Utah NAIP 2006

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Overview

- Relative & Absolute Control Issues
- Absolute Control
- UT NAIP 2006 Pilot Project
- Production & Inspection Control Point Samples

NAIP Relative Control

- New imagery tied to old imagery
  - ± 5-meter for 1-meter NAIP
  - ± 10-meter for 2-meter NAIP
- Pro
  - CLU and other SCA data should match new imagery since both are tied to the old imagery.
- Con
  - Other data sets may not match because they are not tied to the old imagery.

NAIP Absolute Control

- Requests from FSA and NAIP partners to use ground control.
  - Reasons for:
    - Imagery represents reality, not former imagery
    - Know errors and offset in former imagery
    - Imagery would match most other data sets
    - Potentially more NAIP partners
  - Reasons against:
    - Additional cost and time to acquire control
    - Additional time may be needed to produce imagery
    - No nationwide, photo-identifiable control point database for use in production & inspection.
    - Changes to inspection, database, contract, etc.

NAIP Absolute Control

Support from many sides

- UT NAIP Pilot Project
  - FSA (APFO, WDC & State offices)
  - NAIP partners
  - State GIS office (AGRC)
  - NAIP contractor (North West Geomatics)

- The same level of support will likely be required to use absolute ground control in other states.

Standards & Requirements

- Researching & selecting a standard
  - Industry standards, imagery uses, accuracy requirements, existing standards.
- Discussions with George Lee and associates
  - Number and distribution of points, former and existing imagery programs.
- Discussions with AGRC & NW Geomatics
  - Number of points and specifications, scheduling, contacts.

Accuracy Requirements

- Reviewed & evaluated the following accuracy standards:
  - NMAS
  - ASPRS
  - NSSDA
  - IFTN

Accuracy Requirements

- NMAS
  - (U.S. Bureau of the Budget, 1947) specifies that 90% of the well-defined points that are tested must fall within a specified tolerance:
  - For map scales larger than 1:20,000, the NMAS horizontal tolerance is 1/30 inch, measured at publication scale.
  - For map scales of 1:20,000 or smaller, the NMAS horizontal tolerance is 1/50 inch, measured at publication scale.
  - This system is better for maps or photos at a set scale rather than digital imagery in a GIS which is generally viewed at a variety of scales.

Accuracy Requirements

- ASPRS
  - ASPRS Accuracy Standards for Large-Scale Maps (ASPRS Specifications and Standards Committee, 1990) provide accuracy tolerances for maps at 1:20,000-scale or larger “prepared for special purposes or engineering applications.” Root-mean-square error (RMSE) is the statistic used by ASPRS. Accuracy is reported as Class 1, Class 2, or Class 3. Class 1 is shown as a table of RMSE values for various scale maps. Class 2 is twice the RMSE value as Class 1, and Class 3 is three times the value of Class 1.

Accuracy Requirements

- NSSDA
  - Executive Order 12906, states: “Federal agencies collecting or producing geospatial data, either directly or indirectly shall ensure… that data will be collected in a manner that meets all relevant standards adopted through the FGDC process.” This documentation makes it fairly clear that the NSSDA standards, when plausible, should be used.
  - The NSSDA does not specify the geographic area for testing. The NAIP test area could be the DOQQ, CCM, or the Project Area (usually a State). It was noted in talks with USGS that the 20 point standard in the NSSDA does not necessarily mean the smallest possible test area. For aerial photography the number of testable points could reach the number of pixels in an image.

Accuracy Requirements

- IFTN (Imagery For The Nation)
  - Currently listed as 25 feet (7.6 meters).
  - The issue of 6 meters for NAIP and 7.6 meters for IFTN was discussed with Ted Koch & Bill Burgess of NSGIC. Both were fine with revising the proposed IFTN standard if the UT NAIP pilot proves successful.

Acquiring & Maintaining Control Points
UT Pilot Project

- Workload
  - Standards development
  - Point selection for AGRC
  - Coordination with AGRC and other agencies
  - Finding, evaluating, preparing control points from other sources for use in inspection.
  - Database creation
  - Control point inspection
  - Data entry
  - Maintenance
  - Continued research, testing, coordination
- Currently part time workload for 2 people in the APFO SCSS with involvement from contracting, administration, and IT.

Acquiring & Maintaining Control Points Nationwide

- Will need one or more people to oversee:
  - acquisition
  - scheduling
  - coordination
  - maintenance
  - database
  - data entry
  - inspection
  - standards
  - research
- Part to full time commitment for possibly 3 to 6 years to create the initial database. Continued maintenance there after.

Acquiring & Maintaining Control Points

- Creating a National Photo-Identifiable Control Point Database
  - Rely on State (AGRC types) to Obtain/Provide Control Points. Can keep points out of the public domain. AGRC estimates it spent approximately $300 per point.
  - Coordinate acquisition from state, county, regional, city, others. Schedule according to current and future NAIP plans.
  - Create a program similar to NAIP or IFTN. Acquire national standardized control points through partnerships.
  - Include control acquisition as part of NAIP or IFTN contract.
  - Use all available sources (USGS, USFS, State, Local, etc)
  - Purchase from private vendors ($250-$350 per point). Potential issues with licensing. Also the contractors could acquire the same control used for inspection.
  - Combinations of the options listed above.

Utah NAIP 2006 Pilot

- Selecting the points
  - Researched how others select & acquire control
  - Met with AGRC Surveyor Sean Fernandez
  - APFO selected each of the 87 points and created a simple map and descriptor of each point.

  - Field Control Sheet
  - Support Data
    - Photographs (N, S, E, W & Close up view of point)
    - Raw GPS data
    - NGS OPUS report (Online Positioning User System)
    - Maps, sketches, descriptions

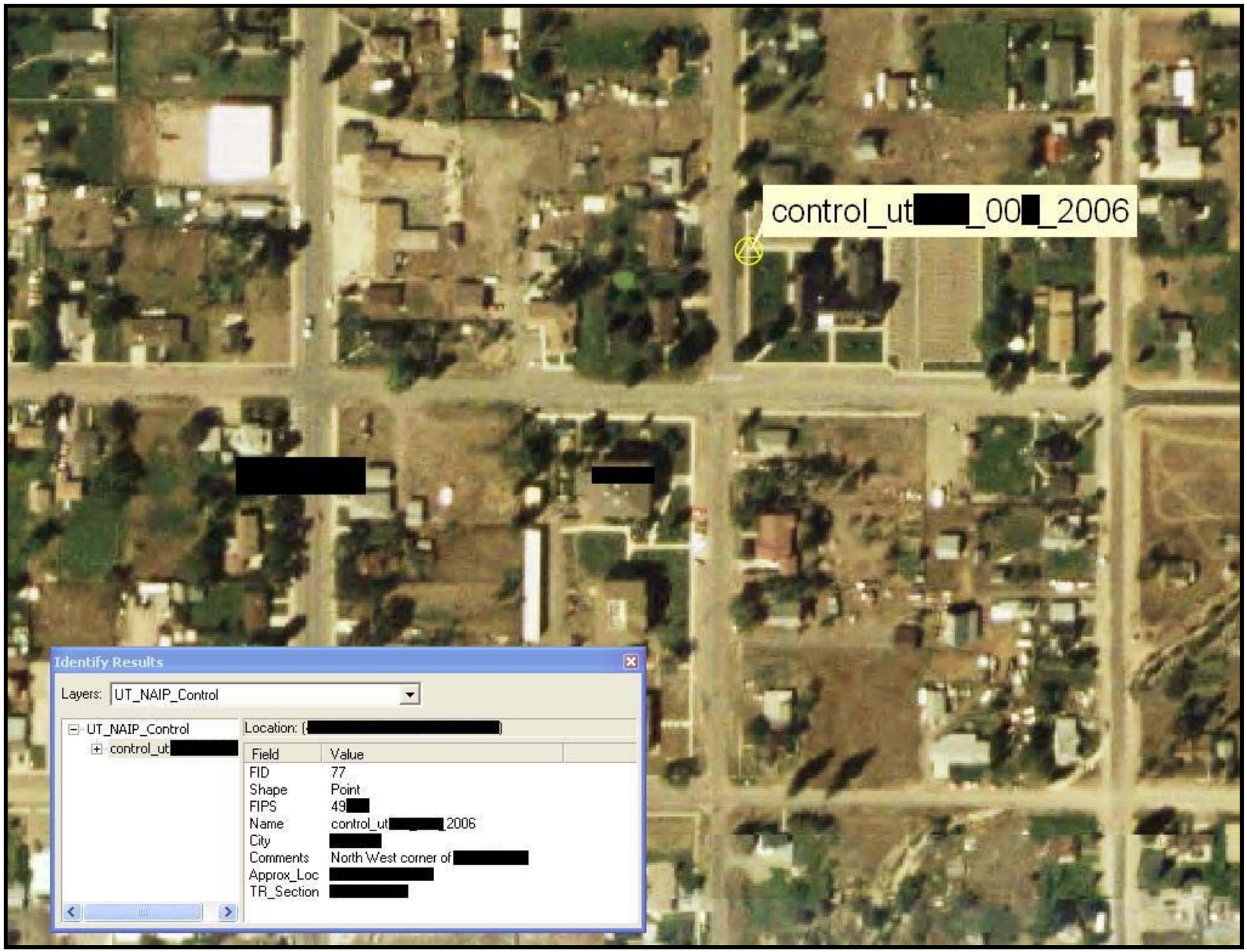
Utah NAIP 2006 Pilot

Control Point Accessibility

- Production Control Points
  - 1 meter NAIP 2006 orthoimagery production
  - 1 foot UT imagery (Coverage for approx ¼ of the state)
  - Use for 6-inch imagery for Salt Lake County
  - Data available for public use

- APFO Inspection Control Points
  - 1 meter NAIP 2006 orthoimagery inspection
  - Data not available for public use. Limited access to the data at AGRC and APFO.

Control Point Sample



Sample Observation Sheet

NAIP 2006 GPS Observation Sheet

Control Station

Station Name	ut[redacted]_2006 [redacted]	**State** Utah	**County** [redacted]
Contacts Name	Matt[redacted]	**Contacts Phone**	(801)[redacted]
Source Agency	AGRC	**Date**	9/15/06

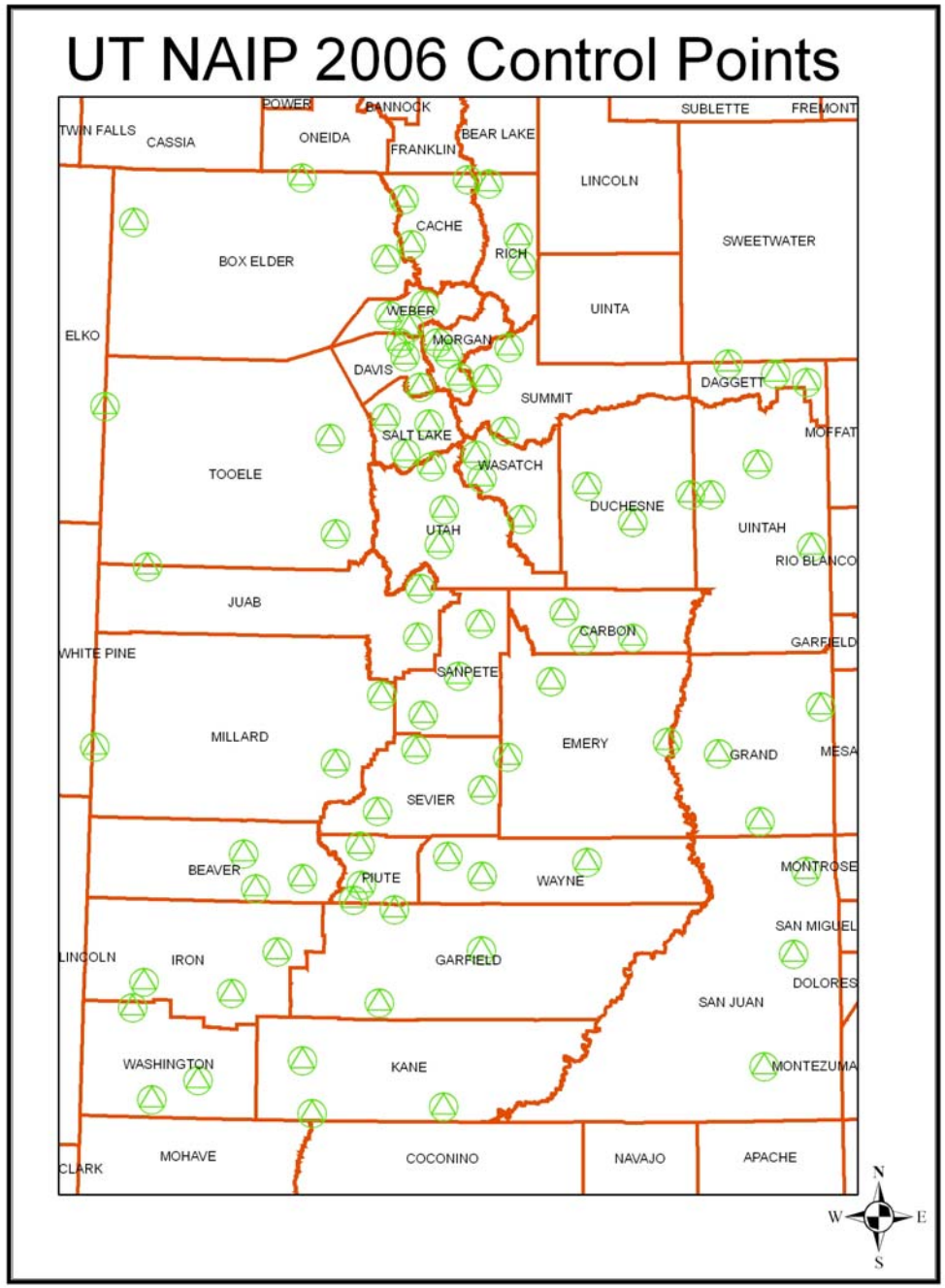
Rover Receiver

Type	Trimble	**Model** 5800	
Serial Number	[redacted]	**Antenna Type** 5800	**Antenna Height** 3.72 sft

