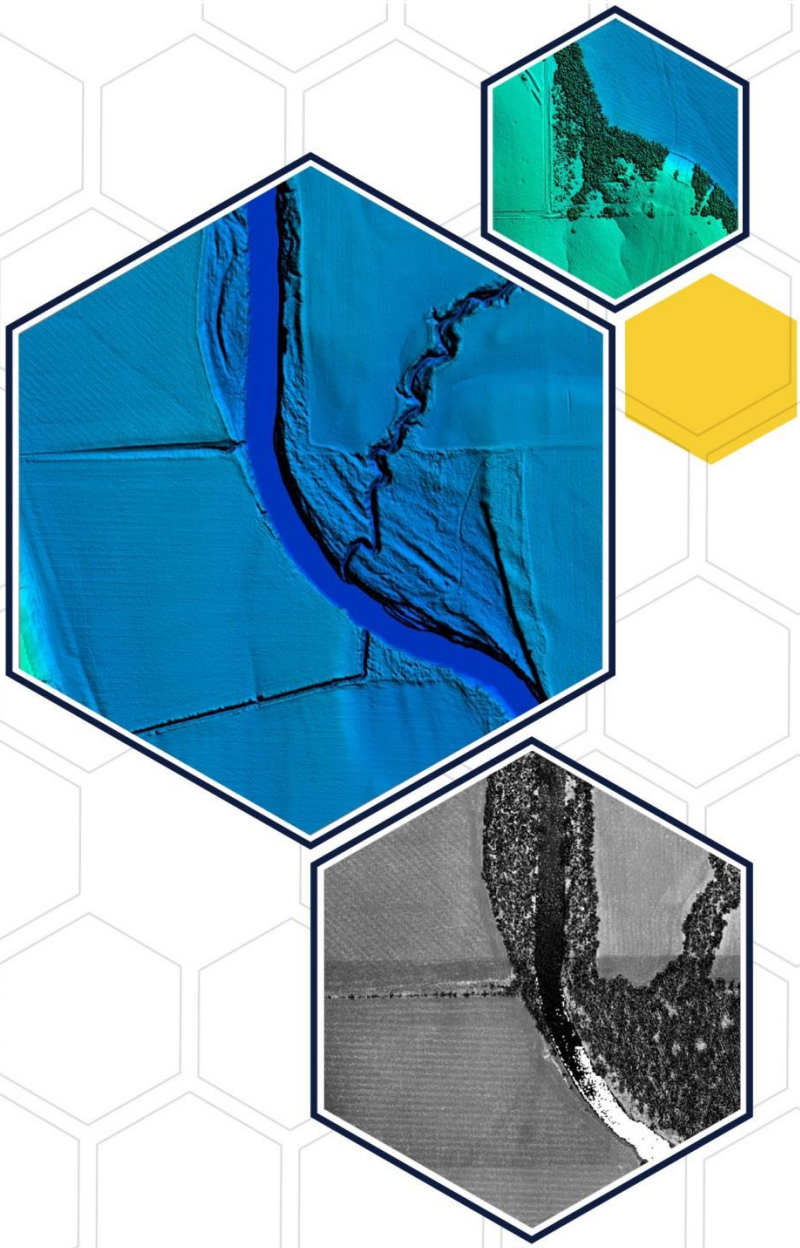


atlantic

Shelby County, TN / ReGIS

2017 LiDAR, Orthophotography, Planimetrics

Project Plan And Procedures Manual

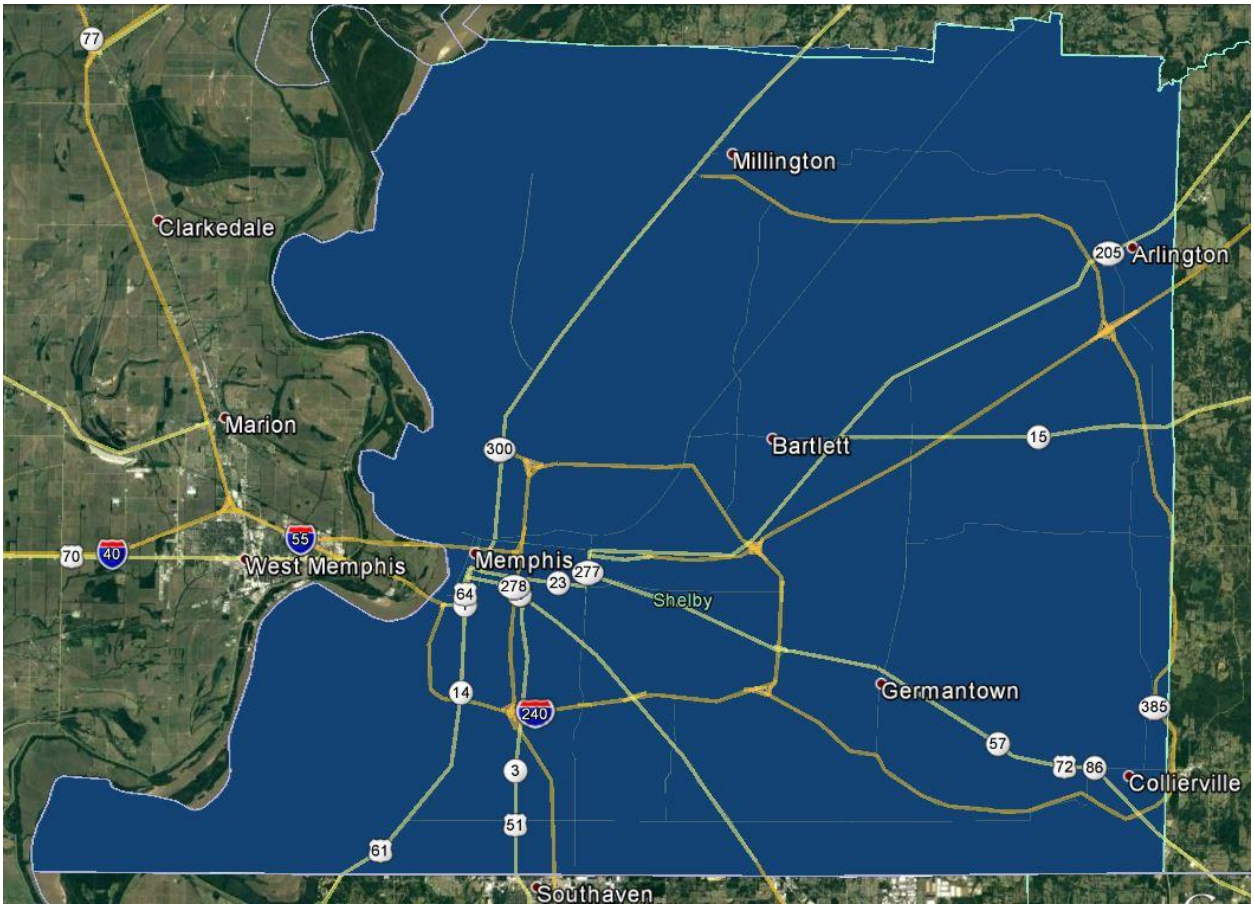
January, 2017

Table of Contents

Section 1: Project Overview

1.1 Project Area

Atlantic will perform the 2017 LiDAR, Orthophotography, and Planimetric program effort utilizing the project boundary file provided by Shelby County. This county boundary shapefile is shown below.



Shelby County Boundary shapefile (SHP) as displayed in Google Earth

1.2 Project Initiation

Atlantic submitted a response to the Shelby County RFP #16-011-25 on December 4, 2015. The Notice of Award Letter was received from Shelby County on February 19, 2016. The official, final signed contract was received by Atlantic on January 5, 2017. Upon receipt of the contract, Atlantic proceeded with the project initiation. This began officially with the first phase of the program effort – this Project Plan & Procedures document.

1.3 Pre-Mapping Coordination And Support

In addition to the award, contract, and formal project proceedings stated above, Atlantic also participated in several meetings and collaborative efforts in anticipation of the project initiation. These activities helped combine insight across the participating municipalities and aimed to achieve a consensus understanding of the required variables within the project scope, and coordination needs.

On March 22, 2016 Atlantic met with representatives of Shelby County and Memphis Light Gas & Water (MLGW) to discuss the benefit of various, utility-specific, Planimetric features. This discussion continued on April 6, 2016 when Atlantic returned to Memphis to address each Planimetric feature in further detail. A follow-up conference call was held between Atlantic and MLGW on April 15, 2016 narrowing down the utility-specific Planimetric features that would be needed.

On June 17, 2016 Atlantic held a conference call with Shelby County and discussed and agreed upon each Planimetric feature that would appear on the final contracted deliverables list.

Atlantic returned to Memphis on August 30, 2016, presenting an overview of the LiDAR portion of the program to Shelby County area stakeholders.

Prior to contract signing, Atlantic's Flight Management team began coordinating with the Memphis International Airport's air traffic control center (KMEM) to approve and finalize the proposed LiDAR and Imagery flight plans.

Finally, Atlantic presented an overview of the 2017 program along with Shelby County representatives at the annual Memphis Area Geographic Information Council (MAGIC) conference in December 2016.

Atlantic's support of small businesses as partners will also be implemented during the 2017 Shelby County program. During the pre-project planning and coordinating phase, Atlantic discussed subcontracting the ground survey and control effort to a local small business - local surveying firm W.H. Porter. Atlantic reached a subcontract agreement with W.H. Porter on January 31, 2017 to have them assist in acquiring the program's survey and ground control network.

The efforts stated above helped to establish and ensure a collaborative partnership between Atlantic, Shelby County, and its stakeholders to execute the 2017 program in the best manner possible for all entities.

1.4 Project Schedule

During the program's contract signing, Atlantic and Shelby County agreed to the project deliverable schedule as shown below:

Approximate Delivery Date	Deliverable Item
1/3/2017	Post-Contract Signing Pre-Acquisition Planning, Management, Mobilization, Reporting
2/1/2017	The Project Plan and Procedures Manual
2/15/2017	LiDAR Acquisition
3/15/2017	3-Inch Imagery Acquisition
4/15/2017	Level 1 (L1) Preliminary Geo-referenced unedited Imagery
6/15/2017	Full Deliverable Pilot Sample
7/1/2017	Monthly 'Proof of Performance' Data Deliveries
8/1/2017	
9/1/2017	
10/1/2017	
10/1/2017	Block 1 - 3" Orthos
11/1/2017	Monthly 'Proof of Performance' Data Deliveries
11/1/2017	Block 2 - 3" Orthos
11/1/2017	Block 1 Planimetrics
11/15/2017	LiDAR Final Deliverables
11/15/2017	Block 3 - 3" Orthos
11/15/2017	Block 2 Planimetrics
12/15/2017	LiDAR Derivative: 1-Foot Contours
12/15/2017	Block 4 - 3" Orthos
12/15/2017	Block 3 Planimetrics
1/15/2018	Block 4 Planimetrics
1/15/2018	MLGW Plan Collection Add-Ons

Section 2: Project Management Plan

2.1 Overview

Atlantic provides an extensive experience and knowledge base to contribute to the success of the 2017 Shelby County LiDAR, Orthophotography, and Planimetric program. The following sections breakdown the Atlantic team that will participate on this program effort – including key staff, management strategies, and procedures.

2.2 Key Personnel

Atlantic employs six ASPRS Certified Photogrammetrists, three Professional Surveyors, three Certified Geographic Information Systems Professionals, four PMI Certified Project Management Professionals, six FAA Licensed Pilots and one Professional Geologist. Atlantic's key management team is well equipped and prepared to supervise and manage large and small scale simultaneous mapping projects.

The table below highlights Atlantic staff in key disciplines ensuring success specific to the services and objectives of the 2017 Shelby County program.

