Utilizing Videography and GIS for Right-of-Way Identification

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Abstract

In this project study, Georgia Power Company (GPC) sought a cost-effective option to fly the utility Right-of-Way's (ROW) and collect low-level, airborne, georeferenced videography complemented with georeferenced still imagery to enable GPC to complete attribute data collection. The project results enabled GPC to access all ROW points of interest in ArcGIS, and "fly" the line with oblique and downward perspectives from its computer screen. The digital video can be reviewed, allowing GPC to review each frame for careful, detailed analysis and to identify potential issues within the ROW. The high-resolution still imagery provides GPC with a closer inspection of site features such as encroachments and facility conditions on the ROW. Additionally, the data is incorporated within the enterprise ArcGIS allowing the video, high-resolution images and facility attributes to be accessed throughout GPC, providing a more comprehensive analysis tool for quality assurance, interpretation and planning.

Introduction

In 2004 GPC felt that the growing use of their existing data set was producing greater demand for additional and more detailed information. The decision was made to refresh their GIS as the last system update of the GPC transmission network was in 1998-99. During that time substantial additions and upgrades had been done to the transmission network to justify a full system update.

GPC awarded LinearVision, LLC (LV) contracts to map the Metro and Northern Transmission Maintenance Centers (TMC). The Metro TMC consists of 26,000 structures on approximately 2,900 miles. The Northern TMC consists of 29,000 structures on approximately 3,500 miles.

Prior to each project, LinearVision and GPC met to outline a plan of action, finalize attribute capture definitions, schedule the project and finalize video standards. With this accomplished, LinearVision began to visit each structure, substation and associated right-of-way by aircraft to obtain the latitude and longitude of every transmission structure and feature.

Deliverables to GPC included point and attribute data in an ESRI Geodatabase format; digital photos and strip Orthophotos of its ROW, oblique forward-looking view of every attributed structure; USB/Firewire external hard drives containing the data files as well as the images and videos; the LinearVision's Viewer, an integrated viewing software.

This paper will detail the background, methodology/technology, deliverables, and analysis of the project.

Background

Corporate History

Georgia Power

Georgia Power, the largest of four electric utilities that make up Southern Company, has been providing electricity to Georgia for more than a century. Georgia Power is an investor-owned, tax-paying utility that serves customers in 57,000 of the state's 59,000 square miles. The company's 2 million customers are in all but six of Georgia's 159 counties. (1)

LinearVision, LLC

LinearVision is a limited liability company with its office headquarters in Herndon, Virginia and a branch office located in Victoria, BC. LV technology features aerial low-level surveys, high-resolution digital video, integrated digital still images, DGPS survey, airborne laser surveys and optional infrared inspections.

Existing Conditions

Through internal discussions, GPC identified the following drivers to proceed with the approval of a full system refresh.

(1) The need for the inclusion of facilities and/or upgrades to the existing facilities within the current data set.
(2) A requirement of an inventory of new and legacy encroachments on ROWs.
(3) Vegetation management reporting – confirmation of data provided to Federal Energy Regulatory Commission (FERC) in a June 17, 2004 report on Vegetation Management.
(4) Requirement to provide up-to-date data for re-licensing processes. Refreshed information on structure locations and rights-of-way condition in the vicinity of generating plants and dams would facilitate fieldwork associated with re-licensing processes.
(5) Identification of environmentally sensitive areas such as wetlands, stream crossings and avian sensitive areas.

Identified Tasks

(1) Aerial Data collection of transmission system facilities and associated assets.
(2) Facility data collection will include GIS delivered data containing:
    a. Point feature classes
    b. Video capture of transmission lines and transmission ROWs within the specified project areas
    c. Associated high resolution images of facilities
    d. Specific attributes of facilities
    e. Locations of facility attachments
    f. Identify and classify ROW encroachments
    g. Provide ROW boundary polygons
    h. Identify all streams within/crossing ROW boundary

Data Collection Methodology

Aerial Reconnaissance

GPC contracted LV to collect aerial footage of the transmission right of way corridor. A helicopter-based, custom data capture system was utilized to fly the Atlanta and North Georgia transmission corridors from Fall 2004 – Spring 2005. The data capture system utilized an oblique video camera, an oblique still image camera, and a ground-facing video camera to record footage of the corridor.