Monument Description and Comments

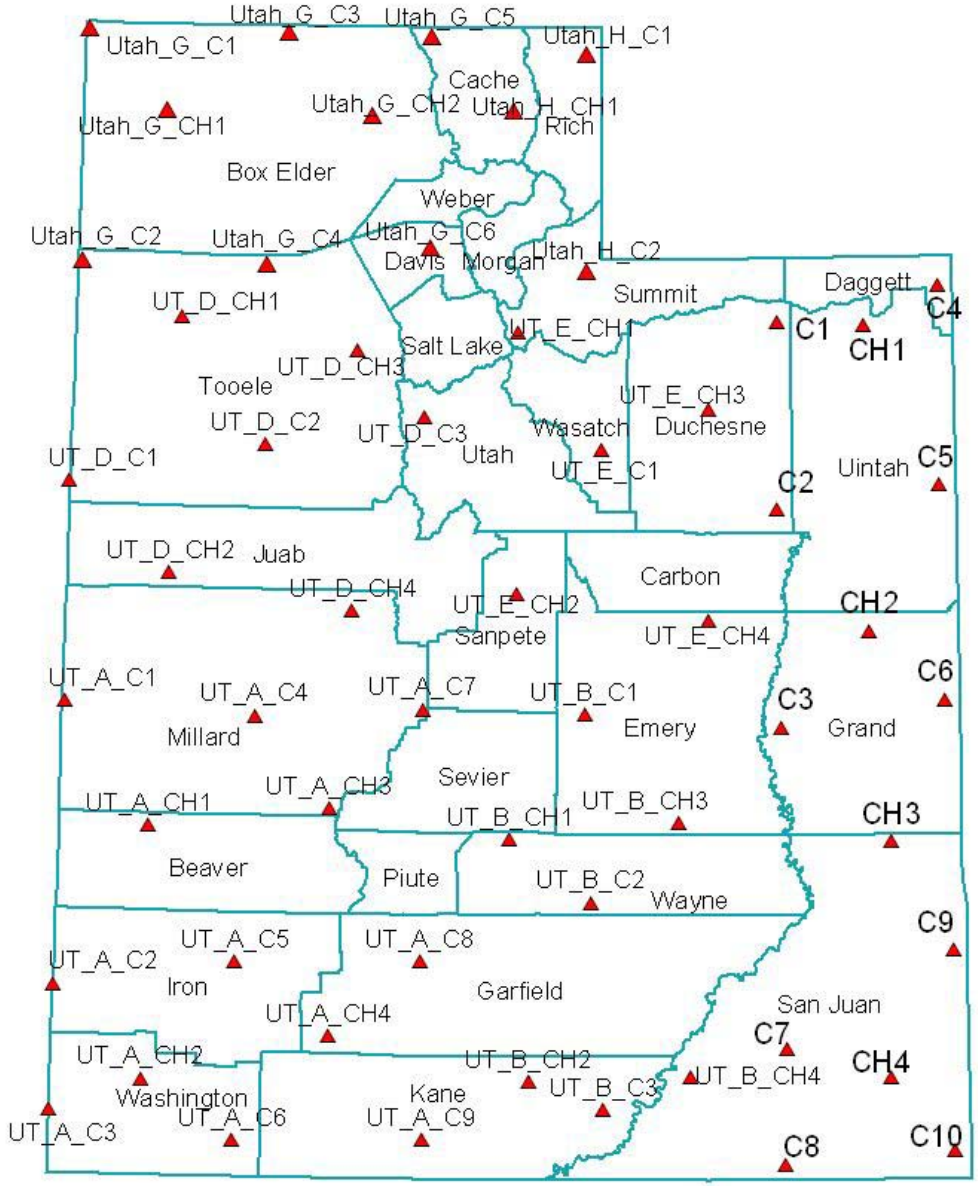
[redacted]–Changed to Southeast corner of church lawn.

Approximate locations of the 87 inspection control points (3 per county)



According to AGRC the points are within millimeters, others centimeters, and others decimeters. In other words, sub-foot accuracy.

Approximate locations of the 79 production control points



Utah NAIP 2006
Ground Control

- **Naming Convention for NAIP06**
  - **Project Name**
  - control_stnnn_yyyy
  - Ex: control_ut035_2006 (Salt Lake County, Year 2006)

  - **Station Name**
  - control_stnnn_nnn_yyyy
  - Ex: control_ut035_005_2006 (Salt Lake County, Point #5, Year 2006)
  - stnnn State postal code abbreviation and three digit county FIPS code
  - nnn control point number (1-999)
  - yyyy calendar year

OPUS Sample Report

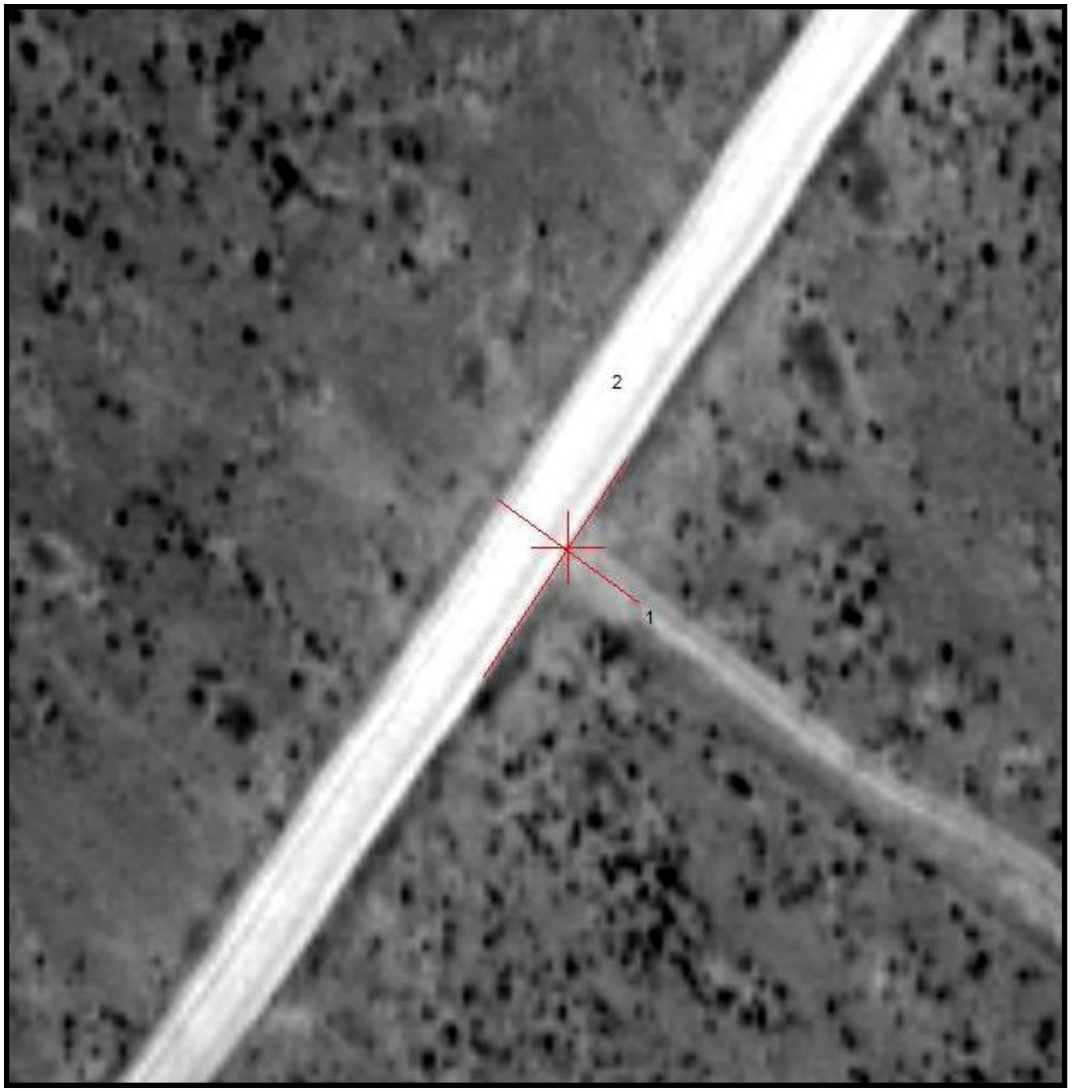
```
FILE: 53[redacted].dat 000014[redacted]

                          NGS OPUS SOLUTION REPORT
                          ========================

      USER: sfernandez@utah.gov                      DATE: October 17, 2006
RINEX FILE: 53172[redacted].06o                      TIME: 22:19:02 UTC


  SOFTWARE: page5  0601.10 master29.pl             START: 2006/10/16  14:56:00
 EPHEMERIS: igr13971.eph [rapid]                    STOP: 2006/10/16  17:03:30
  NAV FILE: brdc2[redacted].06n                   OBS USED:  4198 /  4298   :  98%
  ANT NAME: TRM5800         NONE               # FIXED AMB:    23 /    29   :  79%
ARP HEIGHT: 1.722                              OVERALL RMS: 0.016(m)


 REF FRAME: NAD_83(CORS96)(EPOCH:2002.0000)            ITRF00  (EPOCH:2006.7909)

         X:     -17[redacted].145(m)   0.137(m)          -17[redacted].867(m)   0.137(m)
         Y:     -45[redacted].332(m)   0.038(m)          -45[redacted].053(m)   0.038(m)
         Z:      41[redacted].489(m)   0.039(m)           41[redacted].452(m)   0.039(m)

       LAT:   40 [redacted].55512      0.020(m)        40 [redacted].57375      0.020(m)
     E LON:  248 [redacted].46574      0.117(m)       248 [redacted].41718      0.117(m)
     W LON:  111 [redacted].53426      0.117(m)       111 [redacted].58282      0.117(m)
    EL HGT:          20[redacted].877(m)   0.084(m)              20[redacted].151(m)   0.084(m)
 ORTHO HGT:          20[redacted].215(m)   0.087(m) [Geoid03 NAVD88]

                        UTM COORDINATES    STATE PLANE COORDINATES
                         UTM (Zone 12)         SPC (4301 UT N)
Northing (Y)  [meters]     45[redacted].862          10[redacted].509
Easting (X)   [meters]      45[redacted].021           49[redacted].864
Convergence   [degrees]    -0.34230257          -0.01658174
Point Scale                 0.99962424           1.00000643
Combined Factor             0.99930761           0.99968968

US NATIONAL GRID DESIGNATOR: 12TVL55[redacted](NAD 83)


                              BASE STATIONS USED
PID       DESIGNATION                        LATITUDE    LONGITUDE DISTANCE(m)
CQ6018 MIDV MIDVALE CORS ARP               N403716.045 W1115426.030   32[redacted].2
AF9633 RBUT RED BUTTE CORS ARP             N404651.807 W1114831.490   26[redacted].0
DH3861 P089 WANSHIP___UT2004 CORS ARP      N404825.493 W1112454.992   17[redacted].9

                    NEAREST NGS PUBLISHED CONTROL POINT
LO06[redacted]      C 86                   N40[redacted].    W11[redacted].        846.9

This position and the above vector components were computed without any
knowledge by the National Geodetic Survey regarding the equipment or
field operating procedures used.
```

National Geodetic Survey
Online Positioning User Service

http://www.ngs.noaa.gov/OPUS/

Ortho-Production Control

Selecting the point



Control point marker

Ortho-Production Control

Control point examples

Inspection Control

Control point examples

Inspection Control

Control point examples

Comparison of 2006 NAIP Imagery for Utah

State of Utah USDA Farm

Service Agency

(Preliminary Study)

Prepared By Rodney Johnson, GIS Coordinator/Specialist.

December 6, 2006

UT NAIP 2006

My findings thus far seem very positive. I don’t see the need to move, or shift the lines. All are within the 3 meters.

Rodney Johnson
USDA/Farm Service Agency
Utah GIS Specialist/Coordinator &
GeoData Administrator