Atlantic Key Personnel													
Certified Photogrammetrists	Photogrammetric Technicians	Licensed Land Surveyors	Other Surveyors	Certified GIS Professionals	Other GIS Professionals	LiDAR Specialists	Orthophoto Specialists	Licensed Pilots	Airborne Sensor Operators	QA/QC Specialists	Project Managers	Administrative	Total
6	2	3	2	3	5	4	4	6	4	4	4	2	48

2.3 Communication

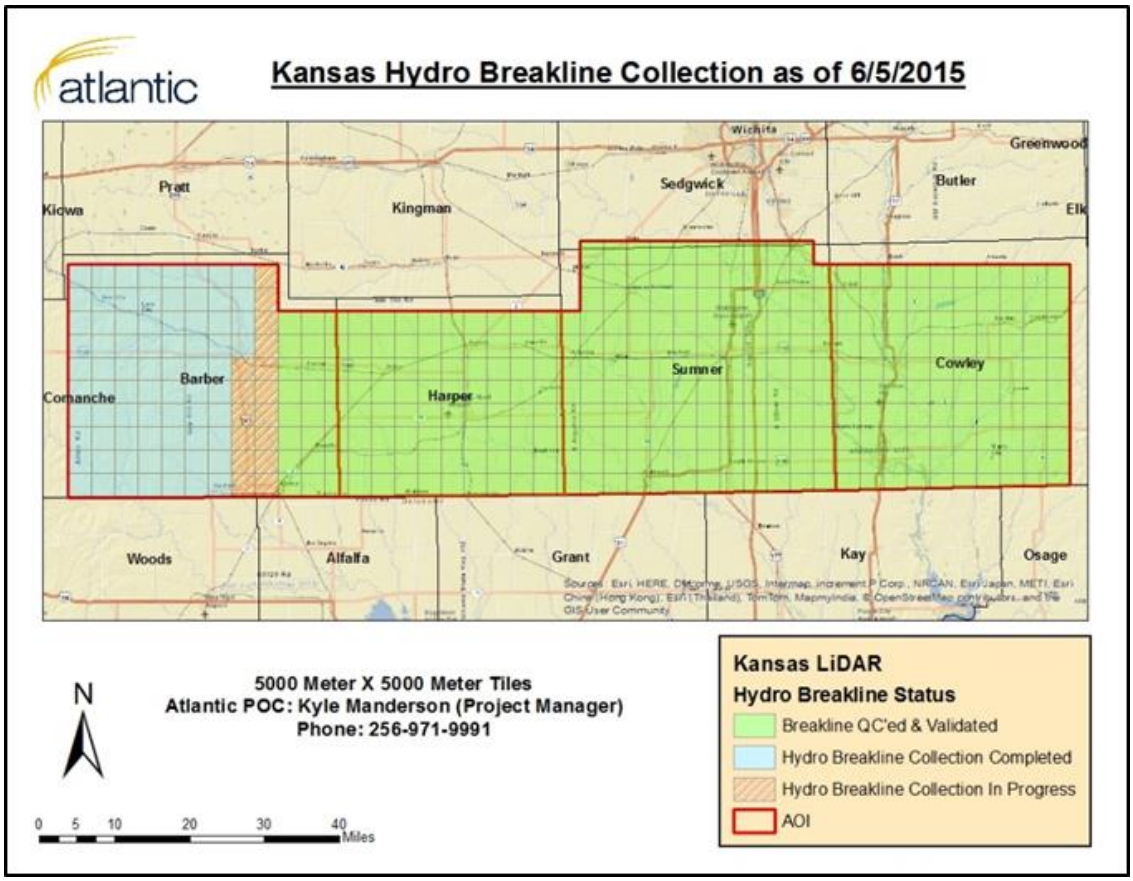
The table below identifies the primary points of contact for the 2017 Shelby County program. Atlantic implements the core belief that the key approach to project management is consistent, effective communication.

Functional Areas	Primary Points Of Contact		Contact Information
Contractual, Administrative, Project Management, Production, Technical Concerns, QA/QC	Justin Lee Henderson	**ALL COMMUNICATION**	justin.henderson@atlantic.tech 256.971.9991 – office 334.559.3694 – cell
	Rick Stieg		rick.stieg@shelbycountytn.gov 901.222.7440 – office

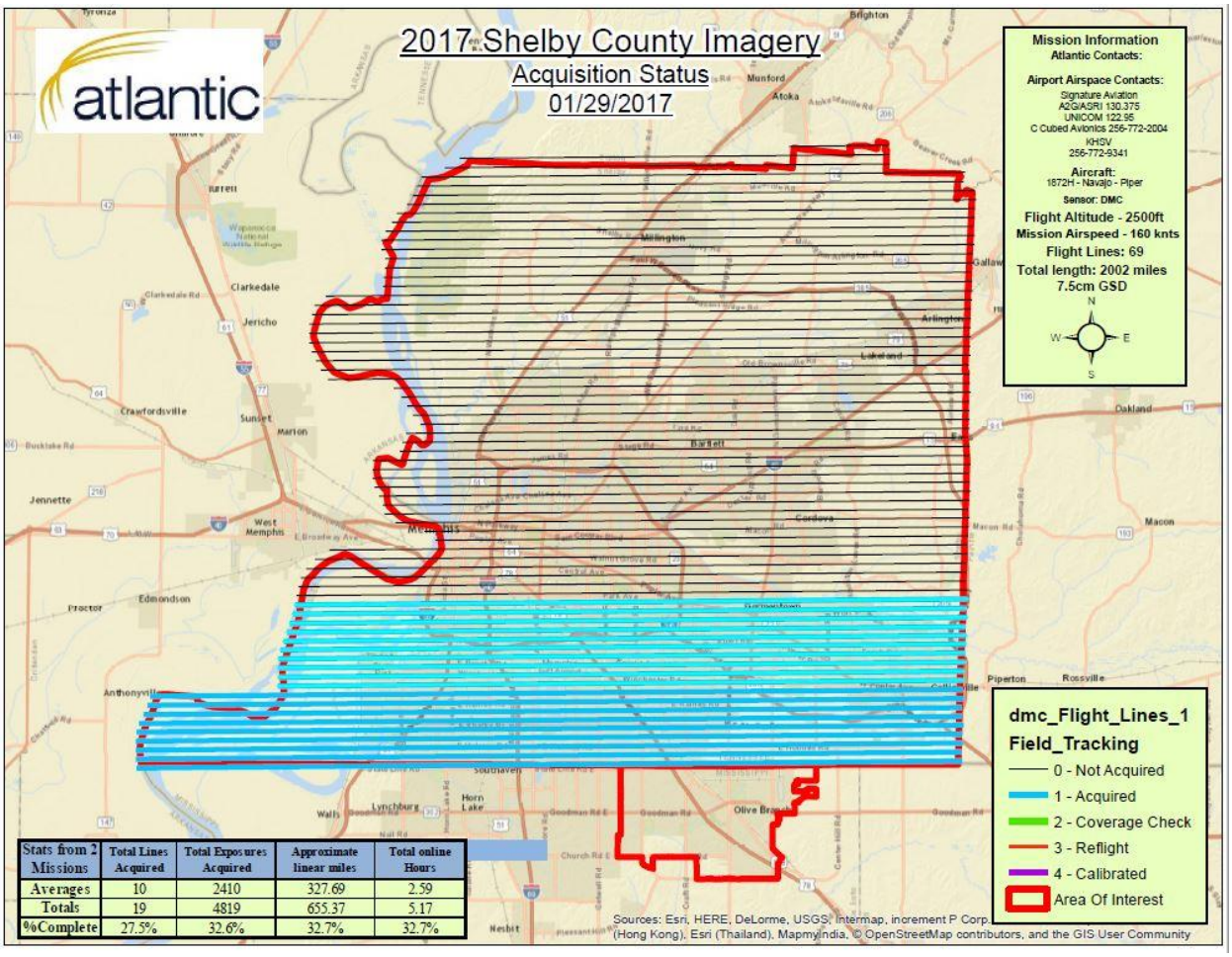
2.4 Project Reporting

Atlantic utilizes frequent, detailed communication and status reporting in an effort to maximize visibility and overall project success. Throughout the lifecycle of the project, Atlantic's assigned Project Manager (Justin Henderson) will provide Shelby County with regular verbal status updates via phone. More formally, monthly project status reports will be provided throughout the life of the project. These status reports aim to address the percentages of tasks completed, estimated completion of project milestones, as well regular assessments of overall project deliverables set forth by the client. Atlantic's ultimate goal is to provide Shelby County with an informed, well-planned, and effectively communicated project experience.

Additionally, Atlantic will provide "a-Track" updates – a real-time project status tracking and reporting application. This system is developed using ArcGIS Server 10.1 and FLEX technology. During the acquisition phases of the project, a-Track is updated daily from our flight operations so that Shelby County will receive up-to-date information on flight acquisition missions – and a daily report. An example of this is seen in the two screen shots below.



Above: PDF display of an "a-Track" Production Status Update



Above: PDF display of an "a-Track" Acquisition Status Update

2.5 Meetings

Atlantic's status review process consists of, at a minimum, three post-contract meetings during the project life cycle:

2.5.1 Client Kick-Off Meeting

Atlantic plans to conduct a Kick-Off Meeting with key members of the Shelby County and ReGIS staff as soon as possible for all parties after notification of the award and before production begins. The purpose of this meeting is to walk through the general objectives of the Shelby County program, while also addressing each of the technical items of the project so that all parties begin with the same set of expectations, goals and objectives. Overall, the gathering helps to define and implement the project structure that will reiterate defined roles and responsibilities for each party. At minimum, the discussion would include the following topics:

- Overall Purpose and Objectives of Program
- Project Details & Design (Scope, Technical Requirements, Special Requests, etc.)
- Project Schedule
- Communication Protocols and Procedures
- Final Deliverables

2.5.2 Pilot Review Meeting

The program's scheduled full pilot delivery is planned for June 15, 2017. A second in-person meeting would be conducted approximately two (2) weeks after this pilot delivery. The two week period provides sufficient time for the key members of the Shelby County and ReGIS staffs to review the deliverables and provide any feedback necessary. The purpose of this meeting is to walk through each of the areas within the pilot deliverables that need adjustment or modification before the full data production proceeds at Atlantic. This allows the client to be a key part of the project design. The discussion would include, at a minimum, the following topics:

- Review pilot deliverables submitted to review:
  - Completeness
  - Omissions
  - Errors
- Discuss adjustments needed in Atlantic's production process, if necessary, to successfully complete the project in accordance with Shelby County and ReGIS members' needs and expectations

2.5.3 Project Wrap-Up Meeting

All program deliverables are scheduled to be complete and delivered to Shelby County by January 15, 2018. A third in-person meeting would be conducted with all project participants and contractual stakeholders at the conclusion of the acceptance of all data deliverables. The purpose of this meeting is to ensure that all work is deemed complete and accepted by all parties. This meeting is also a great opportunity to offer a "lessons learned" environment to Atlantic's staff from the participants and discuss any steps that should be noted to make certain that future efforts are conducted effectively and efficiently. The discussion would include, at a minimum, the following topics:

- Project Review
- Discuss and Document any Lessons Learned
- If any additional tasks are needed, identify those tasks and develop a schedule to implement and complete those tasks immediately
- Identify needs and requirements for future project plans

2.6 Project Management

Atlantic's project manager for the Shelby County program is Justin Henderson. The table below breaks down his official role for this effort:

Position	Responsibility	Authority
Project Manager **Justin Henderson, PMP**	▪ Principal Technical & Administrative Point of Contact for Shelby County ▪ Develop Project Work Plan ▪ Track project schedule and budget ▪ Oversee acquisition and data production tasks ▪ Issue status reports ▪ Conduct Quality and Performance Audits ▪ Provide technical support to the County and the Atlantic project team	▪ Commit & manage team resources ▪ QA/QC corrections ▪ Assignment of personnel ▪ Delegation of responsibilities ▪ Invoicing ▪ Issuing written communications

2.7 Production Management

Atlantic's production manager is Chris Cannon. The table below breaks down his official role for this effort:

Position	Responsibility	Authority
Data Production Manager **Chris Cannon, CP**	▪ Support PM with production resources ▪ Assign tasks to internal production departments ▪ Track schedule & costs ▪ Enforce staff accountability to quality & performance ▪ Identify/address production & quality issues ▪ Provide technical support as required ▪ Hold technical staff accountable for schedule and quality	▪ Commit Atlantic production resources ▪ Enforce staff accountability ▪ Track work progress, technical issues, schedule, and budget ▪ Validate QA/QC corrections

Section 3: Technical Plans & Procedures

3.1 Overview

Atlantic will self-perform 100% of this program work in our Huntsville, Alabama headquarters and production facility. No subcontractors will be used on any portion of the post-acquisition production. Self-producing all production data eliminates the need for subcontractor management and oversight. Further, it avoids inconsistencies within production phases/teams. Thus, Atlantic possesses the necessary in-house acquisition and processing resources required to successfully deliver the Shelby County projects on-time and without the use of subcontractors.

A technical overview of each post-acquisition project phase is broken down in the pages that follow.

