection project.**
- **Work can be done manually, or with differing levels of automation.**
- **A thorough knowledge of imagery software programs and the behavior of digital imagery is necessary for successful use of automated classification procedures.**
- **Results will not be any better than the quality of the imagery and the skill of the operator.**
- **Care must be taken with land cover as opposed to land use classifications. Automated procedures will identify land cover – the operator must select a classification system and translate land cover results into this system.**

In one method, individual imagery bands can be classified “by hand” in ArcGIS as a way of visualizing features. This method would utilize knowledge of the spectral characteristics of different bands.

Classes can be extracted and converted to shapefiles.



In this example, the band's histogram was used to set the class boundaries, and a color ramp was selected for display.



Four band NAIP imagery allows the user to take advantage of Feature Extraction techniques which were originally better suited to satellite imagery.

Unsupervised classification creates different classes which can also be used separately to create polygon files.

When looking for impervious surfaces, the ENVI process picked up streets and other features, such as farm fields.

Blue polygons show areas of change mostly new residential areas.

The extraction from Band 3 is

A subset of a DOQQ near Jackson TN will display the use

An understanding of feature extraction software

be re-drawn.

not all

necessary to effectively

was

converted into

Differences in housing

This image section was processed using the rule-based Feature Extraction tool in ENVI Zoom.

The software allows the user to set up rules based on different characteristics of individual bands, relationships between bands, size, shape, texture, and other factors.

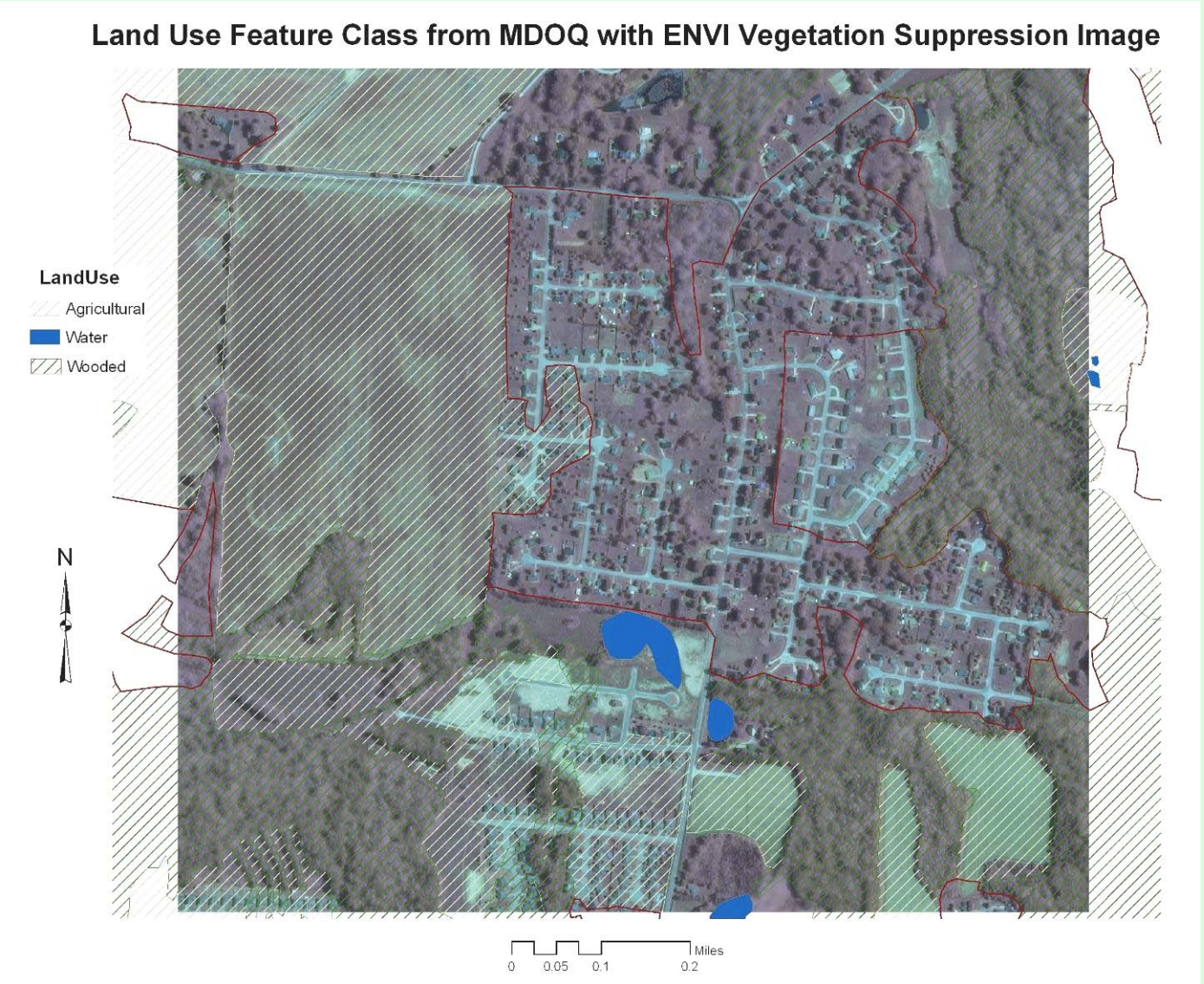
Blue Polygons Show Areas of Change

Some standard models can be run with a simple setup and click of a button.

