Implementing a Digital Archive Backup and Operational System for Aerial Photography Collections

Requested by
James M. Appleton, Chief, Office of Photogrammetry

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The Caltrans Division of Research and Innovation (DRI) receives and evaluates numerous research problem statements for funding every year. DRI conducts Preliminary Investigations on these problem statements to better scope and prioritize the proposed research in light of existing credible work on the topics nationally and internationally. Online and print sources for Preliminary Investigations include the National Cooperative Highway Research Program (NCHRP) and other Transportation Research Board (TRB) programs, the American Association of State Highway and Transportation Officials (AASHTO), the research and practices of other transportation agencies, and related academic and industry research. The views and conclusions in cited works, while generally peer reviewed or published by authoritative sources, may not be accepted without qualification by all experts in the field.

Executive Summary

Background

The Office of Photogrammetry (OoP) is the custodian of the department's film-based aerial photography library. The library is composed of approximately 900,000 large-format (9-by-9-inch and 9-by-18-inch images) aerial exposures on 7,000 negative film rolls and 35,000 20-by-24-inch negative film index sheets. These documents date back to the 1950s and form an invaluable and irreplaceable historical record of the state highway system. Currently there is no backup for this data.

The OoP is interested in creating a digital archive backup and operational recovery system for the Caltrans aerial photography library. Such a system should have the potential to be accessed via a geographic information systems (GIS) interface and become the primary day-to-day record keeping system.

This Preliminary Investigation aims to identify best practices in implementing and maintaining a digital archiving solution for aerial photography collections that can be used to inform an implementation plan for Caltrans. To carry out this investigation, we surveyed state transportation agencies and other organizations that have implemented or plan to implement digital archives. We also investigated other organizations that offer public access to digital aerial photography collections and identified research conducted outside the transportation community that can perhaps provide additional insight into how a digital archive is developed and accessed.

Summary of Findings

To begin gathering data about digital archives, in December 2009 we distributed a brief online survey to individuals who were likely to have experience in either developing or deploying a digital archiving system. This **Survey of Current Practice** yielded information that led to the next step in our research—**Follow-up Discussions with Selected State DOTs** that have implemented archival or backup systems. To augment the state department of transportation (DOT) perspective, we located **Statewide Historical Digital Aerial Photography Collections** and reviewed the literature for **Best Practices for Digital Archiving**. Each section of this Preliminary Investigation is summarized below.

Survey of Current Practice

- As we reviewed the 18 responses to the survey, we noted nine agencies with some type of archival or backup program. The table on page 5 of this Preliminary Investigation summarizes the eight archival or

backup programs described in survey responses. (One agency—Tennessee DOT—provided no details of its program.) (Some of the information in this table is culled from follow-up discussions with selected state DOTs.)

- State DOTs in four states—Alabama, Montana, Oregon and Virginia—report that an archival system is under review, in the early development stages or will soon be implemented.
- Agencies approach digital archiving in a variety of ways, indicating that no one solution fits every agency.
    - Some states have crafted in-house programs, while others use vendor solutions.
    - Agencies are split on the best image resolution. Some are scanning their collections as thumbnails at low resolution, scanning images at high resolution only as needed or upon request; other agencies scan all images at high resolution.
    - Scanned images are retained online in user-defined locations, with vendor software that searches for and supplies requested thumbnail images, or using a consultant-developed web site. One respondent—Washington State DOT—retains scanned images in a DVD library.
    - Three state DOTs—Missouri, North Carolina and Ohio—have completed scanning their entire collections or have plans to do so over the coming years; other survey respondents report plans for selective scanning of their film archive or did not provide information about the scope of their archiving projects.
- Among the challenges reported by survey respondents are securing the storage space needed to retain online images, the time-consuming nature of gathering metadata and entering data in the archival system, the time required to georeference older digital images and brittle film that can slow down the scanning process.
- Current users of archival systems offer the following advice:
    - Use a just-in-time approach to scan high-resolution images only as needed.
    - Collect metadata early on in the project.
    - Be prepared to be flexible and patient.
    - Make sure your online system/network is robust and has adequate storage space.
    - Train staff in multiple areas of expertise.
    - Properly classify data or organize files to ensure quick and easy access to digital images.

Follow-up Discussions with Selected State DOTs

We conducted follow-up interviews with five state DOTs—North Carolina, Ohio, Pennsylvania, Washington and Wisconsin— to gather information that expanded on their survey responses.

- **North Carolina**

  North Carolina DOT heeded the advice contained in a 2006 NIIRS10 Inc. study (see page 16 of this Preliminary Investigation for more information about this study) that recommended a just-in-time approach to high-resolution scanning. Considering its system more of a digital catalog than a true digital archive, North Carolina DOT uses Intergraph Corporation's TerraShare software to house and display low-resolution thumbnail images of its aerial photography collection. Associated metadata allows the images to be displayed in the correct location and orientation by identifying the position of the center of the photo. Metadata written to an Oracle database permits users to create queries and submit requests for high-resolution scans.

- **Ohio**

  In a manner similar to North Carolina DOT, Ohio DOT has scanned its considerable film collection to generate low-resolution thumbnail images. High-resolution images are created for mapping jobs or upon request. Ohio DOT uses GeoCue Corporation's Image Archive and Retrieval System to house and manage the low-resolution images. A multiphase implementation project is in its second phase, which will make the digital image search engine and retrieval system available to Ohio DOT internal customers. The project's third and final phase will provide public access to the system.

- **Pennsylvania**

  One of two agencies we interviewed with an in-house solution, Pennsylvania DOT has been scanning high-resolution images from film since 2001 and has no plans to scan its historical collection of 800,000 exposures, which dates back to 1969. A consultant-developed Photogrammetry Asset Management System, available on the public web, allows users to enter metadata about an image to see the photo footprint. Pennsylvania DOT just started its scanning project and anticipates that the project will take a long time to complete.

- **Washington State**

  In the second of the in-house programs, Washington State DOT's interim solution scans images at high resolution, making two copies of each scan—one stored at the office location and a second taken to a data storage warehouse. Rather than retaining images online, a compression tool creates an optical cartridge—about the thickness of two DVD cases—that can hold data from one film can. Washington State DOT is starting to build a georeferenced electronic index that will have a map base to graphically display the approximate limits of each negative. The ability to produce digital images from this index is not yet available to the customer; instead, the index points staff to the appropriate DVD in its library.

- **Wisconsin**

  Wisconsin DOT considers its program more of a backup system than a true archive. The scanning project began in 2005 and is not expected to reach back to the historical collection. Images are scanned at high resolution; exposure coordinates are entered in a GIS with the scanned image, which associates the metadata—and the georeferencing—with the image. Digital images are retained online, and a physical backup of the server provides a second copy of the images.

Statewide Historical Digital Aerial Photography Collections

- DOTs and other state and federal agencies house vast aerial photography collections. We highlight statewide digital collections from Colorado, Florida, Georgia, Illinois and Texas, and offer technical details of how the collections were digitized.

Best Practices for Digital Archiving

- Two reports from 2009 document findings of the National Geospatial Digital Archive project, which sought to identify how to preserve geospatial data—including aerial photography—on a national scale.
- A June 2008 report of a multistate library cooperative provides digital imaging best practices that can serve as a guide for in-house image capture, presentation, storage and preservation.

Gaps in Findings

We found no consensus among survey respondents as to the "best" approach to digital archiving. We heard from state DOTs that have successfully developed in-house programs, as well as other agencies that have applied vendor solutions to support programs that meet their needs—and their budgets. For some agencies, the type and structure of individual programs are linked to funding, staffing and institutional support.

The December 2009 survey responses indicated that four states are considering an archival system, or planned to implement one in the near future. We have not followed up with these state DOTs to learn more about their planned implementation projects.

Missouri DOT's survey response reported on its active archival program; the vendor providing the software used by Missouri DOT—Intergraph Corporation—also responded to the survey. We attempted to contact the survey respondent for a follow-up discussion but were unable to make a connection.

Next Steps

Caltrans might consider the following related to implementing a digital archive for its aerial photography collections:

- Contact the four state DOTs planning new implementation projects—Alabama, Montana, Oregon and Virginia—to learn more about the process used to select an archiving product/solution.
- Contact Missouri DOT to obtain further information about its archival program, which produces high-resolution, georeferenced images that are stored and retrieved from Intergraph Corporation's TerraShare and GeoMedia WebMap software.
- Contact state DOTs working with vendor solutions to support their archiving programs (see below) to learn more about the vendor products; follow up with vendor representatives to obtain pricing.
    - AeroTech Mapping—Nevada DOT.
    - ESRI—California Department of Water Resources.
    - GeoCue Corporation—Ohio DOT.
    - IBM—Wisconsin DOT.
    - Intergraph Corporation—Missouri and North Carolina DOTs.
- Follow up with state DOTs with in-house programs (Pennsylvania and Washington State DOTs) to gather information for a cost/benefit comparison of in-house and vendor-supported implementations.
- Review the 2006 study produced for North Carolina DOT to determine if the recommendations may apply to the Caltrans environment.