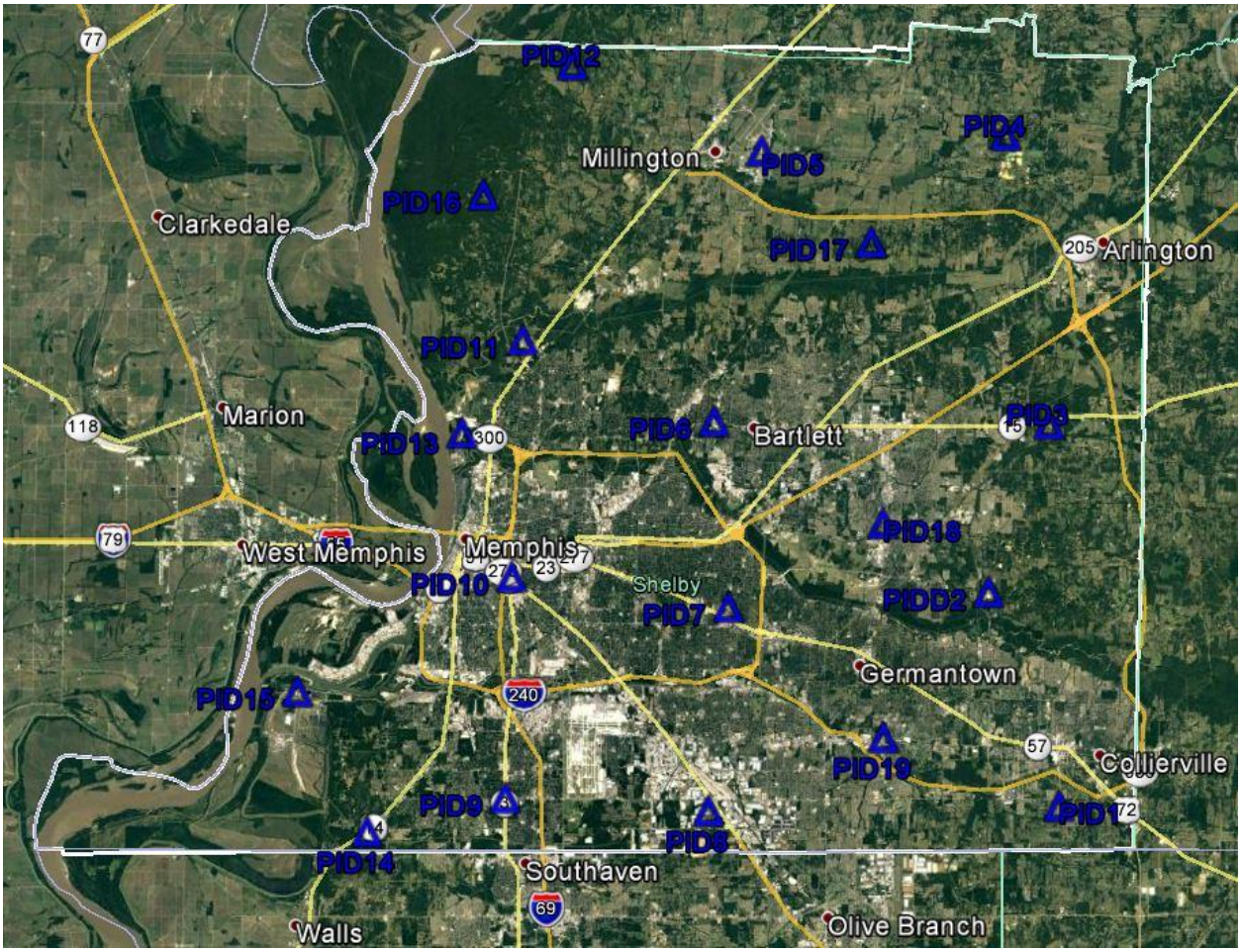
3.2 Ground Control & Survey

As mentioned in Section 1.3 above, Atlantic plans to partner with Memphis-area small business W.H. Porter to complete the ground survey and control portion of the program. With this agreement, the staff of W.H. Porter is considered, officially, to be a part of the Atlantic team. Atlantic will use its collective experience on performing horizontal and vertical control surveys to guide and manage the execution of the program's control deliverables. Atlantic ensures that all efforts will fulfill specification requirements.

The Atlantic team will collect and establish the appropriate amount of ground control points for both the 3" Orthophotography, as well as the 4 PPM LiDAR options that Shelby County requested.

3.2.1 Orthophoto Ground Control & Survey

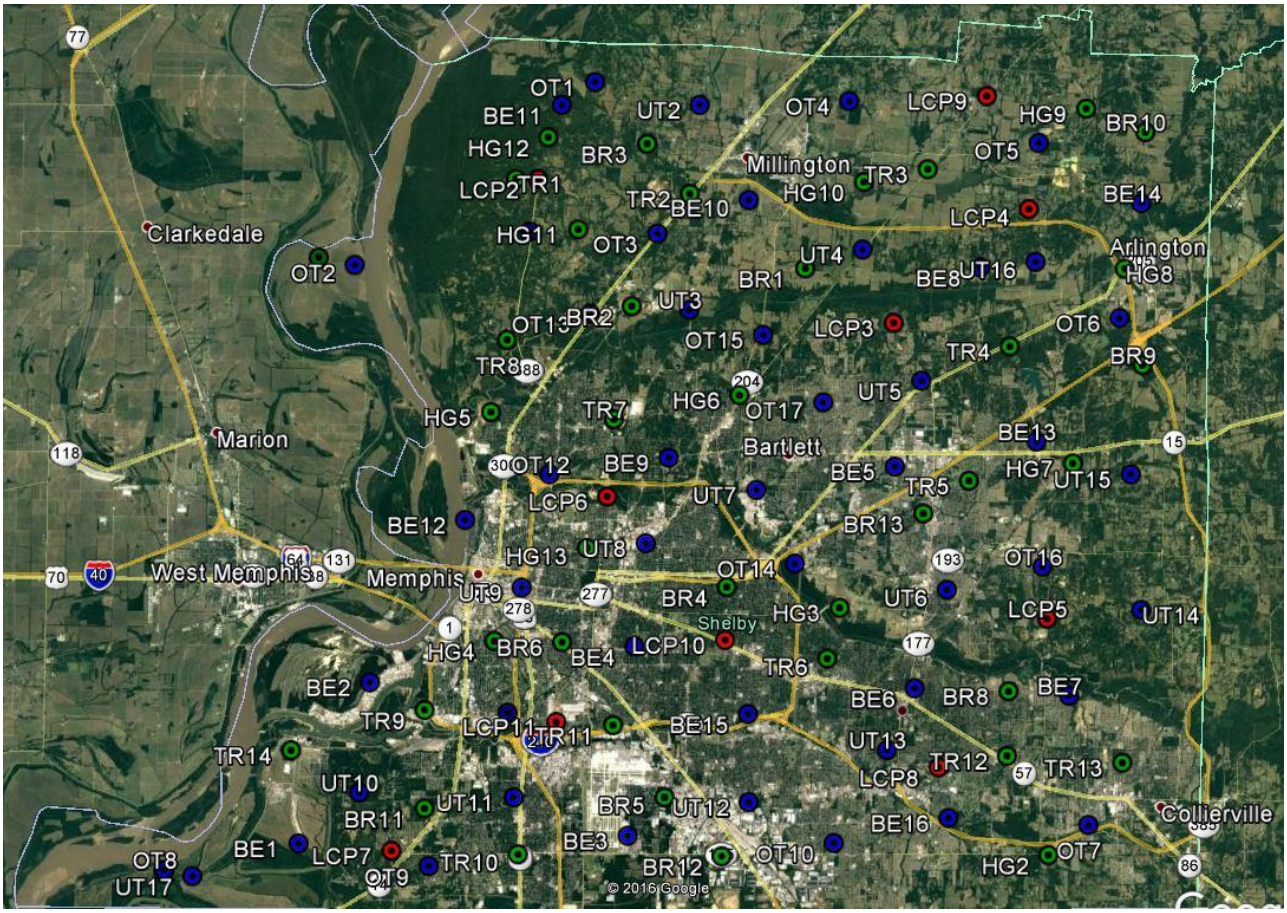
The Orthophotography control points will be collected as approximately 20 photo-identifiable (PID) points used to control the aerial triangulation solution. The planned survey PID point collection layout can be seen on the following page.



Above: Shelby County Orthophotography planned control photo-identifiable (PID) points displayed in Google Earth

3.2.2 LiDAR Ground Control & Survey

The LiDAR ground control survey will be collected as a combination of approximately 100 points at unique locations across Shelby County. These points will be used to calibrate the LiDAR data, as well as act as independent check points to help quality control the end product. Further, the LiDAR points seen in the survey layout are chosen strategically based on specific landcover types, such as Bare Earth (BE), High Vegetation (HG) areas, etc. The planned survey LiDAR point collection layout is shown below:



Above: Shelby County LiDAR planned survey control points displayed in Google Earth

3.3 Airborne GPS Support

Aside from the project's ground survey and control, Atlantic will also utilize a combination of Airborne GPS (ABGPS) and Inertial Measurement Unit (IMU) to support the positioning of the acquired aerial imagery. Atlantic uses Trimble's Qplan and Ashtech's MPwin GPS planning software during this step. In the field during acquisition, Atlantic uses the Leica 530, NovAtel GPS Systems, Leica AT502, and NovAtel NOV702_3.00 antennas, as well as the Applanix Corporation on-board POS/AV 510 processing system. PosPAC 5.3 MMS is used in post processing the POS/AV 510 with multiple ground CORS GPS base stations to develop each respective image exterior orientation (EO).

The local CORS network in Tennessee is sufficient to support the imagery acquisition. Prior to every flight mission, Positional Dilution of Precision (PDOP) is obtained and analyzed to determine optimum GPS strength. All mission collections are conducted with a PDOP of 4 or lower.

3.4 Flight Operations

Atlantic plans all missions using Z/I Mission Planning software. The flight plan developed for the aerial imagery acquisition was designed to meet or exceed the required 0.25 ft. pixel ground resolution and adhere to the ASPRS Aerial Photography Acquisition Standards. Specifications for this standard flight plan include:

1) Flight lines in continuous rows across the project area without interruption
2) Principal points of the first two and last two exposures of each flight strip extending beyond the boundaries of the project area
3) Side boundaries covered by an optimum of 30 percent of the photo image format

The final flight plans for both the LiDAR and Orthophotography are displayed in Sections 3.4.2 and 3.4.5 on the following pages.

During flight operations, the crews monitor weather conditions to include sun angle and its impact on the acquired imagery. The aircraft Pilots continuously monitor aircraft course, position, pitch, roll and yaw of the aircraft. The Sensor Operator monitors the sensor, the status of GPS PDOP's, and performs the first Quality Control review during acquisition. The Sensor Operator is constantly reviewing weather and cloud locations, allowing for any data impacted by clouds and or smoke to be invalidated and re-flown immediately.

For each day of acquisition, the Sensor Operator prepares a flight log containing the date, project name, aircraft used, sensor number and names of crew members. The log is annotated with flight line, altitude, frame numbers, time on line, weather conditions and any other comments relative to the flight activities.

Following the day of acquisition, the Sensor Operator downloads Z/I In-flight data, on-board POS/AV (IMU-ABGPS) data, and the RAW imagery onto two external hard drives: One for delivery to the Huntsville office for post processing, and a second drive for a field backup. The second quality control review is performed on-site following the data download by the Sensor Operator using Z/I viewer. This allows the Sensor Operator to view the acquired data in greater detail for cloud shadows, haze, fog and or smoke. If any images are found to be unacceptable, the respective image is scheduled for re-flight the following day (weather permitting) or at the next best opportunity (as soon as possible). This process continues until all project data is successfully acquired.

3.4.1 Aircraft

Atlantic owns four high-performance imagery and LiDAR acquisition aircraft that could be utilized for the Shelby County program's acquisition. All aircraft are located at the Atlantic Flight Operations Office at the Huntsville International Airport (HSV) – less than an hour's direct flight to Shelby County. Each aircraft has been customized to operate a variety of different mapping cameras and sensors, including all of Atlantic's LiDAR and Digital Aerial Camera Systems. Atlantic certifies that all of the aircraft are maintained and operated in accordance with Federal Aviation Administration Part-91 regulations.

The following chart lists each of Atlantic's aircraft and respective flight times to be 'on-line' for the Shelby County program:

Aircraft	Quantity	Flight Time To Shelby County
Cessna T-210	1	60 minutes
Partenavia P-68 Twin Turbo	1	60 minutes
Piper PA-31 Navajo Chieftain	1	52 minutes
Beechcraft Baron 58	1	46 minutes
TOTAL	**4**	

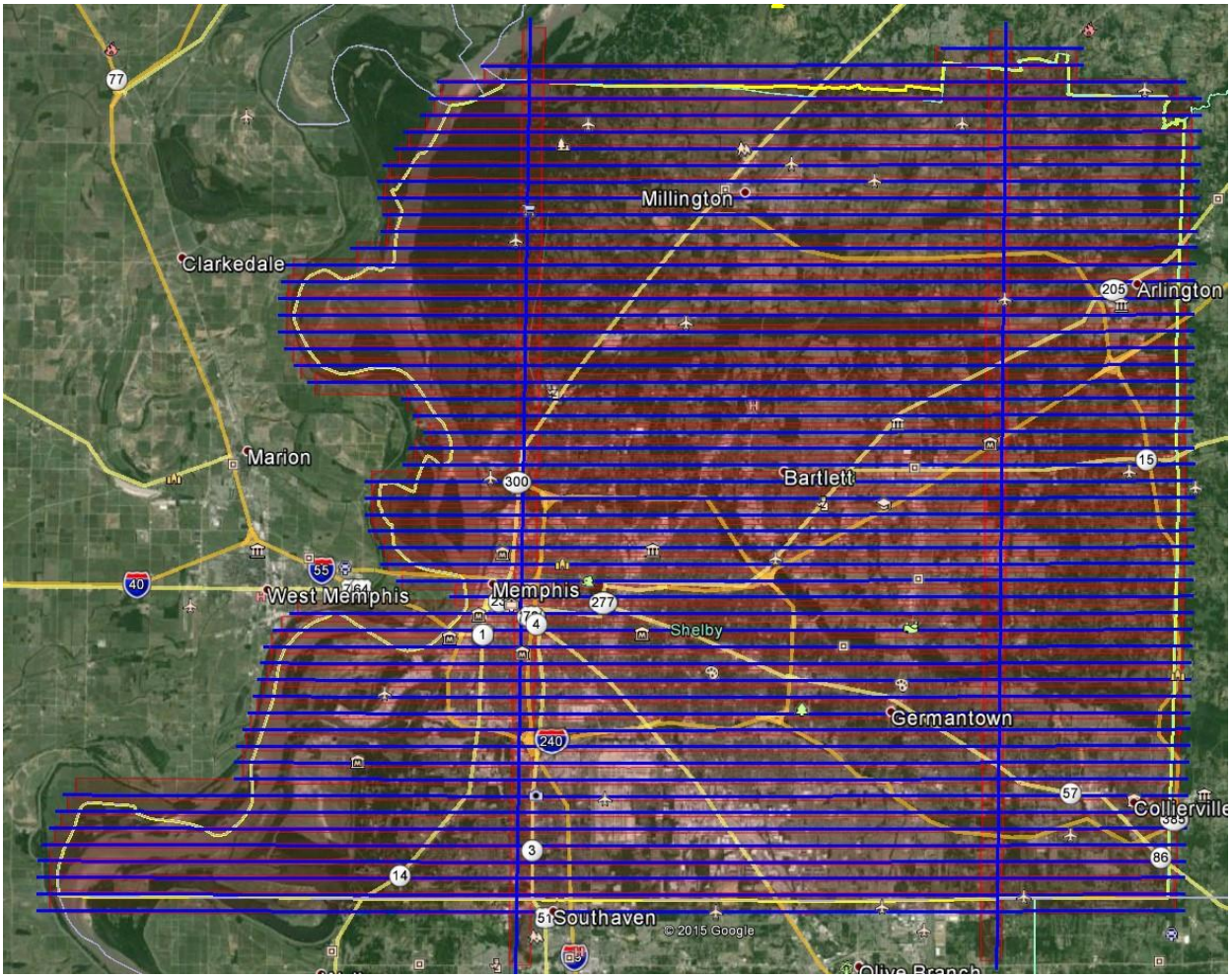
3.4.2 LiDAR Flight Planning & Acquisition