An NDVI image created in ERDAS Imagine, and derived from the NAIP imagery, can be used to highlight features for analysis. The user can set symbology to highlight different types of features.

Land Use Feature Class from MDOQ with NDVI Image from ERDAS Imagine

The Vegetation Suppression tool in ENVI software will output an image which downplays the bright red vegetation in a CIR image, and lets the impervious surfaces stand out.



APFO's historical imagery is mostly black and white, and would be less useful for automated classification tools.

The same image, with color classes set in ArcGIS symbology, demonstrates that black and white imagery would require visual and manual interpretation.

Black and White Image

- Imagery with infrared bands can be especially useful in analysis.
- NAIP is increasingly being flown with four bands – RGB and Near Infrared
- Landsat imagery is now available online for free download. Imagery dates from 1973 (Landsat 1) to the present.
- Basic indices such as the Normalized Vegetation Difference Index (NDVI)can be run with Four Band NAIP or satellite imagery.
- Individual imagery bands can be classified as a means of identifying different types of features.
- Feature Extraction software can be used for Supervised, Unsupervised, or Rule-based classification.

Using Imagery for Change Detection

Satellite imagery and higher resolution aerial photography are now available for free download, or at a low processing fee.

Satellite imagery advantages:

- **Many dates of imagery available for the same scene**
- **Multiple bands of data**
- **Larger pixel size allows quick processing**

Satellite imagery disadvantages:

- **Larger pixel sizes lack detailed information.**
- **Image quality may be poor, with cloud cover or unusable data**

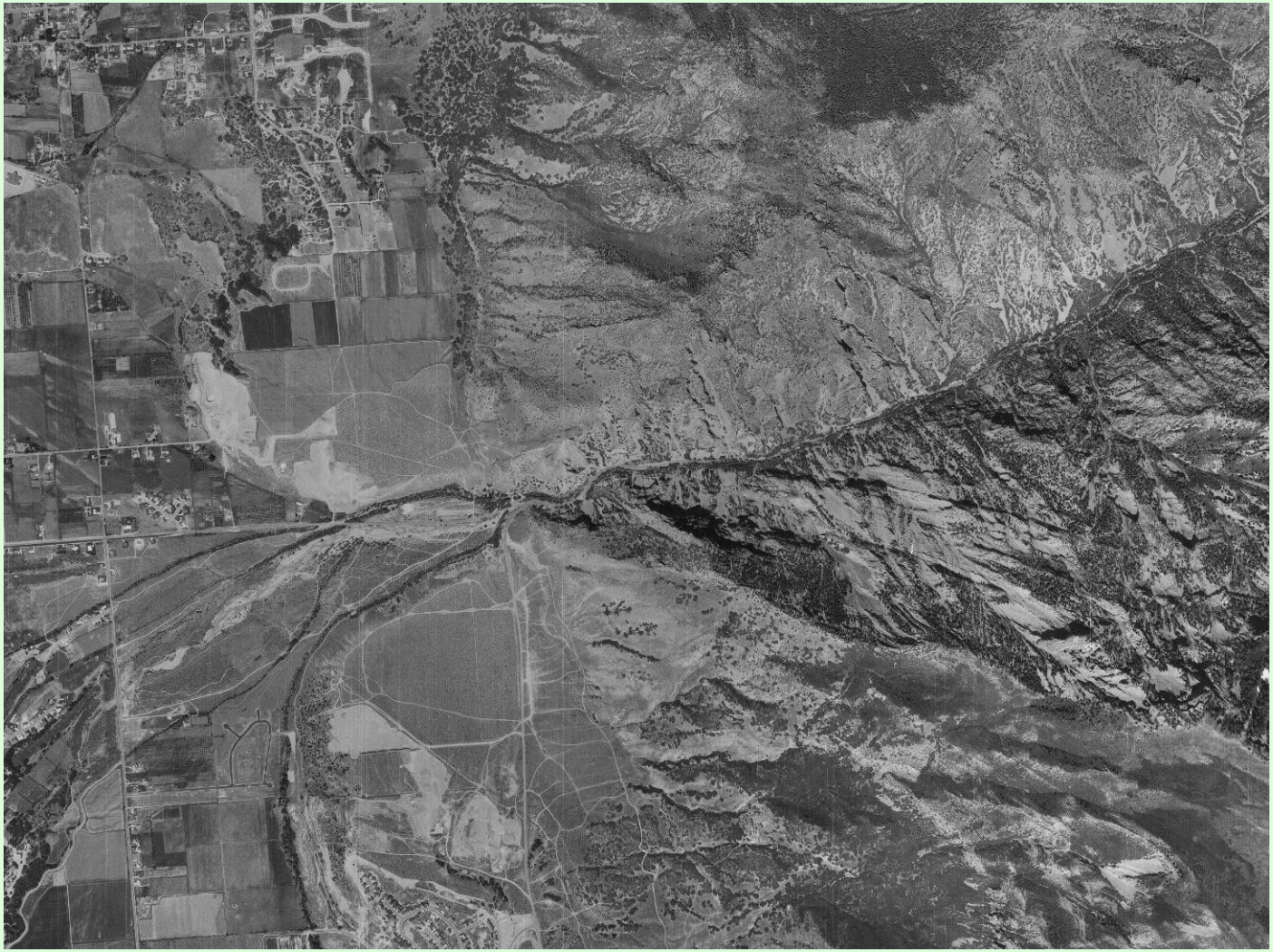
Aerial Imagery Advantages:

- **Smaller pixel sizes provide more detail**
- **Image quality generally good**

Aerial Imagery Disadvantages:

- **Acquired much less frequently than satellite imagery**
- **Imagery with 1 – 3 bands is less useful for analysis**
- **Smaller pixel size requires more processing time and storage space**

APFO will be scanning historical imagery from the Wasatch Front in Utah.