Aerial Photography Backup/Archival Program Descriptions*

State	Software Vendor	Scanning Equipment	Project Scope	Image Resolution (in microns (µm))	Georeferencing (Yes/No)	Project Status
California (Department of Water Resources)	ESRI	N/A	22,000 GeoTIF images stored on and served from the image server	N/A	N/A	Current storage capacity is 10 TB, with an expected growth rate of 5 TB per year
Missouri	Intergraph Corporation	Intergraph	204,351 exposures of roll film; will scan entire collection	14	Yes	Film collection that spans 50 years; 400 of 926 rolls scanned; 104 rolls geocoded
Nevada	AeroTech Mapping	N/A	300,000 negatives; selective process to scan	18	N/A	Developing a digital database of older negatives; retain five years of current imagery on network server
North Carolina	Intergraph Corporation	Epson	400,000-500,000 negatives; will scan entire collection	224	Yes	Just started project; expect it will take a long time to complete
Ohio	GeoCue Corporation	Intergraph Z/I and Ricoh	500,000 low-resolution, positioned images (scanned entire collection); high-resolution images scanned for new jobs requiring mapping and upon request	Mostly low-resolution thumbnails; 14 or 28 (selected images)	Yes	Started scanning nine years ago; new search engine and retrieval system (GeoCue IARS) being implemented
Pennsylvania	In-house	Intergraph Z/I	Scanning current projects since 2001	15	Yes (limited to customer request; estimate 50%)	Historical collection includes 800,000 exposures dating back to 1969; 40,000 images scanned so far
Washington	In-house	Leica DSW700	Scanning current projects since 2001 (scan and write images to DVD); 3,545 true-color images this year	12.5	Yes	Planning a system to read/retrieve DVD library
Wisconsin	IBM (Tivoli Utility Storage Manager)	Wehrli	Scanning soft-copy photos since 2005/2006; 62,880 files = 11.8 TB	10 to 12	Yes	Consider current system more of a backup; may look at an archival system sometime in 2010

* This table summarizes a portion of the results of the online survey and follow-up interviews.

Contacts

During the course of this Preliminary Investigation, we spoke to or corresponded with the following individuals:

State Agencies

North Carolina
Keith Johnston
State Photogrammetric Engineer
North Carolina Department of Transportation
(919) 250-4170, kjohnston@ncdot.gov

Ohio
John Ray
Administrator, Office of Aerial Engineering
Ohio Department of Transportation
(614) 275-1357, john.ray@dot.state.oh.us

Pennsylvania
Brad Foltz
Chief, Photogrammetry and Survey Division
Pennsylvania Department of Transportation
(717) 346-4278, ext. 3002, lbfoltz@state.pa.us

Washington
James A. Walker
Aerial Photography Supervisor, Aerial Photography Branch
Washington Department of Transportation
(360) 596-8910, walkerj@wsdot.wa.gov

Wisconsin
Kimberly Schauder
Photogrammetry Supervisor, Surveying and Mapping Section
Wisconsin Department of Transportation
(608) 246-7980, kimberly.schauder@dot.wi.gov

Vendor

GeoCue Corporation
Lewis Graham
President
(256) 461-8289, lgraham@geocue.com

Survey of Current Practice

We conducted a brief online survey of individuals who were likely to have experience in either developing or deploying a digital archiving system. The list included representatives from the photogrammetry departments of most state transportation agencies as well as individuals from across private industry. The survey consisted of the following questions:

1a. Public Agencies. Is your organization now using or has it considered using a digital archive backup and operational recovery system for your aerial photography collection?

1b. Others. Do you know of an organization that is using or has considered using a digital archiving solution?

2. Please describe the scope of the digital archive implementation project, including the type and number of images digitized.

3. Please describe the digital archive product and how it is used in daily operations.

4. Please provide contact information for the technology vendor.

5. Have you encountered any challenges in implementing or maintaining a digital archive? Please describe.

6. What advice would you offer to a transportation agency preparing to implement an aerial photography digital archive backup and operational recovery system?

We received 18 responses to the survey: three responses from California agencies (California Department of Water Resources and two responses from Caltrans' Division of Right of Way and Land Surveys); 14 responses from state DOTs (Alabama, Connecticut, Louisiana, Missouri, Montana, Nevada, North Carolina, Ohio, Oregon, Pennsylvania, Tennessee, Virginia, Washington and Wisconsin); and one vendor response (Intergraph Corporation). See **Survey Results** beginning on page 9 for the full text of these survey responses.

Key findings from the survey follow.

Prevalence and Type of Digital Archiving Solutions

- Nine respondents noted the presence of some form of backup or archiving system in their agencies.
    - Pennsylvania and Washington State DOTs have elected to develop in-house programs.
    - Vendor solutions are used by California Department of Water Resources (ESRI), Nevada (AeroTech Mapping), Missouri and North Carolina DOTs (Intergraph Corporation), Ohio DOT (GeoCue Corporation) and Wisconsin DOT (IBM). Tennessee DOT indicated that it uses an archival program but did not provide details about the program
- Four state DOTs report that digital archiving solutions are under consideration.

State	Vendor	Project Type	Timetable
Alabama	GeoCue Corporation	Imagery management system	Decision in spring 2010
Montana	In-house	Digital aerial photo archival system	N/A
Oregon	N/A	N/A	Conceptual development
Virginia	GeoCue Corporation	N/A	Early development stages

- Two states DOTs—Connecticut and Louisiana—have not implemented a digital archive solution.

Scope of Implementation Projects

- Most of the respondents with archival programs report the existence of historical collections of significant size. Ohio and North Carolina DOTs have 400,000 to 500,000 images in their collections; Nevada DOT reports holding 300,000 negatives.

- Missouri, North Carolina and Ohio DOTs have scanned or intend to scan their complete collections. Wisconsin DOT's scanning program began in 2005, while Pennsylvania and Washington State DOTs started scanning in 2001; none of these state DOTs have plans to scan the complete historical archive. Other respondents did not clearly indicate their plans for retrospective scanning.

How the Archive Is Used in Daily Operations

- North Carolina and Ohio DOTs are scanning their entire collections at low resolution, producing thumbnails for quick access and retrieval. Both agencies scan high-resolution images as needed for mapping or upon customer request.
    - North Carolina DOT is using Intergraph Corporation's TerraShare product to house thumbnail images and the associated metadata to allow for querying a database and locating images. North Carolina DOT just began its project and anticipates that it will take a long time to complete.
    - Ohio DOT is using GeoCue Corporation's Image Archive and Retrieval System (IARS)—a search engine and retrieval system—to provide access to the thumbnail images and notify users of the availability of high-resolution images. The project, which will eventually make IARS publicly available, is now focused on providing access to internal Ohio DOT customers.
- Missouri and Pennsylvania DOTs also plan to scan their entire collections and are scanning them at high resolution. Missouri DOT is almost halfway through its 926 rolls of film, but has considerably more work to do to complete georeferencing of its scanned images.
- Georeferencing is completed or planned for the entire scanned collections held by Missouri, North Carolina, Ohio, Washington State and Wisconsin DOTs; Pennsylvania DOT georeferences scanned images only upon customer request.
- Nevada DOT scans older negatives for its digital image database in high resolution, organizing the images by flight number. Approximately five years of current imagery are retained on the network server for immediate access.
- Unlike other archival programs, Washington State DOT's archive is not retained online; instead, images are copied to DVDs for long-term retention. A project is under way to develop a system to read/retrieve the DVD imagery.

Implementation Challenges

- Respondents note that georeferencing is a time-consuming aspect of any digital archiving project.
    - Missouri DOT, while noting that the challenges associated with digital archiving are too numerous to list, did comment about the time-consuming nature of georeferencing older images. This is evidenced by the fact that while 43 percent of its film collection has been scanned, only 11 percent has been geocoded.
    - Ohio DOT comments that generating the low-resolution images with the metadata for its 500,000-image archive took a considerable amount of effort.
- For Nevada DOT, scanning fragile, older film can present problems.
- Wisconsin DOT notes the importance of estimating the amount of storage space needed.
- Intergraph Corporation—which provided the lone vendor response to the survey—recommends obtaining buy-in from stakeholders and justifying the investment by making sure the end result is quick, easy access to a diverse user group.

Implementation Advice

- California's Department of Water Resources recommends consideration of Leica Geosystems' ECW Image Manager server in any product analysis.
- Flexibility, patience and multifaceted staff are important elements of Missouri DOT's archiving program.

- Nevada DOT advises archiving using the most current standards available.
- North Carolina DOT recommends its approach, which retains the film archive, scans all images in low resolution and scans images at full resolution only as needed. This just-in-time approach to high-resolution scanning is also used by Ohio DOT.
- Ohio DOT suggests collecting the metadata before the archival system is developed.
- For Pennsylvania DOT, storing images online requires a robust network with lots of storage space.
- Washington State DOT, which maintains its own in-house program, recommends patience. The commercial products are relatively new and should improve and become more affordable with time.
- For Wisconsin DOT, classifying data and establishing a Records Disposition Authority and disaster recovery process are critical.