When developing the flight plan for the LiDAR acquisition, significant effort is applied to consider all aspects of data collection for specific area requirements as well as local geographic conditions critical to the success of the program. The final flight plan developed for this effort was submitted to Shelby County for review and approval on January 9, 2017.

The active game plan for the 2017 Shelby County program's aerial LiDAR acquisition is to collect the aerial LiDAR data sometime between February 2017, and no later than March 15, 2017. All calendar projections are conditional to optimal acquisition opportunities and KMEM airspace restrictions.

For flight mission planning, Atlantic is utilizing the Leica MissionPro software. This suite allows the team to incorporate digital elevation model (DEM) data into the flight planning process. This becomes increasingly critical when planning for flights over any areas of relief. MissionPro is fully integrated into the Leica ALS70 workflow that Atlantic uses for planning, acquisition and during the initial evaluation of all LiDAR data.

Atlantic's flight plan for the Shelby County LiDAR acquisition is displayed on the following page.



Shelby County LiDAR acquisition flight plan as displayed in Google Earth

Atlantic recommends flight line baseline lengths with a maximum distance of 30 kilometers from the acquisition's base stations to compensate for inherent IMU drift associated with all IMU's (as per the sensor manufacturer's recommendations). A calibration flight is incorporated into every flight plan and will be performed prior to each acquisition session. In addition, a cross flight will be flown following the last completion of the last flight line of the session/lift across all flight lines flown within the session.

Atlantic has two sensors that can utilized for the Shelby County LiDAR program, as shown in the table on the following page. Atlantic utilize the following acquisition controls shown within the table to obtain the highest quality 3D elevation data:

Description	Value	Unit
Sensors	ALS70-HP (SN 7123) ALS70-HP (SN 7225)	
Terrain and Aircraft (Varies by Terrain and site – averages shown)		
Flying Height AGL	1487 – 1600	m
Altitude AMSL	1602 / 5256	m/ft
Recommended Ground Speed (GS)	130	kts
Description	**Value**	**Unit**
Scanner		
Field of View (FOV)	40.0 (+/- 20.0 from nadir)	degrees
Maximum Scan Rate	53.4	Hz
Scan Rate Setting used (SR)	43.5	Hz
Laser		
Maximum Laser Pulse Rate	335200	Hz
Laser Pulse Rate used	335200	Hz
Multi Pulse in Air Mode	Enabled	
Aircraft Speed Sensitivity	.40	kts
Fixed Gain	255	
Range Intensity mode	7	
Nominal Maximum Slant Range	1755.89	m
Minimum Range Gate	1086.37	m
Maximum Range Gate	1767.75	m
Range Gate size	681.38	m
Range margin above hills	400.63	m
Range margin below valleys	61.14	m
Recommended Laser Power	100	%
Coverage (Varies by Terrain and Site – Averages Shown)		
Full Swath Width	1164.70	m
Coverage Rate (No line optimization)	226.22	km^2/h
Recommended Line Spacing (No DTM)	939.60	m
Minimum Sidelap (upper)	13.20	%
Point Spacing and Density		
Average Point Density	4.30	pts / m^2
Nadir Point Density	3.90	pts / m^2

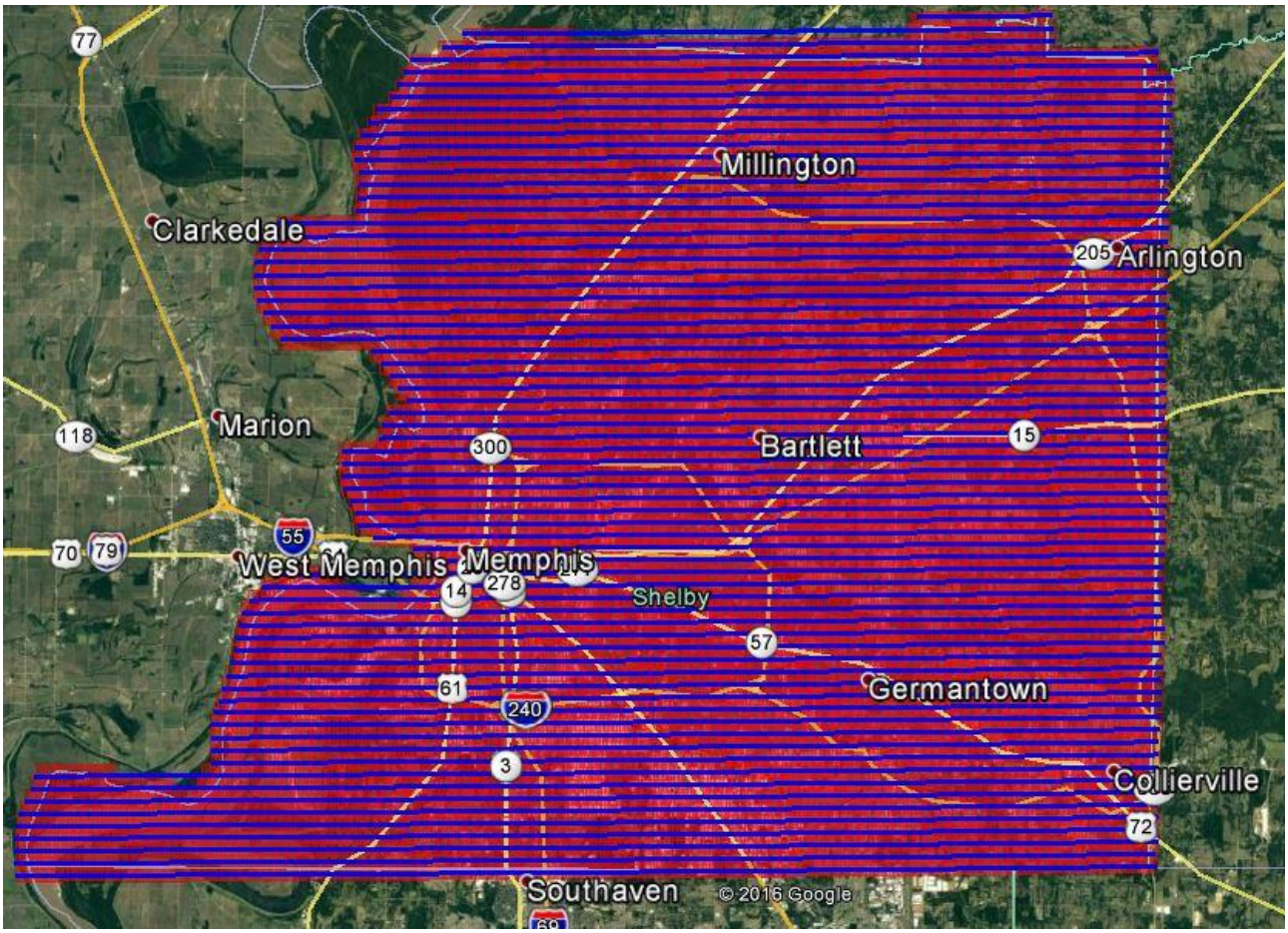
3.4.3 Aerial Imagery Flight Planning & Acquisition

When developing the flight plan for the imagery acquisition, Atlantic applied Shelby County's chosen option of 3" GSD. The final flight plan developed for this effort was submitted to Shelby County for review/approval on January 9, 2017.

The active game plan for the 2017 Shelby County program's aerial Imagery acquisition is to completely collect all of the aerial imagery data prior to March 15, 2017. All calendar projections are conditional to optimal acquisition opportunities and KMEM airspace restrictions.

The aerial imagery acquisition officially began on January 29, 2017 and is projected to complete prior to mid-February, 2017.

Atlantic's flight plan for the imagery acquisition is displayed below:



Shelby County Imagery acquisition flight plan as displayed in Google Earth

Atlantic's aerial acquisition approach leverages the best practices from years of experience in successfully completing large, multi-jurisdictional and countywide mapping initiatives. Atlantic is utilizing a Zeiss/Intergraph Digital Mapping Camera (DMC) with electronic forward motion compensation to ensure photogrammetric accuracy and image quality. The DMC is a high-quality digital framing sensor that uniquely uses a modular design based on Charge-Coupled Device (CCD) matrix (frame) sensors to achieve high geometrical resolution together with multispectral capabilities.

The sensor comprises eight synchronously operating CCD cameras - four parallel cameras generating multispectral imagery for the acquisition of color composites, and four converging panchromatic cameras acquiring imagery. Digital imagery is collected at a 12-bit depth per channel and at a rate as quick as 2.1 seconds between exposures.

The table on the following page outlines the parameters for the Shelby County program's imagery acquisition.

PROJECT DESIGN VARIABLE	CHOSEN PARAMETER (3" Option)
Camera System	Z/I DMC
Altitude (Feet AGL)	2,461'
Flight Lines	72
Exposures	16,285
Item	**Chosen Parameter**
System	DMC
Active Flight Lines	69
Total Flight Line Length (mi)	2002.9
Total Flight Time (h)	21.55
Total Sensor Time (h)	15.8
Approximate Area (km^2)	787.7
Altitude (Alt MSL feet)	2684
Approx. Ground Speed (kts)	130
Flight Scale (1:x)	6250
Ground Sample Distance (cm)	7.5
Image Foot Print (m)	1037mx
Line Spacing (m)	633
Pass heading (degree)	90
Number of Events	14826
Sun Angle (Degrees)	30
Forward Lap (%)	60
Side Lap (%)	30

3.5 Digital Image Processing

The raw DMC image data received from the field is post-processed to 4-band (R/G/B/IR order), 16 bit uncompressed frame format. The data Production Manager performs a second Quality Control by comparing the photo files and flight logs to the flight plan, ensuring complete and accurate coverage. Any discrepancies are noted and returned to the aircrews for immediate action. Additionally, each flight line is reviewed for density, contrast, hot spots, clarity, shadow and highlight detail, as well as overall quality. Atlantic tracks and tabulates the results of the review on Quality Control tracking sheets, for future reference.

Atlantic re-processes the raw imagery and applies a radiometric balancing to the imagery prior to the orthorectification process. This allows initial color adjustment procedures to correct any inconsistencies within and between photographs. Imagery look-up tables (LUT's) are established to provide target radiometric values. The LUT's are used to maintain the uniformity of the imagery's appearance throughout the project. The resulting imagery has a sharp, uniform, balanced color contrast maintaining the full range of the image histogram. Due to the subjectivity of imagery aesthetics, Atlantic will then incorporate any provided guidelines from Shelby County for the balancing of the image radiometry.