Deliverable Summary	
Oblique and Survey Digital Videos	√
High-resolution still images	√
LinearVision Viewer™	√
Coordinate pick ability	√
Video manager to switch videos	√
Shapefiles in state plane projection	√
Ability to launch video from ESRI Products	√

The transmission corridor was flown at a height of 20 – 40 feet above the centerline of the structures and at a speed between 50 to 60 miles per hour. The image capture system provided high-resolution still images at each structure. The video footage and high-resolution still images were geo-referenced at capture with longitude and latitude coordinates.

Data Acquisition

For both projects, the project teams mobilized to a central location on the ROW to install equipment on one of the helicopter partner airships. The custom imaging system is extremely portable and easy to install on multiple helicopter platforms. For these projects, a Bell 206 was used.

The equipment was installed in a single day, and production began the following day. Multiple instruments were mounted on the helicopter, including a video camera to collect an oblique view of the right-of-way, a downward-facing video camera, a high-resolution digital still-image camera, a laser-sensing device, and an inertial motion unit (IMU) to determine and collect height-above-ground information.

A staff operator was in place to operate the data collection software and perform any troubleshooting or analysis that was required during the flight. (Figure 1) A field technician was also in place on the ground to ensure that the equipment was installed correctly and to carry out any organizational and administrative tasks that were required. As well a navigator was added when needed to assist the pilot.

Figure 1 – LinearVision System

After the data-collection stage, all of the data was sent back to the office for immediate processing. The majority of the software used to edit and process the video, images, and spatial data is proprietary and has been developed internally. Due to the "in-house" nature of the tools, everything is designed specifically for the exact needs of the client, which results in an extremely rapid turnaround time for the final deliverable. The final delivered data for this job contained both survey and oblique digital-video in MPEG4 format, high resolution images, spatial data as shapefiles in state plane projection, and the LV proprietary software: the LV Viewer™.

Technology

The LV Viewer™ is a fully integrated video and still image viewer which provides direct access from ARCGIS to all imagery data, as well as access back to the database or ArcGIS. The viewer is specifically designed for linear right-of-way imagery and possesses integrated time saving features such as functionality to advance directly to a structure location, image access, video playback control, the ability to seamlessly switch between both oblique and survey video streams, as well as other features designed for data viewing and comparison. The viewer is designed to work as a stand-alone viewer with full database functionality, and is optimized for direct access to any video frame or geographic index point within the video. This functionality reduces the data flow requirements on a client's network, providing a fast and convenient viewer experience. When integrated with an ArcGIS, the viewer enables point-and-click functionality, enabling a user to start viewing a video at a specific geographic location from within the ArcGIS.

The LV Viewer™ also has built in spatial measurement functionality, allowing the user to perform on-screen measurements of any location or distance which appears in the survey video.

The data used for these measurements was collected using a Satloc SLXG 12-channel GPS receiver utilizing real-time error-correction data via the Wide Area Augmentation System (WAAS) network. The WAAS is a system that improves the precision and accuracy of global positioning system (GPS) signals. It uses specialized satellites to send correction signals to GPS receivers, as well as providing integrity information for each satellite's signal, equivalent or better than RAIM (receiver autonomous integrity monitoring), thereby improving the accuracy of the GPS signal by approximately five times. This location data is precisely correlated with the survey video frames. This geographic data, combined with data collected by the helicopter-mounted laser height sensor, allows for very precise co-ordinates to be determined for the center of every downward video frame, as well as accurate derivation of any other in-frame location.

Analysis of Data / Deliverables

Processing

LV, after receiving the data from the field, began to process the raw data, which included all the images, and video and flight data. Data was filtered and verified for consistency. Images were processed, brightened and adjusted for maximum tower visibility. Survey and Oblique video was encoded and edited in sequence with the flight data to remove data that is not over the ROW. Videos were indexed at each feature (structures, switches and stations), and the appropriate image is linked to it. This allows GPC to view the assets at a higher level of detail. Coordinates of the features were linked to the imagery and videography index points.