Survey Results

The full text of each survey response is provided below. For reference, we have included an abbreviated version of each question before the response; for the full question text, please see page 7 of this Preliminary Investigation. Survey responses are categorized as **California Agencies**, **Other State DOTs**, and **Vendor**.

California Agencies

California Department of Water Resources (DWR)
Contact: Ruppert Grauberger, (916) 653-2698, ruppert@water.ca.gov.

1a. **Public Agencies: Using or plan to use a digital archiving solution?** Yes.

1b. **Know of others using or considering use of a digital archive?** [No response.]

2. **Project scope:** The current storage capacity of DWR's enterprise image server is 10TB, with an expected growth rate of 5TB per year. At present there are over 22,000 GeoTIF images stored on and served from the imager server.

3. **Use in daily operations:** DWR has implemented an enterprise imager server (ESRI ArcGIS Server Image Extension). The source imagery is stored on a component of the enterprise architecture, which has access limited to the data stewards. The viewing availability is open to all DWR staff as an image service.

4. **Vendor contact information:** ESRI, Tony Lafferty, (916) 448-2412, tlafferty@esri.com.

5. **Describe challenges:** The process of creating service definitions is tedious and clunky.

6. **Implementation advice:** I would advise including the Leica Geosystems' ECW [Enhanced Compression Wavelet] Image [Manager] server in your product analysis.

Caltrans Division of Right of Way and Land Surveys
Contact: Kevin Akin, Office of Surveys, (916) 227-7650, kakin@dot.ca.gov.

1a. **Public Agencies: Using or plan to use a digital archiving solution?** Yes.

1b. **Know of others using or considering use of a digital archive?** No.

2. **Project scope:** We are considering digitizing all of Caltrans' existing film aerial photography. This has not been done yet.

3. **Use in daily operations:** The digital archive would provide access to Caltrans personnel and the public for viewing. These photos would replace the cumbersome process of making a photographic print.

4. **Vendor contact information:** None yet.

5. **Describe challenges:** Server space; an application to retrieve and manage, and the money to create it.

6. **Implementation advice:** Make it happen!

Caltrans Division of Right of Way and Land Surveys
Contact: Paul Fredrickson, (916) 227-9440, paul_d_fredrickson@dot.ca.gov.

1a. **Public Agencies: Using or plan to use a digital archiving solution?** No. Caltrans has a document retrieval system, but it does not include aerial photography. Some digital aerial ortho photos are available through the intranet (DHIPP) [Digital Highway Inventory Photography Program], but these images are out of date and relatively low resolution.

1b. **Know of others using or considering use of a digital archive?** [No response.]

2. **Project scope:** [No response.]

3. **Use in daily operations:** [No response.]

4. **Vendor contact information:** [No response.]

5. **Describe challenges:** Server space has been cited as a problem in the past.

6. **Implementation advice:** Make the interface user-friendly and work with partners within your organization to identify key points in the project delivery process where aerial imagery should be obtained and archived.

Other State DOTs

Alabama
Contact: John D. Russell, Alabama Department of Transportation, (334) 242-6139, russellj@dot.state.al.us.

1a. **Public Agencies: Using or plan to use a digital archiving solution?** We do not have a "system" to back up the data. It currently resides on two servers at two locations, both of which are backed up through the normal archive process within the department. Portable drives delivered with the original data are maintained as another backup. We are in the process of looking at an imagery management system from GeoCue but have not had the time to review the details of the system. We plan to review this system and make a decision within the next three months. We would be very interested in seeing the results of this survey.

1b. **Know of others using or considering use of a digital archive?** [No response.]

2. **Project scope:** [No response.]

3. **Use in daily operations:** [No response.]

4. **Vendor contact information:** [No response.]

5. **Describe challenges:** [No response.]

6. **Implementation advice:** [No response.]

Connecticut
Contact: Robert J. Baron, Connecticut Department of Transportation, robert.baron@ct.gov.

1a. **Public Agencies: Using or plan to use a digital archiving solution?** No; not our area of interest.

1b. **Know of others using or considering use of a digital archive?** No.

2. **Project scope:** [No response.]

3. **Use in daily operations:** [No response.]

4. **Vendor contact information:** [No response.]

5. **Describe challenges:** [No response.]

6. **Implementation advice:** [No response.]

Louisiana
Contact: Eric Lanier, Louisiana Department of Transportation and Development, (225) 379-1101, Eric.Lanier@LA.GOV.

In lieu of completing the online survey, Louisiana DOTD provided the following:

> Louisiana DOTD has not implemented these applications yet. We process some digital data from scans but not for long-term storage. I would be very interested in your findings.

Missouri
Contact: Tim Moersch, Missouri Department of Transportation, (573) 526-2404, tim.moersch@modot.mo.gov.

Note: See page 15 of this Preliminary Investigation for Intergraph Corporation's survey response, which provides additional information about Missouri DOT's archiving solution.

1a. **Public Agencies: Using or plan to use a digital archiving solution?** Yes.
1b. **Know of others using or considering use of a digital archive?** [No response.]
2. **Project scope:** We currently have 204,351 exposures of "roll" film needing digital archive. These images span 50+ years. Three years ago we implemented a plan of action to convert all exposures to digital with geocoding. We purchased a scanner and related software. To date there are approximately 400 rolls scanned out of 926 with only 104 geocoded. Keep in mind that one employee provides this service, which is a huge scope.
3. **Use in daily operations:** The product is a georeferenced image with high resolution (14 µm). Note that "georeference" can describe anything from two-dimensional referencing to true orthorectification. Georeferencing is the kicker for us; it is extremely time-consuming with 50-year-old imagery, but the finished product is worth the effort. For more info, drop me an e-mail; I'd be happy to speak with you.
4. **Vendor contact information:** Intergraph.
5. **Describe challenges:** It is an enormous challenge; too many to list.
6. **Implementation advice:** Be prepared to have a photogrammetrist, CADD specialist, GIS specialist, IT and DBA [database analyst] all rolled into one! Flexibility and patience are key.

Montana
Contact: Bryce Larsen, Montana Department of Transportation, (406) 444-6321, blarsen@mt.gov.

1a. **Public Agencies: Using or plan to use a digital archiving solution?** Yes.
1b. **Know of others using or considering use of a digital archive?** [No response.]
2. **Project scope:** In the process of developing a digital aerial photo archival system.
3. **Use in daily operations:** Has not been fully implemented yet.
4. **Vendor contact information:** Montana Department of Transportation.
5. **Describe challenges:** Too early to tell.
6. **Implementation advice:** Too early to comment on.

Nevada
Contact: Paul Cote, Nevada Department of Transportation, (775) 888-7162, pcote@dot.state.nv.us.

1a. **Public Agencies: Using or plan to use a digital archiving solution?** Yes.
1b. **Know of others using or considering use of a digital archive?** No.
2. **Project scope:** NDOT started aerial photography in 1959. We are scanning our older imagery at 1400 dpi using a selective process; we have about 300,000 negatives. The older imagery is scanned on a roll-feed scanner and backed up to tape and stored off-site.

3. **Use in daily operations:** We have been scanning our older negatives to develop a digital image database. We have been organizing the older imagery by flight number on TB [terabyte] drives and backing up the data to a tape backup system. Access for the older dates is two days because it is stored off-site. We are keeping about five years of current imagery on our network server for immediate access.
4. **Vendor contact information:** AeroTech Mapping, Leo Torres, (702) 228-6277, leotorres@atmlv.com.
5. **Describe challenges:** Our photo project negatives have been spliced together and stored on the film reel in plastic or metal film cans for years. The film is brittle, with some dust, and the tape seems to have been stable. The scanner operator has to take care when scanning depending on how many splices are on the film being scanned.
6. **Implementation advice:** The older the film the more brittle it will be, so take it slow. In some cases you may not be able to use auto-feed equipment. Archive the digital imagery using the most current standards available.

North Carolina
Contact: Keith Johnston, North Carolina Department of Transportation Photogrammetry Unit, (919) 250-4170, kjohnston@ncdot.gov.

1a. **Public Agencies: Using or plan to use a digital archiving solution?** No. We have +/- 400,000 negatives that we have inventoried. We are scanning these images at low resolution (224 microns), warping end-of-strip photos and adding to TerraShare [an Intergraph product; see http://www.intergraph.com/sgi/products/productFamily.aspx?family=18&country for more information about TerraShare] to begin to develop a georeferenced catalog of our film holdings. We have just started this project, work on it as time permits, and expect it will take a long time to complete. We don't have any intent to scan these negatives at full resolution (14 microns) due to storage size, cost and time.
1b. **Know of others using or considering use of a digital archive?** [No response.]
2. **Project scope:** [No response.]
3. **Use in daily operations:** [No response.]
4. **Vendor contact information:** [No response.]
5. **Describe challenges:** See number 1.
6. **Implementation advice:** Keep it in film and scan at full resolution as needed. GeoCue did a study for NCDOT Photogrammetry in 2006 where they recommended a "just-in-time" scanning process to accommodate orders for full resolution. I believe Ohio DOT has implemented this type of aerial photography archive system.

