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Los Angeles Region – Imagery Acquisition Consortium (LAR-IAC)

Conceptual Framework

Last Update: January 2006

Prepared by:
Department of Regional Planning
GIS Section

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Purpose and Objectives

Purpose: Provide orthogonal, oblique and DTM imagery for all government entities in Los Angeles County

- **Objective 1:** Obtain high accuracy aerial imagery to support all government needs from pre-engineering design and above.
- **Objective 2:** Unify aerial imagery to improve communication among LA County government entities.
- **Objective 3:** Integrate aerial imagery with GIS parcel database and other GIS layers.
- **Objective 4:** Eliminate multiple acquisitions from government agencies for the same area.
- **Objective 5:** Save taxpayer money.

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Digital Aerial Imagery Products

- Digital Terrain Model (DTM) – based on LiDAR
- 2' Elevation Contours GIS layer (derived from DTM)
- Color Orthogonal Imagery, 4" resolution (urban areas) and 1' resolution (national forests)
- Color Infrared Imagery
- Color Oblique Aerial Digital Imagery (with viewer application)
- Accurate Quality Control Report for all data products

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Points to Consider

- Accurate ortho and oblique digital imagery comes from an accurate digital terrain model (DTM)
- Pixel resolution for imagery is only as good as the quality and accuracy of the terrain model and local control points (geodetic network)
- Resolution needed is for most demanding users (that's why 4" has been recommended).

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Procurement – Three Contracts

- **Request for Proposal (RFP)** – Acquisition for ortho imagery, infrared imagery, digital terrain datasets and elevation contours (VARGIS LLC selected)
- **Extension of Sole Source Contract** – Acquisition of update of oblique aerial digital imagery (Pictometry International Ltd. has unique process protected by US patents)
- **Invitation for Bid (IFB)** – Consultant for QA/QC process and distribution (necessary to select independent consultant; not yet awarded)

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Basic Range of Applications

- Basic cadastral mapping (at a scale of 1" = 100' and less detail)
- Pre-engineering design
- Planning and zoning
- Property assessment / appraisal
- Flood risk management
- Natural Hazard Assessment
- Traffic management
- Law enforcement / Public safety / Homeland security
- Census
- Many more (too many to list)

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Current Analysis – Why A Consortium is Needed

- Today aerial imagery is an important tool for effective government operations
- Multiple acquisition by government entities (at least $5 million spent in 2000 - 2002 for such projects)
- Inconsistent quality of various types of aerial imagery
- Low level of integration with GIS databases and limited sharing of data among local governments
- Ineffective use of public funds

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Nationwide Trend in Large Imagery Acquisition Projects

- Large metropolitan areas are establishing consortiums for reducing costs and increasing quality
- Existing precedent on how to share costs, data and all legal challenges
- Examples of successful consortiums:
  - Dallas/Fort Worth TX metropolitan area
  - Denver CO, (County and cities)
  - Portland OR metropolitan area
  - Detroit MI metropolitan area

Consortium Could Aid the Following

- Los Angeles County
  - 40 departments
  - 21 separate county-related agencies (MTA, LAFCO, AQMD, etc.)
- 88 Cities with hundreds of departments
  - City of Los Angeles represents the largest city government and has 47 departments and bureaus (including DWP, LA World Airports, Port of LA, etc.)
- All Federal & State Law Enforcement & Homeland Security Agencies
- Other government, quasi-government agencies
  - (Federal, State, Region, etc.)

What is Needed to Participate

- Letter of Support (from members of LAR-IAC to LA County CIO)

Eventually, the following documents will be needed:

- Signed MOU between participant and County
- Signed License Agreement for participants

Geographic Scope of Project

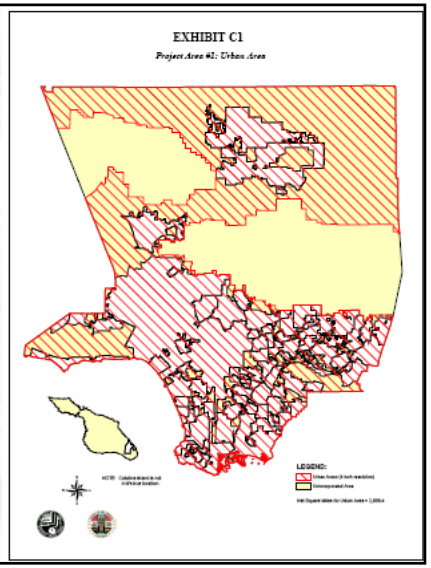
- Los Angeles County
  - 4,083 sq. miles plus 200' buffer
- Split into regions
  - Area #1 (Urban) - Project area covers approx 2,900 sq. miles
  - Area #2 (National Forest) - Project area covers approx 1,050 sq. miles
  - Area #3 (Catalina Island) - Project area covers approx 75 sq. miles

