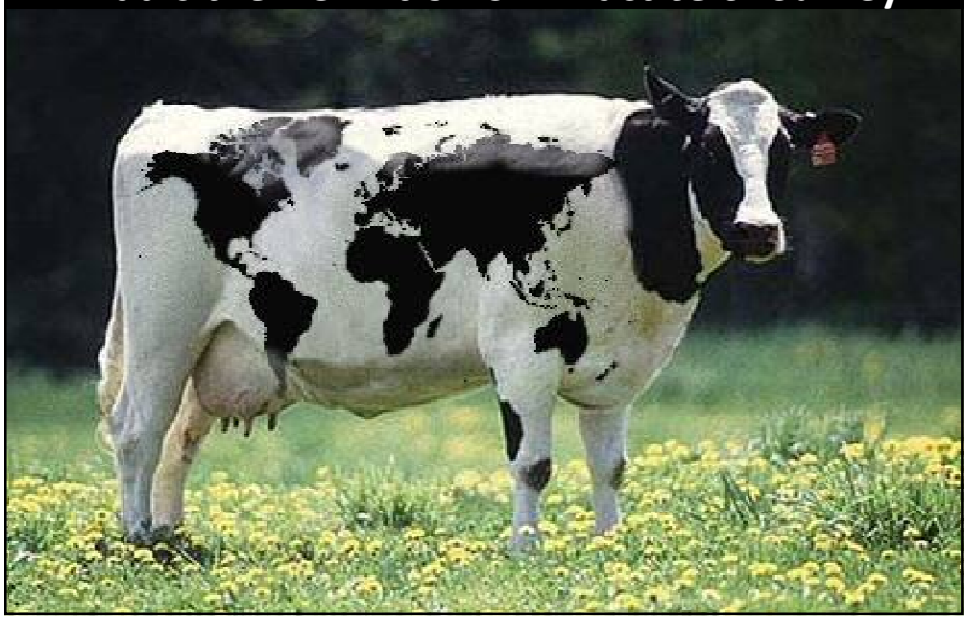
GIS Professionals and Surveyors to Clarify Professional Domains

Tracy Tober, Chair, CGIA
Denise Tober, GIS Director @ ParcelQuest
Ryan Hunsicker, PLS, GISP
Bruce Joffe, GISP (emeritus)

CGIA + CaGPN Joint Committee for GIS Professionals and Surveyors
1-22-26

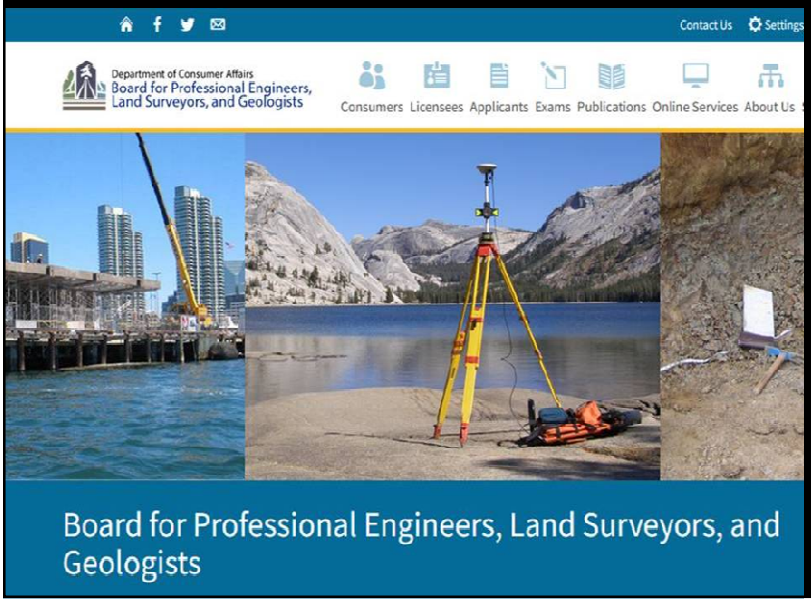
When is a Surveyor Needed?
What is the Definition of "Practice of Survey"



Problem: GIS Professionals' work products being prohibited

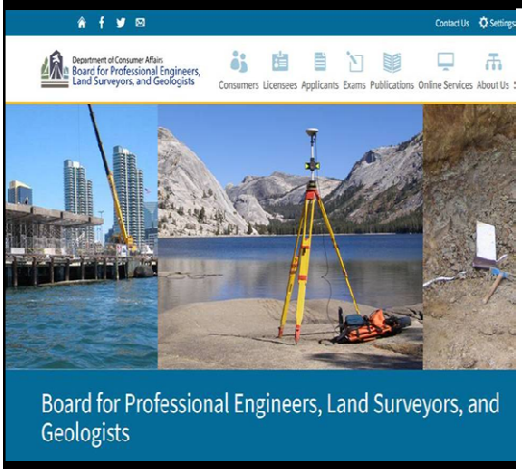
... when CA's surveyor licensing Board thinks they violate statutes

Who Enforces the Practice of Survey vs GIS Professional Practice?



GIS Professionals and Surveyors Clarify Professional Domains

Who Enforces the Practice of Survey vs GIS Professional Practice?



BOARD FOR PROFESSIONAL ENGINEERS, LAND SURVEYORS, AND GEOLOGISTS
2535 Capitol Oaks Drive, Suite 300, Sacramento, California, 95833-2944
Telephone: (916) 999-3600 – Toll Free: 1-866-780-5370
Facsimile: (916) 263-2246
www.bpelsg.ca.gov

CITATION ORDER
10977-U

ISSUED TO

RYAN CROWNHOLM
MY SITE PLAN
siteplan@mysiteplan.com

ON DECEMBER 28, 2021

CASE NO. 2021-03-093

RICHARD B. MOORE, PLS, in his official capacity as the Executive Officer for the Board for Professional Engineers, Land Surveyors, and Geologists (hereinafter referred to as the "Board"), issues this citation in accordance with Title 16, Division 5, California Code of Regulations section 472 for the violation(s) described below.

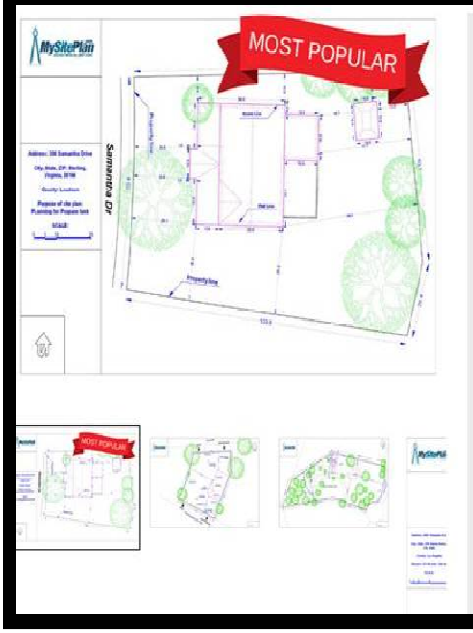
ORDER OF ABATEMENT

The Board hereby orders you to cease and desist from violating Business and Professions Code section(s) 8792(a) and (i).

ORDER TO PAY ADMINISTRATIVE FINE

The Board hereby orders you to pay an administrative fine in the amount of $1,000.00 as provided for by Title 16, Division 5, section 472.1 of the California Code of Regulations for the violation of section(s) 8792(a) and (i) of the Business and Professions Code, within thirty (30) days of the date the citation becomes final.

MySitePlan.com



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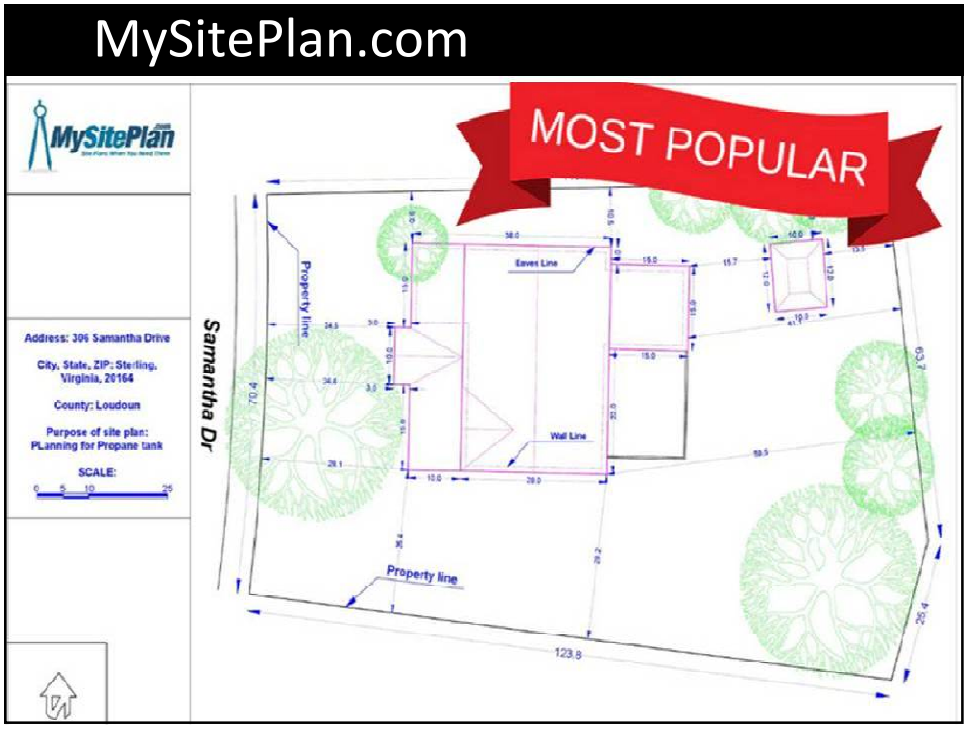
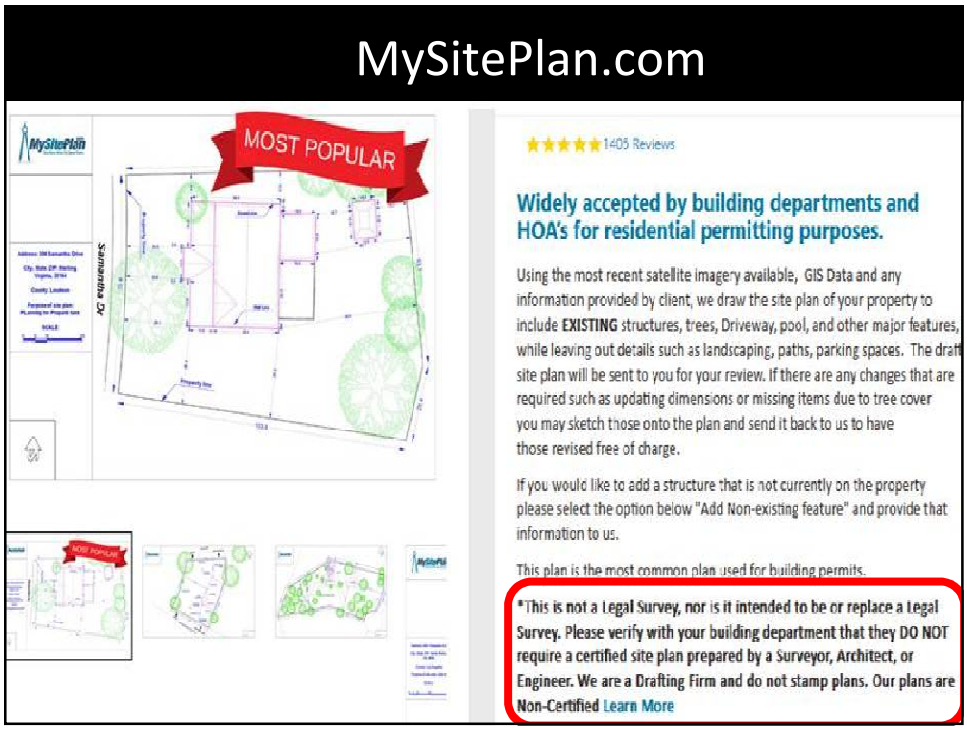
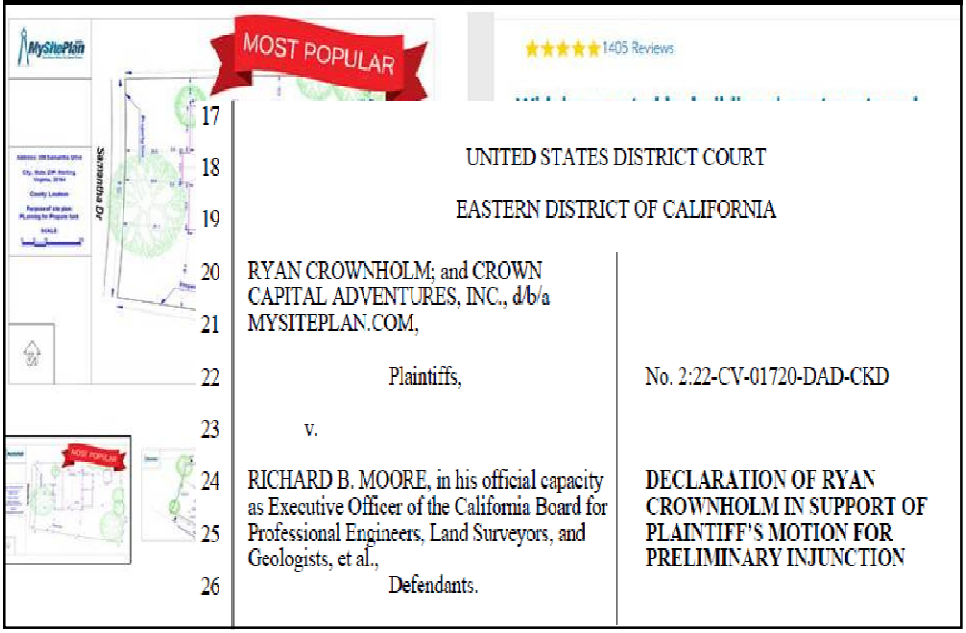
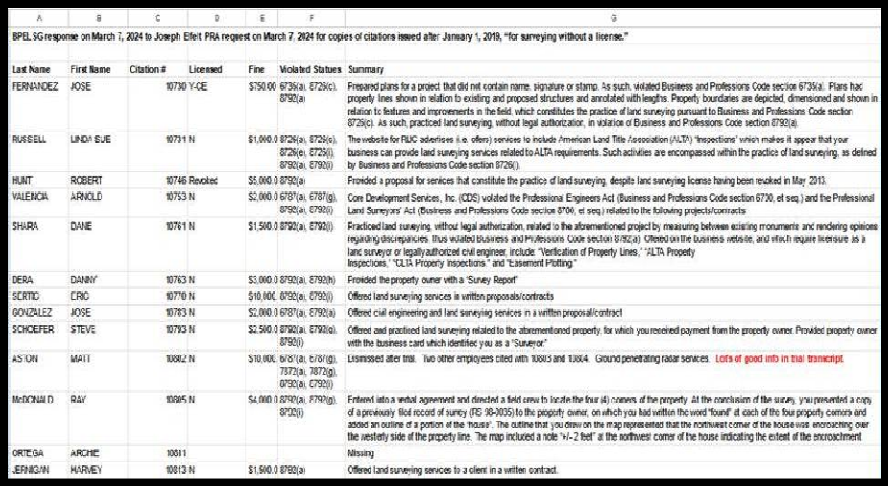