Ohio
Contact: John Ray, Ohio Department of Transportation, (614) 275-1357, john.ray@dot.state.oh.us.

1a. **Public Agencies: Using or plan to use a digital archiving solution?** Yes.
1b. **Know of others using or considering use of a digital archive?** [No response.]
2. **Project scope:** 500,000 low-resolution, positioned images are currently being loaded into our new image archive system. Software was recently developed to display, search (via a GUI interface) and manage any image archive search requests.
3. **Use in daily operations:** The newly developed software and the low-resolution images are used to search and display what is available in the archive, including applicable metadata. Any high-resolution images available are also noted. The new system is currently in the process of being implemented within the DOT.
4. **Vendor contact information:** GeoCue Corporation, Lewis Graham, (256) 461-8289, lgraham@niirs10.com.
5. **Describe challenges:** Generating the low-resolution images with the metadata took a considerable amount of effort.

6. **Implementation advice:** Decide what you want the system to do for you; then collect the information (metadata) before a system is developed.

Oregon
Contact: David Artman, Oregon Department of Transportation, (503) 986-3540, David.R.Artman@ODOT.state.OR.US.

1a. **Public Agencies: Using or plan to use a digital archiving solution?** Yes.
1b. **Know of others using or considering use of a digital archive?** [No response.]
2. **Project scope:** In conceptual development.
3. **Use in daily operations:** [No response.]
4. **Vendor contact information:** [No response.]
5. **Describe challenges:** Digital data storage space, IT staff time to manage the system, misconceptions about routine backup function.
6. **Implementation advice:** Since we do not have one, offering advice would be inappropriate.

Pennsylvania
Contact: Brad Foltz, Pennsylvania Department of Transportation, lbfoltz@state.pa.us.

1a. **Public Agencies: Using or plan to use a digital archiving solution?** Yes.
1b. **Know of others using or considering use of a digital archive?** [No response.]
2. **Project scope:** Since 2001 began scanning all rolls of film as they were processed. Images are stored on servers. Images are recovered by an organized database and proper naming conventions. Archived about 40,000 images so far.
3. **Use in daily operations:** 15-micron scans. New imagery is used to produce requested products within six months then seldom reused.
4. **Vendor contact information:** Done in-house.
5. **Describe challenges:** Not since storage space is inexpensive.
6. **Implementation advice:** Need a robust unit and lots of storage space, especially when thousands of images may be received from digital cameras.

Tennessee
Contact: Dana Sommer, Tennessee Department of Transportation, dana.sommer@tn.gov.

1a. **Public Agencies: Using or plan to use a digital archiving solution?** Yes.
1b. **Know of others using or considering use of a digital archive?** No.
2. **Project scope:** [No response.]
3. **Use in daily operations:** [No response.]
4. **Vendor contact information:** [No response.]
5. **Describe challenges:** Because we work with multiple software platforms, having one solution work with each of those platforms has been a challenge.
6. **Implementation advice:** Organize your files very logically so users can easily find needed imagery.

Virginia
Contact: Michael W. Zmuda, Virginia Department of Transportation, (804) 786-2565, Michael.Zmuda@VDOT.Virginia.gov.

1a. **Public Agencies: Using or plan to use a digital archiving solution?** Yes.
1b. **Know of others using or considering use of a digital archive?** Yes; Ohio DOT and PennDOT.
2. **Project scope:** Early development stages.
3. **Use in daily operations:** Early development stages.
4. **Vendor contact information:** GeoCue, Joe Bima.
5. **Describe challenges:** Money and extent of data to archive.
6. **Implementation advice:** Spend enough money to do it right the first time.

Washington
Contact: James A. Walker, Aerial Photography Branch, Washington State Department of Transportation, (360) 596-8910, walkerj@wsdot.wa.gov.

1a. **Public Agencies: Using or plan to use a digital archiving solution?** Yes.
1b. **Know of others using or considering use of a digital archive?** Yes. Ohio Dept. of Transportation and North Carolina Dept. of Transportation.
2. **Project scope:** Ours is a "home-grown" interim solution. Using a Leica DSW700 scanner, WSDOT Aerial has scanned and written approximately 3,545 true-color images to DVDs this year.
3. **Use in daily operations:** WSDOT publishes two sets of DVDs using the Rimage Protege II publishing system. One set is for near-line storage outside of our studio and one set is for off-line storage in an off-site data warehouse.
4. **Vendor contact information:** [No response.]
5. **Describe challenges:** We are presently planning the capability to read/retrieve our DVD library imagery in the near future.
6. **Implementation advice:** Be patient; the systems presently in the marketplace are barely out of the beta phase. They will improve and will become affordable due to competition.

Wisconsin
Contact: Kimberly Schauder (Cindy McCallum, Tiffany Novinska), Wisconsin Department of Transportation, (608) 246-7980, kimberly.schauder@dot.wi.gov.

1a. **Public Agencies: Using or plan to use a digital archiving solution?** Yes.
1b. **Know of others using or considering use of a digital archive?** [No response.]
2. **Project scope:** WisDOT Information Technology staff investigated options and implemented an IBM solution eight years ago. To date, 62,880 files = 11.8 TB. Images include vertical imagery (TIF), rectified vertical imagery a.k.a. orthos (GeoTiF) and Color Oblique (JPG).
3. **Use in daily operations:** Daily incremental backups to new and modified files. Backups done in-house.
4. **Vendor contact information:** IBM Tivoli Utility Storage Manager software; http://www-01.ibm.com/software/tivoli/.
5. **Describe challenges:** Estimating the amount of data storage needed. WisDOT considers our system a backup but not an off-site archive system. Looking at an archival system in 8 to 12 months.
6. **Implementation advice:** Classify your data (differentiate between aerial imagery, photolog, pavement profiler data). Set up Records Disposition Authority, secondary archive timeline/process and disaster recovery process. Contact Matt Johnson, WisDOT Information Technology, (608) 266-1951.

Vendor

Intergraph Corporation
Contact: Alistair Stuart, Intergraph Corporation, (720) 221-8518, alistair.stuart@intergraph.com.

Note: Find additional information in Missouri DOT's survey response on page 11 of this Preliminary Investigation.

1a. **Public Agencies: Using or plan to use a digital archiving solution?** [No response.]

1b. **Know of others using or considering use of a digital archive?** Yes; Missouri Department of Transportation.

2. **Project scope:** The Missouri DOT project involves the scanning of around 1,500 rolls of 9" x 9" aerial photos from a film archive using an Intergraph photogrammetric scanner and making the georeferenced digital images available to internal customers throughout DOT. Aerial images are scanned at high resolution and geometric fidelity, directly from the rolls of original film negatives.

3. **Use in daily operations:** Intergraph TerraShare and GeoMedia WebMap software products are used. The scanned images and associated metadata are stored directly into the TerraShare environment for image data management, quality assurance and distribution. TerraShare organizes the data and tracks its physical location while presenting the user with a logical view of the data. The images are georeferenced to a base map and made available through web services over an enterprisewide intranet using Intergraph web publisher software, making it easy to discover the available content. Users throughout the DOT can directly access the TerraShare imagery through a simple footprint viewer. Imagery can then be served by TerraShare into GIS and CAD environments using native plug-ins.

4. **Vendor contact information:** Intergraph Corporation, Alistair Stuart, (720) 221-8518, alistair.stuart@intergraph.com.

5. **Describe challenges:** Successful operation of the digital archive requires buy-in from the various stakeholders, including:
   - IT—responsible for implementation and subsequent systems operation, including data integrity.
   - Producers—including photogrammetrists and image specialists.
   - Consumers—users of the archived imagery, such as engineers, planners, etc.

   The challenge is to justify the investment in geospatial imagery by ensuring rapid, dependable and easy access for a diverse set of users throughout the enterprise.

6. **Implementation advice:** Select a solution with a proven track record on similar implementations at other transportation agencies. Ensure that all stakeholders are fully supportive of the project.

Follow-up Discussions with Selected State DOTs

After reviewing survey results, we contacted five states that maintain some form of backup or archival system to delve deeper into survey responses:

- North Carolina DOT uses Intergraph Corporation software to manage low-resolution images.
- Ohio uses GeoCue Corporation software to manage low-resolution images.
- Pennsylvania and Washington State DOTs have developed in-house backup or archival systems.
- Wisconsin DOT uses IBM software for its backup system.

North Carolina
Contact: Keith Johnston, State Photogrammetric Engineer, North Carolina Department of Transportation, (919) 250-4170, kjohnston@ncdot.gov.