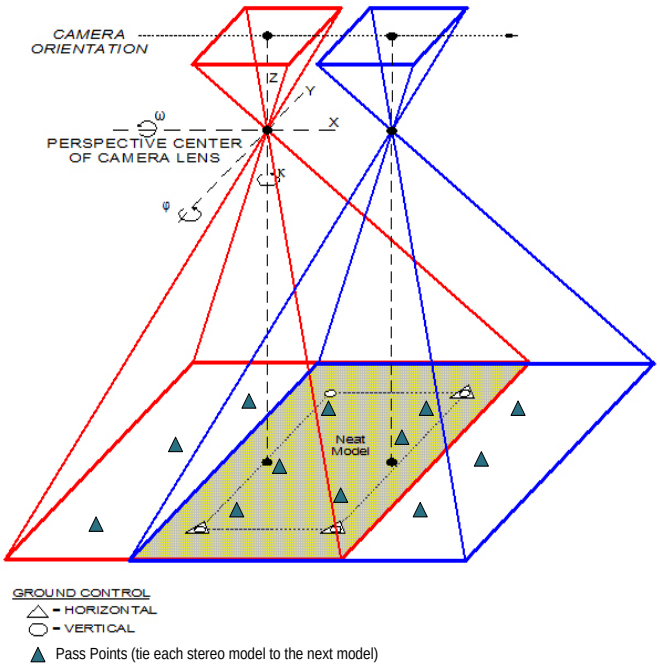
3.6 Aerial Triangulation

Atlantic uses Z/I Imaging ImageStation Automatic Triangulation (ISAT) as the primary software platform for developing Fully Automated Aerial Triangulation (FAAT) solutions. ISAT is an innovative automatic triangulation package that delivers the best-matched multi-ray tie points by using a robust built-in bundle adjustment during all phases of the image matching operation. ISAT is used for accurate positioning of the photography utilizing the airborne GPS developed exterior orientation (EO) parameters for each respective photo centers and the paneled control points located throughout the project area. Interactive quality inspections are conducted to verify and approve input parameters such as the aerial camera calibration information, ground control, EO values, etc.

FAAT is used to expand and supplement the existing horizontal and vertical control for a photogrammetric project. All photogrammetric processes and aerial triangulation procedures are conducted under the supervision of an Atlantic ASPRS Certified Photogrammetrist.

The purpose of Aerial Triangulation in the photogrammetric production process is to establish a precise and accurate relationship between the individual photo coordinate systems and a defined datum and projection.

This relationship is used to bridge the ground surveyed control points via photographic measurements. This is accomplished by relating the photographic coordinates of measured points on the photography with the known surveyed coordinates of the point on the earth's surface.



This requires photographic measurements that are taken with precise photogrammetric instrumentation to be processed through computer algorithms. These algorithms are designed to eliminate blunders and systematic errors from the data while minimizing the residual random errors within the entire triangulation network. The end result of the triangulation is a densified set of ground control points used to control the mapping process.

Atlantic performs a thorough analysis of the Aerial Triangulation. Iterative quality inspections are conducted to ensure the following:

- The project boundary is identified, ensuring that triangulation covers the entire project area.
- Independent checkpoints are utilized and incorporated into the adjustment process.
- Intermediate and final triangulation results are thoroughly reviewed by an Atlantic ASPRS Certified Photogrammetrist.
- The determined Root Square Mean Error (RSME) will not exceed 1/10,000th of the digital imagery

Atlantic will prepare a certified Aerial Triangulation Report immediately upon completion of all aerial triangulation work. At a minimum, the report provides the following information:

- A control and flight line index
- A comprehensive flight line plan that includes exposure stations
- Locations of all ground survey control points
- Control labeled with station descriptions

The results of the Aerial Triangulation adjustment process include:

- RMS residuals at each image point in meters, in x and y
- RMS residuals for GPS control points in meters, in x, y, and z
- RMS residuals at programmatically determined control points in meters, in x, y, and z
- Computed theoretical accuracy of all control points in x, y, and z
- The accuracy of the orientations
- Complete results of all final block adjusted ground coordinates
- Orientation parameter settings for all images
- Image set-up files for future use

3.7 Orthophotography

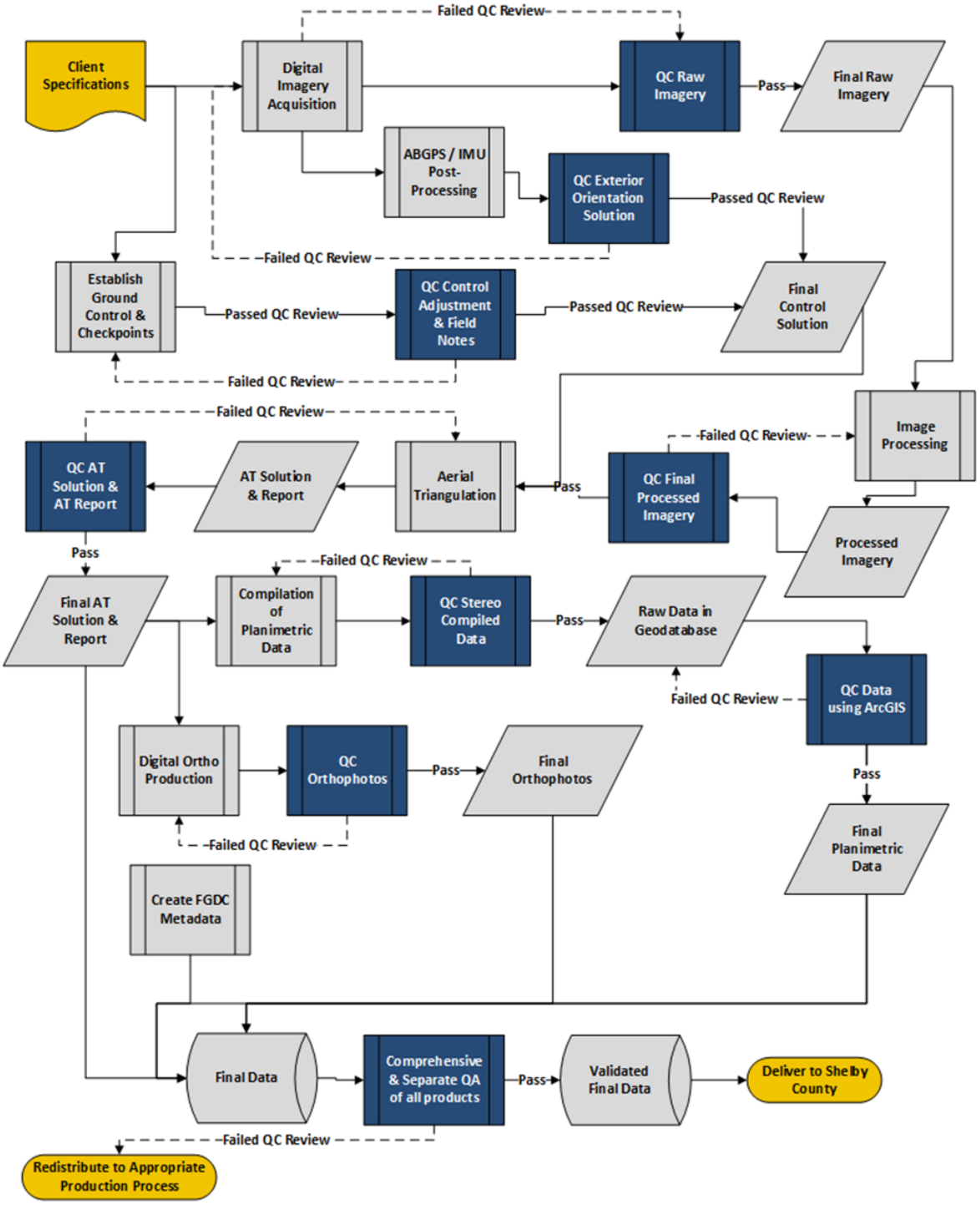
After normalizing all of the digital elevation data to be used into a homogenous DEM file, the project images and input of exterior orientation (EO) information from the Aerial Triangulation solution is used by one of two software suites: OrthoPro and SimActive Correlator 3D. These suites automatically, and intuitively, perform the image orthorectifications. This allows Atlantic to take advantage of multi-core processing allowing to simultaneously rectify multiple images while doubling processing speed of other systems. Atlantic will take advantage of additional processing capacity by scheduling jobs for processing during off-production hours. The software performs adaptive calculation spacing for maximum speed and accuracy and utilization of breakline information.

After the differential rectification process is completed, dodging is performed on the individual rectified images prior to mosaicking. Dodging is necessary to lighten or darken image areas to achieve an even level of brightness that is consistent throughout the mosaicked orthophotography. Inconsistent areas of lightness or darkness are caused by uneven lighting conditions at the time of imaging or exposure. Dodging also brings out the detail in images. Atlantic computes an average intensity value for each input image to ensure the output image retains the same average intensity. This establishes an average intensity throughout the project area. Correction of common photographic problems such as vignetting and other uneven exposure problems is also performed.

After defining the mosaic boundaries and the blend types, the mosaicking process runs in batch form. During this process, the photos are tone-balanced for optimal viewing and to create the appearance of a seamless mosaic. The software suites are then used to tone match and balance the radiometry of all images, both black and white, as well as color. It is also used to mosaic images along automatic or manually drawn boundaries. It feathers the seam lines based upon using defined parameters and produces the final mosaic at a client-specified deliverable output pixel resolution. For the Shelby County Orthophotography, this would be a 0.25 foot pixel resolution.

The workflow diagram seen below contains a visual flow of the Orthophotography and Planimetric stages of this project. (The LiDAR Technical Approach and corresponding workflow diagram can be found in Section 3.8 of this document.)

Highlighted in dark blue are 9 key Quality Control steps that have resulted in relevant, recent, and consistent project successes.



3.7.1 Ortho Quality Control

Atlantic will assess both the quantitative and qualitative characteristics of the digital orthophotos utilizing ArcGIS. The acceptance criteria shown on the following pages will be the performance values that Atlantic tests the data to, ensuring it meets or exceeds these standards. This table guides Shelby County in addressing specific measures of performance for the qualitative assessment of the final Orthophotography deliverables:

Criteria	Tested Characteristic	Measure of Acceptability
1.	Media: USB External Drive	Media files are readable, accessible, none are corrupted.
2.	File organization	Files written in tile sheet order.
3.	File name	All digital file naming conforms to required client convention.
4.	GeoTiff & .tfw format	GeoTIFF 6.0 compliant; reads in ESRI
5.	Pixel definition	GeoTIFF reference will be the upper left corner of the upper left-most pixel. World file reference will be the center of the pixel of the upper left-most pixel.
6.	Georeferencing	World file has correct coordinates expressed to at least 2 significant digits, and correct pixel size and pixel count.
7.	Projection	Tennessee State Plane Coordinate System
8.	Datum	NAD83/2007 and NAVD88 Geoid12A
9.	Units	US Survey Feet
10.	24 bit natural color	256 levels of value for each band, 0 = black, 255 = white
11.	Tonal quality	Less than 2% of values at 0 or 255 Conforms to the color balance, contrast and brightness of the radiometric target images specified by the Radiometric Review Panel.
12.	24 bit natural CIR	256 levels of value for each band, 0=black, 255=white
13.	Image blemishes and artifacts	Generally acceptable within these limits: If 1 pixel wide, 100 pixels in length. If 2 pixels wide, 60 pixels in length. If 3 pixels wide, 20 pixels in length. If 4 - 12 pixels wide, 12 pixels in length. Artifacts exceeding these limits may be acceptable if ground feature detail is not obscured, or if the brightness value of the pixels in the artifact is under 170. Artifacts within these limits may be rejected if critical ground features are significantly impacted. Critical features shall be defined as features having County, State or National