MySitePlan.com
MySitePlan
MOST POPULAR
Address: 306 Samantha Drive
City, State, ZIP: Sterling, Virginia, 20164
County: Loudoun
Purpose of site plan: PLanning for Propane tank
SCALE:
Samantha Dr
Property line
Eaves Line
Wall Line
Property line
123.8


MySitePlan.com
MOST POPULAR
1405 Reviews
Widely accepted by building departments and HOA's for residential permitting purposes.
Using the most recent satellite imagery available, GIS Data and any information provided by client, we draw the site plan of your property to include EXISTING structures, trees, Driveway, pool, and other major features, while leaving out details such as landscaping, paths, parking spaces. The draft site plan will be sent to you for your review. If there are any changes that are required such as updating dimensions or missing items due to tree cover you may sketch those onto the plan and send it back to us to have those revised free of charge.
If you would like to add a structure that is not currently on the property please select the option below "Add Non-existing feature" and provide that information to us.
This plan is the most common plan used for building permits.
*This is not a Legal Survey, nor is it intended to be or replace a Legal Survey. Please verify with your building department that they DO NOT require a certified site plan prepared by a Surveyor, Architect, or Engineer. We are a Drafting Firm and do not stamp plans. Our plans are Non-Certified Learn More

MySitePlan.com



63 Cases of BPELSG Citations



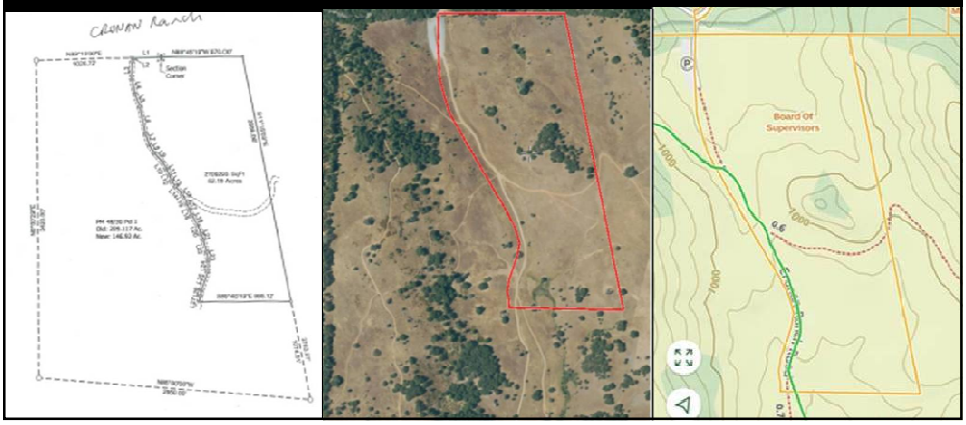
BPEL SG response on March 7, 2024 to Joseph Eifert PRA request on March 7, 2024 for copies of citations issued after January 1, 2019, "for surveying without a license."

Last Name	First Name	Citation #	Licensed	Fine	Violated Statues	Summary
FERNANDEZ	JOSE	10730	Y-CE	$750.00	6739(a), 8726(c), 8792(a	Prepared plans for a project that did not contain name, signature or stamp. As such, violated Business and Professions Code section 6735(a). Plans had property lines shown in relation to existing and proposed structures and annotated with lengths. Property boundaries are depicted, dimensioned and shown in relation to features and improvements in the field, which constitutes the practice of land surveying pursuant to Business and Professions Code section 8725(c). As such, practiced land surveying, without legal authorization, in violation of Business and Professions Code section 8792(a).
RUSSELL	LINDA SUE	10711	N	$1,040.0	8726(a), 8726(c), 8726(e), 8726(j), 8792(a), 8792(i)	The website for RUC advertises (i.e. offers) services to include American Land Title Association (ALTA) "Inspections" which makes it appear that your business can provide land surveying services related to ALTA requirements. Such activities are encompassed within the practice of land surveying, as defined by Business and Professions Code section 8726().
HUNT	ROBERT	10746	Revoked	$5,000.0	8792(a	Provided a proposal for services that constitute the practice of land surveying, despite land surveying license having been revoked in May 2013.
VALENCIA	ARNOLD	10753	N	$2,000.0	6787(a), 6787(g), 8792(a), 8792(i)	Core Development Services, Inc. (CDS) violated the Professional Engineers Act (Business and Professions Code section 6730, et seq.) and the Professional Land Surveyors' Act (Business and Professions Code section 8700, et seq.) related to the following projects/contracts
SHARA	DANE	10761	N	$1,560.0	8792(a), 8792(i)	Practiced land surveying, without legal authorization, related to the aforementioned project by measuring between existing monuments and rendering opinions regarding discrepancies, thus violated Business and Professions Code section 8792(a). Offered on the business website, and elsewhere, to provide licensure as a land surveyor or legally authorized civil engineer, include: "Verification of Property Lines," "ALTA Property Inspections," "CLTA Property Inspections," and "Easement Plotting."
DERA	DANNY	10763	N	$3,000.0	8792(a), 8792(h)	Provided the property owner with a "Survey Report"
SERTIC	ERIC	10770	N	$10,000.	8792(a), 8792(i)	Offered land surveying services in written proposals/contracts
GONZALEZ	JOSE	10783	N	$2,000.0	6787(a), 8792(a)	Offered civil engineering and land surveying services in a written proposal/contract
SCHOEFER	STEVE	10793	N	$2,500.0	8792(a), 8792(q), 8792(i)	Offered and practiced land surveying related to the aforementioned property, for which you received payment from the property owner. Provided property owner with the business card which identifies you as a "Surveyor."
ASTON	MATT	10882	N	$10,000.	6787(a), 6787(g), 7872(a), 7872(g), 8792(a), 8792(i)	Dismissed after trial. Two other employees cited with 10883 and 10884. Ground penetrating radar services. Lots of good info in trial transcript.
McDONALD	RAY	10885	N	$4,000.0	8792(a), 8792(g), 8792(i)	Entered into a verbal agreement and directed a field crew to locate the four (4) corners of the property. At the conclusion of the survey, you presented a copy of a previously filed record of survey (RS 98-0035) to the property owner, on which you had written the word "found" at each of the four property corners and added an outline of a portion of the "house". The outline that you drew on the map represented that the northwest corner of the house was encroaching over the westerly side of the property line. The map included a note "+/- 2 feet" at the northwest corner of the house indicating the extent of the encroachment
ORTEGA	ARCHIE	10911				Missing
JERNIGAN	HARVEY	10913	N	$1,560.0	8792(a)	Offered land surveying services to a client in a written contract.

63: Citations for practicing surveying without a license

- 39: Not GIS related, generally offering surveying services without a license
- 24: Are GIS related, frequently with multiple citations
- 18: Maps quantitatively relating fixed works to property boundaries (1 was dismissed), "dimensions"
- 5: Location or elevation of fixed works
- 4: Contours of the earth's surface (including drone photogrammetry)
- 2: Quantitative statements about map accuracy
- 1: Preparing a subdivision map

Another Citation, for Overlaying an Assessor's parcel on geoimagery and a topo map



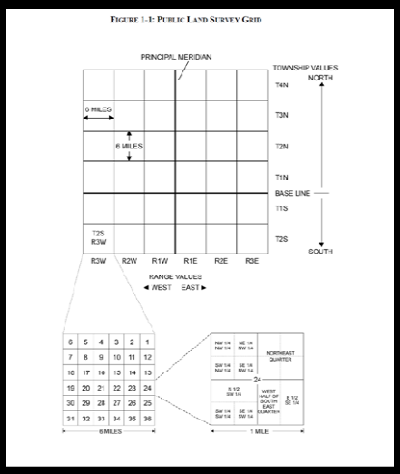
Stated Objections

- Dimensions between boundary lines and fixed works is always the practice of survey
- Possible mis-use of map by uninformed citizens
- Public confusion – need to protect the health, safety, and welfare of the citizens

- **(PBELSG Board interprets use of Assessor maps as determining boundaries)**

PURPOSE OF ASSESSOR MAPS

- INVENTORY
- LOCATE
- IDENTIFY
- APPRAISE

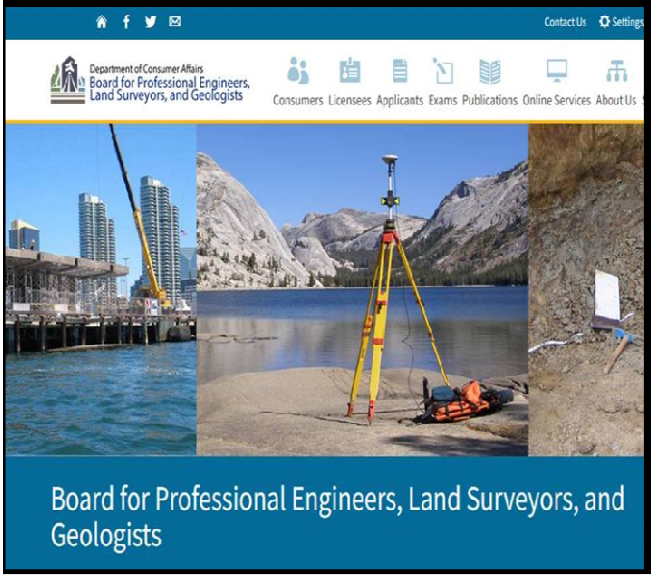


Concern for Public Health, Safety, & Welfare

THE PROBLEM: Improper Use of GIS Data by General Public and Public Officials

- Use of GIS Basemaps to Determine Locations
- Lack of Awareness of GIS Basemap Quality:
  Accuracy
  Currency
  Data Source
  Method of Compilation
  LACK OF ADEQUATE METADATA
- Lack of Explicit GIS Basemap Reference to Data Sources

What Defines the Practice of Survey vs GIS Professional Practice?



California's **BUSINESS AND PROFESSIONS CODE** (BPC)
DIVISION 3. PROFESSIONS AND VOCATIONS [5000 - 9998.11]
CHAPTER 15. Land Surveyors [8700 - 8805]
ARTICLE 3. Application Of The Chapter [8725 - 8731]
Section **8726** (a)
A person … practices land surveying … does or offers to do …the following:

Https://Leginfo.Legislature.Ca.Gov/Faces/Codes_Displaytext.Xhtml?Lawcode=BPC&Division=3.&Title=&Part=&Chapter=15.&Article=3.

Definition of Practice of Surveying

CA BPC DIVISION 3, CHAPTER 15, ARTICLE 3, Section **8726** (a)

- (1) **Locates, relocates, establishes, reestablishes, or retraces** the **alignment or elevation for any** of the **fixed works** embraced within the practice of civil engineering, as described in Section 6731. (last amended 1990)
- (2) **Determines the configuration or contour of the earth's surface**, or the position of fixed objects above, on, or below the surface of the earth by applying the principles of mathematics or photogrammetry.
- (3) **Locates, relocates, establishes, reestablishes, or retraces** any **property line or boundary of any parcel** of land, right-of-way, easement, or alignment of those lines or boundaries.

Crux of the Issue – undefined words

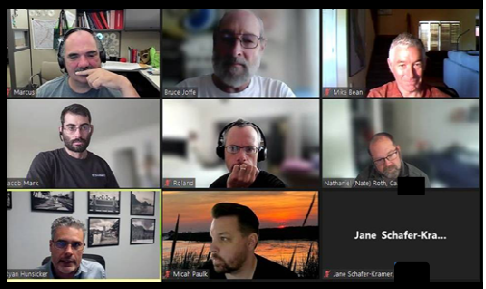
- **Locates, relocates, establishes, reestablishes,** and **retraces** are **not defined in the statute**, and imprecisely defined in Black's Law.
- The statute does not make a **distinction** between **original survey documentation** and **depictions** of boundary lines that are **derivative representations** taken from original survey documents.
- As a consequence, some GIS Professionals' maps and site plans **that depict (represent)** boundary lines have been cited, prohibited, and fined by the BPELSG Board, even though it is **NOT their purpose to establish the authoritative, legal location** of such boundaries.

Inadequacy of the CA's PLS definition

The convergence of surveying and GIS technologies

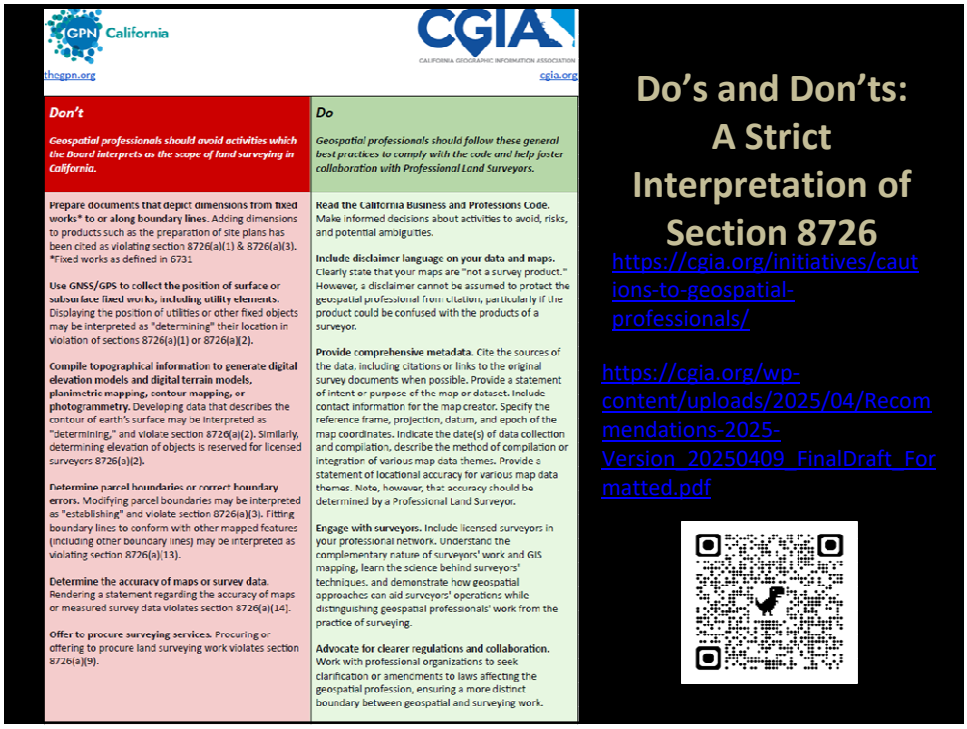
- Mobile field data collection devices are easy to use
- Use of UAS drone technology for mapping
- High precision of positioning systems are easily obtained and used by non-licensed people.