Cache County

Image Comparison. Scale = 1:48,000

2004 Final Product

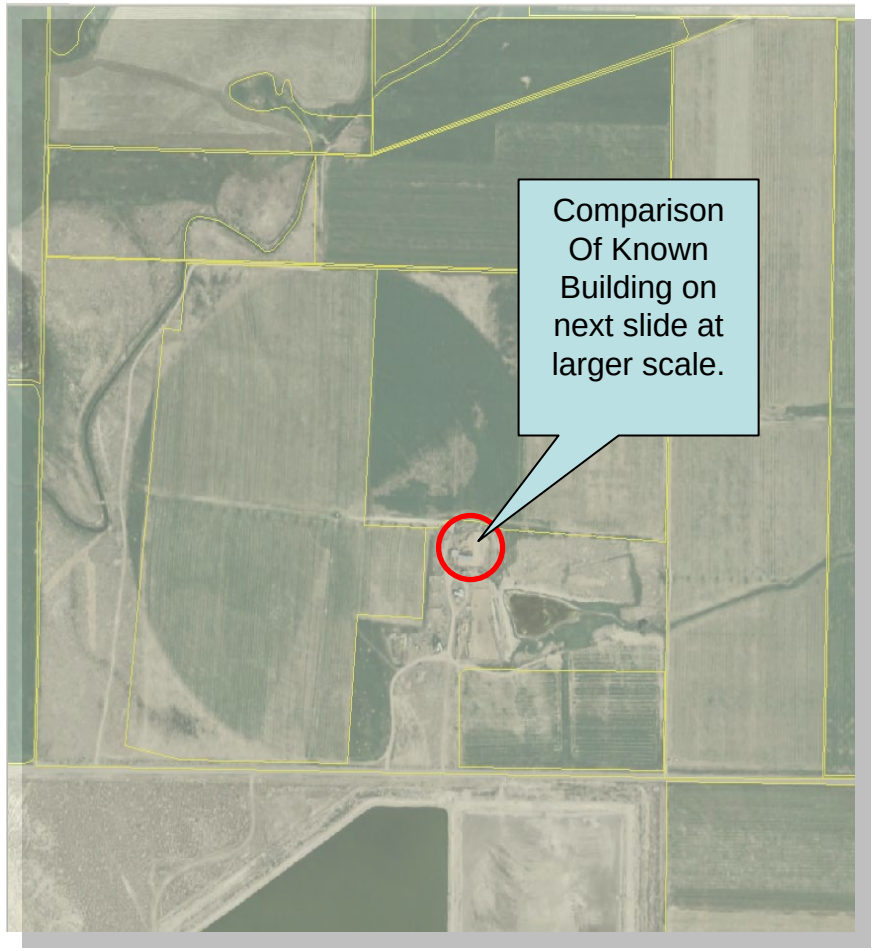
2006 Interim Product

Beaver County NAIP

Scale: 1:4,800

Terrain: Flat

2004 Final Product

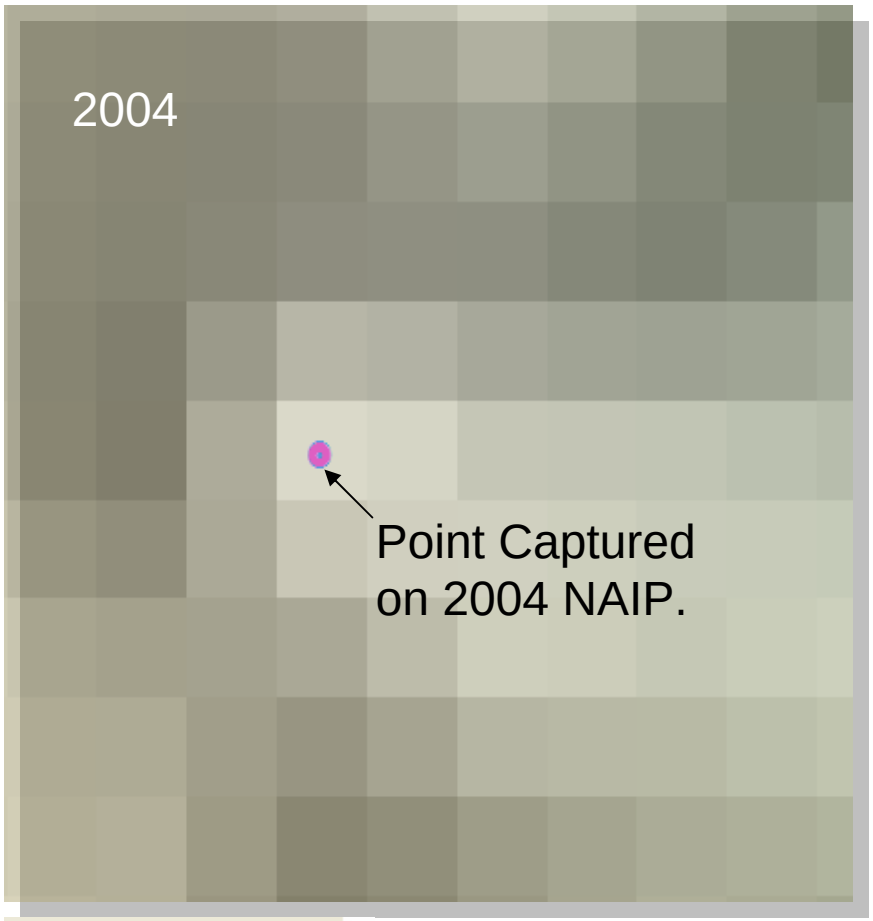


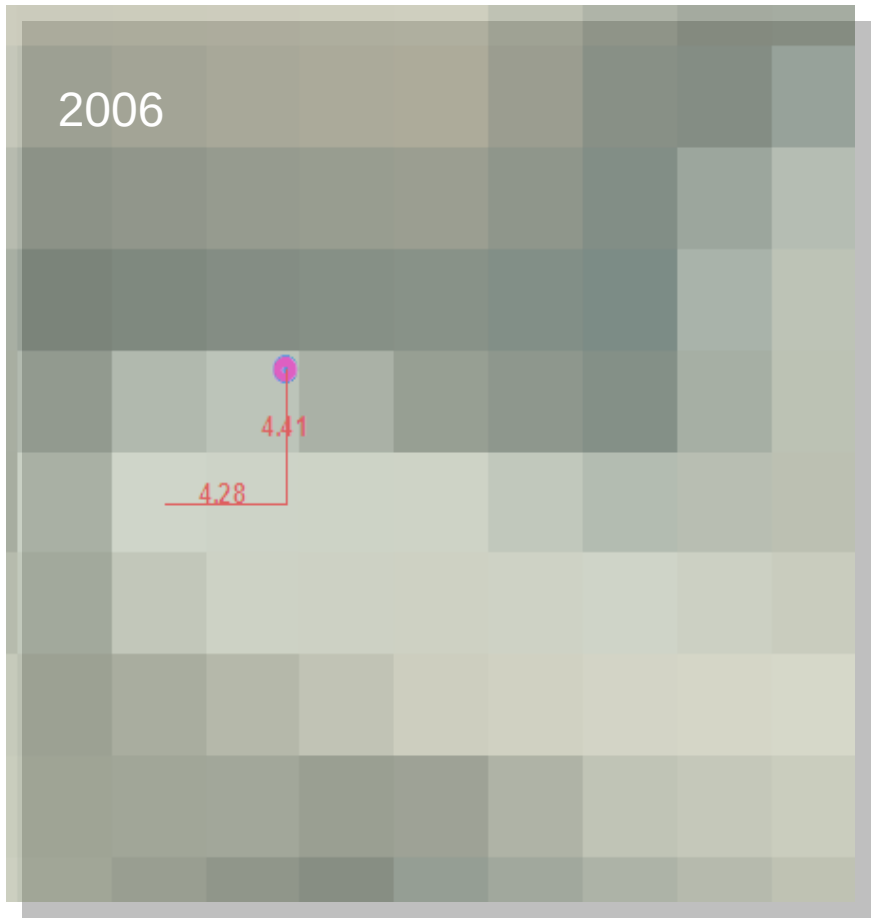
2006 Interim Product

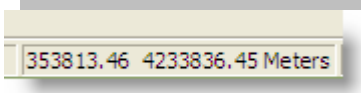
Beaver County

Scale 1:76

Terrain: Flat







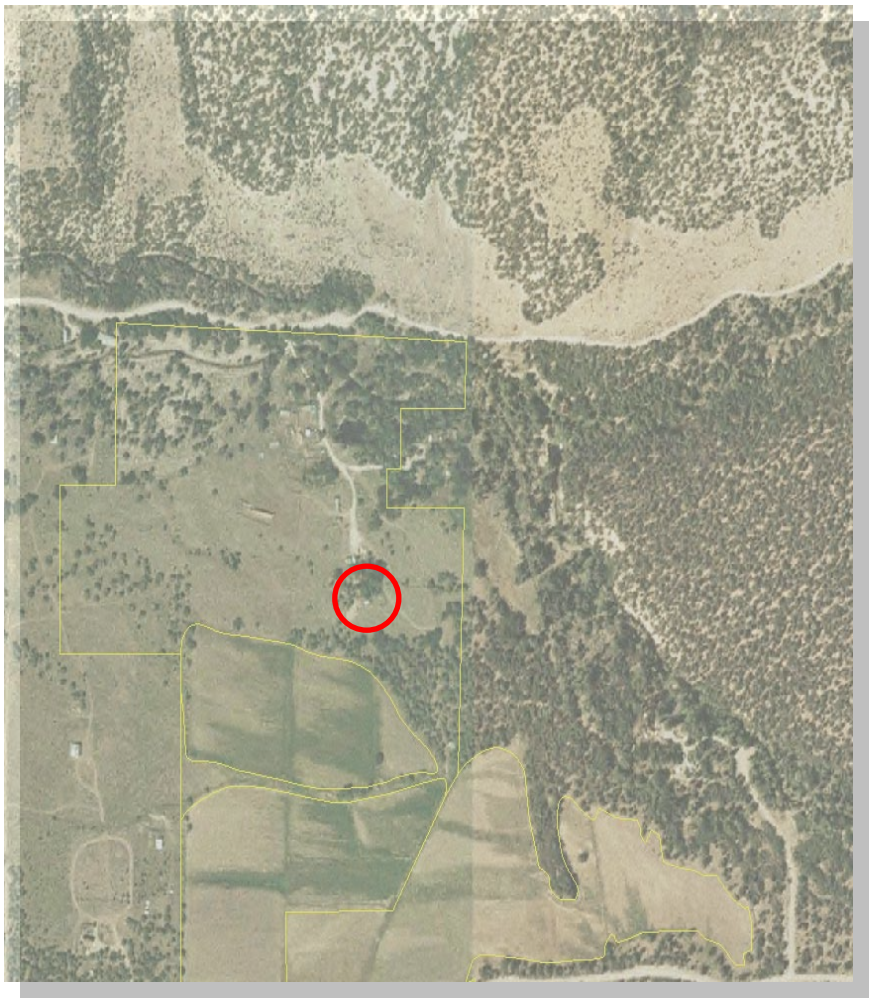
Building Seen In Both Images.

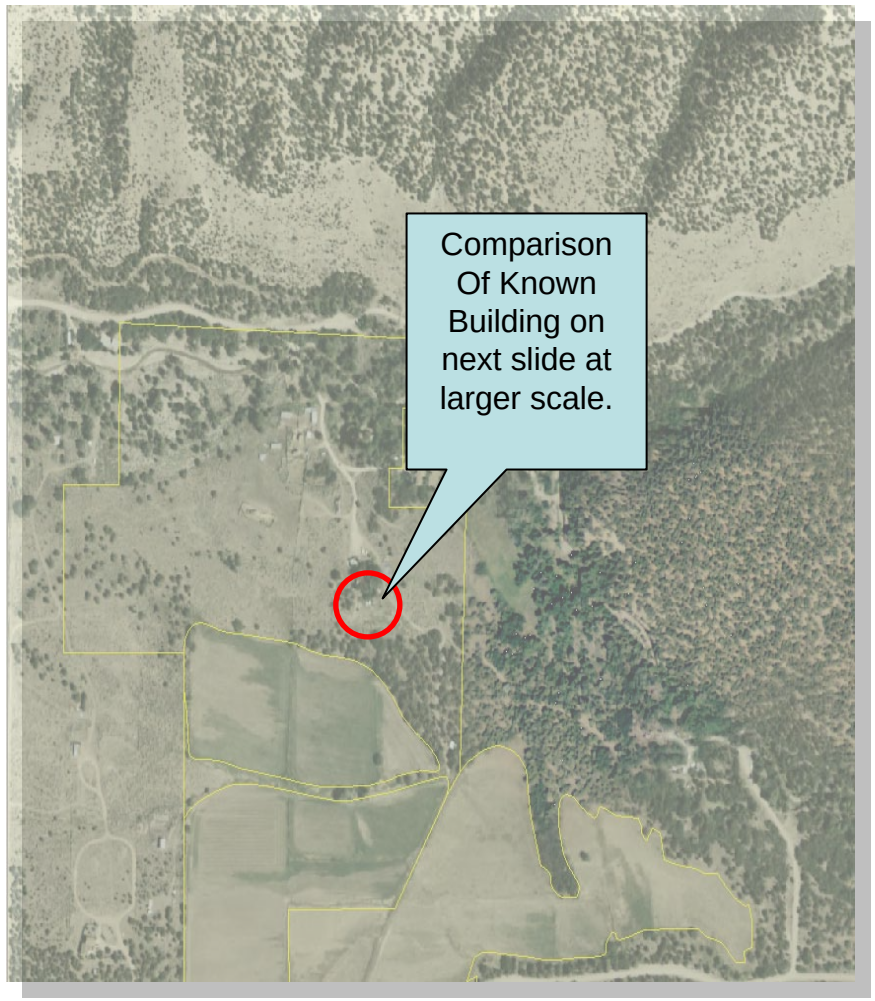
Difference was -1.3 meter Y and -1.3 meter on the X

Beaver County

1:4,800

Terrain: Steep

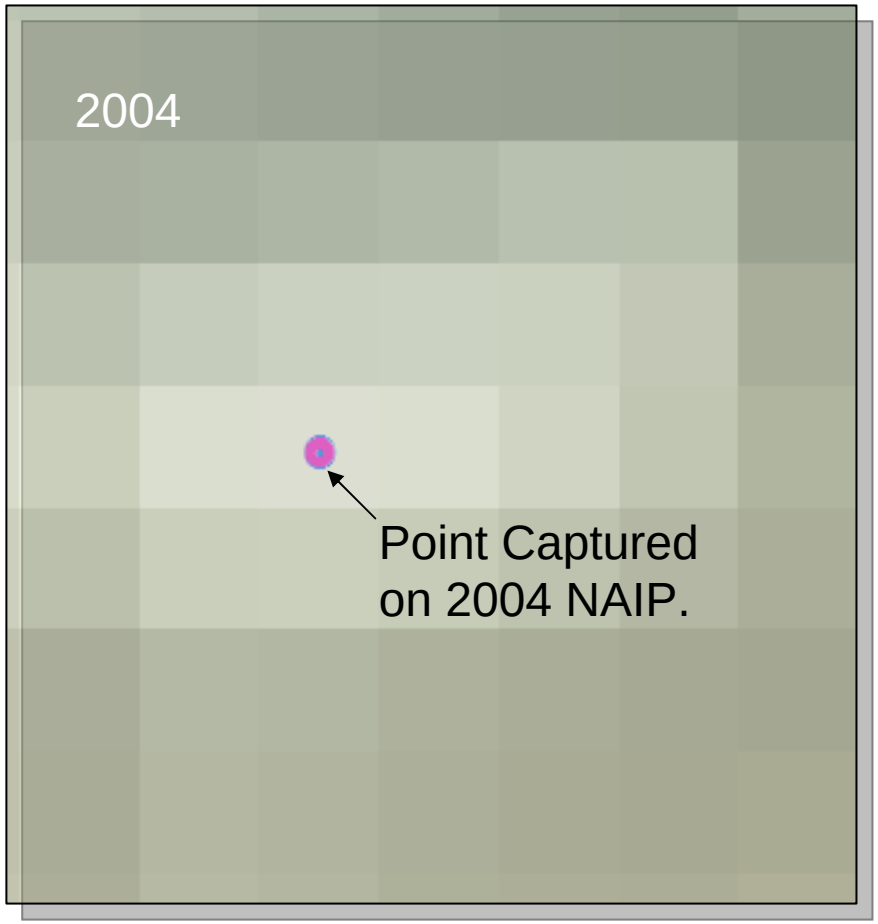


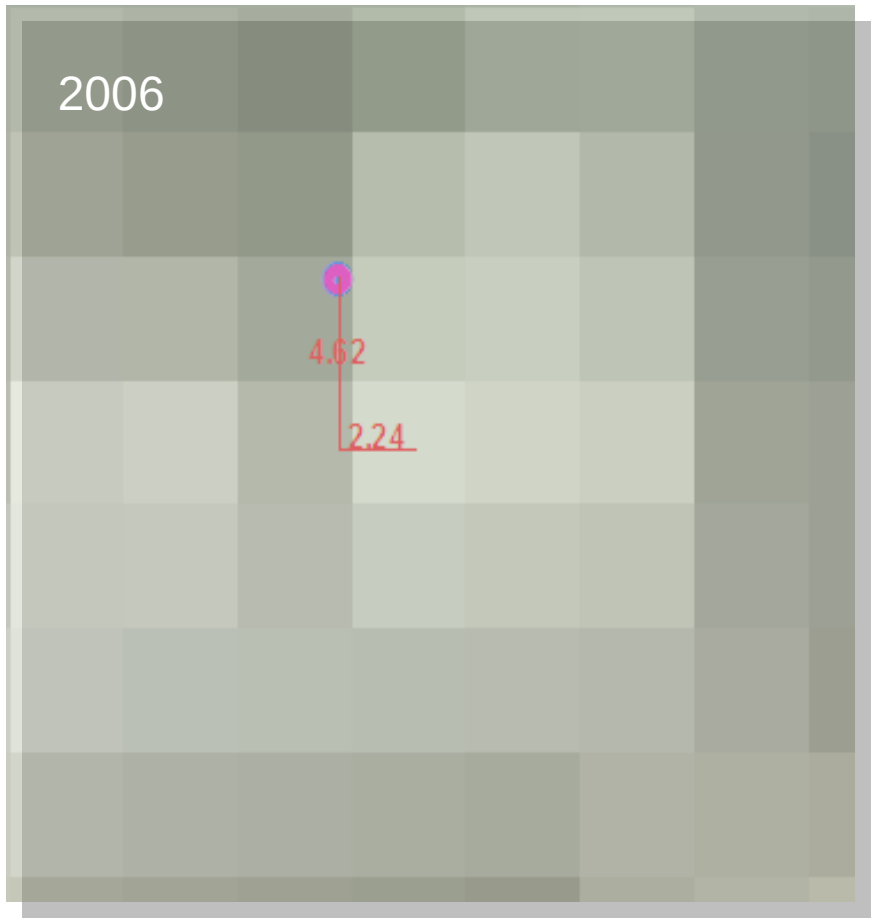


Beaver County

1:76

Terrain: Steep





363678.49 4244956.48 Meters

Building Seen In Both Images.

Difference was -1.4 meter Y and .7 meter on the X

2004 Full-County View
Beaver County, Utah

No-Data Areas Turned off. This Accounts for Jagged edge on imagery.

2006 Full-County View
Beaver County, Utah

FYI: No-Data Areas Turned off. This Accounts for Jagged edge on imagery.