- The scans in Salt Lake County will be used to create DOQQs.

- Scans from the other four counties along the Wasatch Front (Davis, Weber, Summit, and Utah) will be georeferenced.

- Pixel resolutions will depend on the original scale of flying and the scanning resolution.

- The scans will be used as a research tool for customers looking for historical imagery.

- The imagery will be available for purchase in a digital format, or as a high quality paper photograph.

- Customers can request scans of historical imagery from any roll of film in APFO's collection.

- The APFO Imagery Catalog is available online, and lists film available for each county.

- This project may pave the road towards scanning the entire film collection.

UTAH Date: 12-MAR-2009

SALT LAKE - 49035(AAL) Square Mile Land Area: 814
County FSA Office: http://offices.sc.egov.usda.gov/locator/app

PROG	%COV	YEAR	RES SCL	BAND FILM	FMT	QTY	RA	REMARKS
NAIP06	100	2006	1	NC	MR	1		CCM .878GB
NAIP06		2006	1	NC	GT	82		QQ
NAIP04	77	2004	1	NC	MR	1		CCM .333GB
NAIP04		2004	1	NC	GT	66		QQ
NAIP04		2004	40000	CP				
NAIP03	49	2003	2	NC	MR	1		CCM .079GB
NAIP03		2003	2	NC	GT	42		QQ
NAIP03		2003	40000	CP				
NAPP3	100	1997	40000	BW			N	
NDOP	100	1997	1	BW	MR	1		CCM
NAPP2	100	1993	40000	BW	DI	1	Y	
NAPP1	100	1987	40000	CIRP	SI	4	Y	
NHAP1	100	1981	60000	CIRP			N	
FSA	100	1977	40000	BW	PI	4	N	11299
USDA	100	1977	1	BW	MR	1		CCM
FSA	(P)	1971	20000	BW	PI	2	N	11298
FSA	(P)	1965	20000	BW	PI	4	N	11297
FSA	(P)	1959	20000	BW	PI	2	N	11296
FSA	(P)	1958	10000	BW	PI	9	N	11295

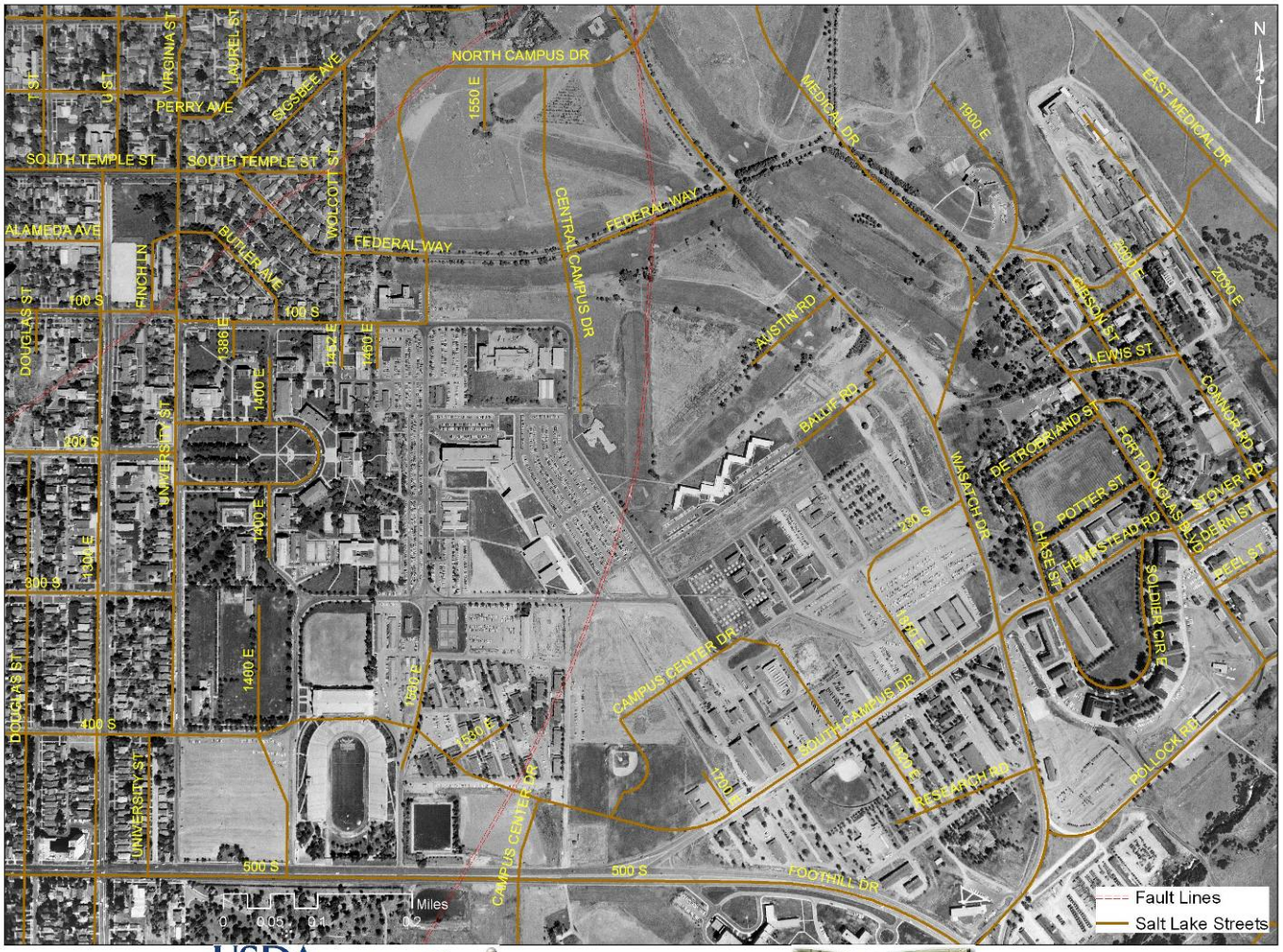
APFO also has film for 2003 and 2004 NAIP In Utah.