CGIA+CalGPN Joint Committee on GIS Best Practices



Convened to provide the CA GIS Community with clear guidance on how to avoid conflict with professional surveying in conducting GIS Professional activities and services.

GIS Professionals and Surveyors Clarify Professional Domains



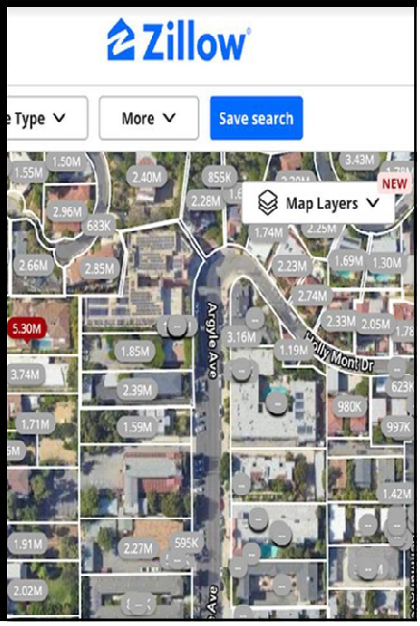
Do's and Don'ts: A Strict Interpretation of Section 8726

https://cgia.org/initiatives/cautions-to-geospatial-professionals/

https://cgia.org/wp-content/uploads/2025/04/Recommendations-2025-Version_20250409_FinalDraft_Formatted.pdf

Don'ts

- Contours
- Elevation-derived hydrography
- Parcel boundary in relation to fixed works
- Dimensions



Do's

- Metadata
  - Projection, Reference Frame, Epoch
  - Data source(s) and date(s)
  - Method of compilation
  - Contact person / agency
- Disclaimer
  - This is not a survey product
  - NOT suitable for legal or authoritative cadastral purposes
- **Statement of Intended Use and Purpose**

What Do Surveyors Actually Do?

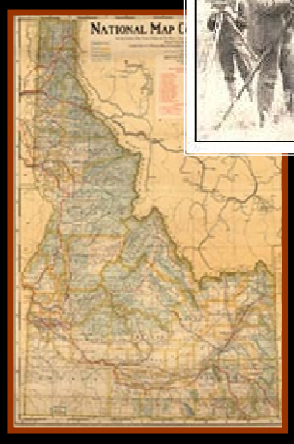
- Measure and document authoritative location
- Assess and mitigate map accuracy and locational errors
- Produce authoritative **original** (source) data/documents for location of boundaries, monuments, reference points, fixed works, elevation, shape of the Earth
- Interpret cadastral law and practices

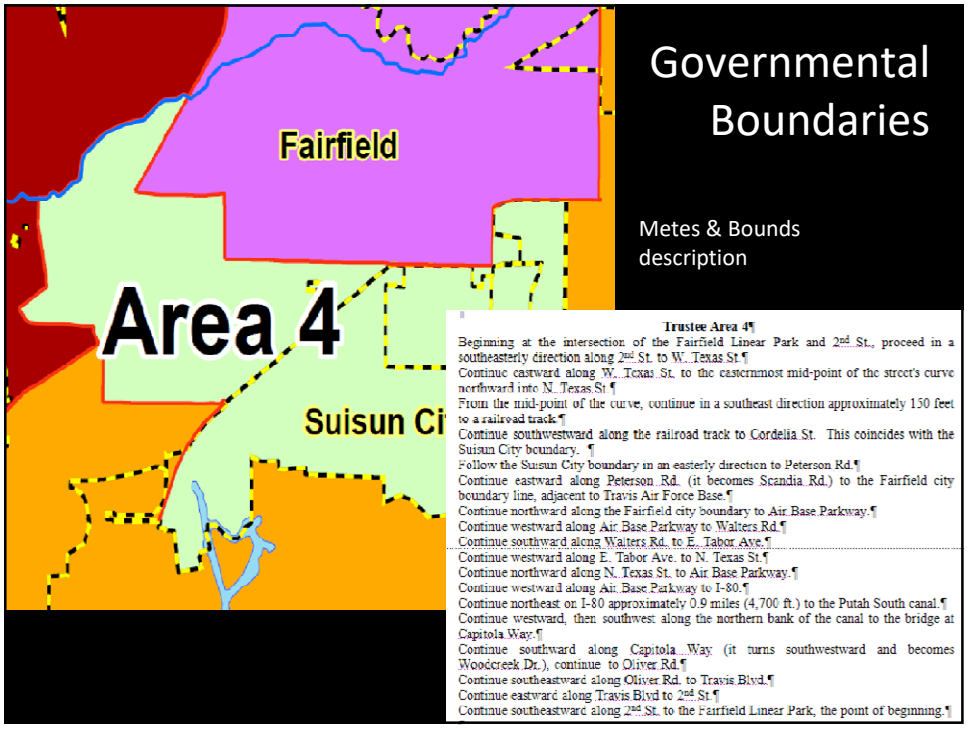
Surveyor Needed !

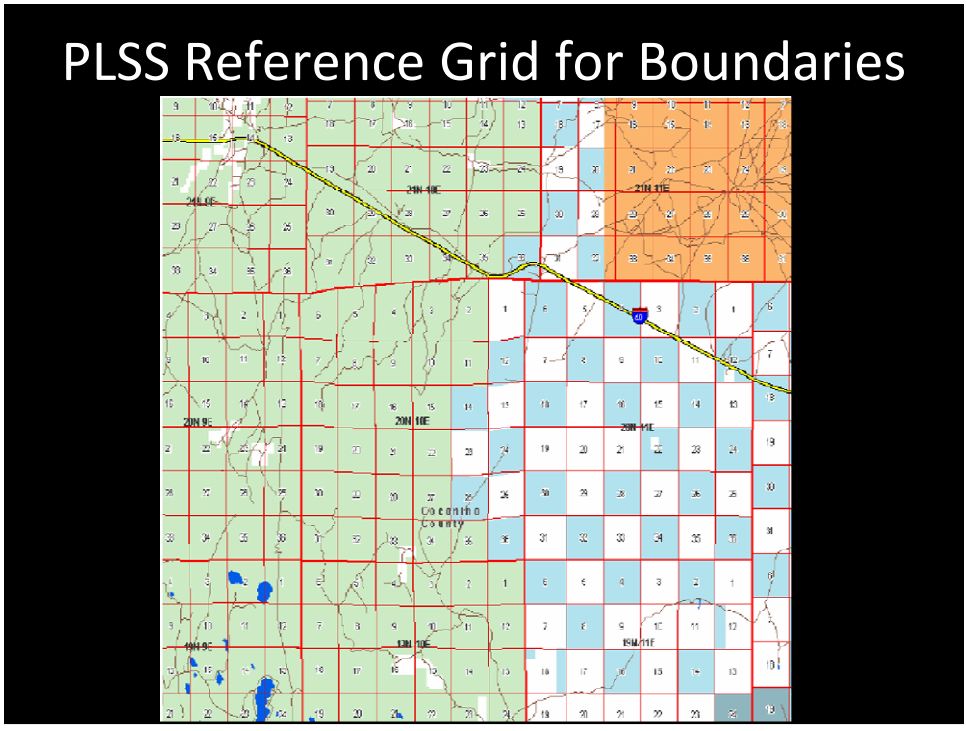
Detecting and Correcting Errors

Survey Work = Measurement

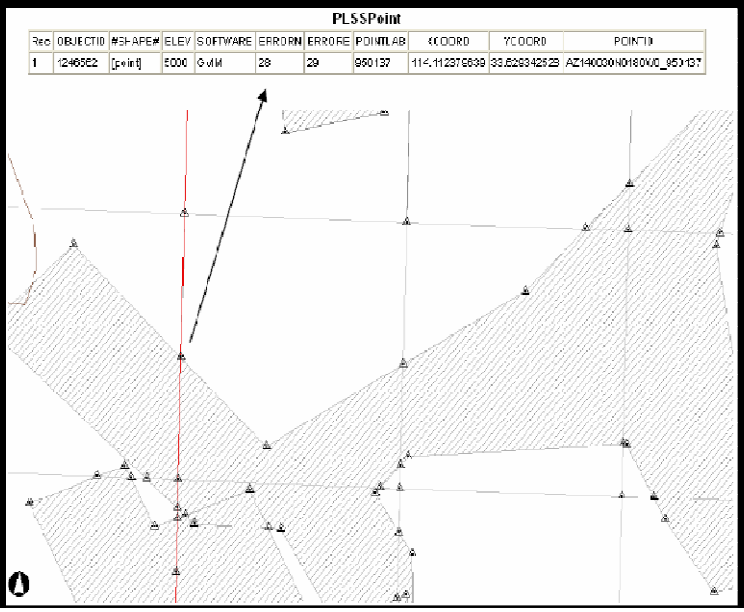
- Property and Boundary
  - Fencing, encroachment, sales
- Dam Deformation Studies
- Preliminary Topography Maps
  - Pipeline, Roads
  - Site design




Fairfield
Area 4
Suisun Ci
Governmental Boundaries
Metes & Bounds description
Trustee Area 4¶
Beginning at the intersection of the Fairfield Linear Park and 2nd St., proceed in a southeasterly direction along 2nd St. to W. Texas St.¶
Continue eastward along W. Texas St. to the easternmost mid-point of the street's curve northward into N. Texas St.¶
From the mid-point of the curve, continue in a southeast direction approximately 150 feet to a railroad track.¶
Continue southwestward along the railroad track to Cordelia St. This coincides with the Suisun City boundary. ¶
Follow the Suisun City boundary in an easterly direction to Peterson Rd.¶
Continue eastward along Peterson Rd. (it becomes Scandia Rd.) to the Fairfield city boundary line, adjacent to Travis Air Force Base.¶
Continue northward along the Fairfield city boundary to Air Base Parkway.¶
Continue westward along Air Base Parkway to Walters Rd.¶
Continue southward along Walters Rd. to E. Tabor Ave.¶
Continue westward along E. Tabor Ave. to N. Texas St.¶
Continue northward along N. Texas St. to Air Base Parkway.¶
Continue westward along Air Base Parkway to I-80.¶
Continue northeast on I-80 approximately 0.9 miles (4,700 ft.) to the Putah South canal.¶
Continue westward, then southwest along the northern bank of the canal to the bridge at Capitola Way.¶
Continue southward along Capitola Way (it turns southwestward and becomes Woodcreek Dr.), continue to Oliver Rd.¶
Continue southeastward along Oliver Rd. to Travis Blvd.¶
Continue eastward along Travis Blvd to 2nd St.¶
Continue southeastward along 2nd St. to the Fairfield Linear Park, the point of beginning.¶


PLSS Reference Grid for Boundaries

Boundary Reference to PLSS



FGDC Cadastral Standards

Private Surveys for Subdivision

Corner Record

CORNER RECORD

Document Number -4487-

City of Walnut Creek County of Contra Costa California

Brief Legal Description Lot 101, Deer Valley Estates, 28 M 27

CORNER TYPE

Government Corner ☐ Control ☐
Monument ☐ Property ☒
Rancho ☐ Other ☐
Date of Survey 2/3/08

COORDINATES (Optional)

N
Zone NAD27 ☐ NAD83 ☐
Units
Vert Datum NGVD29 ☐ NAVD88 ☐
Meas (mth) Meters ☐ Imperial ☐

Corner Left as found ☐ Found and tagged ☐ Established ☒ Reestablished ☐ Retrait ☐

Identification and type of corner found (reference station(s), basis(s) or procedure used to establish or reestablish the corner):

Found monuments as shown on Plat.

A description of the physical condition of the monument as found and as set or reset:

Set monuments as shown on Plat.

SURVEYOR'S STATEMENT

This Corner Record was prepared by me or under my direction in conformance with the Land Surveyors Act on February 21, 2008

Signature [signature] PLS or RCE No. 5999

COUNTY SURVEYOR'S STATEMENT

This Corner Record was received 3/5/08

and examined on/dated 3/18/08

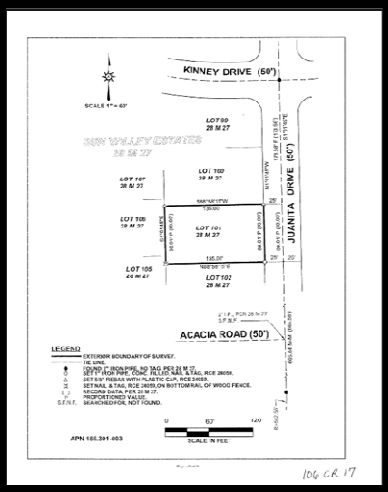
Signature [signature] PLS or RCE No. 5999

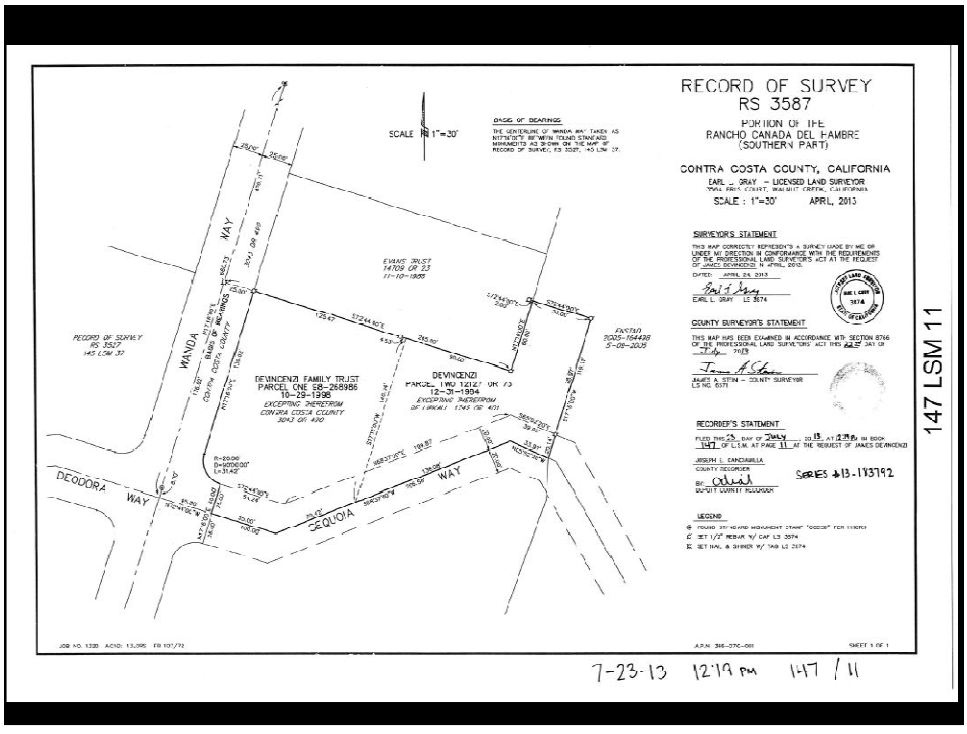
Title Deputy

County Surveyor's Comment

APN 185-301-003

106 CR 17





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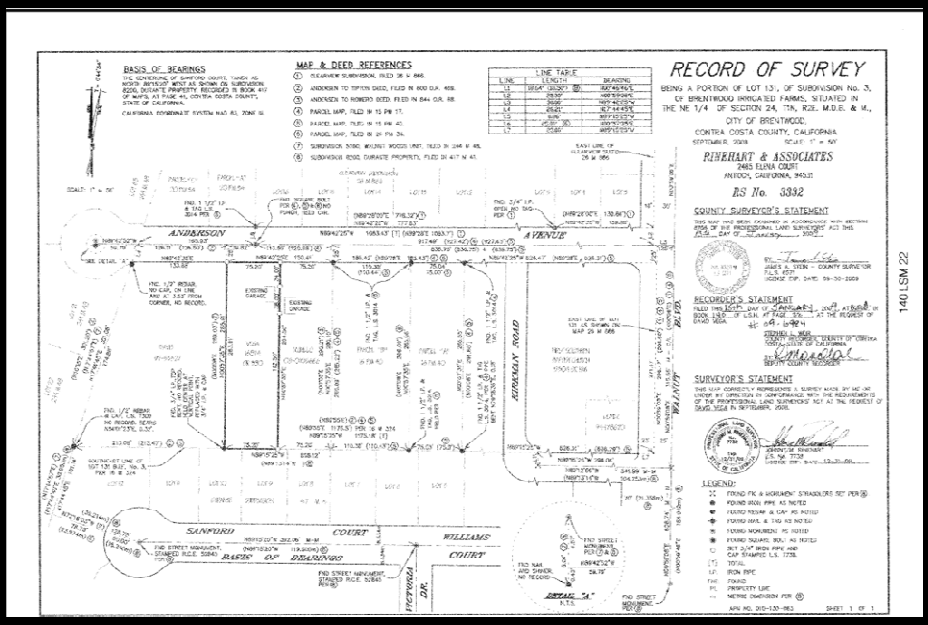


What Do GIS Professionals Actually Do?