Overview

- Control Point Database Design
- 2006 UT NAIP Inspection Process
- Supplemental Data
- Digital Elevation Models (DEM)

Control Point Database Design

- The connecting factor in the move of NAIP from relative to absolute control specifications
  - 2006 NAIP has relative horizontal accuracy for production and inspection (except in UT)
    - Match deliverable to older baseline imagery
  - Future NAIP
    - Absolute horizontal accuracy (+/- 6 meters)
      - Meets or exceed NMAS for 1:12000, ASPRS class 2, and Imagery for the Nation (last iteration)
      - Makes for a “more valuable” dataset
      - Attracts more partners

Control Point Database Design

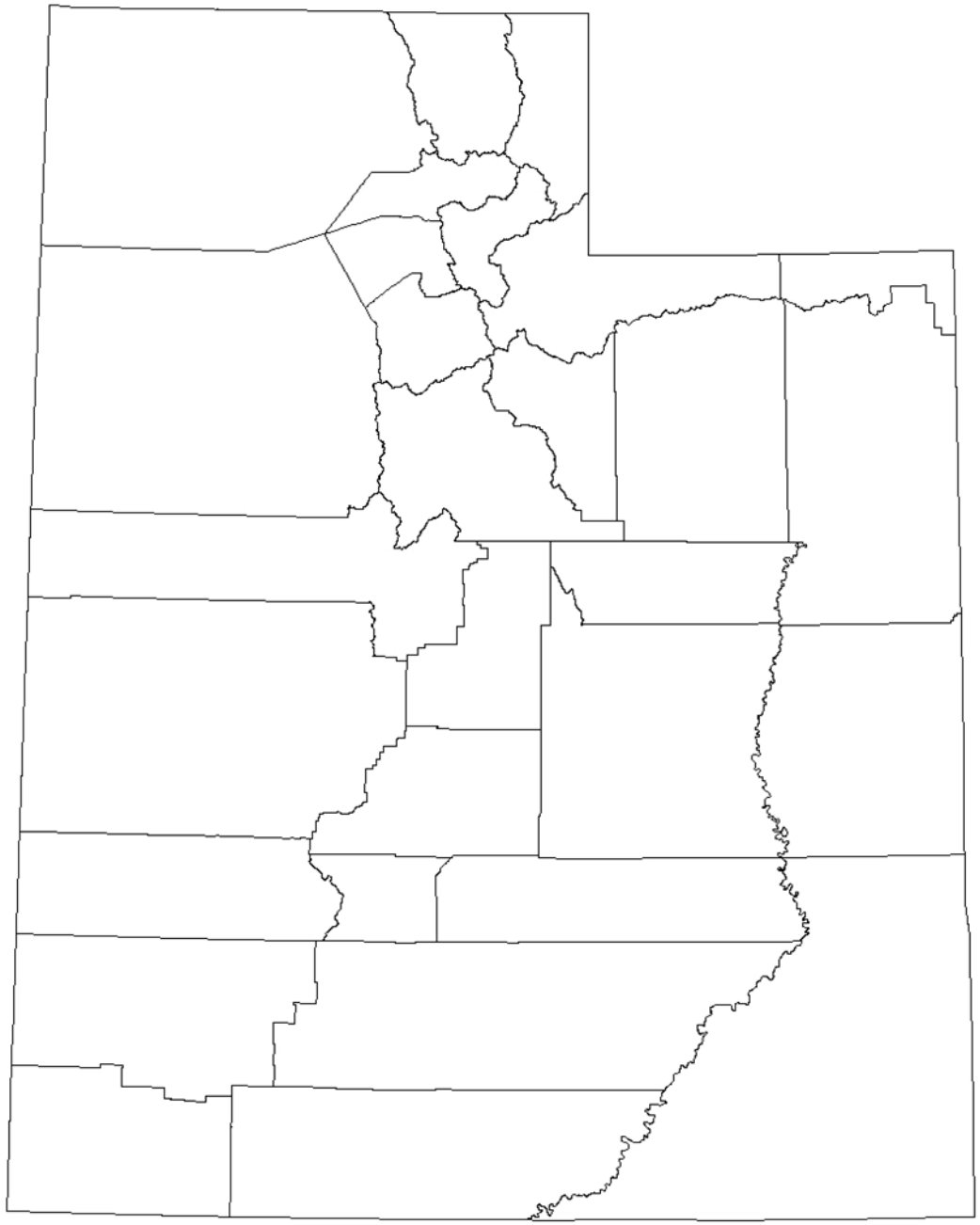
- Control Point Database: database of all photo-identifiable ground control points used for NAIP inspection
  - Start with UT pilot
  - Design geared towards National coverage (long term)
  - Flexibility
    - Can “handle” most data delivery formats
      - Numerous data sources (USGS, USFS, States, NGS, Private, etc.)
      - Accommodating field types and lengths
- Maintained as .dbf this year
  - Eventually will be an Oracle table
- Capable of adding x,y (lat,lon) “events” into ArcMap
- Not for public disbursement

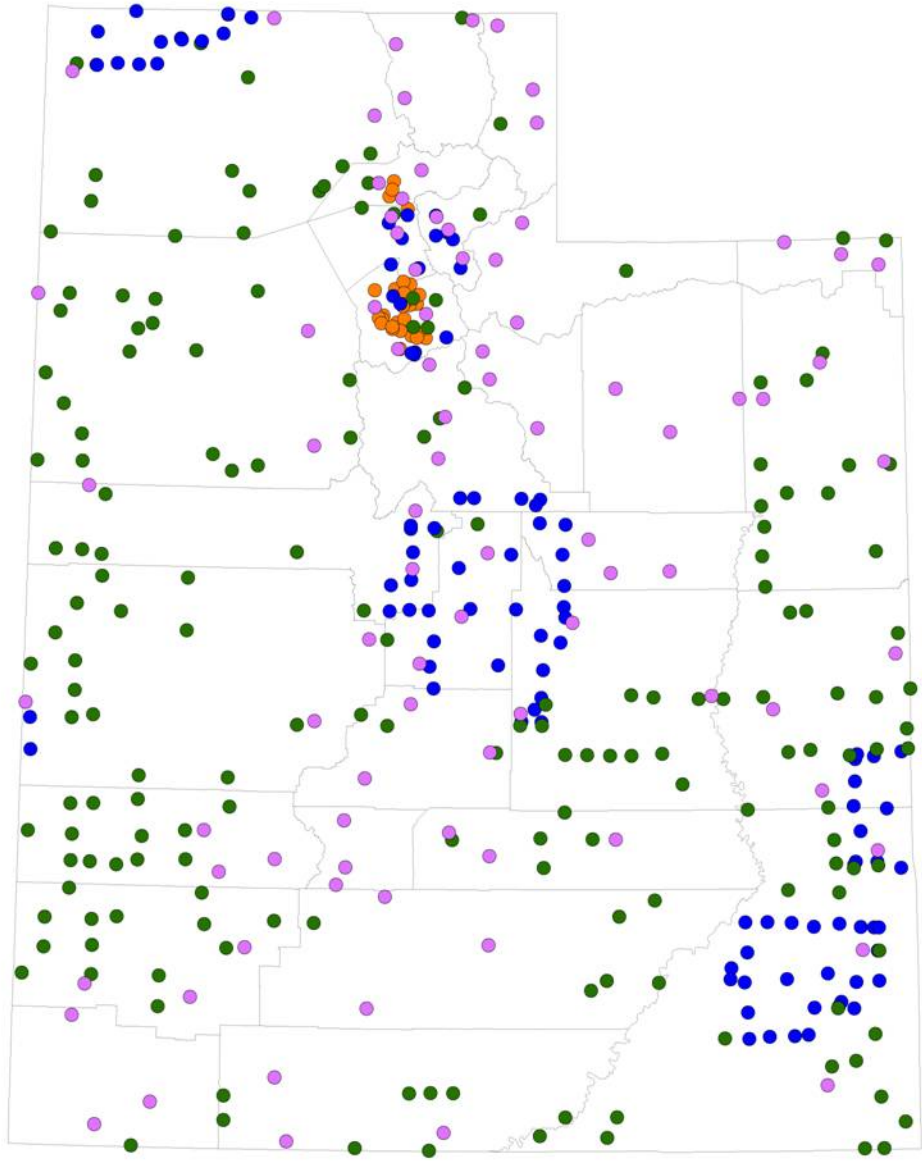
DB Fields

POINT_ID1: Surveyor named identification of point (String 50)
POINT_ID2: Surveyor secondary identification of point (String 50)
APFO_ID: APFO's point identification name (String 50)
LAT: Latitude in Decimal Degrees (Double 19)
LON: Longitude in Decimal Degrees (Double 19)
ACCURACY: Survey accuracy information for point (String 50)
STATECTY: 5 digit FIPS of where the point is located (String 5)
ST: 2 digit State FIPS of where the point is located (Short 2)
DESCRIPT: textual description location of point (String 50)
UTM: UTM zone of where the point is located (Long 9)
COL_DATE: Original or most recent point collection/visit date (String 50)
MON: Is point monumented (String 50)
POS_DATUM: Positional datum (e.g NAD83) (String 50)
ELEV_DATUM: Elevation datum (String 50)
ELEV: Elevation of point (String 50)
QUALITY: APFO populated quality assessment of point for specific purpose of inspection. Is the point easy to use for inspection? 1=Excellent, 2=Good, 3=Average, 4=Difficult, 5=Recommend Removal from Inspection Database. This field will allow for APFO to keep current a quality inspection point database, based on inspector observations (String 50)
ADD_DATE: Date point added to the APFO control database (String 50)
SUP_DATA1: supplemental data field, including hyperlinks to websites, images, sketches, detailed descriptions, etc. (String 100)
SUP_DATA2: Same as SUP_DATA1 (String 100)
SUP_DATA3: Same as above (String 100)
SUP_DATA4: Same as above (String 100)
SUP_DATA5: Same as above (String 100)
SUP_DATA6: Same as above (String 100)
DATA_SRCE: Source of the control data (USGS, NGS, USFS, etc.) (String 50)
CNTCT_NAME: Name of primary contact for control point (String 50)
CNTCT_PHON: Phone for primary contact for control point (String 50)
CNTCT_EMAL: Email for primary contact for control point (String 50)

- Critical fields
  - LAT
  - LON
  - DESCRIPT
  - POS_DATUM
  - ACCURACY
  - SUP_DATA
  - DATA_SRCE
- Meets IT criteria

Order Control Points Added

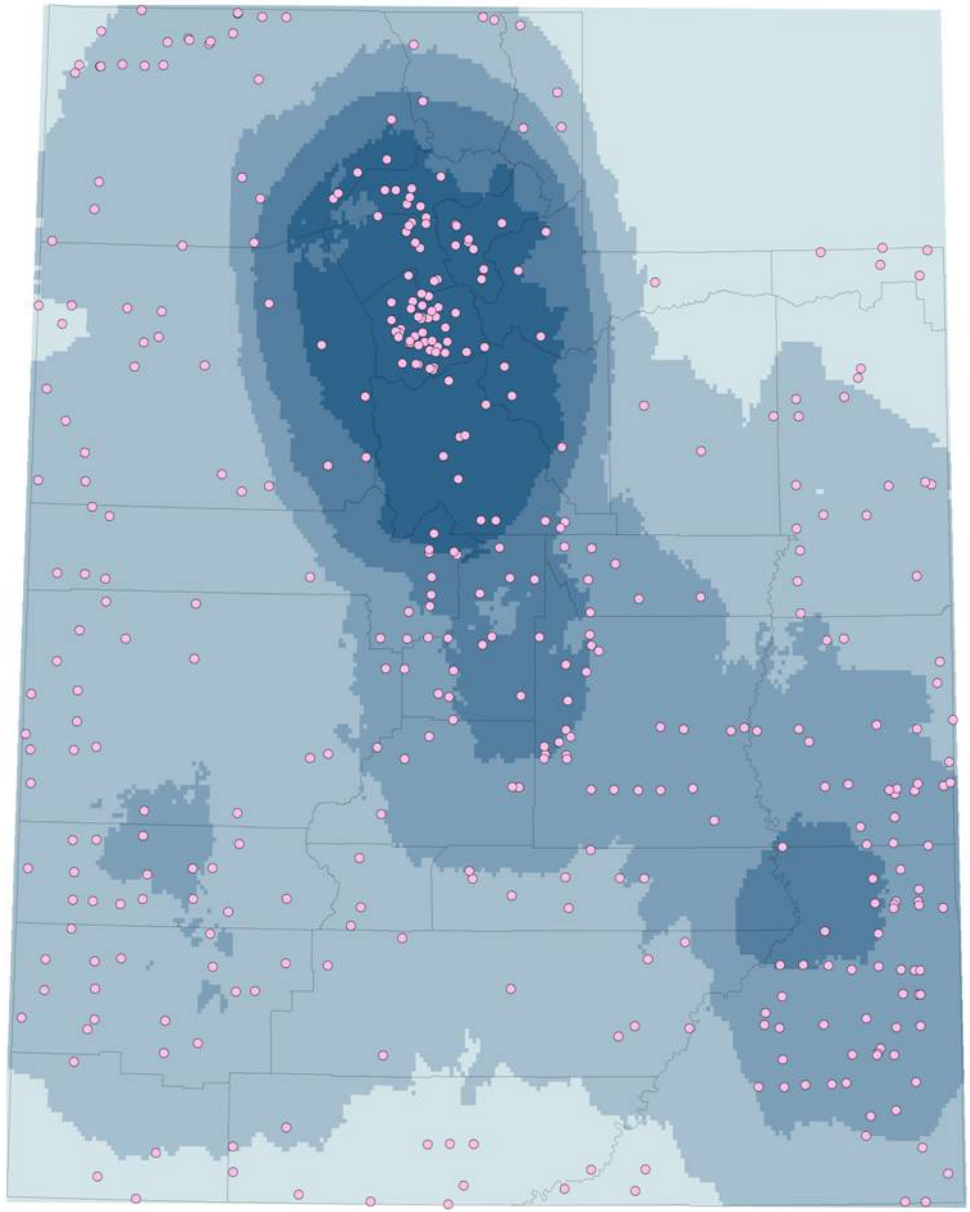




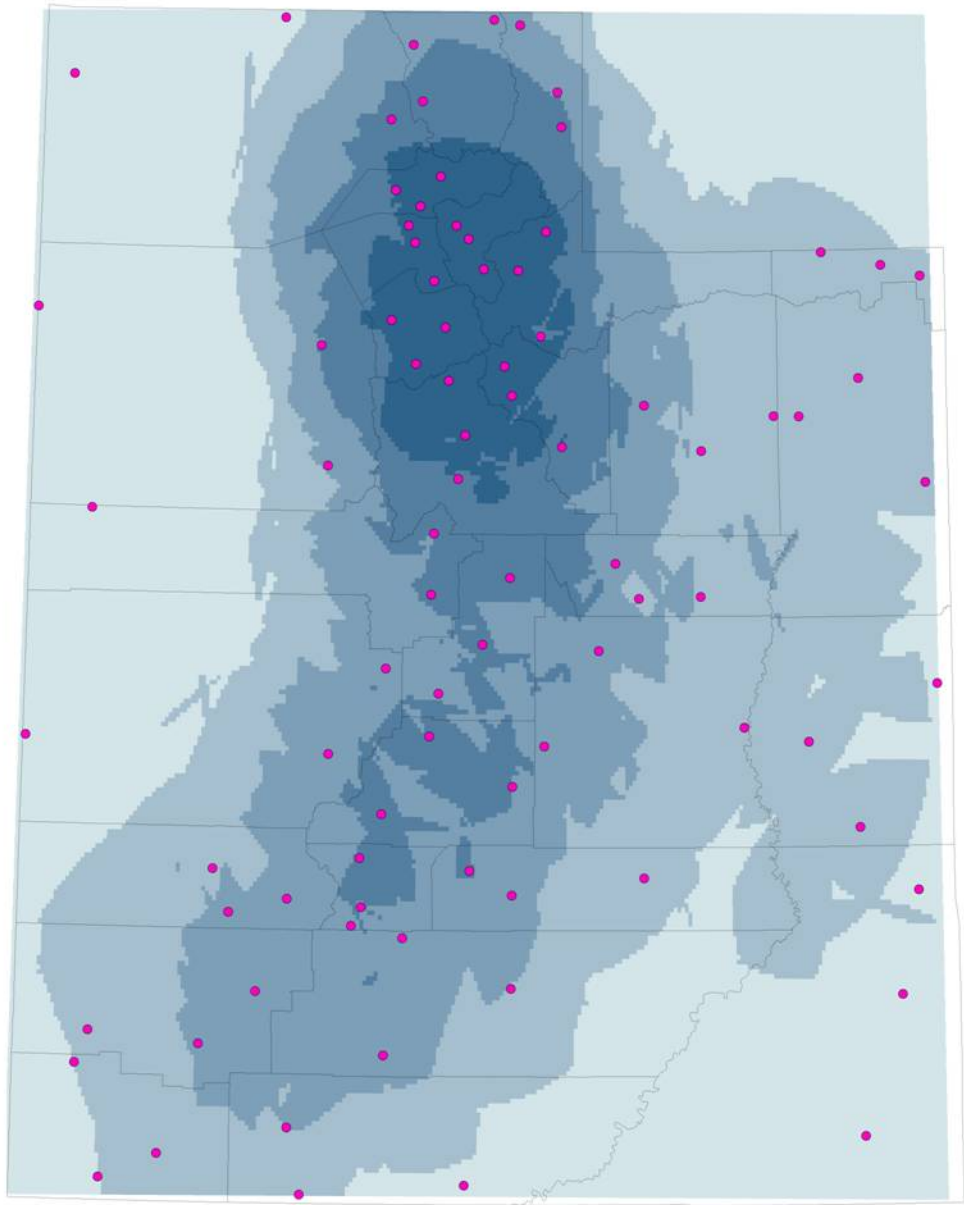
Utah Photo Control Point
Data Sources

Legend

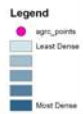
- AGRC
- NGS
- USFS
- USGS



Simple Density of Utah Photo Control Points
(All Points)