NAPP3 film was used to create USGS DOQQs.

Film available for Salt Lake County

Historical imagery can very clearly display the changes which have come to favorite locations, such as the University of Utah campus.

The University of Utah:1958 Imagery with 2009 Streets

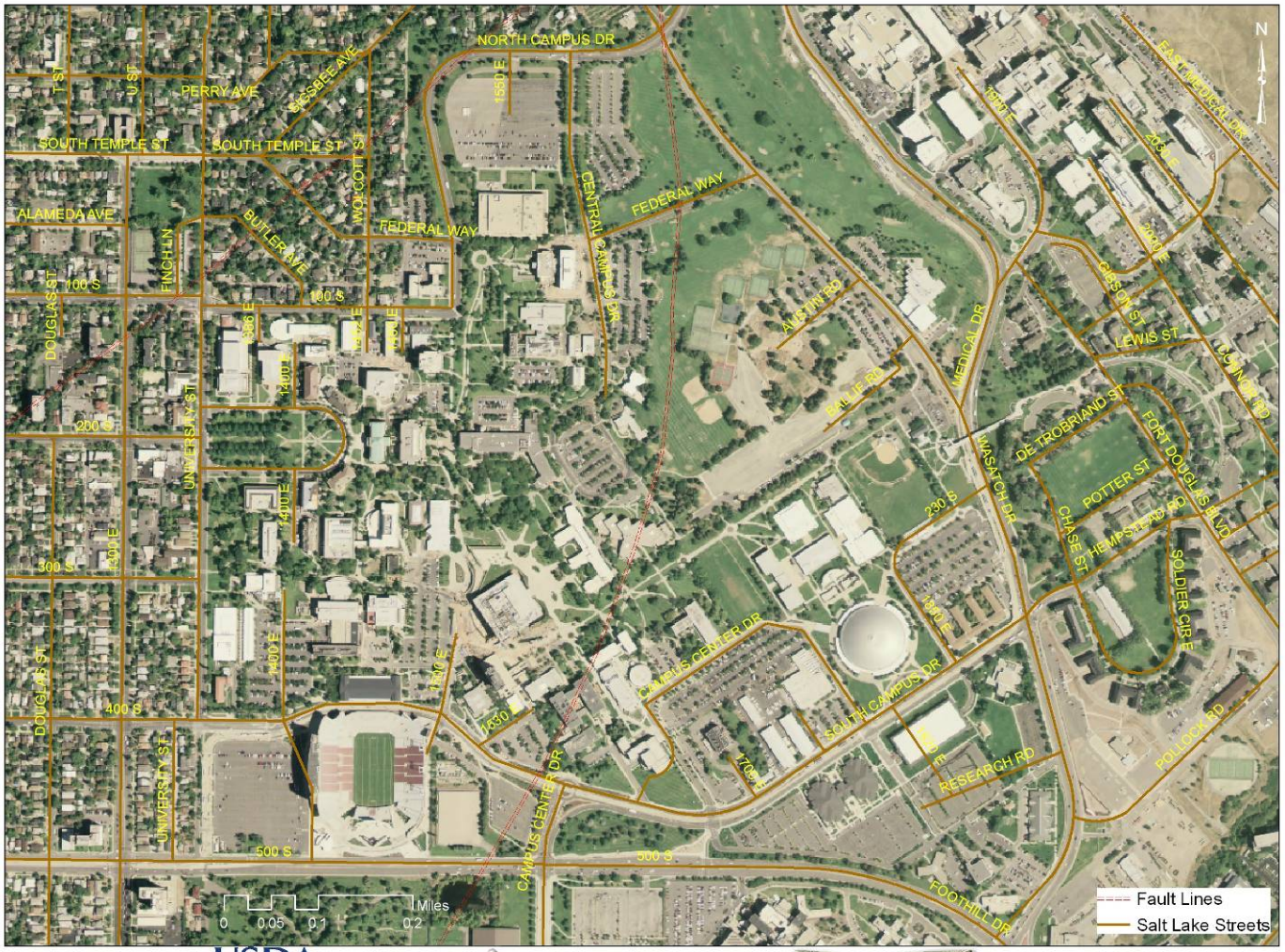


USDA Farm Service Agency

APFO

Historical imagery can very clearly display the changes which have come to favorite locations, such as the University of Utah campus.