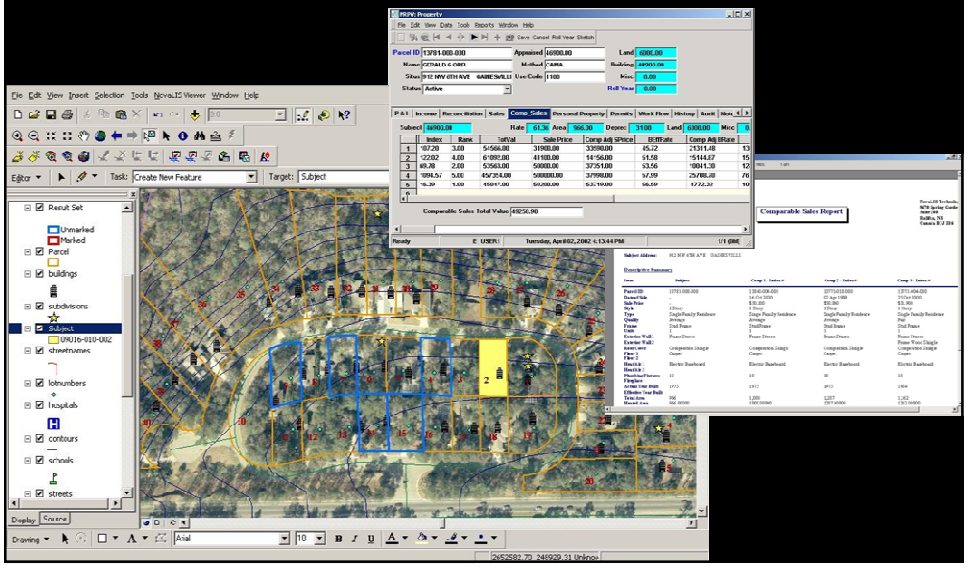
- **Perform geographic analysis**
- Location-based data application services
- **Cartographic display of map-based information**
- Represent surveyed location in non-authoritative maps
- Create geospatial databases
- Create geospatial software and applications
- Manage GIS systems and operations

EVOLUTION FROM PAPER TO DIGITAL

- USAGE IN GIS: Assessor parcel layers are the base of many GIS disciplines
- ADVANTAGES: Location based, Key Identifier, Contiguous graphical representation of parcels
- Location, Inventory, ANALYZE

Assessor's Parcel Maps to GIS Data

GIS Basemap is a Repository Compiled from Local Government Geodata



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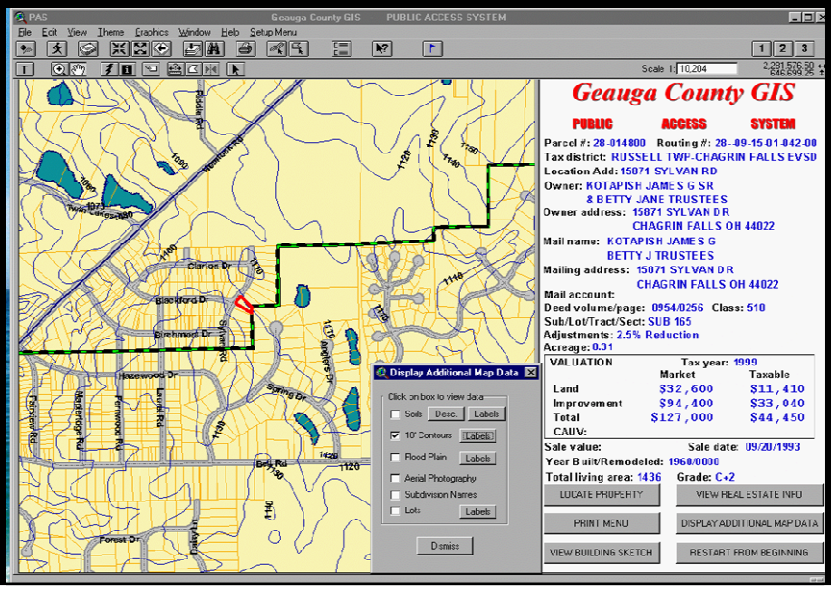
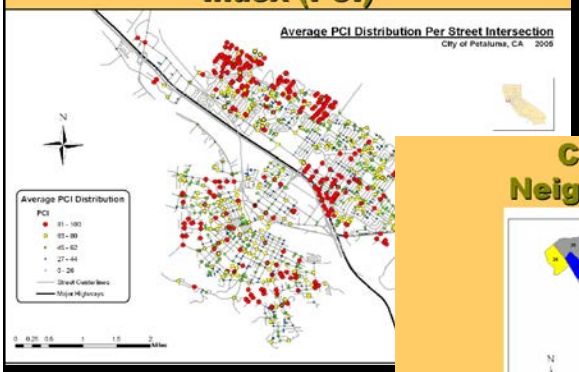
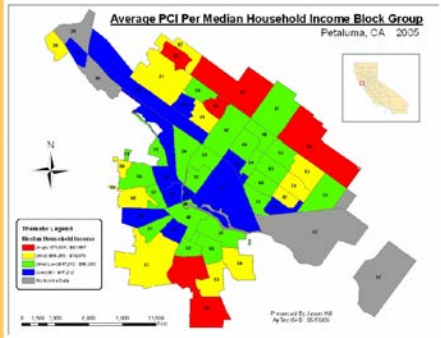


Geodata Analysis - Geoanalysis

Geocoding Pavement Condition Index (PCI)



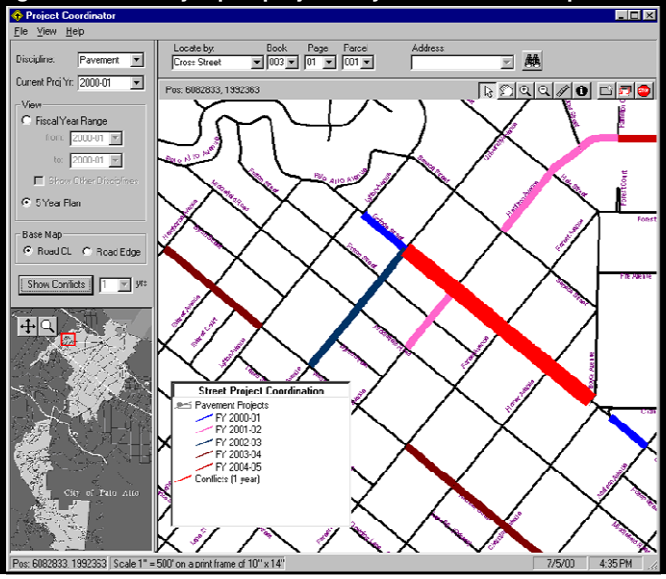
Comparing with Neighborhood Income



Jason Hill
IDEATE

Transportation & Public Works

Palo Alto's Construction Project Coordinator identifies and highlights where utility repair project may conflict with new pavement project



Infrastructure: Water

- Source
  - Digitized from County Water District (Georeferenced TIFs)

Automated Orthoimagery Classification of Impervious Surfaces

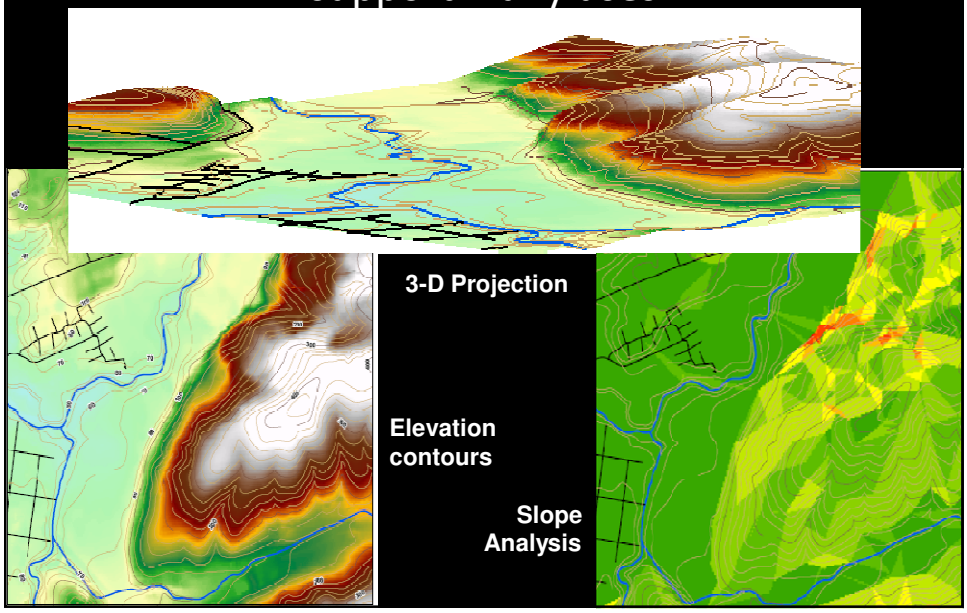
Classification of impervious surfaces

Object-oriented image classification method classifies image objects or segments (groups of pixels delineated as polygons) instead of individual pixels, allowing for the incorporation of shape and context into the classified data output.

Infra-red imagery

Elevations, Digital Terrain Models

support many uses

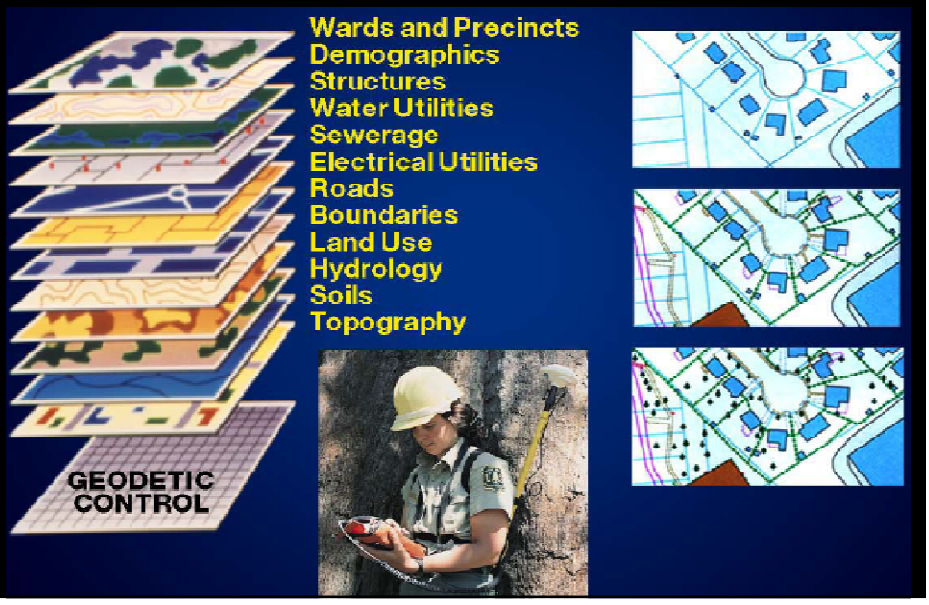


Geoanalysis: mortgage foreclosures

http://www.usatoday.com/news/graphics/foreclosure_map/foreclose.htm

Parcels & Transportation on Orthophoto

Additional Layers of Interest



Usage Can Determine When GIS Needs Surveyor Supervision

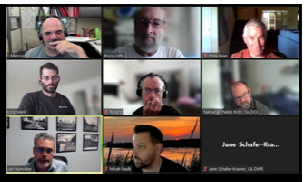
- **Surveyor Supervision for:**
  - Determining Authoritative Location of Property Boundaries
  - Engineering Design Location of Fixed Works
  - Locating Elevation Contours or Shape of the Earth for Engineering Design, Land Development, etc.
  - Creating Survey Control & Geodetic Control
  - Determining and Certifying Basemap Accuracy
- **Non-Survey GIS Professional Services include:**
  - Infrastructure Inventory and Maintenance
  - Planning and Analysis
  - Environmental Management
  - Social, Demographic, Economic, Tax Maps
  - Guides, Educational, Advertising maps

Collaborating to Solve the Problem

CGIA+CalGPN Joint Committee on GIS Best Practices

- Outreach to Surveyors
- Suggest revisions to §8726
- GIS Professionals need to improve operating techniques

CGIA + CalGPN work group Action Plan



1 - Concise, one- or two-page document that clearly outlines the boundaries defined by the PLS Act … **DONE**

2 - Analyze cases BPELSG has brought against GIS professionals … **MOSTLY DONE**

3 - Identify problems with current statute both for GIS professionals and also for surveyors (e.g., undefined terms, contradictions) … **PARTIALLY DONE**

4 - Confer with surveyors (CLSA, CSRC) to incorporate their opinions.

5 - Produce a recommendation for changing the statute. … Draft Suggestions To Improve Definitions **PARTIALLY DONE**

6 - Develop a strategy for changing the statute (in collaboration with CLSA and related organizations)

Draft Suggestions to Revise Section 8726

A Better Definition

Proposed in the GIS Professionals' Amicus Brief

- **Establish** - creates a boundary with an **original survey**, for purposes of describing the location of lines and corners of a parcel that has **not previously been described in a conveyance document**.

