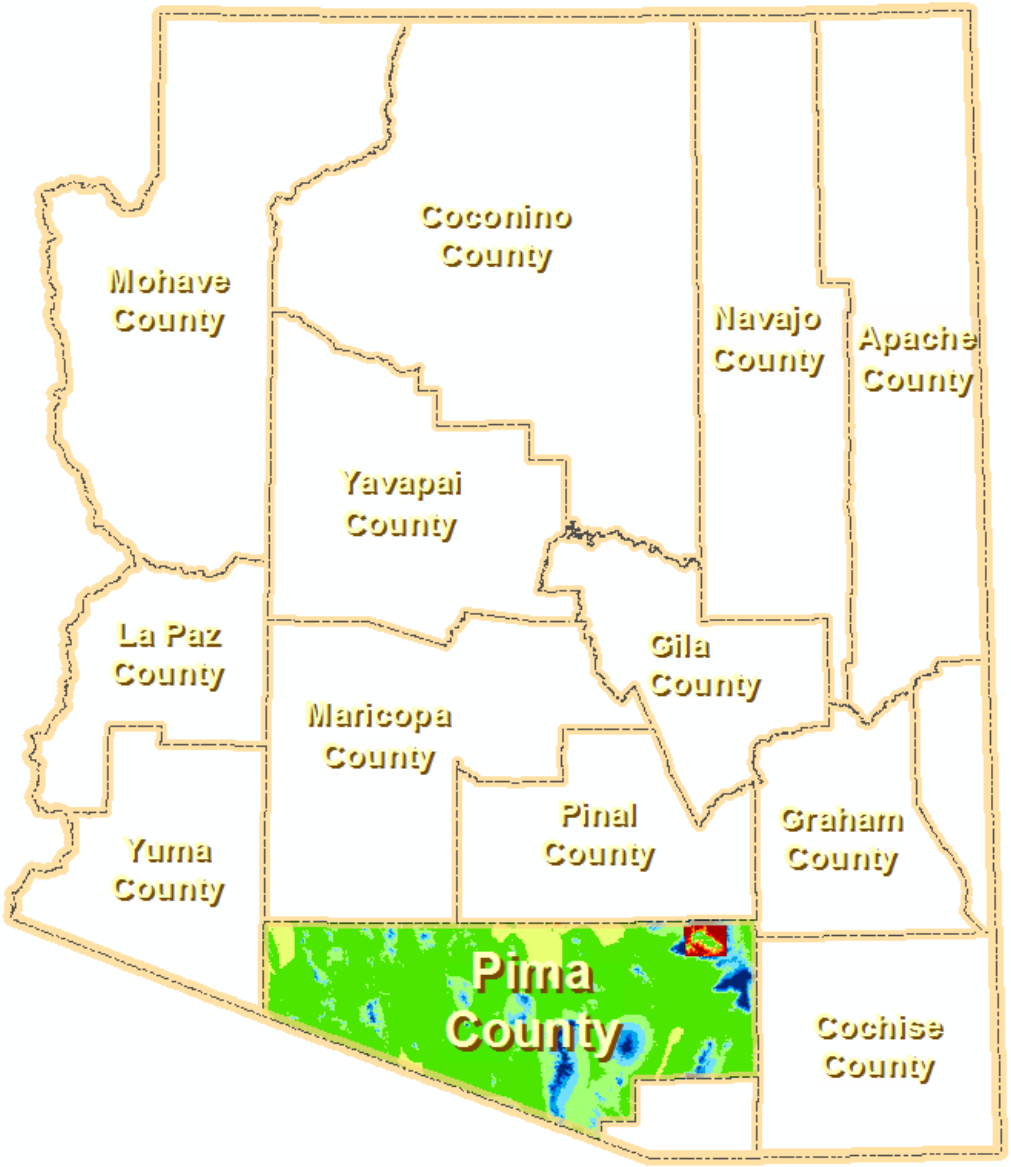
Pima County Low Distortion Projection Coordinate Systems (PCCS)



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Senior GIS Analyst
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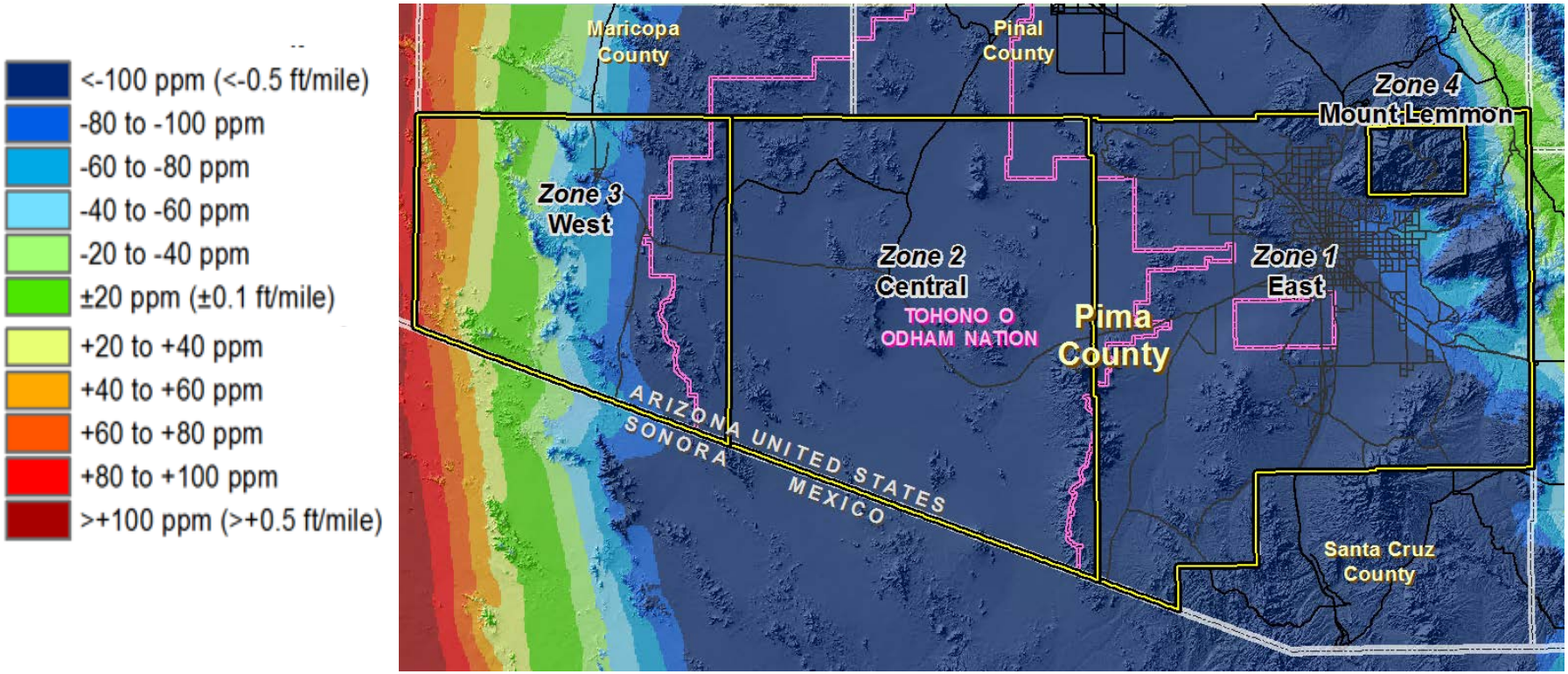
PIMA COUNTY

Why do we need a another coordinate system?

- The Arizona State Plane HARN coordinate system's doesn't support grid based mapping needs for Surveying, Engineering, and GIS
- Distortion is <-100 PPM or <-0.50 ft/Mile in Metro Tucson Area



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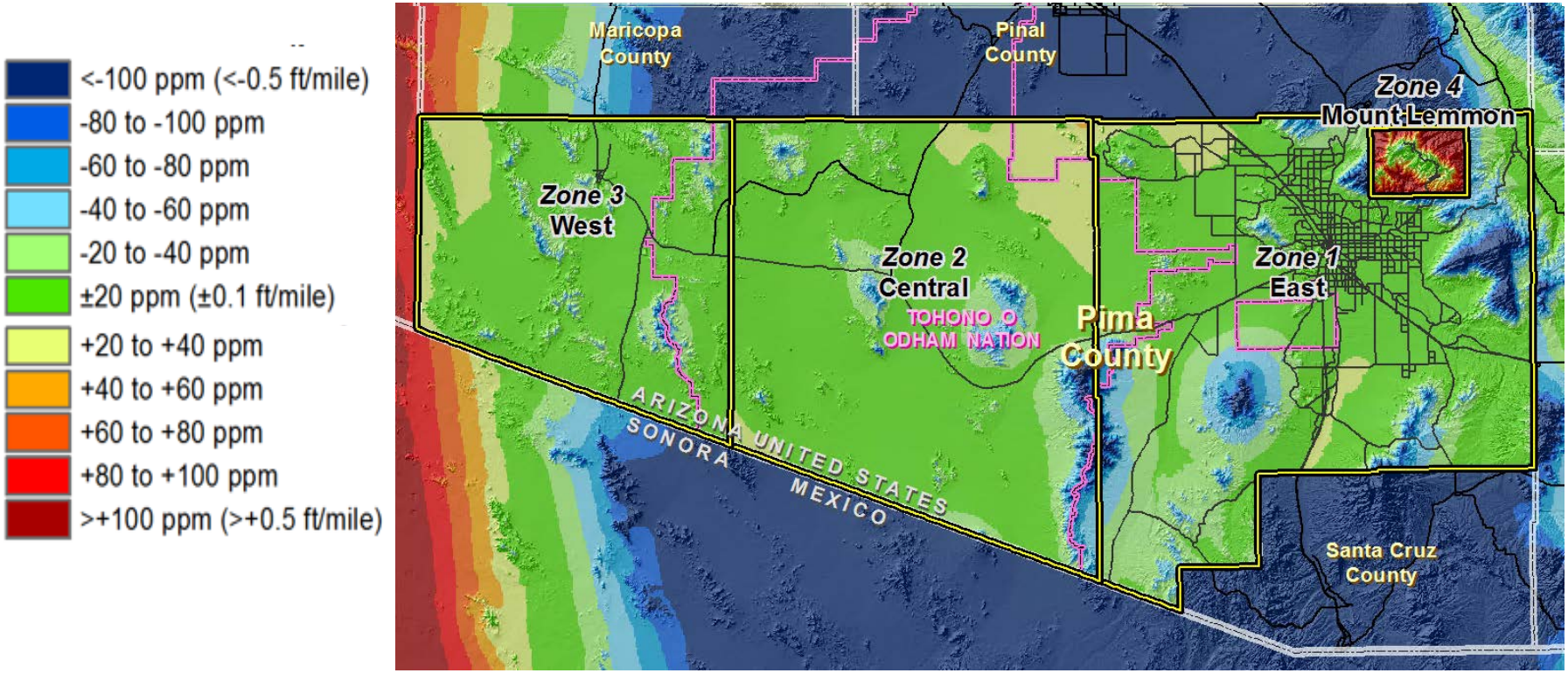
Why do we need a another coordinate system?