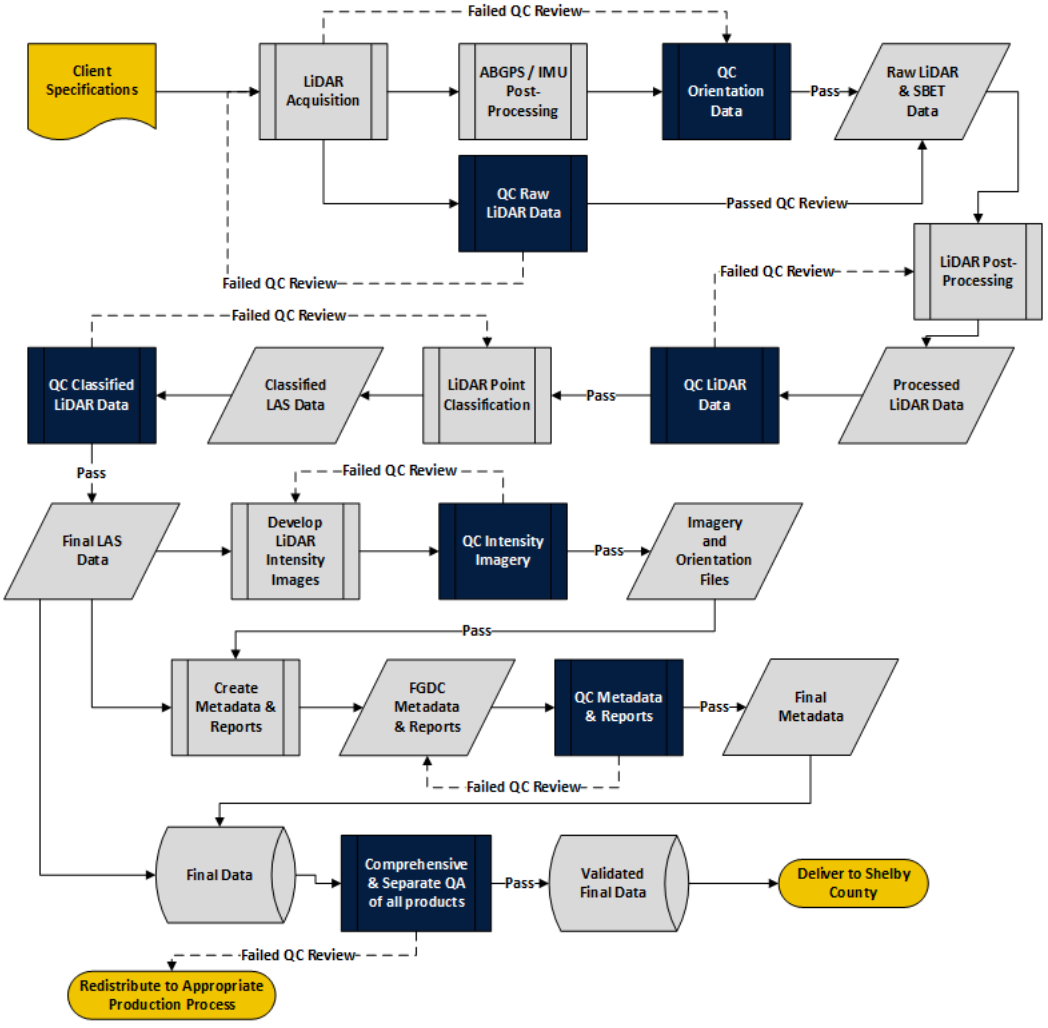
		significance (Courthouses, Capitol Buildings, etc). Clusters of artifacts that do not individually meet these criteria may be considered unacceptable if more than 12 are visible within a viewing screen at 1:1 zoom. (5 or more artifacts within a 200 pixel area preferred).
14.	Conformance of sheet to index grid	Sheet will match the client provided grid. There will be no gap or overlap between tiles.
15.	Mosaic lines	Mosaic lines through buildings and above ground transportation structures shall be avoided to the greatest extent practical.
16.	Metadata	Complies with FGDC standards and runs through the USGS MP parser without returning any errors.
17.	Scratches	Orthoimagery appearance shall be scratch and dust free; sharp uniform balanced color contrast.
18.	Smears	See Image Blemishes and Artifacts Corrected by adding mass points or break lines to DEM as necessary to reflect actual terrain or by image processing where appropriate. Where DTM corrections or image processing will result in reduced horizontal accuracy or misrepresentation of the location or appearance of important features (buildings, roads, etc.), the smear will remain untreated.
19.	Wavy features	See Image Blemishes and Artifacts. 95% of distinct linear ground features (such as road markings, and curbs) shall be positionally correct and should not deviate from their apparent path by more than 5 pixels measured perpendicular to the feature within any 100 pixel distance measured along the feature length. On roads, measurements should be taken from centerline of road instead of road edges, shoulder and railings.
20.	Ground resolution	0.25 US Survey Feet
21.	RMSE of known ground points measured on the image *See ASPRS Class I Standards Page 8, Table 16, and NSSDA Part 3, Appendices 3-A and 3-D for explanation of formulas.*	RMSEx = RMSEy = 1' (2 pixels) and RMSEr = 1.4142 *RMSEx = 1.4142*RMSEy
22.	Mismatch of features along mosaic lines and production block boundaries of equal scale	Equal to or less than 2 pixels at 95% on well defined features (roads, sidewalk curbs) for mosaic lines
23.	Sheet Size	Shelby County's existing tile layout will be utilized for the orthophotography extraction.

3.8 LiDAR

Atlantic utilizes a variety of custom filters and algorithms for processing LiDAR data that results in the highest quality available in the industry. Atlantic processes LIDAR using CloudPro, LMS, Terramatch, Terrasolid, GeoCue, and ESRI processing tools to produce 3-D point cloud, bare earth and classified LIDAR surfaces. Deliverables are field tested for both vertical and horizontal accuracy as stated in National Digital Elevation Program (NDEP) Guidelines for Digital Elevation Data, Version 1.0 for National Standard for Spatial Data Accuracy (NSSDA) of 95% confidence or better. All data will be seamless with no gaps or voided areas. LAS Classification will be met or exceeded per the following FEMA/USGS guidelines:

90% of artifacts removed, 95% of outliners & vegetation removed, 98% of buildings removed

Further, all LiDAR data will be developed to meet the USGS Quality Level 2 data requirements. Quality Level 2 requires that the RMSEz be tested at or better than 9.25cm (1' contour equivalent) and that the data has at least 2 points per square meter in a single swath at the nadir most point of each flight line. For the Shelby County program, the LiDAR will acquired and processed to exceed 4 points per square meter. The workflow diagram below is a visual flow of the stages in order to achieve project success. Highlighted in dark blue are 7 key Quality steps that have resulted in relevant, recent, and consistent project successes.



3.8.1 LiDAR Accuracy Assessment

The Accuracy Assessment plan for Shelby County will follow the requirements in the USGS Base LiDAR Specification, Version 1.2, which references the ASPRS Positional Accuracy Standards. Together, those specifications require the contractor to establish both Non-Vegetated Vertical Accuracy (NVA) assessment points and Vegetated Vertical Accuracy (VVA) points.

Atlantic will develop a LiDAR Accuracy Assessment report by using the NVA and VVA Quality Control checkpoint survey points to test the final LiDAR dataset and resultant DEM data per the USGS specifications. The tables shown below are an example of the assessment that would be given to the Shelby County LiDAR data upon project completion.

Check Points Error Statistics (AOI 1, 2, and 4)								
Category	# of Points	Min (m)	Max (m)	Mean (m)	Median (m)	Skew	Std Dev (m)	RMSEz (m)
Open Terrain/Bare Earth	179	-0.165	0.132	-0.011	-0.016	0.182	0.063	0.064
Urban Terrain	25	-0.139	0.120	-0.036	-0.058	0.495	0.082	0.088
High Grass	100	-0.163	0.166	0.012	0.005	0.017	0.073	0.074
Brush	22	-0.117	0.182	0.042	0.037	-0.082	0.084	0.093
Low Trees	36	-0.127	0.157	0.023	0.013	0.154	0.078	0.081
Consolidated	362	-0.165	0.182	0.000	-0.006	0.203	0.072	0.072

Check Points Vertical Accuracy Assessment (AOI 1, 2, and 4)				
Land Cover Category	# of Points	FVA — Fundamental Vertical Accuracy (RMSEz x 1.9600) Spec=0.196 (m)	CVA — Consolidated Vertical Accuracy (95th Percentile) Spec=0.294 (m)	SVA — Supplemental Vertical Accuracy (95th Percentile) Target=0.294 (m)
Open Terrain/Bare Earth	179	0.125		
Urban Terrain	25			0.105
High Grass	100			0.121
Brush	22			0.155
Low Trees	36			0.150
Consolidated	362		0.118	

Non-vegetated Vertical Accuracy (NVA) and Vegetated Vertical Accuracy (VVA) (AOI 1, 2, and 4)				
Broad Land Cover Type	# of Points	RMSEz (m)	95% Confidence Level (m)	95th Percentile (m)
NVA of Point Cloud	204	0.066	0.129	
NVA of DEM	204	0.067	0.131	
VVA of DEM	158	0.078		0.150

3.8.2 LiDAR Quality Control

In addition to the LiDAR Accuracy Assessment, Atlantic will perform a comprehensive Quality Control of the Shelby County LiDAR data. The acceptance criteria shown on the following pages will be the performance values that Atlantic tests the data to ensure that it meets or exceeds these standards. This table guides Shelby County in addressing specific measures of performance for the qualitative assessment of the final LiDAR deliverables:

Criteria	Tested Characteristic	Measure of Acceptability
LiDAR Data Acquisition Acceptance Criteria		
1.	Returns per pulse	LiDAR sensor shall be capable of recording up to 3 (or more) returns per pulse, including 1st and last returns
2.	Scan angle	≤ ± 12 degrees on each side of nadir, i.e., maximum Field of View = 24 degrees
3.	Design pulse density (nominal)	≥ 17.59 pulse/m^2; assessment to be made against first return located within the geometrically usable center portion of each swath.
4.	GPS procedures	Base stations for GPS surveys shall be based on first or second order survey control stations that are part of the National Geodetic Survey's National Spatial Reference System (NSRS). In the event no suitable control is available, new control stations will be established using NGS-58 Guidelines for Establishing GPS-Derived Ellipsoidal Heights
5.	Collection Conditions	▪ Cloud, fog, smoke, dust, smoke - free between the aircraft and ground ▪ Vegetation is leaf-off and any exceptions should be documented ▪ Ground is clear of snow ▪ No unusual flooding or inundation unless otherwise noted
LiDAR Accuracy Acceptance Criteria		
6.	Vertical Accuracy	RMSEz shall ≤ 9.25 cm for all land cover types. There shall be minimal vertical offset (≤ 7cm $RMSE_z$) between adjacent flight lines.
7.	Horizontal Accuracy	$RMSE_{xy}$ shall ≤ 1 meter
Geographic Coverage and Continuity Acceptance Criteria		
8.	Coverage	No voids because of cloud cover or instrument failure. Voids within a single swath ≥ $(4*NPS)^2$ will not be acceptable except for voids caused by water bodies or low reflectivity.
9.	Aggregate 1st return density	Barring non-scattering areas (e.g., open water, wet asphalt); no voids of more than 4*NPS^2; point spacing (1st return) within each swath must have an average of 1 m, not including overlap points. Acceptable data voids identified in Acceptance Criterion #8 above are excluded from this requirement.
Deliverables		
10.	Aircraft trajectories	Aircraft position (easting, northing, elevation) and attitude (heading, pitch, roll) and GPS time recorded at regular intervals of 1 second or less. May include additional attributes.
11.	All-return point cloud	List of all valid returns in 1.3 Point Record 1 format. For each return: GPS week, GPS second, easting, northing, elevation, intensity, return #, return classification. May include additional attributes that are outlined in the LiDAR SOW. No duplicate entries. GPS second shall be reported to the

		nearest microsecond (or better). Easting, northing, and elevation shall be reported to nearest 0.01 m (nearest 0.01 ft.). Classification of returns shall be as complete as is feasible.
12.	File naming convention	Naming shall conform to nomenclature provided by the project participants and its partners.
13.	Formal metadata	See SOW instructions on formal metadata
14.	Ground Points (Bare Earth)	Post-processed to remove structures and vegetation with < 5% residual artifacts
15.	Inconsistent Post-Processing, Editing	No visible variations in LiDAR data caused by alternating processing techniques from tile-to-tile
16.	Over-Smoothing	Smoothing techniques shall not remove topographic features necessary to define drainage structures.
17.	LAS Artifacts	No obvious artifacts, spikes, holes or blunders; no cornrows or seam line mismatches > 0.1'
Usability Acceptance Criteria		
18.	Internal file formats	Files shall have consistent internal formats
19.	Compressed files	Files shall not be compressed
20.	Ancillary geographic feature data	Ancillary geographic feature data represented as vector data types shall have complete and correct associated projection files.
Breakline Acceptance Criteria		
21.	Completeness	3D Breaklines collected for: ▪ All hydrography as defined in the SOW
22.	Monotonicity	Double Line Streams shall generally maintain a consistent down-hill flow and be collected in the direction of flow – some natural exceptions will be allowed.
23.	Vertical Consistency	▪ Closed Waterbodies shall maintain a constant elevation at all vertices ▪ Vertices should not have excessive min or max z-values when compared to adjacent vertices ▪ Vertical variance between breaklines & LiDAR DTM < 0.196 ft. ▪ Intersecting features shall maintain connectivity in X,Y,Z planes
24.	Topology	▪ Double Line Streams must not self-intersect or intersect ▪ Features must not overlap or have gaps ▪ Features must not have unnecessary dangles or boundaries
25.	Metadata	Metadata must be FGDC compliant and contain sufficient detail to document source materials, projections, datums, processing steps, etc.

3.9 Hydrographic Breaklines To Support LiDAR & Contour Modeling

Atlantic has led the development of hydrographic breaklines for over 100,000 square miles of LiDAR data across the United States. Additionally, Atlantic's President/COO contributed to the breakline sections of FEMA's PM-61 and authored the data dictionary presented in the nationwide standard for breaklines. The notion of whether or not to utilize topographic breaklines with a high density LiDAR surface has been a topic of heavy debate in the remote sensing industry for years. Essentially, as LiDAR technology has evolved, the need for topographic breaklines has also evolved.

Presently, LiDAR systems are now capable of generating a maximum of 500,000 pulses per second and the USGS Quality Level 2 data requirement includes the development of LiDAR data at 2 points per square meter in a single swath. The USGS LiDAR Guidelines and Specifications do not require topographic breaklines. FEMA's PM-61 also does not require topographic breaklines. What both of those specifications require are *hydrographic* breaklines to help enforce hydrologic modeling of the surface model and so that water bodies appear to be flat and flowing downhill.