Area 1

Summary of Project:

Area #1 (Urban Area)

- Project area covers approx 2,900 sq. miles
- Color & CIR Digital Aerial Imagery Acquisition
- 4" Color & CIR Digital Ortho Imagery
- LiDAR Acquisition
- Digital Terrain Model/Digital Surface Model
- 2' Contours

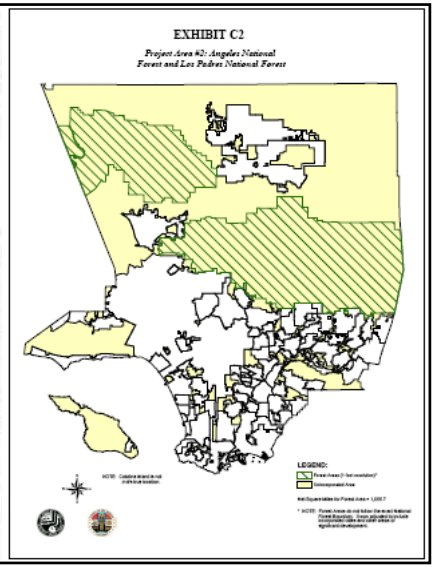


Area 2

Summary of Project:

Area #2 (National Forest)

- Project area covers approx 1,050 sq. miles
- Color (& CIR) Digital Aerial Imagery Acquisition
- Color (& CIR) Digital Ortho Imagery
- Digital Terrain Model/Digital Elevation Model
- 4' Contours (5' accuracy)

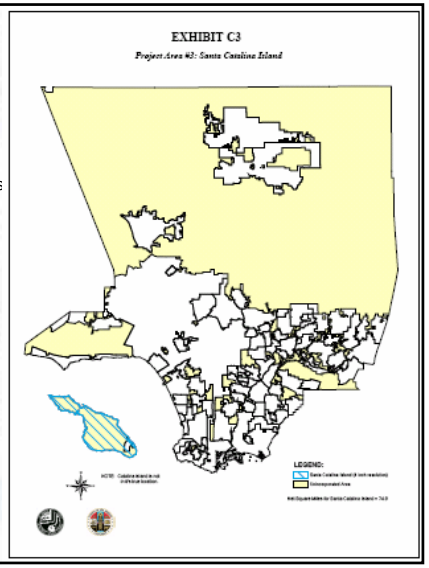


Area 3

Summary of Project:

Area #3 (Catalina Island)

- Project area covers approx 75 sq. miles
- Color (& CIR) Digital Aerial Imagery Acquisition
- Color (& CIR) Digital Ortho Imagery
- LiDAR Acquisition
- Digital Terrain Model/Digital Surface Model
- 2' Contours



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Major Impacts to Acquisition Costs

- Scope of area and ratio between various resolutions (4" or 1')
- Technology used (film camera, small or large digital camera formats)
- Accuracy of digital imagery, DTM and contours (LIDAR, Stereo compilation, request for break lines)
- Speed of acquisition and processing time
- Size and methods of distribution
- Options for using offshore capacity

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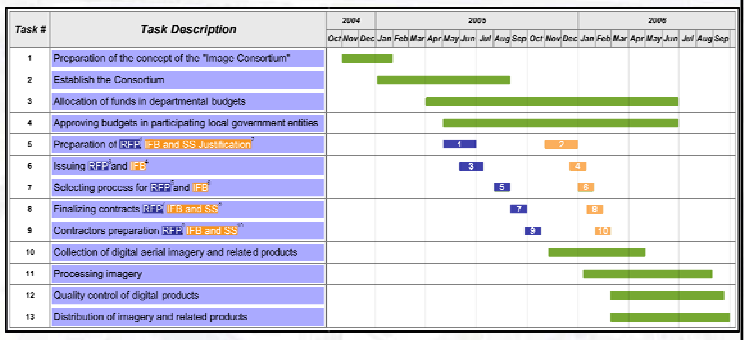
Updated Project Schedule



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Structure of Financing

- The County is underwriting the funding for the project.
- Consortium participants will pay the County their share of project costs (based on population and sq. miles).
- For a cost estimate for your city or agency please send an e-mail or call one of the LAR-IAC managers (last slide).