Simple Density of Utah Photo Control Points
(AGRC Provided)



Inspection Process

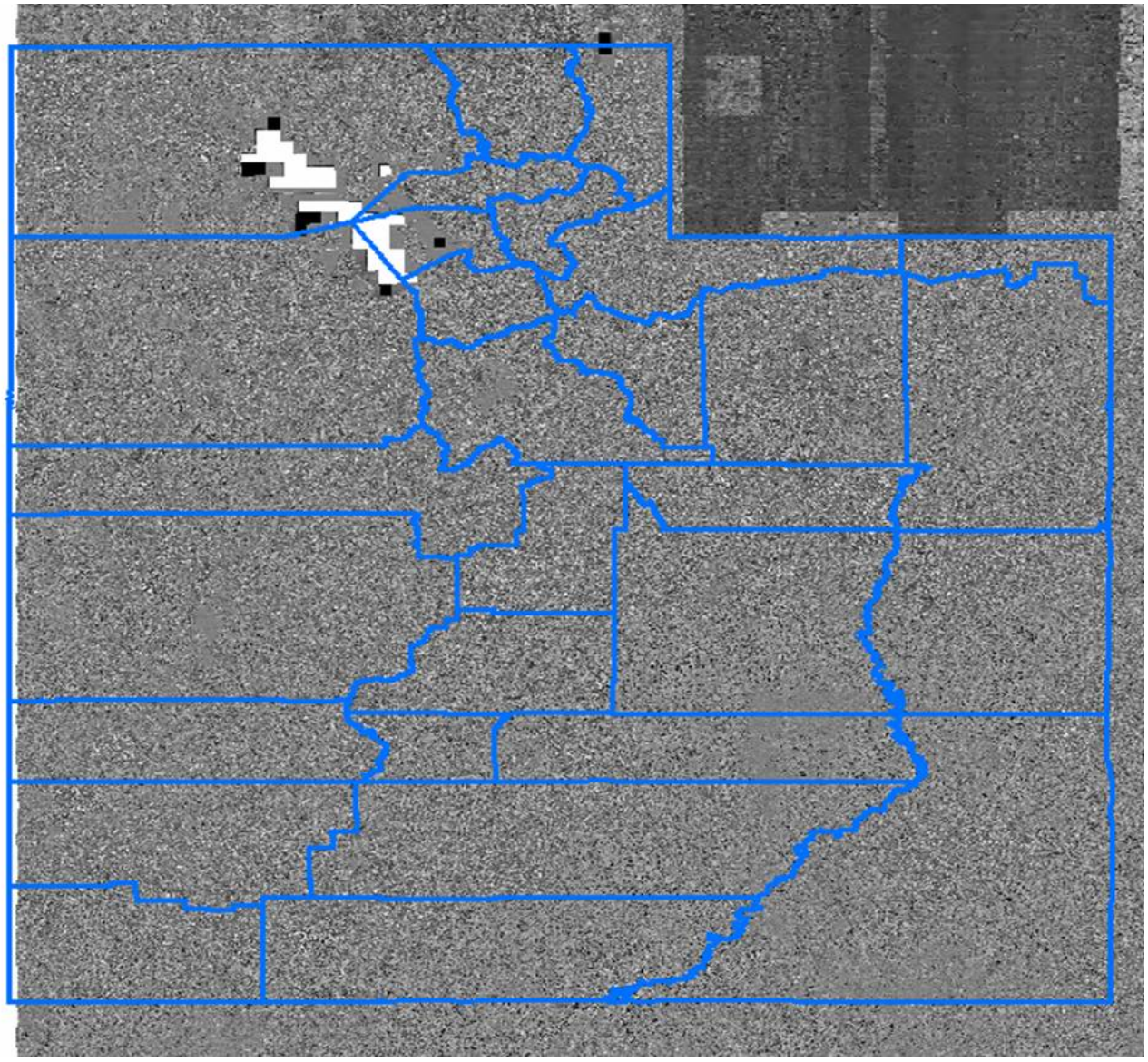
- Parameters
  - Inspect for horizontal accuracy only
  - Off-line process (local computer)
    - first year only
  - 1 meter resolution imagery
  - 2 independent inspectors
  - Inspect State as a whole
    - Inspect all points (410)
    - Subset results later

Inspection Process

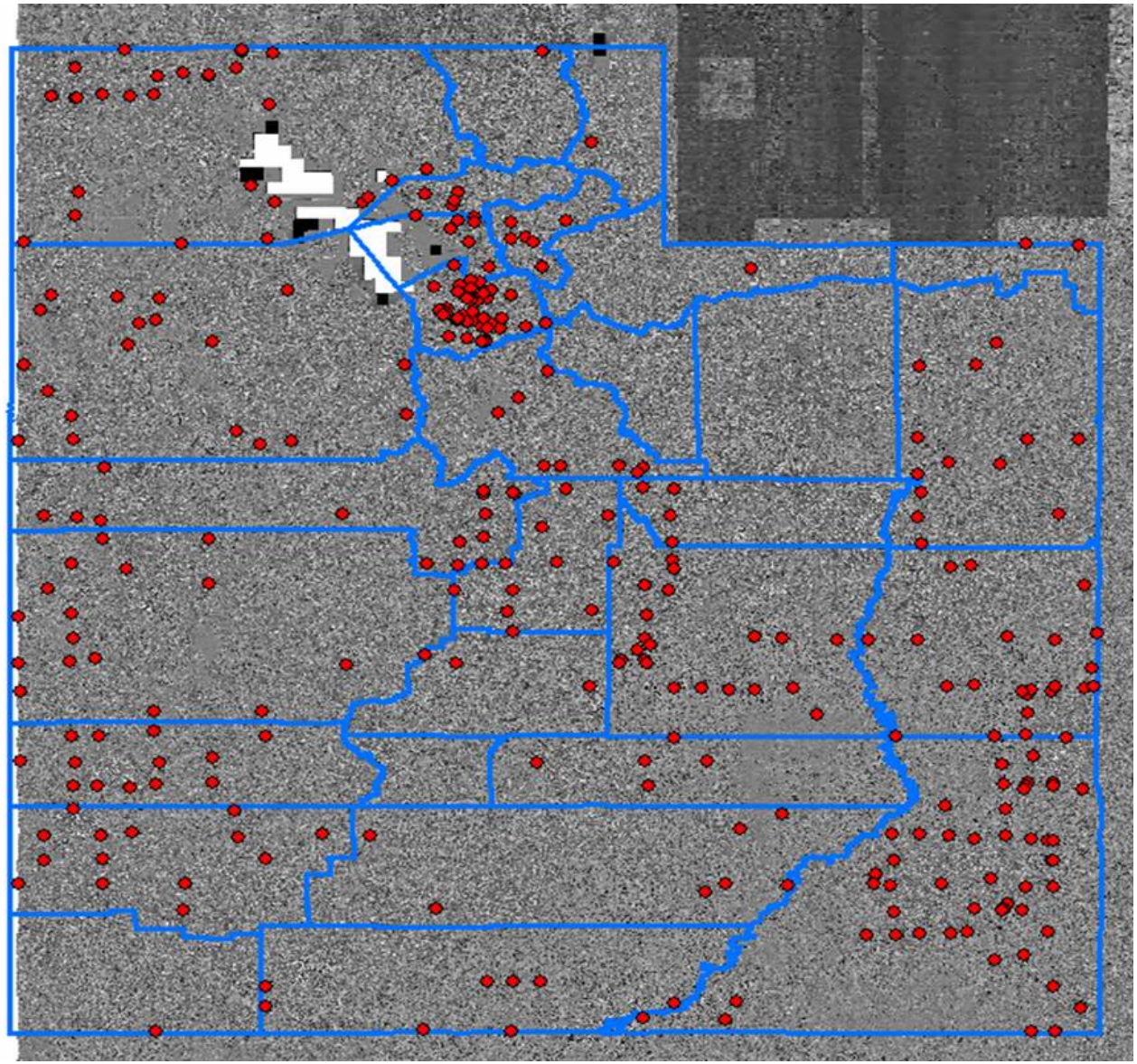
- Methodology
  - Inspection performed using ArcGIS 9.1
  - Add imagery (Compressed County Mosaic) & overlay control points
  - Overlay inspection shapefile and create points
    - Two fields to populate
      - POINT_ID1 (attribute transfer tool to populate)
      - QUALITY (evaluate quality of each point for inspection)
  - Use “Point Distance” tool
    - Creates distances table for distance from control point to its associated inspection point
  - Run statistics (RMSE, mode, average, points over 6 meters off, by whole State, County, DATA_SRCE, Accuracy, etc.)
  - Determine whether imagery meets specifications… **“95% of all well-defined points tested shall fall within six (6) meters of true ground as measured against an independent source of higher accuracy”**
  - Letter language **- “95% of points tested must fall within six (6) meters of pre-determined quality assurance ground control points”**
  - With 410 tested points, allows 20.5 points to be greater that 6 meters off

Inspection Process (Example)