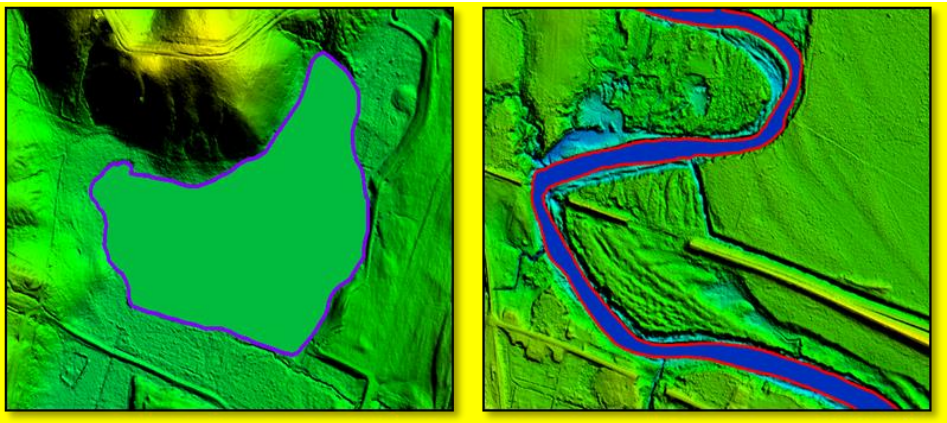
3.9.1 Hydro Breakline Methodology

First, Atlantic will evaluate the horizontal placement and completeness of the existing hydrography against the newly developed LiDAR dataset. Once the horizontal placement of lines has been perfected and any omissions or deletions have been addressed, Atlantic will create 3-D hydrography by assigning each vertex of the modified hydrography a new z-value derived from the LiDAR. This process is known as conflation.

Atlantic will only collect hydrographic breaklines consistent with the USGS specifications. Per the USGS requirements, any pond or lake greater than 2 acres will be collected with a hydroline breakline and any stream or river with an average width of 100' will also be collected with a double line hydroline breakline that is flattened from bank-to-bank.

Atlantic uses LP360 as the primary tool for 3D extraction of hydrographic breaklines that are used to develop hydro-flattened DEM data. LP360 is used within ArcGIS Desktop and has a comprehensive set of tools unique to working with LiDAR data, and specifically, extracting 3D breaklines. Atlantic has used LP360 consistently on LiDAR breakline extraction since 2009, and has developed valuable lessons-learned about that approach and the tools within LP360.

The first step will be outputting a set of LiDAR intensity orthophotos from GeoCue to use within the LP360 environment. It is has been realized that simply using the colorized terrain data that is developed from the bare-earth point cloud data for breakline extraction in LP360 is not enough. Atlantic has learned that the intensity orthos add a much needed perspective of horizontal extents of the water that cannot be easily interpreted by using a terrain alone.

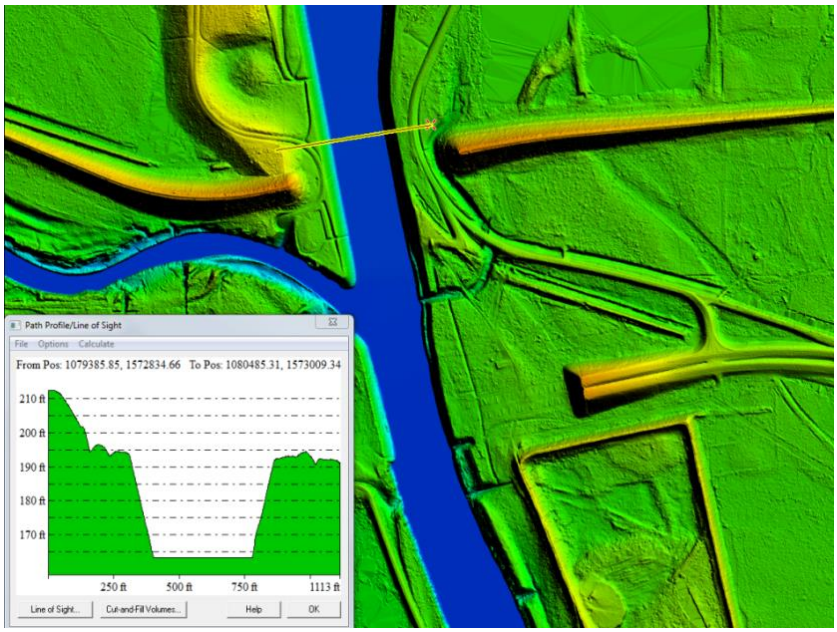


Hydro breaklines of closed water body greater than 2 acres (left) and dual line drain greater than 100' in width. All data was captured in LP360.

The resulting 'hydroline' breaklines are utilized for assigning LAS Class 9 (Water) to the LiDAR data and are also used in the development of hydro flattened DEM's.

3.9.2 Hydro-Flattened DEM Data

To meet the USGS QL2 requirements, the end goal of developing a hydro-flattened or "hydro-conditioned" DEM dataset is for visual interpretation. According to the USGS, the dataset should be interpreted in a manner that is consistent with looking at the data from an aerial or overhead view. The surfaces of ponds, lakes and rivers are flat from shore to shore and all water flows downhill – as seen below.



Hydro-flattened DEM data resultant from Atlantic's LP360 and ArcGIS-based process. Notice the flat water channels.

To develop the hydro-flattened DEM data, Atlantic uses a combination of LP360 and ArcGIS Desktop tools. The first step in this process is to ensure that all dual line features are flat from bank-to-bank. In order to accomplish this task, centerline data is computed from the breaklines extracted in LP360. The centerlines are used in a data conflation process within LP360 to first identify any elevations along the features that do not meet the requirements for monotonicity or flatness. Once those areas are identified, the software uses an algorithm to assign the correct value to the centerline. Those values are then conflated back to the dual line data in a manner that will result in flat hydro features from bank-to-bank.

Once the breakline data is correctly conflated, the LP360 tools select a small buffer of points around the breaklines themselves and re-classify that to a withheld class within the LAS data. This results in smoother transitions at the hydro features in the final DEM data.

Finally, the data is batched into Arc ASCII Grid format and then validated through a manual review to ensure that all features are flat and that no visible surface artifacts are visible in the final data.

3.9.3 Contour Modeling

Atlantic has migrated its contour modeling process to a combination of ESRI ArcGIS and ET Geowizard. The process begins with developing an ESRI Terrain dataset in a file geodatabase. Once the terrain is developed, commercial "off the shelf" tools are used for modeling and smoothing the contours. The workflow for using these tools is proprietary, but Atlantic can provide consulting and training on using those tools in a workflow so that Shelby County could self-perform the contour modeling task, if desired in the future.

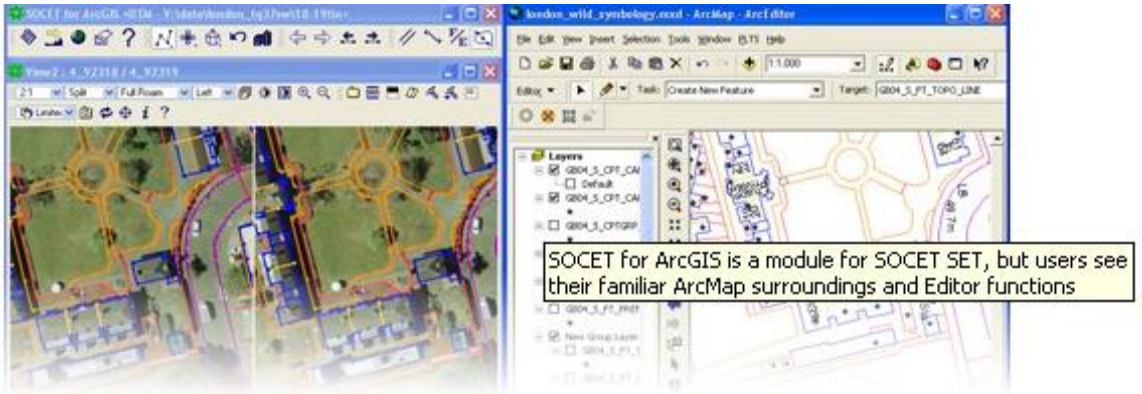
For the 2017 Shelby County program, Atlantic will deliver 1-foot Contours that are hydro-enforced – consistent to the national standard USGS-specification deliverables.

3.10 Planimetric Feature Collection

Atlantic has evolved the photogrammetric data extraction tools from a traditional Intergraph platform to BAE's Socet Set methodology. Within Socet Set, there is a specific extension called Socet for ArcGIS that is particularly beneficial for countywide update projects.

The Socet for ArcGIS extension allows for stereo photogrammetric feature extraction and updates directly into a geodatabase. Since Socet for ArcGIS uses the rigorous photogrammetry of Socet Set in conjunction with ESRI's ArcMap application, the photogrammetric technicians can follow their ordinary GIS workflows in a familiar environment while collecting accurate data.

Using this toolset enables Atlantic to perform the photogrammetric planimetric collection/extraction without the need for data translations to and from the photogrammetric software. Socet for ArcGIS works directly with the final project geodatabase schema, topology rules and attribute requirements as outlined in the program-specific final scope of work. Socet for ArcGIS embeds the photogrammetrically-compiled features into an ESRI ArcGIS geodatabase. This ultimately means there is no CAD-to-GIS file translation required and that the resultant photo interpreted data is topologically correct and GIS ready upon completion.



SOCET for ArcGIS Dual Monitor Display

3.10.1 Shelby County Program-Specific Features

For the 2017 Shelby County program, a specific list of planimetric features was derived through a series of collaborative, multi-entity discussions. A comprehensive list of the agreed-upon features that will be collected by Atlantic are listed on the following pages:

Roads / Rights of Way Features:

- Concrete
- Asphalt
- Chip and Seal
- Gravel
- Brick paver
- Cobblestone
- Alleys
- Athletic Track
- Hardcourt
- Shoulder
- Driveways
- Paved Parking Lots
- Non-Paved Parking
- Curbs
- Steps
- Trails
- Golf cart paths
- Road Medians / Islands
- Bridges
- Sidewalk (Private / Public)

Airport Runways / Aprons:

- Airport Runway / Airfield
- Taxiway
- Runway Taxi Lights
- Runway Taxiway Signage
- Helipad

Buildings:

- Buildings > 5 meters per side
- Buildings < 5 meters per side
- Buildings / Courtyards
- Ruins
- Decks > 100 sq. ft.
- Patios > 100 sq. ft.
- Canopies > 100 sq. ft.
- Above-Ground Tanks
- Propane Tanks
- Silos
- Bunkers
- Foundations
- Smokestacks

- Water Towers
- Pools (Below Ground)
- Tanks
- Stairways
- Building Heights
- Windmills

Street Hardware:

- Large Overhead Signs
- Billboards
- Bus Stop Shelters

Landmarks:

- Golf Course Outlines
- Public Playgrounds
- Public Parks
- Athletic Fields
- Tennis Courts
- Cemeteries
- Open Storage

Barriers:

- Guard Rails

Utilities:

- Electric Transmission Towers
- Landfills

Railroads / Trolley Lines:

- Railroad Tracks
- Abandoned Tracks
- Crossings

Headwalls:

- Headwalls

Detention Basins:

- Dry Basin
- Wet Basin

Culverts:

- Notations Of Culverts Existing
- Culverts (<20’ long)
- Culverts (>20’ long)

Storm Water Inlets:

- Notations Of Storm Water Inlets Existing

Waterline:

- Artificial Path
- Canal or Ditch
- Connector
- Concrete Ditch
- Dam or Weir
- Earth Dam
- Piers
- Breakwaters

- Sea Wall
- Gaging Station
- Gate
- Levee
- Nonearthed Shore
- Pipeline
- Shoreline
- Sink or Rise
- Spring or Seep
- Stream or River
- Stream or River-Intermittent
- Streams or Creeks
- Restoration Ponds
- Tunnel
- Pond
- Reservoirs
- Marshes Swamps
- Hidden Drains (For Connectivity)

Communication Tower / Antenna:

- Communication Tower/Antenna

MLGW-Only Features:

- Substation Fencing
- Substation Control House
- CNG Stations
- LNG Plant (2 large known exist, 1 active, 1 inactive)
- Regulator Stations (Above Ground)
- Regulator Station Vaults (Approx. 100-125 known)
- Gate Stations (8 large known sites)
- Odorant Tanks (within Gate Stations)
- North Shelby Landfill
- Rectifier Boxes (Metal cabinets on pole, will aim to collect if visible)

3.11 Database Design (Data Dictionary)

Along with the complete Planimetric Features listed in the previous section, Atlantic and Shelby County also agreed to establish a working Database Design (Data Dictionary) representing the new feature collection effort. Prior to the production of the Planimetric portion of the 2017 program, Atlantic will create and provide a geodatabase schema for the chosen features. Each item on the list will be explained, show a representative example, and provide a specific feature definition. This data dictionary will serve as a reference for all future Planimetric updating, as well as encompass the criteria used to create the dataset itself.

Section 4: Quality Assurance Plan

4.1 Overview

Atlantic is committed to developing and maintaining a quality system that maximizes both the efficiency of the firm itself, but most importantly, compliance with the quality standards required by Shelby County. In order to do this, Atlantic's overall Quality approach and methodology is based on proven, successful project design parameters. In addition, effort is taken to ensure that data accuracy, quality and content meet or exceed the needs required by Shelby County's end users and stakeholders for 2017 and years to come. These goals are monitored through the implementation of comprehensive Quality Control which is administered and adhered to throughout the life of the Atlantic partnership with Shelby County.