Attribution

The first round of attribution is recording all information that can be visually extracted from the high-resolution still images, such as: structure number, type, material, insulator configuration, and types of underbuild.

The second round of attribution involved visually inspecting the survey and oblique videos for the following items: abandoned motor vehicles, avian contamination, buildings, cemeteries, construction, danger trees, debris, "hazardous conditions", hunting blinds, pools, recreational facilities, signs, underground / overhead utilities, and wells / tanks. Utilizing internal proprietary tools and techniques the above items were identified then attributed and exported into ArcGIS shapefiles.

A third round of attribution was included as GPC requested during the project to identify streams and create ROW boundaries. This deliverable was supplied through the combination of the videos and Orthophotography. ROW Boundaries, stream locations and widths were digitized and exported into ArcGIS.

Integration

When all the data was exported into ArcGIS, the redundant features were eliminated and items were checked for quality. A comparison was then made between the existing GPC data set and the new LV data set. Any differences were flagged and resolved through ongoing interaction with project contacts at GPC.

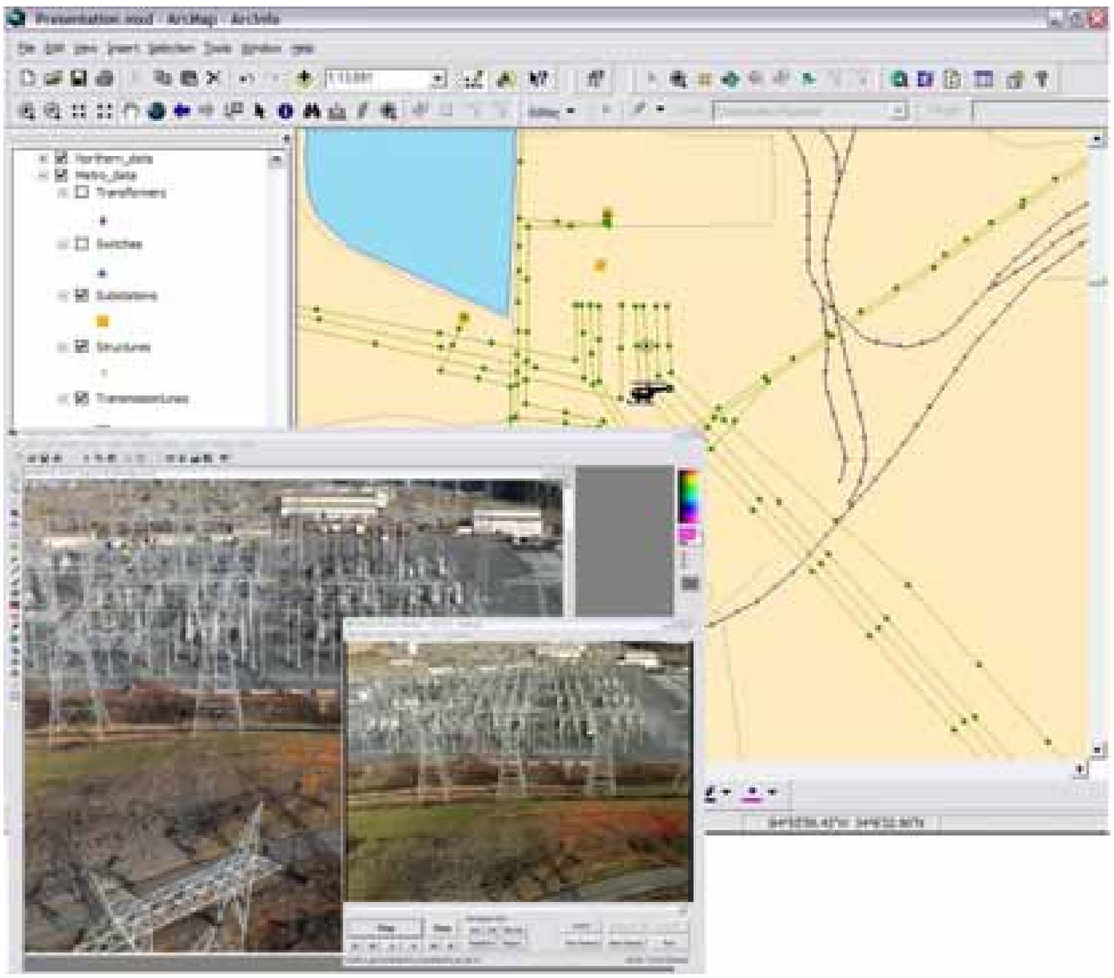

Figure 2 – ArcGIS Integration

While working in ArcGIS all non-graphic information, such as line names and switch numbers were then linked back to the indexed points in the videos. All point features were linked to the video using the “hyperlink” tool in ArcMap. From the video, any GPC user can make a visual inspection of the features that were identified. The final step post QA/QC was loading the deliverables into the GPC-defined geodatabase and submitted for client acceptance. (Figure 2)

Project Assessment

Benefits of Aerial Videography Analysis

- Replaced old and lower resolution images of facilities (Figure 3) with updated, high resolution images (Figure 4)

Figure 3 – Original Imagery

Figure 4 – Refreshed Imagery (Flown Opposite Direction)

- High resolution photos permitted detailed attribution for GIS (Figure 5)