The University of Utah: NAIP 2006



USDA Farm Service Agency

APFO

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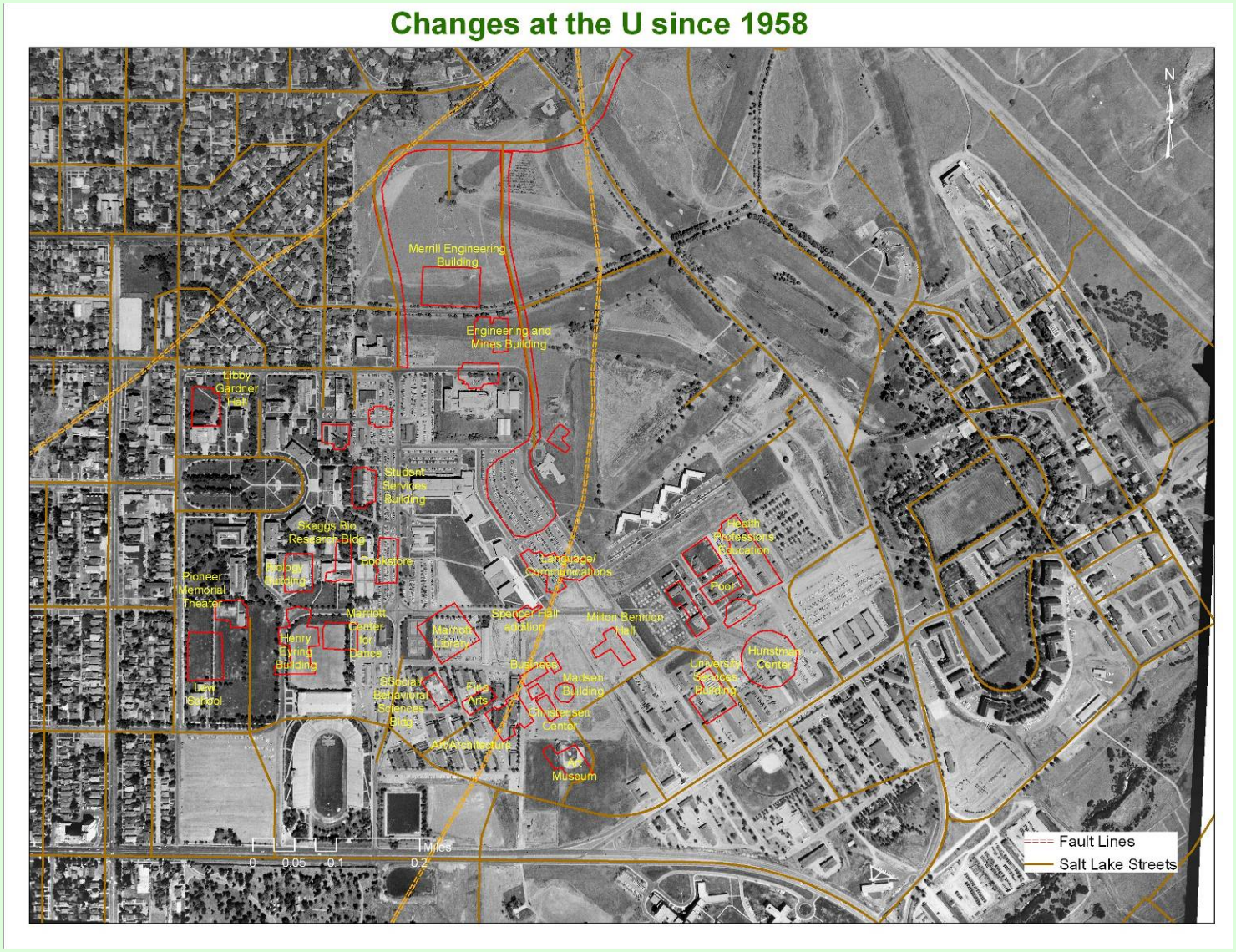
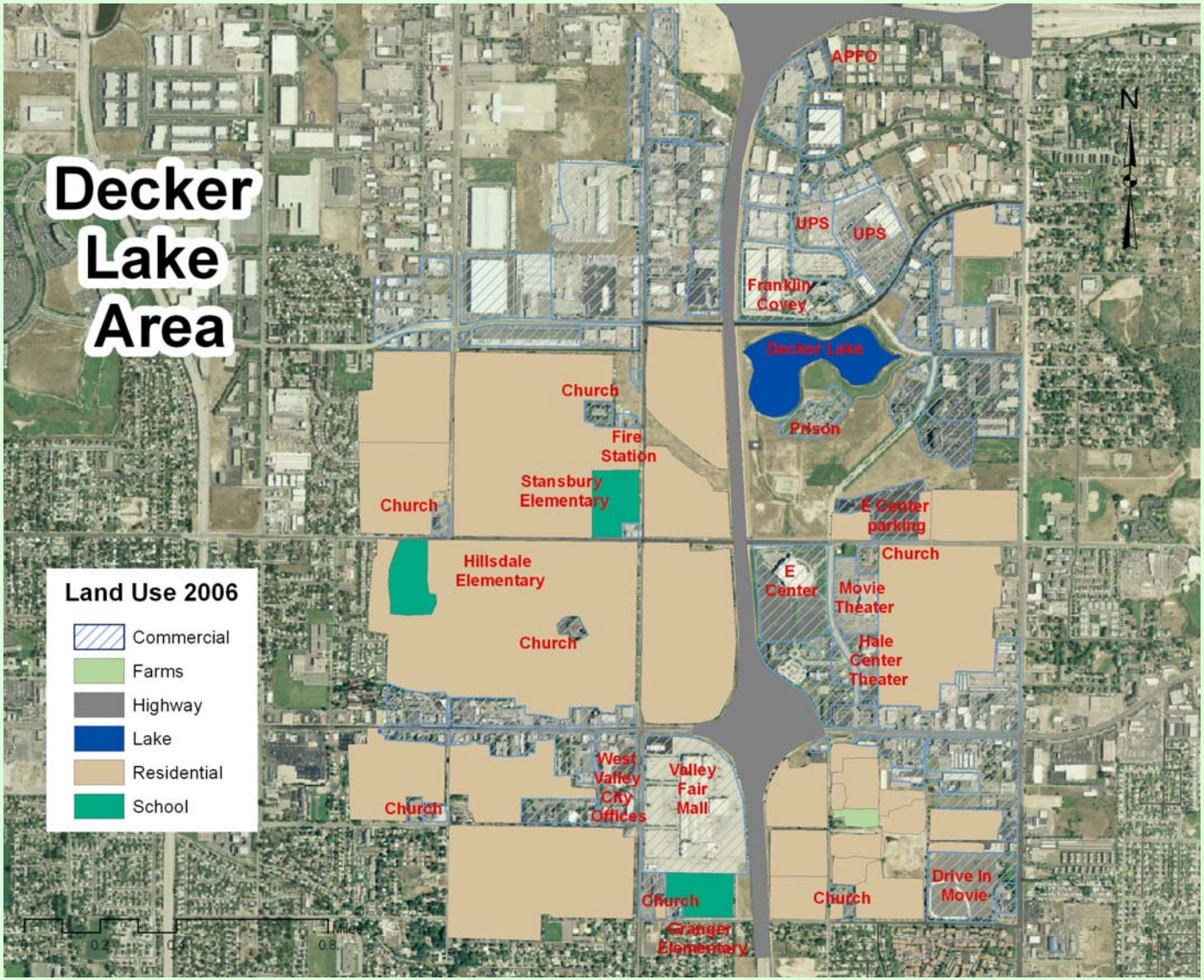