- Replacement of the NAD 83 HARN System with 4 LDP coordinate systems with distortion in the +/-20 PPM or (+/-0.10 ft /Mile)



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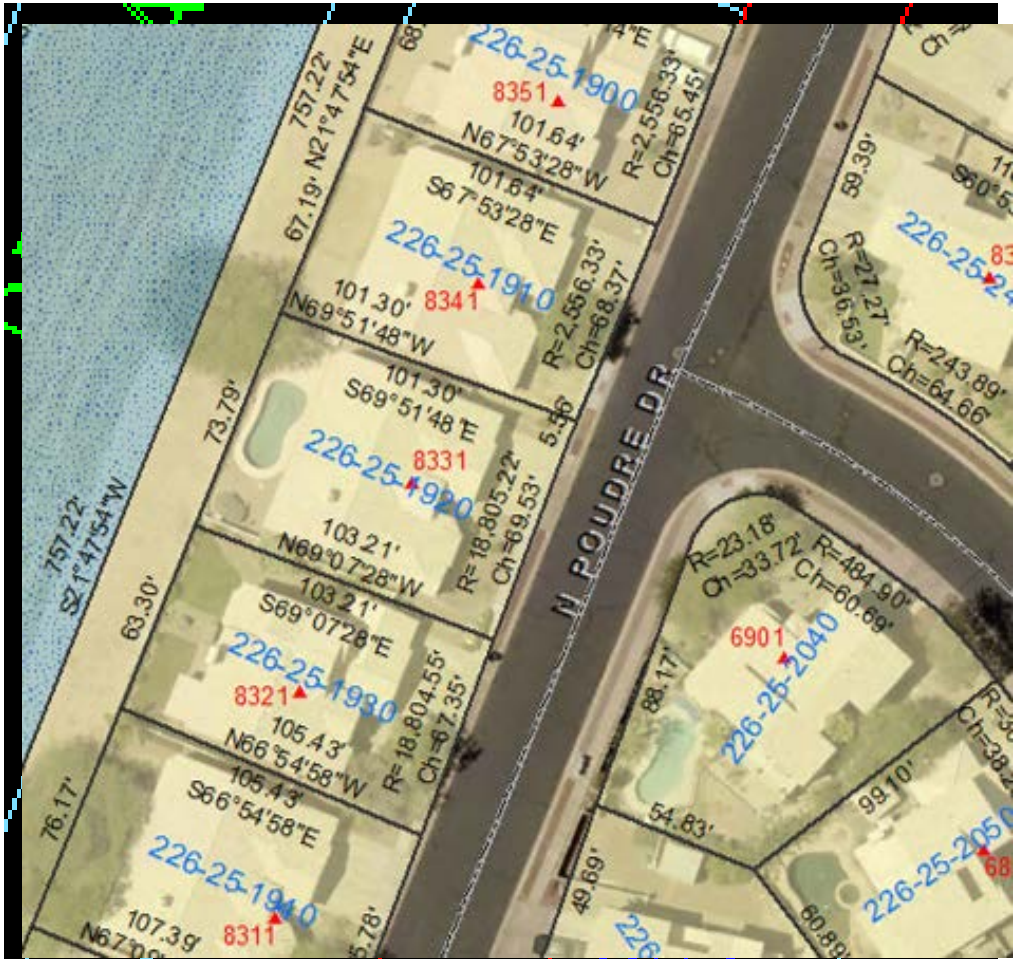
Benefits of Low Distortion Projection (LDP) Coordinate System

- Improve the overall positional accuracy of Survey and GIS data by nearly elimination map distortion
- Nearly eliminates the need for grid to ground conversion of GPS measurements for small project areas
- Allows multiple disciplines to utilize common coordinate systems using standardized grid data collection and mapping procedures
- Facilitates the development of the Parcel Fabric and infrastructures layers within the GIS

Pima County Land Parcels & Infrastructure

- Our GIS system evolved from a digitizing era into a measurement era
- Parcels are now longer digitized there are captured at the source and ground based measurement can be retained in the Parcel Fabric



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Pima County Land Parcels & Infrastructure

- Recovery of PLSS control and right-of-way are a times coincident with parcel lines and improves GIS quality

- Infrastructure layers are becoming GPS measurement based and dependent on accurate GIS system layers in order to identify and resolve conflicts

- UAV remote data collection activates are spatial coincident when registered to an accurate coordinate system

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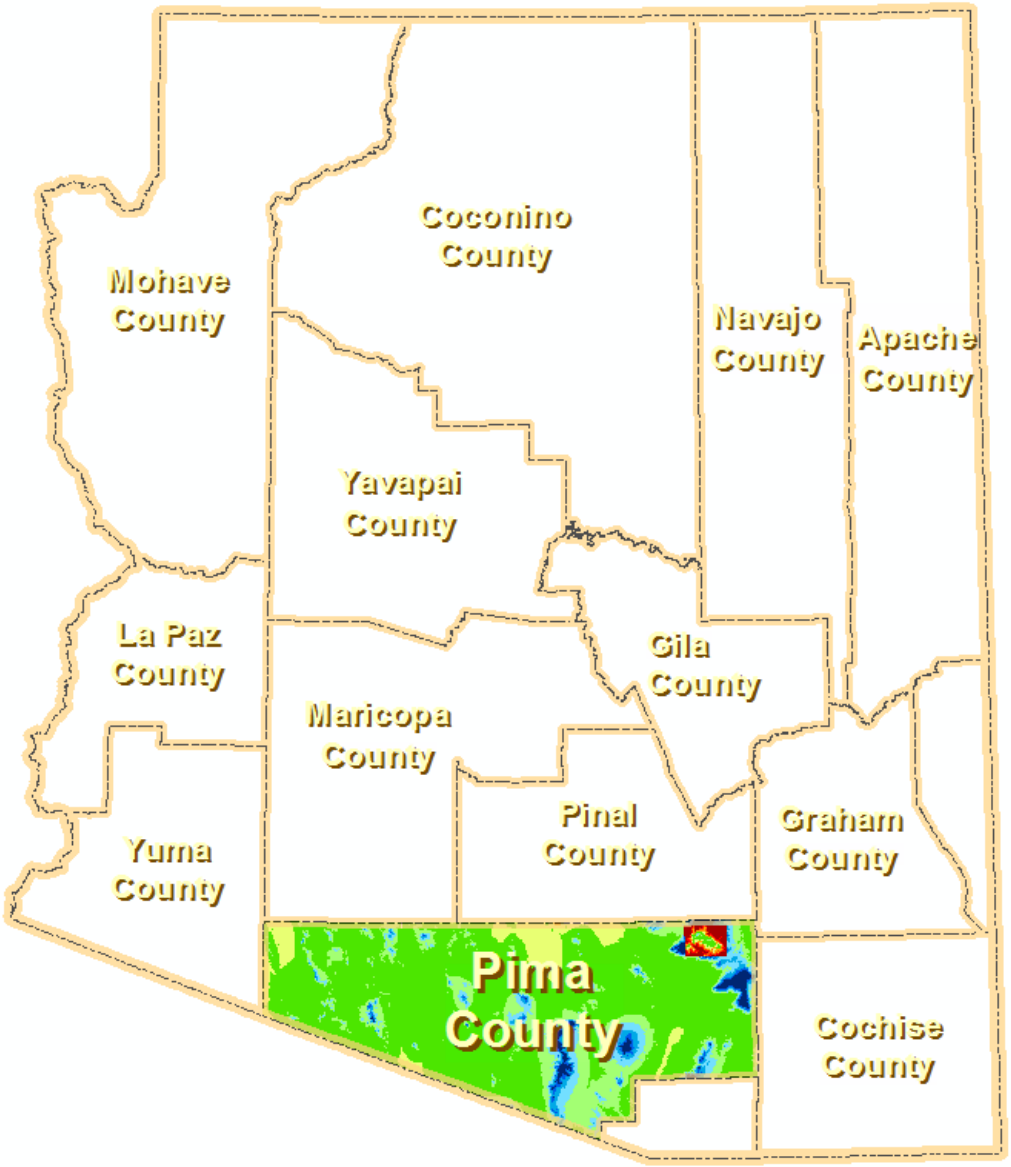
Development of Pima County's Low Distortion Coordinate Systems (PCCS)