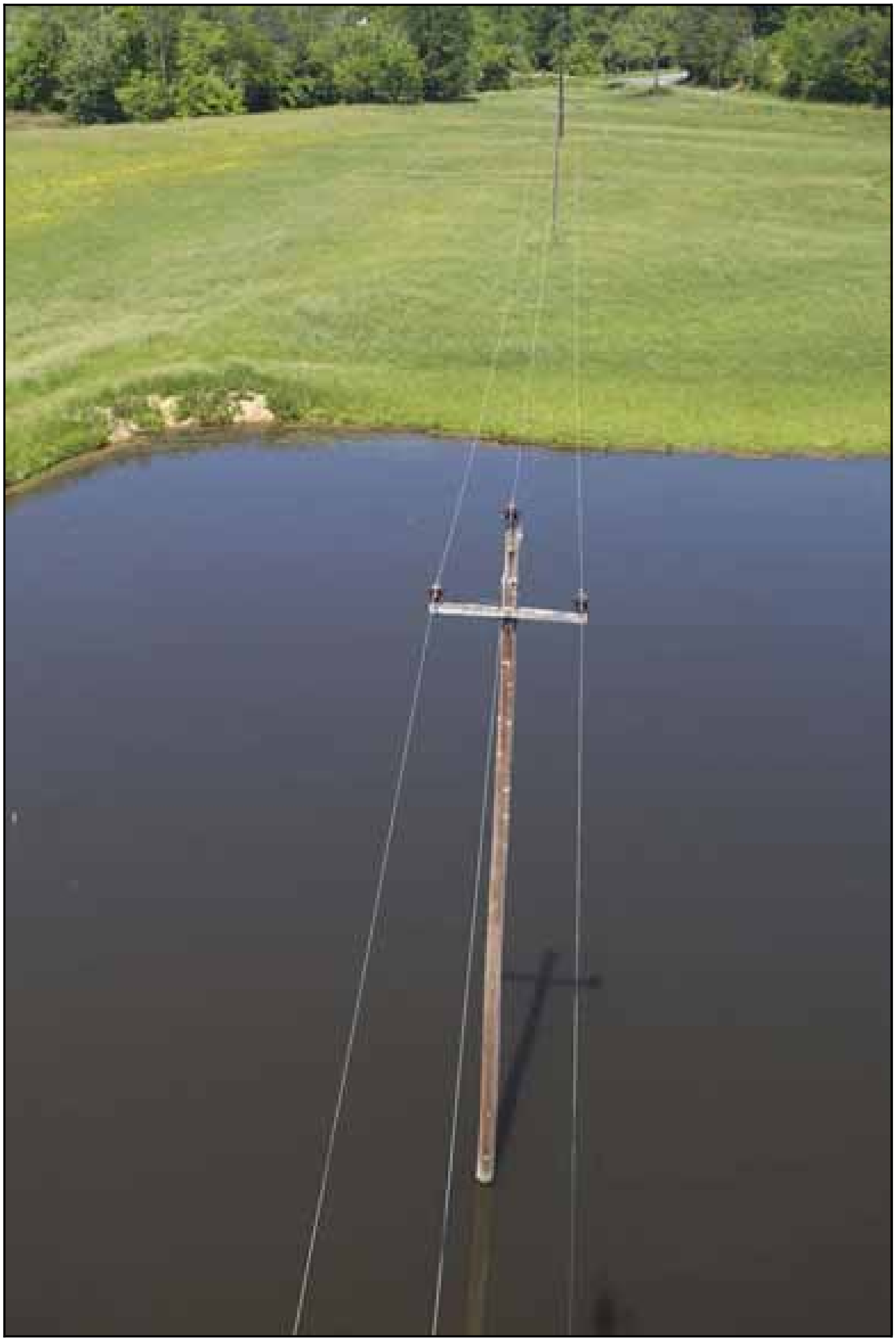
Figure 5 – High Resolution Image

- Captured new and/or updated information on facilities
- Provided an accurate complete "snapshot" and documentation of encroachments across the system (Figures 6 – 7)

Figure 6 – Encroachment

Figure 7 – Zoom in of Encroachment

- Provided status of ROW widths (Figure 8)

Figure 8 – Right-of-Way

- Provided up to date locations of facilities