Imagery can help us look at change in our own backyards.

APFO is located in West Valley City, Utah, close to a small preserve called Decker Lake.

The area has changed a great deal in 50 years,



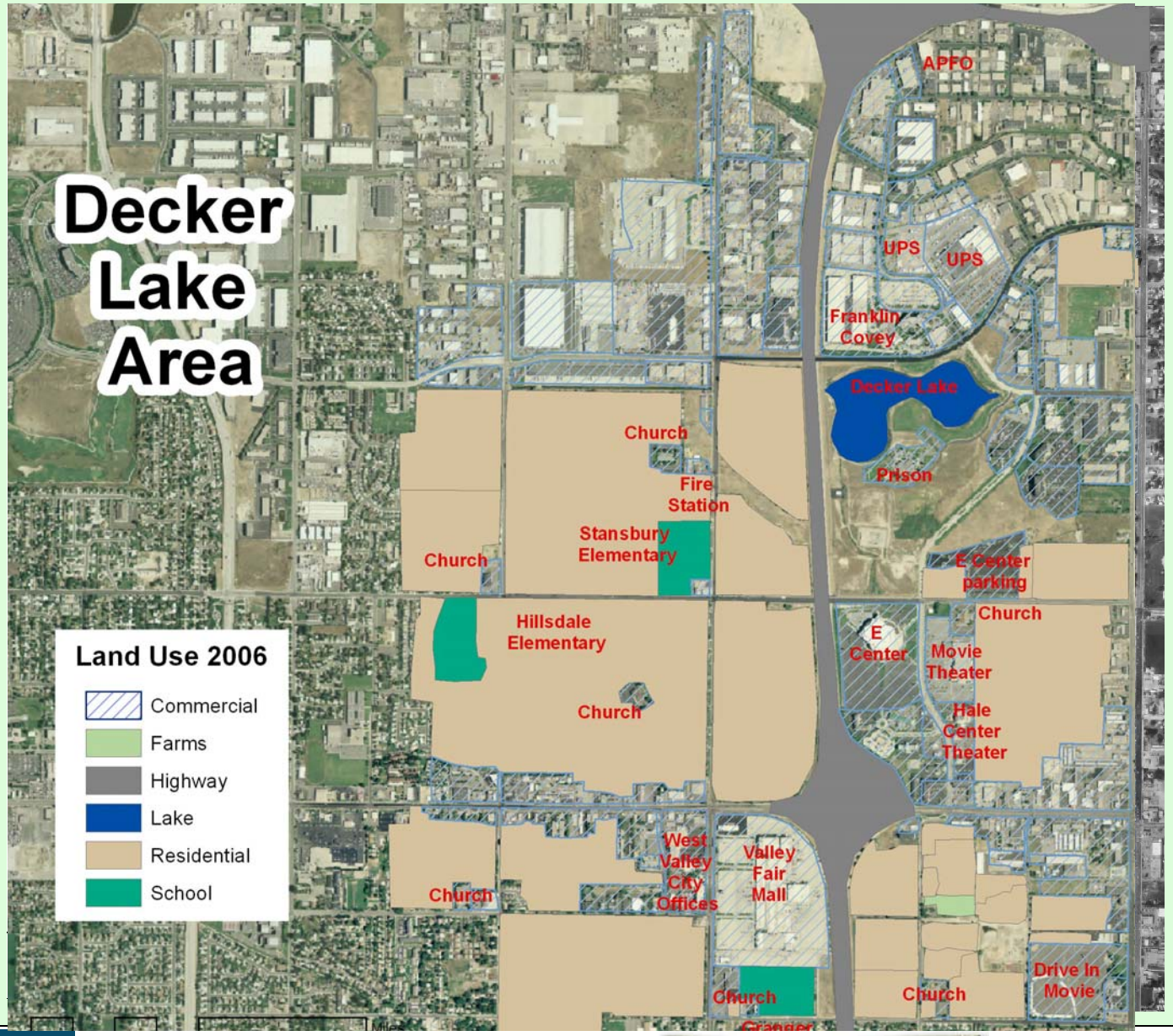
In 1958, Decker Lake was much larger, and the area to the south was classified as wetlands on the USGS topo map. The open lands in the area, the northern part of the community of Granger, but land to the south was not. The E Center, a large hockey arena, was built where the wetlands had been.