Background
North Carolina DOT has been using black-and-white film and soft-copy photography since 1998, only scanning film for mapping purposes. Concerned about the continuing availability of B&W photographic paper and interested in

making the 400,000 to 500,000 negatives maintained by the photogrammetic unit more readily available to customers, North Carolina asked NIIRS10 Inc. (now GeoCue Corporation) to conduct a study to recommend options for modernizing the unit's workflows. The study recommended just-in-time scanning, keeping and storing the film and scanning selected images at a high resolution only when needed.

Workflow
Recently North Carolina began scanning its film backlog in low resolution (224 µm) using Epson flatbed scanners to produce georeferenced thumbnails—essentially creating a "card catalog" of these images. This low-resolution catalog is not considered an archive; rather "buckets" on an internal server house the low-resolution images and data is maintained for each image that allows staff to locate the image in the respective "bucket."

With the use of Intergraph Corporation's TerraShare software, North Carolina DOT is moving to a digital catalog of images. TerraShare allows the user to display historical thumbnail images in the correct location and orientation by identifying the position of the center of the photo and the direction it was flown, and writes metadata about each image into an Oracle database to allow for the development of queries to access images. TerraShare will be used as a library for users to perform queries, locate thumbnail images and submit requests for high-resolution scans.

Raw data from new digital images are copied to the server and archived on tape; images are also stored on the Intergraph camera's solid-state disk cartridge, which is stored at a different physical location. TerraShare provides distributed post-processing for the digital images.

North Carolina DOT collects information about previous and current aerial photography missions for inclusion in the photogrammetry catalog's database. See Appendix A for the information staff enters into an Access database, then exports to Excel for review before copying the data into the Oracle database in TerraShare. Appendix B is an index mosaic created for missions using the digital camera.

Implementation Issues
North Carolina doesn't see its project to create low-resolution images for its historical aerial photography as a true digital archive, but more of a digital catalog. The time, cost and storage required to generate high-resolution images (probably 14 µm) for the entire collection led North Carolina DOT to opt to retain its film archive—polyester film, for the most part, which is more resilient than acetate—and generate high-resolution images only as needed.

Ohio
Contact: John Ray, Administrator, Office of Aerial Engineering, Ohio Department of Transportation, (614) 275-1357, john.ray@dot.state.oh.us.

Background
Ohio DOT's project to scan available film and generate low-resolution thumbnail images began nine years ago. Scanning the 500,000-image backlog began using Ricoh scanners outfitted with Ohio DOT's own light apparatus, which could scan six 250-foot rolls of film per day. The initial scanning effort took two years to complete. Ohio DOT continues to use one of the Ricoh scanners used in its initial scanning effort and also uses Intergraph's Z/I Imaging photoscanner.

Workflow
High-resolution images (14 µm) are created for new jobs if mapping is required. For public requests, staff may scan images at 28 µm. Whole images are scanned at 28 µm and blown up, if necessary.

Georeferencing is done at the center of the image; Ohio DOT is not orienting the image, but does try to make sure the footprint is correct with the proper scale.

Ohio DOT uses GeoCue Corporation's Image Archive and Retrieval System (IARS) to house and manage its low-resolution images. The software positions the image using the coordinates of the center of the image, approximating the flight line as if it were straight, and calculates the image footprint. As a search engine and retrieval system, IARS allows users to search for images graphically or by entering metadata. IARS can also be used to keep track of online and offline image storage, something particularly helpful as more images are born-digital. New digital images are reduced for inclusion in IARS and maintained in full resolution for storage and download. See page 2 of *Aspects:*

News and Views from GeoCue Corporation, GeoCue's Spring/Summer 2007 newsletter, at http://www.geocue.com/news/aspects/geocue_07_sp_su.pdf for more information about IARS.

Implementing Ohio DOT's archival program is a three-phase project: Phase I—create the prototype; Phase II—make the system available inside the Ohio DOT firewall; and Phase III—make the system available to the general public. Current activities are focused on Phase II—making IARS available on Ohio DOT's intranet for use by internal customers.

Implementation Issues

Ray notes that one of the biggest challenges associated with the Ohio DOT project was the time-consuming nature of the initial scanning. Batch-processing scanners that can scan at multiple resolutions were not available at the time the backlog was being scanned. Ohio DOT could have benefited from a scanner that scans at higher resolution and then runs a batch processing program to reduce and rename images to create thumbnails for use in the image search engine. (For Ohio DOT, this is IARS.) Ray also noted that scan speed is critical.

Pennsylvania

Contact: Brad Foltz, Chief, Photogrammetry and Survey Division, Pennsylvania Department of Transportation, (717) 346-4278, ext. 3002, lbfoltz@state.pa.us.

Background

PennDOT has 800,000 exposures in its collection, with the oldest dating back to 1969.

Workflow

Since 2001, high-resolution images at 14 µm are scanned as film rolls are processed. Images are georeferenced only at customer request. There are no plans to go back to scan the film from 1969 through 2002. A consultant developed the Photogrammetry Asset Management System that can be accessed via the public web at http://penndotpams.org/MAP/MapViewer.aspx. From this site, users can enter metadata about an image—including county, flight date and other keywords associated with the desired image—to see the photo footprint. PennDOT users can log in to the site to gather more information about the project that would not be available to the general public.

Implementation Issues

Unlike some agencies, PennDOT is unconcerned about storage space for the high-resolution digital images. Foltz does note that a robust network is required to host and serve the high-resolution images. While scanning the current film has been integrated into day-to-day workflow or done as time permits, going back to scan the images in archive from 1969 to 2001 is not possible given time and funding constraints. Scans are made upon request for images from this period. A key ingredient to the success of the online retrieval system is the file-naming standards—they must be consistent and understandable.

Washington

James A. Walker, Aerial Photography Supervisor, Aerial Photography Branch, Washington Department of Transportation, (360) 596-8910, walkerj@wsdot.wa.gov.

Background

The overriding issue for Washington State DOT is the size of the archive. The photogrammetry branch has been taking photos since 1964; photography was contracted to consultants from the late 1930s to the late 1950s. Images have been taken in color since 1999. Walker estimates that it would take five people 20 years, working six to seven hours a day, to scan the full archive.

The current scanning program began in 2001. Washington State DOT has scanned some of the earliest films from 1933 through 1936, but continues to rely on film from the 1930s and 1940s, which has been maintained in the proper atmospheric conditions. Films from 1936 to 2002 have yet to be converted to digital.

Washington State DOT has looked at vendor solutions, considering GeoCue Corporation and Agfa. However, the time and financial commitment required by a vendor solution led Washington State DOT to pursue its own approach

to archiving. In adopting its system, Washington State DOT had to accept the risk that the digital data has to be read in the future, and storage formats change over time.

Workflow
Preliminary work to get metadata for the images into entry mode was completed in the 1980s with undergraduate student assistance. At that time work had yet to begin on the storage mode.

Two Leica DSW700 high-resolution scanners, which record the film at 12.5 µm (2032 dpi), are used to create color scans. Walker notes that the scanners have the capability to scan at 5 µm; however, scanning at the higher resolution becomes a linear problem of time and storage. It takes longer to scan at the higher resolution, and only one higher-resolution image can be copied to a DVD, while four of the 12.5 µm images can be committed to a single DVD.

All images are georeferenced. A compression tool creates an optical cartridge—about the thickness of two DVD cases—that can hold data from one film can. Two DVDs are published for each set of images—one that is retained for near-line storage outside the studio, and another that is sent for off-site storage at a data warehouse. By storing images on DVD the system does not require online storage space, which can be problematic for some agencies.

Walker described a project in process to build a georeferenced electronic index that uses a map base to graphically approximate the limits of each negative. The ability to produce the digital images from this index is not yet available to the customer; instead, the index points staff to the appropriate DVD in its library.

Implementation Issues
Walker noted that those planning to implement archival systems should be prepared for the data-gathering task to take considerable time. He identified data entry as the biggest challenge in implementing an archival system.

Wisconsin
Contact: Kimberly Schauder, Photogrammetry Supervisor, Surveying and Mapping Section, Wisconsin Department of Transportation, (608) 246-7980, kimberly.schauder@dot.wi.gov.

Background
WisDOT sees its program as a backup rather than an archive. Its aerial photography collection dates back to the 1930s, but there are no plans to scan the historical collection. Scanning current aerial photos began in 2005. Schauder notes that the decision to use IBM for the backup system was made by an information technology group—not her division—and the equipment used to support the backup system is owned by another state agency.

Workflow
Exposure coordinates are entered in a GIS with the scanned image, so the metadata (roll data, mapping information), including georeferencing, is associated with the image in GIS. Images are scanned using a Wehrli scanner at 10 µm to 12 µm, but may be rescanned at a lower resolution. Storage has not been an issue, but staff members do meet periodically to discuss storage needs. Digital images are retained online, and a physical backup of the server provides redundancy.

Implementation Issues
Classifying data is critical.

Statewide Historical Digital Aerial Photography Collections

An examination of how statewide digital aerial photography archives are developed and accessed can inform Caltrans' review of the options available for its own archival and backup solution. Below we highlight archives from Colorado, Florida, Georgia, Illinois and Texas.