- Examination of the development process for Low Distortion Projections and their benefits for Surveying and GIS
- Issuing a contract in 2016 for development of the LDP's
- Organize a Stakeholders meeting with participants from County, State, and private surveying and geospatial groups
- Let's move on to the LDP design process

Pima County Coordinate Systems (PCCS) Website



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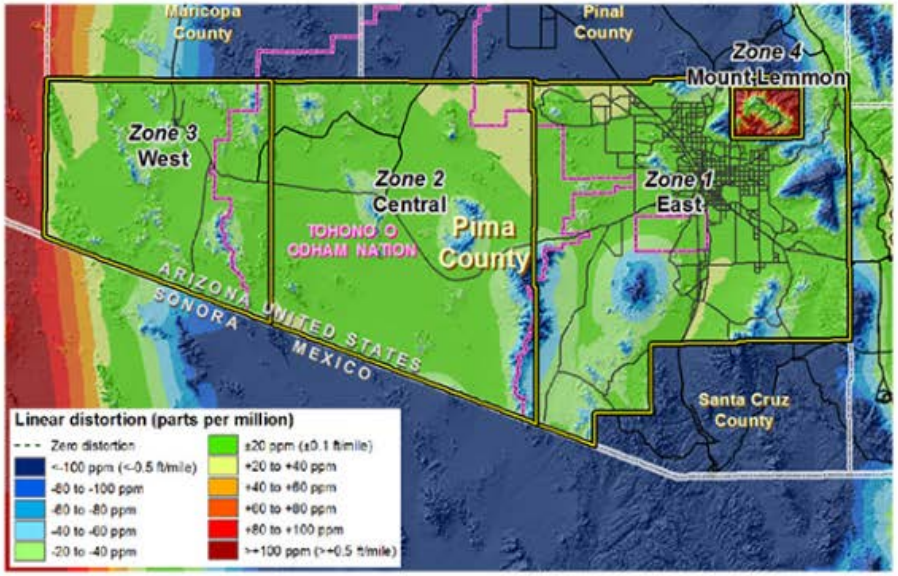
Pima County Coordinate System (PCCS)

The Pima County Coordinate System (PCCS) was created to minimize linear distortion at the topographic surface throughout as much of the county as possible. The main objective was to design a system consisting of four zones with linear distortion not exceeding about ±20 parts per million (±0.1 ft. per mile or 1:50,000) in populated parts of Pima County. The areas in Green in the image below represent the ±20 parts per million within each of the four PCCS Zones.

A stakeholders meeting was held on October 26, 2016, to solicit input and support for the PCCS. Representatives from Geodetic Analysis, Pima County and City of Tucson survey departments, Pima County Public Works, tribal agencies, members of the Arizona Professional Surveyors Association, and private sector surveying and engineering firms were present. They provided insight and overwhelming support for the development of the PCCS and Low Distortion Projections.



Geographic Information Systems
33 N. Stone Ave., 15th Fl.
Mail-Stop Code DTBAB17-425
Tucson, AZ 85701

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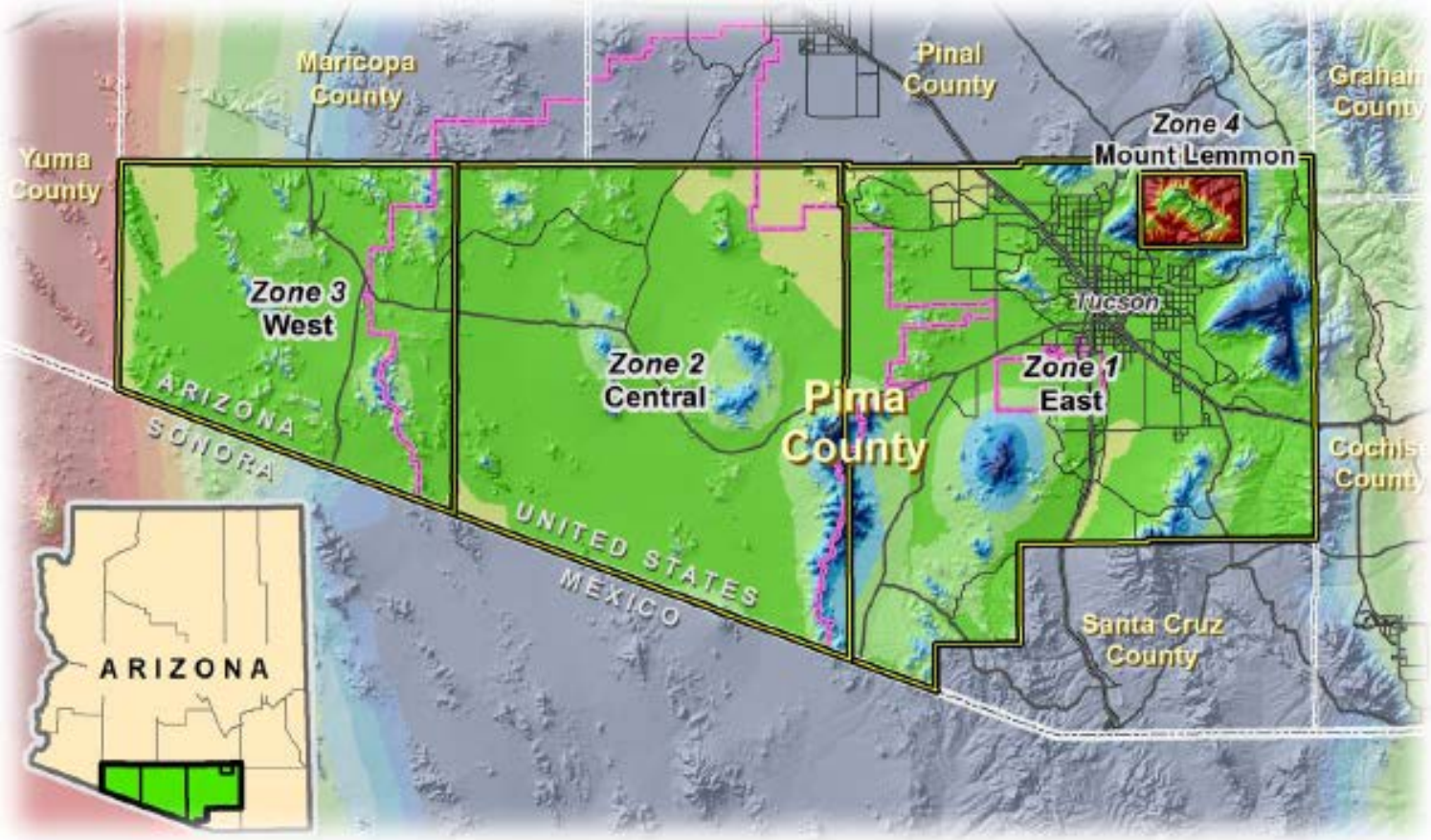
Project Report

The Pima County Coordinate System

Design and documentation of a four-zone low-distortion projection coordinate system for Pima County, Arizona