MDOQs made from 1997 NAPP photography.

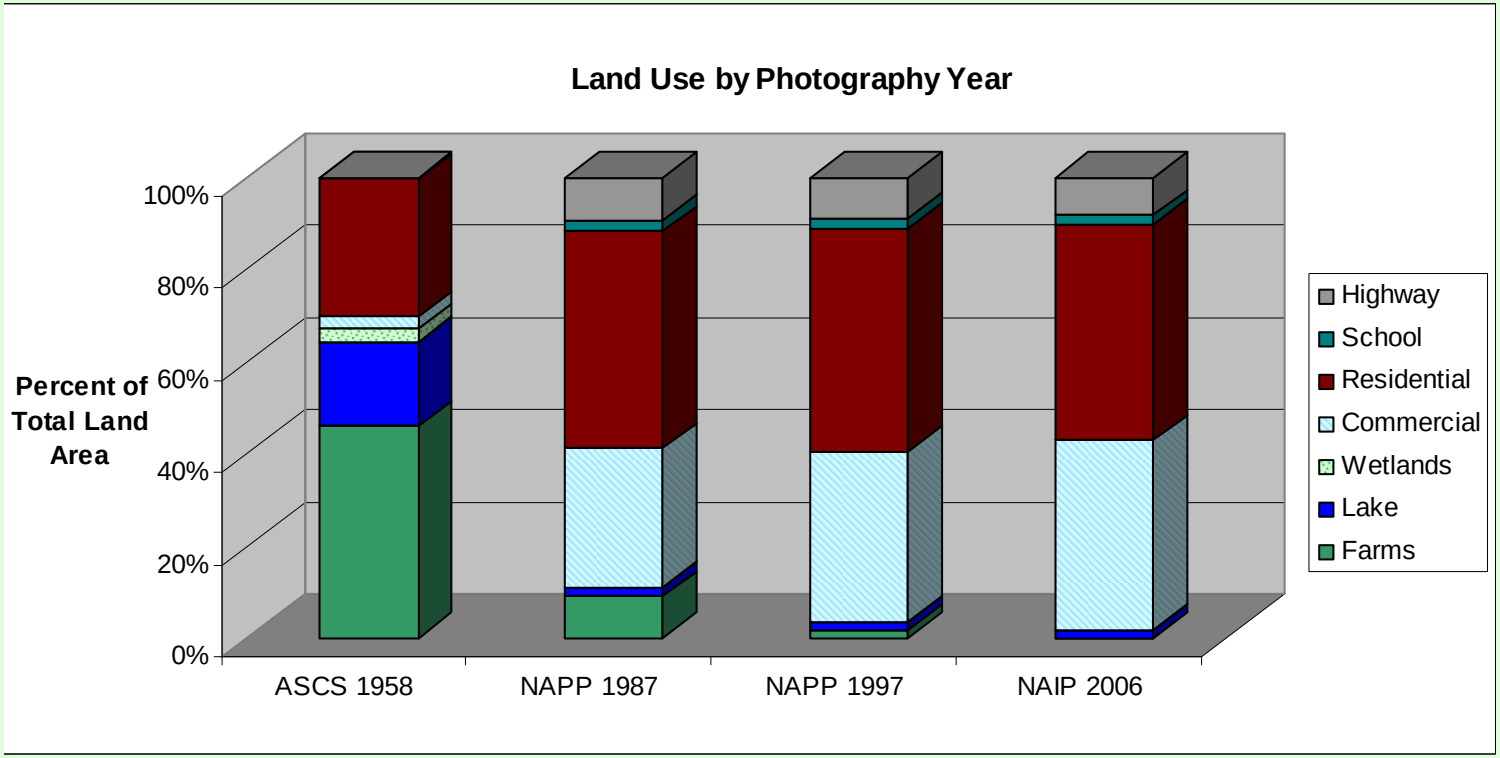
1:40,000 scale

A few more business and residential areas were added by 2006. The farm fields are now virtually gone.