  "Establish" only happens once, thereafter, maps showing the boundary are **representational depictions** of boundaries.

A Better Definition

Proposed in the GIS Professionals' **Amicus Brief**

- **Locate** - finds (and marks) the boundary line **on the ground**; marks the location on the ground where a fixed work will be constructed or installed.

  "Locate" does **not** mean depicting the boundary line on a map that does **not** have **authoritative certification** in **determining** or defining or establishing the **legal location** of a boundary or fixed work.

URISA(GPN)+NSPS GIS-Surveyor Work Group
Draft Recommendations for NCEES Model Law

B.4. Practice of Surveying—

a. The term "Practice of Surveying," shall mean providing … professional services … involving **BOTH**:

1. the making of geometric measurements and gathering related information pertaining to the physical or legal features of the earth, improvements on the earth, the space above, on, or below the earth **AND**
2. providing, utilizing, or developing the same into surveying deliverables, the **purpose** of which is to **establish a legal basis** for the reported locations, shapes, positions, and sizes.

URISA+NSPS GIS-Surveyor Work Group
Draft Recommendations for NCEES Model Law

Surveying Deliverables—**Authoritative** maps, graphics, data, plans, reports, descriptions, applications, projects or other similar electronic or printed products, **resulting from the practice of surveying** as defined in Section B.4 of this Act, and fit for the intended use of the surveying service(s) provided.

URISA+NSPS GIS-Surveyor Work Group

Draft Recommendations for NCEES Model Law

Professional services include acts … related to any one or more of the following:

iii. Performing an original survey or retracement survey ~~Locating, relocating, establishing, reestablishing, or retracing property lines or boundaries~~ of any tract of land, road, right of way, or easement

v. Locating or laying out alignments, positions, or elevations for the design and construction of fixed works with sufficient accuracy and precision to be relied upon for the provision of architectural and engineering services related to fixed works

URISA+NSPS GIS-Surveyor Work Group

Draft Recommendations for NCEES Model Law

- **Original Survey** - performing a **boundary survey** for purposes of locating, on the ground and describing the location of, **an interest in real property that has not been previously described** in a document or **documents conveying an interest** in that real property.

  The term includes the subdivision of a section or portions of a section of land under common ownership in the United States Public Land Survey System, where no such subdivision has been previously conducted on the ground.

URISA+NSPS GIS-Surveyor Work Group

Draft Recommendations for NCEES Model Law

- **Retracement Survey** - performing a **boundary survey of real property** that has been **previously described in a document** or documents **conveying an interest** in that real property by applying the appropriate boundary law principles governed by the facts and evidence found in the course of performing the survey. The term includes retracing the lines and corners of a previous original survey of real property.

URISA+NSPS GIS-Surveyor Work Group

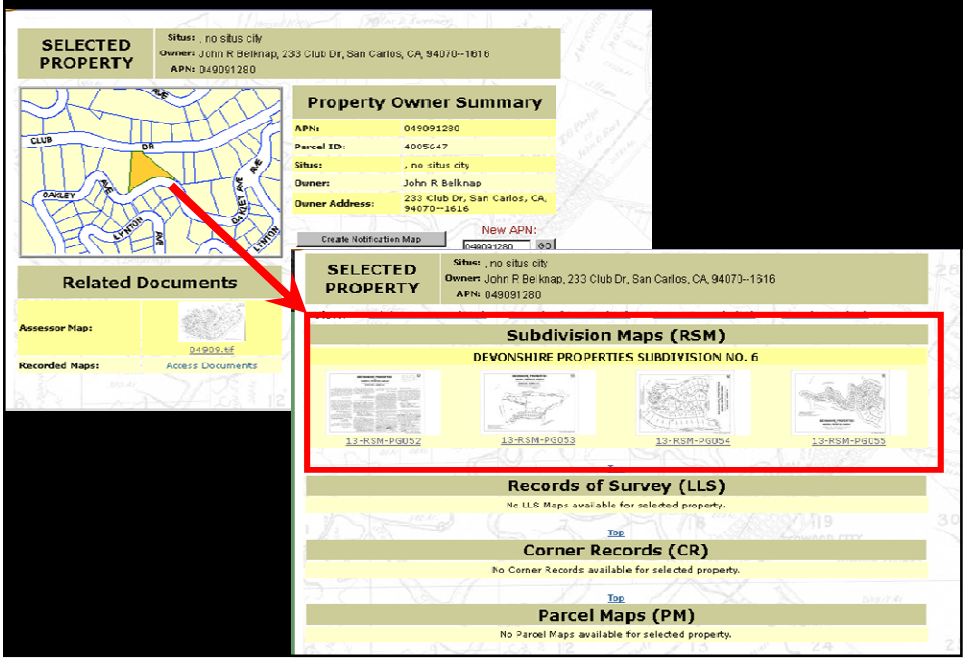
Draft Recommendations for NCEES Model Law

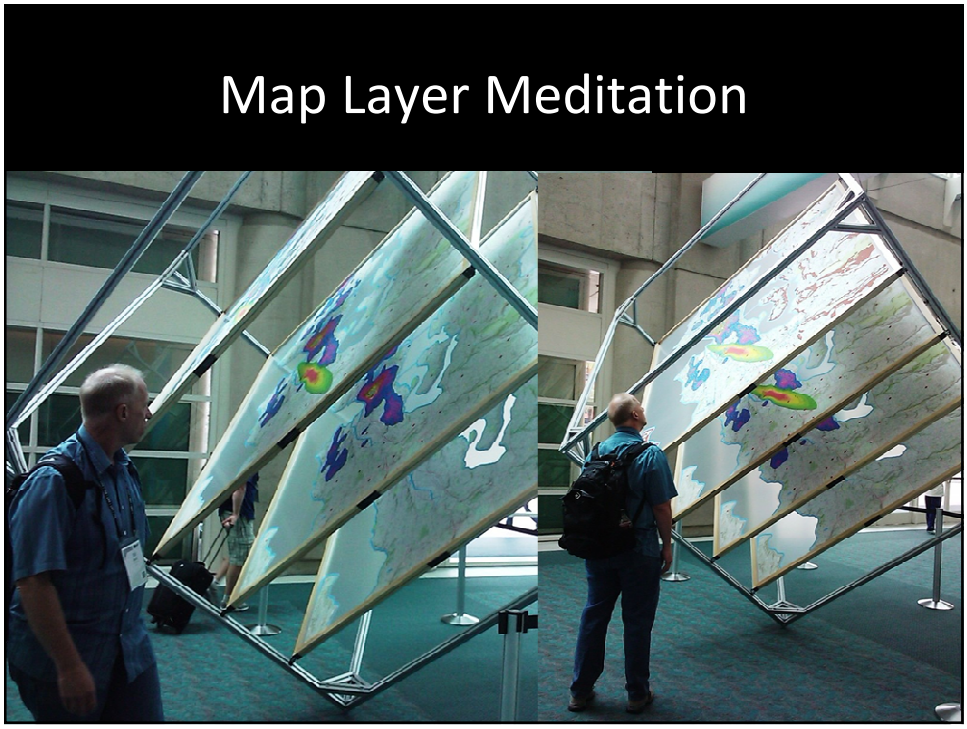
Authoritative — shall mean being presented as **legally reliant (legally admissible)**, trustworthy and competent when used to describe surveying deliverables.

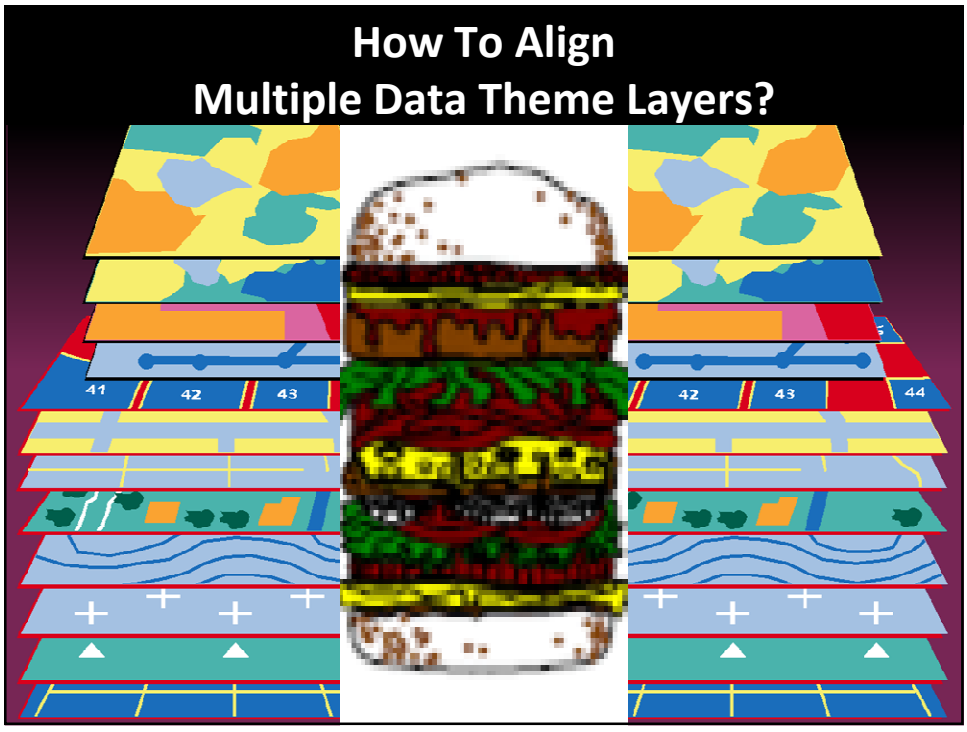
GIS Professionals need to improve operating techniques

- Reference maps to original sources
- Understand how maps connect to Geodetic Control
- Collaborate with surveyors when Adjusting Maps to Imagery
- Provide Adequate Metadata

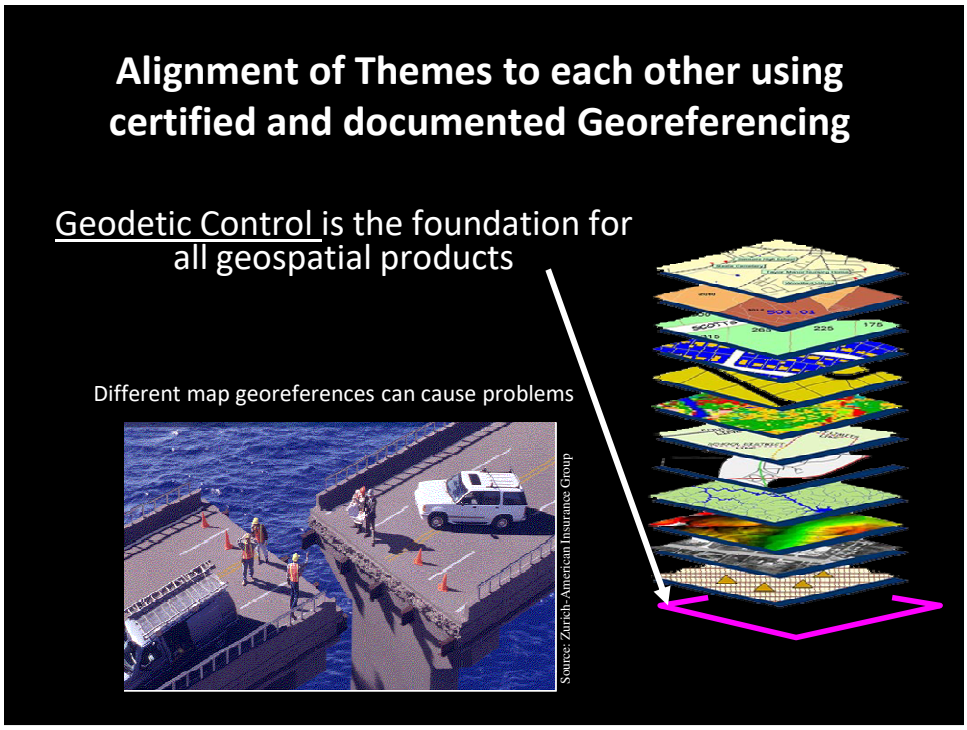
NEEDED: Referential Links to Related Documents




Map Layer Meditation


How To Align
Multiple Data Theme Layers?
41
42
43
42
43
44

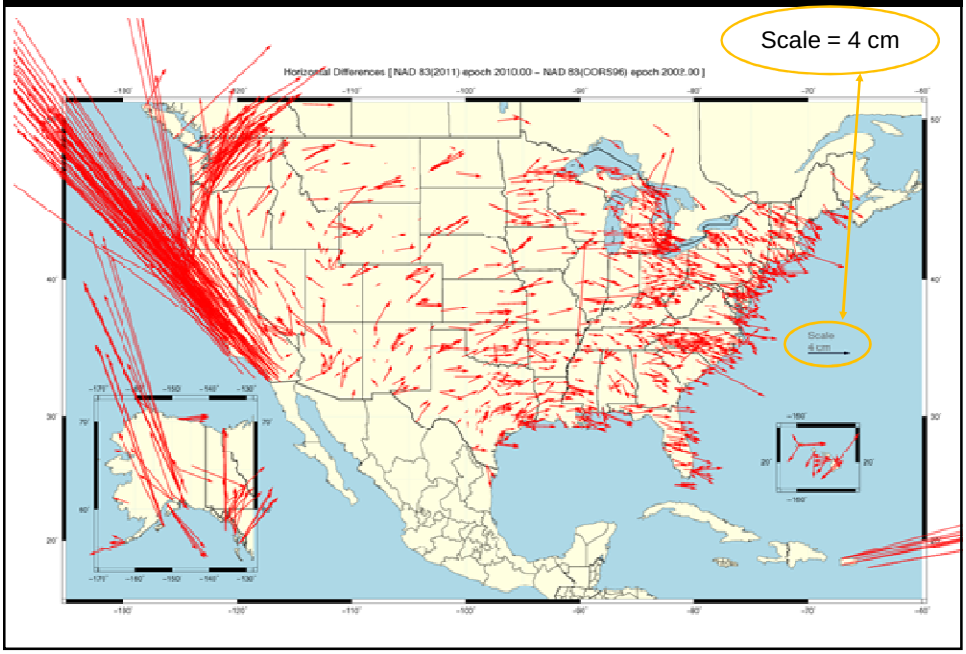

With Toothpicks!
Geospatial Data Referenced to Geodetic Control
41
42
43
42
43
44


Alignment of Themes to each other using certified and documented Georeferencing
Geodetic Control is the foundation for all geospatial products
Different map georeferences can cause problems
Source: Zurich-American Insurance Group

Adjusting Parcels to an Orthophoto

Reference Datum and Date (Epoch) makes a difference

Datum Shifts: NAD83(CORS96) to NAD83(2011)



All data themes Need to Adjust to the same Geodetic Control Network

- Metadata - need to know how, and when, the data was collected
  - Projection, Reference Frame (Datum), Epoch
  - Data source(s) and date(s)
  - Method of compilation
  - Contact person / agency
- Disclaimer
  - This is not a survey product
  - NOT suitable for legal or authoritative cadastral purposes
- **Statement of Intended Use and Purpose**

Q & O

before we begin the Geodetic Control seminar part of this presentation ...