Presentation\PCCS_report.pdf

PIMA COUNTY

PCCS Report | Zone1 | Zone2 | Zone3 | Zone4 | PCCS Control | Projection Files

Pima County Coordinate System (PCCS) Zone 1 East*

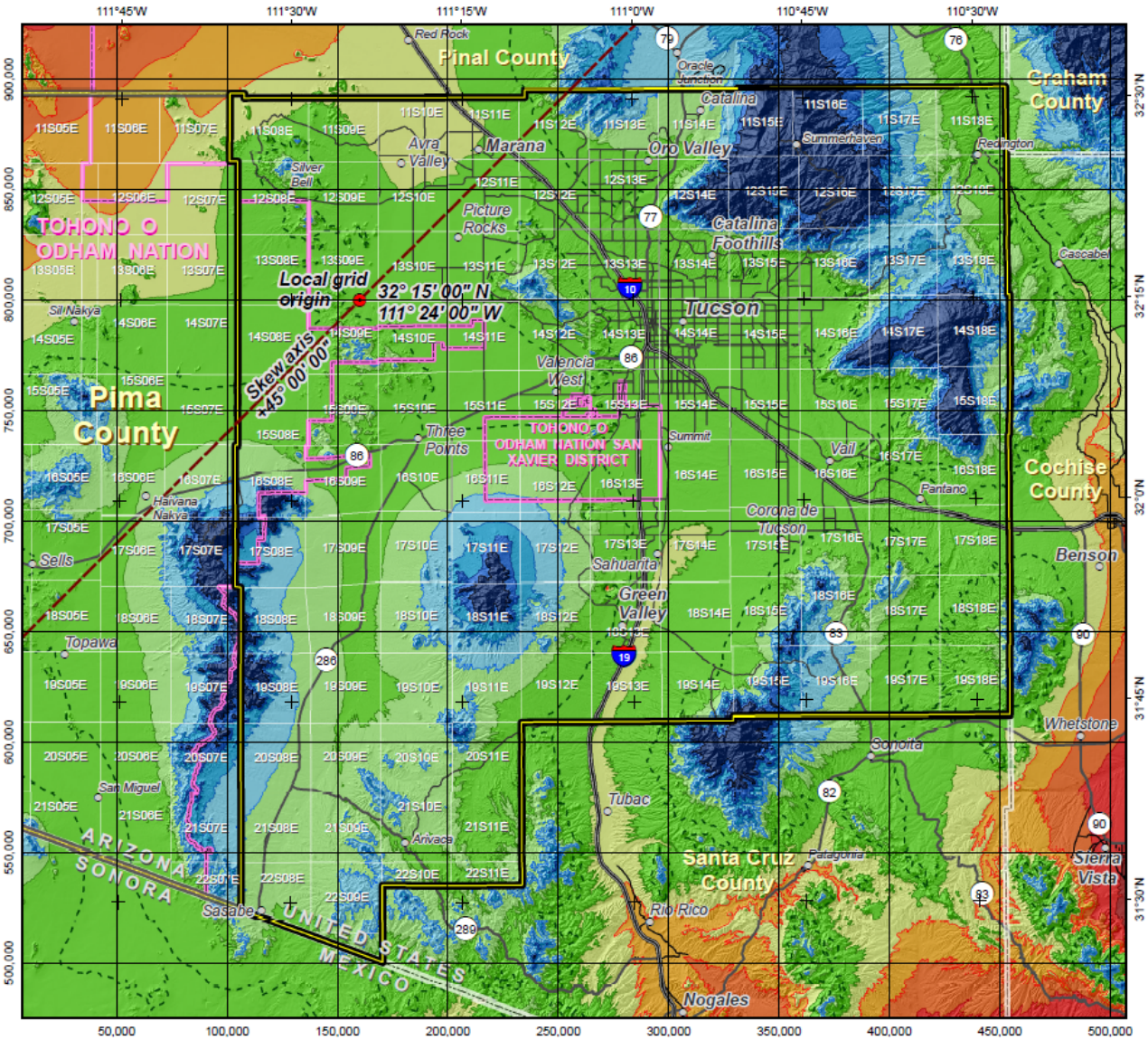
Download - PCCS Zone 1 Map

Linear unit: International foot (ift)
Geometric reference system: North American Datum of 1983 (NAD 83)
Reference ellipsoid: Geodetic Reference System of 1980 (GRS-80)
Projection: Oblique Mercator (local grid origin)
Latitude of local grid origin: 32° 15′ 00″ N
Longitude of local grid origin: 111° 24′ 00″ W
Northing at local grid origin: 800,000.000 ift
Easting at local grid origin: 160,000.000 ift
Skew axis scale at local origin: 1.000 110 (exact)
Skew axis azimuth at local origin: +45° 00′ 00″

* Also known as a Hotine OM or rectified skew orthomorphic (RSO) projection. Local origin also referred to as "center." Can also be defined using the "true" or "natural" origin.

Click image for larger view.

PIMA COUNTY



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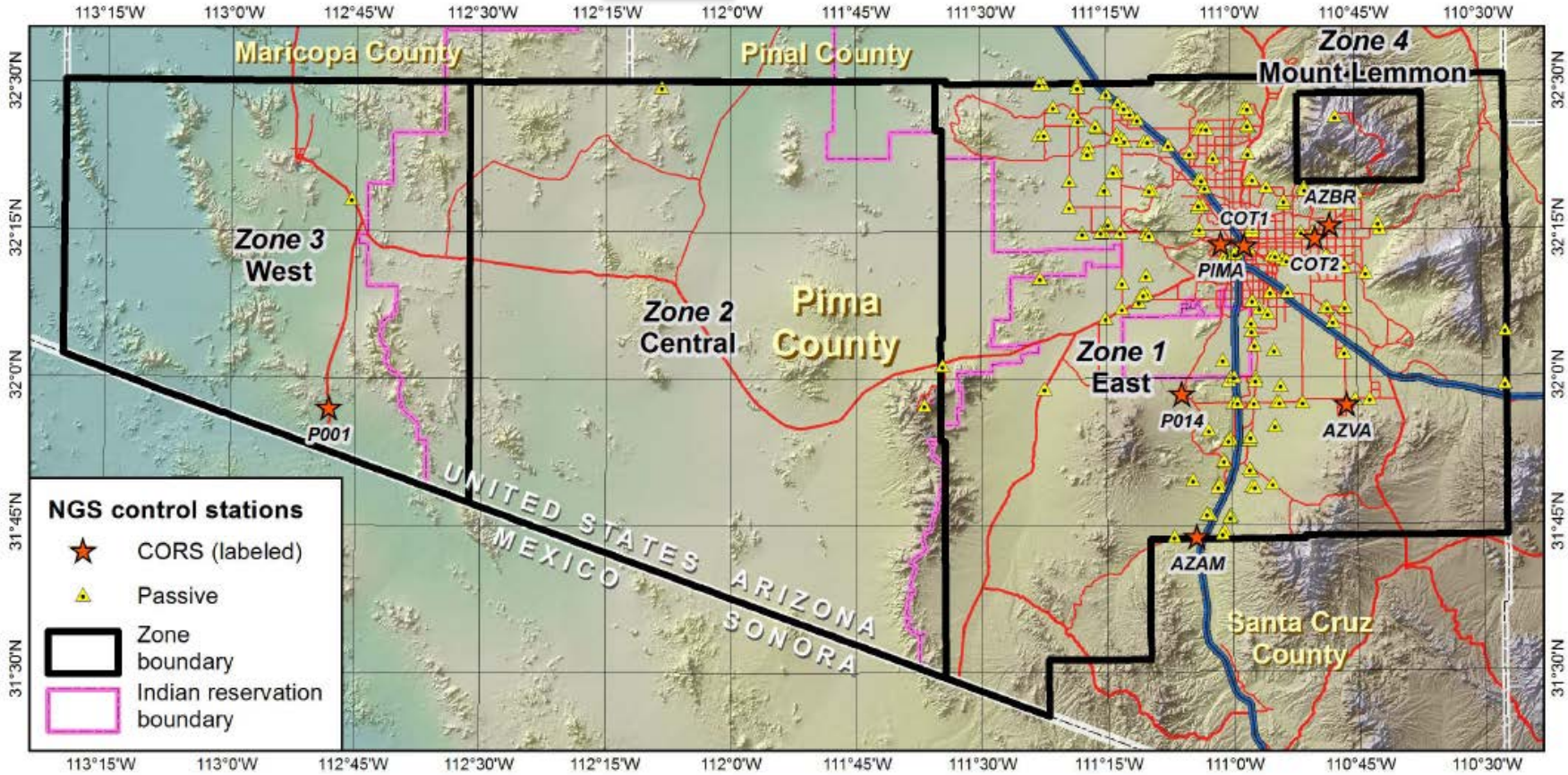
PIMA COUNTY

PCCS Report | Zone1 | Zone2 | Zone3 | Zone4 | PCCS Control | Projection Files

Pima County Coordinate System (PCCS) Control

PCCS NGS Project Control Map

- PCCS Zone Boundaries in Shape File Format. - *zip file*
- NGS Control adjusted to Pima County Control System download - *control text file*



Pima County Coordinate System (PCCS)

North American Datum of 1983

NGS control in Pima County with published NAD 83 (2011) epoch 2010.00 coordinates

Scale 1:1,250,000

when printed on 8-1/2" x 11" sheet

0 10 20 30 40

Miles

Grid North

PCCS Report | Zone1 | Zone2 | Zone3 | Zone4 | PCCS Control | Projection Files

Pima County Coordinate System (PCCS) Projection files

For use with Global Positioning System (GPS) Equipment and Geographic Information Systems.

- PCCS ALL Projection Files Projection File(s) Download - *zip file*

XY Coordinate System | Z Coordinate System

Type here to search

- Favorites
  - NAD 1983 HARN StatePlane Arizona Central FIPS 0202 (Intl
  - PCCS1 East NAD 1983 (2011) OM (Intl Feet)
  - PCCS2 Central NAD 1983 (2011) TM (Intl Feet)
  - PCCS3 West NAD 1983 (2011) TM (Intl Feet)
  - PCCS4 Mt Lemmon NAD 1983 (2011) LCC (Intl Feet)
  - WGS 1984
- Geographic Coordinate Systems
- Projected Coordinate Systems

PIMA COUNTY

We have Registered the PCCS with epsg.org

International Association of Oil & Gas Producers

Register Login Search...

Geomatics home | EPSG home | EPSG Dataset | Guidance notes | Terms of use

What is new?

Online Registry

The current version of the Online Registry which includes all recent updates (version 9.0.1, 2017-03-19)

Download Dataset

Download Dataset (version 9.0, 2016-12-15)

About the EPSG Dataset

The IOGP's EPSG Geodetic Parameter Dataset is a collection of definitions of coordinate reference systems and coordinate transformations which may be global, regional, national or local in application.

The primary EPSG Dataset is maintained in the online registry, from which data may be accessed through a graphic user interface or through a service interface. The online registry contains the most current data. Registry users may query and view the data, generate printable reports and create Well-known Text (WKT) compliant with ISO 19162. The online registry supports anonymous (guest) access, but also permits the user to register for additional services, such as the export of the entire Dataset.

About registration

To gain access to the EPSG data through these web pages, you must agree to the Terms of Use by registering on this site. Once logged in, you may also subscribe to updates and make change requests.