The 2006 NAIP imagery was delivered, but to the 1998 ASCS imagery: 1:10,000 scale



Summary statistics can be used to create spreadsheets and charts illustrating the change in land use over time.

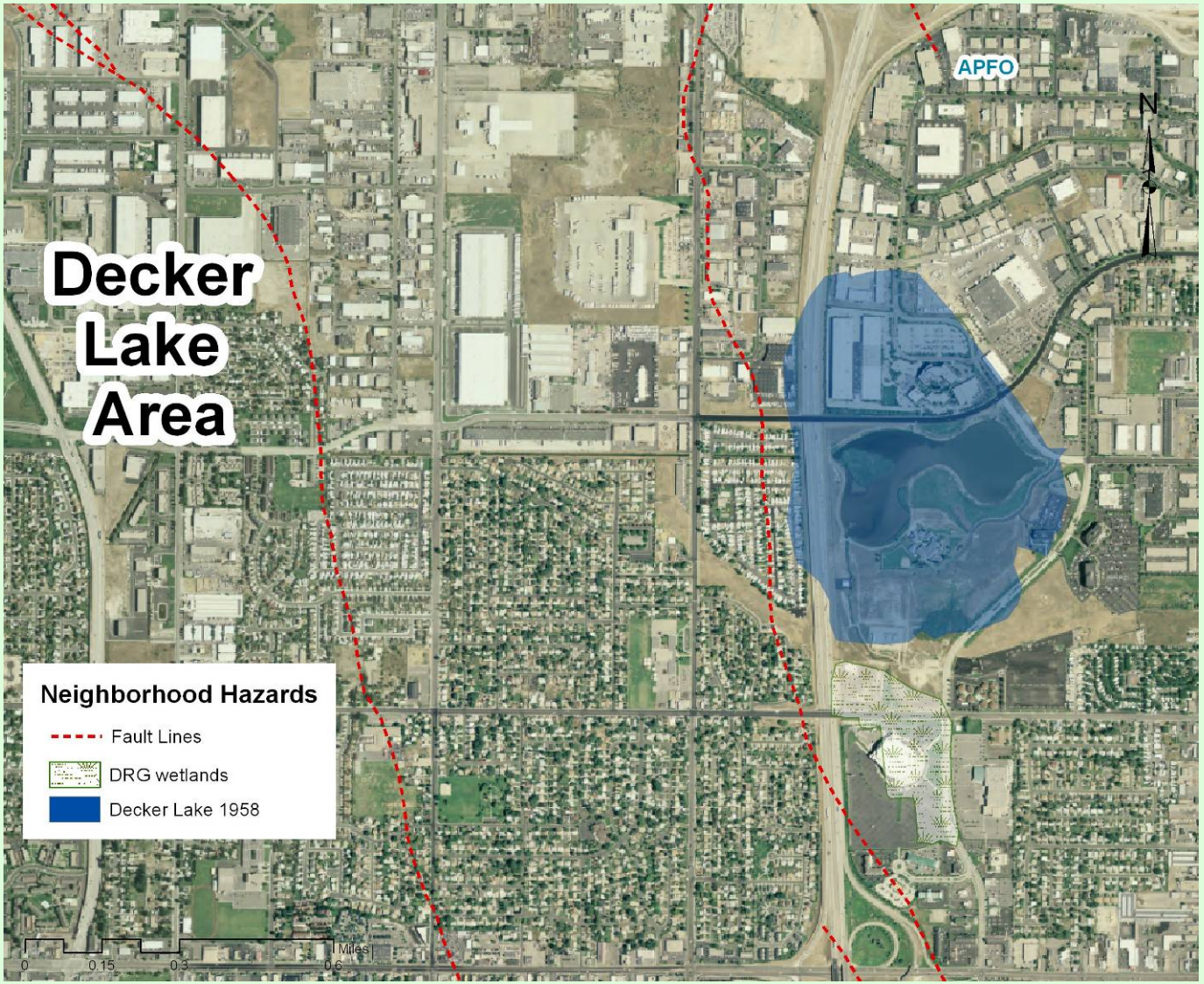


	ASCS 1958		NAPP 1987		NAPP/NDOP 1997		NAIP 2006	
	Acreage	Percent	Acreage	Percent	Acreage	Percent	Acreage	Percent
Farms	474.67	45.99	146.18	9.11	30.55	1.78	3.18	0.17
Lake	189.43	18.35	31.67	1.97	31.67	1.85	31.67	1.72
Wetlands	29.08	2.82	0.00	0.00	0.00	0.00	0.00	0.00
Commercial	27.97	2.71	482.34	30.06	633.86	37.01	756.99	41.01
Residential	308.50	29.89	755.69	47.09	827.53	48.32	865.25	46.87
School	2.43	0.24	38.05	2.37	38.05	2.22	38.05	2.06
Highway	0.00	0.00	150.89	9.40	150.89	8.81	150.89	8.17
	1,032.08	100.00	1,604.82	100.00	1,712.54	100.00	1,846.03	100.00

What about the natural landscape under all of the new development?

Businesses have been built where there once were wetlands, and there are several fault lines nearby.

Preparation for natural hazards is one important use of historical imagery, maps and vector data.



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