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Financial Benefits

- Savings of a minimum of 30-40% of hard costs (when truly comparing like products)
- Savings of 60% to 80% of soft costs (overhead costs for research, procurement, legal, etc.)
- Incremental payments through two fiscal years (2005/06 and 2006/07)

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Value Added Features

- Unprecedented spatial accuracy of imagery products
- Independent professional QC process
- Sharing technological "know how" among participants
- Many other derivative products can be created from these data sets
- Using same imagery data sets in all LA County government entities

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Cooperation

Cooperation among members of the LAR-IAC is essential.

•**County CIO:** Executive Management, securing county resources

•**County DRP:** Preparation of phases, contracts management, GIS integration and managed distribution

•**County Counsel:** Legal support for establishing LAR-IAC and contracts

•**Survey Divisions (Various cities including the City of LA and LA County Public Works):** Establishing network of highly accurate GPS points

•**LAR-IAC Participants:** Providing financial commitment for project funding and participating in the Technical Advisory Group (for input on technical specifications and deliverables).

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Distribution of Costs Among the Consortium Participants

Major factors for consideration in the structure and calculation of fees:

1. Square miles of territory covered of participant
2. Size of population within jurisdiction of participant
3. Multiple usage of imagery by various government entities

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Important Note on Contract Terms and Renewal

- Costs are for a two years license term. This license will start from the agreed upon delivery date (scheduled for Q2/Q3 2006)
- At end of license term – each agency/entity can decide if they want to continue with the Consortium
  - If yes…pay costs for update of imagery within Consortium (estimated at 60-70% of original cost)
  - If no…keep perpetual license for DTM, contours, oblique and ortho imagery with <u>no additional fee</u>.
- Next round of imagery acquisition ("Second Generation") will cost substantially less (for many reasons) – approximately 60-70% of this first round

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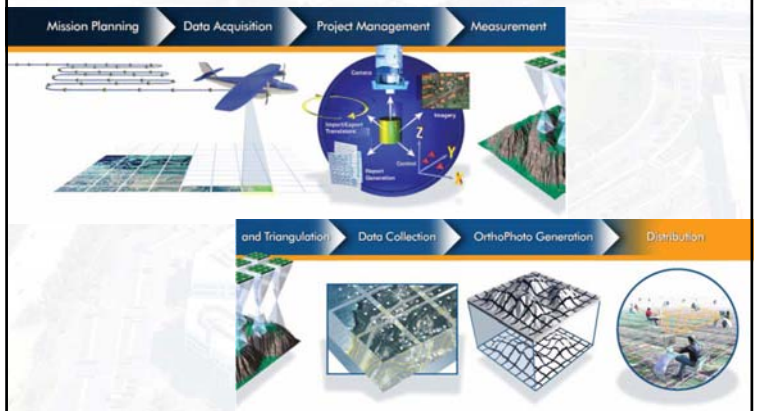
Technical Process & Samples



Credits: Some of the following materials have been provided by various aerial imagery providers (Sanborn, VARGIS, 3001 Inc., Merrick and/or Pictometry).

Sample 1 foot resolution

Sample 6 inch resolution

Sample 4 inch resolution

Sample neighborhood oblique

Sample neighborhood oblique

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Options for Accuracy Standards for Digital Imagery

- American Society of Photogrammetry and Remote Sensing (ASPRS)
- National Map Accuracy Standards (NMAS) for large scale mapping
- United States Army Corps of Engineers (USACE) – Engineering Design Manual for Photogrammetric Production
- Federal Geographic Data Committee (FGDC) – Geospatial Positional Accuracy Standards – Part 3: National Standard for Spatial Data Accuracy

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Choosing the Photo Scale in Relation to Map Accuracy Standards (ortho imagery)

Target Map Scale		Limiting RMSE (Values in Feet)		
1" = x feet	Scale	Class I (ASPRS)	Class 1.5 (NMAS)	Class 2 (ASPRS)
50	1:600	0.5	0.75	1.0
100	1:1,200	**1.0**	1.5	2.0
200	1:2,400	2.0	3.0	4.0

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Currently Available Technologies

Ortho Imagery
- Digital photos from satellites
- Scanned photos from "film cameras"
- Digital photos from "small format cameras"
- Digital photos from "large format cameras"

DEM/DTM
- IFSAR
- LIDAR
- Stereo compilation from digital photos

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Why Not Satellite Imagery?

- Satellite imagery provides only up to 2' resolution.
- Does not support necessary spatial accuracy
- Does not provide DTM
- Strong limitation from clouds (due to high orbit collection)

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Why Not Analog Cameras?