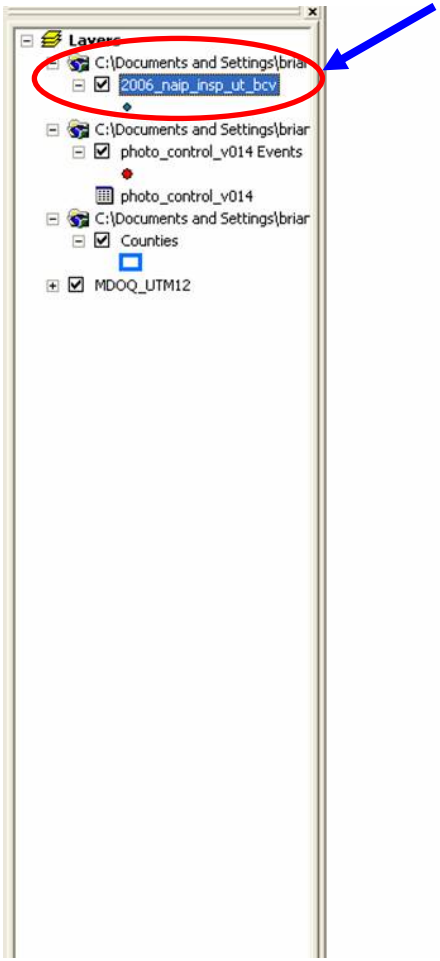
Add Imagery

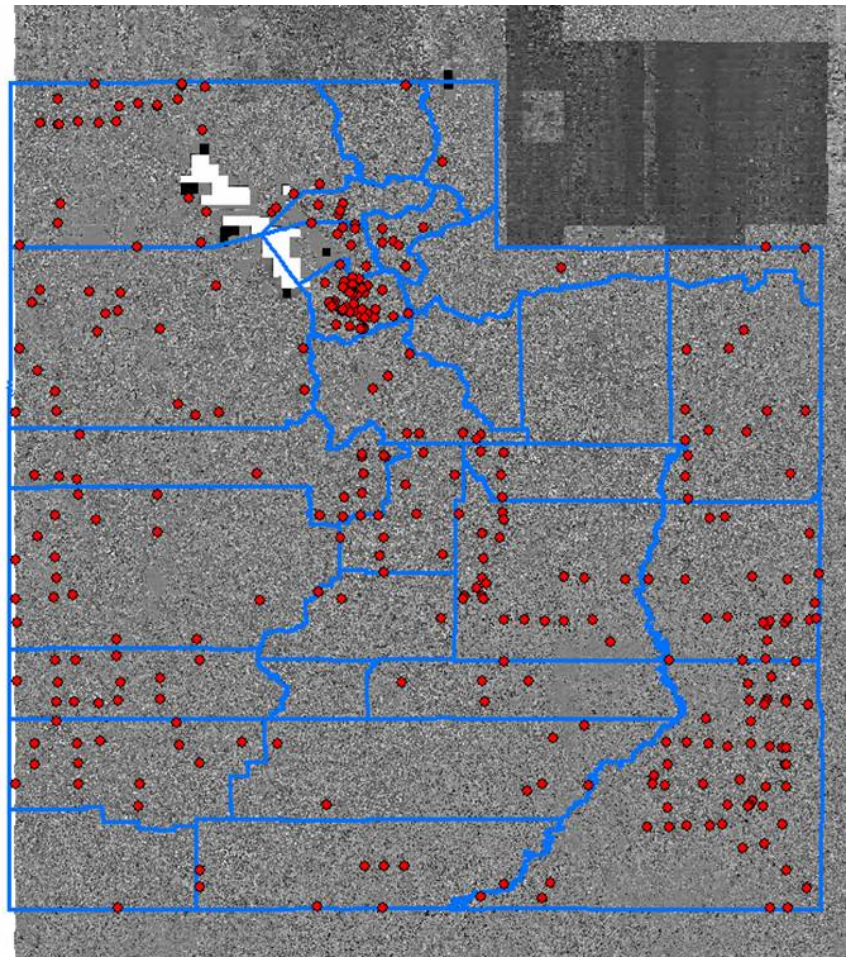


Add Control Data and Display X,Y

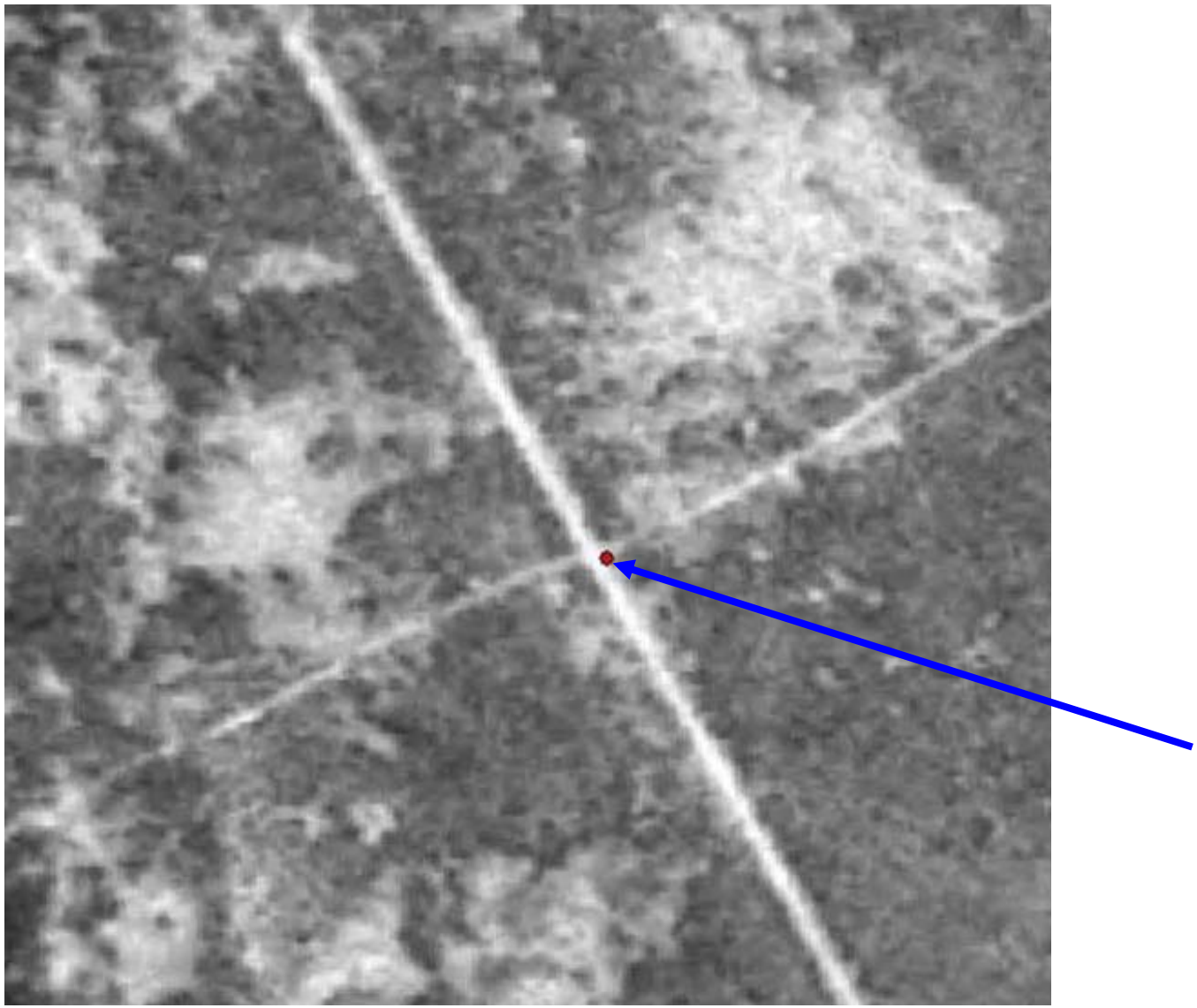


Add Inspection Shapefile

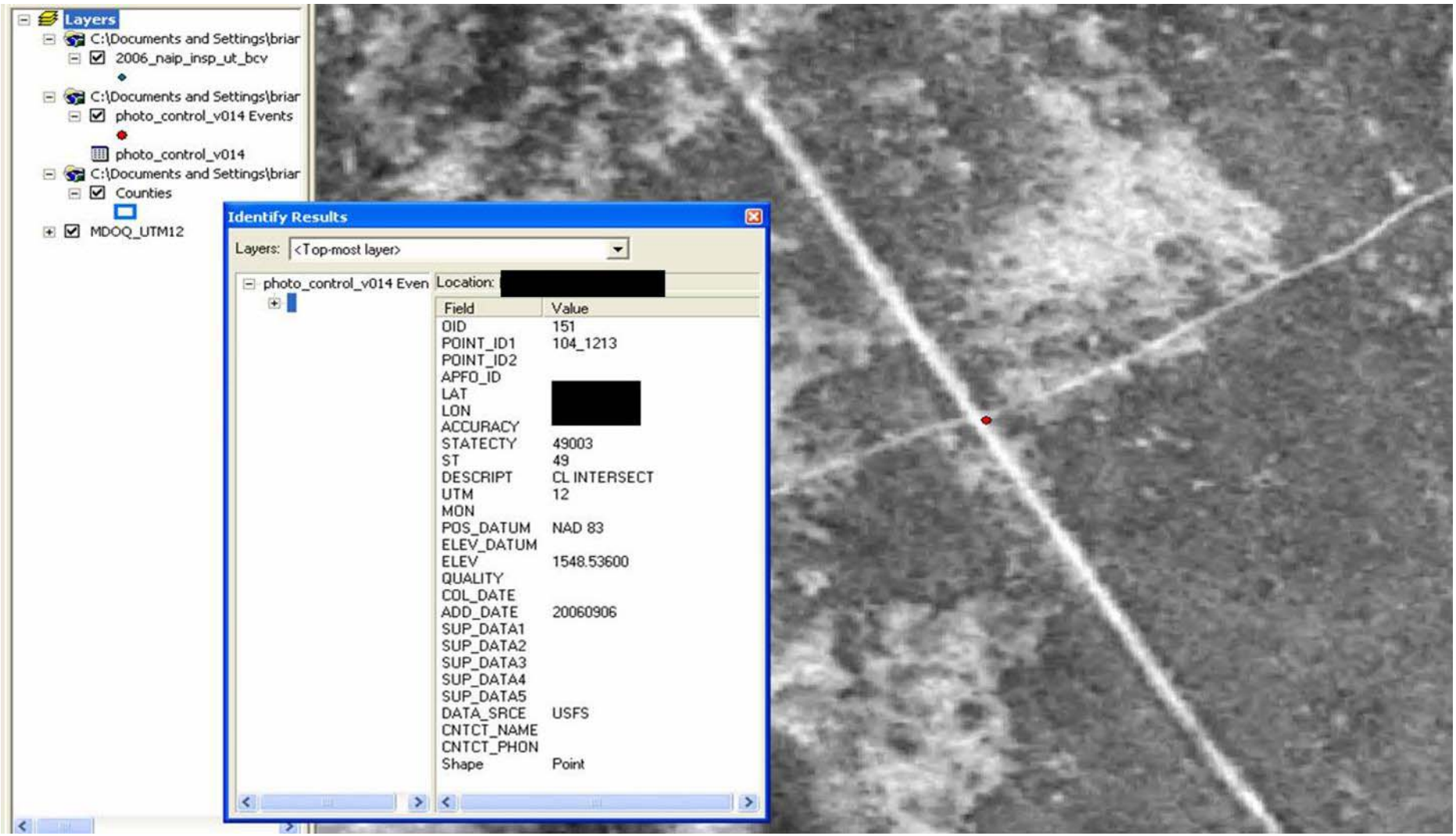




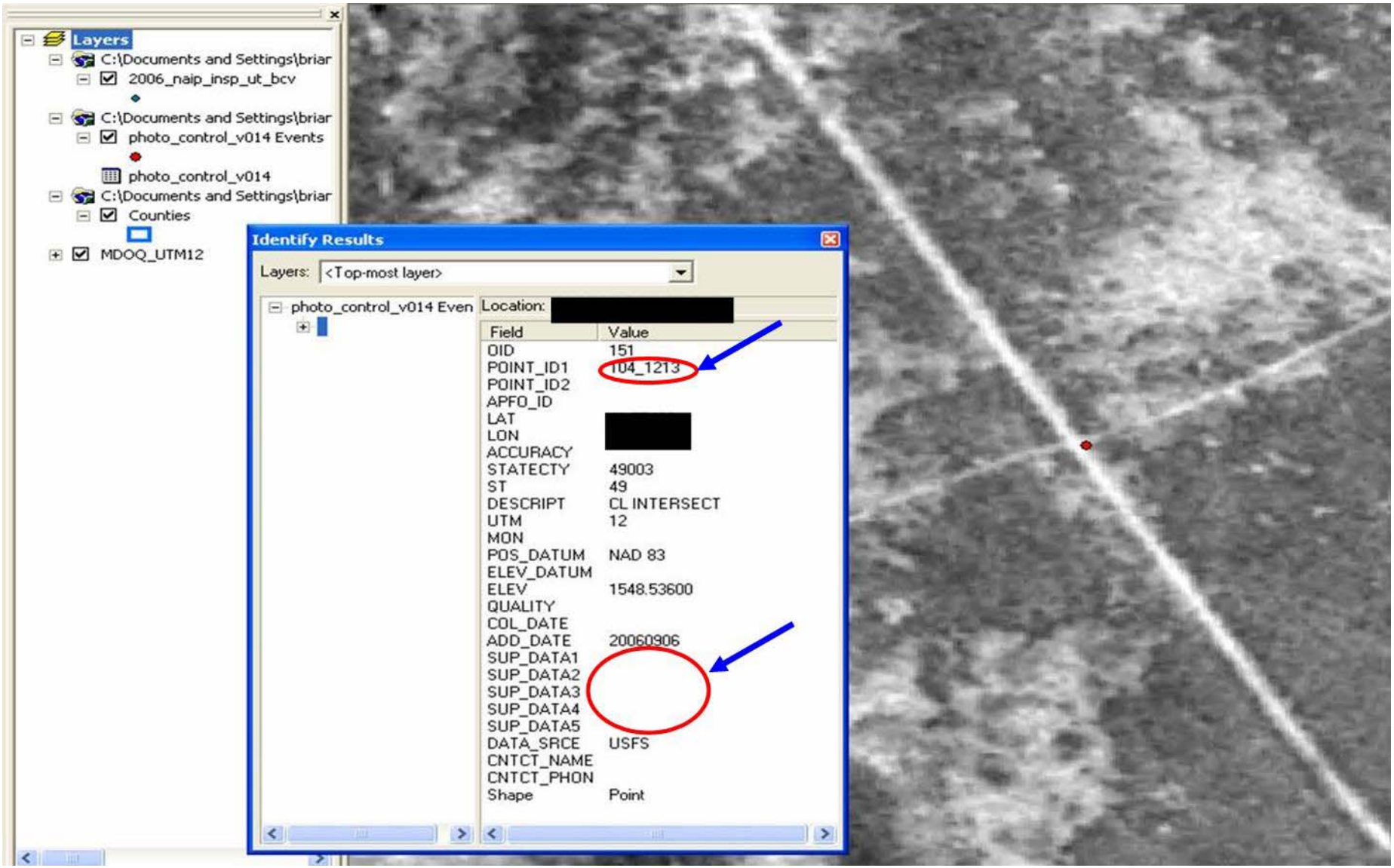
Zoom to a Control Point



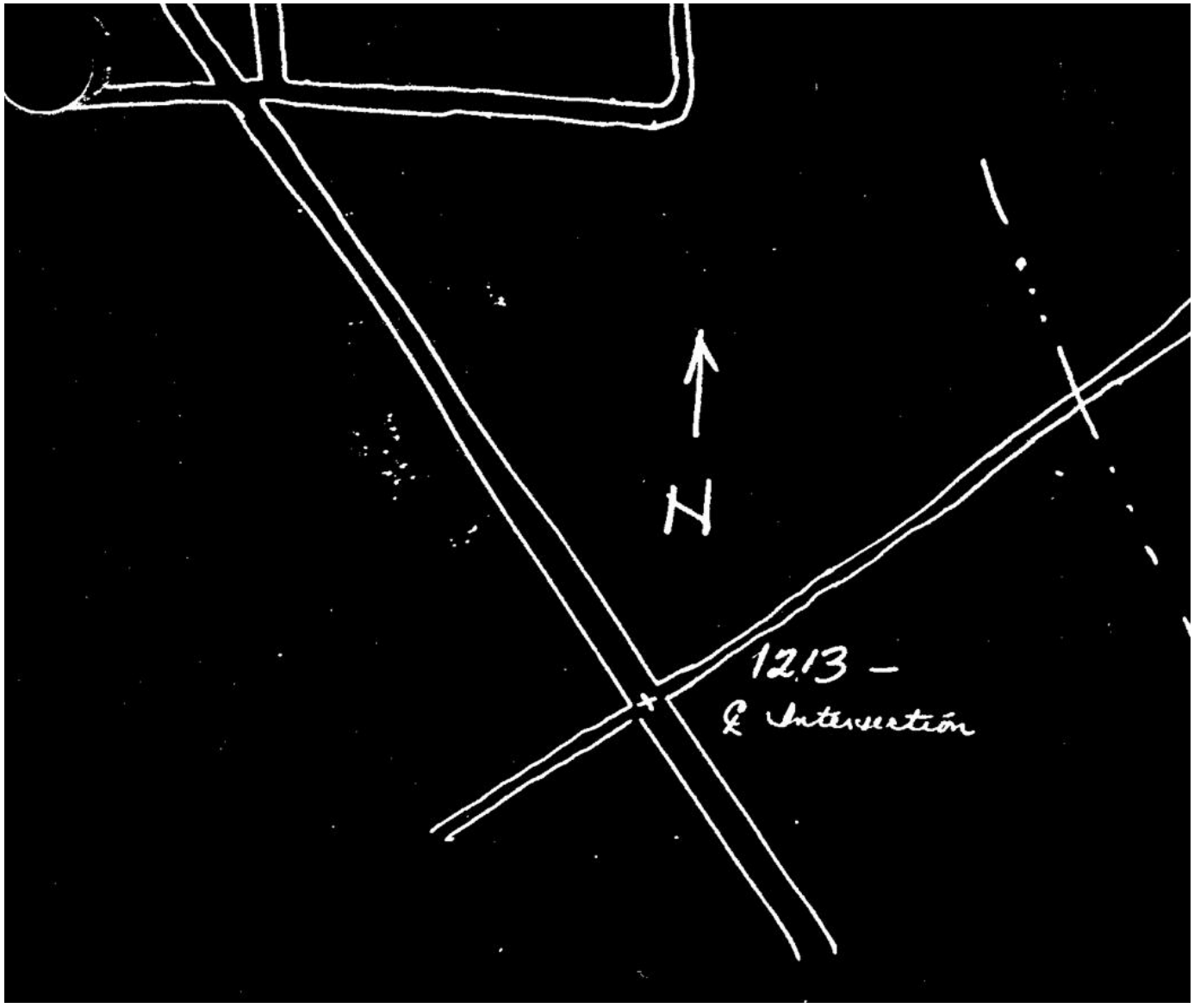
ID the Photo Control Point



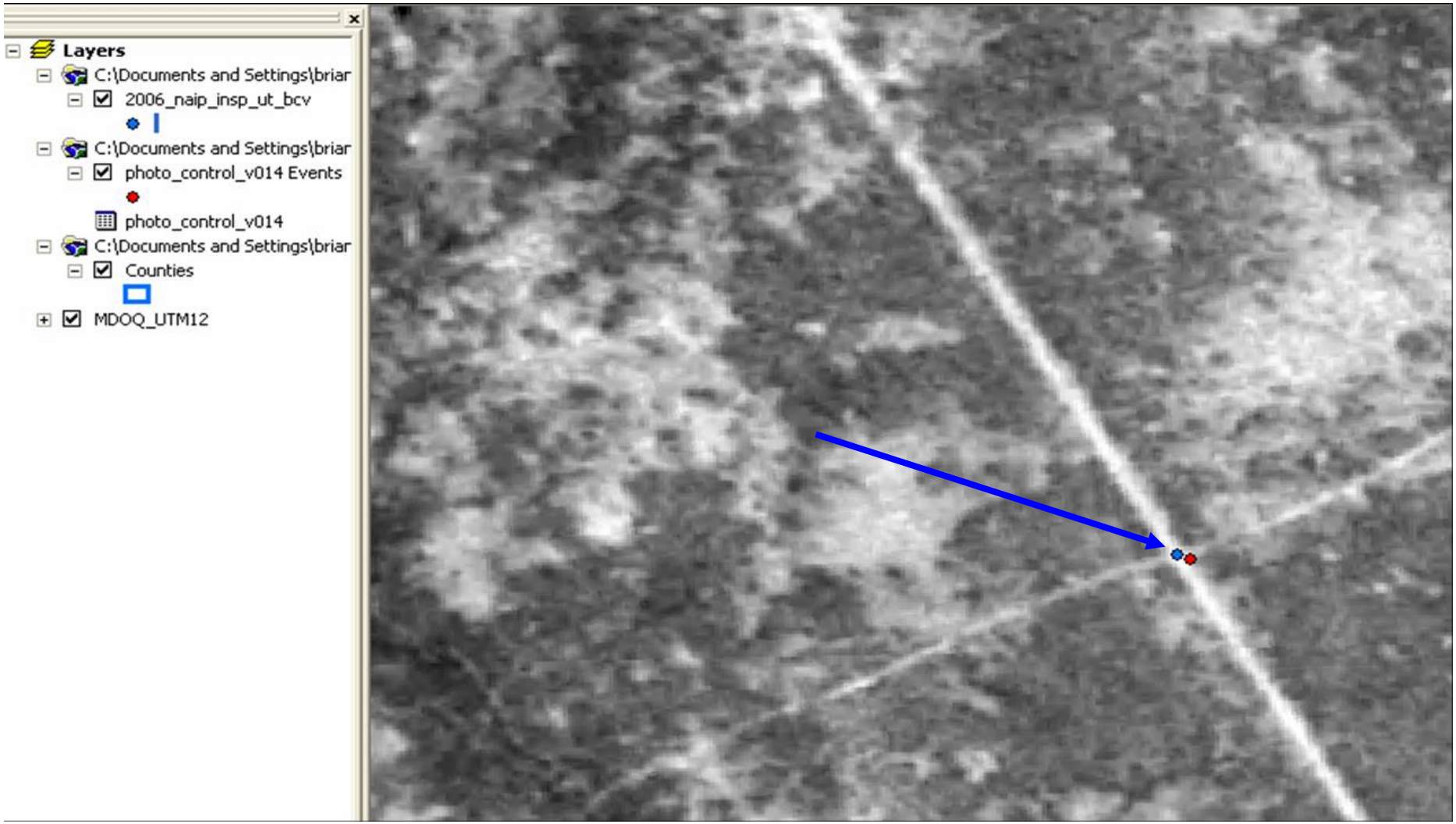
Check SUP_DATA



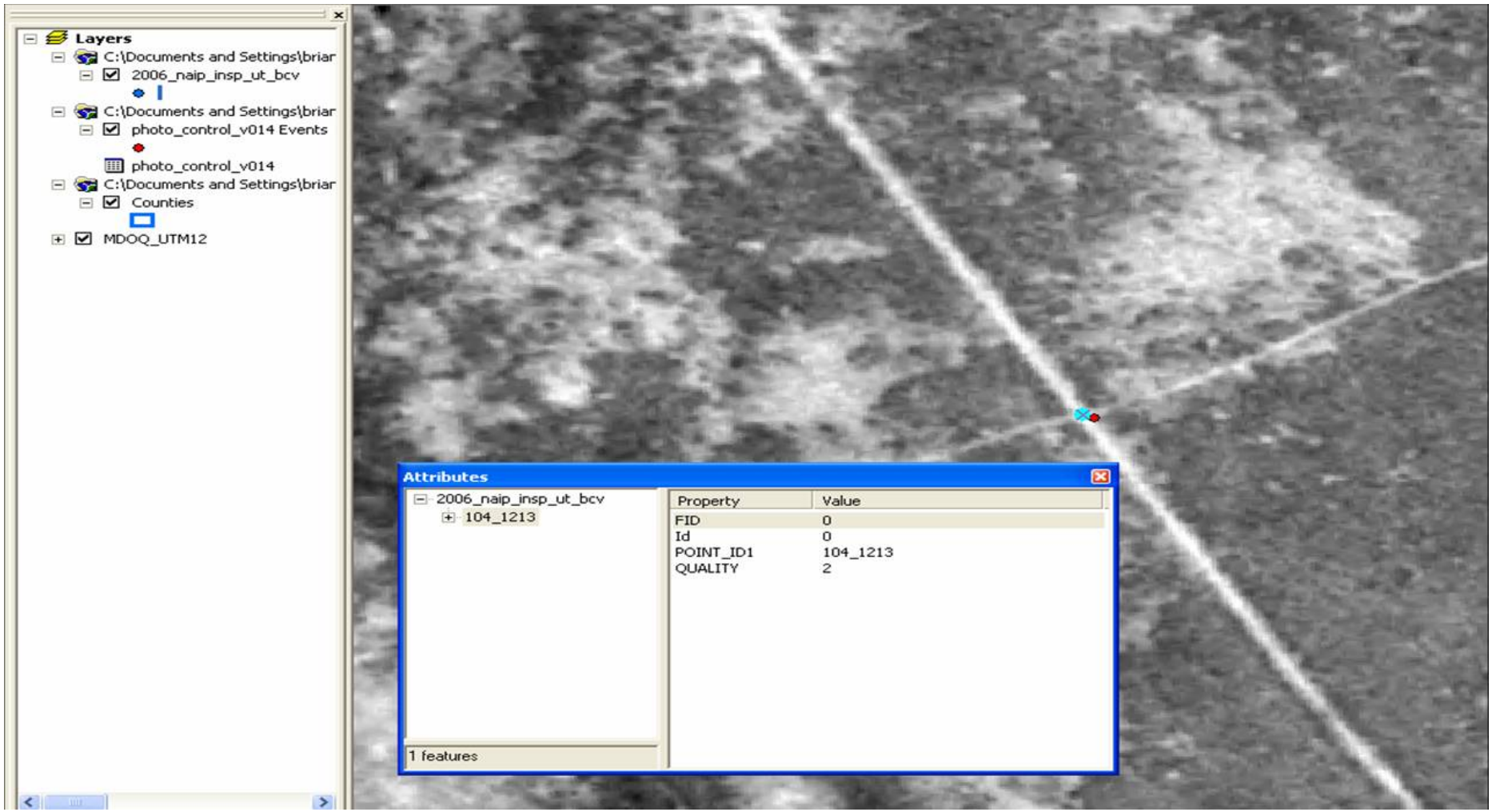
Check SUP_DATA