To register, you must enter your email address (visible to IOGP) and password (not visible). This information is not used outside this site, nor is it passed on to

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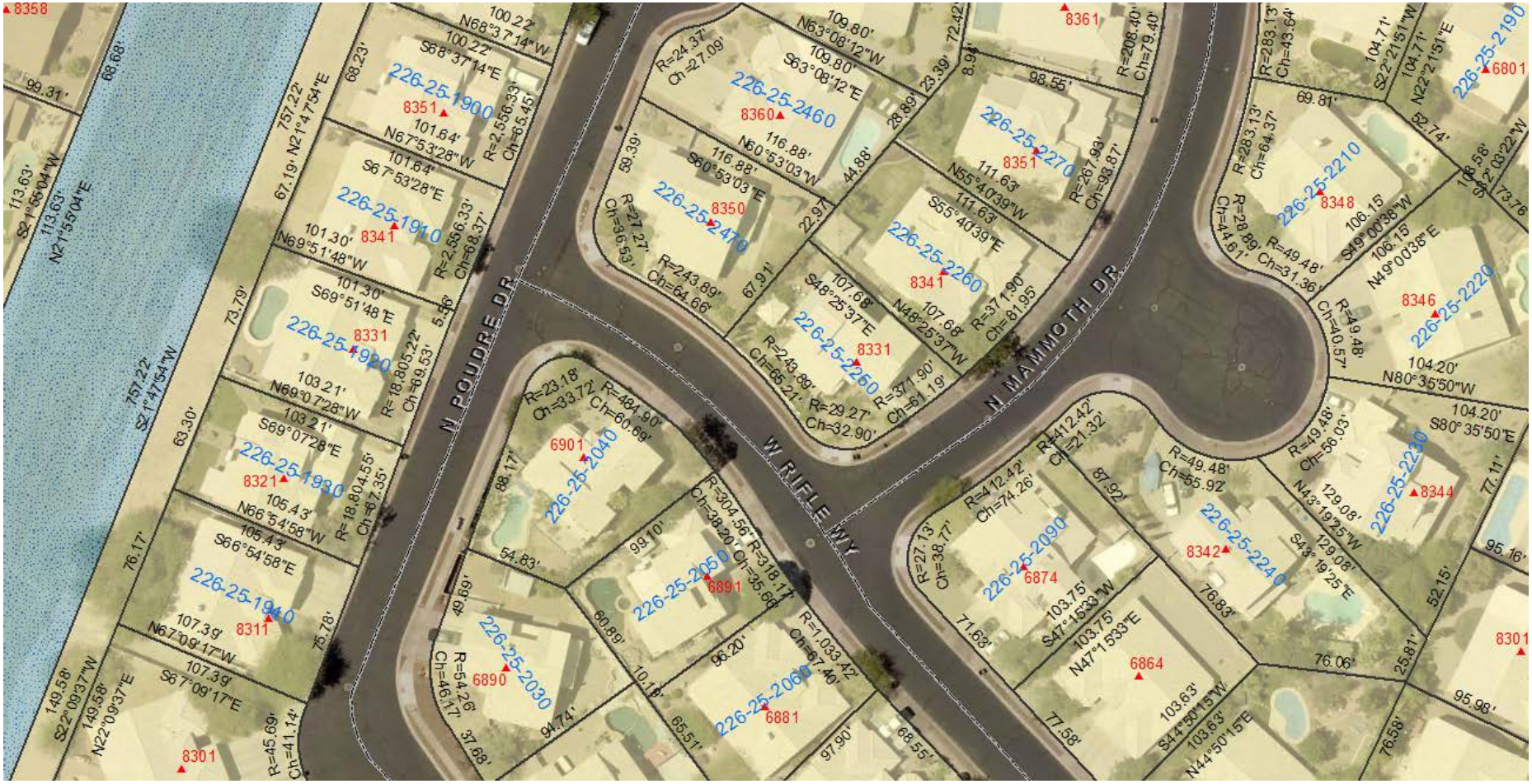
Pima County's Parcel Fabric Development



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Migrating CAD Parcels to the Parcel Fabric

- Research current use of CAD data and its GIS usage
  - Requires a close examination of exiting CAD drawing layers
  - Clear understanding of how the CAD data was created and currently maintained and used to support the GIS enterprise.
- Because our CAD data continues to be used on a daily basis
  - Parallel processing was developed that doesn't impact current CAD or GIS parcel processing
  - Create Quality Control steps to validate Parcel Fabric development
- Processing tools AutoCAD lisp, SQL Server, Python Scripts
  - Automate processing steps to support daily CAD edits
  - Automate Parcel Fabric Topology validation before Loading

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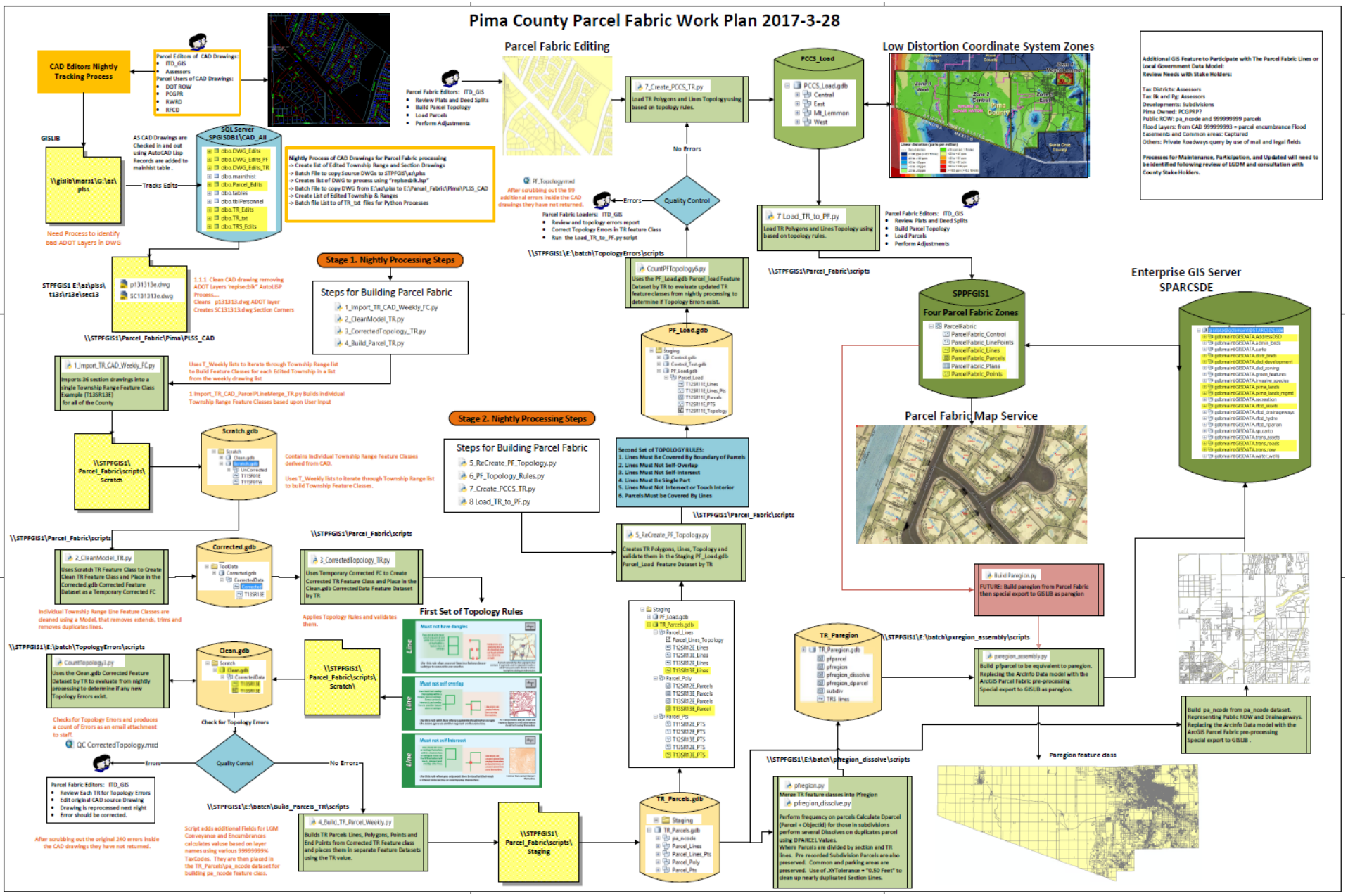
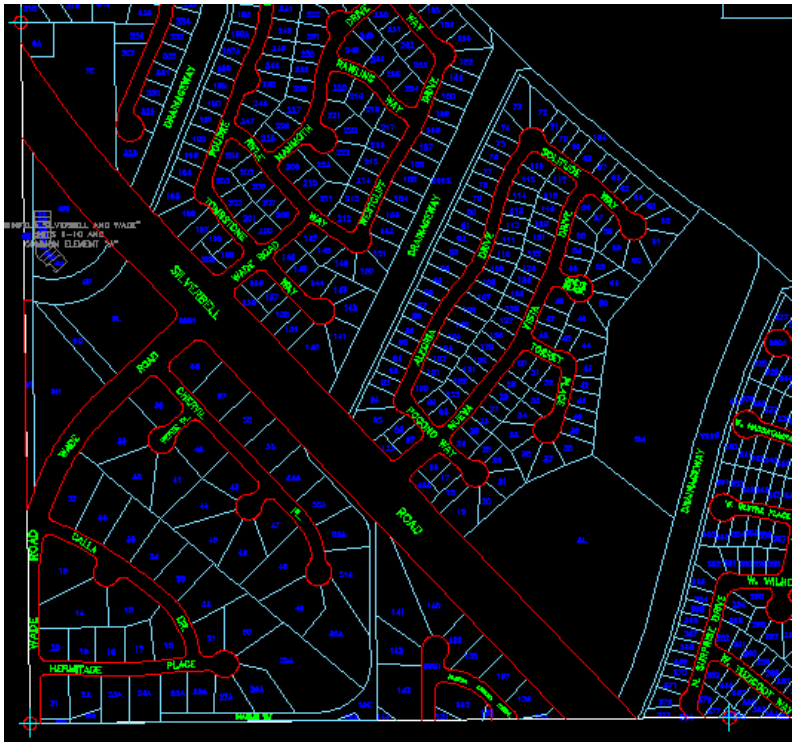
Parcel Fabric Development Work Plan