- Captured avian nest/habitat locations (Figure 9)

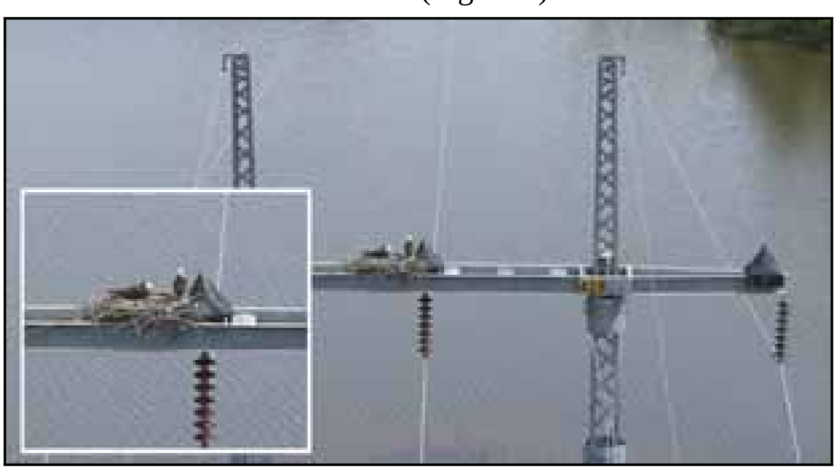

Figure 9 – Avian Contamination

- Provided up to date images of facilities
- Provided vegetation condition of ROW (Figure 10)

Figure 10 – Vegetation Encroachment

- Provided QA/QC of existing facilities database
- Captured locations of attachments – joint use locations (Figure 11)