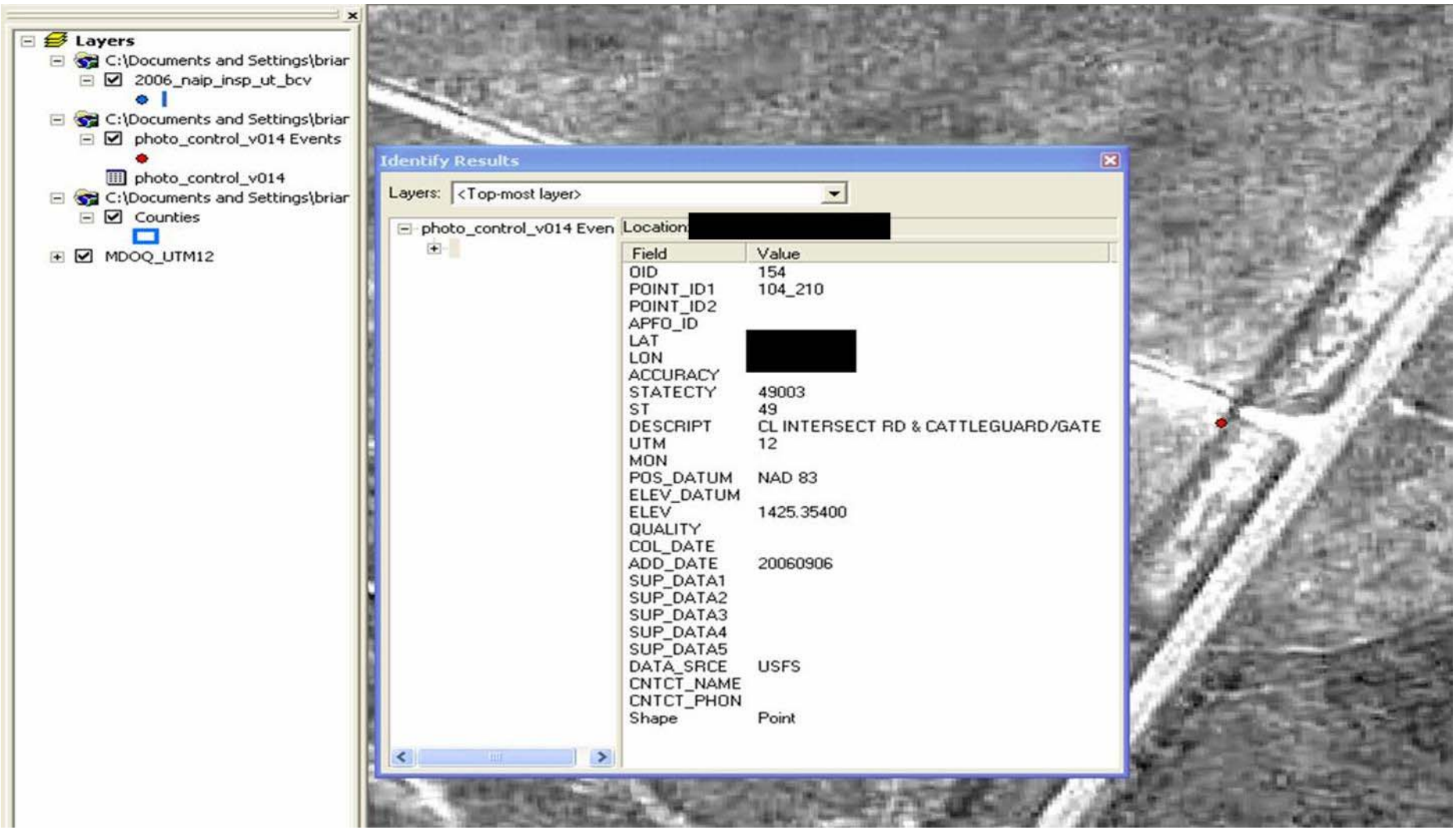
Create Inspection Point



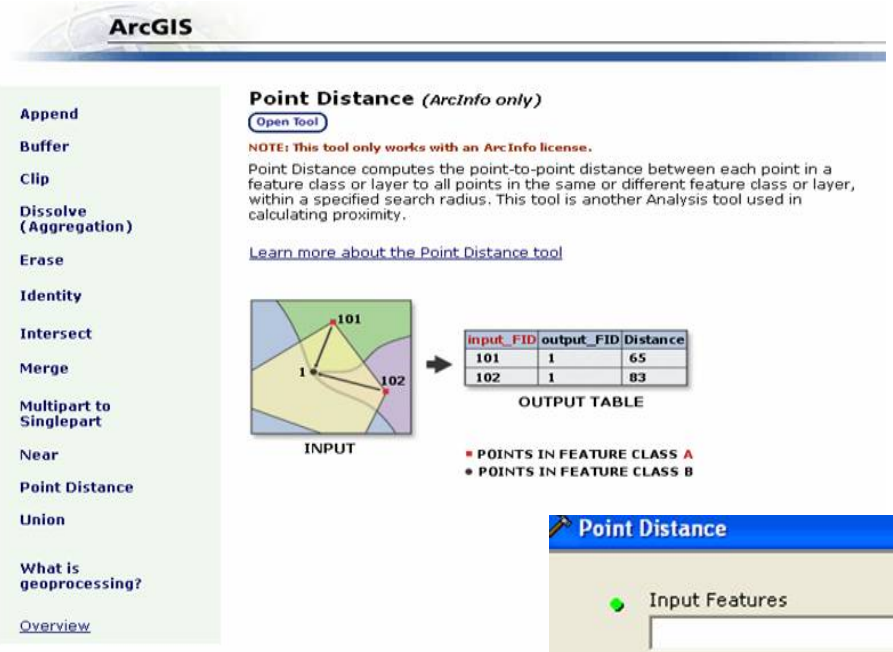
Populate Inspection Point Using Attribute Transfer Tool

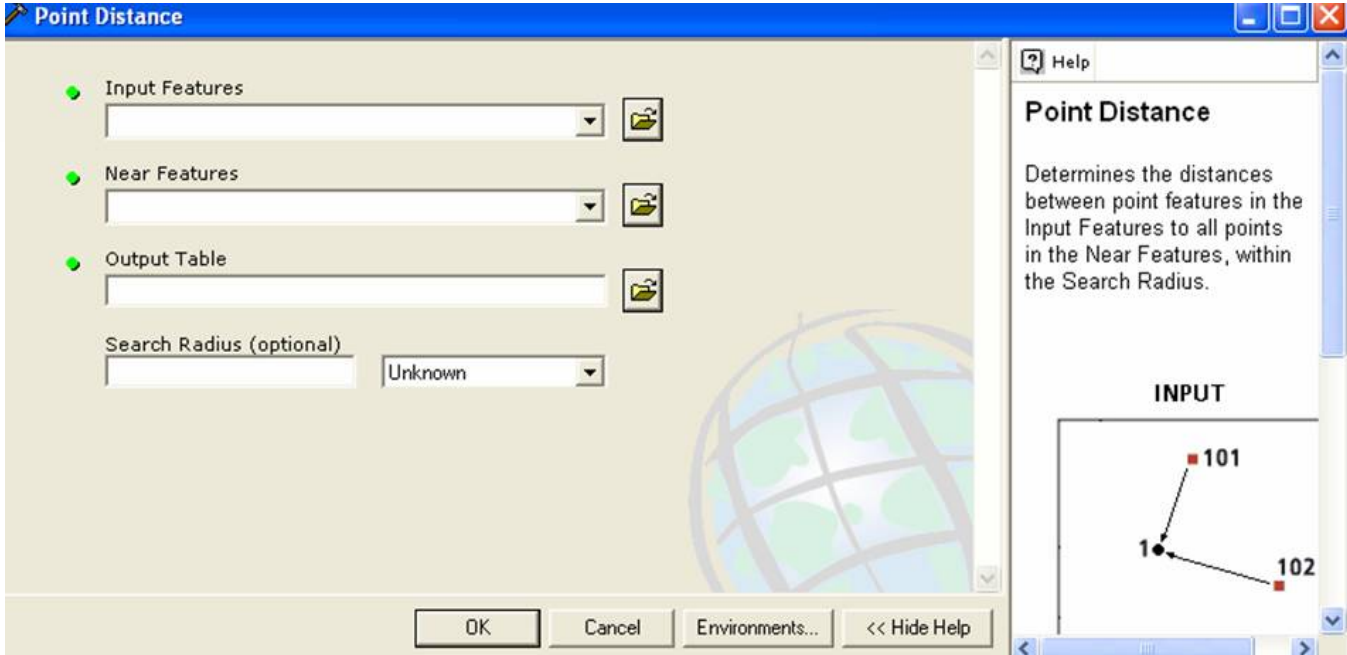


Move on to Next Point



Run Point Distance Tool





Inspection Example Summary

- Process should be further automated in subsequent years
  - All out of the box ArcGIS tools…
- Stats can be run by County, State, Data Source, any field…all due to quality DB
- Training component involved due to elevation/location of some points…