- Very time consuming process which is sensitive for errors in each of the following phases:
  - Taking pictures
  - Developing film
  - Scanning film
  - Rectification
- It is still recommended by some aerial imagery providers because they want to fully amortize the previously purchased, very expensive analog cameras

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Classes of Digital Cameras

- Small Format
  - Small collection area
  - Ideal for corridor mapping
  - Special imagery ("oblique")
- Large Format
  - Large collection area
  - Photogrammetric based
  - Designed to replace analog (film) photogrammetric cameras

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Large Format Digital Camera Characteristics

- Multiple bands of black & white, color and color infrared imagery
- Footprint is slightly smaller than analog cameras
- Flying heights are generally equivalent to analog cameras
- Pixel resolutions are compatible with scanned film
- Very high accuracy of georeferencing of digital images to true ground location
- Images stored on the airborne system (airplane) in mass storage (around 1 TB)
- Extensive redundant storage of imagery on airplane

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Three Leading Types (Brands) of Large Format Cameras

- Leica Geosystems – ADS40
- ZI / Imaging – DMC (Digital Mapping Camera)
- Vexcel – Ultracam

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ADS40 (Leica Geosystems)

- Multi-line “push broom” technology
- 12,000 CCD (pixel) linear array mounted perpendicular to flight direction
- Continuous collection (similar to satellites)
- Minimizes “building lean” in flight direction
- Up to 5 centimeter (2”) pixel resolution
- Heavily dependent on GPS/IMU

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DMC (ZI / Imaging)

- “Fixed Frame” format
- 14,000 x 8,000 pixel footprints
- Up to 4 centimeter (1.5”) pixel resolution

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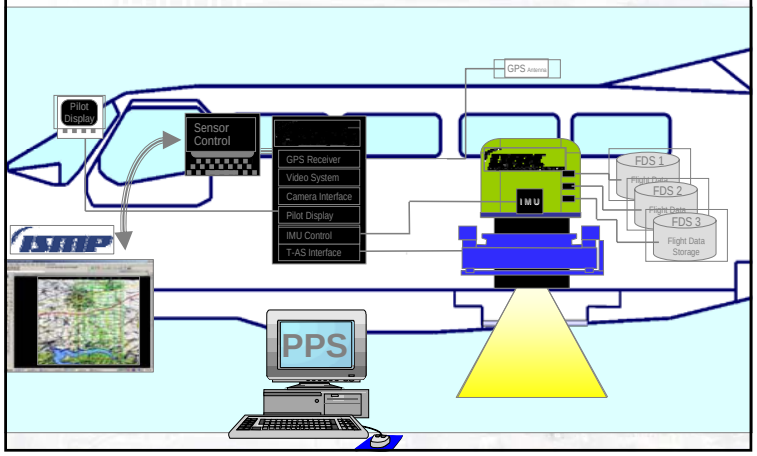
DMC Components



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Ultracam (Vexcel)

- "Fixed Frame" format
- 11,500 x 7,500 pixel footprint
- Up to 3 centimeter (1.2") pixel resolution

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Benefits of Large Format Camera vs. Analog Film Camera

- Multi-Spectral
- Greater Redundancy
- Better Clarity (12-bit)
- No "Information Noise"
- Better Accuracy
- Schedule is faster

Benefits of Large Format Camera vs. Analog Film Camera

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Multi-Spectral

- Ability to provide pan-chromatic, full color and infrared imagery
- No redundant flying
- Significantly reduces costs and time for multi-band (infrared cameras are part of "large cameras")

Benefits of Large Format Camera vs. Analog Film Camera

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Greater Redundancy

- Can achieve a much higher overlap at no additional film costs (just more digital data)
- Less displacement and more visibility in high rise urban areas
- Open opportunities for:
  - Better auto-matching
  - Multi-image matching (more identical points in more images)
  - Better feature extraction and 3-D correlation

Better Clarity (12-bit)

- Analog is 8-bit per channel
- Digital camera imagery is 12-bit and 14-bit (collected in 16-bit file)
- More shadow detail (see through shadows of buildings and mountains)
- Sharper clarity

No "Information Noise"

- Superior stereoscopic clarity
- Fewer defects (absence of lint scratches & other artifacts)

Better Accuracy

- Film is not stable – loses accuracy
  - In the camera
  - During the developing process
  - During the scanning process
- Film averages an accuracy of 5 to 7 microns
- Digital imagery averages an accuracy of 2 microns
- Digital cameras are much more rigid than film cameras

Schedule is faster

- Faster acquisition means more homogenous imagery (time-wise)
- Elimination of processing steps means faster contract completion

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LiDAR – Main Characteristics

LiDAR (light detection and ranging) – Uses laser beam fired at the ground from an airplane to measure the distance to the ground.