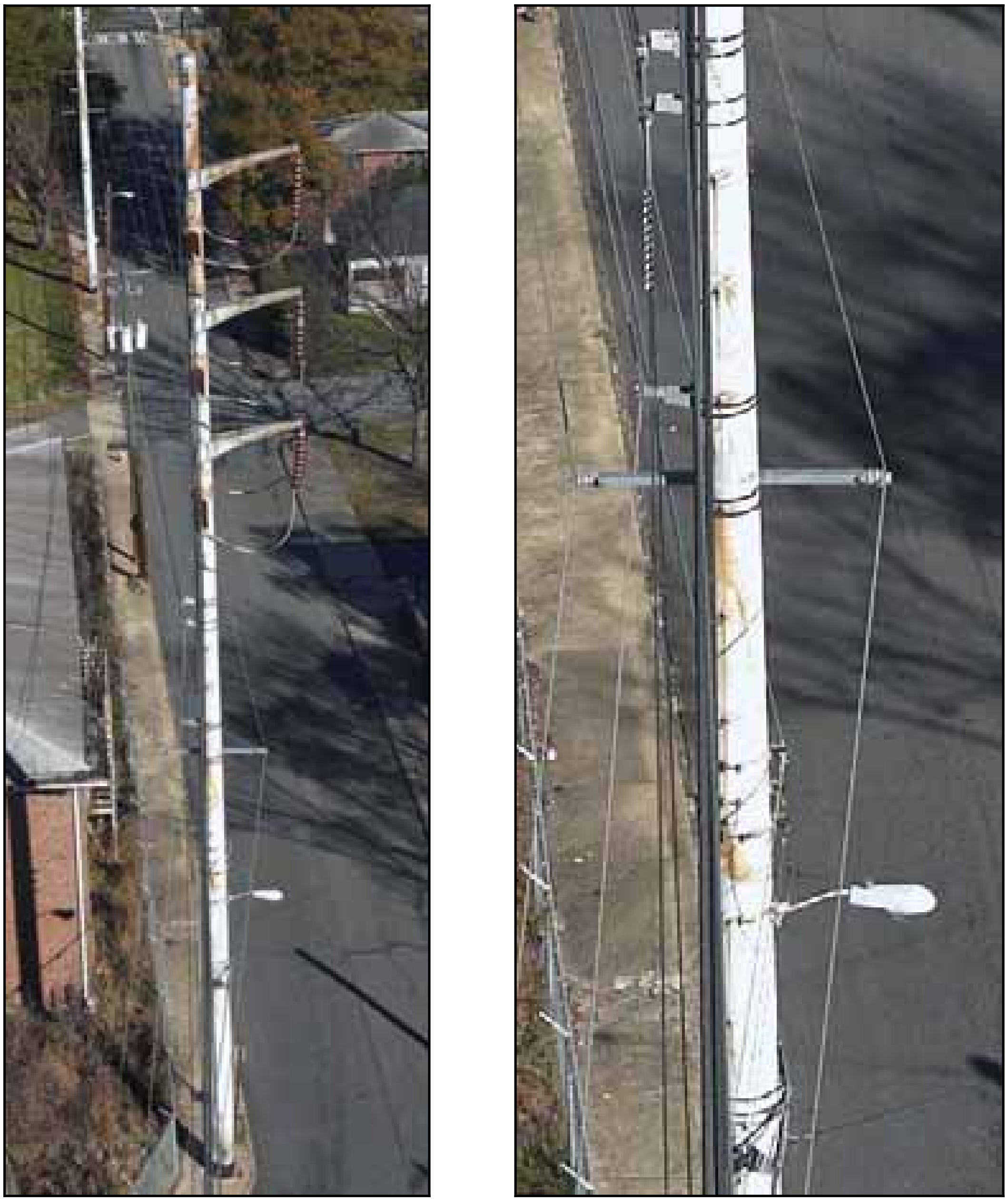

Figure 11 – Underbuilds

Summary

Through the use of the low-level airborne georeferenced videography complemented with georeferenced still imagery, GPC was able to meet all of the five project drivers. The LV data collection methodology enabled a rapid data delivery enabling immediate analysis and integration within the GPC ArcGIS.

Statistics
10 weeks to fly
10 weeks to process
6,400 line miles collected
55,000 images
112 hours of video
900 GB of data

Appendixes

1. www.southernco.com/gapower/about/about.asp

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Dawson Ingram graduated from Samford University with a degree in Environment Sciences and GIS. Dawson has worked in the utility industry for over 10 years and has extensive knowledge of GIS and integrating GIS in the utility industry. Over the past 4 years he has worked in a senior support role for transmission lines at Georgia Power and Southern Company. During this time he has participated in various projects that have helped to improve the inspection and maintenance of transmission facilities at Southern Company. Prior to Georgia Power, Dawson worked 7 years for engineering and environmental consulting firm and 2 years with Alabama Power.

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Mr. Shankland's 12 years' experience in the utility industry focused on Geographic Information Systems in both the Distribution and Transmission side of the utilities. Currently, Mr. Shankland represents LinearVision, LLC as their Director of Sales