Inspection Example Summary

- Training component involved due to elevation/location of some points…

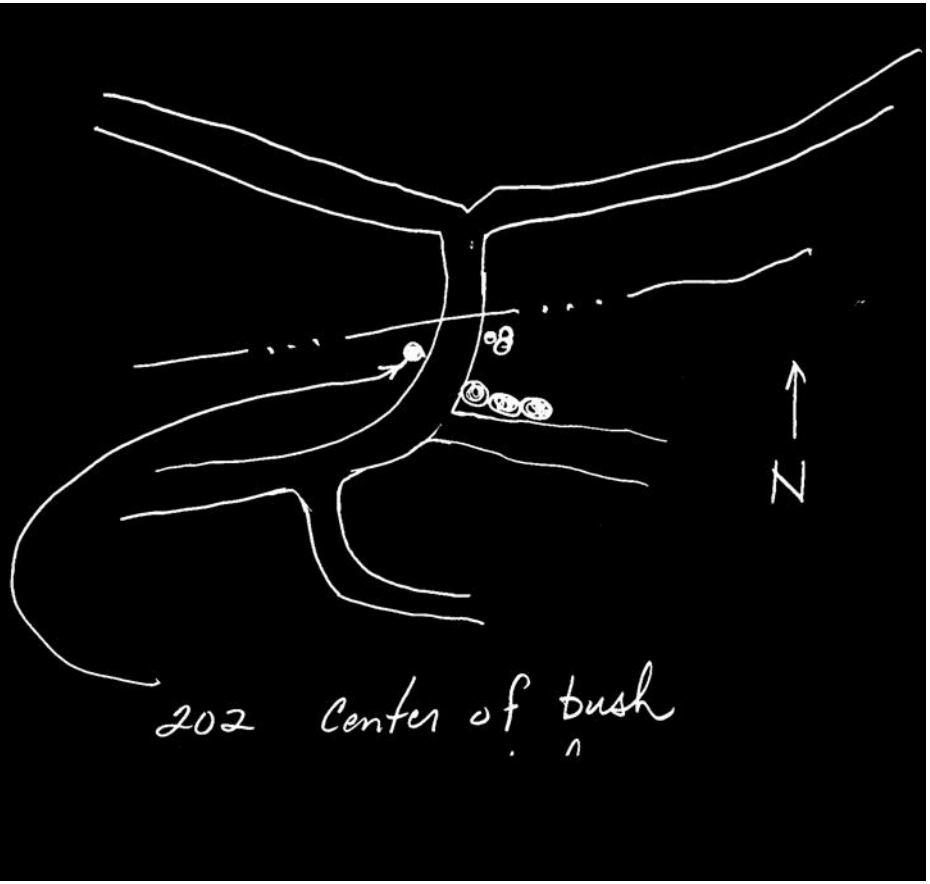
Where is the base of the tower?

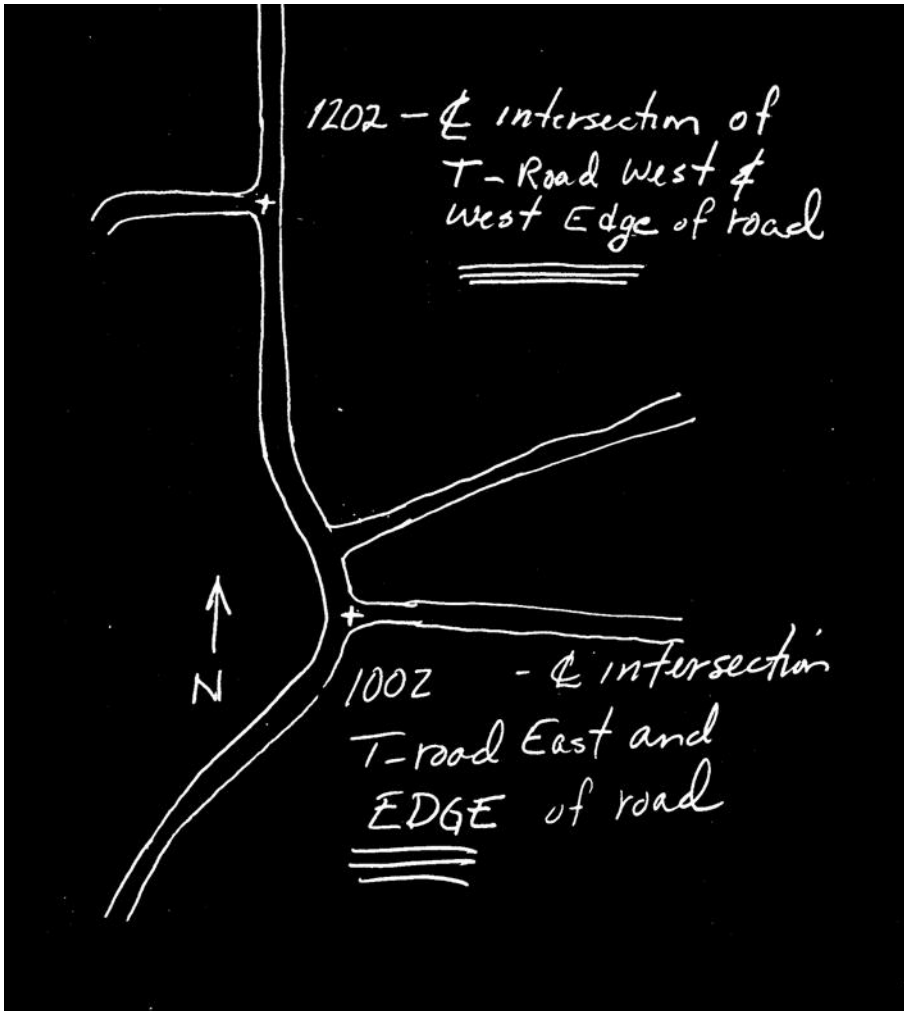
Where is the base of the tower?

SUP_DATA SAMPLES

- Without supplemental data for the control points, one is left only with a short description…usually not sufficient

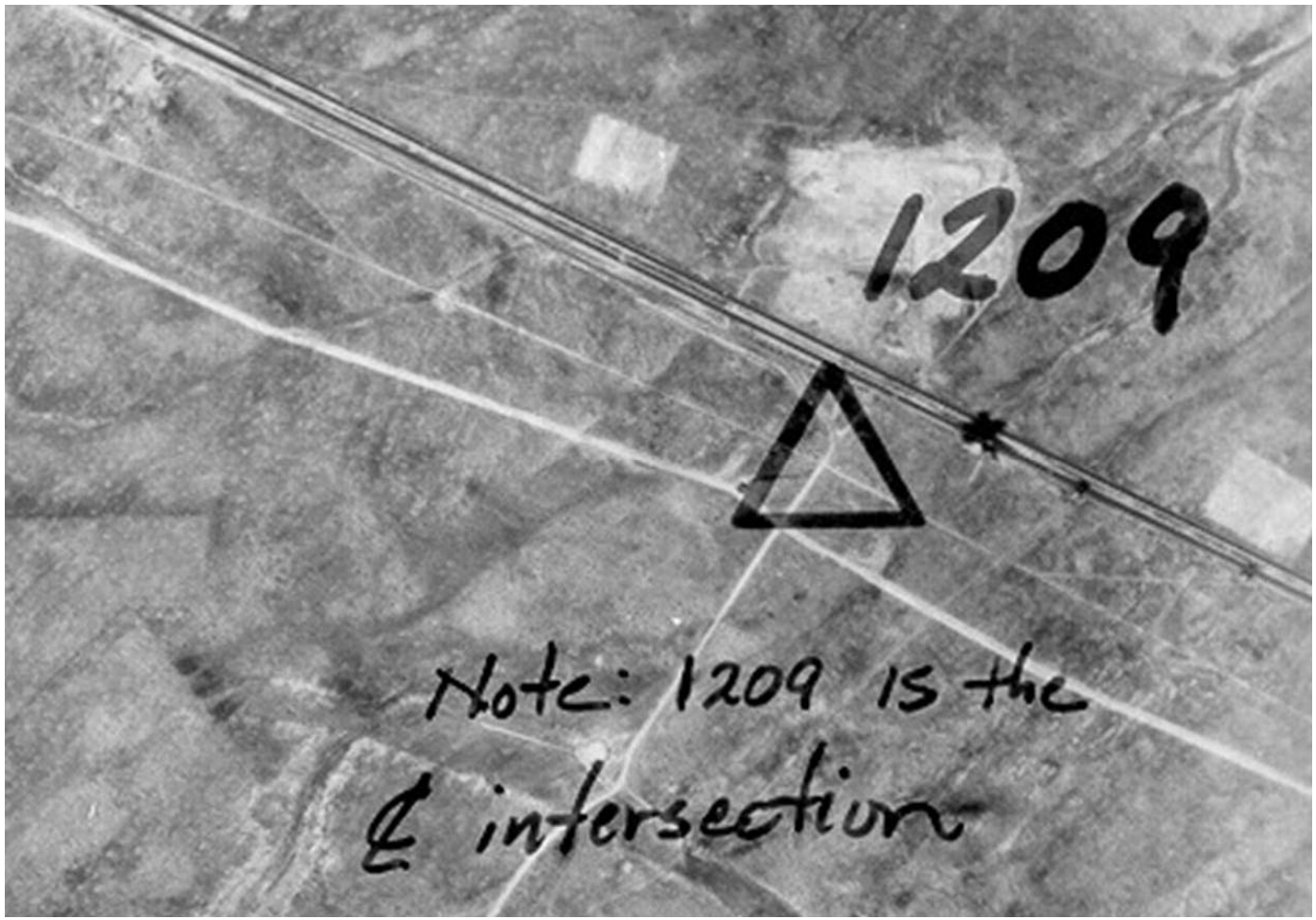
SUP_DATA SAMPLES





SUP_DATA SAMPLES

SUP_DATA SAMPLES



SUP_DATA SAMPLES

The NGS Data Sheet

See file dsdata.txt for more information about the datasheet.

DATABASE = Sybase ,PROGRAM = datasheet, VERSION = 7.42
1 National Geodetic Survey, Retrieval Date = NOVEMBER 20, 2006

****

DESIGNATION - OGDEN DEL MONTE FOOD PROD TANK
PID - [redacted]
STATE/COUNTY- [redacted]
USGS QUAD - [redacted]

*CURRENT SURVEY CONTROL

* NAD 83(1994)- [redacted] ADJUSTED
* NAVD 88 -

LAPLACE CORR- 8.66 (seconds) DEFLEC99
GEOID HEIGHT- -16.79 (meters) GEOID03

HORZ ORDER - THIRD

.The horizontal coordinates were established by classical geodetic methods
.and adjusted by the National Geodetic Survey in November 1997..

.The Laplace correction was computed from DEFLEC99 derived deflections.

.The geoid height was determined by GEOID03.

	North	East	Units	Scale Factor	Converg.
;SPC UT N -	[redacted]		MT	0.99995697	-0 19 53.5
;UTM 12 -	[redacted]		MT	0.99968695	-0 39 39.1

SUPERSEDED SURVEY CONTROL

NAD 83(1994)- [redacted]
NAD 83(1986)- [redacted]
NAD 27 - [redacted]

.Superseded values are not recommended for survey control.
.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
.See file dsdata.txt to determine how the superseded data were derived.

_U.S. NATIONAL GRID SPATIAL ADDRESS: [redacted]
_MARKER: 51 = TANK

HISTORY	- Date	Condition	Report By
HISTORY	- 1963	FIRST OBSERVED	CGS
HISTORY	- 1965	GOOD	CGS
HISTORY	- 1973	GOOD	NGS

STATION DESCRIPTION

'DESCRIBED BY COAST AND GEODETIC SURVEY 1963 (JCC)
'THE STATION IS THE CENTER OF THE TOP OF A 174 FOOT HIGH WATER
'TANK. IT IS ABOUT 1 MILE EAST OF U.S. HIGHWAY 84 AND NEAR THE
'EAST END OF THE TOWN OF OGDEN.

STATION RECOVERY (1965)

'RECOVERY NOTE BY COAST AND GEODETIC SURVEY 1965 (JJC)
'THE INTERSECTION STATION WAS RECOVERED. THE TANK IS PAINTED GREEN
'ON ITS TOP AND BOTTOM WITH THE CENTER PORTION OF THE TANK PAINTED
'BLACK.

STATION RECOVERY (1973)

'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1973 (DLS)
'STATION RECOVERED AS DESCRIBED IN GOOD CONDITION.
'
'AIRLINE DISTANCE AND DIRECTION FROM NEAREST TOWN
'IN TOWN.

*** retrieval complete.
Elapsed Time = 00:00:00

DEM Requirements

- Achievable horizontal accuracy affected by the accuracy of the DEM
  - Do we continue to use “best available” language *or* provide the DEM?
    - If we state +/- 6 meters horizontal accuracy, are the “best available” DEMs good enough to support the accuracy requirement?
  - Ultimatum
    - We provide the DEM and hope the vendor can meet the requirements, or
    - We provide the DEM and verify that the vendor can meet requirements, or
    - Continue to use “best available” language and hold fast to the horizontal accuracy requirement…
      - What if “best available” wasn’t good enough

DEM Requirements

- If the DEM becomes Government Furnished Material
  - What sources will we select and will they be consistent?
  - Will they support the horizontal accuracy requirement?
  - What infrastructure will be required to support delivery of these materials?
  - How will DEM changes be handled?
  - How will disputes regarding horizontal accuracy be resolved if vendor not responsible for DEM?

DEM – The Bigger Picture

- Based on USDA customer needs/requirements
- Acquisition requires funding
  - NAIP avenues
  - Partnership avenues with other agencies that have DEM requirements? DHS/FEMA
- DEM updates to the Government from Vendor
  - Added contract cost to the Government?
- NDEP and “Elevation for the Nation”
  - What are other Government agency requirements?
    - Level of accuracy
    - 1 meter resolution ortho imagery is the “low hanging fruit”
      - As compared to flood modeling, survey, etc. needs

DEM – The Bigger Picture

- How do we get better DEMs into our ortho imagery products consistently on a National Scale?
- Once we have a DEM dataset that meets customer needs, how do we keep it up to date on a National Scale?
  - Refresh cycle
  - Identify
    - Urban growth interface
    - Major landform changes
    - Errors
- Who is the steward?

Merry Christmas