What are your Questions and Opinions?

What GIS Professionals Need To Know About Geodetic and Survey Control

How Accurate is GPS?

Some Non-licensed People Use Survey Equipment To Locate Infrastructure

How Accurate is GPS?
GPS Signal Varies Continuously

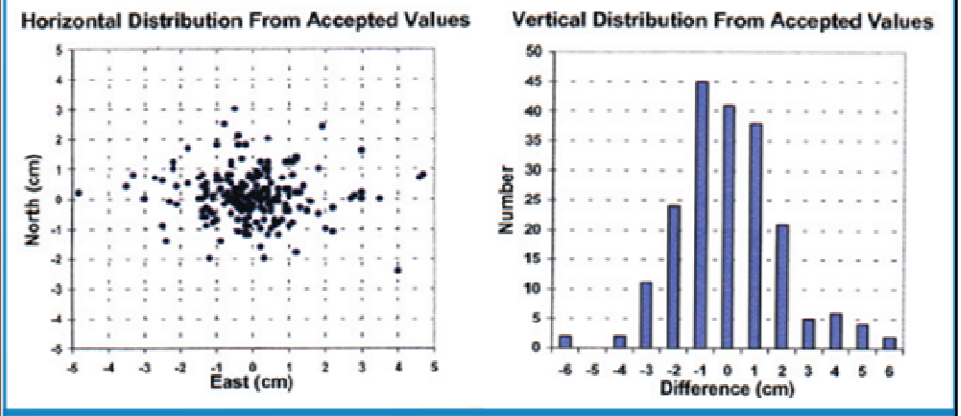
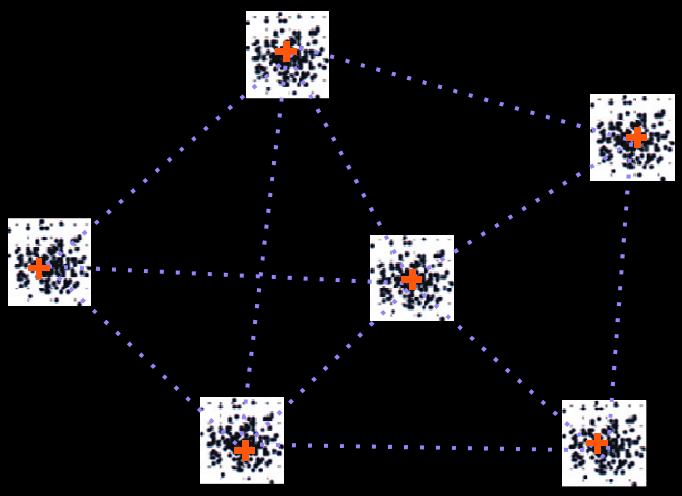
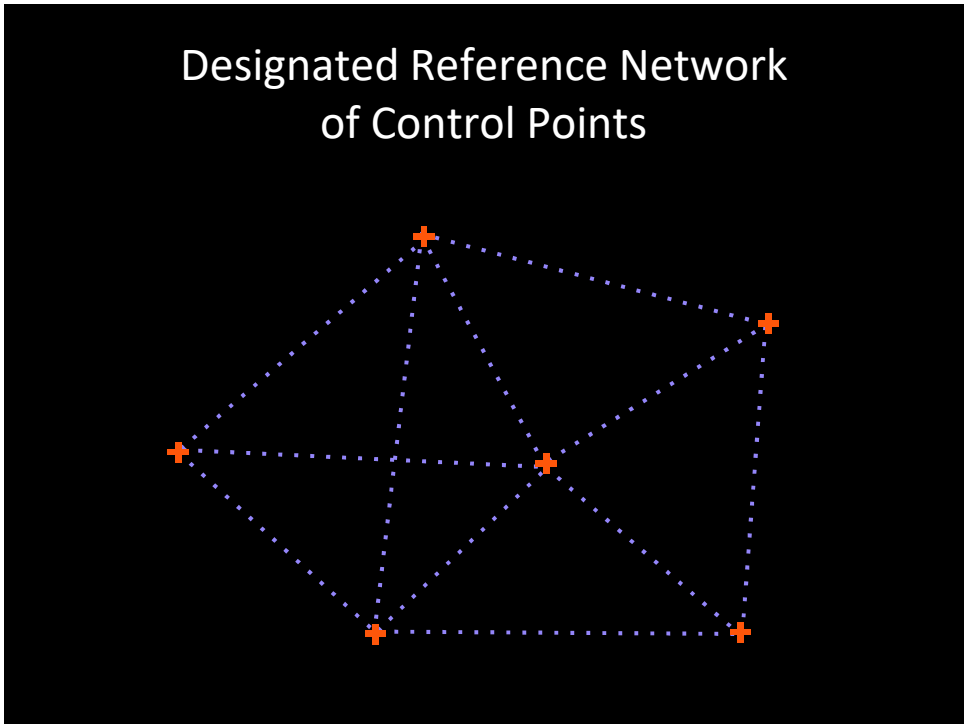


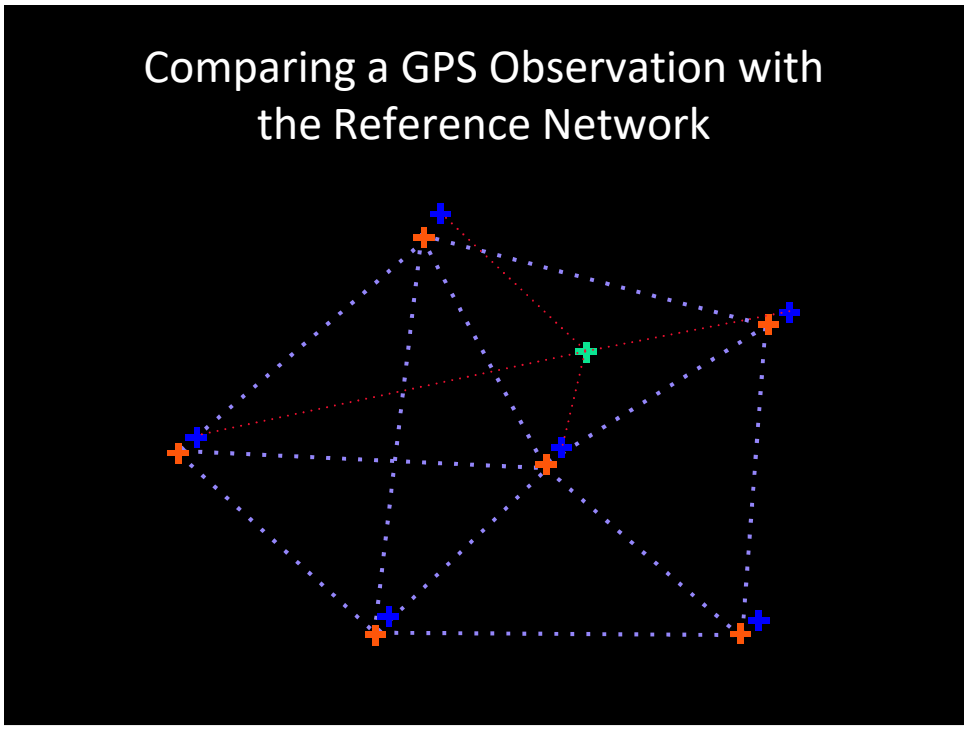
Figure 2 The horizontal and vertical distributions of OPUS solution differences from accepted ITRF values are shown for over 200 CORS stations using only two hours of data, the minimum required by OPUS. The standard deviations of these results are 0.8, 1.4, and 1.9 cm for the north, east and up dimensions respectively. All mean differences were less than 1 mm.

Designated Reference Network of Control Points

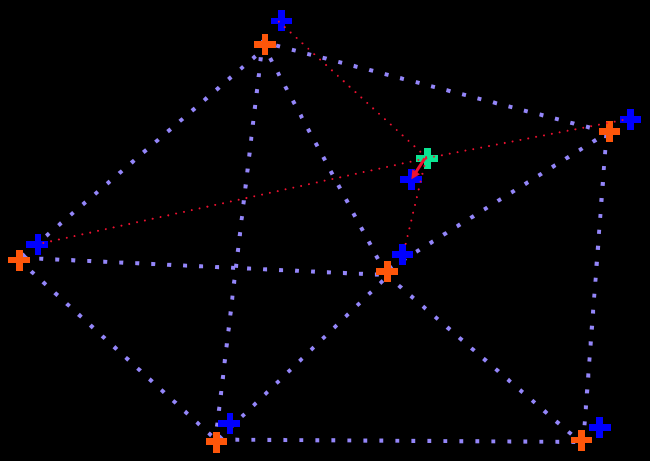


This adjustment process is called "realization" which establishes a new DATUM every few years.
NAD83 (1986)
(HPGN)
(HARN)
(CORS96)
(NSRS2007)
NAD83 (2010)

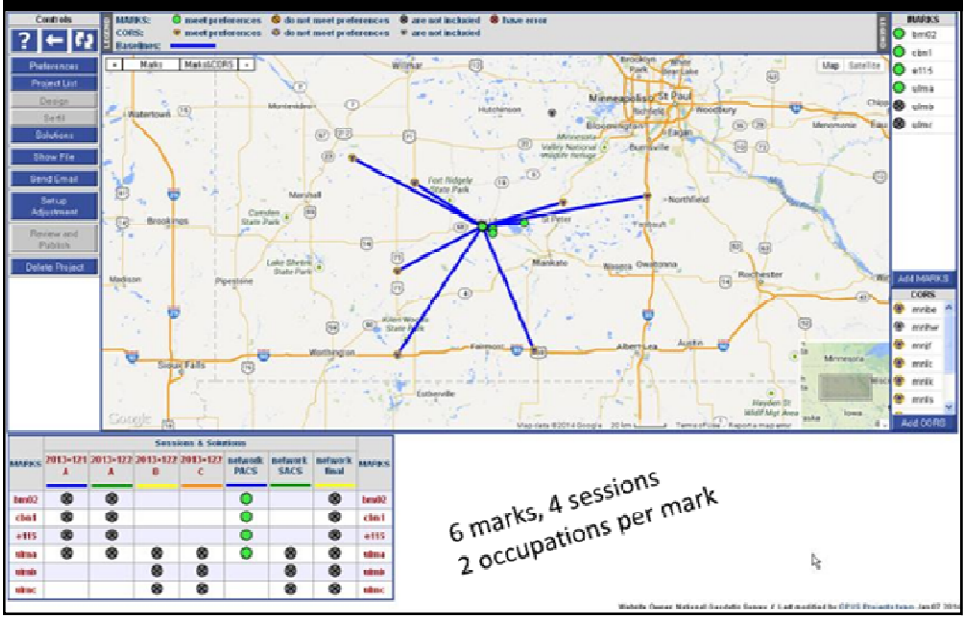

Designated Reference Network
of Control Points

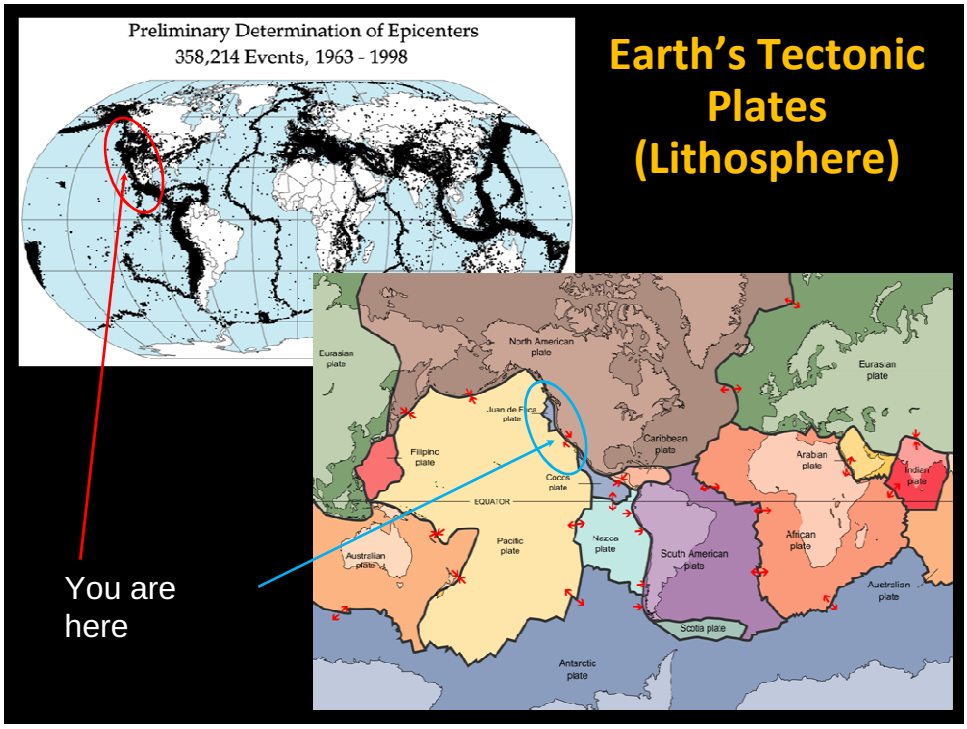

Comparing a GPS Observation with
the Reference Network

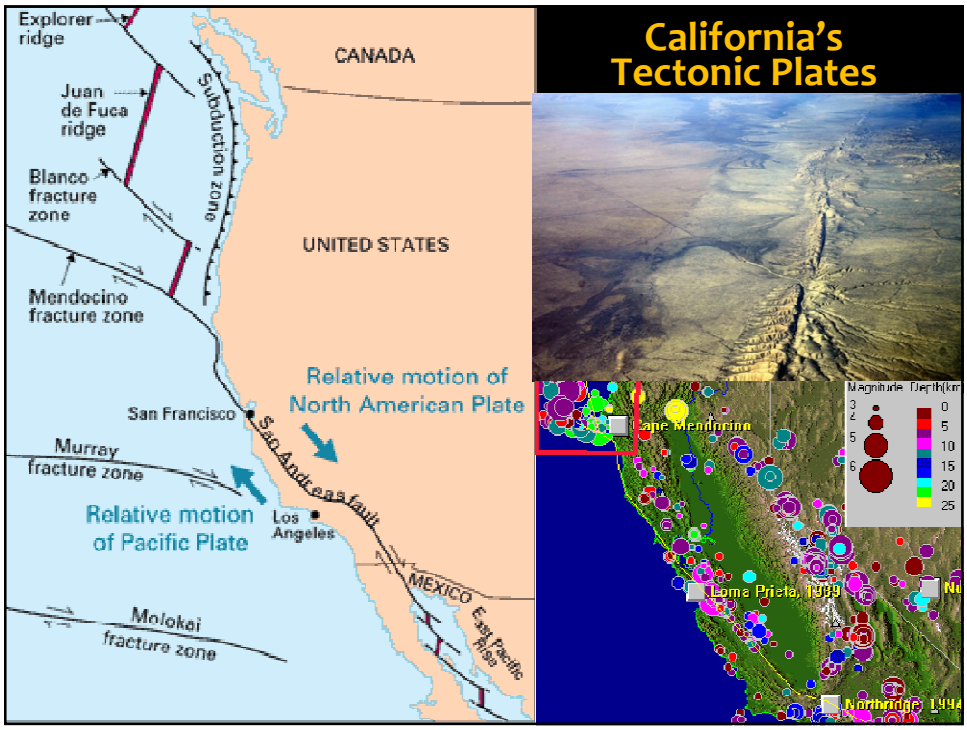
Applying the Reference Network Correction to the GPS Observation