Daily Tracking of Parcel CAD Drawing Edits



Parcel Editors of CAD Drawings:

- ITD_GIS
- Assessors

Parcel Users of CAD Drawings:

- DOT ROW
- PCGPR
- RWRD
- RFCD

SQL Server SPGISDB1\CAD_All

- dbo.DWG_Edits
- dbo.DWG_Edits_PF
- dbo.DWG_Edits_TR
- dbo.mainthist
- dbo.Parcel_Edits
- dbo.tables
- dbo.tblPersonnel
- dbo.TR_Edits
- dbo.TR_txt
- dbo.TRS_Edits

- p131334e.dwg
- p131335e.dwg
- p131336e.dwg
- SC131301e.dwg
- SC131302e.dwg
- SC131303e.dwg

Nightly Process of CAD Drawings for Parcel Fabric processing

-> Create list of Edited Township Range and Section Drawings
-> Batch File to copy Source DWGs to STPFGIS\az\plss
-> Creates list of DWG to process using “replsecblk.lsp”
-> Batch File to copy DWG from E:\az\plss to E:\Parcel_Fabric\Pima\PLSS_CAD
-> Create List of Edited Township & Ranges
-> Batch file List to of TR_txt files for Python Processes

Migrating CAD parcels to GIS Feature Classes

Stage 1. Nightly Processing Steps

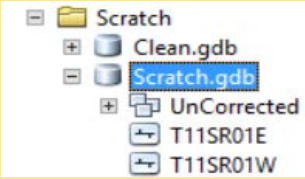
Steps for Building Parcel Fabric

- 1_Import_TR_CAD_Weekly_FC.py
- 2_CleanModel_TR.py
- 3_CorrectedTopology_TR.py
- 4_Build_Parcel_TR.py

1_Import_TR_CAD_Weekly_FC.py

Imports 36 section drawings into a single Township Range Feature Class Example (T13SR13E) for all of the County

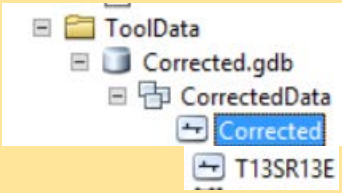
Scratch.gdb



2_CleanModel_TR.py

Uses Scratch TR Feature Class to Create Clean TR Feature Class and Place in the Corrected.gdb Corrected Feature Dataset as a Temporary Corrected FC

Corrected.gdb

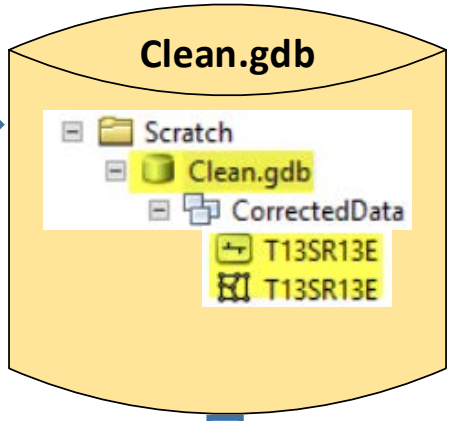


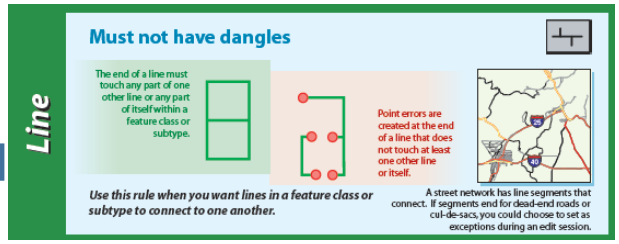
PIMA COUNTY

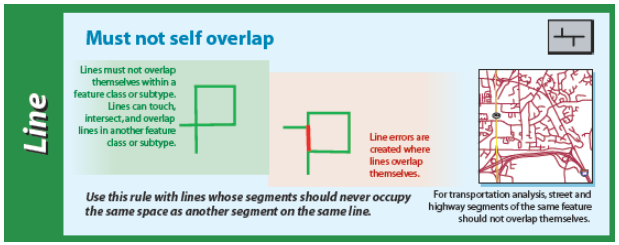
Apply Topology rules and QC check for errors

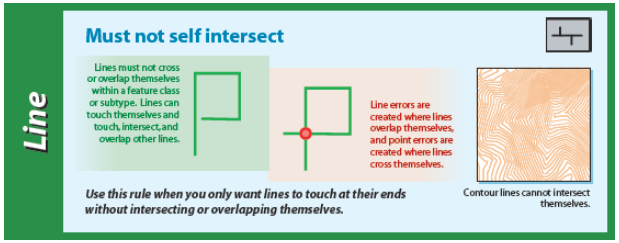
3_CorrectedTopology_TR.py

Uses Temporary Corrected FC to Create Corrected TR Feature Class and Place in the Clean.gdb CorrectedData Feature Dataset by TR









QC CorrectedTopology.mxd

Quality Contol

Parcel Fabric Editors: ITD_GIS

- Review Each TR for Topology Errors
- Edit original CAD source Drawing
- Drawing is reprocessed next night
- Error should be corrected.

4_Build_TR_Parcel_Weekly.py

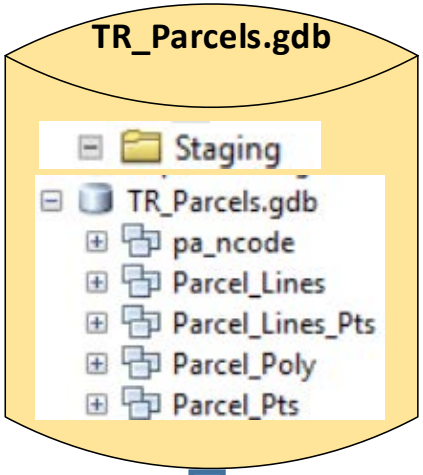
Builds TR Parcels Lines, Polygons, Points and End Points from Corrected TR Feature class and places them in separate Feature Datasets using the TR value.

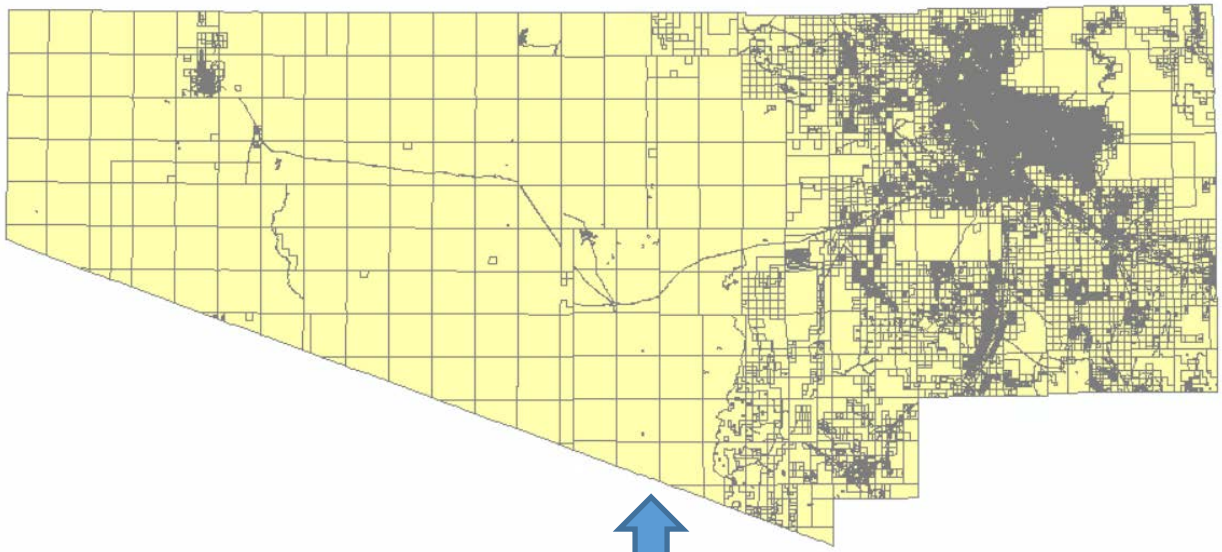
After scrubbing out the original 240 errors inside the CAD drawings they have not returned.

Create Parcel Lines, Polygons Line Points, and Parcel Points for Parcel Fabric

PIMA COUNTY

TR Parcel Polygons to Single Feature Class





pfregion.py

Merge TR feature classes into Pfregion

pfregion_dissolve.py

Perform frequency on parcels Calculate Dparcel (Parcel + Objectid) for those in subdivisions perform several Dissolves on duplicates parcel using DPARCEL Values.
Where Parcels are divided by section and TR lines. Pre recorded Subdivision Parcels are also preserved. Common and parking areas are preserved. Use of .XYTolerance = "0.50 Feet" to clean up nearly duplicated Section Lines.

pxregion_assembly.py

Build pfparcel to be equivalent to paregion.
Replacing the ArcInfo Data model with the ArcGIS Parcel Fabric pre-processing
Special export to GISLIB as paregion.