Colorado

Aerial Photographs of Colorado, University of Colorado at Boulder Map Library
http://ucblibraries.colorado.edu/aerialphotos/home.asp
This web site provides access to more than 1,700 digitized aerial photographs of Colorado taken by the U.S. Forest Service from 1938 to 1947. The project team used ESRI products ArcView and ArcMap to plot the center points of each photograph and provide enhanced keyword indexing using the attribute table. The photographs were scanned at 600 ppi with 24-bit color, using *Western States Digital Imaging Best Practices* as a guide. (A citation for the updated version of this publication, *BCR's CDP Digital Imaging Best Practices Version 2.0*, appears on page 21 of this Preliminary Investigation.) Metadata was created for the photographs by county and year. The web site was developed using images and data exported from ArcMap. Geographic and keyword searching capabilities were developed using ASP and MySQL.

Florida

Aerial Photography: Florida, The University of Florida Map & Digital Imagery Library, University of Florida Digital Collections
http://www.uflib.ufl.edu/digital/collections/flap/
This collection of aerial photographs taken between 1930 and 2000 is accessible through searchable databases and a map interface. The web site describes the technical considerations to prepare the collection for online access:

> As possible, image capture of the 9 x 9 inch aerial tiles and the 20 x 24 inch photomosaic indexes adhered to the standards promulgated by the Cornell Department of Preservation and Conservation. (See Digital Imaging for Library and Archives, Kenny and Chapman, 1996.)
>
> TIFF masters were the original capture format. Electronic archive masters are uncompressed TIFF files (ITU 6.0) at 100% scale: the current de facto standard for electronic image archives. Aerial tile images were scanned at 615 dpi, 256 greyscale. Because digitized aerial photographs average approximately 29.9 MB, a compressed SID version of 1.3-1.5 MB was created for serving over the web.
>
> The photomosaic indexes were scanned at 400 dpi. The photomosaic indexes average 40 MB in uncompressed TIFF format and average 2.0 MB in SID format. SID images are served from a dedicated server at the Florida Center for Library Automation.

Florida Aerial Photography Archive Collection, Florida Department of Transportation Surveying & Mapping Office
http://www.dot.state.fl.us/surveyingandmapping/apac.shtm
From the web site: Florida Aerial Photography Archive Collection (APAC) is Florida's largest collection of aerial photography. This collection consist of over 450,000 digital images that date back to 1951 plus over 700,000 aerial photos that can date back to the 1940s. This collection is a primary source of aerial photography and digital imagery for the Florida Department of Transportation, State Agencies and the general public.

The site's FAQ notes that the primary format is MrSid, which is used due to the large file size of aerial photography. MrSID is a raster file format developed by LizardTech [http://www.lizardtech.com/] to reduce large, high-resolution images to a fraction of their original size while maintaining near original image quality. Generally only the later images are georeferenced.

Georgia

Georgia Aerial Photographs, The Digital Library of Georgia
http://dbs.galib.uga.edu/gaph/html/
The Georgia Aerial Photographs database provides online access to approximately 50,000 black-and-white aerial photographs and indexes of selected counties from the state of Georgia. The web site describes how the collection was digitized:

> The majority of the original collection consists of 9" x 9" black and white photographs on paper and film. The photographs required cleaning prior to scanning to remove photogrammetric markings. To clean the photographs, we used electric erasers fitted with blue vinyl eraser strips specifically made for use on photos and film. Afterwards, the photos were scanned on a flatbed scanner at 600 dpi, 8-bit grayscale. Minor adjustments, such as contrast and brightness, were made to the photos, as necessary, to improve image quality. The original or master images are LZW compressed TIFF (Tagged Image File Format) format files averaging 16 to 25 megabytes in size. From the master TIFF images, MrSid images were created for use on this database. MrSid is developed and maintained by Lizardtech. This file format allows the viewer to zoom in or out on each image to see finer detail. Also, this format allows the user to print a zoomed and/or cropped portion of the image to any available paper size.

Illinois

Illinois Historical Aerial Photography 1938-1941, Illinois Natural Resources Geospatial Data Clearinghouse, University of Illinois at Urbana-Champaign
http://www.isgs.uiuc.edu/nsdihome/webdocs/ilhap/
From the web site: Statewide aerial photographs were first acquired for Illinois from 1938 through 1941. This collection history gives details about the more than 30,000 photographic paper prints. The original silver nitrate film negatives were destroyed by the National Archives in the 1980s due to deterioration and instability. Use of the paper prints over time has resulted in their becoming faded, worn, defaced or lost. Access to these print collections is becoming increasingly restricted.

Digital files are offered as LizardTech's MrSID .sid files, in either first generation or Generation 2 .sid file formats. Target compression ratios were 12:1 or 6:1, respectively; one compressed file is roughly 3 megabytes or 7.5 megabytes in size, respectively.

Texas

"Texas Digital Aerial Photo Archive Project (TXDAPA): TNRIS Preservation and Digital Conversion of Historical Aerial Photography for the State of Texas," Thomas W. Brown Jr., Anwar Slitine, 2004.
http://proceedings.esri.com/library/userconf/proc04/docs/pap1858.pdf
Abstract: Texas Natural Resources Information System (TNRIS) maintains over one million frames of aerial photography for the State of Texas. Deterioration has been a major problem for the collection. In order to reduce the amount of deterioration the TXDAPA Project was initiated two years ago. TXDAPA takes hard-copy photographs and scans them, then using the ArcView 8.x geo-referencing tool to geo-reference each image. By using the geo-referencing tool it allowed us to be flexible in our approach to the TXDAPA project. For example third party plug-ins were used to display the aerial imagery and using a batch .aml file saved us time and money on rectifying each image. In the two years of the project more than 20 years of county coverage has been completed.

Related resource:

- *Historical Aerial Photography Archive*, Texas Natural Resources Information System, Texas Water Development Board
  http://www.tnris.state.tx.us/DataCatalog/AerialPhotos.aspx

Best Practices for Digital Archiving

The reports below document the activities of the National Geospatial Digital Archive project—one of the projects funded by the Library of Congress's National Digital Information Infrastructure and Preservation Program—which considered the preservation of aerial photography. We also present digital imaging best practices recommended by the Collaborative Digitization Program, now merged with the Digital & Preservation Services unit of BCR, a nonprofit, multistate library cooperative. The BCR recommendations are geared to organizations with the expertise required for in-house digitization.

Final Report of the National Geospatial Digital Archive (NGDA) and Federated Archive Cyberinfrastructure Testbed (FACIT) Projects, Greg Janée, Julie Sweetkind-Singer, Terry Moore, December 17, 2009.
http://alexandria.sdc.ucsb.edu/~gjanee/ngda/ngda-final-report.pdf
The National Geospatial Digital Archive project, which began in 2004, was one of eight initial projects funded by the Library of Congress's National Digital Information Infrastructure and Preservation Program. A second phase of funding, named the Federated Archive Cyberinfrastructure Testbed project, carried the project through to the end of 2009. The overarching goal of the project was to identify how to preserve geospatial data on a national scale.

Researchers evaluated the class of information that includes remote-sensing imagery, aerial photography, maps, data produced by both fixed and mobile geographically embedded sensors, and data created and processed by GIS tools. The broader class of georeferenced information—geotagged photographs and textual documents containing geographic references by name—was excluded from the project. Project goals included identifying general design principles, best practices and, if possible, software architectures that have the capability of managing archived information through unforeseeable technological changes.

"The National Geospatial Digital Archives—Collection Development: Lessons Learned," Tracey Erwin, Julie Sweetkind-Singer, Mary Lynette Larsgaard, *Library Trends*, Vol. 57, No. 3, Winter 2009: 490-515.
Citation at http://muse.jhu.edu/login?uri=/journals/library_trends/v057/57.3.erwin.html
This article focuses on collection development policies for the NGDA project. One of the central findings of the NGDA experience is that format information is vital for long-term preservation.

Of interest to those working outside the library community is the core set of metadata fields recommended by the authors. While all fields will not relate to a digital archive of aerial photography, the list can be instructive. Metadata recommendations begin on page 509 of the article and include:

- Geographic area (coordinates in decimal degrees or words describing the extent).
- Type (maps, remote-sensing imagery (aerial photograph; image from satellite), layers).
- Format (e.g., tiff, jpeg, GeoTIF).
- Projection and/or coordinate system.
- Scale and/or resolution.
- Transfer media (the device upon which data are stored when deposited with the archive, which may be CD, DVD, hard drive, etc.).
- Title.
- Date of information (the date the information was created).
- Data quality information.
- Date ingested into the archive.
- Collection name and description.