Using CGPS for Accurate Positioning




Preliminary Determination of Epicenters
358,214 Events, 1963 - 1998
Earth's Tectonic Plates (Lithosphere)
You are here
North American plate
Eurasian plate
Caribbean plate
Filipino plate
Arabian plate
Indian plate
EQUATOR
Pacific plate
Nazca plate
South American plate
African plate
Australian plate
Scotia plate
Antarctic plate


California's Tectonic Plates
Explorer ridge
Juan de Fuca ridge
Blanco fracture zone
Mendocino fracture zone
Murray fracture zone
Molokai fracture zone
Subduction zone
CANADA
UNITED STATES
MEXICO
San Francisco
Los Angeles
Relative motion of North American Plate
Relative motion of Pacific Plate
San Andreas fault
East Pacific Rise
Cape Mendocino
Loma Prieta, 1989
Northridge, 1994
Magnitude
Depth(km)

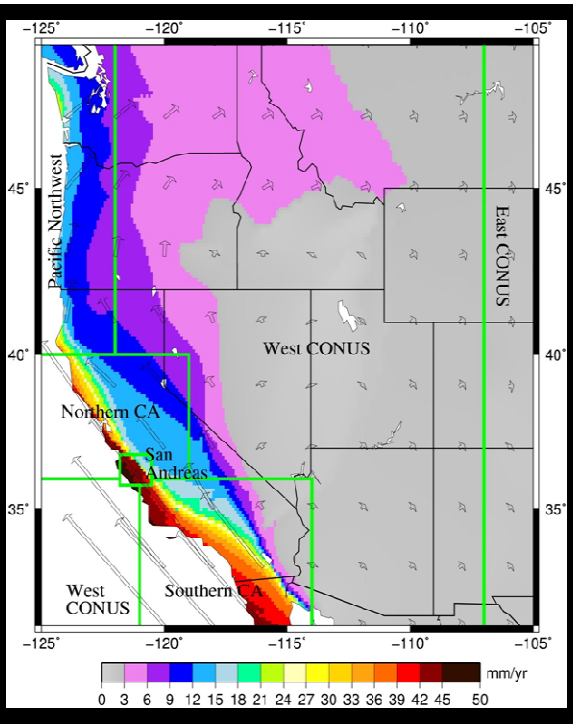


Plate Tectonics

Parts of California Move NW ~1.5 Feet Every 10 Years (45 mm/yr)

Geodetic Control
California Spatial Reference Network (CSRN)

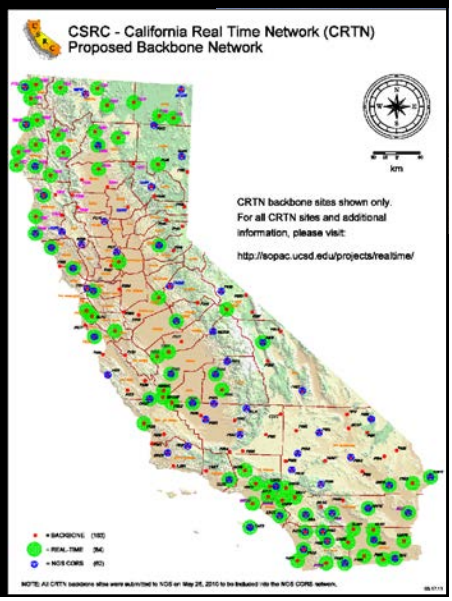
A legislated, state-wide datum, consistent with the NSRS and adapted to our unique geophysical environment

- Passive Monuments:
  - Thousands of monuments set in the ground
  - They require periodic re-observation to determine accurate relative position.
  - Position only valid at the time of survey.
  - NGS no longer re-observes these monuments

- **Continuous GPS (CGPS)**
  - ~830 CGPS station collects data 24 hours a day and its relative position is continually monitored.
  - Positions that change due to earthquakes, subsidence and crustal motion are updated periodically.

Geodetic Control: **CSRN**
California Spatial Reference Network

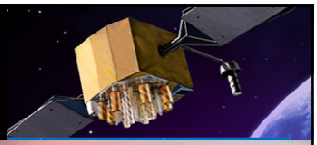
- These are the Toothpicks!
- Network of Continuous GPS-observed geodetic control
- Active: ~830 CGPS Stations
- CSRN is comprised of CGPS infrastructure, database archive & adjustment software
- The CSRC was established to provide and maintain the geodetic network in California.

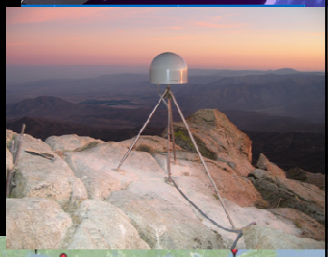


NSRS – National Spatial Reference System

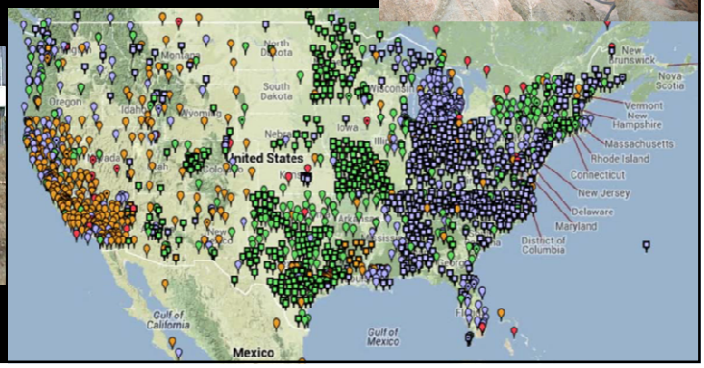
NATIONAL GEODETIC SURVEY (NGS) oversees the Continuously Operating Reference Stations (CORS)

NGS CORS GPS network installed per defined standards



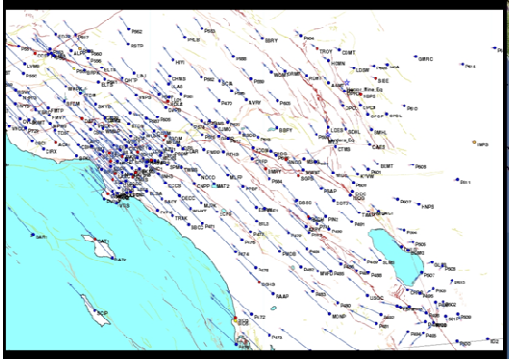


CORS Base Station providing published coordinates

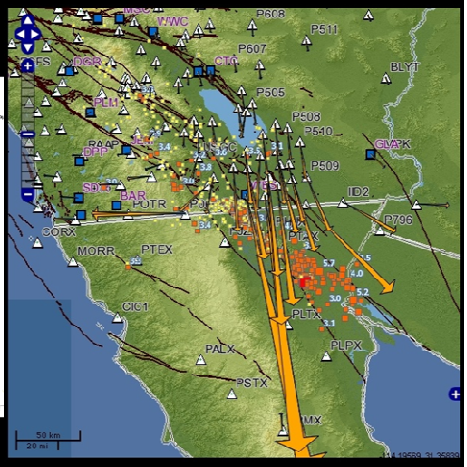


Tectonic Motion Requires Monuments To Be Recalibrated

EPOCH = time stamp of when the computed positions are valid.



VELOCITIES = estimated amount of annual movement due to plate tectonics.



Displacement from the El Mayor Cucapah Earthquake, April 4, 2010.

NAD83 -- a Very Brief Primer

Datum Tag

(NAD=North American Datum)

NAD27 was a regional datum based on a single survey point in Kansas and on an astronomically derived reference ellipsoid.

Datums are realized (measured and recalibrated) more precisely and more accurately by GPS, successive datums are documented with a Datum Tag.

NAD83 (1986) Major recalibration, was originally based on hundreds of thousands of points from VLBI* networks.

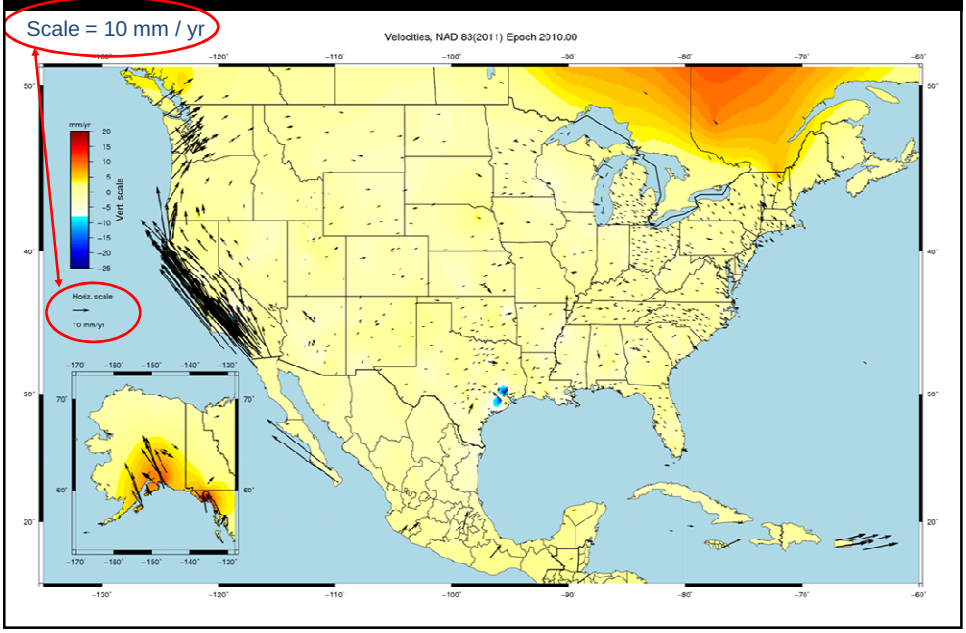
GRS80 is the reference ellipsoid (computational model) that best fits the earth's geoid surface, used to compute geodetic coordinates in WGS84 and NAD83.

Epoch Tag (Epoch Date) – coordinate recalibration date between epochs using a velocity model

- Examples of datum tags: NAD83 (1986), NAD83(1992), NAD83(CORS96), NAD83(2007), NAD83(2011) **(2010.00)**

* VLBI: Very Long Baseline Interferometry, ground-based radio relay stations

Velocities: NAD83(2011) Epoch: 2010.00



NAD83 – An Evolving Reference

Velocity Models and Epochs

- In addition to episodic realizations (adjustments), CGPS arrays allow scientists and surveyors to model secular motion in terms of "velocities".
- Coordinate updating based on velocity models is documented between major datum adjustments by adding a dating term called an epoch date expressed in decimal years
  (e.g. 2013.54 = July 17th 2013).
- The current NGS version of NAD83 is properly expressed as *NAD83(2011) 2010.00*

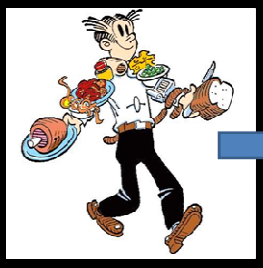
When adding new layers (themes) to the GIS database, Geodetic Control registration should be adjusted to a common Epoch Date.

Datum Tag

Epoch Date

Are Your Map Layers Properly Aligned?

Adjusted to the same Datum?
Adjusted to same Epoch date using velocity models?

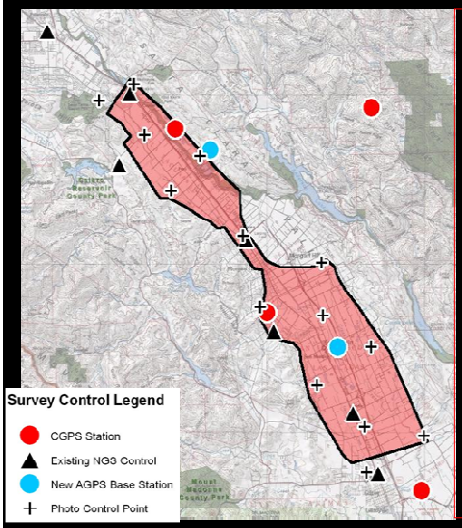


Data Capture

Different Datums

Alignment w/common, Datum Adjustment

All data themes Need to Adjust to the same Geodetic Control Network



Courtesy of Towill, Inc.