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Parcel Lines & Polygons Topology

Stage 2. Nightly Processing Steps

TR_Parcels.gdb

- Staging
- TR_Parcels.gdb
  - pa_ncode
  - Parcel_Lines
  - Parcel_Lines_Pts
  - Parcel_Poly
  - Parcel_Pts

Steps for Building Parcel Fabric

- 5_ReCreate_PF_Topology.py
- 6_PF_Topology_Rules.py
- 7_Create_PCCS_TR.py
- 8 Load_TR_to_PF.py

5_ReCreate_PF_Topology.py

Creates TR Polygons, Lines, Topology and validate them in the Staging PF_Load.gdb Parcel_Load Feature Dataset by TR

Second Set of TOPOLOGY RULES:

1. **Lines Must Be Covered By Boundary of Parcels**
2. **Lines Must Not Self-Overlap**
3. **Lines Must Not Self-Intersect**
4. **Lines Must Be Single Part**
5. **Lines Must Not Intersect or Touch Interior**
6. **Parcels Must be Covered By Lines**

PF_Load.gdb

- Staging
  - Control.gdb
  - Control_Test.gdb
  - PF_Load.gdb
    - Parcel_Load
      - T12SR11E_Lines
      - T12SR11E_Lines_Pts
      - T12SR11E_Parcels
      - T12SR11E_PTS
      - T12SR11E_Topology

CountPFTopology6.py

Uses the PF_Load.gdb Parcel_load Feature Dataset by TR to evaluate updated TR feature classes from nightly processing to determine if Topology Errors exist.

PIMA COUNTY

Topology QC and Loading Parcel Fabric

Quality Control

PF_Topology.mxd

Parcel Fabric Loaders: ITD_GIS

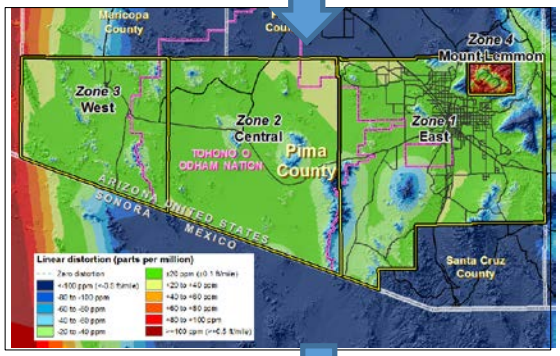
- Review and topology errors report
- Correct Topology Errors in TR feature Class
- Run the Load_TR_to_PF.py script

After scrubbing out the 99 additional errors inside the CAD drawings they have not returned.

7_Create_PCCS_TR.py

Load TR Polygons and Lines Topology using based on topology rules.

Low Distortion Coordi te System Zones



7 Load_TR_to_PF.py

Load TR Polygons and Lines Topology using based on topology rules.

PCCS_Load

- ParcelFabric
  - ParcelFabric_Control
  - ParcelFabric_LinePoints
  - ParcelFabric_Lines
  - ParcelFabric_Parcels
  - ParcelFabric_Plans
  - ParcelFabric_Points

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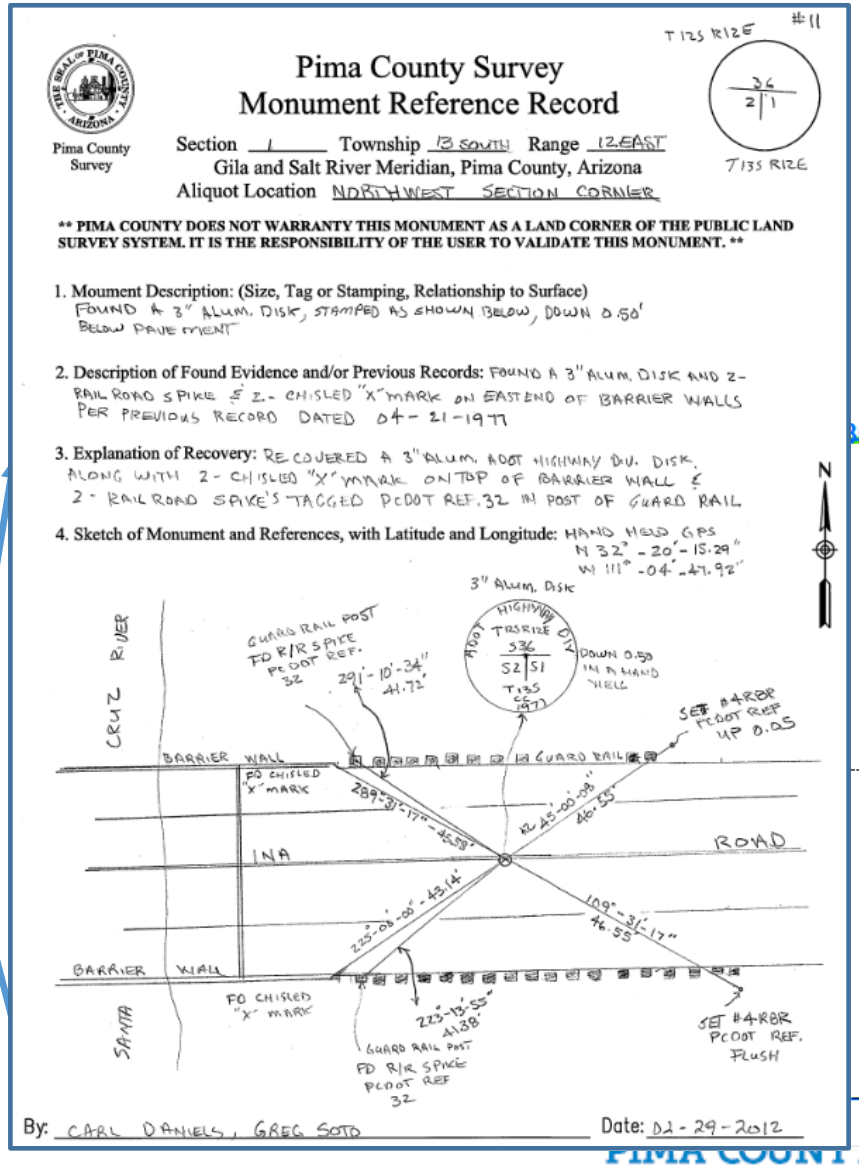
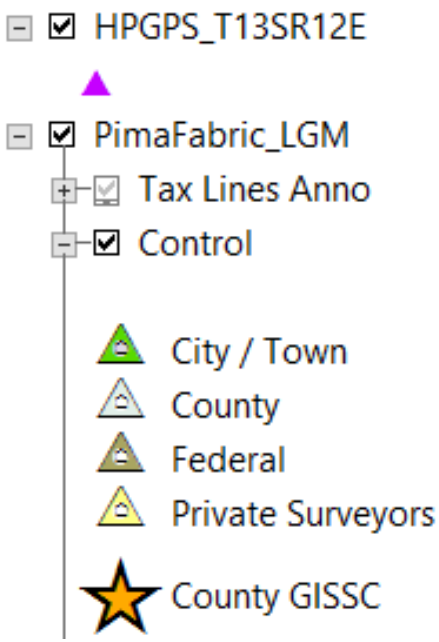
Migrating PLSS CAD Section Lines and Section Corners to GIS

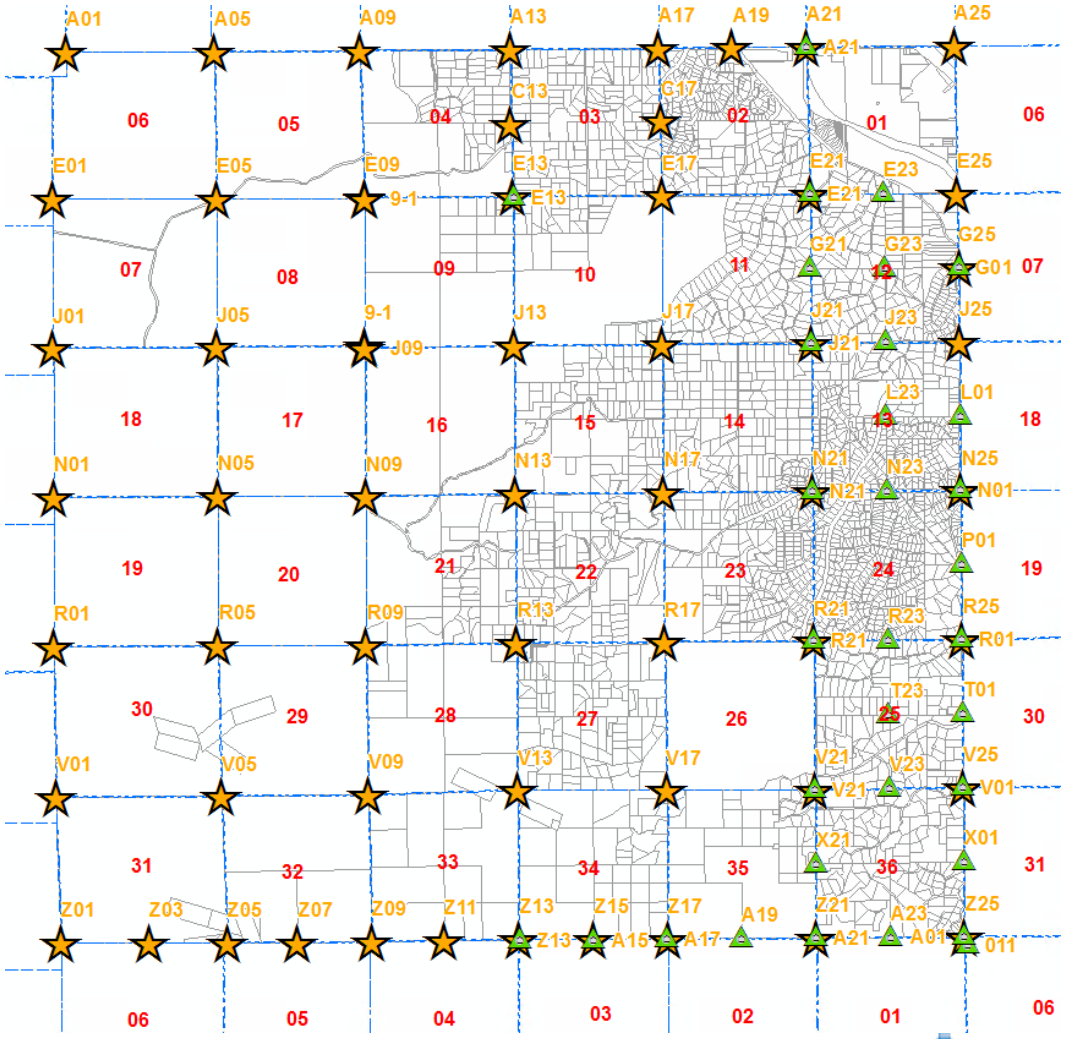
- The GIS Section Lines were extracted from the CAD drawings and migrated into TR Feature Classes
- GIS Section Conners (GISSC) were extracted from the CAD drawings and migrated into TR Feature Classes
- The GIS Section Corners (GISSC) were assigned a unique Arizona Survey Corner Record Index Code