BCR's CDP Digital Imaging Best Practices Version 2.0, BCR's CDP Digital Imaging Best Practices Working Group, June 2008.
http://www.bcr.org/dps/cdp/best/digital-imaging-bp.pdf
From page 6 of the PDF:

> The purpose of this document is to offer guidance and to provide digital imaging recommendations for a variety of institutions and collections that are planning for or are involved in digitization projects. These best practices

are not intended to be seen as the de facto standard for digital imaging, but rather as a guide for image capture, presentation, storage and preservation. Inherent and unique characteristics of different source materials necessitate different approaches to digitizing, and conversion requirements for digital projects should be considered on a case-by-case basis.

The document is written for organizations that have the equipment and expertise to digitize in-house and provides digitizing and file format recommendations for:

- Text, photographs, maps, graphic materials, artwork and 3-D objects, film and born-digital files.
- Suggested hardware configurations.
- Software considerations.
- Quality control.
- File naming conventions.
- Scanner and monitor calibration.
- Targets and color bars.
- Storing images.

Proposed User Defined Metadata for Terrashare ISPM Project

March 3, 2009

Record Name	Data Type	String Length	Default Value	Description	Entry Rule	Data Source
Mission Prefix	String	5	m	Mission Prefix Designator	M, CS, FI, FS	Multiple
Mission Number	Integer			Numeric Mission Number	Integer Number	Multiple
Mission Suffix	String	15		Mission Suffix Designator	alpha character or date?	Multiple
TIP Prefix	String	5		TIP or STIP Prefix Designator	A, B, E, FM, I, K, M, P, R, U, W, X, Y, Z	Multiple
TIP Number	Integer			Numeric TIP or STIP Number	????????????	Multiple
TIP Suffix	String	15		TIP or STIP Suffix Designator	project breakdown alpha	Multiple
nonTIP Name	String	30		Descriptive Name to be used in TS ISPM Folder Name for non TIP Projects	see SFF Note	SFF or PLDB
Charge Number	String	15		WBS or Project or Work Order Number	Alphanumeric	FM or PLDB
Description	String	75		Brief Project or Mission Description	Alphanumeric	FM or PLDB
Route Number Prefix	String	5		Route or RR Prefix Designator	I, NC, SR, RR, US,	Multiple
Route Number	Integer			Route or RR Crossing Number	Integer Number	Multiple
Route Number Suffix	String	15		Route or RR Suffix Designator	alpha character (ALT, BUS, BYP, ?)	Multiple
Primary County	String	15		Primary County Coverage	Entry Rule Committee	SFF or PLDB
Secondary County	String	15		Secondary County Coverage	Entry Rule Committee	SFF or PLDB
City	String	20		City Name	Alpha	FM or PLDB
Start Photo Date	Date			Date of Photography or First Date for Multiple Date Missions	Date of Photography or First Date for Multiple Date Missions	PLDB
End Photo Date	Date			Date of Photography for Last Date for Multiple Date Missions	Leave Null for Single Date Missions	PLDB
Acquisition Flag	String	1	D	Digital or Film Acquistion Designator	D or F	FM or PLDB
Primary USGS Quadrangle	String	20		Primary USGS Quadrangle Map for aerial photography coverage	Entry Rule Committee	FM
Secondary USGS Quadrangle	String	20		Secondary USGS Quadrangle for aerial photography coverage	Entry Rule Committee	FM
Primary Flight AMGL feet	Integer		1667	Planned Flying Height AMGL	Units in feet	FM or PLDB
Secondary Flight AMGL feet	Integer			Secondary Planned Flying Height AMGL	Units in feet	FM or PLDB
Primary Planned Image Scale	Integer		4234	Planned Image Scale Ratio (1:#####)	Unitless; (DMC = 2.54x[FH AMGL]); (Film = 2x[FH AMGL])	FM or PLDB
Secondary Planned Image Scale	Integer			Secondary Planned Image Scale Ratio (1:#####)	Unitless; (DMC = 2.54x[FH AMGL]); (Film = 2x[FH AMGL])	FM or PLDB
Lens Number	String	15	DMC01-132	Camera Lens Serial Number	see SFF files; need to define DMC lens	Multiple
Camera Calibration Name	String	20	DMC01-132_10_08	Camera Calibration Name that Identifies Camera & Calibration Date	See NCDOT CAMERA BOOK; Defined in ISPM files	Multiple
Digital Acquisition GSD	Double		0.17	Digital Acquisition Ground Sample Distance in feet	To nearest 1/100 of a foot; Units in feet	FM
Raw Digital Image Archive Date	Date			Date of Raw Digital Image Archive by IT	Date of Raw Digital Image Archive by IT - from LOG Files	Archive Logs
Strip Count	Integer			Number of Strips	Number of Strips Specific to ISPM Project	FM or PLDB
Image Count	Integer			Number of Images	Number of Images Specific to ISPM Project	FM or PLDB
Thumbnail Image Available	Boolean		FALSE	Thumbnail Images Available Online	TRUE or FALSE	DIP
Oblique Images Available	Boolean		FALSE	Oblique Images Available with Mission	TRUE or FALSE	SFF
Primary Product Type	String	10		Primary Product Type (as identifed in PRISM)	M, OP, T, ST, PT, PMM, PS, SPS, PPS, OX, FI, FX, AP, NP, HAPP	PRISM
Secondary Product Type	String	10		Secondary Product Type (as identified in PRISM)	DEM, DTP, DTM, PROP, DRN	PRISM
Ground Control Panels	Boolean		TRUE	Mission Paneled	TRUE or FALSE	FM or PLDB
Units Flag	String	1	E	English or Metric	E or M	Multiple
EO Level Flag	Integer		4	Exterior Orientation Quality for Majority of Images	0 = none or planned; 1 = display; 2 = ESP; 3 = GPS-IMU; 4 = AT	Multiple
Given EO Level Flag	Integer		3	Given Exterior Orientation Quality for Majority of Images	0 = none or planned; 1 = display; 2 = ESP; 3 = GPS-IMU; 4 = AT	Multiple
Horizontal Datum	String	15	NAD83	Horizontal Datum Definition	NAD83 or NAD27	Multiple
Vertical Datum	String	15	NAVD88	Vertical Datum Definition	NAVD88 or NGVD29	Multiple
GPS Base Station Name	String	25		GPS Base Station Names for GPSIMU Post Processing	Alpha	DIP
Localized Coordinate System	Boolean			Project Localized Coordinate System	TRUE or FALSE	Multiple
Localization Monument Name	String	25		Localization Monument Name	Name as Provided in L&S Control File	Multiple
Localization Scale Factor	Double			Localization Scale Factor (Grid to Local)	Localization Scale Factor in L&S Localized Control File	Multiple
Primary Film Type	String	3		Primary Film Type	B/W, C, CIR	FM or SFF
Secondary Film Type	String	3		Secondary Film Type	B/W, C, CIR	FM or SFF
High Resolution Scan Pixel Value	Integer			High Resolution Scan Pixel Value	Units in micrometers (7 or 14 or 21 or 28 or 56, or user entry)	Image Header
High Resolution Scan Archive Date	Date			Date High Resolution Scanned Image Archived by IT	Date High Resolution Scanned Image Archived - from LOG Files/Books	Archive Logs
Comment	String	50		Special Comments about Project, Photography, Coordinates, or Metadata	Comments not addressed in User Defined Metadata	

The default values are set for 1667 ft AMGL DMC projects as the unit moves forward.

New Acronyms

FM = Flight Map

PLDB = Photo Lab Data Base (several)

SFF = Strip from Frame (spreadsheets)

DIP = Digital Image Processing Staff

PRISM = See Rob Allen

Proposed Entry Responsibility for User Defined Metadata for Terrashare ISPM Project