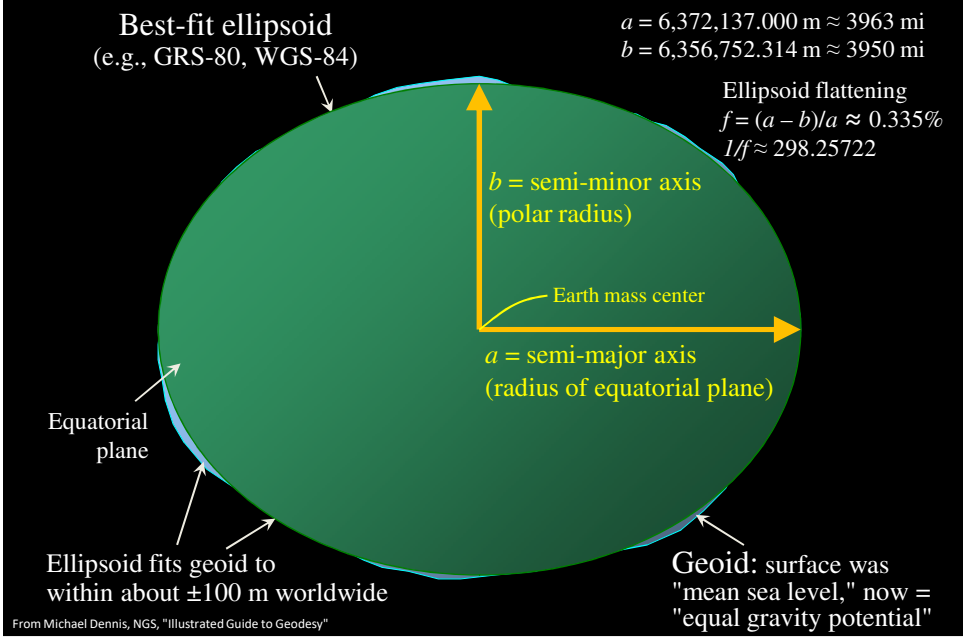
Aerial Imagery, Remote Sensing, and GPS Mapping deliverables should be **referenced to current geodetic control**, with **metadata** to include:

- Reference Ellipsoid
- Projection
- Coordinate System Zone
- Measurement Unit
  (U.S. Survey Foot, International Foot)
- Epoch Date
- Datum / Datum Tag
- Velocity Model used
- Method of Compilation
- Data Source(s) and Date(s)
- Contact Info for data sources

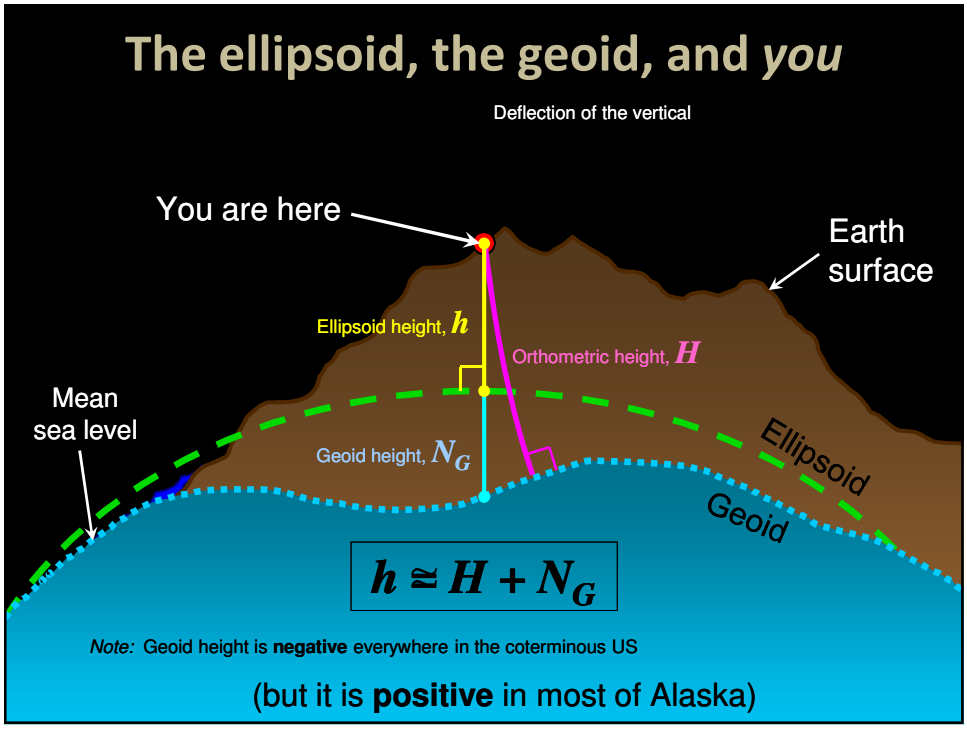
What Does This Mean for Land Surveyors & GIS Professionals?

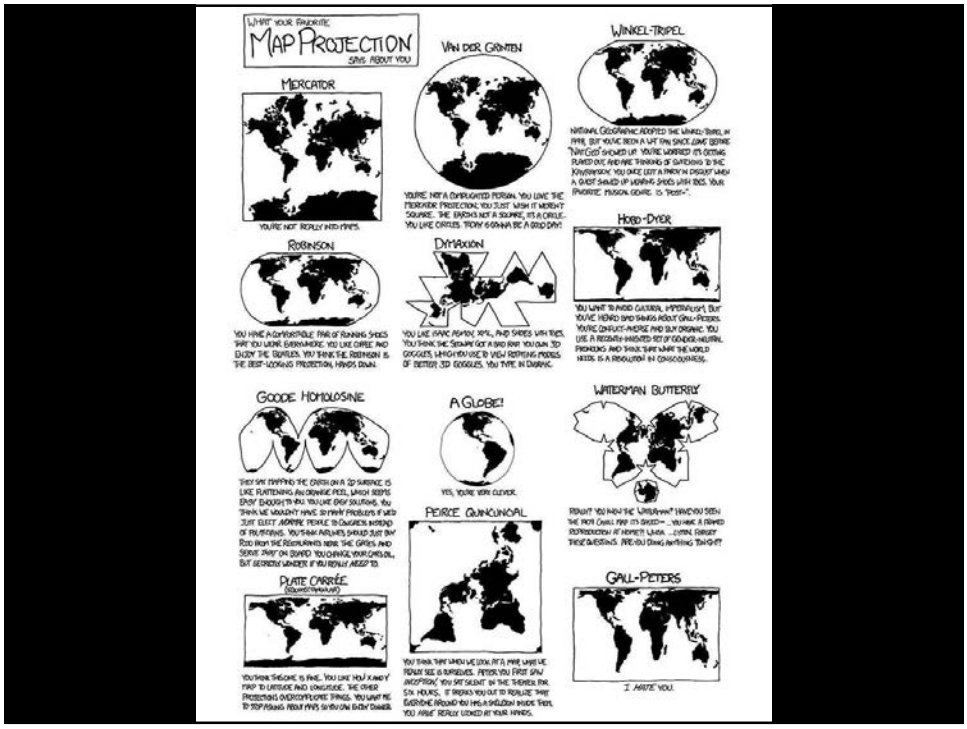
- RFPs should specify survey and photogrammetric data to be tied into the defined Geodetic Control Network.
- Surveyors should have proficiency in tying survey observations to the defined Geodetic Control Network.
- GIS professionals should have proficient methods for aligning all geographic database layers with Geodetic Control layer.
- GIS professionals / project managers should collaborate with Surveyors.

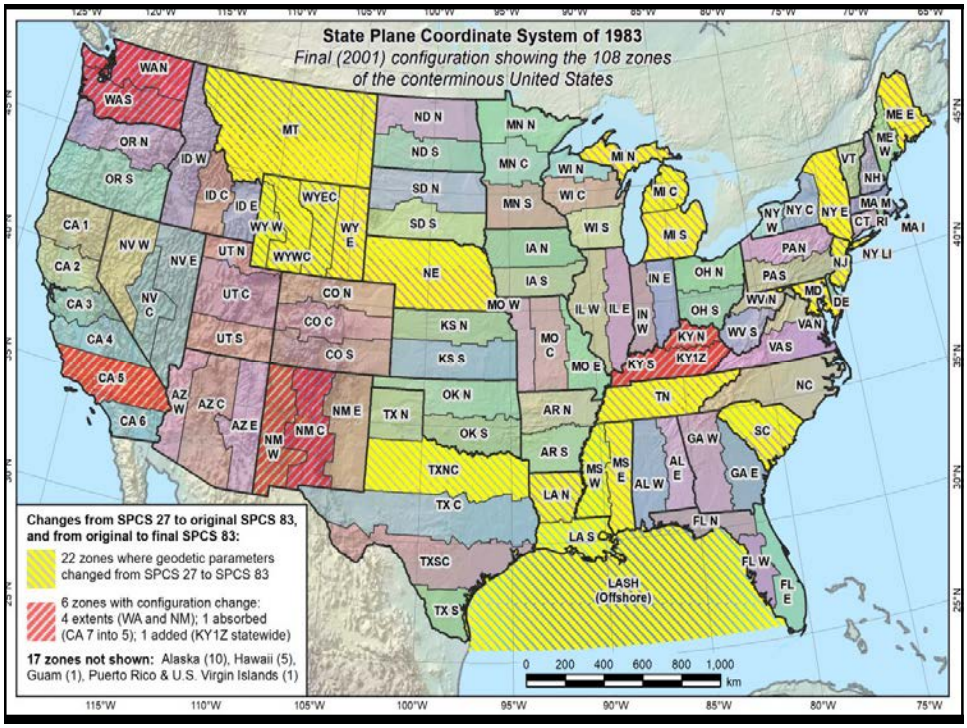
Earth model: Ellipsoid of revolution

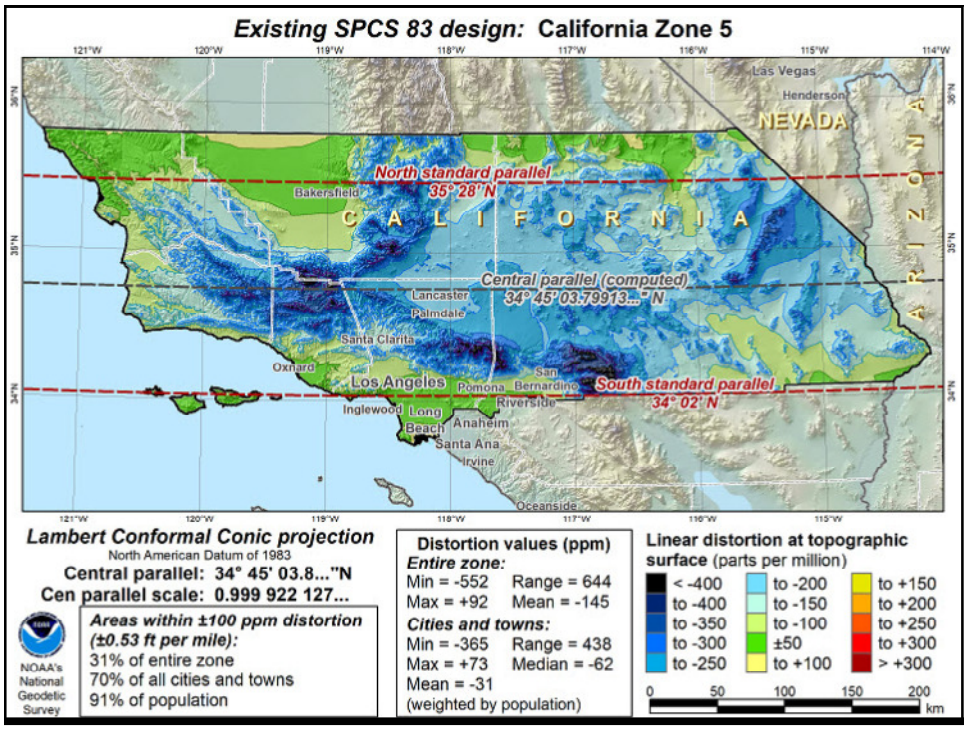


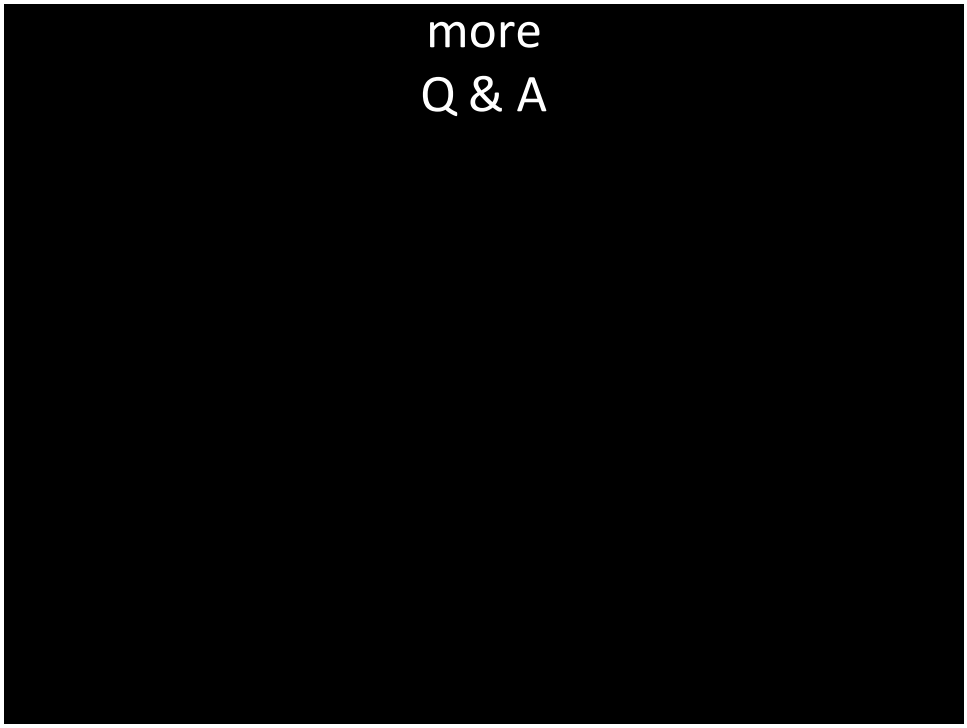
From Michael Dennis, NGS, "Illustrated Guide to Geodesy"


The ellipsoid, the geoid, and you
Deflection of the vertical
You are here
Earth surface
Ellipsoid height, h
Orthometric height, H
Mean sea level
Geoid height, N_G
Ellipsoid
Geoid
$h \cong H + N_G$
Note: Geoid height is negative everywhere in the coterminous US
(but it is positive in most of Alaska)


WHAT YOUR FAVORITE MAP PROJECTION SAYS ABOUT YOU
MERCATOR
VAN DER GRINTEN
WINKEL-TRIPEL
ROBINSON
DYMAXION
HOBO-DYER
GOODE HOMOLOSINE
A GLOBE!
WATERMAN BUTTERFLY
PLATE CARRÉE
PEIRCE QUINCUNCIAL
GALL-PETERS


State Plane Coordinate System of 1983
Final (2001) configuration showing the 108 zones
of the conterminous United States
Changes from SPCS 27 to original SPCS 83,
and from original to final SPCS 83:
22 zones where geodetic parameters
changed from SPCS 27 to SPCS 83
6 zones with configuration change:
4 extents (WA and NM); 1 absorbed
(CA 7 into 5); 1 added (KY1Z statewide)
17 zones not shown: Alaska (10), Hawaii (5),
Guam (1), Puerto Rico & U.S. Virgin Islands (1)
LASH
(Offshore)
0 200 400 600 800 1,000
km


Existing SPCS 83 design: California Zone 5
Las Vegas
Henderson
NEVADA
North standard parallel
35° 28' N
Bakersfield
CALIFORNIA
Central parallel (computed)
34° 45' 03.79913..." N
Lancaster
Palmdale
Santa Clarita
Oxnard
Los Angeles
Pomona
San Bernardino
Riverside
South standard parallel
34° 02' N
Inglewood
Long Beach
Anaheim
Santa Ana
Irvine
Oceanside
ARIZONA
Lambert Conformal Conic projection
North American Datum of 1983
Central parallel: 34° 45' 03.8..."N
Cen parallel scale: 0.999 922 127...
NOAA's National Geodetic Survey
Areas within ±100 ppm distortion
(±0.53 ft per mile):
31% of entire zone
70% of all cities and towns
91% of population
Distortion values (ppm)
Entire zone:
Min = -552 Range = 644
Max = +92 Mean = -145
Cities and towns:
Min = -365 Range = 438
Max = +73 Median = -62
Mean = -31
(weighted by population)
Linear distortion at topographic surface (parts per million)
< -400
to -400
to -350
to -300
to -250
to -200
to -150
to -100
±50
to +100
to +150
to +200
to +250
to +300
> +300
0 50 100 150 200
km


more
Q & A