- LiDAR with 50 kHz produces elevation data of unparalleled density (10 points per square meter)
- Uses high speed airplanes
- Adjust scan frequency, scan angle and pulse repetitions
- Multiple return measurements
- Ability to fly at night
- Data is then processed (including filtering) to produce digital terrain model.

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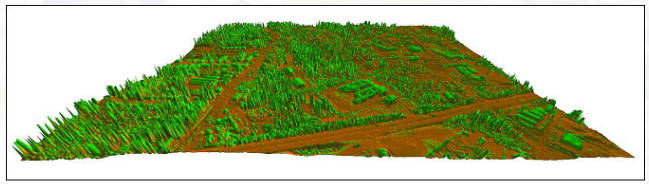
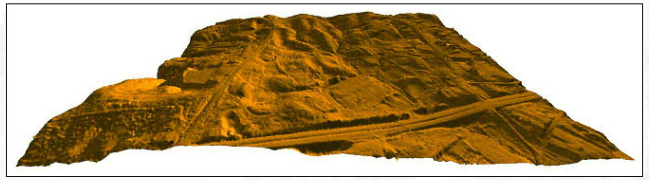
LiDAR

Standard Methods: Filtering and Thinning





Ortho Image in GIS-NET

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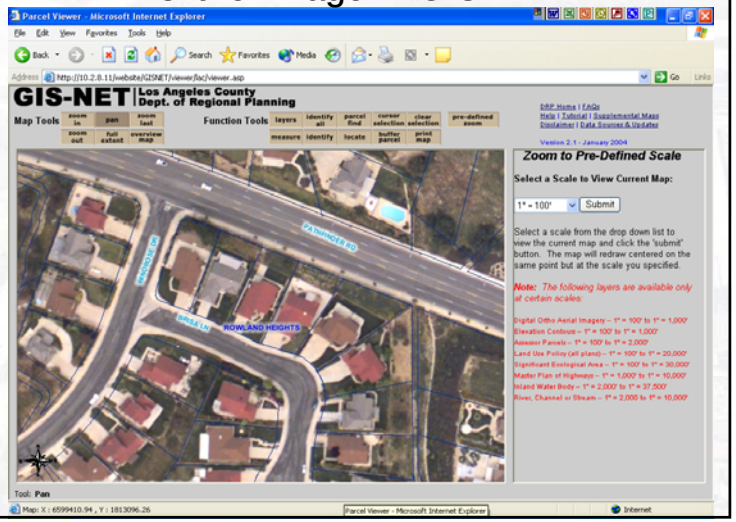

Oblique Image in EFS

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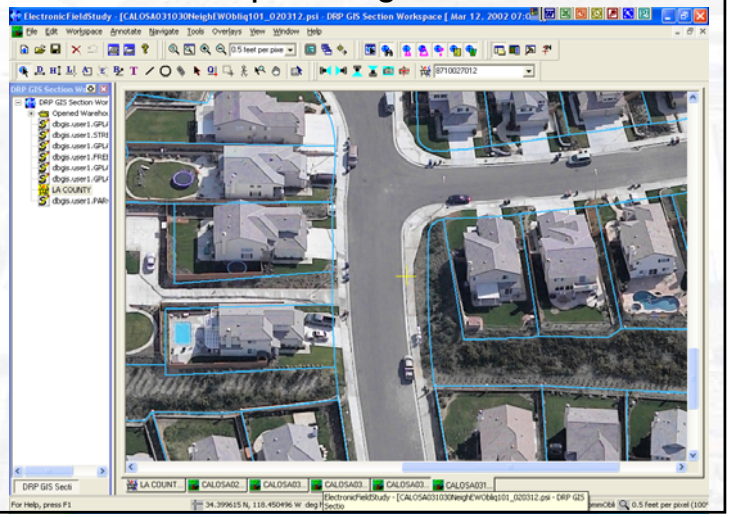

Contact Information

- Project Director
  - John McIntire, Associate CIO
  jmcintire@cio.co.la.ca.us (213) 974-2154
- Project Manager
  - Milan Svitek, GIS Manager, Regional Planning Dept.
  msvitek@planning.co.la.ca.us (213) 893-0881
- Project Monitor
  - Nick Franchino, GIS Analyst, Regional Planning Dept.
  nfranchino@planning.co.la.ca.us (213) 974-6395
- Project Web Site
  - http://planning.co.la.ca.us/GIS/LAR_IAC/LARIAC_home.htm