Importing GISSC Section Corner Control into the Parcel Fabric

- Import GISSC Control
- Import Surveyed Positions





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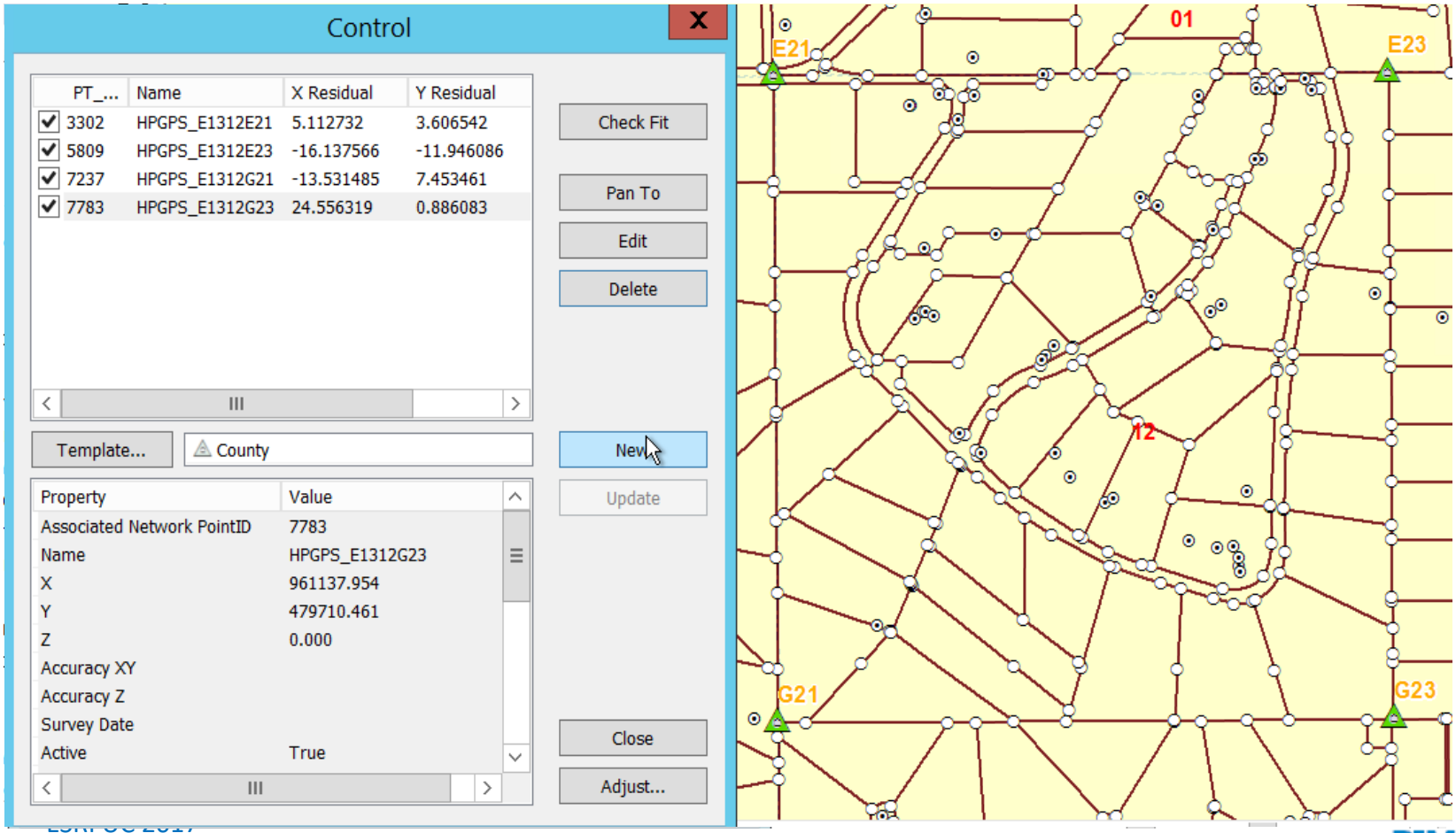
Linking the Parcel Fabric to Control Points

- Checking the fit of linked Control Points before performing Adjustment



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Parcel Fabric Benefits

- The Parcel Fabric stores record parcel measurements
- Supports workflows for migrating new CAD parcels to the Parcel Fabric
- Utilizes section corner control from surveys and CAD plats
- Supports adjustments while preserving measurements
- Preservations of platted parcel records throughout time.

Plans for the Future

- Enlist Surveying Community support for the Parcel Fabric process
- Further define electronic submission of CAD data
- Develop Enterprise level ArcGIS Parcel Fabric Viewer

PIMA COUNTY

Thank You for Attending

Contact:

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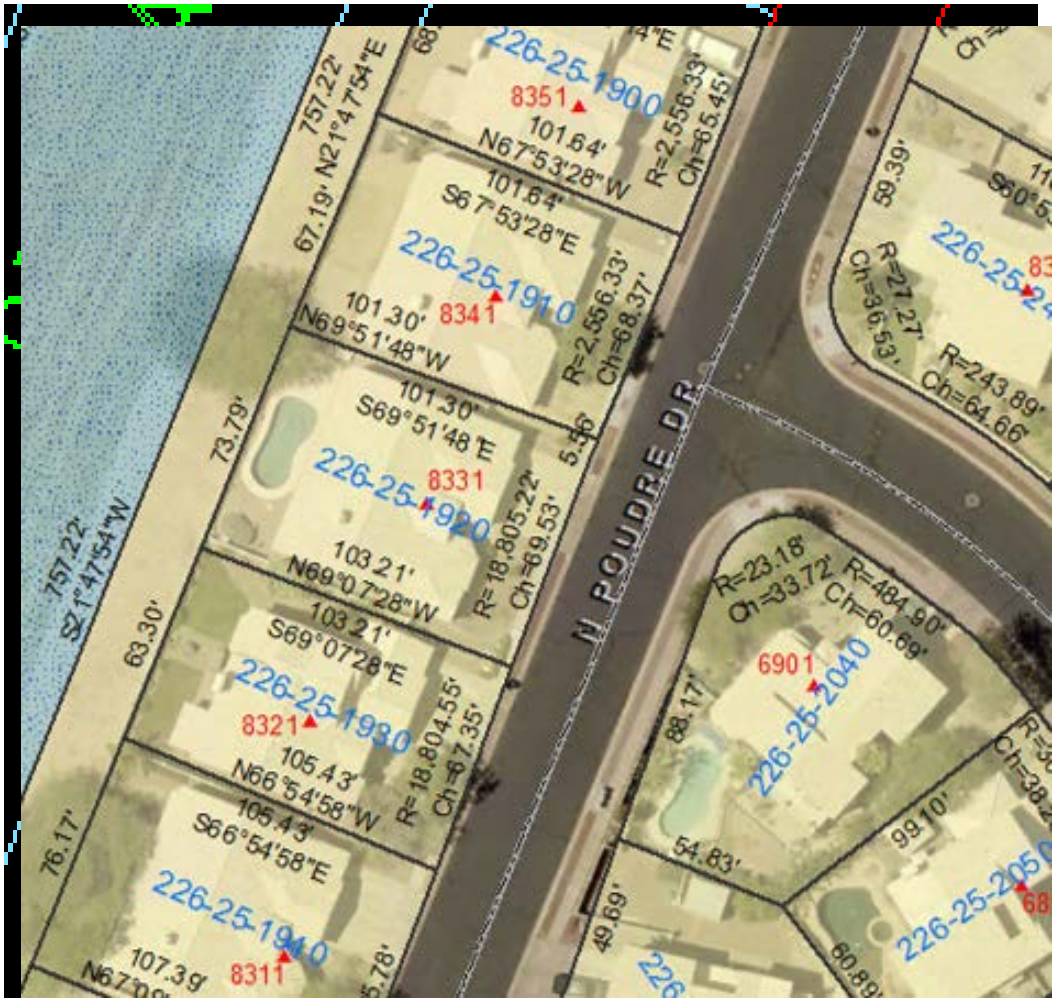

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