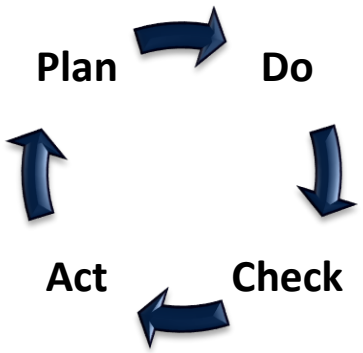
4.2 Quality Control And Acceptance Procedures

The main emphasis of the Atlantic Quality approach is on problem prevention rather than dependence on detection after occurrence. Every effort is made to perform operations and quality-related activities correctly the first time. This includes a formal review of the parameters affecting product quality from initial design to contractual fulfillment of responsibility for quality. Whenever necessary, corrective and preventive actions are effectively implemented at the proper level to ensure continuous improvement.

The Quality approach is to achieve a 100% 'first-time acceptance' of all deliverables provided. Quality Control checks throughout each phase of the production process help to execute this approach. All data produced during the 2017 Shelby County program will undergo an independent review prior to the final delivery, and ultimately, the acceptance, of the program deliverables.

Atlantic subscribes to the Plan, Do, Check, Act principles of Quality Management, as described below:

1. Establish a comprehensive Quality Management Plan for each project that includes specific data definitions, rules, and a comprehensive deliverables checklist. (These project-specific criteria are broken down in the above sections for each deliverable phase).
2. Execute the work according to the plan.
3. Check the work produced to determine if it is consistent with the plan.
4. Modify the work and update the plan if necessary.



Atlantic's Approach to
Process Improvement and Quality Results

This continuous cycle ensures that feedback is at the core of the Quality process. Additionally, it ensures that the process is continually evolving to allow for the most efficient tools and processes to be incorporated when they are fully evaluated and established.

Quality assurance is recognized as being the responsibility of all Atlantic team members. However, a structured leadership and responsibility chain of command has been established which clearly defines the roles and responsibilities of the key individuals involved with the project. The project manager is responsible for ensuring that the Quality plan is implemented and followed by the individual task leaders. Secondly, he ensures that those quality inspections and reports are being conducted, prepared and delivered in accordance with the plan.

In order to ensure awareness of what each Atlantic team member is responsible for achieving, specific quality control procedures are documented, controlled, and maintained for each individual task order. All Atlantic technicians are responsible for following applicable policies, procedures, and work instructions. Each employee has the responsibility and authority to:

- Initiate action to prevent the occurrence of nonconformance relating to product, process, and the quality system.
- Identify and record any problems relating to the product, process, and the quality system.
- Initiate, recommend, or provide solutions through designated channels.
- Control further processing and delivery of nonconforming product until the deficiency has been corrected.

An example of technical staff implementing the above-stated plan is by performing peer quality checks. These measures encourage accountability, interactive analysis, and an open-forum environment focusing on quality. Striving to continually improve client products and services through training, management involvement, and technical improvements is key. Atlantic technicians continuously analyze and set quality objectives through each project's life cycle. This constant evaluation and feedback process ensures that consistent, high-quality dataset will be developed for the 2017 Shelby County program.

Section 5: Deliverables

5.1 Overview

Atlantic has established a strategic, organized game plan for providing Shelby County with regular deliverable products throughout the life of the 2017 project effort. This plan is outlined chronologically on the pages that follow.

5.2 Project Initiation Phase

With the receipt of the official signed contract on January 5, 2017 – Atlantic initiated the first step and deliverable items for the 2017 Shelby County program. This included the pre-acquisition planning and mobilization, management, and reporting. Immediately thereafter, Atlantic finalized the aerial LiDAR and Imagery flight plans, ground survey plans, and project management plan. These are all provided to Shelby County as soon as they are completed.

During the months of January and February, these aerial flight plans will completely executed, with daily status reports provided for any day of field activity. Once the aerial acquisitions are completed, the first major data deliverable will occur. Atlantic will provide Shelby County with Level 1 (L1) preliminary, georeferenced, unedited imagery. L1 imagery provides a complete overview of the countywide imagery for preliminary analysis both internally and externally. The Orthophoto processing and production follows this deliverable. The Level 1 Imagery deliverable will be provided approximately 2 months post-acquisition, and no later than April 15, 2017.

5.3 Pilot Phase

Approximately 3 months after the completion of both the LiDAR and Imagery acquisitions, Shelby County will be provided with a full deliverable Pilot sample. Shelby County previously identified two locations that they elected to be "pilot AOI's". For these two locations, all products will be created and delivered, including LiDAR LAS files, Orthophotography TIFF images, 1-foot Contours, and Planimetric features. Once Shelby County has had the necessary time to review the pilot deliverables (projected no later than 2-3 weeks after receipt), a pilot review meeting will be held to discuss the products, gather feedback and recommendations, and ensure consensus satisfaction of the eventual end products.

5.4 In-Process Deliverables

Coinciding with the Pilot phase, Atlantic and Shelby County agreed to implement monthly 'Proof Of Performance' (POP) data deliveries each month during the main portions of the production. This POP data will vary month-to-month as different portions of the production occur. The first POP delivery will occur on July 1, 2017 and proceed each month until portions of final products are completed and ready for delivery, beginning on October 1, 2017. Like the pilot, this will give Shelby County the opportunity to review data in-process in order to keep the review of the deliverables from being heavily weighted on the back end of the project.

5.5 Orthophoto Product Deliveries

In general, the Orthophoto portion of the production will be performed in four block phases. As each Orthophoto deliverable block passes final internal Quality Control, it will be delivered to Shelby County. This will not be considered an interim product, rather a usable, distributable end product.

- Block 1 of the Orthophotography is schedule to be delivered to Shelby County on October 1, 2017.
- Block 2 will be provided on November 1, 2017.
- Block 3 is scheduled for delivery on November 15, 2017.
- Block 4 Orthos will be provided on December 15, 2017.

5.6 LiDAR Product Deliveries

Unlike the Orthophotography deliverables, the LiDAR portion of the Shelby County program will not be produced and delivered in an incremental block format. Once the full countywide LiDAR dataset is acquired, calibrated, classified, and Quality Control approved, it will be delivered to Shelby County for use and distribution. This final delivery is schedule to occur no later than November 15, 2017. The LiDAR-derived 1-foot Contour product will follow one month later (not to exceed December 15, 2017).

5.7 Planimetric Product Deliveries

Similar to the Orthophotography portion of the 2017 program, the Planimetric deliverables will be produced and subsequently provided in 4 deliverable blocks. Likewise, the delivered blocks are considered internally-approved final products.

- Block 1 of the Planimetric features is scheduled to be delivered on November 1, 2017.
- Block 2 will be provided on November 15, 2017.
- Block 3 is scheduled for delivery on December 15, 2017.
- Block 4 Planimetrics will be provided on January 15, 2018 (along with the MLGW-specific Planimetric add-ons found in the previously mentioned feature list).

Section 6: Invoicing Procedures

6.1 Overview Of Invoicing Schedule

As outlined in the Atlantic-Shelby County contract agreement, the 2017 program will follow a pre-set deliverables and invoicing plan. The invoicing schedule notes the intended delivery date, deliverable items to be received, the contracted dollar amount attributed to each item, retainage that will be withheld for particular deliverables, the timeframe expected for each, and what percentage of the overall program it entails. Retainage that is withheld will be paid 30 days after final client approval of each deliverable. The invoicing schedule plan is outlined chronologically in detail below, by program phase.

6.2 Pre-Acquisition Phase

Approx. Delivery Date	Deliverable Item	Contracted Dollar Amount	*Retainage*	Retainage Value	Timeframe For Completion/Delivery	Project Percentage
01/01/2017	Post-Contract Signing Pre-Acquisition Planning, Management, Mobilization, Reporting	$197,865.31	*0.0%*	$ -	Month of contract signing / Project initiated	20.00%
02/01/2017	The Project Plan and Procedures Manual	$ 49,466.33	*0.0%*	$ -	Delivery of Project Management Plan & Procedures Manual	25.00%

Prior to Atlantic executing the aerial data acquisition, Shelby County will receive two invoices related to post-contract signing planning, and program management. The first invoice was sent upon contract signing, with payment received by Atlantic on January 24, 2017. The second invoice will be sent on approximately February 1, 2017 and coincide with the delivery of the Project Management Plan And Procedures Manual.

6.3 Aerial Acquisition Phase

Approximate Delivery Date	Deliverable Item	Contracted Dollar Amount	*Retainage*	Retainage Value	Timeframe For Completion/Delivery	Project Percentage
03/01/2017	LiDAR Acquisition	$ 86,504.72	*10.0%*	$ 8,650.47	January-February 2017	33.74%
04/01/2017	3-Inch Imagery Acquisition	$134,045.48	*10.0%*	$ 13,404.55	February-March 2017	47.29%

The Shelby County program has two invoicing amounts related specifically to the aerial acquisition phases of the 2017 program. All acquisition-related invoicing will have 10% retainage withheld from each respective amount until project completion and approval.

6.4 Preliminary Deliverables Phase

Approximate Delivery Date	Deliverable Item	Contracted Dollar Amount	*Retainage*	Retainage Value	Timeframe For Completion/Delivery	Project Percentage
05/01/2017	Level 1 (L1) Preliminary Geo-referenced unedited Imagery	$ 49,466.33	*10.0%*	$4,946.63	Projected no later than 2-months post-acquisition	52.29%
06/15/2017	Full Deliverable Pilot Sample	$165,607.59	*0.0%*	$-	Projected no later than 3-months post-acquisition	69.03%

The Shelby County program has two invoicing amounts related specifically to the delivery of post-acquisition preliminary data. The first pertains to the delivery of the Level 1 imagery. The second relates to the delivery of the full Pilot sample. The Level 1 invoicing will have 10% retainage withheld until the project completion and approval.

6.5 Proof Of Performance Phase

Approximate Delivery Date	Deliverable Item	Contracted Dollar Amount	*Retainage*	Retainage Value	Timeframe For Completion/Delivery	Project Percentage
07/01/2017	Monthly 'Proof of Performance' Data Deliveries	$ 9,893.27	*0.0%*	*$ -*	At the end of each month following Pilot Delivery, until final product delivery	70.03%
08/01/2017		$ 9,893.27	*0.0%*			71.03%
09/01/2017		$ 9,893.27	*0.0%*			72.03%
10/01/2017		$ 9,893.27	*0.0%*			73.03%
11/01/2017		$ 9,893.27	*0.0%*			75.16%

The Shelby County program has invoicing amounts related specifically coinciding with each month of the Proof of Performance phase. This occurs between the Pilot delivery phase and the final delivery blocks. No retainage will be withheld from invoicing relating to these phases delivery.

6.6 Ortho Deliverables Phase

Approximate Delivery Date	Deliverable Item	Contracted Dollar Amount	*Retainage*	Retainage Value	Project Percentage
10/01/2017	Block 1 - 3" Orthos	$ 11,170.46	*10.0%*	$ 1,117.05	74.16%
11/01/2017	Block 2 - 3" Orthos	$ 11,170.46	*10.0%*	$ 1,117.05	76.29%
11/15/2017	Block 3 - 3" Orthos	$ 11,170.45	*10.0%*	$ 1,117.05	84.14%
12/15/2017	Block 4 - 3" Orthos	$ 11,170.45	*10.0%*	$ 1,117.05	92.05%

The Shelby County program has four invoicing amounts related specifically to the delivery of the 4 blocks of Orthophotos. These block deliveries begin October 1, 2017 and occur through mid-December, 2017. Each invoice relating to the Ortho Deliverables will have 10% retainage withheld until the project completion and approval.

6.7 LiDAR & Contour Deliverables Phase

Approximate Delivery Date	Deliverable Item	Contracted Dollar Amount	*Retainage*	Retainage Value	Timeframe For Completion/Delivery	Project Percentage
11/15/2017	LiDAR Final Deliverables	$ 28,834.91	*10.0%*	$ 2,883.49	Projected no later than 9-months post-acquisition	83.01%
12/15/2017	LiDAR Derivative: 1-Foot Contours	$ 29,457.78	*10.0%*	$ 2,945.78	Projected no later than 10-months post-acquisition	90.92%

The Shelby County program has two invoicing amounts related specifically to the delivery of the LiDAR and Contours. The final LiDAR delivery is scheduled to occur no later then 9-months post-acquisition. The Contour delivery is projected to occur one month after the LiDAR delivery. All invoicing related to the LiDAR and Contour products will have 10% retainage withheld until the project completion and approval.

6.8 Planimetrics Deliverables Phase

Approximate Delivery Date	Deliverable Item	Contracted Dollar Amount	*Retainage*	Retainage Value	Project Percentage
11/01/2017	Block 1 Planimetrics	$ 37,639.62	*10.0%*	$ 3,763.96	80.10%
11/15/2017	Block 2 Planimetrics	$ 37,639.62	*10.0%*	$ 3,763.96	87.94%
12/15/2017	Block 3 Planimetrics	$ 37,639.62	*10.0%*	$ 3,763.96	95.85%
01/15/2018	Block 4 Planimetrics	$ 37,639.62	*10.0%*	$ 3,763.96	99.66%
01/15/2018	MLGW Plan Collection Add-Ons	$ 3,371.49	*10.0%*	$ 337.15	100.00%

The Shelby County program has 5 invoicing amounts related specifically to the block deliveries of the Planimetric Feature collection. These incremental deliveries are scheduled to occur between November 1, 2017 and January 15, 2018. All invoicing relating to the Planimetrics will have 10% retainage withheld until the approval of all of the program's deliverables.