March 3, 2009

Record Name	Data Type	String Length	Default Value	Description	Entry Rule	Data Source
Mission Prefix	String	5	m	Mission Prefix Designator	M, CS, FI, FS	Multiple
Mission Number	Integer			Numeric Mission Number	Integer Number	Multiple
Mission Suffix	String	15		Mission Suffix Designator	alpha character or date?	Multiple
TIP Prefix	String	5		TIP or STIP Prefix Designator	A, B, E, FM, I, K, M, P, R, U, W, X, Y, Z	Multiple
TIP Number	Integer			Numeric TIP or STIP Number	????????????	Multiple
TIP Suffix	String	15		TIP or STIP Suffix Designator	project breakdown alpha	Multiple
nonTIP Name	String	30		Descriptive Name to be used in TS ISPM Folder Name for non TIP Projects	see SFF Note	SFF or PLDB
Charge Number	String	15		WBS or Project or Work Order Number	Alphanumeric	FM or PLDB
Description	String	75		Brief Project or Mission Description	Alphanumeric	FM or PLDB
Route Number Prefix	String	5		Route or RR Prefix Designator	I, NC, SR, RR, US,	Multiple
Route Number	Integer			Route or RR Crossing Number	Integer Number	Multiple
Route Number Suffix	String	15		Route or RR Suffix Designator	alpha character (ALT, BUS, BYP, ?)	Multiple
Primary County	String	15		Primary County Coverage	Entry Rule Committee	SFF or PLDB
Secondary County	String	15		Secondary County Coverage	Entry Rule Committee	SFF or PLDB
City	String	20		City Name	Alpha	FM or PLDB
Start Photo Date	Date			Date of Photography or First Date for Multiple Date Missions	Date of Photography or First Date for Multiple Date Missions	PLDB
End Photo Date	Date			Date of Photography for Last Date for Multiple Date Missions	Leave Null for Single Date Missions	PLDB
Acquisition Flag	String	1	D	Digital or Film Acquistion Designator	D or F	FM or PLDB
Primary USGS Quadrangle	String	20		Primary USGS Quadrangle Map for aerial photography coverage	Entry Rule Committee	FM
Secondary USGS Quadrangle	String	20		Secondary USGS Quadrangle for aerial photography coverage	Entry Rule Committee	FM
Primary Flight AMGL feet	Integer		1667	Planned Flying Height AMGL	Units in feet	FM or PLDB
Secondary Flight AMGL feet	Integer			Secondary Planned Flying Height AMGL	Units in feet	FM or PLDB
Primary Planned Image Scale	Integer		4234	Planned Image Scale Ratio (1:#####)	Unitless; (DMC = 2.54x[FH AMGL]); (Film = 2x[FH AMGL])	FM or PLDB
Secondary Planned Image Scale	Integer			Secondary Planned Image Scale Ratio (1:#####)	Unitless; (DMC = 2.54x[FH AMGL]); (Film = 2x[FH AMGL])	FM or PLDB
Lens Number	String	15	DMC01-132	Camera Lens Serial Number	see SFF files; need to define DMC lens	Multiple
Camera Calibration Name	String	20	DMC01-132_10_08	Camera Calibration Name that Identifies Camera & Calibration Date	See NCDOT CAMERA BOOK; Defined in ISPM files	Multiple
Digital Acquisition GSD	Double		0.17	Digital Acquisition Ground Sample Distance in feet	To nearest 1/100 of a foot; Units in feet	FM
Raw Digital Image Archive Date	Date			Date of Raw Digital Image Archive by IT	Date of Raw Digital Image Archive by IT - from LOG Files	Archive Logs
Strip Count	Integer			Number of Strips	Number of Strips Specific to ISPM Project	FM or PLDB
Image Count	Integer			Number of Images	Number of Images Specific to ISPM Project	FM or PLDB
Thumbnail Image Available	Boolean		FALSE	Thumbnail Images Available Online	TRUE or FALSE	DIP
Oblique Images Available	Boolean		FALSE	Oblique Images Available with Mission	TRUE or FALSE	SFF
Primary Product Type	String	10		Primary Product Type (as identifed in PRISM)	M, OP, T, ST, PT, PMM, PS, SPS, PPS, OX, FI, FX, AP, NP, HAPP	PRISM
Secondary Product Type	String	10		Secondary Product Type (as identified in PRISM)	DEM, DTP, DTM, PROP, DRN	PRISM
Ground Control Panels	Boolean		TRUE	Mission Paneled	TRUE or FALSE	FM or PLDB
Units Flag	String	1	E	English or Metric	E or M	Multiple
EO Level Flag	Integer		4	Exterior Orientation Quality for Majority of Images	0 = none or planned; 1 = display; 2 = ESP; 3 = GPS-IMU; 4 = AT	Multiple
Given EO Level Flag	Integer		3	Given Exterior Orientation Quality for Majority of Images	0 = none or planned; 1 = display; 2 = ESP; 3 = GPS-IMU; 4 = AT	Multiple
Horizontal Datum	String	15	NAD83	Horizontal Datum Definition	NAD83 or NAD27	Multiple
Vertical Datum	String	15	NAVD88	Vertical Datum Definition	NAVD88 or NGVD29	Multiple
GPS Base Station Name	String	25		GPS Base Station Names for GPSIMU Post Processing	Alpha	DIP
Localized Coordinate System	Boolean			Project Localized Coordinate System	TRUE or FALSE	Multiple
Localization Monument Name	String	25		Localization Monument Name	Name as Provided in L&S Control File	Multiple
Localization Scale Factor	Double			Localization Scale Factor (Grid to Local)	Localization Scale Factor in L&S Localized Control File	Multiple
Primary Film Type	String	3		Primary Film Type	B/W, C, CIR	FM or SFF
Secondary Film Type	String	3		Secondary Film Type	B/W, C, CIR	FM or SFF
High Resolution Scan Pixel Value	Integer			High Resolution Scan Pixel Value	Units in micrometers (7 or 14 or 21 or 28 or 56, or user entry)	Image Header
High Resolution Scan Archive Date	Date			Date High Resolution Scanned Image Archived by IT	Date High Resolution Scanned Image Archived - from LOG Files/Books	Archive Logs
Comment	String	50		Special Comments about Project, Photography, Coordinates, or Metadata	Comments not addressed in User Defined Metadata	

Entry Responsibility
Digital Image (Photo Lab) Processing Squad
Engineering Squads

New Acronyms
FM = Flight Map
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Proposed User Defined Metadata for Terrashare Index Mosaic Project

March 4, 2009

Record Name	Data Type	String Length	Default Value	ISPM User Metadata	Description	Entry Rule	Data Source
Mission Prefix	String	2	m	yes	Mission Prefix Designator	M, CS, FI, FS	Multiple
Mission Number	Integer			yes	Numeric Mission Number	Integer Number	Multiple
Mission Suffix	String	10?		yes	Mission Suffix Designator	alpha character or date?	Multiple
TIP Prefix	String	2?		yes	TIP or STIP Prefix Designator	A, B, E, FM, I, K, M, P, R, U, W, X, Y, Z	Multiple
TIP Number	Integer			yes	Numeric TIP or STIP Number	Integer Number	Multiple
TIP Suffix	String	10?		yes	TIP or STIP Suffix Designator	project breakdown alpha	Multiple
nonTIP Name	String	20		yes	Descriptive Name to be used in TS ISPM Folder Name for non TIP Projects	see SFF Note	SFF or PLDB
Charge Number	String	10		yes	WBS or Project or Work Order Number	Alphanumeric	FM or PLDB
Description	String	50		yes	Brief Project or Mission Description	Alphanumeric	FM or PLDB
Route Number Prefix	String	2		yes	Route or RR Prefix Designator	I, NC, SR, RR, US,	Multiple
Route Number	Integer			yes	Route or RR Crossing Number	Integer Number	Multiple
Route Number Suffix	String	10?		yes	Route or RR Suffix Designator	alpha character (ALT, BUS, BYP, ?)	Multiple
Primary County	String	12		yes	Primary County Coverage	Entry Rule Committee	SFF or PLDB
Secondary County	String	12		yes	Secondary County Coverage	Entry Rule Committee	SFF or PLDB
City	String	15		yes	City Name	Alpha	FM or PLDB
Start Photo Date	Date			yes	Date of Photography or First Date for Multiple Date Missions	Date of Photography or First Date for Multiple Date Missions	PLDB
End Photo Date	Date			yes	Date of Photography for Last Date for Multiple Date Missions	Leave Null for Single Date Missions	PLDB
Acquisition Flag	String	1	D	yes	Digital or Film Acquistion Designator	D or F	FM or PLDB
Units Flag	String	1	E	yes	English or Metric	E or M	Multiple
Horizontal Datum	String	8	NAD83	yes	Horizontal Datum Definition	NAD83 or NAD27	Multiple
Comment	String	50		yes	Special Comments about Project, Photography, Coordinates, or Metadata	Comments not addressed in User Defined Metadata	
Coordinate System	String	10	NCSP	no	Index Mosaic Coordinate System	NCSP, NCSP-LOCAL, or open for others such as UTM	
Image File Format	String	10		no	Image File Format	JPEG2000, JPG, SID, TIF, TIFwJPG	
Index Mosaic Exposure Type	String	3	C	no	Index Mosaic Exposure Type	B/W, C, CIR	
Pixel GSD	Double			no	Index Mosaic Ground Sample Distance in feet	To nearest 1/100th of a foot	
Index Mosaic Status	String	11	PRELIMINARY	no	Completion Status Flag - is it preliminary or final (i.e. elevated structures fixed)	PRELIMINARY or FINAL	
Final Index Mosaic Verification Date	Date			no	Date the Final Index Mosaic Status is set at FIBAL	Date the Final Index Mosaic Status is set at YES	
Preliminary Index Mosaic Archive Date	Date			no	Date of Preliminary Index Mosaic Archive Date by IT	Date of Preliminary Index Mosaic Archive Date by IT - from LOG files	
Final Index Mosaic Archive Date	Date			no	Date ofFinal Index Mosaic Archive Date by IT	Date of Final Index Mosaic Archive Date by IT - from LOG files	

ALL Index Mosaic Metadata Entry will be done by Digital Image Processing Squad

ALL Index Mosaic Replacement (remove Preliminary, add Final) will be done by Digital Image Processing Squad

ALL Index Mosaic Archiving will be done by Digital Image Processing Squad

RANDY - Change String Lengths

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